APRIL · 1955
PRICE 75 CENTS

electronics

A McGRAW-HILL PUBLICATION

Testing Silicon Junction Power Rectifiers

25 YEARS OF electronics

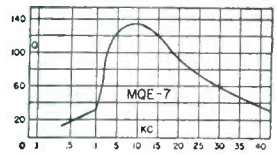
LARGEST PRODUCERS IN THIS FIELD FOR TWO DECADES...

HIGH Q INDUCTORS
FOR EVERY APPLICATION

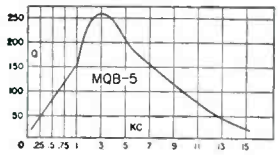
FROM STOCK... ITEMS BELOW AND 650 OTHERS IN OUR CATALOGUE B.

MQ Series Compact Hermetic Toroid Inductors

The MQ permalloy dust toroids combine the highest Q in their class with minimum size. Stability is excellent under varying voltage, temperature, frequency and vibration conditions. High permeability case plus uniform winding affords shielding of approximately 80 db.

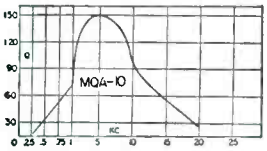


MQE
15 stock values
from 7 Mhy.
to 2.8 Hy.



MQB
12 stock values
from 10 Mhy.
to 25 Hy.

MQA
19 stock values
from 7 Mhy.
to 22 Hy.

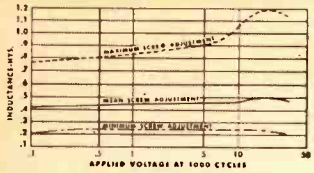


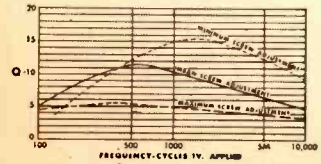
MQ drawn case structure.

	Length	Width	Height
MQE	1/2	1-1/16	1-7/32
MQA	11/16	1-9/32	1-23/32
MQB	1-5/16	2-9/16	2-13/16

VIC case structure

Length	Width	Height
1-1/4	1-11/32	1-7/16





Type	Mean Hys.	Type	Mean Hys.
VIC-1	.0085	VIC-12	1.3
VIC-2	.013	VIC-13	2.2
VIC-3	.021	VIC-14	3.4
VIC-4	.034	VIC-15	5.4
VIC-5	.053	VIC-16	8.5
VIC-6	.084	VIC-17	13.
VIC-7	.13	VIC-18	21.
VIC-8	.21	VIC-19	33.
VIC-9	.34	VIC-20	52.
VIC-10	.54	VIC-21	83.
VIC-11	.85	VIC-22	130.

VIC Variable Inductors

The VIC Inductors have represented an ideal solution to the problem of tuned audio circuits. A set screw in the side of the case permits adjustment of the inductance from +85% to −45% of the mean value. Setting is positive.

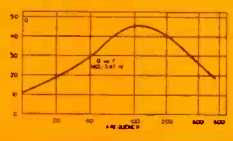
Curves shown indicate effective Q and L with varying frequency and applied AC voltage.

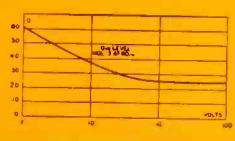
MQL Low Frequency High Q Coils

The MQL series of high Q coils employ special laminated Hipermalloy cores to provide very high Q at low frequencies with exceptional stability for changes of voltage, frequency, and temperature. Two identical windings permit series, parallel, or transformer type connections.

MQL-1	2.5/10 Hys.
MQL-2	5/20 Hys.
MQL-3	50/200 Hys.
MQL-4	100/400 Hys.

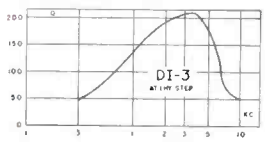
MQL case
1-13/16 dia. X 2-1/2" H.





DI Inductance Decades

These decades set new standards of Q, stability, frequency range and convenience. Inductance values laboratory adjusted to better than 1%. Units housed in a compact die cast case with sloping panel ideal for laboratory use.



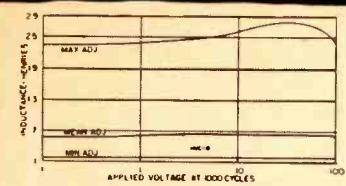
DI-1	Ten 10 Mhy. steps.
DI-2	Ten 100 Mhy. steps.
DI-3	Ten 1 Hy. steps.
DI-4	Ten 10 Hy. steps.

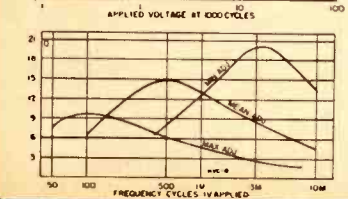
DI DECADE

Length	4½"
Width	4⅜"
Height	2⅜"

HVC Hermetic Variable Inductors

A step forward from our long established VIC series. Hermetically sealed to MIL-T-27 . . . extremely compact . . . wider inductance range . . . higher Q . . . lower and higher frequencies . . . superior voltage and temperature stability.





Type No.	Min. Hys.	Mean Hys.	Max. Hys.
HVC-1	.002	.006	.02
HVC-2	.005	.015	.05
HVC-3	.011	.040	.11
HVC-4	.03	.1	.3
HVC-5	.07	.25	.7
HVC-6	.2	.6	2
HVC-7	.5	1.5	5
HVC-8	1.1	4.0	11
HVC-9	3.0	10	30
HVC-10	7.0	25	70
HVC-11	20	60	200
HVC-12	50	150	500

HVC case structure.

Width	Length	Height
25/32	1-1/8	1-7/32

SPECIAL UNITS TO YOUR NEEDS
Send your specifications for prices.

UNITED TRANSFORMER CO.

150 Varick Street, New York 13, N. Y. EXPORT DIVISION: 13 E. 40th St., New York 16, N. Y. CABLES: "ARLAB"

electronics

A McGRAW-HILL PUBLICATION

APRIL • 1955

TESTING SILICON JUNCTION POWER RECTIFIERS—Special test circuits reduce dissipated power of large-area silicon rectifiers at production and life test positions. The single-cell Transitron units operate at 115 volts with capacitance loads at ambient temperatures up to 200 degrees. See page 146. Photo by Paul Davis ..... COVER

CONTINUED ON NEXT PAGE

contents

continued

SHOP

FLAGGING THE READER—Scanning of articles when an issue is received takes time, and modern living and employment leave but short intervals to quickly absorb the salient points of a technical article in ELECTRONICS. We know that it will be studied later, perhaps on the job, but part of our function is to show all our wares quickly, so you can choose those that help you most, the soonest.

Many research projects have compiled data and analyzed eye movements under certain visual conditions, such as when confronted by a page of type, patterns, pictures or whatever. To catch your eye and more quickly inform you as to content of an article, we are experimenting with type in a summary at the beginning of articles in this issue. It should, backed up by the nearby illustrations, tell you immediately what the article is about.

In keeping with the tenets of modern typography we have long used a display two-line initial letter to start all articles. To point up the word "summary" we might have used a summation sign, Σ, but the integral sign $\int$ suggests summation, appropriately, and we hope it helps direct the eye to the summary.

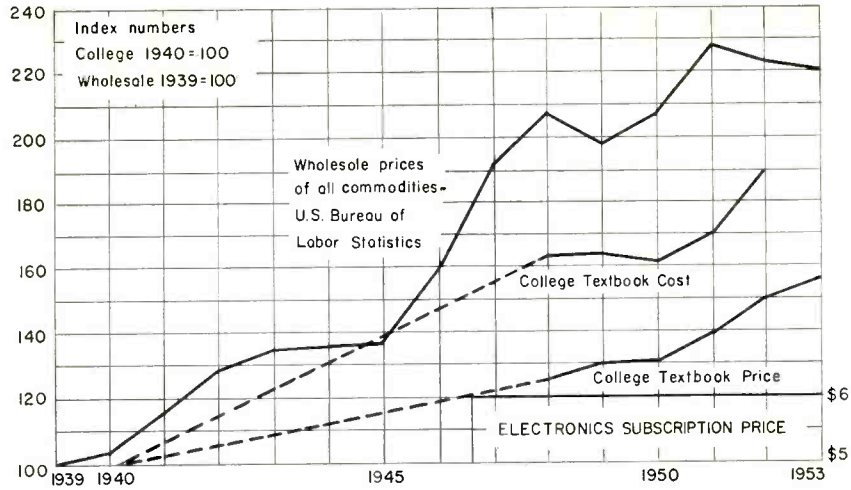
RECOGNITION—Impressed by the growth of the electronics industry, yet also aware that many people in older fields do not yet admit that electronics is an industry, it was with a feeling of satisfaction that we prepared the material for the opening article this month, "25

electronics

APRIL, 1955 Vol. 28, No. 4

Member ABC and ABP

TALK



ELECTRONICS domestic subscription price for one year rose 20 percent in 1946, hasn't followed rising costs since then. 1,717 editorial pages published in 12 regular issues of 1954 cost the reader $0.0035 per page

Years of Electronics".

The industry has certainly arrived, to say the least. That not everyone recognizes this fact, however, is apparent when assembling statistics from various sources. For example, a reader inquired recently about an item in November, 1954 that described how manufacturers use engineers. The accompanying bar graph showed that electronics had the second highest number of engineers per 1,000 employees.

The reader's problem was that he was unable to remember the source. We don't blame him. The article was based on figures buried in a study by the Bureau of Labor Statistics, Division of Manpower and Employment Statistics, entitled "Engineering Personnel Employed in Metalworking Industries". Hi, fellow metalworker.

MOBILE TRAIL AHEAD—During last year's vacation, in his tarpaper New Hampshire camp, associate editor Alex McKenzie turned out a piece on the use of mobile radio communications for another McGraw-Hill magazine.

Having discovered an expert, ELECTRONICS proceeded to exploit him with the result that a forthcoming issue will contain an article entitled, "Getting The Most Out Of Mobile Radio". It covers some of the economics as well as new circuitry in this important and growing field.

Aside from the usual long-distance telephone calls, telegrams, airmail specials, luncheons, conferences and all the other routine of technical writing, Alex tells us that he lost two sources en route—men were transferred to other jobs. At one time, a final conference took place on the night shift!

As a byproduct of this activity we are printing next month a story on a new system of selective calling for two-way radio.

COST ANALYSIS—College textbook prices have increased sharply since 1939, on the average an even 50 percent by 1953. But book production costs have increased 90 percent.

Labor cost has almost doubled in the past ten years. Paper has gone up 54 percent, binder's cloth 75 percent, binder's board 58 percent, and even the gold leaf for stamping covers has gone up 56 percent. The result is the book that cost $1.00 a copy to produce in 1942 costs approximately $1.75 today.

The accompanying chart shows this relationship between cost and prices and compares it with the U. S. Bureau of Labor Statistics index of wholesale prices.

A textbook that sold in the early 40's for roughly a cent a page is priced today at 1.5 to 2 cents per page.

OLD TUBES NEVER DIE—Or rather old types of tubes never do. While doing some research this month it struck us that a number of specialized test equipments made today employ types that were introduced in the 1930's. Such as the 75, 38 and 955. The big advantage of the first two is the fact that the grid lead comes out the top of the glass envelope and thus provides a long leakage path.

ONOMATOPOETIC TITLE—One article last month (Testing Airborne Electronics Components, p 181) discusses environmental testing of electronic components at high sound intensities.

The authors tell us that their colleagues at Armour Research Labs have a pet name for the equipment. It's the "Screaming Meemie".

Published monthly with an additional issue in June by McGraw-Hill Publishing Company, Inc., James H. McGraw (1860-1948), Founder. **Executive, Editorial and Advertising Offices: McGraw-Hill Building, 330 W. 42 St., New York 36, N. Y.,** Longacre 4-3000. Publication Office, 99-129 North Broadway, Albany 1, N. Y. Donald C. McGraw, President; Paul Montgomery, Executive Vice-President; Joseph A. Gerardi, Vice-President and Treasurer; John J. Cooke, Secretary; Nelson Bond, Executive Vice-President, Publications Division; Ralph B. Smith, Vice-President and Editorial Director; Joseph H. Allen, Director of Advertising; J. E. Blackburn, Jr., Vice-President and Director of Circulation.

Subscriptions: Address correspondence to Electronics—Subscription Service, 330 W. 42nd St., New York 36, N. Y. Allow one month for change of address. Subscriptions are solicited only from persons engaged in theory, research, design, production, maintenance and use of electronic and industrial control components, parts and end products. Position and company connection must be indicated on subscription orders.

Single copies 75¢ for United States and possessions, and Canada; $1.50 for Latin America; $2.00 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; $16.00 for two years. Other western hemisphere countries and the Philippines, $15.00 a year; $25.00 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, Ill.; 68 Post Street, San Francisco 4; McGraw-Hill House, London, E. C. 4; Washington, D. C. 4; Philadelphia 3; Cleveland 15; Detroit 26; St. Louis 8; Boston 16; 1321 Rhodes-Haverty Bldg., Atlanta 3, Ga.; 1111 Wilshire Blvd., Los Angeles 17; 738-9 Oliver Building, Pittsburgh 22. ELECTRONICS is indexed regularly in The Engineering Index.

Tubeless Magnetic Amplifier DC Supplies

Here are prices for the

Latest additions to the SORENSEN *line!*

Sorensen Tubeless Magnetic Amplifier DC Supplies are designed for applications where utmost reliability is required. The four instruments described below cover a wide range of requirements; additional instruments are under development and will shortly be added to the line.

MODEL MA640 (illustrated above)

Input	105-125 VAC, 1Ø, 60∿
Output	4.5 - 7.7 VDC, adjustable
Load Range	0-40 amperes
Ripple	1% maximum
Regulation Accuracy	±1.0% for any combination of line and load conditions
Recovery Time	0.2 seconds under worst conditions
Size	17" wide, 12¼" high, 15" deep. Can be furnished for relay rack mounting. Meters, as illustrated, optional at extra cost.

$355.00

MODEL MA65

Input	105-125 VAC, 1Ø, 60∿
Output	6 VDC, adjustable ±10%
Load Range	0-5 amperes
Ripple	1% maximum
Regulation Accuracy	±1.0% for any combination of line and load conditions
Recovery Time	0.15 seconds under worst conditions
Size	For relay rack mounting — 19" wide, 5¼" high, 12" deep. A cabinet is available for bench operation. This is an unmetered unit.

$165.00

SPECIAL UNITS

Sorensen is engaged in a heavy program of research and development leading to continuous expansion of its standard line of Magnetic Amplifier DC Supplies. It is accordingly in a favorable position to develop special magnetic amplifier supplies for use in computer systems or other products requiring the utmost in reliability. If you have special requirements along these lines you will benefit by taking advantage of Sorensen's experience in this power field. Write or call the Applications Engineering Department, and your problems will receive prompt attention.

MODEL MA2850

Input	190-230, 3Ø, 4-wire wye, 60∿
Output	23 - 32 VDC, adjustable
Load Range	0-50 amperes
Ripple	3% maximum
Regulation Accuracy	±1.0% for any combination of line and load conditions
Recovery Time	0.5 seconds under worst conditions
Size	16¾" wide, 28¾" high, 15" deep Unit is self contained and mounted on casters. Meters are standard with this unit.

$985.00

WRITE FOR MORE DATA

For further information about the Sorensen line of tubeless magnetic DC supplies, and for your copy of the latest Sorensen catalog, write Sorensen & Co., Inc., 375 Fairfield Ave., Stamford, Conn. In Europe, address inquiries to Sorensen A.G., Gartenstrasse 26, Zurich 2, Switzerland.

SORENSEN

375 FAIRFIELD AVENUE, STAMFORD, CONN.

The scientific approach to vibration measurement

The D-489 MUIRHEAD-PAMETRADA WAVE ANALYSER

WITH the Muirhead-Pametrada Wave Analyser the localization of obscure vibrations can be carried out systematically. Designed specifically for such measurements, this instrument covers a range of 19*-21,000c/s with a frequency accuracy of ±0.5% over most of the range. Its high selectivity enables component frequencies close to one another to be measured; the flat top of the tuning characteristic can be varied to simplify measurements of fluctuating frequencies; and the 1/3 octave filter characteristic enables predominant vibration components to be rapidly located. In almost every branch of engineering there is a use for this novel instrument.

FEATURES

Operates as a tuned band-pass filter — *not* on the heterodyne principle.

Frequency accuracy ± ½% over most of range.

High selectivity characteristic for greatest discrimination against adjacent frequencies.

1/3rd octave filter characteristic for noise measurement or rapid localization of principal vibration components.

Band-pass characteristic for measurements when frequency is fluctuating.

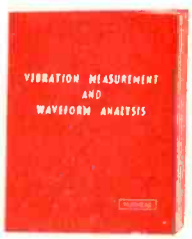
Output frequency is that of the selected component and is available for oscilloscope viewing.

**Additional unit extends useful range down to 2c/s.*

THIS BROCHURE

VIBRATION MEASUREMENT AND WAVEFORM ANALYSIS

FREE ON REQUEST



159

Try it for yourself

The wave analyser may have possibilities in your industry. For a demonstration at your plant, call Muirhead Instruments Inc. — MUrray Hill 8-1633

MUIRHEAD & CO. LIMITED · BECKENHAM · KENT · ENGLAND

Sales & Service, U.S.A.

MUIRHEAD INSTRUMENTS INC · 677 FIFTH AVENUE · NEW YORK 22 · N.Y.

FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RETMA)	Latest Month: Jan. '55	Previous Month: Dec. 54	Year Ago: Jan. '54
Television sets, total	654,582	833,423	420,571
With UHF	117,095	129,181	120,229
Color sets	nr	nr	.....
Radio sets, total	1,068,146	1,261,575	871,981
With F-M	16,568	22,055	24,341
Home sets	280,121	300,023	271,036
Clock radios	166,885	312,967	159,932
Portable sets	47,303	109,001	46,571
Auto sets	573,837	539,584	394,442

RECEIVER SALES

(Source: RETMA)	Jan. '55	Dec. 54	Jan. '54
Television sets, units	647,585	1,093,702	731,917
Radio sets (except auto)	474,947	1,158,588	310,623

RECEIVING TUBE SALES

(Source: RETMA)	Jan. '55	Dec. 54	Jan. '54
Receiv. tubes, total units	37,144,000	37,908,894	22,133,000
Receiv. tubes, value	$26,263,000	$27,391,398	$16,412,000
Picture tubes, total units	866,956	1,009,398	557,681
Picture tubes, value	$17,662,000	$20,521,562	$12,174,000

SEMICONDUCTOR SALES

	Dec. '54	Nov. '54	Dec. '53
Germanium diodes, units Silicon diodes, units	1,464,559	1,494,313	689,409

INDUSTRIAL TUBE SALES

Quarterly Figures

(Source: NEMA)	Latest Quarter: 3rd '54	Previous Quarter: 2nd '54	Year Ago: 1st '54
Vacuum (non-receiving)	$8,803,740	$8,971,335	$10,400,000
Gas or vapor	$3,570,586	$4,589,239	$3,300,000
Phototubes	nr	nr	$700,000
Magnetrons and velocity modulation tubes	$13,112,244	$16,135,274	$10,500,000
Gaps and T/R boxes	$1,476,407	$1,517,426	$1,700,000

TV SETS INSTALLED

(Source: NBC Research Dept.)	Latest Month: Jan. '55	Previous Month: Dec. 54	Year Ago: Jan. '54
Total sets	33,816,000	32,996,000	27,666,000

BROADCAST STATIONS

(Source: FCC)	Jan. '55	Dec. 54	Jan. '54
TV stations on air	443	439	369
TV stations CPs—not on air	130	137	197
TV stations—new requests	19	19	134
A-M stations on air	2,686	2,669	2,524
A-M stations CPs—not on air	101	105	120
A-M stations—new requests	174	172	165
F-M stations on air	545	552	555
F-M stations CPs—not on air	10	7	19
F-M stations—new requests	5	8	4

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	Dec. '54	Nov. '54	Dec. '53
Aeronautical	41,156	40,737	42,455
Marine	48,472	48,255	43,703
Police, fire, etc.	16,931	16,757	14,663
Industrial	22,874	22,742	19,797
Land transportation	7,206	7,127	6,470
Amateur	127,257	126,021	115,518
Citizens radio	9,336	9,116	5,439
Disaster	306	306	254
Experimental	643	636	506
Common carrier	1,782	1,771	1,430

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	Dec. '54	Nov. '54	Dec. '53
Prod. workers, comm. equip.	379,000-p	384,500-r	388,200
Av. wkly. earnings, comm.	$70.70 -p	$71.23 -r	$67.49
Av. wkly. earnings, radio	$69.49 -p	$69.26 -r	$67.03
Av. wkly. hours, comm.	40.4 -p	40.7 -r	39.7
Av. wkly. hours, radio	40.4 -p	40.5 -r	39.9

STOCK PRICE AVERAGES

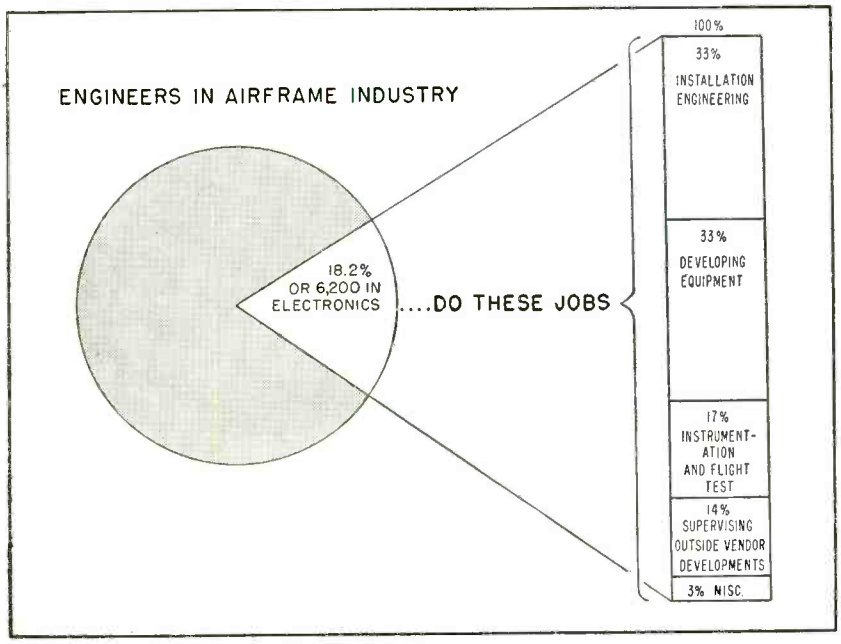
(Source: Standard and Poor's)	Feb. '55	Jan. '55	Feb. '54
Radio-tv & electronics	437.0	413.4	281.7
Radio broadcasters	496.8	463.7	284.8

p—provisional; r—revised
nr—not reported

FIGURES OF THE YEAR

	TOTALS FOR THE FIRST MONTH 1955	1954	Percent Change
Television set production	654,582	420,571	+55.6
Radio set production	1,068,146	871,981	+22.5
Television set sales	647,585	731,917	—11.5
Radio set sales (except auto)	474,947	310,623	+52.9
Receiving tube sales	37,144,000	22,133,000	+67.9
Cathode-ray tube sales	866,956	557,681	+55.5

INDUSTRY REPORT



Engineers Guide Missile Design

Airframe manufacturers handle more of their own electronic problems

GROWTH of electronics in the aircraft manufacturing business is indicated by the number of electronic engineers employed by such companies. As shown in the chart, nearly 20 percent, or 6,200 of all engineers employed by airframe manufacturers are in the electronics field. This number is expected to increase to over 11,000 by 1959. (ELECTRONICS, p 26, March, 1955).

▶ **Breakdown**—Over half of the airframe electronic engineers, 55 percent, are working on missiles; 43 percent work on piloted aircraft.

The specific duties performed by electronic engineers are indicated in the chart. For guided missiles, about 45 percent are engaged in developing equipment in company labs, but for piloted aircraft, the proportion is only 20 percent. While 47 percent of electronic engineers working on piloted aircraft, are engaged in installation engineering, only 20 percent are so engaged for guided missiles.

▶ **Companies**—The extent to which individual airframe manufacturers are in electronic activities is indicated by the number of electronic engineers employed compared to total engineering staffs. In Fairchild's guided-missile division 60 percent of the engineers are working in electronics. At Bell Aircraft, 41 percent of engineers are so engaged and 34 percent of Northrup engineers.

For the airframe manufacturers surveyed, the percentage ranged from 3 percent of the total engineering staff up to 60 percent. Over half of the companies had less than 15 percent of their engineers engaged in electronics work. The remainder had more than 20 percent.

Military Will Probe Spurious Radiations

Both government and industry are increasing efforts to reduce jamming hazards

INCREASING use of the radio spectrum has aggravated the problem of interference. Both government and industry have stepped up programs to reduce spurious radiations.

▶ **Research**—A contract sponsored jointly by the Air Force, Army and Navy has been awarded to Armour Research Foundation to evaluate the effectiveness of the radio interference program of the armed forces. The investigation includes all forms of radio interference, from very low communication frequencies through the microwave spectrum. Data are obtained through field surveys at industrial organizations and military operational activities.

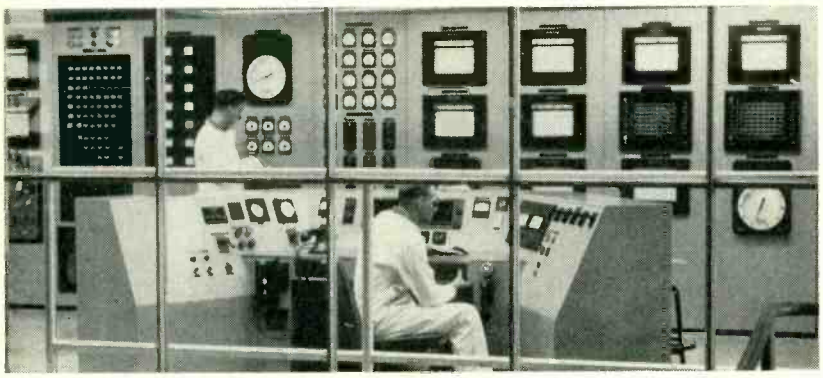
Results of the study will be used to provide recommendations for a long-range program of research and development and to furnish guidance on measures which can be effected immediately to improve field operation and maintenance.

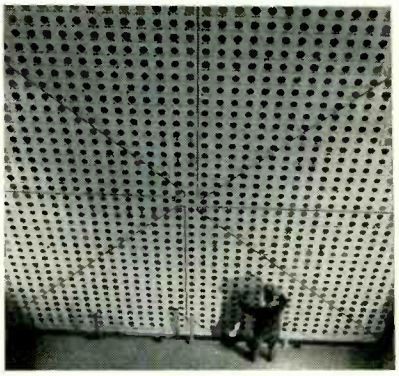
▶ **Cost**—Interference control has become a significant part of the defense program. John W. Klotz of the Department of Defense, in an address before the symposium on radio interference reduction at Illinois Institute of Technology, pointed out that every area of equipment development has become involved in some phase of the interference problem to insure that the equipment will operate effectively in the field. He said that the Department of Defense estimates its annual support of the interfer-

ence control program to be in excess of $200 million.

Last year one radar equipment required a $2-million program of interference control to make it operate properly in its equipment environments. The control program extends to fields such as power generators, x-ray machines, lighting fixtures, office machines etc.

▶**Air**—One model of ARC-27, 225 to 400-mc command communications equipment installed in many U. S. aircraft has been known to radiate harmonics of its fundamental frequency. On some frequency settings, these spurious radiations have interfered with the radio altimeters operating at 440 mc, rendering them useless or causing them to read erroneously. The ARC-27 has on occasion triggered indicator lights on the instrument panel, erroneously indicating that the aircraft has flown over a 75-mc marker beacon.





TUBES take over in reactor control rooms to regulate the nation's growing atomic production as . . .

Electronics Firms Plan To Cash In On Nuclear Power

Growing importance of atomic energy is increasing sales of electronic equipment

ATOMIC energy program which has gained in 15 years net assets of approximately $7 billion has swelled the business volume of the electronics industry. Somewhere between 5 to 15 percent of this expenditure has been for electronic equipment. In the nuclear instrument field alone, the volume of business done by electronics manufacturers has already reached an annual rate of over $25 million. It is estimated that in five years the yearly volume of this business will reach $50 million.

▶**Research**—In addition to increasing the volume of radiation instruments production, the nuclear field is fostering a substantial amount of research and development on radiation instrumentation. Current AEC unclassified research contracts on radiation instrumentation include contracts with DuMont and RCA on multiplier phototube development.

In addition there are contracts with the National Bureau of Standards for research on a radiation monitoring telemetering system and a basic instrumentation program. Three educational institutions have radiation instrumentation research contracts. New York University is doing research investigation of certain physical and chemical dosimetric techniques while Notre Dame is conducting fundamental research on photomission. St. Procopius College is researching special problems in nuclear instrumentation.

The Naval Research Lab has a research contract for work on dosimetry systems employing radiation sensitive solids and New England Center Hospital is working on small G-M and proportional counters for medical research.

▶**Design**—This month, 29 electronic equipment and parts manufacturers, in cooperation with RETMA and the Federal Civil Defense Agency, will participate in an atomic blast to aid the industry and Civil Defense in determining and evaluating the effects of a nuclear explosion on civilian communications equipment.

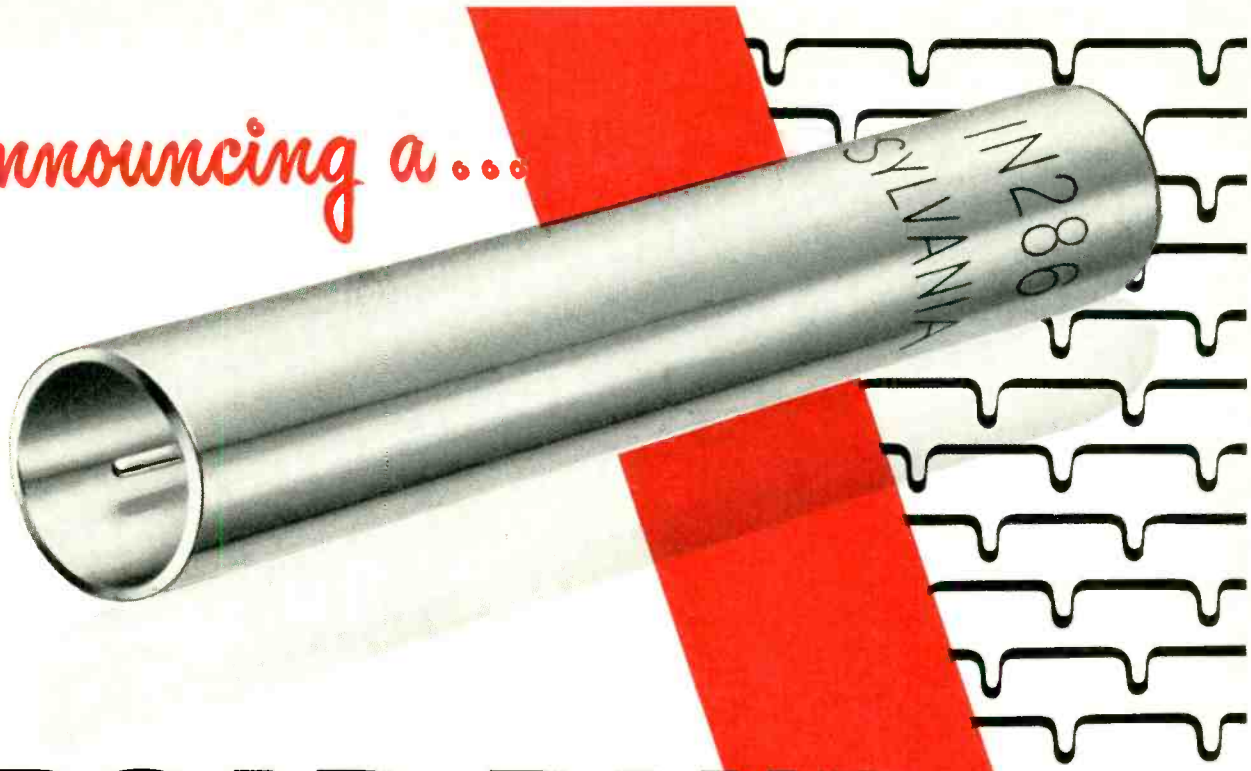
Firms will supply equipment and parts to be exposed to a nuclear detonation test so that data may be gathered to give indications of the kinds of post-disaster repair problems that will face communications personnel.

▶**Reactors**—Indication of the amount of business that the electronics industry is gaining from the reactor field is indicated by the fact that specifications for a 15-megawatt reactor suitable for driving a steam power plant provide an allowance of $85,550 for electronic instrumentation. This amounts to over 3 percent of the total $2.5-million estimate for the complete nuclear power package with building, as planned by Ford Instrument Co.

The itemized list given covers only the units used on the pressurized water-cooled and moderated reactor and on the primary coolant loop which transfers heat to the steam-generating section. The remainder of the plant is the same as

(Continued on page 10)

Announcing a . . .



BROAD-BAND MIXER CRYSTAL

TYPE IN286 covering the frequencies from 10,000 to 22,000 mc

Its broad-band characteristics make the new Sylvania Type IN286 especially useful in tunable radar systems and counter-measure devices. The IN286 is a coaxial, point-contact silicon crystal diode designed for use as a mixer in the frequency range from 10,000 to 22,000 mc.

RF IMPEDANCE

The RF impedance of the IN286 is designed to match a 65-ohm load over its entire frequency range.

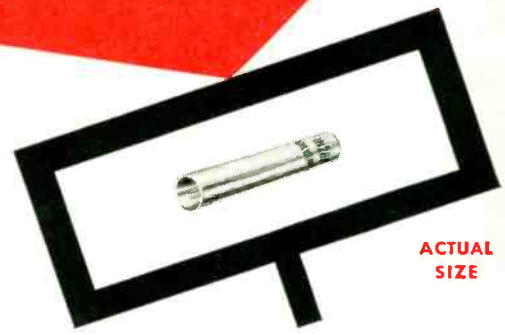
CRYSTAL HOLDERS

A variety of crystal holders may be used with the IN286

—standard X, K_u, K-band waveguide holders to cover appropriate segments of the band.

—WR-51 waveguide holder to cover the range from 15,000 to 22,000 mc.

—WR-75 waveguide holder to cover the frequency range from 10,000 to 15,000 mc.



ACTUAL SIZE

SPECIFICATIONS

Conversion Loss	8.5 db max.
Output Noise	2.5 times max.
IF Impedance	250—450 ohms
RF Impedance	3.0 VSWR max.
Burnout	each crystal subjected to 20 mw (cw) at 10,000 mc.

For complete details write to Department D20R.

"ANOTHER REASON WHY IT PAYS TO SPECIFY SYLVANIA"

SYLVANIA

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd., University Tower Bldg., St. Catherine Street, Montreal, P. Q.

LIGHTING · RADIO · ELECTRONICS · TELEVISION · ATOMIC ENERGY

any other steam plant. Figures are for a small plant typical of those under construction or planned.

Reactor Control and Safety Equipment

2 Fission Chambers (neutron detectors)	$ 900
2 A-1D D-C Preamplifiers	300
2 A-1 D-C Amplifiers	1,000
2 Log Count Rate Meters	1,100
1 Log Count Rate Recorder	800
2 Compensated Ion Chambers (neutron detectors)	3,500
2 Logarithmic Neutron Flux Density Amplifiers	1,500
2 Compensated Ion Chamber Power Supplies	1,000
2 Period Amplifiers (neutron flux rate change indicators)	1,100
2 Sigma Amplifiers (neutron flux peak alarms)	1,700
3 Magnet Amplifiers (to drive magnetic clutches of safety control rod system)	2,500
1 Logarithmic Neutron Flux Recorder	800
1 Period Recorder (neutron flux)	800
3 Parallel Circular-Plate Ion Chambers	4,500
3 Combined Safety Amplifiers (Sigma and Magnet)	3,600
1 Decade Scaler	500
1 2,000-VA Constant-Voltage Transformer	250

Fixed and Portable Radiation-Monitoring Equipment

1 Five-Channel Beta and Gamma Waste Monitor	2,500
1 Five-Point Waste Monitor Recorder	1,200
1 Twelve-Channel Beta and Gamma Area Monitor	2,800
1 Twelve-Point Area Monitor Recorder	1,200
2 Rudolphs (fast neutron detectors)	1,300
3 Cutie Pies (portable gamma-ray monitors)	900
2 Beta-Gamma Survey Meters	500
2 Slow Neutron Survey Meters	1,200

Primary Heat Exchanger Loop Equipment

1 Primary Coolant Outlet Temperature Indicator-Recorder-Controller	1,500
1 Primary Coolant Inlet and Outlet Temperature Indicator-Recorder	1,500
1 Reactor Coolant Temperature Differential Indicator-Recorder	1,600
1 Primary Coolant Flow Indicator-Recorder	3,000
1 Pressurizer Water-Level Indicator-Recorder-Controller	1,900
1 Pressurizer Pressure-Indicator-Recorder-Controller	1,800
1 Demineralized Water Storage Tank Level Indicator-Recorder	1,900
1 Demineralized Water Flow Indicator-Recorder-Integrator	1,700
1 Primary Coolant Conductivity Indicator-Recorder	1,600
1 Makeup Water Conductivity Indicator-Recorder	1,600
1 Reactor Rod Seal Water Leakage Indicator-Recorder	1,300
1 Makeup Water Storage Tank Level Indicator-Recorder	1,700

Installation

Fabrication, Wiring and Testing of Main Panelboard and Installation of Elements	24,000
Fabrication, Wiring and Testing of Desk-Type Control Console	3,000
Total	$85,550

DEW Line Radar To Cost One Billion

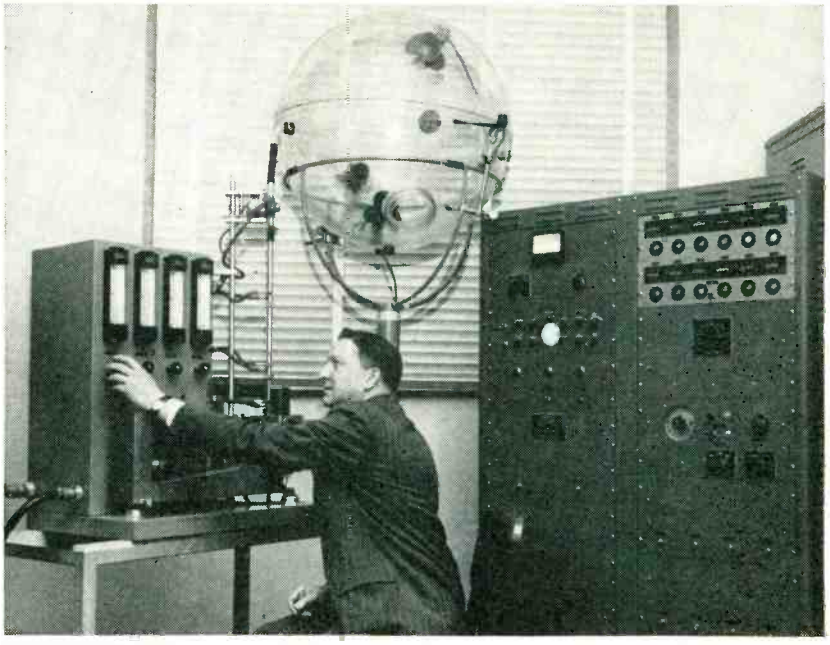
CONSTRUCTION of the Distant Early Warning (DEW) line of radar stations across northern Canada is under way. Western Electric, contractor for the pilot project on Barter Island, Alaska, (ELECTRONICS, p 8, Nov. 1953) is prime contractor. Cost of the line may approach $1 billion.

In November, 1954, the governments of the U. S. and Canada decided jointly to extend this line across the northern edge of the continent. Responsibility for construction and installation is vested in the U. S.

▶**Contracts**—Several subcontractors, including Canadian companies, will participate in construction and equipment manufacturing. Western Electric is in the process of letting subcontracts for some of the electronic equipment.

A project office has been set up in New York. This office is composed of representatives from the Air Research and Development Command, Air Materiel Command, Continental Air Defense Command, Royal Canadian Air Force, The Canadian Department of Defense production and Western Electric.

▶**Line**—The DEW line radar net- automatically sounds an alarm whenever aircraft approach. The equipment was inspired by radar for the Mid-Canada line.



AEROSOLOSCOPE uses multiplier phototube to count airborne particles at the rate of 100 per second while . . .

Phototube Sales Keep Growing

New applications of the unit help to keep sales volume on the upswing

INCREASE in the number of phototubes sold each year by tube manufacturers is sizable and steady. Each year since 1950 the number of units produced has increased by about 100,000. Projection of this rise for 1955 will push total volume to nearly 900,000 units.

▶**Volume**—Sales to initial equipment manufacturers account for the major portion of phototube sales. These companies make everything from garage-door openers—increasing in sales due to lightweight overhead doors—to multiplier phototubes used in atomic energy.

Phototransistors have yet to come into wide-spread use in consumer applications although manufacturers in the field look to greater use because of space and weight savings. Widespread use in auto headlight dimmer applications has not materialized but work in this

(Continued on page 12)

choose from this complete line of

MINIATURE PULSE TRANSFORMERS

Type 10Z
tubular pulse transformer

Type 15Z
miniature bathtub pulse transformer

Type 20Z
drawn-shell bathtub pulse transformer

Type 40Z
plug-in pulse transformer

NOW YOU CAN CHOOSE from eighteen standard pulse transformers in four major construction styles, all in quantity production at Sprague. The standard transformers covered in the table below offer a complete range of characteristics for computer circuits, blocking oscillator circuits, memory array driving circuits, etc.

These hermetically sealed units will meet such stringent military specifications as MIL-T-27, and operate at temperatures up to 85°C. Special designs are available for high acceleration and high ambient temperature operation. In addition, the electrical counterparts of each transformer can be obtained in lower cost housings designed for typical commercial environment requirements.

Complete information on this high-reliability pulse transformer line is provided in Engineering Bulletin 502A, available on letterhead request to the Technical Literature Section, Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

ELECTRICAL CHARACTERISTICS OF SPRAGUE PULSE TRANSFORMERS

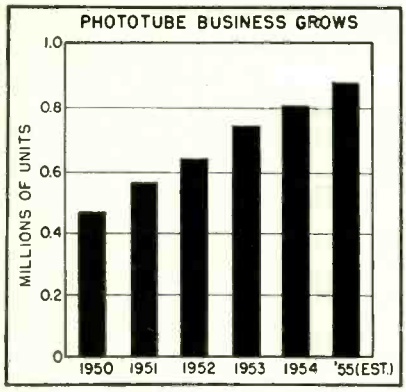
Type No.	Turns Ratio	Pulse Width μ seconds	Rise Time μ seconds	Primary Inductance	Leakage Inductance	Repetition Rate	Load and Output	Typical Applications
10Z1	5:1	0.1	0.04	200 μH	5 μH	1 to 2 MC	15 volts 100 ohms	Used in digital computer circuitry for impedance matching and inter-stage coupling. Pulses are of sine wave type.
10Z2	4:1	0.07	0.03	200 μH	20 μH	1 to 2 MC	20 volts 100 ohms	
10Z3	1:1	0.07	0.03	125 μH	12 μH	1 to 2 MC	20 volts 200 ohms	
10Z4	3:1	0.07	0.03	160 μH	15 μH	1 to 2 MC	20 volts 100 ohms	
10Z6	4:1	0.1	0.04	200 μH	6 μH	1 to 2 MC	17 volts 100 ohms	
10Z12	1:1	0.25	0.02	200 μH	2 μH	12KC	100 volts	Blocking Oscillator
10Z13	1:1	0.33	0.07	240 μH	2 μH	2KC	50 volts	Blocking Oscillator
10Z14	7:1:1	0.50	0.05	1.2 mH	20 μH	1MC	25 volts	Impedance Matching
15Z1	3:1	5.0	0.04	7.5 mH	22 μH	10 KC	10 volts 100 ohms	Impedance Matching and Pulse Inversion
15Z2	2:1	0.5	0.07	6 mH	15 μH		40 volts	Blocking Oscillator
15Z3	5:1	10.0	0.04	12 mH	70 μH	10 KC	10 volts	Impedance Matching
15Z4	1:1.4	6.0	0.1	16 mH	15 μH	0.4 KC	15 volts	Blocking Oscillator
20Z1	5:5:1 Push-Pull	1.5	0.25	4.0 mH	0.3 MH		5 volts 10 ohms	Memory Core Current Driver
20Z3	6:1	1 to 4	0.22	18 mH	0.8 MH	250 KC (max.)	21 volts 200 ohms	Current Driver
20Z4	6:1:1	1 to 7	0.25	55 mH	0.3 MH	50 KC (max.)	22 volts 400 ohms	Current Driver and Pulse Inversion
20Z5	3.3:3.3:1 Push-Pull	2.4	0.2	2.8 mH	0.2 MH		2.5 volts 6 ohms	Memory Core Current Driver
20Z6	11:1	6.0	0.2	90 mH	0.2 MH	50 KC (max.)	10 volts 75 ohms	Current Transformer
40Z1	7:1:1	0.50	0.05	1.2 mH	20 μH	1 MC	25 volts	Impedance Matching

Sprague, on request, will provide you with complete application engineering service for optimum results in the use of pulse transformers.

SPRAGUE® WORLD'S LARGEST CAPACITOR MANUFACTURER

Export for the Americas: Sprague Electric International Ltd., North Adams, Mass. CABLE: SPREXINT

ELECTRONICS Charter-Year Advertiser



field is continuing. A handful of manufacturers are currently making phototransistors and one large tube manufacturer expects to enter the field this year.

► **New Applications**—Two novel uses for phototubes have just been announced. The Army-developed device shown uses a multiplier phototube to count and measure microscopic airborne germs, dust and moisture particles.

The instrument, called the aerosoloscope, is capable of counting and measuring particles ranging in size from one micron (forty-millionths of an inch) to 64 microns at the rate of 6,000 a minute. It is expected that the instrument will be helpful in flour mills, cosmetic plants, paint factories (for measuring pigment particles) and in other industries concerned with particle size control or control of airborne contaminants.

An instrument developed by the U. S. Navy and manufactured by the Lewyt Manufacturing Corp. uses a sensitive infrared tube with a cesium cathode and a built-in coated lens to see objects in the fog and dark. The instrument was originally used by the Navy in signal operations. It is 14 inches long, 3 inches in diameter and weighs 5 pounds.

The instrument operates on either 110 or 6 volts d-c. The company anticipates wide use of the instrument in the future as a transportation safety device. It can warn auto drivers of oncoming cars 1,500 feet ahead in foggy or dark weather.

Taped Color Moves Toward Market

Gains made in perfecting color video tape recording equipment were demonstrated with this experimental system by Bing Crosby Enterprises. The system is the forerunner of new experimental equipment to be demonstrated soon. According to the company, the mechanical and the foot-per-second use rate problems have largely been solved. The new equipment will record 16 minutes of color video on a 15-inch diameter reel of tape. It will be approximately 18 months before commercial equipment can be placed on the market

Manufacturers Plug New Computer Models

More transistor machines appear. Three computers for business men are announced

NEARLY 800 transistors and 11,000 germanium diodes reduce power consumption and enhance reliability of TRADIC, a digital computer for large aircraft developed for the Air Force by Bell Labs.

The computer consumes less than 100 watts and in final form will occupy less than three cubic feet. The machine may perform chores such as fire control, bombing and navigational computation. These jobs are usually done by analog-type computers. TRADIC will do the work of analog computers with the accuracy of a digital type. It handles thirteen 16-digit numbers and can perform a problem requiring 250 steps in 15 milliseconds.

Another transistor computer potentially useful in aircraft is TRANSAC whose arithmetic unit was recently demonstrated by Philco. The unit performs 600,000 additions a second. It consumes only 5¾ watts and employs 1,242 germanium surface-barrier transistors. By use of Philco's direct-coupled transistor circuit the only other components required are 322 resistors. Components are mounted on 20 identical etched wiring boards.

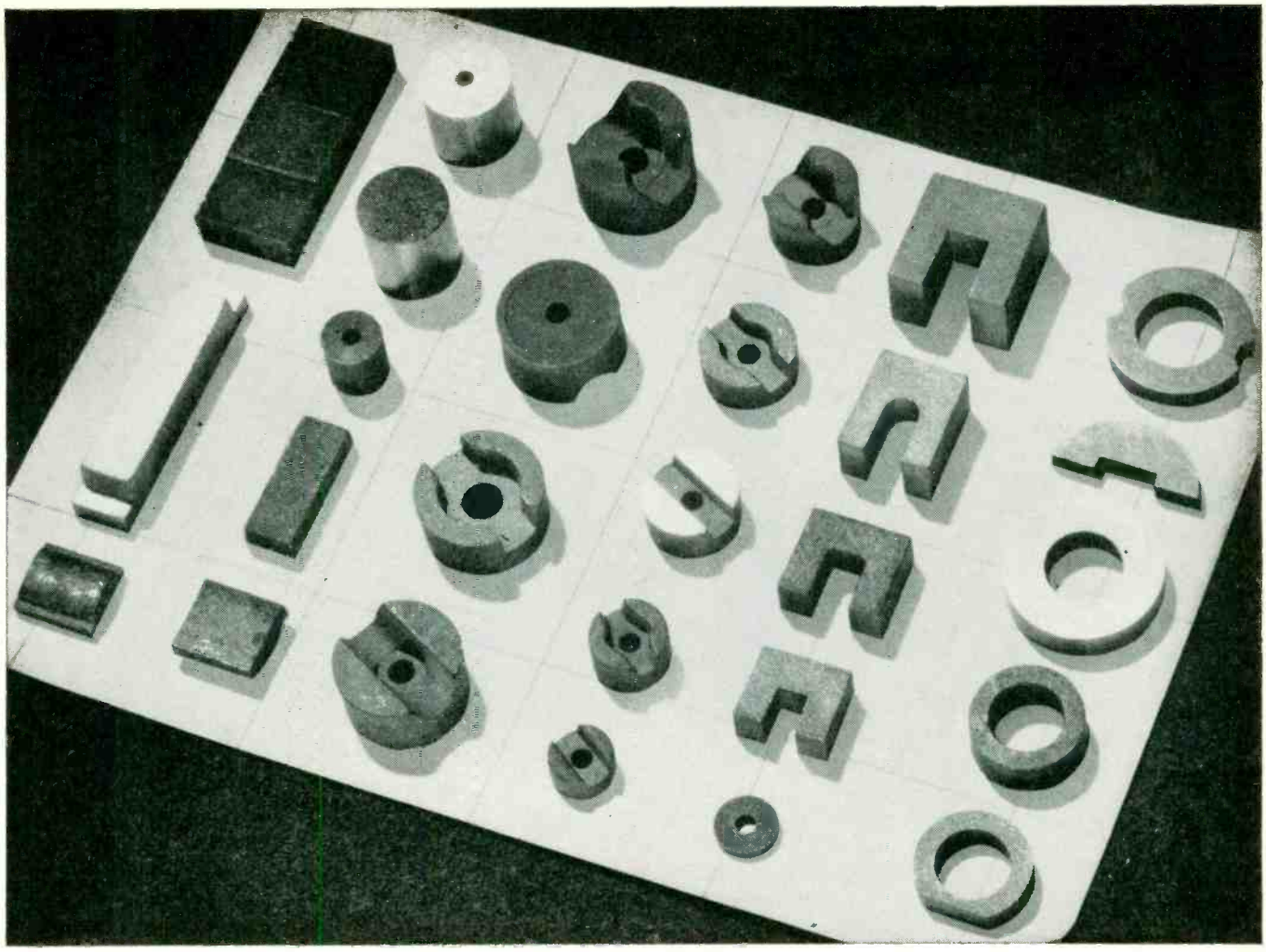
► **Baby Computer**—Payroll and other business operations can be handled rapidly by Underwood's Elecom 50. The machine may sell for under $20,000. It occupies the space of an office desk. Input is by a 10-key manual keyboard with output on ganged accounting machine carriages.

An 8-in. diameter magnetic drum stores 50 ten-digit numbers and the machine adds, subtracts or multiplies 10-digit numbers at the rate of 15 a second.

The computer is programmed by a metallized control tape having 2,400 steps.

► **Electronic Filing**—Processing of

(Continued on page 14)



Page-full of ideas for you on *Sintered Magnets*

"MAGNETIC MATERIALS CATALOG"

Write for your copy

Contains handy data on various types of Alnico Magnets, partial lists of stock items, and information on other permanent magnet materials. Also includes valuable technical data on Arnold tape-wound cores, powder cores, and types "C" and "E" split cores in various tape gauges and core sizes.

ADDRESS DEPT. E-54

"OFF-THE-SHELF" ITEMS or SPECIAL SHAPES to suit your needs

Magnets of sintered Alnico offer endless opportunities to designers who need their useful combination of self-contained power and small bulk. A wide range of sintered Alnico shapes are carried in stock for quick shipment. Special shapes to meet an individual design need can be developed, where the quantity required is large enough to justify the tooling costs. Arnold sintered permanent magnets are fully quality-controlled and accurately held to specified tolerances. ● *We'll welcome your inquiries.*

WAD 5280

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

General Office & Plant: Marengo, Illinois

DISTRICT SALES OFFICES . . . New York: 350 Fifth Ave.

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

Want more information? Use post card on last page.

up to 100,000 unsorted items of business data during an 8-hour day can be accomplished by Remington Rand's Univac File Computer. A building-block plan is used. From one to ten magnetic drums with 180,000 alphabetical/numeric characters per drum may be specified. Prices start at $300,000.

Another electronic filing system is the ElectroData Datareader. The machine uses magnetic tape to store 400,000 ten-digit numbers and can automatically replace the data in a computer's main memory with an entirely new set of facts in less than 8 seconds.

► **Key Punching**—An electronic system has been developed for automatic key punching of credit sales according to an announcement by Farrington Manufacturing Co.

The account number on the tabulating card is read by the scanner, checked and verified by the interpreter (a digital computer) which operates the key punch.

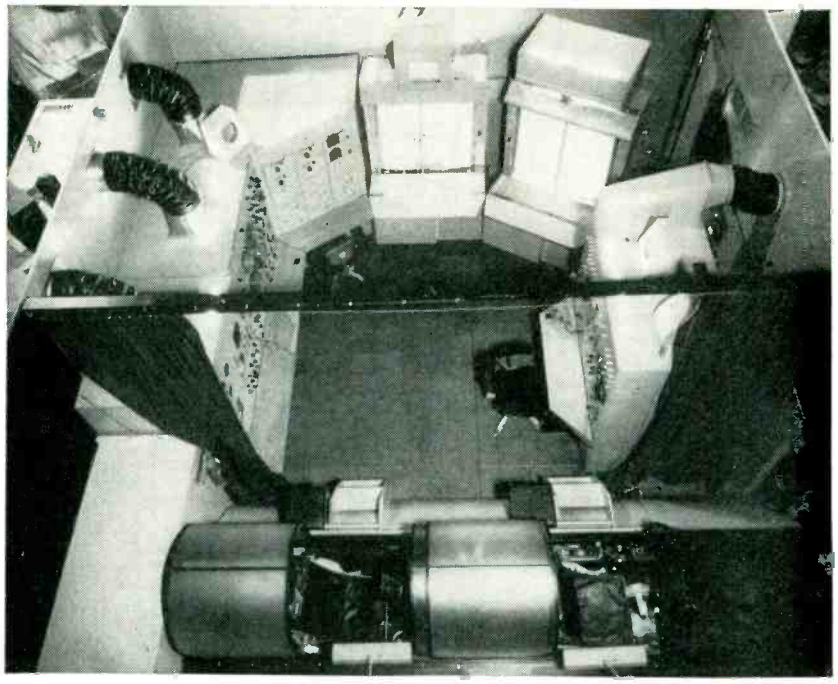
TV Transmitter Firms Size Up Market

New stations going on air decrease but firms find new business in power boosts

TELEVISION transmitter buying declined from its 1953 high during 1954 and may become even slower this year.

In 1954, about 115 tv transmitters were put into operation while in 1953 about 218 stations went on the air. According to RETMA, sales of transmitting equipment and accessories were off about 20 percent in 1954.

► **Power**—Sales of equipment for higher power has already developed into sizable business for transmitter manufacturers. For the year ending in June of 1954, 90 tv stations increased transmitting power and 100 more were planning power jumps. Since then the number of stations planning more power has increased. With power increases have come increases in tower height.



MORE simulators like this Link jet flight model are being sold as . . .

Flight Trainer Business Booms

Commercial airlines and the military are ordering more simulators to cut training costs

OPERATING costs of modern-day aircraft have led both commercial and military aviation to use more flight simulators for training pilots and other air crew personnel. Units for particular models of military aircraft have been ordered before the aircraft itself has been produced.

► **Commercial**—Indication of the volume that has come from commercial aviation for flight simulators is the fact that just one commercial airline has 14 of the devices in use and another has 7. Foreign airlines are buying also.

Total simulator cost per hour including depreciation is about $67 while total airplane cost per hour could run 10 times that. Although the cost of the units may run as high as $1 million, they can soon pay for themselves.

► **Military**—The Air Force and Navy represent the simulator field's largest customers. Some 150 simulators are now in use representing more than a dozen different models. Curtiss-Wright recently announced that the Air Force had placed orders totaling $6.3 million for three new types of simulators. In addition, the military recently ordered a substantial number of navigation trainers. More than 30 of these units are now in use. Over 500 electronic flight trainers also have been produced.

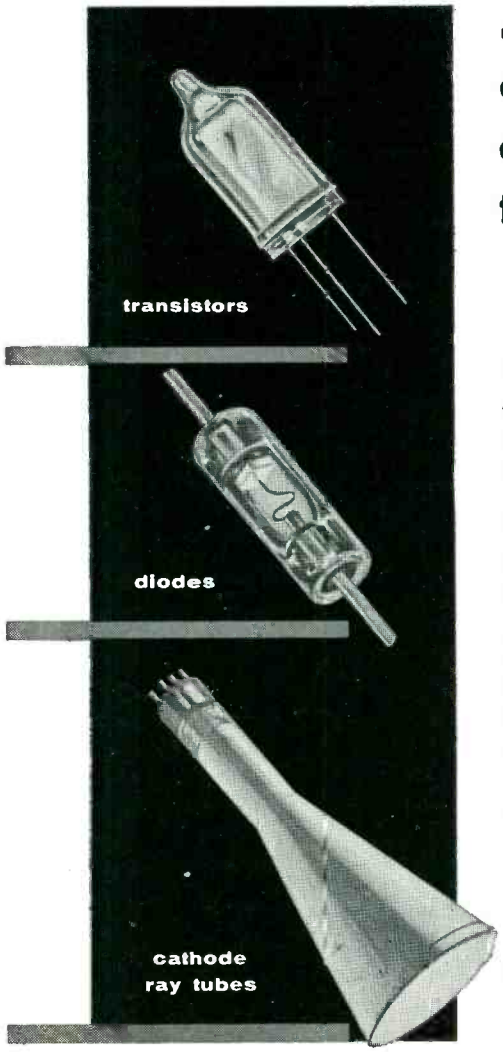
► **Works**—Indication of great amount of electronic equipment that is included in flight simulators is indicated by statistics on the Link simulator. It contains 1,635 electron tubes, 352 transformers, 10,636 resistors and 400 computer assemblies including 163 summing amplifiers, 93 servo amplifiers, 26 phase detectors, 9 audio amplifiers, 5 variable frequency oscillators and 4 linear phase detectors.

► **Companies**—Firms in the flight simulator field include: Curtiss-Wright, Engineering Research Corp., Goodyear Aircraft, Westinghouse Air Brake, Link Aviation, American Machine & Foundry and Otis Elevator. The last two com-

(Continued on page 16)

for modern,
profitable
automatic production...

call on KAHLE



...world's leading exclusive manufacturer of production machinery for the electronics field

If you're making (or plan to make) *diodes, transistors, sub-miniature, miniature, cathode ray tubes, or other electronic tubes or component parts,* take full advantage of Kahle's invaluable experience.

With Kahle methods and "know-how" you're sure of getting exactly the right machinery to produce exactly what you want...accurately, dependably, profitably.

For more than a quarter of a century the leaders in the electronics field have relied on Kahle for production machinery. Typical production steps automatically performed by Kahle equipment include sealing, bulb making, stem making, exhausting, grid winding, filament coil winding, lead wire welding.

Write today for additional details, equipment specifications, production data, and quotations.

Write for information on special experimental and research services offered by Kahle.

Get first hand information at our conveniently located plant—
15 minutes from Times Square, 5 minutes south of Lincoln Tunnel

Kahle ENGINEERING COMPANY

1307 SEVENTH STREET • NORTH BERGEN, N.J.

CONTI

panies specialize in navigation-type simulators. One aircraft firm has built a flight simulator for its own use in pilot training.

NEWS-SERVICE facsimile installations and private-wire units are major factors as . . .

Facsimile Sales Record Upswing

TV stations, newspapers and business men buy and lease more equipment

IN THE past two years the facsimile business, which has had more than its share of ups and downs, has made sizable and steady sales gains.

About 200 units have been installed by the news services in addition to sales to the government and private business. United Press has over 100 installations in service, INS has 25 and AP about 50.

In addition, UP recently ordered 200 units from Cardwell Electronics for expanded use in its newsphoto service. AP has ordered several hundred units from GE.

TV stations and smaller newspapers have been leading clients for news service facsimile. UP clients include over 30 newspapers and 50 tv stations. An additional 20 tv stations and 16 newspapers have orders in with UP for the service which will be installed as soon as equipment is available. Already, news service facsimile uses over 4,000 pounds of facsimile paper a month.

▶ **Business**—Big factor in the commercial facsimile field is Western Union with its Desk-Fax system. This is a compact machine installed on the desk of the business user. Connected to a local office of Western Union, it eliminates the delivery and pickup of telegrams. Approximately 20,000 installations were in use by the end of 1954..

Western Union has, in addition, its Intrafax system which is installed and leased as a complete system.

Development of Ticketfax by Western Union permits travelers, who walk into center-of-city or outlying railroad ticket offices and ask for reservations, quickly to be handed facsimile duplicates of tickets whose originals are miles away at the main office. The facsimile system, which prints a ticket in eight seconds, is the company's latest leased-private-wire service.

▶ **Gear**—Hogan Laboratories, which holds basic patents on facsimile, has developed equipment with transmission speeds ranging from one inch per minute to four inches per minute. The scanner and recorder are capable of operating at several times this top speed special circuits would be required to handle the resulting broad-band electrical signals. Big advantage of the gear is that copy can be run continuously without clamping to a drum.

FCC Reveals Actual Mobile Radio Use

Survey shows 57.5 percent of authorized transmitters currently in use

OF HIGH INTEREST to those in the field of mobile radio communications is the exact number of transmitters in use. It is customary to issue a license covering one base station and several mobile stations. It may be a long time, if ever, before the full complement of authorized mobile transmitters is put on the air.

In April 1954, FCC mailed questionnaires to more than 18,000 licensees. Some 60 percent replied, representing more than 325,000 transmitters out of a total of 433,000 authorized for the Safety and Special Radio Services.

▶ **Actual Occupancy**—Better than half the mobile and base station transmitters licensed in these services are actually on the air as of early 1955.

As an example, questionnaires were sent to 5,507 police licensees who returned 3,270—a percentage of 58.5. Total transmitters authorized for this service is 107,912. Total authorized transmitters included in returned questionnaires is 67,897. Number of transmitters installed is reported as 42,176, 62 percent of units authorized.

Survey of Land-Mobile Radio Services

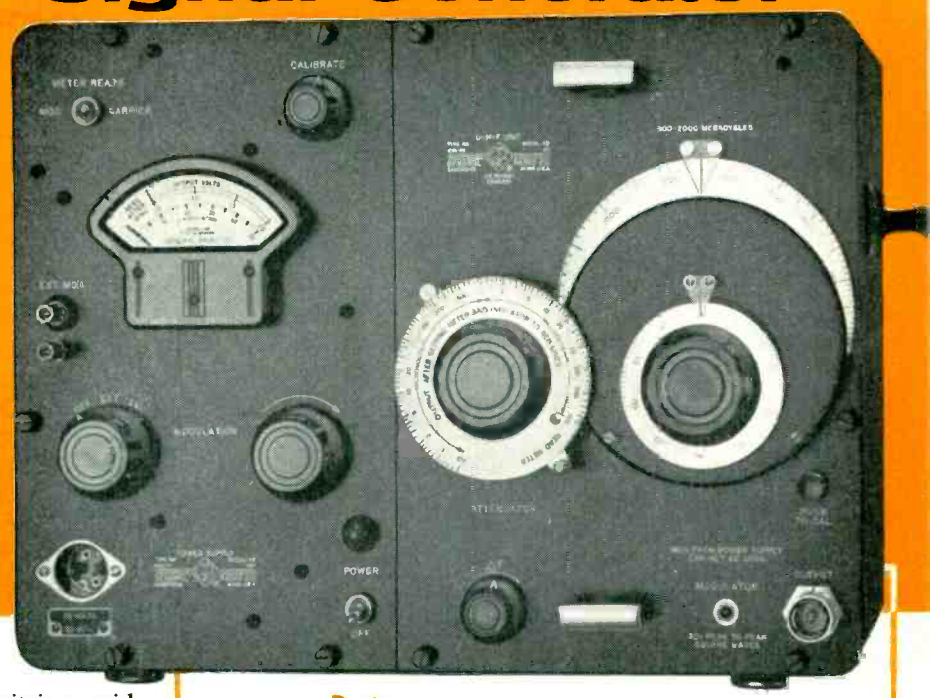
Nature of Service	Use Ratio in Percent
Police	62
Fire	56
Forestry Conservation	73
Highway Maintenance	58.5
Special Emergency	56
Total Public Safety	62.5
Power	62.5
Petroleum	50
Forest Products	40
Motion Picture	53.5
Relay Press	37
Special Industrial	48
Low-Power Industrial	31
Total Industrial	55
Railroad	50
Intercity Bus	80
Highway Truck	40
Urban Transit	72.5
Taxicab	58.5
Automobile Emergency	50
Total Land Transportation	55
GRAND TOTAL	57.5

The table gives the representa-

(Continued on page 20)

Standard-Signal Generator

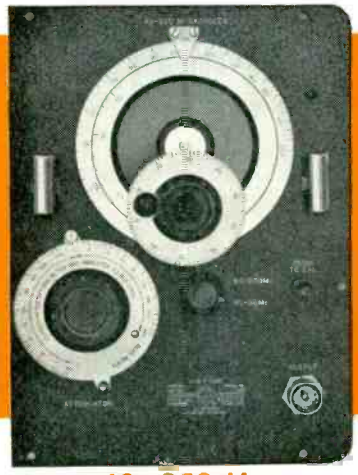
40 to 2000 Mc



The range of the popular Type 1021-A Standard-Signal Generator has been extended to 2,000 Mc with the addition of a third oscillator unit, and downward to 40 Mc with the added 40-50 Mc range of the low-frequency oscillator unit. Now, the complete frequency range from 40 to 2,000 Mc is covered by one power supply and three oscillator units with frequency ranges of 40-250, 250-920, and 900-2,000 Mc, respectively.

The new Type 1021-P4 900-2,000 Mc Unit is a grid separation triode oscillator using a Type 5675 uhf pencil tube. It delivers relatively high output at uhf . . . is stable and well shielded . . . has provision for square-wave modulation . . . and is low in cost for a high-performance signal source. Line sections with sliding contacts are used to tune plate and cathode—tuning is exceptionally smooth. The instrument is remarkably free of noise modulation caused by microphonics and vibrations.

Additional Oscillator Units



40 - 250 Mc

Type 1021-P3B now has added 40-50 Mc range for television i-f measurements, v-h-f receiver and amplifier development.

250 - 920 Mc

Type 1021-P2 is a convenient, well-shielded source of power for bridge and slotted line measurements and u-h-f television work.

NEW

Type 1021-P4 Oscillator Unit

SPECIFICATIONS

Frequency Range 900-2000 Mc

Frequency Calibration Accuracy Large direct-reading dial with slow motion drive calibrated to 1% over 200°

Incremental Frequency Control Variable resistor in grid circuit provides small frequency adjustments.

Frequency Drift Under 0.1% per day

Output Voltage Continuously adjustable from 0.5 μv to 1.0 volt open circuit.

Output Impedance 50 ohms $\pm$10%

Output Meter Output voltage indications accurate to better than 20% — meter circuit can be calibrated in terms of accurately known 60-Cycle voltage.

Modulation Provision Square-wave modulation from 100-5,000 cycles from external modulator.

Leakage Stray fields and residual output voltage cannot be detected with receiver having 2 μv sensitivity.

Heater Voltage Rectified To reduce modulation by power frequency.

Inexpensive Tube Replacement Only $15.20

Frequency	Standard-Signal Genenerator		Oscillator Unit	Power Supply
40 – 250 Mc	1021–AV, $595		1021–P3B, $400	
250 – 920 Mc	1021–AU, $615	. . . . . consists of	1021–P2, $420	} and 1021–P1, $195
900–2000 Mc	1021–AW, $845		1021–P4, $650	

GENERAL RADIO Company

275 Massachusetts Avenue, Cambridge 39, Massachusetts, U.S.A.

90 West Street NEW YORK 6
8055 13th St., Silver Spring, Md. WASHINGTON, D.C.
920 S. Michigan Avenue CHICAGO 5
1000 N. Seward Street LOS ANGELES 38

1915-1955
40 Years of Pioneering
in Electronics

RAYTHEON

TRANSISTORS

MILLIONS OF THEM!!

RAYTHEON IS FIRST AND FOREMOST IN

— **mass production.** Raytheon is long past the experiment and development stage in Germanium PNP Junction Transistors — for over 2 years has had the quantity production and quality control techniques and resources

— **proved reliability in commercial application,** based on billions of hours of actual field performance and a record of success exceeding that of many reliable vacuum tubes

— **range of characteristics.** Look at the chart. You'll find one or more Raytheon Transistors that meet your specific requirements, however exacting.

LOW FREQUENCY TRANSISTORS — PLASTIC CASE

TYPE	Collector			Emitter	Base	Base Current Ampl. Factor	Max. Noise Factor db	Alpha Freq. Cutoff mc.	Max. Junction Temp. °C	Temp. Rise °C/mW
	Volts	Meg. ohms	Cutoff μA	MA	ohms					
CK721	−6	2.0	6	−1.0	700	45	22	0.8	70	0.25
CK722	−6	2.0	6	−1.0	350	22	25	0.6	70	0.25
CK725	−6	2.0	6	−1.0	1500	90	20	1.2	70	0.25
CK727	−1.5	1.0	6	−0.5	700	45	12	0.8	70	0.25

LOW FREQUENCY TRANSISTORS — HERMETICALLY SEALED CASE

TYPE	Collector			Emitter	Base	Base Current Ampl. Factor	Max. Noise Factor db	Alpha Freq. Cutoff mc.	Max. Junction Temp. °C	Temp. Rise °C/mW
	Volts	Meg. ohms	Cu off μA	MA	ohms					
2N63	−6	2.0	6	−1.0	350	22	25	0.6	85	0.58
2N64	−6	2.0	6	−1.0	700	45	22	0.8	85	0.58
2N65	−6	2.0	6	−1.0	1500	90	20	1.2	85	0.58
2N106	−1.5	1.0	6	−0.5	700	45	12	0.8	85	0.58

HIGH FREQUENCY TRANSISTORS — HERMETICALLY SEALED CASE

TYPE	Collector		Emitter	Extrin. Base Resis. ohms	Base Current Ampl. Factor	Alpha Freq. Cutoff mc.	Max. Junc. Temp. °C	Temp. Rise °C/mW	Coll. Capac. μμf	Gain at 455kc db	Gain at 2 mc db	Rise time* μsecs	Decay time* μsecs
	Volts	Cutoff μA	MA										
CK760	−6	1	−1.0	75	40	5	85	0.62	14	32	18	0.05	0.06
CK761	−6	1	−1.0	75	45	10	85	0.62	14	33	20	0.04	0.05
CK762	−6	1	−1.0	75	65	20	85	0.62	14	33	22	0.02	0.03

*measured in circuit which will be supplied on request

Note: above characteristics are average except where noted

There are more — several times more

RAYTHEON TRANSISTORS

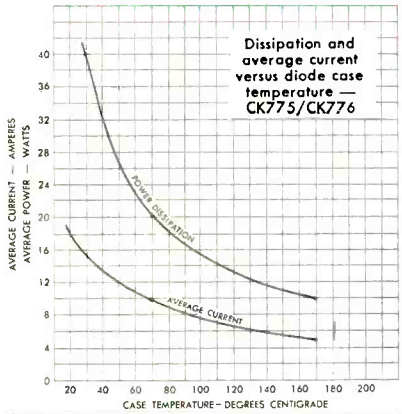
in use than all other makes combined

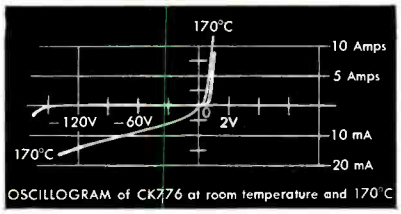
Raytheon presents a new and more efficient

SILICON POWER RECTIFIER

with 95 to 99% EFFICIENCY

ACTUAL SIZE





OSCILLOGRAM of CK776 at room temperature and 170°C

HIGH CURRENT-to 15A
HIGH VOLTAGE RATINGS
HIGH TEMPERATURE-175°C
HERMETICALLY SEALED
MECHANICALLY STABLE
REDUCED COOLING REQUIRED
EXTENDED FREQUENCY RANGE
better than 100kc

RAYTHEON SILICON POWER RECTIFIER CHARACTERISTICS

	MAXIMUM VOLTAGE RMS VOLTS	MAXIMUM VOLTAGE PEAK VOLTS	MAXIMUM CURRENT PEAK AMPERES	MAXIMUM CURRENT AVERAGE AMPERES	TYPICAL DISSIPATION WATTS
TYPE CK775					
CASE TEMP. 30°C*	40	60	50	15	40
CASE TEMP. 170°C*	40	60	15	5	10
NO HEAT RADIATOR					
AMBIENT TEMP. 25°C	40	60	6	2.0	3.0
AMBIENT TEMP. 170°C	40	60	2.0	0.5	2.0
TYPE CK776					
CASE TEMP. 30°C*	125	200	50	15	40
CASE TEMP. 170°C*	125	200	15	5	10
NO HEAT RADIATOR					
AMBIENT TEMP. 25°C	125	200	6	2.0	3.0
AMBIENT TEMP. 170°C	125	200	2.0	0.5	2.0

*maintained by external heat radiator

ADDITIONAL RATINGS (25°C)

Both CK775 and CK776 have maximum drop at 5 amperes of 1.5 volts
CK775 has maximum reverse current at −60 volts of 25 mA
CK776 has maximum reverse current at −200 volts of 25 mA

RAYTHEON®
Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY

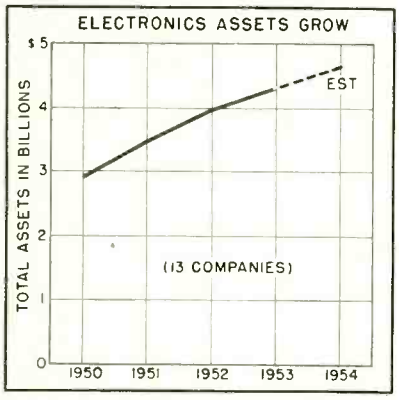
Semiconductor Division — Home Office: 55 Chapel St., Newton 58, Mass. Bigelow 4-7500
For application information write or call the Home Office or: 4935 West Fullerton Avenue, Chicago 39, Illinois, NAtional 2-2770
589 Fifth Avenue, New York 17, New York, PLaza 9-3900 • 622 South La Brea Ave., Los Angeles 36, California, WEbster 8-2851

RAYTHEON *MAKES ALL THESE:*

RELIABLE SUBMINIATURE AND MINIATURE TUBES • SEMICONDUCTOR DIODES AND TRANSISTORS • NUCLEONIC TUBES • MICROWAVE TUBES • RECEIVING AND PICTURE TUBES

tive percentages for the several categories of services. Other data was picked up in the questionnaires, such as the percentage of interference occurring in various bands at different times of day. Answers have been placed on punch cards from which statistical data are available to organizations or individuals upon application to the Secretary of the Commission.

Electronics Assets Continue to Climb



Representative companies gain in total assets as expansion and output gain

TOTAL assets of 13 important manufacturers in the electronics field totaled over $4.5 billion dollars in 1954, up nearly one-half billion dollars from 1953 totals.

► **Chart**—In the past five years, total assets of the 13 companies have nearly doubled. Although the increment has dropped slightly for each year, it has remained over the $300-million mark and has averaged about $400 million annually.

► **Breakdown**—Biggest item in total assets of the companies has been inventories which include materials, supplies, work in process and finished goods.

► **Increase**—Sylvania's total assets more than doubled in the five-year period from $92.9 million in 1950 to over $200 million last year. It registered the greatest rate of growth of any company surveyed. In terms of dollars, the greatest increase was registered by Westinghouse, which increased over $500 million.

Los Angeles Updates Its Progress

West Coast industry has made big strides but some growth problems remain

DOLLAR billing of electronics manufacturers in the Los Angeles area has grown from $47 million in 1941 to an estimated $842 million last year, according to the city's Chamber of Commerce.

In tv set manufacturing, it is estimated that output rose to 350,000 units in 1954 worth a total of $52 million. Components amounted to about $34 million. The tv industry in the area employed 5,000 workers in final assembly and 2,800 in component manufacturing.

► **Problems**—Despite this progress, Los Angeles manufacturers point out that there are some growth deterrents. They are chiefly, higher freight and labor costs and a need for locally made component parts of lower cost.

Manufacturers in the area must absorb higher freight costs to reach the major markets in the U. S. than their eastern and midwest counterparts. Freight costs from the west coast to Chicago run about 4 cents a pound. However, relatively recent rate adjustments have been made so that on most items the cost to ship out of Los Angeles is lower than the costs for shipping into the area.

Labor rates in the Los Angeles area are as high and in some instances higher than those paid in the east. A survey made a few years ago showed that assemblers hourly wages are 20 cents higher in the west. It is sometimes cheaper to buy from the east even after freight charges are added.

While the electronics industry as a whole has shown a very healthy growth in the Southern California area, the increase in component manufacturers has not kept the same pace according to companies there. There were about 25 component parts manufacturers in the area in 1946 and the number has grown to approximately 95 firms. Of these, about 20 are transformer makers. Thus, the bulk of components for tv sets except transformers, cabinets and tuners are secured from the east.

► **Future**—Indications are that most of the present problems of the Los Angeles electronics industry are being solved however. An increasing number of eastern companies are setting up plants on the coast. It is estimated that now over a dozen east and midwest firms have manufacturing operations in the area. Los Angeles electronics manufacturers expect their total dollar volume to hit the $1-billion mark in 1956.

Tones Over Power Line Control Plant Services

Lights, fans and motors can be controlled remotely or by a preselected program

CARRIER current may soon be at work in offices, schools and industrial plants controlling functions such as time clocks, fans and blowers, lights and air conditioners. An electronic supervisor, announced by IBM, can perform up to 40 on-off remote switching functions. Tone signals are sent over existing a-c mains. Cost ranges from $1,100 to $2,200.

► **Tone Signals**—The system provides four control channels each handling 10 switching functions. When the channel switch is thrown there is a 60-second operating cycle in which all the selected switching functions of the channel are performed.

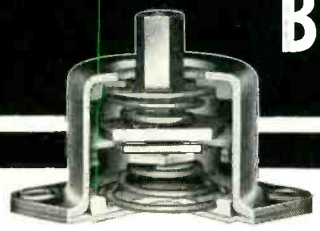
Control impulses are sent as audio tones: 3,500, 4,200, 5,000 and 6,000 cps that provide a ½-volt signal at the switching relay.

Verifier lights on the master control panel show that the selected control signals have been sent out although there is no indication at the board to show whether the

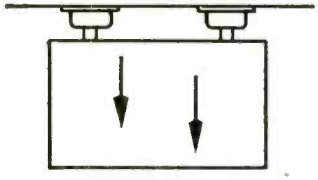
(Continued on page 22)

NEW

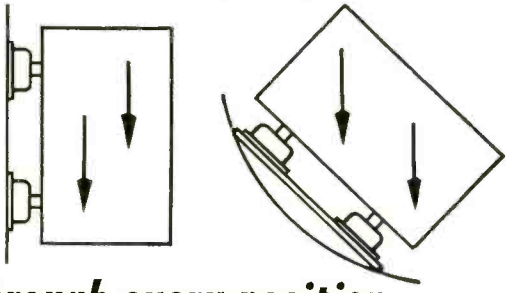
ALL-ANGL BARRY MOUNT



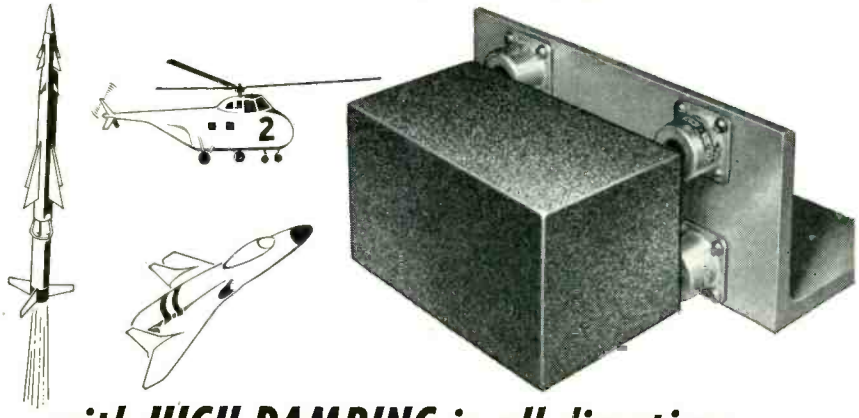
ALL-ANGL **BARRY MOUNT**
Cup diameter .....1 inch
Maximum load .....3 pounds
Weight .....less than 1 ounce



Works at any angle



...in maneuvers through every position



...with HIGH DAMPING in all directions

Now you can forget all limitations on mounting positions for delicate apparatus. You can design for easiest installation and best space utilization, because the new Barry ALL-ANGL vibration isolator works in any position. Upside down, on a bulkhead, at any slant — position means nothing to this new BARRYMOUNT.® Damping is exceptionally high in all directions; transmissibility at resonance is less than 3. The ALL-ANGL mount is interchangeable with other miniature BARRYMOUNT isolators.

This isolator is the answer to your toughest vibration-protection problems. Let us show you what it will do for you; or write for Bulletin.

THE BARRY CORP.

707 PLEASANT STREET
WATERTOWN 72, MASS.

SALES REPRESENTATIVES IN ALL PRINCIPAL CITIES

Want more information? Use post card on last page.

Industrial tractor is guided by radiation from control wire strung from overhead beam

function has been performed. Likewise there is no indication at the board to show if someone on the floor has switched equipment manually although signals from the master control unit can override manual operation from the floor.

▶**Wireless Carrier**—Another remote control application is the operatorless industrial carrier shown in the photograph. Pressing a button on control boxes placed throughout the plant will bring a tractor to that point, guided by an overhead wire.

Manufactured by the Barrett-Craven Co. of Northbrook, Ill., the tractor has a detector unit to pick up radiation from the control wire. The detector information is used to control the steering gear to keep the tractor following the wire.

Electronics Gains In Movies

Both theaters and studios increase use of electronic equipment in new systems

SALES of electronic equipment to the motion picture industry have increased substantially in the past few years. This has been due largely to increased use of wide-screen motion pictures and associated installation of elaborate sound systems. Volume is estimated at $15 million last year.

Electronics manufacturers sold an increased amount of two-way radio equipment to motion-picture studios. Theater television has also shown substantial growth. Today about 100 theaters have large-screen tv installed representing an investment of approximately $2 million.

▶**Market**—Of the 22,000 theaters in the U. S. between 15,000 and 16,000 are equipped for wide-screen motion pictures. But not all of these have completely redesigned sound systems. Some have connected additional loudspeakers to existing equipment.

The most elaborate are the stereophonic systems installed by class A movie houses in the larger cities. About 5,000 theaters in the U. S. have these systems which cost up to $25,000. Another 2,000 theaters are equipped with magnetic sound systems which can utilize three loudspeakers. Nearly 10,000 theaters use the optical system and bridge additional loudspeakers across the line.

▶**Companies**—Example of what wide-screen conversion has meant to manufacturers in dollars and cents is indicated in a breakdown of sales in fiscal 1954 for Ampex Corp. The commercial sales volume of the company were almost two and one-half times that of the previous year. Almost 70 per cent of this increase was accounted for by sales of multidirectional sound equipment to motion-picture theaters. Three complete lines of theater sound equipments were developed by the firm during the year and sales amounted to $1.4 million.

▶**Radio**—Movie makers have increased their use of two-way radio. In 1954 the number of transmitters authorized showed the largest increase of any year on record. The number rose from 195 to 347. In past years the annual average increase was 30 authorizations.

Use of two-way radio sets is largely limited to operation while on location in remote areas. The service is used to connect with the nearest wire lines for safety of life and property and to promote more efficient operation.

Low-power radio equipment is generally used to coordinate action taking place on outdoor sets. It helps minimize retakes.

Testing Laboratories Utilize Electronics

Wide variety of materials are tested by electronics but use is still minor

ABOUT a dozen commercial testing laboratories and 17 colleges utilize electronic equipment exclusive of x-ray equipment for performing commodity tests it was disclosed by a new directory of commercial and college testing laboratories compiled by the American Society for Testing Materials.

The report covers 278 commercial testing labs and 86 college laboratories.

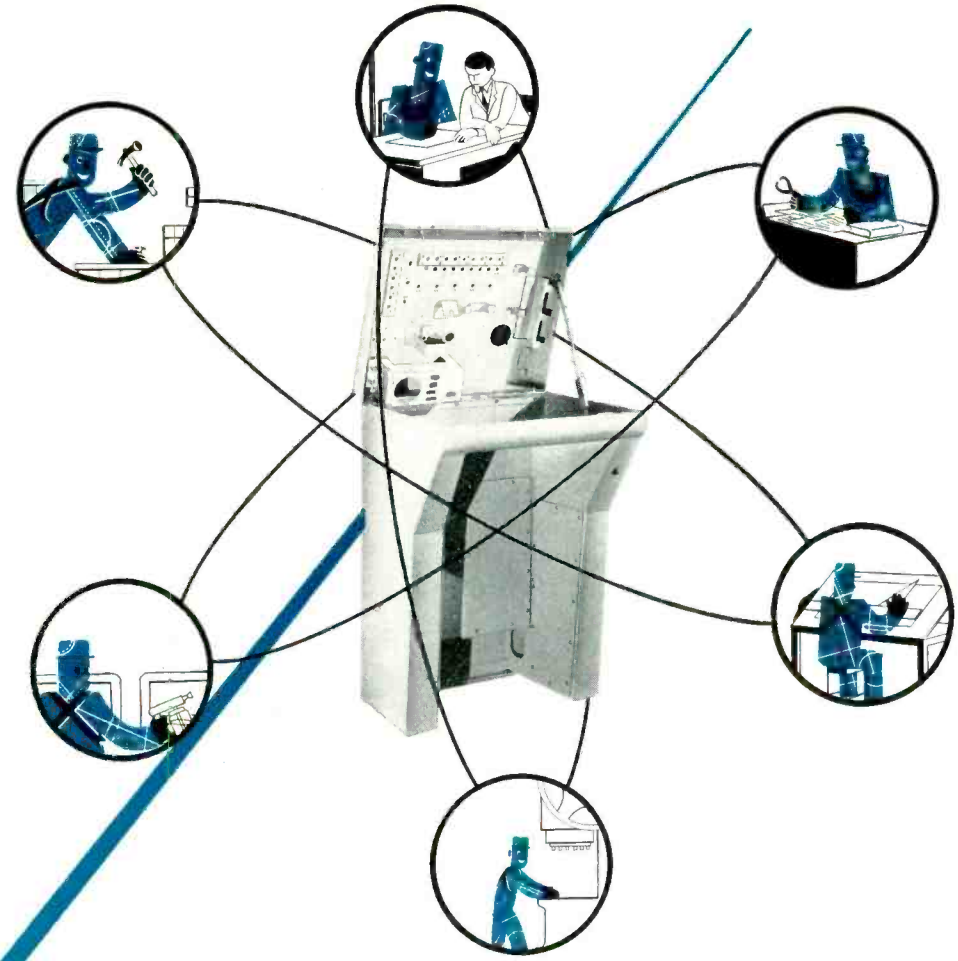
▶**Commodities**—Testing labs use electronics to test a wide range of materials, from paper and paper products to buildings. The largest use of electronics is for testing machinery and vehicles. Over half of the labs with electronic equipment use it for this purpose.

Next important use of electronics is for testing ores, metals and manufactured products. Scientific and medical instruments are other products on which electronic equipment has been used to makes tests.

▶**X-ray**—Less than 20 of the commercial labs used x-ray, radiographic or radiation dosage for testing commodities, indicating a sizable potential market. A larger proportion of the college labs used x-ray, but there, too, the number was less than 20.

▶**Why**—Reason for the small amount of electronic equipment used by the labs reported is that many of them specialize in fields

(Continued on page 24)



KARP enclosures

reflect your electronic skills within

Ask the Karp Man how you can benefit from Karp's 30 years of experience. Phone or write for descriptive literature.

When it comes to engineered sheet metal fabrications, Karp offers you top-quality enclosures, housings and chassis at economies that give your product a real competitive advantage without increasing the selling price. Our large collection of tools, dies and jigs keeps your tooling costs at rock-bottom. Karp "know-how" means that production techniques are individualized to each job, eliminating high costs, bottlenecks and delays to save you money. Yet each Karp fabrication is custom-built to highest quality, with assembly, fitting and bench work performed by skilled craftsmen proud of their work. And remember — At Karp, your job is never too large — or too small.

METAL PRODUCTS CO. • 215 63rd STREET, BROOKLYN 20, N. Y.

Division of H & B American Machine Company, Inc.

FACILITIES FOR ENGINEERED SHEET METAL FABRICATIONS: in aluminum or steel • long run or short • spot, arc, gas or heliarc welding • any type finish

- Modern plant—3 city blocks long
- Thousands of dies available
- Most modern of sheet metal fabricating equipment
- U. S. Air Force Certified Welding Facilities
- Air-conditioned spray room . . . complete baking facilities
- Complete sub-assembly facilities

such as food products where electronic testing is not readily adaptable.

The labs listed are only those commercial and college labs engaged in testing on a commercial or fee basis. Labs of consulting chemists, engineers and metallurgists and research labs of manufacturing companies are listed only when definite information was supplied that they test commodities on a commercial basis. There are nearly 3,000 industrial research labs in the U. S.

FCC Moves In On Ultrasonics

IT WAS mid-December 1935, when the Federal Communications Commission requested the assistance of Cruft Laboratory, Harvard University, in locating the source of a mysterious interference disrupting radio services from 8 to 28 mc (p 19, ELECTRONICS, Feb. 1936). Investigations showed (five days later) that there were some 300 potential sources—each a medical diathermy machine.

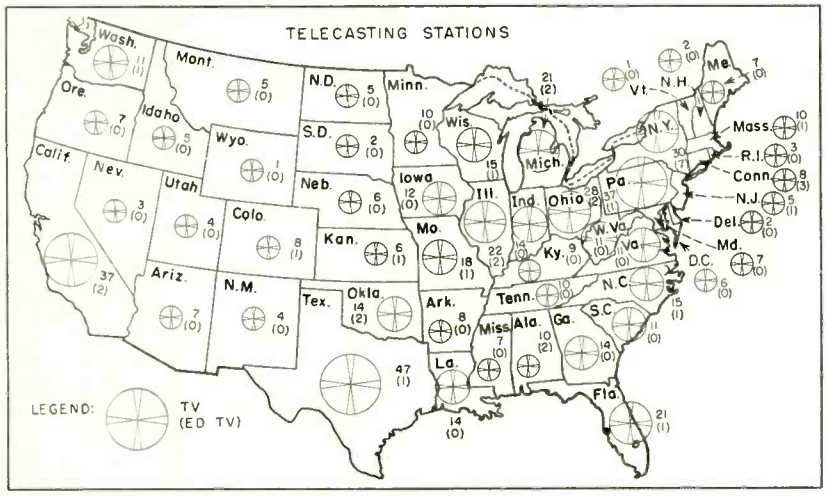
With past history in mind, FCC is taking no chances on the radio-interference menace posed by the tremendously increasing growth of the ultrasonic technique. Technical requirements have long since been established for industrial, scientific and medical equipment, covering diathermy and dielectric heating.

▶**Limitations**—Ultrasonic devices subject to rules include those generating radio-frequency energy above 20 kc (generally above the range of human hearing) utilizing the energy to drive an electromechanical transducer. The mechanical energy is then used for a variety of purposes.

For now, at least, FCC exempts equipments operating below 90 kc and generating less than 500 watts from requirements of type approval or certification.

▶**Closing Dates**—The regulations, on which technical details can be obtained from FCC, become effective March 1. Equipment built after July 1 must comply with the new rules, while devices in operation may either comply with the new rules or an older set of regulations governing miscellaneous equipment. After July 1, 1965, all ultrasonic equipment must comply.

TV Shows In Every State



TELEVISION authorizations (like those for a-m and f-m, ELECTRONICS, p 24, Feb. 1955) have been made to stations in every state. Year-end totals show Texas leading with 47 commercial and 1 educational.

California, Pennsylvania and New York follow with totals of 39, 38 and 37, respectively. Alaska and Hawaii (not shown on the map) have 3 commercial tv authorizations apiece, which equals or exceeds the number for each of six states.

Plant Maintenance Is $10-Billion Business

MAINTENANCE costs for U. S. industry have risen from about $5 billion in 1950 to over $10 billion last year.

GE recently estimated that the nation's maintenance bill for 1955 will increase by $1 billion largely because of increased automatization. (ELECTRONICS, p 26, Mar. 1955.) Annual maintenance costs for all electronics factories are estimated at over $100 million for last year.

▶**Men**—In 1951, in the radio, tv and related products industry there were approximately 230,000 production workers. Nearly 5,000, about 2 percent of the total workforce, were in maintenance. Last year the industry employed nearly 10,000 maintenance men.

Financial Roundup

COMPANIES in the electronics field reported on net profits for 1954 and for many firms the year registered the highest net income on record. Outstanding increases were made by companies such as GE, IBM, Minneapolis Honeywell, RCA and Westinghouse. Following are the net profits of firms in the field for 1954 or for fiscal periods indicated:

Company	Net Profit 1954	1953
AT&T	$480,277,306	$421,485,570
Barry Controls	320,506	252,308
Bendix 3m	5,983,226	4,753,961
Canadian Marconi	1,083,590	1,349,243
Carborundum Co.	3,283,704	5,721,553
Clevite	2,668,648	3,478,611
Cornell-Dubilier 3m	568,556	598,810
A. B. DuMont	7,597,000	
T. A. Edison	908,000	1,479,495
Garrett 6m	1,681,000	1,444,000
GE	212,613,221	165,727,889
Gen. Prec. Equip.	6,258,219	3,436,349
IBM	46,536,625	34,119,210
Litton Industries 6m	341,000	
W. L. Maxson 3m	352,923	370,763
Minn. Honeywell	15,345,203	10,329,825
Philco	6,768,965	18,350,577
RCA	40,525,000	35,022,000
Stewart-Warner	2,757,000	4,081,000
Stromberg-Carlson	1,981,754	1,667,308
Sylvania	9,480,941	9,536,181
Thompson Products	11,678,645	9,652,923
Tung Sol	2,077,062	1,780,882
Western Electric	55,836,430	52,604,613
Westinghouse	84,594,367	74,322,925

▶**Securities**—ElectroData Corp.

(Continued on page 26)

MULTI-GATE®— A Proven Data Transmission "Pipeline"

for C* O C

CENTRALIZED OPERATIONS CONTROL

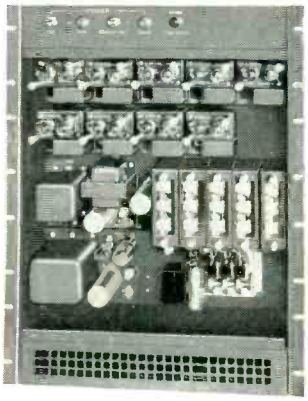
Control Engineers tell us the most important part of any remote supervisory control system is the "pipeline"—the means by which data is sent from control point "A" to operating point "B". And these same control engineers tell us our MULTI-GATE Systems have proven themselves as compact, efficient, and dependable "pipelines."

The MULTI-GATE system provides complete "on-off" or "raise-lower" control and report-back indication of practically an unlimited number of remote switches for valves, pumps, lights, power transfer and other functions, as well as alarm indication. Pipelines, refineries, chemical plants, railroads, public utilities and many other industries are finding MULTI-GATE an efficient, money-saving tool. All their control operations can be performed over a single communications circuit.

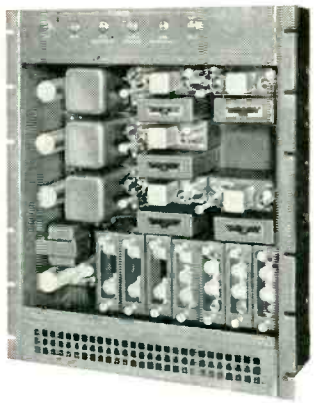
When used with telemetering equipment, *simultaneous control and remote metering* of such quantities as flow, temperature, pressure and electrical quantities are available over the same circuit—radio, microwave, wire or carrier—because all operations are performed by audio tones.

The transmitter and receiver terminals pictured at the right are typical of Hammarlund MULTI-GATE equipment. These units, designed for a 42 function system (21 "on-off" operations), take little space and are readily accessible when mounted in a standard 19-inch rack.

For details write The Hammarlund Manufacturing Co., Inc., 460 West 34th Street, New York 1, N. Y. Ask for Bulletin E4.



Multi-Gate Transmitter



Multi-Gate Receiver

C* O C

CENTRALIZED OPERATIONS CONTROL

(trademarks pending)

Hammarlund's systems for completely controlling and metering of any number of remote functions from central operation points for efficiency, speed and economy.

HAMMARLUND

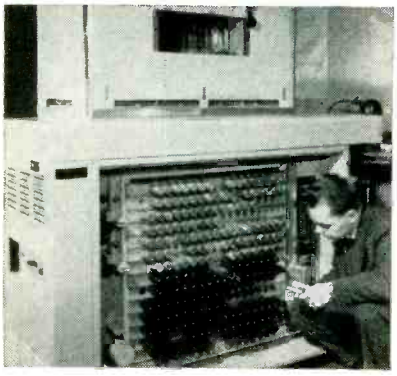
Since 1910

plans to file with SEC for the sale of common stock to raise approximately $2 million in new capital. A total of $225,000 will be used to pay for the cost of building and equipping a new main office and plant now under construction in Pasadena, Calif. The balance will be added to working capital.

Moran Electronic Components field with SEC covering 100 shares of common stock, no par, and 4,000 shares of 7 percent cumulative preferred stock, the latter to be offered at par, $10 per share. Proceeds are to be used to purchase raw materials and equipment and for expansion as warranted.

Granco Products field with SEC covering 120,000 shares of common stock, par 50 cents, to be offered at $2.50 a share. Net proceeds are to be used to buy machinery and equipment for further development and research and for working capital.

Transistors Aid Long Distance Calls



NUMBER of transistors used in the telephone field is increasing as AT&T installs more card translators at its switching centers. Equipment has already been installed in 16 switching centers throughout the country and more will be added this year. When a long distance call is dialed, a selected perforated card falls into position. Beams of light shining through the perforations pick out and energize a number of phototransistors which give the switching apparatus the information needed to send the long distance call automatically over the correct route.

FUTURE MEETINGS

APRIL 5–7: Radio Technical Commission for Aeronautics, Spring Assembly Meeting IRE Los Angeles, Calif.

APRIL 13–15: Symposium On Modern Network Synthesis, II sponsored by Polytechnic Institute of Brooklyn, Engineering Societies Bldg., New York, N. Y.

APRIL 15–16: Ninth Annual Spring Technical Conference, Cincinnati IRE; Engineering Society Bldg., Cincinnati, Ohio.

APRIL 18–22: 77th semi annual convention of SMPTE, Drake Hotel, Chicago, Ill.

APRIL 19–21: Twelfth British Radio Components Show, Grosvenor House, London.

APRIL 24–28: Scientific Apparatus Makers Association Annual Meeting, The Greenbriar, White Sulphur Springs, West Va.

APRIL 25–26: Conference on Automatic Control, ASME, University of Michigan, Ann Arbor, Mich.

APRIL 27–29: Seventh Regional Technical Conference and Trade Show, IRE, Westward Ho Hotel, Phoenix, Ariz.

APRIL 29–30: New England Radio-Electronics Meeting, IRE, Sheraton Plaza Hotel, Boston, Mass.

MAY 2–5: Third Annual Semiconductor Symposium of the Electrochemical Society, Cincinnati, Ohio.

MAY 3–5: URSI Spring Meeting, National Bureau of Standards, Washington, D. C.

MAY 13: Automation, Engineering For Tomorrow, Symposium, Engineering School, Michigan State College, East Lansing, Mich.

MAY 16–19: Electronic Parts Distributors Show, Conrad Hilton Hotel, Chicago.

MAY 18–20: Annual National Telemetering Conference and Exhibit sponsored by IRE, AIEE, IAS, ISA; Hotel Morrison, Chicago, Ill.

MAY 19–21: Global Communications Conference, sponsored by AFCA; Hotel Commodore, New York, N. Y.

MAY 23–25: Ninth Annual Convention of the American Society for Quality Control, Hotels Statler and New Yorker, New York, N. Y.

MAY 24–26: Ninth Annual NARTB Broadcast Engineering Conference, Washington, D. C.

MAY 26–27: Electronic Components Conference, Los Angeles, Calif.

JUNE 2–3: IRE Materials Symposium, Convention Hall, Philadelphia, Pa.

JUNE 3–5: ARRL Hudson Division Convention and Amateur Radio Equipment Show, Hotel Adelon, Long Beach, N. Y.

JUNE 6–8: Fourth Annual Convention and Trade Show, National Community Television Association, Park Sheraton Hotel, New York, N. Y.

JUNE 20–25: Symposium on Electromagnetic Wave Theory sponsored by URSI and the University of Michigan, Ann Arbor, Mich.

AUG. 24–26: 1955 WESCON, Civic Auditorium and Fairmount Hotel, San Francisco, Calif.

AUG. 26–SEPT. 4: Great German Radio, Gramophone and TV Exhibition, Dusseldorf, Germany.

SEPT. 12–16: Tenth Annual Instrument Conference & Exhibit, ISA, Shrine Exposition Hall and Auditorium, Los Angeles, Calif.

SEPT. 28–29: Industrial Electronics Conference, AIEE, Rackham Memorial Auditorium, Detroit, Mich.

OCT. 3–7: National Electronics Conference, Chicago, Ill.

Industry Shorts

► **Sales** and revenues of approximately $20 billion annually for the electronics industry within the next decade were forecast by Sylvania.

► **New** cut in the U.S. listing of critical occupations and essential industries which serves as a basis for draft deferments, doesn't touch the electronics industry. Still on the critical occupational listing are professional engineers, all branches, and electronic technicians.

► **Radar** installations on British merchant ships totaled 2,271 at the end of February, 1954, according to the Ministry of Transport. Present rate of installation is estimated at about 450 a year.

► **Number** of licensed tv sets in Japan totaled 48,125 in February, an increase of nearly 10,000 since the beginning of the year.

► **Mistake** in hiring a salesman costs the average company more than $6,000, according to the American Management Association.

WIDE RANGE WIDE SWEEP- Sweeping OSCILLATOR

The KAY CALIBRATED *Mega-Sweep*

- ***Continuously Tunable Thru Video VHF and UHF Frequencies, 50KC-950MC Range***
- ***Sweep Widths to 40 MC***
- ***Single Dial Tuning***

Used with a standard cathode ray oscilloscope, the Kay Calibrated *Mega-Sweep* will display the response characteristic of wide band circuits over the frequency range of approximately 50 kc to 950 mc. It features a calibrated dial indication of the approximate output frequency. The center frequency of the sweeping output voltage may thus be set to an accuracy of about 10%. The calibrated *Mega-Sweep* is the ideal instrument for use in alignment of amplifiers and filters . . . also as an FM source of wide range for instructional and lab purposes.

SPECIFICATIONS

Freq. Range: 50 kc to 1000 mc.

Freq. Sweep: Sawtooth, adjustable to 40 mc. Repetition rate, 50 to 100 c/s.

RF Output: *High*, approx. 100 mv max. into open circuit. *Low*, 5 mv into open circuit.

RF Output Control: Microwave attenuator continuously variable to 26 db.

Output Waveform: Less than 5% harmonic distortion at max. output.

Meter: Provides crystal detector current for peak output.

Regulated Power Supply: 105-125 v., 50 to 60 cps. Power Input, 100 watts.

Send for Catalog 110-A

$495 f.o.b. factory

Dept. E-4

KAY ELECTRIC COMPANY

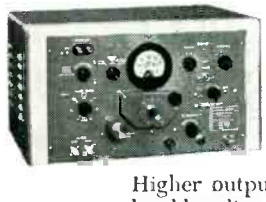
14 MAPLE AVENUE PINE BROOK, N. J.

KAY SWEEPING OSCILLATORS for every application

KAY

Mega-Sweep

Widest range of the Kay line of sweeping oscillators. Provides continuous frequency coverage up through UHF-TV bands — 50 kc to 1000 mc. Widely used in radar system development and in alignment and testing of TV and FM systems and components, as well as wide band IF and RF amplifiers and filters. Freq. range, 10 mc to 950 mc. *Write for Catalog 100-A.* Price, **$465** f.o.b. factory.



KAY
111-A CALIBRATED

Mega-Sweep

Higher output model calibrated *Mega-Sweep*, with zero level baseline. Higher output facilitates frequency response testing of UHF converters or tuners. Wider sweep width permits multi-channel response viewing. Zero level baseline is convenient means of measuring gain of test circuit.

SPECIFICATIONS

Frequency Range	Output Impedance	Output Voltage (Into Load)
1. 10 mc—950 mc	70 ohms unbalanced	0.15 Volts
2. 450 mc—900 mc	300 ohms balanced	0.3 Volts

Sweep Width: Continuously variable to approx. 40 mc max.

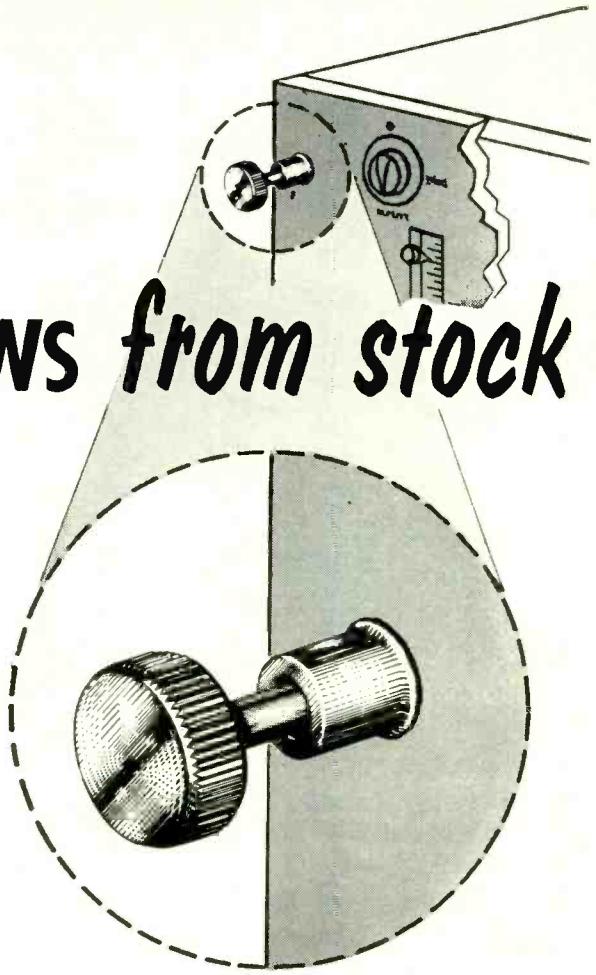
Write for Catalog 111-A Price, **$575** f.o.b. factory

KAY 112-A CALIBRATED *Mega-Sweep*

Same as 111-A, except total frequency range is 800 mc to 1200 mc. *Catalog 112-A.* Price, **$575** f.o.b. factory.

reduce costs with SOUTHCO®

CAPTIVE PANEL SCREWS from stock



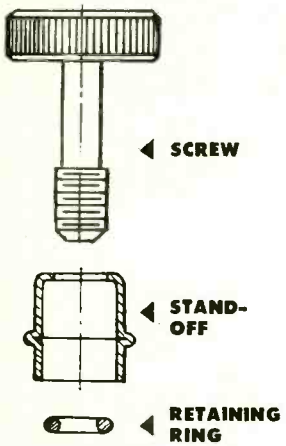
Here's a low-cost retractable screw fastener to save you assembly time and to eliminate the frequent need for costly special design fasteners. Unmatched for fast, economical use by assemblers of electronic units and other paneled cabinets.

"Floating" screw insures easy alignment no matter how many screws are engaged in a single panel. No special skills or tools needed; installation fast and simple.

3 head sizes and 3 standard thread sizes available. On special order, slotted heads, stainless steel screws, and extra long screws.

Write for complete information. Southco Division, South Chester Corporation, 233 Industrial Highway, Lester, Pa.

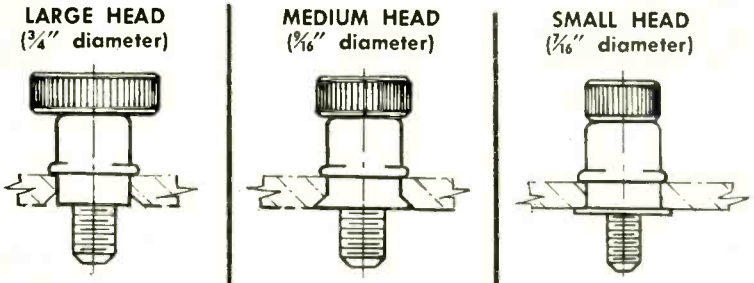
3 SIMPLE COMPONENTS



EASILY INSTALLED

Stand-off is flanged into panel. Screw is inserted into oversize hole in stand-off and locked in place by retaining ring, which is passed over threads to seat behind last thread.

A SIZE FOR EVERY NEED



Screw and stand-off are brass, nickel plated. Retaining ring is durable vinyl plastic.

Choice of stand-offs for each screw size to accommodate panel thicknesses from 1/16" to 17/64".

SOUTHCO® FASTENERS

PAWL • SCREW AND SPRING • DRIVE RIVETS • ANCHOR NUTS • ENGINEERED SPECIALTIES

OFFICES IN PRINCIPAL CITIES

WHEREVER TWO OR MORE PARTS ARE FASTENED TOGETHER, STANDARD AND SPECIAL DESIGNS FOR IMPROVED PERFORMANCE AND LOWER PRODUCTION COSTS

These successful uses of

PHELPS DODGE BONDEZE*

magnet wire . . .

Suggest

UNLIMITED NEW

COILS

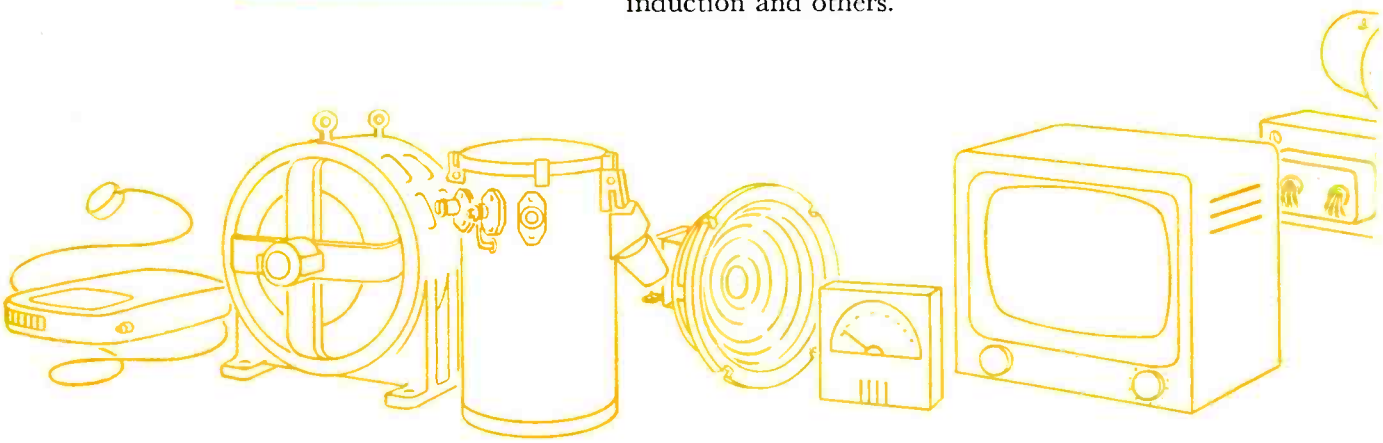
Random-wound, Layer or Paper-section for potentiometers, telephones, brakes and clutches, clocks and timers, hearing aids, instruments, speakers, relays, television, radio and other applications.

TRANSFORMERS

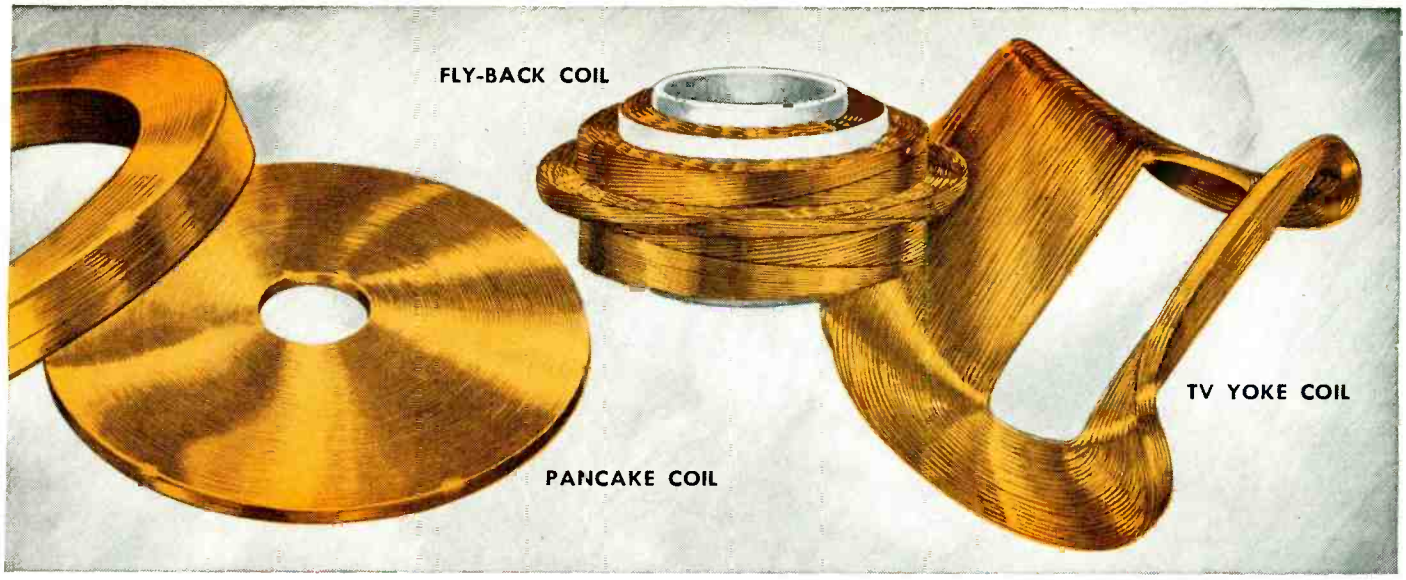
Paper-section, Random-wound, Oil-filled, Air-cooled and High Voltage for distribution, current, X-ray, television, radio and other applications.

MOTORS

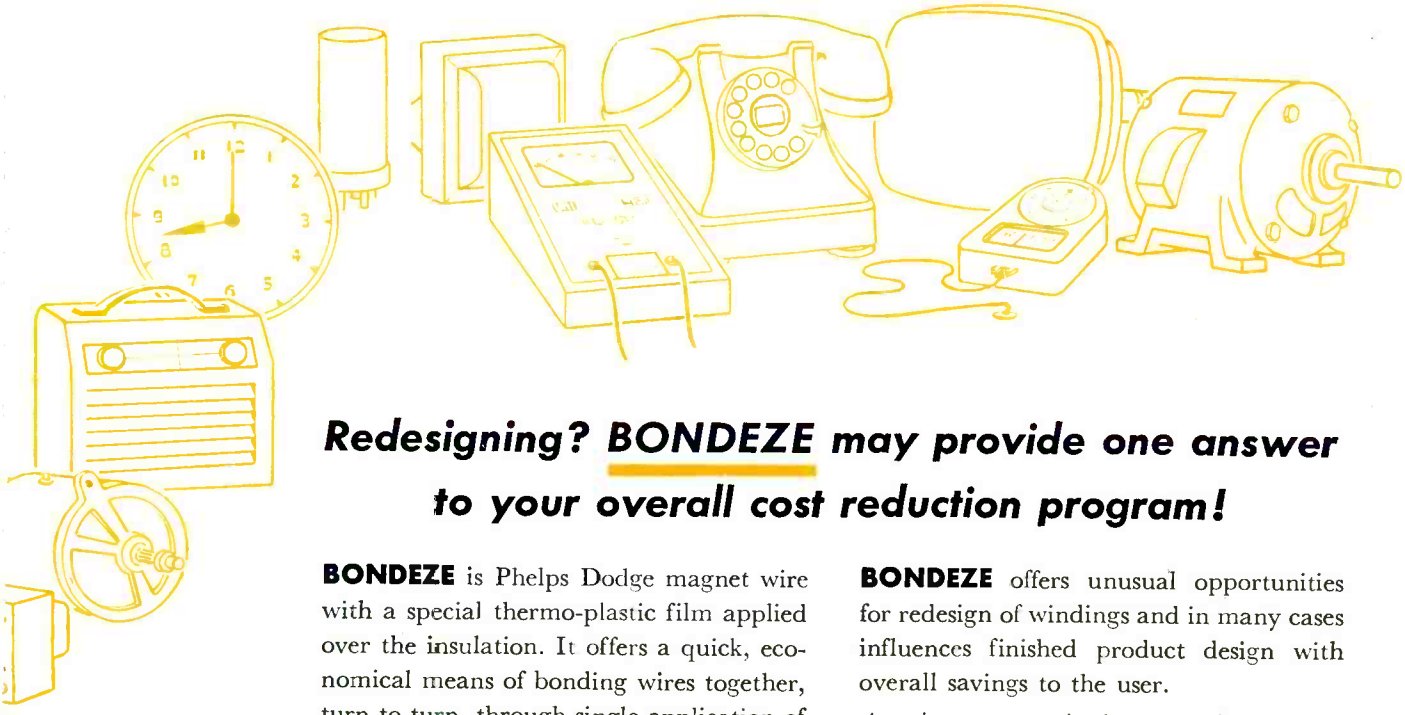
Windings for shaded pole, series fields, instruments, induction and others.



First for Lasting Quality—from Mine to Market!



APPLICATIONS !



Redesigning? BONDEZE may provide one answer to your overall cost reduction program!

BONDEZE is Phelps Dodge magnet wire with a special thermo-plastic film applied over the insulation. It offers a quick, economical means of bonding wires together, turn to turn, through single application of heat or solvents.

BONDEZE offers unusual opportunities for redesign of windings and in many cases influences finished product design with overall savings to the user.

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

*BONDEZE is a Phelps Dodge Trademark

PHELPS DODGE COPPER PRODUCTS CORPORATION
MINE TO MARKET
REG. U. S. PAT. OFF.

PHELPS DODGE COPPER PRODUCTS CORPORATION

INCA MANUFACTURING DIVISION

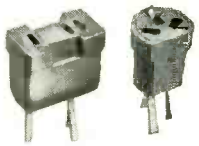
FORT WAYNE, INDIANA

after 25 YEARS the Newest in Sockets is still EBY!

1955

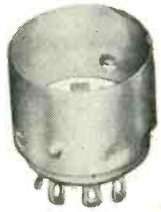
1930

Transistor Sockets



Subminiature Sockets

UHF Radiation Sockets



Printed Circuit Sockets

High Voltage Sockets and Color TV Components

Today as a quarter of a century ago, Eby Tube Sockets lead the field with advanced design and quality workmanship. You can depend on Eby . . . keeping pace with the industry.

TUBE SOCKETS • PLUGS & CONNECTORS • JACKS • BINDING POSTS and other ELECTRONIC, COMMUNICATIONS, RADIO and TELEVISION COMPONENTS

HUGH H. EBY CO.

4708 Stenton Ave., Philadelphia 44, Pa.

ELECTRONICS Charter-Year Advertiser

Want more information? Use post card on last page.

X10,000

BRUSH

Announces . . .

NEW D.C. RECORDING AMPLIFIER WITH GAIN OF 10,000!

This new Brush Amplifier is outstanding for stability, high gain and reliability. When used with any of the Brush Oscillographs it permits instantaneous chart recordings of both low-level D.C. or A.C. voltages with full range of frequencies. The use of a chopper-stabilized feedback circuit eliminates the need for matched tubes and permits an extended frequency response. More than ever, Brush Recording Systems provide full range instrumentation for your measurement problems.

Ask your Brush representative or send coupon for complete information. Brush Electronics Company, Cleveland 14, Ohio.

CHECK THESE FEATURES!

HIGH SENSITIVITY – 100 microvolts per chart mm.

HIGH STABILITY IN USE – less than ¼ chart mm. drift/hour.

EXTENDED FREQUENCY RESPONSE – D.C. to 100 cycles per second with Brush Direct-Writing Oscillographs. With photographic equipment, frequency range can be extended to 5,000 cps.

LOW NOISE – less than 25 microvolts equivalent input.

INPUT IMPEDANCE – 1 megohm.

INTERNAL CALIBRATION – 2 millivolts and 1 volt.

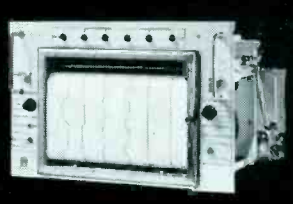
FULL RANGE INSTRUMENTATION

Brush Amplifiers and Oscillographs provide multi-channel recording of voltages from D.C. to 100 cycles per second – or of physical phenomena such as stress, strain, torque, force, temperatures, etc.

Brush Recording Systems give you the greatest flexibility in measurements. You have a choice of 8 or 16 chart speeds; ink or electric writing.

Units can be mounted in standard racks, or portable cabinets.

Four-Channel Oscillograph



Six-Channel Oscillograph

Dual-Channel D.C. Amplifier

Universal* Amplifier

*Trade-Mark

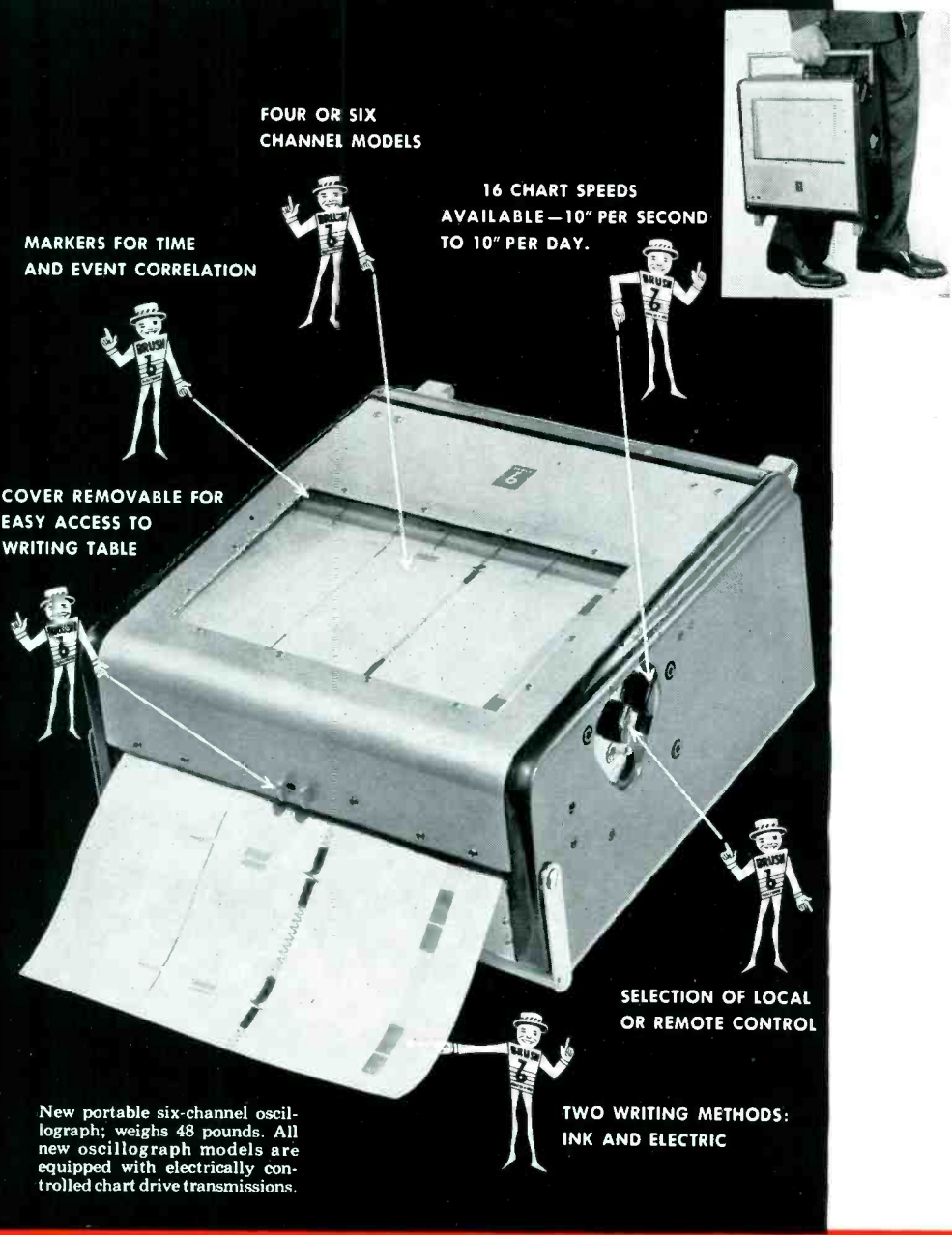
BRUSH ELECTRONICS COMPANY

INDUSTRIAL AND RESEARCH INSTRUMENTS
PIEZOELECTRIC MATERIALS • ACOUSTIC DEVICES
MAGNETIC RECORDING EQUIPMENT AND COMPONENTS

BRUSH ELECTRONICS

Division of Clevite Corporation

USE COUPON →



New portable six-channel oscillograph; weighs 48 pounds. All new oscillograph models are equipped with electrically controlled chart drive transmissions.

NOW!

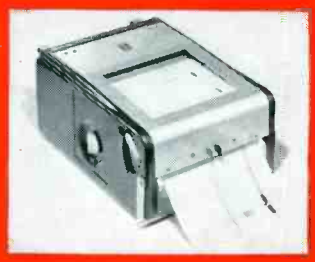
PORTABLES

JOIN THE "NEW LOOK" IN RECORDING SYSTEMS

● The new Brush Portable Recording Systems are light in weight, easy to use. In addition, they provide the full-range instrumentation for portable use now offered by Brush's line of rack and console-mounted systems.

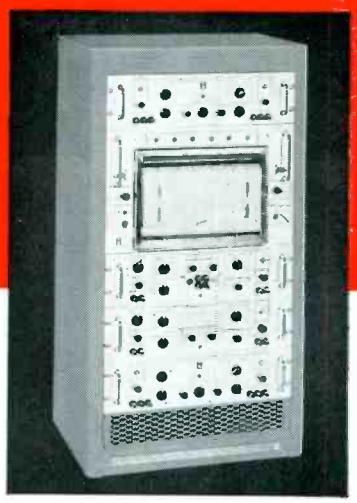
You can record a greater range of signals with optimum resolution than with any other direct-writing oscillographs. These new units have the widest chart speed range available—from 10" per day to 10" per second. Units can be equipped for both ink and electric writing.

Brush Portable Recording Systems are ideal for field tests, are easy to set up, and do not require skilled technicians. Find out how they can simplify your testing problems—electrical variables, stress, strain, torque, vibration, etc. Send coupon for booklet, or call your Brush representative for complete information.



New portable four-channel oscillograph; weighs 36 pounds.

New Universal* Amplifier with portable case.



Amplifiers can be equipped with portable carrying cases or installed directly in standard racks. Both rack-mounting and portable oscillographs have the same electrically controlled chart drive transmissions.

*Trade-Mark

BRUSH ELECTRONICS COMPANY, Dept. K-4
3405 Perkins Avenue
Cleveland 14, Ohio

☐ Please have your representative call.
☐ Please send bulletins on the following: (check below)

_____ New high gain Amplifier.
_____ Portable Recording Systems.
_____ Recording Systems for rack or console mounting.

Name _____
Title _____
Company _____
Address _____
City _____ *State* _____

BRUSH ELECTRONICS COMPANY

INDUSTRIAL AND RESEARCH INSTRUMENTS
PIEZOELECTRIC MATERIALS • ACOUSTIC DEVICES
MAGNETIC RECORDING EQUIPMENT AND COMPONENTS

Division of Clevite Corporation

This NWL TRANSFORMER in continuous use for 6 years, 16 hours per day at RCA Tube Division Harrison Plant

This transformer, one of 25 is located in the tube-manufacturing department on the first floor. The rating is 220/8KV C.T. 7.2 KVA. On the floors above there are 95 similar transformers. Elsewhere in this plant NWL Transformers have been giving satisfactory service for 12 years under the same severe conditions.

Above photo, with cabinet safety door open, shows NWL Transformer in place. Photo at left shows tube-sealex machine. Cabinet containing transformer is shown within circle.

NWL Transformers, such as that illustrated above, are used to supply high voltage D.C. current to the tube-sealing machines shown in lower photo. RCA produces only products of the highest quality. Because of the extremely accurate work done by these machines under high speed production schedules, it is imperative that the transformers be completely dependable over long periods of time. NWL Transformers meet these conditions.

NWL

ESTABLISHED 1920

Kothefer

From 10 VA to 300 KVA Dry-Type only. Both open and encased. 1, 2, and 3 Phase. 15 to 400 Cycles.

WINDING LABORATORIES

P. O. Box 455 - Dept. 102, TRENTON, NEW JERSEY

NEMA

Manufacturers of Electrical Transformers—Testing Equipment

Quality, value,

hp Vacuum

NEW! -hp- 400AB
10 cps to 600 KC

Outstanding value, general application

Model 400AB is a new precision voltmeter offering more utility, dependability and dollar value than any audio voltmeter *-hp-* has ever built!

Replacing the widely-used Model 400A in the *-hp-* line, the new instrument permits measurements from 0.3 millivolts to 300 volts over the full frequency range. Stability and sensitivity are extremely high, and accuracy is ±2% full scale from 20 cps to 100 KC. Input impedance is 10 megohms to prevent disturbance to circuits under test. Readings are direct in voltage and dbm. Special switching arrangements eliminate switching transients.

BROAD USEFULNESS

Model 400AB is particularly suited for measuring amplifier gain, network response or output level on audio, carrier current and supersonic ranges. In many applications it indicates hum and noise level directly and will also serve as a null indicator. It contains an output connector and can be used as an amplifier. With an oscilloscope, it also monitors waveform of a voltage under test. The instrument is moderately priced, yet of typical *-hp-* quality construction throughout including long-life electrolytic condensers and etched circuitry. *-hp-* 400AB is unusually compact, requiring only a 7" x 7" square of bench space.

SPECIFICATIONS

Voltage Range: 0.3 mv to 300 volts. 11 ranges, selected with front panel switch. Full scale readings of:

0.003 volts	0.1	3.0	100
0.01	0.3	10.0	300
0.03	1.0	30	

Frequency Range: 10 cps to 600 KC.

Accuracy: With nominal line voltage ±10% (103 volts to 127 volts), overall accuracy is within ±2% of full scale, 20 cps to 100 KC, ±3% 10 cps to 600 KC.

Calibration: Reads rms value of sine wave. Voltage indication proportional to average value of applied wave. Linear voltage scales, 0 to 3 and 0 to 1.0; db scale, —12 db to +2 db, based on 0 dbm = 1 mw in 600 ohms, 10 db intervals between ranges.

Input Impedance: 10 megohms shunted by 25 μμf.

Amplifier: Output terminals are provided so voltmeter can be used to amplify small signals or monitor waveforms under test with an oscilloscope.

Power: 115/230 volts ±10%, 50/1,000 cps, approximately 70 watts.

Dimensions: 11¼" high, 7¼" wide, 7" deep (cabinet mount). Rack mounting available on 19" x 7" panel.

Weight: Net 15 lbs. Shipping 25 lbs. (cabinet mount).

Price: $200.00.

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

COMPLETE COVERAGE | **HEWLETT-PACKARD**

complete coverage

Tube Voltmeters

-hp- 400D

10 cps to 4 MC
Ultimate quality, high sensitivity

Model 400D is perhaps the finest vacuum tube voltmeter built today.

Accuracy is within 2% to 1 MC, and approximately 56 db of feedback in mid-range assures high stability and freedom from calibration change due to external conditions. An exclusive switching arrangement in the cathode circuit minimizes switching transients. Input impedance is 10 megohms; circuits under test are not disturbed.

-hp- 400D is protected against overloads as great as 600 v on all ranges. The indicating meter is a special 1%, 1 ma instrument. Coupling and bypass condensers are sealed; electrolytic condensers are long-life types. Circuitry and mechanical layout are clean, permitting easy access to all parts. A rugged new all-metal case insures easy portability, and occupies minimum bench space.

SPECIFICATIONS

Voltage Range: 12 ranges: 0.001, 0.003, 0.01, 0.03, 0.1, 0.3, 1, 3, 10, 30, 100, and 300 volts.

Frequency Range: 10 cps to 4 MC.

Accuracy: Overall ±2% 20 cps to 1 MC; ±3% 20 cps to 2 MC; ±5% 10 cps to 4 MC.

Long Term Stability: Better than 0.5%, 20 cps to 1 MC.

Calibration: rms value of sine wave. Linear scale.

Input Impedance: 10 megohms, 15 μμf shunt, 1 to 300 v, 25 μμf shunt, 0.001 to 0.3 v.

Amplifier: Includes output terminals for oscilloscope use.

Power: 115/230 v ±10%, 50/1,000 cps, 70 watts.

Size: 7¼" wide, 11¼" high, 11¾" deep. Wt. 18 lbs.

Price: $225.00.

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

-hp- 410B

20 cps to 700 MC
Industry's standard for vhf-uhf

The famous 410B combines in one instrument an ac voltmeter covering frequencies from audio to radar, a dc voltmeter with over 100 megohms input impedance, and an ohmmeter, capable of measuring resistances from 0.2 ohms to 500 megohms. The instrument covers its tremendous frequency range with an accuracy of ±3% full scale, and has a frequency response flat within ±1 db up to 700 MC. (Good indications to 3,000 MC.)

For ac, *-hp-* 410B employs a special *-hp-* diode probe which places a capacity across the circuit under test of only 1.5 μμf. Input impedance at low frequencies is 10 megohms and resonant frequency is approximately 1,500 MC. The probe is the finest available, and will measure audio, supersonic, rf or vhf voltages more accurately than any other on the market. The dc section has an input impedance of 100 megohms with outstandingly low drift and high calibration stability. The meter requires only one zero adjustment for all ranges.

SPECIFICATIONS

Ranges: ac: 0 to 300 v, 6 ranges.
dc: 0 to 1,000 v, 7 ranges.
ohms: 0.2 ohms to 500 megohms, 7 ranges.

Accuracy: ±3% full scale.

Frequency Response: Flat within ±1 db to 700 MC.

Input Impedance: 1.5 μμf capacity, 10 megohms at low frequencies.

Power: 115/230 v ±10%, 50/1,000 cps, 40 watts.

Size: 7" wide, 11½" high, 8¼" deep. Wt. 12 lbs.

Price: $245.00.

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

HEWLETT-PACKARD COMPANY
3327A PAGE MILL ROAD • PALO ALTO, CALIF.

Please send me additional information on

400AB_____ 400D_____ 410B_____

Name_____

Company_____

Street_____

City_____ Zone___ State_____

hp INSTRUMENTS

Complete instrumentation

IMPEDANCE

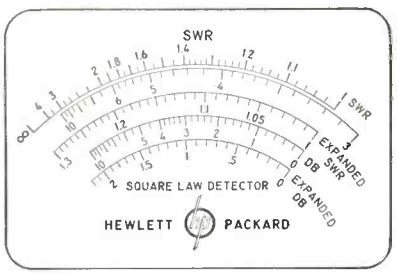


Figure 1. Meter face, –*hp*– 415B. Note expanded scale giving full scale indication of SWR as low as 1.3. All measurements are made in high-accuracy upper portion of scale.

New! -*hp*- 415B

Standing Wave Indicator

- **measures SWR with slotted lines**
- **expanded scale for low SWR**
- **output for recorder operation**
- **measures rf signals with crystal detector**
- **serves as bridge or null indicator**

Model 415B is a completely new instrument, similar to the time-tested –*hp*– 415A Standing Wave Indicator but containing advanced features never before incorporated in one instrument of its type.

Basically a high gain, low noise, amplifier operating at fixed audio frequency, –*hp*– 415B presents output on a square-law calibrated VTVM reading direct in SWR or db for operation with crystal detectors such as –*hp*– 440A and 444A, and –*hp*– 805 series slotted lines.

Among the many extra-convenience features are an expanded meter scale for accurate measurement of very flat systems (see Figure 1); a 200 K input for null or bridge measurements; a bias current for use with bolometers; a 70 db calibrated range adjustable in 5 db steps so meter may be read in a favorable portion of the scale. Output connections for recorder operation are also provided.

–*hp*– 415B is normally supplied for operation at 1,000 cps, but simple "plug-in" units are available on special order for other frequencies 315 to 3,000 MC. The instrument is housed in a light, compact, rugged metal case.

SPECIFICATIONS

Frequency: 1,000 cps ± 2%.
Sensitivity: 0.1 μv at a 200 ohm level for full scale deflection.
Noise Level: Less than 0.03 μf ref. to input operated from a 200 ohm resistor.
Amplifier Q: 25 ± 5.
Calibration: Square law. Meter reads SWR, db.
Range: 70 db. Input attenuator provides 60 db in 10 db steps. Accuracy ± 0.1 db per 10 db step.
Scale Selector: "Normal," "Expand," and "— 5 db."
Meter Scales: SWR: 1-4; SWR: 3-10; Expanded SWR: 1-1.3; db: 0-10; Expanded db: 0-2.
Gain Control: Adjusts to convenient reference level. Range approx. 30 db.
Input: "Bolo" (200 ohms). Bias provided for 8.4 ma bolometer or 1/100 amp. fuse; or 4.3 ma low current bolometer.
"Crystal." 200 ohms for crystal rectifier.
"200,000 ohms." High impedance for crystal rectifier as null detector.
Output: Jack for recording milliammeter having 1 ma full scale deflection, internal resistance of approx. 1,500 ohms.
Input Connector: BNC.
Power: 115/230 v ± 10%, 50/60 cps, 60 watts.
Dimensions: Cabinet Mount: 7¼" wide, 11¼" high, 14" deep. Rack Mount: 19" wide, 7" high, 11" deep.
Weight: Net 20 lbs. Shipping 35 lbs. (cabinet mount).
Price: $200.00.

COMPLETE COVERAGE | **HEWLETT-PACKARD**

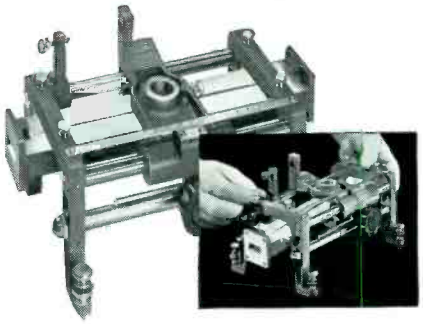
for fast, accurate

MEASUREMENTS

Use this equipment with 415B

FOR SLOTTED LINE SWR MEASUREMENT

–hp– 809B Universal Probe Carriage



Convenient, all-purpose carriage. Operates with 6 *–hp–* slotted sections, waveguide or coax, covering frequencies 3 to 18 KMC. Sections interchange in 30 seconds. Precision construction, calibrated in mm to 0.1 mm; dial gauge may be mounted. Operates with *–hp–* 440, 442, 444 detectors, probes. $160.00

–hp– 810A/B Waveguide Slotted Sections

–hp– 810B, for 809B carriage, is a flanged waveguide section with tapered slots minimizing reflections. Available in 5 bands, 3.95 through 18.0 KMC. *–hp–* S810A (illustrated), complete slotted section including integral probe carriage, 2.6 to 3.95 KMC band only. *–hp–* 810B, (all sizes) $90.00. *–hp–* S810A, $450.00.

–hp– 806A Coaxial Slotted Section

Precision slotted section for SWR measurements 3 to 12 KMC. Mounts in *–hp–* 809B Universal Probe Carriage. Used with Type N connectors, flexible cables. $200.00

–hp– 805A/B Coaxial Slotted Sections

Coaxial units designed for fast, accurate SWR measurement. Exclusive parallel plane design, for operation over all frequencies 500 to 4,000 MC. Identical except *–hp–* 805A is for Type N connectors, and flexible cables; *–hp–* 805B is for rigid 7/8" RG44/U line. *–hp–* 805A or 805B, $475.00.

Use this equipment with 415B

FOR CONVENIENT RF DETECTION

–hp– 420A Crystal Detector

Uses a silicon crystal to detect rf signals in Type N coaxial line. Covers frequencies 10 MC to 12.5 KMC. Flat frequency response, sensitivity 0.1 v/mw. Uses modified 1N76 crystal. $50.00.

–hp– 444A Untuned Probe

A 1N26 crystal plus a small antenna in a convenient, easy-to-use housing. Variable penetration depth, no tuning required. Sensitivity equal to single- or double-tuned probes. Range 2.4 to 18.0 KMC. Mounts in 809B carriage. $50.00.

–hp– 440A Detector Mount

Simple, convenient means of detecting rf energy in coax or waveguide systems. For coax, operates at any frequency 2.4 to 12.4 KMC. Uses either silicon crystals or bolometer. Includes built-in by-pass. Coax connector for UG21B/U Type N; BNC output jack. One-adjustment, single stub tuning. $85.00.

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

–hp– 442B Broadband Probe

Provides variable probe penetration. Probe position held by friction or locking ring. Type N rf jack simplifies receiver connection. Shielded, designed to minimize spurious response. Fits 809B carriage or others with 3/4" bore. With *–hp–* 440A, forms sensitive rf detector for slotted waveguide sections. *–hp–* 442B. $35.00.

–hp– X421A Detector Mount

Accurate, square-law crystal detector for waveguide reflectometer measurements. Composed of waveguide-to-coax adapter terminated in a 1N26 crystal operating into a load resistance selected for accurate square-law operation over an input power range exceeding 40 db. 8.2 to 12.4 KMC; sensitivity 1 mv/0.01 mw, SWR less than 1.5 full range. $75.00 (including crystal).

OTHER IMPEDANCE EQUIPMENT

–hp– 803A vhf Bridge

Gives fast, direct readings of any impedance between 50 and 500 MC. Measures by sampling electric and magnetic fields in transmission line. Usable for comparative measurements 5 to 1,000 MC. Impedance range 2 to 2,000 ohms. Phase angle −90° to +90° at 52 MC and above. Also measures SWR, % reflected power, vhf system flatness. $495.00.

–hp– 417A vhf Detector

For use with *–hp–* 803A bridge; or general laboratory use. Super-regenerative receiver, 10 to 500 MC. 5 bands. Approx. 5 μv sensitivity over entire band. Direct reading frequency control; thoroughly shielded. $250.00

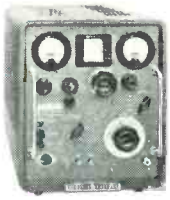
See Your *–hp–* Field Engineer for Complete Details, or Write Direct

HEWLETT-PACKARD COMPANY
3328A PAGE MILL RD., PALO ALTO, CALIF., U.S.A.
Cable "HEWPACK"
Field Engineers in All Principal Areas

hp INSTRUMENTS | COMPLETE COVERAGE

-hp- 608D vhf Signal Generator

10 to 420 MC, highest stability. Very low incidental FM or frequency drift. Calibrated output 0.1 μv to 0.5 v full range. Crystal calibrator frequency check accurate within 0.01% each 5 MC. Master oscillator, intermediate and output amplifier circuit. Premium quality performance, direct frequency and output calibration. $1,050.00



-hp- 608C vhf Signal Generator

10 to 480 MC. High power output (1 v max.). Master oscillator-power amplifier output circuit. Direct calibration of frequency and output power. Constant internal impedance, broad modulation capabilities. Ideal for measuring gain, selectivity, sensitivity or image rejection of receivers, amplifiers, other vhf equipment. Also drives bridges, slotted lines, antennas, etc. $950.00

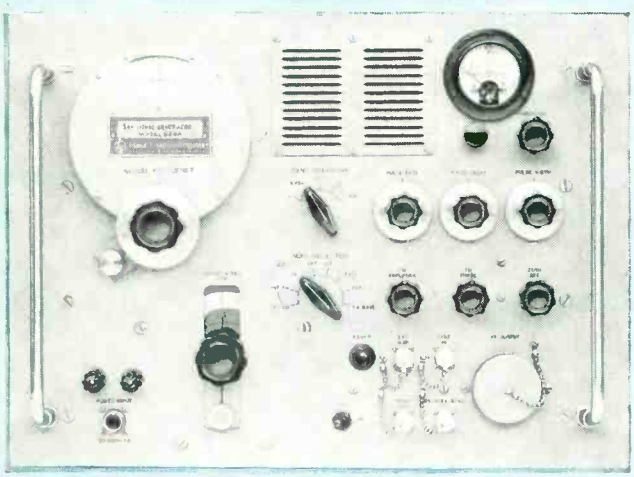
-hp- 612A uhf Signal Generator

450 to 1,220 MC. Master oscillator — power amplifier generator for uhf and TV measurements including gain, selectivity, sensitivity, image rejection. Directly set and read; no charts or interpolation. Low incidental FM high quality broad band sine wave or TV modulation to 5 MC. Pulse modulation, good rf pulses 0.2 μsec or longer. $1,200.00

Direct reading, wide range,

hp SIGNAL

World's most complete



NEW! 15 to 21 KMC

-hp- 628A shf Signal Generator

10 db output. SWR 1.2

High accuracy, high stability

Direct output, frequency control

No calibration charts required

Wide modulation, pulsing facilities

BRIEF SPECIFICATIONS -hp- 628A

Frequency Range: 15 to 21 KMC, one band. Automatic repeller voltage tracking and mode selection.

Frequency Calibration: Direct. Accuracy better than ±1%.

Output Range: 10 mw to 1 μμw. (+10 dbm to —90 dbm, 0 dbm = 1 mw) SWR better than 1.5 at +10 db; 1.2 at +7 db and lower.

Output Accuracy: Better than ±1 db.

Modulation: Internal or external pulse, FM, square wave.

Internal Pulse Modulation: Repetition rate variable 40 to 4,000 pps; pulse width variable 0.5 to 10 μsec.

Sync Out: Signals: 20 to 50 v into 1,000 ohms; rise time better than 1 μsec.
a. Simultaneous with rf pulse
b. Advance of rf pulse 3 to 300 μsec.

External Sync: a. Sine wave 40 to 4,000 cps, amplitude 5 to 50 v rms.
b. Pulse: 0 to 4,000 pps, amplitude 5 to 50 v rms. Pulse width 0.5 to 5 μsec, rise time 0.1 to 1 μsec.

Modulation:
Internal Square Wave: Variable 40 to 4,000 cps.

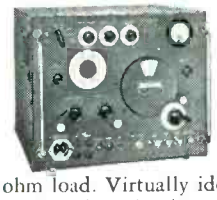
COMPLETE COVERAGE | **HEWLETT-PACKARD**

-hp- 614A/616A uhf Signal Generators

800 to 2,100 MC (614A); 1,800 to 4,000 MC (616A). Frequency accuracy ±1%, calibrated output 0 to —127 dbm, output accuracy ±1 db, —10 to —127 dbm. Provides internal or external pulse modulation, also FM, CW and square wave output. Simple operation, direct tuning, no calibration charts. $1,950.00.

-hp- 618B shf Signal Generator

3,800 to 7,600 MC. Frequency accuracy ±1%, 0 to —127 dbm. Output accuracy ±2 db, —7 to —127 dbm. SWR 2. Offers internal and external pulse and square wave modulation, internal saw-tooth FM sweep, external FM, and CW. Rep rate variable 40 to 4,000 pps, variable pulse widths, pulse sync circuits. $2,250.00



-hp- 620A shf Signal Generator

7,000 to 11,000 MC, output 0.1 μv to 0.071 v into 50 ohm load. Virtually identical to -hp- 618B in operation, circuitry, convenience features. Carrier frequency directly set and read; no voltage adjustment during operation. Rf output also directly set and read; no calibration charts or frequency correction. Compact; quality construction. $2,250.00

high power, outstanding value!

GENERATORS

high quality line

New -hp- 628A is the first commercial signal generator to bring to this microwave range the wide range, high power, direct-reading convenience and accuracy heretofore available only at lower frequencies.

Operation of the new instrument is identical with that of other -hp- generators. Frequencies are directly set and read on a single tuning dial. No calibration charts are required. Output voltage is directly set and read, and the unique 10 db output is 10 to 20 db better than that provided by the best spot-frequency generators now available. SWR is extremely low—better than 1.5 at full power up and better than 1.2 at levels of +7 db and down. Internal pulse, fm, or square wave modulation is provided, as well as facilities for external pulse and FM modulation.

vhf versatility for shf

The wide range, high stability and accuracy of -hp- 628A make it ideal for almost all types of microwave measurements requiring precisely known and controlled shf signals. The instrument is particularly designed for speed and convenience in microwave receiver sensitivity measurements, in determining selectivity or rejection, signal-to-noise ratio, SWR and antenna gain.

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

See your -hp- field engineer or write direct for details

HEWLETT-PACKARD COMPANY
3329A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U. S. A.
Cable "HEWPACK"
Field engineers in all principal areas

Internal FM: At power line frequency, deviation to ±5 MC.
External Pulse: Requires amplitude 15 to 70 v peak, pos. or neg.; width 0.5 to 2,500 μsec.
External Frequency: Capacitive coupling to klystron repeller. Max. deviation approx. ±5 MC.
Output Connector: 0.590" x 0.335" waveguide WR51; flat cover flange.
Power: 115 v ±10%, 50/420 cps, approx. 200 watts.
Size: 19" wide, 14" high, 13" deep. Net wt. 65 lbs.
Price: $3,000.00.

HEWLETT-PACKARD COMPANY
3329A PAGE MILL ROAD • PALO ALTO, CALIF.

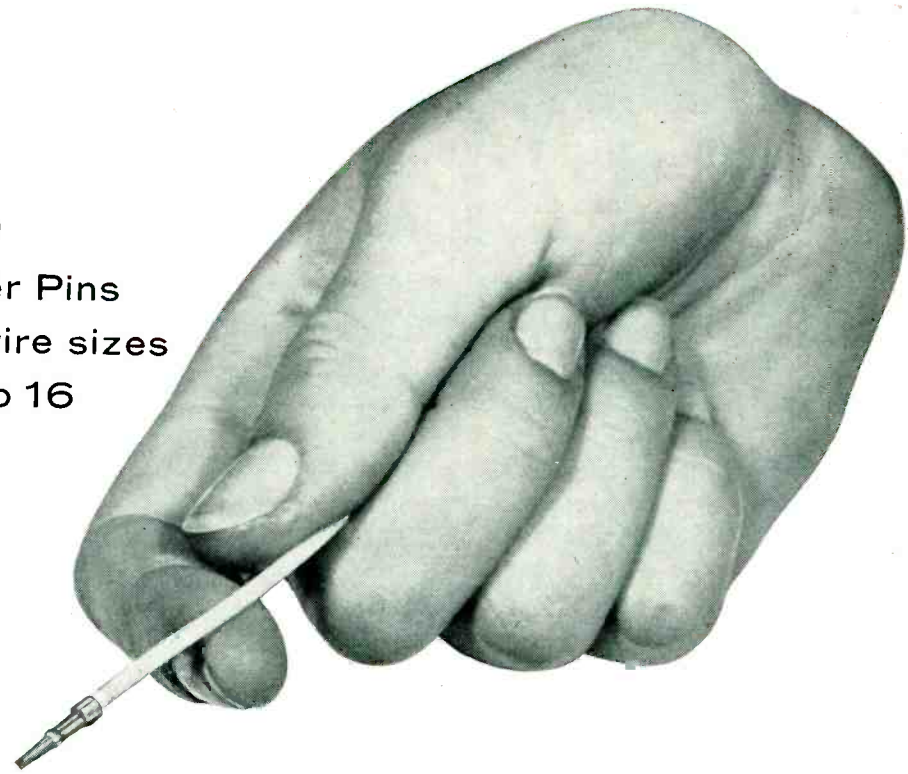
Please send information on:

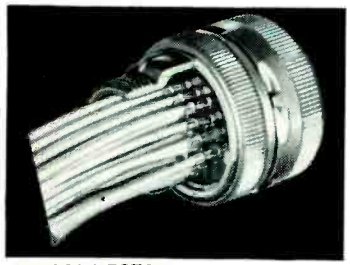
☐ 608C ☐ 608D ☐ 612A ☐ 614A
☐ 616A ☐ 618B ☐ 620A ☐ 628A

Name_____
Company_____
Street_____
City_____ Zone____ State_____

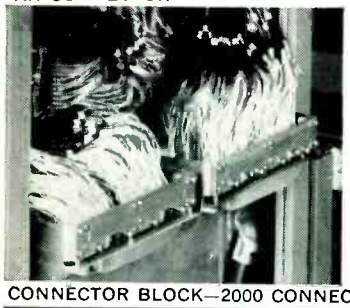
hp INSTRUMENTS | **COMPLETE COVERAGE**

AMP
Taper Pins
for wire sizes
26 to 16

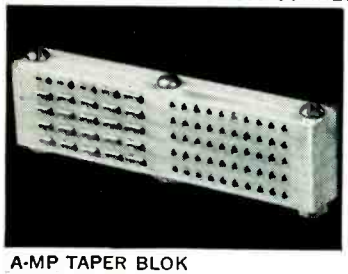




AN CONNECTOR



CONNECTOR BLOCK—2000 CONNECTIONS



A-MP TAPER BLOK

less cube
WITH ADDED

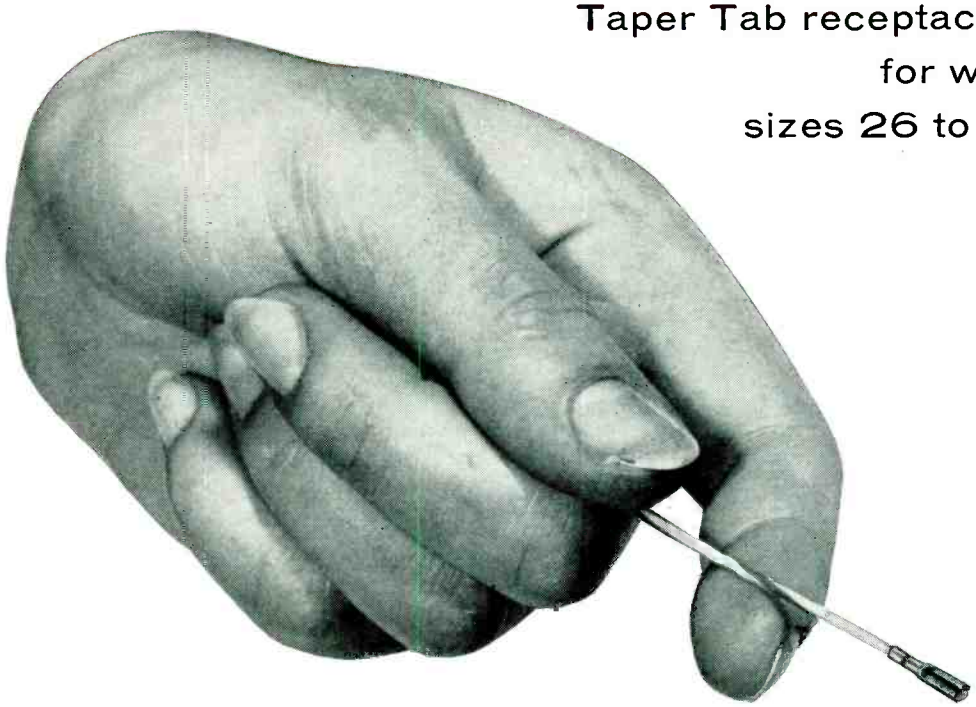
Another example of AMP's Creative Approach to Better Wiring

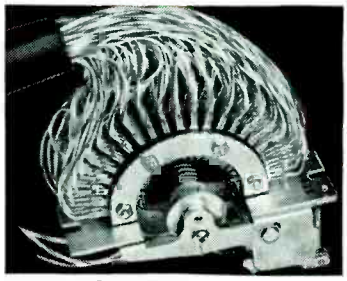
AMP

Taper Tab receptacles

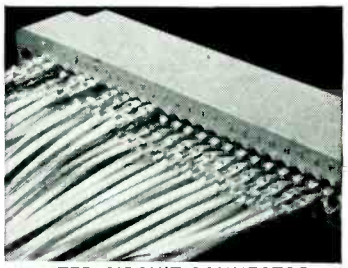
for wire

sizes 26 to 18

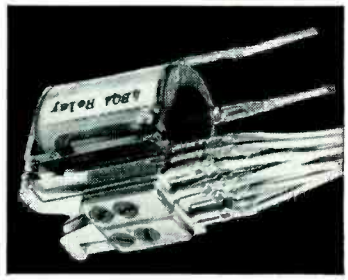




STEPPING SWITCH



PRINTED CIRCUIT CONNECTOR



TAPER TAB RELAYS

and cost

RELIABILITY

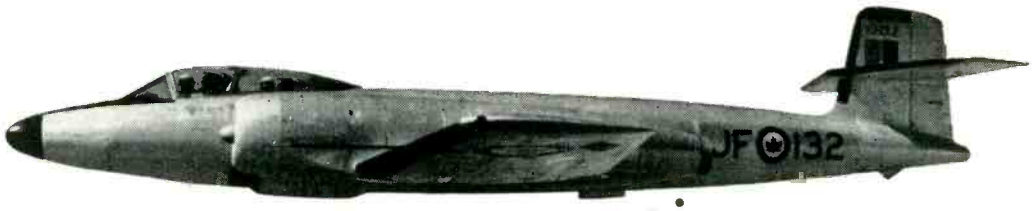
Cubic restrictions have brought about a whole new concept of wire termination. The AMP Taper Technique with AMP taper pins, tab receptacles, blocks and modified miniature components will help you take full advantage of small wire, small insulation and small space for your wire terminations.

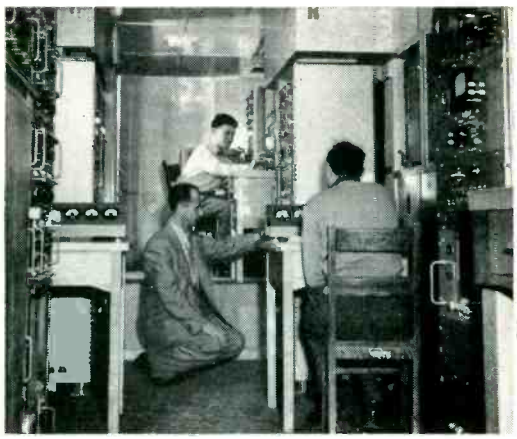
AMP

Send today for your copy of our brochure, AMP's Creative Approach to Better Wiring.

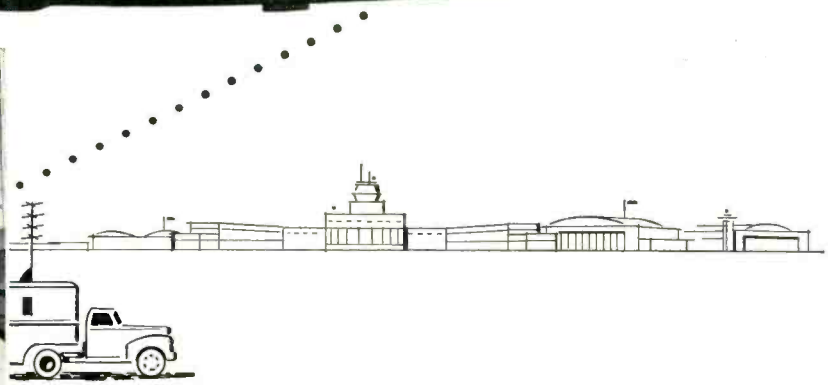
AIRCRAFT-MARINE PRODUCTS, INC., 2100 Paxton Street, Harrisburg, Pa.

In Canada: AIRCRAFT-MARINE PRODUCTS OF CANADA, LTD., 1764 Avenue Road, Toronto 12, Ontario, Canada





Inside this mobile ground station, test flights of the Avro Canada CF-100, RCAF all-weather interceptor for continental defense, are "seen" and "heard" with Ampex magnetic tape recorders.



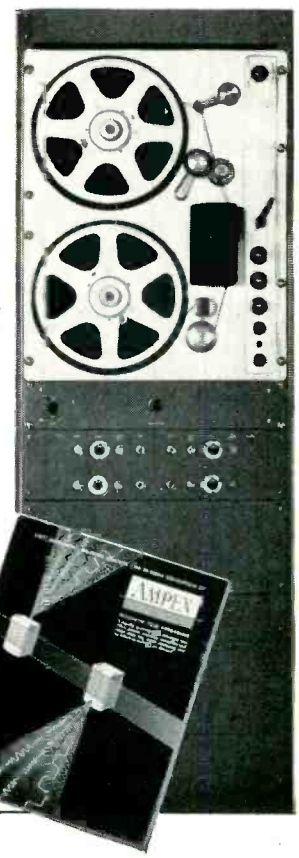
MAGNETIC TAPE RECORDING
helps produce better designs faster

At Avro Canada, as at all major flight test locations in the United States, all test data transmitted by radio telemetry is permanently — completely — and accurately — recorded on magnetic tape. This involves 67 separate items of information **per second** — items such as temperature, pressure, revolutions, acceleration, yaw and roll. The data is "magnified" on playback at slow speed, permitting Avro engineers and aerodynamists to critically study each parameter in gas turbine and airframe designs.

AVRO USES AMPEX MAGNETIC TAPE RECORDERS

The Aircraft Division of Avro Canada, Malton, Ontario is one of the many diversified users of Ampex magnetic tape equipment for data recording.

Ampex recorders are widely preferred for special installations requiring broad frequency response, precise timing, extreme stability of tape motion, high shock resistance and reliable accuracy on transients. A wide variety of models are available featuring pulse width, frequency modulated and direct recording techniques . . . for airborne, mobile, rack-mount or console applications . . . in any frequency band from zero to 100,000 cycles per second.



Ampex 306 Recorder, 0 to 5,000 cps.

MAGNETIC RECORDING HAS MANY APPLICATIONS

Because magnetic tape data is convertible to any form (e.g.: oscillograph traces, scope reading, computor feeds, control signals or punched cards), many practical applications result. Examples are:

- **Data Computing**
- **Machine Control**
- **Advanced Research**
- **Test Cycling**
- **Process Regulation**

LET AMPEX EVALUATE YOUR SPECIAL NEEDS

Without obligation, find out whether "live memory" techniques can be applied to your operation, or ask for our 16-page illustrated bulletin. Contact your nearest Ampex representative, or write or wire Dept. E-1892

AMPEX CORPORATION

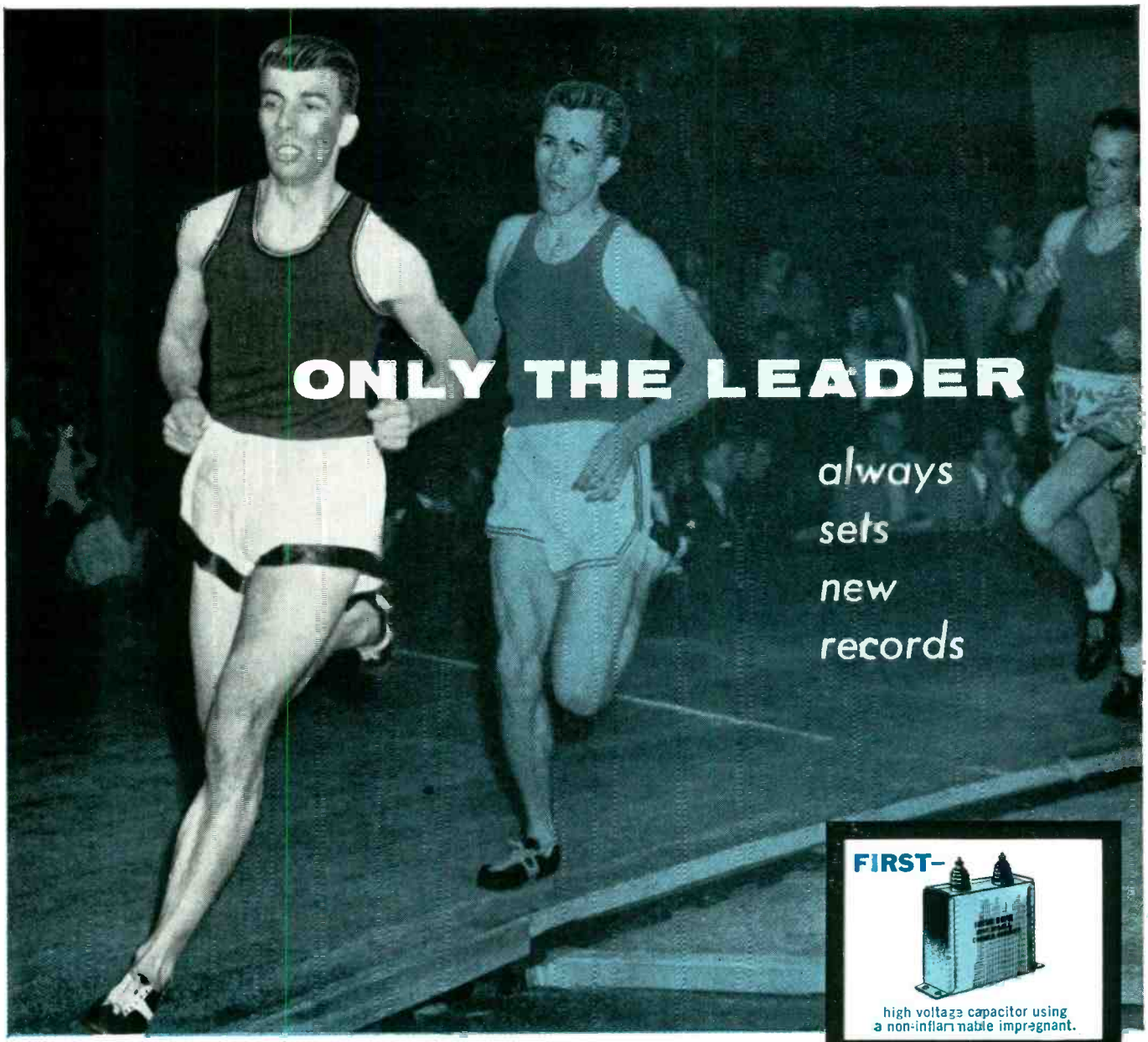
Signature of Perfection in Magnetic Recorders

934 CHARTER STREET, REDWOOD CITY, CALIFORNIA

BRANCH OFFICES: New York; Chicago; Atlanta; San Francisco; Dayton; College Park, Maryland (Washington, D.C. Area).

DISTRIBUTORS FOR AMPEX INSTRUMENTATION RECORDERS: Radio Shack, Boston; Bing Crosby Enterprises, Los Angeles; Southwestern Engineering & Equipment, Dallas and Houston; Canadian General Electric Company, Canada

Distributors of Ampex Audio Equipment listed in your phone directory.



Setting the first 4-minute mile record or making the first miniaturized capacitors are feats that only leaders can accomplish. Cornell-Dubilier's miniaturized capacitor is only one of hundreds of new capacitor developments that we have contributed in our record-making history.

FIRST–

high voltage capacitor using a non-inflammable impregnant.

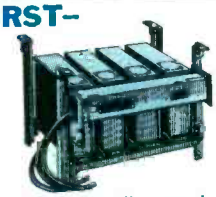
FIRST–

high voltage paper capacitor oil impregnated and filled.

C-D...45 YEARS OF FAMOUS FIRSTS

Typical of these "famous firsts" are the three examples shown here . . . *proof* that whatever your capacitor requirements may be, your needs can be filled by C-D. Write to Cornell-Dubilier Electric Corp., Dept. K-45, South Plainfield, N.J.

FIRST–



box-type, ceiling-mounting, power capacitors.

CONSISTENTLY DEPENDABLE

CORNELL-DUBILIER CAPACITORS

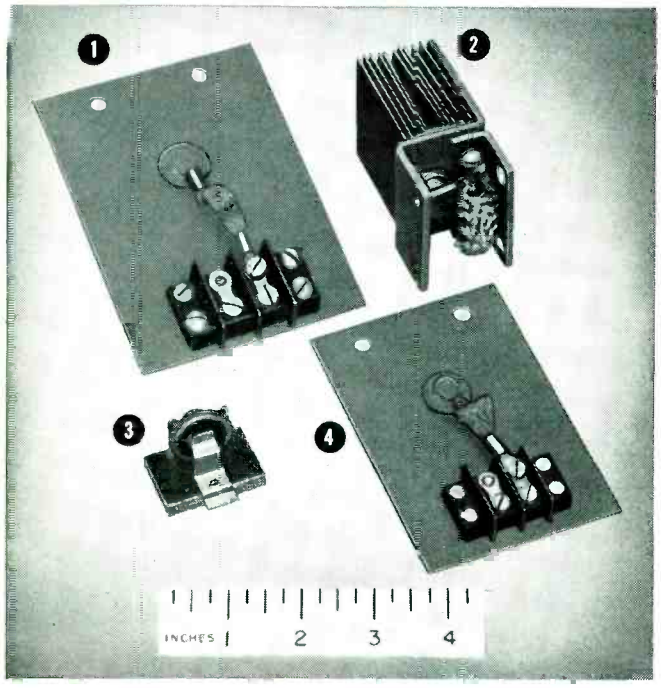
PLANTS IN SO. PLAINFIELD, N. J.; NEW BEDFORD, WORCESTER AND CAMBRIDGE, MASS.; PROVIDENCE AND HOPE VALLEY, R. I.; INDIANAPOLIS, IND.; SANFORD AND FUQUAY SPRINGS, N. C.; SUBSIDIARY, RADIART CORP., CLEVELAND, OHIO.

THERE ARE MORE C-D CAPACITORS IN USE TODAY THAN ANY OTHER MAKE

ELECTRONICS Charter-Year Advertiser

DESIGNER'S

Germanium rectifiers have smallest size/watt output



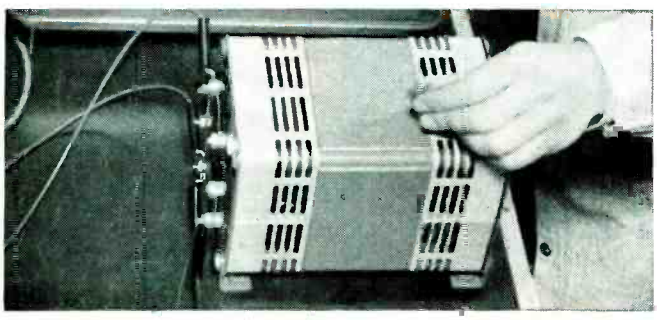
G-E germanium rectifiers operate at extremely high current densities—highest output voltage per cell of all existing metallic rectifiers. A large d-c output is obtained using fewer cells than other types of rectifiers, resulting in a smaller, more compact rectifier. In addition, germanium has the lightest weight per watt output of existing metallic rectifiers. These features give them broad application in power conversion wherever size and weight requirements are at a premium.

(1) Type RA2 has cell mounted on copper cooling fin—fan-cooled at 200 feet per minute. Ratings from 6 volts, 20 amperes d-c up to 26 volts, 8 amperes d-c.

(2) Type RA3 has cell mounted on copper block with multiple fins—blower cooled at 1000 feet per minute. Available in ratings up to 20 volts, 75 amperes d-c.

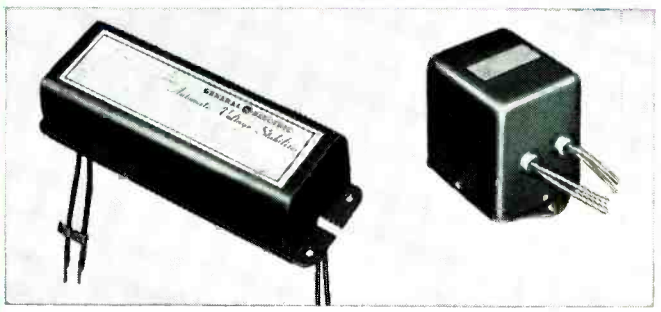
(3) Sealed type RA1 is convection-cooled with ratings from 6 volts, 0.5 amperes up to 50 volts, 0.4 amperes d-c.

(4) Convection-cooled type RA2 has cell mounted on copper cooling fin. Available up to 26 volts, 4 amperes d-c. G-E germanium rectifiers have extremely low reverse leakage and low forward voltage loss. Regulation is less than five percent when operated at the high current densities permissible with germanium. **Bulletin GEA-5773B gives details.**



Inductrols regulate circuits up to 600 V, 520 KVA

Where a-c, or rectified d-c, voltage or current is critical, these induction regulators reduce erratic performance, increase life of your equipment. Available for automatic, motor, or hand (above) operation, Inductrols feature negligible wave-form distortion, begin corrections to 1% accuracy within 1 second. **GEC-795 covers single-phase, GEA-5824 the 3-phase models.**



G-E voltage stabilizers give ±1% voltage control

G-E voltage stabilizers reduce the need to derate components to compensate for voltage fluctuations. Single-phase, standard line units from 15 VA to 1000 VA are available to correct fluctuations between 95 and 130, or 190 and 260 volts within ±1%. Rapid-response stabilizers correct for voltage changes in less than two cycles. Stabilizers limit short-circuit current and help safeguard the load. **Check bulletin GEA-5754A.**

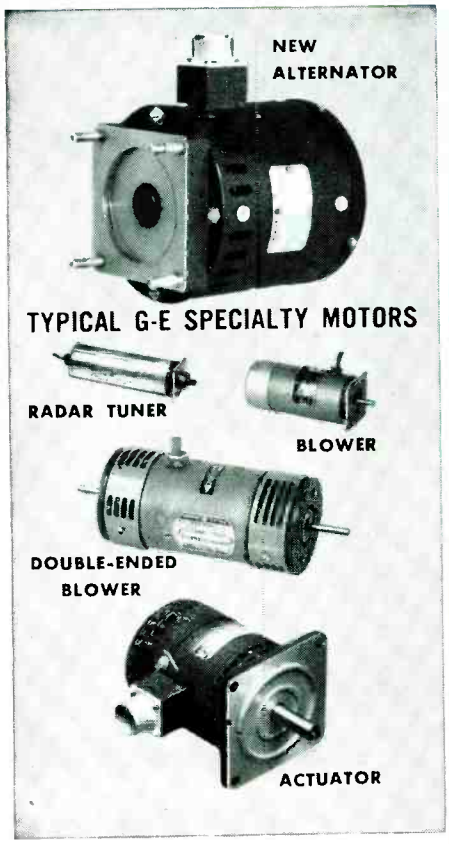
GENERAL ELECTRIC

ELECTRONICS Charter-Year Advertiser

Want more information? Use post card on last page.

DIGEST

TIMELY HIGHLIGHTS ON G-E COMPONENTS

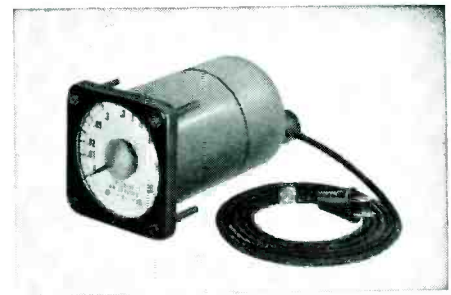


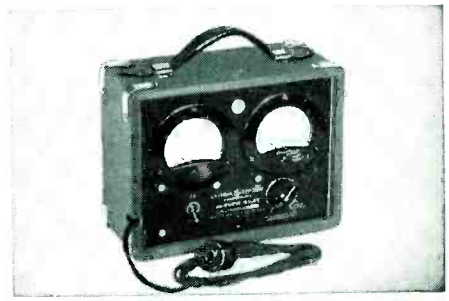
New 400-cycle alternator added to aircraft specialty motor line

Newly developed to withstand the tremendous range of shock, temperature and atmospheric conditions of guided-missile applications, this explosion-resistant 400-cycle alternator meets military specifications MIL-E 5272 procedure 1. Rated up to 1500 volt-amperes, 12,000 rpm, for output of 115 volts, this unit is designed to be driven by a wide variety of d-c, a-c, turbine, and jet-air drives.

Rigid testing assures that this alternator—and all G-E aircraft and armament motors—meet your design needs. Your specifications are all that G-E engineers need to begin applying their motor experience to your aircraft and armament problems. **Write for GEA-6269 (new 400-cycle alternator) or GEC-988 (aircraft and ordnance motors).**

G-E vacuum gages measure pressures from 0 to 20,000 microns





Two G-E vacuum gages accurately measure pressures in such applications as electronic tube manufacture, vacuum coating and plating.

MOLECULAR VACUUM GAGE is available in two calibration types—one for dry air indicates pressures between 0 and 20,000 microns; the other type has a linear scale of 100 uniform divisions which can be calibrated by the customer for measuring other gases. There's no primary element to burn out or replace—gage measures absolute pressure of dry air in direct readings of mm of mercury.

THERMOCOUPLE VACUUM GAGE has range from 1 to 200 microns and 1 to 1000 microns of mercury. Sensitive to both condensable and noncondensable gases, gage does not require recalibration when tubes are interchanged. **For further information write for bulletin GEC-385C (Thermocouple Vacuum Gage) and GEC-986 (Molecular Vacuum Gage)**

G-E potentiometer balances to ±2 microvolts

G.E.'s self-balancing potentiometer converts small d-c voltage to measurable currents—ideal for analyzing electronic circuits because it does not appreciably load the measured circuit. Compact, portable, and self-contained, unit's accuracy is ±2 microvolts or 0.2 percent, whichever is greater. Wide range output permits use of indicating or recording instruments having resistance up to 1500 ohms. **For further information, check coupon for bulletin GEC-367B.**

Section B667-30
General Electric Company
Schenectady 5, New York

Please send me the following bulletins

√ for reference only × for immediate project

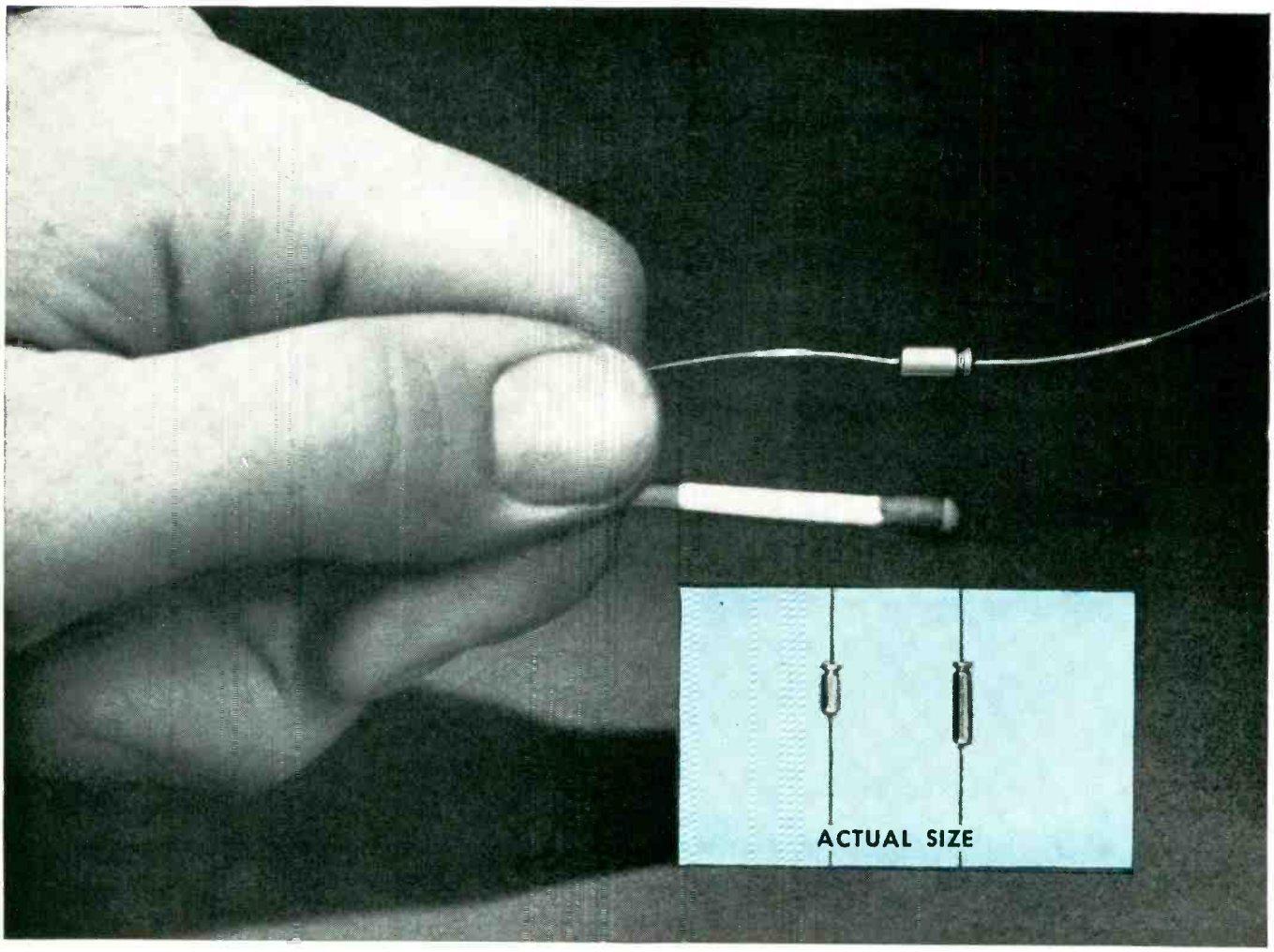
- ☐ GEA-5773B Germanium Rectifiers
- ☐ GEA-5754 Voltage Stabilizers
- ☐ GEC-795A Single-phase Inductrols
- ☐ GEA-5824 3-phase Inductrols
- ☐ GEA-6269 400-cycle Alternator
- ☐ GEC-988 Aircraft and Ordnance Motors
- ☐ GEC-986 Molecular Vacuum Gage
- ☐ GEC-385C Thermocouple Vacuum Gage
- ☐ GEC-367B Self-balancing Potentiometer

NAME.....

COMPANY.....

CITY..... STATE.....

TURN PAGE FOR MORE G-E COMPONENT HIGHLIGHTS



Specify G-E micro-miniature Tantalytic* capacitors wherever large capacitance is required in small space

G-E micro-miniature Tantalytic capacitors represent the ultimate in capacitor miniaturization, and are perfect companions for the transistor or for use in any miniaturized assembly. They have found wide application in hearing aids, paging systems and other transistorized devices. Standard ratings are stocked, and samples are immediately available.

Production quantities can be supplied 6 to 8 weeks after your order is received. Ratings range from 4 to 20 volts, and from 1 to 8 microfarads in the 5/16 in. long case—higher capacitance in the ½ in. case size. Stability of the oxide formation and inert characteristics of the tantalum metal give long operating life over a wide temperature range—−20 C to +50 C. They may be stored at −65 C. Capacitance tolerance is −0% to +200%.

Micro-miniature capacitors are designed for non-resonant, non-critical applications such as coupling, by-pass and filtering where bulk capacity is useful. Their size—smaller than the head of a match—is an advantage over paper capacitors wherever space is at a premium, and their shelf life and electrical stability is greater than aluminum electrolytic capacitors.

G-E capacitors are completely sealed against leakage or contamination of the interior and employ only a non-acid electrolyte. Each unit is identified with a color code. **For further information, contact your nearest G-E Apparatus Sales Office, or check coupon for Bulletin GEA-6065A.**

*Reg. Trade-mark of General Electric Company.

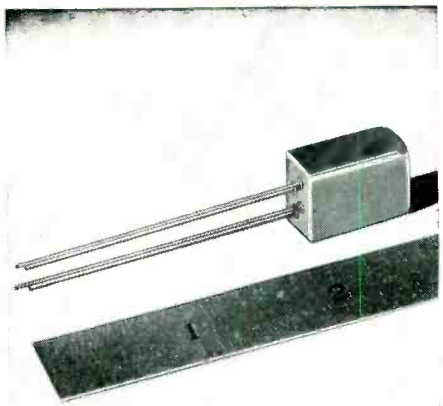
GENERAL ELECTRIC

ELECTRONICS Charter-Year Advertiser

Want more information? Use post card on last page.

DESIGNER'S DIGEST

TIMELY HIGHLIGHTS ON G-E COMPONENTS

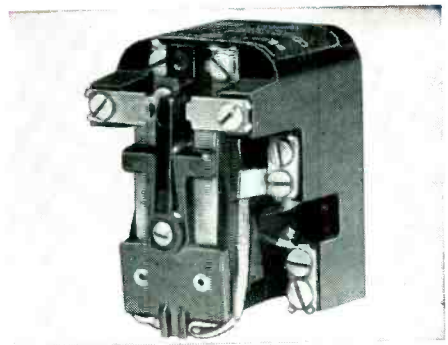


New subminiature transformers tailored to your needs

G-E engineers designed the new line of subminiature transformers to meet a variety of electronic applications. Available in five case designs, 13/16 in. to 1-7/16 in. high, these new transformers are metal-clad and hermetically sealed. The new subminiature transformers can be designed to withstand high-potential test voltages of 1250 volts RMS, or altitudes up to 100,000 feet.

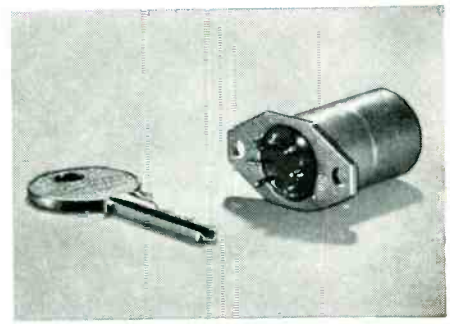
In addition, these units will operate in ambient temperatures of 125 C. The smallest unit (illustrated) is designed for printed circuits and has solid wire conductors two inches long for easy, direct connection to the other components. **Your nearest G-E Apparatus Sales Office will give you complete details.**

Small-size general-purpose relay



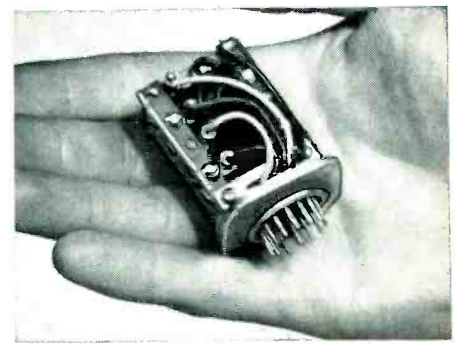
High current rating, small size, and extremely long life make this general-purpose relay ideal for electronic equipment where space is at a premium and reliability is of prime importance. Contact arrangements include DPDT, DPST, SPST, and SPST-double-break. Accessories are available for metal- and compound-base mounting as well as jack assembly for plug-in applications. **Check coupon for bulletin GEC-257C.**

Tiny relay withstands vibration



The G-E subminiature relay withstands vibration of 10g up to 500 cps and operates at temperatures up to 125 C. Lightweight and reliable, this relay has a low capacitance rating making it ideal for switching high frequency signals or pulses. Pickup time is 5 milliseconds or less and dropout time is 2 milliseconds or less. Coils are available for 400-cycle a-c voltage. **Bulletin GEA-6211.**

High-speed polarized relay



This hermetically sealed relay operates at speeds ranging from 250 microseconds to 1 millisecond. It can be adjusted for operating time of less than 250 microseconds, including bounce. Contact combinations up to 4PDT are available in a miniature enclosure 1-7/16 in.x 21/32 in. x 2-3/22 in.—net weight only 5 oz. The relay meets requirements of MIL-R-6106 and MIL-R-5757B. **Bulletin GEA-6212.**

EQUIPMENT FOR ELECTRONIC MANUFACTURERS

Components

Meters, instruments
Dynamotors
Capacitors
Transformers
Pulse-forming networks
Delay lines
Reactors
Motor-generator sets
Inductrols
Resistors
Voltage stabilizers
Fractional-hp motors
Rectifiers
Timers
Indicating lights
Control switches
Generators
Selsyns
Relays
Amplidynes
Amplistats
Terminal boards
Push buttons
Photovoltaic cells
Glass bushings

Development and Production Equipment

Soldering irons
Resistance-welding control
Current-limited high-potential tester
Insulation testers
Vacuum-tube voltmeter
Photoelectric recorders
Demagnetizers

Section B667-30
General Electric Company
Schenectady 5, New York

Please send me the following bulletins;
√ for reference only × for immediate project

☐ GEA-6065A Microminiature Tantalytic Capacitors
☐ GEC-257C General-purpose Relay
☐ GEA-6211 Subminiature Relay
☐ GEA-6212 Polarized Relay

Name.....
Company.....
City..... State.....

Valparaiso, Indiana, April, 1955 — The Indiana Steel Products Company, world's largest manufacturer of permanent magnets, has released information on the development of an important new product...a one-piece wound core.

Called the "Hyflux," its applications are the same as conventional C-type cores...distribution, welding, X-ray, lighting, and special transformers and saturable reactors.

The one-piece core consists of just one piece  instead of two pieces  as in the conventional C-type cores.

Because the one-piece core has but one air gap, instead of two, there is definite improvement in performance...and exciting current is normally lower, often by a significant amount. Vacuum impregnating is not necessary (only the sides of one-piece cores are varnished) and resulting electrical losses are eliminated.

Manufacturers using the new cores find that the simplified one-piece design cuts down assembly time, and permits important assembly cost reductions.

With C-cores, the two halves must be kept and used together to insure a flush fit of their ground pole faces...with one-piece cores there is no chance of mixing different pairs of halves. Nor is there the slight "tilt" sometimes present on the ground pole faces of C-cores.

Substantial manufacturing economies resulting from the new design are reflected in the price of the one-piece core.

So convinced is Indiana Steel that its new core will benefit transformer manufacturers that it has entered the magnetic core field...after 46 years of specializing in permanent magnets.

Hyflux "one-piece" wound cores are now available in the more popular 12-mil standard core sizes. You are invited to write for descriptive literature to: The Indiana Steel Products Company, Dept. A-4, Valparaiso, Indiana.

PERFORMANCE IS BUILT INTO THIS CHOPPER

Painted case resists corrosion and is hermetically sealed to the base so that this chopper operates reliably in any atmosphere from sea level to 50,000 feet.

Permanent magnet polarizes switching to provide phase sensitive mechanical modulation of low-level signals.

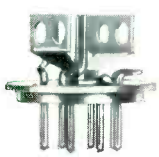
Drive coil is conservatively rated for 6.3 volts RMS $\pm$ 10% at 400 CPS $\pm$ 5%.

Vibrating reed is resonant well above operating frequency to assure that switching phase of 65 degrees remains within $\pm$ 15 degrees for all operating conditions.

Buffer plate counteracts any tendency to chatter at make and break.

Ceramic insulators provide at least 100 megohms between contacts and case for use in high-impedance circuits.

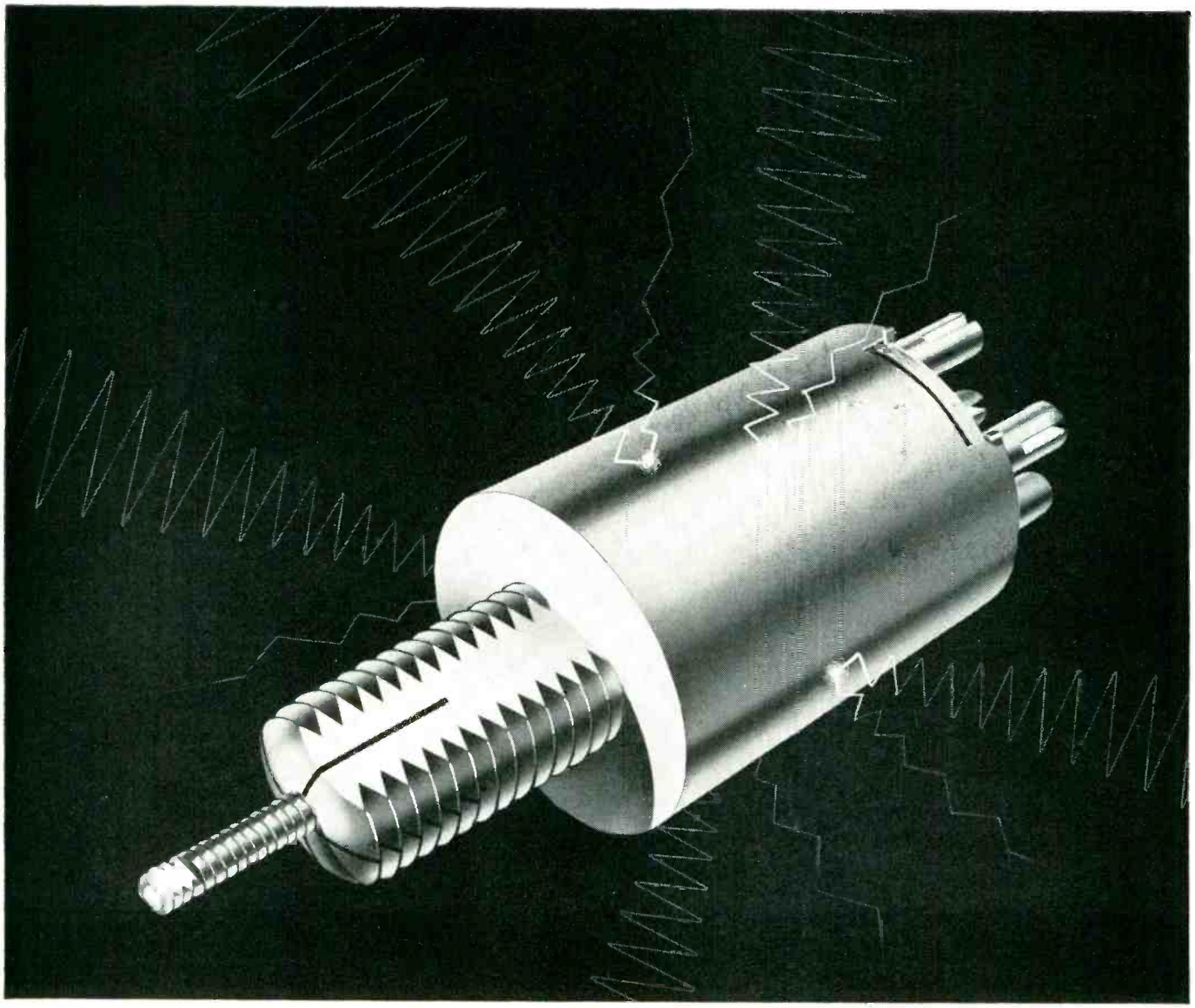
Wiping action on fixed contacts, as in all Airpax choppers, help assure rated life of 2,000 hours.



Miniature 7-pin tube-type base rigidly supports internal assembly of this Airpax Type 300 chopper so that it withstands shock and vibration.

For complete specifications write to

AIRPAX PRODUCTS COMPANY
DESIGNERS ENGINEERS
MIDDLE RIVER BALTIMORE 20, MD.



Built for close "combat" in tight spots

Into the construction of this coil form goes C.T.C.'s rigid *quality control* to highest production standards.

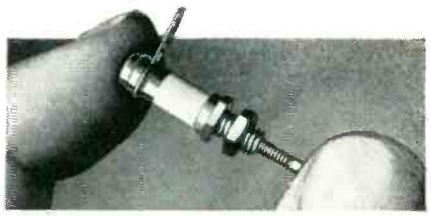
The result is another C.T.C. *first* — a miniaturized coil form (1/16" diameter by ½" high when mounted) that is shock-resistant and exceptionally rugged — shielded against radiation, electrically, and therefore ideal for "close quarter" use in I.F. strips and numerous designs where adjacent mounting is necessary.

C.T.C.'s policy of continuous step-by-step quality control in the manufacture of every component means guaranteed performance. Already certified materials are doubly checked before manufacture.

Whatever your component need — let C.T.C. solve your problem — with either custom or standard designs of *quality-controlled, guaranteed* components — including insulated terminals, coil forms, coils, swagers, terminal boards, diode clips, capacitors and a wide variety of hardware items.

Put *your* component problem up to C.T.C. now. For samples, specifications and prices — write today to Sales Engineering Dept., Cambridge Thermionic Corporation, 437 Concord Ave., Cambridge, Mass. On West Coast, contact E. V. Roberts, 5068 West Washington Blvd., Los Angeles 16 or 988 Market St., San Francisco, California.

Coil Form Data: C.T.C.'s LS-9 coil form has a brass shell enclosing a powdered-iron cup-core, tuning slug, phenolic coil form and silicone fibreglas terminal board. Three terminal boards are available with choice of two, three or four terminal layout. Forms, unassembled, may be had *without windings . . .* or *wound and assembled to your specifications.*



Capacitor: New CST-50 variable ceramic capacitor surpasses range of capacitors many times its size. Stands only 1 9/32" high when mounted, is less than ¼" in diameter and has an 8-32 thread mounting stud. A tunable element of unusual design practically eliminates losses due to air dielectric giving large minimum to maximum capacity range (1.5 to 12MMFD).

C T C

CAMBRIDGE THERMIONIC CORPORATION

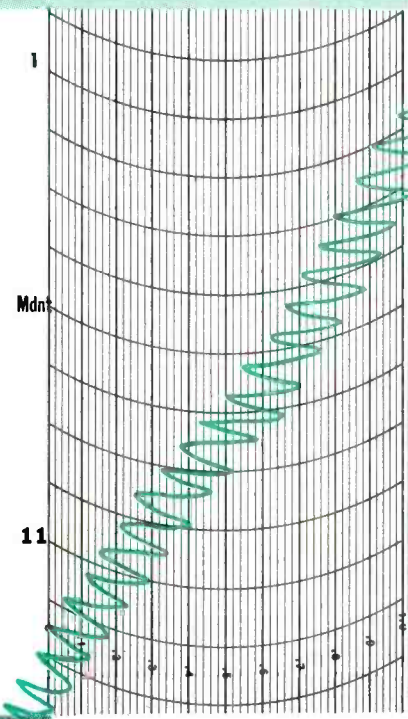
makers of guaranteed electronic components, custom or standard

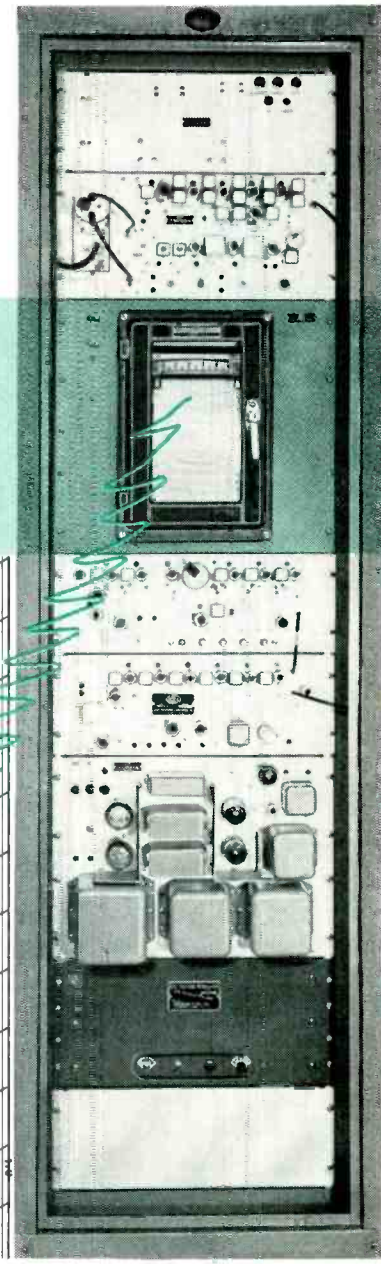
CELESTIAL SECRETS

Valuable information gathered in wave propogation studies conducted with REL radio equipment have opened a whole new concept of communications for commerce and national defense—now and in the future.

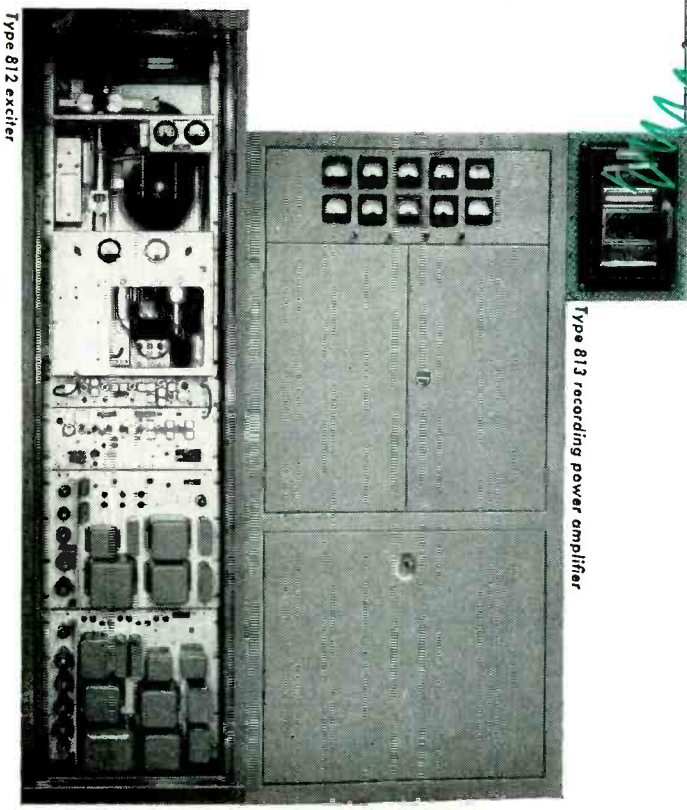
The REL apparatus pictured is specially engineered and manufactured for this field of research.

Third in a series describing REL versatility.





Type 814 recording receiver



Type 812 exciter

Type 813 recording power amplifier

REL

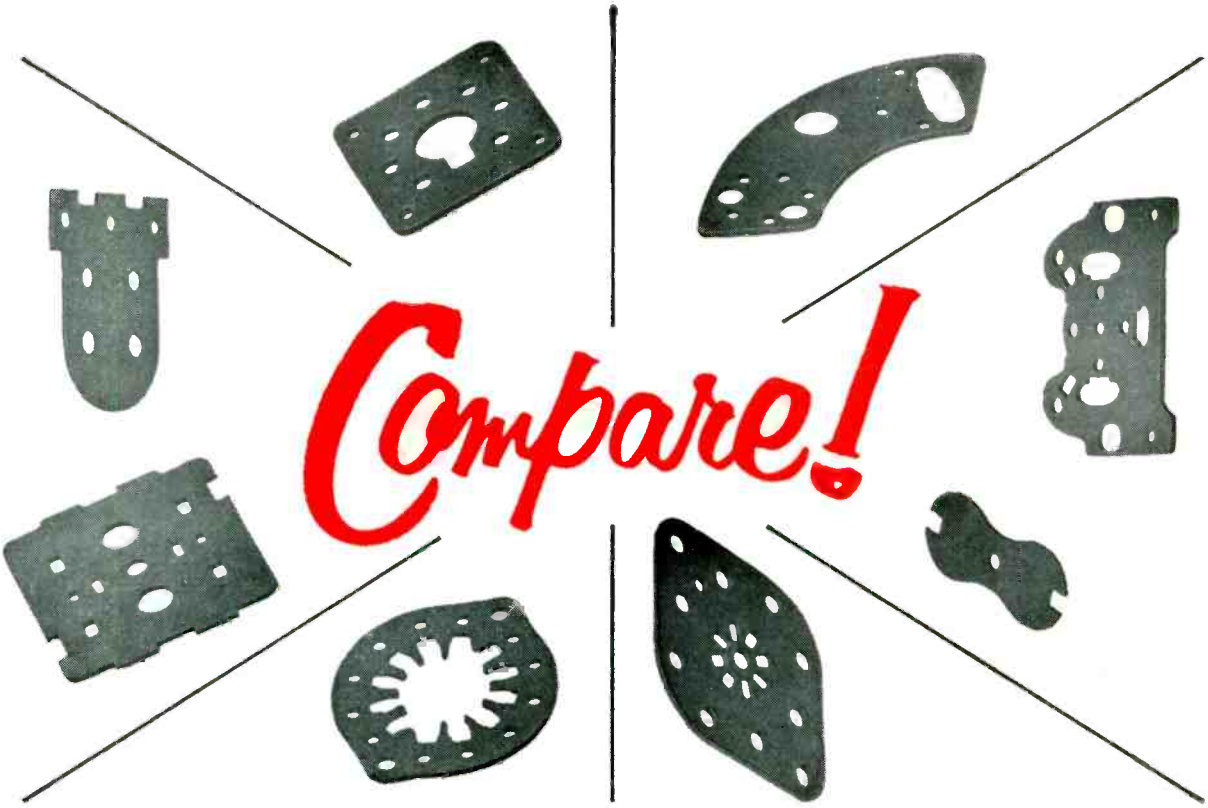
RADIO ENGINEERING LABORATORIES · INC.

36-40 37th St · Long Island City 1, N.Y.

STillwell 6-2100 · *Teletype:* NY 4-2816

Canadian representative:
Ahearn & Soper Co., P. O. Box 715, Ottawa

International representative:
Rocke International Corp., 13 E. 40, N.Y. C. 17



New Mico XXP Laminate Gives You Much Higher Insulation Resistance

Here at last is a uniform, high-quality material with the higher insulation resistance you need for many applications in radar, television, radio, computers, electronic equipment of all kinds. It's MICO's Radar Grade LAMICOID #6229.

Compare for yourself! Test it together with other laminates **under your own test methods** for insulation resistance.

Write today for samples—or ask to have a MICO Sales Engineer call.

Look at these other outstanding values!

WATER ABSORPTION, (%)
Precond. E-1/105
Cond DI-24/23

1/16" thick	0.57
1/8" thick	0.37

SPECIFIC GRAVITY

1/16" thick	1.33
1/8" thick	1.33

FLEXURAL STRENGTH, (psi)
Tested flatwise, Cond. A

1/8" thick	cut lengthwise	21,000
	cut crosswise	16,900

DISSIPATION FACTOR AT 1 MEGACYCLE

1/8" thick	Cond. A	.0314
	Cond. D-24/23	.0316

DIELECTRIC CONSTANT AT 1 MEGACYCLE

1/8" thick	Cond. A	4.42
	Cond. D-24/23	4.63

DIELECTRIC BREAKDOWN, (Kv.)
Parallel to lamination, S/S
Cond. D-48/50

1/16" thick	68.8+
1/8" thick	68.0+

PUNCHING QUALITY

1/16" thick	Heated 1 min.	Good
	Heated 2 min.	Good
	Heated 3 min.	Good

MICO ELECTRICAL INSULATION

MICA *Insulator* COMPANY

Schenectady 1, New York

Offices in Principal Cities

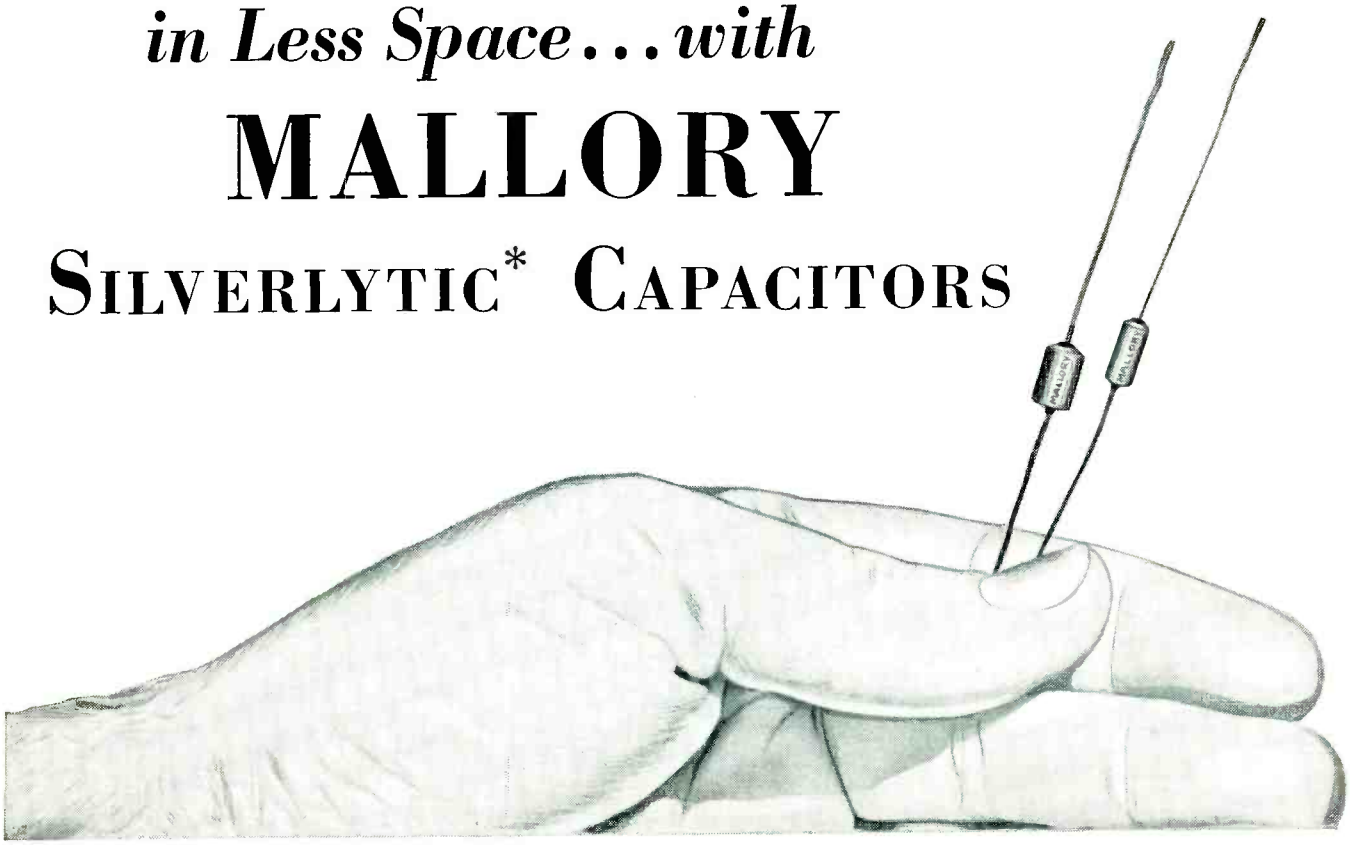
In Canada—Micanite Canada, Ltd., Granby, Quebec

LAMICOID ® (Laminated Plastic) • MICANITE ® (Built-up Mica) • EMPIRE ® (Coated Fabrics and Papers) • FABRICATED MICA • ISOMICA ®

Get More Microfarads in Less Space... with

MALLORY

SILVERLYTIC* CAPACITORS



For transistor circuits and other miniaturized electronic equipment, Silverlytic capacitors will simplify your problem of getting maximum capacitance into minimum space. These subminiature electrolytics offer the highest available ratio of capacitance and voltage to case size.

Made with tantalum anodes, they operate with excellent stability over wide temperature ranges. They are so small they can be mounted readily by their axial leads without danger of vibration troubles. A unique, rugged seal protects them against moisture. In low leakage current and long shelf life, they equal or exceed the performance of most conventional-size capacitors.

Type TAP Silverlytics are rated for temperatures from −55 to +85° C. Their case measures only $\frac{7}{32}$″ in diameter by $\frac{3}{8}$″ long. They are supplied in values from 2 mfd at 100 volts to 30 mfd at 6 volts.

Type TAW Silverlytics are available in a case only 0.145″ in diameter by $\frac{3}{8}$″ maximum length. They are supplied in two standard ratings of 4 mfd at 4 volts and 6 mfd at 4 volts, for temperatures from −55 to +65° C.

Silverlytic capacitors are backed by the years of pioneering research, precision manufacturing and intensive quality control which have made Mallory capacitors the leaders of the industry. For complete technical information, write or call Mallory today.

*Trade Mark

Long-life Mallory Power Supplies for Transistorized Equipment . . .

Mallory Mercury Batteries and Power-Paks provide the constant energy characteristics essential to efficient transistor operation. Made by Mallory, the original producer of miniature mercury batteries, they are available in a range of sizes and types. Write for data.

Parts distributors in all major cities stock Mallory standard components for your convenience

Expect more . . . Get more from

P. R. MALLORY & CO. Inc.

MALLORY

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

Serving Industry with These Products:

Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

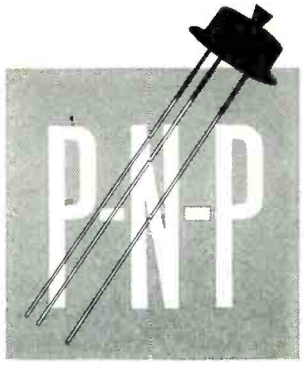
ELECTRONICS Charter-Year Advertiser

Want more information? Use post card on last page.

G.E. MECHANIZED PRODUCTION AT LOWER COST...ASSURES

Both types offer high reliability at temperatures

Take a close look at the transistor values G.E. now offers. Because production lines are now mechanized, these transistors are made in *less time* at *reduced cost.* Machine methods today assure strictest adherence to the top quality standards demanded of all General Electric Germanium Products.



TYPE 2N43A

Mechanization results in CONTROLLED CHARACTERISTICS, removing any inaccuracy on the part of the operator. Narrow limits are built into production transistors giving a more uniform produc

In military and commercial applications these G-E transistors offer precision quality, topmost reliability at mass-volume prices!

General Electric's P-N-P junction transistor, 2N43A, is the first to be written into Air Force specifications! MIL-T-25096 (USAF) was actually written around this G-E product which was developed for the military. Now it serves an ever-increasing number of commercial as well as military applications.

APPLICATIONS AND SPECIFICATIONS

TYPICAL USES: Audio and Intercom Amplifiers, Servo Amplifiers, Carrier Current Amplifiers, Test Equipment, Fuel Gauges.

SPECIFICATIONS OF THE 2N43A and USAF 2N43A

Absolute Maximum Ratings:

Collector Voltage (Referred to base)	−45 volts
Collector Current	−50 ma
Collector Dissipation	150 mw
Storage Temperature	100° C
Collector Cutoff Current (−45 volts)	−10 microamps

DESIGN FEATURES:

STURDY CONSTRUCTION... meets critical military tests for shock, vibration, humidity, life.

SEALED JUNCTION... contamination gases permanently eliminated!

HIGH POWER OUTPUT... case design makes possible a collector dissipation of 150 mw.

HERMETIC SEAL... unaffected by moisture.

LONG LIFE... no change in characteristics during life of equipment.

MAKES TRANSISTORS AVAILABLE CONTROLLED CHARACTERISTICS

up to 100°C...are now available in production lots!

TYPE 2N78

HIGH FREQUENCY TRANSISTOR

A new, revolutionary manufacturing technique, the exclusive G-E rate-growing process, coupled with the all-welded hermetic seal, now makes possible extra long life, and noticeably-reduced manufacturing costs by—

- Making 2000 or more transistors from one rate-grown crystal.
- Achieving uniform characteristics in all 2000 transistors—*eliminating wasteful rejects.*

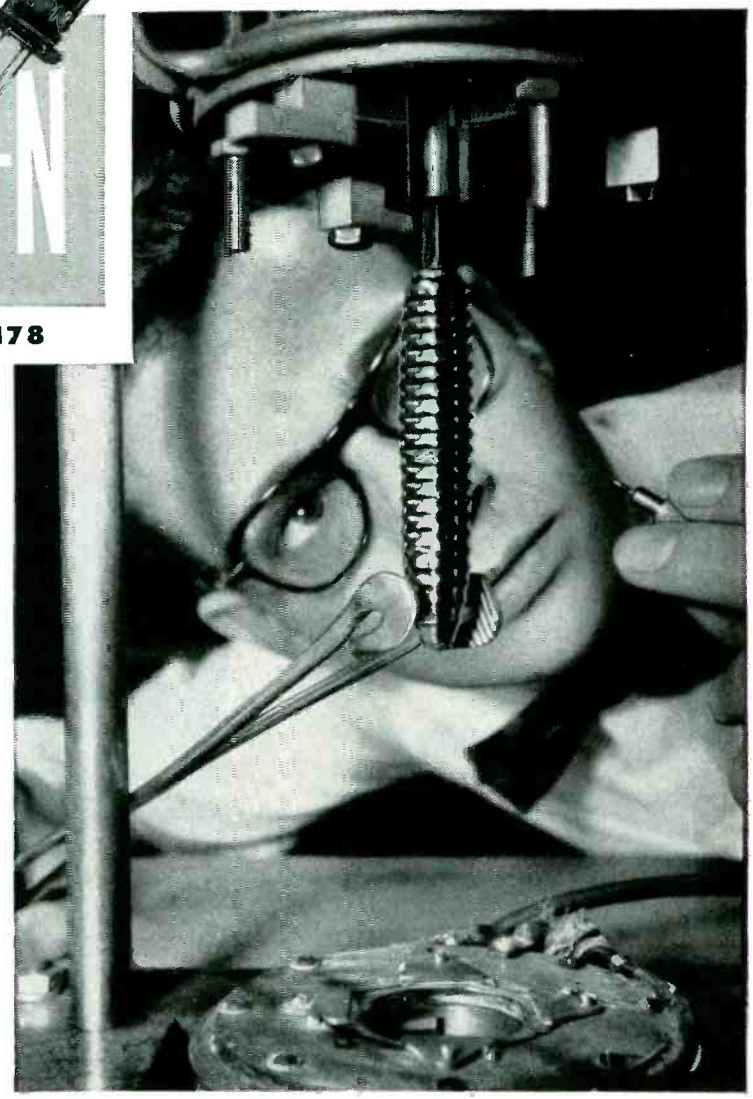
APPLICATIONS

For pulse and switching circuits, RF and IF amplifiers; high-frequency test equipment; telephone repeaters.

SPECIFICATIONS

Collector Voltage (Referred to Base)	15 V
Collector Current	20 ma
Emitter Current	—20 ma
Storage Temperature	100° C.
High Frequency Gain at 2 mc	13 db

- For further details on specifications and prices, write *General Electric Co., Section X445, Germanium Products, Electronics Park, Syracuse, N. Y.*



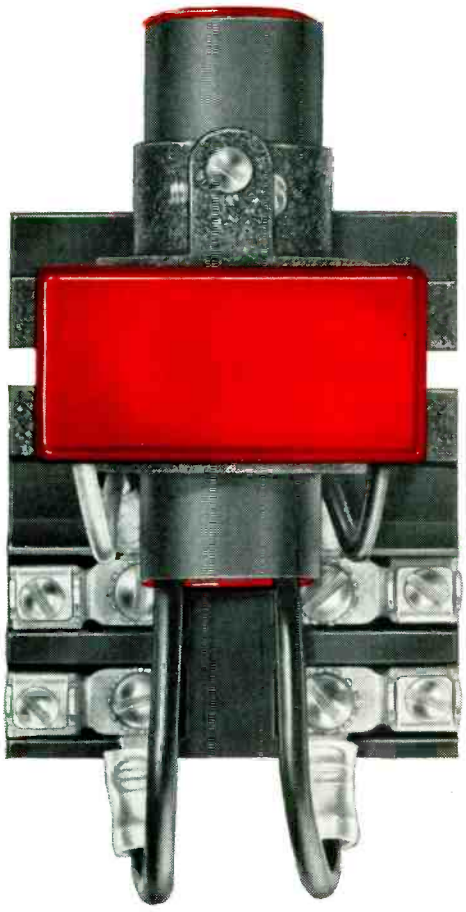
Billet of germanium is removed from furnace, prior to cutting into enough tiny pellets for 2000 transistors.

Progress Is Our Most Important Product

GENERAL ELECTRIC

ELECTRONICS Charter-Year Advertiser

Announcing



Like all Adlake relays, these new "Mighty Midget" relays require no maintenance whatever . . . are quiet and chatterless . . . free from explosion hazard. Dust, dirt, moisture and temperature changes can't affect their operation. Mercury-to-mercury contact gives ideal snap action, with no burning, pitting or sticking.

the new Adlake

"Mighty Midget"

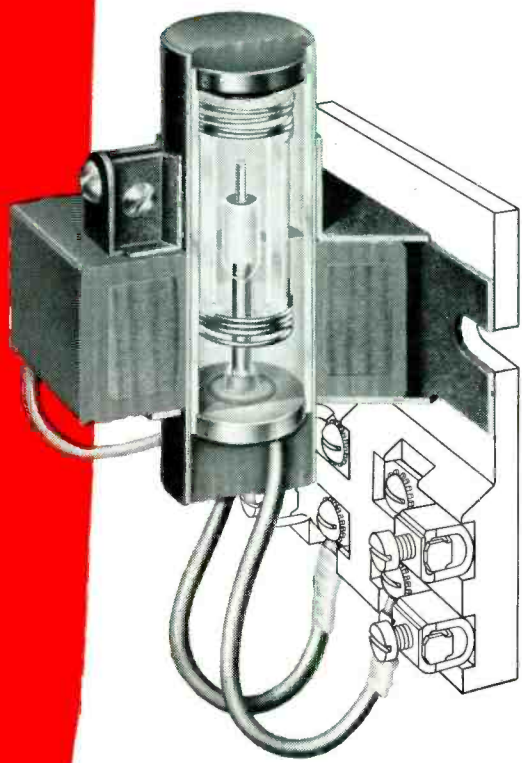
with the revolutionary **MOLDED** coil!

You expect the very latest from the company that originated the mercury plunger-type relays—and here *is* the very latest! It's the Adlake No. 1140, with molded coil in epoxy resin. That neat red coil is exclusive with Adlake, and gives these advantages:

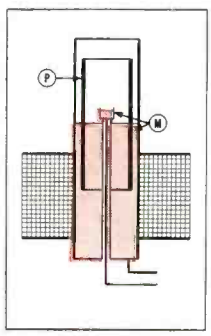
- **Better heat radiation**
- **Absolutely moisture proof**
- **Tested by 4 to 5 million operations at maximum capacity**
- **Guaranteed against coil failure—forever**

This new molded coil "Mighty Midget" is the newest reason why

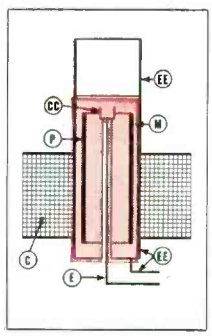
it'll pay you to use Adlake mercury relays



This phantom view and operational sketches show the simple, dependable operating principle of the Adlake "Mighty Midget" Relay.



DE-ENERGIZED



ENERGIZED

DE-ENERGIZED Plunger P is floating in mercury M. External circuit is open because main body of mercury M is below lip of ceramic cup CC.

ENERGIZED Coil C pulls plunger P down into mercury M. Mercury thus displaced completely covers ceramic cup CC filled with mercury. This establishes mercury-to-mercury contact between electrodes E and EE.

Adlake 98th year of serving the transportation and building industries

THE Adams & Westlake COMPANY

Established 1857 • Elkhart, Indiana • New York • Chicago
the original and largest manufacturers of mercury plunger-type relays

Want more information? Use post card on last page.

Accurately Tests and Calibrates Omni-Range and ILS Receiving Equipment

SIGNAL GENERATOR

Type 211-A

Frequency Range 88-140 mc.

Output Frequency Crystal Monitored
Amplitude Modulation 0-100%
Modulation Fidelity ±0.5 db
30 cycles to 11 kilocycles
Negligible Spurious FM

The Type 211-A Signal Generator was designed by Boonton Radio Corporation in cooperation with the CAA and leading manufacturers of aircraft navigation and landing receivers. It was designed for specific application to the calibration of these receivers to the high accuracy characteristics required. The CAA system requiring these receivers guides aircraft from one location to another and assists in landing under marginal weather conditions. The Signal Generator is also useful in testing accurately tuned communications receivers.

SPECIFICATIONS

FREQUENCY RANGE: 88 to 140 mc. in one Range. Vernier Dial marked to 10 Kc. division. Accuracy ± 0.25%.

R. F. OUTPUT: 0.1 to 200,000 microvolts. Output resistance looking into output terminals 26.5 ohms.

AMPLITUDE MODULATION: AM 0-30% and 0-100% with internal or external oscillator. Distortion below 5% at 95% modulation.

INTERNAL AUDIO OSCILLATOR: 400 and 1000 cps.

MODULATION AMPLIFIER: Uniform response within ± 0.1 db 90 to 150 cps. and 9.5 to 10.5 Kc. within ± 0.5 db 30 cps. to 11 Kc.

PHASE DISTORTION: Up to 60% modulation less than 0.25 degrees at 30 cps and 10 degrees at 11 Kc.

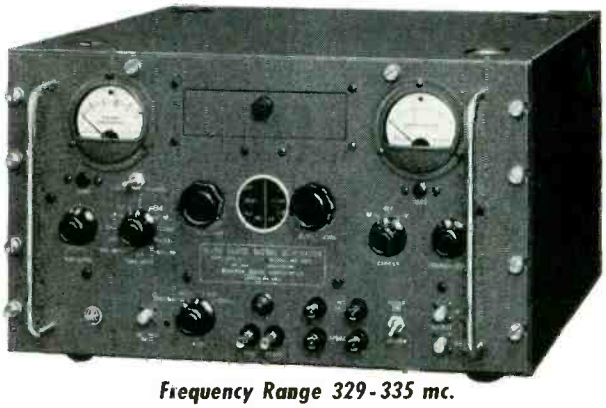
SPURIOUS FM: Less than 1 Kc. at 60% FM.

CRYSTAL CALIBRATING FREQUENCIES: 110.100 and 114.900 mc. ± 0.0035%. Calibrations can be made at these and other frequencies by slipping dial vs condenser shaft position.

PRICE: $1800.00 FOB Boonton, N. J. (Relay Rack not included).

Glide Slope Signal Generator

Type 232-A



Frequency Range 329-335 mc.

The 232-A Glide Slope Signal Generator provides 20 crystal controlled frequencies between 329 and 335 mc for testing aircraft landing receivers. One crystal controlled frequency is provided for the IF amplifier of the receiver.

The 232-A is a completely self-contained signal generator including its own power supply and synchronous motor driven modulator. It is a complete test equipment for Glide Slope Receivers.

SPECIFICATIONS

FREQUENCY RANGE: 329 to 335 mc (20 crystal controlled frequencies).

FREQUENCY ACCURACY: ± 0.0065%.

OUTPUT LEVEL: 1 to 200,000 microvolts.

OUTPUT IMPEDANCE: 53 ohms unbalanced.

IF FREQUENCY: 20.7 mc (By changing crystal 15 to 30 mc).

MODULATION: 90-150 cps, 1000 cps, external.

PRICE: $1500.00 FOB Factory.

BOONTON RADIO Corporation
BOONTON · N·J · U·S·A ·

FINANCIAL AID TO HIGHER EDUCATION

Our Colleges and Universities Are Living on Borrowed Time

. . . time borrowed from underpaid faculty members

The chart on this page tells a story of profound importance to every American. It is the story of the financial beating our college and university faculty members have been taking in the past 14 war and postwar years.

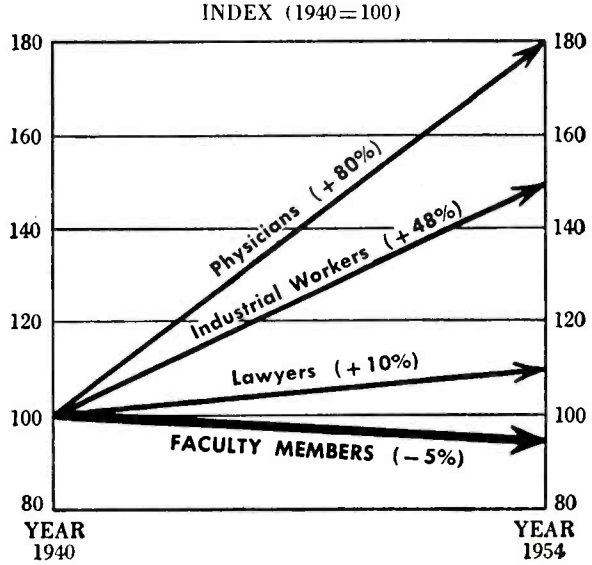
On the whole, this span of 14 years has been one of great and growing prosperity. But, as the chart shows, our college and university faculty members have, as a group, had less than no share in it.

During this period, from 1940 through 1954, the real income of the average industrial worker (that is, what his wages would purchase in goods and services) has increased by almost one-half. Among professional groups, physicians have enjoyed an increase of about 80 per cent in their real income. Lawyers, far less favored financially, have had an increase of about 10 per cent. But faculty members have not only had no increase at all; over these years of prosperity their average real income has fallen by 5 per cent. These figures do not take account of the increase in taxes since 1940.

Senior Teachers Hardest Hit

These figures are, of course, averages. For some groups of faculty members it has been better; for others worse. It has been particularly hard on senior faculty members. Between 1941 and 1953 their salaries lost about 8 per cent of their purchasing power. Being deeply committed to their careers they could not respond to alternative employment opportunities as readily as could their junior colleagues. For junior faculty members there was some increase in real income between 1941 and 1953 but only about half as much as the average for the nation.

What's Happened to College Faculty Salaries*



* Real Income before Taxes.

Source: Council for Financial Aid to Education; U. S. Dep't of Commerce; U. S. Dep't of Labor.

Public Colleges Fare Better

There are also marked differences in the average financial reward received by faculty members in different types of colleges and universities. A recent study by the Council for Financial Aid to Education indicates that, in the last academic year, 1953-1954, teachers in privately endowed, independent colleges and universities were paid an average salary about $1000 less than that paid to faculty members in tax-supported institutions. The same study indicates that salaries far below the average are especially common for faculty members in the small private liberal arts colleges. This study found that during the last academic year the average salary of all college and university faculty members was about $4700.

The special difficulties under which the independent colleges and universities, and particularly the independent liberal arts colleges, are laboring to get back on their feet financially have been discussed in previous editorials in this series. These difficulties underline the need of special help for these institutions to which business firms are now contributing in increasing volume. However, the problem of providing better salaries is not peculiar to any particular type of institution.

Faculty Members Not Greedy

It is not easy to prescribe a precise standard of fair pay for college and university faculty members. This is partly because they put less weight relatively on money rewards than they put on rewards of scholarly accomplishment and prestige. Consequently, they have consistently been willing to work for very modest salaries in relation to the intellectual ability, education and application required. Obviously, however, it is the dictate both of fairness and good judgment to see that faculty members are given a roughly proportionate share in the general prosperity. Indeed, their crucial role in our society could be made to justify a larger share than this.

There is no way to know with any degree of precision what the underpayment of our college and university faculty members over the past 14 years has actually cost the nation in terms of reduced quality of intellectual performance of those institutions. One reason is that the damage has been minimized by the devoted services of many faculty members who have loyally stuck to their jobs in spite of the great financial discouragement.

It is obvious, however, that, if no grave deterioration in the intellectual performance of our colleges and universities has occurred so far, it is because we have been living on borrowed time. It is time borrowed from faculty members who have, in effect, been subsidizing these institutions by their financial sacrifice. This arrangement is not only a menace to the cultural and intellectual life of the nation, it is also a menace to our national security in a time when successful national survival may well depend in peculiar degree on the full development and utilization of our intellectual resources. We depend on our college and university faculties pre-eminently to provide this development. Adequate financial reward for such service is an elementary form of national insurance.

Many of our colleges and universities are working hard to improve the financial lot of their faculty members. Business firms are also playing an increasing role of providing the necessary financial assistance. The methods being used by business for this purpose will be the subject of another editorial in this series. However, **vastly more must be done, and quickly, to stop the financial beating being taken by our college and university faculty members if the nation's welfare and safety are to be properly protected.**

MICROWAVE SIGNAL GENERATORS

Complete coverage of the range 950-10,800 mcs /sec.

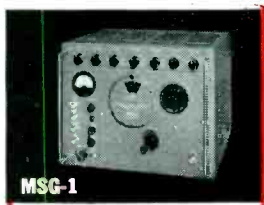
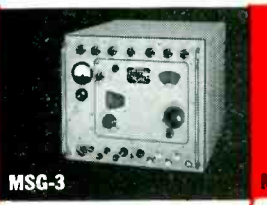
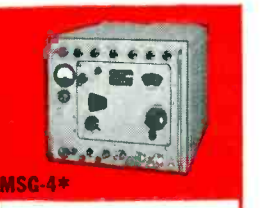
with Polarad single dial operation

Four new Microwave Signal Generators covering the range 950-10,800 mcs/sec. All with famous **Polarad single dial operation.** Each provides the maximum working range possible in one compact signal generator. And, additional Polarad Signal Generators are available to cover 12.8 to 39.7 kmc.

These features on all MSG units assure fast and simple operation: direct reading, single dial frequency control that tracks reflector voltages automatically . . . direct reading attenuator dial . . . conveniently placed controls, in logical sequence . . . high visibility on the face of each instrument.

Polarad Signal Generators are built to the same high standards required for military equipment. They are practical for the factory assembly line—engineered ventilation assures continuous and stable operation of all instrument functions. Components are readily accessible for easy maintenance. And laboratory accuracy is guaranteed under the most rigorous operating conditions.

Write directly to Polarad or your nearest Polarad representative for details.

	 MSG-1	 MSG-2	 MSG-3	 MSG-4*
Frequency Range	950-2400 MCS/sec.	2150-4600 MCS/sec.	4450-8000 MCS/sec.	6950-10,800 MCS/sec.
	(Frequency set by means of a single directly calibrated control)			
Frequency Accuracy	±1%	±1%	±1%	±1%
Power Output	1 MW	1 MW	.2 MW	.2 MW
Attenuator Range	120 db	120 db	120 db	120 db
Attenuator Accuracy	±2 db	±2 db	±2 db	±2 db
Output Impedance	50 ohms	50 ohms	50 ohms	50 ohms
Input Power	115V±10% 60 cps	115V±10% 60 cps	115V±10% 50-1000 cps	115V±10% 50-1000 cps
Internal Pulse Modulation:				
Pulse Width	0.5 to 10 microseconds			
Delay	3 to 300 microseconds			
Rate	40 to 4000 pulses per second			
Synchronization	Internal or external, sine wave or pulse			
Internal FM:				
Type	Linear sawtooth			
Rate	40 to 4000 cps			
Synchronization	Internal or external, sine wave or pulse			
Frequency Deviation	±2.5 MCS	±2.5 MCS	±6 MCS	±6 MCS
External Pulse Modulation:				
Polarity	Positive or Negative			
Rate	40 to 4000 pulses per second			
Pulse width	0.5 to 2500 microseconds			
Pulse separation	(For multiple pulses) 1 to 2500 microseconds			
Output Synchronizing Pulses:				
Polarity	Positive, delayed & undelayed			
Rate	40 to 4000 pps			
Voltage	Greater than 25 volts			
Rise time	Less than 1 microsecond			
Size | Approx. weight	17" long x 13¼" high x 15½" deep | 60 lbs.		17" long x 15" high x 19½" deep | 100 lbs.	

*Also available—MSG 4A: 6,950—11,500 MCS/sec.

"THE FINEST SIGNAL GENERATORS OF THEIR KIND"

Polarad ELECTRONICS CORPORATION

43-20 34th STREET • LONG ISLAND CITY 1, N. Y.

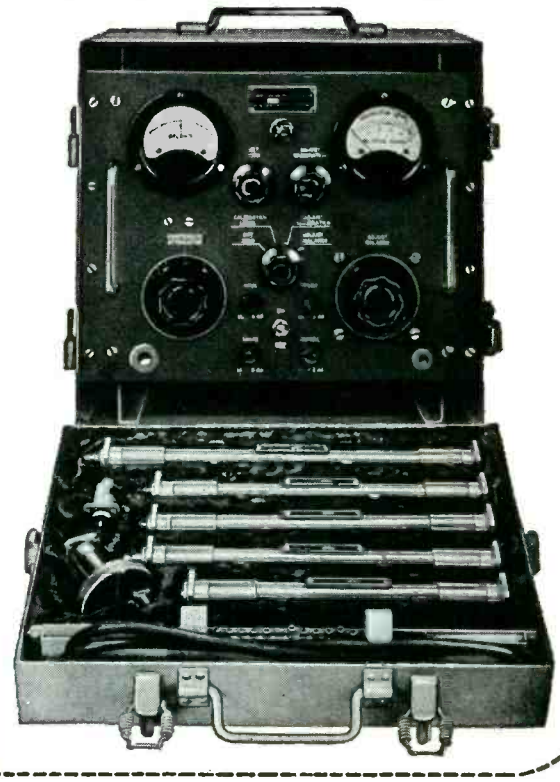
REPRESENTATIVES • Albuquerque • Atlanta • Baltimore • Boston • Chicago • Cleveland • Fort Worth • Kansas City • Los Angeles • New York, Philadelphia • San Francisco • Seattle • St. Paul • Syracuse • Washington, D. C. • Canada, Arnprior—Export: Rocke International Corporation

Broadband RF Power Meters

THE CHOICE OF ALL ARMED SERVICES FOR MICROWAVE POWER MEASUREMENTS

POWER: PULSE and CW—5μW to 5W average
FREQUENCY: 20MC — 10,000MC
ACCURACY: 5% Absolute at all ranges, frequencies, temperatures

- **INDICATIONS:** Direct Reading
- **CALIBRATION:** Compensates for All Variables
- **R-F COMPONENTS:** 3, 6, 10 and 20db Attenuators, Bolometer Mount and Elements, R-F Cable
- **BOLOMETER:** Broadband, High Overload Capacity
- **PLUMBING:** 3/8" and 7/8" 50-ohm Coaxial
- **POWER SOURCE:** 115VAC ±15%, 50-1000 cps
- **CONSTRUCTION:** Rugged, meets all JAN, MIL requirements



TYPICAL APPLICATIONS

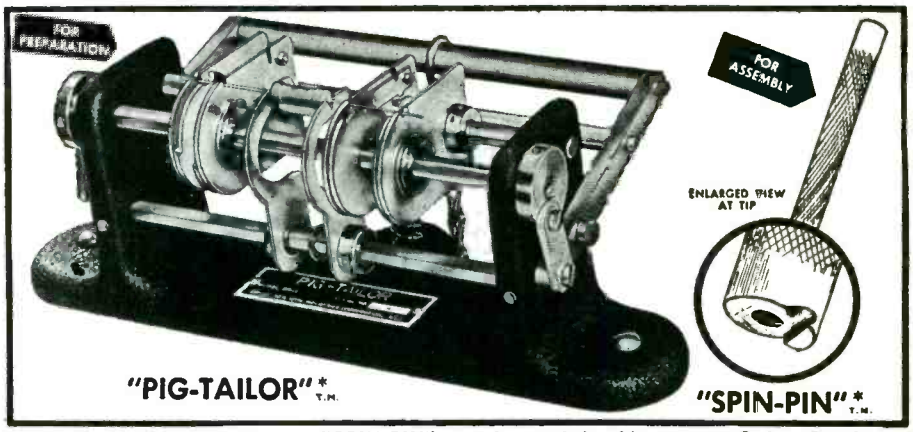
Microwave Links . . . Television . . . Communications . . . Radar . . . Telemetering . . . Signal Generators . . . Laboratory Standards.

Write for descriptive literature to Department E-4M

Bruno-New York Industries Corporation
DESIGNERS AND MANUFACTURERS OF ELECTRONIC EQUIPMENT
460 WEST 34th STREET • NEW YORK 1, N. Y.

"PIG-TAILORING"

. . . . a revolutionary new mechanical process for higher production at lower costs. Fastest PREPARATION and ASSEMBLY of Resistors, Capacitors, Diodes and all other axial lead components for TERMINAL BOARDS, PRINTED CIRCUITS and MINIATURIZED ASSEMBLIES.



The "PIG-TAILOR" plus "SPIN-PIN" — Accurately Measures, Cuts, Bends, Ejects and Assembles both leads simultaneously to individual lengths and shapes — 3 minute set-up — No accessories — Foot operated — 1 hour training time.

PIG-TAILORING provides:

1. Uniform component position.
2. Uniform marking exposure.
3. Miniaturization spacing control.
4. "S" leads for terminals.
5. "U" leads for printed circuits
6. Individual cut and bend lengths.
7. Better time/rate analysis.
8. Closer cost control.
9. Invaluable labor saving.
10. Immediate cost recovery.

PIG-TAILORING eliminates:

1. Diagonal cutters.
2. Long-nose pliers.
3. Operator judgment.
4. 90% operator training time.
5. Broken components.
6. Broken leads.
7. Short circuits from clippings.
8. 65% chassis handling.
9. Excessive lead tautness.
10. Haphazard assembly methods.

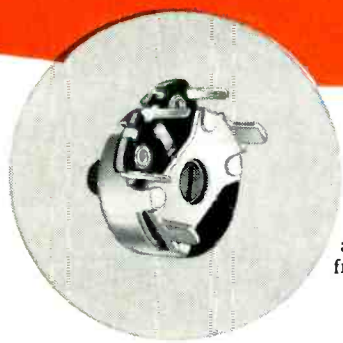
*PATENT PENDING

Write for illustrated, descriptive text on "PIG-TAILORING" to Dept. E-4P

BRUNO-NEW YORK INDUSTRIES CORPORATION
DESIGNERS AND MANUFACTURERS OF ELECTRONIC EQUIPMENT
460 WEST 34th STREET • NEW YORK 1, N. Y.

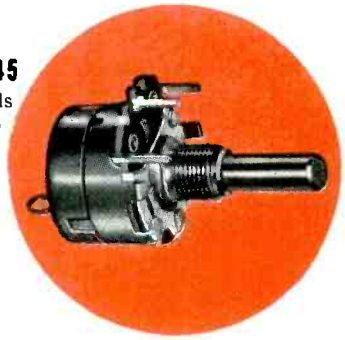
FOR YOUR AUTOMATION PROGRAM

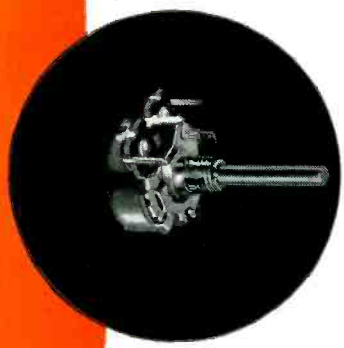
VARIABLE RESISTORS FOR PRINTED CIRCUITS



Type UPM-45
For TV preset control applications. Control mounts directly on printed circuit panel with no shaft extension through panel. Recessed screwdriver slot in front of control and 3/8" knurled shaft extension out back of control for finger adjustment. Terminals extend perpendicularly 7/32" from control's mounting surface.

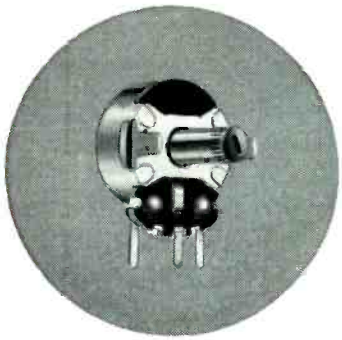
Type GC-U45
Threaded bushing mounting. Terminals extend perpendicularly 7/32" from control's mounting surface. Available with or without associated switches.





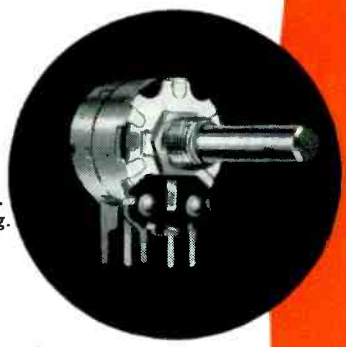
Type U70 (Miniaturized)
Threaded bushing mounting. Terminals extend perpendicularly 5/32" from control's mounting surface.

Type YGC-B45
Self-supporting snap-in bracket mounted control. Shaft center spaced 29/32" above printed circuit panel. Terminals extend 1-1/32" from control center.

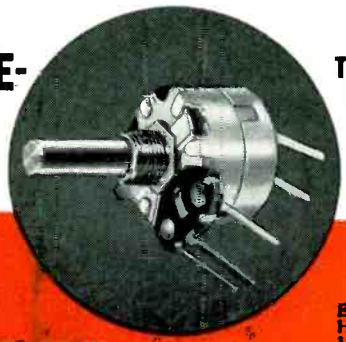


Type XP-45
For TV preset control applications. Control mounts on chassis or supporting bracket by twisting two ears. Available in numerous shaft lengths and types.

Type XGC-45
For applications using a mounting chassis to support printed circuit panel. Threaded bushing mounting.



VARIABLE RESISTORS FOR SOLDERLESS "WIRE-WRAP" CONNECTIONS



Type WGC-45
Designed for solderless wire-wrapped connections with the use of present wire-wrapping tools. Available with or without switch and in single or dual construction.

The controls illustrated are typical constructions. CTS' years of engineering and technical experience makes available many other types for your automation needs.

EAST COAST OFFICE
Henry E. Sanders
130 North Broadway
Camden 2, New Jersey
Phone: Woodlawn 6-1668
TWX No. Camden NJ 380
Phila. Phone: Market 7-3129

SOUTHWESTERN U.S.A.
John A. Green Company
6815 Oriole Drive
P.O. Box 7224
Dallas 9, Texas
Phone: Dixon 9918

SOUTH AMERICA
José Luis Pontet
Buenos Aires, Argentina
Montevideo, Uruguay
Rio de Janeiro, Brazil
Sao Paulo, Brazil

WEST COAST OFFICE
Robert A. Stackhouse
928 S. Robertson Blvd.,
Los Angeles 35, Calif.
Phone: Crestview 4-5931
TWX No. BEV H 7666

CANADIAN DIVISION
C. C. Meredith & Co., Ltd.
Streetsville, Ontario
Phone: 310

OTHER EXPORT
Sylvan Ginsbury
8 West 40th Street
New York 18, New York
Phone: Pennsylvania 6-8239

CHICAGO TELEPHONE SUPPLY *Corporation*
ELKHART • INDIANA
FOUNDED 1896

The Exclusive Specialists in Precision Mass Production of Variable Resistors

Burton browne advertising

New Improved "SCOTCH" 39 Electrical Tape

...King of the paper tapes!

LONGER SHELF LIFE

50% MORE TACK

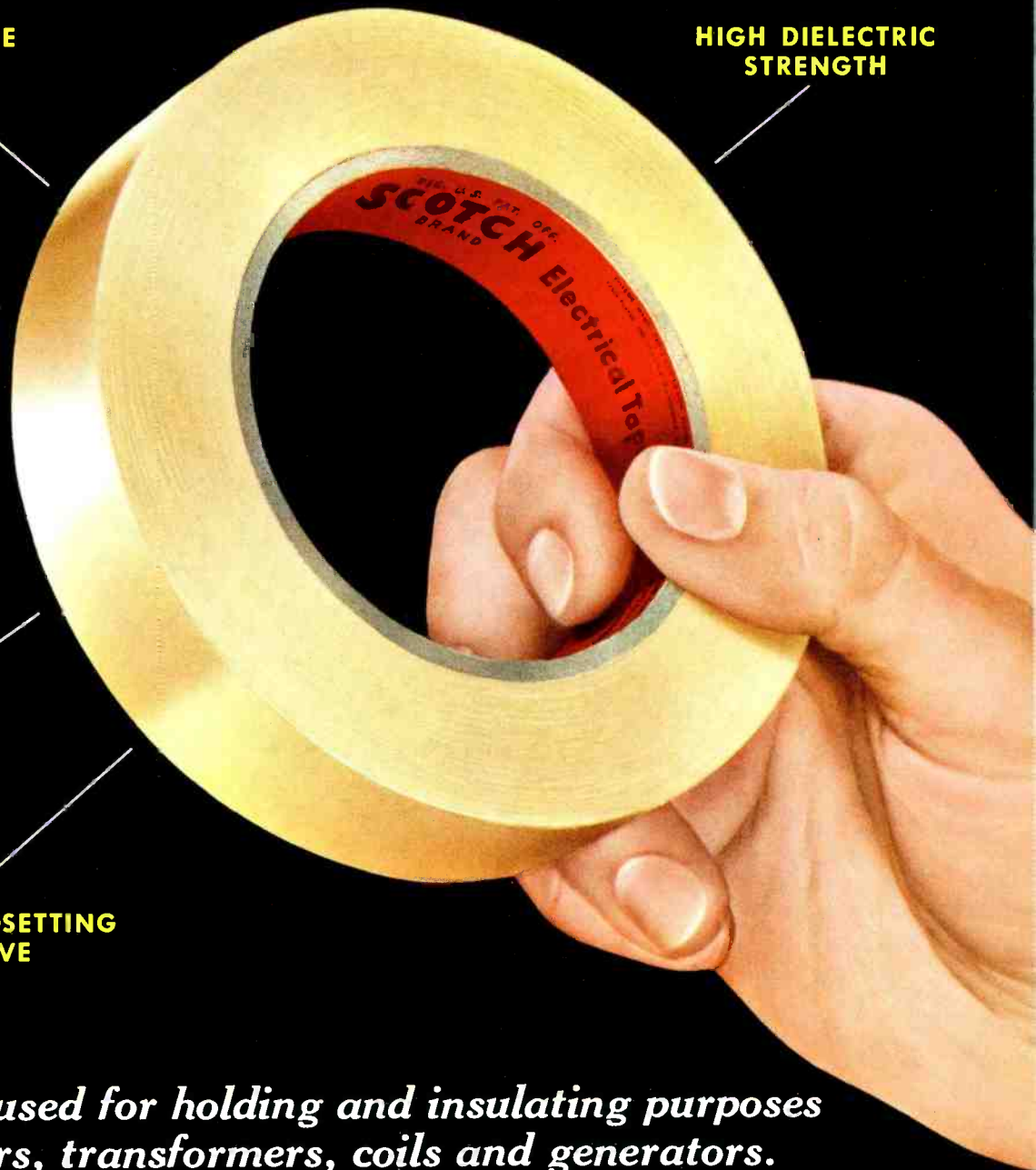
THINNER

HIGH TEAR RESISTANCE

GREATER SOLVENT RESISTANCE

TRUE THERMOSETTING ADHESIVE

HIGH DIELECTRIC STRENGTH



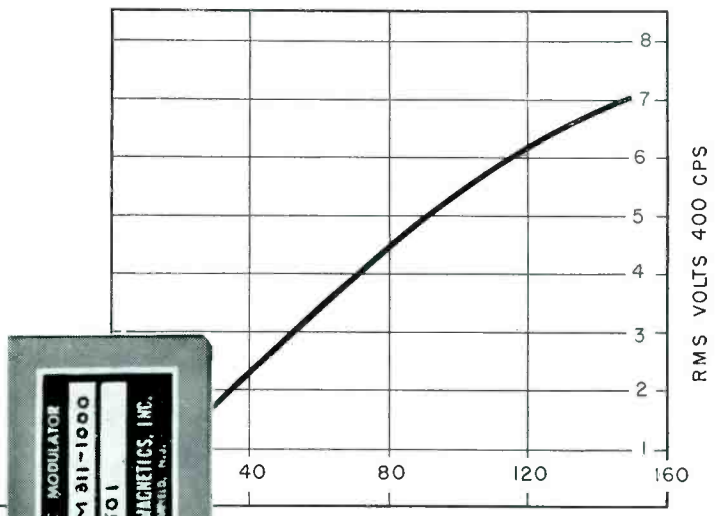
Widely used for holding and insulating purposes on motors, transformers, coils and generators.

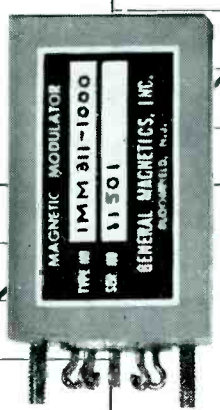
Why Use Mechanical Choppers?

NOW AVAILABLE — a high sensitivity magnetic modulator, featuring infinite life and ultimate reliability as a substitute for the weakest link in the control system chain.

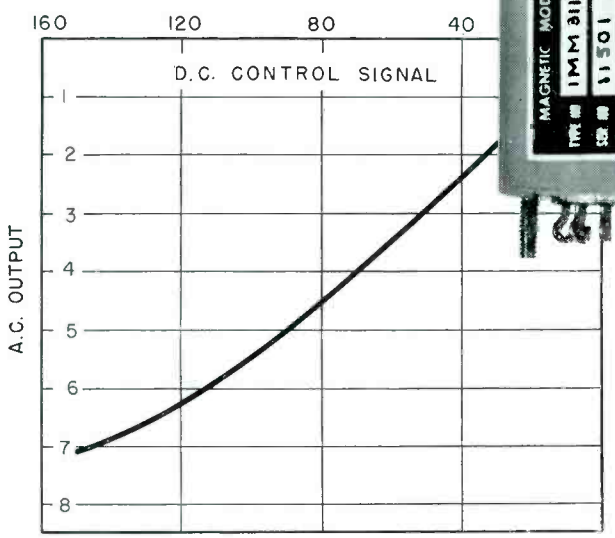
The General Magnetics **"MAG-MOD"** is designed to convert and amplify low level dual polarity DC signals into 400 cycle sinusoidal AC voltages of corresponding amplitude and phase sense.

- high shock & vibration resistance
- ultra-stable under severest environmental conditions
- no rectifier required
- extremely low hysteresis
- fast response time
- clean output fundamental waveform
- no moving parts or contacts to fail





ACTUAL SIZE



SPECIFICATIONS

- excitation: 5 v. rms ± 10% @ 300 — 500 cps
- exc. winding impedance 10K ohms
- output impedance 15K ohms
- DC input resistance 1000 ohms
- harmonic distortion approx. 15%
- null amplitude 20 to 30 mv rms
- output phase 0 or 180° ± 10%
- operating ambient — 70 to +200° C
- overall dimensions 1" x 11/16" x 1¾" high
- approx. weight 3 oz.

We specialize in control systems and magnetic amplifier components for Automatic Flight Control — Analog Computers — Fire Control and Armament — Guided Missiles — Nuclear Applications — Magnetic Voltage Regulators and Power Supplies.

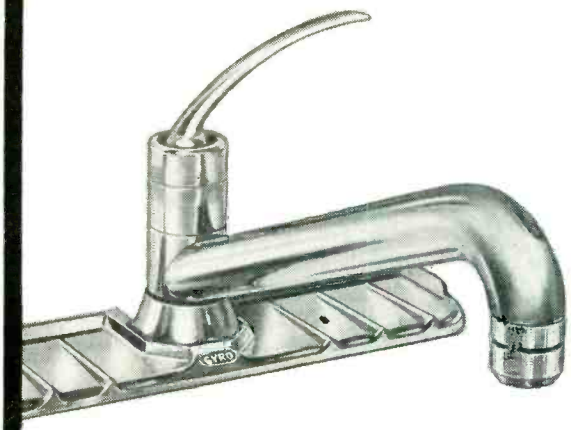
Write on your letterhead for further details

GENERAL GM INC. **MAGNETICS**

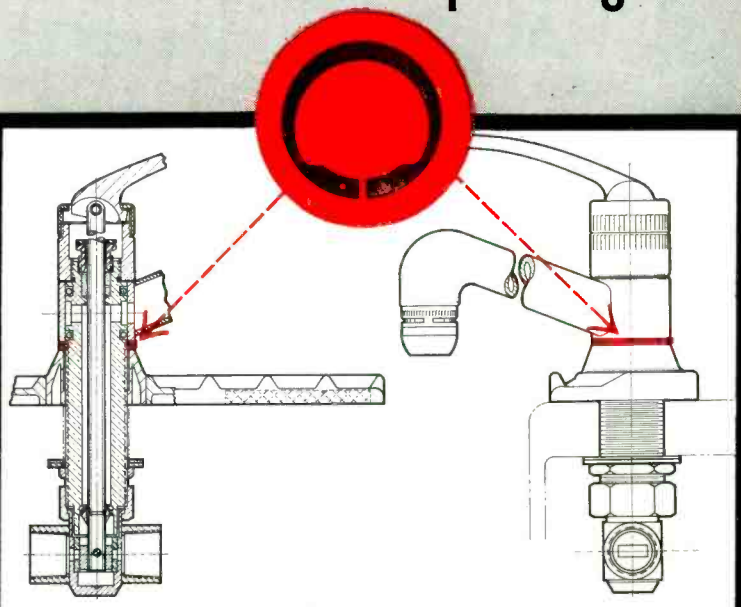
135 Bloomfield Avenue — Bloomfield, N. J.

Waldes Truarc ring reduces valve body from 1 5/16" to 1 1/16", eliminates chrome plating

GYRO MIXING FAUCET



Single-handle kitchen mixing faucet controls hot and cold water, as well as volume. Radical design has no seals or spindles to replace. One Waldes Truarc retaining ring allows complete assembly and disassembly from either top or bottom of unit.



Aluminum Truarc Ring (external inverted Series 5108) acts as bearing retainer, insures precise alignment of spout and escutcheon, gives uniform shoulder with machining. Truarc ring provides shoulder that would otherwise require machining valve body to 1 5/16" against 1 1/16" used. Also eliminates expensive chrome plating of valve body.

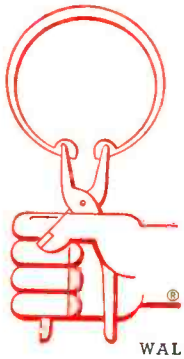
Gyro Brass Manufacturing Corporation of Westbury, L. I., N. Y., uses a single Waldes Truarc retaining ring (Series 5108) both as a positioner and retainer on their Gyro Mixing Faucet. Aluminum Truarc ring not only eliminates expensive machining, but also does away with a chrome plating process that would be necessary if the shoulder were made of the solid material of the body.

You, too, can save money with Truarc Rings. Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better, more economical job. Waldes Truarc Rings are precision-engineered...quick and easy to assemble and disassemble.

More than 5,000 stock sizes of the different Truarc ring types available. Ninety stocking points throughout U. S. A. and Canada.

Find out what Waldes Truarc Retaining Rings can do for you. Send your blueprints to Waldes Truarc engineers.

For precision internal grooving and undercutting . . . Waldes Truarc Grooving Tool!



Send for new catalog supplement

WALDES
TRUARC®
RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.
Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.
(Please print)

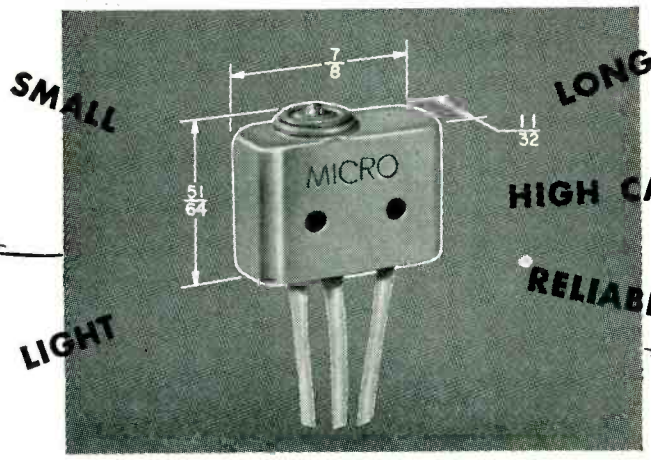
Name.....
Title.....
Company.....
Business Address.....
City.....*Zone*.....*State*.....

E-047

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787. and other U. S. Patents pending. Equal patent protection established in foreign countries.

MICRO SWITCH Precision Switches
A PRINCIPLE OF GOOD DESIGN

This switch has ALL you have asked for in a sealed subminiature switch!



Check these features against your most critical requirements

Absolutely environment-proof:
Switching element is sealed with an elastomer plunger seal. This is bonded to both the pin plunger and the metal housing. The switch element is embedded in an epoxy casting resin which also seals the leads. The exterior is of corrosion-resistant, treated aluminum.

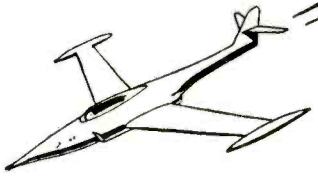
Light weight—small size:
Unit is 7/8" long and 11/32" thick. Weight is less than .03 oz.

Wide temperature range:
Designed to give trouble-free operation in a temperature range of from —65° F. to plus 180° F.

High electrical ratings:
Electrical rating is 30 volts d-c, 2.5 amperes inductive, 4 amperes resistive. Maximum inrush is 15 amperes.

Long life:
Minimum mechanical life, 300,000 operations under average use conditions.

There are always new switches and new assemblies on the drawing boards and on test at MICRO SWITCH. *Don't experiment. Call* MICRO SWITCH *first. It is the short cut to getting THE switch for your application.*



A complete line of snap-action switches for aircraft

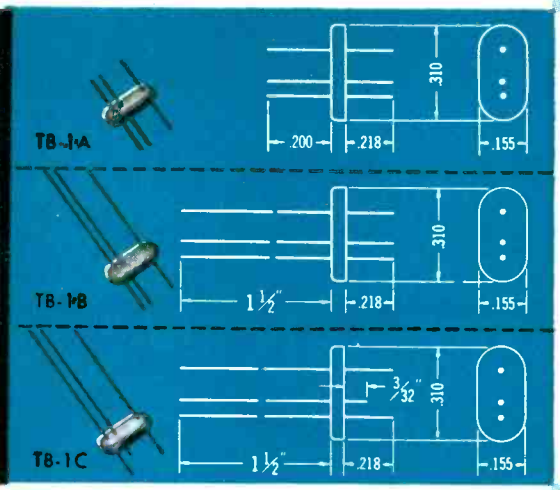
MICRO SWITCH provides a complete line of extremely reliable, small-size, high-capacity, snap-action precision switches and mercury switches. Available in a wide variety of sizes, shapes, weights, actuators and electrical characteristics. For all types of electrical controls.

MICRO SWITCH
A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY
In Canada, Leaside, Toronto 17, Ontario • FREEPORT, ILLINOIS

HONEYWELL

Series No. 1
KOVAR BASES
WITH NICKEL SILVER CASES

Three electroce hermetically sealed Kovar bases supplied with closures. Lead lengths and pin layouts as illustrated. Cases are available in three types. Closures are press-fit to bases.



ALL CASES .300" IN LENGTH

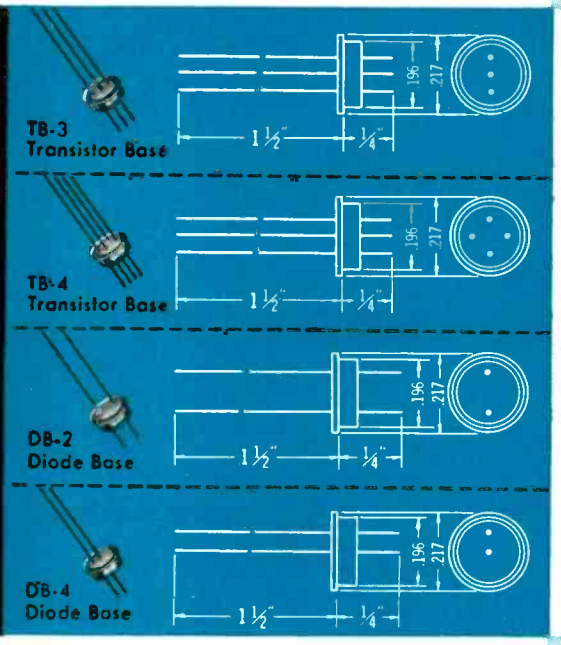
TC-1A plain

TC-1B with hole

TC-1C with hole and dimple

Series No. 3
COMPRESSION TYPE BASES & CLOSURES
WITH NICKEL SILVER CASES

Compression type bases available in two, three and four lead types. Type TC-3 or TC-3A cases, illustrated, can be supplied. Cases are press-fit to bases.



CASES AVAILABLE WITH OR WITHOUT DIMPLE

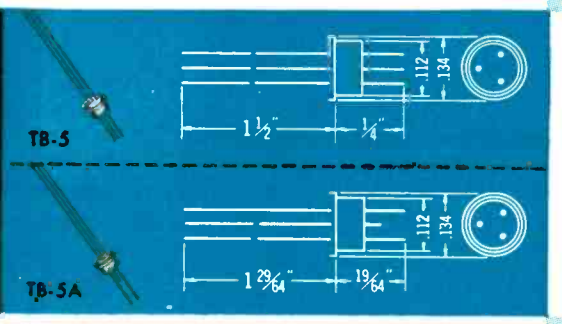
TC-3 with dimple .300" long

TC-3A plain .340" long

Where Special cases are required, EI will quote on your requirements on receipt of your drawings or specifications.

Series No. 5
COMPRESSION BASES
WITH NICKEL SILVER CASES

Available as illustrated. Cases are press-fit to bases.



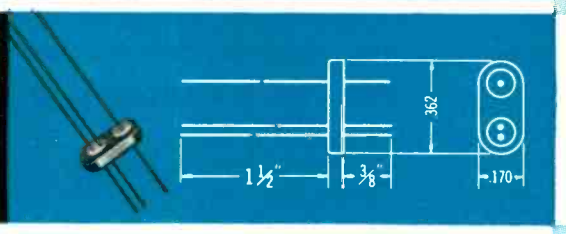
TC-5 with dimple

TC-5A plain

TC-5B with .025" hole All .325" long

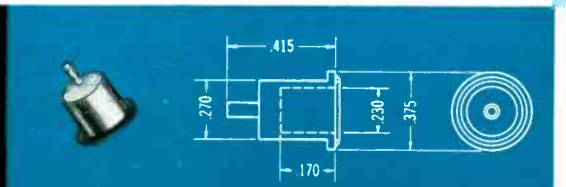
TC-5C plain .240" long

Type TB-6
TRANSISTOR BASE
AVAILABLE WITH TC-6 CLOSURE



TC-6 CLOSURE Plain case .300" in length.

Type DC-5
GOLD PLATED
With welding projection. Available as DC7 without welding projection.



*PATENT PENDING ALL RIGHTS RESERVED

E-I

HEADQUARTERS FOR YOUR HERMETICALLY SEALED MINIATURE

TRANSISTOR and DIODE BASES and CLOSURES*

Electrical Industries is your dependable source of supply for all hermetically-sealed miniature components. Miniaturized transistor and diode bases with closures and sealed components for specialized requirements can be supplied quickly and economically. For samples and quotations on standard components or recommendations on "specials", call or write E-I, today!

ELECTRICAL INDUSTRIES

44 SUMMER AVENUE
NEWARK 4, NEW JERSEY

DIVISION OF AMPEREX ELECTRONIC CORP.

EI®

New TRANSISTORIZED MINIATURIZED

TYPE 2007T

400 CYCLES ±.02%

28 VOLTS D.C.

SPECIFICATIONS

INPUT
20 to 35V DC
at approx. 5 m.a.

OUTPUT FREQUENCY
400 or 500 cycles

Type 2007T
+ —.02% from —65° to + 85°C.

Type R2007T
+ —.002% from + 15° to + 85°C.

Type W2007T
+ —.005% from —65° to + 85°C.

OUTPUT VOLTAGE
5 volts, sine wave.

Substantially uniform
from —65° to + 85°C.

LIFE EXPECTANCY
several times that of vacuum tubes

INTERNALLY SHOCK MOUNTED
on Silastic

MAGNETICALLY SHIELDED

HERMETICALLY SEALED

OCTAL BASE

SIZE
4½" x 1½" diameter

WEIGHT
7 ounces

COMPLETE INFORMATION ON REQUEST
PLEASE SPECIFY TYPE 2007T

Precision

FREQUENCY STANDARDS

These units, which are the result of several years of development and testing, offer a new standard of simplicity and reliability. Particularly noteworthy is the uniformity of output signal voltage with temperature change. Small size and light weight make them ideal for airborne and portable use.

For applications where only higher B voltages are available, a simple voltage reducing circuit may be used.

American Time Products, Inc.

580 Fifth Avenue ***New York 36, N. Y.***

MANUFACTURING UNDER PATENTS OF WESTERN ELECTRIC COMPANY

Raytheon – World's Largest Manufacturer of Magnetrons and Klystrons

2J32 MAGNETRON

2K28 KLYSTRON

HELPING ESTABLISH RELIABILITY RECORDS

Raytheon Magnetrons and Klystrons in proved Gilfillan ASR-1 Radar

Civil Aeronautics Administration reports record-breaking reliability of Gilfillan airport surveillance radar. Boston International Airport had 8,760 hours continuous performance with only 7⅓ hours involuntary outage—less than 1/10 of 1%—from their Gilfillan installation.

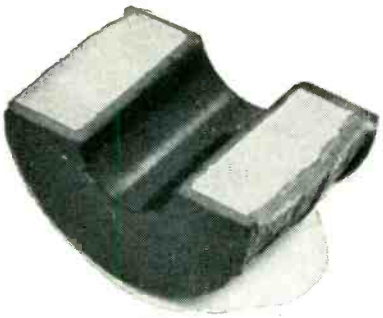
Condensed Typical Operating Data							
	Power Output	Frequency Range, mc	Reflector Voltage	Resonator Voltage	Maximum Temp. Coef.	Tuning	Cavity
2K28	140 mw	1200-3750	—140 v. to —300 v.	300 v.	±.15	Mech. Inductive	Ext.
	Power Output	Frequency Range, mc	Anode kv	Anode Amps.	Pulse Width	P.R.R.	
2J32	285 kw min.	2780-2820 Fixed freq.	20	30	1 μsec	1,000	

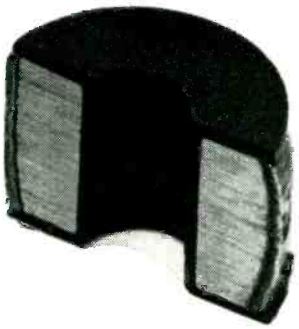
Check these performance records of Raytheon tubes in the Gilfillan ASR-1. Average life, 2J32 Magnetron: 4,000 hours. Average life, 2K28 Klystron: 2,500 hours.

Your microwave and radar equipment offers extra reliability when you specify Raytheon Magnetrons and Klystrons. Use these rugged, reliable tubes in your present and proposed systems. Contact Power Tube Sales to take advantage of Raytheon's Application Engineer Service, without obligation. Write for free Tube Data Booklets.

RAYTHEON *Excellence in Electronics*

RAYTHEON MANUFACTURING COMPANY, Microwave and Power Tube Operations, Section PL18, Waltham 54, Massachusetts





* Unretouched photographs.

WE SPLIT RELAY COILS

to show you why

P&B RELAYS

are the best

These two coil cross-sections illustrate one of the many reasons why P&B's engineering skills and manufacturing facilities have made it *first* in the relay field.

The coil at the left was impregnated by the most universally accepted method.

Note how the varnish failed to penetrate beyond the first few strands—leaving air- and moisture-trapping spaces—allowing strands to pull loose when sawed. *This trapped moisture sets up electrolytic action, causes eventual breakdown.*

Note, however, that the P&B coil above *has* no such "empty" spaces. All strands are solidly embedded in varnish—*completely protected* against moisture and electrolysis.

Centrifugal impregnation, a method exclusive with P&B in the relay field, forces varnish *completely through* the coil—displacing all air and moisture—filling all spaces permanently.

It's one of many excellent reasons why, when you need a relay . . . *of any size, any type, for any application* . . . your smartest move is to P&B and Sterling Relays.

Write
Potter & Brumfield Mfg. Co.,
or Sterling Engineering Co.,
Princeton, Indiana.

Another AMF Product
P&B Relays

DU PONT

Better Things for Better Living
. . . through Chemistry

ELECTRONIC DESIGN NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

No. 2 — 1955

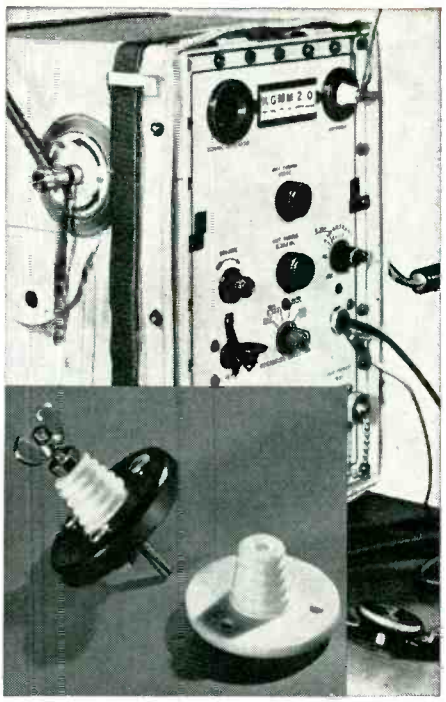
"Teflon" and "Zytel"† nylon combine to make a better relay

Type "TQ" miniature telephone-type relays operate at about 150°F. and are used for power-switching duties – solenoids, valves and magnetic motors. The bobbin is molded of Du Pont "Zytel" nylon – chosen because of its lightness, strength in thin sections, and high insulating properties. It will not gas at operating temperatures.

Miniature telephone-type relays use "Zytel" nylon resin for the bobbin, and wire coated with "Teflon", to assure superior performance. Use the coupon below for complete property information on these Du Pont engineering materials.

The wire is coated with Du Pont "Teflon" tetrafluoroethylene resin. "Teflon" is an electrical insulating material that's especially suited for tough operating conditions. It has good thermal expansion properties and will not gas. The "TQ" miniature relay pictured here is the product of Advance Electric and Relay Company, Burbank, California.

Two-Way Portable Lifeboat Radio Uses Tough TEFLON® for Antenna Post



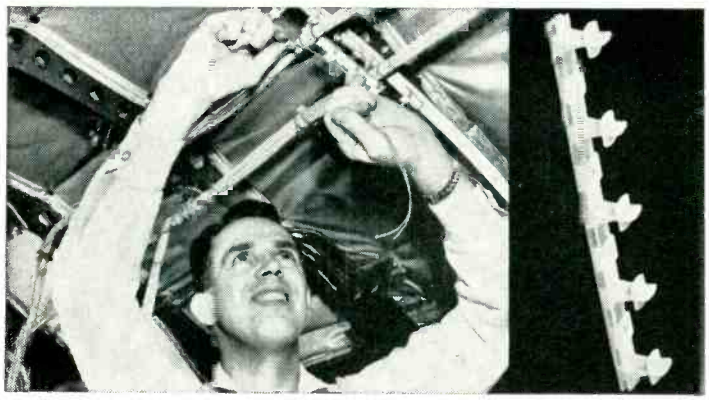
This antenna post of Du Pont "Teflon" tetrafluoroethylene resin has high dielectric properties, resists salt water and can take rough handling. (Radio manufactured by Marine Division, Mackay Radio and Telegraph Company, Inc., New York City, New York. Insulator of "Teflon" made by Tri-point Manufacturing & Developing Company, Brooklyn, New York.)

Resists cracking and chipping, won't corrode from salt spray

Designers have found another use for Du Pont "Teflon"– as the antenna post on a portable lifeboat radio. This radio for emergency use is buoyed up by encased air when it's in the water.

Conventional insulating materials tested for this antenna post failed. Some would chip or crack under the especially rough service this radio encounters. Other materials deteriorated from salt spray. Only Du Pont "Teflon" had the dielectric properties, strength and corrosion resistance to do this job dependably.

The superior properties of versatile Du Pont "Teflon" tetrafluoroethylene resin find a wide use in the electronics field. Fill out the coupon below for full property data about this versatile engineering material.



These wire supports molded of "Zytel" nylon resin (named "tombstones" because of their shape) can take any size wire bundle and eliminate the disadvantages of metal clamps. Besides saving many man-hours in installing airplane wiring, "Zytel" nylon standoff insulators are lightweight, take stress in all directions and are impervious to solvents — including gasoline and jet fuels. "Zytel" is also fungus-resistant, an excellent insulator and won't carbonize. (Stand-off insulators are manufactured by the Nylon Molding Corporation, Garwood, New Jersey, under license of Boeing Airplane Company, Seattle, Washington.)

NEED MORE INFORMATION? CLIP THE COUPON for additional data on the properties and applications of these Du Pont engineering materials.

E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department
Room 224. Du Pont Building, Wilmington 98, Delaware

Please send me more information on the Du Pont engineering materials checked: ☐ "Teflon"* tetrafluoroethylene resin; ☐ "Alathon"* polyethylene resin; ☐ "Zytel"† nylon resin; ☐ "Lucite"* acrylic resin. I am interested in evaluating these materials for_____

NAME_____

POSITION_____

COMPANY_____

STREET_____

CITY_____ STATE_____

TYPE OF BUSINESS_____

*"Teflon", "Alathon" and "Lucite" are registered trade-marks of E. I. du Pont de Nemours & Co. (Inc.)

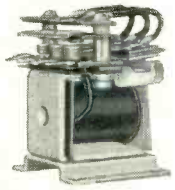
†"Zytel" is the new trade-mark for Du Pont nylon resin.

A.C.

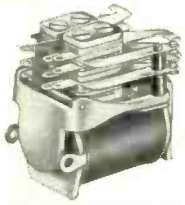
D.C.

GUARDIAN® Relays

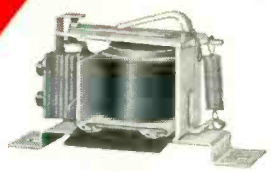
for every industrial and military use...



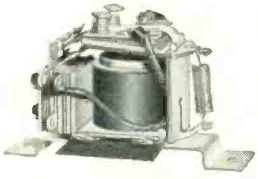
Series 345 D.C.
Versatile
Industrial, Aircraft



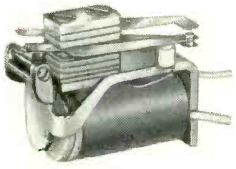
Series 595 D.C.
Midget
Telephone Type



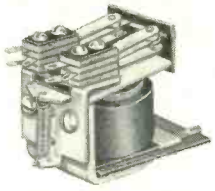
Series 120 A.C.
Sensitive
Small Sized



Series 150 A.C.
Compact
General Purpose



Series 490 A.C.
Midget
Telephone Type



Series 610 A.C.
Economical
Small Sized

Send for your *free copy* of the all-new Guardian Relay Catalog Number 11. Illustrations, dimensional drawings, full technical descriptions and operational data charts combine to present the most complete relay line available from any single source! Write today for your free copy, sent post-paid. No obligation.

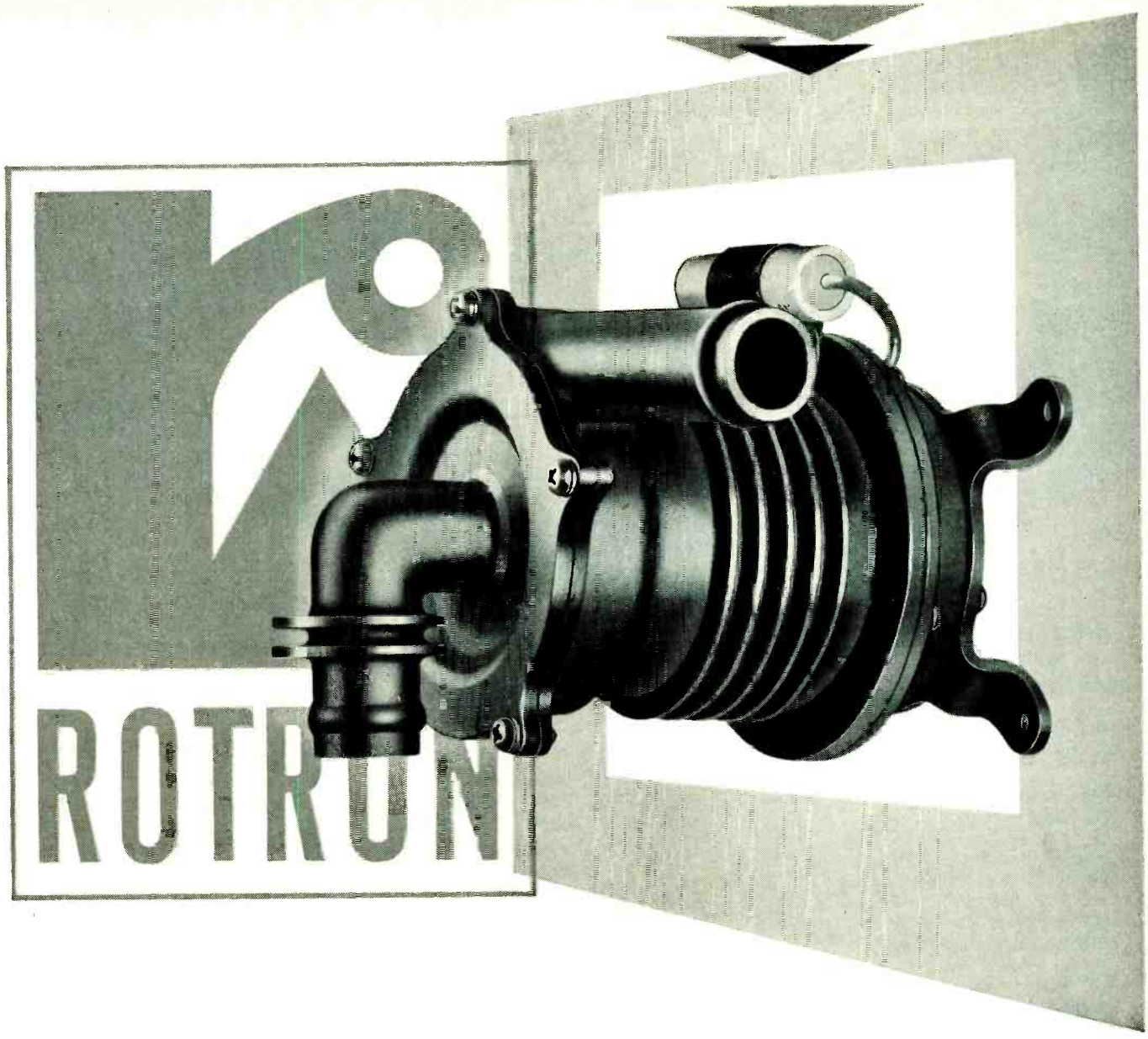
write FOR NEW CATALOG NO. 11

Switches — Steppers — Solenoids — Complete Control Assemblies

GUARDIAN ELECTRIC

1625D W. WALNUT STREET CHICAGO 12, ILLINOIS

A COMPLETE LINE OF RELAYS SERVING AMERICAN INDUSTRY



model "R"-miniature hi-pressure radial blower

...a pioneer in its field!

ROTRON

Moves 7 c.f.m. @ 6 inch w.c. • 400 c.p.s. 1Φ or 3Φ
Weight 2 lbs. • 5 inch overall length

For circulating cooling air over Gyrator in closed air circuit of a wave guide

ROTRON PRODUCTS ARE BUILT TO A HIGH STANDARD OF QUALITY

ROTRON MANUFACTURING CO., INC.

WOODSTOCK • NEW YORK

COOLING EQUIPMENT FOR THE ELECTRONIC INDUSTRIES

Want more information? Use post card on last page.

COMMON CHARACTERISTICS OF ALL TYPE 2131 GEARED MOTOR GENERATOR UNITS

O.D. of Case.....1.000 inch
Case Length.....3.301
Weight.....7.5 ounces
Frequency.....400 cycles
No. of Poles (Motor).....6
*No Load Speed (Min.).....6500 rpm
Rotor Inertia.....1.1 gram-cm²

*Motor Speed at input to gear train

NEW

integral gear head in small servo motors

OUTSTANDING FEATURES OF TYPE 2131 GEARED MOTOR GENERATOR

- New methods of manufacture result in high efficiency
- High torque to inertia ratio to give fast response
- Available for 115 volt–115 volt two phase or single ended tube operation
- High impedance winding for direct plate to plate operation available
- High generator output voltage with excellent signal to noise ratio
- Zero degree phase shift in generator
- All metal parts corrosion resistant
- Extremely wide operating temperature range

Other models of one inch O.D. units

TYPE NO.	DESCRIPTION
2103	Induction Motor
2101	Geared Induction Motor
2028	Motor Generator

A new line of units has been added to the Kollsman "Special Purpose Motors" family combining precision machining, advanced electrical design and the latest in new materials. An unusual feature of the new line is the integral gear head unit. Contained within a single case is the gear train and motor; or gear train, motor and generator. Gear ratios as high as 300:1 can be supplied.

This new line consists of Induction Motors and Induction Generators supplied separately or combined in a single case one-inch in diameter. The new motors have been designed to give the maximum torque per watt ratio with the minimum rotor inertia. The generators have been designed to give the maximum output voltage with the minimum residual voltage and phase shift.

One of the principal features of the Kollsman "Special Purpose Motors" is the interchangeability of parts which permits numerous electrically different combinations of motor and generator windings within the same case.

INPUT PER PHASE ONLY 1.8 WATTS

ELECTRICAL CHARACTERISTICS
OF TYPICAL TYPE 2131 GEARED MOTOR GENERATORS

				MOTOR		GENERATOR		
TYPE NO.	EXCITATION FIXED	EXCITATION CONTROL	INPUT PER PHASE	STALL TORQUE	Theoretical Acceleration At Stall	EXCITATION FIXED	INPUT	OUTPUT PER 1000 rpm
2131-0411110	26	26	2.3	0.4	25600	26	1.8	.51
2131D-0412120	26	26	4.0	0.6	38500	26	2.2	.68
2131D-0413120	26	26	1.8	0.3	19200	26	2.2	.68
2131-0460600	115	115	4.0	0.6	38500	115	2.6	1.00
2131-0463600	115	55	4.0	0.6	38500	115	2.6	1.00
2131-0470600	115	P-P	4.0	0.6	38500	115	2.6	1.00
	volts	volts	watts	Oz-n	rad/sec²	volts	watts	volts

Latest catalog and/or complete specification drawings will be sent upon request.

kollsman INSTRUMENT CORPORATION

80-10A 45th AVE., ELMHURST, NEW YORK • GLENDALE, CALIFORNIA • SUBSIDIARY OF Standard COIL PRODUCTS CO. INC.

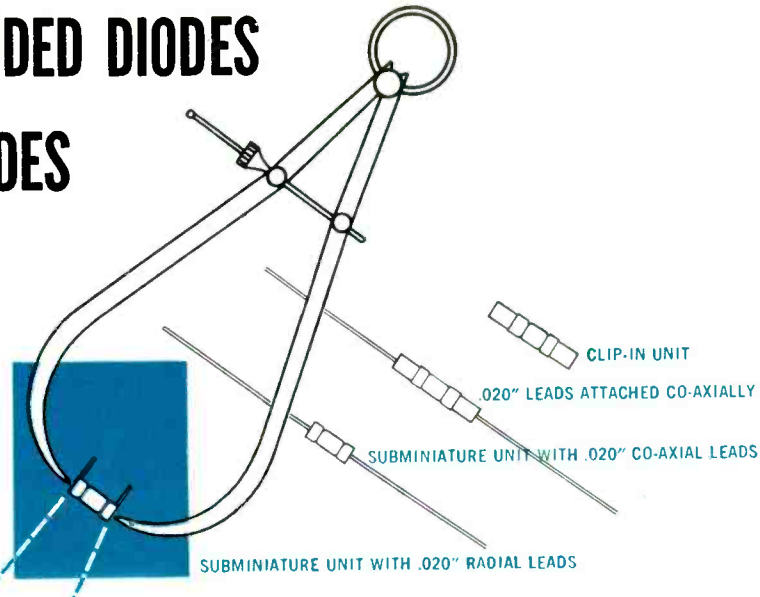
GERMANIUM GOLD BONDED DIODES

SILICON JUNCTION DIODES

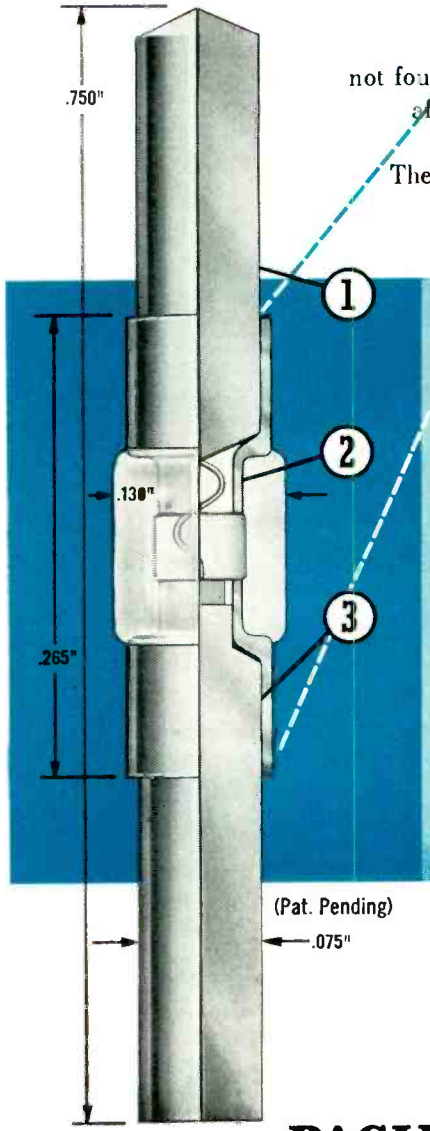
in the new

PSI

DIODE PACKAGE



PSI's revolutionary new package, with advantages not found in any other commercially available diodes, was designed only after an exhaustive survey of user requirements. Space limitations, environmental demands, even assembly procedures became factors in the final design. The result: diodes with demonstrably superior performance, greater versatility, top all-around utility.



CHECK THESE FEATURES...

1. VERSATILE LEAD ARRANGEMENT... for maximum adaptability, diodes may be obtained in a variety of configurations.

2. GLASS-TO-METAL SEAL... for positive moisture resistance, PSI uses a true fusion seal.

3. WELDED CONSTRUCTION... for greater strength and freedom from contamination; no low melting point solders are used.

and your net benefit from all these features...

NEW STANDARDS OF RELIABILITY AND STABILITY

Typical PSI Gold Bonded Diode Characteristics @ 25°C

Forward Current @ 1v (ma)	Inverse Current (μa)	Inverse Working Voltage (volts)
100	100 (−20v)	35
35	10 (−50v)	80
15	25 (−50v) 200 (−200v)	220

Typical PSI Silicon Junction Diode Characteristics

E_S/E_t (volts)	Forward Current @ 1v (ma)	Back Current at 25°C	Back Current at 150°C
30/29	80	.01μa (−15v)	5μa (−15v)
55/53	40	.01μa (−30v)	5μa (−30v)
150/145	15	.01μa (−75v)	5μa (−75v)
300/290	5	.01μa (−150v)	5μa (−150v)

a: The saturation voltage (E_S) is measured at 500μa; the transition voltage (E_t) is measured at 20μa.

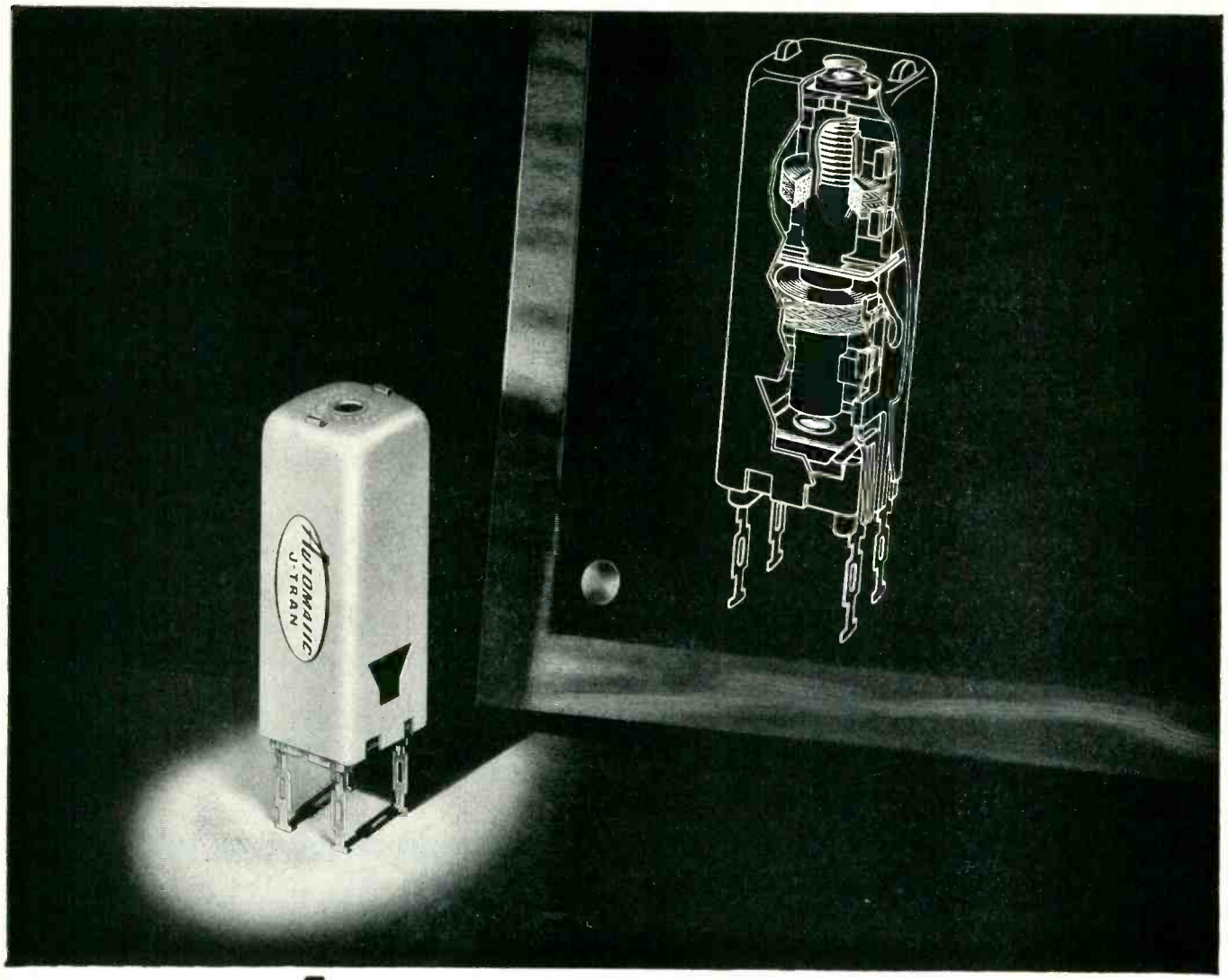
b: Recovery time: after switching from 5ma forward current to ⅔Es for all these types, back resistance reaches or exceeds 50K in 1μsec.

For complete product specifications, application data and quotations, address inquiries to Dept. S-11.

PACIFIC SEMICONDUCTORS, INC.

10451 WEST JEFFERSON BOULEVARD

CULVER CITY, CALIFORNIA

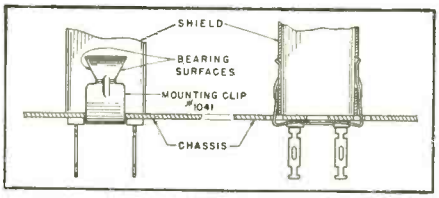


Only AUTOMATIC *makes the J-TRAN®*

3/4" I.F. Transformer for TV • 4.5 to 45 Megacycles

The J-Tran is the standard I.F. Transformer of the television industry. It is the smallest, lowest priced, I.F. Transformer of highest electrical performance – and you can get immediate deliveries! It is used as a Discriminator, Ratio Detector, Input Transformer, Interstage Transformer with traps, and Output Transformer for use with tube and crystal diodes. J-Trans are also made for 262 KC, 455 KC and 10.7 MC radio applications.

One of its many superior features is the hollow, supported, threaded, hexagonal core which permits either double or single ended tuning and allows great latitude in chassis organization. It is the only TV transformer with positive threading and controlled torque. It is supplied also with terminals for printed circuit chassis.



An outstanding mechanical advantage is the clip mounting method, which greatly reduces assembly time. This method of mounting assures a permanent, non-oxidizing contact – *so strong that a heavy chassis can be lifted by gripping only the J-Tran,* without tearing the metal shell.

To become fully familiar with all the superiorities of the J-Tran for TV, write for a copy of the J-Tran* – K-Tran* Manual. It will be invaluable to you in your electronic designing.

*T.M. Reg. U.S. Pat. Off.

AUTOMATIC MANUFACTURING CORPORATION
65 GOUVERNEUR ST., NEWARK 4, N. J.

MASS PRODUCERS OF ELECTRONIC COMPONENTS

Every part Automatic uses ...Automatic makes.

ALITE

A sintered metallic oxide of excellent physical and electrical characteristics, Alite offers the electronic design engineer a new material with intriguing possibilities.

For example, Alite is one of the very few materials which maintain excellent low-loss characteristics over a wide frequency range—from power frequencies throughout the entire spectrum into the super high frequencies. (The power factor at 60 cycles is .0005 and increases to no more than .0008 at 10,000 megacycles.)

Of equal importance is the ability of Alite to maintain its excellent dielectric characteristics at high temperatures. Its volume resistivity at room temperature is 10^{16} ohm cm and at 1000°C is 10^{6}, far superior to electrical porcelains or steatites.

Outstanding electrical characteristics, coupled with high mechanical strength and relative ease of making vacuum tight Alite-to-metal seals greatly expands design possibilities in electron tubes as well as in a host of other electrical applications.

Write for detailed technical data

ALITE DIVISION
of
U. S. STONEWARE
Akron 9, Ohio

NEW YORK **CHICAGO** **HOUSTON**

PROPERTIES OF COMPOSITION AE-212

Alite Composition AE-212 has been developed specifically for electronic applications. Additional Alite formulations are available for other specific purposes.

ELECTRICAL

		ALITE AE-212
Dielectric Constant	@ 60 cy.	9.2
	@ 1 mc	9.0
	@ 1000 mc	8.6
	@ 10,000 mc	8.4
Dielectric Strength	(volts per mil)	250
Power Factor	@ 60 cy.	0.0005
	@ 1 mc	0.0005
	@ 1,000 mc	0.0006
	@ 10,000 mc	0.0008
Loss Factor	@ 10,000 mc	0.0067
Electrical Resistivity	@ 25°C	10^{16}
	@ 200°C	10^{13}
	@ 400°C	10^{10}
	@ 600°C	10^{8}
	@ 900°C	10^{6}

MECHANICAL

Tensile Strength	26,500 psi
Modulus of Rupture (¼" rod)	48,000 psi
Compressive Strength	285,000 psi
Modulus of Elasticity	43×10^{6}
Specific Gravity	3.62
Density (lbs./cu. in.)	0.131
Water Absorption	0.00
Porosity	Vacuum tight
Hardness (Moh's)	9
Color	White
Working Temperature (Max.)	1600°C
	2912°F
Specific Heat	.19
Coefficient of Thermal Expansion	
(25-200°C)	6.58×10^{-6}
(25-400°C)	7.20×10^{-6}
(25-600°C)	7.65×10^{-6}
(25-800°C)	8.07×10^{-6}
(25-1000°C)	8.45×10^{-6}
Thermal Conductivity	
Btu/hr./sq.ft./°F/in. @ 100°F	130

69E

The unique construction of the fly's eye, with numerous tiny lenses on a convex surface, gives the insect an extensive visionary area, in all directions.

Courtesy of the American Museum of Natural History

Wider than a fly can see

Unlike most of nature's children, man's endeavors have carried him far beyond the use of his natural endowments. Spurred on by mental development, human efforts have created a dynamic way of life, demanding the most versatile mechanisms man is able to devise.

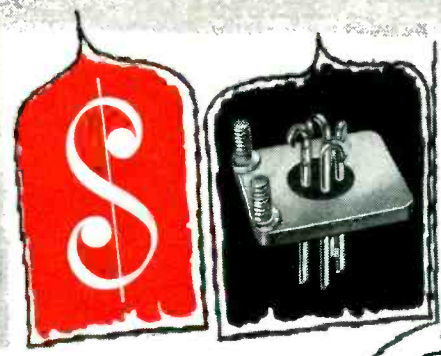
Scientists at Airborne Instruments Laboratory are constantly at work, creating electronic devices to aid industrial progress. In the Wide Range Power Oscillator, they have achieved an instrument, excellent in performance and quality, for testing over the wide frequency range of 300 to 2500 mc.

Equipped with a self-contained rectifier power supply and a single tuning control for grid-cathode and grid-plate lines, the Wide Range Power Oscillator is representative of Airborne's high standard of achievement in research, development and production. Here is another example of individual design, resulting in the universal appeal of AIL products.

Write for descriptive literature.

AIRBORNE INSTRUMENTS LABORATORY INC.

160 OLD COUNTRY ROAD • MINEOLA, NEW YORK



ring up production savings with Hermetic mechanical assemblies

Eliminates a costly production step!

Every production step saved *is money saved!* And production savings increase steadily with every Hermetic Mechanical Assembly used. The integrally glassed assembly terminals eliminate the soldering of terminals to enclosure covers. To the manufacturer, this means a profit increase!

Hermetic Vac-Tite* Seals are available in an unparalleled selection of mechanical designs that provide maximum economy and mounting security.

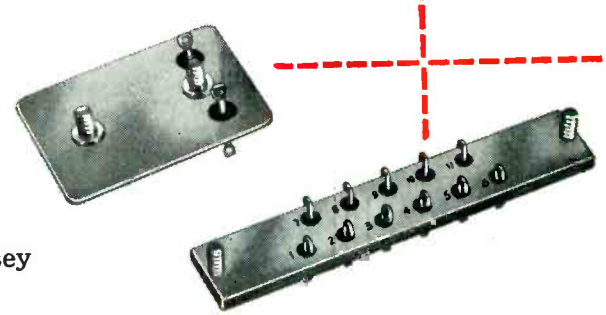
If requirements call for unit headers—Hermetic can supply them with studs attached, shaped to fit enclosures or cans.

For problems concerning terminal strips—Hermetic can provide terminal strips with or without studs and special mounting features, with integrally glassed terminals that offer the advantages of the arc-resistance of glass, and one-piece assembly, modular construction.

Whatever the problem in mechanical assemblies, whether it be color-coded terminal plates, lock-ring safety seals, or attached bracket seals—specially designed Hermetic Vac-Tite* Seals can furnish the money-saving solution to your problem.

Write for engineering assistance, data, and prices.

*Vac-Tite is Hermetic's new vacuum-proof, compression construction glass-to-metal seal.



SEALED IN by HERMETIC HEADERS

Hermetic Seal Products Company

31 South 6th Street, Newark 7, New Jersey

FIRST AND FOREMOST IN MINIATURIZATION

Which Aluminized Picture Tube is Best?

COMPETITIVE TUBE — This photomicrograph magnifies the inside reflective surface of an aluminized picture tube 200 times. You can see clearly its uneven "hill-and-valley" coating which causes some light to be lost within the tube, cuts down on brightness.

WESTINGHOUSE TUBE — Here's a photomicrograph of the Westinghouse aluminized tube manufactured with the exclusive Westinghouse "Flow-Filming" process, taken under the same conditions. Note the smoother, more even aluminum coating. It means you get maximum reflection, sharper, more detailed images.

Here's New Proof of Westinghouse Superiority!

For the first time, here's actual *proof* of the superiority of Westinghouse "Flow-Filmed" aluminized picture tubes.

In a dramatic comparison test of a Westinghouse aluminized picture tube against the tube of another well-known manufacturer, it was proved, beyond any doubt, *by photomicrography — not guess work* — that the Westinghouse aluminized picture tube was superior. Here's what the comparison shows:

WESTINGHOUSE ALUMINIZED TUBE — Look at the photomicrographs. The one on the right is smoother, more even. The aluminum layer has been applied to produce maximum reflection; it provides the viewer more light — *usable light* — that gives an image more brilliance, more clarity. This superior aluminized screen is a result of the *exclusive* Westinghouse "Flow-Filming" process of manufacturing.

COMPETITIVE TUBE — Notice the high peaks and crevices on the competitive tube (left). Light gets lost among them, is reflected backward and toward the sides, not toward the face of the tube. The Westinghouse aluminized tube's coating "caps" every exposed phosphor crystal, makes it an almost perfect reflector and directs the light onto the viewing area. This produces more detailed images, better contrast.

"Flow-Filming" is simply a *better* way of making aluminized picture tubes. It drastically reduces emission failures, caused by chemical residues, which occur under other manufacturing methods. "Flow-Filming" also virtually eliminates the "mottled" or "spotted" effect common to other brands of aluminized picture tubes.

WHAT CAN "FLOW-FILMED" WESTINGHOUSE ALUMINIZED PICTURE TUBES MEAN TO YOU? Just this: Fewer line rejects in your plants. Fewer field rejects. And — in the final analysis — a better, lower cost, easier-to-sell television set. You'll want to know more about Westinghouse aluminized picture tubes. So see your Westinghouse representative or drop a note today to the address below.

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

ET-95067

RELIATRON® TUBES

WESTINGHOUSE ELECTRIC CORPORATION, ELECTRONIC TUBE DIVISION, ELMIRA, N. Y.

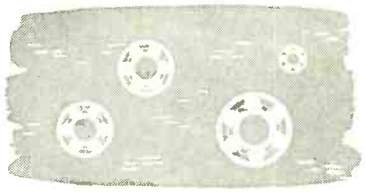
ELECTRONICS Charter-Year Advertiser

Want more information? Use post card on last page.

A GOOD QUESTION?

what does Micro sell

Our Product



Most everyone knows that we sell precision ball bearings of sustained quality. By this, we mean such tolerances as +.0000" —.0002" (ABEC 5) or better. Materials include chrome steel, stainless steel and beryllium copper. Counting the sizes and types made from these materials, about 150 different items are available.

Design Service

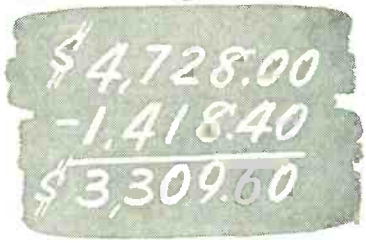
Not everyone realizes the amount of engineering necessary to establish the best bearing in a design. Both in the Plant and Field we have a staff of qualified engineers who can help accomplish this.

Technical information on bearings in general is available in the form of Engineering Bulletins covering such subjects as Torque Testing, Load Capacity, Inspection, Lubrication, Packaging, and others.

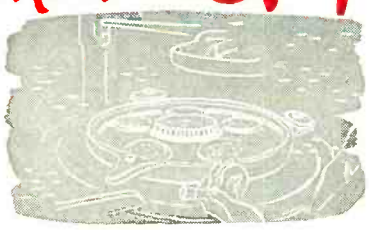
Low Cost

Our Engineering and Sales personnel are constantly providing customers with the best bearings at the lowest possible cost. An example of this is the conversion of many applications to retainer bearings at lower prices and better performance than full types previously used.

Some expensive machining operations are omitted in the manufacture of retainer bearings, and they perform better than the full type in many cases, with substantial savings to customers. CONTINUOUS COST STUDIES ASSURE QUOTATIONS AT LOWEST CURRENT PRICES.



Modern Equipment

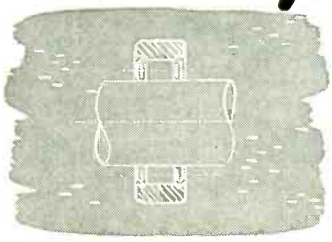


Equipment used in manufacture and gauging of MICRO bearings is the most modern available. Machines dating back further than 1950 have been either retired or relegated to special uses not involved in standard production.

Because of improved techniques, overall costs in the past year have been reduced by 30% on the average.

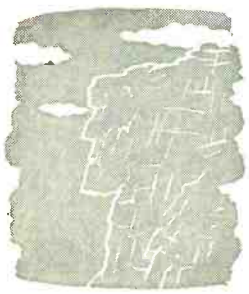
Flexibility

Our Engineers are continually studying new and better ways to solve basic problems. Many special requirements can be accommodated feasibly.



The roller bearing on the left solved the problem of unusually high capacity for small size. Deliveries and bearing sizes can be changed to meet customer requirements within the limits of practicability.

Information



Sales and Engineering service can be obtained from our offices in New York, Boston, Detroit, Chicago, Los Angeles and Dallas. Personnel at these locations and in the Plant consider it their responsibility to provide correct information PROMPTLY.

Integrity

NEW HAMPSHIRE BALL BEARINGS INC.

MICRO CIRCLE • PETERBOROUGH, N. H. • TELEPHONE 424

New MARCONI Vacuum Tube Voltmeter

TYPE TF 1041
FREQUENCY RANGE
20 cps to 700 mc
AND D.C.

The TF 1041 measures up to 300 volts a.c., unbalanced, in 6 ranges and up to 1000 volts d.c., balanced or unbalanced, in 7 ranges. There are also 7 ranges for measuring resistances between 0.2 ohm and 500 megohms.

MARCONI INSTRUMENTS

VACUUM TUBE VOLTMETERS · FREQUENCY STANDARDS · OUTPUT METERS · SIGNAL GENERATORS
WAVEMETERS · WAVE ANALYSERS · Q METERS · BEAT FREQUENCY OSCILLATORS

23-25 BEAVER STREET · NEW YORK 4 · HANOVER 2-0198

ENGLAND: HEAD OFFICE: MARCONI INSTRUMENTS LIMITED, ST. ALBANS, HERTFORDSHIRE
CANADA: CANADIAN MARCONI COMPANY, MARCONI BUILDING, 2442 TRENTON AVENUE, MONTREAL
Managing Agents in Export: MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED, MARCONI HOUSE, STRAND, LONDON, W.C.2.
TC 60 R

For Generation of Pulse Voltages–

CHATHAM
MODEL 5C22
HYDROGEN THYRATRON

A three electrode zero bias thyratron with peak power handling capacity to 2.6 megawatts

MAXIMUM RATINGS — Absolute Values

Maximum Peak Anode Voltage	
Inverse	15 Kilovolts
Forward	15 Kilovolts
Minimum Peak Anode Voltage	
Inverse	800 Volts
Forward	4500 Volts
Maximum Cathode Current	
Peak	325 Amperes
Average	200 Milliamperes
Averaging Time	1 Cycle
Minimum D.C. Anode Voltage	4500 Volts
Maximum Operating Frequency (Note 1)	1000 cps
Minimum Peak Trigger Voltage	200 Volts
Maximum Peak Trigger Voltage	600 Volts
Maximum Heating Factor (Note 2)	3.2×10^9
Maximum Current Rate of Rise	1500 Amps/μs.
Maximum Anode Delay Time	1 μs.
Maximum Time Jitter	0.02 μs.
Ambient Temperature	+90 to –50°C

NOTE 1: This is not necessarily the upper operating frequency limit but represents the highest repetition rate for present life test requirements.

NOTE: 2. Heating factor is the product (epy x prr x ib).

ELECTRICAL DATA

	MIN.	BOGEY	MAX.	
HEATER VOLTAGE	5.8	6.3	6.8	Volts
HEATER CURRENT @6.3V	9.6	10.6	11.6	Amps
CATHODE HEATING TIME	300			Sec.
ANODE VOLTAGE DROP, PEAK	100	150	200	Volts

For detailed characteristic data request sheet DSW-104-1

CHATHAM TYPE VC-1257

Hydrogen filled, zero bias thyratron with hydrogen reservoir for generation of pulse power up to 33 megawatts.

CHATHAM TYPE 5948/1754

Hydrogen filled, zero bias thyratron with hydrogen reservoir for generation of peak pulse power up to 12.5 megawatts.

CHATHAM TYPE 5949/1907

Hydrogen filled, zero bias thyratron with hydrogen reservoir for generation of peak pulse power up to 6.25 megawatts.

CHATHAM TYPE VC-1258

Zero bias miniature hydrogen thyratron for the generation of peak pulse power up to 10 KW. Also available with a 28 v heater and in a super ruggedized type for extreme vibration.

Chatham Hydrogen Thyratrons are the product of many years of concentrated experience in this specialized field. Embodying the most advanced developments in the art, the tubes illustrated offer uniformly high performance when employed in the generation of pulse voltages in the order of microseconds. For complete data and specifications on Chatham Hydrogen Thyratrons, call, write or wire today — no obligation.

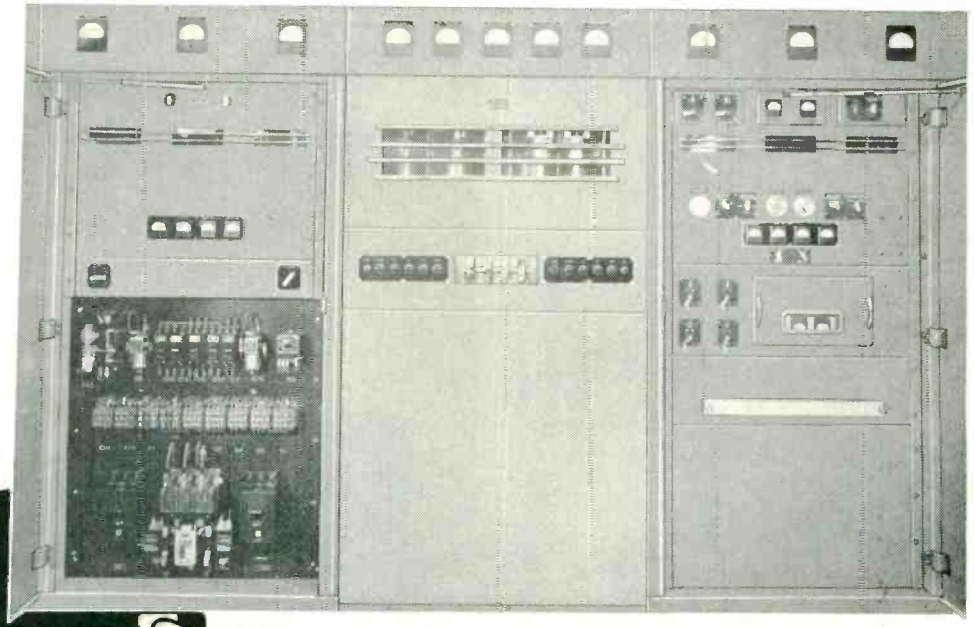
Chatham Electronics

DIVISION OF GERA CORPORATION — LIVINGSTON, NEW JERSEY

GATES

10KW COMMUNICATIONS TRANSMITTERS...

5



Models to Choose From

The popular GATES HF-10 High Frequency Transmitter is available in five different models for applications in broadcast, voice communications, high speed telegraphy or combinations of these services. These fine transmitters have gained world wide recognition for their complete reliability and excellence of signal quality. They are daily handling a sizeable quantity of the intercontinent communications between nations, both government and private.

High level Class B modulation is employed for all voice or broadcast models. The low plate voltage (5000 volts) assures reliability in line with high efficiency. Rated at 10 KW (telegraph) from 2-22 Mc. and 8 KW (telegraph) at 24 Mc., or 10 KW 100% modulated 2-18 Mc., 7½ KW at 22 Mc. and 6 KW at 24 Mc. These rugged transmitters are worth investigating for your future. Write for full descriptions and specifications.

Center cubical of GATES HF-10 Transmitter illustrates husky tank circuit design for high efficiency coverage over entire frequency range.

GATES

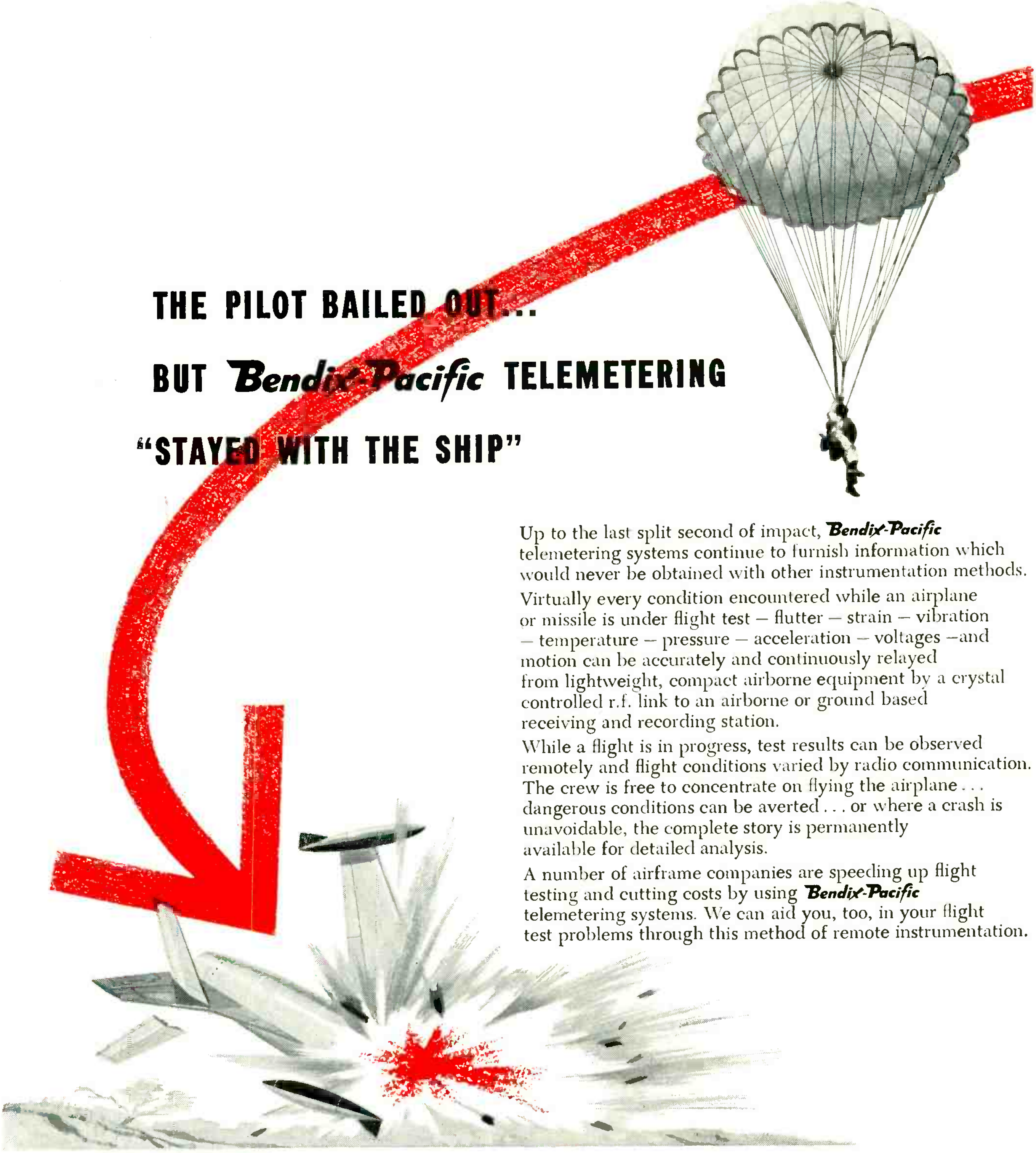
GATES RADIO COMPANY QUINCY, ILL., U. S. A.

Manufacturing Engineers Since 1922

Houston, 2700 Polk Avenue
New York, 51 East 42nd Street

Washington, D. C., Warner Bldg.
Los Angeles, 7501 Sunset Blvd.
New York, International Div., 13 East 40th St.

Atlanta, 13th & Spring Sts.
Montreal, Canadian Marconi Co.



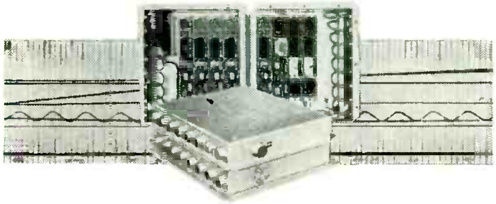
THE PILOT BAILED OUT...
BUT *Bendix-Pacific* TELEMETERING
"STAYED WITH THE SHIP"

Up to the last split second of impact, *Bendix-Pacific* telemetering systems continue to furnish information which would never be obtained with other instrumentation methods.

Virtually every condition encountered while an airplane or missile is under flight test — flutter — strain — vibration — temperature — pressure — acceleration — voltages —and motion can be accurately and continuously relayed from lightweight, compact airborne equipment by a crystal controlled r.f. link to an airborne or ground based receiving and recording station.

While a flight is in progress, test results can be observed remotely and flight conditions varied by radio communication. The crew is free to concentrate on flying the airplane . . . dangerous conditions can be averted . . . or where a crash is unavoidable, the complete story is permanently available for detailed analysis.

A number of airframe companies are speeding up flight testing and cutting costs by using *Bendix-Pacific* telemetering systems. We can aid you, too, in your flight test problems through this method of remote instrumentation.



Typical universal airborne package is provided with plug-in components to facilitate changes in test program.

PACIFIC DIVISION • Bendix Aviation Corporation

11600 Sherman Way, North Hollywood, California

BENDIX PACIFIC

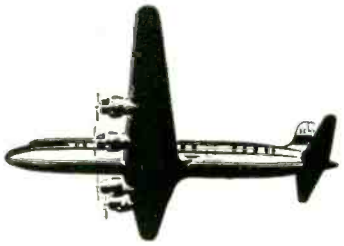
Bendix AVIATION CORPORATION — THE NAME MILLIONS TRUST

Good positions available for Circuit Design and Test Equipment Design Engineers at all levels. Contact W. C. Walker, Engineering Employment Manager.

East-Coast Office:	Dayton, Ohio	Washington, D. C.	Canadian Distributors:	Export Division:
475 5th Ave., N. Y. 17	1207 American Blvd., Dayton 2, Ohio	Suite 803, 1701 "K" St., N. W.	Aviation Electric, Ltd., Montreal 9	Bendix International 205 E. 42nd St., N. Y. 17

Want more information? Use post card on last page.

AEROCOM'S 1046 H.F. TRANSMITTER



POWER + STABILITY

1000 WATTS WITH .003% STABILITY

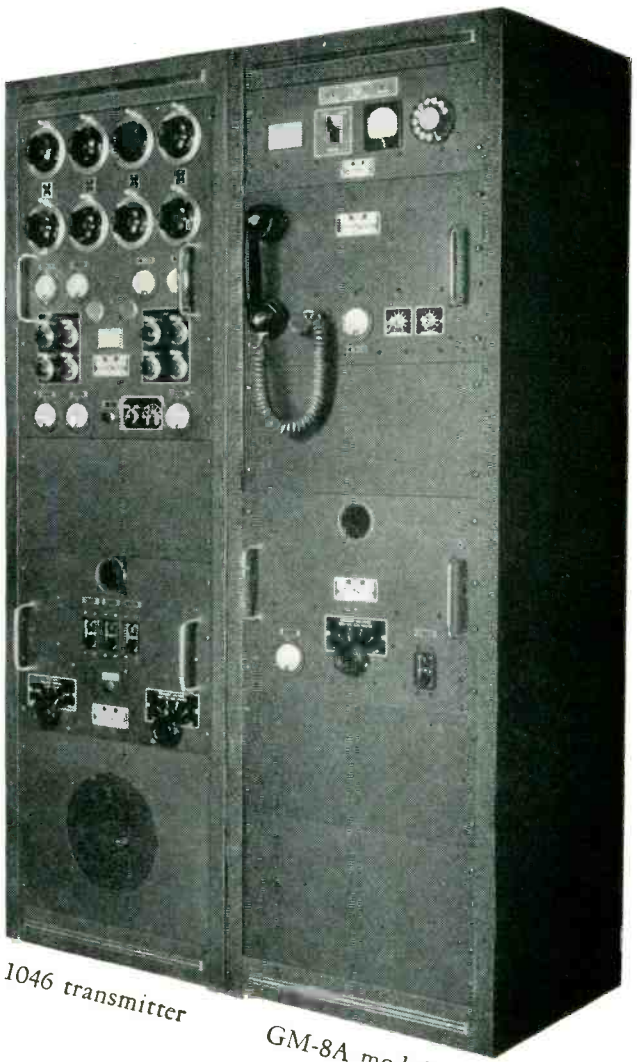
Rugged, versatile general purpose H. F. transmitter—Aerocom's 1046 packs 1000 watts of power and high .003% stability under normal operating conditions (0° to + 50°C.). Excellent for point-to-point or ground-to-air communications.

Multi-channel operation on telegraph A1, or telephone A3 with GM-8A modulator . . . new Aerocom 1046 can be *remotely controlled* with TMC-R at control position and uses only one pair of telephone lines. In A3 operation, the local dial control panel is located in modulator cabinet.

Transmitter cabinet has 8¾ inch panel space available for either local dial control panel or frequency shift keyer.

Model 1046 operates on 4 crystal-controlled frequencies (plus 2 closely spaced frequencies) in the band 2.0—24 Mcs. Operates on one frequency at a time; channeling time 2 seconds. Operates into either balanced or unbalanced loads. Operates in ambient -35° to+50° C. Power supply: nominal 220 volts, 50-60 cycles, single phase.

Complete technical data on request



1046 transmitter GM-8A modulator

AER-O-COM

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

Here's the New

PHILCO

SB

(Surface Barrier)

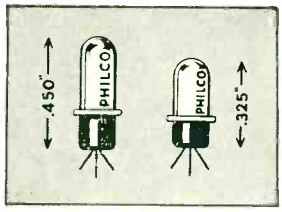
TRANSISTOR

Industry's First High Frequency Transistor ...Available Now!

See Next Page For Details

For the First Time...

High Frequency Circuits Can Be COMPLETELY TRANSISTORIZED



Philco SB Transistors are available in the sizes shown here—standard and miniature.

Today, Philco's new SB Transistor opens up a completely new field of commercial, industrial and military applications for the electronics design engineer. With vastly superior performance assured to 50mc and above, many basic circuits can now be *completely transistorized.* Video bandpass amplifiers, wide band low-pass amplifiers, high frequency oscillators and high speed switching are only a few of the innumerable circuits which the design engineer can produce quickly, easily, efficiently with the revolutionary new SB Transistor.

UP TO 10 TIMES BATTERY LIFE

The Philco Surface Barrier Transistor operates efficiently with power consumption of less than *one* milliwatt ! This extremely low power drain results in up to *ten* times the battery life obtainable with junction transistors, vastly reducing operating costs. Hermetically sealed, the SB Transistor has greater inherent characteristics of stability, longer life and higher efficiency than any other type of transistor.

HIGHEST UNIFORMITY YET ATTAINED

Due to Philco's unique design and precision production methods, the SB Transistor reaches a degree of uniformity and unvarying quality never before achieved with transistors. This remarkable quality permits design engineers to specify the Philco SB Transistor with full assurance of superior performance.

Now being produced in quantity this new Philco SB Transistor is available for your current projects and immediate shipment can be made to you.

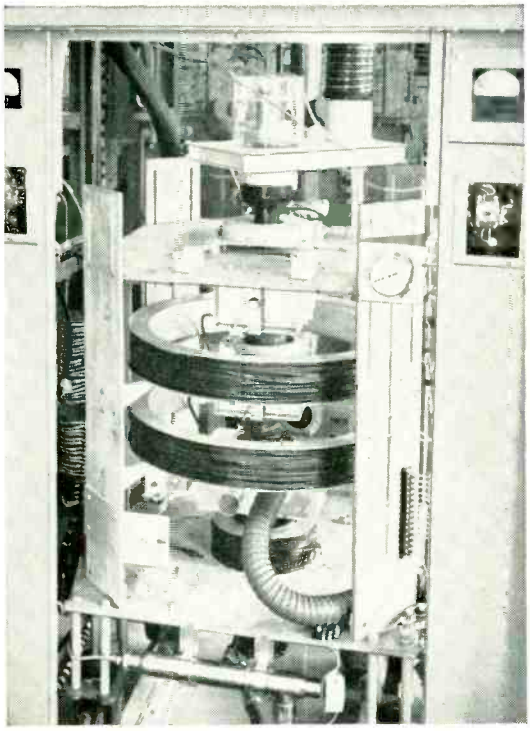
For complete technical information on the PHILCO SB Transistor write Dept. E

PHILCO CORPORATION

GOVERNMENT AND INDUSTRIAL DIVISION • PHILADELPHIA 44, PENNSYLVANIA

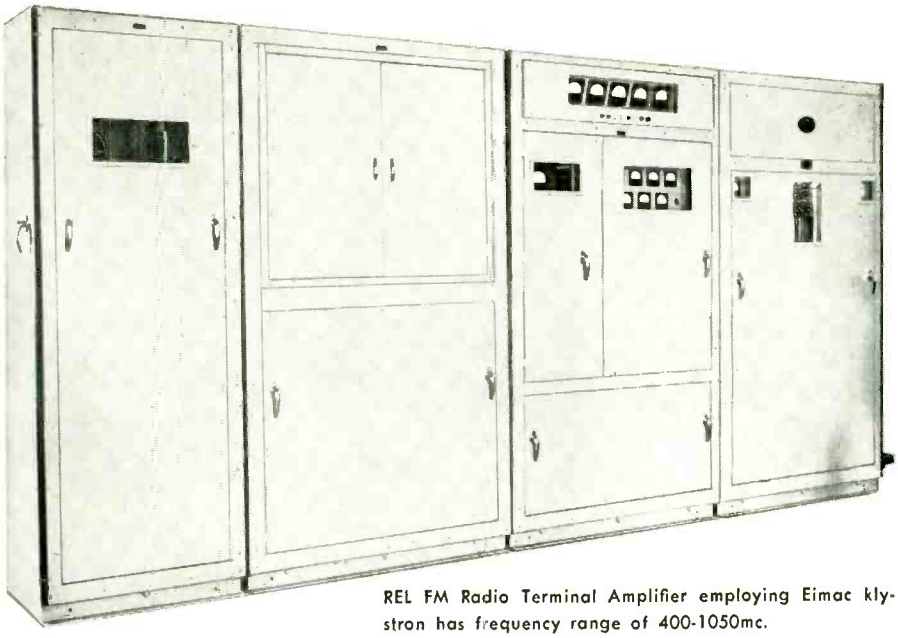
In Canada: Philco Corporation of Canada Limited, Don Mills, Ontario

Radio Engineering Laboratories uses Eimac klystrons in high power, beyond-the-horizon communication equipment



Eimac 3K50,000L klystron in klystron section of REL 10kw power amplifier.

EXTENDED RANGE COVERAGE at frequencies previously limited to low power has been achieved in a new high power beyond-the-horizon UHF communication system. Radio Engineering Laboratories designed and manufactured 30 REL type 826 FM radio terminal equipments for a special system employing Eimac high power klystrons in the final amplifier stage. Eimac klystrons were selected not only because of reliability and high power, 10kw/CW power output with a minimum gain of 26 db, but also for their practical design which permits economical transmitter construction and minimizes replacement problems. Completion of this revolutionary communication system which is now in operation confirms that 1) high power, extended range UHF and microwave coverage is practical, and 2) Eimac klystrons are the most efficient, powerful and reliable tubes for the job.



REL FM Radio Terminal Amplifier employing Eimac klystron has frequency range of 400-1050mc.

For further information on Eimac high power amplifier klystrons, contact our Technical Services Department.

Eimac

EITEL-McCULLOUGH, INC.

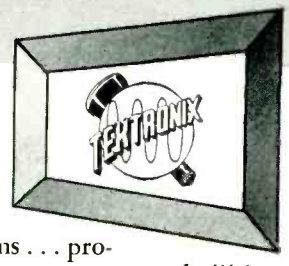
SAN BRUNO • CALIFORNIA

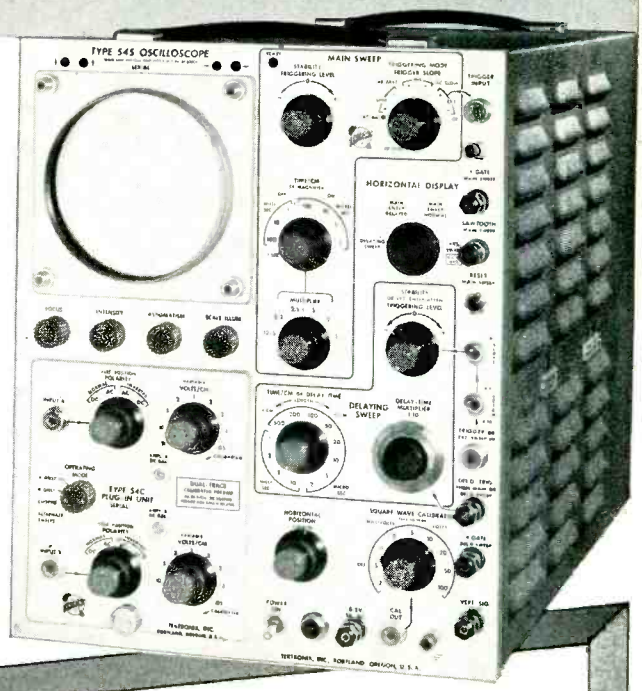
New

for fast-rise applications

(12 MILLIMICROSECONDS)

Tektronix Type 545 and Type 541 CATHODE-RAY OSCILLOSCOPES





TYPE 545—This new high-speed laboratory oscilloscope, in combination with the new Type 53K/54K Fast-Rise Plug-In Unit ... opens the way to quicker, easier analyses of fast-rising waveforms ... providing faithful displays and accurate measurement facilities well beyond the range of previous oscilloscopes of its size and cost. The Type 545-Type 53K/54K combination offers a vertical-amplifier passband of dc to 30 mc (12-millimicrosecond risetime) at calibrated sensitivities to 0.05 v/cm, with a full 4-cm linear vertical deflection. A wide range of calibrated sweeps, with calibrated sweep delay from 1 μsec to 0.1 sec, and high accelerating potential, 10 kv, fully complement this greatly extended vertical-amplifier range.

The Type 545 is the most versatile oscilloscope ever made, for it can be quickly converted to many other applications. By merely plugging in the appropriate Type 53/54 Plug-In Preamplifier you are ready for wide-band, wide-band high gain, dual-trace, high-gain differential, microvolt-sensitivity, or wide-band differential applications. It's a rare oscilloscope application that isn't easily handled by this modern method.

Vertical-Amplifier Characteristics with Type 53K/54K Unit Plugged In

Transient Response—Risetime, 12 millimicroseconds.

Frequency Response—Passband, dc to 30 mc (down 3 db ± ½ db at 30 mc, only 6 db at 45 mc).

Input impedance 20 μμf, 1 megohm.

Sensitivity—0.05 v/cm to 20 v/cm in 9 calibrated steps.

Price—$125

Type 545 Oscilloscope Characteristics

Wide Sweep Range
24 Calibrated sweeps from 0.1 μsec/cm to 5 sec/cm, accurate within 3%. Accurate 5-x magnifier extends calibrated range to 0.02 μsec/cm. Continuously variable from 0.02 μsec/cm to 12 sec/cm.

Wide Sweep-Delay Range
Additional delaying-sweep circuitry provides conventional, or triggered jitter-free delay, 1 μsec to 0.1 sec in 12 calibrated ranges. Range accuracy within 2%. Incremental accuracy within 0.2% of full scale.

Versatile Triggering
Internal or external, with amplitude-level selection or AUTOMATIC TRIGGERING. High-frequency synchronizotion up to 30 mc.

Square-Wave Amplitude Calibrator
0.2 mv to 100 v in 18 steps, accurate within 3%.

New Cathode-Ray Tube
Tektronix T54P 5" precision metallized crt provides 4-cm vertical and 10-cm horizontal linear deflection. 10-kv regulated accelerating potentiol.

Balanced Delay Network
0.15 μsec vertical signal delay.

DC-Coupled Unblanking
Uniform unblanking at all sweep speeds and repetition rotes.

Electronic Voltage Regulation
All voltages affecting calibrations are fully regulated.

CRT Beam Position Indicators

Type 545—$1450 plus price of desired plug-in units.

Type 541—Same characteristics, less delayed-sweep facility—$1145 plus price of desired plug-in units.

Prices f.o.b. Portland (Beaverton), Oregon

LOW INPUT CAPACITANCE

With Accessory Probes for Type 53K/54K

Probe	Input Impedance	Maximum Sensitivity
P405	11.5 μμf, 5 megohms	0.25 v/cm
P410	7.5 μμf, 10 megohms	0.5 v/cm
P420	4.5 μμf, 10 megohms	1 v/cm
P450	2.5 μμf, 10 megohms	2.5 v/cm
P4100	2.5 μμf, 10 megohms	5 v/cm

Please call your Tektronix Field Engineer or Representative for complete specifications.

Tektronix, Inc.

P. O. BOX 831A • PORTLAND 7, OREGON
CYPRESS2-2611 CABLE: TEKTRONIX

FOR TODAY'S PROJECT . . . TOMORROW'S PLANS . . .

Gyros BY Greenleaf...

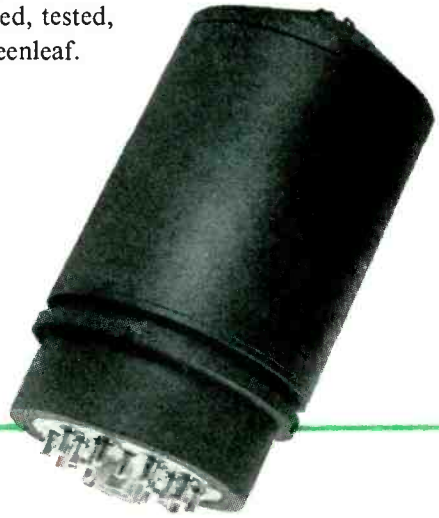
Actual Size

HIG-3

the industry's smallest (1″ dia. x 2″ long), lightest (4.5 oz.) Hermetically-sealed Integrating Gyro . . . developed, tested, and now in production by Greenleaf.

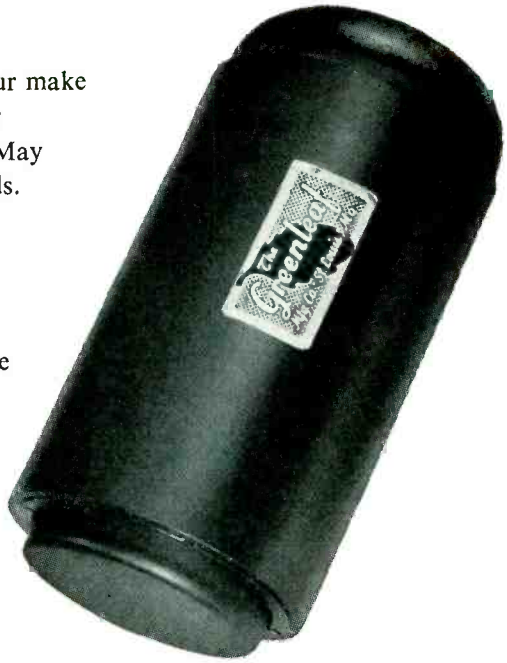
HIG-4

the amazingly accurate "big brother" of the new HIG-3 . . . now being delivered in production quantities.



DIRECTIONAL GYRO

drift rates as low as 1° per hour make this precision unit versatile for a wide range of applications. May be modified to meet your needs.



RATE GYRO

designed for versatility because of its broad range of modification possibilities. A "special" rate gyro.

Whatever your gyro needs, Greenleaf has the answer. A telegram or phone call will put us in touch with you immediately.

THE Greenleaf

ENGINEERING • DEVELOPMENT • PRODUCTION

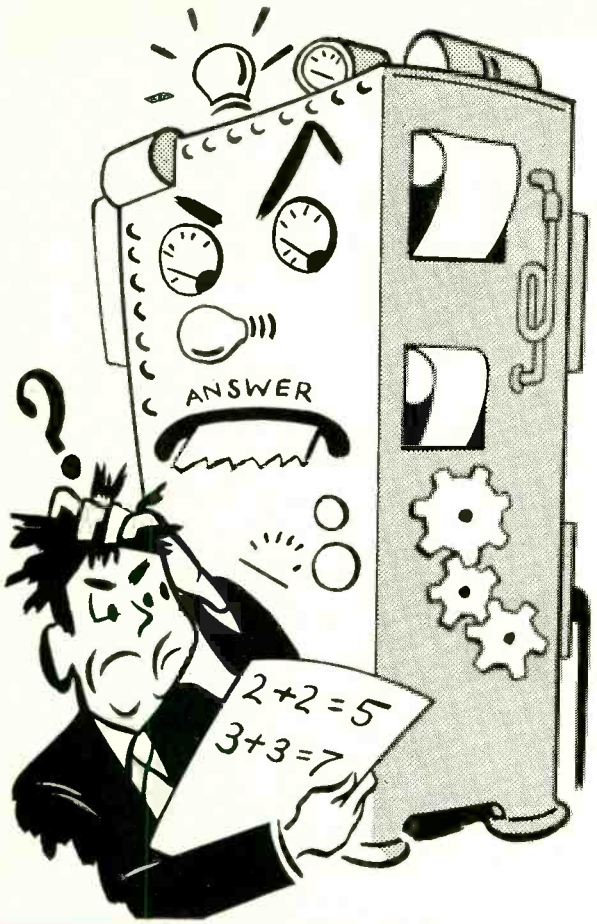
MANUFACTURING COMPANY

7814E W. Maplewood Industrial Court • St. Louis 17, Missouri

Where quality control works on the production line . . . producing the new HIG-3, the HIG-4 and Rate Gyros, Transducers, Accelerometers, Synchros, Air Speed Indicators, Actuators and many other precision-built components.

22

Want more information? Use post card on last page.



Not Getting The Right Answers?

Install Hubbell *Interlock* Plugs To Solve Your Wiring Problems

Computers are just one of the many modern electronic units that depend upon small component parts for accuracy of operation. The wiring of connections to sources of power, as well as between elements within the unit, must be dependable and must be designed for fast, easy rearrangement and maintenance. Hubbell *Interlock* Plugs meet all these requirements and actually provide an extra margin of dependability.

HUBBELL SELF-LOCKING HUBBELL CONNECTORS *Interlock*

You Can Be Sure Of A Positive Connection

Unlike other terminals, *Interlock* Plugs are designed with a locking mechanism that permits contact on *two surfaces* and provides a constant low contact resistance. *Interlock* plugs *lock automatically* in their eyelets or jacks, can be quickly disconnected when intended, yet cannot disconnect accidentally — — and they're designed to withstand unusual strain and vibration!

Tests Prove It!

By actual laboratory test, the Hubbell *Interlock* Type "A" Plug, capacity 10 amperes, withstands a 47 pound pull without disconnecting; the Type "B" Plug, capacity 5 amperes, a 16 pound pull; Type "C", capacity 1 ampere, 4.7 pounds; and the heavy duty Type "S" Plugs, capacity 15 amperes, up to 222 pounds.

HUBBELL

HARVEY HUBBELL, Inc.

Interlock Electronic Connector Dept., Bridgeport 2, Conn.

Added Evidence that—

Everyone Can Count on VEEDER-ROOT

For moderate counting duty, where extreme long life is not required, this new small reset counter is completely reliable. Compact and easily connected, this counter may be actuated by any type of switch, relay or photoelectric unit. Recommended speed is 700 counts per minute. Power consumption is low . . . *and so is the price* . . . but still the same Veeder-Root high quality. So here again is proof that you can count on Veeder-Root for any type of counter . . . electrical, mechanical or manual . . . for any type of duty in any field from atomics to electronics. What do *you* need to count?

Write:

VEEDER-ROOT INCORPORATED
HARTFORD 2, CONNECTICUT

Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C.
Montreal 2, Canada • Dundee, Scotland
Offices and Agents in Principal Cities

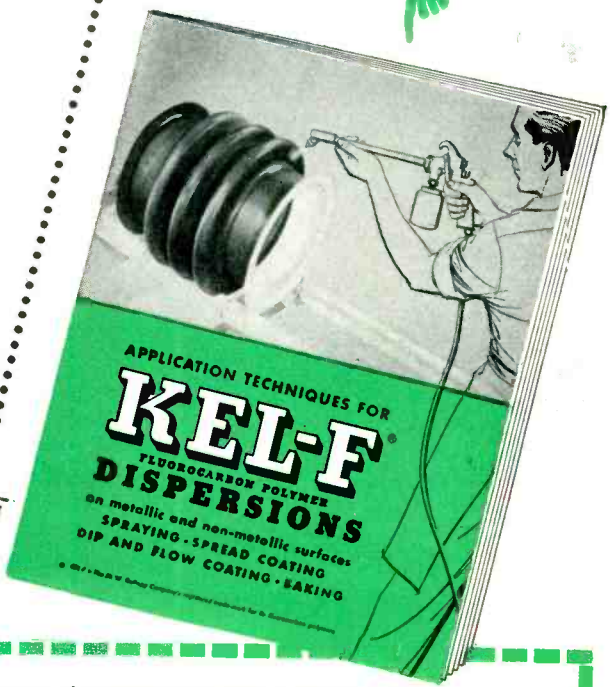
"The Name that Counts"

Find the Newest Answer to

CORROSION CONTROL

in this 20-page KEL-F® Dispersions Manual

Learn how you can get the advantages of KEL-F fluorocarbon plastic: corrosion and heat resistance, anti-adhesion, abrasive resistance, excellent electrical properties, moisture resistance *in a dispersion coating, for application by spraying, dipping or spreading*



® Registered trademark of The M. W. Kellogg Company's fluorocarbon polymers

KELLOGG

THE M. W. KELLOGG COMPANY
Chemical Manufacturing Division
P. O. Box 469, Jersey City 3, N. J.

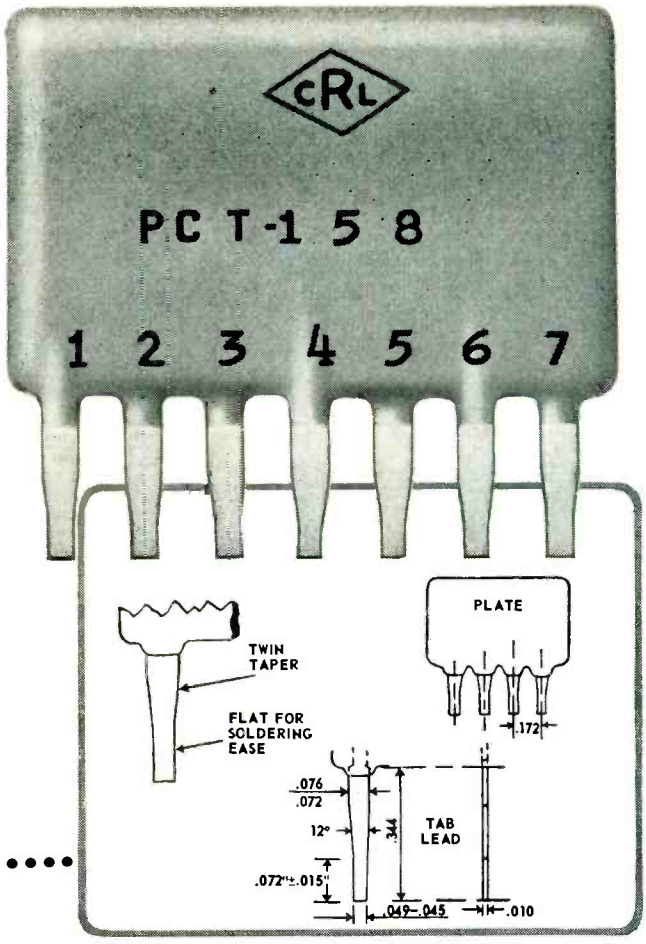
Please send me my copy of the new Kellogg Manual, "Application Techniques for KEL-F® Fluorocarbon Polymer Dispersions."

Name _____
Title _____
Company _____
Address _____
City _____ State _____

I am interested in Dispersion Coating Applications for:

- ☐ trailer tanks
- ☐ tankcars
- ☐ storage tanks
- ☐ pipe lines
- ☐ pumps
- ☐ mixers
- ☐ valves
- ☐ flowmeters
- ☐ reactors
- ☐ shipping containers
- ☐ waste neutralizers
- ☐ agitators
- ☐ calendering rolls
- ☐ forming dies
- ☐ guide rolls
- ☐ mattress molds
- ☐ tire molds
- ☐ ribbon blenders
- ☐ cone blenders
- ☐ hoppers
- ☐ casting molds
- ☐ coated glass tape
- ☐ miniaturized stators
- ☐ distribution transformers
- ☐ miniaturized relays

Other applications (please list) _____



To help you speed assembly of circuit boards, Centralab developed...

Centralab Plug-In Printed Electronic Circuits* with Twin-Tapered Tab Leads

They give you the usual advantages of Printed Electronic Circuits:

Uniformity of circuit performance.
Saving in size — and cost — of circuit chassis.
Saving of soldering time.
Elimination of wiring errors.

...plus these special advantages:

Fast assembly.
Positive positioning.
Positive solder connections inside or outside of chassis holes.

Write for detailed engineering bulletin EP-40R.

*Trademark

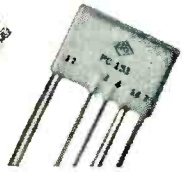
More proof that if it's a job for electronic components, it's a job for Centralab

Centralab's creative engineering and production methods pay off for many users of standard and special electronic components


Volume Controls


Capacitors


Switches


Printed Electronic Circuits


Ceramics

†Nothing to buy. Employees of Centralab and their advertising agency not eligible. Duplicate prizes awarded in case of tie.

Y-552

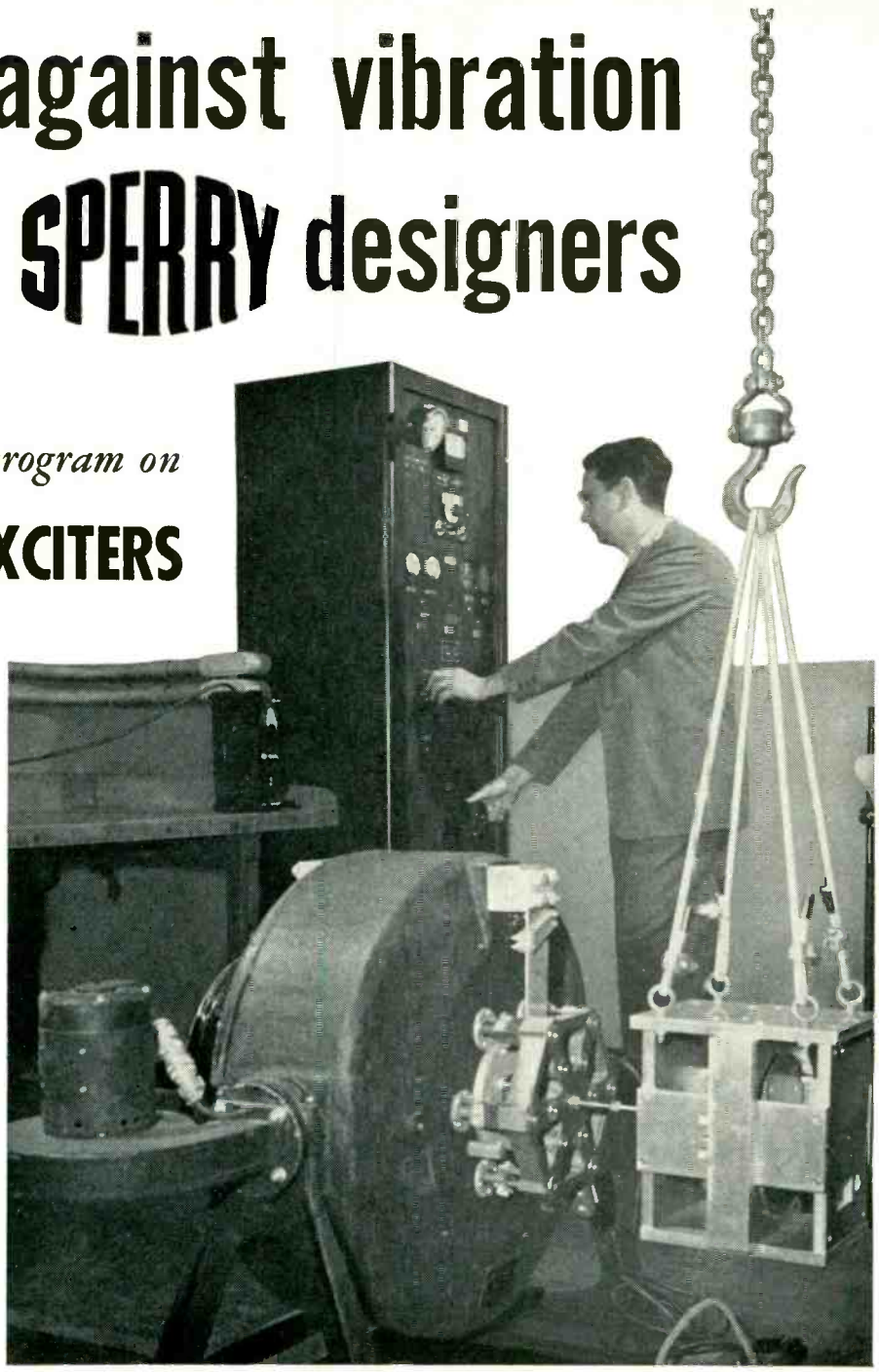
Centralab
A DIVISION OF GLOBE-UNION INC.
914D E. Keefe Avenue • Milwaukee 1, Wisconsin
In Canada: 804 Mt. Pleasant Road, Toronto, Ontario

SINCE 1922, INDUSTRY'S GREATEST SOURCE OF STANDARD AND SPECIAL ELECTRONIC COMPONENTS

Durability against vibration assured by SPERRY designers

. . . with a shake-testing program on

MB VIBRATION EXCITERS



In a Vibration Test Section of Sperry Gyroscope Company, an MB Vibration Exciter Model C-5 is being used to fulfill requirements of MIL-E-5272 and other specification tests.

COMPANIES quick to take advantage of newest techniques for development and testing are generally also those known for outstanding products. Such a concern is the Sperry Gyroscope Company. It maintains well-equipped vibration testing laboratories where searching tests are performed on all designs subjected to vibration in service. Vibration is ruled out as a trouble-maker in vital products and components.

VIBRATION TESTING SPEEDS DATA

With vibration now recognized as an archenemy of product life and performance, it pays to learn early in the game whether corrections in design are needed. MB Shakers can help *you* to do just that. In a few short hours, the equipment can reproduce the ravages of *years* of vibratory service conditions. Within minutes, it can show you visually the vibratory response of a product to a whole range of frequencies.

The result: *savings in engineering time and work, and a better product.*

WHY MB VIBRATION EXCITERS?

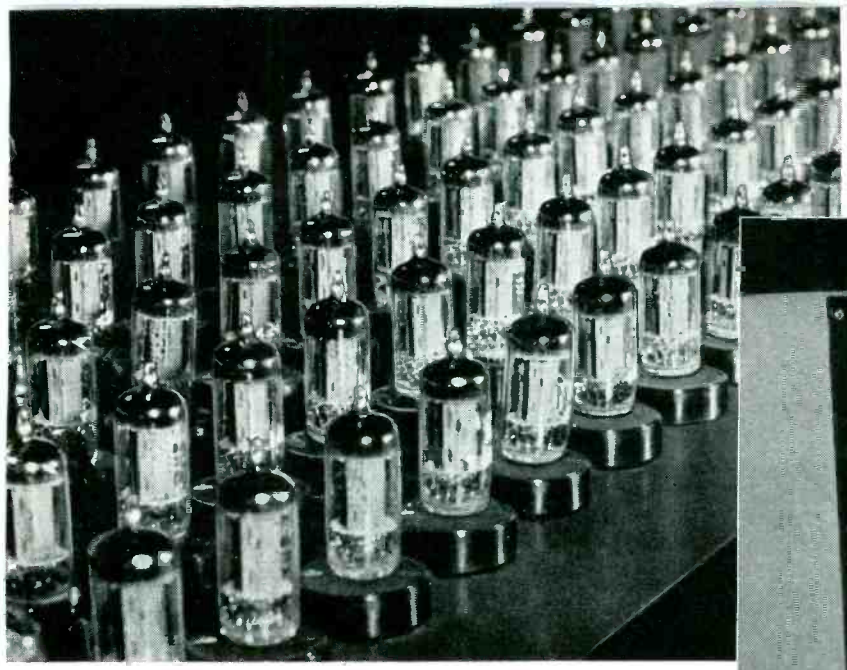
Engineered by vibration specialists to deliver maximum performance, MB Shakers can be counted on for pure table motion and dependable operation to full rated capacity. Moreover, MB's line of vibration testing "tools" is complete—from small specialized-duty shakers to the largest in existence today; also automatic cycling systems, vibration pickups, meters and other accessories.

Like so many well known companies, why not make MB *your* headquarters on vibration?

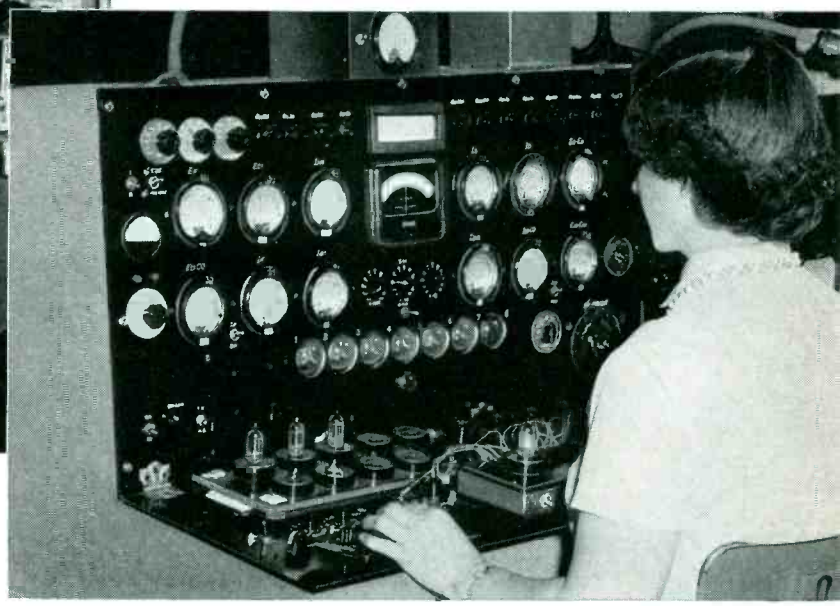
THE MB MANUFACTURING COMPANY, INC.
1060 STATE STREET, NEW HAVEN 11, CONN.

BULLETIN TELLS MORE
Contains specifications, operating information and helpful hints on usages of the complete line of MB Exciters. Write for Bulletin 1-VE-5.

HEADQUARTERS FOR PRODUCTS TO *ISOLATE* VIBRATION...TO *EXCITE* IT...TO *MEASURE* IT



LEFT: G-E computer tubes undergo a cut-off life test. The tubes are operated for long intervals with their grids biased to cut-off. Periodically the tubes are given a cathode interface check, to make sure no "sleeping sickness", or failure to respond to changed grid voltage, has developed during inactivity.



RIGHT: extensive instrumentation is used to test tube electrical qualities that closely affect operation in computer circuits. Zero-bias plate current; cut-off performance; any difference in cut-off between twin-triode sections—these are three of many characteristics checked.

G-E Computer Tubes are specially tested for qualities that safeguard computer reliability!

General Electric pioneered special tubes for computers . . . also developed tests such as those above, which assure that G-E tubes in your computer circuit can be relied on to meet designers' aims in all respects.

The tests are specific in purpose. Each covers one or more tube characteristics important in computer use, and which closely influence the accuracy and reliability of the equipment.

There is no substitute for G-E computer-tube quality, which starts with special tube design—extends through precision manufacture—concludes with exhaustive tube tests that relate directly to computer service.

Also . . . there is no counterpart to G.E.'s range of special computer tubes *now in production.* You have a choice of proved G-E types available for your present circuit needs, with new tubes constantly being added.

Ask for "G-E Computer Tubes And Their Applications" (ETD-1140). 54 pages—just off the press. A book every designer and builder will find useful! *Tube Department, General Electric Company, Schenectady 5, New York.*

* * *

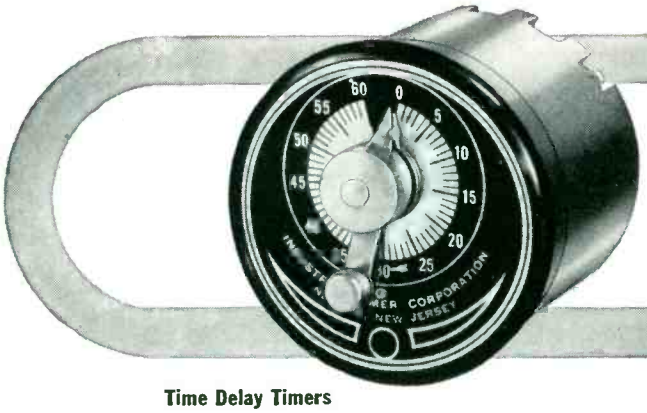
● G-E computer-tube development is a continuing process, with new types being added regularly for faster, more advanced equipment, or to meet special customer requirements where volume warrants. Five types—proved, popular—already are in full production:

GL-5844 **GL-6211**
GL-5965
GL-5915A **GL-6463**

Progress Is Our Most Important Product

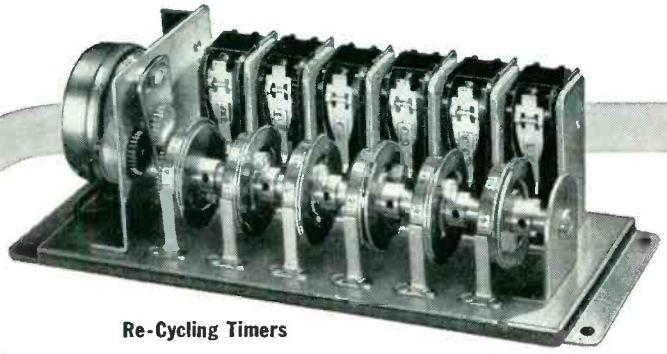
GENERAL ELECTRIC

162-1C1

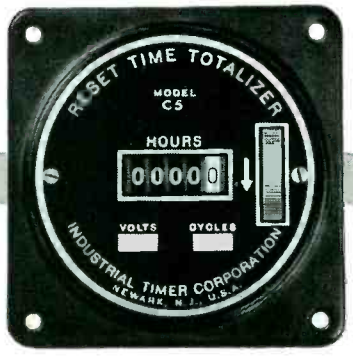


Time Delay Timers

Interval Timers



Re-Cycling Timers



Running Time Meters

MOST COMPLETE LINE OF INDUSTRIAL

TIMERS for automation

The individual requirements of each automation problem are best met by selecting timers designed to perform specific functions. Whatever your timing-control problem, Industrial Timer Corporation can meet it with one of its standard timers, a combination of its standard units, or by designing an entirely new timing element. Our Engineering Department not only originates new designs, but also develops modifications to meet our customers requirements.

We manufacture a complete line of timers in these 4 broad classifications:

TIME DELAY TIMERS • RE-CYCLING TIMERS
INTERVAL TIMERS • RUNNING TIME METERS

Our large stocks of 17 basic types from which we have developed over 660 combinations to date, enables us to make rapid deliveries in most cases . . . and excellent deliveries on special orders. Our automation timer specialists will be happy to discuss your automation timer requirements. Your inquiries will receive prompt attention.

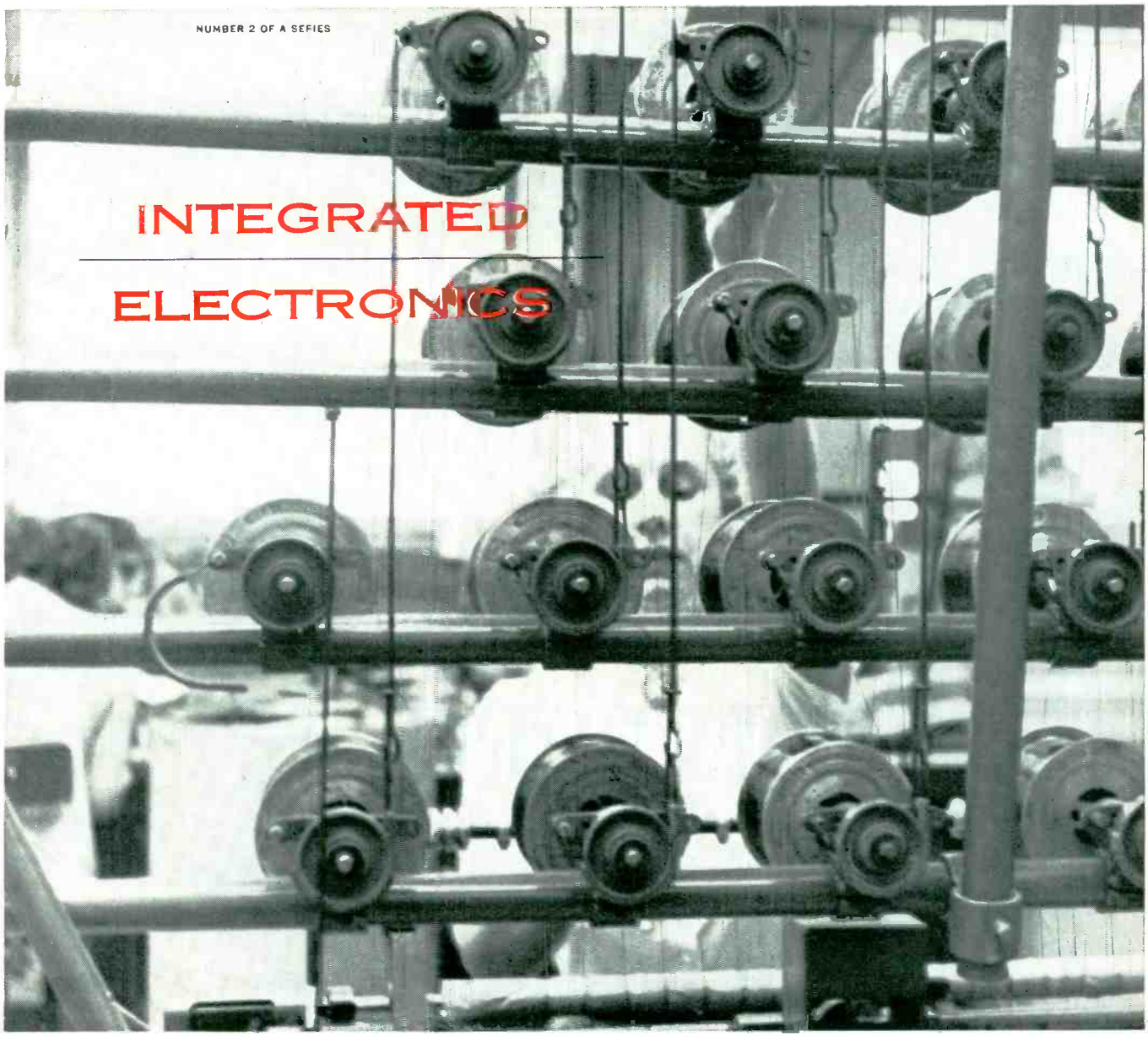
Timers that Control the Pulse Beat of Industry

INDUSTRIAL TIMER CORPORATION

INDUSTRIAL TIMER CORPORATION
131 OGDEN STREET, NEWARK 4, N. J.

NUMBER 2 OF A SERIES

INTEGRATED ELECTRONICS



WINDING PRECISION COILS

THE IMAGINATION FOR RESEARCH + THE SKILL FOR PRODUCTION

Three complete plants with a total of 240,000 square feet are devoted exclusively to precise military electronics and electro-mechanical production. These facilities are staffed and equipped to design, develop, test, and manufacture equipment ranging in size from miniature trans-ceivers to heavy shipboard fire control weighing more than two tons.

Hoffman Laboratories is equipped with a completely integrated manufacturing operation with sheet metal, machine shop, plating, welding, assembly, and test departments.

Constant quality control and inspection procedures assure the highest equipment efficiency . . . equipment that meets and exceeds requirements.

Write the Sales Department for your free copy of "Report From Hoffman Laboratories."

- Navigational Gear
- Missile Guidance & Control Systems
- Radar
- Noise Reduction
- Countermeasures (ECM)
- Communications
- Terminal Equipment
- Transistor Application

Hoffman
LABORATORIES, INC.

A SUBSIDIARY OF HOFFMAN ELECTRONICS CORP.

CHALLENGING OPPORTUNITIES FOR OUTSTANDING ENGINEERS TO WORK IN AN ATMOSPHERE OF PRACTICAL, CREATIVE ENGINEERING. WRITE TO DIRECTOR OF ENGINEERING, HOFFMAN LABORATORIES, INC., 3761 SOUTH HILL STREET, LOS ANGELES 7, CALIFORNIA

IF YOU ARE LOOKING for *high uniformity* molybdenum to help you reduce vacuum tube costs—Sylvania is now your dependable source!

Sylvania's exacting quality control assures you of excellent uniformity, in both physical properties and dimension—today or a year from today. Every step in the production of molybdenum . . . from crude oxide to finished form . . . is carried on in Sylvania's own plants. Your orders are filled to your exact specifications by Sylvania, and Sylvania alone.

The superior elongation, ductility and machinability of Sylvania molybdenum has made it a preferred metal for many vacuum tube applications . . . support, mandrel and grid wires; heat shields; heating elements. It has an outstanding record of success in heavy emission tube types where high heat resistance is essential.

Sylvania's engineering department will gladly help you explore the advantages of molybdenum for your specific applications.

Write for complete information.

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd.
University Tower Bldg., St. Catherine St., Montreal, P.Q.

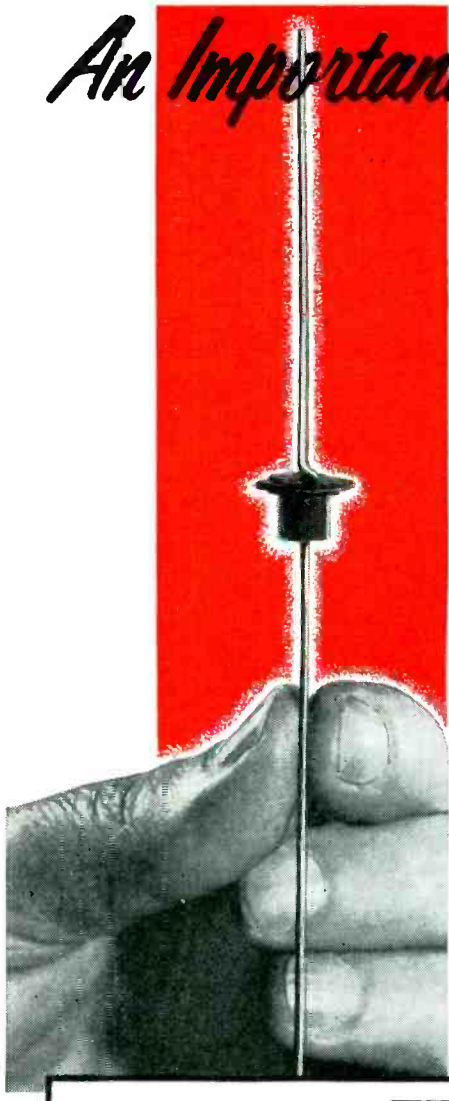
SYLVANIA

Lighting • Radio • Electronics • Television • Atomic Energy

An Important Announcement to Industry-

SILICON POWER RECTIFIERS

AVAILABLE FOR THE FIRST TIME IN PRODUCTION QUANTITIES

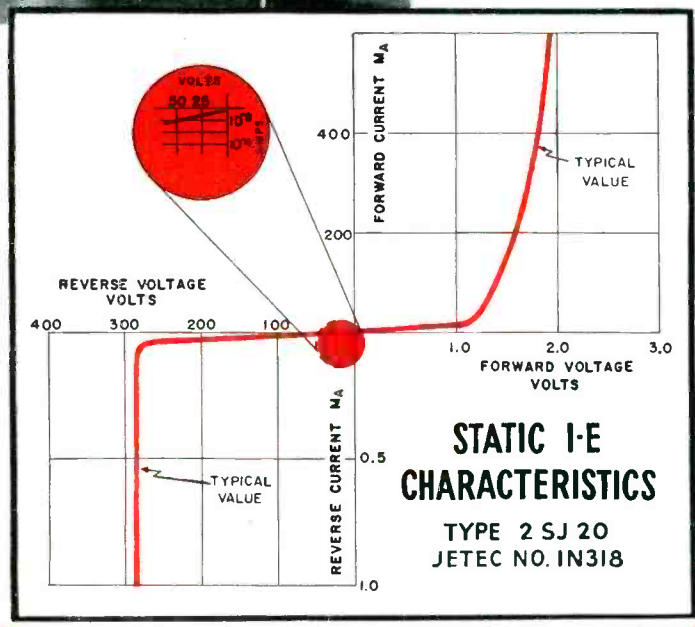


PRECISION ELECTRICAL Bogue EQUIPMENT SINCE 1892

★ These units are ideally suited for aircraft and guided missile requirements. Other typical applications that can benefit from their superior characteristics are power rectifiers in commercial equipment, magnetic amplifiers, clipping, meter protection and counter circuits. Anxiety over temperatures is completely eliminated when they are used in digital computers. Automation and control engineering suggest additional fields.

Performance:

1. Rectification Efficiency Over 99%
2. Forward Voltage Drops Averaging 1.5 Volts at 200 MA
3. Peak Inverse Voltages to 1,000 Volts
4. Operates Continuously up to 200°C.
5. Leakage Current as Low as 10-10 amperes
6. Rectification Ratios as High as 10^{9}
7. Practically Flat Zener Characteristics



STATIC I-E CHARACTERISTICS

TYPE 2 SJ 20
JETEC NO. IN318

Characteristics:

1. HIGHEST EFFICIENCY
2. HIGH CURRENT
3. HIGH VOLTAGE
4. HIGH AMBIENT OPERATION
5. HERMETICALLY SEALED
6. SMALL IN SIZE
7. LIGHT IN WEIGHT
8. RUGGED — ALL WELDED
9. LOW FORWARD DROP
10. LOW LEAKAGE

Write for fully illustrated and informative Bulletin SR-18-2

Jetec No.	TYPE	Forward Drop @ 200 MA	Forward Current Continuous	Power Current Peak	Peak Inverse
IN 316	2SJ5	2V Max	200 MA	2A	50V
IN 317	2SJ10	2V Max	200 MA	2A	100V
IN 318	2SJ20	2V Max	200 MA	2A	200V
IN 319	2SJ30	2V Max	200 MA	2A	350V
IN 320	2SJ50	2V Max	200 MA	2A	500V

Units with peak inverse rating of 850 volts available in sample quantities.

BOGUE

BOGUE ELECTRIC MANUFACTURING COMPANY
152 PENN. AVE. PATERSON 3, NEW JERSEY

Why —

YOU CAN SAVE TIME AND TROUBLE BY STANDARDIZING ON BUSS FUSES!

Whatever your fuse requirements may be — you can turn to BUSS and select the right fuse for the job.

The complete BUSS line includes fuses in any size from 1/500 up, plus a companion line of fuse clips, blocks and holders.

You'll find that relying on this one, dependable source for fuses helps to simplify your buying, stock handling and records — and results in profit-saving efficiency.

Every BUSS fuse is electronically tested to assure "trouble-free" protection.

To make sure that BUSS fuses will operate properly under all service conditions — every BUSS fuse normally used by the Electronic Industries is electronically tested. A sensitive device automatically rejects any fuse not correctly calibrated, properly constructed and right in all physical dimensions.

If you should have a special problem in electrical protection . . . the world's largest fuse research laboratory and its staff of engineers are at your service — backed by over 40 years of experience. Whenever possible, the fuse selected will be available in local wholesalers' stocks, so that your device can be easily serviced.

For more information on BUSS and Fusetron small dimension fuses and fuse holders . . . Write for bulletin SFB.

ELRC-455

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

FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
BUSS

BUSSMANN MFG. CO. *(Div of McGraw Electric Co.)*
University at Jefferson, St. Louis 7, Mo.

LOOK ..... TO **Transitron**®

SILICON RECTIFIERS AND DIODES

designed for specific applications

SILICON POWER RECTIFIERS

Rated for 125°C operation, Transitron's silicon rectifiers provide high power handling ability and reliability at high temperature. They are specifically designed for magnetic amplifier and power supply applications. Send for Bulletin TE-1321.

Specifications and Ratings at 125°C

POWER SUPPLY TYPES			MAGNETIC AMPLIFIER TYPES		
TYPE	P.I.V.* (volts)	Idc** (ma)	TYPE	P.I.V.* (volts)	Idc** (ma)
1N341	400	400	1N332	400	400
1N343	300	400	1N334	300	400
1N345	200	400	1N336	200	400
1N347	100	1000	1N338	100	1000

* Peak Recurrent Inverse Voltage at full load
** Maximum Average Forward Current at full load

ACTUAL SIZE

SILICON JUNCTION DIODES

Transitron's silicon junction diodes are characterized by superior forward conductance and reliable operation up to 150°C. They are specifically designed for applications requiring extremely high inverse resistance at high temperatures. Send for Bulletin TE-1322.

TYPE	Forward Current at +1 V (ma)	Inverse Current at Specified Voltage (ua)		Maximum Working Voltage (volts)
		at 25°C	at 125°C	
1N137A	3	.03 at 20V	—	36
1N138A	5	.01 at 10V	—	18
1N137B	20	.03 at 20V	5 at 20V	36
1N138B	40	.01 at 10V	2 at 10V	18
1N350	20	.03 at 60V	5 at 60V	70
1N351	8	.03 at 100V	5 at 100V	120
1N352	5	.05 at 150V	10 at 150V	170
1N353	3	.10 at 200V	20 at 200V	225
1N354	1	.10 at 300V	20 at 300V	325

ACTUAL SIZE

SILICON BONDED DIODES

Transitron's silicon bonded diodes are specifically designed for high frequency and very fast switching applications at high temperatures. They are particularly useful in detector, discriminator and pulse circuitry. Send for Bulletin TE-1308.

TYPE	Forward Current at +1 V (ma)	Inverse Current at Specified Voltage (ua)	Inverse Breakdown Voltage
S4	1	1 at 10V	15
S5	1	.1 at 10V	20
S6	4	.5 at 5V	10
S7	2	1 at 10V	20
S8	1	1 at 10V	10

Operating frequency range 0-500 mc. Average Shunt Capacitance 0.8 uufd

ACTUAL SIZE

Transitron's special engineering group is available to assist you with specific applications. Inquiries concerning your particular design problems are invited.

Transitron electronic corporation • melrose 76, massachusetts


Glass Diodes


Silicon Diodes


Germanium Diodes


Transistors


Silicon Rectifiers

GENERAL ELECTRIC ANNOUNCES

Vac-u-Sel RECTIFIERS

New Line of G-E Component Rectifiers Achieves 3 Performance Highs

- **63 VOLT PEAK INVERSE**
- **130 C AMBIENT OPERATION**
- **60,000 HOUR LIFE EXPECTANCY**

General Electric's new line of Vac-u-Sel Component rectifiers offer greater application flexibility than any other rectifiers in history. You can now obtain a rectifier cell with a peak inverse rating of 63 volts, or a rectifier which will operate up to 130 C ambient temperature, or a rectifier which has a life expectancy of 60,000 hours.

New G-E Vac-u-Sel rectifiers now make it possible to match performance requirements for life expectancy, ambient operating temperature, and atmospheric protection, as well as electrical characteristics.

THREE NEW RECTIFIER CELLS make up the new line of Vac-u-Sel rectifiers; a 26-volt low temperature cell, a 26-volt high temperature cell, and a 45-volt high temperature cell. All three are produced by the vacuum evaporation process described at the right, but special variations in the manufacturing give them distinctly different electrical characteristics.

26-VOLT LOW TEMPERATURE CELL is the standard industrial cell, used on applications where ambient operating temperature will not exceed 55 C. Rectifiers using this cell have a life expectancy of 60,000 hours at normal current rating.

26-VOLT HIGH TEMPERATURE CELL can meet operating requirements up to 130 C at full voltage. Current need not be derated where shorter life is acceptable. Life expectancy at 130 C is 1000 hours.

45-VOLT HIGH TEMPERATURE CELL has a 63-volt peak inverse voltage. Unlike most 45-volt rectifiers, this is a true, long-life industrial cell. Frequently this rectifier may be substituted for ones employing 26-volt cells. Since fewer cells are required, savings of up to 30% in cost, and up to 35% in the size of the stacks are possible. Life expectancy of this 45-volt cell is 40,000 hours, and the cells can be used at ambient temperatures up to 110 C.

ALL VAC-U-SEL RECTIFIERS operate with exceptionally low forward voltage drop and low reverse leakage, and their margin of superiority in these characteristics increases in service. All Vac-u-Sel rectifiers undergo extensive testing and grading, and matched cells are used in assembling stacks. A variety of finishes and mounting arrangements are available to meet virtually any requirements.

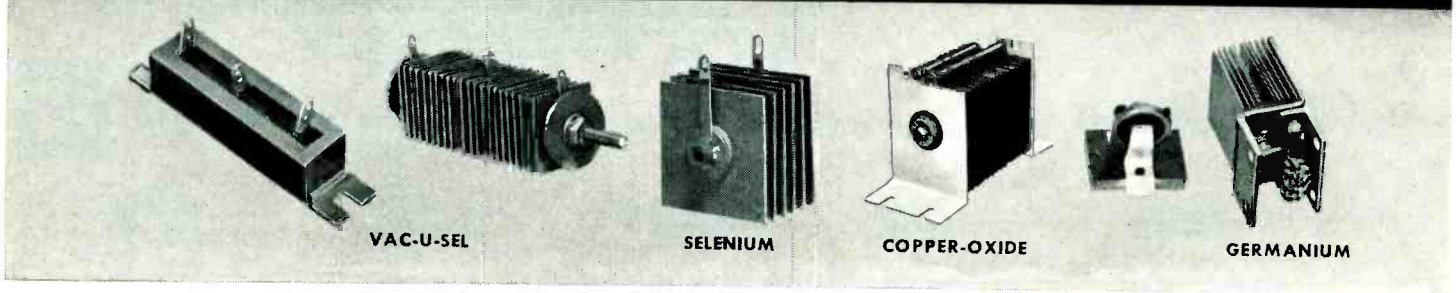
MORE INFORMATION on these new Vac-u-Sel rectifiers is available from your nearest General Electric Apparatus Sales Office, or by writing Section 461-36, General Electric Co., Schenectady 5, N. Y.

Progress Is Our Most Important Product

GENERAL ELECTRIC

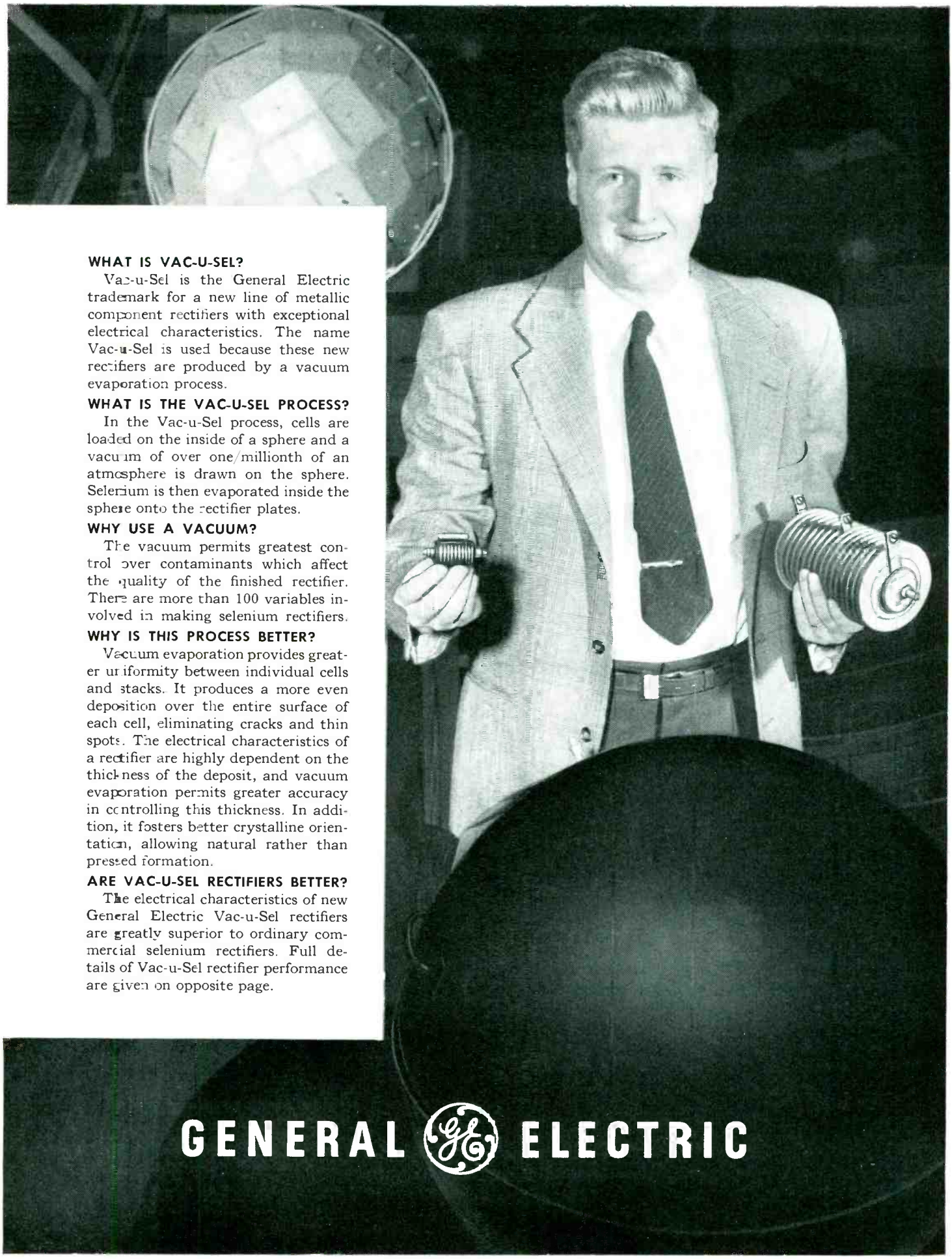
RECTIFIER DEPARTMENT

METALLIC RECTIFIER COMPONENTS FOR PRACTICALLY EVERY DC REQUIREMENT



ELECTRONICS Charter-Year Advertiser

Want more information? Use post card on last page.



WHAT IS VAC-U-SEL?

Vac-u-Sel is the General Electric trademark for a new line of metallic component rectifiers with exceptional electrical characteristics. The name Vac-u-Sel is used because these new rectifiers are produced by a vacuum evaporation process.

WHAT IS THE VAC-U-SEL PROCESS?

In the Vac-u-Sel process, cells are loaded on the inside of a sphere and a vacuum of over one millionth of an atmosphere is drawn on the sphere. Selenium is then evaporated inside the sphere onto the rectifier plates.

WHY USE A VACUUM?

The vacuum permits greatest control over contaminants which affect the quality of the finished rectifier. There are more than 100 variables involved in making selenium rectifiers.

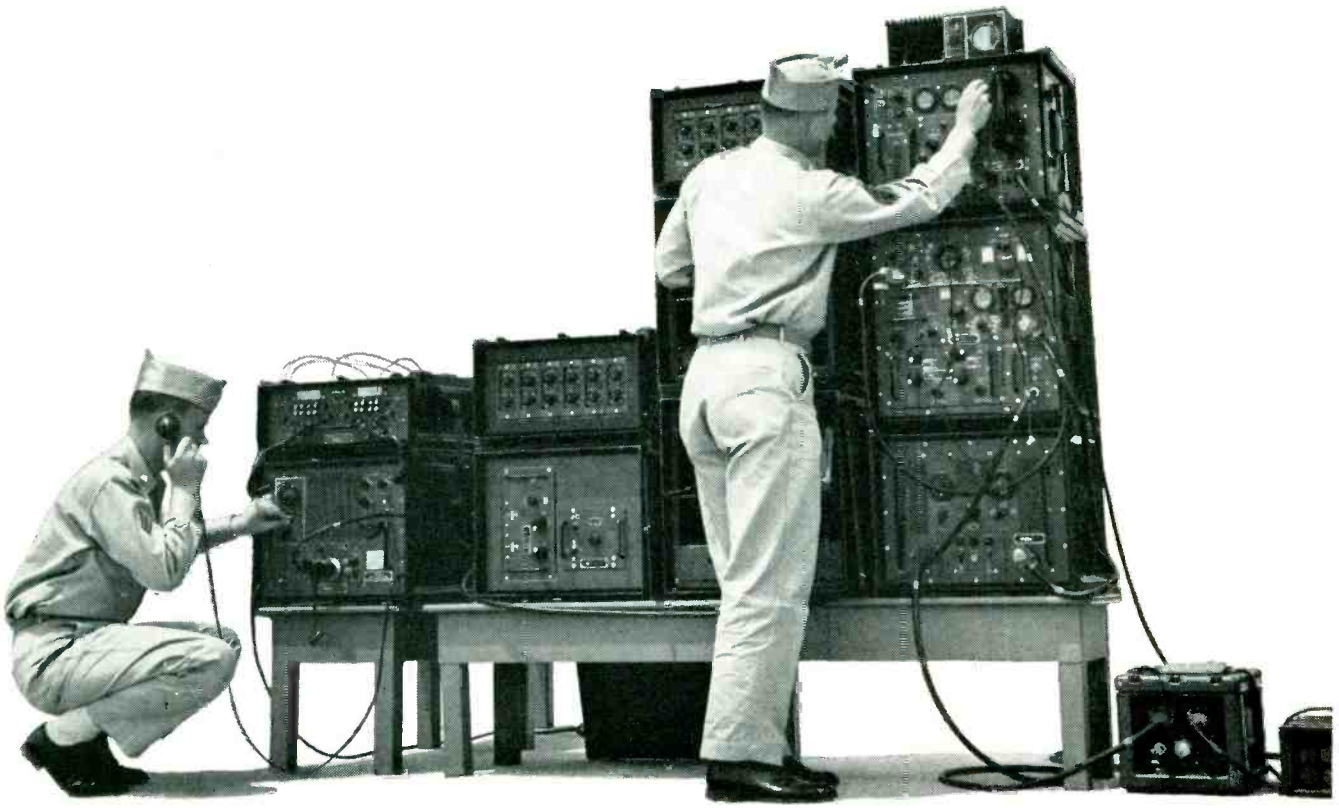
WHY IS THIS PROCESS BETTER?

Vacuum evaporation provides greater uniformity between individual cells and stacks. It produces a more even deposition over the entire surface of each cell, eliminating cracks and thin spots. The electrical characteristics of a rectifier are highly dependent on the thickness of the deposit, and vacuum evaporation permits greater accuracy in controlling this thickness. In addition, it fosters better crystalline orientation, allowing natural rather than pressed formation.

ARE VAC-U-SEL RECTIFIERS BETTER?

The electrical characteristics of new General Electric Vac-u-Sel rectifiers are greatly superior to ordinary commercial selenium rectifiers. Full details of Vac-u-Sel rectifier performance are given on opposite page.

GENERAL ELECTRIC



Tuning in for radio transmission. Each item of equipment is not much bigger than a suitcase.

A leapfrog telephone system for the Armed Forces!

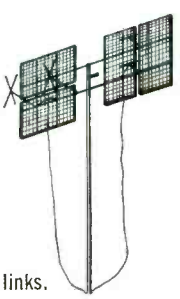
A new communications system, which takes to the air when water or rough terrain prevents the stringing of wires, has been developed for the U.S. Signal Corps by Bell Telephone Laboratories.

The system uses cable and radio relay interchangeably over a 1000-mile range. It is easily portable, unaffected by climate, and rugged enough for global use. Twelve voices travel at once over a pair of wires or radio waves—as clearly and naturally as over the regular telephone system.

This is the first time a completely integrated wire and radio system of this large a channel capacity has been available for tactical use by the Armed Forces. It is already in production at Western Electric, manufacturing and supply unit of the Bell System.

The new system is a joint achievement of the Signal Corps, Bell Laboratories and Western Electric . . . one of the many results of long and fruitful co-operation. It shows again how techniques which the Laboratories develop contribute to our national strength.

Amplifiers like this are used every 5¾ miles in the cable portions of the system. They are weatherproof, can be used on a pole or the ground, and will even work under water. The system uses a spiral wound cable developed by the Signal Corps.

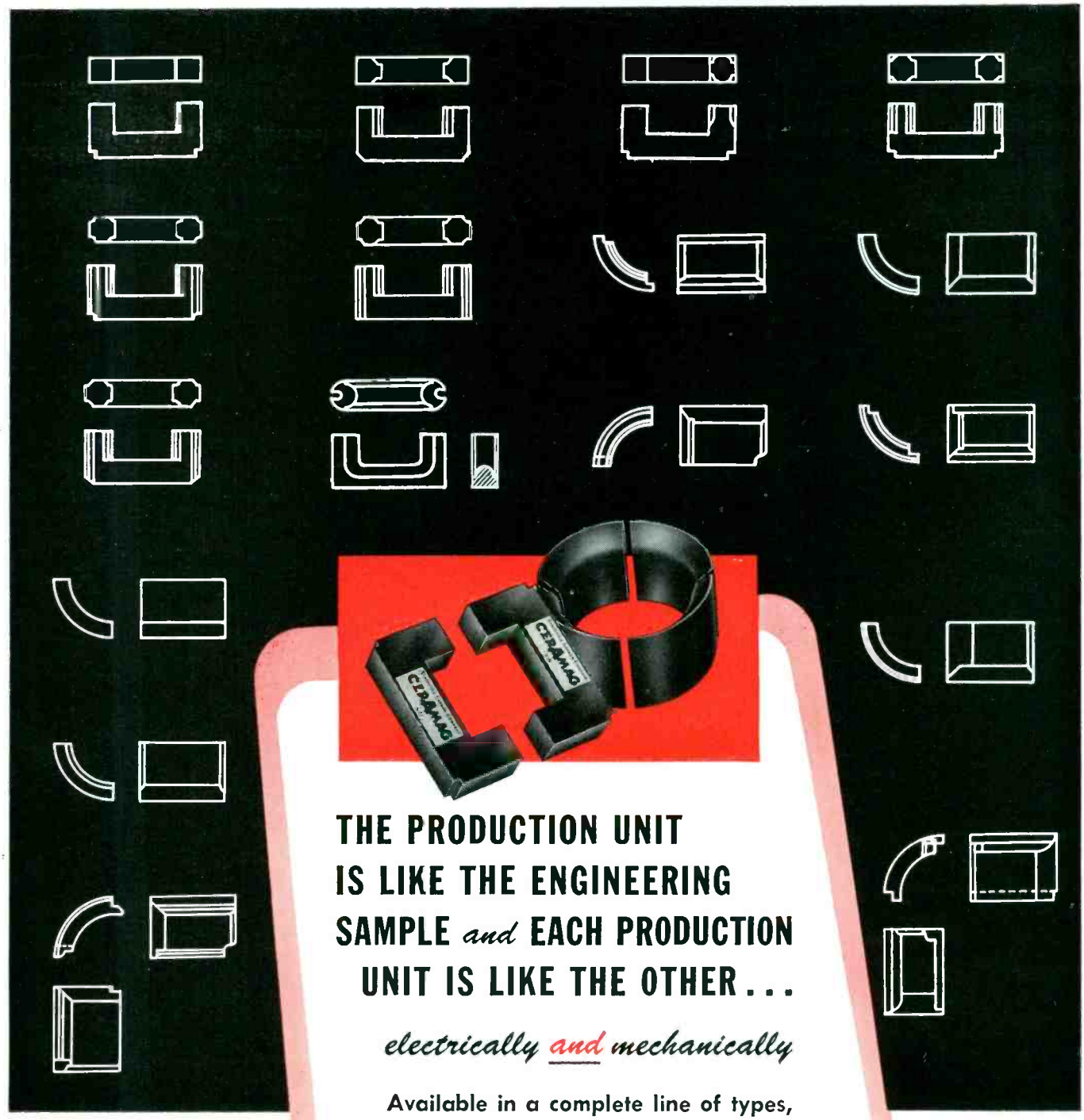


Easily raised antennas send or receive for the radio links.

Bell Telephone Laboratories

Improving telephone service for America provides careers for creative men in scientific and technical fields

Want more information? Use post card on last page.



THE PRODUCTION UNIT IS LIKE THE ENGINEERING SAMPLE *and* EACH PRODUCTION UNIT IS LIKE THE OTHER . . .

electrically and mechanically

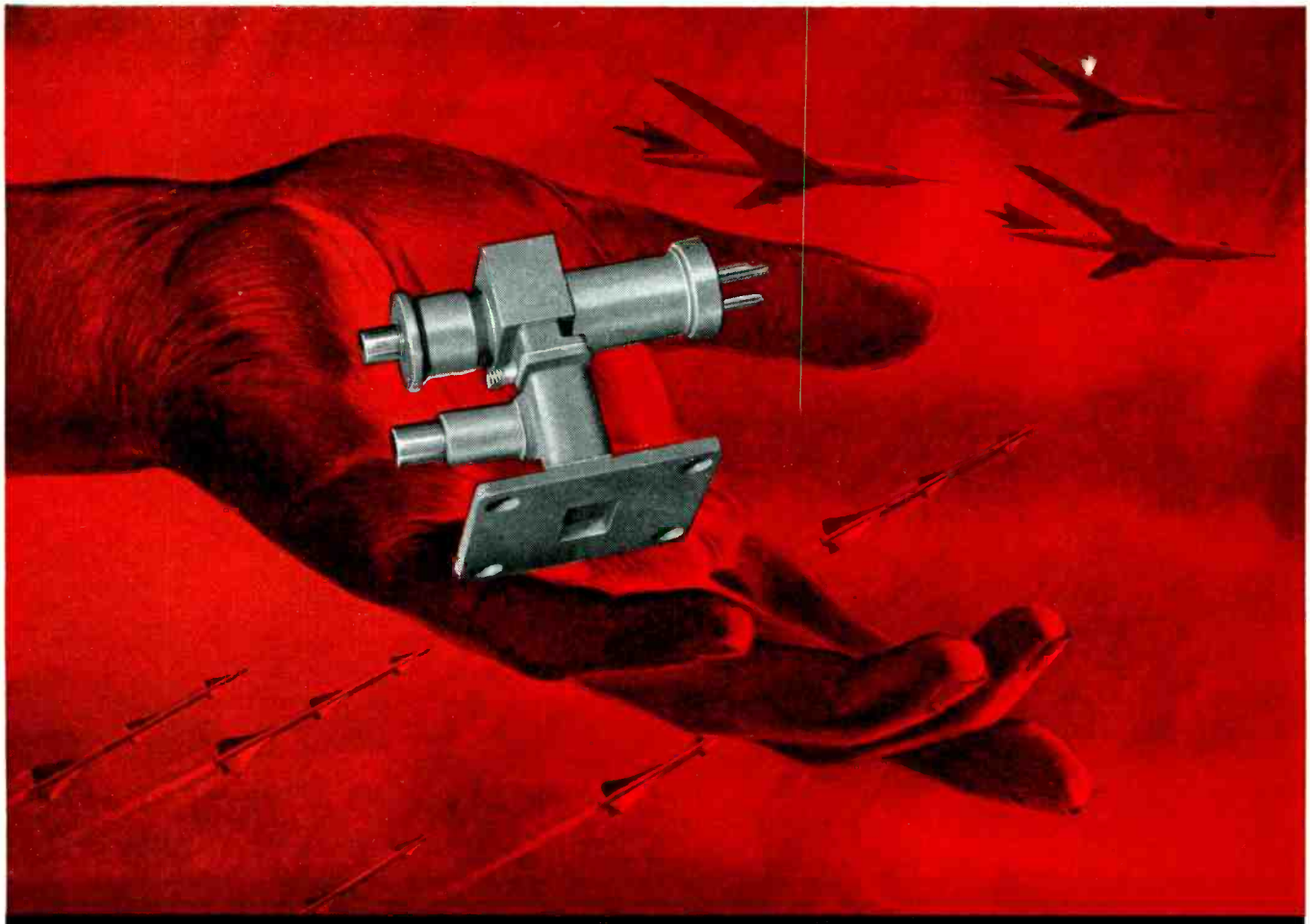
Available in a complete line of types, sizes and shapes for today's engineering needs. Write for Bulletin RC-9A

STACKPOLE Ceramag®

FERROMAGNETIC CORES

Electronic Components Division
STACKPOLE CARBON COMPANY, *St. Marys, Pa.*

Want more information? Use post card on last page.



INCOMPARABLE *Frequency Stability...*

for Airborne X-Band Radar Receivers

Now — at a New Low Cost — Varian announces the rugged VA-203 . . . most advanced reflex klystron ever developed for airborne radar and beacon local oscillator service. The exclusive brazed-on external tuning cavity provides frequency stability obtainable in no other klystron. This construction provides outstanding stability during shock, vibration and temperature cycling . . . takes punishing 50 to 100 G shocks and provides absolutely reliable operation at high altitude WITHOUT pressurization.

For Super-Rugged Service (Shocks to 250G) . . . Varian offers the VA-201 klystron. This tube is equipped with integral molded silastic leads, is similar to the VA-203 and performs with the same absolute reliability.

All these exclusive Varian features . . .

- ★ **Unique brazed-on external tuning cavity assures exceptional frequency stability.**
- ★ Reliable operation at low voltage and from poorly regulated power supplies.
- ★ Negligible microphonics.
- ★ Slow tuning rate . . . long tuning life . . . single shaft tuner adapts easily to motor tuning.
- ★ Withstands 50 to 100 G shocks (up to 250 G's for the VA-201)
- ★ VA-203 weighs less than 4 ounces. Both tubes mate directly to standard waveguide flanges.

GUARANTEED SPECIFICATIONS		
8500 to 9600 mc	VA-203	VA-201
Resonator Voltage	300 V	250 V
Heater Voltage	6.3 V	6.3 V
Heater Current	0.45 Amp	1.2 Amp
Power Output	20mW, Min	15mW, Min
Electronic Tuning Range	30 Mc, Min	30 Mc, Min
Vibration FM at 10 G	1 Mc, p-p, Max	0.2 Mc, p p, Max

GET COMPLETE TECHNICAL DATA and specifications on the outstanding new VA-203 and its companion VA-201 . . . finest klystrons made for airborne radar. Write to our Applications Engineering Department today.

THE MARK OF LEADERSHIP

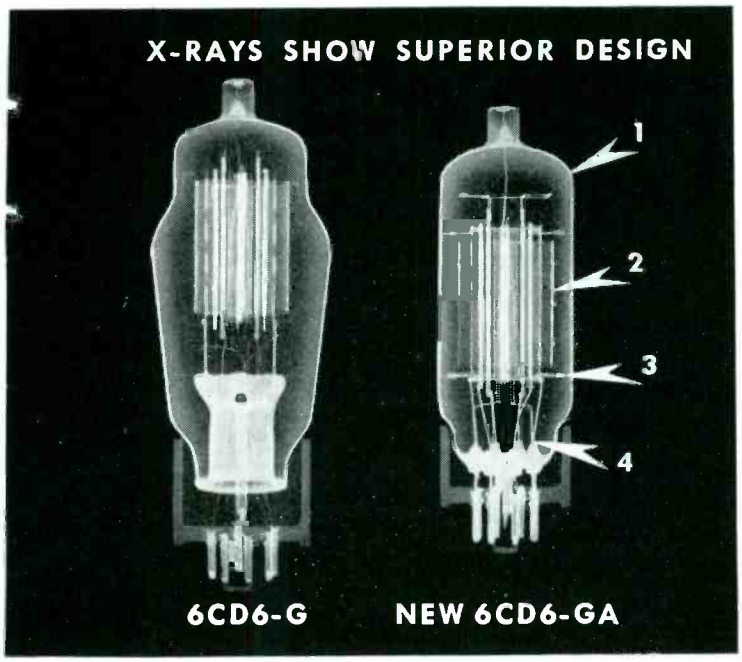
VARIAN associates

PALO ALTO 1, CALIFORNIA

Representatives in all principal cities

KLYSTRONS, TRAVELING WAVE TUBES, BACKWARD WAVE OSCILLATORS, R.F. SPECTROMETERS, MAGNETS, STALOS, U.H.F. WATERLOADS, MICROWAVE SYSTEM COMPONENTS, RESEARCH AND DEVELOPMENT SERVICES

G.E.'s IMPROVED 6CD6-GA SWEEP TUBE IS COMPACT, STURDY...HAS NEW, HIGH RATINGS!

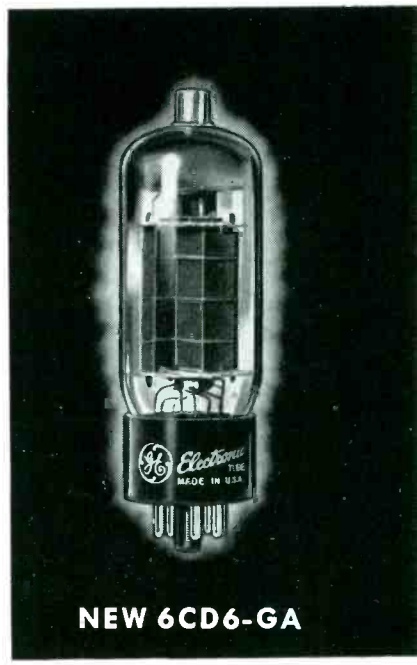


1. New bulb is straight-side, smaller and sturdier.

2. Redesigned, more shock-resistant tube structure. Redesigned plate, with larger area.

3. Bottom mica, as well as top, now contacts the glass, for greater rigidity. Both micas are completely redesigned to minimize arc-overs.

4. Button-stem base gives shorter and better-separated leads; improves heat conduction.



No price increase! Now one economical tube will serve in both monochrome and color TV sets!

NEW high-rating tube performance, arc-overs cut 'way down . . . yet price stays the same as the prototype 6CD6-G! Plate positive-pulse voltage now is 7,000 volts, against 6,600 volts. Plate dissipation has been increased one-third—from 15 watts to 20 watts.

Every 6CD6-GA gets an arc-over test at absolute max ratings. This built-in, tested-in freedom from tube arcing, with high-capacity performance as shown by the new ratings, makes G.E.'s new sweep tube equally suitable for color TV along with black-and-white.

Consequently, you need specify and stock only one tube for monochrome and color. You save on inventory . . . and save substantially on tube cost, at the 6CD6-GA's low price. Also, TV quality benefits. Fewer arc-overs mean less horizontal picture streaking.

To high-rating tube performance, add important structural improvements. These make the new 6CD6-GA more shock-resistant—far longer-lived. The tube also takes up less chassis space than before. Side-by-side X-ray pictures above show details of Type 6CD6-GA's new design.

Ask for complete information! *Tube Department, General Electric Co., Schenectady 5, New York.*

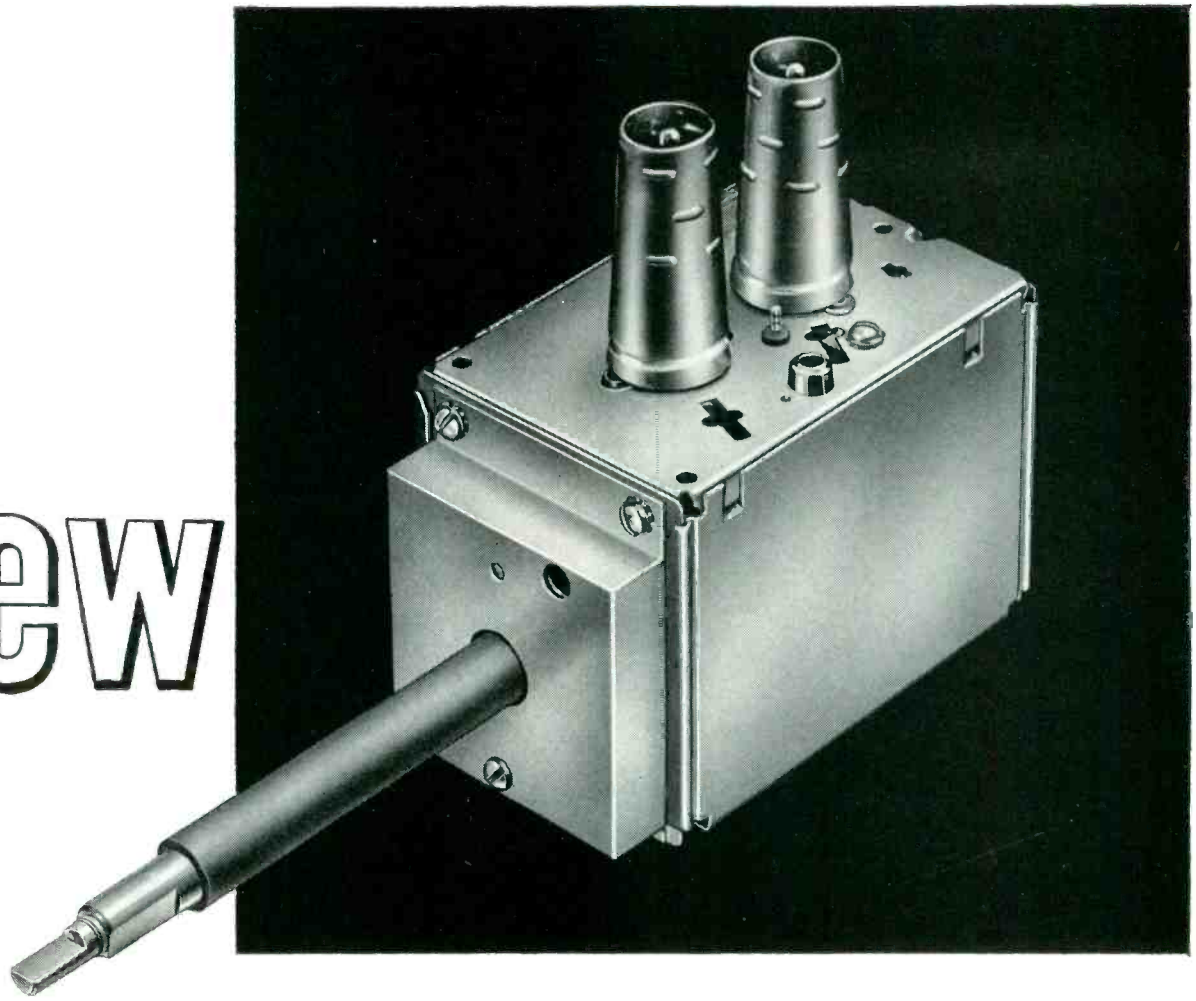
Also available: NEW 25CD6-GB. Same improved design and performance as 6CD6-GA, but has heavy-duty 600-ma heater with "series-string" warm-up time.

Progress Is Our Most Important Product

GENERAL ELECTRIC

162-1A2

new

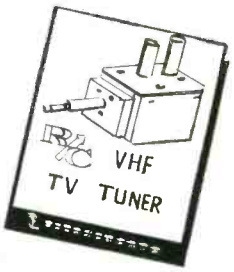


VHF TUNER

interference-free at a down-to-earth price

Here's the ideal vhf tuner choice for hot competition in today's t-v market. Radio Condenser's new T-31 Series gives you the high quality for which R/C tuners are famed . . . even meets all RETMA spurious radiation requirements. Yet it is the lowest cost vhf t-v tuner Radio Condenser has ever made.

Like all R/C t-v tuners, the T-31 Series is characterized by fine i-f and image rejection for high selectivity . . . good noise figure and drift characteristics. The compact twelve position, four-wafer switch pentode tuner illustrated is just one of the many variations available in this Series. All, of course, have been rigorously tested in the field . . . are ready for proved performance in the sets you manufacture.



Get Complete Engineering and Performance Data.
Write Radio Condenser for your free copy of Bulletin T-31.

RC

RADIO CONDENSER CO.

Davis & Copewood Streets • Camden 3, New Jersey
EXPORT: Radio Condenser Co., International Div., 15 Moore St., N.Y. 4, N.Y. *CABLE: MINTHORNE*

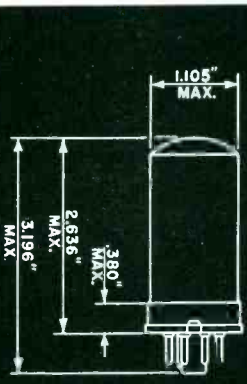
A BILLION OPERATIONS

. . . with no maintenance whatsoever

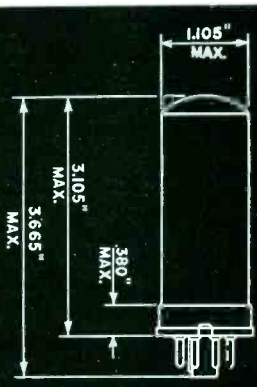
. . . from NEW CLARE

Mercury-Wetted Contact Relays

• Cutaway view showing sealed-in-glass, mercury-wetted contact switch, surrounded by the operating coil and encased in a metal housing mounted on an octal base.



Type HG Relay



Type HGP Relay

CLARE Type HG and HGP Relays are built to meet the exacting requirements for—

Computing machines	Servo-mechanisms
Sorting machines	Relay amplifiers
Tabulating machines	High-speed keying relays
Totalizers	Signaling devices

All kinds of high-speed switching devices

Outstanding features of CLARE Type HG and HGP Relays

ELECTRICAL FEATURES

LONG LIFE: Conservative life expectancy of over a billion operations when operated within ratings.

HIGH SPEED: Give consistent performance at speeds up to 60 operations per second.

HIGH CURRENT—and voltage-handling capacity (up to 5 amperes, and up to 500 volts).

UNIFORMITY: Operating time varies by only about 0.1 millisecond under constant drive conditions.

CHATTER-FREE: Mercury dampens armature vibration and bridges mechanical chatter between metal contact surfaces.

MECHANICAL FEATURES

- Small chassis space required
- Convenient plug-in mounting
- Environment-free
- Tamperproof
- High sensitivity
- Maintenance-free
- No contact wear
- Adjustment cannot change

This first announcement of the new CLARE Mercury-Wetted Contact Relays is of especial importance to designers of high-speed switching machines and devices which demand accuracy and dependability of a high order.

In these relays, with their unique electrical and mechanical stability, you will find exactly the qualities this kind of apparatus requires—

—Long life (over a billion operations)
—High speed (up to 60 operations a second)
—High current- and voltage-handling capacity (up to 5 amperes, and up to 500 volts)
—Bounce- and chatter-free contacts
—Extraordinary uniformity of operation

These distinctive characteristics are achieved by the use of platinum contact surfaces, continuously wetted with mercury by capillary action, and the hermetic sealing of a magnetic switch in a protected glass capsule, filled with pressurized hydrogen.

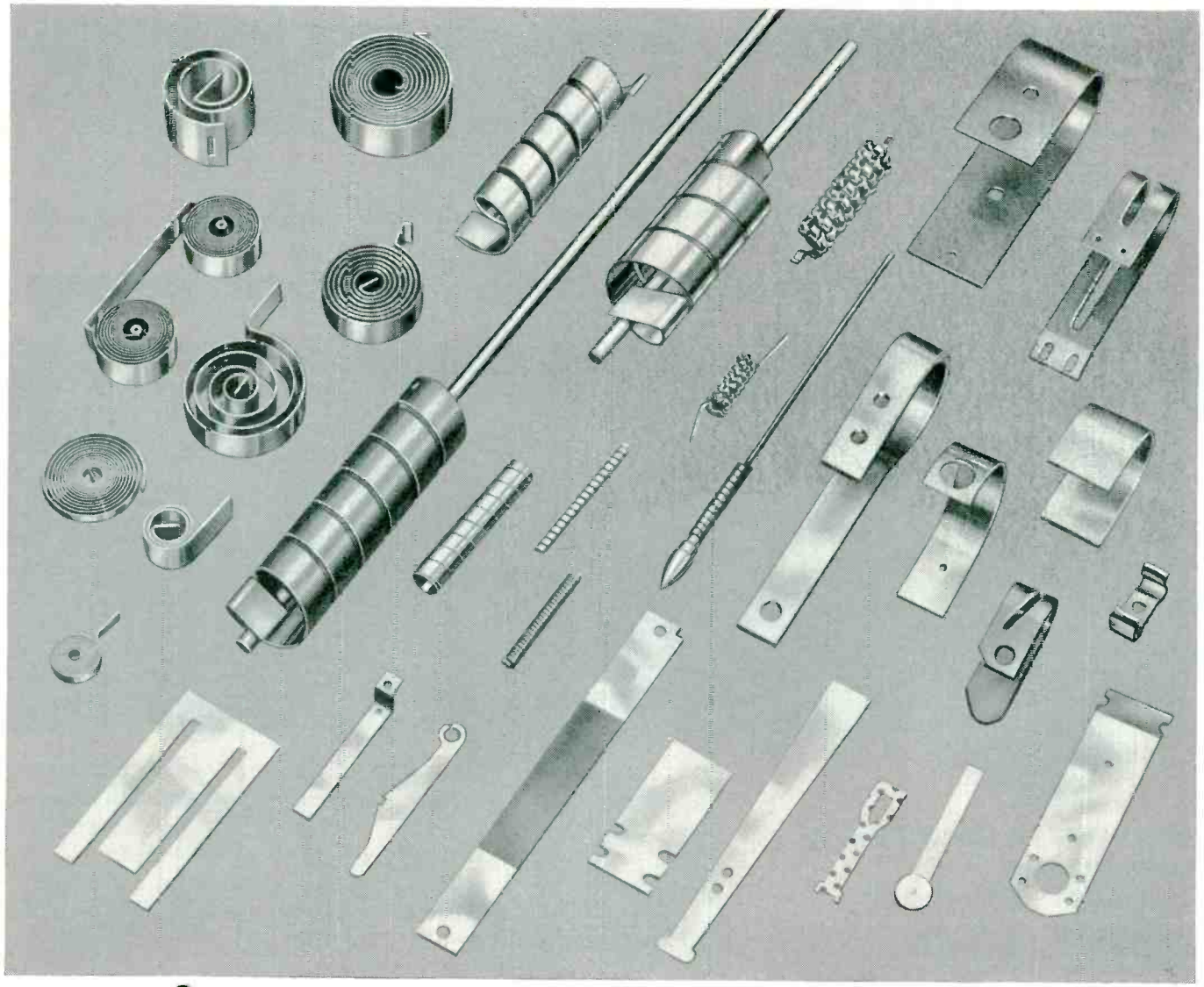
CLARE Type HG Relays comprise a switch element and an operating coil. CLARE Type HGP Relays are similar but can be factory-adjusted to provide either biased or polarized operating characteristics.

For complete information on the new CLARE *Type* HG *and* HGP *Mercury-Wetted Contact Relays, contact your nearest* CLARE *representative or address C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois.*

Send for CLARE Sales Engineering Bulletin No.120

CLARE RELAYS

FIRST IN THE INDUSTRIAL FIELD



Any way you Figure it...

GENERAL PLATE TRUFLEX®
Thermostat Metals and Assemblies
Add up to Performance and Economy

If your products require temperature control . . . indication or compensation, General Plate TRUFLEX thermostat metals and fabricated elements and assemblies give you reliable, accurate performance and at the same time *cut your costs.*

Here's why — Advanced General Plate production methods coupled with the best equipment available insure positive consistency in thermal and mechanical performance and maintain close dimensional tolerances. Every lot, whether it is 10 pieces or 10,000, is a duplicate of the original, thus eliminating rejects and costly adjustments in assembly.

General Plate TRUFLEX fabricated elements and assemblies ready for installation in your products are engineered and manufactured to your exact specifications. You get accurate and consistent performance, because every order comes to you a faithful duplicate of the original. Costly fabrication problems . . . needless expense for special calibration equipment . . . and time consuming assembly adjustments are eliminated.

General Plate TRUFLEX thermostat metal and assemblies are made to meet your specific requirements for temperature range, electrical resistance, corrosion resistance, etc. If you prefer to make your own elements, General Plate will produce TRUFLEX thermostat metal strip to your material specifications. Write for TRUFLEX thermostat metal catalog and engineering assistance.

You can profit by using General Plate Composite Metals!

METALS & CONTROLS CORPORATION

GENERAL PLATE DIVISION

34 Forest St., Attleboro, Massachusetts

A NEW LINE OF BROADBAND MICROWAVE COMPONENTS

MICROWAVE TEST ANTENNAS

Covering 1,000 to 26,600 mc. Rugged, portable units built especially for field intensity measurements, antenna pattern recording, leakage measurements and other communications use. Supplied complete with tripod mount, adjustable pan head, and convenient carrying case.

Each of these Polarad test antennas is highly directional with excellent front to back ratio, and is supplied with flexible waveguide or coax couplings.

MODEL No.	FREQUENCY RANGE	MAX. VSWR
A-L	1,000 to 2,300 mc	3:1
A-S	2,150 to 4,600 mc	2:5
A-R	4,450 to 8,000 mc	2:5
A-X	7,850 to 12,400 mc	2:7
A-KU	12,400 to 18,000 mc	1.5:1
A-K	18,000 to 26,000 mc	1.5:1

BROADBAND-PASS FILTERS

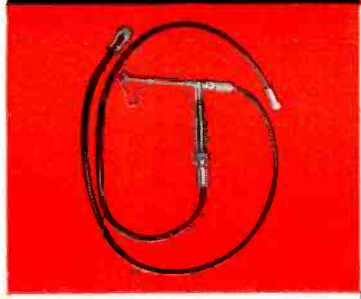
Covering 650 to 13,000 mc. These Polarad Broadband-Pass filters are the first of their kind commercially available. They feature sharp skirt selectivity and low pass band insertion using standard 50 ohm co-axial connections. Curves showing typical bandpass characteristics are available on request.

MODEL No.	FREQUENCY RANGE
F 650	650 — 1,300 mc
F 1100	1,100 — 2,200 mc
F 1800	1,800 — 3,600 mc
F 3500	3,500 — 7,400 mc
F 6100	6,100 — 13,000 mc

MICROWAVE WAVEMETERS

Covering 500 to 4000 mc. Precision, adjustable, cavity-type meters designed for measuring frequency with ± 0.2% accuracy over the range 500 to 4000 mc. Each meter in the series has a 2:1 frequency range. Specific frequency metering is accomplished by adjustment of micrometer head until a dip of at least 20% in output occurs when input or output impedance is nominal 50 ohms. Micrometer head readings are easily converted to frequency by using calibration chart furnished with each instrument. Utilizes Type "N" coax connectors.

MODEL	FREQUENCY RANGE
FR	500 — 1,000 mc
FL	1,000 — 2,000 mc
FS	2,000 — 4,000 mc



MICROWAVE ATTENUATOR—Model SIJ

Covering 4,000 to 12,400 mc. A continuously variable, stub-tuned, mutual inductance attenuator (waveguide beyond cut-off) designed for external use in making microwave measurements with spectrum analyzers, signal sources, receivers and for power measurements. The Model SIJ can be used as a standard calibrated attenuator; for circuit protection; or for monitoring and measuring. It will insure RF circuit isolation. It may be used to convert signal source or laboratory oscillator into a signal generator.

SPECIFICATIONS:

Frequency Range:	4 to 12.4 kmc
Impedance:	50 ohms
Attenuation Range:	130 db
Minimum Insertion Loss:	Approximately 10 db depending on frequency.

AVAILABLE ON EQUIPMENT LEASE PLAN

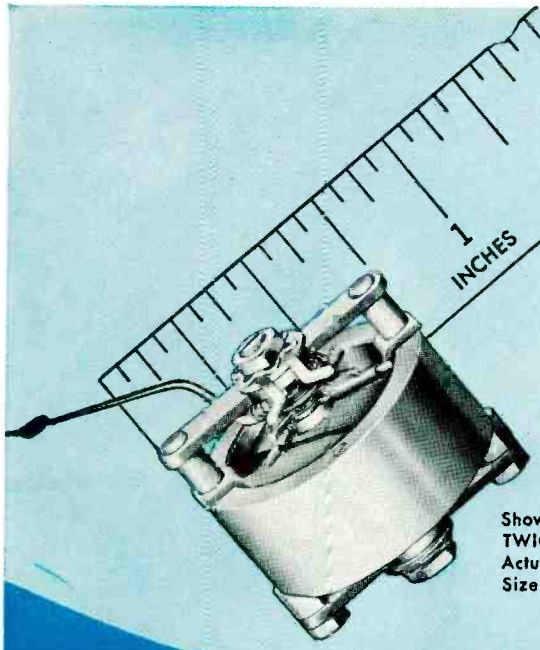
FIELD MAINTENANCE SERVICE AVAILABLE THROUGHOUT THE COUNTRY

POLARAD
PROVEN RELIABILITY

ELECTRONICS CORPORATION

43-20 34th STREET • LONG ISLAND CITY 1, N. Y.

REPRESENTATIVES • Albuquerque • Atlanta • Baltimore • Boston • Chicago • Cleveland • Fort Worth • Kansas City • Los Angeles • New York Philadelphia • San Francisco • Seattle • St. Paul • Syracuse • Washington, D. C. • Canada, Arnprior—Export: Rocke International Corporation



Shown TWICE Actual Size

New Simpson Core Meter Movement

Rugged . . . yet built like a fine watch!

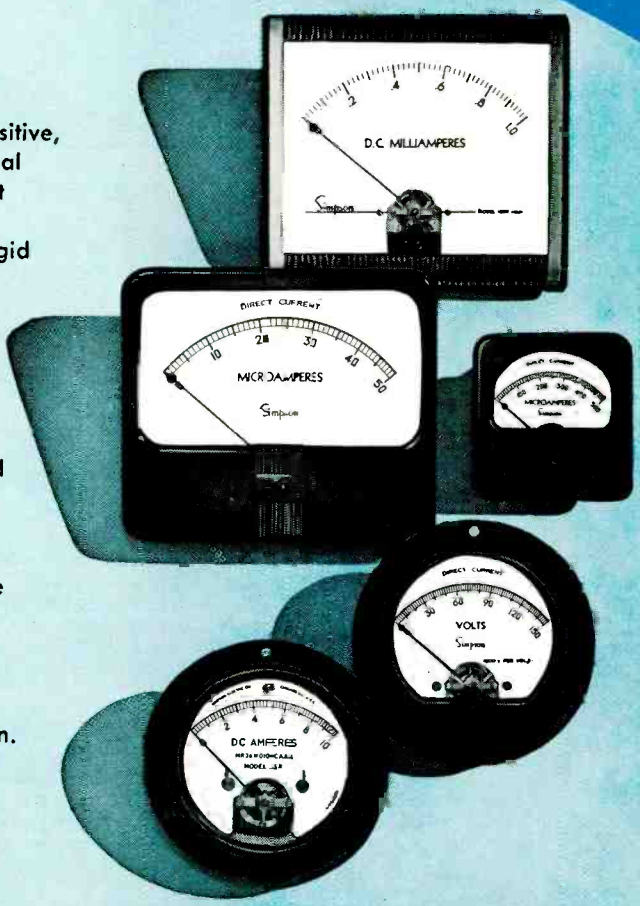
Here's the new Simpson ***Core-Type Meter Movement.*** It's a more compact, more sensitive, ***self-shielding*** movement that gives electrical measurements with laboratory accuracy, yet has the ruggedness to withstand severe shocks. Its accuracy specifications are so rigid that Simpson engineers had to devise unusual production techniques.

Let Simpson engineers design panel meters using the new core movement to your special instrument requirements. Simpson continues to maintain its large stock of standard panel meters in over 700 sizes and ranges, available through distributors.

RUGGEDIZED METERS

Simpson's 2½" and 3½" Panel Meters are available in ***sealed, ruggedized*** models to meet specifications MIL-M-10304-(Sig. C). Movements are sealed against moisture and other adverse atmospheres, and are spring-mounted to absorb excessive vibration.

SEND FOR NEW CATALOG 17



INSTRUMENTS THAT STAY ACCURATE

Simpson ELECTRIC COMPANY

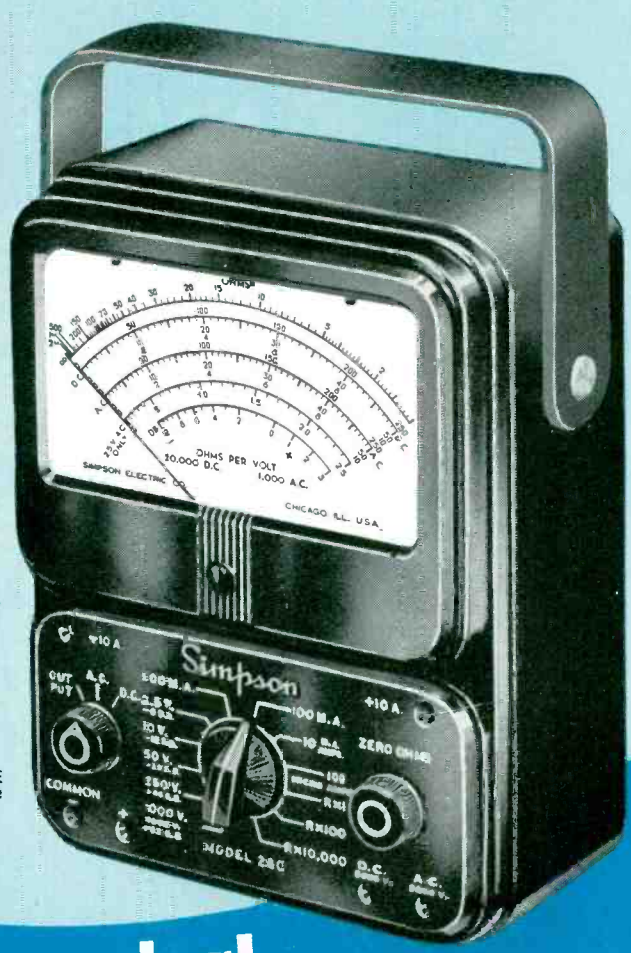
5217 W. Kinzie St., Chicago 44, Illinois, Phone: EStebrook 9-1121
In Canada: Bach-Simpson, Ltd., London, Ontario

Simpson

MODEL
260
MULTI-TESTER

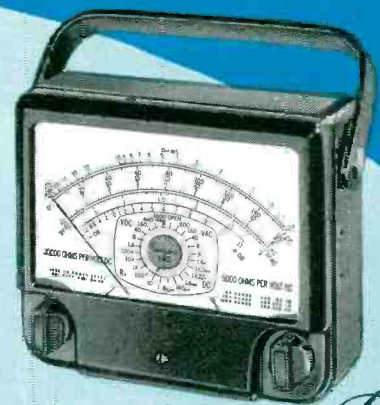
outsells all others combined!

More technicians are using the Model 260 than any other high-sensitivity VOM. Over half a million Model 260's have been sold to date! 20,000 Ohms per volt. You'll find it wherever quick, accurate, electrical checks are needed. It's so handy, so dependable, so sensibly priced. Ask your jobber to show you the Simpson Model 260. Only **$38.95,** including Adjust-A-Vue Handle. Carrying cases from **$6.75.**



world's most popular!

MODEL
262
the new vom with a 7″ meter



20,000 Ohms per volt DC. 5,000 Ohms per volt AC. 33 RANGES

DC VOLTAGE: 0-1.6, 0-8, 0-40, 0-160, 0-400, 0-1600, 0-4000 volts (20,000 ohms per volt sensitivity)
AC VOLTAGE: 0-3, 0-8, 0-40, 0-160, 0-800 volts (5,000 ohms per volt sensitivity)
AF OUTPUT VOLTAGE: 0-3, 0-8, 0-40, 0-160 volts (0.1 microfarad internal series capacitor)
VOLUME LEVEL IN DECIBELS: −12 to +45.5 DB in 4 ranges. Zero DB Power Level, .001 watt in 600 ohms.
DC RESISTANCE: 0-500 ohms (4.5 ohms center); 0-5,000 ohms (45 ohms center); 0-50,000 ohms (450 ohms center); 0-500,000 ohms (4,500 ohms center); 0-5 megahms (45,000 ohms center); 0-50 megohms (450,000 ohms center)
DC CURRENT: 0-80, 0-160 microamperes, 0-1.6, 0-16, 0-160 milliamperes, 0-1.6, 0-16 amperes (267 millivolts maximum drop)
MODEL 262 complete with 2 test leads with removable alligator clips, 4,000 v. DC multiplier
Dealer's Net Price, including Adjust-A-Vue Handle. .**$59.50** Carrying Case. .**$9.95**
Accessory High Voltage Probe for 16,000 volts DC. .**$11.50,** 40,000 volts DC. .**$12.50**

Deluxe!

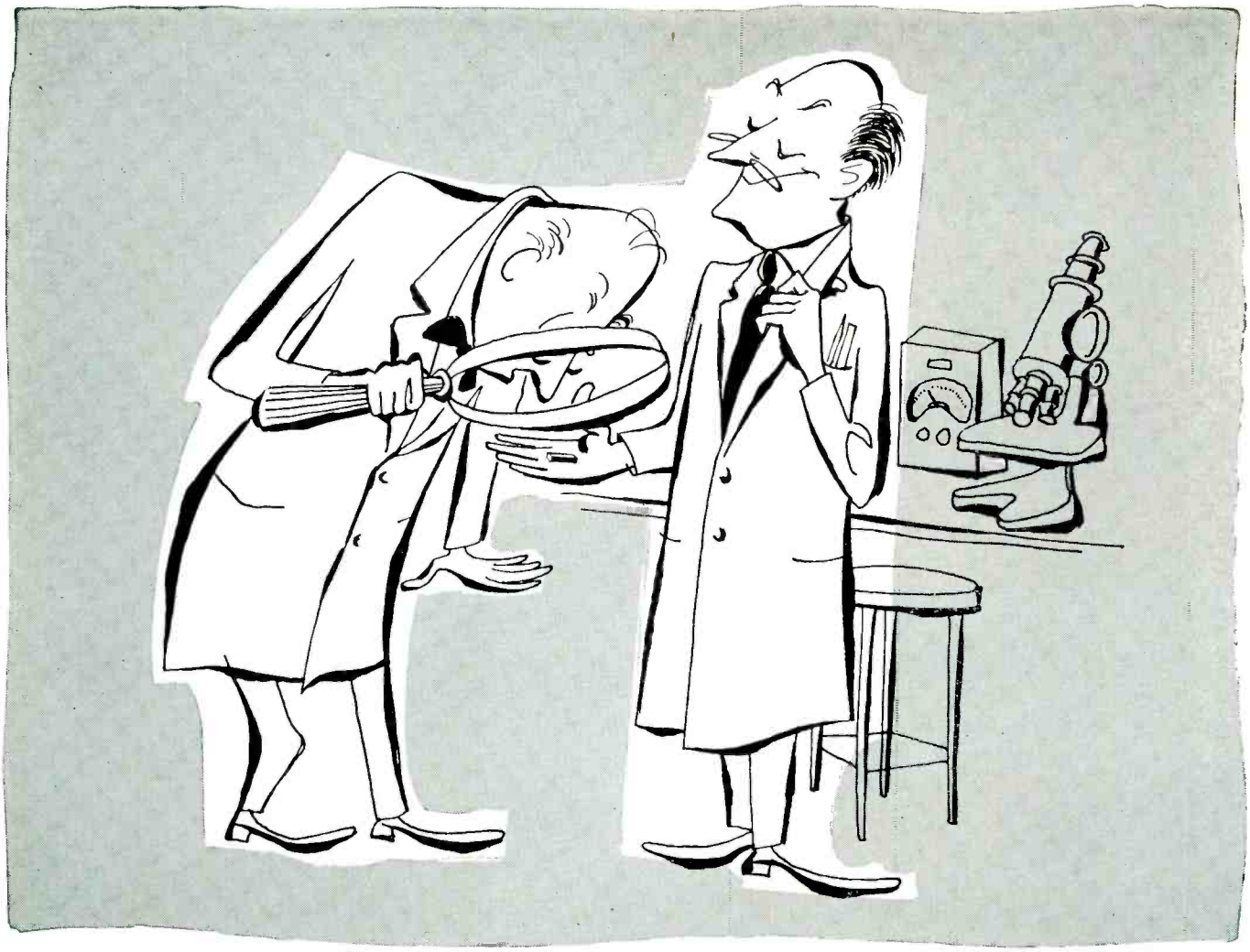
SEE THEM AT YOUR JOBBER, OR WRITE . . .

Simpson ELECTRIC COMPANY

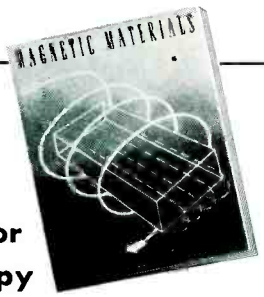
WORLD'S LARGEST MANUFACTURER OF ELECTRONIC TEST EQUIPMENT

5217 W. Kinzie St., Chicago 44, Illinois, Phone: ESterbrook 9-1121
In Canada: Bach-Simpson, Ltd., London, Ontario

Want more information? Use post card on last page.



How to make a Magnetic Core that's really small? Use PERMENDUR!



Write for your copy "MAGNETIC MATERIALS"

This 32-page book contains valuable data on all Allegheny Ludlum magnetic materials, silicon steels and special electrical alloys. Illustrated in full color, includes essential information on properties, characteristics, applications, etc. Your copy gladly sent free on request.

ADDRESS DEPT. E-64

When the conditions of service make it imperative for you to hold the size and weight of magnetic cores at an absolute minimum, that's the place to use Permendur. With it you can push the flux density up to 20 kilogausses, and practically eliminate weight as a consideration.

Along with its suitability for cores wherever the premium is laid on compactness, Permendur is just the thing for sonar magnetostriction applications, too. We maintain proper annealing facilities for this alloy. Write for technical data on it, and let our engineers help you to cash in on its possibilities.

In addition to Permendur, we offer a range of high-permeability alloys, oriented silicon steels and other electrical alloys that is unmatched in its completeness. Our services also include the most modern facilities for lamination fabrication and heat treatment.

Let us supply your requirements. *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.*

STEELMAKERS to the Electrical Industry

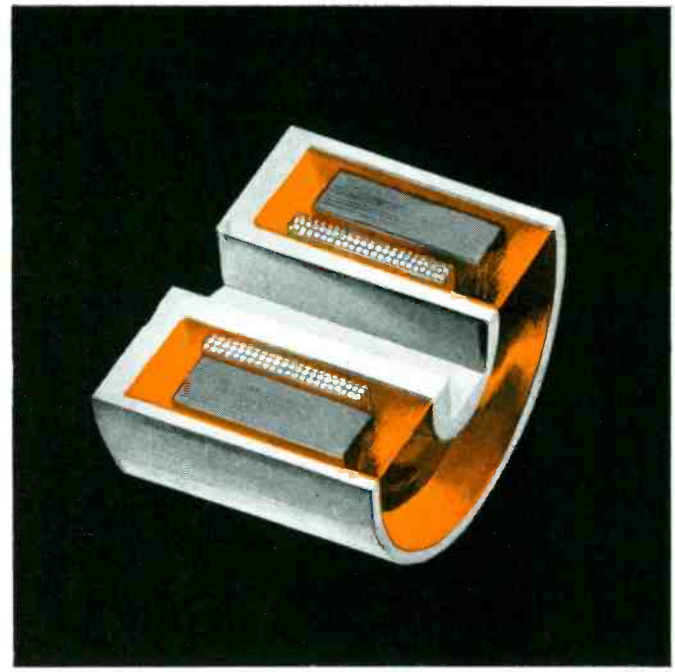
Allegheny Ludlum

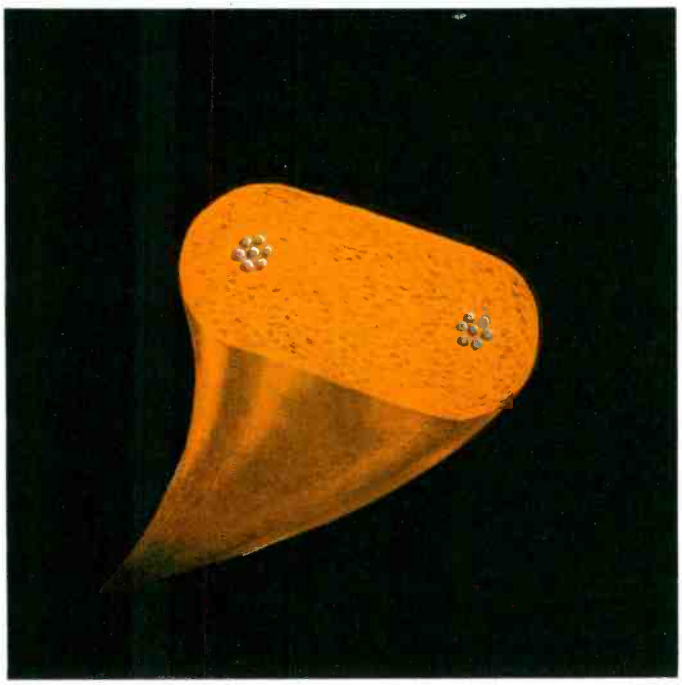
AL® STEELS FOR THE ELECTRONIC AGE

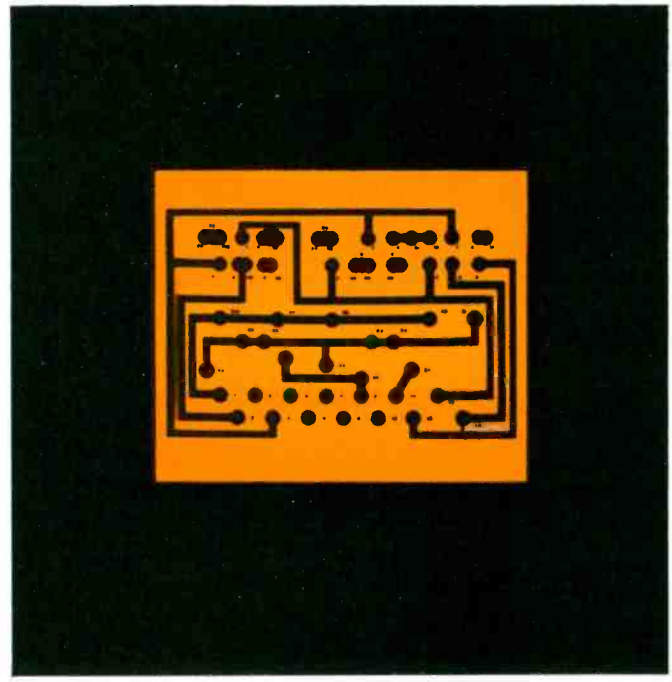
W&D 5443

Want more information? Use post card on last page.

What's important to remember about these?







These are just three of countless mileposts marking the closely parallel growth of two great industries—electronics and plastics.

You'll recognize the epoxy resin potted coil. The cellular polyethylene TV lead-in. The phenolic laminate printed circuit. Each typifies new processes and materials that have wrought basic technological changes affecting the design, quality and cost of such things as radar, TV, and computers.

BAKELITE has long been especially identified with the steady growth of electronics. Almost historically classic are the panels, knobs and dials of early home radios made of BAKELITE Brand Phenolic Plastic . . . the first molded plastic radio cabinets.

But as electronics became truly complex and critical, BAKELITE developed other basically new plastics *that actually became one with circuits themselves.*

Today the number and variety include not only BAKELITE Brand Phenolics, but Styrenes, Vinyls, Polyethylenes, C-11's—and the even newer and extremely versatile Epoxies, Fluorothenes, and Cellular Polyethylene.

What's important to remember? Simply that BAKELITE's leadership in plastics will continue to keep pace with the growth of the electronics industry—with still better plastics as needed.

BAKELITE
BRAND
Plastics and Resins

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.

The term BAKELITE and the Trefoil Symbol are registered trade-marks of UCC

ELECTRONICS Charter-Year Advertiser

RCA DATA FOR

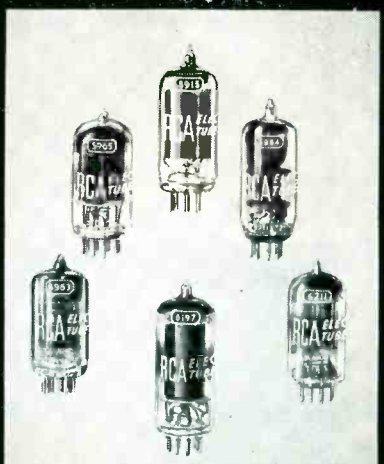
NEW RCA TRANSISTOR RCA-2N104 (FOR LOW-POWER AF SERVICE)

Hermetically sealed type for low-power af service . . . features extreme stability and excellent uniformity of characteristics—initially and during life.

This new germanium alloy-junction transistor (p-n-p) type is intended for low-power af service. It utilizes an insulated metal envelope and a lineotetrar 3-pin base. Maximum noise factor—only 12 db. The design of the 2N104 features low base-lead resistance which minimizes ohmic losses, improves frequency response, and insures high input-circuit efficiency. In a common-emitter circuit, the 2N104 has a collection-to-base current amplification ratio of 44, a matched-impedance, low-frequency power gain of 40 db, and a collector-to-emitter alpha frequency cutoff of 700 kc.

NEW RCA MULTIPLIER PHOTOTUBES (FOR HEADLIGHT DIMMER SERVICE)

Having instantaneous response to light, RCA-6328 and 6472 are your answer for "road-proved" multiplier phototubes that meet the exacting timing requirements of headlight control. Both tubes have high luminous sensitivity—for operation with amplifiers of relatively low input impedance. Both combine stability with long life. Identical in characteristics to the 6328, RCA-6472 is built with flexible leads—for use in printed circuits.



YOUR CHOICE OF COMPUTER TUBES RCA-5915, 5963, 5964, 5965, 6197, 6211 . . . Dependable performance, a must in computer applications, is accomplished in these six RCA tubes—by using production controls correlated with typical electronic computer conditions. RCA computer tubes feature controlled cutoff for switching applications, low-grid current for applications utilizing high values of grid resistance, high zero-bias plate current, special cathode material to minimize interface, and low leakage.

NEW RCA STORAGE TUBE (FOR COMPUTER SYSTEMS)

Designed especially for use in binary-digital computer systems, this 3-inch storage tube is of the single-beam type, has electrostatic focus and deflection, and employs "redistribution writing" and "capacitance-discharge reading". Outstanding design features of the tube include: a storage surface having relatively uniform secondary emission to prevent "bad spots" on which information can not be stored; a focused beam having an exceptionally small effective area including the fringe of low-density beam current and a well-defined boundary; and a separate external connection for the collector to permit flexibility in circuit operation.

RCA HIGH-VOLTAGE THYRATRON (FOR DC POWER CONTROL AND LOAD-CIRCUIT PROTECTION)

Having a negative control characteristic, this high-voltage 3-electrode, mercury-vapor thyratron is primarily designed for dc power-control applications, but is also useful in load-circuit protection. For example, in power-control application, three RCA-5563-A's in a half-wave, 3-phase circuit can handle up to 45 kw—at a dc output voltage up to about 9500 volts. Six of these tubes in a series, 3-phase circuit can handle up to 143 kw at a dc output voltage up to 19,000 volts (approx.). In protection applications, the 5563-A may be operated as a grid-controlled rectifier to remove the dc load voltage by blocking action of the grid, or as an electronic switch across the rectifier output for instant removal of the load voltage in case of a load fault.

ELECTRON TUBES — SEMICONDUCTOR DEVICES — BATTERIES — TEST EQUIPMENT — ELECTRONIC COMPONENTS

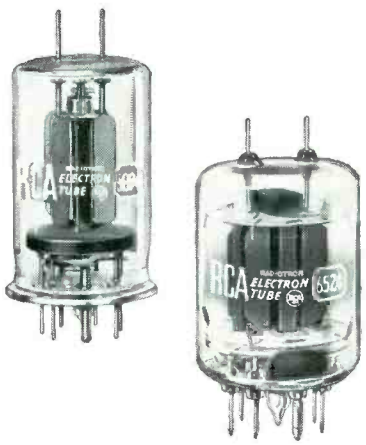
ELECTRONICS Charter-Year Advertiser

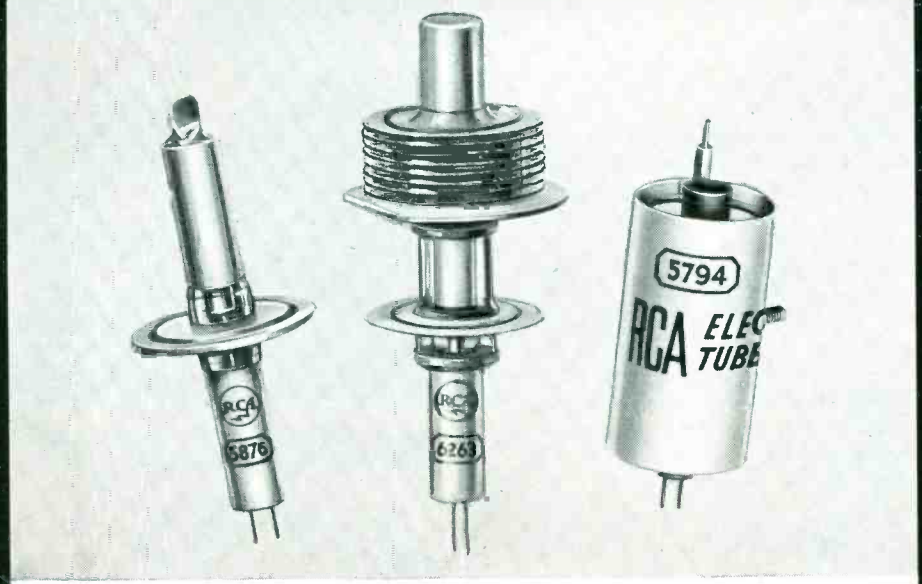
Want more information? Use post card on last page.

DESIGNERS

RCA SMALL-SIZED UHF POWER TUBES

Well-suited for fixed and mobile uhf applications up to 470 mc, these unique twin beam power tubes offer designers unusual advantages—as balanced push-pull rf power amplifiers or frequency triplers. RCA-6524 delivers approx. 20 watts (ICAS) in push-pull class C amplifier service—at 462 mc! Max. plate dissipation: 25 w (ICAS). RCA-5894 delivers approx. 55 watts (CCS) at 470 mc. Max. plate dissipation: 40 watts (CCS).





RCA "PENCIL" TUBES FOR UHF

Available in a choice of types for uhf applications, RCA "Pencil Tubes" are designed to have minimum transit time, low lead inductance, and low interelectrode capacitances. Features include small size, light weight, low heater wattage, and good thermal stability. RCA-6263 with external plate radiator is intended for rf power amplifier and oscillator services; 6264 is like the 6263 but is well-suited for frequency-multiplier service. Additional RCA "Pencil Tubes" include 5674, 5794, 5876, 6173.

NEW 5" PROJECTION KINESCOPE (FOR CLOSED-CIRCUIT INDUSTRIAL TV)

Providing a clear, bright, projected picture about eight feet by six feet when used with a suitable reflective optical system, the RCA-5AZP4 is especially useful for closed-circuit industrial TV. Contributing to the brightness of the "auditorium-size" picture of high-efficiency, aluminized screen having very good color stability under varying conditions of screen current, and an unusually high operating ultor voltage (40,000 volts max.) for a tube of this type.

For technical information, write—specifying tube types in which you are interested—to RCA, Commercial Engineering, Section D19R, Harrison, N.J., or call your RCA Representative:

EAST_____HUmboldt 5-3900
744 Broad St.
Newark, N. J.

MIDWEST_____WHitehall 4-2900
589 E. Illinois St.
Chicago 11, Ill.

WEST_____MAdison 9-3671
420 S. San Pedro St.
Los Angeles 13, Calif.

RCA ® **RADIO CORPORATION of AMERICA**
TUBE DIVISION **HARRISON, N.J.**

ELECTRONICS Charter-Year Advertiser
Want more information? Use post card on last page.

TAYLOR Laminated Plastics Vulcanized Fibre

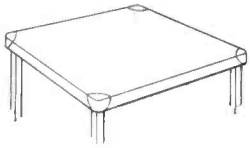
Shop Talk

TAYLOR FIBRE CO.

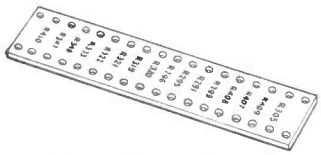
Plants in Norristown, Pa. and La Verne, Calif.

PHENOL—MELAMINE—SILICONE—EPOXY LAMINATES • COMBINATION LAMINATES • VULCANIZED FIBRE • POLYESTER GLASS ROD

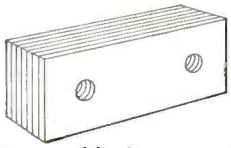
Tips for designers



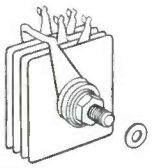
Furniture can make good use of the mar-resistant, tough surface afforded by Taylor Vulcanized Fibre plywood combination table tops.



Terminal strips for high-precision electronic instruments benefit by the excellent insulating properties of Taylor XXXP-301 hot-punch phenol laminate.



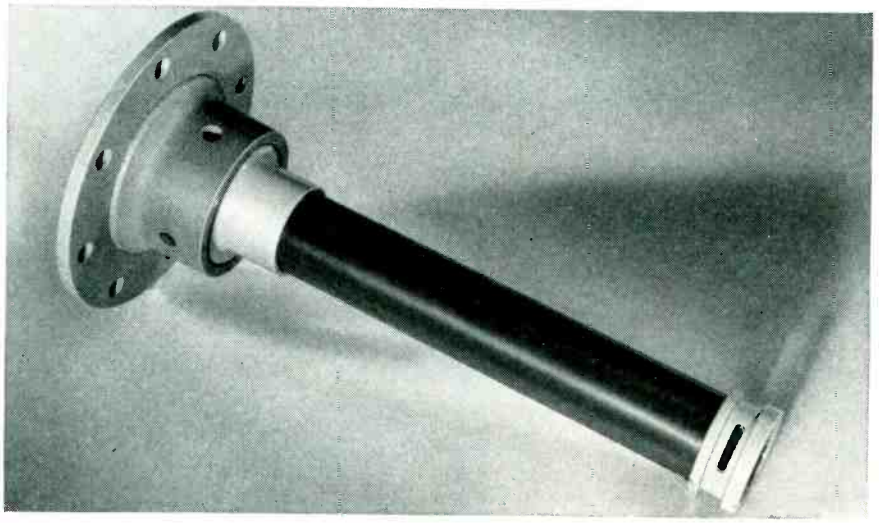
Heavy bumper blocks for steel mill use, made of Taylor Built-Up Fibre several inches thick, give long service under severe shock and abrasion.



Selenium rectifier plates are insulated by washers made of Taylor Grade 353 phenol laminate . . . chosen for its dimensional stability and mechanical strength.

TAYLOR FABRICATING FACILITIES

Your production can be simplified . . . schedules safeguarded . . . inventory headaches cured . . . and overall costs reduced by having Taylor fabricate finished parts to your specifications. Efficient, modern facilities are ready to serve you. Get in touch with Taylor about your specific requirements.



High strength, light weight, excellent insulating and corrosion-resistant qualities make Taylor Epoxy Glass Base Laminate the ideal material for tubing in an aircraft fuel gage tank unit made by Avien, Inc.

When service conditions are tough— *use Taylor special-purpose laminates*

Designing for severe service? Then take a look at what Taylor special-purpose laminates can do. Taylor's resin chemists have developed special formulations of melamine, silicone and epoxy resins . . . for combination with a variety of base materials. The result is a line of laminates which offer the plus performance that your new designs may require.

Taylor epoxy laminates. Retain superior mechanical properties after exposure to high temperatures (above 430 F) . . . have outstanding electrical characteristics, moisture resistance and resistance to corrosive chemicals . . . setting these laminates apart as a means of solving difficult design problems.

Taylor melamine laminates. Excellent resistance to arcing, electrical corona, flame and chemical attack characterizes these materials . . . useful in many electrical applications.

Taylor silicone laminates. These withstand temperatures up to 500 F . . . provide insulation where other laminates thus far cannot be used. They also possess high mechanical strength, low power factor and low moisture absorption.

Sheets, tubes and rods of these materials are available in a range of sizes that will give you maximum economy of material in your manufacturing processes.

To help you in the application of these specialized materials to your specific product, Taylor offers the service of its experienced engineering staff. Call on Taylor for a consultation on your individual requirements.

IT OPENED MY EYES. These fellows have actually *mass-produced Regulated Power Supplies!* If you're thinking they made a single, expensive "Universal" . . . guess again! They've got 64 different models . . . you buy only as much power supply as you need, and you can have it right off the shelf.

I wrote for this new catalog and woke up!

HOW? It's all right here in the catalog. The 64 models are not 64 designs. They've standardized on *two,* and build all 64 models on only *three* chassis. While they were at it, they cooked up two *good* new ideas: a four-way dual, and an ultra-dependable type using *only* 10,000 hour components.

And the prices . . . The lowest I've ever seen!

Send for your copy of "A Sensible Approach to Regulated Power Supply Design". Full price and performance data on the industry's most complete line of regulated plate supplies.

NEW JERSEY ELECTRONICS CORP.

345 Carnegie Avenue, Kenilworth, New Jersey

Competent Engineering Representation Everywhere

Rapid, complete, competitive custom quotes from 500 amperes (low voltage) to 100 KV (low current).

NEW MALLORY Multiple Controls

New strip-type Mallory controls are available in single, dual and triple sections.

Can Cut Your Production Costs . . .

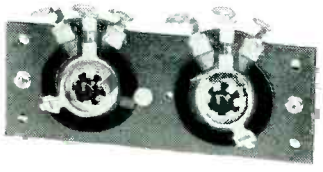
JUST added to the Mallory line of carbon controls is a new, completely different series that make possible real economies in your production. By means of a unique strip-type design, side-by-side dual and triple units are now available in a form that takes only as much labor to mount as a conventional single unit.

In addition, because of the radically simplified design, Mallory is able to offer multiple units at materially lower cost than that of corresponding numbers of conventional single controls.

WIDE VARIETY OF MODELS

The unusual flexibility of the new design makes it possible to offer many adaptations . . . at low cost. Mounting arrangement can be twist tabs or holes punched for riveting. Terminals can be solder lugs or wire wrap solderless types. Phenolic hex shafts are available in lengths up to 7/8" FMS, in 1/8" increments, with screwdriver slot for ease in adjustment. Resistances from 250 ohms to 10 megohms are available. Rotational stops, ground ring or provision for a flexible lead can be provided.

A Mallory control engineer will be glad to consult with you on how these new controls can be applied to your present or future equipment. For technical data, write or call Mallory today.



Rear view shows simple, rugged design, with resistance wafer attached directly to phenolic panel.

Parts distributors in all major cities stock Mallory standard components for your convenience.

Serving Industry with These Products:

Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

Expect more . . . Get more from

P. R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

ELECTRONICS Charter-Year Advertiser

Want more information? Use post card on last page.

electronics

W. W. MacDONALD, Editor

APRIL • 1955

CROSS TALK

►**THE NEXT 25 YEARS . . .** With this issue, ELECTRONICS begins its 26th year of publication.

The magazine and the industry have grown up together and we like to think that our initial broadness of purpose provided a rallying point for men who right from the beginning visualized much more versatile application of the tube than just radio alone. We also like to think that our continued broadness of purpose will stimulate such men to develop still more ways to harness the electron.

The art of electronics has always been distinguished by its versatility and there is every reason to believe that it will continue to be so distinguished. While it is true that more and more development is the result of teamwork there is plenty of room for the ideas of the individual and the next quarter century will surely contain its share of standout names.

Looking into the future is a difficult job but some things seem certain.

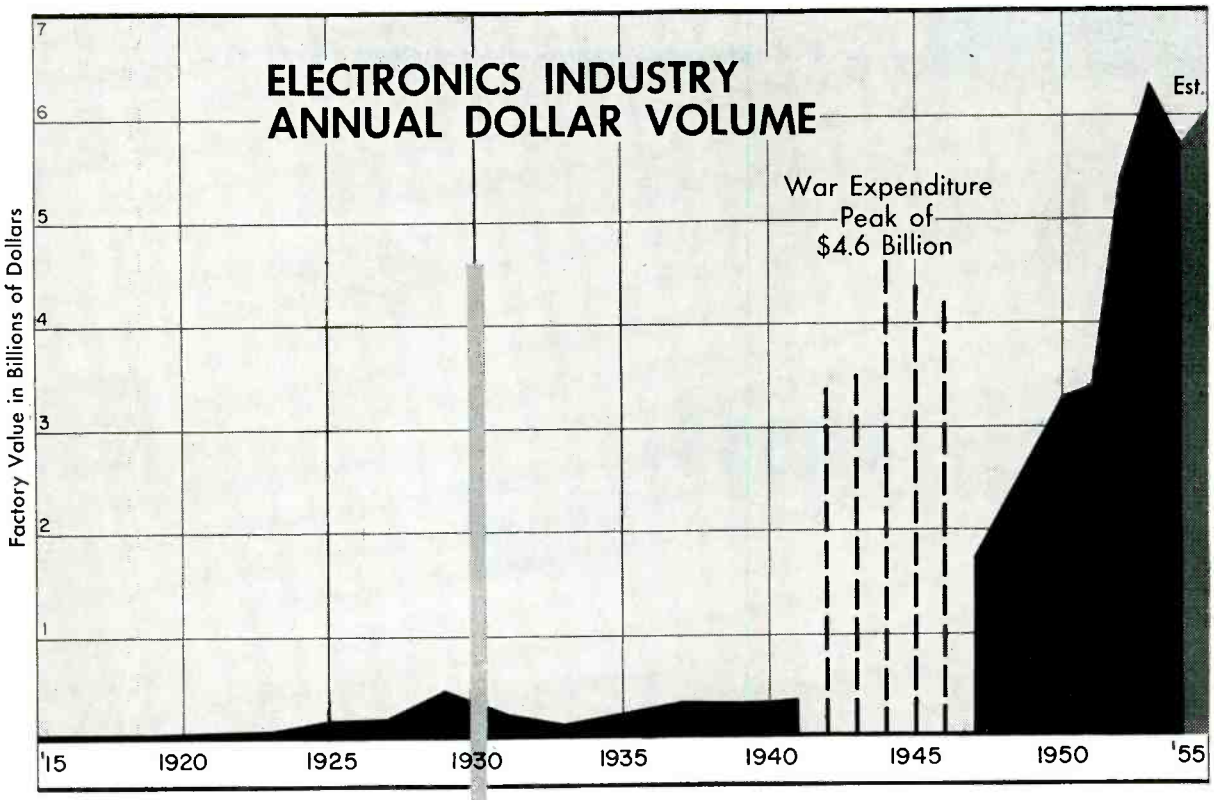
Semiconductors will open up more markets to electronics, either by performing tasks that could not satisfactorily be performed before or by handling existing applications more economically. Magnetic amplifiers will follow a similar path. More mechanized production of all kinds of electronic equipment will have a profound effect upon the industry's economics.

Broadcast radio will continue to serve the listening public and radio's point-to-point communications applications will be greatly expanded. Microwaves will provides the channels and new long-range propagation techniques will expand their usefulness. Wire will give way to radio at an accelerated pace. Color will provide a brand-new replacement market for television. And tape recordings will furnish pictures as well as sound and perhaps other services in the home.

Industrial applications of electronics will be stimulated by an increasing need for automatic control of manufacturing processes. Many clerical jobs will succumb to a similar approach, bringing our products heavily into the business office. More controls of a work-saving nature will find their way into the hands of the general public.

Military, scientific and medical uses now scarcely a glimmer in some designer's mind will cross the horizon as spectacularly as did radar. Men as well as missiles will be more automatically guided through space, physicists will gaze still deeper into the fundamental nature of matter, and important new instruments for diagnosing the ills of mankind and perhaps even curing them will be developed.

These are just a few of the most obvious applications of electronics that lie ahead. They are enough to indicate that no matter how interesting and profitable the last quarter century has been the next twenty-five years hold at least equal promise.



25 Years

Expanding technical principles, ideas and applications familiar to engineer-readers produced growth rate that suggests logarithmic progression. The business side of the industry moved rapidly ahead by capitalizing on engineering knowhow

ENGINEERS involved in the design of electronic equipment should be familiar with the economics of their amazing field. The accompanying graphs show some of the strides that electronics has taken in becoming a major industry.

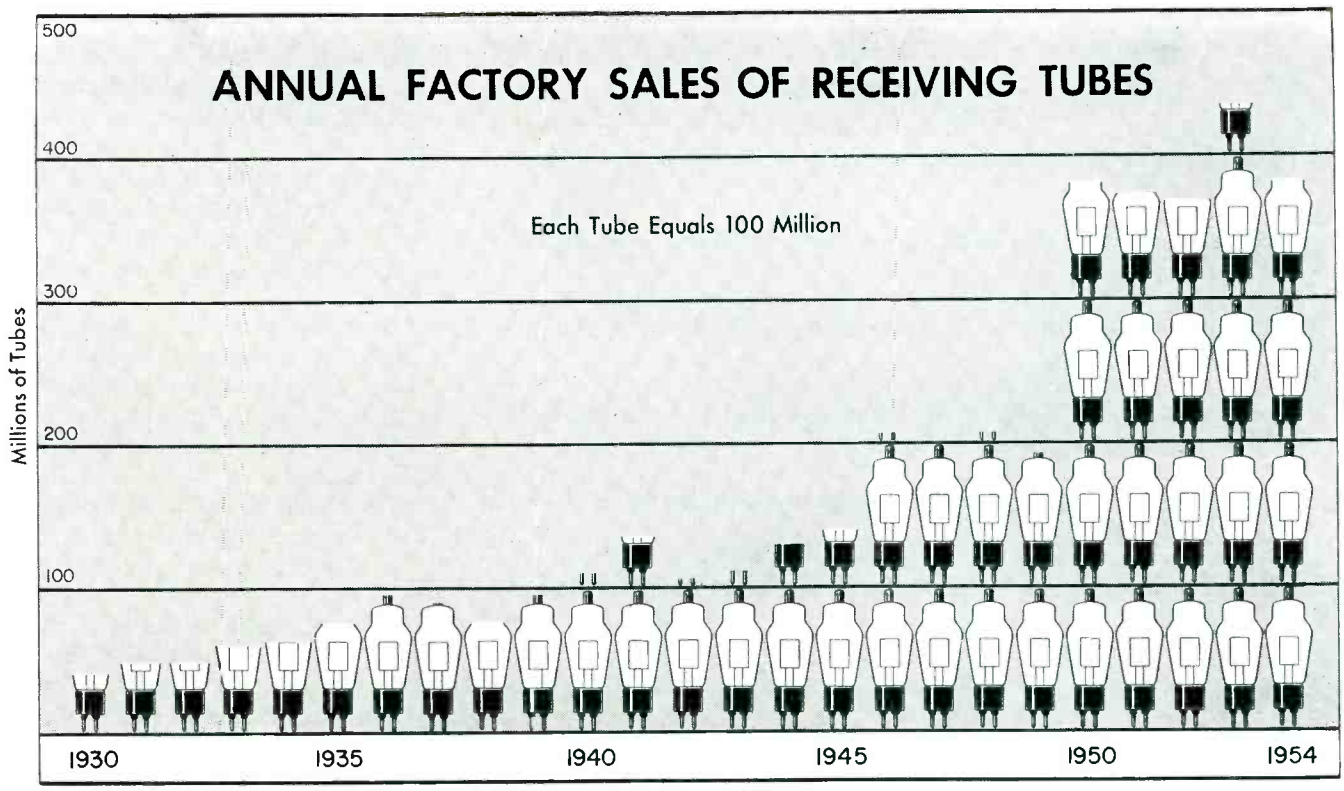
Any complete review of advances made in the last 25 years would require several hundred pages. But highlights of the beginning of the electronics era are interesting in at least two ways. They show, by contrast, what is now being done and what might have been done earlier, and they show things done in the early days that still seem to be the best way today. These serve as guides for the future.

Radio

The art and industry in 1930 revolved around radio. Broadcasting was nine years old and 600 stations served the country. Commercial communications had been well established for a much longer period. Some photoelectric equipment was in use but industrial electronics was still in the cradle stage. Even so, about twelve million dollars worth of electronic equipment was purchased for industrial purposes that year. The overall electronics business totalled 350 million dollars.

Receivers designed for home use were "all-electric" and usually employed a line-up of tuned-radio-frequency stages, a plate-circuit detector and two audio amplifier stages. Some superheterodyne receivers were available with 175-kc intermediate stages.

Modern design of the day included electrodynamic loudspeakers and push-pull output stages using transformer coupling. Some loudspeakers went as high as 12,000 cycles. Interstage r-f coupling and



# of Electronics

By VIN ZELUFF and
Managing Editor
WILLIAM G. ARNOLD
Assistant Editor

antenna coupling were problems then, the latter in view of the wide variation of L and C of the antenna that the consumer might use. Three and four-gang capacitors were the usual but five gangs were not uncommon.

The most evident new technical idea at the Trade Show in Atlantic City was the tone control.

Radio receiver sales in 1930 were 3.7 million sets. There were 29 million homes in the U. S. and only 12 million had radios. Of these only 7,700,000 had a-c sets; 4.3 million homes had battery sets. Many of these had been "electrified" with B eliminators and trickle chargers.

The RMA Annual Convention was held during the Trade Show. Some 200 companies exhibited in 30,000 sq ft of space. Officers of RMA for the year were: president, Morris Metcalf, American Bosch Magneto Corp.; vice presidents, Joseph L. Ray, Radio Corp. of America, Ben G. Erskine, Sylvania Products Co., and Arthur L. Walsh, Thomas A. Edison Inc.; treasurer, E. A. Rauland, Rauland Corp.; Bond Geddes was re-elected executive vice president.

Tubes of the Day

Designers of home radio receivers were favoring type 27, 24 and 45 tubes but some older types, 71A, 26, 10 and 50, were still found in new models. Types 30, 31 and 32, 2.0-volt filament tubes, were brought out for battery portables. The 30 was a triode, the 31 a power triode and the 32 an r-f screen-grid type.

Screen-grid tubes in those days were often rated in amplification factor. The 32 had a factor of 440 and a mutual conductance of 550 micromhos.

Pentodes were at the drawing-board stage. A subcommittee of RMA consisting of five receiver designers and five tube engineers was appointed to collect and study all data on the five-element tube and to formulate pentode standards.

The first issue of ELECTRONICS had an article on the split-anode magnetron by W. C. White (just now retiring in 1955) of the Vacuum Tube Engineering Dept. of General Electric. The tube was a water-cooled version and provided an output of 2.5 kw at 75 megacycles. A smaller tube provided about 10 watts at 400 megacycles. Both were operated as oscillators.

Hot-cathode mercury-vapor rectifier tubes had been available for about two years. The 866 was being used in broadcast station transmitters and is still a popular tube today, 25 years later. Its receiver counterparts, the 82 and 83, were smaller double-diode types. These were needed for the class-B audio systems designed for home receivers in the early thirties. They

EARLY RADAR

1922 Reflection of radio signals from steel buildings and ships noted

1930 Discovery that radio signals were reflected from aircraft in flight

1934 Experimental pulse radar system for detection of aircraft tested

1936 Range achieved of 40 miles over land and resolution of 500 yards

1938 First service radar for marine use installed on USS New York

1941 20 radar sets in operation in the Fleet on Pearl Harbor Day

dropped out of wide use quickly along with that type of audio design for home sets.

Development of the hot-cathode gas diode led to the grid-controlled gas triode, the thyratron. It went to work in 1930 in motor-control circuits.

Broadcasting

Eight clear-channel broadcasting stations were operating at 50 kw and 28 stations applied to the Federal Radio Commission (preceded FCC) for permission to go to that level. WGY and KDKA planned to go to 200 kw and 400 kw respectively for experimental purposes.

Poland was building a transmitter using six 100-kw water cooled tubes to combat propaganda broadcasts from Moscow.

Tallest of the new style of vertical antennas for a-m stations was being built for WABC, Wayne, N. J. Its height was 676 feet.

Amplion Corp. announced a transverse-current microphone in which current was forced to cross the face of the device by the provision of two carbon electrodes, located near the periphery of the diaphragm, diametrically opposite each other. Between these electrodes a shallow channel was cut and filled with granules.

A fifty-kw American-built broadcast station, then the largest in Europe, was operating in Rome, Italy.

Industrial Electronics

Selsyns and thyratrons were used in tube control of stage lighting at the Chicago Civic Opera House.

In several cities, electrical display signs were being lighted at dusk each evening by phototubes. In steel mills, red-hot billets as they came from the rolls were being reversed by photoelectric controls.

Carrier current dispatching systems were being used on power lines by utility companies. The longest line in regular use was 445 miles.

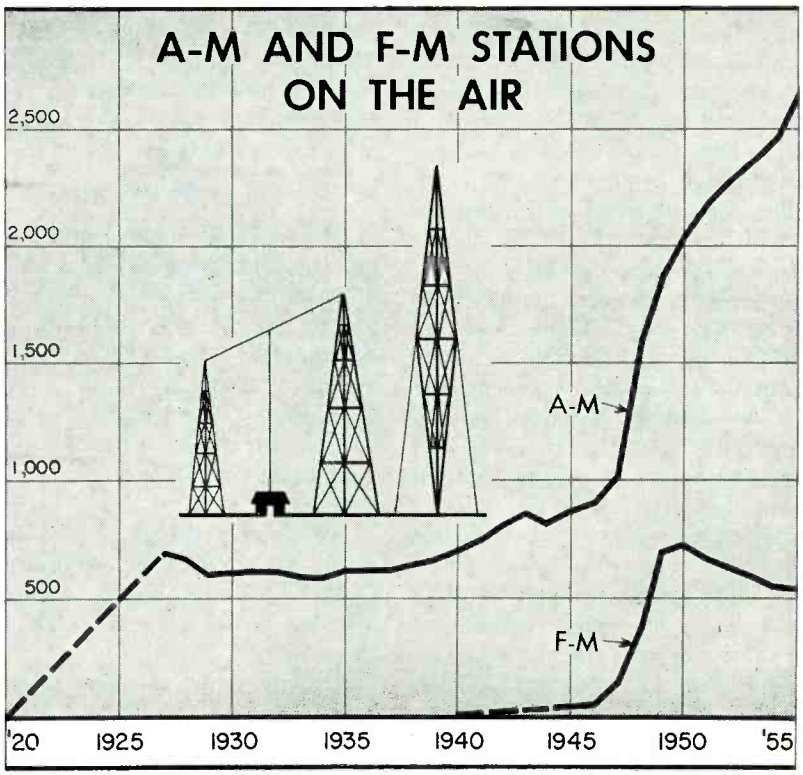
One company at least was marketing a packaged photoelectric relay. It contained a phototube, a sensitive relay, a contactor, and an amplifier tube and was designed for operation of counters, control of mechanisms and for starting and stopping machinery.

A Westinghouse vice-president in charge of engineering placed a tiny model corner stone in position and actuated phototubes, relays and motors that caused a large crane in synchronism to swing into place the actual corner stone. The work was done at the site of a new $2 million laboratory.

Automatic door openers operated by phototubes were demonstrated at a railway supply convention in 1930.

Measurements

An electronic colorscope for analyzing hues and matching sam-



ples, even miles apart, was shown.

Sonic and x-ray tests of steel welds were demonstrated at Lehigh University. An amplifier and loudspeaker reported strains by characteristic sounds when the wall was struck in the sonic test. The x-ray revealed hidden faults visually.

Vacuum-tube voltmeters and signal generators were battery operated.

Sound Reproduction

Audiophiles may take some comfort from the fact that the advantages of push-pull versus single-ended output were shown in curves of power and distortion published in May 1930. Push-pull output was found to be double that of a single tube provided the proper load was used, and distortion was roughly one-sixth that of a single tube.

A new phonograph pickup design featured reduction of weight on the needle to 4 ounces, while keeping the pickup head weight high enough to insure the inertia of the head would not be overcome due to needle vibration.

The number of manufacturers of sound equipment totalled 154 and sales in 1929 were 125 million dollars, largely to the movie industry. The motion picture industry supplied 22,600 theatres in the United States, of which 9,500 were equipped for sound. About 5,000 more were equipped during 1930.

Amplifier loudspeaker systems were used in factories for radio programs, phonograph records and to enable the boss to address all hands without leaving his desk.

Large-Screen Movies

Wide film for panoramic pictures was used to some extent and it was estimated that universal adoption of the panoramic picture would cost the industry one half as much as the introduction of sound. "Grandeur" film was being promoted by Fox Film Corp. and a film, "Happy Days", was shown at the Roxy Theater, N. Y. on a screen 21 by 42 feet. Sound track on the 70-mm film was 250 mils in width compared to 100 mils for standard film.

It was expected that if binaural recording and reproduction became feasible that the wide sound track would be split to allow recording and reproduction of two separate systems from the same film.

Use of color film was growing and Technicolor, Photocolor, Eastman-Sonochrome, Multicolor and Harris were overcoming technical difficulties.

Television

Although there was no television broadcasting except sporadic transmissions of an experimental nature around 100 meters, attempts were made to interest the fans of the day in purchase of equipment for closed-circuit experiments or reception of the occasional broadcasts.

At the transmitter units, a Nipkow disk scanned light from the object being televised across the sensitive surface of a phototube to obtain the video signal. At the receiver, a similar disk was synchronized to scan the light from a neon-filled lamp. Picture size for direct viewing was one or two inches on a side, the dimensions of a flat plate in the neon lamp.

The technique provided a recognizable face with 50 lines, while 72 showed marked improvement in detail. Even with the latter, the detail was insufficient to show the division between normal teeth in a close-up of a face. It was felt that one hundred lines might constitute a television service of good quality for reproducing faces. Viewed ten to fourteen inches from the eye and one inch square, a hundred-line reproduction was said to be the minimum which might be expected to attract and hold public attention.

A typical televisor was that of Jenkins Television Corp. The kit consisted of motor-control rheostat, television lamp house and a Faraday induction motor which drove a scanning disk at synchronous speed. The disk was obtainable in 48, 60, 24, and 45-hole types with corresponding rotors for the desired number of pictures per second. Kit and television lamp (picture tube) retailed for $50, and up.

To provide amateurs and experimenters with a basic television transmitter and receiver, Insuline Corp. of America brought out a complete unit selling under $300. The transmitter consisted essentially of a motion-picture projector, utilizing standard 35-mm safety film. A synchronous motor operated the projector through a suitable gear reduction and the same

INDUSTRIAL TOE HOLD

1922 Locomotives first used 32-volt pliotrons to amplify block-signal-code impulses inductively picked up from tracks

1930 4,500 locomotives were so equipped and 7,000 miles of track protected

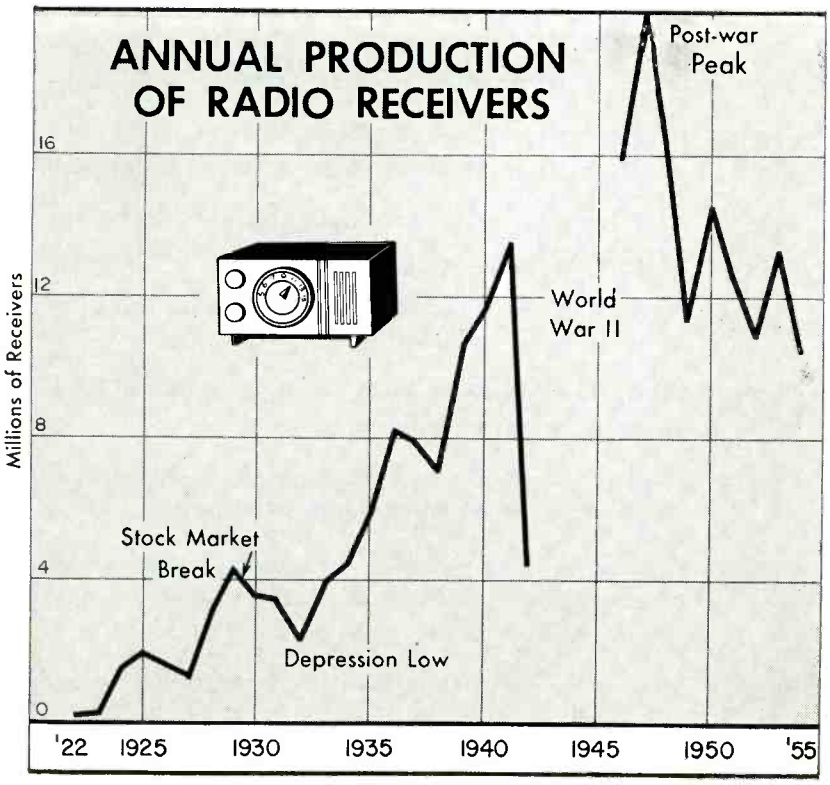
1930 Thyratrons controlled 200 color-changing projectors in floodlighting of building

1930 Oil burner control by grid glow and amplifier tubes was operating in several hundred homes

1931 Control of cut-off knives in wrapping waxed paper on cereal boxes was established in food industry

1931 Continuous sheet processes were using electronic oscillators for measuring thickness of rubber, and moisture in paper

1931 Steam valve for power plants was controlled by audio over telephone line



motor also operated a transmitting scanner.

An optical focusing system was mounted in front of the reel housing, while a condensing lens focused the scanned diverging rays into a photoelectric cell. Closed-circuit connections were made from the photocell to the receiver, which consisted of a four-stage, resistance-coupled amplifier, working into a neon lamp.

Large-screen television was demonstrated by E. F. W. Alexanderson. The size of six by seven feet for the images was made possible by use of a high-intensity arc and a light valve. The latter, a Karolus cell, changed the plane of polarization of the light beam going through it by means of an electrostatic field. The system employed a scanning disk, too.

Communications

Regular radiotelephone service was available in 1930 to London, Paris, Buenos Aires, Havana and Mexico.

Police and fire departments of 30 American cities had transmitters operating and 22 other cities held construction permits.

Facsimile reproduction of a newspaper page was accomplished from San Francisco to Schenectady within three hours of issue from the printing press. Radio impulses were used to transmit typewritten messages from Washington to Hampton Roads, Va.

Then operated by the Department of Commerce, the Federal monitoring station opened at Grand Island, Nebraska.

Some interesting techniques were disclosed in patents granted. One covered a method of cutting off one side band of a modulated carrier by varying the transfer admittance as a function of frequency. Another described a system of transmitting broadcast matter over wires to several subscribers, using modulated radio waves and heterodyne frequencies.

Measurements of echoes on telephone lines received attention. A method of transmitting color pictures was described in another patent.

Other patents covered a remote metering system and a method of effecting grid modulation by using a transformer in the grid return circuit of an r-f stage.

Early Diathermy

While working on high-frequency oscillators, GE engineers noticed that their feet heated rapidly, especially when they were standing on metal plates. The company physician found that when working with a six-to-eight-kilowatt generator producing 20 to 30 meter waves the blood temperature was slowly raised when the men were close to the equipment.

Further experiments deliberately produced actificial fever in man. A high-frequency oscillator was built using two 500-watt tubes and feeding two large metal plates mounted vertically on a table. The plates were connected to the ends of the tank coil. The patient was suspended on cotton tapes stretched across a wooden frame made of two-by-six timbers. Sheets of half-inch thick Celotex further surrounded the body to form a fairly airtight chamber around it.

Temperature rises to 104 F were common and, in one instance, a temperature of 106.5 F was recorded. Best results were obtained at 10 megacycles.

Dielectric Heating

Using an r-f generator of similar power, a live mouse was subjected to increasing field intensities, with consequent increases in body temperature. Soon the mouse lost its tail, but apparently without discomfort. It was a case of dehydration; the short waves had driven out the moisture and the tail shriveled and dropped away.

Using the same equipment, insects were killed, metals were melted, rats responded to insensible heat, moisture was driven out of procelain, and hibernating fruit flies were revived despite zero temperatures.

Science

A. A. Michelson repeated his famous speed-of-ether-waves experiment in a mile-long evacuated pipe laid on the ground near Pasadena, Calif.

The concept of electrons as wave motions rather than corpuscular bodies assembled in atomic solar systems was argued before the American Philosophical Society.

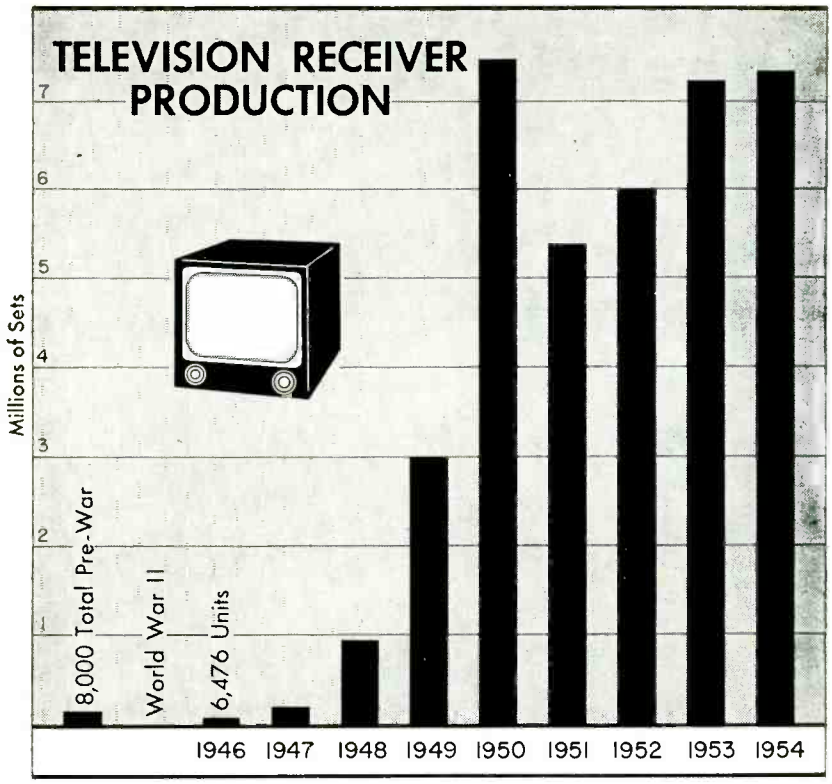
Electronic synthesis of heavy atoms from light ones was demonstrated before the American Chemical Society.

Military

Japanese soldiers at the Tokyo military college were conducting experiments in operating pilotless army tanks by short-wave control from behind the lines.

A squadron of British bombing planes flew 400 miles by radio control. Pilots were aboard for take-off and landing but kept hands off controls during ground-station control.

Transmission of sketch maps and pencilled notes by facsimile was accomplished from a Signal Corps plane flying along the west coast. Part of one message transmitted was "located two subs approaching Golden Gate".



Aeronautics

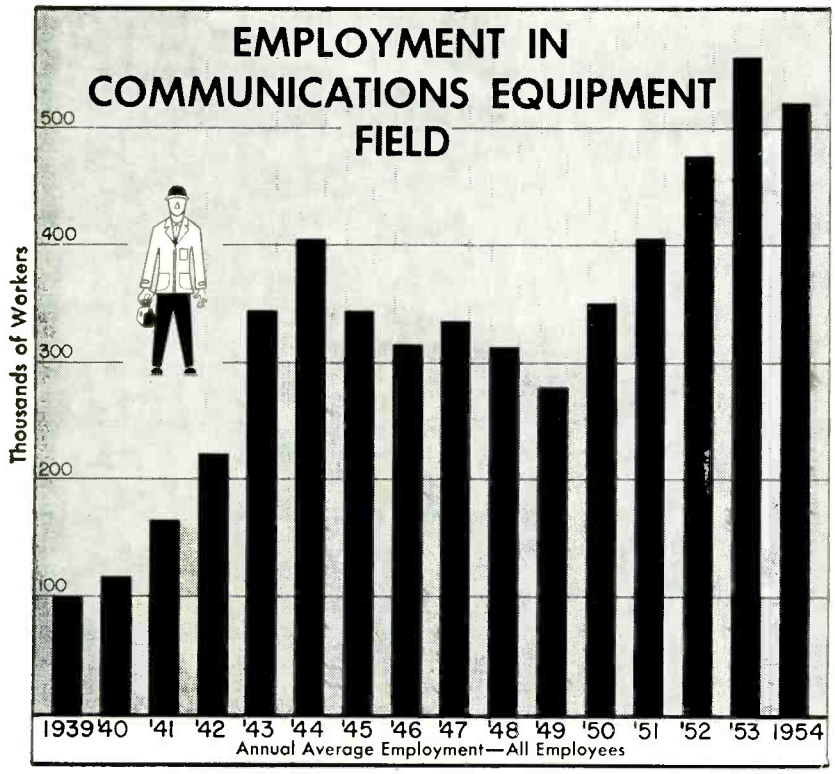
The 5th annual convention of the IRE was held at Toronto in 1930. The liaison committee on aeronautic radio research reported to the Assistant Secretary of Commerce for Aeronautics the value of radio to aviation and the material progress of aeronautics that could be accomplished by research in several pertinent problems. It recommended, particularly, research in the fields of transmission data on medium and high frequencies, radio receiver design, airplane direction finders, simultaneous reception of telephone and beacon service, altimeters, collision prevention, blind landing aids, characteristics of various types of fixed antennas, ice formation on antenna, ignition interference problems, antenna design and location of receiver, spark-plug shielding, drag of wind-driven generators and engine-driven generator problems, including ripples and voltage variation.

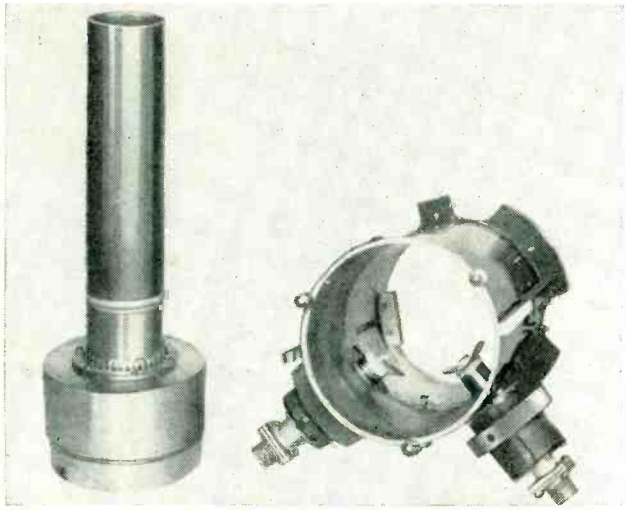
A television system was applied to airplanes in flight so that the pilot might locate his position and see the landing field below him despite fog.

Now Assistant Secretary of State, Herbert Hoover, Jr. was elected president of Aeronautical Radio, Inc., formed to operate the radio divisions of the principal aviation companies.

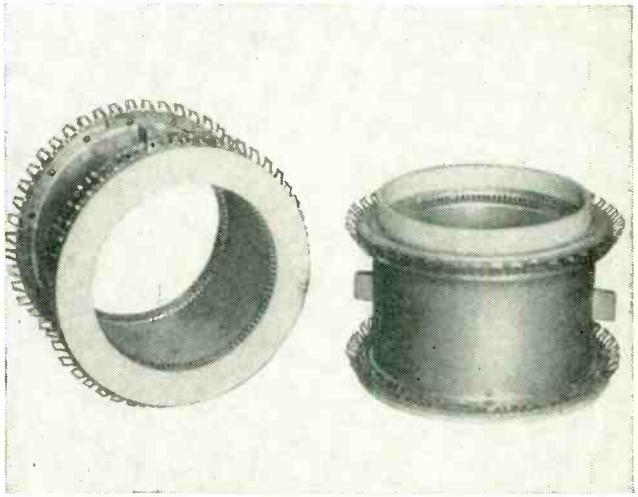
Such was the status of the electronics industry 25 years ago. The accompanying graphs show the growth of the whole industry since then. Particularly outstanding is the progress of the past five years. The present level, if level is the right word, greatly exceeds that of the wartime peak.

That this is only the beginning, and that the next 25 years will show even greater growth, is inevitable. Much of the progress in this field will continue to be due to the efforts of engineers in developing new techniques and equipment for new applications of electronics.





Inner conductor of grid cavity with sliding extension (left) and external conductor (right)



Teflon-insulated tuning-line section used within the plate cavity. Only one is used. Different views show construction

High-Power UHF-TV

SUMMARY —— Search for less expensive kilowatts at uhf leads to new water and air-cooled beam-power tube combined with unconventional plate cavity that provide power up to 15 kw on sync peaks. Output to antenna line is coupled directly from cavity step-down transformer through d-c blocking capacitor. Stored wattless power is held to minimum

DESIGN of a novel uhf-tv power amplifier employs the type 6448 beam-power tube[1] in grounded-cathode operation for visual service up to 15-kw peak of sync output with a power amplification factor of 15 and, for aural service, with a power amplification factor of 50. This development of high power-outputs with grid-controlled tubes at ultra-high frequencies depends in great measure upon the unconventional plate-cavity construction used.

New Problems

Some of the problems faced during the development of the uhf high-power amplifier differ from those found at lower carrier frequencies. Although the voltages in the input cavity are of moderate level and consequently do not require the application of basically new techniques, the output-circuit design must solve the following problems. Space available in the output cavity is inherently small; thus it is not practicable to apply conventional load-coupling elements. High d-c and r-f voltages increase the difficulties. Stored wattless power must be kept low to obtain required bandwidth and to reduce power losses.

Both problems are solved by a plate cavity that acts as step-down transformer between tube and load. Thus no conventional load-coupling element is used; the output line is directly connected to the power-tube plate through a d-c blocking capacitor. Inherently, this type of voltage-step-down cavity stores only the minimum amount of wattless power.

It is an important economical requirement that a wide tuning-range must be covered with a minimum of component changes in the cavity. The same type of plate cavity can be applied for class-B linear r-f visual amplifiers or for a grid-modulated visual-amplifier stage and also for the class-C amplifiers for the f-m sound-channel.

Plate Cavity

A half-wavelength resonator is used for the plate cavity. It is not feasible with the type 6448 tube to use a quarter-wavelength plate cavity for the uhf range.

An important element of the cavity is a sliding-line section that acts as a tuner and also as a coupling reactance between the tube and antenna. This work was partly based on previous results of L. W. Haeseler and S. A. Watson[2] and of T. M. Gluyas with cavities including sliding capacitors as tuning elements and on L. S. Nergaard's[3] studies on cavities.

Figure 1 represents a typical form of the cavity. Figure 2 shows the voltage distribution in the cav-

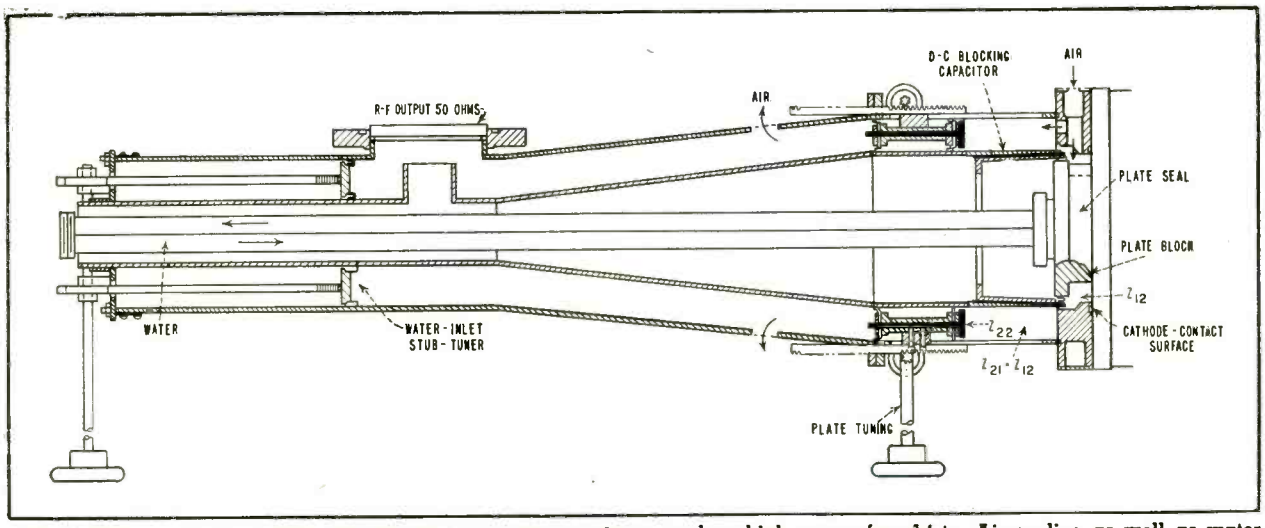


FIG. 1—Plate cavity used with grid-controlled beam-power tube to produce high power for uhf tv. Air cooling as well as water flow is required to dissipate the heat that is generated

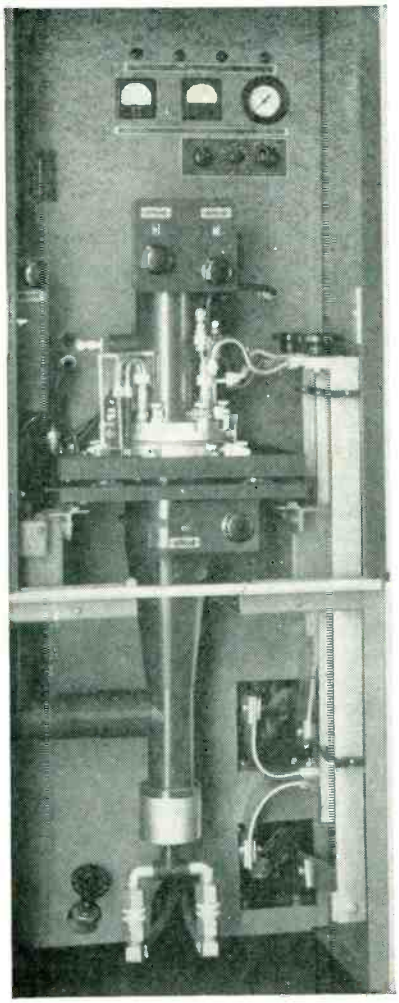
Uses Grid-Control Tube

By L. L. KOROS
Radio Corp. of America
Camden, N. J.

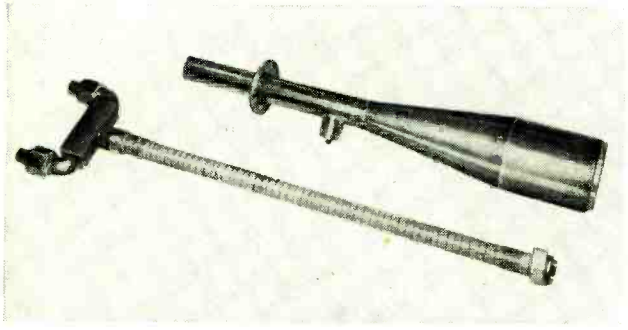
ity. The cavity sees in the tube an r-f generator and a capacitive reactance. The cavity, which must show an inductance for the tube for resonance, is built from two electrically uniform line sections Z_{12} and Z_{21}. Into Z_{21} is inserted sliding line element Z_{22}. In the first line section the inner-conductor of the coaxial cavity is the tube-anode block, in the second section the inner conductor is the cavity line that contacts the tube plate. To assure an equal surge impedance in both line sections, the external conductor of the cavity follows the diameter changes of the inner conductor.

There are, however, two discontinuities. One is the d-c blocking capacitor for the plate voltage. This Teflon-dielectric capacitor is built into the cavity center-conductor; consequently it is in series with the Z_{12} line. This capacitor shows low reactance for the Z_{12} line and can thus be neglected. The other discontinuity is a capacitance C_p that is parallel with the Z_{21} line. It is formed between the tube-plate contacting edge and the external conductor of the cavity. This capacitor is close to the low-voltage plane of the cavity: thus it has only an insignificant effect. At the low-voltage plane is the end of the first quarter-wavelength section of the cavity.

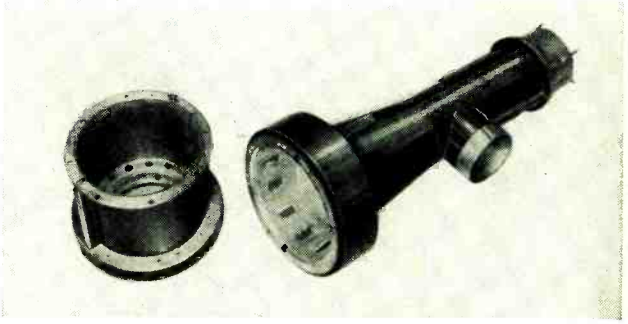
The second quarter-wavelength section is substantially confined in low surge-impedance line section Z_{22}. This section slides on contact springs. The position of the sliding-line section determines the length of the half-wavelength resonator; thus it tunes the carrier frequency. The Z_{22} section is a Teflon-insulated line with a typical surge-



Assembled plate and grid cavities as used in transmitter



Inner conductor of plate cavity and insulated water pipe normally inserted therein



External conductor of plate cavity. Cylindrical and tapered parts are disassembled

impedance of 2 ohms. The surge impedance of this sliding section and the surge impedance of the line in which the Teflon line slides, Z_{21}, are selected to obtain at the end of Z_{22} the necessary voltage, which must be applied across a fictitious resistor (R_L in Fig. 2) that equals the Z_{21} line surge impedance, to produce the rated power output. At the end of the Z_{22} sliding line element is the end of the second quarter-wavelength section of the cavity. Impedance Z_{21} is transformed by a tapered section into 50 ohms, which is the surge impedance of the antenna line. The tapered section, when sufficiently long, introduces only an unsignificant reflection.

Plate-Cavity Details

Lengths of the coaxial-line elements for the plate cavity are determined from the requirement for resonance, which calls for an electrical half-wave resonator, open circuited at the tube end and at the load end. The tube, as an oversimplification, is replaced by a uniform line element of 4.8 centimeters, with the average surge impedance Z_{11} = 10.63 ohms and with the terminating capacitance C = 4.5 $\mu\mu$f as shown in Fig. 2. The rest of the line elements are in the cavity and can be selected by the designer.

The r-f generator action of the tube can be considered to be concentrated in one plane, which is designated as a_t. This plane is at a distance of 1.2 cm from the end of the anode block. A fictitious loading resistor R_t is reflected into this tube plane by the antenna. Another fictitious resistor R_L is applied at the end of the half-wavelength section of the cavity. Between the 50-ohm antenna line and R_t the cavity is interconnected as a transformer. The transformer ratio is determined by the selected line surge impedances and by the electrical length of the Z_{22} line. A typical voltage transformer ratio is 6.5 between the tube plane a_t and the R_L plane. It is about 3.5 between the tube plane and the antenna, which is represented by a 50-ohm line.

Experimental data indicate that the optimum plate load for the type 6448 beam-power tube in class B, television picture-channel operation is R_t = 700 to 1,100 ohms and for class-C sound-channel operation 1,000 to 1,300 ohms. Adjustment of R_L sets R_t within the proper limits. On the selection of R_t depends also the bandwidth.

Voltage at the end of the sliding line E_L is very low. This minimizes the stored (wattless) power in the cavity and helps to obtain a broad bandwidth. The cavity stores only about 20 percent of the overall wattless power; 80 percent is stored in the tube. The voltage is stepped down first by the sliding Z_{22} line section to a lower value than required for the 50-ohm line. The tapered section steps up the voltage for the 50-ohm line without substantially increasing the stored wattless power.

Grid Cavity

The grid cavity shown in Fig. 3 is a ¾-wavelength resonator. The first quarter-wavelength section of the resonator and also one part of the second quarter-wavelength section are entirely in the tube. The reason for this is that the grid-to-ground capacitance is in the order of 300 $\mu\mu$f; thus the first quarter-wavelength section becomes very short. The tube shows inductive reactance to the cavity, the value of which is between 1 and 3.5 ohms within the uhf band. Thus, the cavity must represent a capacitive reactance for resonance.

A capacitive low-impedance coaxial-line element follows the coaxial grid structure outside the tube. This low-impedance section has a sliding, telescopic extension. The position of the sliding extension is set to produce the required capacitive reactance at the grid-contact plane for grid tuning. The low-impedance line is fed by a high-impedance line-section that is substantially a quarter-wavelength resonator. For broad-band operation the coaxial capacitive line section should have a low surge-impedance and the feeding, quarter-wavelength section a high impedance. Typical surge impedance values are 2 ohms for the low-impedance section and 50 ohms for the high surge-impedance section.

The high-impedance section is excited from a driver stage with an adjustable capacitive coupling. If the power amplifier is in visual class-B service, the bandwidth of the grid circuit must be broad. One step toward this end is to add a swamping resistor to the grid cavity with another adjustable coupling plate. This increases the required power output from the exciter stage, generally by the factor of two. The typical power-amplification factor, the ratio of the power-amplifier and exciter-stage outputs, is 15 in a linear class-B color-picture amplifier service; in

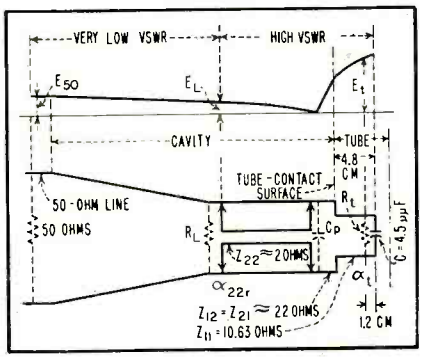


FIG. 2—Voltage distribution in the plate cavity shown graphically

aural class-C f-m service, where no swamping load is applied, the power amplification factor may reach 50. Peak sync power of 15 kw can be obtained from a typical tube with 1-kw driver power. Voltage distribution in the grid cavity is shown in Fig. 4.

Loading Control

If no impedance transformer is connected between the 50-ohm output line of the plate cavity and the terminating 50-ohm antenna load, the only possible R_L value is identical to Z_{21} of Fig. 2. The surge impedances and the length of the sliding section are selected to approach this ideal case at the proper tube plate loading R_t and at the required bandwidth. In this ideal case the line between the end of the Z_{22} section and the antenna is properly matched.

Such an ideal condition cannot be obtained for all the frequencies in a cavity where tuning within wide carrier-frequency limits is a requirement. It is possible, however, to approach the ideal condition sufficiently. To correct deviations from the ideal case, a resistance-transforming device is necessary in the 50-ohm output line, as shown in Fig. 5. This device must introduce a moderate standing wave into the tapered cavity-section and by this means the value of R_L can be adjusted to a value that is different from Z_{21}.

Two quarter-wavelength line elements of a lower surge impedance than 50 ohms are utilized in the form of sliding slugs in the 50-ohm line for load adjustment[4]. Care must be taken, however, that this impedance-transformer system shows a pure resistive load to the end of the sliding section, which is denominated α_{22r} in Fig. 2 and 5. To attain this condition, it is necessary to find a plane in the output line that is at an electrical half-wavelength distance, or a multiple thereof, from the end of the tuning element.

This plane is designated as plane 1 in Fig. 5. The center-line of the two slugs, plane 3, must be at $5\lambda/8$ or $3\lambda/8$ distance from plane 1. The position of plane 3, which is the symmetry line between the two slugs, must be unchanged; the slug distance $C/2$ from plane 3 must be adjustable. If the distance between plane 1 and plane 3 is $5\lambda/8$, an increase of $C/2$ from zero up to $\lambda/8$ increases the load resistance at the α_{22r} plane. If the distance between plane 1 and plane 3 is $3\lambda/8$ an increase of $C/2$ decreases the load resistance. If $C/2 = 0$, $R_L = Z_{21}$.

Experimental Data

For picture-transmission test a one-kilowatt uhf television transmitter was used as the modulated exciter. The grid cavity of the power amplifier must match the input line at the carrier frequency. It

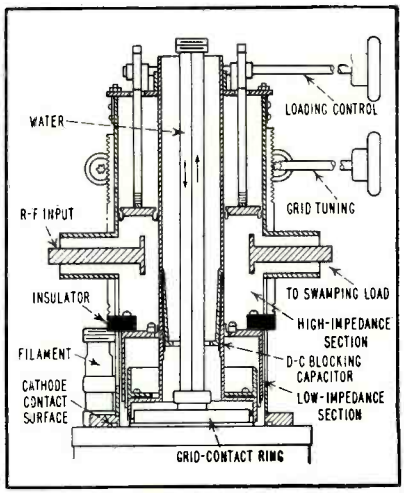


FIG. 3—Tuned grid cavity used in the new transmitter

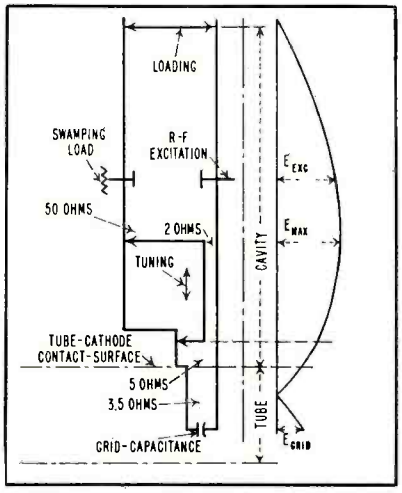


FIG. 4—Voltage distribution in grid cavity of transmitter

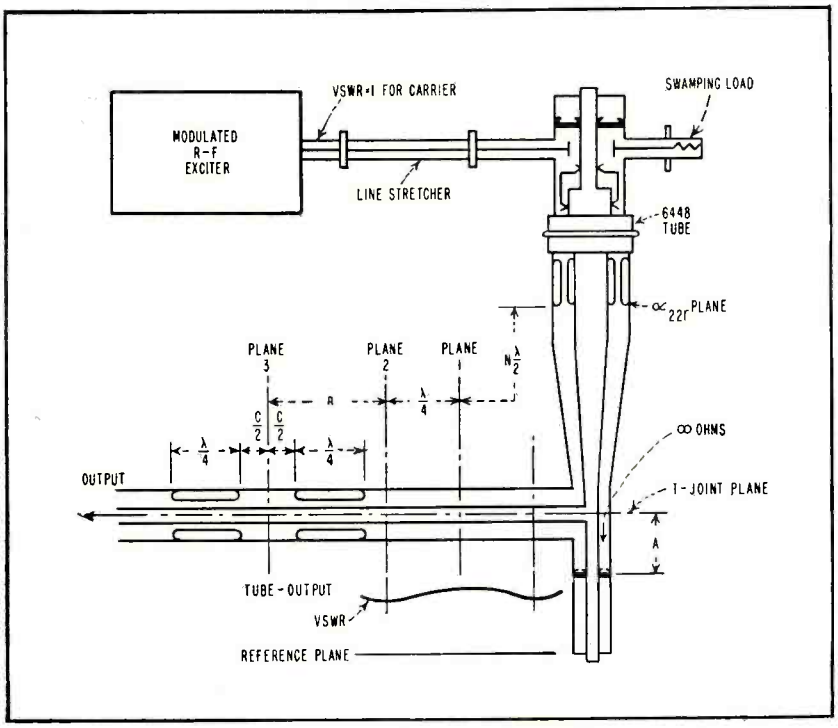


FIG. 5—Diagram showing required adjustment of amplifier as explained in text

has not been found necessary to match for the whole tv sideband spectrum. There is considerable advantage in working with a narrower grid bandwidth, adjusting the input line-length and by this means the vswr for the sidebands, so that a peaking of the grid-response up to about 2 db is observed at the +4.2 megacycle sideband frequency, as shown in Fig. 6A. This adjustment permits the use of a relatively narrow plate-cavity bandwidth, about 8.5 megacycles for the −3-db points.

If in the plate cavity the carrier is offset by one megacycle toward the lower sidebands the overall response becomes nearly flat between the −1.5 and +4.2-megacycle sideband limits, which is satisfactory for color-picture transmission. Figure 6B shows the frequency response in the output line of the amplifier. A uhf-tv sideband response analyzer[5] was used to produce the sideband pictures in Fig. 6.

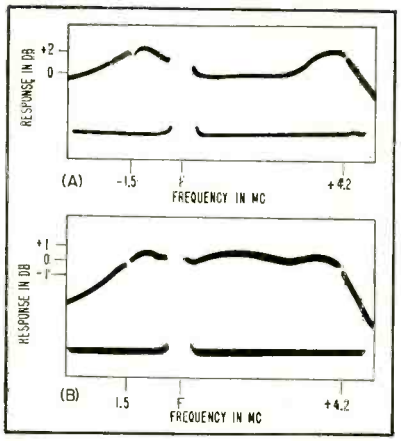


FIG. 6—Amplitude response of sidebands in grid cavity (A) and output line (B)

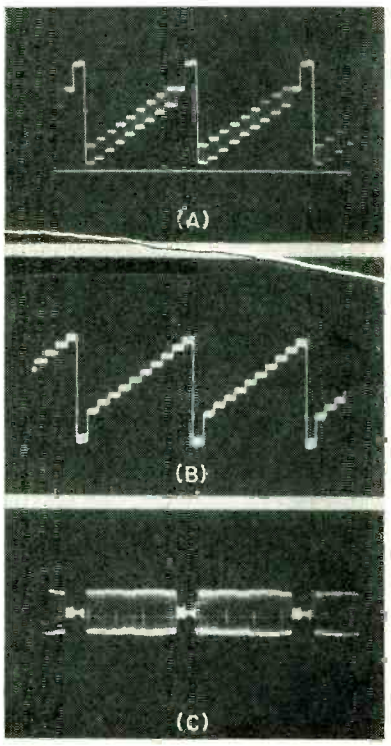


FIG. 7—Step-wave modulation with color burst (A) bursts filtered (B) and step wave rejected by high-pass filter

Step-Wave Test

The curve in Fig. 7A represents a step-wave modulated output, sampled from the power-amplifier output line. A burst of 3.58-megacycle color subcarrier frequency is on the steps. The input signal to the modulator of the exciter stage was produced with a linearity checker[6]. The output envelope was detected with a diode. Figure 7B represents the same information after passing it through a low-pass filter and (C) shows what happens to signal (A) after sending it through a high-pass filter. These curves indicate that the transmitter has a satisfactory linearity in the low-frequency region and also in the region of the color information.

A color signal analyzer measurement gave additional information based on the demodulated output (Fig. 7C) which was sent through the high-pass filter[7]. The 3.58-megacycle color subcarrier bursts, modulated on the uhf carrier at different amplitudes (different luminance-levels) may show different phase relationship to each other. Such a phase-vs-amplitude distortion introduces color error in the picture so this distortion must be kept very low.

With increasing screen-grid voltage the phase-amplitude distortion decreases and almost disappears at the 1,000-volt screen-grid voltage region. Comparative laboratory measurements on the phase relationship between the bursts in the input and output of the power amplifier indicated 3-deg phase difference between the bursts of the lowest and highest power level, which is satisfactory. A further control on the phase-amplitude distortion can be applied at the modulator of the exciter stage. Thus, it is possible to keep the overall phase-amplitude distortion at 1 deg. The promising test results were confirmed with practical color transmissions.

Losses in the cavity and the tube can be determined by cold test on the system. The expression $P = P_o Q_U/(Q_U - Q_L)$ gives the relation between the real output from the cavity P_o and the electronic output P produced by the tube. The values Q_U and Q_L are the unloaded and loaded Q-values of the plate network. For the measurement of Q_U, the load and also the tapered section of the cavity (Fig. 1) must be decoupled. Otherwise a high standing-wave ratio is built up in the taper, which operates at low-standing-wave ratio when the cavity is loaded. The circuit loss is computed by $P - P_o$, which includes the r-f losses in the tube-transmission-line (Fig. 2) and in the cavity. Measurements indicate that about 95 percent circuit efficiency can be obtained with the described cavity system at the middle of the uhf band.

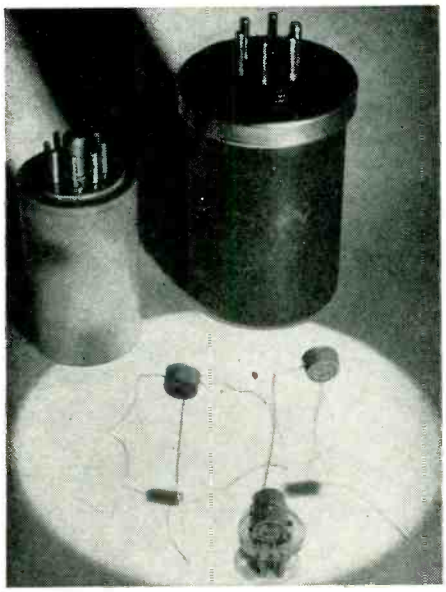
Efficiency

In a typical operation at lower carrier frequencies, the plate-power efficiency is about 40 percent at the peak output of the sync pulses. Because the 6448 is a grid-controlled tube, the plate-input power changes proportionally with luminance during picture transmission.

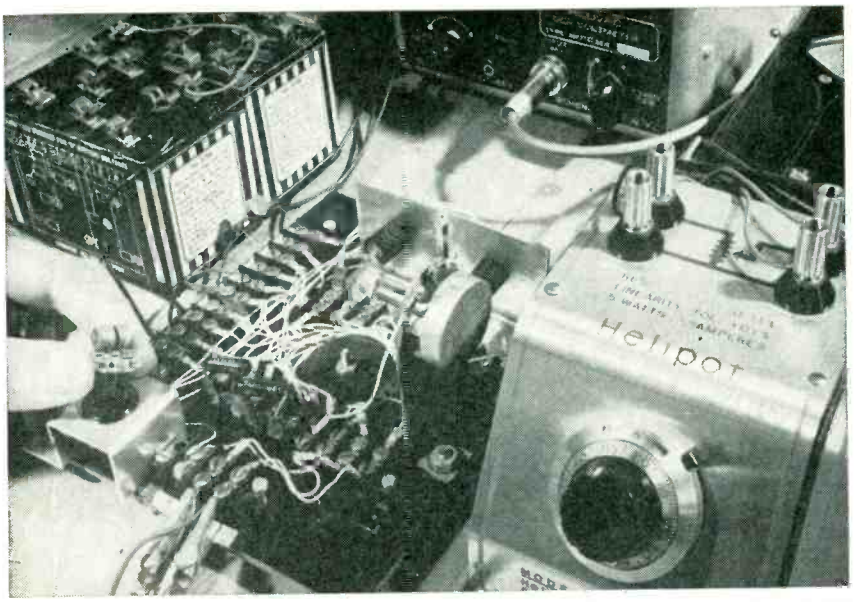
The author is indebted to T. J. Boerner and W. P. Bennett for valuable discussions and to M. W. Duris, R. N. Clark, F. C. Blancha, G. J. Rogers, R. L. Meisenheimer, D. H. Eberlin, J. W. Chasteen, T. Douma, R. E. Wolf, N. J. Oman, J. E. Joy, E. M. Coombs and T. N. Newman for their co-operation.

References

(1) W. P. Bennett, A Fifteen-Kilowatt Beam Power Tube for UHF Service, Transactions Record of the Fourth Annual Broadcast Symposium of the IRE Professional Group on Broadcast Transmitter Systems.
(2) U. S. Patent 2,421,784, filed Feb. 1943.
(3) L. S. Nergaard, A 5031 as a Wide-Band 520 MC Power Amplifier, RCA report, PTR-96, April, 1948; presented at IRE Electron-Tube Conference at Cornell University, June 1948.
(4) T. Moreno, "Microwave Transmission Design Data", p 108, McGraw-Hill Book Co., Inc., New York, N. Y., 1948.
(5) J. A. Bauer and F. E. Talmage, The RCA-BW-5A Television Sideband Response Analyzer, *Broadcast News*, p 32, July-Aug. 1953.
(6) J. A. Bauer, A Versatile Approach to the Measurement of Amplitude Distortion in Color Television, *Proc IRE*, p 240, Jan. 1954.
(7) A. C. Luther, Jr., Method of Verifying Adherence to the NTSC Color Signal Specifications, *Proc IRE*, p 235, Jan. 1954.



Plug-in transistor chopper, *pnp* transistors used and comparable mechanical choppers



Experimental d-c amplifier setup in which plug-in transistor pair at left performs functions of contacts in electromagnetically driven mechanical chopper

Transistor Choppers for Stable D-C Amplifiers

SUMMARY —— Two fused-junction transistors driven at power-line frequency approximate the ideal switch for converting weak d-c input signals into proportional square-wave a-c signals. Circuits are simple. Life expectancy is long even with 300-kc switching rate

By R. L. BRIGHT and A. P. KRUPER

Materials Engineering Department
Westinghouse Electric Corporation
Pittsburgh, Pennsylvania

SMALL IN SIZE and high in reliability, it was natural indeed that transistors should find early use in d-c amplifiers. Transistors can be utilized as choppers which are linear down to a fraction of a millivolt and which, in low-impedance circuits, will operate over an extremely wide temperature range without compensation. This device makes possible completely transistorized low-level d-c amplifiers which have inherently slight temperature drift.

The family of characteristic curves of a transistor when operated as a switch is shown in Fig. 1. The *npn* fused-junction transistor is in the common-emitter connection.

The nearly vertical segments in the first quadrant represent the linear range and are the characteristics commonly published. In switching operation the base input signal is sufficient to swing the operating point from beyond cut-off (point *C*) to a point far into saturation (point *S*). The applied polarities may place the operating point in any one of the four quadrants.

Note how closely a transistor approximates a switch at moderate or low-power levels. The characteristics of an ideal switch would simply be two lines coincident with the axis, the one along the current axis corresponding to a closed contact and the one along the voltage axis corresponding to an open circuit.

If the base voltage applied to the transistor is switched from −1 volt to +1 volt, the small-signal collec-

ADVANTAGES OF TRANSISTOR CHOPPERS

- No contacts to pit or get dirty
- Not affected by vibration
- Will operate at high speeds with little phase shift
- Linear down to 0.1 millivolt
- Small temperature drift when used with low-impedance inputs
- Small size
- Light weight
- Low power consumption
- Long life

tor-emitter characteristics are two lines which are nearly parallel to the axis but which do not intersect at the origin O, but rather at a point P (I_p, V_p) in the first quadrant. In other words, the transistor is nearly equivalent to an ideal switch in series with a battery V_p and shunted by a current source I_p. This battery and current source impose a practical lower limitation on the power level of a load circuit that can be satisfactorily controlled by a transistor switch. The closer this point P can be brought to the origin O the lower the satisfactory operating level becomes.

It was first found experimentally and later verified theoretically that if the collector and emitter terminals were interchanged, the resulting characteristics have an intersection that is much closer to the origin than the common-emitter or normal connection. This connection has been termed the inverted connection and is the one recommended for low-level operation.

The normal connection for an *npn* transistor and its equivalent circuit are shown in Fig. 2A, while the inverted connection and its equivalent circuit are shown in Fig. 2B.

Inverted Connection

Although the equivalent circuits are the same for the normal and inverted connections, the magnitudes of V_p and I_p are markedly different. Whereas typical values of V_p and I_p might be 30 millivolts and 15 microamperes for the normal connection, these are reduced to about 1.0 millivolt and 1.0 microampere respectively in the inverted connection at room temperature. Voltage V_{pi} varies somewhat with temperature, but in general remains between 0.5 and 2 millivolts over the range −50 C to 90 C. Current I_{pi} increases exponentially with temperature at about 8 percent per degree C. Figure 3 is a plot of the temperature dependence of V_{pi} of six randomly selected experimental *npn* germanium transistors.

The values of the coordinates V_p and I_p are given more exactly by

Normal connection (common-emitter connection)

$$I_{pn} = \frac{1 - \alpha_i}{\alpha_i} I_o$$

$$V_{pn} = 0.025 \ln \frac{1}{\alpha_i} \qquad (1)$$

Inverted connection

$$I_{pi} = \frac{1 - \alpha_n}{\alpha_n} I_o$$

$$V_{pi} = 0.025 \ln \frac{1}{\alpha_n} \qquad (2)$$

where α_n is the current gain normally published, α_i is the current gain with collector and emitter interchanged, and I_o is a constant for any particular unit.

For most commercial fused-junction transistors, α_n is much nearer unity than α_i, typical values being $\alpha_n = 0.99$ and $\alpha_i = 0.5$. Substituting these values in the above expressions gives $I_{pn} = 1.0\ I_o$ and $V_{pn} = 0.69\ (0.025)$ for the normal connection, and $I_{pn} = 0.01\ I_o$ and $V_{pi} = 0.01\ (0.025)$ for the inverted connection. Thus the coordinates of the intersection P for the inverted connection may be orders of magnitude smaller than those for the common emitter.

Switch Circuits

A switch should have the property of conducting regardless of the polarity of the voltage when it is closed, and should block regardless of the polarity when it is open. The transistor switch performs these functions well. The curves in Fig. 1 show that the switch will conduct with either polarity of emitter-collector voltage, but it will only block if the base is more negative than both the collector and the emitter.

The simple circuit shown in Fig. 4A illustrates this condition. If the source voltage E becomes greater than 1.5 v, the switch will not block. Figure 4B shows how this can be overcome by using two transistors to form a switch which is capable of blocking or conducting on either polarity. When the bases are negative, the transistor whose collector is positive will block the circuit; when the bases are positive, the transistors can conduct in either direction and the circuit is closed.

Since a transistor operated in the

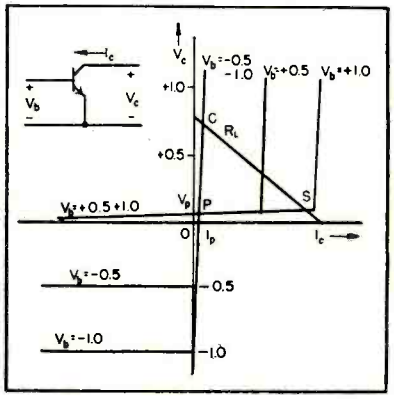


FIG. 1—Characteristic curves for operation of *npn* fused-junction transistor as switch

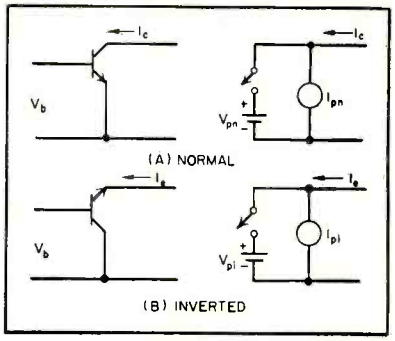


FIG. 2—Equivalent switch circuits for the two types of transistor connections

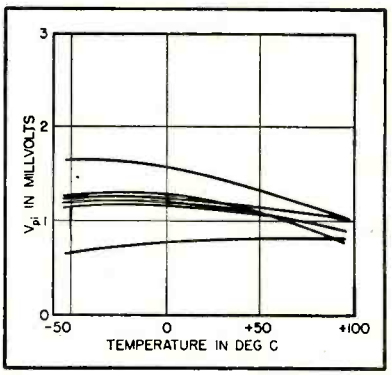


FIG. 3—Curves showing relative freedom of transistors from temperature effects

inverted connection so closely approximates an ideal switch, one of the interesting possibilities of using a transistor switch would be to replace the mechanical vibrator or chopper in the input of d-c amplifiers. A d-c amplifier employing a chopper-type input is shown in Fig. 5.

D-C Amplifiers

To amplify a d-c signal in a manner which is free of the drift and instability of d-c amplifiers, a mechanical switch converts the d-c input into a square-wave a-c signal which can be easily amplified by an a-c amplifier. After amplification, the signal is converted back to d-c by a suitable output rectifying system.

A chopper may also be used to obtain an a-c output signal whose phase and magnitude are functions of the polarity and amplitude of a d-c signal. The amplified a-c signal may then be applied to the control winding of a two-phase servo motor. In these applications it is important that there be no a-c output signal present with zero d-c input signal. Commonly used static electronic chopper circuits have difficulty meeting this requirement.

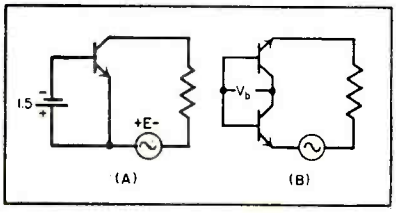


FIG. 4—Two-transistor circuit arrangement will block or conduct on either polarity

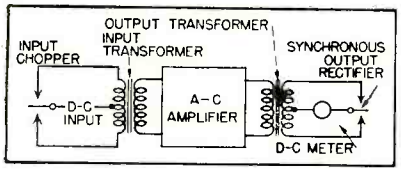


FIG. 5—Conventional chopper-input d-c amplifier arrangement

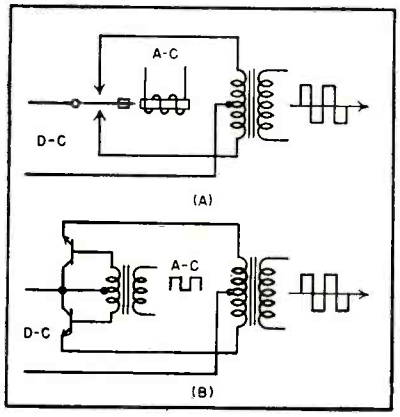


FIG. 6—Comparison of electromagnetic and transistor chopper circuits

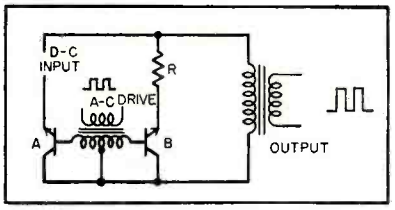


FIG. 7—Two-transistor chopper circuit using only two transformers and one resistor

Transistorized Chopper

A schematic of an electromagnetically-driven mechanical vibrator chopper is shown in Fig. 6A, and a direct substitution of the vibrator switch contacts with transistor switches is shown in Fig. 6B.

Direct substitution of Fig. 6B would not satisfy the requirement of zero a-c output signal with zero d-c input signal since the V_p values of the two transistors are applied to the output transformer in such a direction as to add, producing an a-c signal whose peak-to-peak amplitude is equal to their sum. This could be compensated for by using the back-to-back transistor pair shown in Fig. 4B in place of each single transistor. The V_p values of each pair are in opposition and will tend to cancel, the degree of cancellation depending upon how well the V_p values of each transistor match. It is easily possible to match to within better than a tenth of a millivolt over a temperature range of −50 C to +90 C.

Two-Transistor Chopper

Another circuit which will perform the function of a chopper is shown in Fig. 7. Here only two transistors are used, which cancel the V_p values. A square-wave a-c voltage is applied to the bases of transistors *A* and *B*, causing them to alternately conduct and be open-circuited. On one half-cycle the input is connected to the output transformer through transistor *A*, transistor *B* being open. On the alternate half-cycle, transistor *A* is open-circuited, isolating the input circuit, while transistor *B* is closed, short-circuiting the output transformer. With zero d-c input signal, the V_p values of *A* and *B* appear across the output transformer in the same direction; if they are equal, the output is d-c and contains no a-c component.

Source Impedance

Since the equivalent circuit of the transistor switch was shown in Fig. 2 to include a current generator I_p, it is important to operate with a low-impedance source to assure that this leakage current will not cause an appreciable drop that will appear in the output. Matching of both the V_p and I_p values is possible, but in general it is much simpler to keep the input impedance low and match only the V_p values.

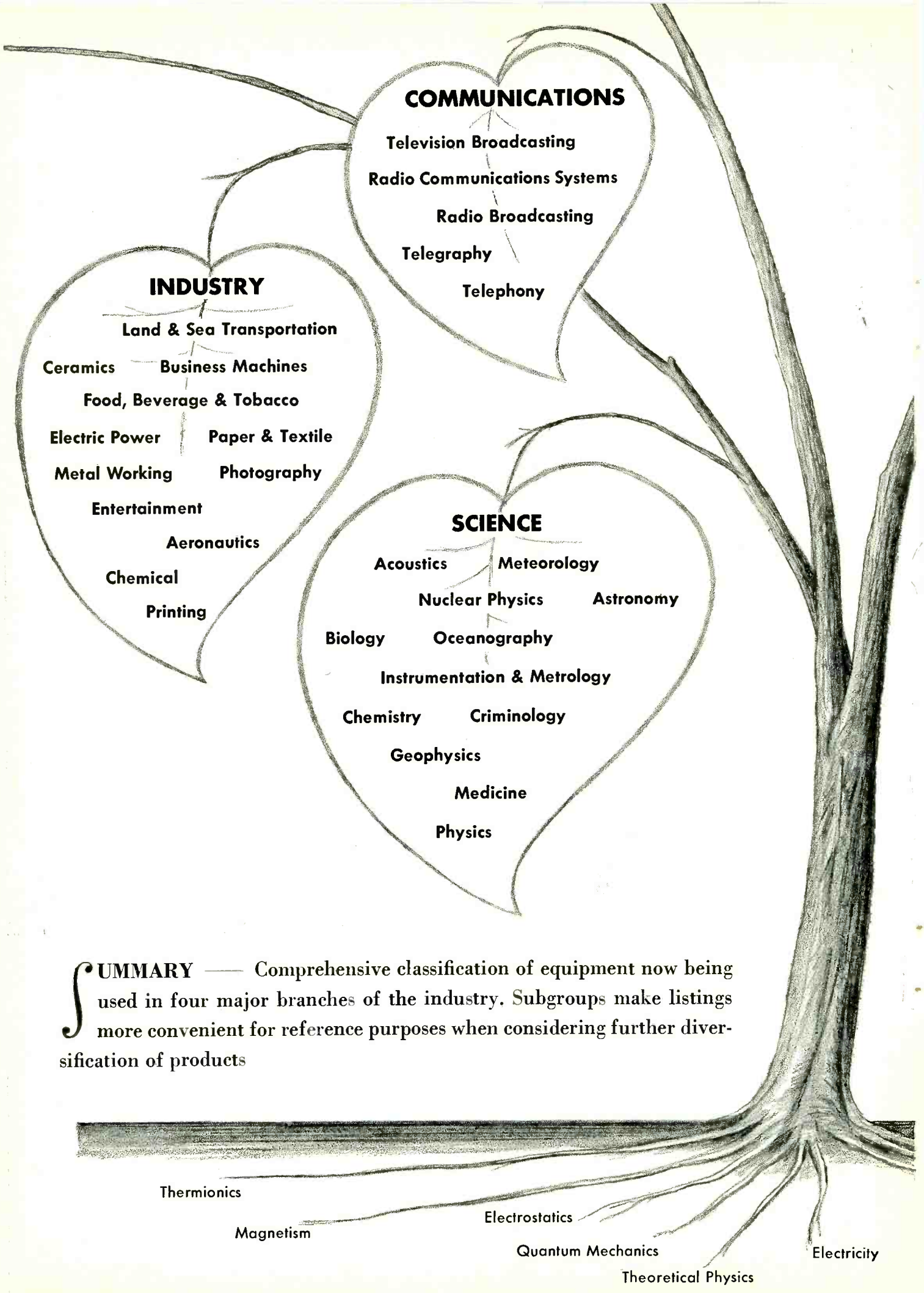
Advantages

One of the big advantages of transistors over mechanical choppers is that they are inertialess devices. As such they can be operated at any line frequency without loss in performance. They have practically zero phase shift up to about 10 kc, as contrasted to phase shifts of from 30 deg to as high as 90 deg for mechanical choppers. In addition, mechanical choppers are usually designed for a specific frequency or a narrow range of frequencies and cannot suffer much change in frequency without introducing additional phase shift in the output signal.

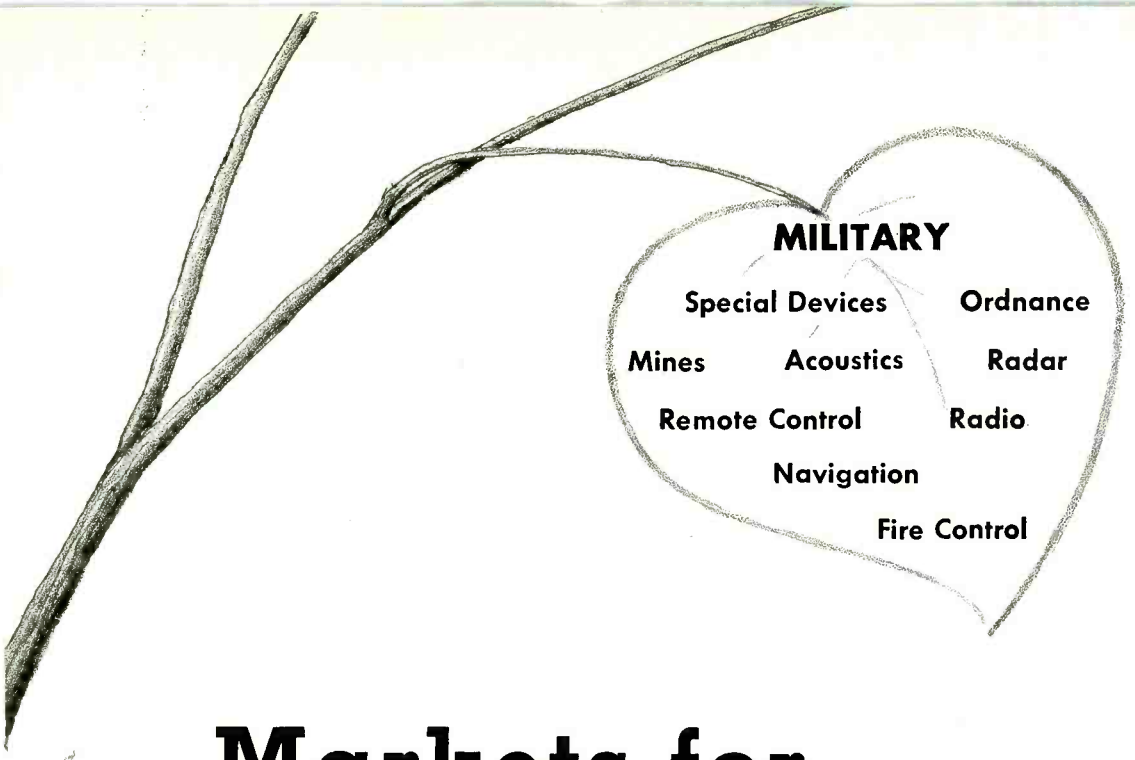
The fact that the transistor chopper can be operated at all frequencies up to hundreds of kilocycles makes possible its use as a carrier for rapidly varying d-c signals or even a-c signals, as well as steady d-c signals. Operation at high chopping frequencies opens up the possibility of servos with extremely fast response times.

Conclusions

This article has illustrated only one of many possible circuit applications of transistors as switches at low power level. Although data has been presented on only *npn* fused-junction transistors, any high-gain fused-junction *pnp* transistor, such as the Westinghouse 2N54, will prove equally satisfactory for this application.



SUMMARY — Comprehensive classification of equipment now being used in four major branches of the industry. Subgroups make listings more convenient for reference purposes when considering further diversification of products



By JOHN T. MILEK
Consulting Engineer
Los Angeles, California

Markets for Electronic Equipment

EACH major branch is broken down into subgroups with individual items listed alphabetically.

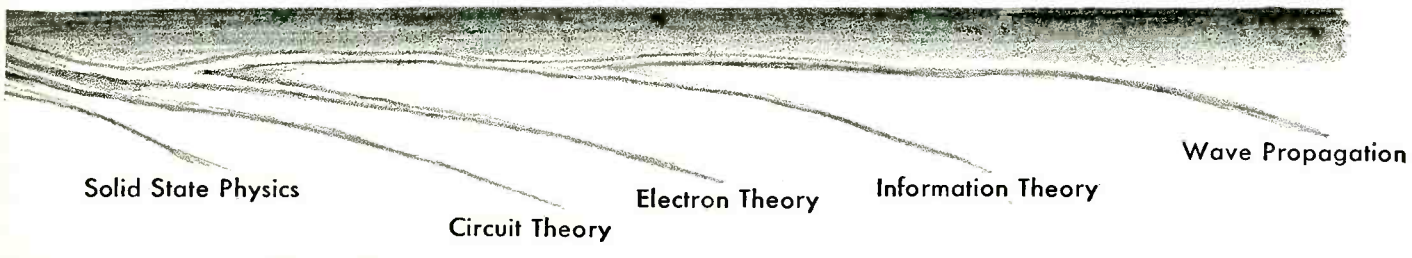
Industry

AERONAUTICS

Aircraft Vibration Analyzers
Airport Lighting Controls
Airspeed Indicators
Angular Rate & Displacement Indicators
Anticollision Radar
Automatic Pilots
Communication Systems
Electronic Regulators
Engine Analyzers
Fire Detection Systems
Flight Recording Units
Flight Trainers & Simulators
Fuel Flow Totalizers & Indicators
Horizon Indicators
Manifold Pressure Gages
Navigational Aids:
  Automatic Direction Finders
  Compass Locators
  Consol Systems
  Continuous Wave Navigation Systems:
    Decca
    Raydist
  Distance Measuring Equipment
  Flight Path Control Devices
  Fluxgate Compass Systems
  Flux Valve Compass Systems
  Gee Systems
  Gyromatic Compass Systems
  Gyrosyn Compass Systems
  Instrument Landing Systems
  Loran Systems
  Navaglobe Systems
  Omnirange Distance Systems
  Radio Direction Finders
  Radio Magnetic Indicators
  Radio & Radar Altimeters
  Radio Range Markers
  Rho-Theta Systems
  Teleran Systems
  Terrain Surveillance Systems
  VHF Omnidirectional Ranges
  Visual Aural Radio Ranges
  Zero Readers
Propeller Synchronizers
Radar Air Traffic Control:
  Airport Surface Detection Unit
  Airport Surveillance Radar
  Ground Control Approach
  Precision Approach Radar
  Traffic Delay Predictor
Radar Altimeter Surveyors
Telemetering Devices

BUSINESS MACHINES

Analog Computers
Analog-to-Digital converters
Bookkeeping Machines
Currency Counters
Differential Analyzers
Digital Computers
Electronic Information Handlers
Function Plotters
Memory Devices
Punched-Card Calculators
Tele-Identification Systems



Teleplotters

CERAMICS

Automatic Fuel Controls
Automatic Weighing Devices
Color Comparison Units
Dielectric Heating Units
Electronic Thermostats
Electrostatic Precipitation Units
Fire & Smoke Alarms
Flaw Detection Units
Furnace Controls
Grinding Mill Controls
Humidity Controls
Infrared Drying Units
Kiln Controls
Liquid Level Controls
Materials Handling Systems
Powder Level Controls
Process Controls
Radiation Pyrometers
Slack Controls
Temperature Recorders
Tile Sorting Devices

CHEMICALS

Analytical Instruments
Chemical Reaction Catalysis Equipment
Color Densitometers
Conveyor Controls
Counters
Cutoff Machine Controls
Diaphragm Valve Controls
Dielectric Heaters
Dust Measuring Equipment
Electronic Flow Meters
Electronic Manometers
Electronic Thermostats
Electronic Timer Controls
Emulsification Units
Filling Machine Controls
Flame Failure Safeguards
Foam Controls
Footage Totalizers
Gas Detectors
Gel-time Meters
Gloss Meters
Induction Heating Equipment
Industrial TV Systems
Inspection Devices
Label Cutoff Machines
Leak Detectors
Liquid Degassing Units
Liquid Level Controls
Liquid Metering Devices
Moisture Meters
pH Meters
Plastics Molding Press Controls
Smoke Indicators
Smoke Precipitation Units
Sorters
Weighing Equipment

ELECTRIC & POWER

Alarm Systems
Battery Chargers
Boiler Furnace (light off) Devices
Boiler Water Level Controls
Cathode Ray Synchroscopes
Carrier Current Controls
Circuit Breakers
Conductivity Meters
Electric Load Controls
Fault Detectors
Flame Failure Devices
Flowmeters
Frequency Conversion Units
Gas Analyzers & Detectors
Illumination Controls
Industrial TV Systems
Inverters
Motor Control Systems
pH Meters
Power Factor Meters
Rectifiers
Relays & Reactors
Servomechanism Devices
Smoke Stack Controls
Street Lighting Controls
Telemetering Devices
Thermocouples
Transients Analyzers
Voltage Stabilizers

ENTERTAINMENT

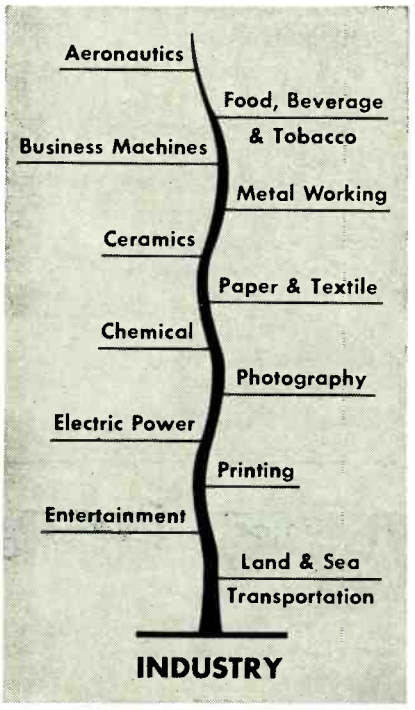
Carrier Current Equipment
Electronic Musical Equipment
Electrostatic Air Cleaners
Elevator Controls
Facsimile Systems
Fire Detectors
Humidity Controls
Illumination Controls
Intercommunicators
Limit Controls
Magnetic Recording Systems
Phonograph Recorders
Photoelectric Controls
Photoelectric Door Openers
Public Address Systems
Radio Broadcasting Systems
Radio Garage-Door Openers
Radio Receivers
Radio, Two-Way Systems
Recorder, Quantities
Remote Controls
Smoke Detectors
Sorters
Stage Lighting Controls
Television Systems
Temperature Controls
Timers

FOOD, BEVERAGE & TOBACCO

Chocolate Homogenization Units
Conveyor Jam Detectors
Counters
Egg Candling Units
Emulsification Units
Filling Machine Controls
Flame Failure Safeguards
Foam Controls
Food Dehydration Units
Food Grading Units
Food Preservation Equipment
Food Sorting Devices
Food Sterilization Equipment
Industrial TV Systems
Inspection Devices
Label Cutoff Machine Controls
Liquid Level Controls
Liquid Metering Devices
Metal Detectors
Microwave Cookers
Milk Homogenization Units
Moisture Meters
Packaging Machine Register Controls
pH Meters
Seed Sorting Units
Smoke Indicators
Sugar Indicators
Stroboscopes
Surface Analyzers
Tachometers
Ultrasonic Hops Extractors
Weighing Equipment
Wine & Spirit Ageing Equipment

METAL WORKING

Arc & Electric Furnace Controls
Automatic Fuel Controllers
Capacitive Micrometers
Conductivity Meters
Conveyor Jam Detectors
Counters
Creep Testing Equipment
Cutoff Machine Controls
Dielectric Core Baking Ovens
Dilatometers
Electron Drills
Electronic Comparator Gages



Flame Failure Safeguards
Flaw Detectors
Foundry Ladle Pouring Controls
Gas Cutting Controllers
Grinding Machine Controls
Grinding Tolerance Warning Devices
Heat Treating Furnace Controls
Height Indicators
Honing Machine Controls
Hot Strip Mill Width Gages
Hydraulic Press Controls
Induction Brazing Units
Induction Heat Treating Units
Induction Soldering Equipment
Industrial TV Systems
Machine Controllers
Machine Safety Controls
Machine Tool Contour Controls
Metal Detectors
Metal Fatigue Testing Units
Motor Controllers
Oil Mist Precipitators
Oven Conveyor Alarms
Paint Spray Gun Controls
Punch Press Protection Systems
Radiation Pyrometers
Radiographic Inspection Units
Rolling Mill Controls
Scales
Sheet Metal Footage Totalizers
Smoke Indicators
Sorters
Steel Mill Drives
Strain Recorders
Stroboscopic Frequency Meters
Surface Analyzers
Synchro Indicators & Controls
Temperature Recorders
Tension Controls
Thickness Gaging Systems
Tinplate Reflow Machines
Tracing Devices
Ultrasonic Metal Cleaning Units
Ultrasonic Metal Drilling Units
Ultrasonic Soldering Irons
Ultrasonic Tinning Pots
Variable-Speed Drives
Weld Inspection Equipment
Welding Controllers

PAPER & TEXTILE

Counters & Sorters
Cutoff Machines
Electronic Colorimeters
Footage Totalizers
Humidity Controls
Hydraulic Press Controls
Infra-red Drying Units
Liquid Level Controls
Liquid Metering Devices
Metal Chip Detectors
Paper Hole & Flaw Detectors
Printing Controls
Seam Detectors
Shearing Machine Controls
Side Position Regulators
Smoke Detectors & Indicators
Tenter Hook Guides
Thickness Measurement Devices
Thread Break Indicators
Ticketing Machine Controls
Towel Racking Machinery
Web Guide Controls
Winding Controllers
Yarn Irregularity Gages
Yarn Tension & Speed Controls
Yarn Torsion Measurement Units

PHOTOGRAPHY

Automatic Exposure Controls
Film & Emulsion Processors
Color Film Printing Machines
Darkroom Exposure Meters
Densitometers
Electronic Photoflash Equipment
Electronic Printers
High-Speed Cameras
Light Flux Meters
Microphotometers
Oscilloscope Recording Cameras
Photoelectric Aperature Controls
Sound Movie Cameras
Sound Movie Projectors

PRINTING

Electronic Halftone Engravers
Electronic Stencil Cutters
Electronic Typesetters
Photoelectric Register Controls
Photoelectric Web Controls
Printing Press Speed Controls

LAND & SEA TRANSPORTATION

Automotive:
- Battery Chargers
- Cavitometers
- Dynamometers
- Electrostatic Paint Sprayers
- Engine Cam Contour Inspection Units
- Engine Detonation Indicators

Engine Test Stand Devices
- Fuel Evaluation Units
- Headlight Dimmer Control
- Ignition Monitors
- Mobile Telephone Units
- Radiator Soldering Units
- Road Testing Equipment
- Spark Plug Testers
- Tire Tread Noise Analyzers
- Traffic Speed & Signal Controls
- Ultrasonic Tire Testers

Marine:
- Autoalarm Equipment
- Depth Sound Equipment
- Direction Finding Equipment
- Gyro Compasses
- Loran
- Radar Navigation & Surveillance
- Radio Navigational Aids
- Radio Telegraph Equipment
- Radio Telephone Equipment
- Ship-to-Shore Radio
- Sonar

Railroad:
- Automatic Train Controls
- Block Signal Controls
- Closed TV Systems
- Communication Systems
- Rail Fault Detectors
- Signalling Equipment
- Train Makeup Systems
- Train-position Indicators

Communications

RADIO BROADCASTING

Amplitude Modulation
Frequency Modulation

RADIO COMMUNICATION

Air-to-Ground
Amateur, Citizen, Civil Defense
Disaster, Fire
Forestry, Highway
Microwave Relay Transmission
Military
Mobile Communication
Point-to-Point Communication
Police
Ship-to-Shore
Traffic Controls

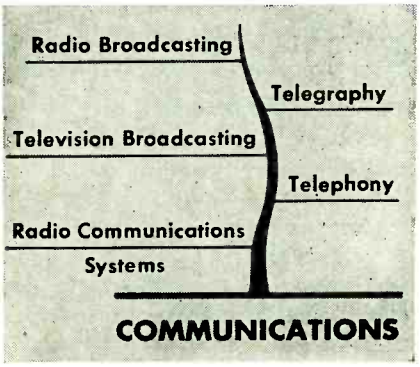
TELEGRAPHY SYSTEMS

Carrier Telegraph
Electronic Multiplexers
Radio Telegraphy
Telegraph Printers
Underwater Cable Repeaters

TELEPHONY

Carrier Current Equipment
Power Line Carrier
Sound Powered Telephones
Intercommunication Systems:
- Hospitals, Hotels, Offices
- Schools, Stores

Radio Telephony Systems:



Airliner, Auto, Ship, Train
Telephone Repeaters
Transoceanic Radio Telephony
Facsimile Systems
Magnetic Recording Systems
Public Address Systems
Signalling Devices
Telemetering Systems
Teleplotters, Teleprinters
Telescribers

TELEVISION BROADCASTING

Black & White
Color
Television Relay Systems
Video Tape & Film Recording

Science

ACOUSTICS

Electronic Organ
Noise Level Meters
Sonographs
Sound Analyzers
Sound Level Meters
Sound Recorders
Sound Spectrographs
Stroboscopic Spectrometers
Ultrasonic Generators
Ultrasonographs

ASTRONOMY

Cosmic Ray Measuring Units
Crystal Clocks
Galactic Radio Wave Receivers
Ionosphere Sounding Equipment
Meteor Tracking Equipment
Moon Radar Systems
Photoelectric Photometers
Radio Telescopes
Solar Radio Wave Receivers
Sun Spot Measuring Equipment
Telescope Servo Drives

BIOLOGY

Bacteria Destruction Devices
Bioelectric Amplifiers
Cardiotachometers
Electron Microscopes
Electron Sterilizers
Historadiographs
Oscilloscopes & Oscillographs
Pneumotachographs
Recording Photofluorometers
Spectrophotometers
Ultrasonic Tissue Disintegrators

CHEMISTRY

Analytical Balances
Colorimeters & Turbidimeters
Conductivity Meters
Electroanalyzers
Electrometers
Electrometric Titrimeters
Electron Diffraction Equipment
Electron Microscopes
Electronic Recorders
Fluorimeters
Gas Analyzers
Leak Detectors
Mass Spectrometers
Mercury Vapor Detectors
pH Meters
Polarographs
Spectrographs
Spectrophotometers
Spectroscopes
X-Ray Diffraction Equipment
X-Ray Photometers

CRIMINOLOGY

Infrared viewers
Lie Detectors
Projectile Velocity Measuring Devices
Spectroscopy
X-Ray Analyzers

GEOPHYSICS

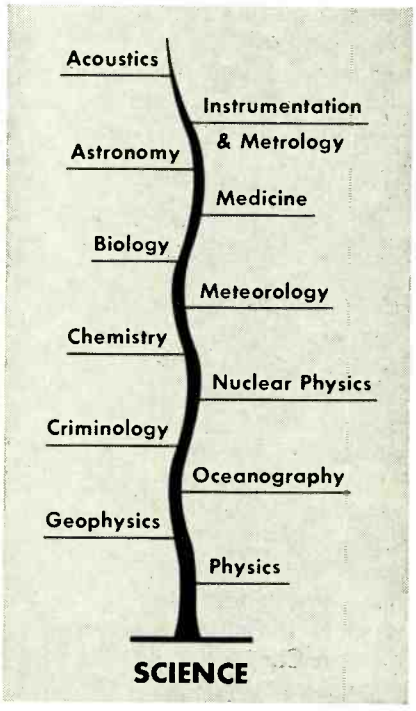
Airborne Profile Recorders
Earthquake Recording
Gauss Meters
Geiger-Mueller Counters
Geophysical Prospecting:
Radar Mapping
Radio Surveying
Magnetic Airborne Magnetometers
Metal Locators
Oil Drilling Rig Brakes
Scintillometers
Well Logging Equipment

INSTRUMENTATION & METROLOGY

Acceleration Measurement Units
Amplifiers, Analyzers
Attenuators, Barreters
Autometers (Dust Pollution)
Bolometers, Calibrators
Chronographs
Chronoscopes
Comparators
Counters, Detectors, Meters
Decibel Level Instruments
Delay Lines
Displacement Measurement
Elapsed Time Meters
Electronic Fringe Interpolators
Electronic Gages
Electronic Timers
Frequency Changers
Frequency Standards
Humidity & Moisture Measurement Units
Integrators, Modulators
Noise Measurement Equipment
Oscilloscopes
Power Supplies
Pressure Measurement Devices
Quartz Clocks
Radar Signal Spectrographs
Radio Time Signal Systems
Recorders, Monitors
Regulators
Signal Generators
Signal Tracers
Stress-Strain Measurement Units
Stroboscopes, Synchroscopes
Tachometers
Temperature Measuring Units
Thermocouples, Rectifiers
Time Intervalometers
Tuners, Indicators, Bridges
Vacuum Measurement Units
Velocity & Flow Measurement Equipment
Vibration Measurement Devices
Watch Rate Recorders

MEDICINE

Acoustic Stethoscopes
Anesthesia Control Equipment
Anoxia Photometers
Ballistocardiographs
Betatron Therapy
Blood Conductivity Meters
Blood Pressure Recorders
Blood Sterilizers
Bone Density Computers
Chronaximeters
Cine-Radiographers
Corticle Stimulators
Dermal Radiometers
Echoscopes (Ultrasonic diagnosis)
Electrocardiagraphs
Electrocauterizers
Electrocoagulation Units
Electrodesiccation Units
Electroencephalographs
Electrofulguration Units
Electrohysterographs



Electromyographs
Electron Microscopes
Electronic Cane (for Blind)
Electronic Depilation Devices
Electronic Fluoroscope
Electronic Polyneumographs
Electropsychometers
Electroretinographs
Electrosedative Generators
Electroshock Machines
Electrosurgical Units
Fluoroscopes
Gastromanometers
Heart & Brain Wave Analyzers
Hemoglobinometers
Ionization Therapy Equipment
Medical Audiometers
Neurostimulators
Oximeters
pH Meters
Phono Electrocardioscopes
Photoelectric Hemoglobinometers
Photoelectric Plethysmographs
Pneumotachographs
Psychogalvanic Reflex Indicators
Psychogalvanometers
Sanguinometers
Scintillation Counters & Detectors
Stethographs & Stethophones
Sudomotometers
Surgeon's Metal Locators
Thermostromuhr Apparatus
Ultrasonic Therapy Units
X-Ray Diagnosis & Therapy Units
X-Ray Intensity Meters

METEOROLOGY

Acoustic Anemometers
Cloud Height Measurement Equipment
Computers
Electronic Psychrometergraphs
Flood Warning Systems
Hygrometers
Radar Storm Warning Equipment
Radioactive Snow Gages
Radiosondes, Rawinsondes
Rotating-Beam Ceilometers
Sunspot Noise Measurement Equipment
Water-Level Telemetering Units
Wind-Finding Radar Systems
Wind-Run Indicators

NUCLEAR PHYSICS

Atomic Clocks
Betatrons, Bevatrons
Capacitrons
Cosmotrons
Counting Rate Meters
Cyclotrons
Electrometers
Electrostatic Generators
Geiger Counters
Ionization Chambers
Linear Accelerators
Omegatrons
Proportional Counters
Proton Synchrotrons
Radiation Meters
Remote Television Manipulators
Scalers
Scintillation Counters
Synchrocyclotrons
Synchrotrons

OCEANOGRAPHY

Echo Depth Recorders
Hydrographic Surveyors
Iceberg Detection
Ocean Depth Indicators
Ship-to-Shore Radio
Underwater Gaussmeters
Water Height Recorders
Wave Pressure Recorders

PHYSICS

Absorptiometers
Bolometers
Densitometers
Electrometers
Electron Micromanometers
Electroscopes
Infrared Spectrometers
Mass Spectroscopes
Microwave Spectroscopes
Photoelectric Interferometers
Photometers
Pyrometers
Radiometers
Scintillation Spectrometers
Spectrophotometers
Thermopiles
X-Ray & Radiology Equipment

Military

ACOUSTICS

Echo Ranging Sonar
Hydrophone Equipment
Sonobuoys

FIRE CONTROL

Control Systems
Gun Ranging Systems

MINES

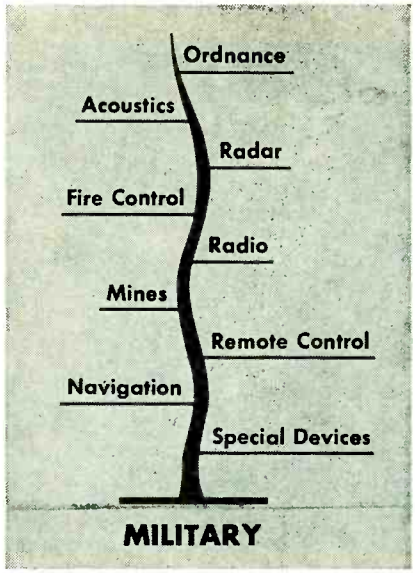
Acoustic Mines
Degaussing Equipment
Detectors
Detonators

NAVIGATION

Bombing Systems
Flight Simulators
Loran
Sofar Systems
Navigational Aids
Naval

ORDNANCE

Gun Barrel Crack Detectors
Projectile Velocity Measuring Equipment



Ultrasonic Rocket-powder inspection

RADAR

Anti-Jamming Equipment
Automatic Tracking
Defense Systems:
Air Interception
Ground-Controlled Interception
Gun Directors
Height Finders
IFF Systems
Jamming Devices
PPI Repeaters
Search Systems

RADIO

Airborne Communication Systems
Anti-jamming Equipment
Ground Communication Systems
Jamming Devices
Radio-Controlled Drones
Radio-Controlled Tanks
Shipborne Communication

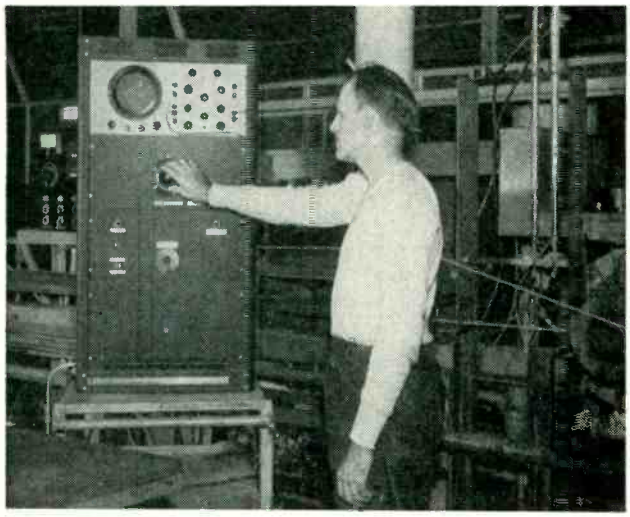
REMOTE CONTROL

Guided Bomb Controls
Guided Missile Controls
Rocket Controls
Searchlight Controls
Telemetering Systems
Torpedo Control Devices

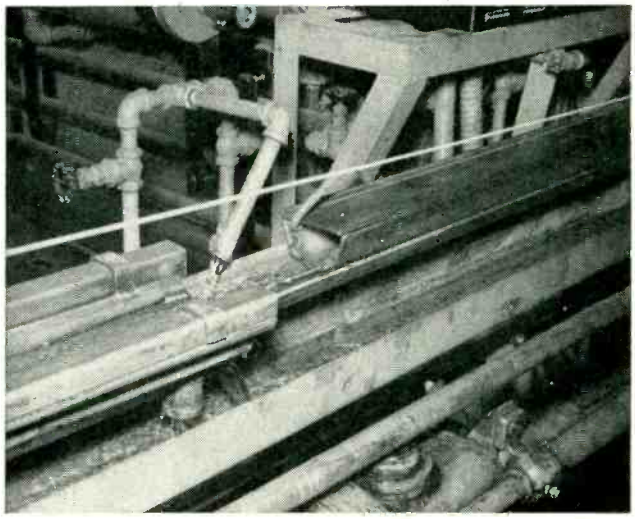
SPECIAL DEVICES

Countermeasure Devices
Electronic Code Machines
Homing Devices (target seekers)
Proximity Fuzes:
Rescue Devices
Sniperscope & Infrared Devices

Some items of electronic equipment such as tube testers, vtvm's and so forth are used under every classification and have therefore not been listed—*The Editors.*



Operator merely sets dial to desired micromicrofarads per foot



Insulated conductor emerging from capacitance-sensing electrode

Controlling Extrusion

SUMMARY —— Capacitance of expanded plastic insulation on wire is maintained constant by running output of extruder through liquid electrode connected into a-c bridge circuit. Associated control circuit acting with servo varies wire speed to achieve uniform product

By R. D. GAMBRILL

Development Engineer
Western Electric Co., Inc.
Baltimore, Md.

IN THE MANUFACTURE of telephone cables, capacitance to ground, equal capacitance of a pair of wires to other pairs as well as uniform distributed capacitance to the cable sheath are important to minimize interferences to transmission.

The capacitance between the metallic conductor and the outside of the insulation of the individual conductors should be held as constant as possible. With solid dielectrics, the diameter of the insulation is quite precisely related to the capacitance so that either diameter or capacitance gaging may be used.

With the new expanded plastic insulations, however, neither diameter nor weight measurements or a combination of these two have a suitably precise relationship to capacitance because the percentage of gas and the size and distribution of the gas cells are factors in determining capacitance. It was necessary, therefore, to develop a means of continuously measuring the conductor capacitance and automatically controlling the extrusion of the expanded plastic insulation to hold capacitance within limits.

The system used, shown in Fig. 1, utilizes a special sensing probe as one arm of a capacitance bridge which is normally balanced with respect to a 10-kc oscillator signal. The oscillator output is then compared with the bridge unbalance on an oscilloscope and in a mixer which determines the directional error. The output of the mixer is amplified to control a servo-motor-driven rheostat, which in turn controls a variable-speed drive mechanically coupled to the wire-pulling capstan. The speed of the wire as it leaves the extruder is varied to hold capacitance within limits.

Details of Circuit

The measuring circuit consists of an equal-ratio-arm bridge with oscillator and detector connected across the diagonals of the mesh. The sensing electrode is connected across one of the lower arms and a calibrated variable capacitor is connected across the opposite arm. Two conductance arms comprise the remainder of the bridge.

The sensing electrode is a measured length of special water trough, permitting water to make contact around the periphery of the insulation to form one side of the unknown capacitor. The metallic conductor is grounded at the extruder wire supply stand to form the other side. The oscillator is a phase-shift type utilizing a single 6AU6. A 6L6 beam-power tube steps up oscillator power to the remainder of the circuit through a transformer.

The output from this transformer feeds directly to the bridge and to the d-c bias control, and feeds through a phase-shifting network to a grid of the 6J6 mixer tube and to the X-amplifier of the cathode-ray oscilloscope.

By deriving all of these voltages

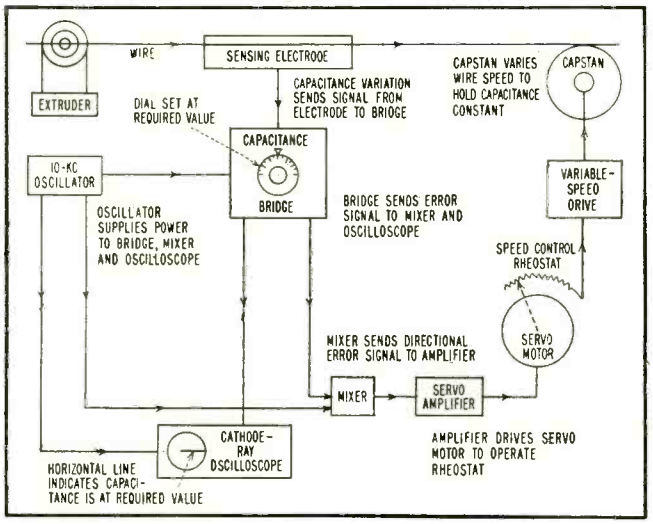


FIG. 1—Method of measuring and controlling wire capacitance

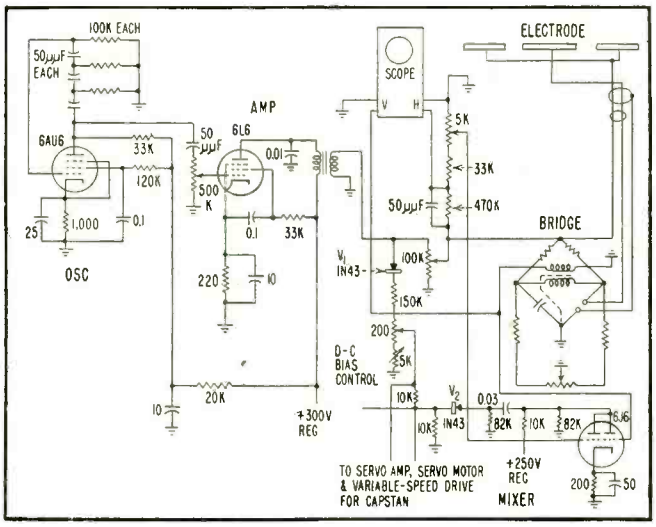


FIG. 2—Capacitance-sensing circuit used to drive servo amplifier

# of Foam Plastic on Wire

from the oscillator, the effect of variations in oscillator voltage is minimized. When an unbalance in the bridge occurs, the voltage appears across the primary winding of the bridge transformer and is stepped up by the transformer and fed to a second grid of the 6J6 mixer tube and also to the Y-amplifier of the cathode-ray oscilloscope.

The output of the mixer will then be the algebraic sum of the instantaneous oscillator and bridge unbalance voltages, so that there will either be an increase or decrease in the a-c component of the 6J6 plate current, depending on the direction of bridge unbalance. This a-c component is then rectified by crystal diode V_2 to provide a d-c signal to ground. This d-c voltage is biased by another d-c signal which is derived by rectifying a portion of the oscillator voltage through crystal diode V_1 and applied across a 200-ohm potentiometer in series with a 5,000-ohm variable resistance. These latter two resistances were initially adjusted until the voltage across the 10,000-ohm converter input resistor was zero with the bridge balanced. Then the voltage across this 10,000-ohm resistor will be positive for one direction of unbalance and negative for the opposite direction of unbalance. Any bridge unbalance will then result in a polarized d-c signal being fed into the standard converter servo amplifier, so as to energize one phase of a two-phase servo motor and thus cause the motor to run in one direction if high capacitance is indicated and in the opposite direction for low capacitance.

The servo motor drives a rheostat through a gear reduction and a slip coupling so as to vary the grid voltage of a control tube in a variable-speed drive to change the speed of the take-up capstan motor.

The X-amplifier of the cathode-ray oscilloscope is fed a voltage derived from the oscillator shifted in phase to give a horizontal line when the bridge is balanced and to point upward or downward, depending upon the direction of unbalance. Should any failure of the insulation occur, the oscilloscope will show an elliptical pattern.

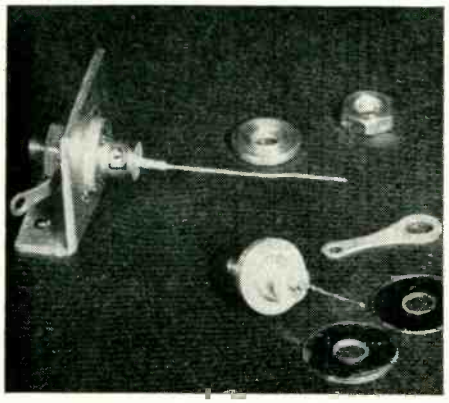
Since the indicator and controller circuits are substantially independent of each other, the indicator provides a continuous check on the controller operation and informs the operator as to when automatic operation may be begun after starting.

All of the panels of the capacitance indicator-controller are electrically interconnected by means of plugs and jacks so that the panels may be readily removed and replaced with spares should any failures develop.

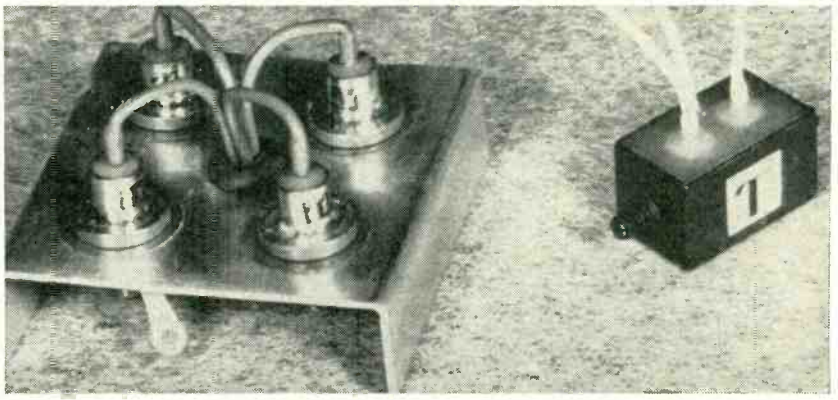
Operating Procedure

The extruder is started and the capacitance indicator-controller is turned on, with the AUTOMATIC-MANUAL control in the MANUAL position. The dial of the calibrated capacitor is set to the desired number of μμf per foot and the manual controls of the extruder are operated until the horizontal line pattern is indicated on the oscilloscope. The AUTOMATIC-MANUAL control is then switched to AUTOMATIC, connecting in the second-phase winding of the servo motor so that capacitance will be automatically controlled. Should anything develop within the process to cause the controller rheostat to run to its maximum position, the slip coupling will function and a cam will operate a switch to light a panel lamp, calling the operator's attention to the condition so that he may take the proper corrective action. A dial is provided on the front of the panel to indicate the position of the rheostat to the operator; under normal operating conditions this dial will indicate only limited variations.

Silicon Power Rectifiers



THE FRONT COVER—Single power rectifier cells undergoing tests appear as shown here before and after mounting



Four-unit full-wave bridge assembly shown approximately actual size at left. Low-current full-wave double-diode assembled in potted case at right occupies only ¼ cubic inch

SUMMARY —— Tiny single-cell units having large-area alloy-type junctions give up to 98 percent efficiency at 400 v peak inverse voltage, permitting construction of miniature rectifiers operating directly from a-c line at ambient temperatures up to 125 C. Low inverse currents improve sensitivity and stability in magnetic amplifier applications

THEORY SHOWS that silicon rectifiers can operate at current densities 1,000 times higher than those customary with copper-oxide and selenium rectifiers, and with much better forward and inverse characteristics. This promise of improved practical devices has been realized in new silicon power rectifiers having alloy-type junctions.

Present production of the silicon power rectifiers described here has been concentrated on units designed for currents of 100 ma to 1 amp and inverse voltage of 100 to 600 v. The 400-v cells, which thus withstand an inverse voltage of 135 v rms each, can be operated directly from the 117-v power line with either inductive or capacitive loads and filters.

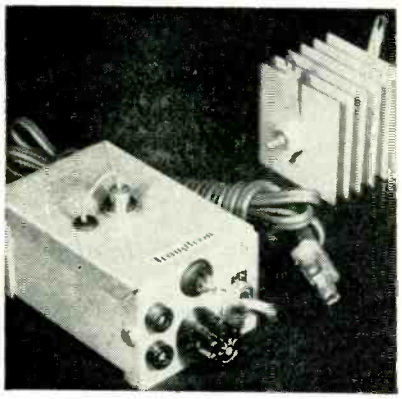
Dry-disk rectifier cells such as selenium are excellent for ratings up to about 36 v rms. This is equivalent to about 100 v d-c inverse voltage. Such units must be considerably derated above 85 C, however, and have short life under these conditions. Customarily 5 to 6 cells are put in series to provide a 135-v rms rectifier stack, and these have forward voltage drops 5 to 6 times the value of a single cell, with efficiencies of around 70 percent.

Germanium power rectifiers have shown many advantages at room temperature, where they have good forward and inverse characteristics. However, it is difficult to manufacture single cells with peak inverse voltages exceeding 65 v rms. Germanium power rectifiers must be considerably derated above 55C, and generally cannot operate above 75C at any power level. In contrast, the silicon rectifiers here described will handle useful power levels at 125C and will, with further development, be capable of operating at 200 C. Other silicon rectifiers, not yet in quantity production, can operate at currents of hundreds of amperes or at voltages up to several thousand volts.

The heart of the new rectifier is a wafer of single-crystal silicon less than ⅛-inch square, having contacts fused to either side. As shown in Fig. 1, one side of the silicon wafer has a fused aluminum alloy contact. This provides the semiconducting barrier which determines the properties of this junction rectifier. A soldered contact is made to the other side of the silicon wafer, the sandwich is soldered to a copper base and an anode lead is attached to the aluminum. A Kovar hermetic seal is placed over the copper base and the unit is sealed together. Hermetic sealing has been found preferable to plastic filling, as the slightest contamination can give leakage currents. In fact, unless the unit is very carefully cleaned, washed and dried during processing, the minute leakage due to contamination would provide shorter life than the thousands of hours to which such units have already been subjected.

Since the copper base provides

for A-C Line Operation



Complete miniaturized power supply, with single silicon rectifier cell on top. Equivalent dry-disk stack is at right

By GUNTHER RUDENBERG

Director of Research and Development
Transitron Electronic Corp.
Melrose, Massachusetts

heat conduction in addition to serving as the cathode connection to the silicon, the base should be mounted firmly either on a chassis or a bracket. This can be done by means of thin, large-area mica insulators, arranged as in Fig. 2. These mica washers offer a low resistance to the flow of heat but are excellent electrical insulators. Alternately, a cooling fin may be mounted on the stud projecting from the copper base to provide for convection cooling.

Electrical Characteristics

The 1N341 silicon power rectifier has been designed for power applications in medium-power rectifiers and in magnetic amplifiers, as shown in Fig 3. The forward characteristics are relatively unaffected by temperature in the useful medium-current and high-current ranges, where the voltage drop is a few volts at an ampere. Only at very low currents is the effect of temperature appreciable. In most cases this amounts to a forward drop reduced by 22 mv for every 10C rise in temperature.

At currents in the 1 to 10-amp range, the forward characteristics vary among units. Some show a slight rise of forward resistance due to the increase of resistivity with increase in temperature. Others show a reduction of forward resistance due to an increase of injection depth at the junction at increased temperatures. No aging of the amount experienced with dry-disk type rectifiers has yet been found on these silicon rectifiers.

The inverse characteristics show clearly one outstanding feature of all silicon rectifiers, namely, the increase of breakdown voltage with increased temperature. This amounts to a 10-percent increase in breakdown voltage for a 100C increase in temperature, which is more than sufficient to allow the same peak inverse voltage ratings for a hot rectifier as for operating at room temperature. The fact that the peak inverse voltage does not have to be reduced with increasing temperature is an important practical property of silicon power rectifiers. The absence of any appreciable inverse leakage current increases the posible output voltage in rectifier applications.

The inverse currents of good silicon devices are extremely small, but increase exponentially with temperature. The initial inverse currents at room temperature are the order of fractions of a microampere, so that even at 125C, many units show inverse currents less than 100 μa at inverse voltages of several hundred volts. Such leakage currents are small enough to be completely negligible for rectifiers operating at a 100 to 1,000-ma level.

Certain types of silicon power rectifiers, such as the type 1N332, carry additional specifications on the averaged inverse current. Such specifications would be preferable for applications such as magnetic amplifiers, where maximum inverse current determines the limits of amplifier stability and gain.

Rectifier Applications

With a bridge circuit comprising four type 1N343 300-v rectifier cells operating directly from the 115-v a-c line, the no-load, unfiltered output voltage of 102 v drops only to 97 v with a 1-amp load and to 94 v at 2 amp, as shown in Fig. 4. The peak voltage drop from the bridge is thus quite small, so that the regulation due to the rectifier bridge is excellent. With practical filter cir-

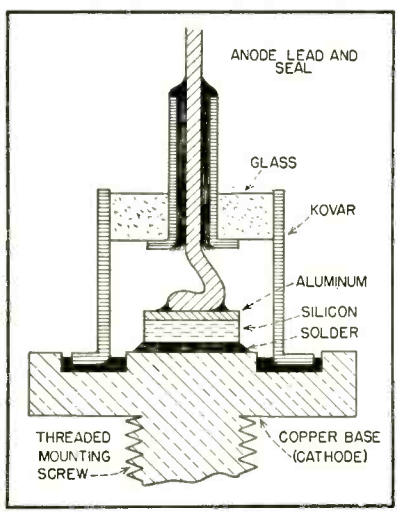


FIG. 1—Cross-section of new hermetically sealed silicon power rectifier cell. Diameter is only ½ inch

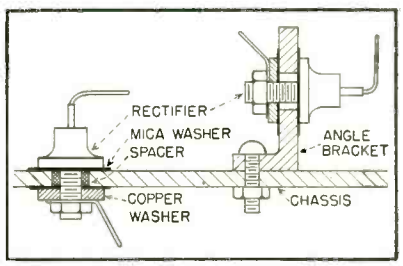


FIG. 2—Cell may be mounted directly on chassis as at left or on bracket

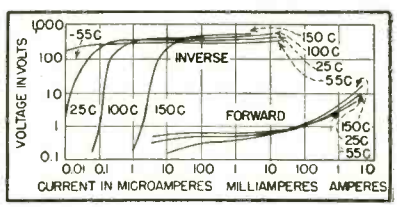


FIG. 3—Voltage-current characteristic of typical 1N341 unit at different ambient temperatures

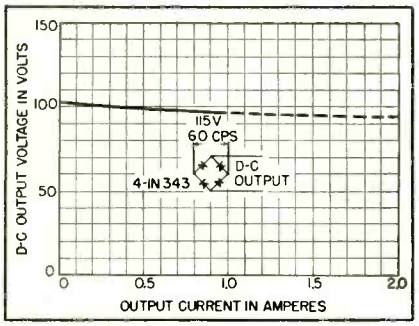


FIG. 4—Output voltage of bridge circuit having resistive or inductive load

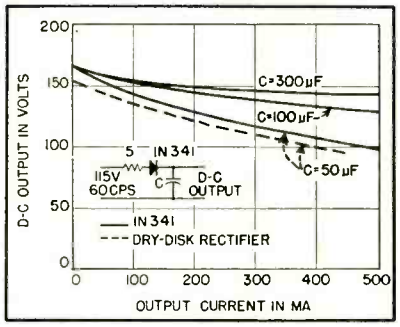


FIG. 5—Regulation characteristic of half-wave arrangement

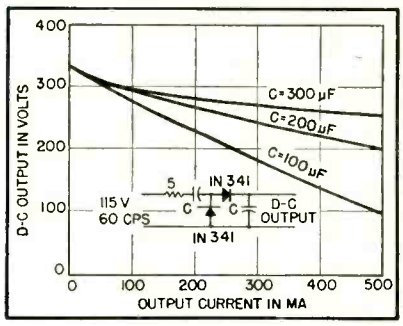


FIG. 6—Regulation of voltage-doubler arrangement using capacitor-input filter

cuits and transformers, however, the internal resistance of the transformer and filter choke would result in an additional voltage drop.

Of considerable interest for direct line voltage operation are the half-wave rectifier of Fig. 5 and the voltage doubler of Fig. 6, using type 1N341 units. In both cases the rectifier output approaches the theoretical ideal for a high-capacitance capacitor-input filter. The internal resistance of these silicon power rectifiers is so low that a surge-limiting resistor (5 to 15 ohms) must be placed in series with the power source to reduce capacitor surge currents to safe values when the rectifier is switched on.

Heat Sink Mounting

The electrical efficiency of silicon rectifiers is extremely high, even at low current levels. This is due to the almost complete absence of inverse dissipation at voltages below the peak inverse voltage. Figure 7 shows the efficiency of the rectifier in an unfiltered single-phase bridge circuit as a function of rated load current. Even at rated currents of the order of 1 amp where 100 watts of output power are supplied, the efficiency is still as high as 94 percent. This means that the units in the bridge circuit of Fig. 4 dissipate 6 watts, or 1.5 watts each, and it is necessary that this power be conducted through the copper base of the silicon unit without exceeding the maximum junction temperature of 150C. For a unit of such small physical size, this requires that it be mounted on a good thermal conductor such as an aluminum chassis of reasonable area, or on a well-designed fin to provide adequate convection.

Various mounting alternatives have been developed to provide adequate cooling for such rectifiers. Properly mounted, a bridge circuit can supply loads of 100 watts even at ambient temperatures as high as 125 C. Proper mounting of the silicon power rectifiers is a thermal problem which closely affects the electrical dissipation permissible with these rectifiers.

An idealized maximum power rating has been determined which refers to the rectifier mounted on what is called an infinite heat sink. This means a plate of large thermal conductivity held at the ambient temperature referred to by means of any satisfactory cooling method such as an air blast or a liquid. Under these conditions the rectifier will dissipate a power determined by the outside case temperature (the same as that of the infinite heat sink) and a maximum allowable junction temperature, in this case 150C.

Since the internal temperature drop of 1N341 silicon power rectifiers is well under 10 degrees per watt, a derating curve as shown in Fig. 8 is readily obtained. This curve shows the absolute maximum power dissipation permissible as a function of case temperature.

For use with practical dissipating structures, such as fins or brackets or direct connection to a chassis, the thermal power conducted away by such a mounting structure under the external ambient conditions will set the rectifier case temperature and therefore the internal dissipation allowable for each condition.

An L bracket used with mica washers on a $\frac{1}{8}$-inch-thick aluminum chassis 6 inches square reduces the ratings to one-half. The thermal resistance of the bracket is 6 deg per watt, and that of the chassis is 4 deg per watt. However, when maximum power output is required, it is usually better to design a thermal path and heat sink best suited to the application. The thermal resistance of the mounting structure in degrees per watt is added to the thermal resistance of the rectifiers, and from this the permissible power rating is obtained for an allowed junction temperature rise to 150 C.

Production Test Method

Assembled rectifiers are measured for direct current specifications and temperature-tested. It seemed desirable to set up a load test which could regularly be used as a production test on completed rectifiers. However, even at present production rates, simple load resistors would absorb considerable power, all of which would be dissipated as heat.

A simulated load test has been developed with a synchronous switch operating from the 60-cycle power line. During half of the 60-cycle alternating current, forward voltage is supplied to the rectifier under test as shown in Fig. 9, from a low-voltage high-current transformer, and the average load current is measured on an ammeter.

During the second half-cycle, this forward transformer is switched off and inverse voltage is applied through the same switch from a high-voltage, low-current transformer. The inverse characteristic is generally observed on an oscilloscope, although it could readily be measured on other test instruments. As a result, the two transformers need supply only the internal losses of the rectifier, yet the load tester simulates a high-power resistive

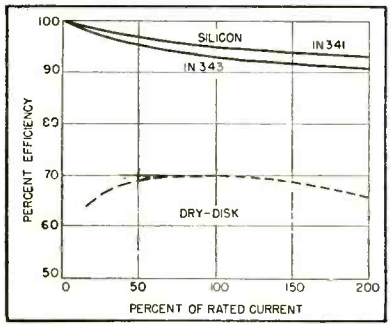


FIG. 7—Variation of efficiency with rated current for full-wave bridge

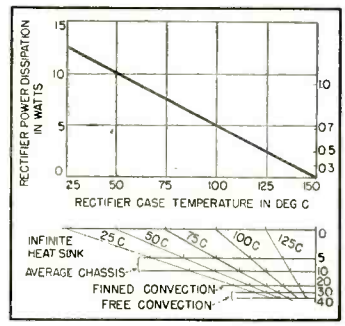


FIG. 8—Curves below represent ambient temperature of heat sink

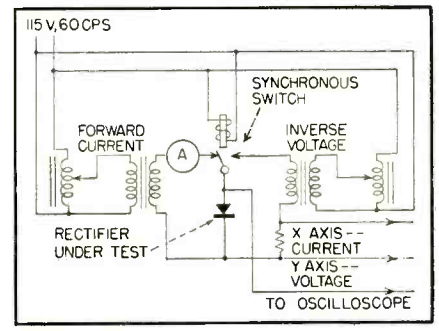


FIG. 9—Production test circuit for silicon power rectifiers

load of specified forward current and inverse voltage. Both these parameters can be separately adjusted by autotransformers and are set to the specifications of the various units of rectifiers in production.

In addition to these tests, some life tests have been in progress since the first units were manufactured over a year ago. Circuits using capacitive filters have been switched on and off every day in order to determine the life of the rectifier cells under normal operating conditions. A miniaturized rectifier employing a half-wave circuit with a 50-μf filter capacitor has been in operation for over a year, supplying 120-ma output current.

Magnetic Amplifier Applications

The extremely low inverse currents up to nearly the full breakdown voltage make this silicon power rectifier attractive for magnetic amplifier applications. A self-saturated magnetic amplifier uses a pair of rectifiers in a positive feedback circuit, so that the leakage current of these rectifiers is equivalent to a signal or control current. The sensitivity and stability of such a self-saturated magnetic amplifier can be limited by the maximum rectifier leakage currents.

For silicon power rectifiers operated somewhat below their inverse breakdown voltage, this leakage current amounts to only a few microamperes at excursions of several hundred volts. Considerably improved performance can be obtained from magnetic amplifiers utilizing these silicon power rectifiers. As the forward and inverse characteristics of the 1N341 are specifically designed for 117-volt power supplies, the 1N333 through 1N340 are more suitable if low inverse leakage currents are important.

Conclusion

The d-c characteristics of new silicon power rectifiers show minute leakage currents and high inverse voltages. The inverse voltage ratings allow direct operation of a single cell from 117-volt a-c lines even with capacitive loads at ambient temperatures up to 250 F or 125 C.

Junction temperatures of 150 C are practical. Typical units rated for 135-volt maximum rms a-c input will deliver 150 ma in half-wave connection to capacitor-input filters at 125 C. Similarly a typical bridge circuit will deliver 800 ma to a choke-input filter at 125 C or 1.5 amperes at room temperature.

Performance data on rectifier circuits, such as voltage doublers, choke input rectifiers and bridge circuits, show excellent regulation due to low internal resistance of the silicon rectifier cells, and due also to the fact that a single cell, rather than a large series stack, is used. With rectifiers of such low forward voltage drop, some surge current protection is needed for direct line voltage operation. A few ohms of source or filter impedance are generally sufficient, so that this restriction does not affect regulation with capacitor-input filters. With choke-input filters, regulation is excellent.

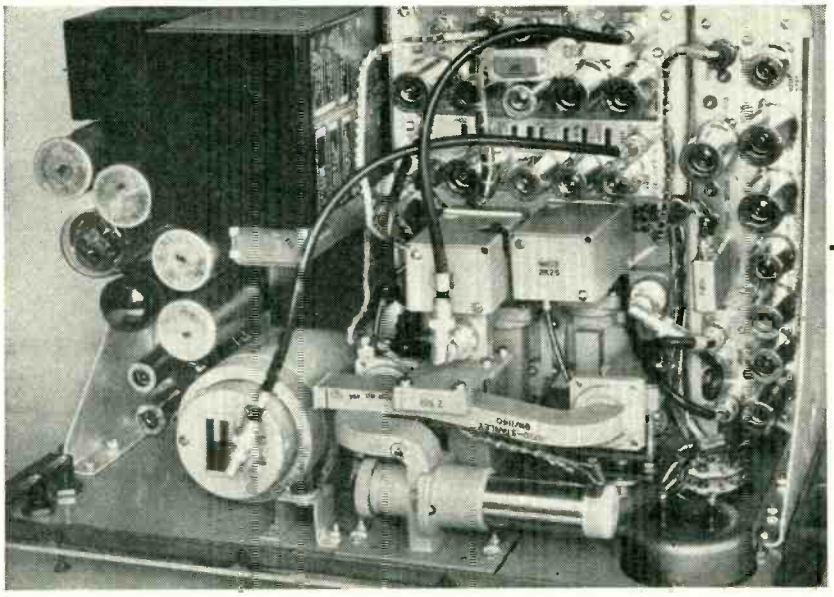
Both series and parallel operation of these rectifier cells is feasible. Series operation is safe because the sharp voltage breakdown characteristic prevents over-volting one of a series of units. Parallel operation requires a slight selection of units to avoid serious unbalance of current between paralleled units.

Rectifier test methods have been devised to allow testing silicon power rectifiers on the production line at full rated cell power without dissipating ten to fifty times that power into a resistive load. The test circuit applies separate forward and inverse voltages and currents to simulate operation at full power output. Cooling problems are solved in many cases by chassis mounting through a copper stud. In other cases finned units can be air-cooled from a blower, or convection-cooled in still air. In all cases, the high efficiency of these rectifiers reduces the surface required for cooling over that required for less efficient rectifiers supplying similar loads.

Operation of the power rectifiers in electronic equipment having high ambient temperatures requires considerable care to provide for adequate dissipation of the power losses in the rectifiers. Some increase of the 125C rating is possible for room temperature operation. The peak inverse voltage can be kept at full value throughout this temperature range. Since the difference between the ambient temperature, the rectifier case temperature and the internal rectifier junction temperature becomes important above 100C, tight mechanical and thermal contact and good heat flow must be designed into each application.

The rectifiers described here have been developed by Transitron Electronic Corp. Certain types are being perfected to military specifications for the Signal Corps Supply Agency of the United States Department of the Army.

Precision Calibrator



Top view of radar range calibrator shows quartz-crystal delay line at lower left in temperature-controlled oven. Radio-frequency head end at center

By R. DONALD SINISH
Staff Engineer
Farnesworth Electronics Co.
Fort Wayne, Ind.

RADAR RANGE is perhaps the most accurate information that can be obtained from present radar systems. In system calibration, extreme precision of the test equipment for measuring range is a necessary requirement. The radar range calibrator described in this article was developed to fulfill the need for a precision instrument and differs from previous designs. It includes internal circuits to allow the range calibration of beacon function in navigational radars as well as ordinary radar circuits.

The range calibrator operates essentially as a transponder. Input r-f pulses from the radar being calibrated are introduced either by connection to the directional coupler on the radar system or using the external pickup horn included in the test set. For each input pulse fed into the calibrator, a series of r-f pulses is fed back to the radar system. They are displayed as a series of artificial targets whose range is accurately controlled. In normal radar operation, the return pulses are at the same frequency as that of the radar transmitter. In beacon operation, the return pulses are at the nominal 9,310-mc frequency of X-band radar beacons.

The test equipment was designed to be operable with pulsed radar systems in the X band, having peak power outputs ranging from 5 to 250 kilowatts, pulse widths from 0.3 to 3.0 microseconds and pulse repetition rates from 300 to 3,000 pulses per second. Maximum input r-f power required for guaranteed accuracy is 35 microwatts average. At this input power level, the return r-f pulses are within 200 kc of the input r-f frequency and the beacon return is within ±2 mc of 9,310 mc.

The block diagram of the range calibrator is shown in Fig. 1. Microwave energy is introduced into the input waveguide. A portion of this power is taken through a 30-db directional coupler and introduced into the afc mixer where it is combined with the output of the radar local oscillator. The radar local oscillator is tuned 40 mc below the input radar frequency.

Unit Functions

A variable 65-db attenuator permits setting level of the input radar r-f power to the afc mixer to prevent saturation of the mixer crystals. The two mixer crystals are types 1N23C and 1N23CR. Use of the reversed-polarity crystal permits a push-pull input to the radar afc chassis with the same configuration of the crystal holders.

The afc chassis generates the afc error voltage to maintain the fre-

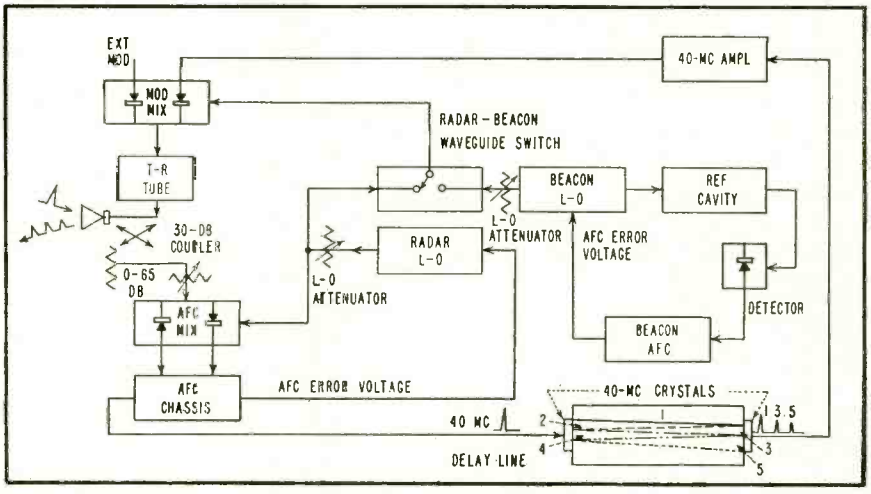


FIG. 1—Overall interconnection of range calibration equipment

Checks Radar Beacons

SUMMARY —— Radar-ranging and beacon-return effectiveness depend upon precision of field calibration. Portable equipment now checks range accuracy to ±5 yards. Spacing between subsequent calibration pulses is ±2 yards. Circuits include ultrasonic quartz-crystal delay, phantastron sweeps and stagger-tuned amplifiers for testing X-band radar

quency of the radar local oscillator 40 mc below the input r-f frequency and also furnishes the 40-mc pulse to the ultrasonic delay line. The delay line produces a series of echo pulses, the first pulse occurring at the approximate one-way delay of the line, with subsequent pulses occurring at intervals of approximately twice the one-way delay of the line. This series of 40-mc pulses is amplified in a broad-band 40-mc amplifier and fed to a 1N23C crystal in the modulator mixer.

Also fed to the modulator mixer is the c-w output of either the radar or beacon local oscillator. The mixing action is such that r-f pulses are fed from the mixer, through the t-r tube and back to the radar under calibration. This form of modulation results in two frequencies of output pulses, the frequency of the local oscillator plus and minus 40 mc. As the local oscillator is held 40 mc below the input radar, one pulse output is at the same frequency as the radar while the second pulse output is 80 mc below.

On beacon operation, the radar-beacon waveguide switch allows only the beacon local oscillator output to be injected into the modulator mixer. The beacon local oscillator is held by the beacon afc circuits to a nominal frequency of 9,350 mc or 40 mc higher than the X-band beacon frequency. The resultant r-f output pulses from the modulator mixer are thus at 9,310 mc and 9,390 mc.

R-F Assembly

Balanced magic-T mixers are used throughout the assembly. A solenoid-operated shutter in the input waveguide section provides 40-db insertion loss to protect the mixer crystals when the range calibrator is not in operation. A second attenuator in the input afc arm, has a range of 0 to 65 db to set the level of the sampled input radar pulse to the afc mixer. This control is required when the range calibrator is used with high-power radars to prevent crystal-mixer saturation with subsequent loss in fidelity of the output pulse from the range calibrator. The sampled input radar pulse is fed to the *E*-plane arm of the afc mixer while the c-w output of the radar local oscillator is fed into the *H*-plane arm of the afc mixer. The two mixer crystals are mounted in the symmetrical arms of the mixer. The resultant 40-mc output pulses from the mixer crystals are connected by coaxial cables to the radar afc chassis.

The radar local oscillator output power is fed into the *H*-plane arm of a modified magic-T mixer. A 0-to-20 db attenuator sets the output-power level. The symmetrical arms of this mixer are connected to the afc mixer and radar-beacon switch.

The radar-beacon switch contains a movable vane loaded with poly-iron. Its mechanical action is such

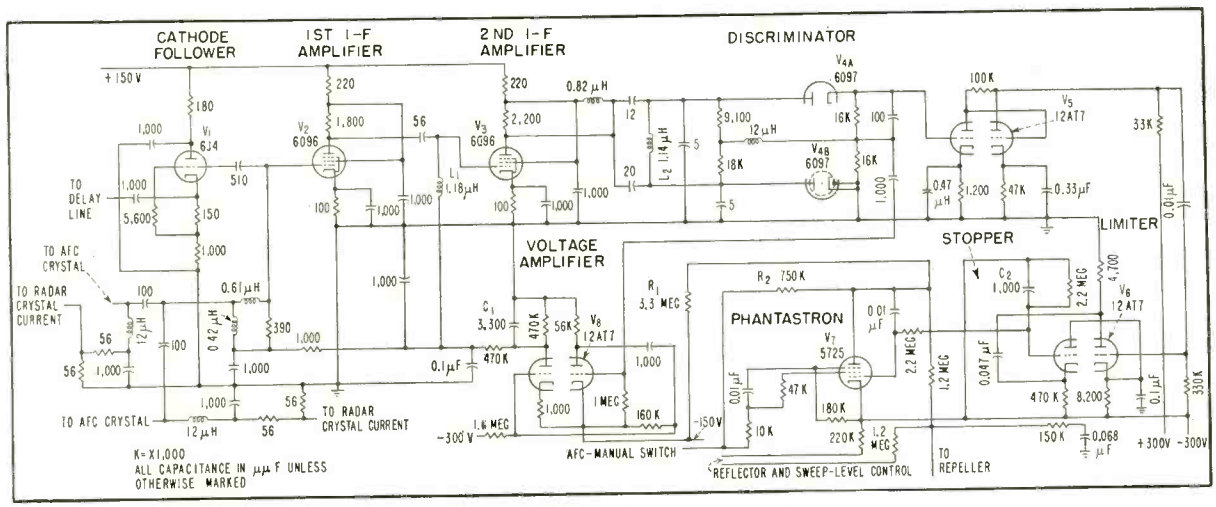


FIG. 2—Radar automatic-frequency-control chassis includes phantastron sweep

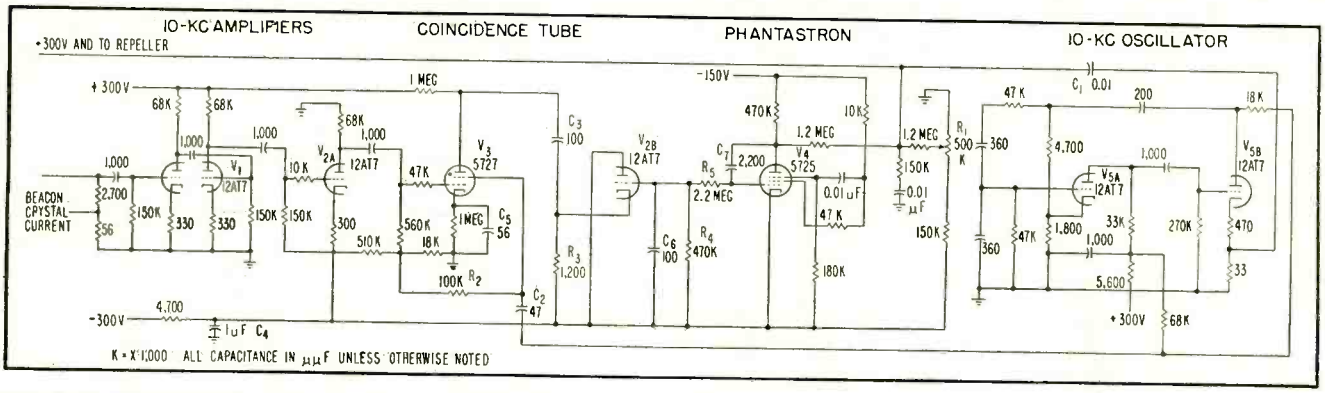


FIG. 3—Beacon automatic frequency control employs Wien-bridge oscillator

that in the radar position, c-w power from the radar local oscillator is fed to the modulator mixer. In the beacon position, the vane is switched to present a terminating load to the radar local oscillator and at the same time permits c-w power from the beacon local oscillator tube to be fed to the modulator mixer. The 30-db isolation provided by this shutter prevents interaction between the radar and beacon local oscillator tubes.

As a further precautionary step, when the range calibrator is in radar operation, the repeller of the beacon local oscillator is returned to −300 volts which prevents the tube from oscillating. Removal of the −300-volt potential by the action of the radar-beacon switch permits instant operation of the beacon local oscillator tube with no additional warm-up time.

The modulator-mixer is a balanced magic T with the two 1N23C crystals mounted in the symmetrical arms. Local-oscillator power is fed into the *H*-plane arm while the output signals resulting from the mixing action are transmitted out through the *E*-plane arm. The 40-mc pulses are applied to one of the crystals. The second crystal allows for external modulation. This allows the use of either sine wave, square wave or noise modulation of the output pulses. It may also be used when it is desired to use the range calibrator to produce a simulated one-way target signal in conjunction with an external pulse generator. A type 1B63A t-r tube is used to protect the modulator-mixer crystals from burnout by high-level input radar pulses.

The beacon local oscillator feeds into a modified magic-T mixer to split the output power, one portion of which goes through the radar-beacon switch to the modulator mixer, the other part going to the 9,350-mc beacon reference cavity. Normal frequency tolerance is ±0.3 mc while the maximum deviation from nominal over the temperature range is ±0.4 mc. A 1N23C crystal detector is used with the cavity to feed input error signals to the beacon afc chassis.

Radar AFC

The radar afc employs the basic phantastron sweep type of automatic frequency control shown in Fig. 2. The two input pulses from the afc mixer are combined in a broad-band degenerative pi network and fed to the grids of the cathode follower V_1 and the first i-f amplifier V_2. The cathode follower is used to drive the ultrasonic delay line. It has a gain of approximately 0.8 and an overall bandpass of 20 mc centered at 40 mc. Tubes V_2 and V_3 are in conventional i-f amplier stages, used to feed the Weiss discriminator V_4 and associated circuits. Tunable coil L_2 is used to adjust the crossover frequency of the discriminator to 40 mc, while L_1 balances the discriminator output.

The positive-going peak of the S curve occurs at 38.4 mc while the negative-going peak occurs at 41.6 mc. To prevent overload of the i-f amplifier stages, agc voltage is derived from the negative-going portion of the discriminator curve. This voltage is amplified in one section of V_5 and applied to the second section, which operates at fixed bias. When the amplified voltage is sufficient to overcome the bias, agc voltage is developed across C_1. After filtering it is applied to the grids of the two i-f amplifier stages.

Phantastron Circuits

The output of the discriminator is fed to a direct-coupled inverse-feedback-pair video amplifier V_6. This amplifier has a high gain at low signal levels and low gain at high signal levels to furnish the required dynamic range. The amplified video signals are connected to a peak-limiting amplifier, one section of V_6. The second section of V_6 is used as the stopper tube for the phantastron V_7. The negative-going signal at the output of the limiter tube is connected to the cathode of the stopper tube. Stopper tube action charges C_2 negatively. After filtering, the negative charge is applied to the input grid of the phantastron.

The phantastron operates as a free-running saw-tooth oscillator at a frequency of approximately 2 cycles a second. This saw-tooth sweep voltage is applied to the reflector control of the radar local oscillator tube, where the frequency excursion due to the saw-tooth voltage is approximately 60 mc. A control is provided to set the d-c level on the reflector.

The bias voltage from the stopper tube effectively lowers the transconductance of the phantastron to the point where it stops sweeping, at which point the phantastron acts as a d-c amplifier maintaining the correct d-c level of the radar oscillator. When the afc-manual switch is in the manual position, a potential of −300 volts is applied to the screen of the phantastron to prevent sweeping. At the same time, the d-c level of the plate of a thyratron is set to its average sweep

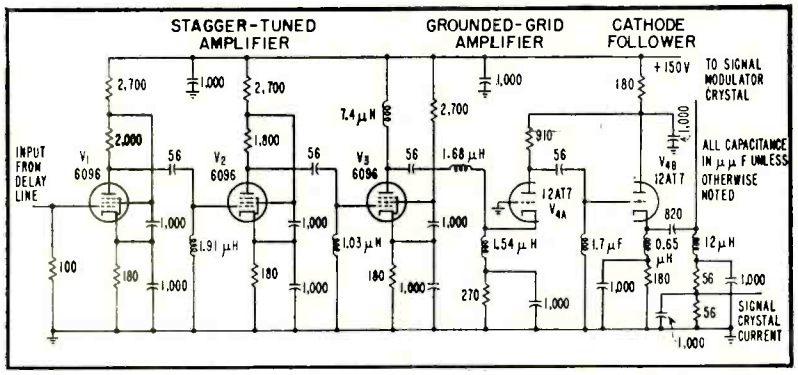


FIG. 4—Amplifier for 40-mc pulse compensates losses in delay line

level by the bleeder network of R_1 and R_2, thus allowing the same external control to be used in both afc and manual operation.

Beacon AFC

An absolute-frequency type of afc is used to maintain the beacon local oscillator at 9,350 mc, the frequency of the beacon reference cavity. Again, a phantastron-type sweep circuit is employed. A 10-kc signal is superimposed on the sweep voltage and slope detection in the cavity is utilized to furnish the afc error voltage. The circuits are shown in Fig. 3.

Tube V_4 and its associated circuits serve as the phantastron. The saw-tooth voltage output, modulated with 10 kc, is applied to the repeller of the beacon local oscillator, thus causing the output frequency of the local oscillator to sweep through the frequency of the beacon reference cavity. The sweep frequency is approximately 13 cycles and the total sweep excursion of the local oscillator is approximately 50 mc. As the beacon local oscillator is preset to one frequency, no external controls for this local oscillator are required. Internal adjustments consist of R_1 to set the d-c level of the reflector and an internal attenuator to set the injection level.

Tube V_5 comprises the 10-kc Wien-bridge oscillator. The 10-kc modulating voltage is taken from the cathode of V_5 and coupled through C_1 to the beacon local oscillator sweep voltage. A 10-kc reference voltage is taken from the plate of V_5 and fed to the second grid of coincidence tube V_3. Capacitor C_2 and resistor R_2 comprise a phase-shift network to correct for the phase difference between the currents in the plate and cathode resistors.

The resulting frequency-modulated output of the beacon local oscillator is fed through the beacon reference cavity which has a minimum Q of 1,500. By slope deflection in the cavity, the frequency-modulated output is converted to amplitude-modulated power, with the phase of the 10-kc amplitude modulation reversing as the local-oscillator frequency sweeps through the cavity resonant frequency. When the beacon local oscillator frequency is higher than the cavity frequency, the 10-kc modulation is in phase with the cavity output.

The 10-kc modulation is detected in a 1N23C crystal and applied to the 10-kc amplifiers in the beacon afc chassis. The overall gain at 10 kc of the three stages is approximately 20,000. The amplified 10-kc error signal is applied to the control grid of the coincidence tube V_3. When the 10-kc error signal and the 10-kc reference signal are in phase, the coincidence tube conducts, discharging C_3 through R_3, C_4 and C_5. The voltage developed across R_3 is rectified by V_{2B} and applied to C_6 and R_4. After filtering by R_5 and C_7, this voltage is applied as bias to stop the sweep action of the phantastron.

Delay Line Oven

The delay line is a hermetically sealed unilateral unit approximately 1 inch in diameter by 3 inches long. The delay element is either Z or X-cut quartz. Physical length of the quartz determines the delay through the line. A 40-mc transducer crystal is bonded to each end of the delay bar, converting from 40 mc r-f to ultrasonic waves and back again to 40-mc r-f pulses. The input 40-mc pulse from the cathode follower of the radar afc is used to shock-excite the delay line. The first pulse is propagated through the line and picked up by the output transducer crystal. A portion of the pulse energy is reflected back through the line to the input transducer crystal where it is again reflected back to the output crystal. This process is repeated until the energy is dissipated.

The second and succeeding pulses are spaced at intervals approximately twice the one-way delay of the line. The total number of useful pulses is in the vicinity of 15 to 20 depending on the particular lengths of delay bar used. Each succeeding pulse is of smaller amplitude than the preceding pulse, thus effectively adding to the realism of the pulse simulation of remote radar targets. The bandpass of the delay line is a minimum of 12 mc centered at 40 mc. The insertion loss measured at the tenth pulse is approximately 55 db down from the input pulse.

Delay-Line Amplifier

The 40-mc amplifier necessary to overcome the losses of the ultrasonic delay line consists of three pentodes and a twin triode. The circuit shown in Fig. 4 uses a staggered-triple design followed by a broadband grounded-grid amplifier preceding the cathode-follower output stage. The amplifier has a 10-mc bandpass centered at 40 mc and an overall gain of 37 db.

It was required to maintain the inherent signal delay of the 40-mc amplifier fairly constant over a wide variety of input conditions since this delay is the major portion of the calibrated equipment delay.

Development and subsequent production of this range calibrator was done under Air Force Contract AF33(604)-5819, J. J. Pokorny of the Armament Laboratory, Wright Air Development Center, Dayton, Ohio, serving as project engineer for the Air Force. Credit is also due E. L. McDirmit, G. A. Richards, R. A. Saxe, D. E. Fisher, R. W. Harpel and L. D. Stewart, all of Farnsworth Electronics, who participated in the development of this equipment.

SUMMARY —— Exact and accurate division of any frequency from sub-audio to 450 kc by any whole number from 1 to 10,999, including prime numbers, is accomplished by a direct-reading four-decade divider utilizing binary counter circuits

By G. K. JENSEN and J. E. McGEOGH

Naval Research Laboratory, Washington, D. C.

Four-Decade

DIVISION by any integer including prime numbers is accomplished by a direct-reading four-decade frequency divider that does not become frequency sensitive below its upper operating frequency. The actual division ratio may be read directly from dial settings.

To simplify circuit explanation, a two-decade divider is shown in Fig. 1. Each decade contains four bistable binary dividers in cascade. Each divider consists of a double triode connected so that one section will conduct while the other is cut off and a stable state will exist for conduction by either section.

The divider uses triple coincidence of positive signals from the binaries to cause reset of the binaries to a known starting polarity at a selected count; the reset pulse will occur at the desired division.

Division is accomplished by counting the number of units digits in the selected division ratio in a triple-coincidence mixer called the

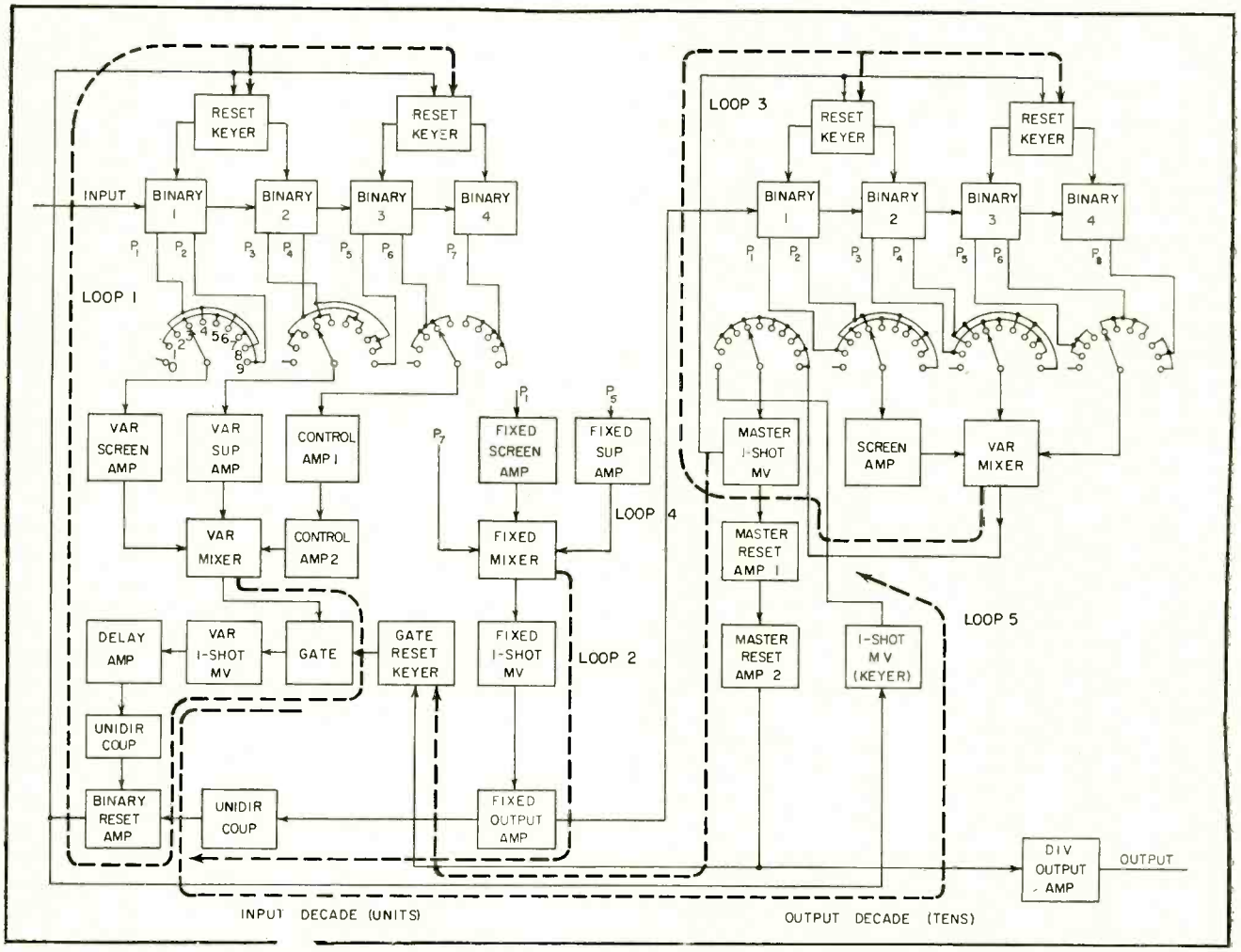
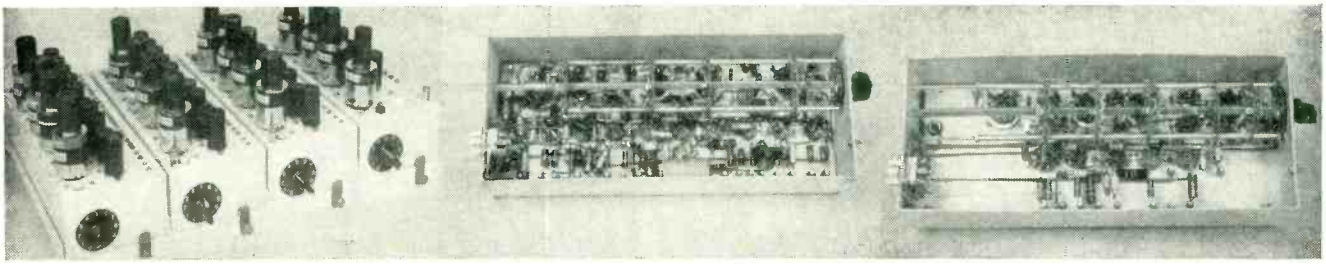


FIG. 1—Block diagram of direct-reading two-decade divider, which contains circuits necessary for a four-decade unit



Four-decade frequency divider showing use of decade subchassis (left), underchassis view of input of units decade (center) and output of thousands decade (right)

Frequency Divider

variable mixer. This mixer is then disabled and the decade will count by ten in a second triple-coincidence mixer called the fixed mixer.

Although both mixers are required in the input decade, only the variable mixer is necessary in the output decade. In a four-decade divider, decades 1, 2 and 3 are identical to the input decade of a two-decade divider. The last decade is different regardless of the number of decades. A pulse signal is fed from the input to the output decade after each group of ten input signals. The output decade counts the number of these as indicated by the tens digit of the division ratio and resets the variable-mixer circuit of the input decade.

Other decades, used as in a four-decade divider, each contain both variable and fixed mixers. Tables I and II show the reset or reference polarities and the resulting polarities at subsequent input cycles for the output and input decades. A different reference polarity was chosen for both input and output decades.

Three positive binary plates, which have not previously been positive at the same time, may be chosen for any count between one and ten.

A selection was made for each count of one through ten for both types of decades; the selected plates are encircled in Tables I and II.

Where the encircled plate is negative, amplifier inversion will produce a positive polarity at the triple-coincidence mixer. Coupling between binary plates and each input of the mixer is made through a selector switch so that the division ratio may be selected from the front panel. In the input-type decade, one of the mixers is used for division by ten only and therefore the inputs are permanently connected. This selection is shown in Table II where squares enclose the selected plates.

Division by 10 through 110

In a two-decade divider one counting procedure applies for division by ratios of 10 through 110 and a second for counts of one through nine.

Division is accomplished by setting the selector switch of each decade to the desired ratio. Coincidence at the input-decade variable mixer will occur when the selected number of units counts has been reached. The mixer output resulting from coincidence will reset the binary dividers to starting polarity through loop 1 consisting of the variable mixer, gate, variable one-shot multivibrator, delay amplifier, unidirectional coupler, binary reset amplifier and binary reset keyers.

In the reset process the gate is disabled and when the units count again occurs no signal will pass through loop 1 to reset the binaries; hence they will continue until the tenth pulse following reset by loop 1.

Coincidence then occurs in the fixed mixer, which resets the units binaries through loop 2, consisting of fixed mixer, fixed one-shot multivibrator, fixed output amplifier, unidirectional coupler, binary reset amplifier and reset keyers and provides a signal to the input of the next decade.

The units decade continues to provide one output pulse for every ten input pulses and the units binaries are reset after each group of ten through loop 2 until a master reset signal is derived from the second decade.

The switch selection of the output decade determines the number of input pulses at which coincidence occurs in the variable mixer of this decade. At coincidence, the binaries of this decade are reset through loop 3, which consists of the variable mixer, master one-shot multivibrator and reset keyers.

Simultaneously, the one-shot-multivibrator output resets the units-decade gate through master reset loop 4, which contains master reset amplifiers 1 and 2 and the gate reset keyer. This returns the gate to starting condition. The two-decade divider will continuously repeat the cycle to provide continuous division by the selected ratio.

Division by 1 through 9

An additional switch in the output decade is required for division by numbers less than 10. The units decade operates in the predescribed manner and coincidence occurs in the variable mixer at the selected count. The signal, however, not only resets the binaries through loop 1, but also provides a signal through loop 5 to trigger the master one-shot multivibrator. This initiates reset of the units-decade gate through loop 4 prior to the next

input pulse. Loop 5 consists of the gate, variable one-shot multivibrator, delay amplifier, binary reset amplifier and one-shot keyer returning to the units gate through loop 4.

The frequency divider operates from subaudio frequencies to about 500 kc. To provide this frequency range without tuning, the input signal must be shaped into a negative pulse of fast fall time, have an amplitude above the required minimum and have less than the maximum permissible width.

Time constants in the binaries have been minimized for high-frequency operation. These short time-constant circuits, however, will not pass low frequencies in amplitudes sufficient for binary keying unless the low frequency is converted into a pulse which contains the required high-frequency component. Pulse fall time should be 0.4 microsecond or less. The desired input-pulse amplitude is in excess of 50 peak volts.

The upper frequency determines the maximum allowable width of the input pulse. This width must be less than the time between input cycles at the upper operating frequency. If the input pulsewidth is greater than the time delay in loop 1 (Fig. 2A), the input keying signal and the binary reset signal may attempt simultaneously to trigger the binaries in opposite directions and pulse bucking will result in erratic operation. The maximum allowable input pulsewidth is less than 0.6 microsecond for a high-frequency limit of 500 kc.

Loop 1

Signals to the three grids of the variable mixer in the input decade (Fig. 3) must be shaped and amplified for best divider operation. At the mixer grids, the time of the rise and fall must be rapid or a change in the mixer-grid bias voltage will change the time at which coincidence occurs and the binary-reset delay time for loop 1.

The screen grid requires more driving power than the other grids of the 6AS6 mixer, but the average power may be minimized by operating the screen grid from the narrowest pulsewidth signal. The signal coming from the first wafer switch is differentiated and is the narrowest of the coincident pulses.

The variable suppressor amplifier reduces delay of the mixer-signal rise and fall. The amplifier permits the input signal to be obtained from a tap on the binary-plate load resistor reducing the capacitive load on the binary plate.

Control Grid Amplifiers

Two amplifiers couple binary signals to the mixer control grid and permit use of the positive binary signal to cause coincidence at the mixer without excessive binary loading. A double amplifier utilizes the positive binary signal that has a slow rise time to drive the mixer control grid positive and uses the first amplifier, which is normally nonconducting to insert a delay.

Table II shows that this delay will add directly to the reset time of loop 1 and reduce high-frequency response only when count 1 or 5 is selected. Thus the delay is minimized in positions 1 and 5 by reducing the delay-circuit bias voltage, which is normally obtained from a fourth wafer switch in the units-type decade. Delay is not required for counts 1 and 5.

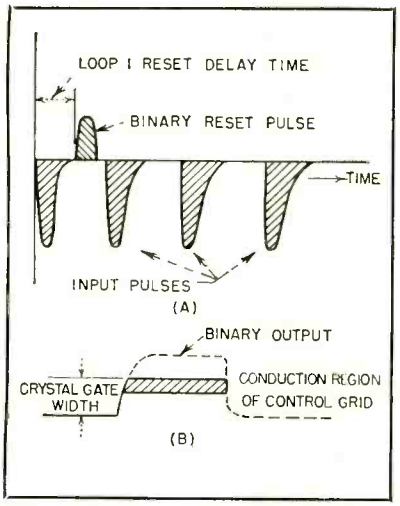


FIG. 2—Time sequence of input and reset pulses (A) and delay-amplifier suppressor-grid pulse (B)

Delay-circuit operation provides crystal-diode gating with freedom of swing within the gate in excess of the cutoff value of the first-amplifier control grid (Fig. 2B). The amplifier is normally biased beyond cutoff, and the grid is allowed to swing only by the magnitude of the gate width.

An increase or decrease in the gate width, however, is accompanied by a corresponding increase or decrease in delay. A 0.4-microsecond delay was found most satisfactory for counts 3, 7 and 9 on which delay is primarily required.

Since reset is made to the output plate of the third binary, the negative pulse at reset will couple from this plate to the positive plate of the fourth binary stage. The first of the cascaded mixer control amplifiers is operated as a normally nonconducting stage and the spurious negative pulse does not affect the amplifier output signal.

The time of the rise and fall for signals at the mixer grids is greatly improved by crystal-diode limiting in both the positive and negative directions. By returning a 1N34 crystal diode directly to the bias bus, the negative swing is limited at the bias-supply potential and back biasing is prevented. The swing in the positive direction is limited by a crystal diode returned from the control grid to the cathode bus and by a diode from the suppressor grid to the cathode bus. The time of rise and fall is better than 0.1 microsecond.

The mixer screen grid has a crystal diode to prevent back biasing by returning the screen grid to the bias supply. By eliminating the back bias the screen may be driven more positive and the mixer output voltage pulse is consequently of greater amplitude.

Reset Pulse

To permit stable reset over a wide range of bias voltages, the signal at the keyer grids must be at least 50 volts. It must have a rise and fall time of the order of 0.2 microsecond. The start of the pulse must be delayed sufficiently to assure full keying of the gate before the binaries are reset and before the mixer grid signals are removed. The reset pulsewidth must be no less than 0.8 microsecond. If it is less when the reset pulse disappears, the third binary reset plate will continue to fall and retrigger the fourth binary to the incorrect starting polarity. The width must not exceed approximately 1.0 microsecond. When added to the delay time, this width determines the

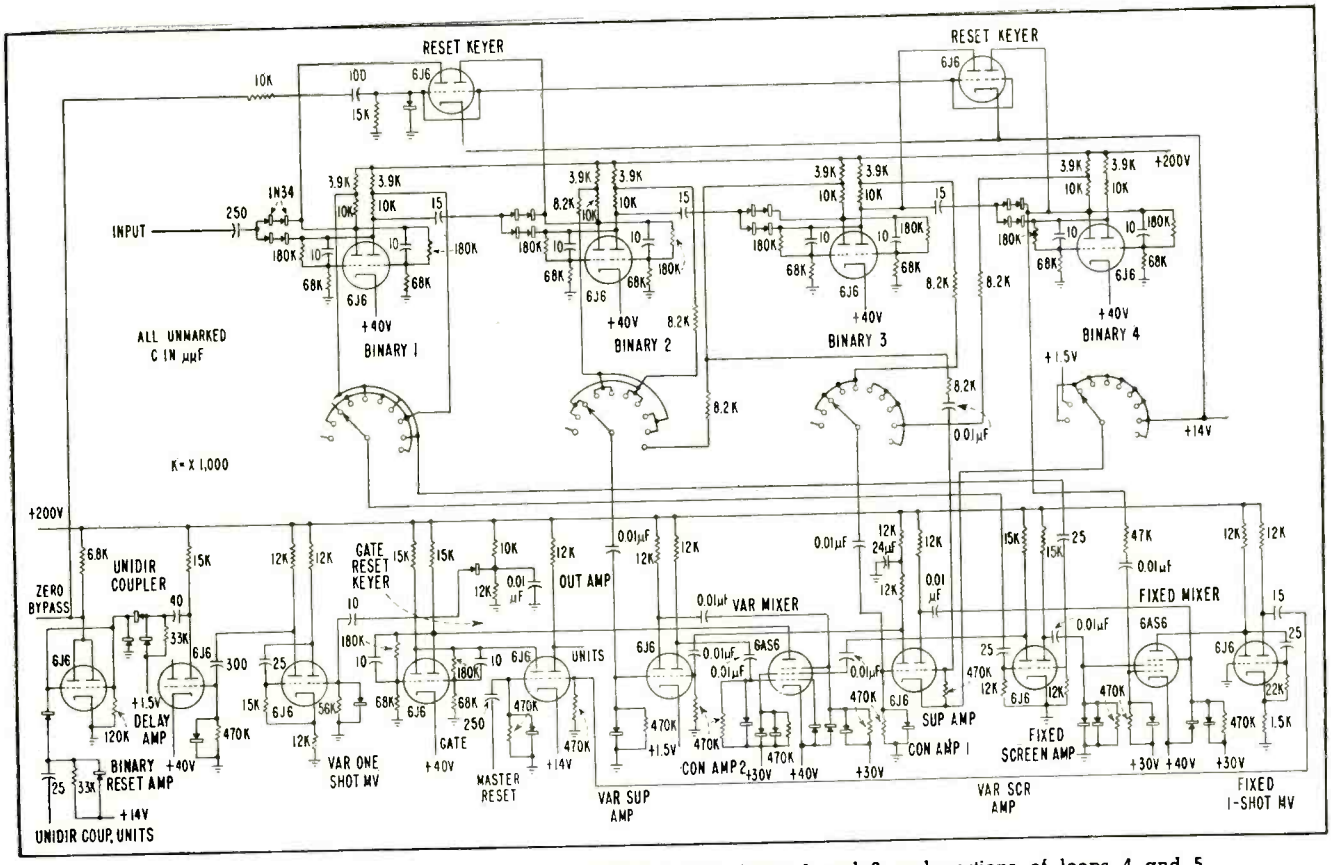


FIG. 3—Schematic diagram of units or input-type decade containing reset loops 1 and 2 and portions of loops 4 and 5

response time and the corresponding upper frequency limit of loop 1.

Gate Signal

The circuits operated from the gate output signal must respond to signals predominately positive for counts 1 through 9, as well as signals predominately negative for counts above 10. To avoid apparent polarity reversal, the gate signal is fed through a differentiating circuit to grid key the variable one-shot multivibrator. The grid contains a crystal diode returned to ground and connected to prevent back biasing. The grid is normally cut off so that only positive spikes from the differentiating circuit will key the multivibrator.

The multivibrator provides an output pulse of constant width determined by the cross-coupling time constant and stray capacitances. The rise of the output plate is relatively slow. Output of the second one-shot multivibrator plate is fed to the delay amplifier where the delay is introduced in the grid circuit. The amplifier is cut off by a relatively large bias voltage which requires about one-half of the multivibrator output amplitude to cause conduction. The delay time in reaching this amplitude has been set for the required circuit delay.

Reset Amplifier

The delay-amplifier output is fed to the reset amplifier through a unidirectional coupler consisting of three crystal diodes arranged so that only a negative signal may be coupled to the amplifier grid and negative signals applied to the same grid through loop 2 will not be coupled back to the delay-amplifier plate circuit. This prevents excessive loading of loop 2 and is used also as a gate circuit to prevent baseline feedthrough from reaching the binary reset amplifier grid. Only that part of the negative signal in excess of the 1.5-volts bias will be coupled to that grid circuit.

The reset amplifier is zero biased

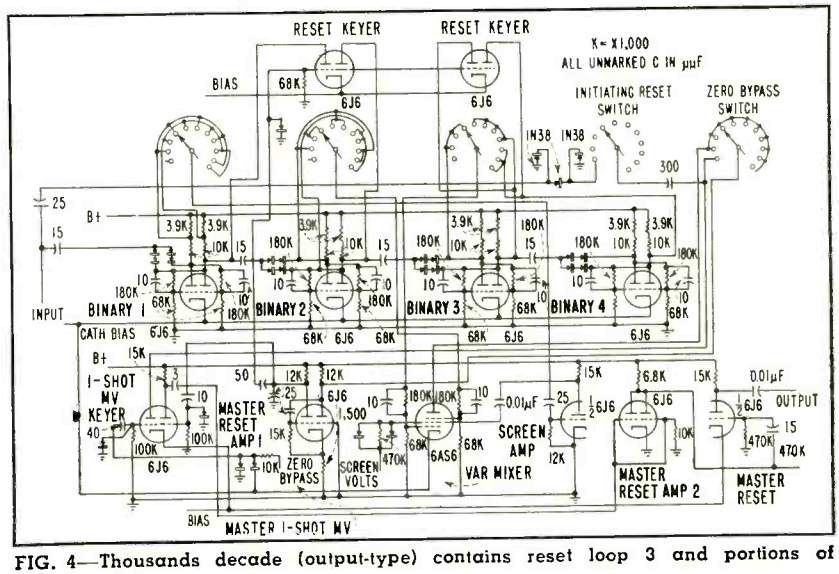


FIG. 4—Thousands decade (output-type) contains reset loop 3 and portions of loops 4 and 5

Table I—Binary Plate Polarity for Thousands Decade

No. of Input Pulses	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8
0 (Reset Ref)	+	−	+	−	+	−	+	−
1	⊖	+	⊕	−	⊕	−	+	−
2	+	⊖	−	⊕	⊕	−	+	−
3	⊖	+	−	⊕	⊕	−	+	−
4	+	⊖	⊕	−	−	⊕	+	−
5	⊖	+	⊕	−	−	⊕	+	−
6	+	⊖	−	⊕	−	⊕	+	−
7	⊖	+	−	⊕	−	⊕	+	−
8	+	⊖	⊕	−	+	−	−	⊕
9	⊖	+	⊕	−	+	−	−	⊕
10	+	⊖	−	⊕	+	−	−	⊕

and uses two sections of a dual triode in parallel to supply the necessary rise time and driving power required in driving the combined capacitive loads of the reset keyer grid bus and the zero-bypass output cable. The keyer grid bus is coupled to ground through a crystal diode to prevent back biasing that would normally accompany overdrive and add to the keying time. To utilize the maximum bias range, the signal on the grid bus must be free of extraneous signals. Decoupling resistors in the two loads prevent clamping in either load from affecting the other.

Each binary divider requires a keying time of 0.075 microsecond. The longest keying time of the mixer will occur on counts 1 and 5 where the change in polarity of the third and fourth binaries are required to fulfill the conditions of mixer coincidence. On count 5, the fourth binary rises in 0.3 microsecond, the mixer delay is about 0.1 microsecond and the shaper and keyer delays total 0.2 microsecond. Overall delay for loop 1 is then 0.6 microsecond. If the reset pulsewidth is 1.0 microsecond, the delay plus pulsewidth becomes 1.6 microseconds and the top frequency limit of loop 1 will be $10^6/1.6$, or 600 kc.

Loop 2

The mixer of loop 2 (fixed mixer) is permanently connected for division by ten. Thus, the control-grid input delay circuit used in the variable mixer is not required since the counts at which delay is essential are not utilized; a-c coupling can be used in the control-grid circuit without an amplifier and mixer keying time will be unaffected since the control grid rises at the fifth input pulse. A connection to the direct plate of the binary is necessary for sufficient voltage swing; yet resistance decoupling must be used in preventing capacitive loading of the binary plate to avoid unstable operation.

The fixed one-shot multivibrator's pulse width determines the width of the reset pulse, which at the reset keyer grids must be about equal in width, rise time, fall time and amplitude to the pulse produced at that point through loop 1. Here, the delay between the one-shot multivibrator and the reset grid bus need not be as great as in loop 1.

The delay necessary to assure full keying is obtained in the unidirectional coupler of loop 2 and follows the fixed-circuit output amplifier. The input crystal diode of the coupler is returned to the 14-v keyer bias bus allowing only that part of negative signals in excess of this voltage to feed through to the reset amplifier grid. This delay should be 0.2 microsecond or less. The remainder of loop 2 coincides with loop 1.

Loop 3

The variable mixer, master reset and one-shot multivibrator of loop 3 are common with loop 4 (Fig. 4). Here it is imperative to minimize reset time.

The mixer circuit is different from those of the units-type decades because the suppressor and control grids are directly coupled from the binary output plates through a network similar to the cross coupling within binaries.

The mixer functions as plate keyer for the multivibrator. To assure full keying by the multivibrator before the binaries are reset, a delay circuit is inserted between the multivibrator and the reset keyer grid bus.

The keying times of loop 4 are of prime importance whenever the input decade is set to one. The gate of the input decade must be reset in a time about equal to the time between input pulses of the highest frequency for this count selection. The input pulse which initiated

Table II—Binary Plate Polarity for Units, Tens and Hundreds Decades

No. of Input Pulses	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8
0 (Reset Ref)	−	+	−	+	+	−	−	+
1	+	⊖	+	⊖	−	⊕	−	+
2	⊖	+	+	⊖	−	⊕	−	+
3	+	⊖	⊖	+	−	⊕	−	+
4	⊖	+	⊖	+	−	⊕	−	+
5	+	⊖	+	⊖	+	−	⊕	−
6	⊖	+	+	⊖	+	−	⊕	−
7	+	⊖	⊖	+	+	−	⊕	−
8	⊖	+	⊖	+	+	−	⊕	−
9	+	⊖	+	−	⊖	+	⊕	−
10	⊟	+	+	−	⊟	+	⊞	−

master reset is delayed in each units-type decade by the first binary keying time, fixed-circuit mixer delay, fixed multivibrator delay and output-amplifier delay.

In the output decade, the binary and mixer delays vary with count, but the longest will be for a setting of eight. These output-decade delays and the multivibrator keying delay will be added to the master reset time. The delays and pulse width in master reset loop 4 are also added. The gate keying time through the variable mixer of the input decade is small but adds to the allowable time in which master reset must occur. This delay may be subtracted from the overall master reset time delay.

Loop 5

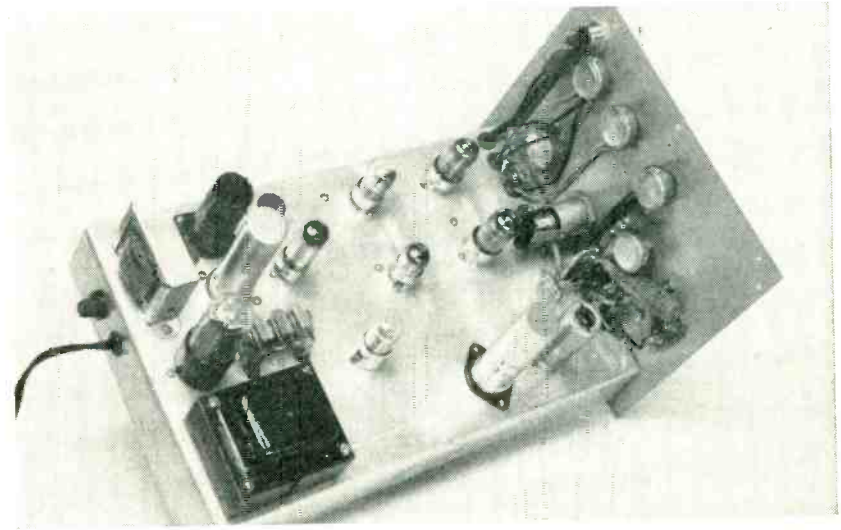
Loop 5 is the zero-bypass circuit utilized in a multiple-decade divider whenever a decade is set to zero at the same time preceding digits of the division ratio are also zero. This condition occurs when the first significant digit in the division ratio follows the digit of the division ratio corresponding to the decade in question. In a two-decade divider, loop 5 is used only when the thousands decade is set for zero. The thousands binary and mixer circuits are bypassed; the output of the units decade derived from the binary reset amplifier is fed into the thousands decade to key the one-shot multivibrator keyer and initiate master reset.

Short reset times are obtained because little or no delay is contributed by the by-passed decade.

Trigger Adapter for Transient Oscillograms

SUMMARY —— Accessory unit for existing cathode-ray oscilloscope equipment provides single sweep and unblanking of beam, initiated by transient to be captured. Indicator shows when the signal has been recorded. Satisfactory oscillograms are obtained with instantaneous-type camera at sweep speeds of 2 to 5 milliseconds per screen width

By LAWRENCE FLEMING*
Instrument Consultant
Falls Church, Va.



Upper chassis view shows simplicity of trigger and sweep accessory used to record transients from a separate oscilloscope

OSCILLOSCOPE PHOTOGRAPHY of transients meets with certain difficulties when the magnitude and wave shape of the transient signal is not accurately known beforehand and the exact time of its occurrence is not precisely under control of the operator.

Signals of this kind are encountered in studies of noise in electronic components and insulation, in chatter of switch and relay contacts and in a large area of mechanical and ballistic measurements. Durations of signals in this type of work are commonly of the order of milliseconds.

Transient Oscillograms

The usual general-purpose oscilloscope is designed primarily for repetitive sweep and presents inconveniences that lead to lost records in transient type of application. Recording is most conveniently done with a single-sweep oscilloscope and a still camera, because a moving-film camera will waste a great deal of film between useful records.

The accessory unit described here will eliminate these difficulties and enable good photographs to be obtained with a high degree of reliability and a minimum of critical adjustment and operating skill.

The oscilloscope beam should be blanked off and the sweep inoperative until the signal appears. Thereupon the beam should be brightened, swept once across the screen and then extinguished. An oscilloscope with internal blanking and a driven sweep will suffice if the signal can be produced at will, to permit adjustment of the oscilloscope sweep controls.

However, only the most expensive commercial oscilloscopes have driven single-stroke sweep circuits that will trigger reliably over a wide range of input levels; excessive signal will cause the sweep to repeat itself several times before stopping, producing a confused record. Insufficient signal level will fail to trigger the sweep. If the control is set to trigger on small signals it is usually critically close to the repetitive sweep condition. Many driven sweep circuits, moreover, must execute a retrace before beginning the sweep.

Basic Elements

Figure 1 shows the general arrangement. Basically it comprises a one-shot multivibrator that will trigger positively and only once upon receipt of an input signal. Its output is a positive-going step wave of the order of 30 volts increment. The step is coupled to the first grid of the cathode-ray tube in the oscilloscope, to unblank the beam.

This same step wave is integrated by means of a simple *R-C* circuit to

*Work described was done at Diamond Ordnance Fuze Laboratories, Washington, D. C.

produce a sweep voltage, applied to the horizontal input terminals of the oscilloscope. Since these two functions are derived directly from the same source, there is no uncertainty or delay whatever about the initiation of the sweep once the trigger has functioned. A preamplifier and a phase-inverter and full-wave rectifier complete the system.

Circuit Description

In Fig. 2, the dual triode V_1 is a conventional preamplifier, with its gain stabilized and adjusted to a value of 100 by means of negative feedback. A two-position attenuator is provided at the input to handle large signals. Bandwidth is approximately 10 cycles to 100 kc.

The output of this preamplifier feeds both the vertical input terminals of the external oscilloscope and the control circuits for the internal trigger.

Trigger control includes dual triode V_2 and dual diode V_3. The first section of V_2 is an amplifier, the second a split-load phase inverter. The inverter feeds the full-wave diode rectifier V_3. Thus the output of diodes V_3 is the same negative polarity regardless of the polarity of the transient signal applied to the input to the system.

A variable bias is applied to the diodes V_3 through a panel control potentiometer P_1. Thus no output is obtained from the diodes until the signal level exceeds the delay bias. Control P_1 is so set that triggering does not occur on minor noise that may be present in the input, but only on the desired signal. Its setting is not critical.

The negative triggering signal from the output of full-wave diode V_3 is direct-coupled to the grid of one of the tubes (V_4) of the d-c trigger pair or flip-flop.

The bistable pair is a Schmitt trigger circuit, comprising tubes V_4 and V_5. The plate of V_4 is direct-coupled by the potentiometer or Nyquist circuit to the grid of V_5. Back coupling is effected through the common cathode resistor R_1. Tube V_4 is normally conducting and V_5 normally cut off. Thus the d-c output level at the cathode of V_5 is normally 1 or 2 volts positive to ground.

When the diode signal cuts off

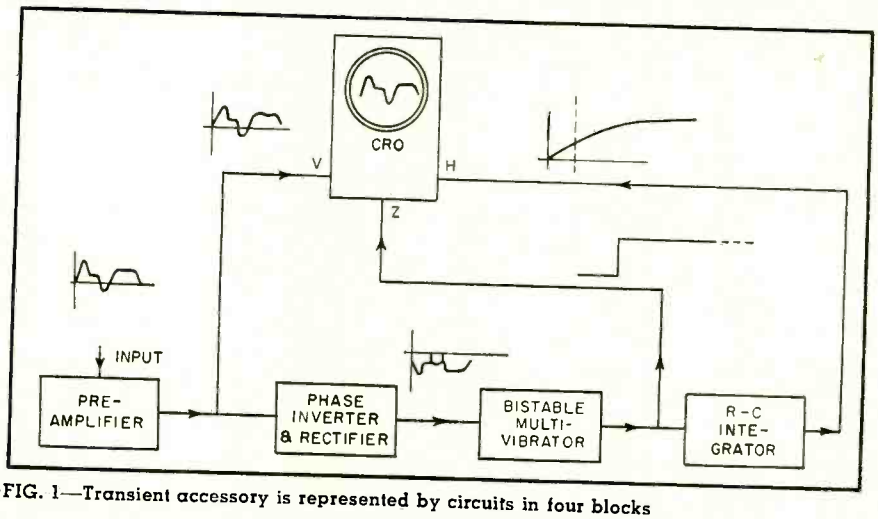


FIG. 1—Transient accessory is represented by circuits in four blocks

V_4, tube V_5 suddenly conducts and the output at the cathode, point B, rises suddenly. The output at point B is thus a 30-volt positive-going step function.

Once this bistable circuit has been triggered, it will not respond in any way to further signals from the vertical input channel. Such signals always appear as negative-going voltages at the output of double diode V_3. Since, after triggering, the next tube V_4 is cut off, this tube is no longer affected by any further negative signals applied to its grid. Thus, the bistable circuit V_4 and V_5 will never trigger more than once on any input signal.

Bias Level

A screwdriver adjustment P_2 is needed in the d-c interstage coupling network between the tubes of the bistable pair V_4 and V_5. This merely sets the bias level for proper operation; if its resistance is too low, the flip-flop circuit will run repetitively and if too high the circuit will not trigger. Once set it rarely requires readjustment.

A portion of the step voltage generated at point B by the bistable circuit is applied to the Z axis or crt grid terminal of the external oscilloscope. The magnitude of this portion of the step is adjustable by means of control P_3.

In operation, the brightness or intensity control on the external oscilloscope is set for the beam to be just, or nearly, extinguished. Brightening adjustment P_3 is then set so the crt beam is brought up to full intensity without defocusing when the trigger is actuated.

It is not necessary that the step-wave be direct-coupled to the first grid of the cathode-ray tube unless very slow sweep rates are used. Normally the R-C time constant in the grid-coupling circuit is long enough to allow uniform brightness over the sweep.

Because this device is used only with transient signals, it is necessary to have some kind of indicator to show that a transient has been recorded and a reset button to return the circuits to their original state, ready to record another transient.

The firing indicator is a neon lamp mounted in the panel. It is lighted through an auxiliary tube V_6. This tube is normally biased to cutoff and is rendered conducting by the positive-going step at point B, which is applied to its grid. The extra tube is employed, instead of simpler means, to insure that the neon lamp does not affect the functioning of the flip-flop circuit.

The reset button merely operates a switch connected across the cathode load of the bistable pair. Momentary closing of the switch returns the circuit to its unfired state in which it remains.

Integrator

The step function is converted into a linearly rising voltage by a simple R-C network R_2 C_2. When the step appears, C_2 immediately starts to charge through R_2. The rising voltage across C_2 is applied to the horizontal input terminals of the external oscilloscope and sweeps the beam across the screen.

Only the initial portion, 10 per-

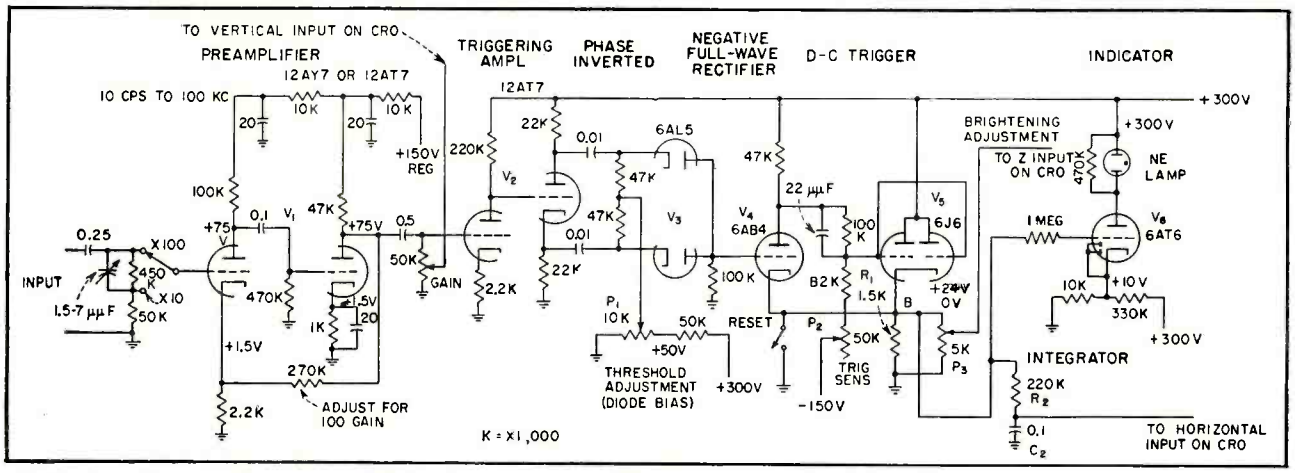


FIG. 2—Recording adapter uses regulated voltage on preamplifier and separate dry-disk rectifier for bias

cent or less, of the rising voltage is used to insure linearity. The later, nonlinear portion of the rise is thrown away since the beam is off the screen. Since this is a transient device, the duration of the unused portion of this voltage is of no consequence.

The horizontal speed of the sweep may be adjusted conveniently merely by changing the horizontal gain-control setting on the oscilloscope. There is no advantage in providing a continuous or fine adjustment of sweep speed in the accessory unit since the gain-adjustment method is quite valid.

The values of R_2 and C_2 shown are good for a speed range in the order of roughly 1 to 10 milliseconds per screen width on a standard high-gain oscilloscope, such as the DuMont 304H. Other ranges are obtainable by providing a switch to cut in other values of capacitance at C_2.

The recharging of C_2 back to its initial value (retrace) may be hastened by connecting a diode across resistor R_2, poled so its anode goes to the upper terminal of C_2. A vacuum diode is preferable to a crystal because the back resistance of a crystal is usually low enough to disturb the time constant.

Regulation is employed on the preamplifier to keep out line voltage transients. It is not necessary in the high-level stages. An auxiliary negative supply is required for the interstage coupling system used in the bistable pair V_4 and V_5. Total B supply drain is under 50 milliamperes.

To one accustomed to using an oscilloscope only on repetitive signals, transient techniques tend at first to appear difficult. All that is needed, however, is mental reorientation, which comes with a little practice.

A source of calibrating signals is required and some means of introducing the signal into the recording system without switching transients. The most convenient calibration source is a pulse generator. The string of pulses provides not only time-base and amplitude calibration, but also an accurate check on time-base linearity and on the system delay time in brightening the trace and starting the sweep.

Time Delay

In the particular application employed, 25 μsec pulses at a 1-kc repetition rate were used. No shortening of the first pulse was discernible, the stray time delay being less than 5 microseconds, or in the order of 0.02 percent of a typical sweep length.

The problem of switching or turning-on a calibrating signal being introduced into the system was found to present difficulties. When injecting the output of a continuously-running pulse generator, it is desirable that the sweep be triggered by the first pulse that comes along after the switch is closed. Most ordinary electronic switching circuits produce a pedestal or switching transient that triggers the sweep device immediately, so that no known pulse is available at the beginning of the trace to provide a measure of the system delay. Straight contact-type switching was found to be practical. It requires a switch of simple construction.

It was found that ordinary snap-action switches chatter and that lever, rotary and knife switches scrape. A telegraph key was better but had some chatter. The best switch was found to be a small leaf of spring bronze about 1½ in. long and ¼ in. wide, pressed against a stationary contact by the finger. The leaf is made light enough, for example 0.01 in. thick, so that effective mechanical damping is provided by the operator's finger and there is no extraneous mechanical structure coupled to the leaf to induce mechanical resonances.

The cro gain controls must be set to give a convenient display of the transient signals expected; then a calibrating signal is introduced of suitable amplitude and repetition rate.

Extended use of this device in recording transients of similiar magnitude has shown that frequent calibration is not necessary; once or twice a day is sufficient.

Satisfactory photographs at sweep speeds of 2 to 5 milliseconds per screen width were obtained on Polaroid film at a lens opening of f/2.8. The oscilloscope had a P11 screen and 3,000 accelerating volts.

Elmer Ellsworth, who built and operated the device, contributed many valuable suggestions.

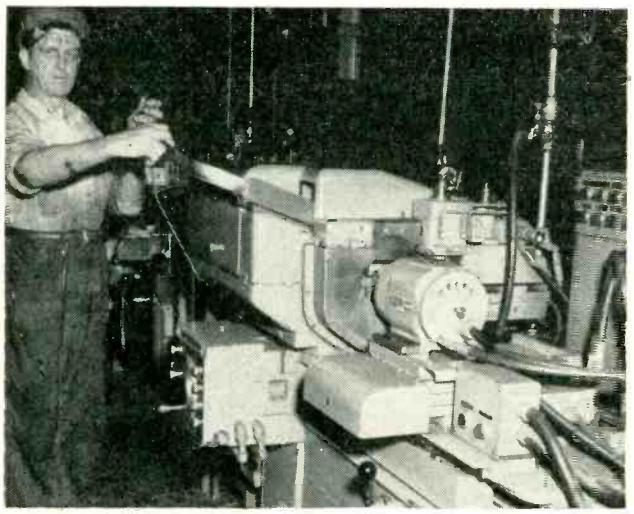
BIBLIOGRAPHY

Walter Richter, Beam-Blanking Circuit for Oscilloscopes, ELECTRONICS, p 128, Sept. 1944.

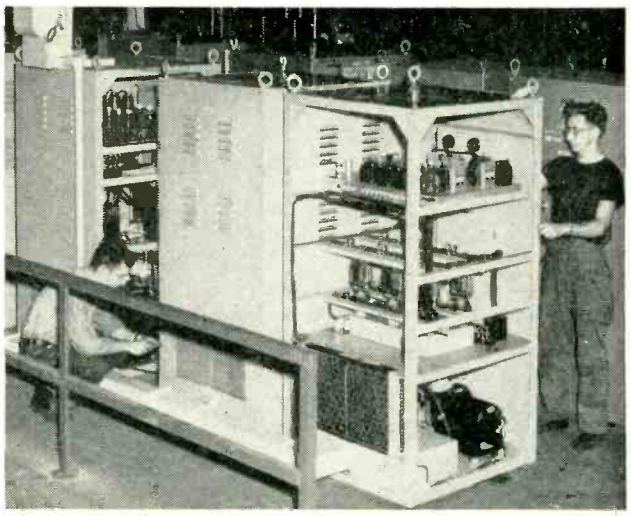
A. L. Dunn, A. R. McIntyre and A. L. Bennett, Automatic Beam Blanker for Oscilloscopes, ELECTRONICS, p 94, Sept. 1950.

M. Maron, A Single-Sweep Triggering Circuit, *DuMont Oscillographer*, p 18, April 1950.

Variable-Speed Control



Variable-frequency supply controls speed of ball-bearing-race grinder drive motor



Motor-control power supplies in production. Variable-frequency supply chassis are at top and rectifiers are at center level

By E. G. COWIE and J. H. GREGSON

Canadian Westinghouse Company Limited
Hamilton Ontario, Canada

MULTIFREQUENCY-OUTPUT power supplies are useful where a number of motor speeds are required.

High-speed bore-grinding machines requiring many different fixed speeds are supplied by the equipment shown. It provides a choice of six fixed frequencies from 480 to 1,660 cps available at four independent 3-phase outlets. Line voltage is variable up to 300 v and approximately 5 kva is available at each of these outlets to give the required speed range of 20,000 to 100,000 rpm. The four channels obtain their high-voltage plate supplies and control-circuit voltages from a common power-supply unit.

Frequency stability of the units at any frequency is better than 2 percent and the voltage regulation is approximately 5 percent for motors operating between idling and full-load conditions.

High-Frequency Channel

The block diagram of a high-frequency power channel is shown in Fig. 1. The output of a Wien-bridge oscillator is fed into the phase-splitting and voltage-regulating circuit. Three output voltages from this stage feed three identical amplifiers consisting of a 6F6 class-A preamplifier, class-AB_2 push-pull 807 driver and class-B push-pull 833A output stage.

Secondaries of the output transformers are connected in delta for three-phase output. Taps permit load matching.

Any one of six predetermined frequencies may be obtained from the oscillator by switching to the appropriate R-C combination in the Wien-bridge circuit. This frequency switch also adjusts the voltage-equalizing and phase-shift circuits so that when frequency is changed a minimum of additional adjustment is required. The output voltage is adjusted to the desired level by the potentiometer in the input circuit of the regulator stage.

The first half of the 6SN7 in Fig. 2A is the voltage regulator and the second is the phase-splitting circuit.

The regulator circuit relies on the variable-mu characteristic of the 6SN7 and is similar in operation to the avc circuit used in radio receivers. The tube is normally self-

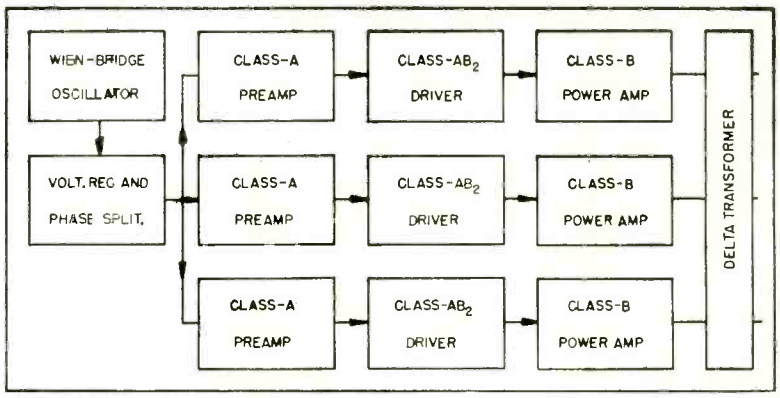


FIG. 1—Complete control unit has four independent sections of type shown

for Integral H-P Motors

SUMMARY —— Five-kva electronic power source has six preset frequencies to control speed of synchronous and induction a-c motors. Unit has 3-phase output with line voltage variable up to 300 volts. Frequency stability is better than 2 percent

biased at the high-gain portion of the characteristic curve for zero-signal operation. The control bias, which is derived from the output voltage, is adjusted by negative feedback so that the stage gain is inversely proportional to the output voltage. Input to this stage is adjusted to give the desired voltage at the output (motor) terminals. Output-voltage fluctuations caused by load variations are almost completely compensated by this circuit.

Phase Shifting

Phase shifts required to supply 3-phase operation are obtained by the LCR network in the phase-splitting circuit. One C-R circuit provides voltage *OD* leading by 60 deg., the other voltage *OC* lagging by 60 deg., as shown in Fig. 2B. The inductor provides two equal out-of-phase voltages, *OE* and *OF*.

Since the full-load demand of the largest motor used on the grinder approaches the rated output of the high-frequency channel, across-the-line starting is not possible, for the demand on the channel would then exceed its capacity. Furthermore, sudden application of the motor load to the channel sets up transients, which are destructive to insulation.

Reduced-voltage starting is obtained by applying the filament voltage to the 6SN7 while full a-c drive voltage is applied to the grid. Since this tube supplies voltage for all three phases, the three phase voltages are equal throughout the starting cycle.

Rate of rise of output voltages can be matched to the speed of the largest motor by inserting resistors in series with the filament of the 6SN7. This filament circuit is energized when the motor start button is pressed.

Resistances in series with the motor reduce inrush currents and provide a better impedance match between the output tubes and the load. A resistance of 3 ohms was found to be best. This resistance is shorted out when the motor reaches synchronous speed. The series resistors also limit any negative-sequence current which may be generated on starting the motor.

Correcting the load for unity power factor on starting is unsatisfactory for it introduces complicated starting problems; however, sufficient capacitance is connected in parallel with each motor to give unity power factor at full load.

Operation

To set up the equipment, the drive voltages to the 833A tubes are equalized. The individual phase-shift circuits are then adjusted for equal phase voltages across the output of the high-frequency power channel. The main gain control is then adjusted for the required output voltage.

The equipment operates from a 440-volt, 60-cycle, 3-phase line. The line voltage is converted to 4,000 and 600 volts d-c for the power-output and driver stages of the high-frequency channels and to 115 volts a-c for blowers, filament transformers and control circuits. Power transformers are connected 3-phase double-Y, which results in a 360-cycle ripple on d-c. Since the driver and output stages are push-pull, no d-c filtering is necessary.

Acknowledgement is due to the late J. T. Thwaites who conceived the plans for this power unit.

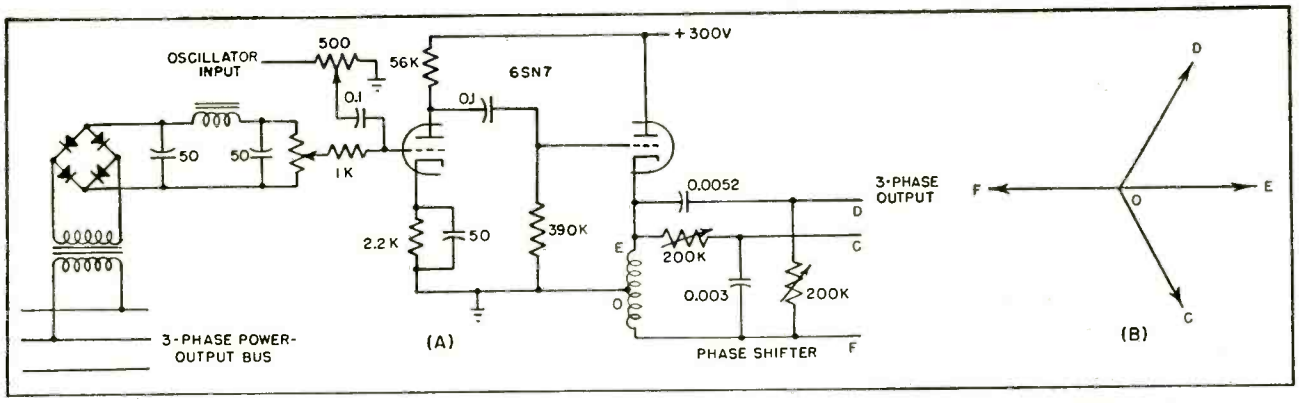


FIG. 2—Voltage regulator and phase-splitter circuit uses negative feedback to maintain line-voltage regulation of 5 percent

Phase-Controlled

SUMMARY —— Crystal oscillator pulses key high-order harmonic generator to provide series of outputs in vhf-uhf range without selective amplification. Simple compact unit employs single triode for both fundamental and phase-controlling oscillator functions

By ALWIN HAHNEL
Signal Corps Engineering Laboratories
Red Bank, N. J.

GENERATION of any one of an unbroken series of harmonically related frequencies is possible with the oscillator type to be described. It consists of two sections: a crystal oscillator operating at the fundamental to the desired output frequencies and an oscillator that is periodically phase-controlled by the fundamental oscillation. The oscillator output-frequency spectrum contains only harmonics of the crystal oscillator frequency. The oscillator operates simultaneously in the range of the desired output frequency and at the crystal-controlled fundamental to it. Spectrum energy is concentrated about the harmonic nearest to the frequency of the periodically phase-controlled oscillator.

Circuit Operation

Figure 1 shows the circuit diagrams of two periodically controlled oscillators. In the crystal oscillator section the crystal is connected between grid and cathode and the plate circuit is tuned. The phase-controlled oscillator is a Colpitts type. Feedback is determined by the electrode capacitances of the vacuum tube and the cathode-to-plate capacitor. The uhf tank circuit (right) is paralleled by a network consisting of the tuned plate-circuit of the crystal oscillator section and a choke that makes the shunt impedance of this network high at the ultrahigh frequencies.

Grid-capacitor reactance is sufficiently high at the fundamental frequency to separate the tank circuit of the phase-controlled section from the quartz crystal. The choke used to keep the grid above ground potential at uhf is chosen small enough not to disturb oscillation at the crystal frequency.

Simultaneous self-excitation of oscillations at two or more independent frequencies requires that their frequency ratio be large. For operation at each one of these frequencies, all circuits tuned to the other frequencies must be of negligible influence.

The phase-controlled oscillator section is tuned to the desired frequency and keyed by pulses generated in the crystal-oscillator section. These pulses bias the grid so that generation of oscillations is restricted to the pulse duration. Thus, the pulse repetition interval is divided into a regenerative and a degenerative period. During the initial part of the regenerative period, the oscillations build up exponentially.

These oscillations decay exponentially in the degenerative phase due to the pulse-controlled decrease of the oscillator-tube transconductance below the value at which the phase-controlled section is oscillatory. The time constant of the buildup function depends upon the negative resistance and upon the amplitude of the harmonics of the keying voltage near the oscillator frequency.

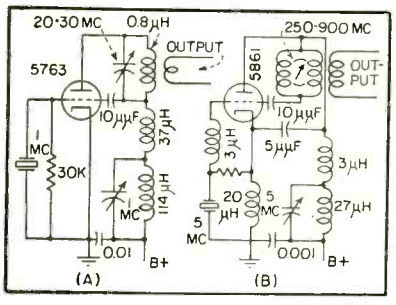


FIG. 1—Periodically-controlled oscillators covering the 20 to 30-mc range in 1-mc steps (A) and covering the 250 to 900-mc range in 5-mc steps (B)

Operating conditions of a periodically phase-controlled oscillator are illustrated by the oscillograms of Fig. 2. Phase control occurs at the time of the voltage step. The time interval between two successive voltage steps corresponds to a pulse repetition rate of 100 kc.

If the regenerative period is sufficiently long, the oscillation amplitude will be limited due to the nonlinearity of the tube characteristic.

The amplitude envelope of the output spectrum is peaked at the frequency at which the oscillator is free-running between two successive voltage steps. The spectrum envelope is peaked at a harmonic of the keying frequency in Fig. 2A. The envelope peak shown in Fig. 2B is located between two adjacent harmonics, resulting in two output signals of similar amplitudes.

It is essential that the output wave shape be periodic at the pulse-repetition frequency. Periodicity is most easily obtained if the oscillations disappear in the noise level before the next pulse arrives. The oscillator output may consist of relatively large-amplitude pulses at the end of the decay period. Their phase-control requires harmonics that are large in amplitude compared to these residual oscillations.

Desired Bandwidth

To obtain a minimal bandwidth spectrum, it is necessary to make the constant-amplitude period long compared to the build-up and decay periods. This operating condition requires that most of the

Multichannel Oscillator

energy be available at the desired output frequency. It requires extremely steep buildup and decay slopes of the output waveform. To shorten the time constant of the decay, a low circuit-Q is required.

By periodically loading the tank circuit with a pulse-controlled diode, the constant amplitude condition can be extended over a large part of the pulse-repetition period. Above 300 mc little advantage is gained by use of this method because of the lower negative resistance during the build-up period and reduction of the tuning range resulting from addition of the diode.

At 300 mc, the circuit-Q and harmonic content of the keying voltages are higher than at 500 mc. This results in reduced bandwidth of the spectrum envelope and increase of the output at the desired frequency to about 1 mw.

The spectrum envelope is not symmetrical about the frequency to which the uhf tank circuit is tuned. The unsymmetry is caused by the frequency variation of the periodically phase-controlled oscillation during the pulse-repetition interval. Another effect of frequency variation during the pulse repetition interval is the broadening of the envelope peak. It permits an increase of the long-time frequency instability of the oscillator circuit with little deterioration of the degree of undesired harmonic suppression.

Adjusting Oscillators

Restricting the spectrum bandwidth leads to increased requirements on the accuracy with which the oscillator has to be tuned to the desired harmonic. It is therefore important to know the shape of the spectrum envelope between two adjacent harmonics. To determine it, either the frequency of the phase controlled oscillation is varied while maintaining the crystal frequency or the first one is kept constant and the frequency of the keying voltage varied. The results obtained with a 250 to 900-mc oscillator that was crystal controlled at 10 mc are shown in the oscillograms of Fig. 3.

The boundary between light and dark is the envelope observed during a sweep of the fundamental frequency of approximately 20 kc about the center frequency of 10 mc. The oscillogram in Fig. 3A gives the relative amplitude of the 30th harmonic as a function of the tuning of uhf tank circuit. When tuning the same oscillator about a center frequency of 500 mc, the envelope in Fig. 3B is produced. These oscillograms were obtained at different receiver sensitivities.

Frequency Accuracy

Accuracy and stability of the phase-controlled oscillator section depend upon the level of undesired harmonics that is permissible. A detuning of the oscillator from the frequency, equal to an exact integral multiple of the fundamental frequency, causes a decrease of the desired-frequency amplitude. To keep adjacent harmonics below 1/10 of the amplitude of the desired output frequency, the uhf oscillator would have to be accurate to ±750 kc (±0.25 percent) at 300 mc. To maintain a 20-db suppression of the undesired harmonics at 500 mc, a frequency drift of approximately 1 mc can be allowed toward the higher frequencies. Owing to the unsymmetry of the spectrum envelope a 2-mc frequency drift toward the low-frequency side can be tolerated.

To approach the power output of a conventional crystal oscillator the periodically controlled oscillator has to be followed by one stage of selective amplification. The resulting output spectrum is illustrated in Fig. 4.

The contributions of L. Battersby, E. Christian and E. Conover are acknowledged.

REFERENCE

A. Hahnel, Multichannel Crystal Control of VHF Oscillators, *Proc IRE*, p 79, Jan. 1953.

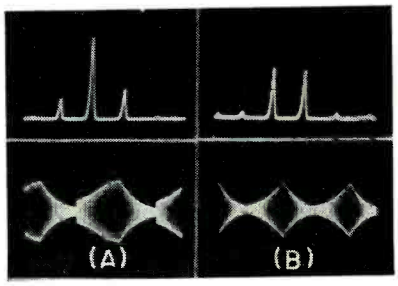


FIG. 2—Waveforms and output spectra of a periodically controlled oscillator tuned to an integral multiple of the repetition frequency (A) and with frequency halfway between two integral multiples of the repetition frequency (B)

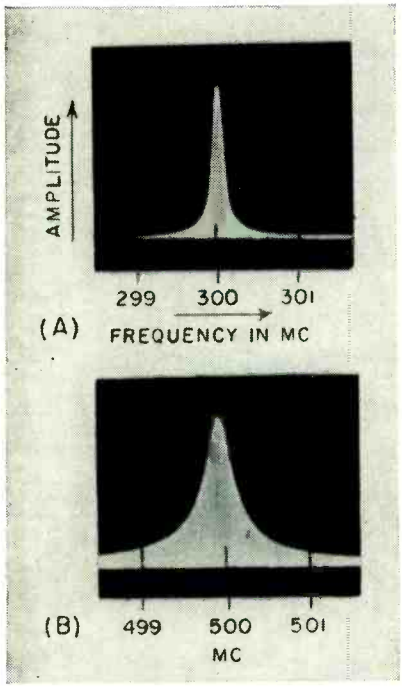


FIG. 3—Spectrum envelopes at different settings of the uhf-oscillator tank circuit. The peak amplitude at 500 mc is ⅓ of the amplitude at 300 mc

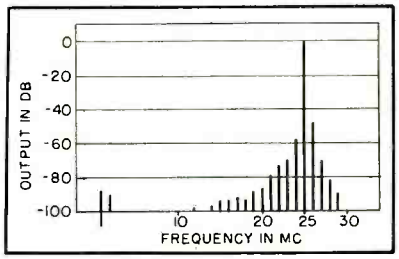


FIG. 4—Output spectrum of 20 to 30-mc oscillator followed by one stage of amplification. Zero db level corresponds to 3 volts across 50 ohms

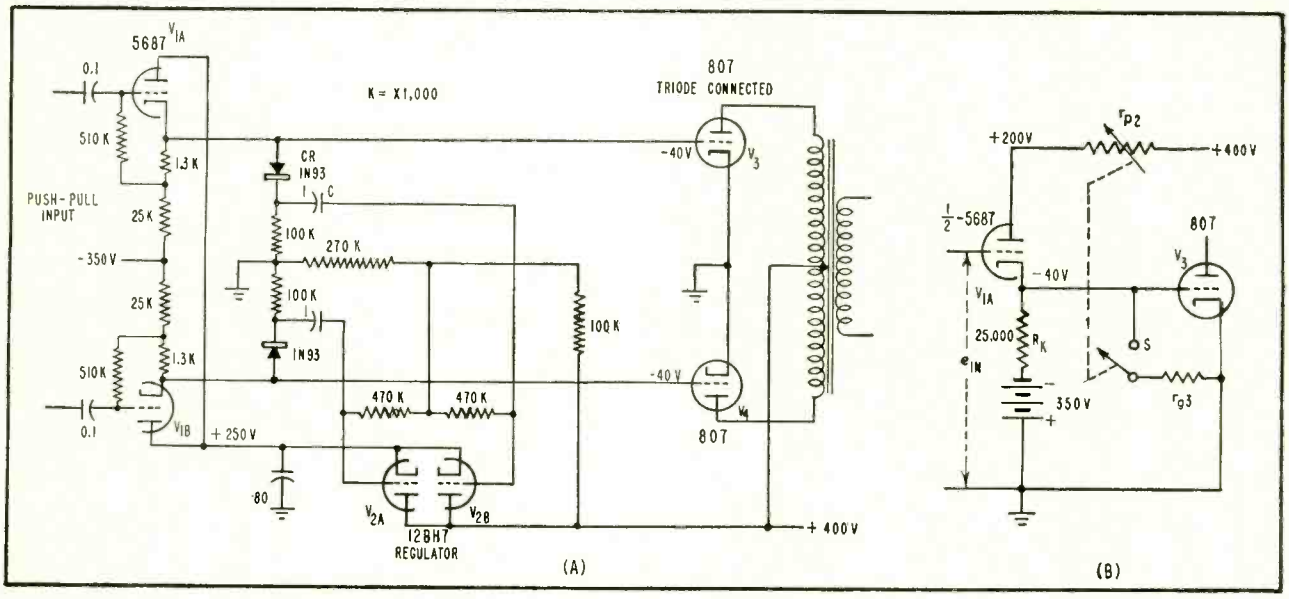


FIG. 1—Kicker circuit gives improved grid regulation for AB_2 operation from cathode-follower driver stage (A). Equivalent circuit of one side of push-pull circuit aids analysis of regulating action (B)

Circuit Design Factors for

SUMMARY —— New amplifier circuits feature high power output with low intermodulation distortion. Kicker-type circuit closely regulates plate supply of cathode-follower driver stage. Improved versions of Williamson and ultra-linear amplifiers are included

WHILE setting up a development program for a line of audio amplifiers, several new design configurations were evaluated, using both triode and beam power tubes.

Standard output and power transformers were used. To obviate use of a special grid-driving transformer, a cathode follower was employed to drive the output stage into the positive grid voltage region.

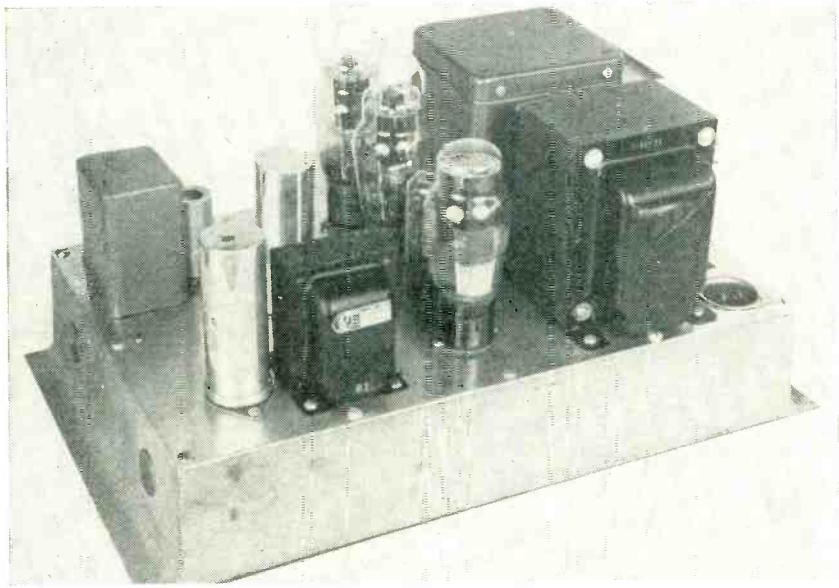
When a cathode follower drives the following stage into the grid-current region, flow of grid current is from the driven-stage cathode or filament to its grid, through the cathode of the driver stage to the plate of the cathode-follower driver and back through the plate supply of the driver stage to ground. The plate supply to the cathode-follower plate circuit must supply all the grid current which appears on the grid of the driven stage. This means the cathode-follower plate supply must have perfect regulation if the cathode-follower is to provide a low-distortion signal.

Regulation

To keep costs to a minimum, it is generally possible to have only one well-regulated, positive high-voltage supply. Low cost, high g_m, high-perveance tubes suitable for cathode-follower use in this function are limited in dissipation and plate-to-cathode voltage so some type of voltage-dropping circuit is required to secure the necessary 200 to 250 volts from the high-voltage plate supply. An R-C filter has poor regulation characteristics. Better regulation is available with a voltage-regulator tube used with an L-C filter or a cathode-follower type of degenerative regulator, but a more positive type of regulator was required for these amplifiers.

The kicker circuit of Fig. 1A was devised to obtain the required regulation of the cathode-follower plate supply. The cathode-follower stage supplied by this circuit is capable of driving the output stage grids into the positive grid current region with good linearity and excellent stability. The regulation circuit may be analyzed with reference to Fig. 1B, which is an equivalent circuit showing one side of the push-pull circuit of Fig. 1A.

Prior to the time V_3 is driven positive, the plate current through cathode follower V_{1A} and regulator tube V_{2B}, whose dynamic plate resistance is shown as r_{p2}, is constant and the voltage at the plate of V_{1A} is steady. When V_3 is driven positive, S is effectively closed and the grid-cathode dynamic resistance shown as r_{g3} (which may drop as low as several hundred ohms) is thrown into the circuit, which for



Typical prototype chassis for 11, 24 and 33-watt amplifiers described in text; power supply is built on same chassis

Audio Amplifiers

by M. V. KIEBERT, Jr.*

Convair
A Division of General Dynamics Corp.
Pomona, California

a given value of e_{IN} requires a greater plate current through V_{1A} to attain equilibrium. This normally results in a drop of plate voltage at V_{1A} with attendant positive-peak flattening off of the driving voltage to the grid of V_3. In Fig. 1A, however, diode *CR* immediately senses the instant when V_3 starts to go positive.

As a result of the connection of *CR* through *C* to the grid of V_{2B}, r_{p2} of V_{2B} may be simultaneously decreased to maintain the plate of V_{1A} at a constant voltage to permit driving V_3 to large positive voltages while maintaining excellent linearity. The origin of the kicker cognomen is thus seen.

Use of cathode-follower drivers may also reduce component costs and/or help the frequency response and phase shift performance of the driving circuit, if full advantage is taken of the high-input-impedance characteristic of the cathode-follower connection. Figure 2 illustrates the proper connection of this interstage circuit for maximum value of the input time constant *RC*.

Low-Impedance Driver

The apparent input-circuit time constant is 0.56 sec compared to 0.056 sec for conventional circuits.

To obtain the best possible driven grid-voltage waveform (and lowest driving impedance) it is possible and desirable to employ feedback over several of the preceding stages. Another advantage in doing this is establishment of equal gains, independent of tube characteristics, on each side of the push-pull circuit provided that R_1 R'_1 and R_2 R'_2 in Fig. 3 are carefully balanced. This permits the use of feedback from the primary of the output transformer to preceding push-pull stages. This also permits feedback to be applied across the sides of the push-pull circuit, which reduces cross-modulation and distortion to a very low value.

The cross-coupled push-pull pri-

*Formerly Chief Engineer, P. R. Mallory & Co., Inc., Indianapolis, Indiana

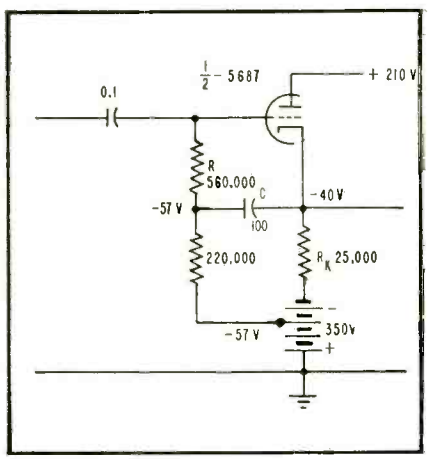


FIG. 2—Input coupling for large *R-C* time constant: output impedance is 225 ohms and maximum output 180 v peak to peak.

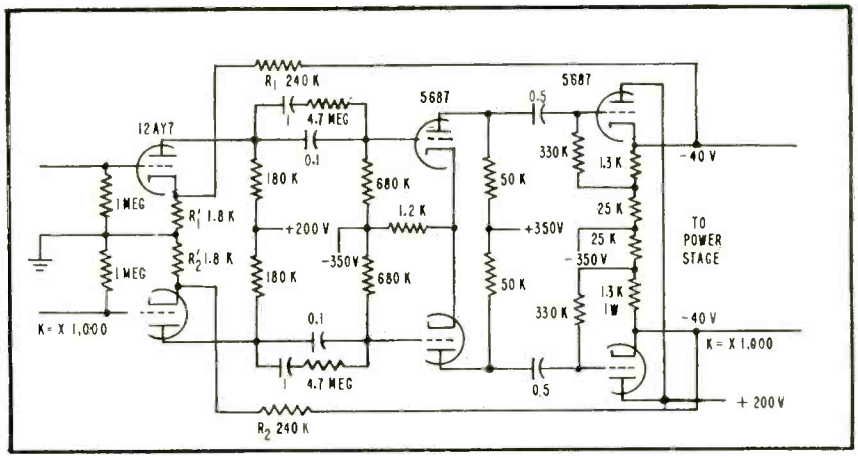


FIG. 3—Low-impedance push-pull driver amplifier has gain of 40 db with 12-db feedback. Resistors R, R', and $R_2R'_2$ must be balanced. Sufficient drive is available for operation of push-pull 807 tubes.

mary feedback amplifier (where a low leakage reactance transformer is used) is a special feedback case analogous to the situation where a tertiary transformer winding is used in a single-ended amplifier. Its equivalent circuit is shown in Fig. 4.[1]

Use of feedback in audio amplifiers operated in part over a nonlinear portion of the output tube characteristic may improve the overall performance of push-pull amplifiers.[2]

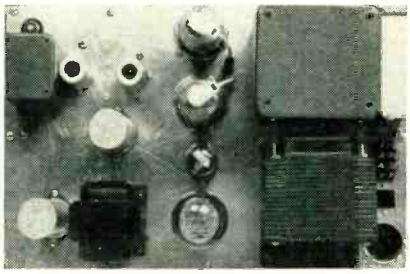
Tests indicate that use of the kicker circuit and 12 db of feedback from the driver grids, with an additional 12 to 20 db of cross-connected feedback from the output tube plates to an earlier stage, will permit design of an efficient amplifier which will supply a large output with low distortion. This arrangement is shown in Fig. 5.

Automatic Balancing System

To maintain the output stage in a statically balanced condition, the d-c servo type of automatic balancing system shown in Fig. 6 has been devised. This circuit employs a d-c differential sampling amplifier, each section of which is followed by a cascode stage for securing the proper phase relationships and maximum servo gain while permitting ready static adjustment of the output stage through adjustment of the cathode-follower driver bias voltages. In addition to the self-balancing feature, this circuit may be adjusted and operated to permit automatic control-bias variation[3] to secure optimum output-stage operation at all power levels. The kicker modification may also be used.

Modified Williamson

In the past, the basic Williamson circuit has been widely followed. Care must be used in the operation of this unit because of the severe distortion that occurs when the grids of the power output stage are driven positive. An improved version of the Williamson type amplifier is described in the literature.[4] Since then, simplification and improvements have been made for the purposes of further reducing distortion, minimizing the effects of the wide range of tube characteristics normally encountered, simplifying construction and reducing the cost of the amplifier system.



Top view of chassis for amplifiers of Fig. 7, 8 and 9 shows component layout

The new amplifier shown in Fig. 7 employs parallel 5V4 tubes in the power supply to provide automatic time delay for the high voltage while maintaining the low power-supply impedance necessary for such a wide-band amplifier. Low-frequency performance is aided by improved decoupling circuitry and longer time constants in some networks. Low-frequency stability characteristics have been improved by reducing interstage time constant between the 12AY7 and the 5687.

Intermodulation Distortion

Since publication of the improved Williamson circuit, greater attention has been paid to optimizing the intermodulation characteristics of the input and driver stages by employing circuit values which will tolerate normal variations in tube characteristics as will occur from one lot of tubes to the next. Also, tests indicate that the 12AX7 may

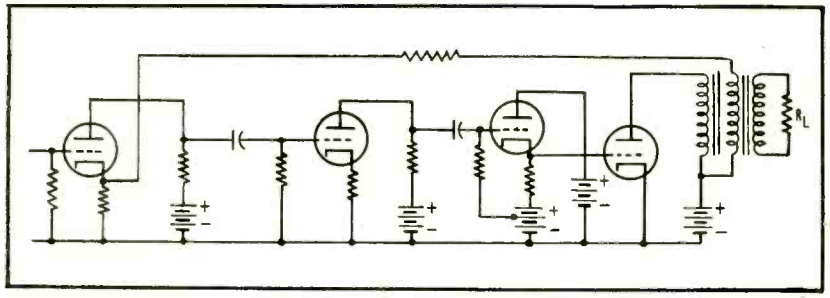


FIG. 4—Equivalent circuit of one side of cross-coupled push-pull feedback amplifier

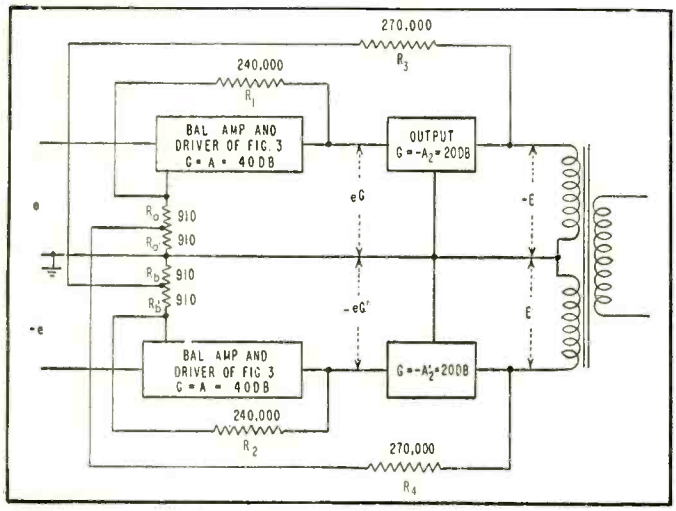


FIG. 5—Low i-d push-pull amplifier has balanced feedback and balanced output

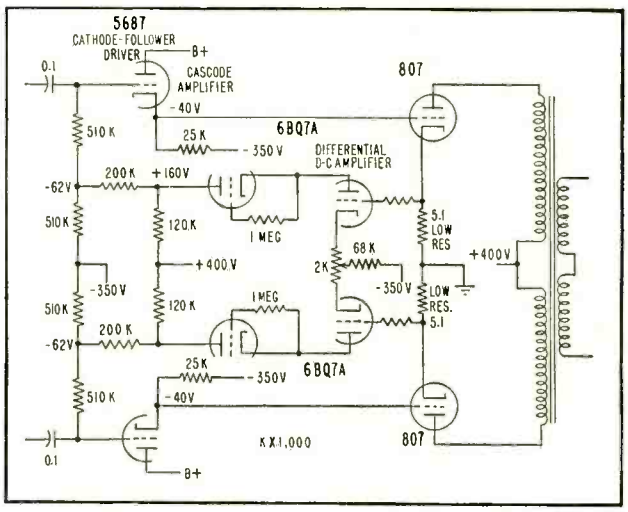


FIG. 6—Servo-balancing system automatically keeps output stage in static balance

serve as a replacement for the 12AY7, with but slight deterioration in performance. Circuit values for this improved input circuit are shown in Fig. 7.

It was found that the inverter section of the 12AY7 makes a large contribution to the intermodulation distortion of the amplifier. This results from too low a plate-supply voltage being generally employed in this stage. If the i-d is to be kept low in the first stage, the optimum cathode resistance should be approximately 270 ohms.

Cross checks were made with a 6SN7 in this part of the circuit and exactly the same results were experimentally verified. Accordingly, the new circuit employs a higher voltage for the plate supply to the inverter section of the 12AY7 and utilizes a 270-ohm resistor in the cathode of the input section. It was possible to get 3 volts rms out of each side of the inverter without measurable i-d, even when four sets of tubes from three manufacturers were interchanged.

Hum Reduction

A 2-ohm resistance in series with the filaments of the 12AY7 input stage helps to stabilize the d-c coupled operation of this stage and reduces hum susceptibility over a considerable variation in tube characteristics.

The 5687 driver stage was checked next, but the original circuit values proved to be optimum from the i-d point of view.

After evaluation of the driver stage, the triode output stage was examined carefully and adjustments were made to determine the optimum bypass point on the cathode resistor. This was found to be at a point 140 ohms down from the cathodes. This value applies only to the triode circuits of Fig. 7. The entire cathode must be bypassed in the tapped beam-power connection of Fig. 8.

The output transformer was next investigated. Two outstanding units were found, General Radio 942-A and the Freed 18777. The Peerless S-268Q, the ACRO, UTC and probably others would exhibit similarly excellent characteristics had they been available for test. These units all have low distortion, reasonably high primary inductance, low leakage reactance and good power-handling capability at both ends of the spectrum. Tight coupling is particularly required to minimize switching transients.

These modifications bring the Williamson circuit of Fig. 7 up to its finest point and provide an amplifier with i-d held to 0.1 percent at 7-watt equivalent single-signal output, to 1.0 percent at 11 watts. Like all amplifiers drawing grid current, the distortion goes to high levels as the grids are driven positive.

When the 807 power-stage grids are driven positive, the driving-point (source) impedance of the 5687 is approximately 1,000 ohms on positive peaks with consequent flattening off of the positive peaks. Matters are made even more acute when the 1,000-ohm series parasitic resistors are considered. An amplifier of this type will only exhibit extraordinary cleanness provided it is never required to deliver a high energy peak.

Ultra-Linear Circuit

A modification of the circuit of Fig. 7 to utilize the ultralinear connection is shown in Fig. 8. At an i-d level of 0.1 percent a power output of 13.7-watt equivalent single

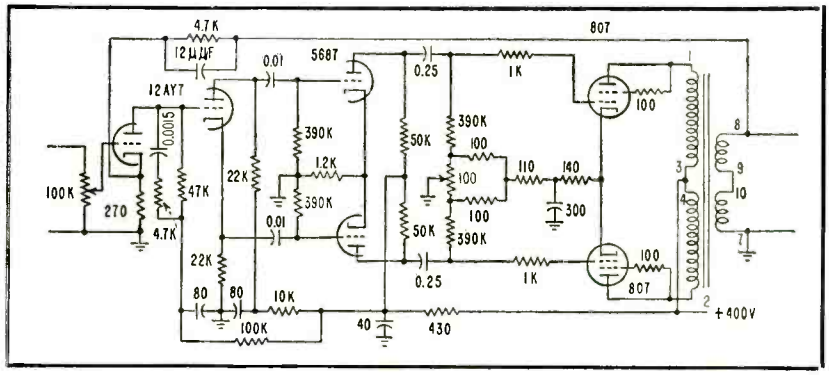


FIG. 7—Improved Williamson amplifier has 11-watt output. Output transformer is Peerless S-265-Q

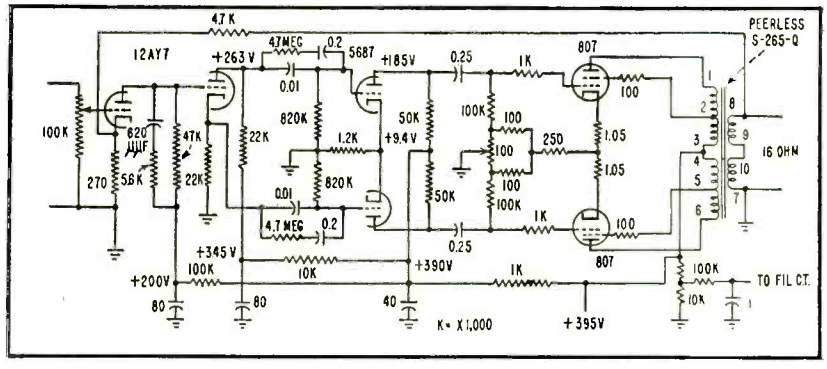


FIG. 8—Improved ultralinear amplifier has 24-watt output. Tube heaters are biased about 35 volts above ground to reduce hum modulation

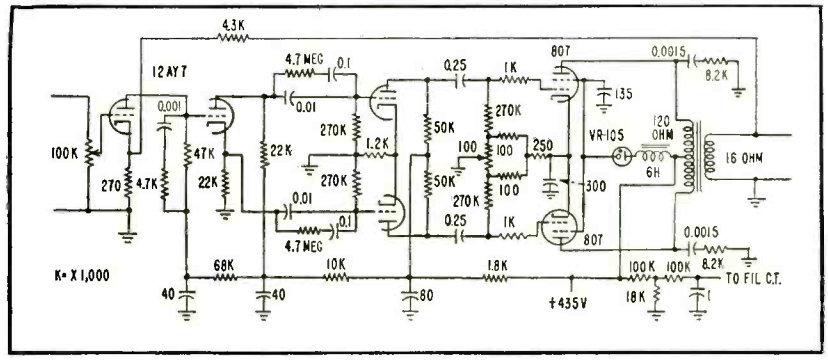


FIG. 9—Thirty-three-watt beam-power amplifier has gas-tube screen-voltage regulation. Output transformer is Peerless S-265-Q

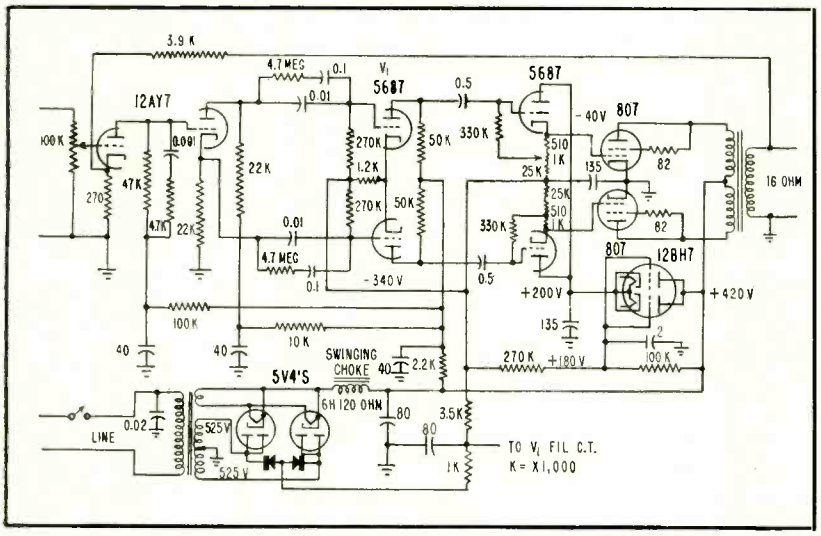


FIG. 10—Forty-five-watt amplifier uses kicker regulation circuit shown in Fig. 1

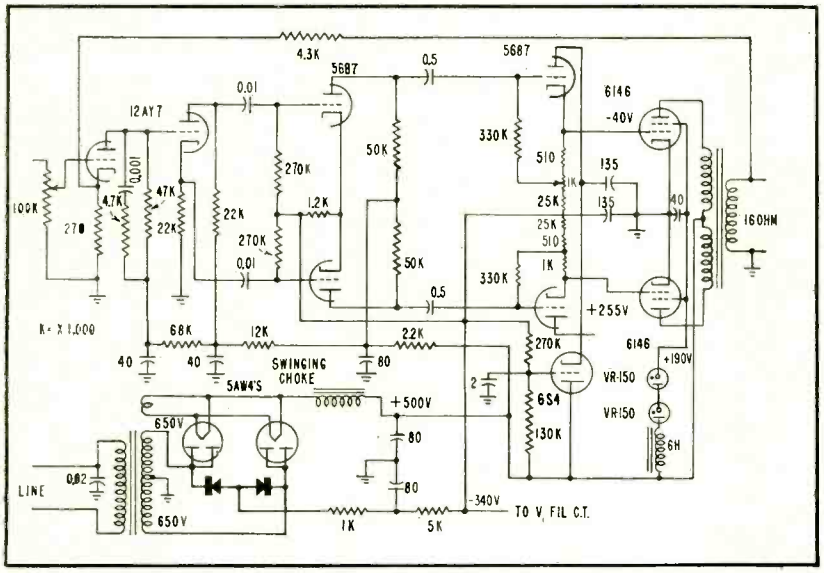


FIG. 11—Push-pull 6146 tubes produce 70-watt output. Output transformer has 6,600-ohm plate-to-plate primary. Total output-stage quiescent plate current is 80 ma

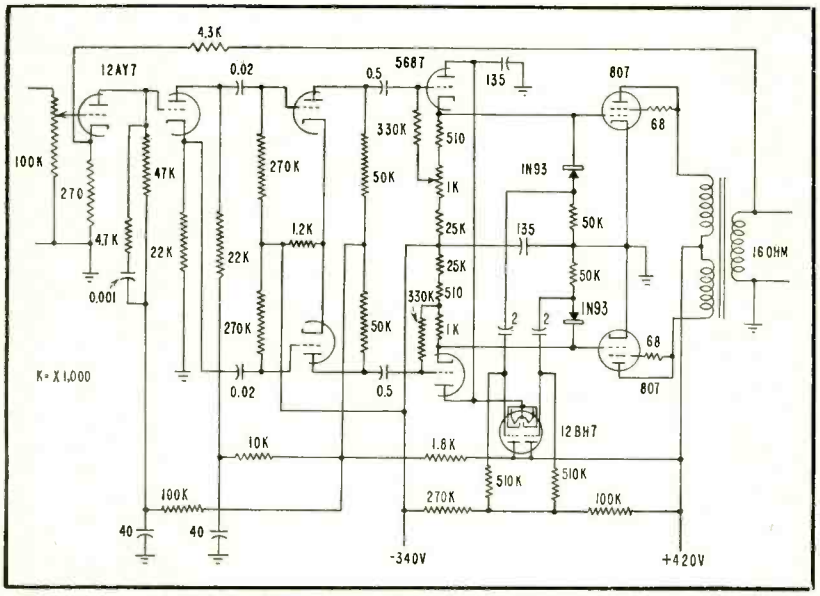


FIG. 12—Sixty-five-watt amplifier uses power supply similar to that in Fig. 10. Total output transformer primary impedance is 2,800 ohms. Second tube is 5687

signal is obtained while at an i-d level of 1.0 percent a power output of 24 watts is obtained, a very real gain in performance.

Approximately 20-db feedback is utilized in the triode version and approximately 24 db with the ultralinear version. The ultralinear version has greater gain because of the quasi-beam-power connection, but also a slightly increased amount of feedback because the feedback resistors are left unchanged. In this case the net circuit gain is about equal to the original triode circuit. Under these conditions, the following comparison of mid-range output damping was measured with a 15-ohm load, 6-volt level at 500 cps: 807 tubes triode connected, output = 0.54 ohm; 807 tubes ultralinear connected, output = 0.39 ohm.

The circuit of Fig. 8 was next modified to use a straight beam-power connection as shown in Fig. 9. At an i-d level of 0.1 percent, a power output of approximately 14 watts equivalent single signal was measured while at an i-d level of 1 percent a power output of 33 watts was obtained. The 24 db of feedback did not cause instability and the output damping was just as satisfactory as in the other two cases.

New Amplifiers

A new series of amplifiers was investigated and carried to a point near completion. Power output, simplicity and cost were the design objectives in this evolutionary program. In each case, care was taken to provide excellent i-d performance as well as output-damping characteristics in the range of 20 or 30 to 1.

The first amplifier built under this program is shown in Fig. 10. This unit employs a cathode-follower driver. Fixed biasing of the output stage combined with a negative high-voltage supply provide approximately 650 volts for the plate supply to the high-level voltage-amplifier driving stage. This amplifier provides 15 watts output at a i-d level of 0.1 percent and 45 watts at the 1.0 percent i-d level.

Fig. 11 shows a beam-power connected counterpart of the amplifier of Fig. 10. In this case, approxi-

mately 14 watts are available at a 0.1-percent i-d level and 70 watts at the 1-percent i-d level.

To check more closely the grid-regulation problem and the desirability of the triode connection, the configuration of Fig. 12 was evaluated and provisions made to use the kicker circuit of Fig. 1A. The improved grid regulation was apparent. At a power level of approximately 21 watts the i-d was 0.1 percent, while 65 watts were available at the 1.0-percent i-d level.

Figure 13 embodies a number of the circuit techniques previously discussed. This design pushes the output, from only two conventional tubes operated at rated levels, to about the maximum power level available from these tubes when operated at nominal receiver voltages and in conventional circuits. It is essential that the high-voltage power supply have good regulation so that peak plate currents of 290 ma, from a static level of 135 ma, will entail only a negligible drop in high-voltage supply. A beam-power connection was used due to the lower grid voltage required and greater gain available with this connection.

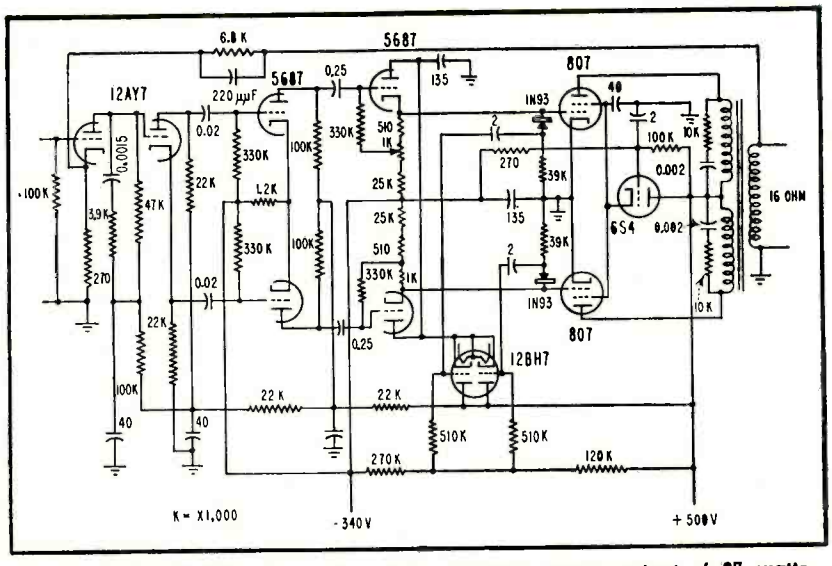


FIG. 13—Push-pull 807 tubes deliver their maximum power output of 87 watts. Total output-transformer primary impedance is 4,800 ohms

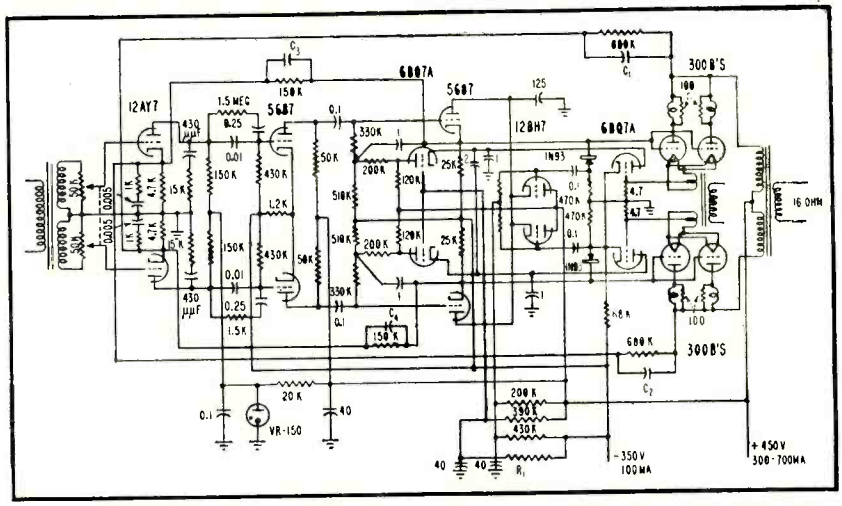


FIG. 14—Recording and/or distribution amplifier has 100-watt output and will deliver 200 watts on instantaneous peaks. Output transformer has total primary impedance of 1,650 ohms

Recording Amplifier

As a result of a meeting with BBC engineers and the acquisition of one of their acetate cutters, which required 87 volt-amperes to obtain a cutting level which was still about 10 db below direct cutting levels ordinarily employed in this country, it was necessary to design an amplifier of greater output capability.

This amplifier, shown in Fig. 14, has a normal rated output of 100 watts, but is capable of putting out 200-watt instantaneous peaks with negligible intermodulation distortion. The output stage efficiency is maintained at a relatively high level over a wide power range as the output stage gradually changes from class A operation to class AB_2 operation with an electronic, servo type of automatic balancing of the output stage static plate currents and simultaneous automatic optimum-bias adjustment.

Resistor R_1 is adjusted for total final-output quiescent plate current of 300 ma. Parasitic-suppression chokes in final-output-tube plate circuits are 20 turns of 32 wire on each associated 100-ohm, ½-watt resistor. Values of C_1, C_2, C_3 and C_4 depend on circuit wiring and transformer characteristics. The stability of this circuit is affected by the wiring and the power supply impedance.

The Freed 18777 transformer was specifically designed for use in this amplifier.

In the design of high-level audio equipment one important point becomes apparent. Cathode emission of cathodes or filaments is quite sensitive to operating temperature (voltage) if distortion is to be held to reasonable levels on peaks. At a point about two to four percent below rated voltage, emissivity starts to limit on peaks. Overvoltage reduces tube life and may give difficulty as a result of increased grid current.

Conclusion

The foregoing covers a considerable range of equipment. For home use, however, there seems to be no need or justification for an amplifier with an output rating in excess of 10 to 20 watts at an i-d level of 1 percent or less.

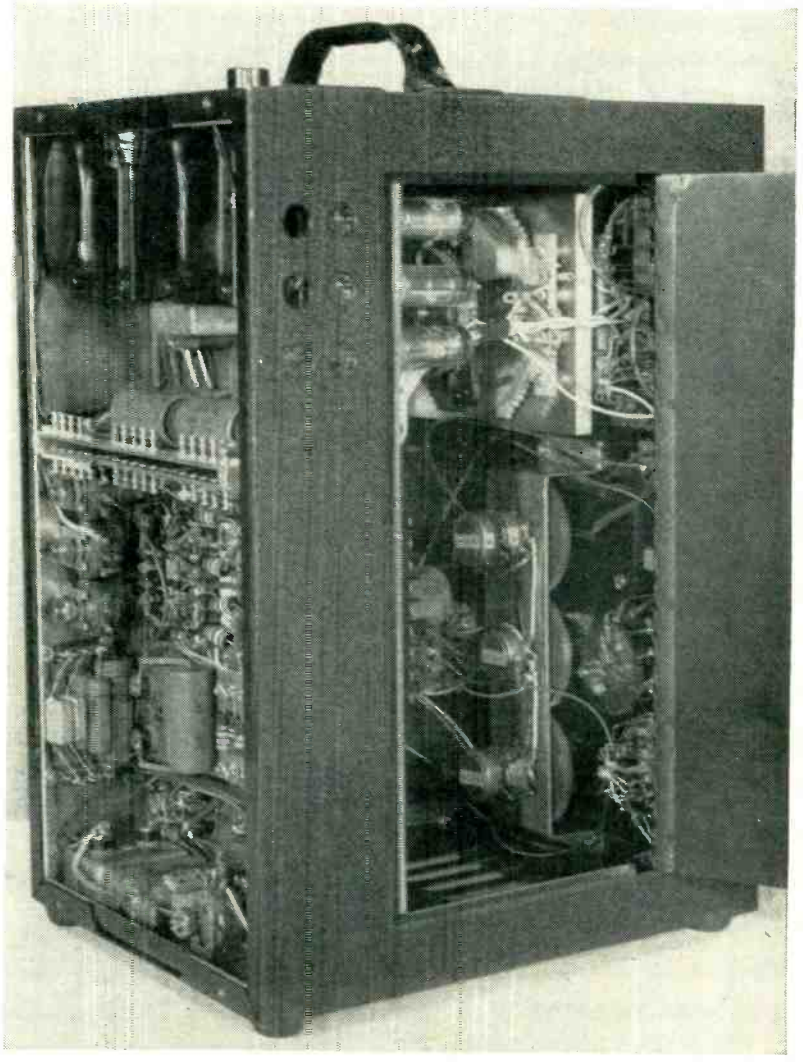
References

(1) Kurt Singer, A High-Quality Recording Power Amplifier, *Jour SMPTE*, p 560, June 1947.

(2) E. E. Zepler, Harmonic Distortion and Negative Feedback, *Wireless Engineer*, May 1954.

(3) A. Edinger, High-Quality Audio Amplifier with Automatic Bias Control, *Audio Eng*, June 1947.

(4) M. V. Kiebert, Jr., The Williamson Type Amplifier Brought Up To Date, *Audio Eng*, Aug. 1952.



Use of electronic oscillator to provide servo driving voltage results in a compact analyzer unit. Null-phasing sine potentiometers are on plate at top right

Servo Analyzer

By F. E. DICKEY

Systems Development
Aeronautic & Ordnance Systems Division
General Electric Company
Schenectady N. Y.

AS PERFORMANCE requirements of servos increase, inner loops need better response at high frequencies and their characteristics have to be measured at frequencies which were not important a few years ago.

In the tester to be described, a phase-shift oscillator, covering a range of 0.25 to 300 cps (1.5 to 1,900 rad), provides an output voltage to drive the unit under test as shown in the block diagram, Fig. 1. The oscillator also provides a two-phase output which is added and phase shifted to null against a voltage taken off the device being tested. Phase shift and attenuation are read directly from dials on the front of the tester.

Phase-Shift Oscillator

The phase shifting circuit is the key to the compactness and wide frequency range of this device. It provides a constant-amplitude signal having a phase shift equal to the number of degrees of rotation of a dial and yet is independent of frequency. The signal can be shifted ±180 deg from the reference without quadrant switching. This allows use of an electronic oscillator to provide the signal in place of the usual two motor-driven synchros or potentiometers. These devices were limited to low frequencies or short life by contact wear.

The phase-shift oscillator is tapped so that it puts out two voltages which are 90 deg out of phase as shown in Fig. 1:

$$a_1 = A \sin \omega t$$

$a_2 = A \sin (\omega t + 90) = A \cos \omega t$

These two voltages are sent through phase inverters and cathode followers to a pair of sine potentiometers whose arms are coupled together but 90 deg apart. Their outputs are

$e_1 = E_1 \sin (\theta + 90) = E_1 \cos \theta$

$e_2 = E_2 \sin \theta$

if $E_1 = A \sin \omega t$ and $E_2 = A \cos \omega t$, and if e_1 and e_2 are added together in a network of gain B, then $e_{out} = B (e_1 + e_2) = A B \sin (\omega t + \theta)$

Equation 1 shows that the output of the phase shifter is constant in amplitude and its phase is shifted by an amount equal to the degrees of rotation of the sine potentiometers. It can be shifted smoothly ±180 deg from the reference and is independent of frequency.

Figure 2A shows the output of the analyzer at several different frequencies. Figures 2B and 2C show 60 and 400-cps suppressed carrier output when a modulator is used to convert the sine wave into a modulated signal.

The complete circuit of the tester is given in Fig. 3. Tube V_{14} is the oscillator using four R-C networks to obtain 180 deg phase shift from plate to grid. Both sections of V_2 are buffers to remove loading from the networks so that there are 90 deg phase shift per pair. They also provide the output voltages.

The 10,000-ohm cathode potentiometers adjust the outputs to zero volts d-c. The 500,000-ohm linear potentiometers are ganged and

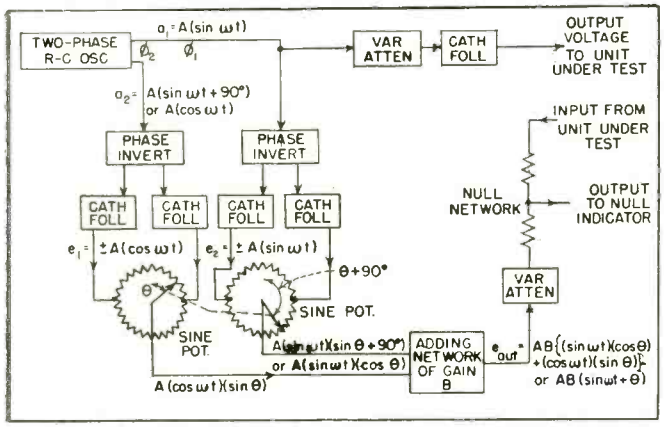
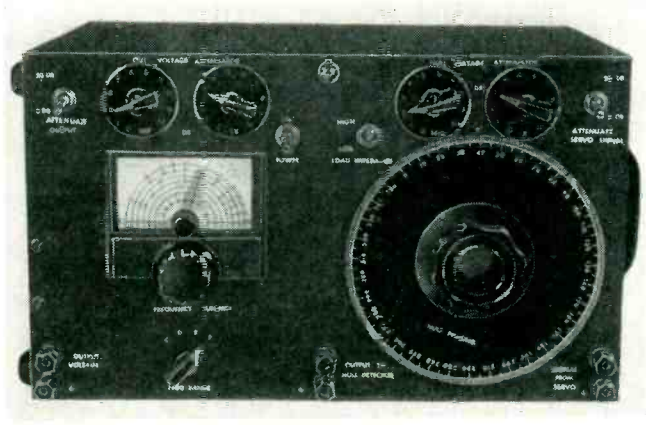


FIG. 1—Drive voltage and nulling voltages are obtained from same oscillator in servo analyzer



Servo analyzer supplies driving and nulling voltages for measuring performance of servo systems

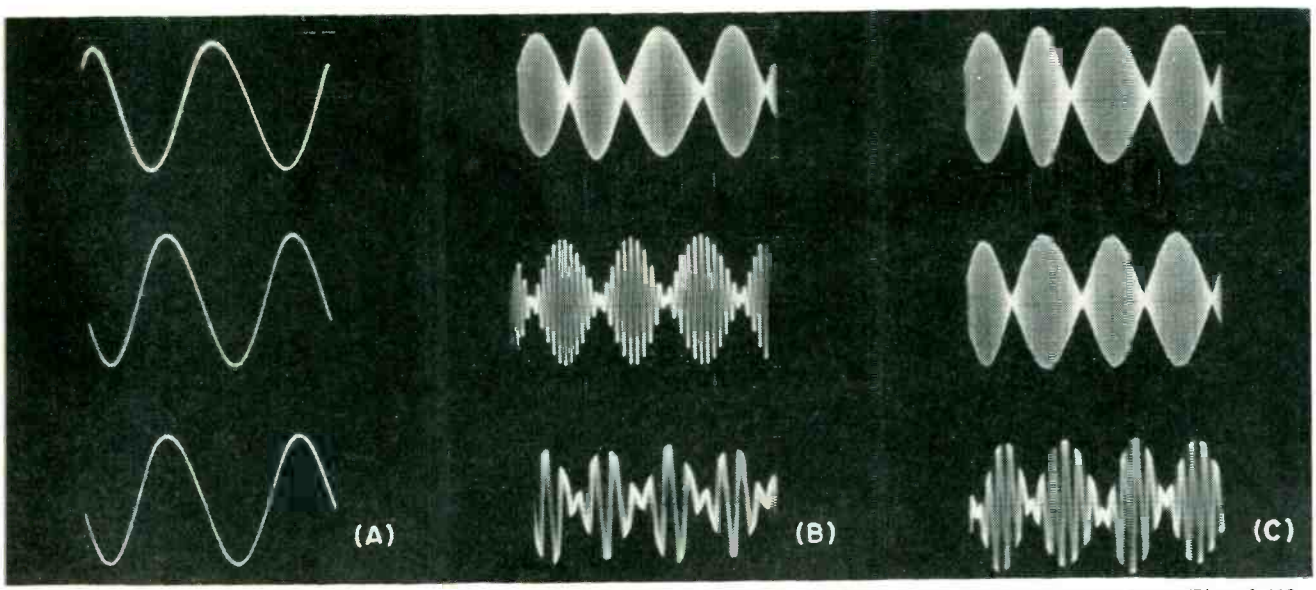


FIG. 2—Output of analyzer (A) at 0.5 cps, top; 10 cps, center and 200 cps, bottom. Modulator unit provides 60 cps carrier (B) and 400 cps carrier (C). Modulation frequencies are 0.5, 3 and 10 cps, top to bottom for 60-cps carrier and 0.5, 5 and 40 cps for 400-cps carrier

for Wide-Range Testing

SUMMARY —— Phase-shift oscillator supplies driving and nulling voltages for servo-system testing over range from 0.25 to 300 cps. Modulator unit can be added to convert output to 60 or 400 cps suppressed-carrier a-m signal

driven by the frequency setting dial. Resistor R_1 is ganged with the frequency-changing resistors so that tube bias changes with frequency and the output remains more nearly constant. Bias resistance is decreased for the high-frequency scale. The output voltage varies ±1 db over the 5-to-1 frequency range on each scale. However, since the driving voltage and the nulling voltage change in exactly the same manner this change is cancelled out.

One phase of output voltage goes through a variable attenuator, shown in detail in Fig. 4, to V_{1B} which provides an output voltage of 15 volts rms max. With high-gain servos, the driving signal will be small to prevent saturation. If this signal is only a few millivolts, there will be some noise present from V_{1B}.

Switch S_2 permits attenuation of the output of V_{1B} by 20 db. The variable attenuator must then be reduced by the same amount to compensate, thus effecting a 20-db increase in signal-to-noise ratio.

If load impedance is over 10,000

ohms, the output may be applied directly. For a lower impedance switch S_3 is set to the low position adding 10,000 ohms in series with the output.

Both output phases are fed through phase inverters and cathode followers, V_3, V_4, V_5 and V_6, to the sine potentiometers. Their outputs are added and sent through a variable attenuator to the nulling network. The output of the null network is fed to an oscilloscope or recorder.

The signal from the servo loop is fed through S_1 into the null network. For feedback signals greater than 15 v rms, S_1 provides 20-db attenuation.

Frequency Dial

The frequency dial turns only 180 deg so there must be a 1¾ to 1 step-up of its motion. This allows the five-gang potentiometer to turn at least 300 deg to give a 5-to-1 change in frequency on each scale. Since this tester was designed to measure characteristics of networks and filters as well as servos, there had to be some compromise in the manner of reading the phase-shift dial. Connections to the sine potentiometers are made so that the dial reads zero when the output of the phase shifter is in null with the driving voltage. Increasing readings mean leading angles and decreasing readings indicate lag. This makes the feedback voltages from servos read 180 deg when there is no phase shift in the system. For use only on servos, the dial can be arranged to read zero deg for pure negative feedback signals.

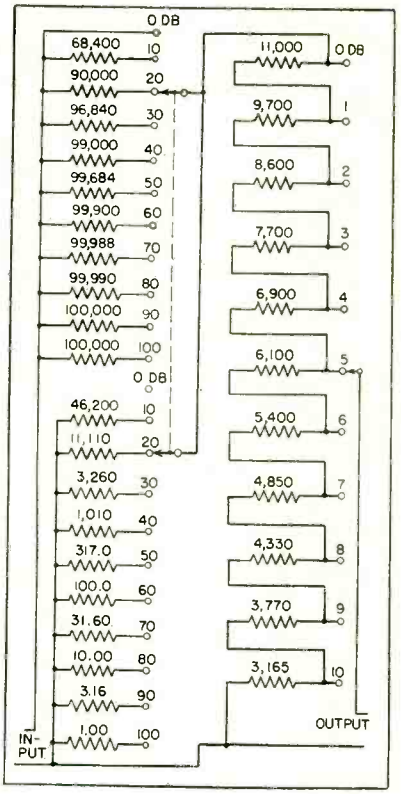


FIG. 4—Variable attenuator for servo tester provides up to 100-db attenuation in 1-db steps. The 60-db unit is similar in construction except that no steps past 60 are used

Nulling

At frequencies above three cps, it is easy to null two voltages by putting the null signal on the Y axis of a cro using a sweep slow enough to give several cycles on the screen. At lower frequencies or in the presence of distortion at any frequency, it becomes very difficult to null by this method. Under these conditions a better null system consists of putting the output of the null network on the Y axis of a long persistence cro as before, but using the variable-phase voltage (before it is attenuated) as the sweep sig-

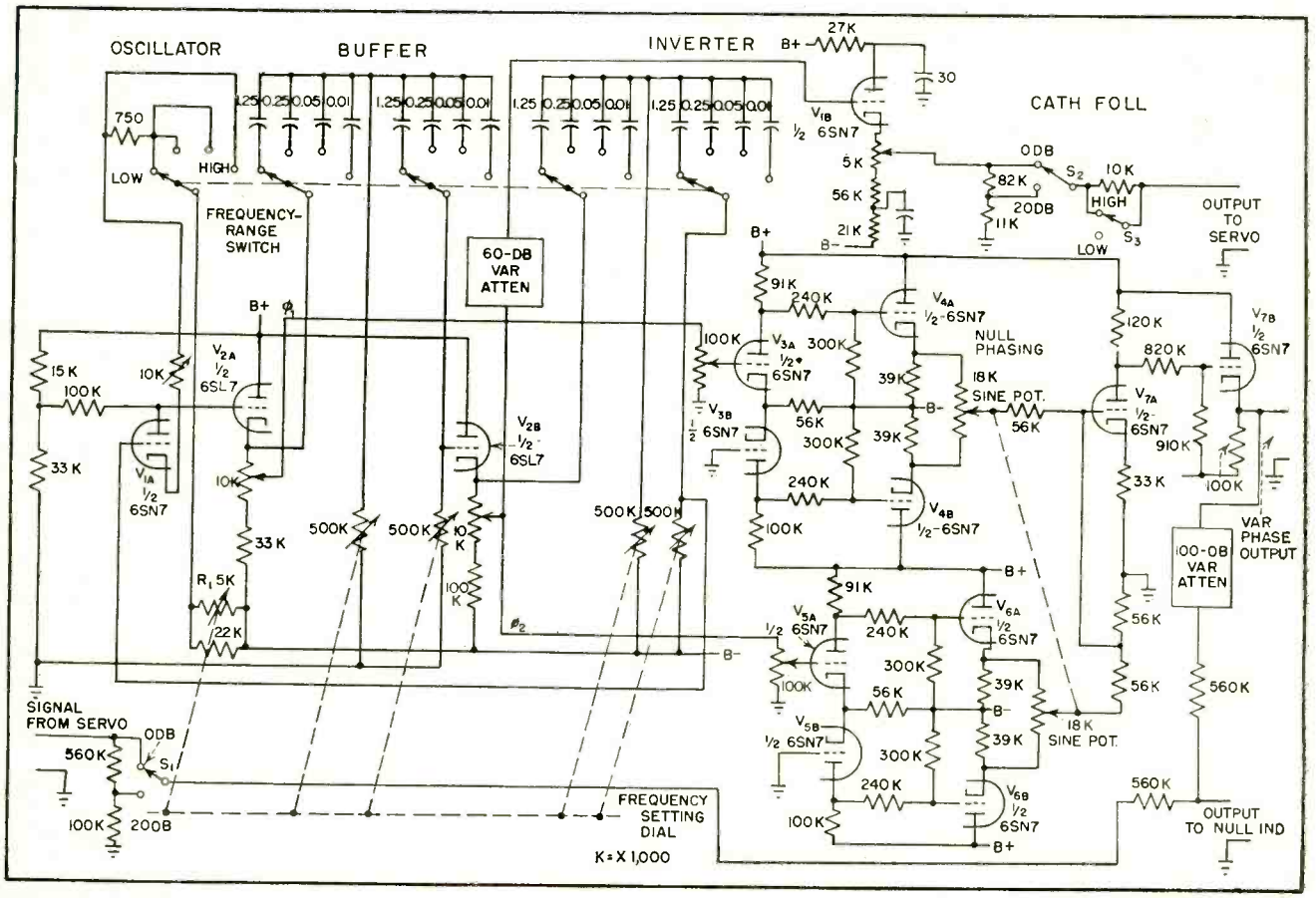


FIG. 3—Four phase-shift networks in oscillator circuit provide 180-deg phase shift in variable output without quadrant switching

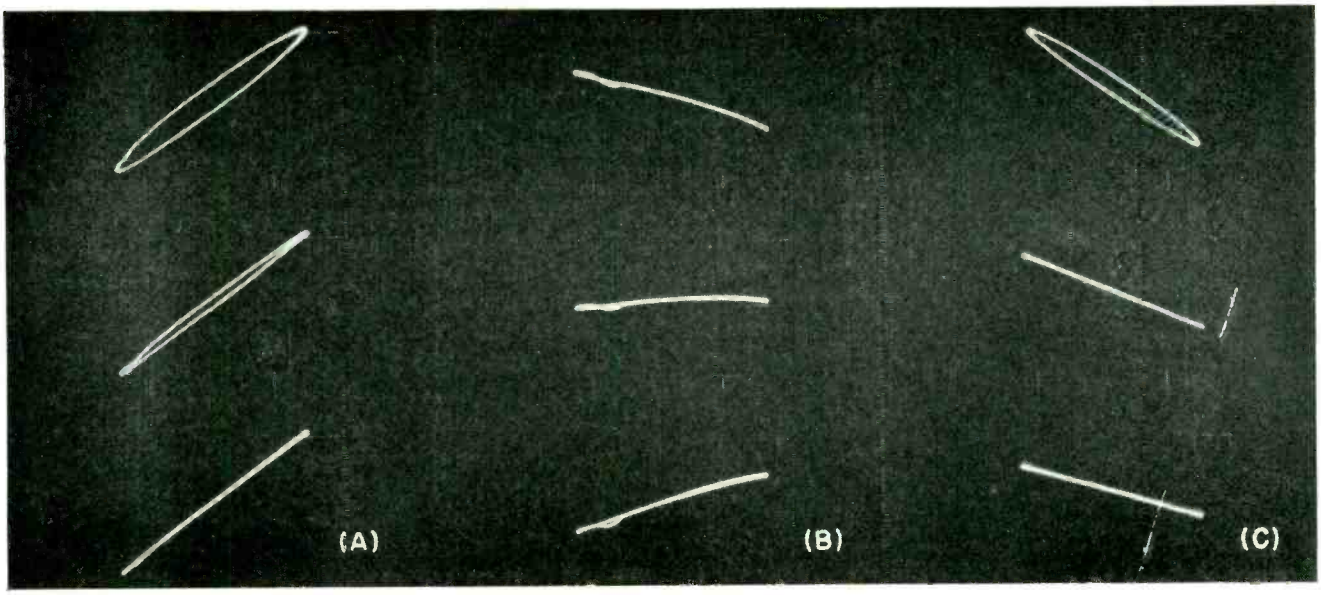


FIG. 5—Oscillograms show amplitude null (A) and phase null (B). False null (C) obtained when signals are 180-deg out of phase can be easily detected since adjusting attenuator will not change slant of pattern

nal. This requires d-c amplifiers for both axes of the scope. The variable phase voltage is brought to output terminals for this purpose.

Figure 5 shows typical patterns obtained with this system in the presence of distortion. The phase shift dial is turned until the pattern closes as in Fig. 5A. Then the attenuation of the variable phase is adjusted until the pattern is horizontal as shown in Fig. 5B. If the variable phase voltage is too large the pattern will slant in one direction and if too small the pattern will slant in the other direction.

If the phase-shift dial is turned 180 deg, the pattern will close and a false null will be obtained as in Fig. 5C. However, it is discernible as a false null because no adjustment of the variable-phase attenuator can reverse the slant.

Since the input and output of the tester have a common ground, it is sometimes necessary to use resistor networks to add signals into servo loops or to buck out d-c components of feedback voltages. Figure 6 shows a method by which closed loop tests were run on a large electrohydraulic servo.

Self Checking

For cross checking this device, it is necessary only to feed the output back in as the signal from the servo. The attenuators should read the same at null. The phase dial should read zero deg at all frequencies. For further checks, an R-C lead or lag network can be connected between input and output and its measured characteristics compared with the calculated.

Figure 7 shows a modulator converting the tester output to either 60 or 400-cycle modulated signals as shown in Fig. 2B and 2C. Since the synchro output is a suppressed-carrier amplitude-modulated voltage, it is necessary to use a modulator which will give that type of signal. With no modulation signal, the 500-ohm potentiometer in the cathode of V_2 is adjusted so that carrier voltage is balanced to zero in the output. When modulation voltage is brought in, the only signals in the output are $f_{carrier}$ plus and minus $f_{mod.}$ The capacitors across the interstage transformer are used to compensate for phase shift in the transformers and should be adjusted so that the modulated output, with $f_{mod.}$ very low, is in phase with the carrier.

The author wishes to thank J. C. Hobbs, B. A. Tietjen and E. H. Cabaniss for their assistance in the development and J. E. Moulton who did the construction.

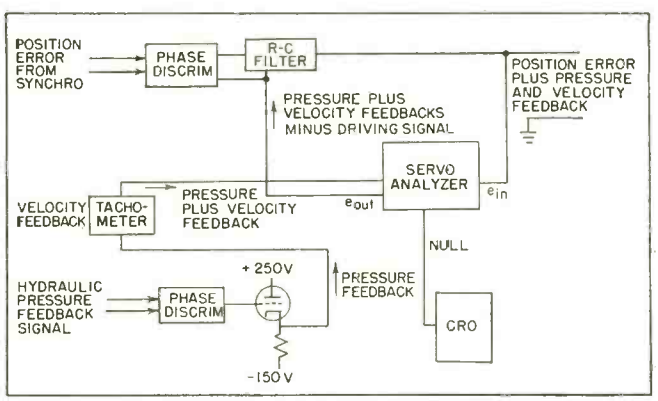


FIG. 6—Test setup for using servo analyzer to measure overall response of closed position loop with series added feedback

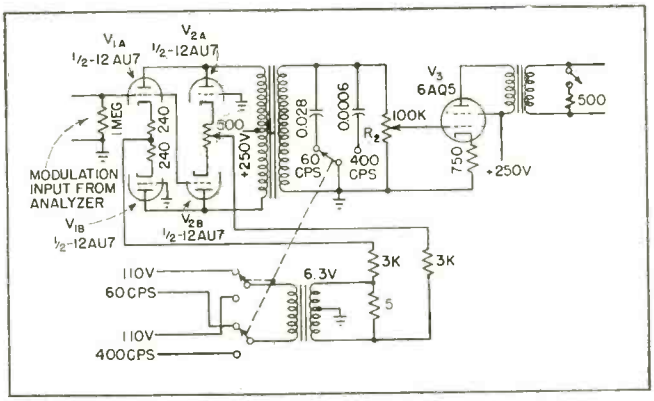


FIG. 7—Modulator unit converts output of analyzer to 60 or 400-cps suppressed-carrier a-m signal

Dielectric Mixture Chart

SUMMARY —— Nomograph determines dielectric constant of mixture of two dielectrics when their respective dielectric constants and proportions are known. Computation is useful for filled resins used in encapsulation

By ELIO SION

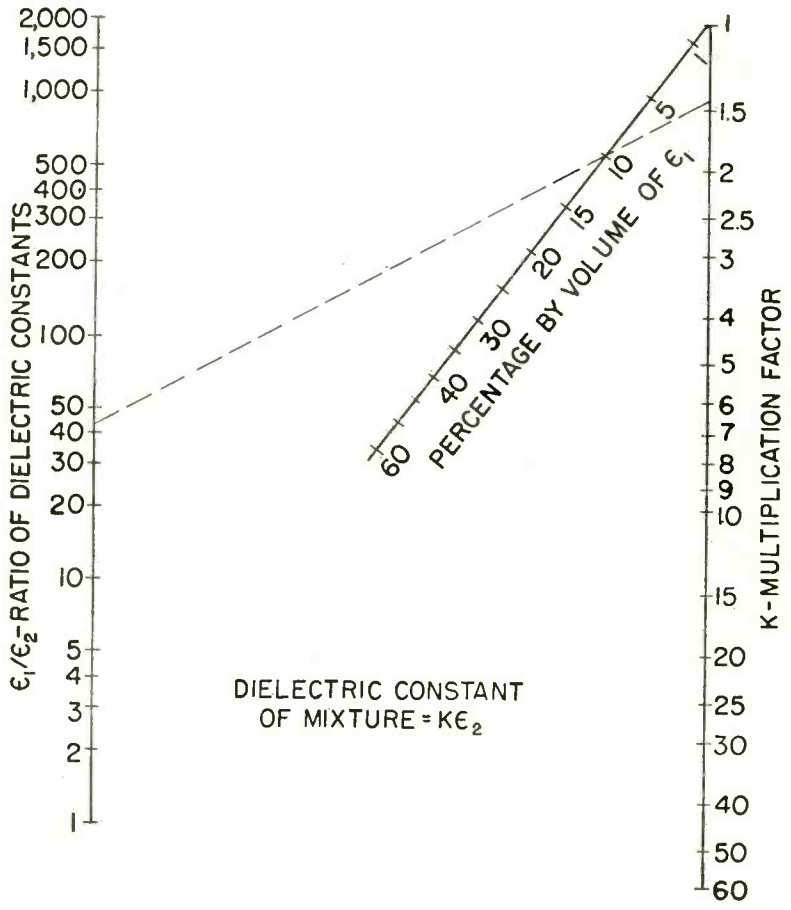
Airborne Instruments Laboratory, Inc.
Mineola, N. Y.

PLASTIC materials used for encapsulation are often mixed with filler material such as glass fibers, asbestos, silica or alumina to reduce shrinkage and increase dimensional stability. The dielectric constant of the resulting compound can be determined from the nomograph given here.

The law governing the dielectric constant of a mixture of two different dielectrics is

$$\log E = p_1 \log \varepsilon_1 + p_2 \log \varepsilon_2$$

where E is the dielectric constant of the resultant mixture and p_1 and p_2 are the percentages by volume of substances with dielectric constants ε_1 and ε_2 respectively. For convenience, this nomograph assumes ε_1 to be the additive and to have the higher di-electric constant.

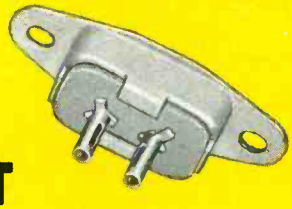


To find the dielectric constant of a mixture, find the ratio $\varepsilon_1/\varepsilon_2$ and enter the left-hand scale at this value. Draw a line joining this value with the percentage by volume of ε_1 to be added on the intermediate scale. The intersection of this line with the right-hand scale yields the factor K which is the value by which ε_2 is to be multiplied to give the dielectric constant of the new mixture; that is, $K\varepsilon_2 = E$.

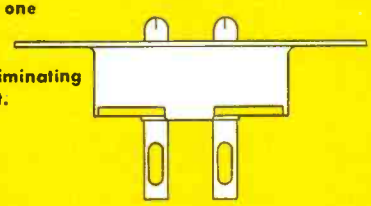
For example, to find the resultant dielectric constant of a mixture containing 10 percent rutile (TiO_2) by volume for which $\varepsilon_1 = 110$, and 90 percent polystyrene for which $\varepsilon_2 = 2.54$, enter the left-hand scale at $\varepsilon_1/\varepsilon_2 = 110/2.54 = 43.4$, join the intermediate scale at 10 percent and extend the line finding $K = 1.46$. Hence the dielectric constant of resultant mixture is $E = K\varepsilon_2 = 1.46 \times 2.54 = 3.7$.

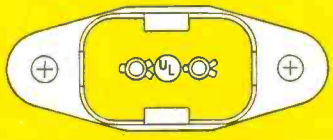
ELECTRONICS REFERENCE SHEET

TV 110 VOLT DISCONNECT PLUG:

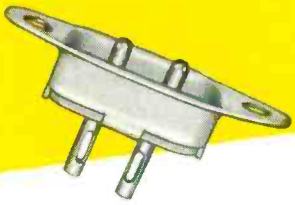


. . . one piece pin with solder tail is featured in the 110 volt TV lead in. Underwriters approved. Eliminates intermittents. The new one piece pin with solder tail insures positive electrical flow through plug to set by eliminating old style pin-lug riveted joint.





Saves scarce materials . . . eliminates one piece of insulation and two soldering lugs. Saves solder and soldering operations.



Cinch ELECTRONIC COMPONENTS

KINESCOPE SOCKETS

QUANTITY PRODUCTION OF LOW LOSS MICA COMPONENTS

Finest molding machines and equipment operated under most experienced guidance and engineering supervision with adequate and unequaled facilities has advanced CINCH to the foremost in production of low loss Mica components in quantity.

. . . Magnal and Diheptal; molded of high dielectric black or low loss mica-filled phenolic material. Full floating CINCH solder coated phosphor bronze contacts insure easy insertion of tube and provide excellent electrical connections.

Consists of main casting with required number of contacts assembled. Insulator is assembled in position but not fastened. Supplied with two screws, two nuts and two lock washers. Available with .062 steel mounting ring as shown.

Cinch components are availble at leading electronic jobbers—*everywhere.*

Cinch automatically assembled parts assure the uniformity and quality mandatory for use in AUTOMATION in the end users equipment.

Cinch ELECTRONIC COMPONENTS

CONSULT CINCH!

CINCH MANUFACTURING CORPORATION

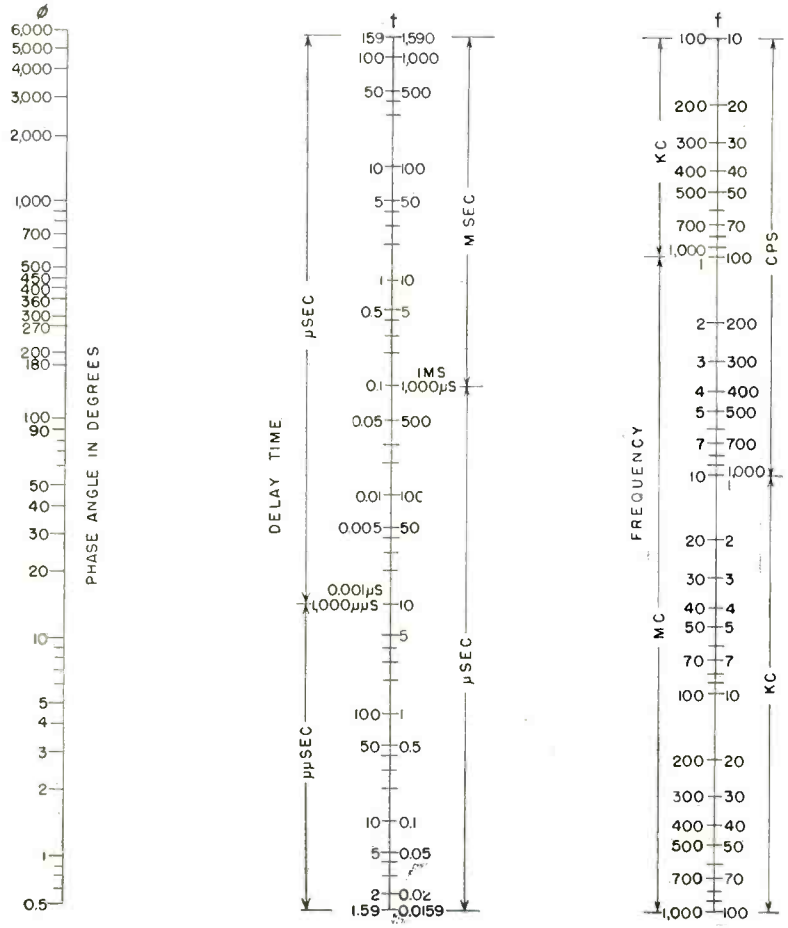
1026 South Homan Ave., Chicago 24, Illinois

Subsidiary of United-Carr Fastener Corporation, Cambridge, Mass.

Phase-Linearity Nomograph

SUMMARY – Chart relating time delay, phase shift and frequency facilitates testing of phase-shift, band-pass and delay time characteristics of video amplifiers and other pulse circuits

By JOSEPH F. SODARO
Los Angeles, Calif.



IN the design of video amplifiers, i-f amplifiers, delay lines and similar circuits, it is desirable to obtain uniform gain and linear phase shift over the desired passband.

This condition of phase shift proportional to frequency may also be defined as constant time delay. If phase shift in radians is expressed as $\varphi = 2\pi ft$, the expression can also be written as $t = \varphi/2\pi f$.

If φ is proportional to frequency f, the right-hand member of the second equation is a constant. Thus, t, the time delay is a constant.[1]

Large angular measurements may be simplified if frequencies corresponding to principal angles are measured. At these angles the cro pattern is a straight line or circle. Small angles can be measured by the intercept method in which the phase-angle sine equals the ratio of y-intercept to maximum-deflection values. From this, the angle can be calculated.[2]

As frequency is varied and angular difference observed on the cro the amount and constancy of time delay can be determined from the nomograph. Select angular difference on the ψ scale in degrees.

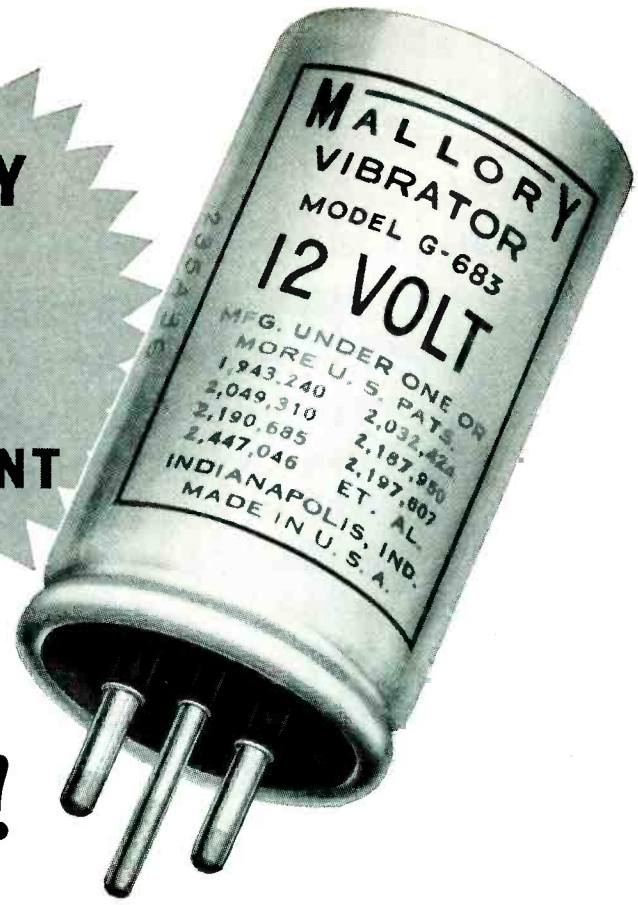
Draw a line to the frequency on the right-hand scale. Read time delay where the line intersects the t scale on right or left-hand scale corresponding to the f scale used. As frequency is varied, pivot a straight-edge about the time-delay value to other φ and f combinations. Observe the deviation from a constant time delay to determine bandpass limits of the circuit under test.

By providing limit lines on the t scale in accordance with test specifications, this chart can be used by production test personnel.

REFERENCES

(1) A. A. Barco, Measurement of Phase Shift in Television Amplifiers, *RCA Rev*, Apr. 1939.
(2) J. F. Sodaro, Phase Shift by CRO, ELECTRONICS, p 192, May 1953.

A MALLORY *25th Anniversary* VIBRATOR DEVELOPMENT



The *Quietest* Vibrators Ever!

Mechanical hum has been reduced to a new low, in the latest vibrators developed by Mallory. A product of Mallory's 25 years of pioneering research and manufacturing experience in the vibrator field, this new model makes it possible to design automobile radios and other battery-powered electronic equipment for lower hum levels than ever before possible.

"FLOATING" DESIGN. The secret of this vibrator's exceptional performance is a new construction in which the vibrator mechanism "floats" inside the case. Transmission of mechanical hum or shake to the outside of the can or base is held to an absolute minimum.

QUIET IN ANY MOUNTING POSITION. Noise output remains consistently low regardless of the position in which the vibrator is mounted . . . actually is lower in level than the electrical hum emitted by most auto radio speakers.

PREMIUM PERFORMANCE WITHOUT PREMIUM COST. The new, extra-quiet Mallory vibrators cost no more than previous models. They are now the standard type, in most instances bearing the same part number.

For quiet operation, long life and consistent performance, you will find these Mallory vibrators your best choice . . . both for new designs and for the units you now have in production. For specialized consultation on your power supply problems, call on the experience which Mallory has gained during a quarter century of leadership in vibrator development and application. Write today for our Technical Bulletin, or for a call by a Mallory representative.

IN POWER SUPPLIES BE SURE TO USE . . .
Mallory FP Electrolytic Capacitors . . . The original fabricated plate capacitor, FP electrolytics have for many years been built for continuous operation at 85° C. Famous for long shelf and service life.

Expect more . . . Get more from

P. R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

Parts distributors in all major cities stock Mallory standard components for your convenience.

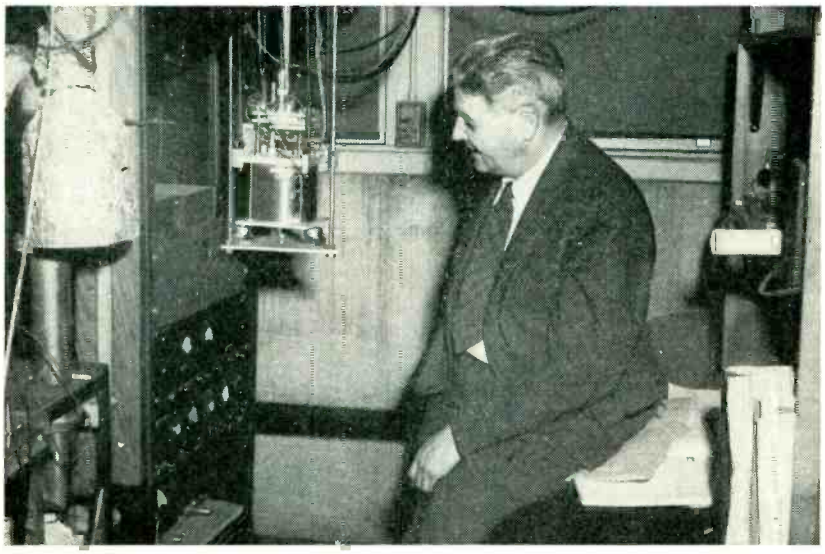
Serving Industry with These Products:
Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

ELECTRONICS Charter-Year Advertiser

Electrons At Work

Edited by ALEXANDER A. McKENZIE

Cesium Frequency Standard Controls Accurate Atomic Clock



Model of the new time standard so accurate that it might be only a half-second wrong in 2,000 years is viewed by Jerrold R. Zacharias of MIT

ACCURATE SYNCHRONISM of events in different places anywhere on the earth is possible with the aid of the cesium atomic frequency standard developed under the direction of Jerrold R. Zacharias at Massachusetts Institute of Technology.

Similar to the MASER (microwave amplification by simulated emission of radiation) recently announced by Columbia University but operating on a different principle, the device depends upon oscillation of electrons in the cesium atom.

As an electron revolves around the nucleus of an atom, it wobbles very slightly at a constant rate. This unvarying rate of oscillation is reflected in the frequency of waves emitted.

The element cesium has a frequency of about 9,192.632 mc that serves as the time unit in the atomic clock. One one-hundredth of a gram of cesium is enclosed in a metal crucible. When heated to about 100 C, the cesium shoots a stream of atoms through a hole in the crucible. The atoms strike a detector screen and their frequency is determined in the apparatus.

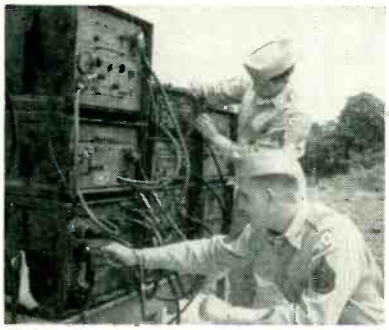
Since the cesium loses only about a millionth of a gram a day, the clock is, for all practical purposes, perpetual. The ordinary primary standard of frequency that depends upon oscillations of a quartz bar is checked by astronomical measurements and is accurate to 1 part in 10^9. At the present stage of development, the cesium standard is accurate to 1 part in 10^{10} but is capable of accuracies of 1 part in 10^{12}.

Applied to navigation problems, astronomy, geophysics and communications, the new time standard will permit very much more accurate measurements that can lead to more exact knowledge.

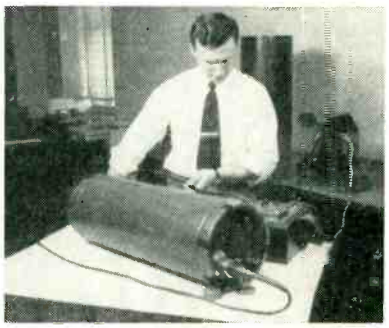
Associated with Dr. Zacharias in the work have been James G. Yates and Robert D. Haun. Support has come from Signal Corps, Office of Scientific Research, Air Research and Development Command and the Office of Naval Research.

(Continued on p 182)

Threefold Gain In Military Telephone Channels



Terminal units of 12-channel carrier telephone system that can be extended to 200 miles. Three times as many conversations over a single cable are handled on the new system as compared with Korea and World War II systems. Equipment is made by Western Electric



Laboratory test of unattended repeater designed for use in 12-channel carrier telephone system. Watertight unit in cylindrical aluminum casing is required every six miles to restore transmission levels. Bell Telephone Laboratories did the development work

Portable Army Signal Corps telephone system uses electronic methods to handle four conversations at a time over a single cable. The repeater (above) is one of several that can be used in the hundred-mile circuit that is now possible in the field

KEPCO

KR SERIES

7 NEW

VOLTAGE REGULATED POWER SUPPLIES

for powering electronic equipment

SAVE TIME AND MONEY

Build these compact Power Supplies into your equipment!

Kepco Voltage Regulated Power Supplies are conservatively rated and are designed for continuous duty at 50°C ambient. The regulation specified for each unit is available throughout its output voltage range for line voltage variations from 105-125 volts and load variations from 0 to full load.

FEATURES:

- Superior Regulation.
- Ultra-Stable 85A2 OG3 Reference Tube.
- Low Ripple.
- Low Output Impedance.
- Fast Recovery Time, Suitable for Square Wave Pulsed Loading.
- Voltage Range continuously variable without Switching.
- Either Positive or Negative may be Grounded.
- Oil Filled Condensers.
- Wire Harness and Resistor Board Construction.
- Power Requirements 105-125 volts, 50-60 cycles. Units operate up to 400 cycles.
- Terminations and locking type voltage control on rear of unit.
- AC, DC Switches, Fuses, and Pilot Lights on Front Panel.
- Color Grey Hammertone.
- Guarantee One Year.

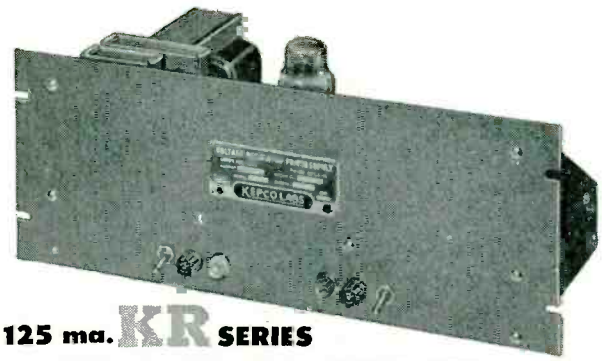
To include 3" Current and Voltage Meters, Add M to Model number (e.g. KR 1-M) and Add $30.00 to the Price.
To include Dust Cover and Handles for Table Mounting, Add C to Model number (e.g. KR1-C) and Add $10.00 to the Price.
To include Meters, Dust Cover and Handles, Add MC to Model number (e.g. KR1MC) and Add $40.00 to the Price.
PRICES F.O.B. Flushing.

KEPCO Laboratories

KEPCO LABORATORIES

131-38 SANFORD AVENUE • FLUSHING 55, N. Y.

INDEPENDENCE 1-7000



125 ma. KR SERIES

MODEL	OUTPUT	VOLTS	CURRENT	REGULATION line 105-125V	REGULATION load 0-max.	RIPPLE (RMS)	19" Rack Mount W	H	D
KR1 $90.	1	100-200	0-125 ma.	0.3 volts	0.3 volts	3 mv.	19"	7"	7½"
	2	6.3 AC	3 amp.	*	*				
KR2 $90.	1	200-325	0-125 ma.	0.2 volts	0.2 volts	3 mv.	19"	7"	7½"
	2	6.3 AC	3 amp.	*	*				

*AC Voltages unregulated.

300 ma. KR SERIES

MODEL	OUTPUT	VOLTS	CURRENT	REGULATION line 105-125V	REGULATION load 0-max.	RIPPLE (RMS)	19" Rack Mount W	H	D
KR3 $180.	1	100-200	0-300 ma.	0.3 volts	0.3 volts	3 mv.	19"	7"	11"
	2	6.3AC	5 amp.	*	*				
	3	6.3AC	5 amp.	*	*				
KR4 $180.	1	200-325	0-300 ma.	0.2 volts	0.2 volts	3 mv.	19"	7"	11"
	2	6.3AC	5 amp.	*	*				
	3	6.3AC	5 amp.	*	*				

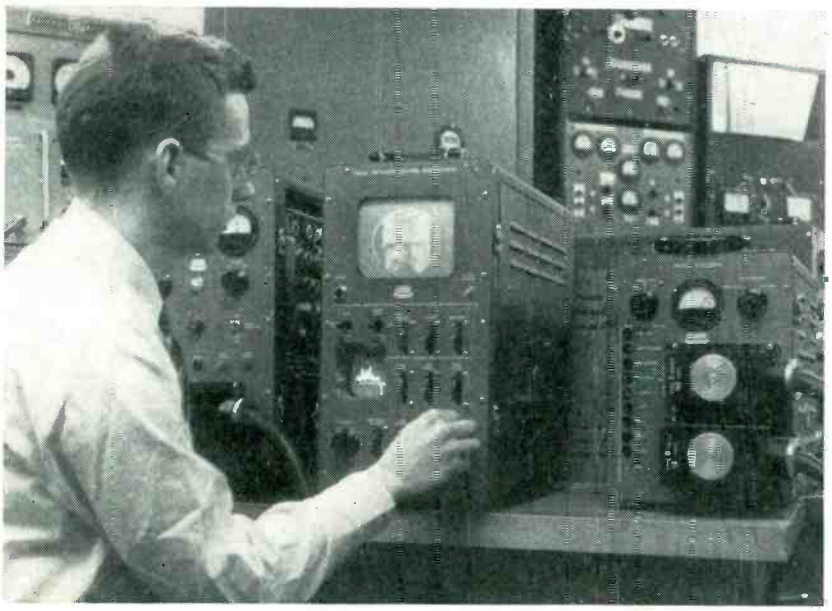
*AC Voltages unregulated.

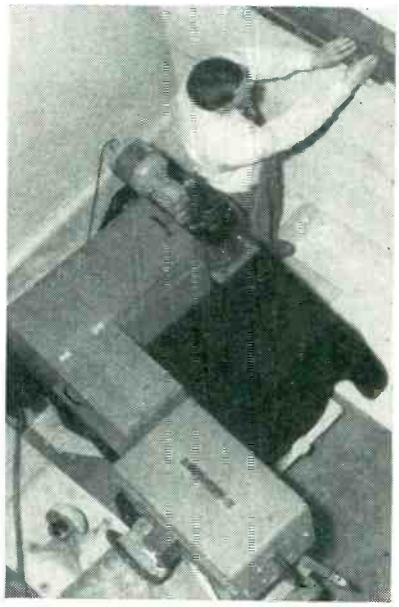
600 ma. KR SERIES

MODEL	OUTPUT	VOLTS	CURRENT	REGULATION line 105-125V	REGULATION load 0-max.	RIPPLE (RMS)	19" Rack Mount W	H	D
KR5 $240.	1	100-200	0-600 ma.	0.3 volts	0.3 volts	5 mv.	19"	10½"	13"
	2	6.3 AC	10 amp.	*	*				
	3	6.3 AC	10 amp.	*	*				
KR6 $240.	1	195-305	0-600 ma.	0.2 volts	0.2 volts	5 mv.	19"	10½"	13"
	2	6.3 AC	10 amp.	*	*				
	3	6.3 AC	10 amp.	*	*				
KR7 $250.	1	295-405	0-600 ma.	0.2 volts	0.2 volts	5 mv.	19"	10½"	13"
	2	6.3 AC	10 amp.	*	*				
	3	6.3 AC	10 amp.	*	*				

*AC Voltages unregulated.

X-ray Television Shows Inside of Operating Engine





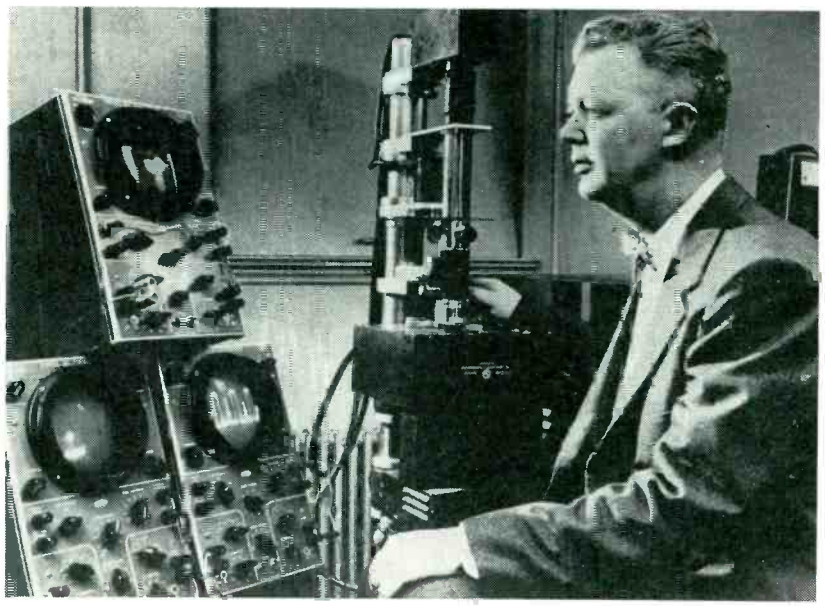
At a recent demonstration staged by the National Bureau of Standards, working parts of an operating engine were shown by means of penetrating x-ray energy and a closed-circuit television system. A small one-cylinder engine was placed between a betatron and a large thallium-activated sodium iodide crystal. The visible replica of the x-ray image was picked up by the camera of a closed-circuit television system. Using x-radiation from a 180-mev synchrotron, the technique allows observations through 6 feet of concrete or 12 feet of water

Scanner Compares Cancer Cells Against Normal Cells

GRANTS totaling $100,000 have been awarded Airborne Instruments Laboratory of Minneola, N. Y. for continued development of an optical electronic device known as the Cytoanalyzer. Its purpose is to detect cancer cells obtained from body fluids by the Papanicolaou method —the reading and interpretation of cell properties exhibited by smears of fluids from natural body openings.

An experimental model of the machine views microscope slides prepared from Papanicolaou smears and a scanning technique transforms the picture into an electric signal. A computer distinguishes between normal and cancer cells.

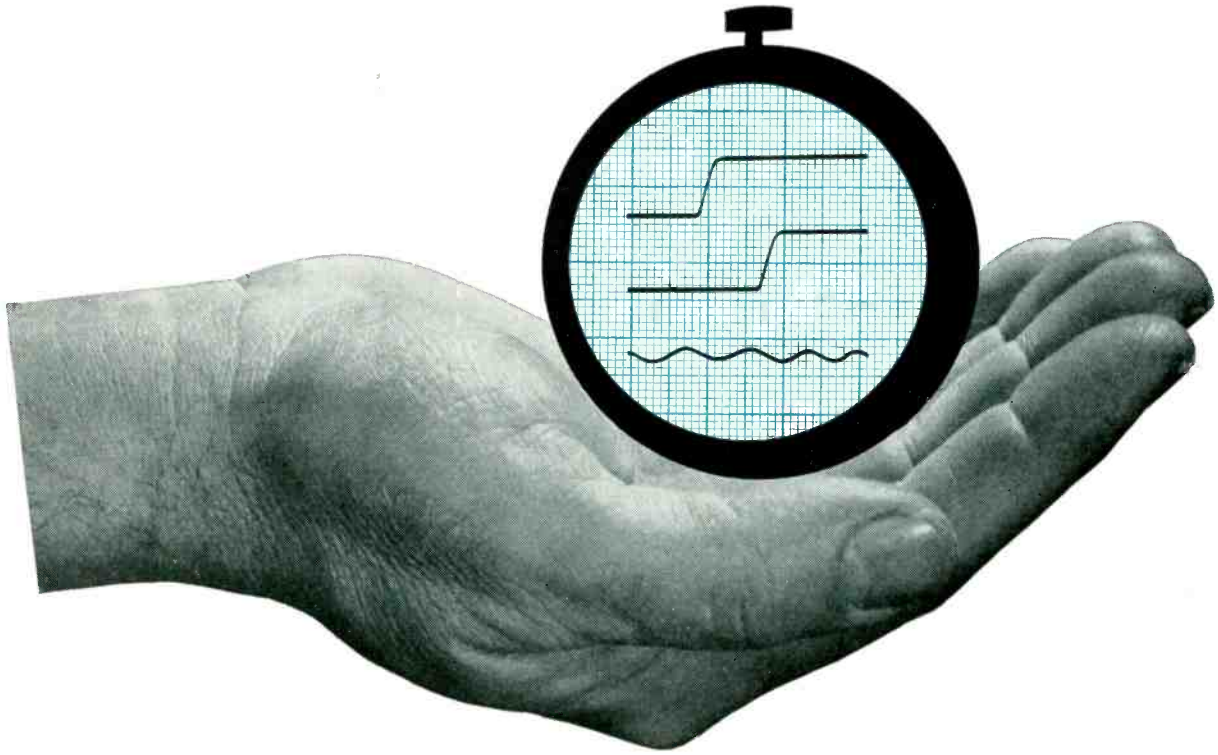
Four characteristics measured include cell color, cell size, diameter of the cell nucleus and optical density of the nucleus. If, as is believed, these characteristics are sufficient to discriminate, the electronic scanner will be able to sort out slides rapidly. Data gathered on normal and cancer cells from over 100 patients will provide criteria for the initial testing of the technique.



Experimental form of the Cytoanalyzer in operation under the direction of Walter E. Tolles, physicist at Airborne Instrument Lab, Mineola, N. Y.

At present, trained technicians examine slides under a microscope. Suspicious specimens are referred to a pathologist. The Cytoanalyzer would separate slides almost as fast as they could be fed into the machine. The technical staff would then examine only those selected electronically as abnormal, reducing the human task to about 5 percent of its routine load. This would allow millions of additional examinations without training hundreds of additional technicians.

(Continued on page 184)



time on our hands

Here's a handful of microtime . . . doled out in hundredths of a millimicrosecond. It's our new HELIDEL* delay line.

It's precise . . . wide-band . . . continuously variable. This is not an adwriter's pipedream . . . it's an engineer's, come true.

Which means that definitions are in order.

Precise = delay increments of only 2 x 10^{-11} sec; resolution 0.01% and better; linearity "better than ±1%" . . . actually, so fine it can't be measured.

Wide-band = transmission of pulse signals up to 20 mc with negligible phase-distortion, overshoot, or distortion of waveshape.

Continuously variable = a distributed-constant, electromagnetic type . . . dreamed up in 1946 . . . developed in helical form since 1951, by Helipot and DuMont.

The HELIDEL is already used successfully in color-TV broadcasting and oscilloscopes . . . and as a trimmer in transmission systems.

What can you dream up?

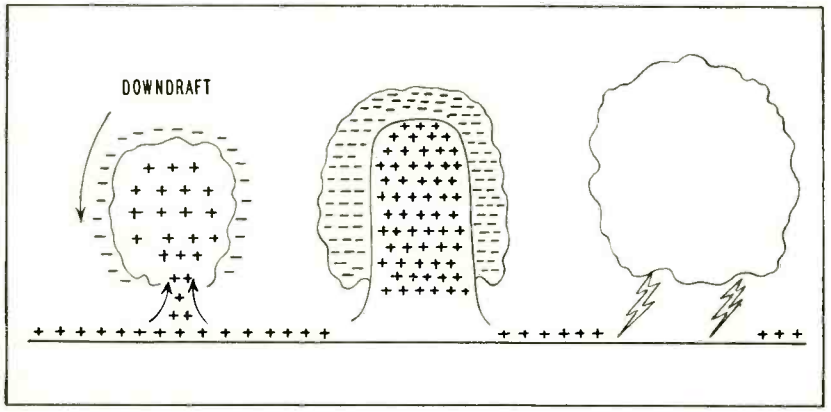
Helipot *first in precision potentiometers*

Helipot Corporation/South Pasadena, California
Engineering representatives in principal cities
a division of BECKMAN INSTRUMENTS, INC.

To help you dream, there's a 10-page technical paper on the HELIDEL, *presented at the 1954* WESCON . . . *and a new data sheet, with complete specs. For your copies, write for Data File 401.*

444 *TRADEMARK

Theory For Formation Of Thunderstorm Electricity



Normal positive charge above the earth is carried by convection up into cloud (left) resulting in attraction of negative ions that are swept towards the base of the cloud by downdrafts. Difference of potential finally results in lightning strokes (right)

ACCORDING to presently accepted theory, precipitation particles such as rain, snow, hail or sleet somehow become charged with one sign, while air or slower falling particles become charged with the opposite sign. Difference in the rate of falling thereby creates a separation of charge that results in lightning.

Understanding the mechanism of generating static electricity is important in the fields of weather, navigation and communication. A new theory has recently been advanced by Bernard Vonnegut of Arthur D. Little, Inc., Cambridge, Mass.

In brief, it is proposed that electrification in thunderstorms results from strong updrafts and downdrafts (as shown in the illustration) that cause multiplication of the small space charge normally found in the lower atmosphere. Because the lower air contains a slight positive space charge, clouds formed from it have a small positive charge and produce an electric field.

Negative ions under the influence of this field move down from the upper atmosphere. They do not neutralize the cloud as might be expected because they are caught in downdrafts that carry them to the lower part of the cloud where they accumulate to form a large region of negative space charge.

When it becomes large enough, this charge produces a large positive space charge by corona from points on the ground beneath the cloud. Air containing this increased positive space charge is carried by updrafts into the top of the cloud, causing it to become even more positively charged.

This effect increases rate of growth of the center of negative charge and finally the charges become great enough to produce lightning.

There is some historical and recent observational evidence to indicate that tornados may be formed, under certain conditions, by this type of action as a result of that heat released by successive lightning strokes.

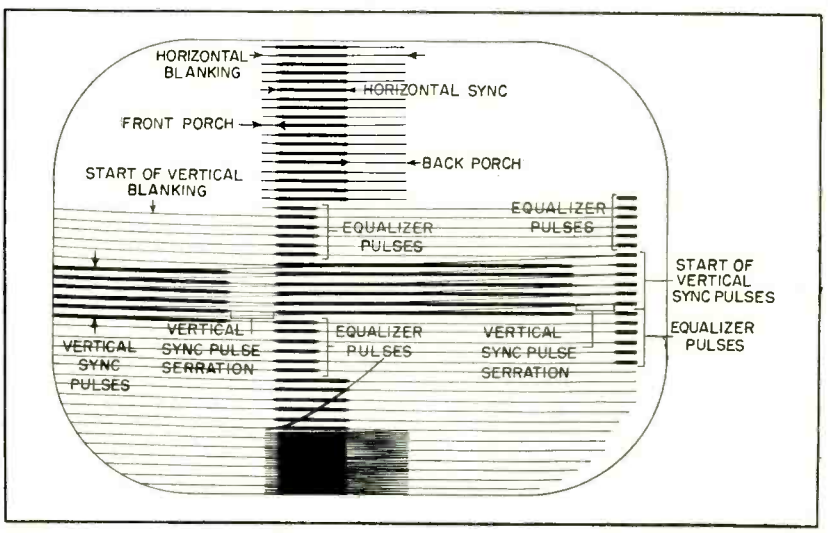
Aligning TV Receivers by Pulse-Cross Display

By HARRY E. THOMAS

Federal Telecommunication Labs.
Nutley, N. J.

TELEVISION RECEIVER circuit analysis can be facilitated by use of the pulse-cross display. The pulse cross or hammer is a presentation on the picture tube of the sync and blanking portions of a tv signal through simple adjustment of the receiver controls. This display, when adjusted correctly, serves to analyze synchronization faults in the system.

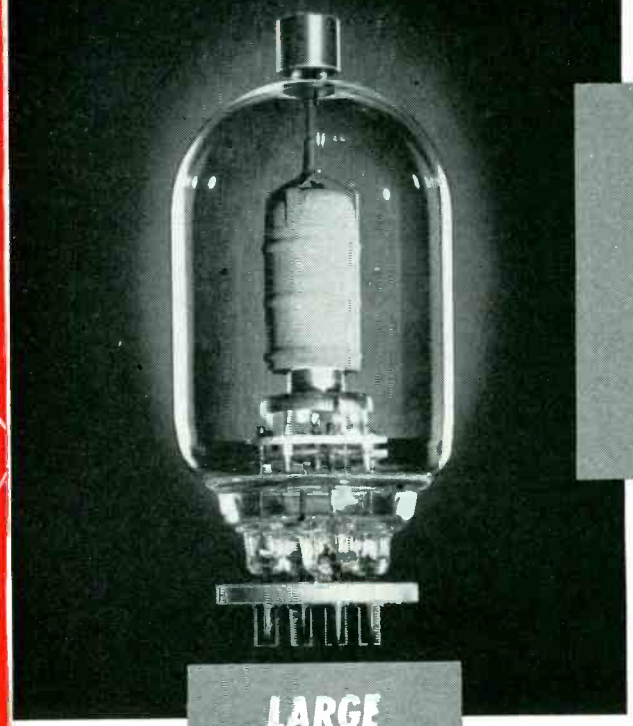
There are two types of pattern used when adjusting a receiver for such an analysis. In the vertical pulse-cross display, the vertical hold control is adjusted until the picture rolls and stops at approximately the halfway position on the viewing screen as shown in Fig. 1. At this point there will be a dark gray horizontal bar across the face of the tube. If the contrast control is then adjusted there can be seen,



Pulse-cross expanded vertically about six times for easier viewing

Proved in Service!

CLIPPER DIODE 719A



EXCLUSIVE SINTERCOTE® ANODE

LARGE STURDY CATHODE STRUCTURE

for high pulse-peak emission

In the Los Gatos 719A all internal insulators across high voltage points are eliminated. Efficient heat dissipation is provided by the black-body Sintercote® anode.

nine lives plus

Ample cathode for high pulse-peak emission makes the Los Gatos 719A diode ideal for clipper use in radar and similar pulse applications, where long service life is important. Lewis and Kaufman tube engineering emphasizes longevity at every critical point.

LEWIS and KAUFMAN, Ltd.

LOS GATOS | CALIFORNIA

LOS GATOS LONG LIFE ®

Export Representatives:
MINTHORNE INTERNATIONAL CO., INC.
15 Moore St., N.Y. 4, N.Y. Cable: Minthorne

In Canada:
RADIO VALVE COMPANY, LIMITED
189 Dufferin Street, Toronto 1, Ontario, Canada

superimposed on this bar, another black horizontal bar extending across the screen with a short wide section or head located slightly to the left of center. This superimposed bar resembles a double-headed hammer with the handle extending to the right-hand side of the raster. If the shading difference between the gray of the wide bar and the black shading of the hammer are not distinct enough from each other, receiver contrast control can be adjusted until the hammer just becomes black; the wider part of the bar should then be at its correct shade of gray. Next to the hammer head toward the left side of the raster there is a gap in the pure black area. Following this gap the handle section of the black area continues to extend to the left across the picture to the edge of the raster.

This display gives information about the vertical synchronizing and blanking pulses that are being transmitted from the tv transmitter. In studio practice, since these pulses are generated in the synchronizing generator, the display immediately tells whether this equipment is functioning correctly. The pulse-cross display is accordingly included on most studio monitors. In a receiver the display tells whether the synchronizing pulses are reaching the picture tube at the correct levels or whether they have been distorted or clipped in passing through the video circuits. This becomes apparent when it is impossible to adjust for a black hammer.

Interpretation of the vertical dis-

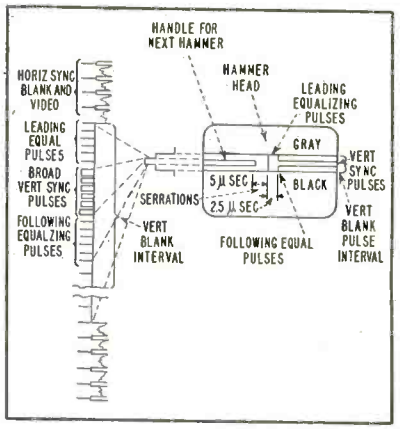
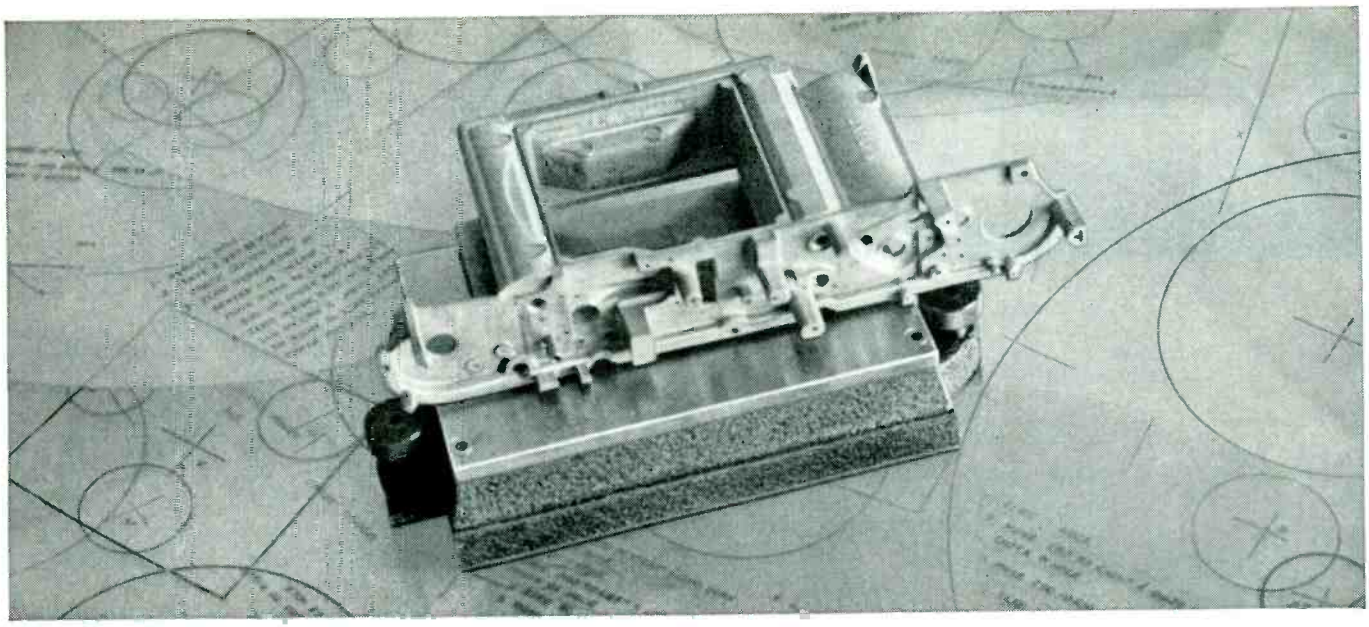


FIG. 1—Composition of vertical pulse-cross display from standard RETMA tv waveform



How Graflex, Inc., *cut production costs* with a Kodak Contour Projector

If you've been thinking of optical gaging only in terms of toolroom measurement or final inspection, see what it does when linked to production operations.

GRAFLEX, INC., was producing a complex precision part in which spacing of 40 holes and 12 bosses had to be held to ±.001".

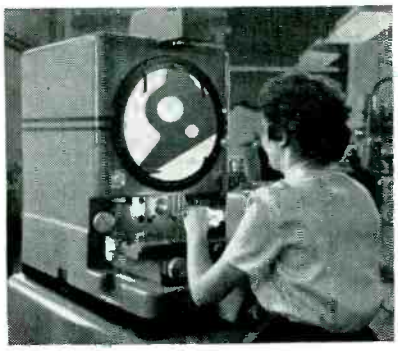
To solve this tolerance problem, Graflex used a Kodak Contour Projector because: (1) mechanical gages would have been too costly for the required run; (2) optical gaging would be faster; (3) the Kodak Contour Projector gave a quantitative as well as qualitative check.

Here's how this helped cut production costs and speed the work:

Optical gaging made it possible to check parts as they were run, to discover errors before more time and labor were spent on the part; no expensive machining was wasted on parts later found to be out of tolerance. It assisted in assembly operations, too, since the exact condition of the parts was known. And the part could be quickly rechecked at any point during production when a question of tolerance or condition arose.

A Kodak Contour Projector was also used in final inspection—doing in 20 minutes a job estimated at 4¾ hours by surface plate inspection. When the run was completed, the comparator was available for another job.

Perhaps you have production problems that can be solved by fast, accurate, *complete* measurement and inspection. There's a field representative in your area who can evaluate your needs for you. To get in touch with him, or for a copy of the illustrated booklet "Kodak Contour Projectors," mail the coupon below.



Graflex, Inc., used a Kodak Contour Projector, Model 2A, for this operation. The Model 2A is completely equipped for precision micrometry. In addition, it has a magnification selector, built-in surface illuminator, and permits the staging of parts in any plane. As with all Kodak Contour Projectors, it requires no hood.

the KODAK CONTOUR PROJECTOR

48

EASTMAN KODAK COMPANY
Special Products Sales Division, Rochester 4, N. Y.

☐ Please send me a copy of your booklet "The Kodak Contour Projectors."
☐ Put me in touch with your representative.

NAME_____ TITLE_____

COMPANY_____

STREET_____

CITY_____ STATE_____
(Zone)

Kodak
TRADE-MARK

Want more information? Use post card on last page.

play is aided by reference to the standard RETMA television signal which specifies accurately the values, percentages and timing used in transmitting synchronizing information. The standard signal is shown in Fig. 1.

The vertical blanking interval covers a space-time area of 18 to 21 horizontal lines, or from 1,140 to 1,330 microseconds. The level of this area is below the sync level so that if the sync tips were black, the vertical blanking level would be gray. The blanking area thus constitutes the widest part of the overall display.

Below the top edge of the gray band, at a distance of six lines downward, is the start of the main vertical sync pulses. These consist of six broad pulses and appear at the black level at which the contrast control has been set. They form the handle of the hammer. They are separated by an interval known as the serration which appears as a gap at the left side of the hammer head. The serration is 5 microseconds long.

The hammer head area is formed by equalizing pulses. In the tv signals there are six of these preceding the vertical-sync pulses; they start with the beginning of the blanking interval and proceed downward from the start of the gray area. They are narrow, being only 2.5 microseconds in duration. Being at sync-tip amplitude they form part of the black area. Six more of them follow the completion of the vertical sync pulses, thus making up the bottom part of the hammer head.

In analyzing receiver performance the pulse-cross display tells by its relative shading and the shape of the various areas where sync troubles are occurring. For instance, if there is no gradation between the darkest area of the sync pulses and the blanking pulses, showing that the sync is being stripped, restoration of proper shading by changing the contrast control, agc action, or amplifier gains can be used to trace the trouble.

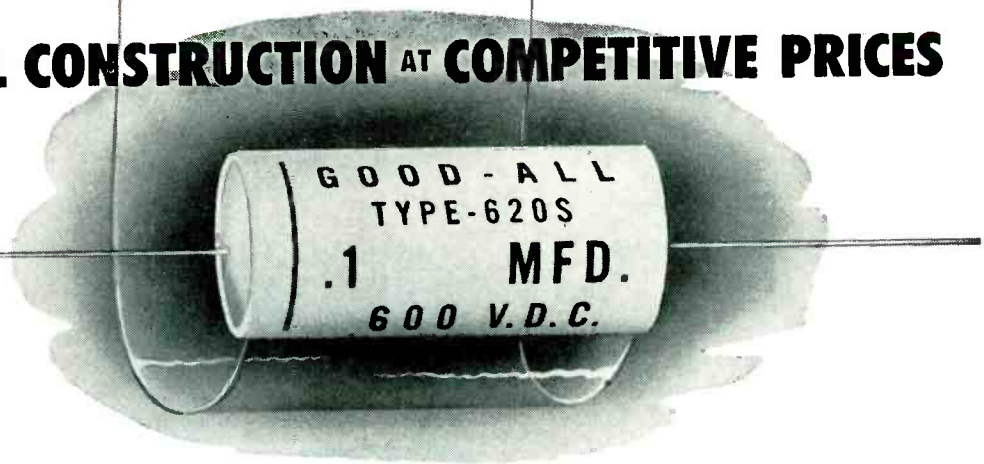
In case the blanking pulses are no darker than the darkest picture elements there may be some defi-

Good-ALL capacitors

MYLAR* DIELECTRIC

*Du Ponts Trade Mark for its Polyester Film

COMMERCIAL CONSTRUCTION AT COMPETITIVE PRICES



Good-ALL SERAMELITE Capacitors

MODELS 620S and 621S

. . . combine the excellent electric characteristics of "MYLAR" with the superior humidity resistance properties of "Seramelites" to produce a completely new capacitor for exacting applications at reasonable prices.

These competitively priced new miniature capacitors closely approximate the performance of expensive hermetically sealed units. They are designed to cover the entire capacitance and voltage range.

CHARACTERISTICS:

- Insulation resistance 20,000 megohm-microfarads
- Power Factor is Less than 1%
- Operating Temperature −55° C to + 125° C
- Generally smaller than RETMA Standards
- Tolerances as close as ½ of 1%

CONSTRUCTION FEATURES:

- Tubular Ceramic Enclosure
- New Plastic End Seal
- Inserted Tab or Extended Foil
- Miracle X Impregnated

OTHER GOOD-ALL "MYLAR" CAPACITORS

FILM-X (Hermetically Sealed) • MARBELITE (Plastic Impregnated Paper Tube)

Available for printed circuit or other applications in all mounting styles. Built to your specifications.

So Superior . . . They are being used extensively by leading Electronic, TV, and Radio Manufacturers throughout America.

GOOD-ALL ELECTRIC MFG. CO. 120 FIRST ST • OGALLALA, NEBRASKA

Good-ALL capacitors

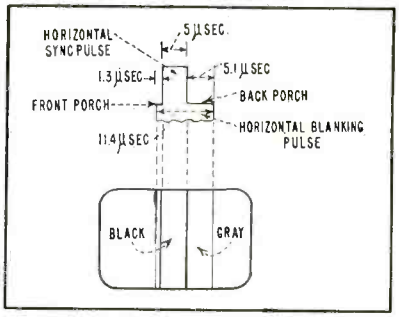


FIG. 2—Make-up of horizontal pulse-cross display

ciency in low-frequency response, either in the video amplifier or in poor alignment of the rf or if stages. In the latter case, the picture carrier may be adjusted too low on the slope of the response curve. If the gradations are essentially correct and sync troubles still persist, the trouble must lie in the sync separator and sweep circuits.

In the same way that the vertical sync signals can be phased, the horizontal signal can also be phased by means of the horizontal-hold control so that its sync pulse produces a display on the picture tube. This adjustment appears on the viewing screen as a vertical bar. Figure 2 shows the display formed by phasing the horizontal-sync pulse at 180° from its normal position. The result is a vertical bar having two shadings when the contrast control is correctly adjusted. One is a wide section of gray and the other a narrower superimposed black bar.

As in the vertical case the wide bar represents the blanking pulse and the black bar the sync pulse. The horizontal - blanking pulse should ideally be 11.4 microseconds long and, since it is at the same video level as the vertical blanking pulse, it should have the same gradation of gray in its makeup. The horizontal sync pulse forms a darker vertical bar of 5 microseconds length, and is located at 1.3 microseconds beyond the start of horizontal blanking.

This step, or delay of the sync pulse is called the front porch. The remainder of the time from the end of the sync pulse to the end of blanking is the back porch. In many pieces of equipment it is important that the time interval of these pulses be precisely preserved since other operations such as clamping

THIS IS IT!

NEW 3-WATT Blue Jacket®

miniaturized axial-lead wire wound resistor

This power-type wire wound axial-lead Blue Jacket is hardly larger than a match head *but it performs like a giant!* It's a rugged vitreous-enamel coated job—and like the entire Blue Jacket family, it is built to withstand severest humidity performance requirements.

Blue Jackets are ideal for dip-soldered sub-assemblies . . . for point-to-point wiring . . . for terminal board mounting and processed wiring boards. They're low in cost, eliminate extra hardware, save time and labor in mounting!

Axial-lead Blue Jackets in 3, 5 and 10 watt ratings are available without delay in any quantity you require. ★ ★ ★

SPRAGUE TYPE NO.	WATTAGE RATING	DIMENSIONS L (Inches)	D	MAXIMUM RESISTANCE
151E	3	1 7/32	13/64	10,000 Ω
27E	5	1 1/8	5/16	30,000 Ω
28E	10	1 7/8	5/16	50,000 Ω

Standard Resistance Tolerance: ±5%

SPRAGUE

WRITE FOR ENGINEERING BULLETIN NO. 111B

SPRAGUE ELECTRIC COMPANY • 35 MARSHALL ST. • NORTH ADAMS, MASS.

ELECTRONICS Charter-Year Advertiser

and gating are often timed to occur during this interval.

Composite Display

In many receivers it may be impossible to adjust for the vertical bar because the horizontal-control circuits jump into and out of sync without the possibility of intermediate phasing. When it is possible to adjust both vertical and horizontal oscillators for simultaneous bar displays there is the complete pulse-cross display illustrated.

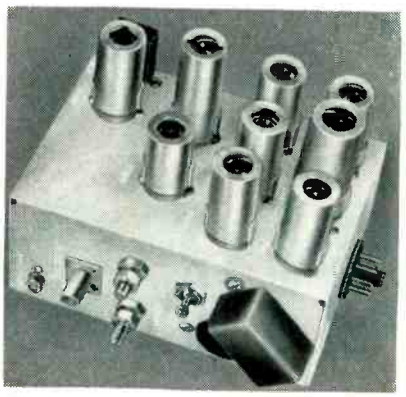
In this display, the interrelation of the horizontal and vertical pulses can be better seen since the display from a studio monitor has been expanded about 6 to 1 in the vertical direction.

Highly Regulated R-F Voltage Supply

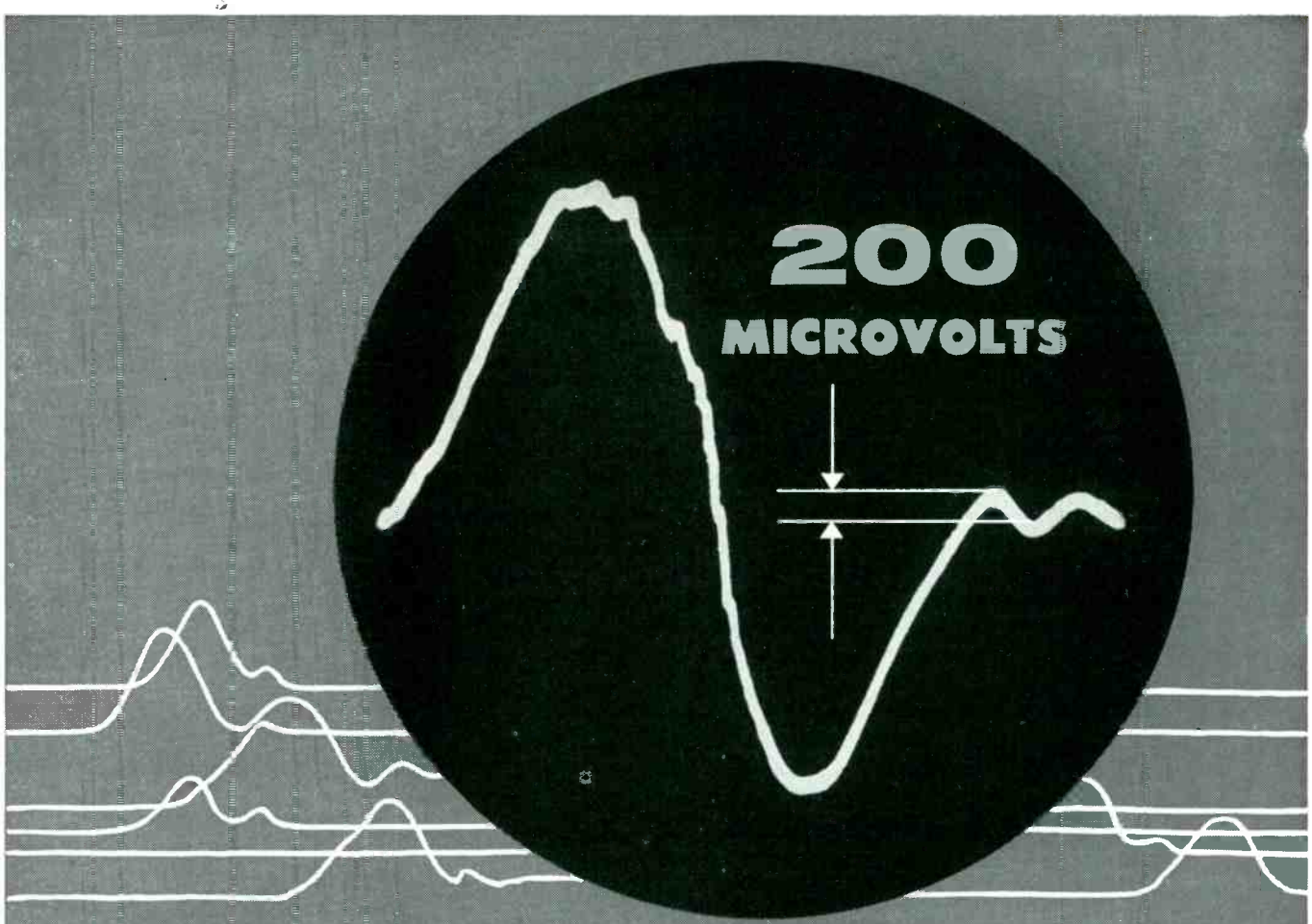
By L. G. SLOAN, R. W. RAIBLE and M. K. TESTERMAN
University of Arkansas
Engineering Experiment Station
Fayetteville, Arkansas

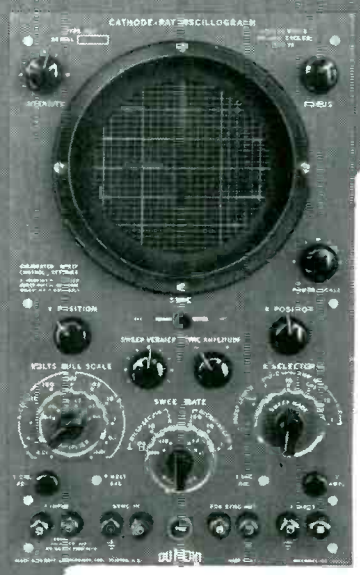
A PLUG-IN type power supply providing a highly regulated r-f output with low level second and third harmonics is shown in the photograph. The design of the unit is based on circuits[1,2] using simple components, but has a regulation about six times better than that of previous units.

Low harmonic content of the r-f voltage output at approximately 5 volts rms is obtained by a conventional crystal-oscillator circuit operating on the fundamental frequency of the crystal and using high-Q components in the plate tank



Radio-frequency power supply constructed as plug-in unit





(ACTUAL SIZE PHOTO)

. . . and this amazing sensitivity is only one of many outstanding characteristics of the entirely new DuMont Type 324 cathode-ray oscillograph. New standards of stability, low noise and hum level assure full use of the Type 324 for d-c to 300 kc measurements even in the microvolt region. Furthermore, the Type 324 is completely calibrated to read time and amplitude directly. There are so many features incorporated in this new instrument we can't begin to give you the whole story here. Write us for complete specifications, or better still, ask for a demonstration of the

NEW DUMONT TYPE 324

For further information write to:

Technical Sales Department • ALLEN B. DU MONT LABORATORIES INC. 760 Bloomfield Ave., Clifton, N. J.

circuit. Harmonic content is further minimized by using a small amount of positive feedback in the oscillator. Only negligible quantities of second and third harmonics are present in the output, as evidenced by measurements made with an absorption-type wavemeter and a high-frequency oscillograph. Sufficient frequency stability is obtained by use of a standard crystal as the frequency-determining element.

Variation of screen voltage on the crystal oscillator varies the r-f output voltage linearly over a wide range. This is not true of plate-voltage variations. Thus, screen-grid voltage regulation is used to obtain maximum wide-range regulation of the r-f voltage output.

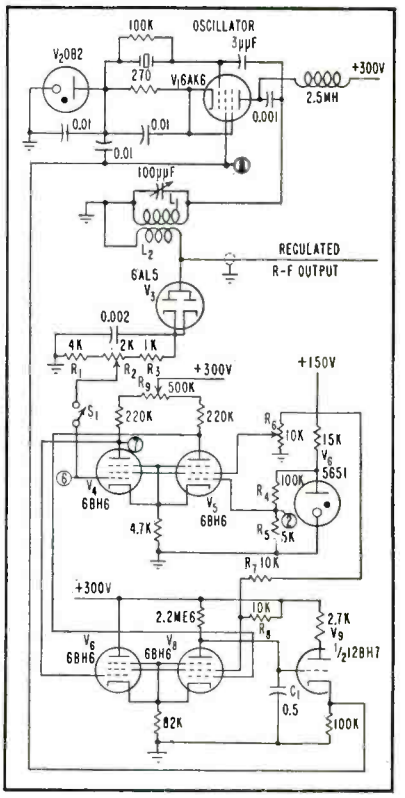


FIG. 1—Circuit of r-f power supply. In construction, points indicated by circled numbers are brought out to test socket to aid in initial adjustment of unit

The r-f voltage output of the oscillator is found to be more sensitive, over all ranges, to screen-voltage variation than to plate-voltage variations.

The use of a high-gain d-c amplifier in the negative feedback loop results in better regulation than had been achieved with previous circuits. Two stages of pentode

difference amplifiers are used to obtain the high gain and are reasonably insensitive to changes in B+ voltage. Of the miniature tubes tested, the 6BH6 pentode gives optimum gain in this application.

The schematic diagram of the regulated r-f supply is shown in Fig. 1. The r-f voltage generated by V_1 is inductively coupled from the tank circuit to L_2, where the regulated r-f output is produced. At the same point, a portion of this r-f voltage output is rectified by V_3. Because of the stepdown ratio between L_1 and L_2, the circuit is not loaded appreciably by the rectifier. A 6AL5 tube was used instead of germanium diodes, because the tube is more rugged and the d-c voltage produced is less sensitive to temperature.

No detectable 60-cycle ripple is introduced on the rectified d-c from this diode. Resistor R_2, which acts as an r-f voltage output control, places a portion of the rectified d-c on the grid of V_4, of which V_4 and V_5 comprise the first pentode-difference amplifier.

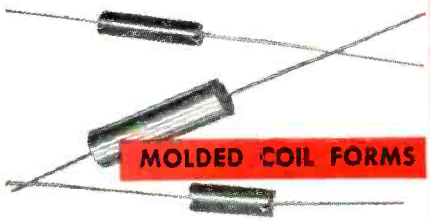
A reference d-c voltage is applied to the grid of V_5. This is a part of the voltage from the voltage-reference tube V_6. Since the primary stability of the unit cannot be greater than the stability of the reference potential placed on the grid of V_5, this is the most critical point in the supply. This explains the use of low-temperature-coefficient wire-wound resistors for R_4 and R_5 as well as at R_1 and R_3. An attempt was made to use mercury cells as a source of reference potential.

This potential, both with and without constant applied load, was less stable than that obtained from the 5651 voltage-reference tube. Although mercury cells produced a short-term stability comparable to that obtained with a voltage-reference tube, the stability was considerably less over long periods of time. The mercury cells had two other distinct disadvantages: they take more space and require replacement every six to eight months. As a specific example of obtaining a regulated r-f output of 4 to 5 volts, the voltage divider R_4 and

Superior in every way

Moldite Core "Standards"

They are precision mixed, precision made, and precision controlled for every electronic use.

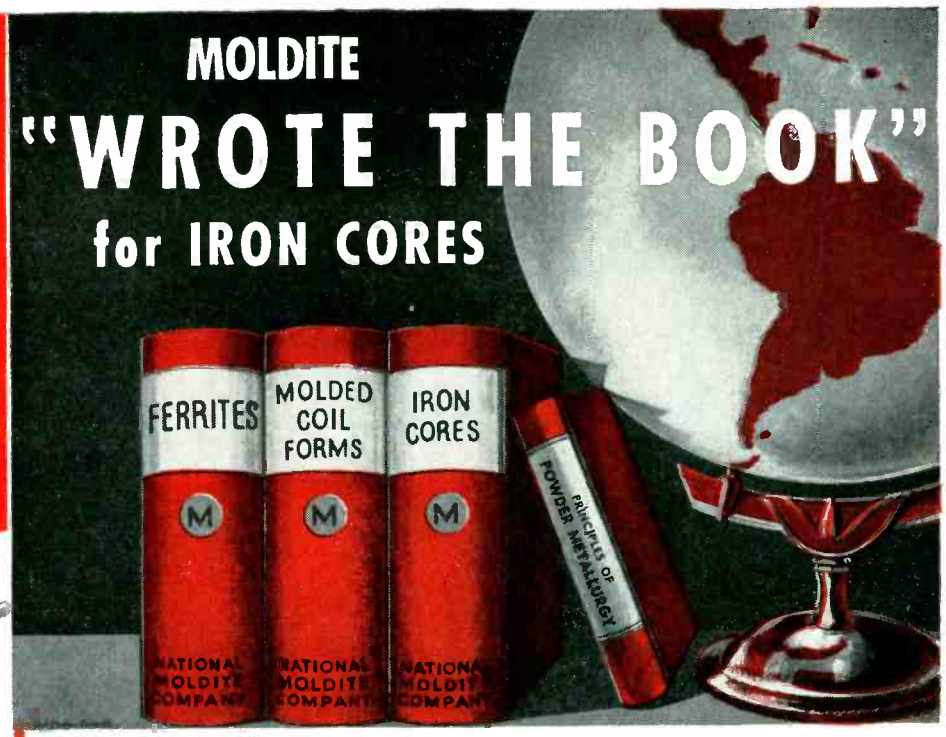


Give your products the advantages of MOLDITE Core Standards that offer you . . .

ECONOMY
AVAILABILITY
UNIFORMITY
INTERCHANGEABILITY
HIGH QUALITY
FLEXIBILITY

NATIONAL MOLDITE COMPANY

MOLDITE "WROTE THE BOOK" for IRON CORES



MOLDITE'S record of performance for the past ten years in producing millions of cores, coil forms and ferrites has contributed substantially to the accomplishments of the electronic industry.

To check with MOLDITE is a Must, because only MOLDITE leads in all three . . . iron cores, coil forms and ferrites.

MOLDITE *iron cores, ferrites* and *molded coil forms* (iron and phenolic) are being selected for use in high quality equipment by all leading television, radio and electronic manufacturers as well as all branches of the Armed Forces. Only MOLDITE makes them all . . . for your service and convenience. One source for all three — iron cores, ferrites and molded coil forms.

We are particularly proud of a Certicate of Cooperation awarded us by the U. S. Foreign Operations Administration for furnishing technical assistance.

Our success is measured by the ever increasing number of loyal satisfied customers. MOLDITE'S quality, service and spirit of progress sets the keynote for tomorrow. No specification is too difficult, no order too small, no requirement too rigid. The MOLDITE label is your guarantee of complete satisfaction.

MOLDITE'S world-wide reputation is a result of . . .

1. Creative research and engineering.
2. Specialized materials processing techniques.
3. High quality mass production facilities
4. Modern core manufacturing facilities for precision molding.
5. Exclusive, specially designed, press controls.


FOREIGN OPERATIONS ADMINISTRATION

CERTIFICATE OF COOPERATION

awarded to

National Moldite Co.

for furnishing technical assistance to the peoples of friendly countries cooperating to maintain individual liberty, free institutions and peace.

Harold S. Vanderbilt
Director of Foreign Operations

Send for our Catalog NM #110

1410 CHESTNUT AVE., HILLSIDE 3, N. J.

Bill Franklin
3 Holly Road
North Syracuse, N. Y.

Robert T. Murray Co.
614 Central Avenue
East Orange, N. J.

Jerry Golten Co.
2750 W. North Ave.
Chicago 22, Ill.

Perlmuth-Coleman Assoc.
2419 So. Grand Ave.
Los Angeles 7, Calif.

Jose Luis Ponte
Cardoba 1472
Buenos Aires

R_5 places 4.1 volts on the grid of V_5 and approximately the same voltage appears at the grid of V_4.

The output of the first difference amplifier is fed into the second pentode-difference amplifier V_7 and V_8 and is finally coupled to the cathode follower V_9. The gain of the entire amplfier is approximately 10,000. The magnitude of the error signal created by the difference in d-c potentials placed on the grids of V_4 and V_5 is amplified and fed back to the screen grid of oscillator V_1. The potential applied to the screen grid of V_1 varies in a way that restores the oscillator to the same operating level and causes the voltage appearing at the regulated output to be constant.

Operation of oscillator V_1 is maintained at a level low enough to obtain a good waveform of the r-f voltage. The plate and screen voltage are both effectively decreased by floating the circuit on top of voltage-regulator tube V_2. This arrangement further simplifies the feedback loop from the amplifier to the screen grid of the oscillator.

Capacitor C_1 is necessary to eliminate oscillations that occur in the regulator circuit. Potentimeter R_6 is adjusted to apply 35 volts to the screen grids of V_4 and V_5, while R_6, R_7 and R_8 maintain the screen voltage of V_7 and V_8 at approximately 190 volts. Stable operation of the unit was obtained when the B+ supply had only vr-tube regulation.

It was found, however, that the stability of the r-f output was affected considerably by the a-c voltage placed on the filaments of V_4 and V_5. Sufficient stability in the filament supply was obtained by the use of a Sola filament transformer. In this particular application the entire unit was to be operated from a power supply having ±0.5 percent regulation. Therefore, no additional precautions were taken for stabilizing the filament voltage. If maximum regulation is desired, possibly other techniques, such as the use of Amperite regulators, might be employed to stabilize the filament voltage.

In the initial adjustments of the unit when it is placed in operation,

Fishtail...

New anti-rattle fastener for NAMEPLATES and trim holds threadless studs

Quick, tight, permanent fastening for name-plates and other die-cast trim is now possible without nuts and washers, thanks to United-Carr's Fishtail fastener.

Easily attached with simple hand tools, its teeth actually bite into chrome-finished, threadless studs so that there is no chance of slippage or looseness.

Fishtail's grip on welded, staked or extruded studs is independent of the pressure of the spring take-up legs. Leg pressure, however, allows positioning adjustments while it provides secure anchorage even when the studs protrude through oversize holes.

Fishtail fasteners can be used on flat or contoured surfaces and their cup-shaped centers hold and retain sealing compounds.

Like thousands of other fasteners and allied devices, designed and manufactured by United-Carr, Fishtail fasteners help speed assembly and cut costs. Available in a complete range of sizes and in volume quantities; further details on request.

UNITED-CARR

MAKERS OF DOT® FASTENERS

UNITED-CARR FASTENER CORPORATION, CAMBRIDGE 42, MASSACHUSETTS

switch S_1, which is normally closed, is opened. A jumper is placed between points 2 and 6, and this causes an equal potential to appear on the control grids of both V_4 and V_5. A voltmeter of reasonably high impedance or a battery-supplied vacuum-tube voltmeter is then connected between points 5 and 7 and the potential, between these two points is adjusted to zero by varying R_9.

The short-term stability of this unit was determined by rectifying the regulated r-f output and measuring it on a recording potentiometer. Short-term fluctuation is less than 0.04 percent. These data are presented in Fig. 2.

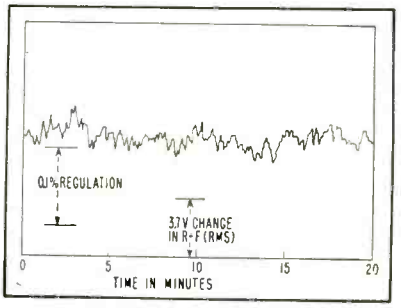


FIG. 2—Stability of r-f output of power supply. Average fluctuation over period of six days was about 0.45 percent

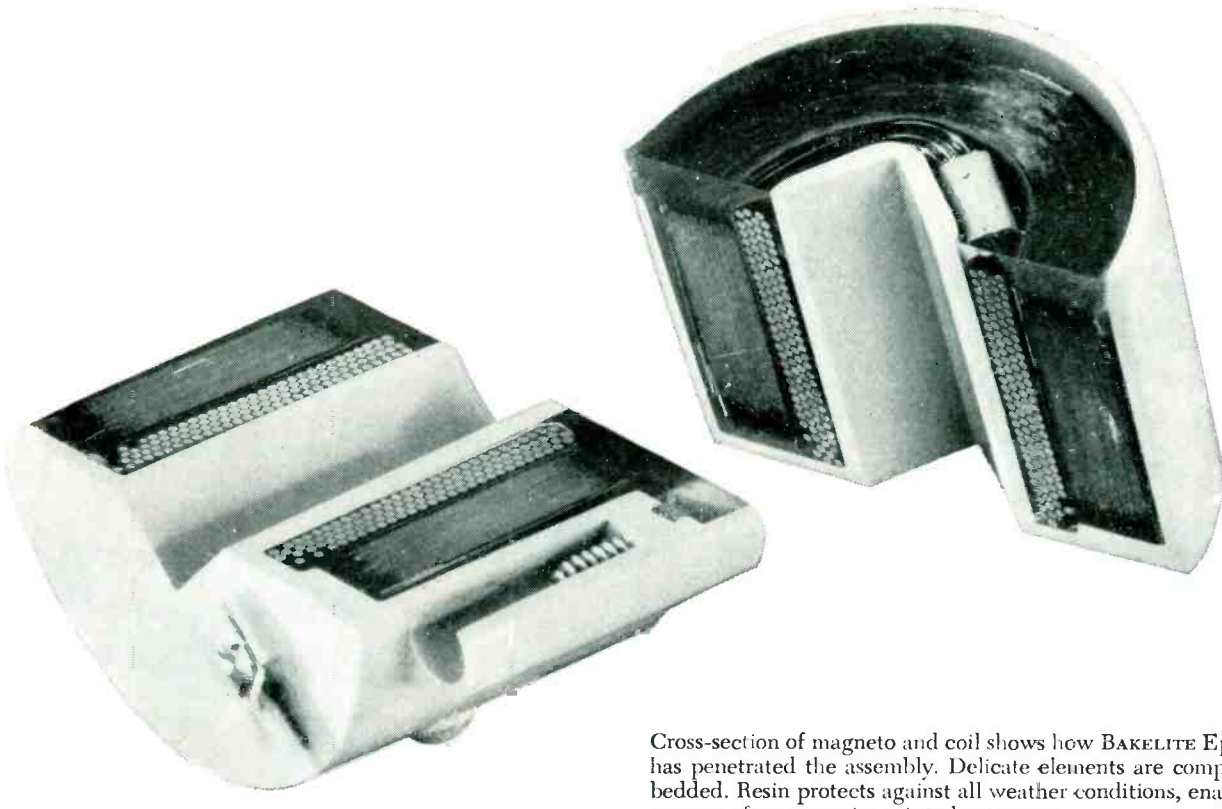
The long-term stability of the instrument was determined by rectifying the r-f output voltage and measuring a fraction of it with a potentiometer. This measurement showed an average fluctuation over a period of six days of 0.45 percent. These data show that the regulation of this unit is at least six times better than the previous designs[2].

REFERENCES

(1) N. C. Hekimian, ELECTRONICS, p 164, July, 1951.
(2) S. Rubin, ELECTRONICS, p 154, Oct. 1952.

Robot Sings New Tunes

COMBINING synthesis of musical tones with the technique of the player piano, RCA scientists at Princeton, N. J. have developed an electronic device that produces music. Unlike the mechanical piano, it is not limited to the straightforward production of one note or one combination of



Cross-section of magneto and coil shows how BAKELITE Epoxy Resin has penetrated the assembly. Delicate elements are completely embedded. Resin protects against all weather conditions, enables motor to start after an entire winter's exposure.

Fragile electrical parts safely embedded at low temperatures

WITH BAKELITE EPOXY RESINS

Delicate electrical assemblies can often be damaged by the high temperatures needed to cure ordinary potting materials. That's where BAKELITE Brand Epoxy Resins have the advantage. In most cases, they cure at room temperature, or are oven-cured at low temperatures.

In addition, the low viscosities of these materials enable them to penetrate every crevice. Air entrapment is minimized. Vibration or centrifugal casting can be used as a further aid in eliminating air bubbles.

BAKELITE Epoxy Resin, mixed with a liquid hardener, is poured into place, and cures with a minimum of shrinkage. It has excellent resistance to moisture, chemicals, and shock. It forms a strong bond with metal, glass, and ceramics, holding every element firmly in position.

Three types of BAKELITE Epoxy Resins are available, together with four different hardeners. This assortment provides a variety of curing speeds and viscosities to match your needs. The resins can also be cured by several conventional catalysts. And you can choose from several BAKELITE Phenolic and Polyester Resins for the widest selection of potting materials and procedures now available. Get the facts on all these materials by writing Dept. BP-79.

BAKELITE BRAND EPOXY RESINS

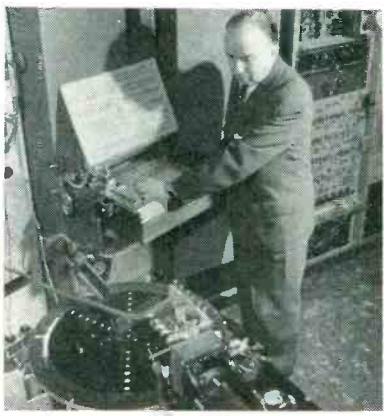
BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.

The term BAKELITE and the Trefoil Symbol are registered trade-marks of UCC

ELECTRONICS Charter-Year Advertiser

notes after another. It is possible to provide a portamento or glide from a tone of one frequency to a tone of a different frequency.

In addition, tones simulating those of any known instrument may be synthesized so that a musical selection may be played as by a pipe organ or a saxophone. Nor is reproduction limited to familiar musical instruments. New combinations of tones with, as yet, unheard timbre may be called into being.



Harry F. Olson of RCA operates the keyboard of the electronic music synthesizer in the laboratory

According to Harry F. Olson, director of the acoustical and electromechanical research laboratory, the new system produces tones of purer musical quality than those from conventional musical instruments. It overcomes the operating limitations of many existing instruments and forms new tone complexes that cannot be otherwise attained.

The device illustrated is used to produce selections recorded on disks.

X-Band Receiving Amplifier

By KORYU ISHII
Microwave Laboratory
Nihon University
Surugadai, Tokyo, Japan

AN X-BAND regenerative amplifier has been constructed having a net gain of more than 16 db at 9,760 mc and a bandwidth of 20 mc.

Adjusting the output impedance of the reflex-klystron 723A/B

modern genie in a bottle!

announcing

RADIO RECEPTOR

subminiature, hermetically sealed

GLASS DIODES

Radio Receptor engineers have rivaled the Arabian Nights with these new diodes hermetically sealed in tiny glass envelopes. Like the fabled genie who lived in a bottle, RRco. glass diodes are long lived, efficient and capable of performing amazing feats with remarkable endurance.

Here are some of the important features we've built into these subminiature glass units:

Actual size

DIMENSIONS

Diameter ..... .098" max.
Length ..... .265" max.
Lead diameter.. .021"–.019"
Lead length .....1.125" min.

GOLD BONDED GERMANIUM TYPES	SILICON ALLOYED JUNCTION TYPES
A few of these numbers include every registered RETMA type and many more. This will simplify engineering, purchasing and stock-keeping.	. . . with almost unbelievable specifications.
200 MA at + 1 volt.	500 MA at + 1 volt.
Reverse leakage in microamperes.	Reverse leakage — .01 microamperes at 25° C.
150 volt peak inverse.	Operation to 200° C.
Excellent recovery time.	Reverse breakdown — 300 volts, abrupt characteristic rising slightly with temperature.
Others with specified characteristics at high temperatures.	

OTHER PRODUCTS OF RADIO RECEPTOR:
Selenium Rectifiers, Germanium Transistors, Dielectric Heating Generators and Presses, Communication, Radar and Navigation Equipment.

Radio Receptor's line of glass diodes is constantly expanding and new numbers are added all the time. For latest news of these and other RRco. semi-conductor products write today to Department E-7

Really RR Reliable

Semi-Conductor Division

RADIO RECEPTOR COMPANY, INC.

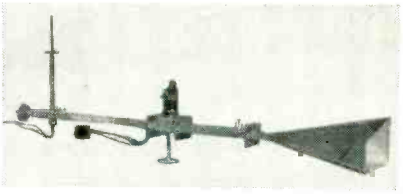
In Radio and Electronics Since 1922

SALES OFFICES: 251 WEST 19TH STREET, NEW YORK 11, N. Y., WATKINS 4-3633, FACTORIES IN BROOKLYN, N. Y.

ELECTRONICS Charter-Year Advertiser

makes the oscillation stop at a selected frequency and amplifies an incident signal of the same frequency by regeneration.

Figure 1 shows an experimental X-band receiving system using the X-band amplifier. Since this is not a superregenerative amplifier, there is no quenching source. The crystal



Assembled r-f section of experimental X-band receiver

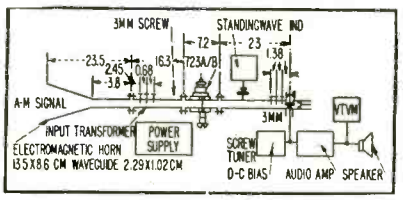


FIG. 1—Arrangement of components of experimental X-band receiving amplifier

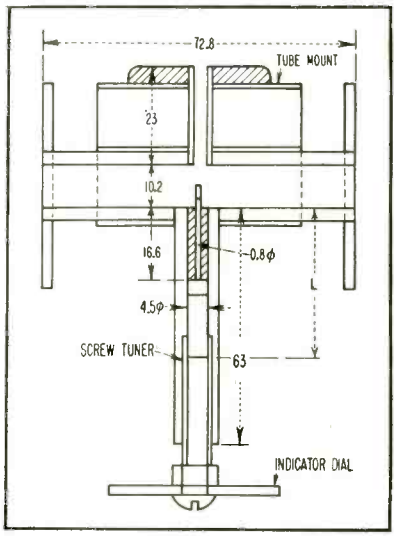


FIG. 2—Amplifier section of receiver. Dimensions are given in mm except where indicated

detector 1N23 is d-c biased to obtain maximum sensitivity.

Amplifier Section

Figure 2 shows details of the amplifier tube mount. Output impedance is adjusted by the screw tuner. Repeller voltage versus gain characteristic is given in Fig. 3A. Apparent gain is the ratio of output voltages of the audio-frequency amplifier when the amplifier

tube is on and off.

Frequency and the repeller voltage for self-oscillation are different from those for amplification. With the tube removed from the waveguide, the oscillation frequency of the tube was 9,570 mc with 280 volts beam voltage and −53 volts on the repeller. The vswr on the output waveguide was 1.225 at 9,760 mc.

Figure 3B shows the repeller voltage and gain characteristics of the 723A/B amplifier when the input transformer waveguide is removed and the electromagnetic horn is directly connected to the amplifier section. In this case, the maximum gain is almost equal to the case of Fig. 3A but the tube is likely to oscillate. By the use of this waveguide, the gain in the cold state is increased 3 db.

Figure 4 shows experimental results on the relation between the heater current and the apparent

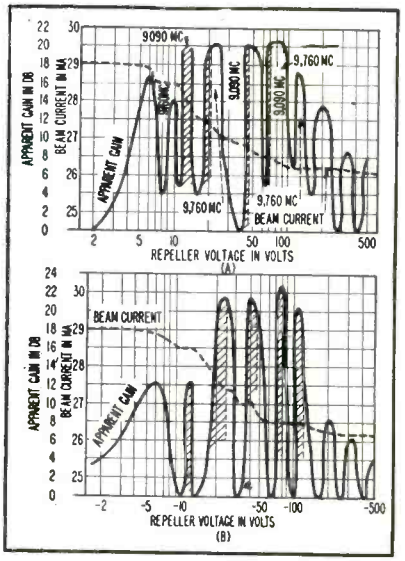


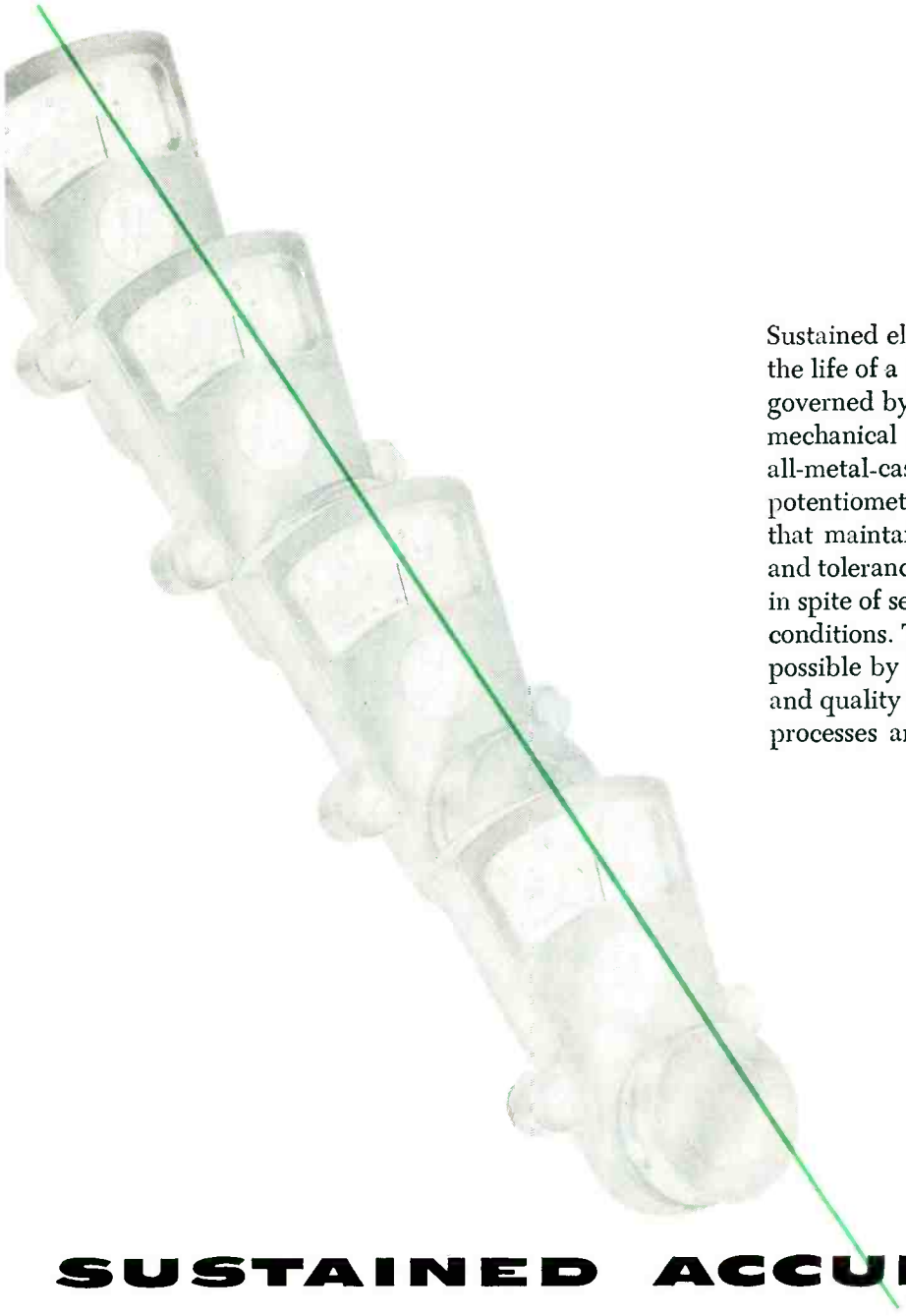
FIG. 3—Amplification characteristics of receiving amplifier with (A) and without (B) input transformer waveguide at 9,760 mc. Shaded areas indicate high noise levels

gain. The higher current gives higher gain in this region.

An apparent-gain curve in Fig. 5 shows relation between the apparent gain and output impedance adjustment.

The plunger position of the impedance adjusting screw is on the abscissa. This is represented by *L* in Fig. 2. During this experiment, d-c voltages of all electrodes were kept constant.

An insertion loss curve in Fig. 5



Sustained electrical accuracy throughout the life of a potentiometer is largely governed by the unit's ability to resist mechanical dimensional changes. The all-metal-case construction of Fairchild potentiometers assures mechanical rigidity that maintains superior initial accuracies and tolerances throughout a long life cycle—in spite of severe changes in environmental conditions. This is another advance made possible by Fairchild's continuous research and quality control program on materials, processes and manufacturing.

SUSTAINED ACCURACY

through mechanical rigidity

Now for the first time Fairchild brings you the sustained accuracy of all-metal-case construction in a 10-turn potentiometer. This unit has only ½ the diameter and ⅓ the weight of usual standards. It is the Fairchild Standard Type 920. Its 24½" coil length assures linearities of ±0.25% in a resistance range of 1,000 to 200,000 ohms, with ±0.1% available for special applications. Your choice of servo, threaded bushing or three-hole pilot bushing mountings.

This is another example of how Fairchild's complete line can give you the answers, no matter what factors govern your choice of precision potentiometers. Write Fairchild Camera and Instrument Corporation, 225 Park Avenue, Hicksville, L. I., N. Y., Dept. 140-62A.

FAIRCHILD

PRECISION POTENTIOMETERS

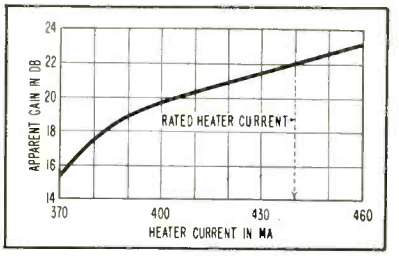


FIG. 4—Heater current and gain characteristics of amplifier

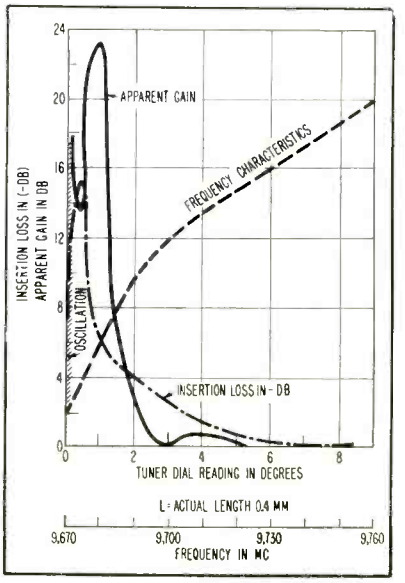


FIG. 5—Insertion loss and apparent gain for variation of tuning screw

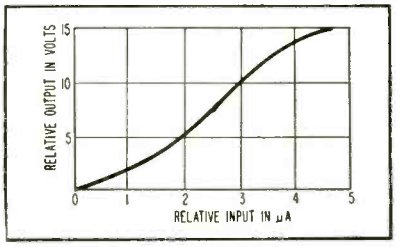


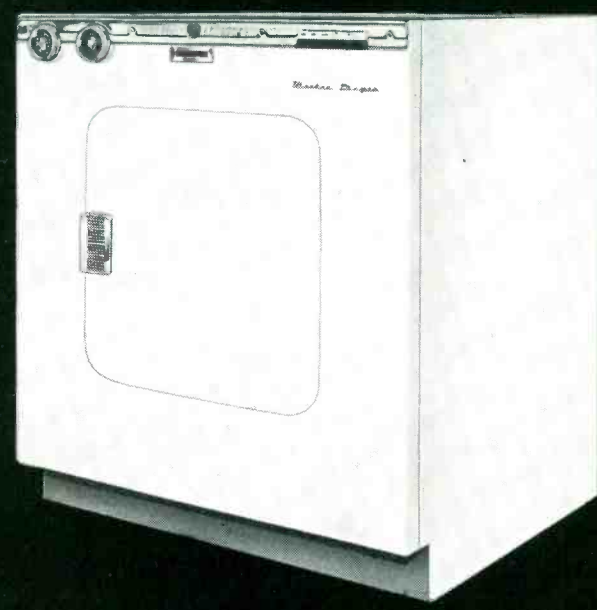
FIG. 6—Linearity of input-output relationship

shows how attenuation of the input signal due to the insertion of the coaxial output line for the tube into the waveguide is affected by the adjustment of the tuning screw. The attenuation was measured with the tube cold. The zero-db level means the incident signal intensity on the crystal detector when the amplifier section is removed with the input transformer waveguide and the horn antenna directly connected to the output waveguide.

The dashed curve in Fig. 5 shows a relation between the apparent gain and the frequency of the incident signal. In this experiment, all potentials and conditions of the

G-E COMBINATION WASHER-DRYER

Washes and drys a full load of laundry completely automatically with a single loading—can be placed where it's most convenient. Only 30" wide, it fits under standard kitchen counter like a base cabinet—or can be built-in flush with o woll. As with so many G-E quolity products, this new Combination Washer-Dryer uses EVERLOCK fasteners to hold vital parts secure against vibrotion.



AMF Everlock® fasteners . . .

used in NEW G-E Combination Washer-Dryer

For a bulldog bite that just won't let go, there's nothing quite like EVERLOCK lock washers. Note those exclusive alternating chisel-like edges. They bite right into the face of the work *and* the screw under powerful spring tension . . . hold snug and tight even under extreme conditions of jolting, jarring and vibration.

Next time you order lock washers, be sure you specify EVERLOCK. There are none better. EVERLOCK lock washers are made in a complete range of common sizes and types—to special order if you need them.

THOMPSON-BREMER & COMPANY
Dept. E, 520 N. Dearborn St., Chicago 10, Ill.
Subsidiary of American Machine & Foundry Company—New York

Another AMF Product
Everlock INDUSTRIAL FASTENERS

Kenneth D. Delanoy Dayton 3, Ohio	J. M. Murphy Manchester, Conn.	W. L. Barth, Jr. Chicago 34, Ill.	Thom Lundeen Moline, Illinois	Richard C. Dudek Beverley Hills, Calif.	J. J. McIntosh Atlanta 6, Ga.
Oscar P. Martin Lakewood 7, Ohio	Russell T. Brosius Philadelphia 3, Pa.	C. W. McNeil Houston, Texas	Forrest Moschner St. Louis, Missouri	P. L. Robertson Milton, Ont. Can.	Donald G. Teeling Indianapolis 44, Ind.
J. Ramsey Reese, Inc. New York 7, N.Y.	Sam T. Keller Detroit 1, Mich.	Leonard F. Berg St. Paul 14, Minn.	A. J. Murphy DeWitt, N.Y.	Sam T. Gleaves Louisville 5, Ky.	Oregon Indus. Factors Portland 1, Oregon

circuit were kept constant. The frequency bandwidth is 20 mc with sacrifice of −3-db gain at end of passband.

Figure 6 shows relation between the relative input power and the relative output power of this amplifier. The output is saturated at the higher level of the input signal. The apparent gain with a weak signal was more than 30 db.

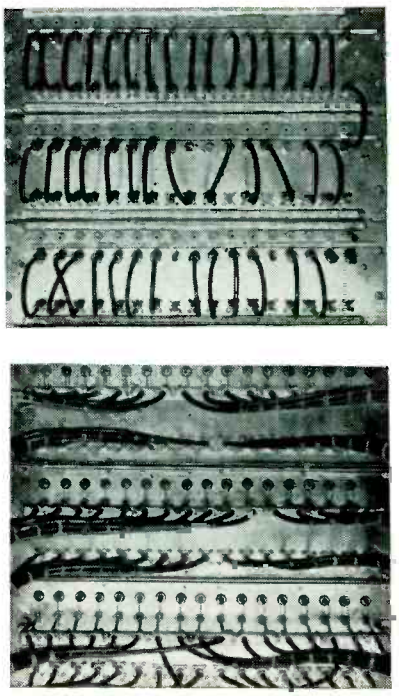
This X-band receiving amplifier may be used as the high-frequency amplifier of a microwave television receiver.

The author wishes to thank T. Okabe, Shizuoka University, K. Owaki, Kobe Industrial Co. and S. Nakamura, The Public Corporation of Telegraph and Telephone and Mr. Fujinawa.

Video Patch Panel Using R-F Connectors

By Duane M. Weise
Chief Engineer
WTTW
Chicago, Ill.

Most television stations desire to install an extensive video patching system with its inherent advantages, but find that the rather high cost of commercial panels over-



Front and rear views of video patch panel. Each line has test jack for rapid troubleshooting

STANDARD *flexlab*

IN INDUSTRY and RESEARCH

IN GOVERNMENT

IN VOCATIONAL and TECHNICAL SCHOOLS and UNIVERSITIES

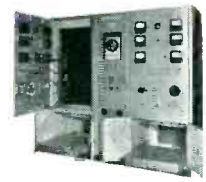
Why not send for Flexlab Catalog #187 — "Laboratory Equipment for Industry and Government" . . or for Flexlab Catalog #216 — "Laboratory Equipment for Vocational and Technical Schools."

"Custom Designed and Built"

IN GOVERNMENT

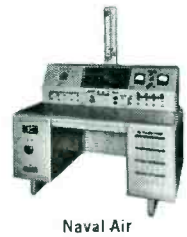
Naval Research Laboratory

Los Alamos Physics Laboratory

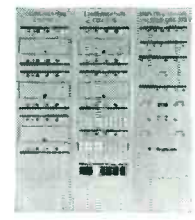


McClellan Air Force Base

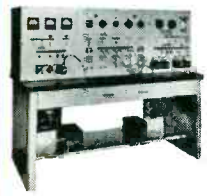
Aberdeen Proving Grounds



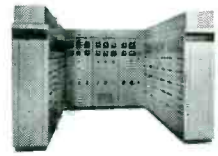
Naval Air Development Station



Frankford Arsenal



Pensacola Naval Air Station

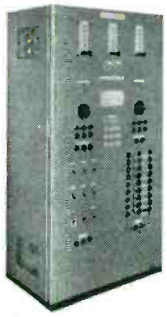


White Sands Proving Grounds

Naval Research Laboratory

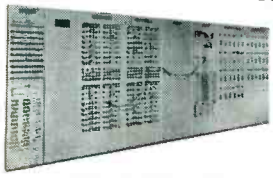
IN SCHOOLS and UNIVERSITIES

Bell Vocational School



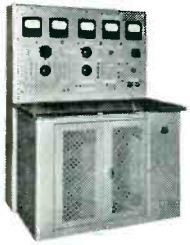
Bell Vocational School

Iowa State College

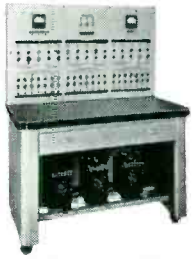


Princeton University

Bergen County Vocational School

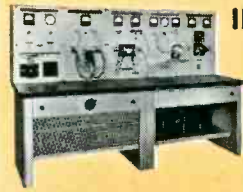


Technical School



Bell Vocational School

IN INDUSTRY and RESEARCH

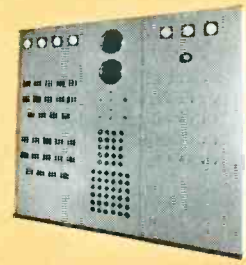


Westinghouse Electric Co.

Monsanto Chemical Co.

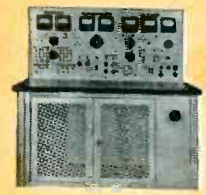
Ford Motor Co.

Radio Corp. of America

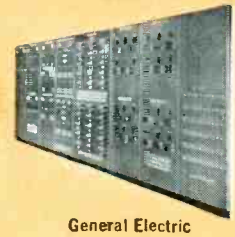


Glenn L. Martin Co.

Commonwealth Edison



Packard Motor Co.



General Electric

STANDARD *flexlab*

Since 1884

THE STANDARD ELECTRIC TIME COMPANY

97 Logan Street • Springfield 2, Massachusetts

ELECTRIC CLOCK AND PROGRAM SYSTEMS • FIRE ALARM SYSTEMS • HOSPITAL SIGNAL SYSTEMS
PRECISION TIMERS • CHRONO-TACHOMETERS • PIPELINE NETWORK ANALYZERS

shadow the advantages to be gained. In addition to the question of cost, there is also the technical consideration as to whether or not a particular commercial patch panel will function to meet the needs of every installation. For instance, it may be found desirable to be able to bridge across a video line, or to monitor the signal level at the patch panel, or to terminate a video line at the patch panel.

At the University of Missouri television station KOMU-TV, video input and output circuits on each chassis are brought to a centrally located video patch panel. Over one hundred connectors are required to handle the monitoring circuits, the local and remote circuits, the test signal circuits and the special-effects circuits. In addition the same type video patching system is used for the various synchronizing signals from the two synchronizing generators used by the station. The photograph shows three 5¼-inch video patch-panel chassis that were constructed by the station technical staff. The patch panels are centrally located in an equipment rack four feet from the line or calibration monitor. This enables the operator to observe the picture and

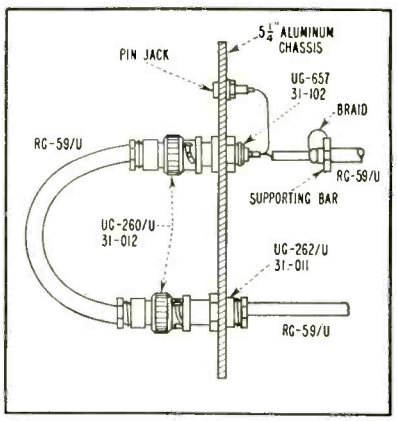
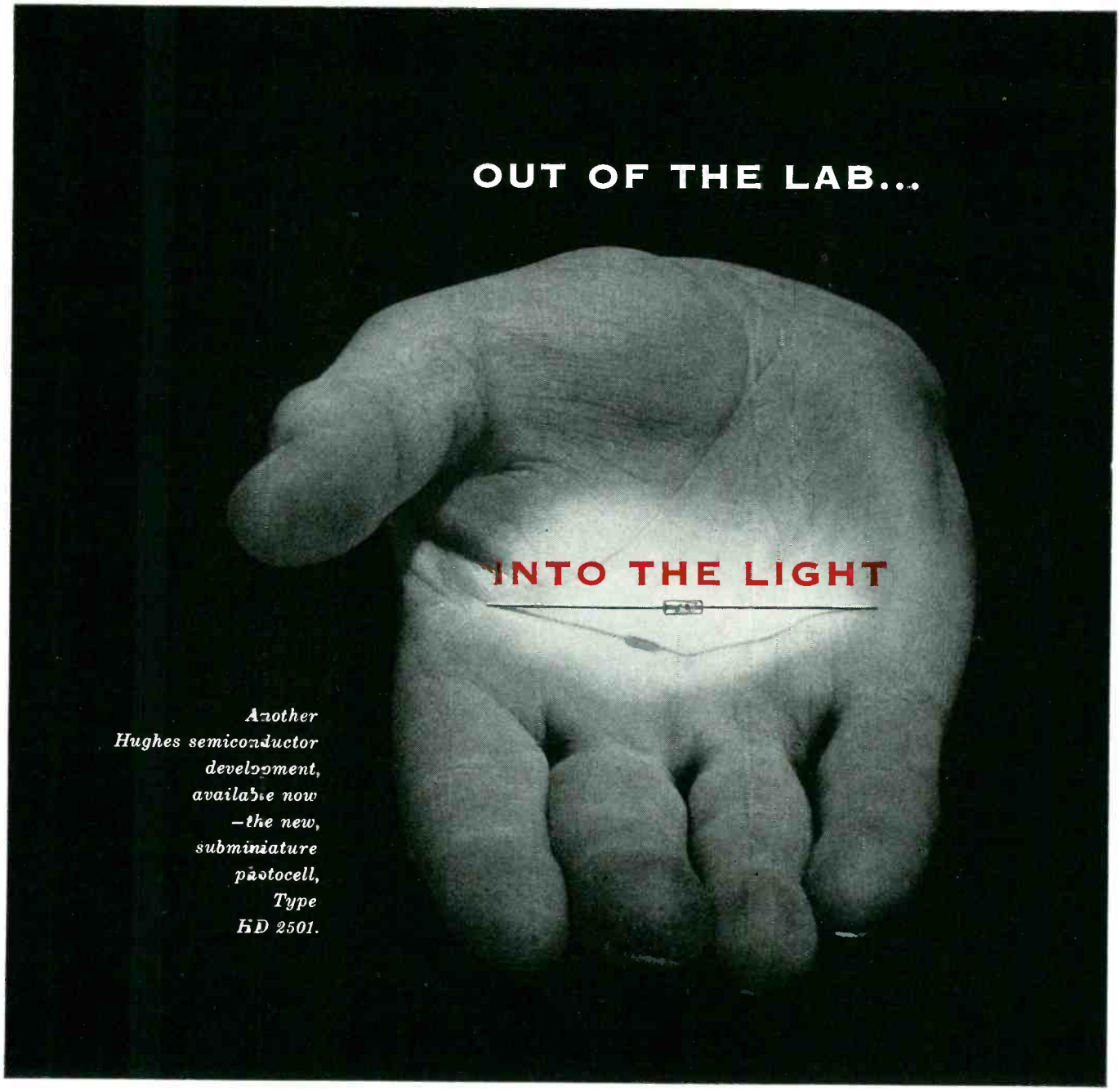


FIG. 1—Construction of patch panel. Outer shields of coaxial lines are grounded on support bracket

waveform when utilizing the patch panels for checking signal levels or trouble shooting faults in the video system.

An added feature of the patch panels construction was the addition of video test jacks as illustrated in Fig. 1. The pin jacks installed on the video patch panels, as well as the patch panel for the syn-



SUBMINIATURE—smallest over-all volume of any photoelectric detector (approx. 1/1000 cu. in.).

FUSION-SEALED—only subminiature photocell with true glass-to-metal seal.

FAST—response at 20 kc down less than 5 per cent.

VERSATILE—non-directional sensitivity (360°) and photovoltaic properties lend unusual flexibility in equipment design.

RUGGED—welded whisker construction withstands severe shock, vibration, and acceleration.

RELIABLE—packaged in the famous Hughes one-piece glass envelope, impervious to moisture and external contamination. A 100% testing ensures uniformity of characteristics.

Hughes Type HD 2501 germanium point-contact photocell can be used as a light detector in card readers, binary encoding and decoding wheels, motion picture sound—and for near infrared applications. Because of this infrared response, tungsten light sources can be operated at voltages below normal and their effective life increased accordingly.

For other diode applications in high and low temperature ranges, be sure to check the growing family of Hughes semiconductors. Scores of types of germanium point-contact and silicon junction diodes are available in RETMA, JAN, and Special listings.

Photocell dimensions, glass envelope
Length: 0.263-inch, maximum
Diameter: 0.086-inch, maximum

HUGHES SEMICONDUCTOR SALES DEPARTMENT

Aircraft Company, Culver City, Calif.

New York Syracuse
Philadelphia Chicago

TYPE HD 2501 PHOTOCELL—SOME CHARACTERISTICS AT 25° C.

Dynamic Breakdown Voltage: 175 Volts, minimum.
Maximum Dark Current: 20 μA at 50 Volts.
Minimum Sensitivity: 1 mA/L at 50 Volts and 25 ML.
Dynamic Resistance: 1 megohm at 50 Volts and 25 ML.

Want more information? Use post card on last page.

chronizing pulses have proved invaluable in quickly locating and isolating troubled circuits and also in checking and adjusting video levels throughout the system.

The video signals have been found to suffer no degradation either from poor frequency response or crosstalk in the patch panel system described. The mounting arrangement enables a neat and compact lacing of video cables.

The three video panels were, in general, laid out so that the upper patch panel was devoted to video circuits in the overall system which finally terminated at the transmitter input. The middle panel was devoted to monitoring circuits. The bottom panel was devoted to distribution circuits, special effects circuits and test signal circuits.

This arrangement has proved satisfactory, in that, following six months of operation there have been only one or two instances where other than the original layout has been found to be more satisfactory. The three panels were constructed at a cost of approximately $350, including labor and materials.

Empire State Antenna for WOR-TV

By G. J. ADAMS, ANDREW ALFORD, H. H. LEACH, RICHARD RUBIN AND FRED ABEL

Andrew Alford Consulting Engineers
Boston, Mass.

WHEN THE ANTENNA system for station WOR-TV (channel 9) was installed, five television stations were already operating from the Empire State Building tower and space for a sixth station had been allocated. The space that was available for the WOR-TV antenna is shown in the photograph. The vertical distance *A-A* is about 14 feet in height. This same space was already partially occupied by four WNBT emergency dipoles equally spaced around the periphery of the building at level *J-J* where the diameter is 28 feet.

The large diameter of the building at the level available for the antenna presented a problem. Various schemes were first tried on paper

NEW...

small size, twelve-channel, precision balance adjustment

MIDWESTERN
MODEL 430
BRIDGE BALANCE UNIT

A 10-turn precision potentiometer with a series, limiting resitor is provided for each channel. Will work with any 2 or 4 arm transducer having input resistance of 120 ohm or greater.

Midwestern Instruments' new Model 430 Bridge Balance Unit is a general purpose instrument suitable for either laboratory or flight-test work. The main design emphasis was placed on producing a unit of the smallest possible size consistent with the wide versatility of operation and application which is desirable in such an instrument. The Bridge Balance Unit is contained in a rugged, aluminum-alloy case. Printed circuits have been used wherever possible throughout the instrument in order to minimize the volume. The front panel of the instrument, on which the controls are mounted, is recessed in order to provide protection against accidental movement. Means are provided for both internal and external calibration.

products

- OSCILLOGRAPHS (LABORATORY AND FLIGHT TEST)
- MAGNETIC STRUCTURES
- GALVANOMETERS
- AMPLIFIERS
- HYDRAULIC SERVOVALVES
- TORQUE MOTORS
- SERVOAMPLIFIERS
- DATA REPEATERS
- WATERPROOF CONNECTORS
- GEOPHYSICAL EQUIPMENT

MIDWESTERN MI INSTRUMENTS

MIDWESTERN INSTRUMENTS

41st and Sheridan Road — Tulsa, Oklahoma

Empire State Building before construction of WOR-TV antenna showing space available for installation

with the aid of model measurements in an effort to obtain an omnidirectional radiation pattern in the horizontal plane. The arrangement that showed the most promise was one that consisted of 24 antennas equally spaced around the building and fed in a progressive 90-degree phase relationship for the video signal and in the opposite direction for aural signal.

The gain of an omnidirectional antenna depends primarily on its illuminated height. The vertical limitation made it desirable to insure that every foot of the available vertical aperture was properly illuminated. A vertical aperture 14 feet high could be illuminated well by four layers of dipoles. The balcony and the heavy parapet wall around the balcony just below the assigned space would have interfered badly with radiation from the lower layer of dipoles. Three layers of dipoles were considered but were not used because dipole-reflector combination offered the advantage of a less complex feeding system without compromising gain and at the same time eliminated the dis-

Now Puerto Rico Offers 100% Tax Exemption to New Industry

by BEARDSLEY RUML

"We don't want runaway industries" says Governor Muñoz. "But we do seek new and expanding industries." Federal taxes do not apply in Puerto Rico, and the Commonwealth also offers full exemption from local taxes. That is why 300 new plants have been located in Puerto Rico, protected by all the guarantees of the U. S. Constitution.

Beardsley Ruml

IN A dramatic bid to raise the standard of living in Puerto Rico, the Commonwealth Government is now offering U. S. manufacturers such overwhelming incentives that more than three hundred new factories have already been established in this sun-drenched island 961 miles off the Florida coast.

First and most compelling incentive is a completely tax-free period of ten years for most manufacturers who set up new plants in Puerto Rico.

For example, if your company is now making a net profit after taxes of $53,500, your net profit in Puerto Rico would be $100,000—a gain of 87 per cent as a result of non-applicability of U. S. Corporate Income Tax in Puerto Rico.

Your dividends in Puerto Rico from a corporation there could be $50,000 against $25,000 net in the U. S.—owing to the non-applicability of the U. S. Income Tax.

What About Labor?

Puerto Rico's labor reservoir of 650,000 men and women has developed remarkable levels of productivity and efficiency—thanks, in part, to the Commonwealth's vocational training schools. These schools also offer special courses for managers and supervisors.

The progress made in technical skills may be gauged from the fact that there are now twenty-eight factories producing delicate electronic equipment.

Among the U. S. companies that have already set up manufacturing operations in Puerto Rico are Sylvania Electric, Carborundum Company, St. Regis Paper, Remington Rand, Univis Lens, Shoe Corporation of America, and Weston Electric.

CORPORATE TAX EXEMPTION

If your net profit after U. S. Corporate Income Tax is:	Your net profit in Puerto Rico would be:
$ 17,500	$ 25,000
29,500	50,000
53,500	100,000
245,500	500,000
485,500	1,000,000

DIVIDEND TAX EXEMPTION

If your income* after U. S. Individual Income Tax is:	Your net income in Puerto Rico would be:
$ 3,900	$ 5,000
7,360	10,000
10,270	15,000
14,850	25,000
23,180	50,000
32,680	100,000
43,180	200,000
70,180	500,000

*These examples are figured for dividends paid in Puerto Rico to a single resident. Based on Federal rates effective Jan. 1, 1954.

"Close to Paradise"

Listen to what L. H. Christensen, Vice President of St. Regis Paper, says:

"The climate is probably as close to paradise as man will ever see. I find Puerto Ricans in general extremely friendly, courteous and cooperative.

"This plant in Puerto Rico is one of our most efficient operations, in both quality and output. Our labor has responded well to all situations."

Mr. Christensen might have added that the temperature usually stays in the balmy 70's twelve months a year.

The swimming, sailing and fishing are out of this world. Your wife will rejoice to hear that domestic help is abundant.

The Commonwealth will leave no stone unturned to help you get started. It will build a factory for you. It will help you secure long-term financing. It will even screen job applicants for you—and then train them to operate your machines.

Transportation

Six steamship companies and four airlines operate regular services between Puerto Rico and the mainland. San Juan is just 5½ hours by air from New York.

Light-weight articles such as radar components come off the line in Puerto Rico one day and are delivered by air freight next day in Los Angeles, Chicago and other mainland cities. And, of course, there is no duty of any kind on trade with the mainland.

Are You Eligible?

Says Governor Muñoz: *Our drive is for new capital. Our slogan is not "move something old to Puerto Rico," but "start something new in Puerto Rico" or "expand in Puerto Rico."*

The Commonwealth is interested in attracting all suitable industries, and especially electronics, men's and women's apparel, knitwear, shoes and leather, plastics, optical products, costume jewelry, small electrical appliances, hard candy and pharmaceuticals.

To get all the facts, and to find out whether you and your company would be eligible for complete tax exemption, mail the coupon below.

MAIL THIS COUPON

Economic Development Administration
Commonwealth of Puerto Rico, Dept. V1
579 Fifth Avenue, New York 17, N. Y.

Mail me "Facts for Businessmen," your report of the advantages of Puerto Rico for plant location.

Name_____

Company_____

Product_____

Address_____

_____

turbing effect of the parapet wall.

An arrangement comprising pairs of dipoles, one above another, with each dipole provided with its own relatively small parabolic reflector was found to be satisfactory. Figure 1 shows the vertical pattern obtained with this arrangement.

Each bay consists of two dipoles with their reflectors. The entire array shown in Fig. 2 consists of 24 bays arranged around the cylin-

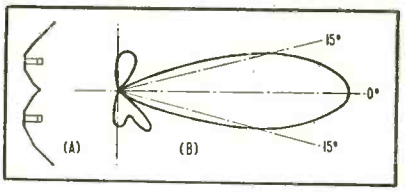


FIG. 1—Double parabolic reflector (A) and radiation pattern (B) for channel-9 operation

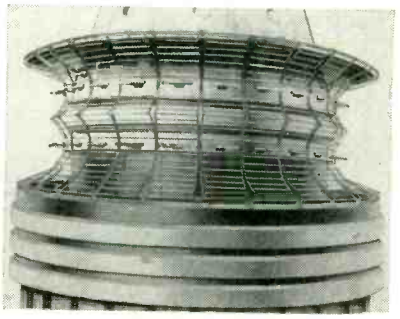


FIG. 2—Arrangement of parabolic reflectors and dipoles around base of Empire State Building tower

drical surface of the building. Figure 3 shows the calculated vertical and horizontal patterns of the whole array. These calculations were checked experimentally by calculating the patterns of 4 bays, 6 bays and other combinations and measuring these patterns with an 850-mc scaled model of the array.

It was found necessary to proceed so that the four emergency channel-4 dipoles could be operated at any time during and after the erection of WOR array. Model measurements showed that the effect of the channel-4 dipoles on the WOR array pattern was fairly small. It was also found that such disturbance in WOR pattern occurred only in the directions of the four channel-4 dipoles. In other directions the disturbance was quite small.

The interaction measurements made with the aid of scaled models showed that the mutual impedances

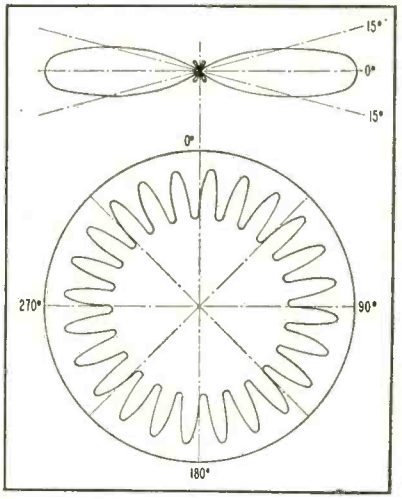


FIG. 3—Vertical and horizontal radiation patterns of WOR-TV antenna

were also small and insignificant.

The levels of the signal induced by the WOR dipoles in the channel-4 dipoles and vice versa were also measured with the aid of the scaled models. These levels were found to be sufficiently low to make the simultaneous operation entirely practical.

In the r-f feeder system the bays are connected in alternate pairs. The alternate pairs are connected in four groups of threes. These four groups are connected in groups of two at the bridge diplexer. The arrangement is symmetrical in spite of the elevator housing, structural steel members supporting the mast and a number of feeders for other tv and f-m stations.

Each bay consisting of two dipoles with reflectors was compensated so that over the 6-mc band its standing wave ratio did not exceed 1.08. An average bay had an swr of less than 1.06. The swr of all components was checked separately and in functional groups at the plant.

Upon completion of the installation an impedance run was taken on the entire video system at its input in the transmitter room. The measured vswr is plotted versus fre-

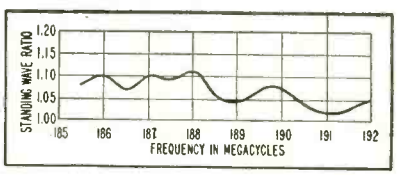


FIG. 4—Standing-wave ratio of channel-9 antenna after installation

NOW from GENERAL ELECTRIC...

3 New TEXTOLITE® PUNCHING GRADE LAMINATES

for easy fabrication excellent electrical characteristics and the BEST PUNCHING QUALITIES EVER!

You'll want to meet these new members of the General Electric Textolite family—three new paper base laminates engineered for high mechanical and electrical strength, easy fabrication and uniform appearance.

Distinguished by exceptional punchability, these new laminates can help *save you money* by helping to eliminate production delays often caused by unsatisfactory punching grades.

G-E TEXTOLITE 11562
(NEMA Grade P)—ideal for general-purpose applications. Can be punched cold to 1/16" and sheared cold to 3/32".

G-E TEXTOLITE 11563
(NEMA Grade XXP)—for medium electrical resistance. Can be cold punched under 1/16" and sheared cold up to and including 1/16".

G-E TEXTOLITE 11564
(NEMA Grade XXXP)—for applications requiring the highest electrical qualities. An excellent *hot* punching grade for high frequency under severe humidity conditions.

MEET THE LOW-COST TEXTOLITE "TWINS!"

G-E Textolite 2053—offering excellent hot punching qualities with high mechanical and electrical strength!

G-E Textolite 11561—combining excellent cold punching and shearing qualities with high impact and dielectric strength!

BOTH AT A NEW LOW COST!

Copper clad electrical grade laminates are also available!

General Electric Company
Laminated and Insulating Products Dept.
Sect. No. E4-5
Coshocton, Ohio

Please send me samples and data sheets on G-E Textolite laminates.

( ) 11562 ( ) 11563 ( ) 11564 ( ) 11561 ( ) 2053

Name_____

Firm_____

Street_____

City_____ Zone___ State_____

Progress Is Our Most Important Product

GENERAL ELECTRIC

ELECTRONICS Charter-Year Advertiser

quency as shown in Fig. 4.

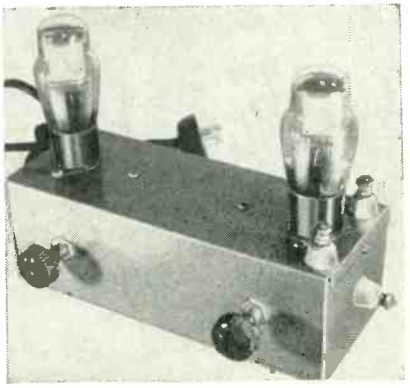
Interaction tests between WOR-TV and the other antennas on the Empire State Building were performed under the supervision of Frank G. Kear, consultant to the Empire State Building Primary Committee. Test results show better than 60-db isolation for video and aural frequencies, with one exception. Isolation between the WOR-TV antenna array and the WNBT emergency antenna array is over 45 db.

High-Voltage Waveshape Generator

By JESS M. REED
National Schools
Los Angeles, Calif.

THE signal generator shown in Fig. 1 will produce various waveshapes with peak amplitude of 160 volts. It is simple to construct, easy to adjust and small. The pulse width and rise and fall time can be controlled.

With the regular 115-volt power line as input, the generator can be adjusted for rectangular pulses with a peak amplitude of about 160 volts. Since the maximum output voltage is the same as the



Simple waveshape generator can be used to obtain peak output voltages of several thousand volts

inverse peak voltage applied to the thyratrons, voltages of several thousand can be obtained with the proper input.

If a variable-amplitude output of each waveshape is desired, a voltage-divider potentiometer of about 1,000 ohms should be connected across the output.

A double phase-shift circuit is

New Tubeless Magnetic Stabiline *Automatic* Voltage Regulators

Type TM7101

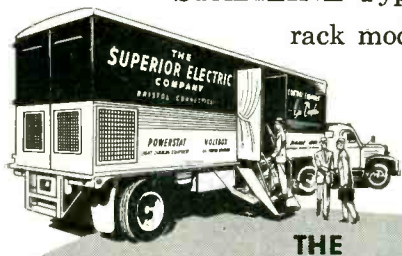
- *No tubes to replace*
- *No electromechanical parts to wear out*

STABILINE Automatic Voltage Regulators Type TM are the newest addition to Superior Electric's complete line of voltage control apparatus. Without tubes or moving parts it provides constant voltage regardless of line voltage or load changes. Where failure at any time under the most adverse operating conditions cannot be tolerated or where service is not a possibility over long periods of time STABILINE Type TM is a necessity. Both cabinet and rack models are offered. Send coupon below for full information.

FOR UNATTENDED LOCATIONS:
- Microwave relay stations
- Remote installations

FOR CRITICAL APPLICATIONS:
- Where sudden need for tube replacement can be costly (at a critical time in a process) or impossible (at an unattended location)
- Where conditions cannot tolerate moving parts

STABILINE Type TM7101 shown is rated:
1. Input — 95 to 135 volts
2. Output — nominal 115 volts can be adjusted from 110 to 120 volts
3. Output held within 1 volt band
4. Frequency range — 55 to 65 cycles
5. Waveform distortion — 3% maximum
6. Speed of response — less than 1.0 second for full range correction
7. Maximum load — 1.0 KVA.
8. Load power factor range — .5 lagging to unity



See Superior Electric's Mobile Display when it visits your area.

THE SUPERIOR ELECTRIC COMPANY
BRISTOL, CONNECTICUT

SALES OFFICES

1436 N. Serrano Avenue, Hollywood 27, California
P.O. Box 946, 1246 Junipero Ave., Redwood City, California
453-A Eglinton Ave., W., Room 202, Toronto 12, Ontario, Canada
P.O. Box 48, 721 South Boulevard, Oak Park, Illinois
P.O. Box 132, 250 South Court St., Medina, Ohio
4515 Prentice Street, Room 202, Dallas 6, Texas

REPRESENTATIVES

Buryl R. Hill Company, 19481 James Couzens Highway, Detroit 35, Michigan
Fred H. Haight Company, 3212 Eastlake, Seattle 2, Washington

THE SUPERIOR ELECTRIC COMPANY, 204 Reynolds Ave., Bristol, Conn.

Please send me full information on the new STABILINE Automatic Voltage Regulator Type TM (Tubeless Magnetic)

Name.....

Company.....

Address.....

City.....Zone.....State.....

Want more information? Use post card on last page.

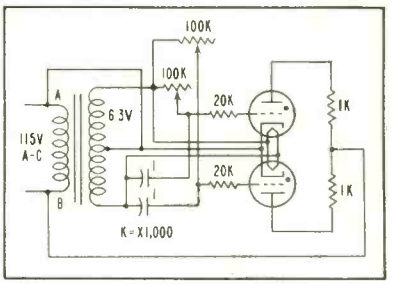


FIG. 1—Thyratron waveform generator provides peak amplitudes of 160 volts from 115-v a-c line

used whereby one thyratron's grid voltage is shifted in phase with respect to the plate by an amount slightly different from that of the other thyratron. This results in a cancellation of output voltage of the in-phase component, leaving a wave equal to the difference in phase angle between the two grids.

A diagram and vector of a simple phase-shift circuit is shown in Fig. 2. Phase angle between grid and plate voltage is determined by the relative magnitudes of resistance and reactance. The peak ouput voltage is $e = E_m \sin \theta$ where θ is the angle that the grid voltage lags the plate voltage. This must be a lagging voltage. A leading phase angle results in the potentiometers' losing their control. If the circuit is tested and doesn't operate, reverse wires at *A* and *B*.

The unit illustrated in Fig. 1

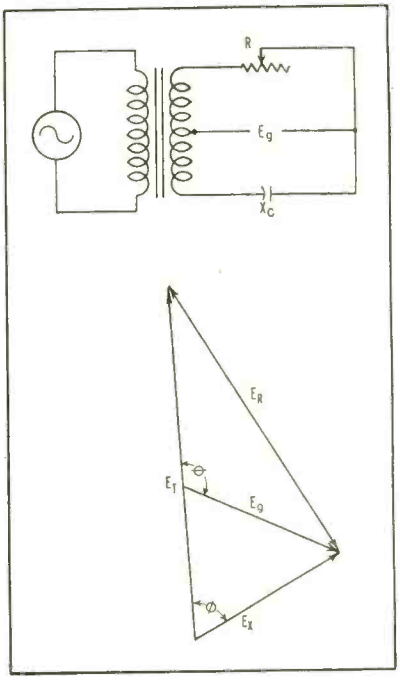
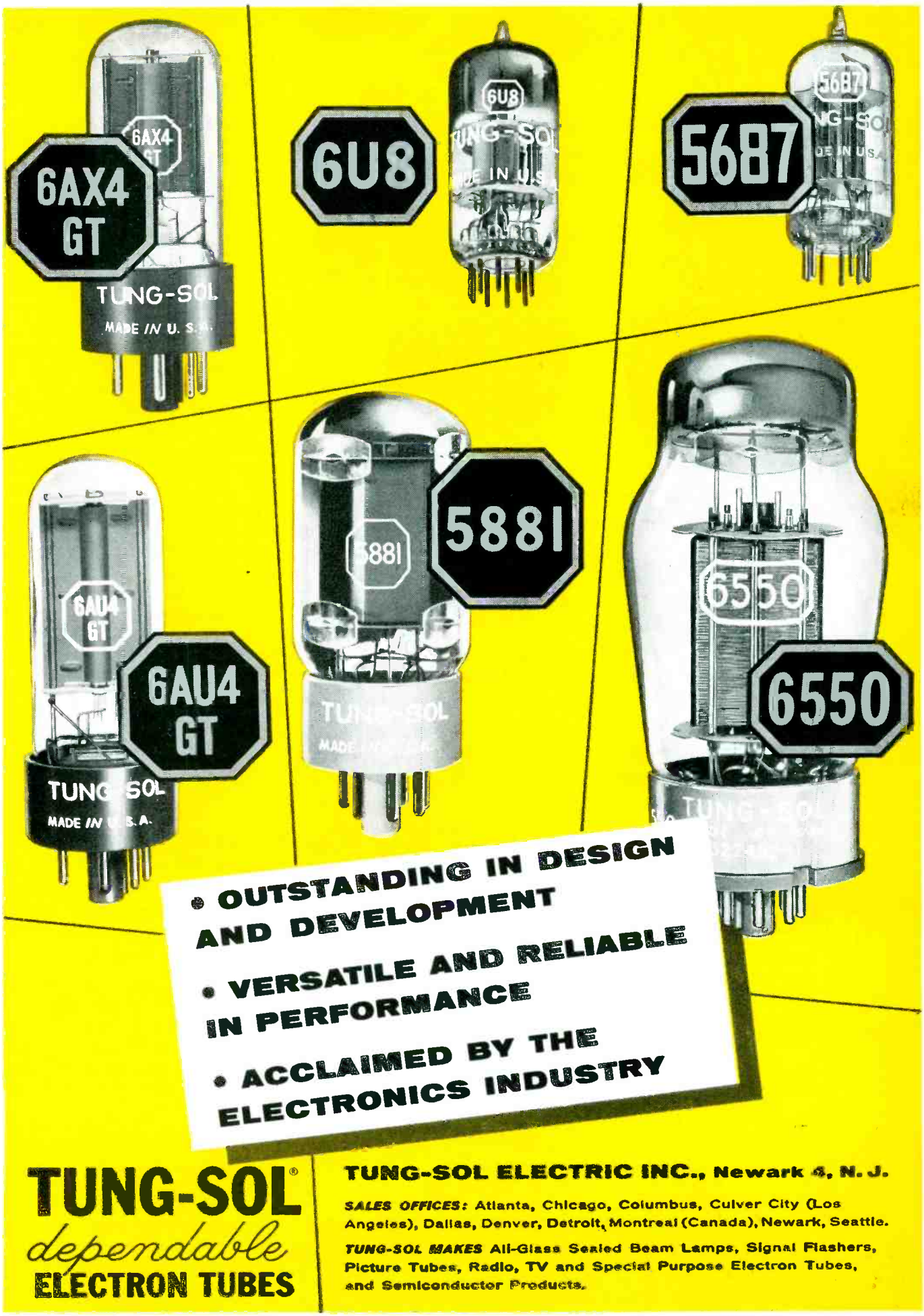


FIG. 2—Equivalent circuit and vector diagram used to calculate component values for waveshaper



• OUTSTANDING IN DESIGN AND DEVELOPMENT

• VERSATILE AND RELIABLE IN PERFORMANCE

• ACCLAIMED BY THE ELECTRONICS INDUSTRY

TUNG-SOL®
dependable
ELECTRON TUBES

TUNG-SOL ELECTRIC INC., Newark 4, N. J.

SALES OFFICES: Atlanta, Chicago, Columbus, Culver City (Los Angeles), Dallas, Denver, Detroit, Montreal (Canada), Newark, Seattle.

TUNG-SOL MAKES All-Glass Sealed Beam Lamps, Signal Flashers, Picture Tubes, Radio, TV and Special Purpose Electron Tubes, and Semiconductor Products.

produces 0-160 volts output. To change this voltage, connect wires A and B to the desired source.

The values of 1 μf and 100,000 ohms for the phase-shift circuit were chosen so that there would be an overlap beyond the 90-deg peak.

To illustrate the method of calculation, assume a control is wanted over 170 degrees of the cycle. The vector diagram shows that θ would be 170 degrees and ϕ would always be one half of this, or 85 degrees. Note that E_r, E_x and E_t form a right triangle and these values could be replaced with R, X_c and Z_t without changing the angles. In this vector, $\tan \phi = R/X_c$ from which $R = X_c \tan \phi$. A 1-μf capacitor at 60 cycles has a reactance of about 2.67×10^4 ohms. The tangent of 85 is 11.4. The value of R is $2.67 \times 10^4 \times 11.4 = 305{,}000$ ohms.

The 100,000-ohm potentiometer covers from 0 to about 150 degrees. To obtain control over the entire 180-degree wave, a potentiometer of about 500,000-ohms is satisfactory. The higher the value of potentiometer used, the more critical become the adjustments for a given waveshape.

PERTINENT PATENTS

By Norman L. Chalfin
Hughes Aircraft Co.
Culver City, Calif.

Diversity of the electronic technique is well demonstrated by the range of applications represented in the present group of patent abstracts.

Integrator

An "Integrating Circuit" has been awarded patent 2,638,493, issued to John W. Trischka and Henri S. Sack, of Ithaca, New York. The patent is assigned to the United States as represented by the Secretary of the Navy.

A block diagram of the circuit of this invention is shown in Fig. 1.

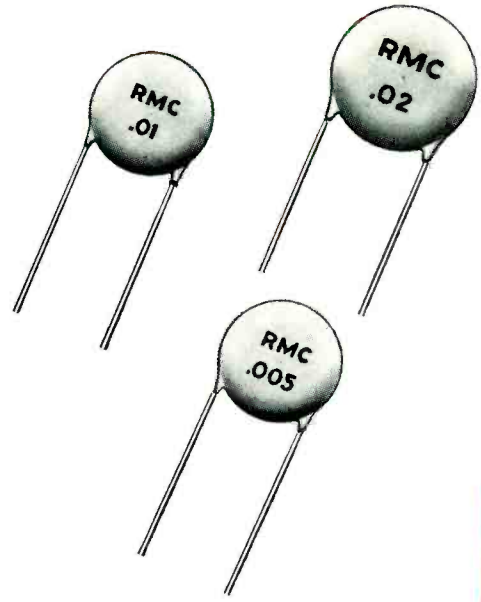
It is the purpose of this invention to provide a circuit for adding two direct currents and integrate the sum thus obtained with respect to time, the result being determined from the angular rotation of a dial.

Two direct currents are applied to a magnetic amplifier that provides a

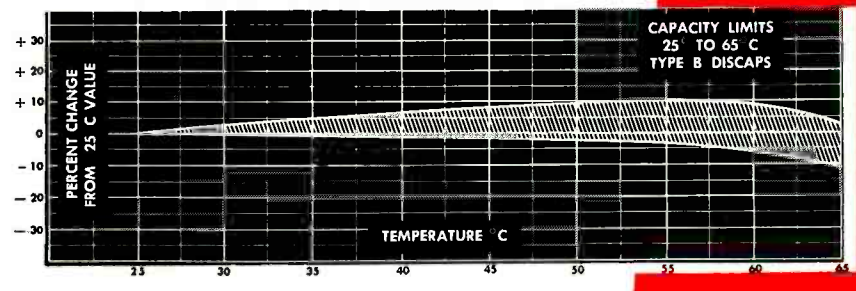
RMC BY-PASS DISCAPS

RMC Type B "Heavy Duty" DISCAPS are designed for all by-pass or filtering applications and meet or exceed RTMA REC-107-A specifications for type Z5Z capacitors

- Rated at 1000 working volts
- Available in any capacity between .00015 MFD and .04 MFD
- Minimum capacity change between +10°C and +65°C (See Curve)
- Heavy duty construction means greater dependability at no extra cost



PLUG-IN TYPES NOW AVAILABLE



RMC is now producing plug-in DISCAPS designed for printed circuit applications. Available in by-pass, temperature compensating, and stable capacity types, plug-in DISCAPS have the same high specifications featured in standard RMC capacitors. Leads are No. 20 tinned copper (.032 diameter) and are available up to 1½" in length. Popular range of sizes for all applications.

DISCAP CERAMIC CAPACITORS

RMC

RADIO MATERIALS CORPORATION

GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.

FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

Two RMC Plants Devoted Exclusively to Ceramic Capacitors

direct current proportional to the sum of the input currents. The output current is applied to a motor control circuit, which in turn drives a motor at a speed proportional to the applied currents. A dial is driven by the motor to indicate the integrated sum of the input currents at any instant.

The motor also drives a generator

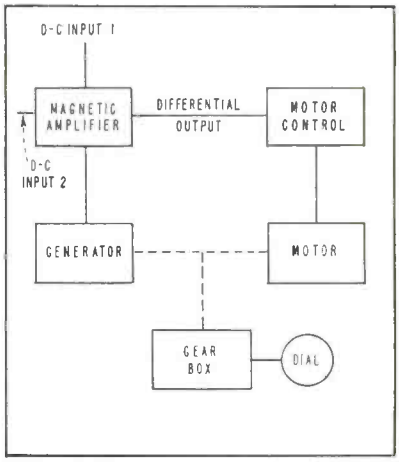


FIG. 1—Block diagram of integrating circuit

whose voltage output is substantially linear to provide a negative feedback voltage to the magnetic amplifier. This makes the output stable and the ratio of output to input linear.

Speech Typewriter

An inventor, M. V. Kalfaian of Los Angeles, Calif. has been awarded patent 2,673,893 for a "Phonetic Printer of Spoken Words."

According to this inventor, an analysis of speech waves shows that the complex waveforms associated with speech patterns of male and female voices can be brought into a common frequency band by frequency-changing techniques. Following this, certain areas of the common frequency band are separated into selected areas wherein the standardized frequencies of the frequency-changed speech patterns may be broken down into four ranges.

The output signals in each of these ranges is rectified and applied to a ratio-metering device, the output of which, in turn, is applied to a modified electric typewriter of the type now familiar in computer apparatus.

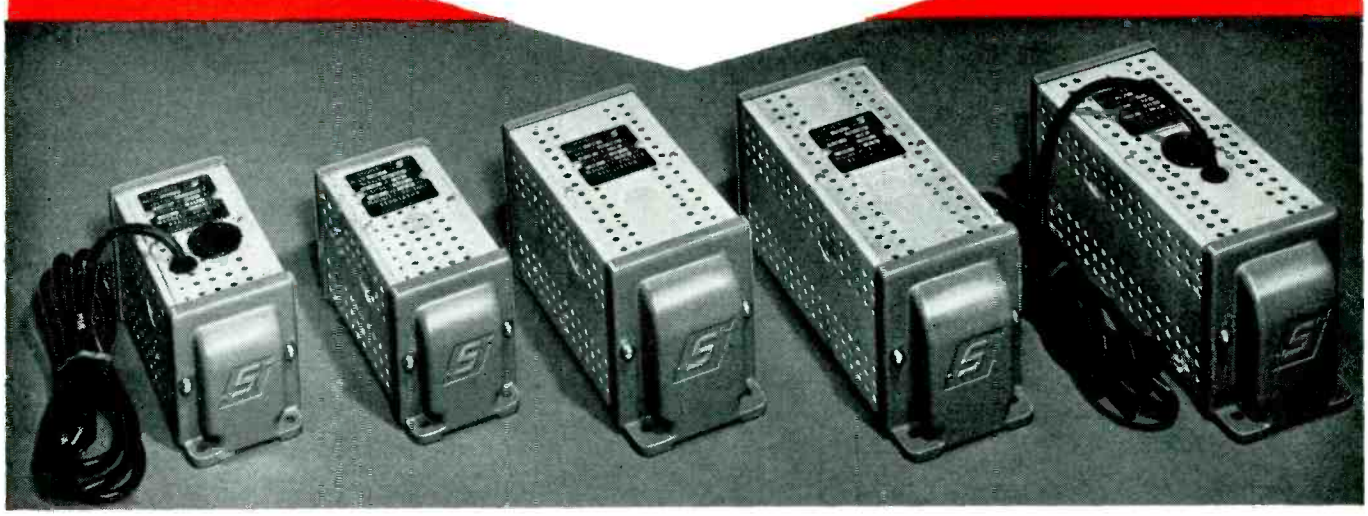
A simplified block diagram of the

NEW! NEW! NEW!

MAGNETIC VOLTAGE REGULATORS

These Magnetic Voltage Regulators, or Regulating Transformers, are the first units in a comprehensive line of equipment of this type being developed by Sorensen. They are primarily intended for incorporation into other equipment, where performance becomes more effective when the incoming line voltage is stabilized. However, they can be used as auxiliary line stabilizers.

The units now available have capacities of 15, 30, 60, and 120 VA. Soon to be added will be units of 250, 500, and 1000 VA capacities.



ELECTRICAL SPECIFICATIONS

Input voltage range	95-130 VAC, 1ϕ, 60 cycles.
Output range	115 VAC, RMS, 1ϕ.
Regulation accuracy	±0.5% against line changes.
Load conditions	±0.5% against line at any given load from 0 to full load.
Time constant	From 2 to 6 cycles for line changes.

MECHANICAL SPECIFICATIONS

Model MVR15	Length 6½", Width 2⅞", Height 3½"
Model MVR30	Length 6½", Width 2¾", Height 3½"
Model MVR60	Length 8⅛", Width 3½", Height 4¾"
Model MVR120	Length 9⅜", Width 3½", Height 4¾"

Send for Catalog MVR1, which gives full information on the magnetic voltage regulator line.

Since Sorensen is now offering a new type of line voltage regulator, your inquiries regarding special requirements in magnetic voltage regulators will be welcomed. Write to the Sales Engineering Department, Sorensen & Co., Inc., 375 Fairfield Avenue, Stamford. Conn.

SORENSEN

SORENSEN & CO., INC., 375 FAIRFIELD AVENUE, STAMFORD, CONN.

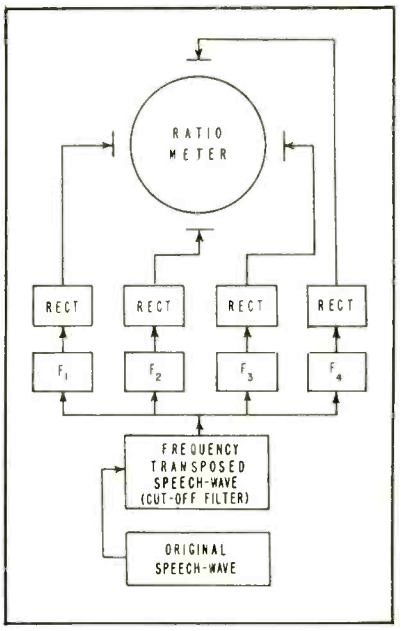


FIG. 2—General nature of the speech typewriter

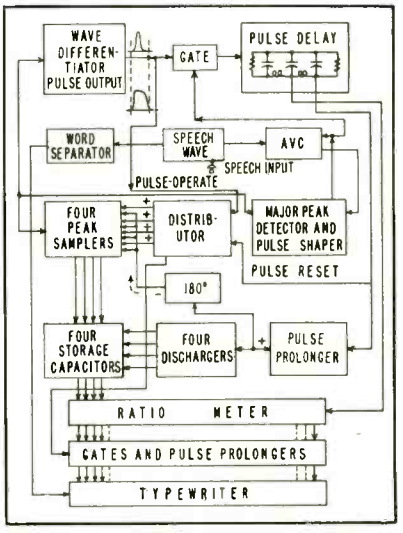


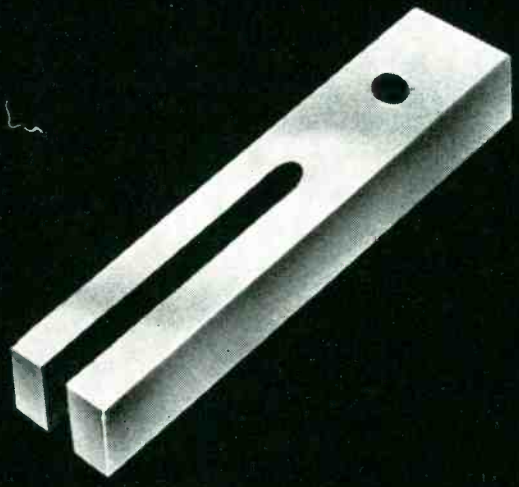
FIG. 3—Block diagram shows details of speech analysis equipment

invention as described above is shown in Fig. 2.

A more elaborate block diagram is given in Fig. 3. The speech wave is amplified, broken down into the common frequency bands where major peaks are detected and appropriate pulses generated.

At the same time the four peak samplers are operated to separate the distinguishing characteristics of the phonetic speech patterns and the outputs thereof mixed with delayed pulses from the peak separation and differentiator networks into four storage devices. Four discharging circuits control each of the storage units to apply appropriate pulses to the cathode-ray de-

Tuning Fork Resonators, the ultimate in precision audio frequency control . . .



... phone or write

for complete information regarding component type **Tuning Fork Resonators,** or variously packaged **Tuning Fork Frequency Standards.**

Philamon Laboratories Inc.

90 HOPPER STREET, WESTBURY, LONG ISLAND, N. Y. EDgewood 3-1700

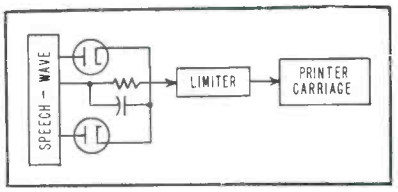


FIG. 4—Word separator unit spaces by moving carriage

vice of the ratio meter where the signals generated are gated and sampled.

Appropriate combinations of signals operate the combinations of typewriter keys to print phonetically the words spoken into the speech input.

Some of the circuits of this invention are of particular interest. One of these is the word separator shown in Fig. 4.

The circuit consists of a rectifier and *RC* network that produces output signals during spoken words. The time constant of *RC* is adjusted to equal about the shortest time period that a speaker may pause between spoken words. All higher frequencies are cut out. This results in a series of square waves of

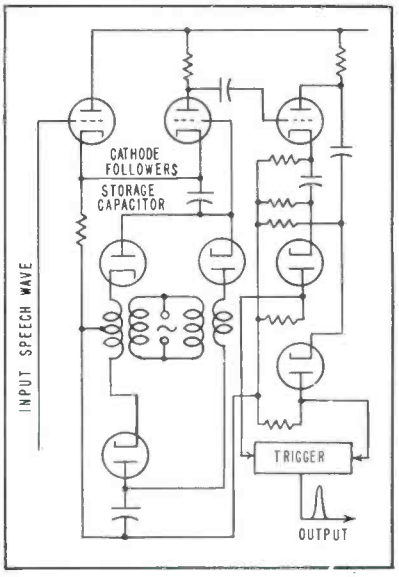


FIG. 5—Wave-differentiator circuit

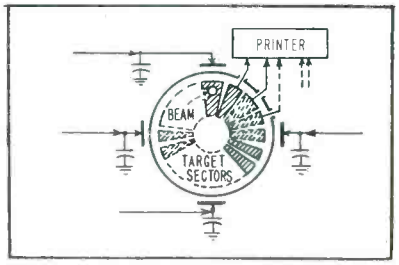


FIG. 6—Ratiometer is based upon cathode-ray tube

IBM news

TRADE-MARK

FOR ENGINEERS

APRIL'S BIG CAREER OPPORTUNITIES

DEVELOPMENT ENGINEERING*

Digital computer component development – design of components and functional units of accounting and data processing machines – transistors and transistorized units – special electron tubes–counters–magnetic core, drum, tape, and ferro-electric storage devices. ALSO fine openings in digital computer circuit design, electro-mechanical development and systems planning and analysis.

MANUFACTURING ENGINEERING*

Design and development of electronic test equipment for digital computer production testing–circuit design–systems planning and analysis–test planning. ALSO excellent openings in functional and acceptance testing–test equipment installation and maintenance–automation engineering–manufacturing research.

***Required** – a degree in E.E., M.E., or Physics, or equivalent experience.

Desirable – experience in any of the following fields: digital and analog computers, including airborne types, radar, TV, communications equipment, relay circuitry, automation, servo-mechanisms, instrumentation, or data handling systems.

APPLIED MATHEMATICS**

IBM seeks a special kind of mathematician and will pay well for his abilities. You'll work as a special representative of IBM's Applied Science Division as a top-level consultant to business executives and scientists. Employment assignment can probably be made in almost any major U.S. city you choose.

****Required**: major or graduate degree in Mathematics, Physics, or Engineering with Applied Mathematics equivalent. Desirable, but not required, experience in teaching Applied Mathematics and use of automatic computing equipment.

For information on these career opportunities

WRITE,

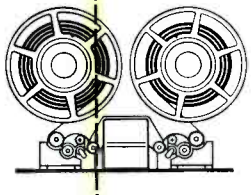
giving details of education and experience, to:
William M. Hoyt, IBM, Room 404
590 Madison Ave., New York 22, N. Y.

"I'VE GROWN WITH IBM"

says Wallace D. Bolton, Development Engineer at the Endicott Laboratories

"The way IBM is growing certainly offers a young engineer the opportunity to move ahead–and in work that's interesting," says Wally. "Since I joined IBM in July of '50, right after getting my BS/EE from the University of Pennsylvania, I've been closely associated with a new development in the field of high-speed printing. Now, I'm in charge of the research phase of this program. And in just about every other area around me, I've seen opportunities opening up all the time for other young engineers."

IBM MAGNETIC TAPE DEVELOPED BY ADVANCED ENGINEERING



The great data processing machines produced by IBM employ the latest advances in processing and data storage. Among these is oxide-coated acetate tape used to record information in the form of magnetized spots. Tape units for either reading or writing operate at a rate of 15,000 characters per second.

The density of recording is 200 characters per inch, permitting permanent files of data to be compressed onto a 10½-inch diameter reel holding 2,400 feet of tape. A single reel can contain over 50,000 grouped records of 100 characters each.

Your replies, of course, will be held in strictest confidence.

INTERNATIONAL BUSINESS MACHINES CORPORATION

World's Leading Producer of Electronic Accounting Machines and Computers

JOIN YOUR FRIENDS AT IBM

THEY'LL TELL YOU IT'S A GREAT PLACE TO WORK.

varying lengths that move the typewriter carriage one step forward for each spoken word or in some cases each syllable.

The circuit of a wave differentiator is shown in Fig. 5 and the ratiometer in Fig. 6.

Color TV Adapter

A color television adapter was described in patent 2,638,816 issued to Milton M. Stolzer of Uniondale, N. Y.

The invention comprises an assembly to be placed in front of a television screen such as shown in Fig. 7A. Figure 7B indicates the details of a carbon bisulphide (CS_2) window used as part of the assembly.

Polarizing elements are placed on either side of an isotropic medium such as a CS_2 cell along with a birefringent sheet between the outer

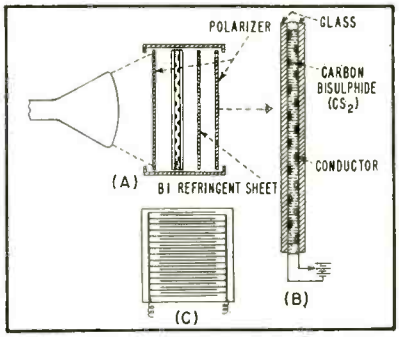


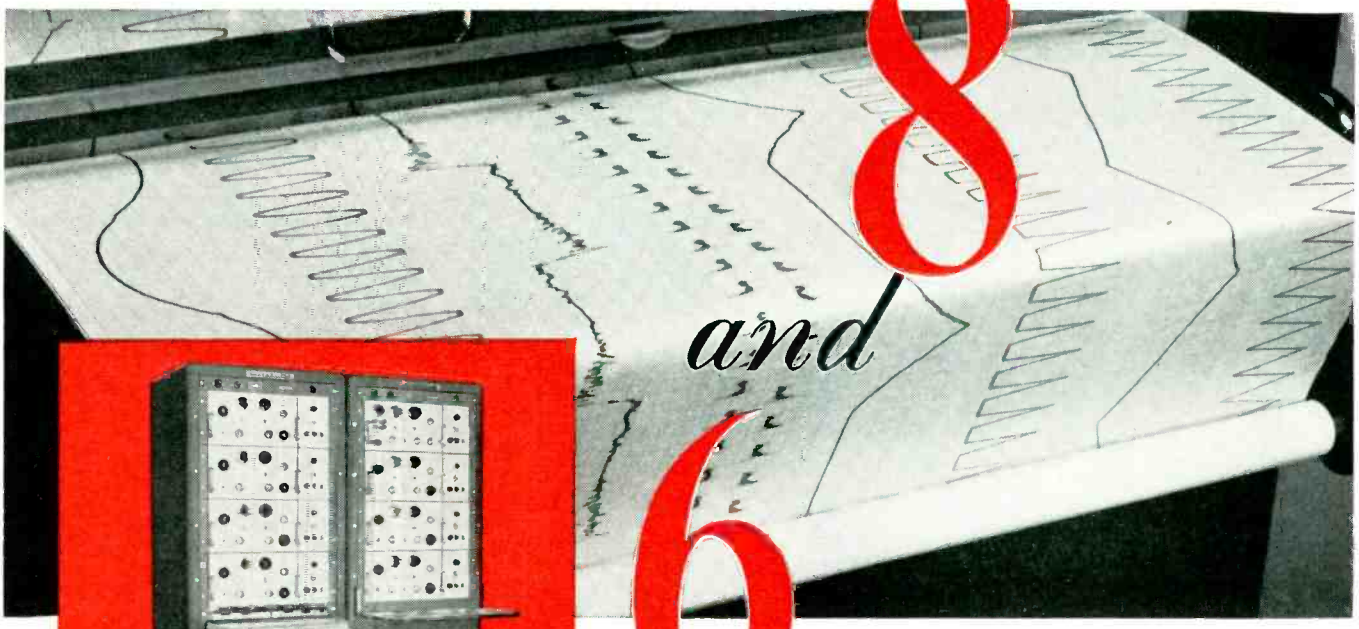
FIG. 7—Polarizer is placed in front of tv screen (A) and comprises carbon bisulphide window (B). Grid structure is shown at (C).

side of the cell and the outer polarizer. There is a grid structure as shown in Fig. 7C inside the CS_2 cell.

When voltages are applied to the grid structure the stress electric fields in the cell (as in the Kerr cell effect) polarizes the light 45 deg elliptically upon entering the cell. The optical rotation is in the direction of electric stress. When the appropriate voltage is applied light of only one color is transmitted.

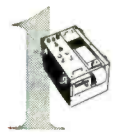
While not so stated in this patent, it would seem that the inventor intended that as the beam is swept horizontally across the screen appropriate voltages applied to the grid structure result in the proper degree of rotation for the beam to be transmitted in the appropriate color.

now SANBORN



8 and 6 CHANNEL "150" SERIES OSCILLOGRAPHIC RECORDING SYSTEMS

in addition to



and

Channel Models

These new additions to the "150 family" follow the original "150" design concept which permits rapid change-over from one set of recording requirements to another by means of interchangeable, plug-in type preamplifiers.

The Model 158-5460 eight-channel system (upper left photo) consists of an eight channel recorder assembly and eight Driver Amplifier-Power Supply units. To this basic assembly the user adds any combination of Sanborn "150" plug-in preamplifiers to meet his requirements. Each channel provides a 4 cm deflection.

The six-channel system (156-5460) has the same basic assembly, except for *two less* galvanometers and *one less* Driver Amplifier-Power Supply unit in each cabinet. Each channel provides a 5 cm deflection.

Both systems offer: *nine* chart speeds (0.25 to 100 mm/sec.); *extended* frequency response; *improved* regulated power supplies; *individual* stylus temperature control for each channel; *improved* control of input signals by 1, 2, 5, 10, 20, etc. attenuator ratios; controls for timing, manual and remote coding.

Also 8 and 6 Channel Systems for recording analog computer outputs,

or other applications where 1 volt/cm sensitivity is usable. complete eight-channel system shown comprises four Model 150-2000 Dual Channel DC Amplifiers and an eight-channel Recorder Assembly. Each Dual-Channel Amplifier is complete with common power supply. (The six-channel version is identical, except for two less galvanometers and one less Dual-Channel Amplifier.) Also four channel models.

Write for catalog material on any Sanborn "150" Recording System

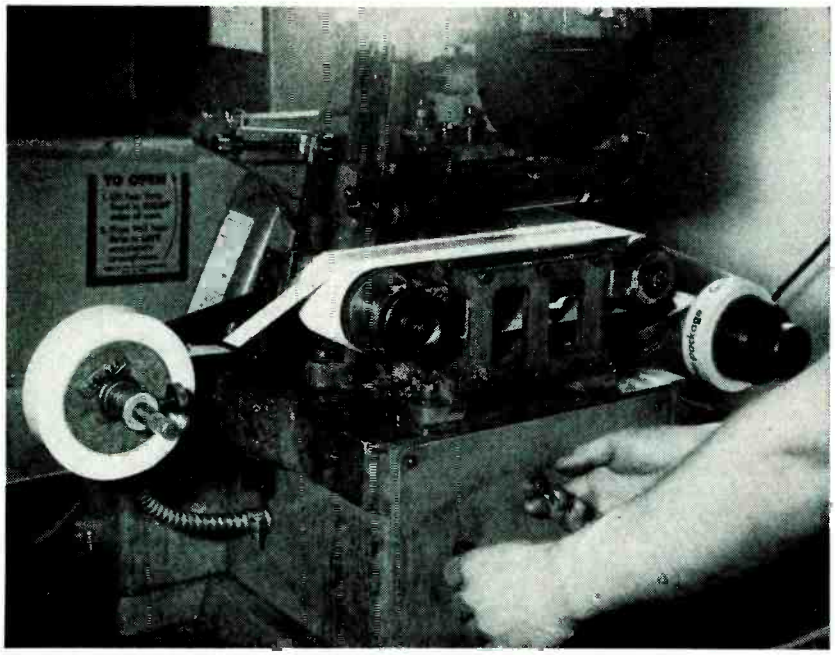
SANBORN COMPANY

CAMBRIDGE 39, MASS.

Production Techniques

Edited by JOHN MARKUS

Tape Printer Aids Identification of Antenna Parts



Machine for printing identifying legends on Scotch tape right on the production floor of an antenna assembly plant. Type and machine settings can be changed in about one minute to accomodate changing production needs

IDENTIFICATION of more than 100 types of preassembled television antennas during mass production is achieved at Channel Master Corp. in Ellenville, N. Y. through use of four colors of Minnesota Mining and Manufacturing Co.'s Scotch brand acetate fibre tape No. 700. The tape is imprinted in black right in the antenna plant as needed, with appropriate identifying messages at intervals along the length of the tape.

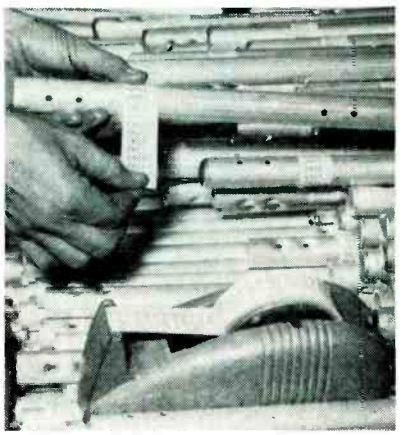
Strips of the yellow (most commonly used) tape, for example, are used in a one-inch width for identifying one-channel antenna units and masts; ½-inch widths are used for various straps, hardware and mounting accessories. The red tape is used to designate multiple-channel antenna units, while the green and white tapes in one-inch width are for special mast-identification purposes.

The tape is imprinted with such messages as "Channel 11", "Channel 4", "Straight-Away Telescoping Mast", "Strato-Matic Telescoping Mast", "For Peaked Roof" and "For Flat Roof", to identify the particular part during fabrication, identify the correct assembly components for distributor use at the time of sale and subsequent erection, and provide brand-name identification for unboxed merchandise.

Application of tape to the all-aluminum antenna units is the first phase of the mass-production operation after the raw aluminum has been extruded, stamped and prepared for final assembly. A worker at the head of each of the six assembly lines does the job by pulling about a 3¼-inch strip of the printed tape from a heavy-duty dispenser and wrapping it around the main crossarm piece for the antenna being produced by her line. Other workers check the message on the tape to determine exactly what parts to add to the crossarm. These added dipoles, directors, reflectors and other parts collapse together onto the crossarm to form a compact unit for packaging.

Other workers, meanwhile, are applying 6-inch-long strips of the preprinted tape to identify mast constructions and ½-inch-wide strips in various lengths to identify hardware items.

Because the need for particular identification messages varies from day to day, Channel Master prints its own messages on the tape as they are needed. For this task a special pressure-sensitive tape printing machine has been installed in the plant and a stock of 75 rubber printing cuts is maintained for immediate use. The machine is a Markem Model 26A pressure-sensitive tape printer, made by the Markem Machine Co., Keene, N. H. It prints the blank tape as it feeds from the roll and rewinds the tape automatically, at rates up to 70 impressions per minute.



Applying tape to identify a channel-11 crossarm during later assembly

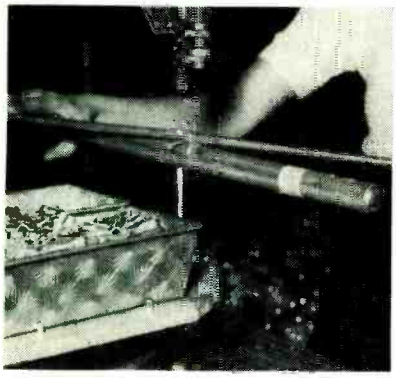
The tape runs on a silicone-treated endless belt driven at the same speed as the tape takeup shaft. The tape adheres to this belt just enough to prevent side play during printing. A rack-and-gear arrangement combined with a drive cam and clutch serves to stop the tape for an imprint after it has advanced the desired distance. This distance, corresponding to the spacing between imprints, can be adjusted from 0 to 9 inches by turning a feed screw that is part of the trip linkage. After each printing operation,

KESTER "44" RESIN, PLASTIC ROSIN AND "RESIN-FIVE" FLUX-CORE SOLDERS are tried-and-proved remedies for almost every production situation where soldering time gets out of hand. Kester's great adaptability to widely divergent soldering requirements has time and again helped so many manufacturers combat rising production costs. It could be the solution you've been looking for!

THIS IS IT . . . *the informative 78-page free Kester textbook "SOLDER . . . Its Fundamentals and Usage." Send for your copy today!*

KESTER SOLDER

COMPANY 4204 Wrightwood Avenue, Chicago 39, Illinois; Newark 5, N. J.; Brantford, Canada



Identifying tape on crossarm guides operator in selecting correct reflector rods for riveting to crossarm at this work position in large antenna plant

feed is automatically resumed, the rack retracts to start measuring again and inking rollers pick up ink from a platen and transfer it to the printing type in readiness for the next impression.

Either rubber or metal type can be used for imprinting. For two-color work, two printing heads are used with a split-type arrangement such that the second color is applied to the next adjacent imprint. Special ink is used in conjunction with chemical treatment of rollers and platen, so that the ink dries slowly on the machine yet dries almost instantly when printed on the tape. There is practically no transfer of ink to the sticky backing of the tape.

Applying tape for later guidance of customer in assembling antenna. Other printed lengths hold hardware together

Controlling Dust in Microwave Tube Assembly Plant

By Richard B. Leng
Microwave Tube Laboratory
Sylvania Electric Products Inc.
Mountain View, California

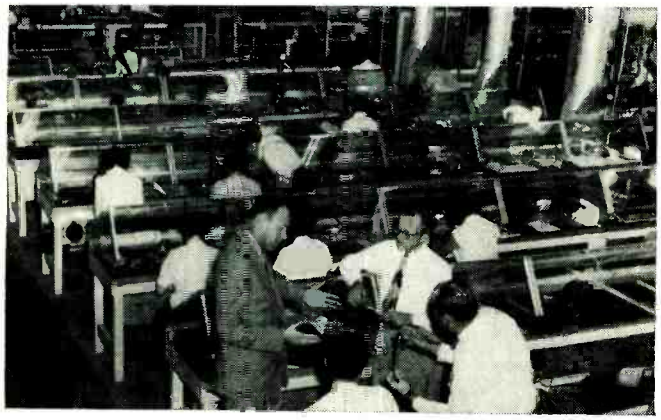
Simplified facilities for the control of dust and particles in vacuum-tube assembly areas have been developed, using completely flexible equipment that can be adapted to the production of other devices where dust must be controlled during assembly.

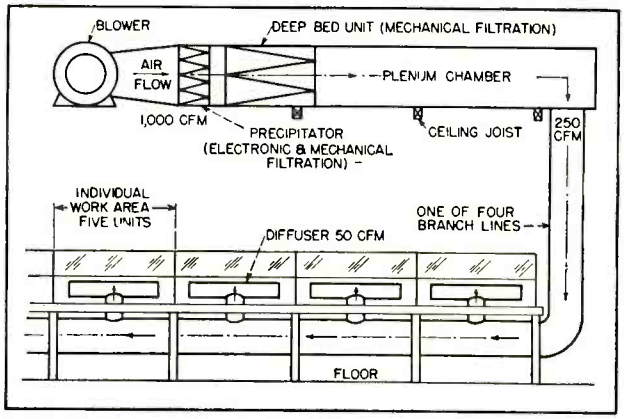
The heart of the system is a ceiling-mounted electrostatic dust precipitator plus a deep-pack filter to catch the heavier particles. A blower conducts clean air to the assembly benches. This unit was assembled from commercially available equipment. The ceiling mounting was dictated by the fact that there is adequate overhead space in the plant and a recirculating system will not blow cold air on the assemblers working on the benches.

Air is ducted down from the electrostatic precipitator to under-bench ducts. Computed velocity drops provide a maximum volume of air with minimum velocity at the work area. The air is evenly distributed over the benches by nylon-cloth-covered wire-mesh T-shaped diffusers. The work area is covered on sides and top with a clear Plexiglas hood. The top is peaked, with a piano hinge running along the ridge so the forward flap can be raised for insertion of equipment. This forward flap is arranged to lie along an angle perpendicular to the operator's line of sight, minimizing optical distortion and undesirable reflections from overhead lights. Operators can easily insert their arms into the hood to perform the tube assembly operations.

The system gives each of 66 operating positions 50 cfm of air at an inlet velocity of 600 fpm. This is diffused through the exit area at a face velocity of 50 fpm. Between 50 and 100 fpm exit velocity is not objectionable to the operators and supplies a sufficient air front to keep ambient air turbulence from getting into the hooded area.

The nylon diffusers at each work position reduce the inlet velocity and provide a uniform pressure within the hood. An alarm bell system alerts the plant guards to equipment failures. Material is transferred to and from operators' stations in dust-free covered boxes. These boxes and all parts are first cleaned in an alcohol bath, then dried in cleaned air. Filtered high-pressure blow lines are used wherever high-pressure air is utilized





Dust-free air comes down ducts at upper right for distribution to benches. Flexibility of transparent hinged hood design permits installation of special binocular microscopes and other equipment needed for precision assembly of tubes. Diagram shows arrangement of units on ceiling and floor

in tube assembly. It is estimated that maintenance cost is approximately $60 per year for replacement and examination of the filters and electric power cost is approximately 80¢ per 24-hour day.

Successful operation of this system was accomplished through the cooperation of engineering and manufacturing sections of the Laboratory, of which Paul G. Bohlke is engineering manager. Edwin M. Knapp was responsible for mechanical engineering phases of this program and Homer D. Broker, manufacturing superintendent, was largely responsible for putting the system into successful and practical operation.

Grounding Shield Braid in Guided Missiles

SEVERAL METHODS are used at Glenn L. Martin's Baltimore plant to ground shield braid pigtails in guided-missile electronic equipment when most or all of the wires to a terminal strip are shielded.

In one method, the pigtails are all soldered to a grounding strip and the grounding strip itself is

Mating grooves in plier jaws near tips aid in squeezing braid neatly over straight grounding wire

Alvin I. Handmacher, President of Handmacher-Vogel, Inc., says

He knows how to suit the women!

"When a woman sees a style she wants, she wants it *fast,*" says Mr. Handmacher. "In fact, she wants it first!

"And we see that she gets it — in *her* size and color. How do we do it? By Air Express!

"We push our production schedules to meet insistent buyers' re-orders. Then we rely on Air Express to deliver door to door in record time.

"Without Air Express, we'd never suit women as well as we do!

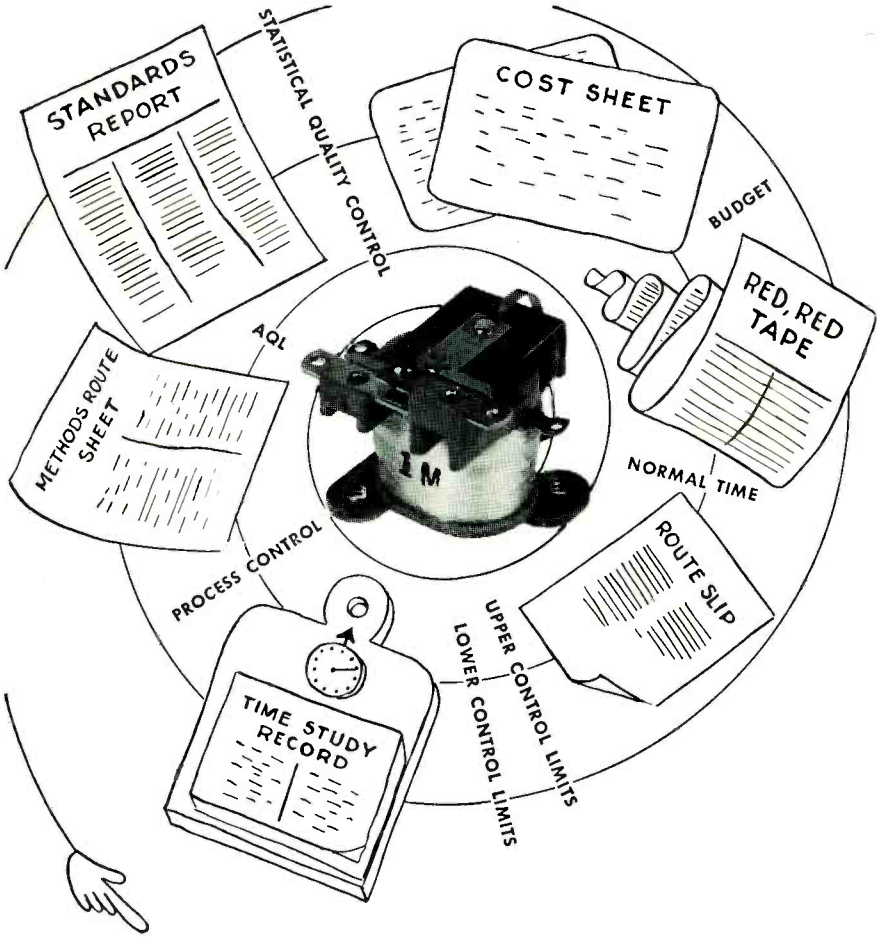
"Air Express pays off in two ways. It wins us customer good will and saves us money! For instance, it costs $4.10 for a ten-pound shipment from New York to Louisville—$1.64 less than by the next lowest-priced air service."

It pays to express yourself clearly. Say Air Express!

Air Express

GETS THERE FIRST *via U.S. Scheduled Airlines*

CALL AIR EXPRESS . . . *division of* RAILWAY EXPRESS AGENCY



There is a group around here, mostly with short hair or receding hairlines, who actually took schooling or read books and toss the above terms around believing they know what they mean. Some of these experts figured it would be fun to try to make a relay for around 75¢, maybe a little less, which would do a creditable job. (That's it, in the middle.)

We do have some good equipment around here. We know a little about compound dies with automatic feed, hopper-fed drilling and tapping, and maybe even something about "Automation." We think that we can produce this new little marvel in both large and small quantities for a real competitive price.

THIS RELAY WE'LL CALL THE TYPE 11 AND EXPECT THAT IT WILL PERFORM LIKE THIS:

Contact arrangement: SPDT
Min. Operate: 50 M.W.
(2.4 ma in 9000 ohm coil)
Max. Contact load: 1 amp.
Coil values: up to 9000 ohms
Max. Size: $1\frac{3}{16}$ x $1\frac{5}{32}$ x $1\frac{5}{16}$
Max. Weight: 1 ounce

POSSIBLE APPLICATIONS
Automatic headlight dimmers
Radiosonde
Remote controlled toys

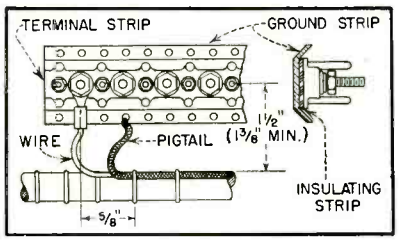
We're not saying this relay is ready yet because we're just now making a thousand of them with temporary tools. We're not looking for orders until we get our tooling program finished and until we know more about when we can deliver. Our guess is along about late Spring or early Summer.

If you would like to be informed about our progress and maybe get a sample, drop us a line, attention: Production Department, and we'll see that you get an answer.

Since the President, his crowfeather collecting brother, and the Sales Manager are not involved in this venture, we'll eliminate from the overhead the cost of keeping them around here when we figure the price.

SIGMA

SIGMA INSTRUMENTS, INC.
62 Pearl Street, So. Braintree, Boston 85, Mass.



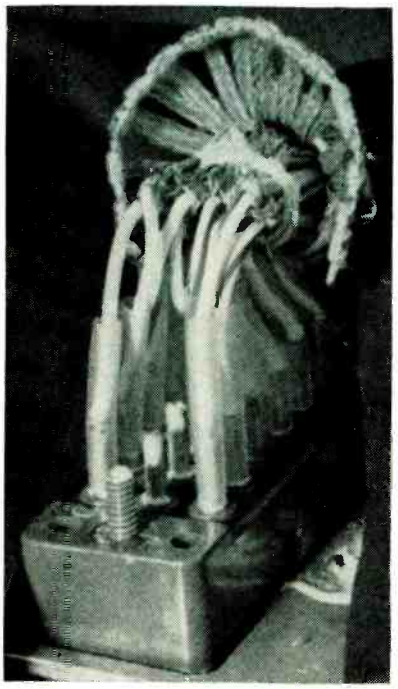
Method of using ground strip for anchoring shield braid pigtails

grounded at one or both ends and at intermediate points approximately 4 inches apart.

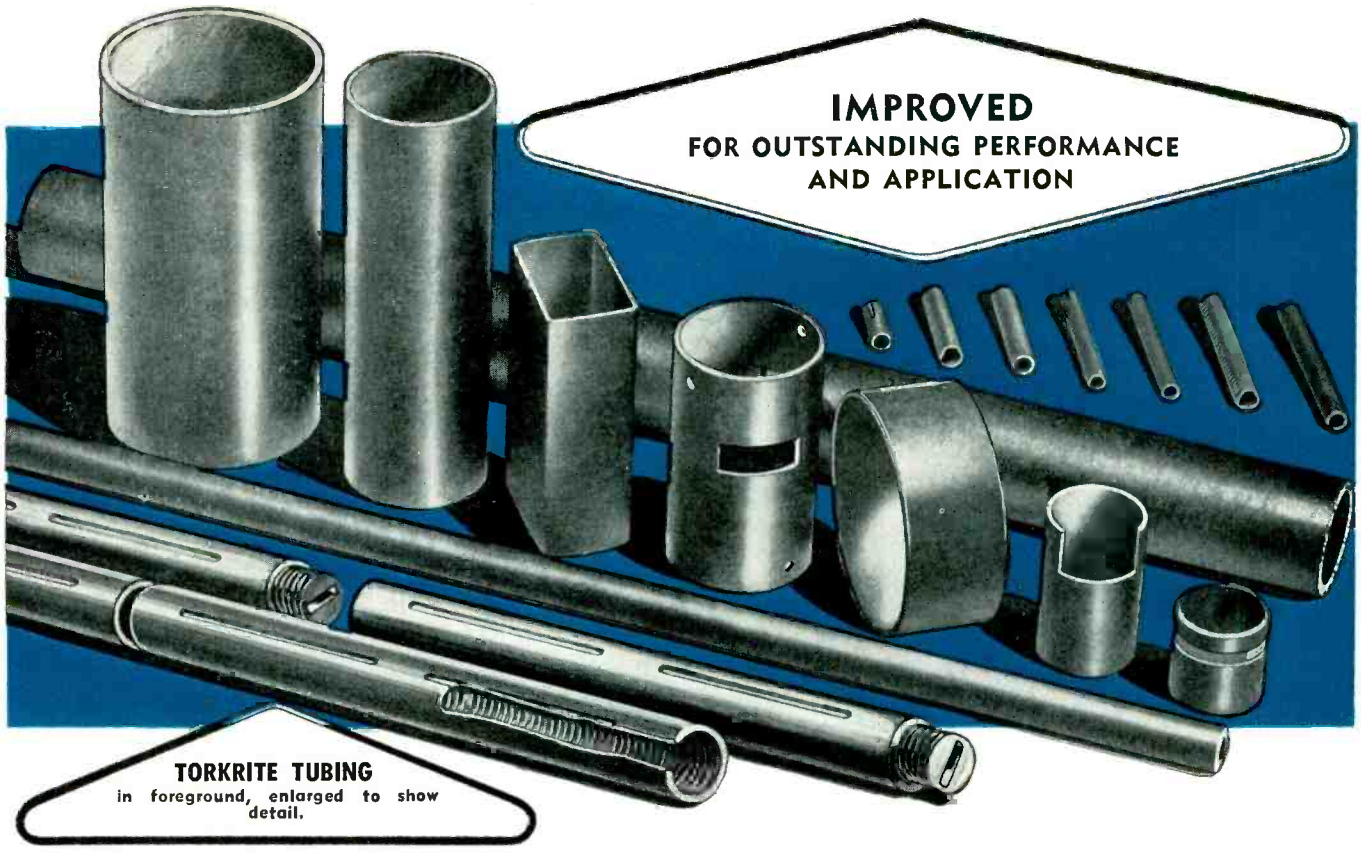
The length of wire from break-off before stripping is 2 inches. This allows for one service cut. The length of the pigtail from break-off is 1⅜ in. The lacing cord is tied directly behind the pigtail break-off.

The pigtail is soldered to the ground strip about ⅝ inch from the wire it shields. This spacing pattern provides room for the operator to form wire runs and shape the bundle with a minimum of difficulty.

When grounding strips are not available, a straight length of stranded ground wire is run parallel to the cable at the takeoff point, about an inch away, and the pigtails are soldered to this in the manner shown in the photo. Longnose pliers having grooved tips are used to compress the braid neatly around the wire to achieve a good mechani-



Method of fanning out braid pigtails to curved grounding wire



★ ★ ★

TORKRITE POSSESSES MANY ADVANTAGES

Torkrite affords unmatched recycling ability. After a maximum diameter core has been recycled in a given form a reasonable number of times, a minimum diameter core can be inserted and measured at 1" oz. approximately.

Torkrite has no hole or perforation through the tube wall. This eliminates the possibility of cement leakage locking the core or cores.

Torkrite permits use of lower torque as it is completely free of stripping pressure.

With Torkrite, torque does not increase after winding, as the heavier wall acts to prevent collapse and core bind.

Improved new Torkrite is now available in various diameter tubes. Lengths from 3/4" to 3-1/8", are made to fit 8-32, 10-32, 1/4-28 and 5/16-24 cores.

★ ★ ★

WRITE for your copy of our new CLEVELITE folder

★ ★ ★

CLEVELITE*

LAMINATED PAPER BASE PHENOLIC TUBING

In seven specific grades, Clevelite is one of the finest and most complete lines of tubing available to the electronic and electrical industries.

Grade	Application
Grade E	Improved post-cure fabrication and stapling
Grade EX	Special grade for TV yoke sleeves
Grade EE	Improved general purpose
Grade EEX	Superior electrical and moisture absorption properties
Grade EEE	Critical electrical and high voltage application
Grade XAX	Special grade for government phenolic specifications
Grade SLF	Special for very thin wall tubing having less than .010 wall

High performance factors, uniformity and inherent ability to hold to close tolerances, make Clevelite outstanding for Coil Forms, Collars, Bushings, Spacers and Cores.

Competent Research and Engineering facilities are always available to aid in solving those tough and stubborn design and fabrication problems. May we help you?

Fast, Dependable Delivery at all times.

WHY PAY MORE? For Good Quality . . . call CLEVELAND!

*Reg. U. S. Pat. Off.

The CLEVELAND CONTAINER Co.
6201 BARBERTON AVE. CLEVELAND 2, OHIO

PLANTS AND SALES OFFICES at Chicago, Detroit, Memphis, Plymouth, Wisc., Ogdensburg, N. Y., Jamesburg, N. J.
ABRASIVE DIVISION at Cleveland, Ohio
CANADIAN PLANT: The Cleveland Container, Canada, Ltd., Prescott, Ontario

REPRESENTATIVES

NEW YORK AREA R. T. MURRAY, 604 CENTRAL AVE., EAST ORANGE, N. J.
NEW ENGLAND R. S. PETTIGREW & CO., 62 LA SALLE RD., WEST HARTFORD, CONN.
CHICAGO AREA PLASTIC TUBING SALES, 5215 N. RAVENSWOOD AVE., CHICAGO
WEST COAST IRV. M. COCHRANE CO., 408 S. ALVARADO ST., LOS ANGELES

cal joint before soldering.

When a large number of individually shielded wires go to a connecting plug, the braid pigtails are fanned out and similarly anchored to a curved grounding wire. This gives the operator free access to each joint for crimping and soldering, permits better inspection of grounds than if all were anchored to the same point, and actually improves the effectiveness of the shielding.

These improved grounding techniques served to reduce assembly time from 102 hours to 37 hours on one 400-cps power chassis for the Matador guided missile.

Round-Robin Noise Test for Tubes

IN SAMPLING tests aimed at pinpointing the unpredictability of tubes as regards noise, microphonic and hum conditions, a special three-round test procedure is used in Tung-Sol's Bloomfield, N. J. plant. A printed 8½x11 form is used for recording the results of these round-robin tests for instability.

A typical test, illustrated by the filled-in form shown, involves starting with 100 6CD7G tubes to be tested for noise. On the first run of these tubes through the test set, 99 were good and one was noisy. A tube noisy in the first round is set aside, for separate good-bad testing

Setup for making round-robin noise tests. Slanting rack at right serves for preheating tubes before test. Noise is heard from loudspeaker and indicated by flickering of pointer of wattmeter on bench

Get better printed circuits . . . lower costs . . . fewer rejects

with NEW C-D-F METAL CLADS

All manufacturers of metal clad stock for printed circuitry have made considerable progress in improving their product—a material with a metal foil surface bonded to a non-conducting base. How this has been done by one leading manufacturer, the Continental-Diamond Fibre Company, illustrates some of the problems involved in buying this type of material and in understanding its design potentials.

C-D-F CONSOLIDATED GRADES

At first, small test lots of Dilecto laminated plastic with copper surfaces were made. Almost every core material was used. Finally the number of practical grades for printed circuit work narrowed down to these few grades which retained to a large degree the inherent electrical qualities of their base material and resin at high temperatures:

COPPER CLAD GRADE XXXP-26

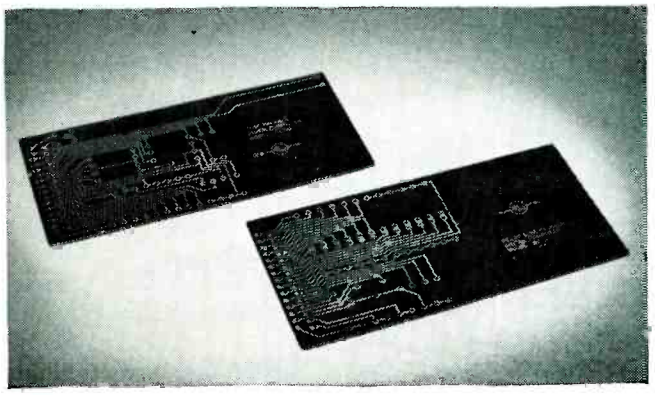
A laminate with excellent electrical and mechanical properties. High moisture resistance and dimensional stability. Recommended for applications where high heat and high insulation resistance plus low dielectric loss under high humidity is needed. Low cold flow characteristics. Can be hot punched to ⅛″. Good flexural strength. Natural green color.

This is one of the *improved C-D-F Dilecto laminates*. Advances in resins and manufacturing techniques makes this grade almost homogeneous, with improved impregnation of the filler. Thorough impregnation eliminates entrapped moisture and air, giving greater moisture resistance and better dielectric properties.

Any metal clad is no better than its base and the care taken in laminating. With the cost of material high, compared to labor and inspection, the purchase of a *uniform* metal clad material, like this C-D-F grade, becomes vital.

COPPER CLAD GRADE XXXP-24

Similar to grade XXXP-26 in electrical and moisture resistance properties, but not quite as strong mechanically. Equal cold flow and punching characteristics. Natural brown.



COPPER CLAD GRADES GB-112S AND GB-261S

These silicone grades use a glass fabric laminate with a copper foil surface on one or both sides. Recommended where high heat resistance and low dielectric loss properties are required. For certain tuners and inductances the low dielectric loss factor of this grade makes its higher cost acceptable. A continuous filament (Grade GB-112S) is used for thicknesses 1/32 to 1/16″. A staple filament (Grade GB-261S) is used for thicknesses over 1/16″.

COPPER CLAD GRADE GB-116T

A glass base laminate using duPont's tetrafluoroethylene resin, Teflon, for outstanding resistance to high heat with extremely low dielectric loss properties. A fine weave continuous filament glass fabric cloth is used for superior mechanical strength and good machining qualities. In spite of its high cost, this C-D-F grade has demonstrated that it can save money and do a job that no other single material can in microstrip high-voltage, high-frequency circuit elements. Remember, C-D-F is a major supplier of sheets, tapes, rods, tubes of Teflon, has valuable experience in its manufacture and fabrication. Write for samples.

C-D-F INCREASED BOND STRENGTH

By developing a special thermo-setting adhesive particularly suited for metal clads, C-D-F was able to increase the bond strength of their laminates considerably above their original figures. Bond or peel strength, the amount of pull required to separate the foil from the core material, is one of the most important physical properties. Therefore, the purchaser should compare his source of supply with these C-D-F average test values:

BONDING STRENGTH—FOIL TO LAMINATE

MATERIAL	Average or Typical Value Lbs. pull per 1″ width of foil to separate
XXXP-24 or XXXP-26 plus 0.0014″ copper	5 to 8
XXXP-24 or XXXP-26 plus 0.0028″ copper	7 to 9
GB-116T plus 0.0014″ copper	5 to 12
GB-112S plus 0.0014″ copper	6 to 8
GB-261S plus 0.0014″ copper	7 to 10

These values are based on tests at prevailing room temperature (20-30°C.)

C-D-F INCREASED HEAT RESISTANCE

Special efforts by C-D-F technicians to increase the heat resistance of all C-D-F Metal Clads have resulted in certain special grade variations able to withstand higher soldering temperatures without damage. As production methods change, C-D-F offers materials to meet your requirements.

NOW . . . HOW ABOUT YOUR STORY?

Notice how we have talked about C-D-F and what we have done to improve quality and uniformity of metal clad products. Much of this has been accomplished with the guidance and cooperation of leading users of printed circuit stock. No one company knows all the answers . . . but C-D-F, a big reliable source of supply, can help you get better printed circuits . . . lower costs . . . fewer rejects. Look up the address of your nearest C-D-F sales engineer in Sweets Design File, write us for samples you can test in the lab and on the production line, technical bulletins, help on your specific project. We want to work with you!

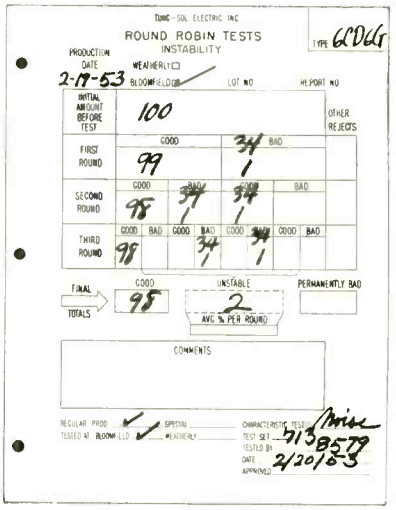
CDF Continental-Diamond Fibre

CONTINENTAL-DIAMOND FIBRE COMPANY

NEWARK 16, DELAWARE

ELECTRONICS Charter-Year Advertiser

Want more information? Use post card on last page.



Form used for recording round-robin tests. Code numbers are used to identify faults: 34 is noisy, 35 is microphonic and 39 is hum

and recording on the next two rounds.

On the second round, generally made some time later, one of the 99 good tubes showed up noisy and the bad tube now tested good. On the third round, the 98 good tubes of the second round were all good, the bad tube of the second round showed bad again, and the first-round bad tube again went bad. The final totals are therefore recorded as 98 good tubes and 2 unstable, with none permanently bad.

Since a good tube can go bad on a subsequent test and a bad tube can go good, the form provides good and bad boxes under both the good and the bad boxes of the first round. Similarily, for the third round there are good and bad boxes under each second-round-good box and under each second-round-bad box.

Air Shield On Air Gun Stops Flying Chips

ADDITION of small radial outlets to the nozzle of a standard air gun provides a protective shield of air when using the gun to clean an electronic assembly bench or machine. This prevents sharply pointed bits of wire and other metallic particles from hitting the face of the operator in the event that they bounce off some object as a result of a direct air blast. The modified air gun has proved highly successful on the production lines used for as-

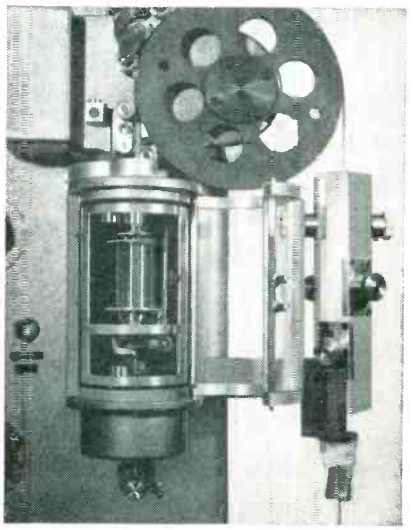
Modified air gun, with air shield outlet barely visible at base of nozzle for producing protective cone of air

sembling the electronic units of guided missiles in the Baltimore plant of The Glenn L. Martin Co.

This Guardair safety air gun is made by Safety Mann Co., 100 E. Palisade Ave., Englewood, N. J. The nozzle is machined to have a complete-circle around its base, through which emerges the conical stream of air forming a protective air shield.

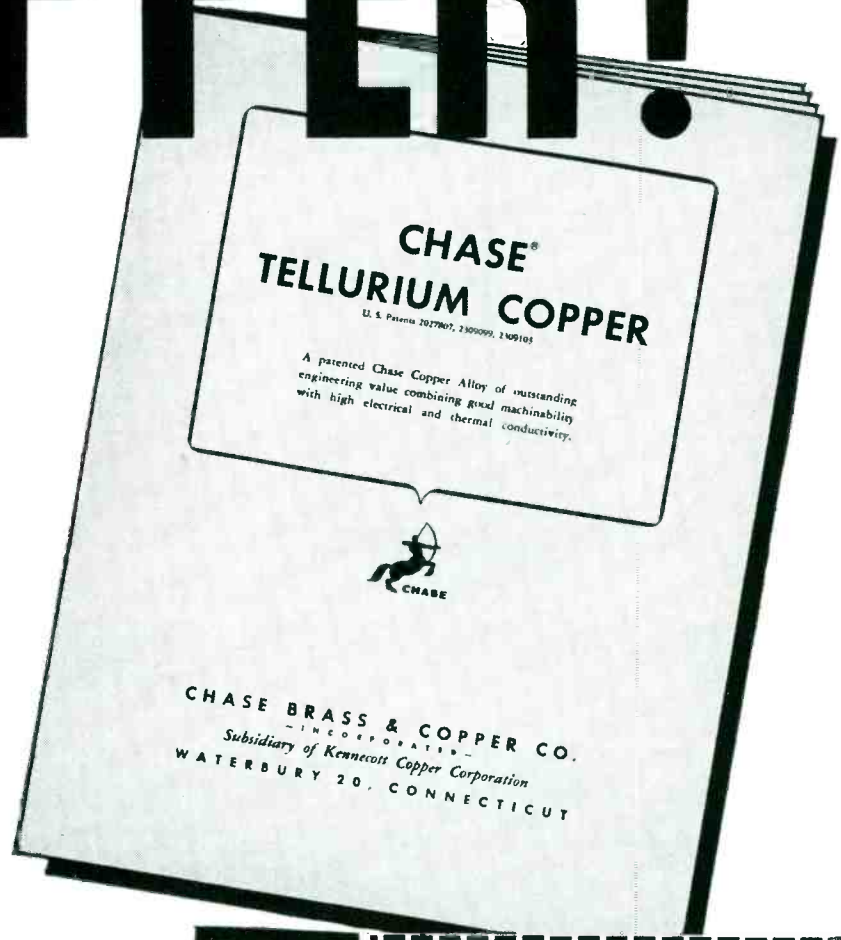
Coil-Winder for Precision Potentiometers

IN THE HIGH-SPEED coil-winding machine developed by Helipot Corp., South Pasadena, Calif. for producing resistance units for precision potentiometers, copper mandrel wire of the proper diameter first travels up through pressure rollers to elimi-



Input end of machine. Copper mandrel wire passes up through straightening rollers inside hexagonal housing at right, then up over large pulley and down through winding chamber (shown with transparent cover open)

TELLURIUM COPPER!



Has high conductivity, good machinability... saves production time!

Chase Tellurium Copper gives you the advantages of high conductivity *plus* good machinability.

Chase Tellurium Copper can be machined with tool speeds and settings similar to those used with Free-Cutting Brass, permitting high rates of production. But, unlike Free-Cutting Brass, Chase Tellurium Copper can be *hot worked* easily, and can be cold worked almost as extensively as pure copper.

For more information on Chase Tellurium Copper, check the coupon below.

Chase®

BRASS & COPPER CO.

WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION

The Nation's Headquarters for Brass & Copper

Albany†	Chicago	Detroit	Los Angeles	New York	St. Louis
Atlanta	Cincinnati	Grand Rapids†	Milwaukee	Philadelphia	San Francisco
Baltimore	Cleveland	Houston	Minneapolis	Pittsburgh	Seattle
Boston	Dallas	Indianapolis	Newark	Providence	Waterbury
Charlotte†	Denver	Kansas City, Mo.	New Orleans	Rochester†	(†sales office only)

FREE

Chase Brass & Copper Co.
Waterbury 20, Conn.
Dept. E-455

Gentlemen:
Please send me your free Tellurium Copper booklet.

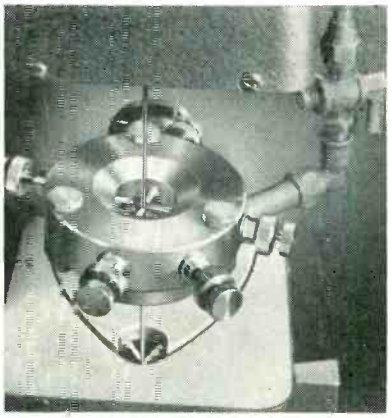
Name_____

Position_____

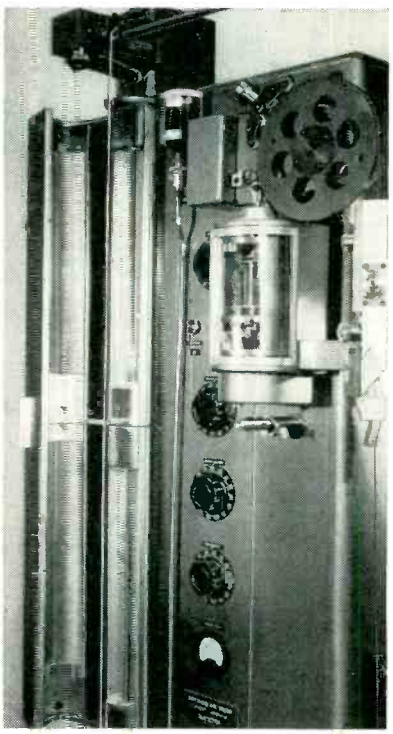
Firm_____

Street_____

City_____ State_____



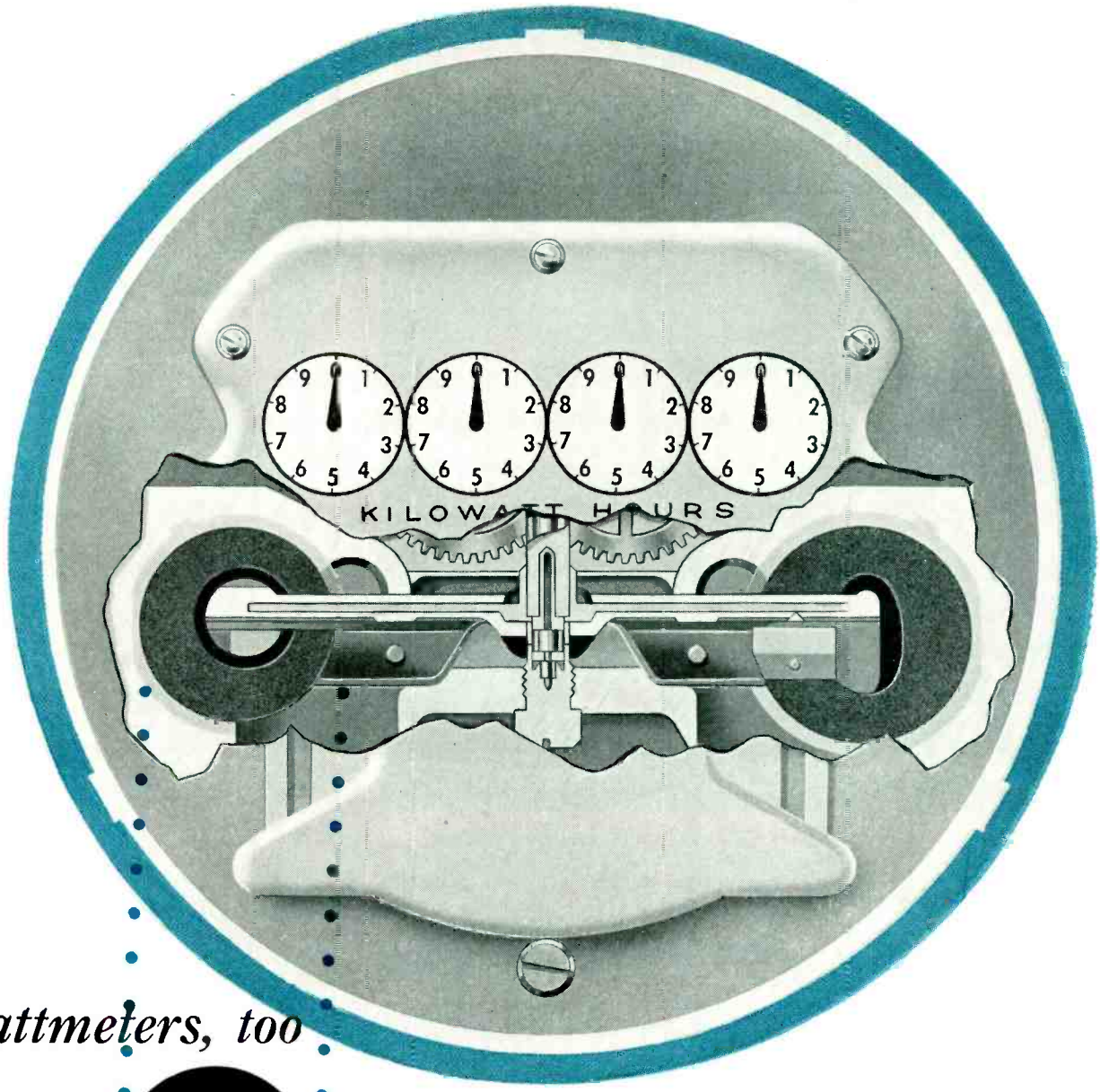
Wound mandrel here comes up from preheating oven, passes through varnishing jets, then goes up into infrared varnish-drying oven



Varnish-drying oven (at left) with cover swung open. Baked coil is wound into helix at top

nate kinks. The mandrel wire then goes over a large pulley at the top of the machine and down through a dust-free chamber where the correct alloy and gage of resistance wire is wrapped around the core. To insure even spacing, the rate of travel of the core wire and the speed at which the resistance wire is wound are both accurately controlled.

The wound mandrel travels down to a large pulley at the base of the winding machine and up again through a preheater to varnish jets which coat it with just the right



wattmeters, too

USE CRUCIBLE PERMANENT MAGNETS

for maximum energy . . . minimum size

With Crucible alnico magnets you get *consistently higher* energy product . . . which means *more* energy from a *smaller* magnet.

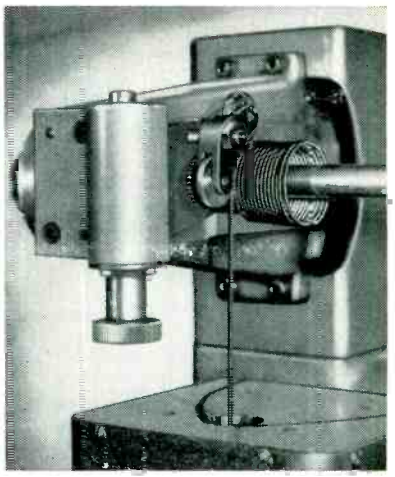
That's why they provide maximum design freedom for manufacturers of watt-hour meters, voltmeters, and devices of all kinds requiring magnets from 0.2 ounces to several hundred pounds.

Crucible has been a leading producer of these powerful magnets ever since alnico alloys were first developed. And its magnet experience is backed by over a half-century of *special purpose* steelmaking.

For technical assistance in solving magnet applications, call Crucible. *Crucible Steel Company of America, Henry W. Oliver Building, Pittsburgh 22, Pa.*

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America



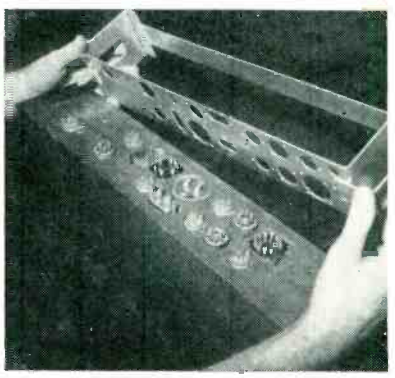
Coiling finished resistance element into helix at top of winding machine

amount of insulating varnish. Next comes an infrared oven for drying the varnish, after which the wire is coiled into a helix of the correct diameter by a set of forming rollers. All coil-winding operations are performed by this machine in a continuous operation, carefully controlled at each step, followed by microscopic inspection and rigorous testing of the completed coils.

Wood Jigs Speed Mounting of Large Parts

A LENGTH of 4x4-inch hardwood having appropriately shaped holes for tube sockets and other parts that are to be bolted to the chassis speeds assembly of a control amplifier for the Matador guided missile in Martin's Baltimore plant.

The operator drops the parts into their holes in the block one by one with correct orientation, then places



Appearance of block when loaded. One transformer hole is made larger to accommodate two different sizes of units. Brackets on chassis fit into slots at ends of block

AlSiMag®

SERVES YOU BEST!

Precision Tolerances
Uniform Quality
Volume Production
Dependable Deliveries

AlSiMag offers top-notch technical ceramics of every type . . . Die Pressed, Extruded, Machined. Simple or intricate shapes. Large designs. Miniatures. Metal Ceramic Combinations.

Complete equipment for efficient production in any quantity. Widest selection of materials. Competent Engineering and Redesign Service. Tooling at lowest cost from the AlSiMag Die Shop. Plenty of kiln space. Quality Control. Thoroughly trained personnel. Continuous Research.

Complete information on AlSiMag for your requirements on request. Send sample, blueprint or sketch today.

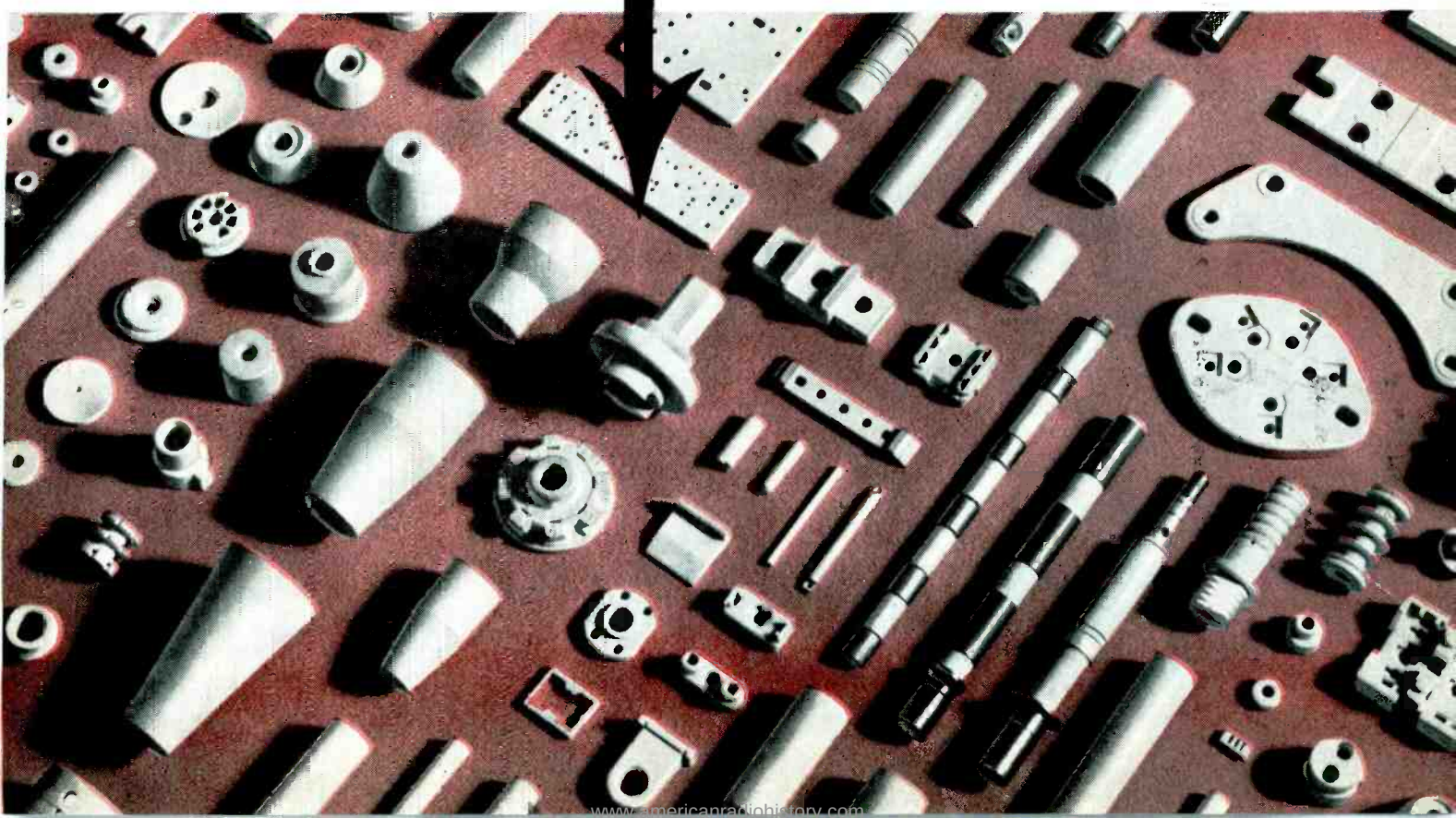
54TH YEAR OF CERAMIC LEADERSHIP

AMERICAN LAVA CORPORATION

A SUBSIDIARY OF MINNESOTA MINING AND MANUFACTURING COMPANY

CHATTANOOGA 5, TENNESSEE

BRANCH OFFICES IN THESE CITIES (SEE YOUR LOCAL TELEPHONE DIRECTORY): Cambridge, Mass. • Chicago, Ill. • Cleveland, Ohio • Dallas-Houston, Texas Indianapolis, Ind. • Los Angeles, Calif. • Newark, N. J. • Philadelphia-Pittsburgh, Pa. St. Louis, Mo. • South San Francisco, Calif. • Syracuse, N. Y. • Tulsa, Okla. **Canada:** Irvington Varnish & Insulator Division, Minnesota Mining & Manufacturing of Canada, Ltd., 1390 Burlington Street East, Hamilton, Ontario, Phone Liberty 4-5735.



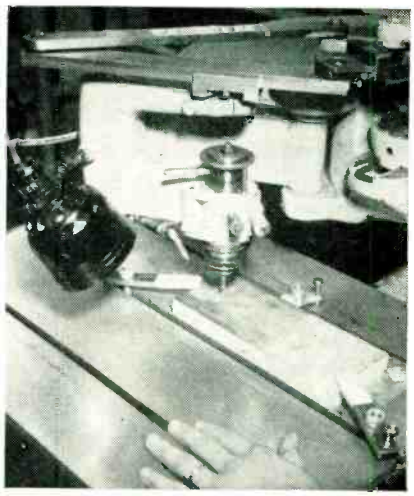
Chassis in position ready for application of mounting bolts and nuts

the chassis over the block. Where parts have recessed mounting holes, as do many hermetically sealed units, mounting bolts are inserted and tightened with a power tool. Where parts have projecting mounting bolts, nuts are put on and tightened with a power wrench. For tube sockets, screws are inserted in the block before putting on the sockets. Nuts are then run on and tightened while the screw is held by the pressure of the chassis against the screw.

Shop-Made Rubber Stamps Identify Chassis Parts

RUBBER STAMPS needed for identifying electronic components on the chassis of a guided missile are made in a few minutes right in the Baltimore electronic assembly plant of The Glenn L. Martin Co. The stamps are also used by the electronic drafting department to speed preparation of working drawings.

Instead of using movable steel

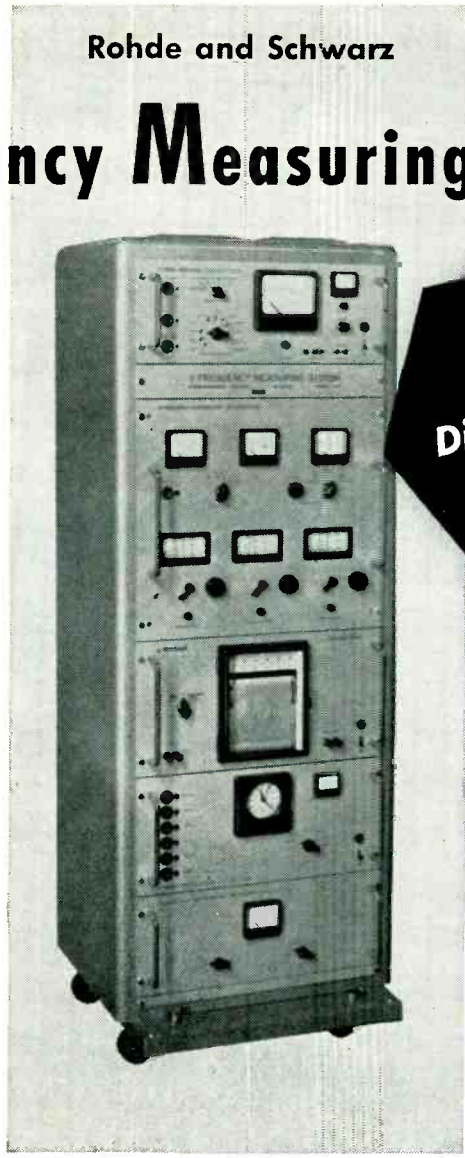


Engraving desired rubber stamp pattern for electronic print in block of hardwood. Regular pantograph assembly of machine gives perfectly formed letters as operator moves stylus on template

Rohde and Schwarz

Decadic Frequency Measuring System

for measuring frequency with speed, precision and greater-than-ever simplicity . . .



with exclusive Direct Reading Frequency Synthesizer

30 c/s to 600 mc/s

The Decadic Frequency Measuring System contains in one compact unit all the equipment necessary to generate and measure frequencies over a range from 30 c/s to 600 mc/s. It consists of a Master Quartz Oscillator, Frequency Synthesizer, Frequency Indicator, Inkless Recorder and Power Supply.

The Quartz Oscillator, in addition to its fundamental frequency of 100 kc/s, provides additional standard frequencies of 10 kc/s, 1 kc/s, 100 c/s and 50 c/s for distribution at a level of about 1 volt.

The Frequency Synthesizer, with its various modes of operation, supplies standard frequencies for comparison with the unknown signal. Its unique design provides a simplicity and versatility of operation not heretofore available.

The main purpose of the Frequency Indicator is to measure the frequency difference between standard and unknown frequencies. The instrument has nine ranges with full deflection from 50 c/s to 500 kc/s. It also indicates zero beat frequency and generates harmonics, by means of which the range of the Synthesizer is extended to 600 mc/s.

An Inkless Recorder is provided as an optional accessory which can be connected in parallel with the Frequency Indicator for plotting of frequency variations versus time.

The overall design of the Decadic Frequency Measuring System is well-balanced, providing an accuracy of frequency generating and interpolation equipment compatible with the accuracy of the Master Quartz Oscillator.

This distinctive unit of the Decadic Frequency Measuring System can be operated either as a continuously variable signal generator with no band switching from 30 c/s to 30 mc/s and with calibrated variable output voltage, or as a frequency decade variable in steps of 100 kc/s, 1 kc/s and 1 c/s with an accuracy determined by the Master Quartz Oscillator of 1 part in 10 million, plus or minus 0.5 c/s.

The exact output frequency is read as the sum of the three front panel decadic frequency scales.

The calibrated attenuator and output meter (100 uv to 1 v) increase the flexibility of the Synthesizer, permitting its use as a signal source for many additional applications.

SPECIFICATIONS:

Frequency Range: Standard frequencies from 30 c/s to 30 mc/s and harmonics to 600 mc/s. Fixed standard frequencies of 100 kc/s, 10 kc/s, 1 kc/s, 100 c/s and 50 c/s . . . one continuously variable standard frequency from 30 c/s to 30 mc/s direct reading on 3 decadic controls in steps of 100 kc, 1 kc and 1 c/s. Distortion: Less than 10%. Spurious Signals: Better than 60 db down.

Output Voltage: Fixed standard frequency outputs—1 volt each into impedance of 150 ohms . . . variable frequency output adjustable in amplitude between 100 microvolts and 1 volt as indicated on calibrated meter.

Stability and Accuracy: Frequency variations of standard frequencies—less than 1 part in 10 million. Mean value of daily frequency change is less than 1 part in 10 million per day. Accuracy of variable frequency equals that of the standard—plus an additional tolerance of ±0.5 c/s when using the last decade.

Recorder: Inkless Recorder available as an optional accessory.

Mounting: System supplied complete with own cabinet rack. Overall dimensions: 67 x 23⅜ x 25¼ inches. Weight: 419 pounds.

Power Supply: 100-120 v or 200-240 v, 40-60 c/s, 600 va.

INSTRUMENT DIVISION — FEDERAL TELEPHONE & RADIO

Federal Division of IT&T

Telephone and Radio Company

A Division of INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION

INSTRUMENT DIVISION

100 KINGSLAND ROAD, CLIFTON, N. J.

Federal Telephone and Radio Company Dept. S-313
Instrument Division, Clifton, N. J.

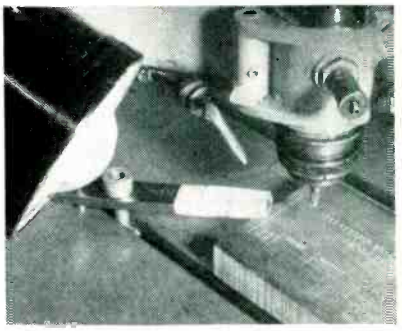
Please send further information on the Decadic Frequency Measuring System, and General Catalog showing other items in your instrument line.

Name _____ Title _____

Company _____

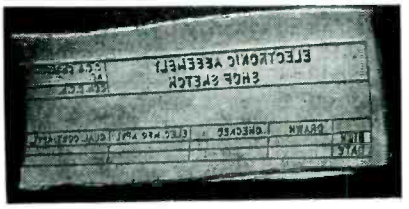
Address _____

City _____ Zone ____ State ____



Method of mounting lamp and chip-blowing nozzle on engraving head

Putting engraved block and rubber sheet in hot press



Finished stamp as it comes from mold. Patterns too large for press are made in two pieces and cemented together on block

type molds as is customary in commercial manufacture of rubber stamps, engineers devised a technique involving use of a standard Gorton engraving machine to produce the desired impression on a block of hard wood. The mold can thus be produced in no more time than it would take for a comparable engraving on a metal panel.

The operation has been standardized on use of $\frac{7}{8}$-inch maple similar to that used for engraving blocks. Clamps hold the wood on the table of the engraving machine. A small lamp is mounted on the engraving head to follow it and throw light on the work at all times. The only other modification is addition of a soft copper tube with its end

ANNOUNCING

5 NEW HIGH-WATTAGE H-H Rheostats

Now the full Hardwick, Hindle line includes H-50, H-75, H-100, H-150, *H-225*, *H-300*, *H-500*, *H-750* and *H-1000*.

Our H-50 -75 -100 and -150 watt models have established in the field a great reputation for unusual ruggedness under abnormal conditions. They have proved themselves to be thoroughly dependable in service.

Their many improvements are all incorporated in these 5 *new* models, together with added new features including our recently patented contact arm.

All are designed to comply with current standards of:—

- **Military Specifications MIL-R-22**
- **R.E.T.M.A.** • **N.E.M.A.**
- **Underwriters' Laboratories, Inc.**

Write today for Rheostat Bulletin 355

HARDWICK, HINDLE, INC.

Rheostats and Resistors • **NEWARK 5, N.J., U.S.A.**

The mark of quality for more than a quarter of a century

drawn down to a nozzle and directed at the engraving point. When coupled to an air supply by rubber hose, it blows chips away immediately and thereby insures clean engraving at all times.

After engraving, a sheet of rubber is placed over the block and the combination is placed in a small heated press for conventional vulcanizing treatment. The rubber is then trimmed and cemented to sponge rubber for mounting conventionally on a rubber stamp holder.

Shock-Testing Machine for Precision Potentiometers

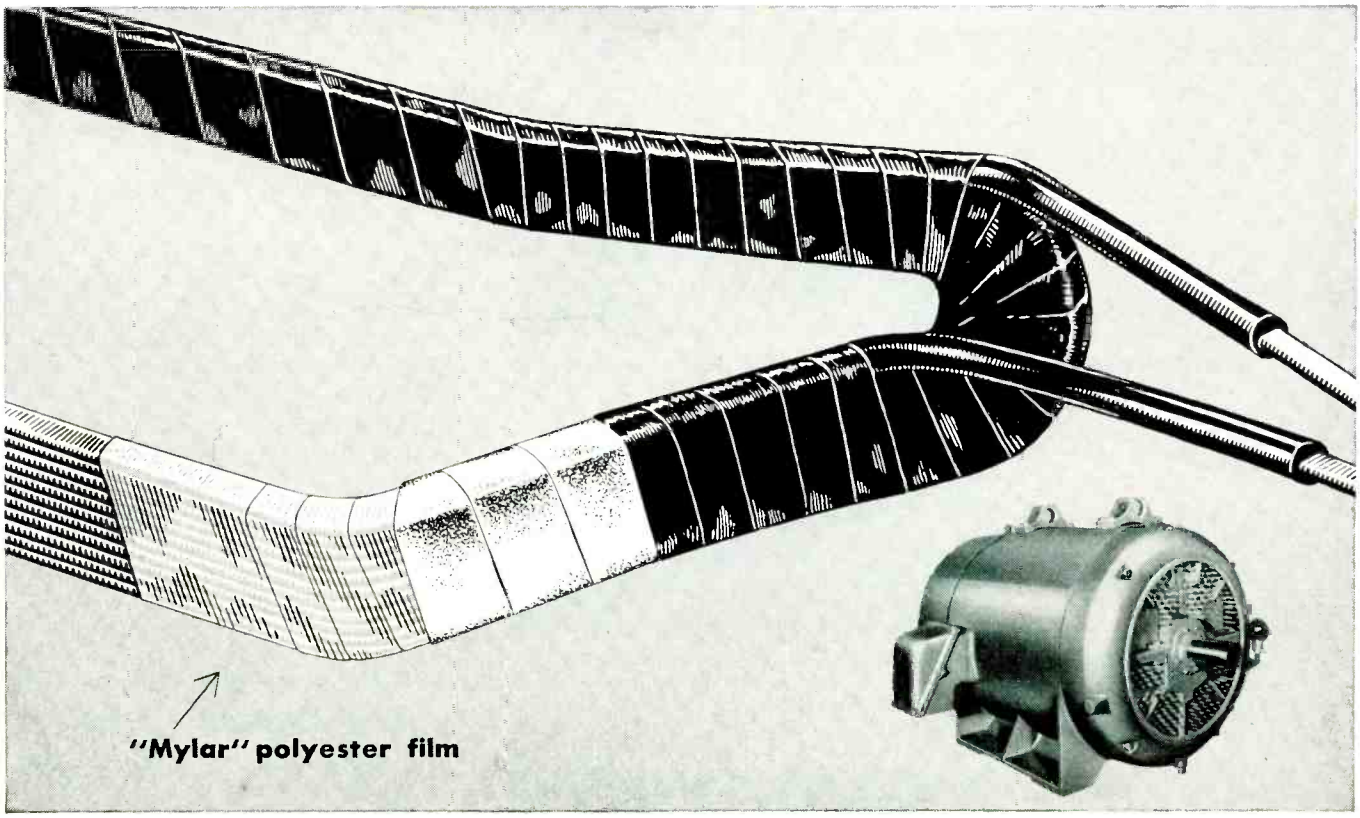
A SIMPLE sliding carriage designed by the Research and Development Division at Helipot Corp., South Pasadena, Calif. provides impact shocks of 0 to 50 g at 11 milliseconds and 0 to 100 g at 7 milliseconds.

The design is based on JAN-S-44 specifications and has the range and performance shown on the accompanying chart. The potentiometer is mounted in a metal cage so constructed that additional weights may easily be added. This cage is in turn bolted to a larger frame that slides vertically on two metal rods. A pointer on the frame moves over

Raising carriage with precision potentiometer in position

G. E. uses Du Pont MYLAR® to develop motor insulation that's 7 times tougher

REG. U. S. PAT. OFF.



Saves you money in reduced motor failures, reduced maintenance costs

One example of the revolutionary improvements made possible by Du Pont "Mylar" polyester film is a complete new insulation system for form-wound coils, developed by General Electric. G.E. reports that this new system lasts 50% longer than any other Class A insulation in use today . . . has 7 times greater physical strength than conventional insulation.

Polyex, as this new insulation system is called by G.E., combines Du Pont "Mylar" film, "Dacron" polyester fiber, and hydrocarbon resins. The remarkable tensile and dielectric strengths of "Mylar," together with its unusual thermal and chemical properties, are essential to the superior performance of the new insulation system.

HOW CAN YOU MAKE YOUR PRODUCT BETTER WITH "MYLAR"?

New Du Pont "Mylar," used alone or in combination with other materials, may well offer you an opportunity for improving your own products. "Mylar" has a dielectric strength of 4000 volts/mil. Tensile strength of 23,500 p.s.i. permits its manufacture in gauges as thin as ¼ of a mil (0.00025 inch). "Mylar" is inert to the attack of many solvents and insensitive to moisture. Its thermal stability permits an operating range of -60°C. to 150°C.

Du Pont
MYLAR®
polyester film

DU PONT
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

Find out more about new DuPont "Mylar." Send for your free copy of the new booklet that gives you the facts and figures . . . shows you how this versatile film is already being used to advantage as slot and phase insulation in motors . . . layer insulation in transformers . . . as primary insulation and barrier tape for wire and cable.

E. I. du Pont de Nemours & Co. (Inc.)
Film Department, Room 3-E, Nemours Bldg.
Wilmington 98, Delaware

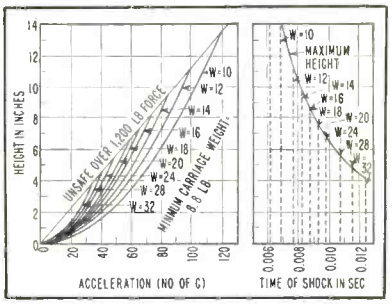
Please send me sample and further information on "Mylar" polyester film.

Name_____

Firm_____

Street Address_____

City_____ State_____

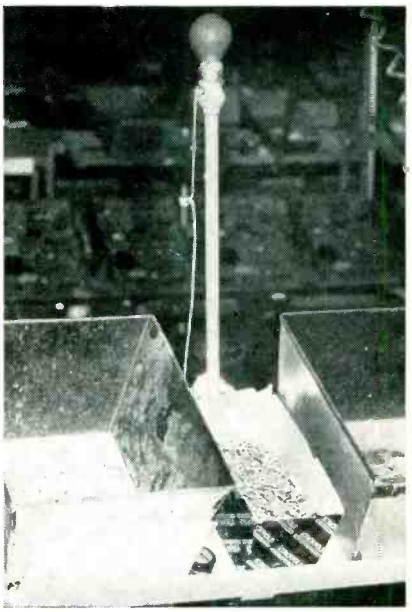


Range and performance curves

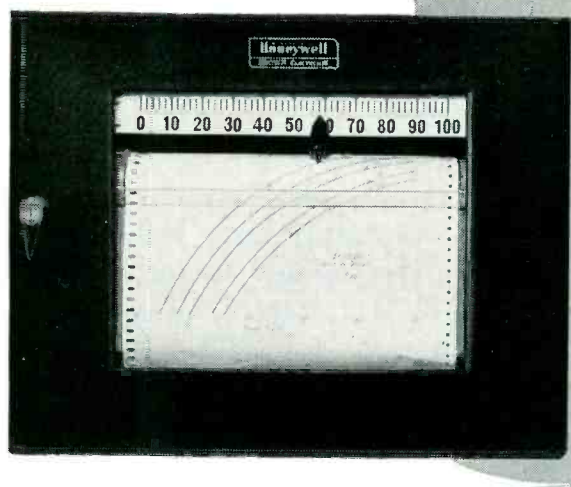
a steel scale bolted to one upright member of the shock tester. A sliding stop on one vertical rod can be locked at any desired point on the vertical rod, so that the frame can be brought precisely up to a desired height as indicated by the pointer, then released. A spring crosspiece 0.153 inch thick, having a spring constant of 5,270 lb per inch, is bolted to the bottom of the carriage. During a drop, this spring lands on the curved hardened steel anvil bolted to the bed of the tester.

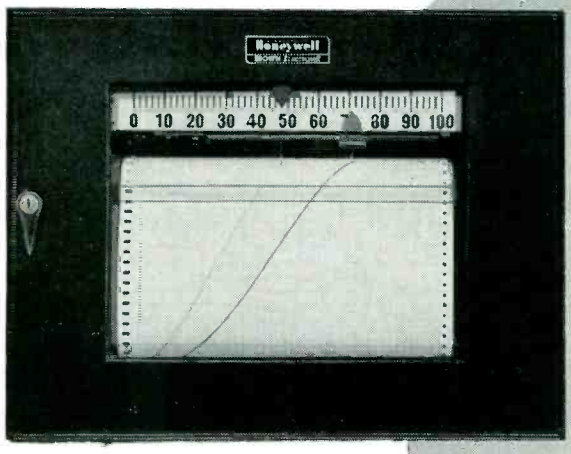
TV Assembly Line Uses Red Trouble Lamps

ON A METAL post at each inspection station on both black-and-white and color television assembly lines in the Westinghouse Metuchen, N. J. plant are red trouble lamps that can be turned on and off by pulling a chain. When an inspector feels that supervisory guidance is



Red trouble lamp at inspection station, as seen from opposite side of bench





2 time-saving instruments for research men

The *ElectraniK*® Function Plotter

. . . Automatically produces a continuous curve of x = f (y). Eliminates time and possibility of error in transcribing data into the form required for analysis. Independent measuring systems actuate the pen and the chart.

The Duplex Function Plotter

. . . A two-pen model of the Function Plotter, which records two variables as a function of a third, or x, x′ = f (y). The three inputs can be different calibrations, since the measuring circuits are completely independent. This model gives two distinct curves . . . does the work of two instruments simultaneously.

Both versions of the Function Plotter are standard instruments. They're an economical investment which can be repaid quickly in saving of scientist's time, in acceleration of critical research projects, and in reduction of manual errors. Both are readily adapted to such uses as recording antenna radiation patterns, vacuum tube characteristics, transistor operation, temperature-viscosity curves, and literally innumerable other research applications.

For a discussion of your specific requirements, call your local Honeywell sales engineer. He's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

● **REFERENCE DATA:** Write for Data Sheets No. 10.0-5a and 10.0-17.

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS

H HONEYWELL *First in Controls*

Want more information? Use post card on last page.

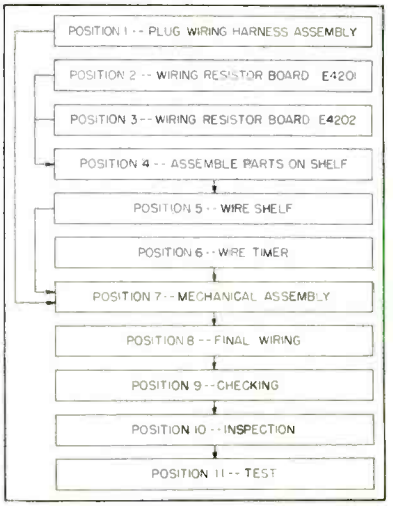
needed, she turns on the lamp. The height of the lamp allows it to be seen from some distance by supervisors, who converge on that inspection station to find out what is going wrong and take immediate corrective action.

Assembly-Line Benches Are Loaded From Rear

By WALTER PRINCE
and
JACK USHER MOWLL
The Glenn L. Martin Co.
Baltimore, Md.

BENCHES DESIGNED for continuous-flow production make available all subassemblies, parts, materials and tools in a most convenient manner for efficient production of electronic controls for aircraft and guided missiles.

Basically, the benches have a



Flow diagram of bench setup used in producing electronic control assembly for guided missiles

Subassembly line, showing use of component bins that are loaded from rear

At WICO... Leesona coil winders have long been standard equipment

Years of efficient, economical performance result in new installation of No. 107 machines

For many years the Wico Electric Company has enjoyed an enviable reputation for its manufacture of magnetos, distributors, complex ignition systems and other allied precision products. During that time the company has found Leesona Coil Winders to be thoroughly satisfactory in every respect, meeting every need for fast, accurate, low-cost winding on a wide range of jobs.

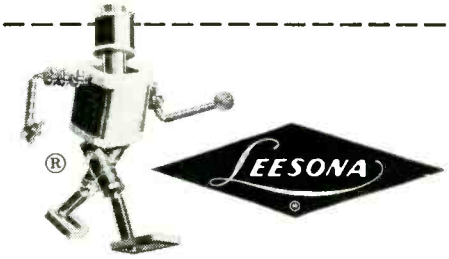
So when the time came to expand their coil winding production, Wico made certain that their new machines would be Leesonas.

These new machines are Leesona No. 107 Automatic Coil Winders, the last word in automatic coil winder design, which produce 4 to 30 compact, uniform paper-insulated coils simultaneously — in fastest time — with minimum operator attention.

Investigate

how Leesona No. 107's in your own production can eliminate human error, reduce wire breakage to a minimum and cut production time to its shortest. The coupon will bring you complete details, together with other helpful coil winding information. Why not check and mail it today?

New Leesona No. 107 Automatic Coil Winders, shown in the plant of Wico Electric Company, West Springfield, Mass., were selected because of this firm's long, satisfactory experience with Leesona machines. Leesona No. 107 Winders, featuring speed and accuracy in automatic winding, are enabling many plants to boost production and cut costs. Inset shows a cutaway of a Wico Model XH Magneto. Coil at top of unit is precision wound on Leesona No. 107's.



FOR WINDING COILS
IN QUANTITY... ACCURATELY
...AUTOMATICALLY... USE
UNIVERSAL WINDING MACHINES

UNIVERSAL WINDING COMPANY

P. O. BOX 1605, PROVIDENCE 1, RHODE ISLAND, Dept. 14

Please send me

- ☐ Bulletin on the Leesona No. 107 Automatic Coil Winder.
- ☐ Condensed catalog of Leesona Winders.
- ☐ Bulletin on the new Leesona *Pay-As-You-Profit Plans* for purchasing or leasing modern coil winding machinery.

Name.....Title.....

Company.....

City.....Zone....State.....

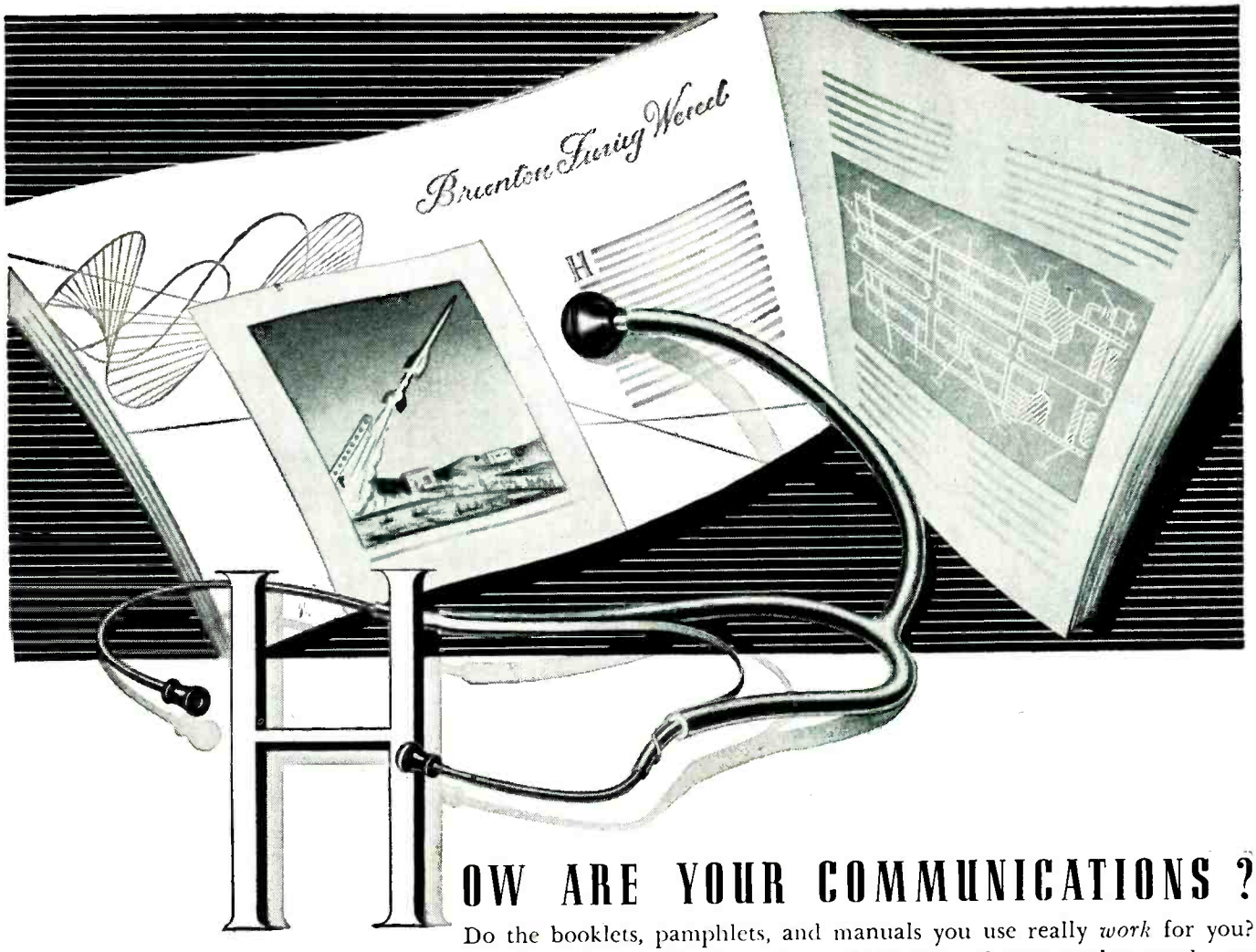
ELECTRONICS Charter-Year Advertiser

flexible design. They can be placed anywhere in the production line. The number placed in a line depends on the number of unit operations to be performed on a given assembly. Once in the line they become the work station for a unit operation or a test operation and are equipped with removable facilities for servicing that operation. All movement of parts, supplies and subassemblies is done at the rear of the benches. The operators are never disturbed by the stock clerks who move the material along the line.

Method of swinging hinged parts rack for replenishing stock from rear

In front of each operator and to her left is a stack of sliding trays which hold the subassemblies she needs. She removes the subassemblies from the front and the tray is refilled from the rear. Directly in front of her, the bench provides three major elements—a panel which holds the shop sketches for that particular operation, holes through which wire, solder and tying cords or tape are fed from reels mounted at the rear of the bench, and sockets for soldering irons or other tools. The empty reels of wire or other material are replaced from the rear of the bench.

The right-hand panel in front of the operator is a door which opens inward. It has brackets on which are mounted tote pans containing the small parts and hardware needed in the operation. Fresh supplies of these materials are provided from the rear. The stock clerk opens the door, replenishes what-



HOW ARE YOUR COMMUNICATIONS ?

Do the booklets, pamphlets, and manuals you use really *work* for you? Are these vital publications, that tell the story of your products and your company, as effective, readable, well designed and illustrated as they can be? Today more than ever, your entire operation is judged by each annual report, employee manual, and public relations piece that you produce. Have you examined your communications lately? If you have any doubt as to the impact of your instructional and promotional literature, remember . . .

COMMUNICATION IS OUR BUSINESS

For a good many decades McGraw-Hill has stood for complete coverage in the business literature field. Now the McGraw-Hill TECHNICAL WRITING SERVICE offers a new approach to your publication problems — an *integrated* writing, editing, illustrating, and printing service for the *custom* production of: INSTRUCTION MANUALS, PRODUCT BULLETINS, TRAINING AIDS, INDUSTRIAL RELATIONS LITERATURE, ANNUAL REPORTS, COMPANY HISTORIES, PROCEDURAL GUIDES and other collateral literature. More than 150 editorial and graphic experts are at your disposal, ready to prepare high-quality material to your own or government specifications. Save time, save money . . . and make your communications work! Let *our* staff be your staff for technical and business publications.

McGraw-Hill Book Co. TECHNICAL WRITING SERVICE

Write or phone Technical Writing Service, McGraw-Hill Book Co., Inc.
330 West 42nd Street, New York 36, N. Y. • LOngacre 4-3000

This service is available through ad agencies.

ever is needed in the tote boxes and closes the door without any interruption to the operator.

The working surface of the bench is mounted on rails and is removable. It can be a flat table top on which the unit operation is performed, or it can be a holding fixture for a complicated chassis assembly. It can, if necessary, be moved along the rails from bench to bench as the assembly progresses.

Typical assembly-line position, where timer is installed in chassis for pilotless bomber

Assembly line in which rails are used on bench to aid pass-along operation

Below the work surface, each bench has racks for soldering irons, a cabinet for tools and personal equipment and a handy waste can which hangs just below the work surface.

The accompanying flow diagram and illustrations show how the benches are teamed together to form a production line. In this case the line is producing an electronic unit for a pilotless bomber. The line has eleven work stations or positions. In position 1, plugs are wired and harness assemblies are made. The plugs and precut wires are stored in the trays and tote pans in front of the operator. A multiple-

Vacuum-melted metals — new weapon in the fight for miniaturization . . .

Because of the superior properties of vacuum-melted metals, weight and size of motors, transformers, controls and instruments can be substantially reduced. What's more, vacuum-melted metal's greater magnetic permeability means you get superior performance . . . greater reliability. That's why they are being proposed for aircraft instruments, synchronous motors, power tubes, receiving tubes, controls for automatic production lines, computers.

The reason these alloys are superior is easy to explain. *Vacuum-melting removes unwanted gaseous impurities and inclusions — literally sucks them from the molten metal.* Result: close composition control . . . high-purity, gas-free metals that far outperform those made by conventional air-melted methods.

Vacuum Metals Corporation, pioneer in development and leading producer of vacuum-melted and cast metals, has a wide variety of these unique new metals available for electrical and electronic uses. If you have an application you believe they can improve, please write, giving full details. Our engineers will give your letter prompt, careful attention. *Vacuum Metals Corporation, P. O. Box 977, Syracuse 1, N. Y.*

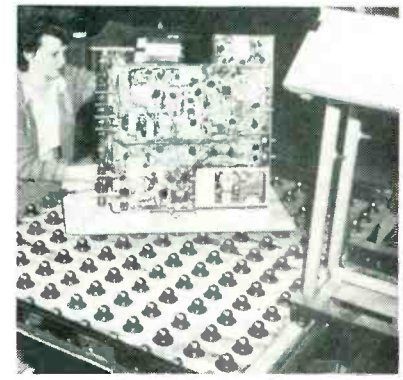
VMC

VACUUM METALS CORPORATION

Jointly owned by Crucible Steel Company of America and National Research Corporation

plug holding fixture is used in this operation. In positions 2 and 3, resistor boards are made up and wired on special multiple holding fixtures. In position 4, the resistor subassemblies are assembled on a shelf and in position 5 all the wiring on the shelf is completed. In position 6 the timer subassembly is wired. In position 7 the mechanical assembly of all parts is done, using a special fixture which holds the parts; the chassis is placed over them so all parts and fasteners are correctly positioned for quick and easy assembly. In position 8, final wiring of the complete assembly is accomplished by placing the assembly on a rotating fixture which permits the operator to reach every junction. In positions 9, 10 and 11, the assembly is checked, inspected and tested. At each station, a special holding fixture is used to prevent damage to the assembly.

Pallet Turnaround



Turnaround point for color tv chassis

BALL-BEARING rollers screwed to a 4-foot-square sheet of ½-inch plywood serve as the U-turn on the 400-foot-long color tv assembly line at the Westinghouse Metuchen, N. J. plant. One operator seated at this end of the line can easily turn the flat plywood pallet on which the heavy chassis rests, and give it a push to get it started down the other side of the roller conveyor.

Air-Powered Tilt-Table Speeds Chassis-Mounting

MANUAL HANDLING of black-and-white television receivers is reduced to a minimum in the Westinghouse

NEW

VINYL-GLASS SLEEVING

BH VINYL-SIL 8000

Vinyl Chloride *Silicone* *Volts*

Now in production — BH Vinyl-Sil 8000 — the first major improvement in vinyl glass insulation in five years. By combining stabilized organic resins with those of the silicone group, BH Vinyl-Sil 8000 offers unequaled heat resistance and non-corrosiveness. Look at these features . . .

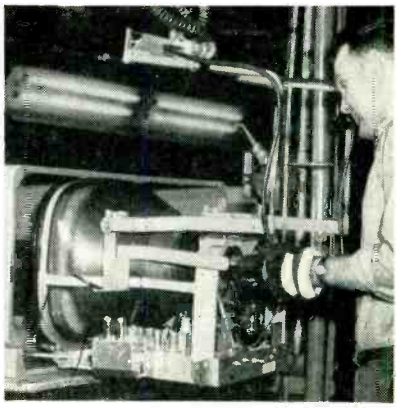
- High dielectric . . . 8000 volt *minimum* short-time dielectric breakdown.
- Non-wicking . . . No entrapped moisture in the sleeving to impair the effectiveness of the varnish impregnation.
- Heat endurance . . . Remains flexible through exposure to 130° C for 2000 hours, and the tests are still going on.
- Non-corrosive within operating temperatures.
- Meets all requirements for Class B-A-1 insulation under ASTM and NEMA Specifications.
- Meets all performance requirements for Mil-I-3190.

You owe it to your product to investigate the advantages of insulating with BH Vinyl-Sil 8000 Sleevings . . . write for data sheets and samples today.

BENTLEY, HARRIS MANUFACTURING CO.
1304 Barclay Street
Conshohocken, Pennsylvania
Telephone: Conshohocken 6-0634

BENTLEY, HARRIS *Fiberglas** **SLEEVINGS**

*BH Non-Fraying Fiberglas Sleevings are made by an exclusive Bentley, Harris process (U.S. Pat. No. 2393530; 2647296 and 2647288). "Fiberglas" is Reg. TM of Owens-Corning Fiberglas Corp.



Using pneumatic fork-lift device mounted on free-rolling dolly to move chassis into cabinet of table-model black-and-white television receiver

Table in tilted position for insertion of mounting bolts. Air cylinders are used throughout plant for actuation of mechanized aids to production

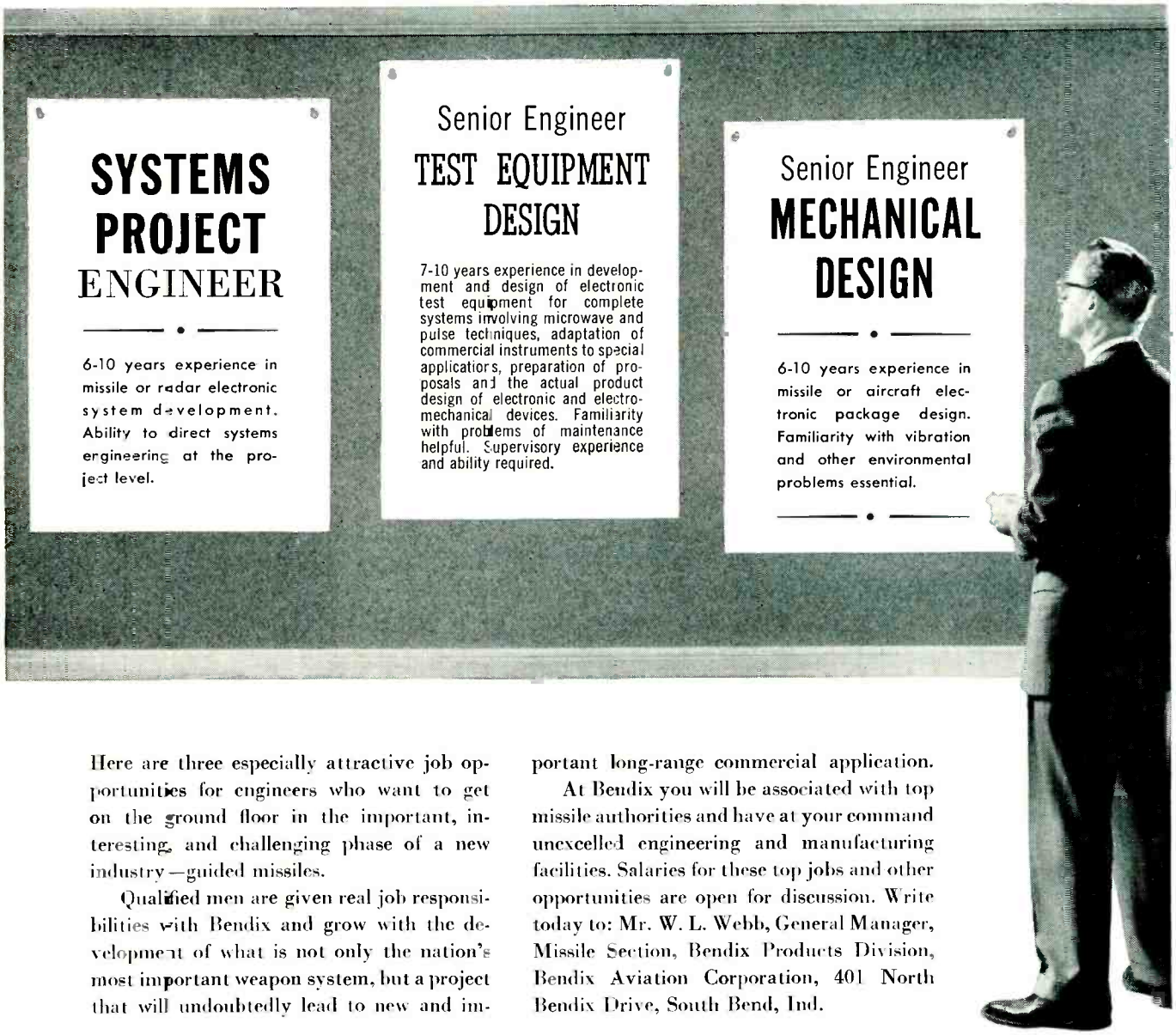
Metuchen, N. J. plant through use of a pneumatic fork-lift device for transferring the completed chassis to its cabinet and use of a pneumatic tilt-table for aiding insertion of mounting bolts.

The fork-lift device is designed to hook over the deflection yoke frame of the receiver. With the lift in position, the operator raises the chassis by pushing an air valve, rolls the lift over to a tilt-table on which he has previously placed an empty metal cabinet, pushes the chassis right into the cabinet while still on the lift, then releases air pressure to clear the lift for another operation.

Next, the air valve on the tilt table is operated to tilt the complete receiver upward for easy insertion of chassis mounting bolts from underneath the cabinet. Four snap-action switches mounted on the tilt-table at strategic positions are connected to red indicator lamps on the table control board to tell the

3 SENIOR ENGINEERING JOBS

WELL WORTH LOOKING INTO . . .



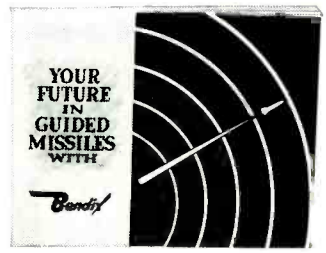
Here are three especially attractive job opportunities for engineers who want to get on the ground floor in the important, interesting, and challenging phase of a new industry—guided missiles.

Qualified men are given real job responsibilities with Bendix and grow with the development of what is not only the nation's most important weapon system, but a project that will undoubtedly lead to new and important long-range commercial application.

At Bendix you will be associated with top missile authorities and have at your command unexcelled engineering and manufacturing facilities. Salaries for these top jobs and other opportunities are open for discussion. Write today to: Mr. W. L. Webb, General Manager, Missile Section, Bendix Products Division, Bendix Aviation Corporation, 401 North Bendix Drive, South Bend, Ind.

23 OTHER ENGINEERING POSITIONS!

Bendix also offers unusual job opportunities for assistant engineers, junior engineers, and technicians, as well as a score of other assignments. A 30-page book describing in detail every phase of our guided missile operation will be sent to you on request. If you are interested in guided missiles, this book is bound to interest you. Write for it today.



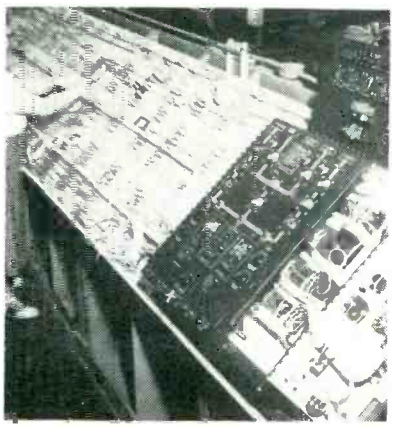
Assembling console on tilt table. Left hand of operator rests on freely pivoted pan containing mounting bolts

operator when the chassis is properly centered in the cabinet.

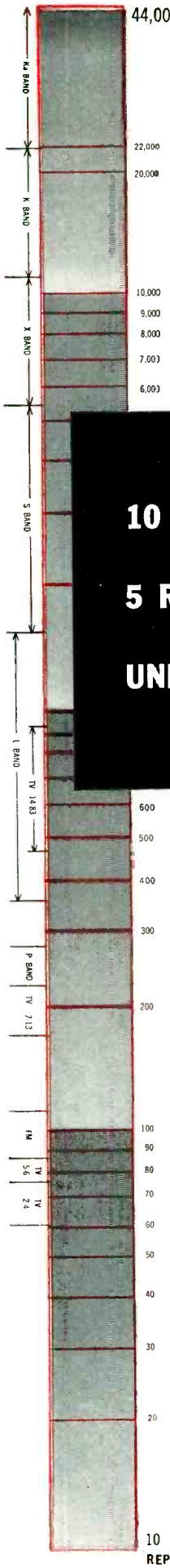
By changing hold-down stops for the top of the cabinet, the same tilt-table can be used for consoles. Without stooping or lifting, the operator anchors the chassis with the aid of a pneumatic-powered bolt gun. Felt padding on the frame members of the table protects the cabinet from scratches.

Minimizing Splices in Aircraft Radio Panel

IN ASSEMBLING the radio operator's control box for the P5M-2 Martin ocean patrol plane, the entire box is placed right on the wiring harness board in the Baltimore plant of The Glenn L. Martin Co. Wires are placed in position between the pegs of the board one by one and each threaded through holes in the control box for connecting directly to the terminals of the meters, relays, transformers, switches and



Radio operator's control box on wiring harness board



PORTABLE DIRECT READING SPECTRUM ANALYZER

10 TO 44,000 mcs

5 RF HEADS

UNI-DIAL TUNING

MODEL TSA

Now, a new Polarad spectrum analyzer only 21 inches high that covers the entire frequency range 10 to 44,000 mcs with 5 interchangeable RF tuning heads. The model TSA operates simply—single dial frequency control—with utmost frequency stability. It provides highest accuracy, and reliability for observation and true evaluation of performance over the entire RF spectrum—saving engineering manhours.

This instrument is designed for maximum utility and versatility in the laboratory and on the production line providing an easy-to-read 5 inch CRT display of the RF spectrum.

Model No.	Equipment
Model DSA	Spectrum Display and Power Unit
Model STU-1	RF Tuning Unit 10-1,000 mc.
Model STU-2A	RF Tuning Unit 910-4, 560 mc.
Model STU-3A	RF Tuning Unit 4,370-22,000 mc.
Model STU-4	RF Tuning Unit 21,800-33,000 mc.
Model STU-5	RF Tuning Unit 33,000-44,000 mc.

SPECIFICATIONS:

Frequency Range: 10 mc to 44,000 mc.

Frequency Accuracy: 1%

Resolution: 25 kc.

Frequency Dispersion: Electronically controlled, continually adjustable from 400 kc to 28 mc per cne screen diameter (horizontal expansion to 20 kc per inch)

Input Impedance: 50 ohms—nominal

*Sensitivity:
STU-1 10-400 mcs —89 dbm
400-1000 mcs —84 dbm
STU-2A 910-2,200 mcs —87 dbm
1,980-4,560 mcs —77 dbm
STU-3A 4,370-10,920 mcs —75 dbm
8,900-22,000 mcs —60 dbm
STU-4 21,800-33,000 mcs —55 dbm
STU-5 33,000-44,000 mcs —45 dbm

Overall Gain: 120 db

Attenuation:
**RF Internal 100 db continuously variable IF 60 db continuously variable

Input Power: 400 Watts

*Minimum Discernible Signal
**STU-1, STU-2A, STU-3A

The model TSA Spectrum Analyzer has these exclusive Polarad design and operating features:

- Single frequency control with direct reading dial. No klystron modes to set. Tuning dial accuracy 1%.
- Five interchangeable RF tuning units for the entire frequency range 10 to 44,000 mcs.
- Temperature compensation of Klystron Oscillator.
- Swept IF provides 400 kc to 25 mc display independent of RF frequency setting.
- Internal RF attenuator.*
- Frequency marker for measuring frequency differences from 100 kc to 25 mc.

AVAILABLE ON EQUIPMENT LEASE PLAN

FIELD MAINTENANCE SERVICE AVAILABLE THROUGHOUT THE COUNTRY

NEW! Write for Handbook of Spectrum Analyzer Techniques

POLARAD PROVEN RELIABILITY

ELECTRONICS CORPORATION 43-20 34th STREET, LONG ISLAND CITY 1, N. Y.

REPRESENTATIVES • Albuquerque • Atlanta • Baltimore • Boston • Chicago • Cleveland • Fort Worth • Kansas City • Los Angeles • New York Philadelphia • San Francisco • Seattle • St. Paul • Syracuse • Washington, D. C. • Canada, Arnprior—Export: Rocke International Corporation

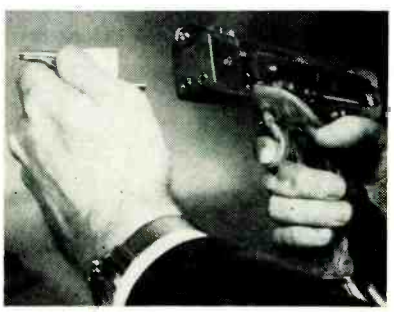
other parts on the hinged panels. The panels can be opened entirely or propped at convenient angles for this work.

A few splices of wires are still permitted in circuits of lesser importance, but the number is very much less than was required when cables were made up separately before.

Automatic Soldering Gun Uses Electronic Timing

AN AUTOMATIC SOLDERING GUN developed by Cornell Aeronautical Laboratory has many unique features, including automatic solder feed, unheated untinned tips, electronic timing and a flashing-signal pilot lamp. The gun avoids many common soldering problems, including burnt-out, burnt insulation, standby heat, time lag, tinning, wasted solder, inaccessibility and lack of a third hand. It does consistently good work on repetitive operations using random lengths of 60-mil rosin-cored or solid solder wire. The amount of solder feed is predetermined, giving uniform results on repetitive work.

The gun uses the principle of resistance heating in a manner which resembles electric spot welding, as current flows through the work by way of two contacts. The contacts are a pair of stainless steel soldering tips, which are long-lived plug-in units made in several shapes to suit various kinds of work. Curled tips hook around flexible wire splices, and straight tapered tips span connector pins, leads and lugs. Above the tips is a pilot lamp which illuminates the work and dims while the work is



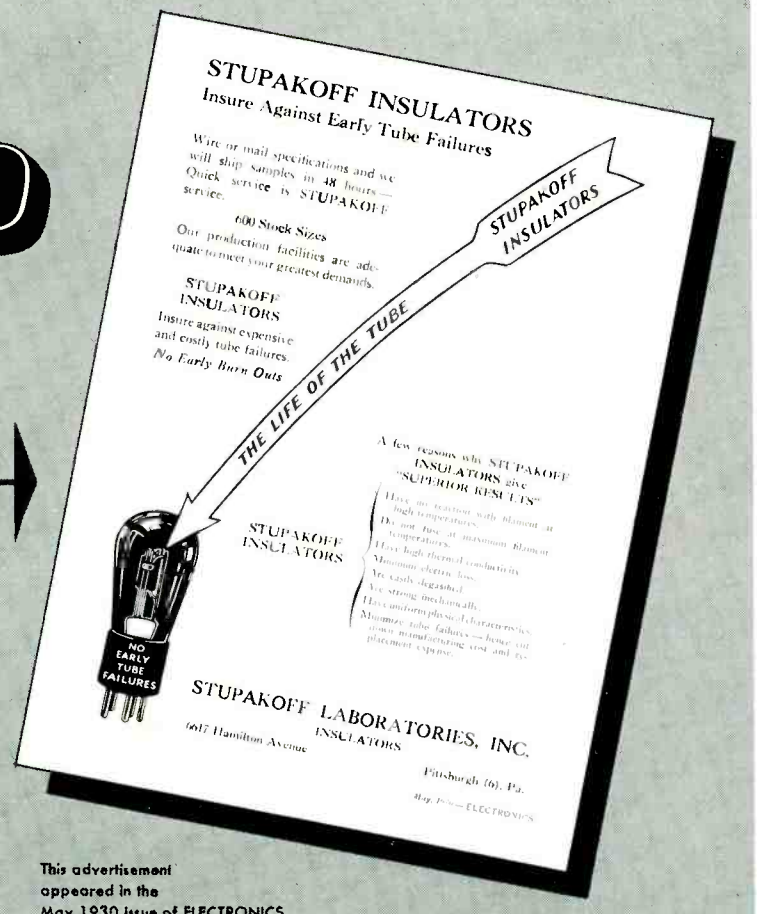
Gun and electronic control box. Knurled nut at rear adjusts amount of solder that is fed each time trigger is pulled

In **1930**

Stupakoff

advertised . . .

- *Quick service . . .*
- *Ample stocks . . .*
- *Large production facilities . . .*
- *Dependable, uniform products . . .*



This advertisement appeared in the May 1930 issue of ELECTRONICS

In **1955** . . .

our policies are the same, but our products and services have been expanded. Through progressive planning, scientific research, advanced engineering and modern manufacturing techniques, Stupakoff has maintained leadership in the development and production of hermetic seals and ceramic products.

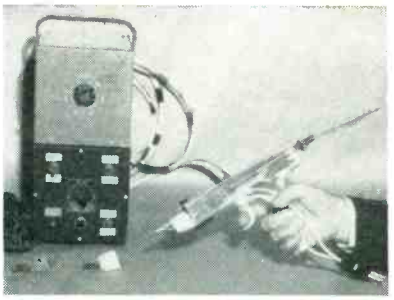
Stupakoff

CERAMIC & MANUFACTURING COMPANY • LATROBE, PENNSYLVANIA

Division of The CARBORUNDUM Company

ELECTRONICS Charter-Year Advertiser

Want more information? Use post card on last page.



Inserting stainless steel soldering tips in gun

heating. Heating starts when the tips touch the work and the trigger is pulled; heating stops automatically when the job is done or the tips are removed from the work. Guided by changes in light intensity, the operator quickly learns how to make good contact between tips and work. A dim light means good contact.

The soldering operation requires little skill as it occurs automatically. Each pull of the trigger actuates a spring which feeds an adjustable length of solder wire into the work at a point midway between the tips. As the work heats, it melts the solder, which coats the work progressively. At the end of the solder feed stroke, heating continues for a predetermined time, which is long enough for the solder to flow freely and saturate the work, but is short enough to avoid overheating the work and adjacent insulation. A thumb nut permits adjustment of the solder feed rate.

The automatic timing feature is provided by a snap-action switch in the gun and a 117L/M7GT diode-pentode tube in an external box which contains the necessary step-down soldering transformer. The electronic timer is adjustable for any desired time delay by turning a knob. This varies the time constant of a half-wave rectifier circuit and the corresponding time at which a relay interrupts the heating current and signals the operator by brightening the pilot lamp.

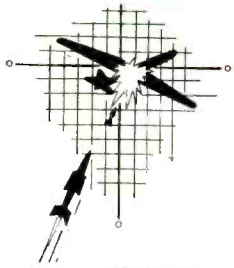
If automatic timing is unwanted, as in a single soldering operation of unpredictable duration, the timer is disabled by throwing a switch. Another two-position switch, connected in the transformer primary circuit, provides a choice of high and low current, and

1 component fits 10 exacting applications

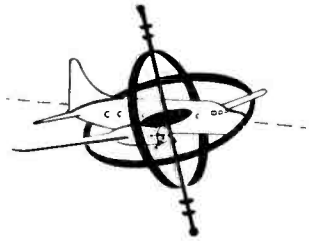
Each new military and industrial control system is different, but they all have certain common requirements—precise control performance ...rugged construction to withstand extreme operating conditions ...absolute minimum size and weight...and complete dependability.

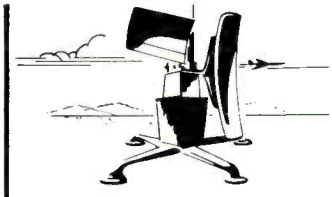
Best answer to the problem is the Keystone "Moto Mag" magnetic amplifier, an unusually flexible component designed to meet unique demands in a wide variety of control applications. Available in 7 standard models...each can be modified to meet special requirements. All units are made in accordance with MIL specs.

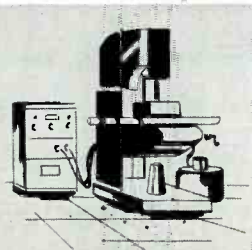
TYPICAL MOTO MAG APPLICATIONS

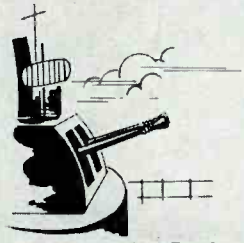

GUIDED MISSILES

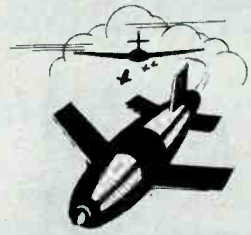

COMPUTERS

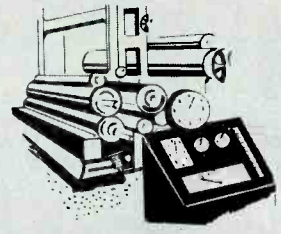

AUTOMATIC PILOTS


RADAR CONTROL


AUTOMATION

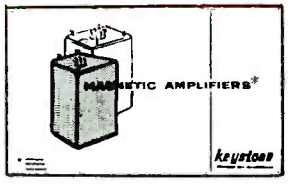

A. A. FIRE CONTROL


DRONE AIRCRAFT


SPEED CONTROL

Write for new illustrated MAGNETIC AMPLIFIER catalog

Gives complete specifications, performance data, and quotations for Moto Mags covering a wide range of special requirements. Write for your copy today.




TORPEDO CONTROL


TEMPERATURE CONTROL

keystone PRODUCTS COMPANY

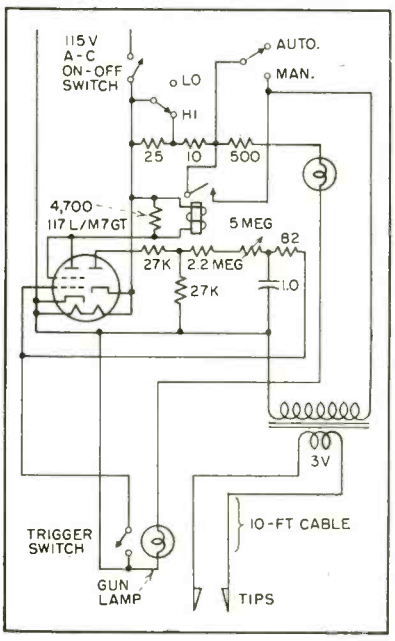
904 23RD STREET UNION CITY 2, N. J.

permits large and small work to be heated within similar ranges of time. In either position of the switch, the electronic timer provides fine heat control.

The two pilot lights and a current-limiting resistor are connected in series to the transformer side of one heat-control resistor and to the common or return wire of the a-c line. Since the voltage applied to the pilot lights decreases when the transformer draws load current, by reason of the voltage drop in the heat-control resistor, the pilot lights dim when the heat is on, as desired.

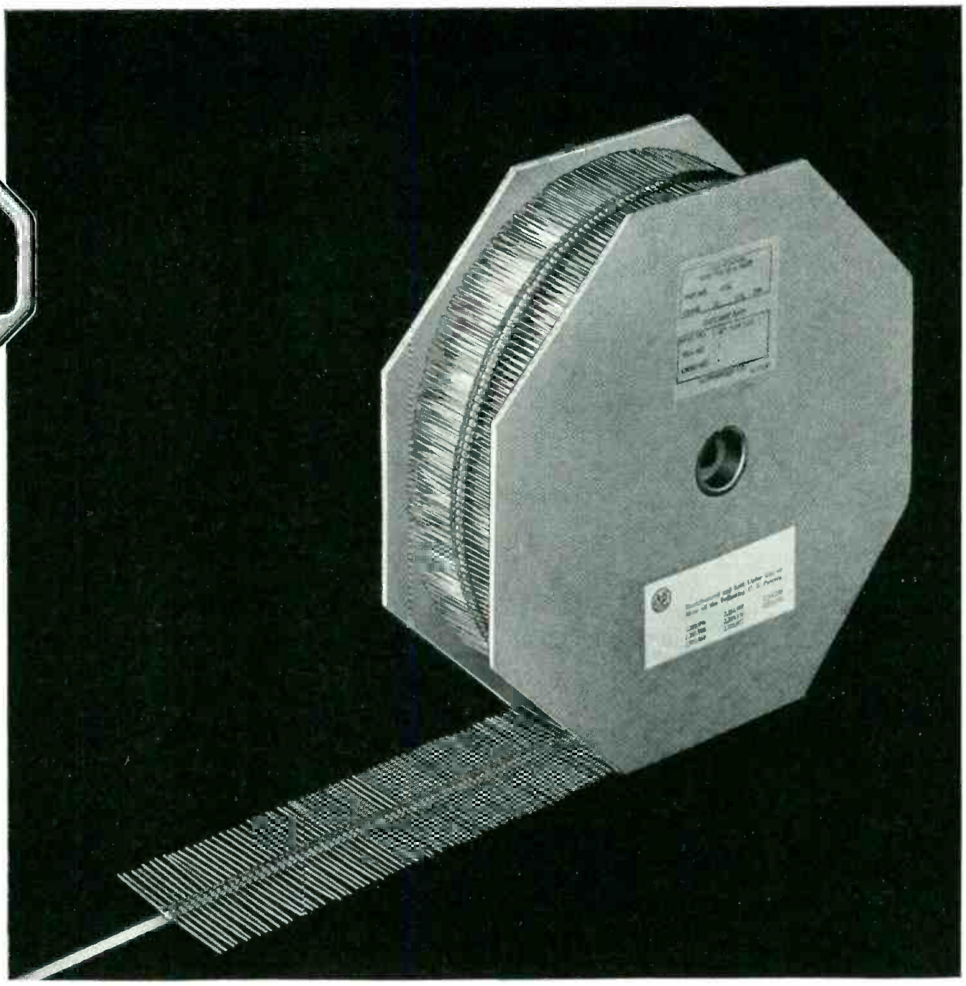
The heart of the automatic timing circuit is a snap-action switch in the gun, whose contacts close when the trigger is pulled and open when the solder wire has fully advanced. When the switch contacts close, the relay is energized instantly by the electronic circuit. When the switch contacts open, this relay is not de-energized until a certain time has elapsed. When the relay is energized, its contacts close and connect the power line to the soldering transformer through the heat-control resistor, thus applying secondary voltage to the tips.

The diode part of the tube serves as a half-wave rectifier to charge a time-delay capacitor slowly through a resistance voltage divider and a fixed and variable high resistance. Negative voltage from the capacitor is applied to the control



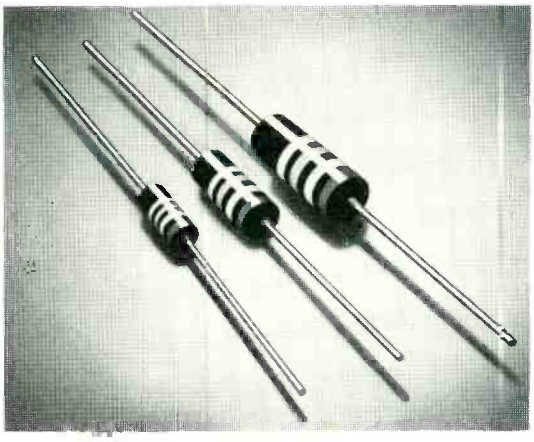
Circuit of soldering gun

The Sign of
QUALITY



NOW- ALLEN-BRADLEY RESISTORS

available in reels for automatic assembly lines



BRADLEYUNITS are available in standard RETMA values in ½ and 2 watt sizes from 10 ohms to 22 megohms; in the 1 watt size from 2.7 ohms to 22 megohms. Allen-Bradley resistors do not use "wax impregnation" to pass salt-water immersion tests.

Allen-Bradley Types EB (½-watt), GB (1-watt), and HB (2-watt) fixed molded resistors . . . furnished in patented cartons as standard . . . can now be packaged also in reels for use in automatic assembling equipment.

The resistors are aligned on a narrow, pressure-sensitive tape and wound on a corrugated fiberboard expendable reel with a 9/16th inch mandrel. A lateral pull on the resistor leads detaches the unit easily from the tape.

Type EB resistors are packaged 5000 units per reel; Type GB resistors have 2000 units per reel; and Type HB resistors have 1000 units per reel.

Reel packaging can be supplied for Bradleyunits of any standard RETMA value or tolerance. If automatic assembly is one of your "problems" it may pay you to investigate this reel packaging of A-B "Quality" resistors.

Allen-Bradley Co., 110 W. Greenfield Ave., Milwaukee 4, Wis. • In Canada—Allen-Bradley Canada Limited, Galt, Ont.

ALLEN-BRADLEY

RADIO, ELECTRONIC AND TELEVISION COMPONENTS

ELECTRONICS Charter-Year Advertiser

Want more information? Use post card on last page.

grid of the triode-connected pentode part of the tube when it is necessary to cut off plate current and thus de-energize the relay and tips. This negative voltage builds up soon after a short-circuit across the capacitor has been removed. The build-up time is governed by the time constant of the capacitor and charging resistors. The short-circuit is applied by the switch in the gun, and starts when the trigger is pulled, continuing until the solder wire has fully advanced.

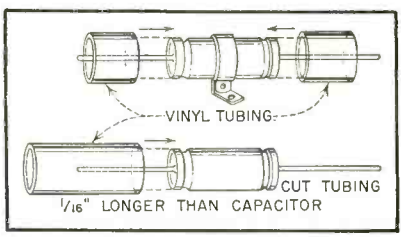
To avoid high peak currents and possible welding of the switch contacts when they are closed across the charged capacitor, an 82-ohm current-limiting resistor is used.

In a comparative test of the gun and an ordinary 100-watt soldering iron, both tools were used in soldering leads to AN-type connectors and photomicrographs were made of cross-sections of contact pin sleeves. This test showed complete encasement of wire strands with solder applied by the gun and crevices inside and outside of the strands with solder applied by the iron. Crevices and voids of this nature usually result from cold-soldering, which is often responsible for failure in electric and electronic circuits, especially in airborne applications.

Further details are given in Report No. ND-194-D-3 of Cornell Aeronautical Laboratory, Buffalo, N. Y., entitled "The C. A. L. Resistance Soldering Gun and Electronic Control," by Carleton F. Maylott.

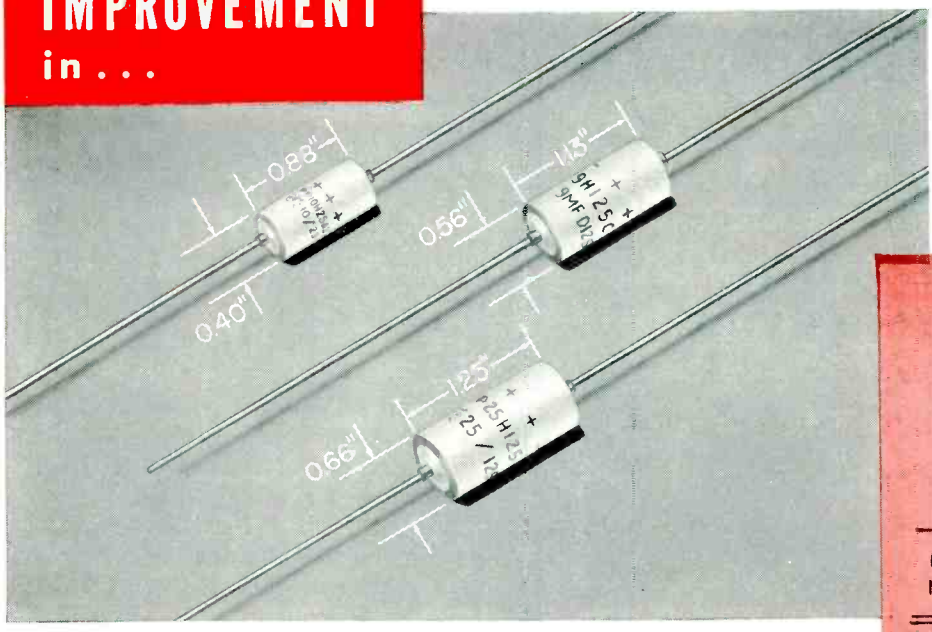
Placing Plastic Tubing on Metal-Cased Capacitors

TUBULAR METAL-CASED fixed capacitors are used in many locations on a chassis and on resistor and terminal boards. Installations in close-



When capacitor has mounting strap, use two lengths of tubing

IMPORTANT IMPROVEMENT in . . .



Hermetically Sealed Fansteel Tantalum Capacitors are made in 3 sizes, 29 ratings.

. . . Fansteel TANTALUM CAPACITORS

Now . . .

Hermetically Sealed for High Temperature Operation

Wider Temperature Range: Continuous operation in ambient temperatures up to 125°C, with working voltage derated to 85% of nominal. Low temperature limit,—55°C.

Vastly Improved Leakage Characteristics: Precision construction results in lowest d-c leakage of all tantalum capacitors. Maximum leakage ranges from 1 to 8 microamperes as shown in table.

Closer Capacity Tolerances: All Fansteel Grade 1 Hermetically Sealed Tantalum Capacitors are manufactured to capacity tolerances of −15%, +20%. Grade 2 capacitors, also available, are −15%, +50%.

Rugged Construction: These capacitors have an actual metal to glass hermetic seal. The sturdy, plated steel case is insulated from the capacitor. They have passed rigorous tests for vibration, impact, humidity, reduced barometric pressure and thermal shock.

If your product requires capacitors of long life, small space and exceptionally stable characteristics over a wide temperature range, Fansteel Tantalum Capacitors may be the answer. Engineering samples may be ordered from the list at right.

CONDENSED LIST OF AVAILABLE CAPACITORS

☆

CATALOG NUMBER	CAPACITY MFD.[1]	WORKING VOLTAGE, D-C	MAXIMUM D-C LEAKAGE[2]
PP30H6A1	30	6	1.0
PP25H8A1	25	8	1.0
PP20H10A1	20	10	1.0
PP15H15A1	15	15	1.5
PP10H25A1	10	25	2.0
PP8H30A1	8	30	2.0
PP5H50A1	5	50	3.0
PP4H60A1	4	60	3.0
PP3.5H75A1	3.5	75	3.0
PP2H100C1	2	100	3.0
PP1.75H125C1	1.75	125	3.0
PP140H6A1	140	6	2.0
PP100H10A1	100	10	2.0
PP70H15A1	70	15	3.0
PP40H30A1	40	30	4.0
PP25H50A1	25	50	5.0
PP20H60A1	20	60	5.0
PP15H75A1	15	75	6.0
PP11H100C1	11	100	7.0
PP9H125C1	9	125	7.0
PP325H6A1	325	6	3.0
PP250H10A1	250	10	3.0
PP175H15A1	175	15	4.0
PP100H30A1	100	30	5.0
PP60H50A1	60	50	6.0
PP50H60A1	50	60	6.0
PP40H75A1	40	75	7.0
PP30H100C1	30	100	8.0
PP25H125C1	25	125	8.0

[1]—15%, +20% at 120cps, 25°C
[2] Microamperes, at 25°C

C551

FANSTEEL METALLURGICAL CORPORATION, NORTH CHICAGO, ILLINOIS, U. S. A.

fitting spaces and on crowded boards often dictate the need for insulation on the metal cases.

When the insulated-case capacitor is needed but not available for any reason, the bare metal unit may be encased in vinyl tubing of slightly smaller size, as follows:

Capacitor O.D.	Tubing I.D.
3/8"	0.312"
7/16"	0.375"
1/2"	0.437"
9/16"	0.500"
5/8"	0.625"
3/4"	0.625"
13/16"	0.750"
1 1/16"	1.000"

Cut the insulating tubing to allow approximately 3/32 inch extension on each end of the capacitor, then immerse the tubing for about 30 seconds in methyl ethyl ketone solvent (inflammable and toxic; do not breathe the vapor). Avoid prolonged immersion as it will make the plastic mushy and difficult to handle. Slide the tubing over the capacitor, shape smoothly and allow to dry undisturbed for about 30 minutes.—*Glenn L. Martin Co. electrical and electronic bulletin.*

Heater-Storing Trays

BENT HEATERS for type 6AL5 tubes are stored and handled in green plastic strips mounted in aluminum trays in the Bloomfield, N. J. plant of Tung-Sol Electric Inc. The strips have holes in which the heaters are inserted. Each heater requires two adjacent holes. During loading, a strip is set upright by itself,

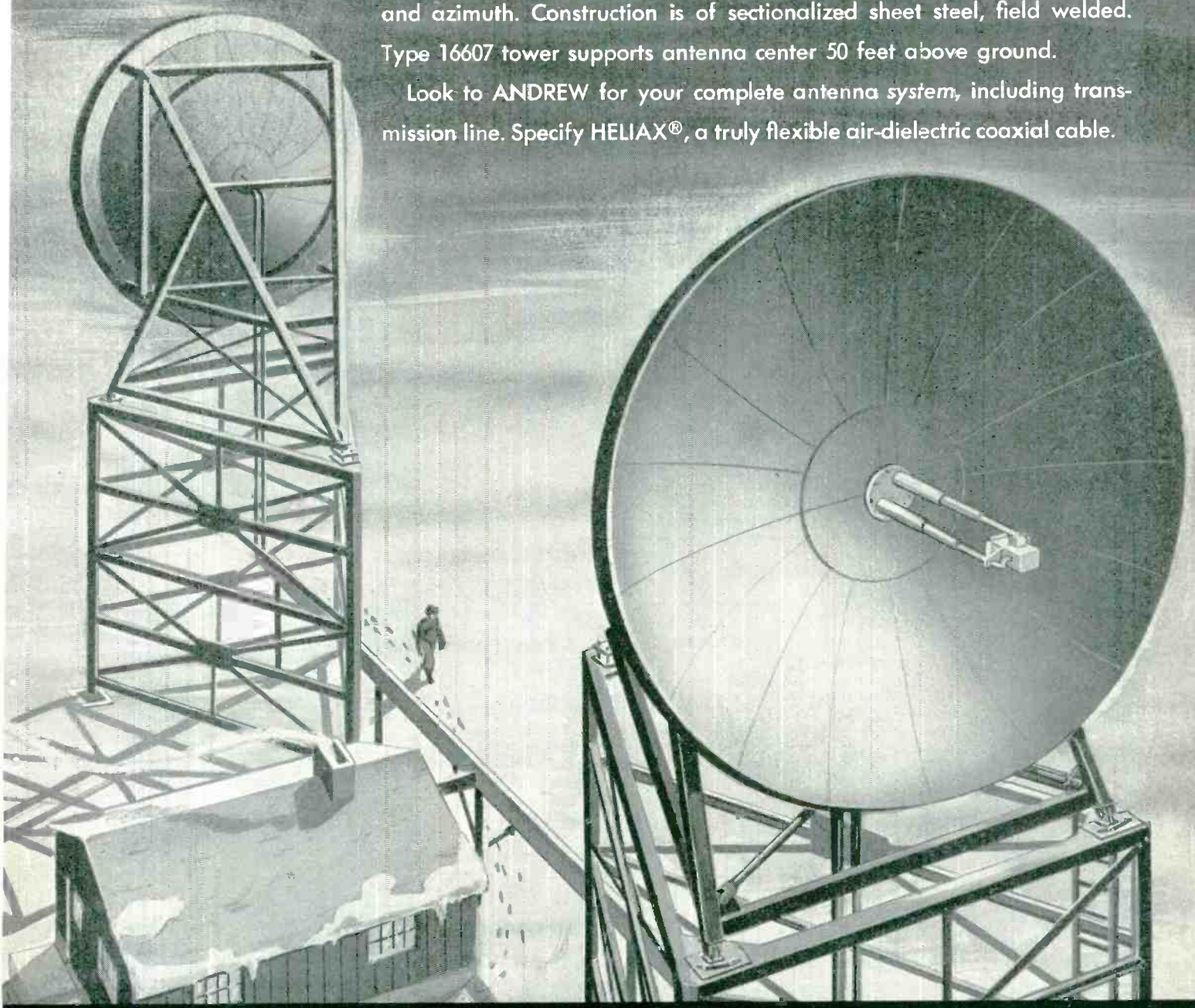
Inserting heaters in plastic strip. Loaded strips are pushed off at angle as in foreground

SCATTER

ANDREW Parabolic Antennas for this exciting new method of communication are available in standard sizes of 15, 30 and 60 ft. diameter.

The 30 ft. Type P-30-1 illustrated has a gain of 36 db at 800 MC and the Dual feeds have 40 db isolation. Antenna is adjustable in both elevation and azimuth. Construction is of sectionalized sheet steel, field welded. Type 16607 tower supports antenna center 50 feet above ground.

Look to ANDREW for your complete antenna *system*, including transmission line. Specify HELIAX®, a truly flexible air-dielectric coaxial cable.



Andrew CORPORATION

363 EAST 75th STREET · CHICAGO 19

TRANSMISSION LINES • ANTENNA EQUIPMENT

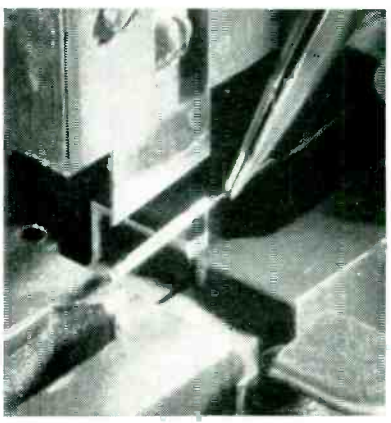
ANDREW

and loaded strips are tilted away from this at an angle so that the operator does not damage already loaded heaters while filling a new strip.

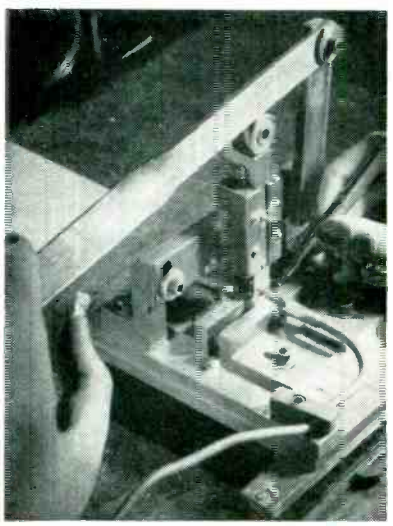
Each strip has a captive ball-bearing and spring in one end to serve as a detent for holding the strip upright during loading. Matching holes for this are drilled in the end of the black plastic piece that is bolted to the inside of the brazed aluminum frame.

Cathode-Shaving Tool

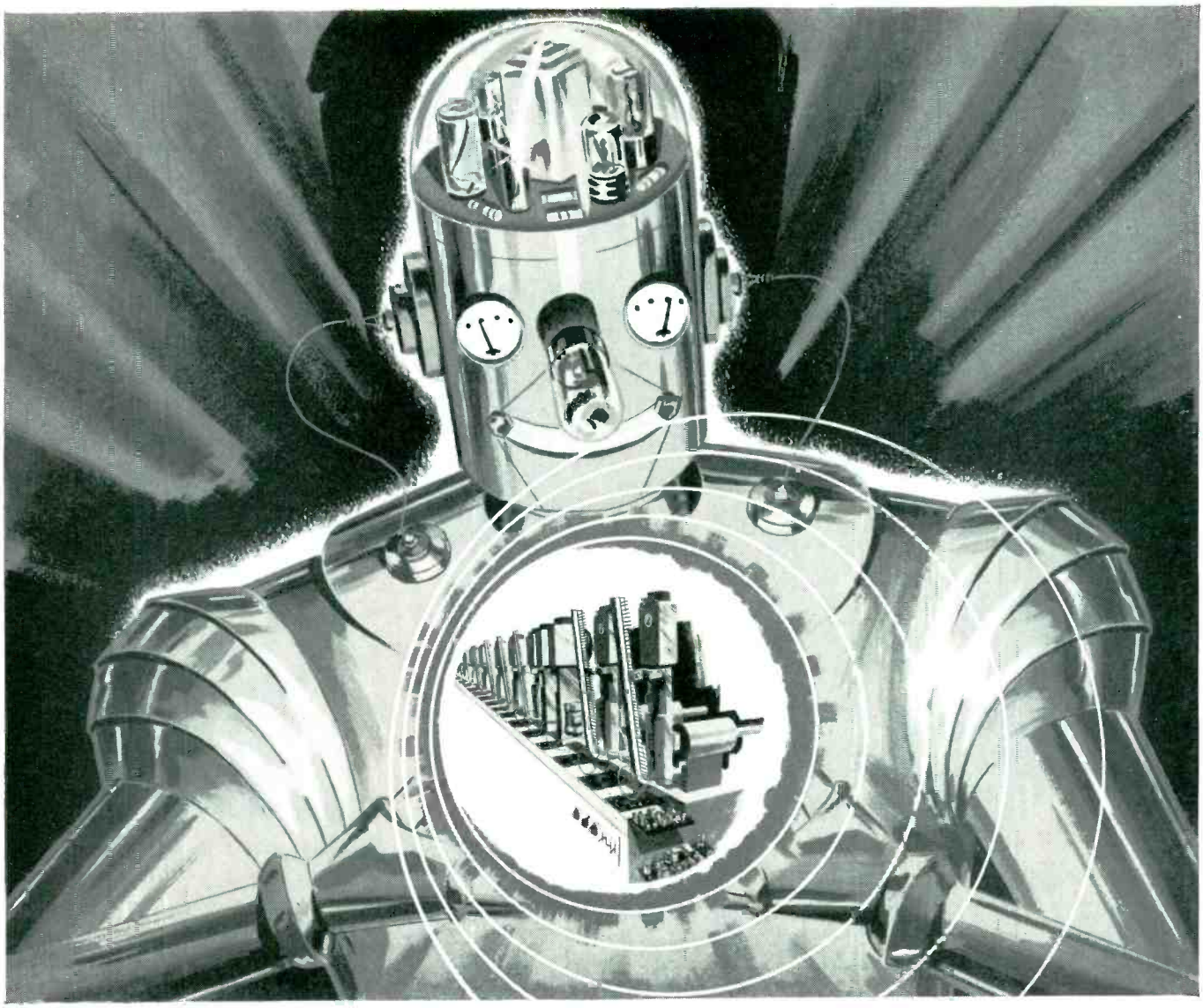
A HAND-OPERATED tool in Tung-Sol's Bloomfield, N. J. plant automatically shaves off the excess coating from the sides of flat cathode sleeves so that coating thicknesses on the opposite sides will be equal to within 0.0004 inch. With



Method of dropping cathode into centering slots



Bringing down handle of cathode shaver to push cathode through shaving dies. Compressed air line in foreground cleans die after each operation



Everybody *talks* about AUTOMATION...

Admiral® *has it!*

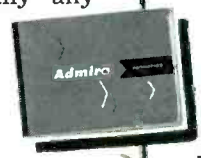
Automation, at Admiral, is an established fact . . . fully proved-in-practice on a wholly automatic assembly line which for many months has been producing electronic assemblies at rates up to 5,000 per day.

The importance of automation to the production of military electronic equipment cannot be over-stated. For one thing, automation substantially reduces unit costs . . . makes expendable items less expensive. Automation also guards against error and helps to maintain unwavering quality standards.

The automation equipment now in use was designed, developed and produced by Admiral's own engineering staff. Facilities are available for the production of electronic or electromechanical units in virtually any quantity, large or small. Address inquiries to:

Admiral Corporation
Government Laboratories Division, Chicago 47, Illinois

NOTE: COLOR SOUND FILM on Automation available for showing to technical or business groups. Film runs 9 minutes. Address requests to Public Relations Director, Admiral Corporation, Chicago 47, Ill.



Look to Admiral for

- RESEARCH
- DEVELOPMENT
- PRODUCTION

in the fields of:

COMMUNICATIONS, UHF and VHF, air-borne and ground.
MILITARY TELEVISION, receiving and transmitting, air-borne and ground.
RADAR, air-borne, ship and ground.
RADIAC • MISSILE GUIDANCE
TELEMETERING
CODERS and DECODERS
DISTANCE MEASURING
TEST EQUIPMENT

Send for Brochure . . . complete digest of Admiral's experience, equipment and facilities.

ENGINEERS! The wide scope of work in progress at Admiral creates challenging opportunities in the field of your choice. Write to Director of Engineering, Admiral Corporation, Chicago 47, Ill.

tweezers the operator inserts a cathode in such a way that the uncoated collars of the cathode are centered in fixed slots. A downward pull of the operating handle then pushes the cathode through the shaving dies and on down into a tray below. A foot-operated air valve is then pressed to clean the die in readiness for the next cathode.

Turntable Aids Inspection

Demonstrating use of chassis inspection turntable.

AT ONE inspection position in Hammarlund's New York City plant, each finished chassis in turn is placed on a heavy metal turntable mounted on the bench. The inspector can thus rotate the chassis easily for inspection from all sides as required.

Oil Damper Controls Wire Tension

A VANE ROTATING in a plastic pot half-filled with oil serves to control the tension of the fine gold-plated wire used on grid-winding lathes in Tung-Sol's Bloomfield, N. J. plant. The spool of wire is placed on the vertical vane shaft projecting up through the cover of the damper, then locked in position with a setscrew and locknut going into the end of the shaft. The degree of tension is changed by adding or removing oil to vary the depth of immersion of the four curved vanes mounted on the lower end of the shaft.

The plastic case is made from

when *Your* problems — are *Ours*

The Vitrohm Resistor illustrated above is equipped with ferrule terminals for insertion in fuse clips. It can be supplied for all National Electric Code standard diameters.

Other types of terminals and mountings are available to meet every requirement and condition of service.

WARD LEONARD ELECTRIC CO.
31 South Street
Mount Vernon, N. Y.

Resistor Specialists for More Than Thirty-Nine Years

WHEN you invite us to help decide the proper resistor for use in your equipment, the chances are good that you will save time and future expense. Make your resistor problems ours and you have the cheerfully-given advice which comes from more than 39 years' experience in the design and manufacture of Vitrohm Resistors.

It is surprising how frequently difficulties in space, mounting or heat dissipation are difficulties no longer when reference is made to the records of one of the more-than-a-million jobs turned out by Ward Leonard.

You have in Ward Leonard an auxiliary plant, modern, skilled in the development of new resistor requirements, speedy and accurate in production, and capable of meeting your production requirements, however large.

Meet and know the Ward Leonard Sales Engineer serving your territory. His knowledge of the industry in general, and control equipment in particular will interest you. Ward Leonard manufactures a wide variety of products* and operates in many divisions of the electrical industry.

* Vitrohm (vitreous enamelled) Resistors and Rheostats . . . . Voltage Regulators . . . . Theatre Dimmers . . . . A.C. and D.C. Motor Starters and Controllers . . . . Field Rheostats . . . . Arc and Spot Light Rheostats and Ballasts . . . . Mobile Color Lighting Equipment . . . . Adaptorans . . . . D.C. Battery Charging Equipment . . . . Circuit Breakers

68

April, 1930 — ELECTRONICS

⇦ APRIL *1930*

That's when this ad first appeared in ELECTRONICS.

We were already manufacturing control components to help solve customers' electrical problems. Made quite a point of what was then our 39 years' experience, and how it helped us meet specific customer requirements.

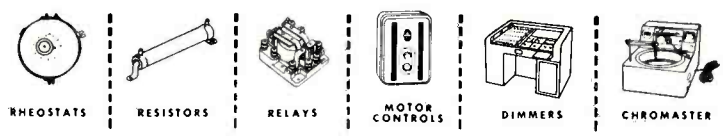
⇨ APRIL *1955*

That part of the Ward Leonard story is still true—only more so. We've got another quarter century's experience to draw on in manufacturing or recommending the resistor, relay, rheostat or motor control you need.

We've also got new, improved products to offer you—new manufacturing methods and controls to insure their accurate, uniform, reliable performance. Details on this part of the Ward Leonard story are yours for the asking. Write Ward Leonard Electric Co., 123 South St., Mount Vernon, N. Y.

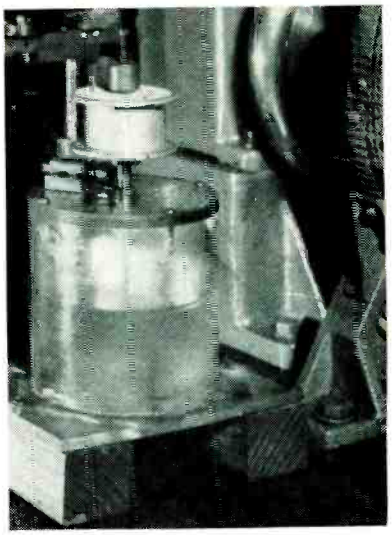
5.26

WARD LEONARD ELECTRIC COMPANY
MOUNT VERNON, NEW YORK



Result-Engineered Controls Since 1892

ELECTRONICS Charter-Year Advertiser



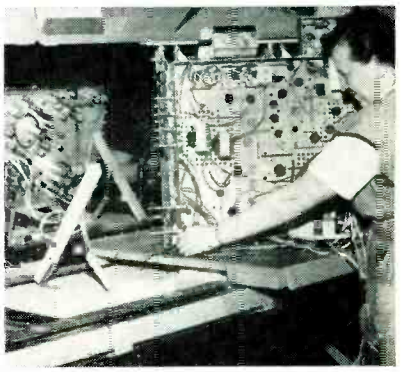
Wire tensioner mounted alongside grid-winding machine

Lucite, the base plate being cemented to the wall cylinder with acetone cement. The transparent plastic shows the oil level and vane action at all times.

A clamping lever on the cover serves to lock the reel in position so that the springy wire cannot unwind while a mechanic is working on the machine. The oil that is used is carefully selected so as to have a viscosity that remains constant despite temperature changes, as required for optimum performance of critical grid-winding machines.

Prop on Pallet Supports Chassis at Angle

AFTER PRELIMINARY assembly work on a color tv chassis in the Westinghouse Metuchen, N. J. plant, the chassis is slid onto a specially de-



As empty pallet emerges from under table, operator flips up prop and then slides chassis onto pallet.

HERE'S WHY . . .

The Magnetics, Inc. "Performance-Guarantee" on molybdenum permalloy Powder Cores is a revolutionary concept in the communications and electronics industries, and opens the way to substantial savings in your production and assembly operations. The guarantee of performance *to your specifications* is your assurance that these Powder Cores are standardized to meet your circuit requirements.

These Performance-Guaranteed Powder Cores cost no more—indeed, despite the fact that you have a guarantee of performance, they are sold at prices standard in the industry. You can't afford not to investigate Magnetics, Inc. molybdenum permalloy Powder Cores.

Keep in Mind These Advantages of Powder Cores . . .

1. Low hysteresis and eddy current losses;
2. High electrical resistivity;
3. Constant permeability over widely varying flux densities;
4. Magnetic stability with dc magnetization.

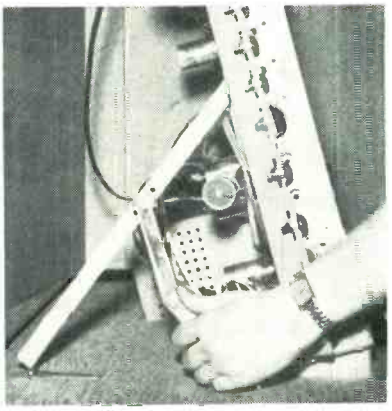
WANT THE COMPLETE STORY? . . .

Write us . . . on your company letterhead . . . we'll be delighted to send you literature, delighted to answer specific questions. No obligation, of course. . . .

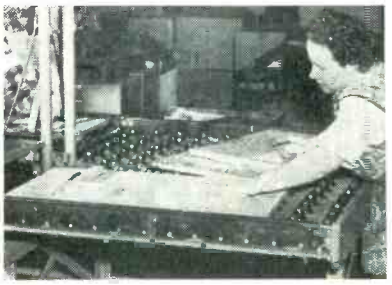
*Manufactured under a license agreement with Western Electric Co.

MAGNETICS inc.

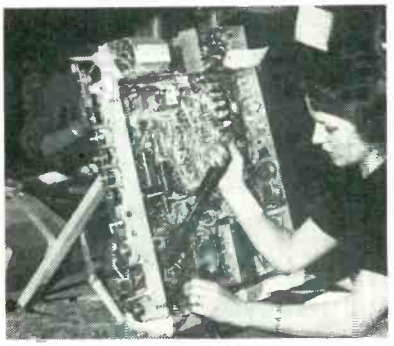
DEPT. E-13 BUTLER, PENNSYLVANIA



Chassis in position on pallet



Feeding empty pallet into conveyor line after removal of finished color tv chassis. Pallet then travels under steel-topped worktable on which chassis assembly is started



Assembly position on line

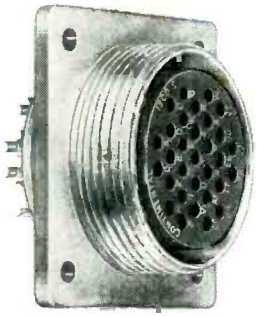
signed wood pallet for easy movement along the roller-conveyor production line. A hinged wood prop on the pallet holds the chassis at a convenient working angle as it rests on positioning blocks screwed to the front edge of the pallet.

The roller conveyor runs under the metal-top table, and serves to bring empty pallets to the transfer position. Hinging of the prop permits folding it flat onto the pallet for passage under the table.

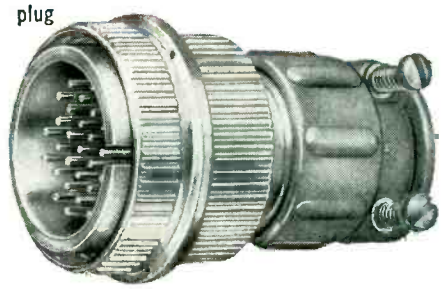
Jack-Wiring Jig

TO FACILITATE wiring test jacks that are to be mounted directly on the metal cabinet for one of the

new...precision Continental Connectors



receptacle

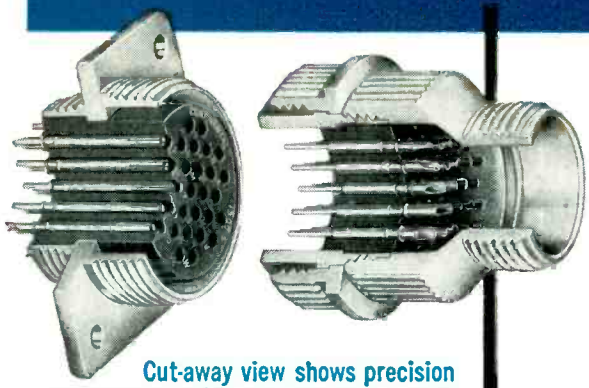


plug

cable clamp

ACTUAL SIZE

miniature AN-type



Cut-away view shows precision construction of Continental Series 1300

CONTACTS FOR #20 AWG WIRE

NO. OF CONTACTS	SHELL SIZE
4 and 5	9/16 -24
15, 19, 27 and 31	1 3/16 -18

If you have been looking for a dependable, miniaturized version of the popular A N-type connector, then consider this new Continental Connector Series 1300.

Two small shell sizes accommodate several contact arrangements. The shells are precision machined aluminum, threaded for use with conventional cable clamps. Brass pin contacts and spring temper phosphor bronze female contacts are gold plated for easier soldering — pre-tinning of solder cups is unnecessary. Each contact is individually floating, to assure self-alignment and reduced engagement forces.

One-piece molded inserts prevent moisture traps and possible electrical breakdown. They can be interchanged between the plug and receptacle shells for greater versatility. Our standard molding compound is Mineral filled Melamine (MIL-P-14D, Type MME). However, other compounds are available on order.

Write to our sales engineering department for technical data on the Series 1300, PLUS other special designs and circuit applications requiring the use of sub-miniature, printed circuit, hermetic seal, pressurized, high voltage or power connectors.

JUST OFF THE PRESS!

98-page technical catalog for engineers, purchasing executives and engineering libraries. Gives detailed specifications on Continental precision connectors. Request a free copy on your company letterhead, indicating your name and title.

Electronic Sales Division **DeJUR**

DeJUR-Amsco Corporation, 45-01 Northern Boulevard, Long Island City, 1, N. Y.

ELECTRONICS Charter-Year Advertiser

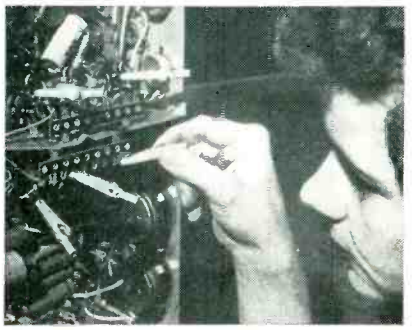
Want more information? Use post card on last page.

Appearance of jacks on jig when wiring is completed

electronic control units of the Matador guided missile, a jig is used to provide a temporary support for the four jacks during wiring at the Baltimore plant of The Glenn L. Martin Co. The jig fits snugly just inside the housing, so that the jacks project above the top of the housing when inserted. Identifying nomenclature is printed on the jig just as on the housing.

When wiring to the cable has been completed, the jacks are lifted out, the jig removed, and the jacks then mounted conventionally inside the housing.

Yellow Alligator Clips Identify Terminals



AS A COLOR TELEVISION receiver chassis moves past assembly-line inspection stations in the Westinghouse Metuchen, N. J. plant, yellow alligator clips are attached to any points that will require further checking. The clips are painted a bright yellow to stand out from among the wires and parts in the chassis. At final test stations, the clips are removed one by one as the circuits receive final checks.

Americans Are Rolling Up Their Sleeves!

YES, ALL KINDS OF PEOPLE ARE GIVING BLOOD SO THAT OUR WOUNDED MAY LIVE!

● Today, the blood of a Boston bookkeeper may be flowing through the veins of a wounded kid from a Kansas farm . . . the blood of a pretty Southern housewife may have saved the life of a grizzled leatherneck. For, blood is blood, a God-given miracle for which there is no substitute . . . and when a man's life hangs in the balance and blood is needed, there is nothing else to take its place!

Right now the need for blood is urgent. In hospitals —at home and overseas— many men require four and six transfusions during delicate operations. And the blood *must be there*—when it's needed. So give the most precious gift of all—*your* blood!

Be assured that giving blood is neither difficult nor distressing. And what a thrill there is in knowing that you've performed a really unselfish act! So call your local American Red Cross today and make an appointment. And tell your friends and neighbors about your experience. Let them share the wonderful feeling Americans get when they roll up their sleeves—and give blood.

But—

WHAT HAPPENED TO THAT PINT OF BLOOD YOU WERE GOING TO GIVE?

Call Your American Red Cross Today!

A PUBLIC SERVICE PROJECT · THE ADVERTISING COUNCIL · TENTH ANNIVERSARY

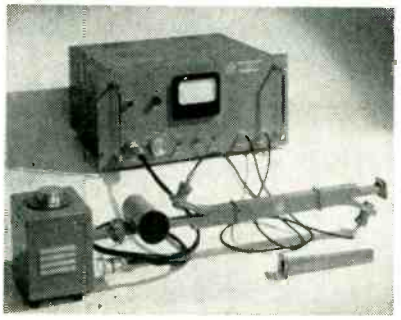
New Products

Edited by WILLIAM P. O'BRIEN

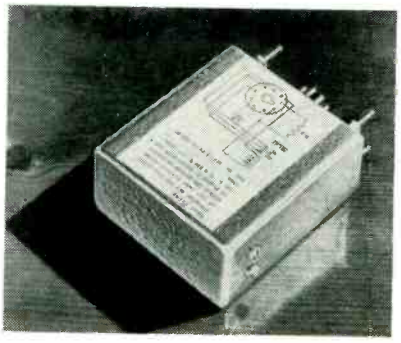
60 New Products and 50 Manufacturers' Bulletins Are Reviewed . . . Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered

MEASURING SYSTEM
indicates X-band vswr

COLOR TELEVISION INC., 935 E. San Carlos Ave., San Carlos, Calif. Model 110B X-band vswr measuring system has an added attenuation scale and new vswr scales reading from 1.02 to 1.20 and 1.1 to 2.50. The system includes a tunable oscillator permitting complete and continuous coverage from 8,500 to 9,600 mc, an accurate wavemeter to supplement the direct-reading dial of the oscillator, a bidirectional coupler with bolometer detectors for incident and reflected power and a direct-reading vswr indicator. Overall accuracy of the system—better than 2 percent—makes it ideal for laboratory measurements. The r-f power source is a V-260 klystron; wavemeter accuracy, ±0.08 percent; directivity of couplers, greater than 45 db; output waveguide fitting, UG-39/U; and overall length of waveguide assembly, 31¾ in.



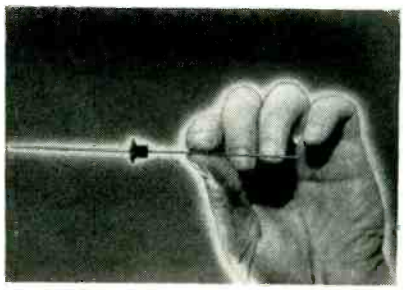
PLUG-IN CIRCUITS
for automation purposes



ASSEMBLY PRODUCTS INC., Chesterland, Ohio. Power supplies, load relays and automatic interrupters (all plug-in units) simplify the assembly of meter-relay controls. The 1817-2 load relay (illustrated) contains a 5-ma relay, 200-μf timing capacitor and limiting resistor. Connections are brought out to a 9-pin octal-type plug. The relay has a 12,000-ohm coil. It pulls in at 5 ma, releases at 1.5. Snap-action contacts are conservatively rated 5 amperes, 115 v a-c resistive, spdt. The 200-μf capacitor, when connected across the coil, gives 5-sec delay on release. Other plug-in units include power supplies, both single and double. There are several load relays in the series with coils for 6, 12, 24 and 75 v. One plug-in unit is a complete automatic interrupter with a period of about 5 sec. For further information send for bulletin G-6.

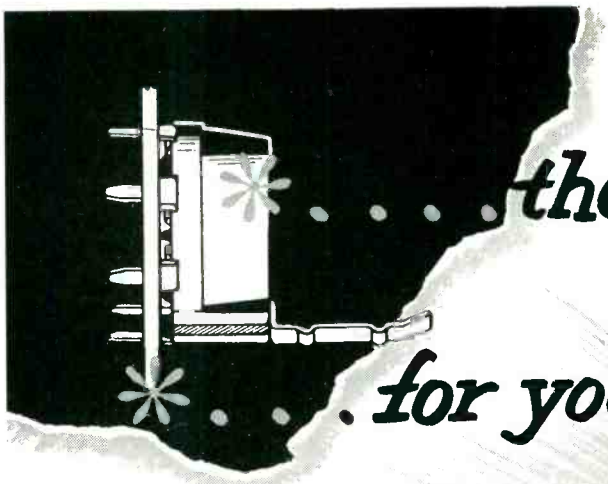
POWER RECTIFIERS
are h-v silicon type

BOGUE ELECTRIC MFG. CO., Paterson, N. J. The new high-current, high-voltage silicon power rectifier has an efficiency of approximately 99 percent and can operate in extremely high ambient temperatures. It occupies about ⅛ cu in., weighs about 0.1 oz, is of all-welded construction and is hermetically sealed. The unit's high efficiency is due to the low voltage drop and infinitesimal reverse leakage current (as low as 10^{-10} ampere). This silicon rectifier may be used without derating in ambient temperatures of 100 C and higher. The many types in production are rated from 100 to 500 ma. Rectification ratios run as high as 10^8. The forward voltage drops average 1.5 v at 200 ma. Versatility of the silicon power rectifier and its other characteristics make it ideally suited for aircraft and guided-missile requirements.



PLUG-IN DELAY LINES
available in a wide variety

THE JACOBS INSTRUMENT CO., Bethesda 14, Md., has available a wide variety (186 types) of plug-in delay lines called Pluglines. These are intended for 3 general applications: (a) for use in electronic



. . . the efficient socket . . . for your printed-circuit

Sylvania Printed-Circuit Sockets

7-pin and 9-pin sockets now available

. . . for more efficient *printed-circuit* design

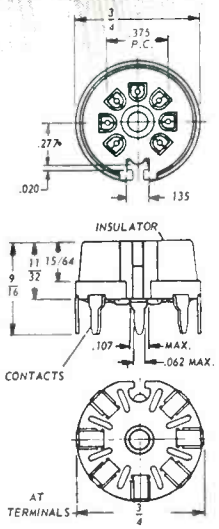
Contacts fit through smaller holes in the circuit board, providing more space and greater freedom in design of circuitry. Circuits can be arranged for shorter conductor paths and greater compactness, including cross circuits between contacts.

. . . for more efficient *printed-circuit* production

Sockets lend themselves to automatic socket-to-board assembly techniques. Tube shield ground strap location keys the socket for positive orientation. Strap retains and grounds the tube shield. Sockets are supplied with ground strap loose, eliminating the need to stock two production assemblies.

. . . for more efficient *printed-circuit* performance

Sylvania's printed circuit socket, provided with an all-molded insulator, eliminates moisture traps, offers higher insulation qualities and superior contact characteristics. Top surface installation allows greater heat dissipation.



INSULATOR:
General Purpose or Low Loss Phenolic

CONTACTS:
Brass, Cadmium plated

TUBE SHIELD GROUND STRAP:
Brass, Cadmium plated

Sylvania manufactures a complete line of high quality sockets, terminal strips, and other electronic components. Write for the complete catalog. Address literature or quotation requests to Department D20S.

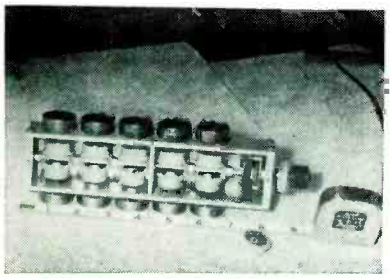
SYLVANIA

LIGHTING • RADIO • ELECTRONICS • TELEVISION • ATOMIC ENERGY

Sylvania Electric Products Inc.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd.,
University Tower Bldg.,
St. Catherine Street, Montreal, P.Q.

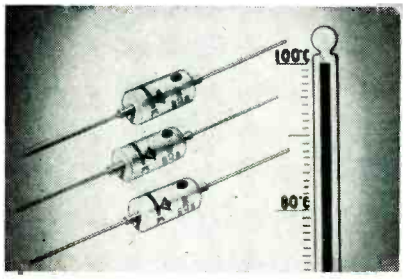
equipment where a delay line which can be easily replaced is desired, or where it is desirable to be able to change the value of a delay (or a characteristic impedance) by removing one line and plugging in another; (b) for lab use; (c) for prototype construction. The Pluglines are cylindrical in shape, and have an o-d of 1⅛ in. They are offered in 2 versions. The capped (C) version has an octal plug at one end and a solid cap at the other. Input and output connections are obtained through the plug pins. The socket (S) version has an octal plug at one end, and an octal socket at the other.

MAGNETIC CLUTCHES
have wide applications



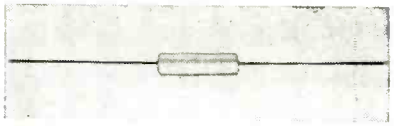
ELECTRONIC MANUFACTURING ENGINEERS Co., 2410 Beacon Ave., Seattle 44, Wash. The 500 series miniature gear drive magnetic clutches feature: low-cost multiple clutching, precision construction, high performance, ease of operation and only two moving parts. The clutch assembly weighs less than 1 oz, can be supplied to operate at voltages from 6 to 30 d-c or rectified a-c with under 1-w power consumption. The clutch transmits from less than 1 in. oz to over 15 in. oz from engagement to disengagement. Differential drives, computers, guided missiles, multiple servo drives and multiple positioning are some of the generalized applications. Clutches are also supplied as chassis assemblies to specification.

GERMANIUM DIODES
for 100 C operation



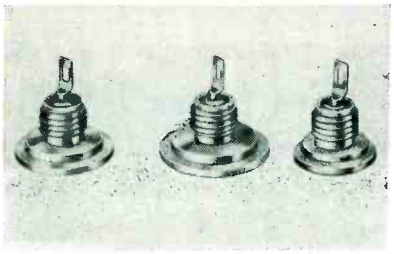
INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif., has available three new, high-temperature germanium diodes for operation over an ambient temperature range from −60 C to +100 C. All are rated and tested at 25 C and at temperatures above 75 C. They are RETMA registered as types 1N265, 1N266 and 1N267. Typifying their high temperature characteristics are the ratings of the 1N267 diode at 85 C: 4.0 ma minimum at +1 v, 0.040 ma maximum at −10 v, 20 v d-c maximum allowable inverse voltage. Designed for clip-in or solder-in application, these diodes measure 0.230 in. in diameter and 0.470 in. in length. For complete information write for bulletin ER-191A.

CAPACITORS
are tiny Mylar dielectrics



FILM CAPACITORS, INC., 3400 Park Ave., New York, N. Y., are now producing miniature Mylar dielectric capacitors housed in ceramic jackets with thermosetting plastic end fill. These capacitors are specially impregnated to minimize temperature coefficient. The insulation resistance is maintained under the most severe conditions of temperature and humidity.

SEALED TERMINALS
for tubular components



ELECTRICAL INDUSTRIES, 44 Summer Ave., Newark 4, N. J., is producing a new line of hermetically sealed terminals for tubular components. Designed for use on capacitors and similar components, the terminals feature threaded barrels. Three standard types are available—flared tubing types, lug types and grooved flange types. They offer very rugged construction that withstands pressure changes, shock and vibration. No special skill is required to apply the seal and assembly is rapid as all metal parts are tin dipped for easy soldering. In addition to standard types, special constructions and diameters can be supplied or order.

DECADE SCALER
measures radioactivity

NUCLEAR-CHICAGO, 229 W. Erie St., Chicago 10, Ill. Designed for use

ELECTRO TEC SLIP RING ASSEMBLIES

HIGH TEMP PLASTIC!

NEW ETC-7 (POLYESTER RESIN) USED ON ILLUSTRATED PART FOR HIGH TEMPERATURE OPERATION

—for high temp applications!

HARD GOLD RINGS!

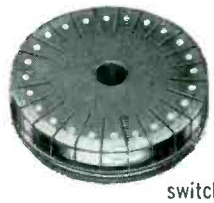
24 KT. SOLID GOLD RINGS — ENTIRE RING THICKNESS ELECTRODEPOSITED UNIFORM HARDNESS, 90 to 100 BRINELL.*

COURTESY LEAR, INC.
— these two features were incorporated in the assembly illustrated above, having 45 rings, dia. .180", ring width .020", barrier width .010". Overall length, less leads 1.763".

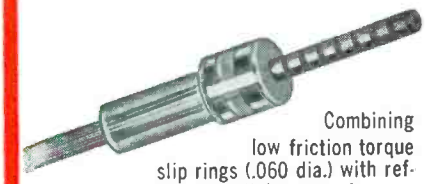
Electro Tec Corp., in its constant endeavor to keep pace with the most exacting requirements, has developed these new processes and products. They provide flawless performance under conditions far exceeding the capabilities of other types of construction. Where high temperature is involved, the superiority of these assemblies is so marked, that acceptance has been industry-wide. At the same time, an increasing number of users are specifying these assemblies for the ultimate in dependability under normal operating conditions. Inquiries will receive prompt attention; no obligation.

← 72 rings on integral support — no accumulated tolerances — fulfills electrical, minimum weight and space requirements.

Dual purpose assembly combining "V" grooved signal circuits and wide power rings.

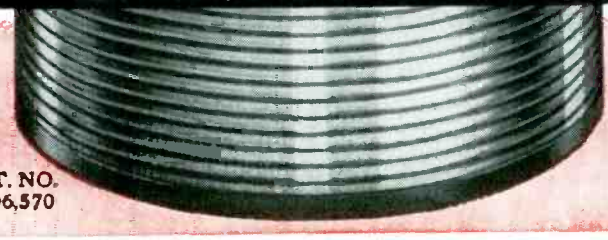


Miniature high speed sampling switch — 24 channels.



Combining low friction torque slip rings (.060 dia.) with reference switch segments.

NEW ETC-7 (POLYESTER RESIN) WITHSTANDS TEMPERATURE RANGE FROM —60° to +500°F.

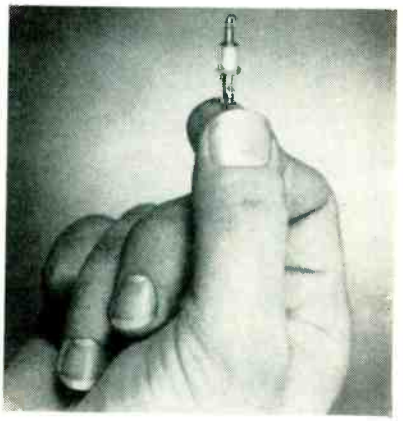


*PAT. NO. 2,696,570

PRODUCTS OF PRECISION CRAFTSMANSHIP BY A NEW AND REVOLUTIONARY PROCESS

ELECTRO TEC CORP.
SOUTH HACKENSACK, NEW JERSEY

with G-M or scintillation detectors, the new model 181 decade scaler has 5-μsec resolving time permitting extremely precise measurements of radioactivity. Three 5-μsec decade circuits and a built-in register are used in determining total number of counts recorded during a specific time interval. A scale selector switch permits a choice of scaling factors of 10, 100 or 1,000. A 60-cycle test signal is provided to check proper operation of the plug-in decades and a single lever resets register and scaling stages after a count is completed. High-voltage supply for the detector is continuously variable from 400 to 3,000 v and will deliver 100 μa at 3,000 v. Low power dissipation, minimum number of tube types and reliably rated circuit components provide long operational life.



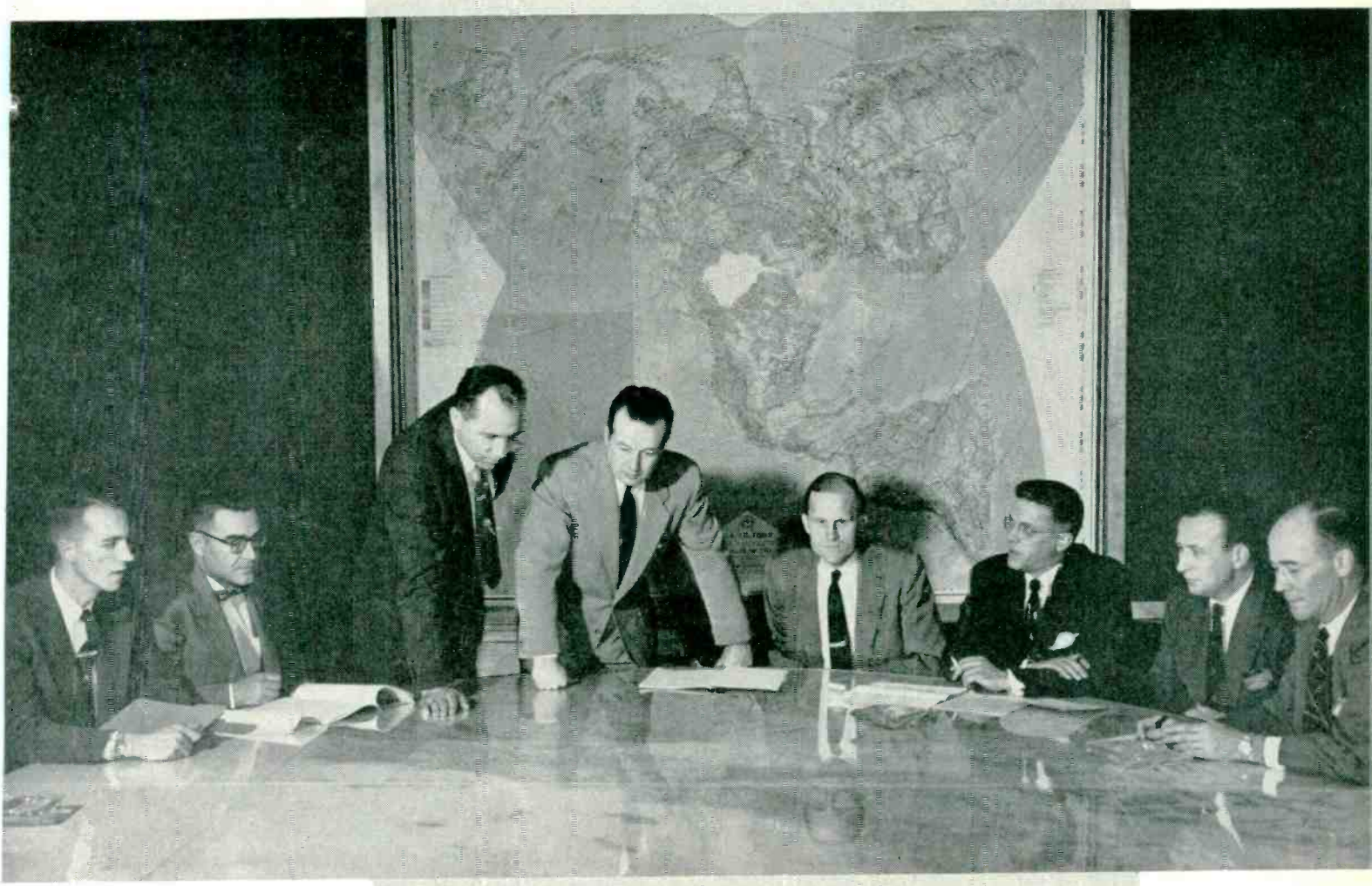
NYLON JACKET
for interlock plugs

HARVEY HUBBELL, INC., Bridgeport 2, Conn. A new nylon jacket for interlock type B plugs now makes them completely shock-proof and short-proof. Covering the entire exposed area of the plug, except for contact points, this insulation permits plugging in or disconnecting of the plug with absolute safety. For heavily concentrated wiring where interlock plugs are frequently used, the jacket prevents shorting if plugs should make accidental contact. This protection is particularly necessary when plugs are used to set up problems in computing machines where accurate results are vital. Interlock type B plugs have a current capa-

MISSILE SYSTEMS

Research and Development

Physicists and engineers at Lockheed Missile Systems Division are engaged in a group effort covering virtually every field of science.



Missile Systems Division scientists and engineers discuss a new missile systems concept in light of tactical requirements. Left to right: Dr. H. H. Hall, nuclear physicist; I. H. Culver, system development division engineer; Dr. R. J. Havens, research scientist; W. M. Hawkins, chief engineer; Dr. Ernst H. Krause, nuclear physicist and director of research laboratories; S. W. Burriss, experimental operations division engineer; Ralph H. Miner, staff engineering division engineer; and Dr. Eric Durand, nuclear physicist.

Continuing developments are creating new positions for those capable of significant contributions to the technology of guided missiles.

Lockheed MISSILE SYSTEMS DIVISION

research and engineering staff

LOCKHEED AIRCRAFT CORPORATION • VAN NUYS, CALIFORNIA

city of 5 amperes, dielectric strength of 1,000 v and contact pressure of 10 oz.

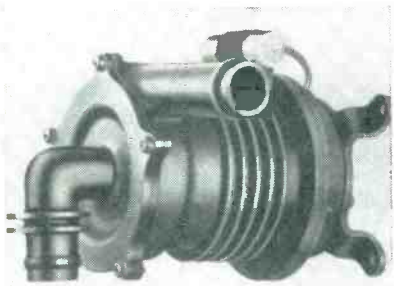
CONTINUITY METER
tests intricate circuits

AMELCO, INC., 2040 Colorado Ave., Santa Monica, Calif., has developed a low-voltage meter for testing intricate circuits in order to speed up continuity testing and locating of shorts. It is simple to use and saves time and material. The new low ohm safety meter will not damage delicate component or expensive meters. It differentiates between legs of high current filament circuits and will also indicate sources of trouble in switches, relay contacts and connectors. The safety meter will locate incomplete electrical bonding and detect unsoldered and cold-soldered connections. It completely eliminates the possibility of a good continuity indication through a misconnected part. The company plans to sell these direct to electronic manufacturers at $75.00 with a full performance guarantee.

BUSHING
is hermetically sealed

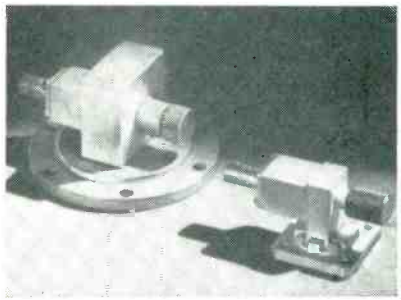
HELDOR MFG. CORP., 238 Lewis St., Paterson, N. J., has announced a

new rivet-type, hermetic seal bushing which meets MIL-T-27 specifications and conforms to the MIL-T-27 twist test. This new and improved terminal was engineered to provide a superior terminal which will not develop cracks or leaks and which will make possible space conservation for capacitor manufacturers. Its insulation resistance at 45-percent relative humidity at sea level is over 500,000 megohms. These new bushings are available in 5 standard styles or can be modified to meet the customer's requirements.



MINIATURE BLOWER
is a high-pressure unit

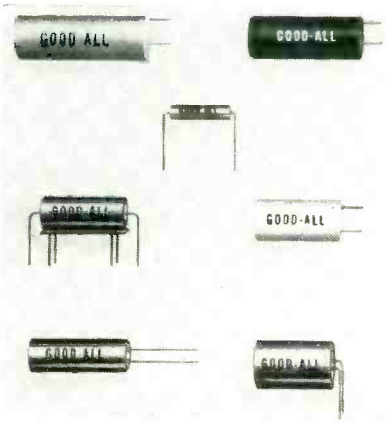
ROTRON MFG. Co., Schoonmaker Lane, Woodstock, N. Y. Model R type 201 high-pressure miniature blower is specially designed for cooling a gyrator in a pressurized waveguide system. It is part of a new line of model R single-stage radial blowers with high pressure-to-volume ratios. The blower moves 7 cu ft per min against 6 in. w-c. It is available either 1 or 3 phase, 400 cps. Total weight is less than 2 lb.



CRYSTAL MOUNTS
used as microwave mixers

COMMERCIAL PRODUCTS, DIV. OF AIRCRAFT ARMAMENTS, INC., 4003

Seven Mile Lane, Baltimore 8, Md. Models 497C and 497K microwave mixer crystal mounts operate without tuning over the 5.4 to 5.9 and 15.75 to 17.25 kmc ranges, respectively. The crystal mounts are useful as mixers and also as video detectors. These mounts have single-ended output for operation into 400 ohms, nominally. Output capacitance is about 13 $\mu\mu$f. High detection efficiency is afforded because the crystal effectively terminates the waveguide to present a low vswr over the operating range. Neither an attenuator nor an absorption termination is necessary to maintain the low vswr.

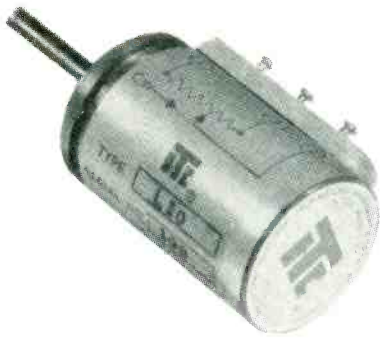


CAPACITORS
for printed circuit uses

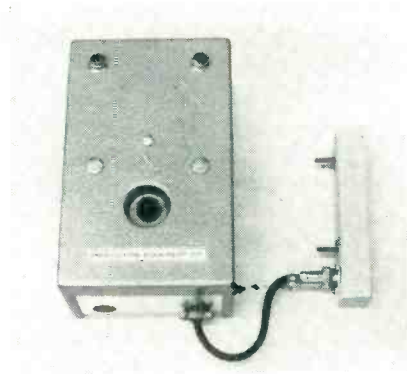
GOOD-ALL ELECTRIC MFG. CO., Ogallala, Nebraska, has developed a new line of capacitors designed for printed circuit applications. The miniature capacitors are available with paper or Mylar dielectric in hermetically sealed ceramic tubular, plastic impregnated paper, phenolic, metal, or metal-paper laminated enclosures. They are designed to eliminate costly pull-outs and for maximum adaptability to most printed circuit production. Laboratory tests and field use have eliminated the cause for solder shorts and most problems connected with vibration.

POTENTIOMETER
is 10-turn type

TECHNOLOGY INSTRUMENT CORP., 531 Main St., Acton, Mass., has available a miniature 10-turn precision potentiometer featuring



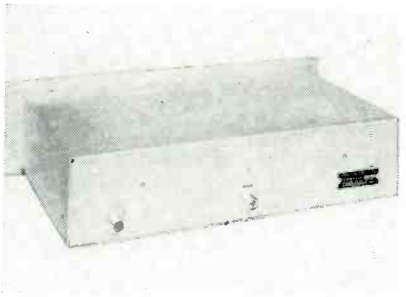
linearity of 0.05 percent standard and 0.025 percent as a special tolerance where required. Overall length of the L10S is 1⅜ in. from front mounting surface. High resolution, low torque, long life and stability under environmental conditions meet military specifications. The synchro mounting provides precision positioning. Resistance range is 1,000 ohms to 100,000 ohms, with a tolerance of ±5 percent; ±0.05 percent on special order. Ambient temperature range is −55 C to +125 C. Power rating is 5 w at 40 C, derated to zero at 130 C. Maximum starting torque is 0.75 in. oz at 20 C; and running torque is 0.60 in. oz.



INDUCTION RELAY
is rugged and versatile

PRODUCTION EQUIPMENT Co., 111 Ortega Ave., Mountain View, Calif. Featuring rugged construction and versatility this relay is intended primarily for material flow control or counting operations. The inductance coil pickup will detect light weight steel objects as small as beverage bottle caps at speeds up to 250 per minute. Sensitivity is adjustable up to a 1-in. gap between coil and metal. Flow con-

trol is obtained with a built-in time delay so that objects moving past the detector coil will not operate the relay. When flow stops, there is a short time delay; then the relay operates. The pickup coil will operate under extreme conditions and may be remotely situated. Mounting is facilitated by plug connection between case and backplate.



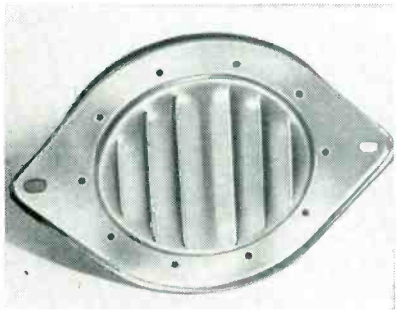
LOW-PASS FILTERS
for tv broadcasters

ALLEN B. DUMONT LABORATORIES, INC., 1500 Main Ave., Clifton, N. J., has announced a video low-pass filter which assures tv broadcasters that video signals being fed to a tv transmitter meet certain technical requirements of the FCC. Type 5397-A video low-pass filter is inserted into the video feed to a tv transmitter. It provides phase-corrected attenuation of all video information above 4.75 mc as required by part of FCC regulation 3.687 (a) (3). It also provides envelope delay correction of the video signal so as to satisfy envelope delay requirements as set forth in FCC regulation 3.687(a) (5). The filter is a passive network mounted on a front mounting panel. It weighs 5 lb and is 5¼ in. high, 19 in. wide and 11 in. deep.

DIGITAL VOLTMETER
is self-balancing unit

NON-LINEAR SYSTEMS, Del Mar, Calif. Model 419 digital voltmeter

is a self-balancing, digital potentiometer for measuring d-c voltages from 0.001 to 999.9 v. Maximum error is less than 0.1 percent of the applied voltage. Resolution is 0.001 v in low range. The instrument makes an average of 100 zero-to-full-scale readings per minute, with automatic indication of polarity and decimal position. The measured voltages are displayed as a single, horizontal line of 4 illuminated numerals and polarity sign 1 in. high, with the decimal point positioned automatically. An internal 1.018 v d-c Weston standard cell is switched manually into the input circuit for calibration adjustment. A direct and functional application of the principles and advantages of etched circuitry contributes to the compactness and sturdy design of the instrument. All major assemblies are plugged into connectors on the chassis.

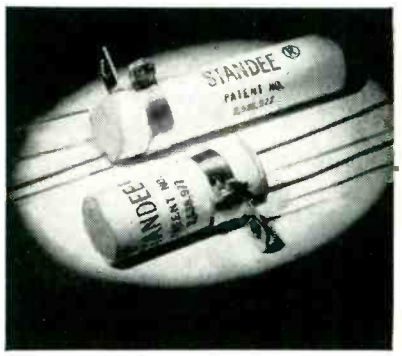


LOUDSPEAKER
is the electrostatic type

KINGDOM PRODUCTS LTD., 23 Park Place, New York 7, N. Y. The SKL 100 electrostatic h-f loudspeaker was developed to meet the need for a low-cost reproducer of the tweeter class. It requires a bias d-c voltage to stress the dielectric which is then modulated by the a-c signal. Maximum d-c bias should not exceed 300 v. To maintain minimum distortion, particularly at lower frequencies, the ratio of a-c (rms) to d-c bias voltage should be below 0.25. Inherent in the design of this type of loudspeaker is the limited mechanical displacement of the dielectric acting as the diaphragm. This tends to establish a limit to the l-f response. Signals below 5,000 cps entering the loudspeaker must be by-passed with an efficient filter network. Circuits are

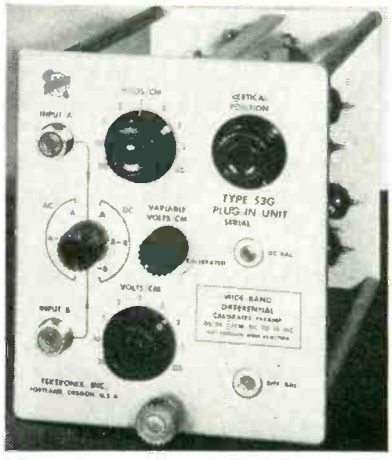
For additional information on all items on this page, use post card on last page.

shown on a single page bulletin now available.



POWER RESISTOR
are above-chassis-mounted

CLAROSTAT MFG. CO., INC., Dover, N. H. Standee or above-chassis-mounted power resistors are now further simplified by the adaptation of wire leads, when preferred to solder-lug terminals. These components feature a resistance element wound on a glass fiber core inserted and sealed in a ceramic tube. The Standee resistor protrudes above the chassis for maximum heat dissipation while hot terminals are accessible below the chassis. These resistors are available in 10, 15, 20, 25 and 30-w ratings, and in resistance values up to 6,000, 9,000, 12,000, 15,000 and 20,000 ohms respectively. Intermediate taps can be provided.



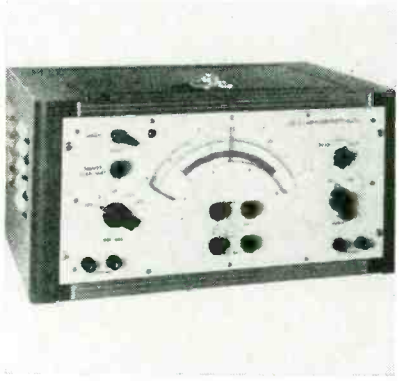
PREAMPLIFIER
is wide-band, plug-in type

TEKTRONIX, INC., P. O. Box 831, Portland 7, Oregon. Type 53G differential wide-band d-c preamplifier features d-c to 10-mc fre-

quency response, 0.035-μsec rise time. Sensitivity is 0.05 v per cm to 20 v per cm in 8 calibrated steps; separate step attenuator for each input, with 80 db isolation. Sensitivity is continuously variable from 0.05 v per cm to 50 v per cm. Common-mode rejection is better than 100 to 1 for the entire passband at full gain; better than 300 to 1 at 60 cycles. Weight is 4½ lb. Price is $175.

POTENTIOMETERS
of the multiturn type

TECHNOLOGY INSTRUMENT CORP., Acton, Mass. Three noteworthy changes in type M10T multiturn potentiometers have been announced. Now available are 10-turn precision potentiometers with linearity of 0.025 percent standard, 0.01 percent special. Resistance range is 100 ohms to 500,000 ohms. Prices are substantially reduced. Write for the new M10T brochure.



DEVIATION BRIDGE
for precision inspection

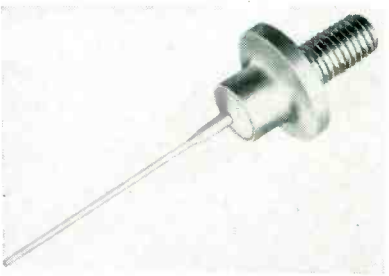
BARNES DEVELOPMENT CO., 213 W. Baltimore Pike, Lansdowne, Pa., has announced a new deviation bridge which compares the resistance of a sample resistor to that of a standard resistor of the same nominal value and indicates the deviation of the sample from the standard in percent of nominal value. It operates on a null-balance principle, which makes the readings of equal accuracy at all points on the scale, and readings are independent of bridge voltage variation. It can be used as a resistance comparator and as monitor. Bulletin 38B contains infor-

For additional information on all items on this page, use post card on last page.

mation on construction, specifications and sorting mechanisms.

VARIABLE CAPACITOR
for transistor receivers

RADIO CONDENSER CO., Camden 3, N. J., has announced a new miniature variable capacitor especially designed for transistorized radio receivers. It includes two variable sections, oscillator and radio frequency, both nested in a formed aluminum frame with trimmers on the bottom. The rotor shaft is available with pulleys, flats, knurls or slots. Presently available for application in all transistor type radio receivers, it can be further modified for automatic production if desired.



POWER RECTIFIER
for 125 C operation

TRANSITRON ELECTRONICS CORP., Melrose 76, Mass., has available a group of silicon power rectifier capable of continuous operation at full rated power at an ambient temperature of 125 C. These new rectifiers overcome the basic disadvantage of selenium, germanium, and vacuum-tube types, and provide reliable operation under wide variations in ambient temperature. Their high forward conductance and extremely low leakage current allow operation at efficiencies up to 98 percent. Designed for conduction cooling, these rugged rectifiers provide major savings in both size and weight.

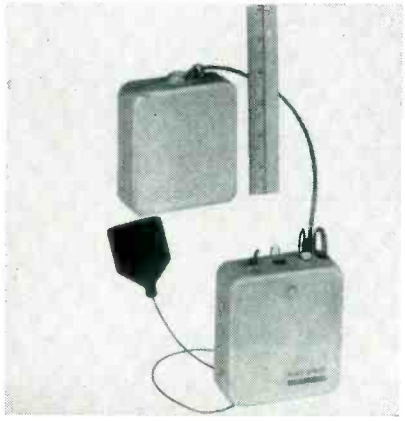
D-C RELAY
has no mechanical linkages

THE MERCOID CORP., 4201 Belmont Ave., Chicago 41, Ill. Series WM mercury switch d-c relay opens and

closes a load circuit from minute changes of voltage or current through a d-c coil. It incorporates a d-c electromagnet coil whose magnetic field directly actuates a magnetic mercury switch. It is available for spst operation only, with contacts either normally open or normally closed. Two models provide a choice of electrical contact (load) capacity with varying coil sensitivities. Coil operating voltages range from 2 to 230 v d-c only. The relays are designed to pick-up to 20 percent below minimum rated coil voltage. There are no mechanical linkages, no bearing points and no open contacts. Further information is contained in bulletin CA-11R.

D-C RELAY
is 32-pole series

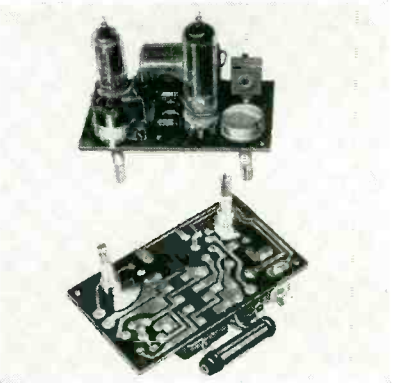
GUARDIAN ELECTRIC MFG. CO., Chicago 12, Ill., has available a 32-pole series 805 d-c relay. Originally designed as a group relay, it is capable of simultaneously connecting together 32 electrical circuits. Individual contact blades are molded in thermosetting phenolic for maximum strength, durability and heat resistance. All contacting members are completely enclosed in an aluminum cover, making the series 805 virtually dust-proof. The unit weighs slightly less than 5 oz. Complete operating data are included in the No. 11 relay catalog.



WIRELESS MICROPHONE
eliminates cables

PORT-O-VOX CORP., 521 W. 43rd St., N. Y., announces a new type of wireless microphone, employing 5 subminiature tubes in a pocket f-m

transmitter worn on the person. Final amplifier input power is 200 mw on a frequency of 27.51 mc. All components are subminiatures mounted on a phenolic printed circuit board. A companion f-m receiver employing 18 tubes feeds into p-a amplifiers or into recorders. A crystal calibrator is incorporated. Literature is available.

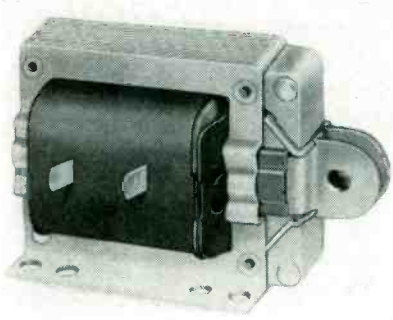


AUDIO AMPLIFIER
uses printed circuits

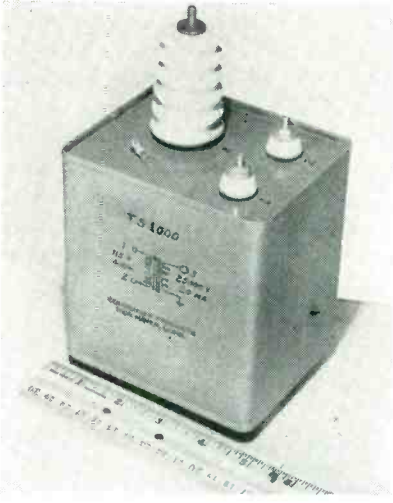
PHOTOCIRCUITS CORP., Glen Cove, N. Y. Only 2½ in. wide × 4⅛ in. long × 1¾ in. deep, exclusive of control shafts, this two-stage unit produces up to 2-w output, sufficient for many audio applications. It can be used as an amplifier by itself, or can be incorporated into equipment as a subassembly. The amplifier is a complete unit, including volume control and a tone control, except for an output transformer which is usually mounted on the loudspeaker. Frequency response is flat to 8,000 cycles. Input voltage required is 0.2 v. Power required at 115 v, a-c or d-c, is 24 w. A 12AT6 is used as a voltage amplifier driving a 50B5 power output tube. The power supply uses a selenium rectifier.

SOLENOID
is small and compact

DORMEYER INDUSTRIES, 3418 N. Milwaukee Ave., Chicago 41, Ill., has developed a compact solenoid for small equipment and components. Incorporating new positioning of double shading coil for high seated pull, the solenoid is a lightweight, powerful unit especially adapted to rugged duty. This solen-



oid is engineered to outlast the product in which it is installed. It will operate in any position and is regularly furnished for both constant and intermittent duty, 115-v, 60-cycle a-c. Blade terminals are standard, with flexible leads optional.

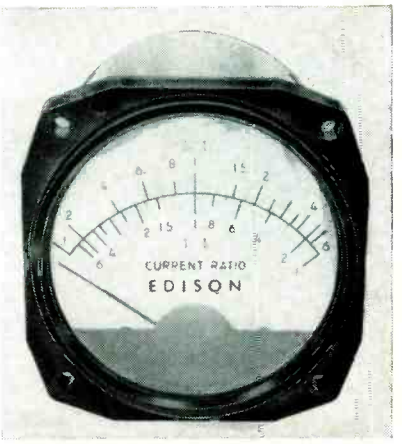


H-V TRANSFORMER
used in h-v test equipment

CONDENSER PRODUCTS CO., division of New Haven Clock & Watch Co., 140 Hamilton St., New Haven, Conn., has introduced a high-voltage oil-immersed transformer for use in a-c and h-v test equipment and power supplies. The transformers are made in both 60-cycle and 400-cycle types up to a 5-kva power level. The company impregnates these transformers with the conventional types of high dielectric strength transformer oils, as well as with silicone oil for high-temperature uses.

PANEL METER
measures ratio of 2 currents

THOMAS A. EDISON, INC., INSTRUMENT DIV., West Orange, N. J., is



producing a new panel meter to indicate the ratio of 2 direct currents. The instrument has a capacity to handle 50 ma in either coil and will accurately indicate a ratio on an input of 2 ma minimum. Scale tolerances are based on an angular tolerance of 1 deg. The movement uses a pair of fixed coils surrounding a small Alnico magnet attached to a pivoted pointer shaft. With equal current in both coils the pointer will indicate unity ratio (1). An increase in strength of one current over the other will pull the pointer right or left of center to indicate a ratio.

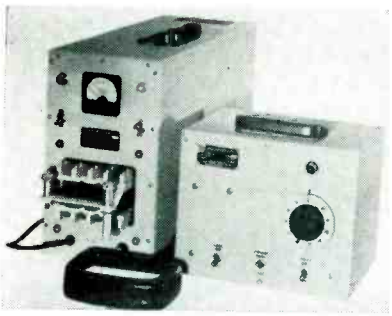
H-V POWER SUPPLY has calibrated controls

JOHN FLUKE MFG. CO., INC., 1111 W. Nickerson St., Seattle 99, Wash. Model 400BDA is an extremely stable calibrated power supply with a range of 500 to 5,000 v at 0 to 1 ma. Polarity of output is instantly reversible, positive or negative with respect to chassis, via polarity switch located on front panel. Regulation is better than 0.01 percent from no load to full load and better than 0.01 percent for line voltage changes from 105 to 130 v. Long term stability is 0.05 percent with short term stability of 0.005 per-

cent. Calibrated controls accurate to better than 1 percent resolution of 50 mv at any setting. Output is noise free with no trace of corona, jitter or bounce. Residual ripple in either polarity under all conditions is less than 5 mv.

SSB FILTER
is torodial type

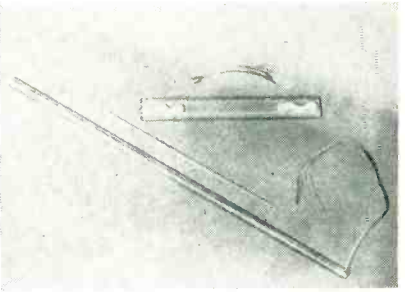
BARKER & WILLIAMSON, INC., 237 Fairfield Ave., Upper Darby, Pa. The design of a new single-sideband filter includes use of 8 stabilized torodial inductances and precision silver mica capacitors in an L-C type filter designed to pass the 17.0 to 20-kc. The filter amplitude characteristic is relatively flat for its 3-kc passband with sharp skirt selectivity on both sides. A receiving type, model 360, with an impedance value of 20,000 ohms for both input and output, permitting operational use as an interstage coupling device is available as standard. Model 361, for use in transmitting and receiving applications with balanced coupling windings of 500 ohms and/or 10,000 ohms, is available on special order.



DEMAGNETIZING UNIT
with built-in Variac

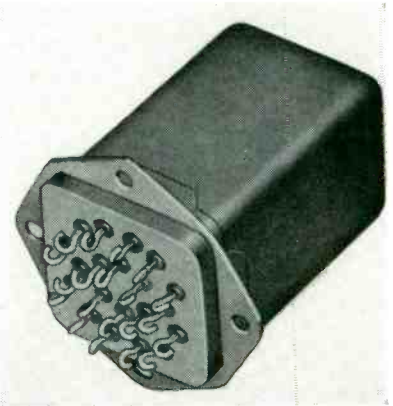
RADIO FREQUENCY LABORATORIES, INC., Powerville Road, Boonton, N. J. A portable demagnetizing unit, the model 889 Magnetreater, will quickly and accurately treat most types of electrical instrument magnets, including the new core type mechanisms. The prime function of the unit is its ability effectively to demagnetize saturated magnets to any desired level. A built-in Variac controls the demagnetizing current and provides a constant discharge rate of approxi-

mately 80 pulses per minute. Designed specifically for use with the model 107A magnet charger, the unit operates from a 110-v, 60-cycle outlet and is ready for use in seconds.



DISPLACEMENT PICKOFF
for industrial and military

CONTROL COMPONENTS Co., 1 Holden St., Brookline 46, Mass., announces a new, very long stroke shielded differential-transformer linear-motion displacement pickoff for the industrial and military control fields. The stroke range is 10 in.; ±5 in. about the null position. Pickoff is designed for use with 400-cps excitation voltage. The Linearsyn model 7S5 is designed with emphasis on resistance to shock and mechanical abuse. The moving core has been made shorter than the coil assembly. An output impedance of less than 2,000 ohms makes it possible to use the unit with relatively long cable runs in remote control applications.



SUBMINIATURE RELAY
is sealed 5-ampere type

GUARDIAN ELECTRIC MFG. Co., 1621 W. Walnut St., Chicago 12, Ill., announces its all-new 6-pole, double-throw, hermetically sealed, 5-

ampere subminiature series 2005 relay. The unit meets the requirements of military specifications MIL-R-6106-A, class A, and MIL-R-5757-B class A. Built to withstand 100-g shock and 10-g vibration, from 75 to 2,000 cps in all mounting planes, it has fine silver contacts to insure extremely low contact resistance. All contacts are rated at 5 amperes, 24 to 30 v, d-c, resistive load. High contact pressure in both energized and de-energized positions insures reliable operation at both low and maximum current ratings.

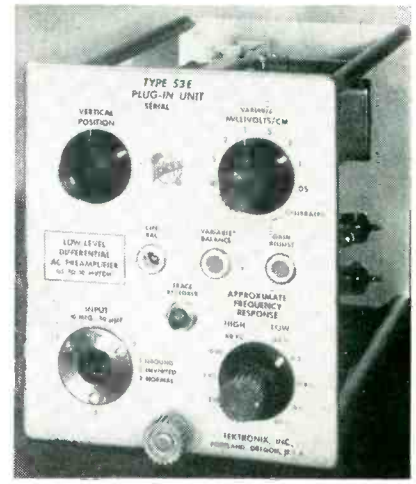
PULSE GENERATOR
is a millimicrosecond unit

TELETRONICS LABORATORY, INC., Westbury, N. Y. Model PG-215 is a mercury-relay plus pulse-forming-line type of generator producing rectangular waveforms having rise, duration and decay times in the milli-μsec range. Practically ideal rectangular pulses at 60 or 120 per sec recurrence rates are provided, with rise and decay times down to 1.2 milli-μsec. Minimum width is 1.2 milli-μsec, and maximum width is unlimited. Amplitude of the output pulse is variable from 0 to 35 v with a 93-ohm load. It also furnishes an isolated trigger signal, advanced in time with respect to the main pulse, for synchronizing associated equipment.

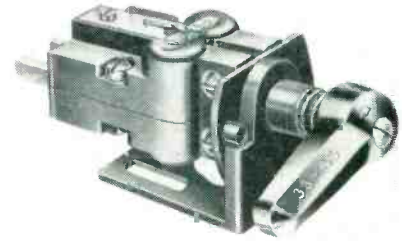
PREAMPLIFIER
is low-level differential type

TEKTRONIX, INC., P. O. Box 831, Portland 7, Oregon, announces type 53E low-level differential preamplifier with a sensitivity of 50 μv per cm to 10 mv per cm in eight cali-

For additional information on all items on this page, use post card on last page.



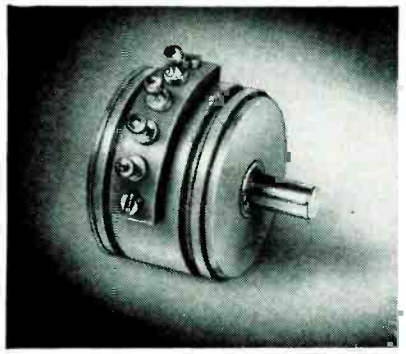
brated steps; continuously variable over the same range. Frequency is 0.06 cycle to 60 kc. Rejection ratio is 80,000-to-1 for in-phase signals at full gain. It features 7 μv rms maximum combined noise and hum with input grids grounded at the input connector. High-frequency and low-frequency controls permit restricting the bandwidth, when desirable, to further increase the signal-to-noise ratio. Weight is 4½ lb. Price is $165.



MAGNETIC CARTRIDGE
has push-pull coil assembly

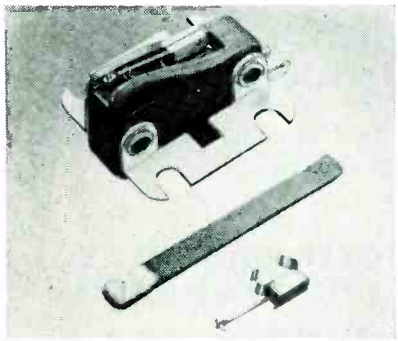
RECOTON CORP., 147 W. 22nd St., New York 11, N. Y. Model 500 is a high-fidelity cartridge of the turnover type, using separate stylus for 78's and 33's. It may be installed simply in any standard tone arm equipped with half-inch-center mounting holes. Among its features is a push-pull coil assembly which cancels out hum originating in turntable motors and nearby electrical appliances. Additional protection against hum pickup is afforded by a Mumetal shield around the polepiece assembly. Frequency response of the cartridge is virtually flat from 20 to 16,000 cycles. High com-

pliance and low moving mass permit excellent tracking at 6 to 7 grams, with distortion reduced to a practical minimum.



POTENTIOMETERS
are small and light

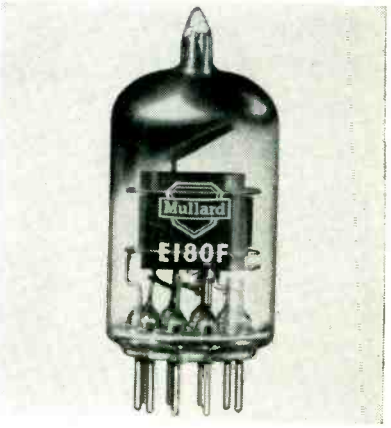
GEORGE RATTRAY & CO., INC., 116-08 Myrtle Ave., Richmond Hill 18, N. Y., announces the addition of the miniature model 106 to its regular line of precision wire-wound potentiometers. The combination of small size, light weight, wide choice of resistance values or functions and ganging features, facilitates the application of this potentiometer to fire control, navigational, guided missile or other computers where compactness and precision are mandatory. This unit retains the advantageous features of linear or nonlinear functions of high accuracy in regular production within the shell size of 1⅛ in.



CERAMIC CARTRIDGE
for high-fidelity use

SONOTONE CORP., Elmsford, N. Y., announces the 1P single-needle, high-fidelity ceramic cartridge that features high compliance and an extended frequency response. It is available in two versions—one for fine groove records (33's and 45's)

and the other for standard groove records (78's). It does not require either equalizers or preamplifiers and is unaffected by moisture or temperature. Because of its small size, it will fit into an unusually large number of tone arms. Output voltage is 1 v on microgroove records. The replacement needle (bottom of photo) snaps into place and is available with either diamond or sapphire tip.

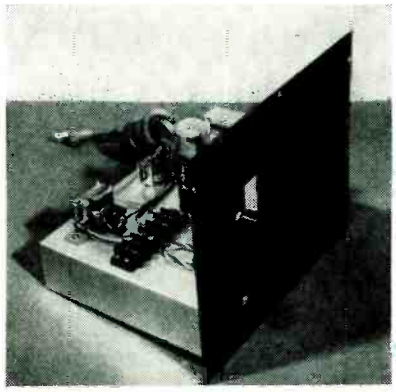


HIGH-SLOPE PENTODE
for wide-band amplifiers

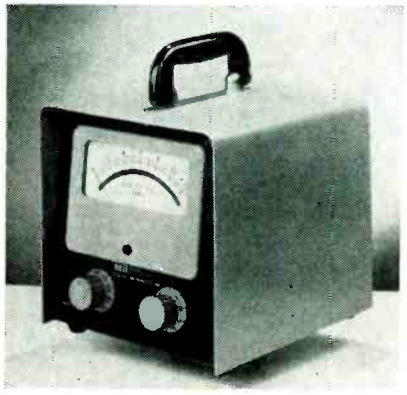
MULLARD LTD., Century House, Shaftesbury Ave., London, W. C. 2, England. Model E180F is a miniature pentode amplifying tube with a mutual conductance of 16.5 ma per v. This, together with its low interelectrode capacitances, makes the tube ideal for all wide-band amplifier applications, such as radar i-f amplifiers, high-definition tv cameras and transmission equipment, and carrier telephone equipment. For h-f performance the equivalent noise resistance is only 460 ohms.

OVERLOAD RELAY
protects equipment work

STANDARD ELECTRIC & MFG CO., Pittsburgh 22, Pa. This electronic relay is intended for use wherever fast acting and precise electrical overload protection is desired. It can be adjusted to operate entirely reliably with a current differential as small as 0.05 ampere, or if intended for use on over voltage, as for example, on a d-c shunt application, the voltage differential



would be of the order of 50 mv. The heart of the unit is a thyratron control tube with a spdt relay connected in its plate circuit. Operating characteristics of this tube can be varied by means of the control dial which is suitably calibrated in volts or amperes so that the thyratron will fire only after a certain voltage is applied to its grid circuit. Ordering information should include complete data on a-c or d-c and voltage characteristics, including the overload range for which the unit is designed. Price is $65.00.

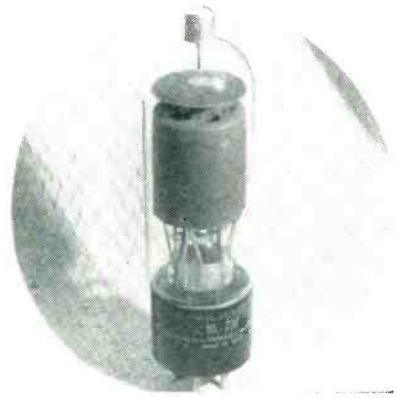


A-C VOLTMETER
with expanded scale

SHASTA DIVISION, BECKMAN INSTRUMENTS, INC., 1432 Nevin Ave., Richmond, Calif. Model 101 a-c voltmeter features both scale expansion and recording over the 100 to 500-v range. It covers the range in 39 easy-to-read steps, full scale. True rms readings are obtained with accuracies better than ±0.25 percent of input voltage. Frequency response is uniform between 50 and 2,000 cps, eliminating the need for delicate or specially built laboratory voltmeters to measure a-c voltages accurately. The voltmeter

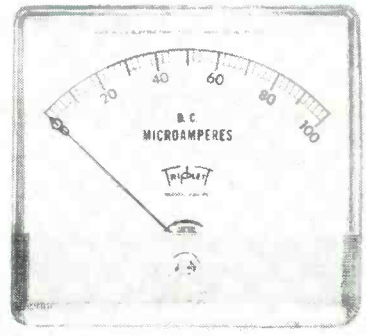
For additional information on all items on this page, use post card on last page.

offers built-in recorder connections for continuous recording of line voltage fluctuations with a 1-ma d-c recorder, simplifying problems of voltage regulation or stabilization in a-c systems. Price is $360.



THYRATRON
for motor speed control

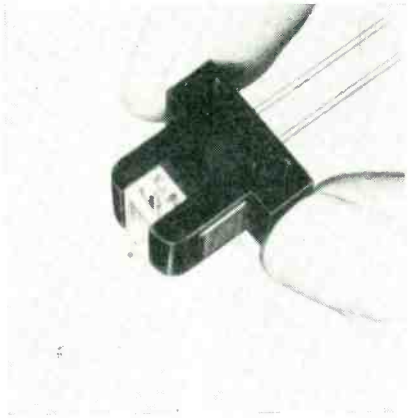
NATIONAL ELECTRONICS, INC., Geneva, Ill., has developed a new 3.2A d-c thyratron. The NL-730 is gas and mercury-vapor for long life, quick starting and wide temperature limits. It is especially designed for motor speed control and regulated rectifier applications. Ratings are: filament volts, 2.5; filament current, 12 amperes; peak inverse and forward volts, 1,500; anode current, 3.2 amperes; peak anode current, 40 amperes; anode current averaging time, 5 sec; and filament heating time, 30 sec.



PANEL METER
in new 4-in. type

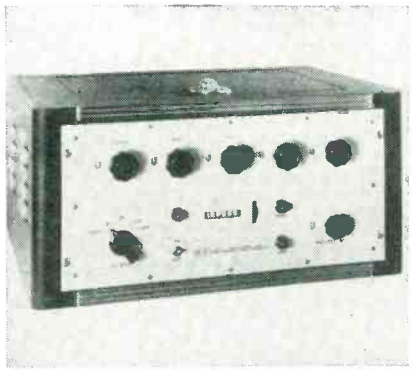
TRIPLETT ELECTRICAL INSTRUMENT CO., Bluffton, Ohio. Model 420-P1 panel meter combines a transparent plastic case with a molded base. The case front projects over the rim of the instrument giving longer scale

length and permitting easier readability. It mounts on studs inserted through the panel and is available in 2 basic types: d-c permanent-magnetic moving coil and a-c iron vane.



CARTRIDGE
for professional use

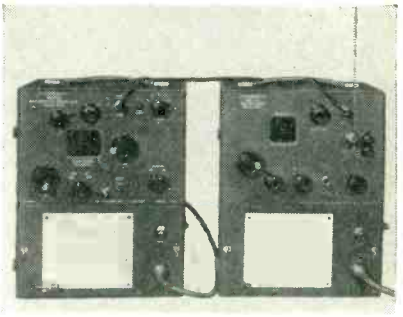
ELECTRO-SONIC LABORATORIES, INC., Long Island City, N. Y. The new ESL electrodynamic cartridge has a smooth response from 20 cycles to above 20 kc, less than 1-percent intermodulation distortion, a minimum compliance of 4.43×10^{-6} dyne per cm^2, an equivalent mass of 0.003 gram, no inherent resonances over the entire audio range, and excellent dynamic range and transient response.



SORTING BRIDGE
a high-speed automatic unit

BARNES DEVELOPMENT CO., 213 W. Baltimore Pike, Lansdowne, Pa. The instrument illustrated is a self-contained unit, consisting of a Wheatstone bridge and a sensitive balance detector with relay output. Its function is to determine rapidly whether a resistor submitted to it

has a value above or below the valuet set on the bridge, and to signal other equipment so that appropriate action can be taken. It has a memory feature, so that it will retain the reading until it has been given a return signal indicating that the action has been taken. The high speed of the instrument makes it particularly valuable to resistor manufacturers and others who must test and sort a great volume of resistors.

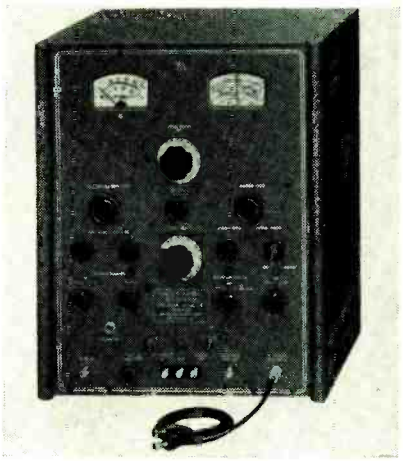


FREQUENCY DIVIDER
extends frequency range

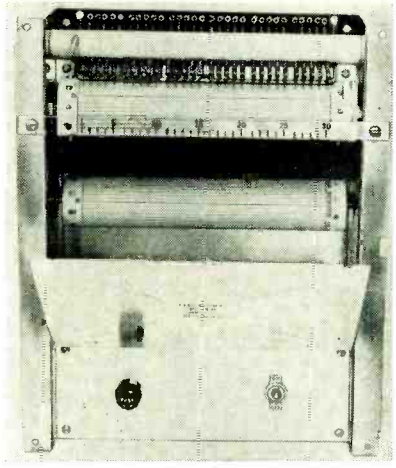
GERTSCH PRODUCTS, INC., 11846 Mississippi Ave., Los Angeles, Calif. The FM-5 frequency divider is designed specifically to extend the frequency measuring range of either the FM-3 or AM-1 down to 50 kc, and the frequency generating range down to 200 kc with no loss of accuracy. It both measures and generates up to 20 mc with continuous coverage. The FM-5 consists basically of two tuned frequency dividers in cascade, each dividing by ten. Included is a detector-audio system for heterodyne-type measurements.

SIGNAL SOURCE
has 4.5-120 mc range

BOONTON RADIO CORP., Boonton, N. J., announces the type 240-A sweep signal generator. It can be used as a single frequency source, an amplitude-modulated signal generator, a sweep frequency signal generator with frequency deviation variable over a wide range, and a sweep frequency signal generator with frequency identifying marks. Arrangements have been included for calibrating the single frequency



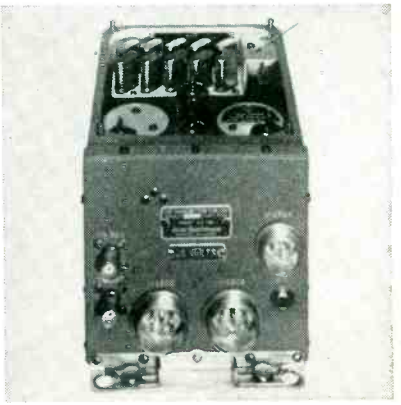
output against internal crystal controlled frequencies. The frequency range is 4.5 to 120 mc continuously tunable in 5 ranges with an accuracy of ±1 percent. The calibrated r-f output voltage is continuously variable from 1.0 to 300,000 μv across a 50-ohm load. Amplitude modulation at 30 percent from a 1,000-cps internal oscillator is available. The instrument has very low leakage and a high degree of stability.



INKLESS RECORDER
is a multistylus unit

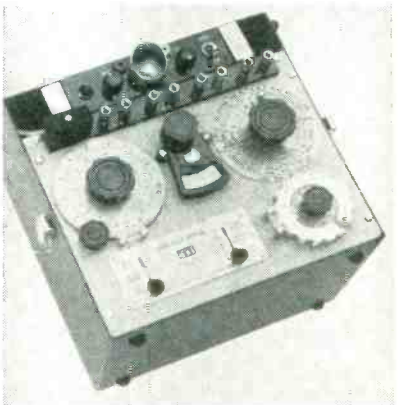
LARSON INSTRUMENT Co., 24 Orchard St., Tarrytown, N. Y. Model ROS inkless multichannel strip chart recorder is designed to record instantly the time, sequence and duration of as many as 30 events on one chart. It gives an on-off history on a rectilinear chart in such a manner that the time of each individual unit may be measured, or the simultaneous set of units may be compared. This accurate and permanent record is made

on electrosensitive paper. The electrosensitive chart makes possible accuracy and speeds which can not be obtained with ink. A large variety of chart speeds are available to meet various applications.



CRYSTAL ADAPTER
for vhf transmitters

AIRCRAFT RADIO CORP., Boonton, N. J. The 16950 crystal adapter provides each ARC type T-11B vhf transmitter with 10 communication channels instead of 5. By equipping 3 transmitters with these plug-in adapters, ARC's 2-way vhf equipment now covers most of the vhf civil communication channels presently in use throughout the U. S., and weighs only 22 lb. It is particularly suitable to the 4-6 place twin-engine executive aircraft where frequency flexibility is an important factor.



IMPEDANCE BRIDGE
for a-c line operation

ELECTRO-MEASUREMENTS, INC., 4312 S. E. Stark St., Portland 15, Oregon. Model 250-DA is an extremely accurate wide range impedance

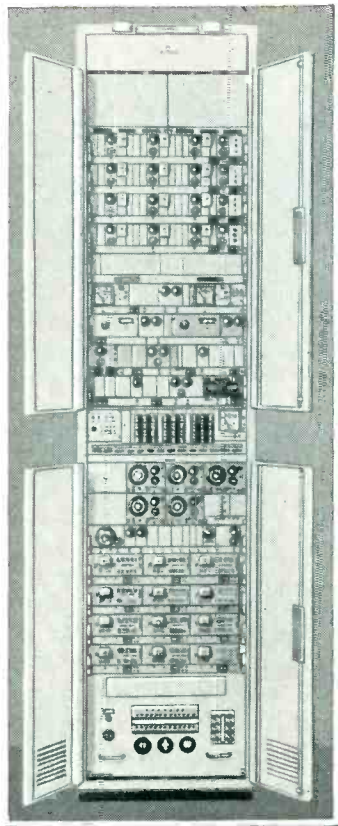
bridge designed for the measurement of resistance, capacitance, inductance, dissipation factors and storage factors. The instrument operates directly from an a-c power line. It uses precision resistor components throughout and a carefully stabilized capacitance standard that is adjusted to better than ±0.15 percent of its nominal value. Operating limits for the bridge have been extended to 0.1 milliohm to 12 megohms in 8 ranges, 0.1 μμf to 1,200 μf in 7 ranges, 0.1 μh to 1,200 henrys in 7 ranges, 0.001 to 1.0 for dissipation factor and 0.02 to 1,000 for storage factor. The instrument weighs 20 lb and measures 9 in. × 10½ in. × 10½ in. overall.

POWER SUPPLY
used in research labs

MORROW PRODUCTS CO., 550 Grant St., Pittsburgh, Pa., has announced a low-priced precision electronically regulated power supply for tv and radio shops as well as research laboratories with less than 0.5-percent voltage variation within its 100 to 400-v range with any load from 0 to 200 ma. This unit also has a 6.3-v a-c outlet at 6-amperes output for filament strings nonregulated. A flyer is available giving all the pertinent details of the unit and its many features.

INDUSTRIAL CRT
with new electron gun

ALLEN B. DUMONT LABORATORIES, INC., 760 Bloomfield Ave., Clifton, N. J. Type 5AQP is a flat-faced tight-tolerance electrostatic-focus and deflection crt operating on the new mono-accelerator principle. It

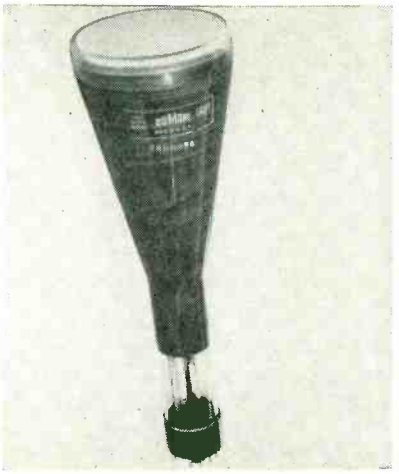


TWELVE-CHANNEL OPEN-WIRE LONG-HAUL CARRIER-TELEPHONE SYSTEM OF ADVANCED DESIGN

This is a 12-channel 2-wire single-sideband carrier-suppressed miniaturized plug-in equipment operating in the band 36 to 143 kc. Six frequency allocations are available. Channel bandwidth is 300 to 3400 cycles. Three of the voice channels may be replaced by a 10-kc program channel. Built-in ringing and dialling facilities are available. Maximum attenuation per repeater section is 74 db and full automatic regulation of transmission variations is provided. Either frogging or non-frogging repeaters are used, and systems of any length can be set up to meet standard toll-transmission requirements, with adequately engineered lines.

This system is assembled from a series of standardized equipment units, which are employed to form universal carrier-telephone systems of from three to 960 channels. Information on these systems will be furnished on request.

Type T12 Terminal complete with test equipment mounts on one side of an 8′ 6″ bay.

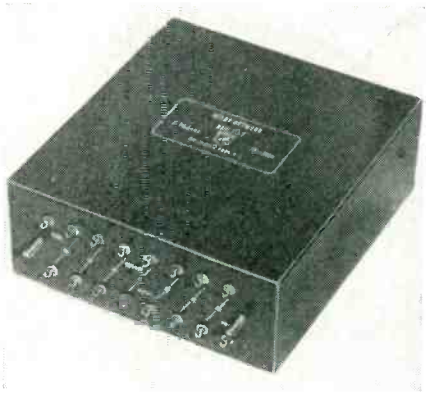


is designed to provide a scanning area of 4 in. × 4 in. to afford high sensitivity on both X and Y axes thus simplifying the signal output requirements of the low and medium-frequency deflection amplifiers for which this tube was intended. A catalog sheet now available gives electrical and mechanical characteristics, maximum ratings, typical operating conditions and circuit design values.

SELF-COOLED SERVO features much power

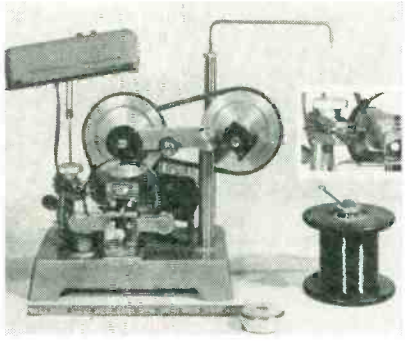
JOHN OSTER MFG. CO., Racine, Wisc. Although the series 5100-2237 weighs only 3.188 lb, the servo motor alone pulls as much as 1/15 h-p at 6,000 rpm and has 22 oz in. of stall torque. Overheating of the servo motor is prevented by a blower which functions independently yet is an integral part of the servo. The device is designed to drive an antenna on airborne military radar or for any other application combining absolute dependability with unusually compact and powerful response. It is a 2-phase, 115-v, 400-cycle motor with a no-

load speed of 10,000 rpm and a full-load speed of 6,000 rpm. Stalled power input is 150 w per phase. Acceleration is 31,000 Radians per sec² minimum. Rotor inertia is 50 gram cm² maximum.



DELAY NETWORK
for equalization functions

ESC Corp., 534 Bergen Blvd., Palisades Park, N. J., has available a new delay line for equalization between tv cameras and central console. Custom-made to precise specifications, this unit replaces 1,423 ft of 75-ohm cable in its equalizing function.



TOROID WINDER
measures only 9½ in. long

Electro Devices Co., Inc., 463 Commercial St., Boston, Mass., has developed a midget toroid winder for winding small toroid coils having an inner diameter when finished of ⅜ in. Wire sizes from No. 30 to No. 44 can be wound on closed magnetic cores of wound tape, stacked ring punchings or molded powder. Winding speeds range from 400 turns per minute to 600 turns per minute regardless of wire size. Turns are laid radially under ten-

sion which is adjustable to suit the tensile strength of the wire being used. Highly polished guides prevent abrasion of wire insulation. Manual rotary core feed allows clockwise or counterclockwise progress of the winding. A register type counter records the wire loaded on the shuttle and counts the turns laid upon the core.

Literature

Range Servo. Servomechanisms, Inc., 500 Franklin Ave., Carden City, N. Y., is offering a 32-page bulletin, "An Introduction to the "A" Series Range Servo", covering the use of functional packaging. The booklet humorously describes the many applications possible as a result of functional packaging techniques pioneered by the company.

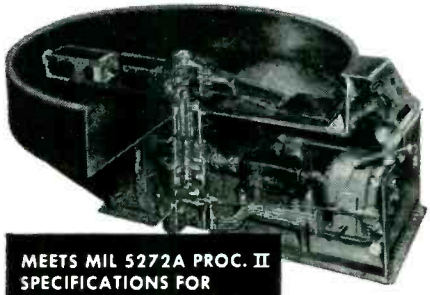
Servo Catalog. Servo-Tek Products Co., Inc., 1086 Goffle Road, Hawthorne, N. J., announces publication of catalog No. 41. This new 36-page booklet lists many new servo motors, motor tachometers and synchros, as well as a new line of special transformers for use with grid-controlled rectifiers. Nearly all prices have been substantially reduced from those shown in previous editions.

Miniature Clutches. Electronic Manufacturing Engineers Co., 2410 Beacon Ave., Seattle 44, Wash., has available an 8-page brochure describing its line of miniature clutches. It contains photographs, drawings, features, specifications, data, ordering information, price list and generalized applications.

Precision Test Equipment. Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N. Y. A 136-page catalog covers the company's line of precision test equipment. The table of contents lists the following sections: attenuators and terminations; impedance measurement and transformation; transmission

GENISCO MODEL B G-ACCELERATOR

A precision centrifuge for testing reliability of electronic components under simulated operational G-loadings



MEETS MIL 5272A PROC. II SPECIFICATIONS FOR ACCELERATION TESTING

Simple operation—To operate, simply mount test object, connect slip rings and accessories, push "start" button and turn handwheel to desired r.p.m. Quick, easy operation makes the Model B particularly suited to large quantity test programs.

Extreme accuracy—The Vickers Hydraulic Transmission provides smooth, constant boom rotation over full r.p.m. range. Wow is less than 0.5% of set speed above 10 r.p.m. Drift at any set speed above 10 r.p.m. is less than 0.1% per minute.

R.P.M. easily measured—A tachometer and timer and counter for measuring rotation rates are standard equipment. A strobe unit which measures exact boom speed (within accuracy of line frequency) at 90 settings over the full r.p.m. range is available as optional equipment.

G-range of 0.017 to 120 G's—Boom rotation speed is infinitely variable from 5 to 420 r.p.m. Radius of gyration ranges from 19" to 24".

Rugged construction—Heavy cast-and-fabricated structure and adequate safety factors assure maximum operator safety, long life, minimum maintenance.

Now four Genisco G-Accelerators!

MODEL NUMBER	G-RANGE	CAPACITY	RADIUS OF GYRATION
B78	0.017 to 120	25 lbs.—8" cube	24"
C159	0.024 to 75	100 lbs.—24" cube	44"
D184	1 to 800	6 1-lb. objects	12"
E185	0.01 to 60	300 lbs.—30" cube	72"

Optional equipment . . . additional internal and overhead sliprings, air system, optical system, and other accessories are available for Genisco G-Accelerators. Write to Genisco, Inc., 2233 Federal Avenue, Los Angeles 64, California, for detailed specifications.

RELIABILITY FIRST

Genisco INCORPORATED

NEW PRODUCTS (continued)

line components; frequency measuring measuring devices; detection and power measurement; signal sources and receivers; vhf-uhf, millimeter, and ridged waveguide test equipment. At the beginning of each section are background, theoretical, and applications data. Ordering information is included. The catalog is available free on letterhead request.

Air Capacitors. The Allen D. Cardwell Electronics Productions Corp., 97 Whiting St., Plainville, Conn., announces a new catalog on the line of fixed and variable air capacitors. Catalog No. 823 gives mechanical and electrical specifications on all standard models as well as information on special items available on request. A capacitor price list is also available.

Laminations. Thomas & Skinner Steel Products Co., Inc., 1122 E. 23rd St., Indianapolis, Ind. Bulletin L-155 describes a new series of EI type laminations designed for 60-cps transformers. Substantial savings are realized through the use of these laminations as compared with the sheared I type of core construction which has been prevalent in the past. Principal usage to date of the EI type laminations has been in 29 gage Orthosil 3X. They are now also available in 26 gage or other 29 gage grades, and will be quoted to requirements on request.

Waveguide Parts. American Radar Components Inc., Whippany, N. J. A recent bulletin lists a portion of the great variety of standard and special waveguide fittings manufactured by the company. In addition to fittings fabricated from bronze, brass and aluminum, the company has facilities to supply parts from magnesium, silver, invar and stainless steel. Prices are available on request.

House Organ. Microlab, Okner Parkway, Livingston, N. J., is now publishing "The Microlab Memo", a medium for exchanging technical information partinent to its allied products. Volume 1, No. 1 deals with coaxial high-pass fil-

For additional information on all items on this page, use post card on last page.

ters; the second issue covers the determination of coax filter specifications. Future issues will be published periodically and one may be put on the mailing list for the asking.

Catalog Supplement. Columbia Wire & Supply Co., 2850 Irving Park Road, Chicago 18, Ill., announces a supplement to its catalog No. 104. Among illustrated items in the supplement are the Permaline tv transmission line; Permaline rotor cables; Permaline intercommunication and telephone wire for outdoor use; a new hookup wire display; and new connectors, cords and cables.

Electric Circuit Control Units. Electric Regulator Corp., 506 Pearl St., Norwalk, Conn., has available an 8-page bulletin on Regohm direct-action finger-type electric circuit control units. It gives complete technical details and lists the modifications of the basic types of units. Instructions for use and the selections of the correct type of Regohm for a specific purpose are included in the text. Engineering dawings give outline dimensions and form for the sizes 1 and 3 models as well as standard sockets, chassis and enclosures.

R-F Interference Filters. Filtron Co., Inc., Flushing, L. I., N. Y. A 22-page combined catalog reviews the company's complete standard line of type FSR r-f interference suppression filters for use in screen rooms, induction heating equipment, diathermy and x-ray units or similar equipment which may produce radio interference. Detailed information on each filter is given, by means of cutaway views, dimension drawings and descriptive text. Graphs of attenuation characteristics and complete engineering data on every unit permit the user to select and specify the right filter for a particular application requirement. Filtron's facilities for manufacturing more than 3,000 types of r-f suppression filters, used in both commercial and military equipment of all types, are discussed. The company also offers engineering assistance to help

solve unusual problems connected with r-f interference suppression.

Vibrating Reed Amplifier. Applied Physics Corp., 362 W. Colorado St., Pasadena, Calif. Bulletin P54 gives a complete description of the Cary model 36 vibrating reed amplifier. It discusses the uses for the instrument which include: rapid recording of low currents from the mass spectrometer; insulator and semiconductor research; rapid measurement of nuclear and x-radiations, photoelectric and other electron emission phenomena. It also describes performance, stability sensitivity, response speed, accuracy and reproducibility. Specification information includes input, output, power requirements, dimensions and construction.

Color Notch Filters. Allen B. DuMont Laboratories, Inc., Clifton, N. J. Bulletin TR-786 illustrates and describes the types 5395-A (channel 2-6) and 5396-A (channel 7-13) color notch filter for use with a tv transmitter. The filters discussed are r-f stubs constructed from transmission line, are inserted in the visual transmitter output transmission line, and are tuned to short circuit the line at the notch frequency. The bulletin gives electrical and mechanical specifications, installation information and data on terminal connections.

Automation Dictionary. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa., has undertaken to define some automation terms so that they will be readily understood by laymen. Surveying the technical terms most broadly used, the company has packaged them in a booklet called the "Automation Dictionary." It covers some 87 words and phrases, all of which had their origin with the engineers but are now creeping into the lexicon of today's modern businessman.

Precision Facilities. Avien, Inc., 58-15 Northern Blvd., Woodside 77, N. Y. A 16-page, illustrated brochure, entitled "Precision Defined", depicts production facilities that are adapted to a wide range of electrical, electronic and

mechanical equipment in the instrument and other fields. In addition to manufacturing plant and equipment, the brochure describes extensive supporting services, including quality control, field service, technical publications, and military packaging, which the company makes available to provide a complete subcontracting facility for either military or commercial production programs.

Transistor Catalog. General Transistor Corp., 95-18 Sutphin Blvd., Jamaica 35, N. Y., has released a new catalog of diffused *pnp* junction transistors. The new sheet illustrates the company's double sealing process—encapsulated in plastic and hermetically sealed in a can. It also includes absolute maximum transistor ratings and characteristics.

D-C Microvoltmeter and Amplifier. Kay Lab, P. O. Box 16, San Diego 12, Calif. A recent catalog sheet covers the model 202 d-c microvoltmeter and amplifier which features wide voltage range and high input impedance. Circuit description, specifications and price are included.

Connector Catalog. American Phenolic Corp., Chicago 50, Ill. The extensive line of Blue Ribbon connectors are described and illustrated in catalog R1. These rack and panel connectors employ a ribbon-type contact instead of conventional pin and socket contacts, a design that provides for fast connect and disconnect of mating pairs. The catalog gives complete electrical and mechanical data on all these connectors including the new keyed shell and latch-lock can types that utilize the barrier polarization insert.

Indicators, Recorders and Controllers. Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa. Complete information about the Speedomax type H indicators, recorders and controllers is available in a series of 5 data sheets, ND46-33 (100) to (104). The data sheets describe how the instruments can be used to indicate or record temperature, or to provide two-position or one of

three types of proportional control: proportional action, position-adjusting type or duration-adjusting type. The last two types also provide automatic reset and rate actions. Included in the sheets are photographs and line drawings. To facilitate control selection, there are listed various process conditions for which each type of control is usually recommended, and in addition, there is provided an illustrated, tabular arrangement of complete control systems. Specifications and standard ranges for all models are conveniently tabulated. Ordering instructions are given.

Recording Charts. Technical Charts, Inc., 189 Van Rensselaer St., Buffalo 10, N. Y., offers a 12-page catalog outlining its services in producing recording charts for standard and special instruments. It includes samples of both dial and roll-type charts. The method of production of over 8,000 different standard charts is outlined. Technical information is given on requirements for special charts.

Pressure Transducer. Technology Instrument Corp., 531 Main St., Acton, Mass., has available a new brochure describing the dual-element pressure transducer that translates static and dynamic air pressures to equivalent voltages. Included are altitude and velocity computations, as well as a wide range of applications for the potentiometer-type pressure transducer.

TV Picture Tube Guide. CBS-Hytron, Danvers, Mass., has announced the second edition of its reference guide for tv picture tubes. It lists all magnetically deflected picture tubes to date—monochrome or color—including those made by other manufacturers as well as CBS-Hytron. Basing diagrams and pertinent data for 242 tubes are presented in an easy-to-read, easy-to-use format.

Wire-Wound Resistors. Shallcross Mfg. Co., Collingdale, Pa. Engineering bulletin L-35 describes and lists 0.10 to 2-w Akra-Ohm ceramic-bobbin precision wire-wound

For additional information on all items on this page, use post card on last page.

resistors from 0.1 ohm to 1,000 megohms, 75 to 2,000 v. The resistors discussed are offered in radial or axial lead, radial or axial lug, or bracket-type mountings for the most varied size and mounting requirements. Tolerances of 0.05 percent to 1 percent are standard, and a tolerance of 0.01 percent can be obtained on special order. While BX impregnation is standard, the resistors described may be supplied without impregnation or with multiple coats of moisture-resistant varnish or silicones.

Pantograph Engraver. Green Instrument Co., 386 Putnam Ave., Cambridge, Mass., has available a brochure describing in detail the model D-2 heavy-duty pantograph engraver. The new engraver is open on three sides and equipped with a single vertical adjustment for both spindle and copy table. The brochure tells all about this unique design which enables the model D-2 to mill, profile and engrave large panels and bulky work pieces. It also contains a full description of the engraver's rugged construction and precision machine tooling.

Bobbin Resistor Winders. Geo. Stevens Mfg. Co., Inc., Pulaski Rd. at Peterson, Chicago 30, Ill., announces a new specification sheet illustrating and describing models 212-AM and 212 AML bobbin resistor winders. Complete data in clude dimensions, weights, types of windings accommodated, maximum traverse for any single winding, maximum o-d of coils wound, maximum distance between winding centers, wire sizes handled, tension devices available, gears, winding range, winding speeds, setup time, instant resetting counter, positive stopping brake, mounting, wire guide reset feature, wire guide carriage, new magnetic self-adjusting reversing mechanism, output end of spindle, winding width, price, delivery and other features.

Tube Literature. Sylvania Electric Products Inc., 1100 Main St., Buffalo 9, N. Y., announces three new brochures in the electronics field. The first is a wall chart

brochure which lists the company's complete line of 600-ma tubes for series string television. The second is a brochure listing Sylvania's gas tubes for use in control mechanisms by industrial customers. The third is a new folder listing complete information about the company's crystal diodes.

Capacitor Catalog. Good-All Electric Mfg. Co., Ogallala, Nebraska. Catalog 551 is a 2-color, 32-page booklet describing an entire line of paper and Mylar dielectric capacitors for civilian, military and specialty applications. Line drawings and photographs of all case style mounting are shown. Graphs and charts are included describing electrical and mechanical characteristics of each capacitor series. MIL-C-25A types are listed in easy-to-order form. A comprehensive index assures quick reference to all material.

Magnetic Amplifiers. Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa. Technical aspects of Magamp magnetic amplifiers for control applications are discussed in a recent 20-page booklet. The booklet explains the basic theory underlying magnetic amplifier operation, gives information necessary for application, and describes operating characteristics. Introducing the section on magnetic amplifier operation is a glossary of technical terms as proposed by the AIEE Magnetic Amplifier Subcommittee. Those sections of the booklet dealing with component parts, applications and operating characteristics are illustrated with tables, charts, graphs and circuit diagrams. The magnetic amplifiers described have a power output of 0.03 to 325 w, 6.3 to 230 v, 0.015 to 1.7 amperes.

Selenium Rectifiers. Radio Receptor Co., Inc., 251 W. 19th St., New York 11, N. Y., has available upon request a 24-page bulletin describing all the company's selenium rectifiers. Included is a discussion of the type 8Y1 for half-wave applications, which has an inherent ruggedness that

For additional information on all items on this page, use post card on last page.

makes it ideal for duty in extremes of temperature and other rigorous conditions.

Magnetic Amplifiers. Keystone Products Co., 914 23rd St., Union City 2, N. J., has available a new illustrated magnetic amplifier catalog. It shows the mechanical and electrical specifications of packaged Moto Mags covering a wide range of military and industrial applications. Types illustrated include 2-stage magnetic amplifiers with self-contained phase detector, saturable transformers and magnetic amplifiers with v-t phase detector completely self contained. The catalog has been designed with illustrations of the units, complete specifications, quotations and typical Moto Mag schematic on one large page which can be used as a handy wall reference chart.

H-F Steatite Insulators. American Lava Corp., Cherokee Blvd. & Mfgrs. Road, Chattanooga 5, Tenn. Bulletin No. 546 deals with AlSiMag L-5 h-f electrical insulators. It is a convenient working tool for the many people who buy ceramics to government specifications. The introduction on the inside front cover gives a detailed explanation of what the widely used JAN-I-8 part numbers mean and how to locate them in the bulletin.

Camera Equipment. Allen B. Du Mont Laboratories, Inc., Clifton, N. J. Bulletin TR-605 illustrates and describes the 5400-A dolly and 5401-A tripod combination. Chief features and specifications are listed.

Cable Catalog. The American Phenolic Corp., Chicago, Ill., has released a new catalog devoted exclusively to Amphenol wire and cable products. Catalog W1 contains 34 pages of cable illustrations and descriptions and includes the following information: jackets, conductors and dielectric data, attenuation and power ratings, a complete listing of military RG/U nomenclature, and a cable/connector selector chart. Each of the RG-type coaxial cables is individually illustrated

and described. The W1 also catalogs noise-free Aljak, miniature and triaxial cables as well as transmitting and receiving twinleads. Cables and connectors for community tv systems are described. The entire catalog is cross-indexed by Amphenol and military numbers.

Engineering Sound Products. Altec Lansing Corp., 9356 Santa Monica Blvd., Beverly Hills, Calif., has issued a 36-page catalog containing complete technical data on all the company's engineering sound products. It covers a-m/f-m tuners, transcription reproduction arms, 12 different broadcast, p-a and scientific microphones, more than 20 amplifiers and preamplifiers, power supplies, control consoles, 19 different loudspeakers, horns, cabinets and matching transformers.

Relay Catalog. Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago 12, Ill. A 72-page catalog covers a complete line of basic type relays. Each relay is illustrated and fully described as to physical and electrical characteristics, also complete operating data and suggested applications are included. In addition, the book devotes two pages to definitions of engineering and electrical terms and laws.

Precision Ceramics. Stupakoff Ceramic and Mfg. Co., Latrobe, Pa. Bulletin No. 301 covers a line of precision ceramics made in plain, ground, metallized and assembled types—for any voltage, frequency or temperature. Drawings of typical parts illustrate the high degree of precision attained.

Potentiometer Winding Alloys. Secon Metals Corp., 7 Intervale St., White Plains, N. Y. To help the engineer in his determination and selection of platinum metals potentiometer winding alloy wires for specific applications, the company has prepared a special cross-reference chart which plots bare diameter versus resistance values of several platinum metals potentiometer winding alloy wire. This chart will prove highly useful in the preparation of drawings, blueprints and purchase

order specifications. Ask for chart PR.

Standing Wave Indicator. Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N. Y. Included in Vol. 3, No. 2 of *PRD Reports* is an article entitled "Impedance Measurements in the 50-1000 mc Range With a New Standing Wave Indicator." The article contains illustrations and full technical data. Also shown in the bulletin are a listing and description of the company's vhf-uhf equipment.

Mass Spectrometer. Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif. The 16-page bulletin 1800C deals with the type 21-103C mass spectrometer. It tells how the unit works, gives applications, description of components and accessories, discusses the company's available services and gives ordering information.

Linear Motion Potentiometer. Benson-Lehner Corp., 2340 Sawtelle Blvd., Los Angeles 64, Calif., has available a bulletin on the Linipot, a precision wire-wound linear motion potentiometer with a rather extraordinary linearity of, for example, ±0.05 percent over a 4-in. stroke. The instrument described is designed for recording and control instrumentation and its primary function is to translate accurately mechanical position into an electrical signal. Specifications and a work sheet are included.

Video Switch Unit. Allen B. DuMont Laboratories, Inc., Clifton, N. J. Bulletin TR-812 covers the type 5304-A video switch unit designed primarily for use at tv transmitter locations or small studio control rooms. The unit described provides facilities for switching any one of five input signals to a single output bus. Chief features and specifications are shown.

Miniature Circuit Breakers. E-T-A Products Co., 5506 N. Bernard St., Chicago 25, Ill., has available catalog 1a/52 illustrating and describing a line of single-pole

thermally operated miniature overcurrent circuit breakers. One of the line, the type 5700, weighs only 1½ oz. The heater coil used in the breakers described is wound directly over the bimetal strip. This results in high efficiency since the heat produced by the coil will transfer to the bimetal strip without any loss. The circuit breakers discussed may be calibrated within 0.1 ampere and are available in current ratings from 50 ma to 25 amperes.

Metal Housings. Premier Metal Products Co., 3160 Webster Ave., New York 67, N. Y., has released a new 1955 catalog showing a complete line of precision built metal housings. Tabbed for easy reference, the 16-page catalog illustrates over 450 standard stock metal housings for the electronics industry. It includes full details on many newly designed items not found in previous catalogs. Ask for catalog No. 550.

Industrial Television Equipment. Radio Corp. of America, Camden 2, N. J. Catalog E.51 describes the new ITV-6 industrial television equipment manufactured by the company. Features, applications and construction details on ITV-6 closed circuit television are illustrated and described in the folder. Specifications are also listed.

Shock and Vibration Control. Barry Controls, Inc., 700 Pleasant St., Watertown, Mass., has available a product digest discussing the company's variety of leveling and spring mounts for control of shock and vibration. Included are construction information, illustrations, selector charts and a listing of technical articles available on request.

Retaining Rings. Waldes Kohinoor, Inc., 47-16 Austel Place, Long Island City 1, N. Y. An 8-page supplement to the Truarc retaining ring catalog No. RR9-52 has been issued. The publication —designated as supplement No. 1 to the catalog—contains revisions, corrections, additions and new product developments. Much of the material supersedes informa-

tion in the catalog. Two pages in the supplement are devoted to engineering data and specifications covering the use of two internal rings (series 5000 and 5008) and two external rings (series 5100 and 5108) in deeper grooves than those specified in the catalog.

Waveguide Data. Hewlett-Packard Co., 275 Page Mill Road, Palo Alto, Calif. Volume 6, No. 5 of the company's *Journal* contains two Illustrated technical articles. One is entitled "A Precision Wave Guide Attenuator Which Obeys a Mathematical Law;" and the other, "A New Precision Wave Guide Phase Shifter." Specifications and prices are listed in both articles.

Snap-Action Basic Switches. Micro Switch, Freeport, Ill. Catalog No. 62 is a 28-page booklet describing 10 classifications of the standard line of phenolic enclosed, precision snap-action basic switches, including those with high electrical capacity, high sensitivity, single-pole, double-pole, double-break and split-contact arrangements, magnetic blowout and make-before-break switching elements, and those with sealed construction. Over 400 listings of basic switches, auxiliary actuators and terminal enclosures are covered.

Radioisotope Instruments. NRD Instrument Co., 6429 Etzel Ave., St. Louis 14, Mo. A new 28-page catalog of radiation instruments has just been issued. The booklet describes scintillation counters, scalers and other electronic circuits, as well as a variety of radioactivity counting accesories.

Microwave Bulletin. Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa. A complete description of 2,000-mc microwave radio systems for a variety of applications is given in a new 8-page booklet. Features of type FR microwave radio and type FJ multiplexing equipment and their importance to the overall system are discussed. Points covered include frequency-division multiplexing, crystal frequency control, standby equipment and maintenance features.

Plants and People

Edited by WILLIAM G. ARNOLD

Electronic manufacturers expand plants and acquire companies within the field. New companies are formed and firms from other industries enter electronics. Engineers and management personnel are promoted, make job changes

U.S. Parts Group Formed At University Of Pennsylvania

A CLEARING house for U. S. military research and development in the field of electronic parts has been established by the Department of Defense at the University of Pennsylvania.

It is the secretariat of the Defense Department's Advisory Group on Electronic Parts. It is staffed and operated by the University's Institute for Cooperative Research, under U. S. contract.

Heading the office is Brigadier General Edwin R. Petzing, USA (ret.), secretary of the Advisory Group, serving in a civilian capacity as a member of the University staff.

The secretariat is the full-time technical and administrative arm of the Advisory Group. The group, which meets periodically, is a panel of military and civilian experts who guide and coordinate the development of electronic components for the Army, Navy and Air Force.

The Advisory Group is responsible to the office of Donald A. Quarles, Assistant Secretary of Defense for R&D.

Besides its administrative functions, the secretariat continually will analyze and prepare digests of the work of the Defense Department's far-flung electronic parts research projects, enabling the Advisory Group to discern unfilled needs and eliminate duplication.

General Petzing, until he retired from the Army last year after 37 years' service, had been signal officer of the U. S. Army Forces in Europe for about 18 months. Before that he was commanding general of the Signal Corps Engineering Laboratories, Fort Monmouth, N. J.

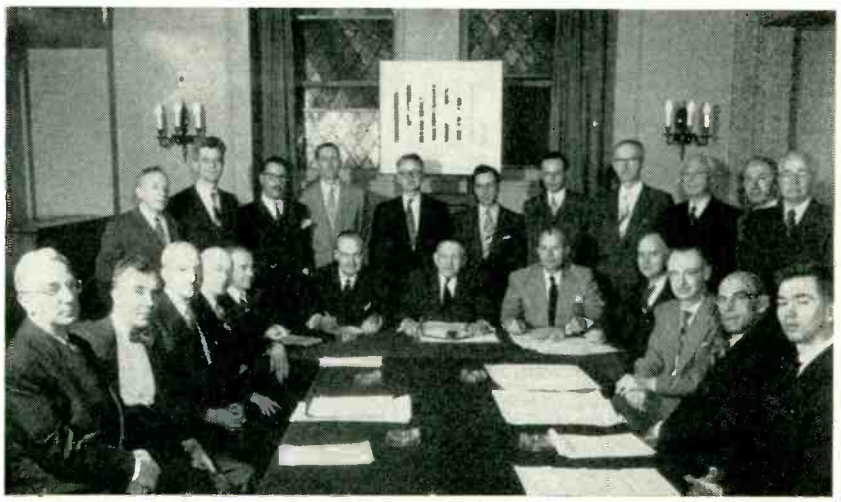
Julian K. Sprague, president of the Sprague Electric Co., North Adams, Mass., is chairman of the Adivsory Group on Electronic Parts.

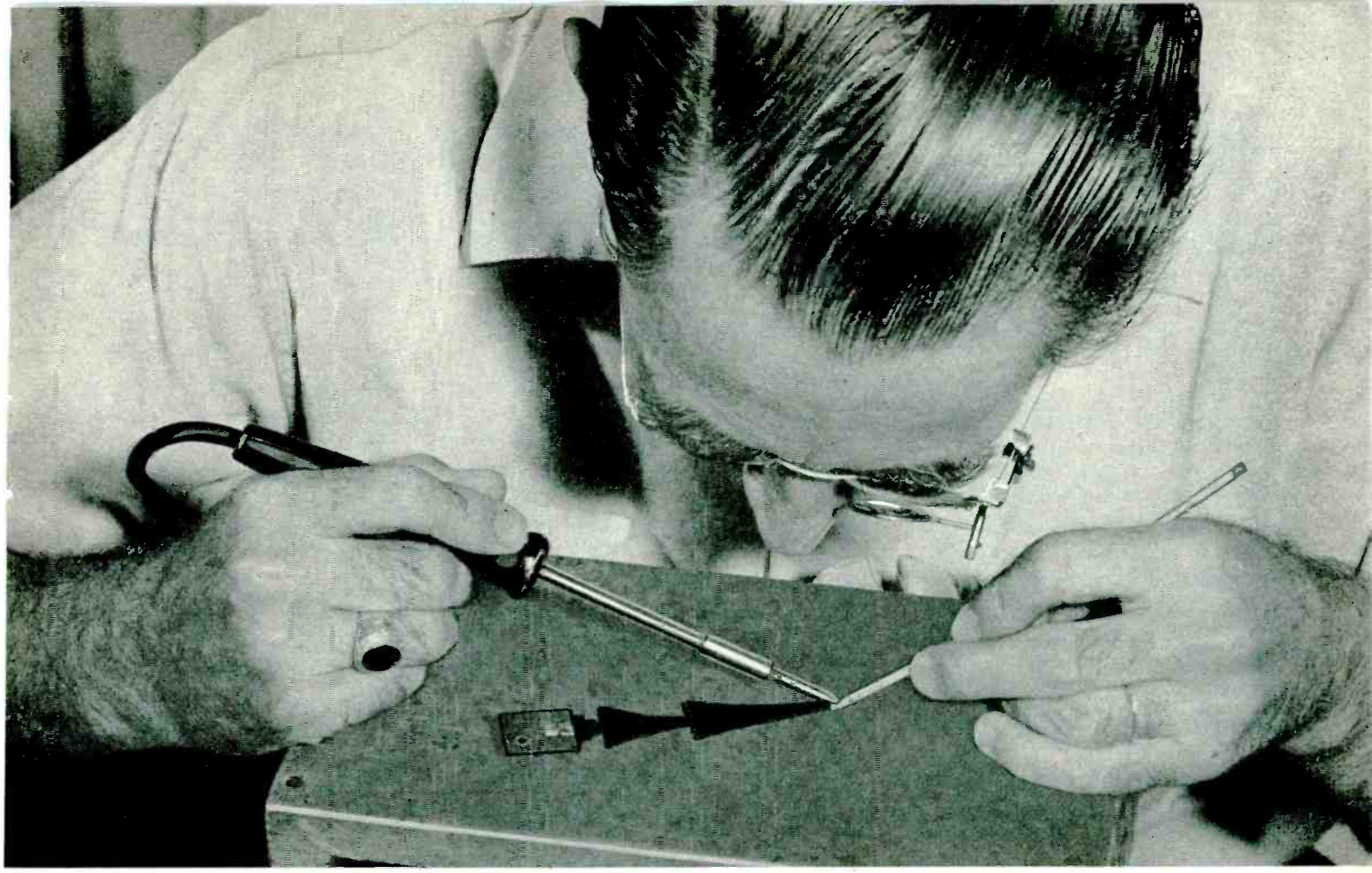
Served also by the secretariat are eight sub-groups, on assemblies and assembly techniques; capacitors; coils, inductors and transformers; electromechanical devices; electronic materials; frequency control devices; resistors; and transmission lines.

The Advisory Group's field does not include vacuum tubes and transistors, for which there is a separate Advisory Group, with its secretariat currently at New York University.

Canada's Radio Technical Board Holds Tenth Meeting

SOME of Canada's top engineers gathered at the tenth annual meeting of the Canadian Radio Technical Planning Board in Ottawa. Seated (left to right) are: L. G. Buck and S. Bonneville, of the Telephone Association of Canada; R. C. Poulter, of the Canadian Radio Technical Planning Board; J. E. Hayes, of the Canadian Broadcasting Corp.; G. C. W. Browne, Controller of Telecommunications, Department of Transport; Stuart D. Brownlee, secretary-treasurer of CRTPB; Ralph A. Hackbusch, retiring President of CRTPB; C. W. Boadway, newly-elected president of CRTPB; A. B. Hunt, of the Engineering Institute of Canada; C. F. Pattenson, of the IRE; E. L. Palin, of the Canadian Education Association and F. Mathers, of the American Institute.

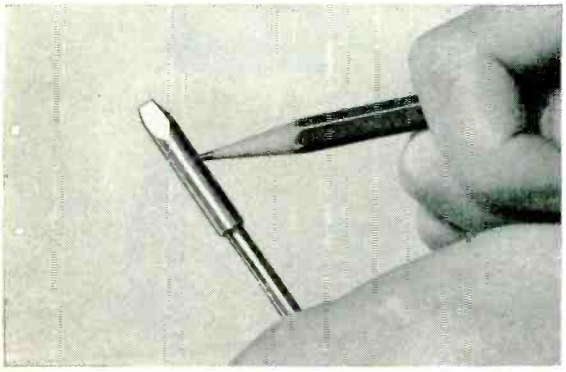




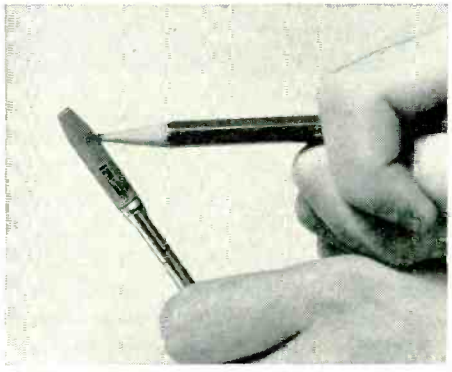
CRAFTSMAN USES JEWELER'S GLASS and the G-E Midget iron to solder a potentiometer joint the naked eye can't see. Equipped with a pencil-fine tip, the iron solders delicate joints without damaging adjacent parts. A General Electric Calrod* heater located in the tip offers amazingly rapid heat transfer. Ironclad tip eliminates need for filing, reduces maintenance costs.

*Reg. Trademark of the General Electric Company

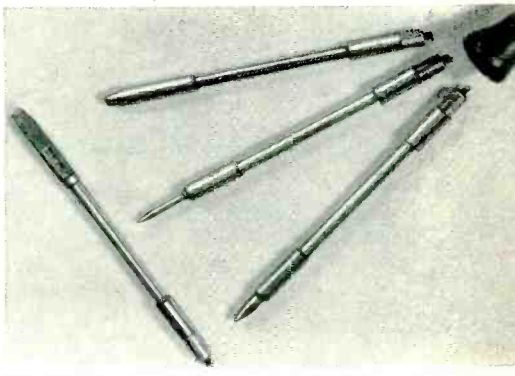
G-E Midget Soldering Iron handles like a pencil, quickly solders joints the naked eye can't see



IRONCLAD-COPPER TIP NEEDS NO FILING. And by actual production-line test, a General Electric Midget iron lasts up to ten times longer than an ordinary iron.



RAPID HEAT TRANSFER is achieved through a famous Calrod heater located in copper tip. Result—the General Electric Midget iron's heat efficiency is 90%.



THREE-IN-ONE IRON with $\frac{1}{8}$", $\frac{1}{4}$", $\frac{3}{16}$" tip sizes. Weighing less than three ounces, the General Electric Midget iron speeds production by reducing operator fatigue.

For more information write for GED-2243, G-E Midget Soldering Iron, Section 724-1, General Electric Co., Schenectady 5, N. Y.

GENERAL ELECTRIC

of Electrical Engineers.

Standing (left to right) are: C. J. Acton, W. B. Smith, C. M. Brant and F. G. Nixon of the Telecommunication Division, Department of Transport; T. J. Allard, of the Canadian Association of Radio & Television Broadcasters; J. C. R. Punchard, of the RTMA of Canada; H. E. Rice, of the Canadian Electrical Mfrs. Association; F. H. R. Pounsett, of the IRE; A. Reid, of the American Radio Relay League; G. B. Tebo, of the Hydro-Electric Power Commission of Ontario and A. S. Runciman, representing the Canadian Electrical Association.

Mack Trucks Acquires Two Electronics Firms

MACK TRUCKS has acquired White Industries and Radio Sonic Corp., New York manufacturers of electronics for aviation, industrial and military applications. The two companies will become the electronics division of Mack Trucks which, until this acquisition, specialized exclusively in the manufacture of heavy-duty trucks, buses and fire apparatus.

In key executive posts with the new electronics division will be Robert G. Kramer who has been president of White Industries and G. Emerson Pray who has been president of Radio Sonic.

Prior to joining White Industries, Kramer was president of Remington Radio Corp. Previously he had been vice-president of Ansley Electronic Corp.

Pray has served as assistant chief of the Naval Research Laboratories, Washington, D. C.; as chief engineer of Airplane Submarine Instruments of Clearfield, Pa., and as a consultant.

P. O. Peterson, president of Mack, said that the new electronics division would utilize some of the extensive facilities of Mack's research laboratory center at Plainfield, N. J.

He also said that the division would concentrate on research, engineering and production of electronic equipment and components of the most advanced design.

Engineers Form Guided Missile Manufacturing Company

A NEW guided missile firm, known as Associated Missile Products Corporation, has been established in Pomona, Calif., for the design, development and manufacture of missile ground handling and checkout equipment. Officers are (left to right) Earl R. Skaggs, vice-president and director of product engineering; Robert L. Hull, secretary-treasurer; Dr. Joseph Tampico, vice-president and director of research and development; Raymond Crisp, president and general manager and Samuel H. Depew, vice president and director of customer relations.

General Instrument Builds Plant In Georgia

A NEW $1,500,000 radio-tv- electronic components plant is being built for General Instrument Corp. at Statesboro, Ga., a farming center of 6,400 people.

Behind the move, according to GI board chairman Abraham Blumenkrantz, is company planning not just for the immediate future but as much as ten years ahead, which takes into account both the danger that the cold war might become hot and the limitless peacetime horizons of tv and electronics.

General Instrument plans to start production at the 106,000 sq ft plant around June 1. Employees will be trained in the specialized processes under a state-sponsored program and, as training facilities permit, both production and employment will be expanded, with 400 to 500 employees the goal within a year and possible eventual employment of 1,000.

General Instrument also announced that John K. McDonough, formerly general manager of Sylvania's radio and television division, has joined the firm as vice-president of its F. W. Sickles division and director of sales for both the subsidiary and the parent company.

Hoffman Enters Computer Field

HOFFMAN ELECTRONICS Corp. of Los Angeles, Calif., has acquired The Analyzer Corp. of Los Angeles, analog computer firm and the exclusive license to manufacture and sell the Nordsieck integrator, a

FREE TO ELECTRONIC ENGINEERS & DESIGNERS

A new Superior Tube catalog gives complete facts on cathodes, anodes, grid cups—their characteristics, uses, variety

For the first time, Superior Tube Company puts all the basic data on its broad line of cathodes and other vacuum tube components into a single catalog. The new CATHALOYS are fully described. Easy-to-read tables give dimensions and tolerances on all standard cathode types, plus detailed chemical and physical properties on 23 different alloys. If you design vacuum tubes or electronic equipment using fabricated tubular parts, don't fail to send for this complete new catalog from Superior Tube Company—world's leading independent supplier of cathodes to the electronics industry.

*Manufactured under U.S. Patents. †TM Reg. U.S. Pat. Off., Superior Tube Co.
NOTE. Cathaloy is a trademark of Superior Tube Co., Reg. U.S. Pat. Off.

Superior Tube

The big name in small tubing

All analyses .010" to ⅜" O.D.
Certain analyses in light walls up to 2½" O.D.

HOW YOU CAN USE THIS CATALOG

WHICH ALLOY. Complete descriptions of Superior Tube alloys make it easier for you to make the right selection.

WHICH TYPE. Tabulated dimensional information given on seamless, Lockseam*, and WELDRAWN† cathodes.

ANY KIND OF TUBE. Sections cover receiving tubes, cathode ray tubes, transmitter tubes, other tubing applications.

SALES POLICY: Detailed explanation simplifies ordering procedure for you, and shortens your procurement cycle.

SEND FOR YOUR COPY

Use this handy coupon or write

Superior Tube Company
2500 Germantown Ave., Norristown, Pa.
Yes, I want a copy of your new Electronics Catalog #50

Name _____ Title _____
Department _____
Company _____
Street _____
City _____ Zone ____ State ____

Want more information? Use post card on last page.

medium-priced mechanical differential analyzer.

Albert S. Cahn, former president of The Analyzer Corp., will act as consultant to improve the Nordsieck prototype model.

A computer engineering and production department has been formed at Hoffman to handle inventory, tooling and equipment and to complete the first production model, expected to be put out within the next six months.

Daystrom Promotes Three Engineers

NELSON H. MAGEOCH has been appointed vice-president for operations at Daystrom Instrument in Archbald, Pa.

At Daystrom Electric John C. Merman has been named vice-president of manufacturing. He was formerly works manager of Daystrom Instrument. Alexander Greenfield, former chief research and development engineer, has been named director of Daystrom Instrument's expanded research and development department.

Mageoch, formerly with firms such as GE, Atwater Kent and Western Electric, came to Daystrom Instrument in 1951. He was made chief engineer in 1952 and became director of research and engineering in 1953. In 1954 he was advanced to vice-president of research and engineering.

In his new position he will direct certain phases of product engineering and all activities related to in-

John C. Merman

dustrial engineering, manufacturing engineering, quality control, production control, assembly, fabrication and installation.

Prior to joining the company in 1951, Merman was general manager of the Electronic Tube Corp. of Philadelphia. From 1940 to 1948 he was general superintendent of Philco in charge of television and radio assembly, wiring, test and inspection, as well as production of radar, loran and other electronic military equipment. Greenfield was formerly associated with Bendix Research Laboratories, Remington Rand Institute of Advanced Research and Hart Moisture Gauges.

ElectroData Plans New Pasadena Plant

ELECTRODATA CORP., an affiliate of Consolidated Engineering Corp., plans construction of a new 40,000-sq ft plant in Pasadena, Calif. to be completed in August.

Production activities will occupy a large part of the new $750,000 building, more than doubling the firm's present capacity. Other areas will be reserved for administrative and sales functions, and for engineering and special projects research facilities.

Bulova Research Selects Shelley

EDWIN F. Shelley has been named vice-president of the Bulova Research and Development Laboratories. As chief engineer of the

Labs since 1951, he has headed technical activities in its development work on flight control systems, reconnaissance cameras, gyroscopic instruments, ballistics and guided missiles.

Shelley joined the company when it was organized in 1950, as one of the original group of scientists specializing in research in the field of high precision manufacture. Earlier he was with the propeller division of Curtiss Wright.

Hammarlund Expands To Dixie

HAMMARLUND Manufacturing Co. moved part of its manufacturing operations to a new 22,000 sq ft plant in Mars Hill, North Carolina.

The company's standard components and its amateur communications receivers will be produced in the southern factory.

Hugh A. McCloskey, works manager, will continue in charge of both the New York and Mars Hill plants with the assistance of Joe Klein, who has recently been made assistant plant manager in New York and Ed Lozier, who is plant manager in charge of the North Carolina installation.

Cohn Elected President Of Radio Receptor

HUGO COHN has been elected president of Radio Receptor Co. He succeeds Ludwig Arnson, who is retiring from that post which he held for the past 31 years. Arnson will continue to serve the company as a director and consultant. Harold R. Zeamans was elected secretary-

treasurer of the company.

Cohn, who formerly held the post of executive vice-president, has been an officer of the company since its founding in 1922.

Elgin Watch Buys American Microphone

ELGIN NATIONAL WATCH CO. purchased American Microphone Co. of Pasadena, Calif. The company will be operated as a division of Elgin-Neomatic.

J. G. Shennan, president of Elgin, described the purchase as part of Elgin's planned diversification program announced in 1953, through which it is entering the growth fields of miniature electronic components and automatic production instruments.

George M. Christ has been named plant manager for the American Microphone operation. Christ, who has been an Elgin employee since 1935, has been serving as general foreman of the firm's Lincoln, Nebraska, plant.

American Microphone was founded in 1929 by F. A. Yarbrough, sole owner since 1946. The firm has a 20,000 sq ft building in Pasadena and employs approximately 130 workers.

National Appoints Director of Engineering

EUGENE F. GRANT has been named director of engineering of the National Company of Malden and Melrose, Mass. He will be responsible for all research, development and

Eugene F. Grant

engineering activities at National.

Previously, he was an engineering manager at W. L. Maxson. Before that he was chief, computor branch, air defense group, at the Air Force Cambridge Research Center. Previously, at Sperry Gyroscope and Westinghouse Research Labs, he was project engineer and research engineer respectively.

Motorola Plans Another Phoenix Plant

MOTOROLA plans to build a second plant at Phoenix, Ariz., to employ between 400 and 500 persons with an annual payroll of more than $2 million.

The company will manufacture small precision items, similar to the electronics projects under way at its present Phoenix plant.

The company has acquired 18 acres for its plant site and plans to construct a 200 x 260 ft concrete structure.

Construction of the new plant is expected to start by spring.

Lynch Named Brush President

DOUGLAS C. LYNCH, executive vice-president of Brush Electronics Co. of Cleveland, has been named president of the company, a unit of Clevite Corp.

He joined the firm in 1952, having previously been head of the international operations of Crosley Division of Avco and later a

senior staff executive of Willys-Overland Motors.

Du Mont Selects Manufacturing Head

F. P. RICE has been appointed to the newly created position of director of manufacturing and purchasing for A. B. Du Mont Labs.

Rice, who had been manager of the firm's cathode-ray tube division, will supervise manufacturing and purchasing activities. He joined Du Mont in 1942 and had wide experience in a number of manufacturing and management posts with the pioneer electronics manufacturer. He has successively served as assistant to the general manager, as general purchasing agent, general production control manager, manager of the company's television receiver cabinet department, vice-president of a Du Mont-owned cabinet manufacturing subsidiary, as the company's training director and, since 1950, as assistant manager and then manager of the cathode-ray tube division.

Wireless Operators Honor Houck

HARRY W. HOUCK, president and general manager of Measurements Corp. of Boonton, N. J., subsidiary of Thomas A Edison, was awarded the Marconi Memorial Gold Medal for achievement in the field of radio and wireless by the Veterans Wireless Operators Association.

His work with the Signal Corps in 1918 brought Houck into direct contact with Edwin H. Armstrong, who was engaged at the time in development work on direction finding and communications equipment. They formed a team which was subsequently to produce the superheterodyne radio receiver. Later Houck designed the "second harmonic" superheterodyne broadcast receiver for commercial production. His research on capacitors made practicable the filter systems used in receivers, and his pioneer work on alternating current operated radio receivers resulted in many patents.

Following engineering and research posts with many leading

companies Houck joined Measurements Corp. in 1940. The firm was purchased by Edison in 1953.

Allen D. Cardwell Elects New President

PETER L. STONE has been elected president of Allen D. Cardwell Electronics. Stone, who was also named to the firm's board of directors, replaces Ralph H. Soby, who has resigned as president and has been appointed special consultant.

Peter L. Stone

Richard O. Kennedy, Jr., who has been assistant to the president, was named vice-president of the Plainville, Conn. subsidiary of Chesapeake Industries.

Stone has been executive vice-president and a director of Ludlow Manufacturing and Sales Co. of Boston. Before coming to Ludlow in 1943, he had been assistant to the president of Harrisburg Machinery Corp. and with Sperry Gyroscope as materials engineer.

Burroughs Corp. Promotes Wockenfuss

WILLIAM WOCKENFUSS, vice-president of engineering at Control Instrument Co., Burroughs Corp. subsidiary in Brooklyn, N. Y., was named assistant vice-president of engineering of the parent company.

Wockenfuss will continue in the same position at Control Instrument and will assist in carrying out the overall product development program of the corporation.

Wockenfuss joined the subsid-

NEW Subscription Order

Please enter my new subscription for
TWO YEARS of ELECTRONICS for $9.

If you prefer 1 year of ELECTRONICS for $6 check here ☐

C-

Name:..... Position.....

Home Address:.....

City:..... Zone..... State.....

Company Name:.....

Foreign Rates (1 year) Canada $10, Latin America $15, Other $20 L 4-55

NOTICE TO PUBLISHER OF CHANGE OF ADDRESS

Please change the address for my copies of

ELECTRONICS

FROM .....
(Street Number, Apt. Number, P. O. Box Number or RFD Number)

.....
(City) *(Zone Number)* *(State)*

.....
(Show any numbers or dates included in address on copies for identification)

TO .....
(New Address—Street and No., Apt. No., P. O. Box No., or RFD Number)

.....
(City) *(Zone Number)* *(State)*

NAME ..... Date.....
(As it appears on your magazine) L 4-55

Postage Will be Paid by McGraw-Hill Pub. Co.

No Postage Stamp Necessary if Mailed in the United States

BUSINESS REPLY CARD

First Class Permit No. 64 (Sec. 34.9, P. L. & R.) New York, N. Y.

4¢ POSTAGE WILL BE PAID BY —

McGRAW-HILL PUBLISHING CO., Inc.

ELECTRONICS

330 WEST 42nd STREET

NEW YORK 36, N. Y.

Postage Will be Paid by McGraw-Hill Pub. Co.

No Postage Stamp Necessary if Mailed in the United States

BUSINESS REPLY CARD

First Class Permit No. 64 (Sec. 34.9, P. L. & R.) New York, N. Y.

4¢ POSTAGE WILL BE PAID BY —

McGRAW-HILL PUBLISHING CO., Inc.

ELECTRONICS

330 WEST 42nd STREET

NEW YORK 36, N. Y.

iary company in 1945 and was named vice-president two years ago. He also serves on its board of directors.

Systems Center Opened By GE

GENERAL ELECTRIC formally opened a new 100,000 sq ft system center in Syracuse, N. Y. for its heavy military electronic equipment department.

The center will serve as headquarters for the company's development and manufacturing operations on electronic nerve centers for military use.

The new two-building center has space for over 700 of the department's 3,300 employees in the Syracuse area. They previously worked at other locations in the area.

Its major programs are in the military fields of air defense, ground warfare, communications, anti-submarine operations, strategic air operations, missile control, radiation instrumentation, air navigation and traffic control and components and circuitry.

Iron Fireman Elects New President

WAYNE F. STRONG was elected president of Iron Fireman Manufacturing Co. Strong was first employed as a shipping clerk at the original Iron Fireman plant in Portland, Oregon 26 years ago. In 1953, he was transferred to Cleve-

Wayne F. Strong

land and elected vice-president in charge of manufacturing for Iron Fireman plants located in Cleveland, Portland, and Toronto, Canada. Prior to that he was manager of the Iron Firemen Electronics Division in Portland for eight years.

Pacent Named Emerson Works Head

LOUIS G. PACENT, Jr., was appointed works manager of Emerson Radio succeeding Edward J. Kelly, vice-president in charge of manufacturing who has resigned. Pacent had been vice-president in charge of manufacturing of Quiet Heet Manufacturing Corp., Emerson subsidiary.

He has been associated with the company since 1944 when he became its chief industrial engineer. From 1946 to 1949, Pacent was works manager, then vice-president in charge of manufacturing of Radio Speakers, an Emerson subsidiary. In 1954, he was named Quiet Heet's works manager and later was elected vice-president in charge of manufacturing.

Electrosonic Firm Formed In New York

EASTERN Electrosonic Industries has been formed in New York, N. Y. merging with Alcar Instruments of Little Ferry, N. J., manufacturers of ultrasonic and electronic equipment. President of the new company is Francis Hekking. Jack Strauss, president of Macy's is a director. Alcar plans to move to a new and larger plant in Little Ferry.

Mitchell Re-assumes Sylvania Presidency

DON G. MITCHELL, chairman of the board of Sylvania, has been elected president of the company to fill the vacancy caused by the death of H. Ward Zimmer. Mitchell will serve in the dual capacity for an indefinite period.

He joined Sylvania as vice-president in charge of sales in 1942. After nearly four years in that

capacity, he was elected executive vice-president in January, 1946, and president in May of the same year. He was elected chairman in 1953.

Sylvania also announced that Rudolf G. E. Hutter has been appointed manager of its physics laboratory.

Rudolph G. E. Hutter

Formerly manager of the physical electronics branch of the labs, Dr. Hutter has been with the Sylvania Laboratories since 1944.

Born in Berlin, Germany, Dr. Hutter was a research physicist in the transmitter laboratories at Telefunken, G.M.B.H. from 1936 to 1938. He was chief engineer of KZIB, Manila, Philippine Islands from 1939 to 1940. In 1941 he became a research associate in the division of electron optics at Stanford University.

American Electronics And Berlant Merge

AMERICAN ELECTRONICS of Los Angeles, Calif., has merged with Berlant Associates and its affiliate Tri-Di Sound Corp., both in Los Angeles, through a stock exchange of 28,360 shares for all common stock of Berlant. Berlant preferred will be exchanged for $108,000 principal amount 5-percent nonconvertible notes.

Both companies will operate under the name Berlant Instruments, as a subsidiary of Amer-

ican Electronics. Bert Berlant will continue as president and general manager.

Amateur Award Goes to Hamilton

NATION'S top radio amateur for 1954 visited the Pentagon during his trip to Washington, D. C. to receive the third annual Edison Radio Amateur Award sponsored by GE for outstanding public service. Winner Benjamin S. Hamilton, La Mesa, Calif., was shown the military amateur radio station in the Pentagon by Brig. Gen. Walter B. Larew, chief of army communications services division. He was presented the award for establishing a crack civil defense radio network in San Diego County. He has taught edectronics for eight years at the San Diego Junior College and Vocational School.

Western Electric Plans New Facilities

UNDER a contract with the United States Air Force, Western Electric plans construction of a four-story building of approximately 100,000 sq ft at McGuire Air Force Base near Wrightstown, N. J.

The building will be used as one of the operational facilities planned for the Continental Air Defense System.

New Ultrasonic Firm Established

THE GENERAL Ultrasonics Co. has been formed in Hartford, Conn. to manufacture and market industrial ultrasonic processing equipment.

The new corporation will handle the Rich-Roth "400" ultrasonic generator and associated transducers.

Officers of the company are Alexander S. Keller, president and treasurer, Stanley R. Rich and Wilfred Roth, vice-presidents and Saul Seidman, secretary.

Rich and Roth are co-directors of Rich-Roth Laboratories of Hartford. They invented the Ultra-Viscoson, the ultrasonic instrument

for the continuous automatic measurement of viscosity. This development was sold about two years ago to Bendix Aviation. Rich-Roth Laboratories will continue its separate identity and activities under their direction.

CBS-Hytron Promotes Butcher

CHARLES BUTCHER has been promoted to manager of the Newburyport, Mass. receiving-tube operation of CBS-Hytron.

Butcher had been chief engineer at the Newburyport plant and has been associated with CBS-Hytron for over 20 years. He joined the company at the Salem plant, where he served as production supervisor and foreman. Transferred to Newburyport when the plant there was opened in 1942, he rose to the engineering position which he occupied until his promotion.

Teleregister Appoints Systems Engineer

THE TELEREGISTER CORP. appointed Samuel Levine as systems engineer. He was formerly deputy chief of the systems engineering section, radar systems branch at the Evans Signal Laboratory in Belmar, N. J.

Purchasing Agents Elect Officers

AT THE annual election of the P.A.'s Inc. the following officers were elected:

President, H. M. Munson of Bendix Radio; vice-president, S. Oser of Tech-Master; treasurer, A.

Schneiderman of Olympic Radio; corresponding sec, B. Ttimboli of C.B.S. Columbia and recording sec, S. Woolfson of Emerson Radio.

Opad Electric Formed In New York

THE OPAD ELECTRIC CO. has been formed in New York, N. Y. to design, develop and manufacture selenium rectifiers, battery chargers and battery testing equipment. Henry L. Opad, president of the newly formed organization and formerly one of the principals in the now dissolved firm of Opad-Green Co. states that production is already under way on all equipments previously manufactured by Opad-Green. Key personnel of the old firm has been retained.

Moloney Electric Names Winter

MOLONEY Electric Co. transformer manufacturer of St. Louis, Mo. appointed David F. Winter as director of research for its new engineering research and development laboratory.

Winter worked at the Radiation Laboratory of M.I.T. and became research associate from 1945 to 1948.

In 1948 he joined the staff of Washington University as an assistant professor of electrical engineering. In 1951 he was made an associate professor.

He joined Moloney as a consultant in 1950 and in 1954 obtained a

leave of absence from Washington University to continue the development of a speciality transformer section of the company.

The firm also appointed W. C. Reinhardt as laboratory supervisor. His new duties will consist substantially in assisting Winter. He will supervise the laboratory operations for research and development in the testing and application of new materials to transformer design. He joined the company in 1950.

Davis Heads Aerovox Research

AEROVOX established a West Coast Research Laboratory. It will be under the supervision of Arthur C. Davis as managing director. It will work primarily on research projects for the Cinema Engineering Division, the West Coast Division and Acme Electronics.

Davis is founder and chief engineer of the Cinema Engineering Division.

Parris Appointed by RETMA Engineering

C. A. PARRIS, a member of the engineering staff of NEMA since 1948, has joined the engineering department of RETMA as a staff engineer to handle military activities.

He will devote his time entirely to military engineering problems and specifications as an added service to Association members engaged in the production of military electronics equipment.

The RETMA Engineering Department has also established a military equipment panel under the chairmanship of H. M. Hucke of Bendix Radio. Under this panel, six committees will operate.

Aircraft Radio Acquires Orion Industries

AIRCRAFT RADIO of Boonton, N. J. bought Orion Industries of Richmond, Va. for $83,000 and acquired 10,000 shares of ARC stock. The acquisition involves two corporations and a partnership. Robert Haskins, Orion founder and presi-

dent, and John M. Walker, Orion's vice-president and secretary have joined ARC's research staff.

Haskins was project engineer with Sperry Gyroscope Co. from 1941 to 1944 and from 1944 through part of 1946 he was with the bombing and torpedo section of the Bureau of Aeronautics. Haskins founded Flight Research Engineering Corp. in 1946. In 1953 he and Walker organized Orion Industries, Inc., Orion Sales Corp. and Haskins & Co.

Walker was with Westinghouse for a year and then went into the Navy. He was secretary-treasurer of Experiment of Richmond, joining Flight Research Engineering Corp. in 1950.

Sangamo Buys Gothard Manufacturing

THE SANGAMO Electric Co. of Springfield, Ill., through a wholly owned subsidiary, has acquired the assets of the Gothard Manufacturing Co., also of Springfield. The latter will operate under the name of Sangamo Generators. Officers and directors are all officials of the Sangamo Electric Co.

Langmuir And Moreno Join Ramo-Wooldridge

DAVID B. LANGMUIR and Charles A. Moreno have joined the staff of Ramo-Wooldridge Corp. of Los Angeles in its guided missile re-

David B. Langmuir

Charles A. Moreno

search division.

For more than 12 years Dr. Langmuir was engaged in government work with the AEC, the Defense Department and the Guided Missile Committee. Prior to his government service he was a research physicist with the Rand Corporation for 6½ years. Moreno's experience includes 8½ years as project engineer, senior project engineer and research engineer for Sperry Gyroscope as well as 1½ years as field engineer for Submarine Signal Co.

John G. Thompson Heads Heppner Plant

JOHN G. THOMPSON has become plant manager of Heppner Manufacturing Co. of Round Lake, Ill. Thompson was with Western Electric for 7 years. His next 15 years were with RCA. He next became product manager of the Westinghouse tube plant at Bath, N. Y. His new duties consist of supervising the manufacture of ion traps, focomags, centering devices and flyback transformers.

Austin Company Promotes Kuhnel

ALEXANDER H. KUHNEL has been named assistant manager of The Austin Company's Special Devices Division, which he will continue to serve in the capacity of division engineer.

Kuhnel joined Austin's Special Devices Division as an electrical

engineer in the summer of 1944 and for the past eight years has directed its industrial and military research and development program as division engineer.

Kuhnel spent 15 years in design work with Gibbs and Hill, the New York Board of Transportation and the M. W. Kellog Company, prior to joining the Austin organization.

Gudeman Moves To Larger Plant

THE GUDEMAN CO., electronic components manufacturer, has moved into a newly built factory in Sunnyvale, Calif. that is three times larger than the former building. The new structure is designed and equipped for the manufacture of paper, plastic dielectric and special capacitors.

AMF To Erect Radar Testing Range

AMERICAN Machine & Foundry Co. plans the erection of two radar-testing elevated platforms on the banks of the Housatonic River in Shelton and Seymour, Conn.

The range, with the towers a mile apart, will provide AMF's engineering laboratories in Greenwich, Conn. a means of testing the work it is carrying on in the realm of microwave analysis and radar antenna design. The labs recently leased 27,000 sq ft of space in Greenwich to be occupied eventually by 200 engineers and aides.

GPL Appoints Arne Wikstrom

ARNE WIKSTROM has been appointed senior staff member at General Precision Laboratory in Pleasantville, N. Y. Dr. Wikstrom has been director of research at Technical Service of Pontiac, Rhode Island, since the beginning of 1953.

He was previously consulting scientist at Woods Hole Institution; research engineer at Universal Winding and professor of electrical engineering at Brown University. From 1938 to 1947,

he was engaged by the U. S. Government in research and development in electronics, five years of which were in sonar.

Mallory Elects New Officers

G. BARRON MALLORY was elected a director of P. R. Mallory & Co. to fill the vacancy created by the death of Richard C. Hunt.

George M. Arisman, Jr., was elected controller of the company and Frank B. Powers, formerly vice-president in charge of manufacturing, was appointed operating vice-president. As such, he will

Frank B. Powers

have administrative responsibility for manufacturing, purchasing, labor relations and special assignments.

Norden-Ketay Leases Plant

NORDEN-KETAY has leased a 20,000 sq ft plant in New York City to expand its production of aircraft instruments. The new facilities will increase production capacity for these instruments by more than 50 percent.

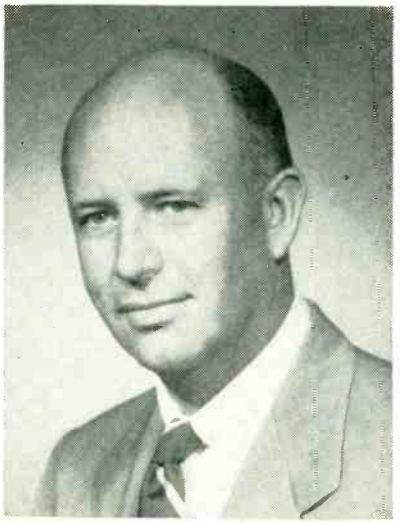
Philco Promotes Lagore And McLean

JOSEPH A. LAGORE was appointed vice-president of manufacturing and James D. McLean as vice president of sales of philco's Government and industrial division.

For the past 3 years, Lagore has been general manager in charge of

operations of the division. McLean has been general sales manager of the division since 1949.

Lagore joined Philco in 1928 as a tester on the radio production lines and soon became supervisor of the testing group. He was made operations manager of the radio and television division in 1950, a position he held for one year prior to becoming general manager in charge of operations of the government and industrial division.



Sweet Establishes New Company

MONROE H. SWEET, former Ansco physicist, has formed the M. H. Sweet Engineering Co. of Binghamton, New York.

The new company, of which Sweet is president, consists of a navigation division and a photometric division. It will also serve as consultant in the optical, photographic and aviation fields.

Associated with Sweet as chief engineer is James Casterlin, formerly of Ansco and Link Aviation who has had more than 15 years experience as a designer of cameras and other precision instruments.

Pruss Promoted By Audio Products

HUGH PRUSS has been named chief engineer of Audio Products Corp. of Los Angeles. He joined the company last year as head of the telemetering division. Pruss has been asso-

ciated with aviation electronics since 1941. His experience includes twelve years with Convair in the application of telemetering to missile instrumentation.

Prior to joining Audio Products, he was technical operations director and chief engineer of the telemetering division of Raymond Rosen Engineering Products of Philadelphia.

Lenkurt Electric Elevates Three

JOSEPH R. SHERMAN, Alden P. Bowser and Glenn R. Gunnison have been named to new positions with Lenkurt Electric Sales Co. of San Carlos, Calif.

Sherman, who joined Lenkurt in 1951, was appointed manager of component sales. Bowser was promoted to manager of carrier and radio sales. He was deputy chief of the electronics branch of CAA before joining Lenkurt last year.

Glenn R. Gunnison was named general manager of the company. He has been with Lenkurt since 1952 and was contract administrator prior to his new appointment.

Elcon Electronics Changes Its Name

ALL business formerly conducted by Elcon Electronics of Brooklyn, N. Y. will be carried on under the name of Armel Electronics.

Management or policy is not affected by the name change, according to the firm. Officers will remain: Carl E. Soderstrom, president; Walter S. Johnsen, vice-president and Alex K. Niemi, secretary-treasurer.

Constantin Names J. Comer

J. COMER has been appointed executive vice-president of L. L. Constantin & Co., manufacturers of glass to metal vacuum seals and other electronic components. He joined the firm in 1953 and was previously plant manager and chief engineer. Before that he was factory engineering manager for General Instrument.

NEW BOOKS

Noise

By ALBERT VAN DER ZIEL. *Prentice Hall, Inc., New York, N. Y.*, 1954, 450 *p*, $10.35.

THIS BOOK is an up-to-date treatise on fluctuation phenonema in electron devices and related systems. It includes a discussion of the extension of Nyquist's theorem to microphones, galvanometers, and the like and a chapter entitled Noise in Physical Instruments.

There is a good balance between theoretical work, experimental methods and the results of measurements made by the author and many others. Enough material is included from previously published work to save the reader the necessity of seeking these references. The book also includes background material such as the Lewellen-Peterson equations for vacuum tubes, the elements of semiconductor theory and a discussion of space-charge waves in electron beams. Although this background material is presented to assist the development of fluctuation-noise theory, it is sufficiently complete to be useful to the reader in other connections. The author disclaims any intention of dealing with those noise problems encountered in information theory, but the chapters on Statistical Methods and Fourier Analysis of Fluctuating Quantities and the appendix dealing with matrices and probability distribution functions, should be useful in that field as well as in the study of electron devices.

Other Headings

Some of the other chapter headings are Noise Measurements, Tube Noise at Low Frequencies, Tube Noise at High Frequencies, Practical Low-Noise Circuits, Excess Noise in Semiconductors and Vacuum Tubes, Noise in Feedback Circuits. There is no material dealing directly with fluctuation phenonema in television pick-up devices or grain structure in film.

This book can be recommended to anyone working with fluctuation-noise problems in the design or the application of electron devices. It will probably also be useful as a

graduate-level text. In addition, it is useful in suggesting methods of attack on noise problems for which solutions are still needed. W. A. HARRIS, *Radio Corporation of America, Harrison, N. J.*

Television (Second Edition)

By V. K. ZWORYKIN and G. A. MORTON. *John Wiley & Sons, Inc., New York,* 1954, 1,020 *p* +17 *index* +*xv*, $17.50.

FIFTEEN YEARS AGO, when television was still a highly experimental field of engineering, it was clearly evident that its commercial future was assured. The day of the Nipkow disk and the flashing gas-filled viewing tube had already passed, and the success of the all-electronic scheme, which is now the basis of the standard system, has been convincingly demonstrated.

It was at this time that the first edition of Zworykin and Morton's book was published, filling a definite need for a unified presentation of the engineering aspects of the rapidly-expanding field of television transmission and reception. The book was well received, and served for years as a standard reference. The new edition is obviously designed to serve in the same capacity, and while the task of preparing such a book was unquestionably an enormous one, the result is satisfying. As might be expected, engineering advances in the various branches of television technology have been so great that, despite the new book's more than one thousand pages, the treatment of various problems discussed is usually in outline form.

Structure

Organization of the material in the new edition follows closely that of the first, in which the various discussions were grouped into three parts. Parts I and II together cover basic physical principles; Part III, which constitutes nearly half the book, discusses the principal components of television systems. Part IV, which is entirely new, is devoted mostly to color television.

In Part I, the authors discuss those concepts of basic importance in the various electron devices used

in television. Included are chapters on physical electronics, fluorescent materials, electron optics and electron optical systems.

Part II is largely an exposition of the principles of black-and-white television and of the devices used. The descriptions are fairly simple, and while it would obviously have been impossible to cover these subjects adequately without the use of mathematics, the mathematics employed are not difficult.

Apparatus

In Part III the authors have provided what is probably the only reasonably complete treatment of the theory and application of television engineering principles to be found in a single volume. Chapters are included on the iconoscope, television pickup tubes, the kinescope, electron guns, video amplifiers, scanning and synchronizing, television receivers and television transmitters.

The last five chapters of the book constitute Part IV, which includes 175 pages in three chapters on the fundamentals and practical aspects of color television. The last two chapters are on industrial television and practical television systems.

Like almost any book of its size, the new edition of Zworykin and Morton has its flaws. These, almost invariably, can be attributed to the difficulty most writers who are not teachers encounter in stating a fact in such a way that the reader who does not already understand the concept can read exactly what the authors had in mind. While this often puts the more-or-less casual reader at a disadvantage, it should not constitute a serious handicap to the student or engineer who will follow through by consulting the references given at the ends of chapters.

In summary, the second edition of "Television" is an excellent piece of work that merits the high esteem earned by its predecessor. GEORGE D. O'NEILL, *Sylvania Electric Products Inc., Bayside, N. Y.*

Storage Batteries

By GEORGE WOOD VINAL. *John Wiley & Sons, Inc., New York, N. Y.*, 1955, *Fourth Edition*, 446 *p*, $10.

SOURCE of emergency power for electronic equipment, the storage

battery, by virtue of its long and faithful service, has little glamor. It has, however, developed in several different respects over the years, and the present revision of this text reflects changes that have taken place since about 1940.

In addition to improvements in lead-acid batteries, the book describes production of nickel-cadmium and silver-oxide types. Probably the most important new application of batteries in the electronics field is for microwave relay communications circuits. Introduction of 12-volt systems in automobiles and 24-volt (or higher) systems in aircraft directly affect the design of radio equipment.

Other chapters include information on materials and methods of manufacture, electrolytes, theory of reactions, energy transformation and voltage, capacity, operation, resistance, efficiency and testing methods.

The combination of older information with more recent details make a useful volume. The author's preface indicates a complete revision, with much rewriting, elimination of obsolete material and added illustrations.—A.A.McK.

Mathematics of Engineering Systems

By Derek F. Lawden, *John Wiley & Sons, Inc., New York, N. Y.*, 1955, 380 *p*, $5.75.

Engineers and physicists find a knowledge of higher mathematics indispensable in their work but during their college years they often find their schedules so crowded with essential scientific courses that they haven't the time to take up some of the topics in higher mathematics that they should have for a sound understanding of their respective fields.

This book is intended to provide a link between the conventional calculus text and higher treatises employing the methods of the theory of functions of a complex variable. It deals with mathematical systems that may be used to analyze the behavior of systems such as amplifiers, oscillators, networks, servomechanisms and regulators.

Topics covered include a review

of selected subjects from calculus and algebra, the solution of linear differential equations with constant coefficients by classical and modern methods including the Laplace transform, Fourier analysis and solution of nonlinear differential equations.

The book would be valuable for collateral reading by physical science students and engineers taking graduate work. For self study, answers are provided to many of the exercises.—J.M.C.

Analog Methods in Computation and Simulation

By Walter W. Soroka, *Professor of Engineering Design, University of California. McGraw-Hill Book Co., New York, N. Y., 1954, 390 p, $7.50.*

Recent advances in computers have been summarized in several books. Professor Soroka has broadened the perspective to bring together methods dating back to the turn of the century and to treat both mechanical and electrical methods. At the same time he has shifted the viewpoint from that of hardware, as treated in such books as "High-Speed Computing Devices" by the staff at Engineering Research Associates and "Electronic Analog Computers" by the team of Korn and Korn and Svoboda's volume in the MIT Radiation Laboratory Series (also McGraw-Hill Publications), more to that of the mathematical methods to be instrumented. The treatment is more like that of Lipka in "Graphical and Mechanical Computation" published by John Wiley & Sons. Thus the present book lies between the engineering texts and such mathematical surveys as Sokolnikoff and Sokolnikoff or Karman and Biot.

The avowed purpose of the book is to provide a broad review, augmented by references to detailed treatments, that will point out the utility of analogies and thereby lead individuals to more intensive studies of special problems. In this the book should prove highly successful. It is both a guide to the subject matter and to the literature. The designer may not find solutions to his specific problems here but the systems engineer

will find the general methods summarized by which he can translate his problems into block diagrams.

Contents

The content of the book is grouped as follows. Analogies, first mechanical then electrical, are developed for the various arithmetical processes. These are combined into analog computers for linear simultaneous algebraic equations, polynomial equations and ordinary differential equations. The mechanical differential analyzer and the electronic analog computer are discussed in this connection.

In the seventh chapter the dynamical similarity between electrical circuits and mechanical systems is taken as the basis for representing mechanical systems in lumped form by equivalent electrical circuits with lumped parameters. In the eighth chapter, ordinary and partial differential equations of various degrees of complexity, linear and nonlinear, are expressed in finite differences and electrical networks are developed for their solution. The final chapter is devoted to a study of membranes and of electrically conducting sheets as simulating devices for continuous systems.

Both the treatment and the writing are lucid. For an example of the writing, the two paragraphs above are quoted nearly verbatim from the author's preface because they describe the book so aptly. The presentation of secular-equation computers (p 120-126) is typical of the treatment. First there is an introductory discussion of the mathematics involved to refresh one's memory and to define the terminology and the problem. This is followed by a description of the machine.

A book of this sort finds its greatest use as a reference at the outset of a project. It is well suited for such use, presenting such needed facts as realizable accuracies. However, the four-page index is completely inadequate. The reader will soon observe that he can locate a subject faster by running through the table of contents than by referring to the index.

No consistent basis is used for the entries. Under adders is a sub-

entry for errors. Under errors is a subentry for adders. Thus there is some cross indexing; but wait. Also under errors is a subentry for differentiators, but there is not even an entry for differentiators let alone a cross-reference to errors. Rather, the index deals with this subject as a process (differentiation) rather than as a mechanism (differentiator); still no cross-reference.

If one went by the index, he would conclude that division (or divider) was omitted from the book. Quite the contrary; both mechanical (p 22-23) and electrical (p 71-75) division are treated. But all this does not mean that the lack of a useful index detracts from the book. The author has organized his material so well that one can usually locate pertinent information directly from the table of contents.

The book fills its intended purpose, the more so because of its copious footnote references to source material. The author has provided a guide to mathematical instrumentation at a time when such devices have proved their utility in the laboratory and are moving into the office and factory. The book goes on the shelf next to "An Index of Mathematical Tables," by Fletcher, Miller and Rosenhead. —F. H. ROCKETT, *Research and Engineering Division, Airborne Instruments Laboratory, Inc., Mineola, N. Y.*

On The Air: A study of broadcasting in sound and television.

By ROGER MANVELL. *The British Book Centre Inc., New York, N. Y.* 1954, 202 *p*, $3.50.

INCREASING AWARENESS of the importance of broadcasting as a tool of either propaganda or education makes any serious-minded book on the subject a matter of interest. Although the volume reviewed contains material primarily sociological in nature, it reads rapidly enough that the communications engineer may easily absorb its many points of importance.

Written with its focus upon the British Broadcasting Corporation, the book does a good job of explain-

ing a broadcasting phenomenon unfamiliar to the average American. It reviews, as well, the systems of control and programming in the United States, Canada, Russia, Australia and New Zealand.

While to the non-British reader the author's preoccupation with the effect of BBC's monoply of broadcasting may seem single-minded, the example of this monoply stands conveniently for scrutiny by the rest of the world.

The fact that commercial television may shortly compete (under the new law that says BBC must first achieve reasonable national coverage) with governmentally controlled telecasting is likewise interestingly explained.—A.A.McK.

THUMBNAIL REVIEWS

Vorschaltgerate und Schaltungen für Leuchtstofflampen. By Carl Heinz Strum. Brown, Boveri & Cie., Mannheim, Germany, 1954, 263 p. A vest-pocket size handbook on fluorescent lamp techniques, in German.

Cook Technical Review, Vol. 1, No. 1, Cook Electric Co., Chicago, Ill., 1954, 113 pages, $1.00. A collection of papers, some reprinted from *Review of Scientific Instruments*, ELECTRONICS etc., and some original, dealing with servomechanisms and related subjects.

Magnetic Control of Industrial Motors. By Gerhart W. Heimann, John Wiley & Sons, Inc., New York, N. Y., 1954, 714 p, $9.50. A second edition of a text first published in 1947, considerably enlarged and with new material on adjustable voltage and regulating systems, rotating and magnetic amplifiers. Thoroughgoing text on motors and circuits, operator protection, installation, pilot devices etc.

Obtaining and Interpreting Test Scope Traces. By John F. Rider. J. F. Rider Publisher, Inc., New York, N. Y., 1954, 186 p, $2.40. Practical operating instructions for engineers and technicians using scopes in connection with maintenance and production of electronic equipment, applicable to a general variety of scope models. Chief emphasis throughout is on waveforms —interpreting them and choosing the most useful presentation for each problem.

Analyzing and Tracing TV Circuits. By Milton S. Kiver. Howard W. Sams & Co., Indianapolis, Indiana, 1954, 146 p, $3.00. Practical suggestions for interpreting information shown on schematic circuit diagrams of tv receivers and analyzing circuit operation.

BACKTALK

Four Decades Ago

DEAR SIRS:

I READ WITH considerable interest the article, "Keying VLF Transmitters at High Speed" by M. I. Jacob and H. N. Brauch. In the described transmitter circuit a saturable reactor plays an important part. (p 148, Dec. 54)

For those readers who are interested in previous applications of saturable reactors to communication circuits, I would like to point out the following reference: "Magnetic Amplifiers for Radio Telephony" by E. F. W. Alexanderson and S. P. Nixdorff, *Proc. IRE*, April 1916, p 101–129.

DR. H. F. STORM
General Engineering Laboratory
General Electric Co.,
Schenectady, N. Y.

More Pot Data

DEAR SIRS:

CONGRATULATIONS on the excellent article on precision potentiometers in the October issue. We have yet to find a more comprehensive study by a nonpartisan author like Frank Rockett.

Unfortunately, some typographical errors crept into the data on our miniature potentiometer. Temperature coefficient should have been —0.01 percent rather than the plus-or-minus shown; power dissipation derates to 0 at 90 C, not 65; and the decimal point on the torque slipped from 0.05 to 0.5 ounce-inches.

Best wishes for continued high standards and informative articles.

MELVIN LINDNER
Chief Engineer
Elektro-Serv Co.
Brooklyn, N. Y.

Production Problem

DEAR SIRS:

AS AN AMERICAN engineer, for many years employed in Europe and Africa, I have had an opportunity to view a wide variety of American and European electrical and electronic gear. I have recently become aware of certain conditions which I feel should be brought to the attention of the industry.

A short time ago, I had occasion

to replace a 133-kva transformer manufactured in America with a similar one of German manufacture. The defective transformer was mounted in a steel-enclosed welded frame. Before the defective coils could even be examined, it was necessary to cut the frame apart with a torch.

Examination of the coils showed that they had been wound in a very sloppy manner. The various pies had been laced together in a most unhappy spider-web pattern, and the whole thing had been immersed in insulating varnish, leaving long stalactites hanging everywhere. . .

The German transformer was mounted in a ruggedly built, bolted frame. The windings were neatly, almost perfectly wound. The coils had been carefully varnished and baked, with no evidence of excess varnish to be seen.

A group of German engineers working on the installation did not miss the opportunity to draw their own conclusions about American workmanship, and with the evidence so nakedly displayed, it was hard to disagree with them.

Certainly American industry in its broadest scope is so far superior to European industry as to defy comparison, but it is clear to me that American industry can not hope to maintain world leadership, so long as it is content to market shoddy products. For years, American labor has paid for its tremendous gains with increased productivity. It now appears that this is no longer true.

America is presently able to outstrip the rest of the world, only in such production as lends itself to present-day automation and assembly-line techniques. Low-cost European craftsmanship is no myth. It is an ever-increasing threat to America's export market.

This is not a "Letter to the Editor" in its usual sense. . . But I do hope . . . the American electrical and electronic industry (will awaken) to the danger which will beset it, if some means are not immediately taken to restore pride in workmanship, and thereby offer goods of a higher quality to the world market.

ANONYMOUS

PROFESSIONAL SERVICES

Consulting—Patents—Design—Development—Measurement

in

Radio, Audio, Industrial Electronic Appliances

AIRPAX PRODUCTS CO.

Development Division

Specialists in the
Design and Manufacture of
UNUSUAL TRANSFORMERS AND RELAYS

Middle River — Baltimore 20, Md.

Consult these SPECIALISTS

Let them save your time by bringing their broad experience in their specialty to bear on your problems.

NIAGARA ELECTRON LABORATORIES

CONSULTATION - DESIGN - CONSTRUCTION
MFG. THE THERMOCAP RELAY

Specializing in solution of problems of electronic and electro-physical instrumentation for the research or analytical laboratory. Industrial plant problems also invited.

Andover, New York Cable Address: NIATRONLAB

ANALYSIS INSTRUMENT CO.

Consultants on Magnetic Problems

Magnetic Materials Tested
Special Magnetic Devices Designed
Magnetizing & Testing Equipment Supplied

P. O. Box 7 — Pequannock, New Jersey

HANSON-GORRILL-BRIAN INC.

Product & Mfg. Development

ELECTRICAL - ELECTRONIC
HYDRAULIC - MECHANICAL

One Continental Hill — Glen Cove, N. Y.
Glen Cove 4-7300

PICKARD & BURNS, INC.

Consulting Electronic Engineers

Analysis and Evaluation
of Radio Systems

Research, Development and Production
of Special Electronic Equipment

240 Highland Ave. — Needham 94, Mass.

THOMAS H. BRIGGS & ASSO.

Electronics Consultants

Electron Tubes - Automation - Product Surveys
Specializing in Tube Materials & Reliability.
Development of circuits and servo-mechanisms.
Engineering and production facilities.

Box 185 RD#2 — Tel. 8-7671
Norristown, Pennsylvania

INTERFERENCE MEASUREMENT LABORATORY

Interference Study per Government Specifications
Shielded Space for Interference Investigation
Field Surveys for F.C.C. Certification of Induction and Dielectric Heating Equipment

907 East 51st Street • Brooklyn 3, New York
Ingersoll 9-1765

ALBERT PREISMAN

Consulting Engineer

Television, Pulse Techniques, Video
Amplifiers, Phasing Networks,
Industrial Appliances
Affiliated with
MANAGEMENT-TRAINING ASSOCIATES

3224-16th St., N. W. — Washington 10, D. C.

CROSBY LABORATORIES, INC.

Murray G. Crosby & Staff

Radio - Electronic
Research Development & Manufacturing
Communication, FM & TV

Robbins Lane, Hicksville, N. Y.
Hicksville 3-3191

THE KULJIAN CORPORATION

ELECTRONICS DIVISION

Consulting Electronic Engineers

•

Research, Development, Production of
Automatic Controls—Special Instrumentation

1200 No. Broad St., Philadelphia 21, Pa.
Stevenson 2-9000

JOSEPH RACKER CO., INC.

HOW *GOOD* IS YOUR *NEW PRODUCT*?
NEW PRODUCT CONSULTANTS

A complete service for your new product
Evaluation . . . Market Research . . . Sales Building
Commercialization . . . Financing . . . Promotion
. . . Production

140 Nassau St., New York 38, N. Y. — Worth 4-1463

EDGERTON, GERMESHAUSEN & GRIER, INC.

Consulting Engineers

Stroboscopy — Transient Oscillography
Photoelectricity — Pulse Techniques — Timing
High-Speed and Electronic Flash Photography
Telemetering - Industrial Television Applications

160 Brookline Avenue — Boston 15, Mass.

ROBERT McCABE

Radio Noise Measurement and Elimination
Field Intensity Surveys

1781 Bide-a-Wee Park — Columbus 5, Ohio

THE TECHNICAL MATERIAL CORPORATION

Communications Consultants

Systems Engineering

General Offices and Laboratory
700 Fenimore Rd., Mamaroneck, N. Y.

Eldico of New York, Inc.

Pioneers of Television Interference Elimination from Transmitters, Induction Heaters, Diathermy and etc.

Donald J. S. Merten & Engineering Staff

70 E. Second St. — Mineola, L. I., N. Y.
Garden City 7-0383

Measurements Corporation

Research & Manufacturing Engineers

HARRY W. HOUCK — MARTIAL A. HONNELL
JOHN M. VAN BEUREN

Specialists in the Design and
Development of Electronic Test Instruments

Boonton, New Jersey

TELECHROME, INC.

Electronic Design Specialists

COLOR TELEVISION EQUIPMENT

Flying Spot Scanners, Color Synthesizers, Keyers, Monitors, Oscilloscopes and Related Apparatus
J. R. Popkin-Clurman, *Pres. & Ch. Engr.*

88 Merrick Rd. — Amityville, L. I., N. Y.

ELECTRONIC RESEARCH ASSOCIATES, INC.

"TRANSISTORIZE" YOUR PRODUCT!

Complete Service in consulting, research, development, and production on Transistor circuitry, products and instrumentation.

67 East Centre Street — Nutley, N. J.
NUtley 2-5410

MERCURY ELECTRONIC COMPANY

Power Supplies

Electronic • Magnetic • Static

Red Bank — New Jersey

WHEELER LABORATORIES, INC.

Radio and Electronics
Consulting — Research — Development
R-F Circuits — Lines — Antennas
Microwave Components — Test Equipment
Harold A. Wheeler and Engineering Staff

Great Neck, N. Y. — HUnter 2-7876

ERCO RADIO LABORATORIES, INC.

Radio Communications Equipment

Engineering - Design - Development - Production
Our 25th Year in Air to Ground
Communications and Radio Beacons

Garden City • Long Island • New York

NEW ROCHELLE TOOL CORP.

FOR CERTIFICATION OF INDUCTION AND DIELECTRIC HEATING EQUIPMENT IN ACCORDANCE WITH F.C.C. RULINGS

Mobile Test Unit Available Entire U. S.

320 Main St. — New Rochelle, New York
Phone NE 2-5555

YARDNEY LABORATORIES, INC.

Research - Design - Development

Electro-Chemical Generators of Energy

40-46 Leonard Street — Worth 6-3100
New York 13, N. Y.

CHIEF ACOUSTICAL ENGINEER
COMMUNICATIONS INDUSTRY

Exceptional opportunity with medium-sized progressive Eastern manufacturer of electro-acoustic transducers such as microphones and receivers for military and industrial use.

Must have administrative ability with a record of at least ten years in design and related production and be a recognized authority in this field. Age 35-45.

Education: Minimum B.S. degree, or additional 5 years' experience plus university study.

APPROPRIATE SALARY ARRANGED
AGENCY FEE PAID

Please mail duplicate resume in confidence or phone

H. B. HERBERT

EXECUTIVE SERVICE CORPORATION
Established 1919 (Agency)

19 West 44th St.,
New York 36, N. Y.
Murray Hill 2-4000

Electronic Engineering Company *of California*

The Electronic Engineering Company of California is an independent firm engaged in the design, development and fabrication of electronic equipment for private industry and the Armed Forces. Founded and managed by electronic engineers, the Electronic Engineering Company offers a broad background of experience, highly trained personnel, excellent facilities plus a well integrated, expanding organization.

The Electronic Engineering Company has openings for engineers with experience and background in industrial and military electronics.

Please send resume of experience and education with salary requirements to:

Electronic Engineering Company *of California*
180 SOUTH ALVARADO STREET
LOS ANGELES 57 CALIFORNIA

ELECTRONIC ENGINEERS

Technical Operations, Inc., is looking for an electronic engineer with three to five years of experience, capable of supplying original ideas in the fields of transistor circuitry and operations research instrumentation. Join an expanding research and development organization located in suburban Boston. Please send complete resume and requirements to:

R. R. SMYTH

Technical Operations, Inc.

6 Schouler Court Arlington 74, Mass.

ENGINEERS—ADMINISTRATORS
—SALESMEN—EMPLOYERS

Confidential, rapid and professional service for nation wide placement in the Electronics field. Write giving age, education and brief experience. Employers send us job description. We will let you know how we can help you by return mail.

Graebner's Electronics Exchange
"The Nation's Largest"
116 South Michigan Chicago 3, Illinois

ENGINEERING DEGREES
(Under and Postgraduate)
E.E. Major in Electronics,
Earned Through Home Study.
AMERICAN COLLEGE OF ENGINEERING
Box 27724(G),
HOLLYWOOD 27, CALIF.

REPLIES (Box No.): Address to office nearest you
NEW YORK: 330 W. 42nd St. (36)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

POSITION VACANT

ELECTRONICS ENGINEER. Eng. degree preferred but not required. Must be familiar with industrial electronics and instrumentation. Majority of time to be spent on product development and application of electronics to various testing devices. Harry W. Dietert Co., 9330 Roselawn Ave., Detroit 4, Michigan.

SELLING OPPORTUNITY OFFERED

SALES ENGINEERS Wanted—excellent opportunities for several engineers with well established East Coast instrument manufacturer now expanding its line of aviation products which includes electronic and electro-mechanical components for jet engines and guided missiles. Electrical engineering background essential. Contacts within the aircraft industry desirable. Openings in Los Angeles, Dallas, and East Coast areas. Generous company paid benefits include hospitalization, pension, insurance, and vacation plans. SW-5630, Electronics.

POSITIONS WANTED

CHIEF ENGINEER, cathode ray tubes, development, production design, screening and aluminizing techniques, and all other factory processes. Desires top level offer. Available shortly. PW-5742, Electronics.

COMPONENT PARTS, missiles, avionics, and military electronics, 15 years experience, BSRE, capable of installing and supervising a test lab to evaluate parts for tough environments. Mandatory position be genuine. PW-5825, Electronics.

CONTRACT WORK WANTED

Small Electronic units or assemblies to wire, Eastern Electronic Service, Box 213, Maple Shade, New Jersey.

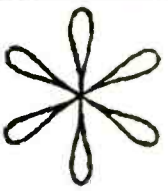
ASSISTANT TO DR. CARDELL

Medium size subsidiary of large corporation has small, but rapidly expanding Research and Development Division. Administrative experience or potential in civilian or military electronics shall receive favorable consideration.

This seems to us a "once in a lifetime" opportunity, where politics nor lack of capital, equipment nor contracts can ever limit your horizon.

Starting salary $9600-$12,000 plus usual incentives and fringe benefits. Company pays interview expense, our fee and your relocation expenditures.

28 E. Jackson, Chicago 4 WAbash 2-9400
MONARCH PERSONNEL



B.S.E.E.

for dynamic sales representation in the West contact

*ASSOCIATED SALES ENGINEERS

a **B.S.E.E.** *organization*

2140 Westwood Blvd., Los Angeles 25, Calif.
ARizona 9-2253

SCIENTISTS:

Check the chart below for openings in your field.

FIELDS OF ENGINEERING ACTIVITY	TYPE OF DEGREE AND YEARS OF EXPERIENCE PREFERRED											
	Electrical Engineers			Mechanical Engineers			Physical Science			Chemistry Ceramics Glass Technology Metallurgy		
	1-2	2-3	4+	1-2	2-3	4+	1-2	2-3	4+	1-2	2-3	4+
SYSTEMS *(Integration of theory, equipments, and environment to create and optimize major electronic concepts.)*												
AIRBORNE FIRE CONTROL			W						W			
DIGITAL DATA HANDLING DEVICES			C			C			C			
MISSILE GUIDANCE			M			M			M			
INERTIAL NAVIGATION			M			M			M			
COMMUNICATIONS		F	C O F					F	C O F			
DESIGN • DEVELOPMENT												
COLOR TV TUBES—Electron Optics—Instrumental Analysis—Solid States (Phosphors, High Temperature Phenomena, Photo Sensitive Materials and Glass to Metal Sealing)	L	L	L	L	L	L	L	L		L	L	L
RECEIVING TUBES—Circuitry—Life Test and Rating—Tube Testing—Thermionic Emission	H	H	H		H	H		H			H	H
MICROWAVE TUBES—Tube Development and Manufacture (Traveling Wave—Backward Wave)		H	H	H			H	H			H	H
GAS, POWER AND PHOTO TUBES—Photo Sensitive Devices—Glass to Metal Sealing	L	L	L	L	L		L	L		L	L	
AVIATION ELECTRONICS—Radar—Computers—Servo Mechanisms—Shock and Vibration—Circuitry—Remote Control—Heat Transfer—Sub-Miniaturization—Automatic Flight—Design for Automation—Transistorization		F	M C F		F	M C F		F	M C F			
RADAR—Circuitry—Antenna Design—Servo Systems—Gear Trains—Intricate Mechanisms—Fire Control		F	M C F		F	M C F		F	M C F			
COMPUTERS—Systems—Advanced Development—Circuitry—Assembly Design—Mechanisms—Programming	C	C F	M C F	C	C F	M C F	C	C F	M C F			
COMMUNICATIONS—Microwave—Aviation—Specialized Military Systems		F	M C F		F	M C F		F	M C F			
RADIO SYSTEMS—HF-VHF—Microwave—Propagation Analysis—Telephone, Telegraph Terminal Equipment		O	O F		O	O F		O	O F			
MISSILE GUIDANCE—Systems Planning and Design—Radar—Fire Control—Shock Problems—Servo Mechanisms		F	M F		F	M F		F	M F			
COMPONENTS—Transformers—Coils—TV Deflection Yokes (Color or Monochrome)—Resistors		C	C		C	C		C	C			
MACHINE DESIGN Mech. and Elec.—Automatic or Semi-Automatic Machines		H	H		H	H		H	H			

Location Code

C—Camden, N. J.—in Greater Philadelphia near many suburban communities.

F—Florida—on east central coast.

H—Harrison, N. J.—just 18 minutes from downtown New York.

L—Lancaster, Pa.—about an hour's drive west of Philadelphia.

M—Moorestown, N. J.—quiet, attractive community close to Phila.

O—Overseas—domestic and overseas locations.

W—Waltham, Mass.—near the cultural center of Boston.

Please send resume of education and experience, with location preferred, to:

Mr. John R. Weld, Employment Manager
Dept. C-3D, Radio Corporation of America
30 Rockefeller Plaza
New York 20, N. Y.

RCA®

RADIO CORPORATION OF AMERICA

GOOD ENGINEERS GO with GOODYEAR AIRCRAFT

Forceful, creative thinking by top-flight engineers is the key to Goodyear's progressive research and development programs.

Experienced engineers . . . men with ability and imagination . . . do top work for Goodyear. Positions are open to qualified physicists and electronic, electrical, and mechanical engineers for research, design, development, and product engineering in these fields:

Electro-mechanical	Pulse Techniques
Microwave	Weapons Systems
Servomechanisms	Antenna Design
Electronic Packaging	Miniaturization

Send a résumé of your qualifications or request application—

C. G. Jones, Salary Personnel Department

GOODYEAR AIRCRAFT CORPORATION

1210 Massillon Road Akron 15, Ohio

GOODYEAR AIRCRAFT

Admiral Increases ENGINEERING STAFF

Diversification at ADMIRAL is making itself felt in more and better engineering careers.

Real ability and originality can find new challenge and opportunity with a leader in electronic development and manufacturing.

Positions available for engineers with the following backgrounds:

★ MICROWAVE ENGINEERS

Experienced in UHF and SHF circuitry and components, with understanding of wave guides, cavities, and duplexers.

★ ELECTRONIC ENGINEERS

Junior and Senior engineers for television receiver circuit design. Experienced men also needed for V.H.F. and U.H.F. tuner work.

★ RADIO ENGINEERS

Duties involve designing household and portable radio receivers. FM and AM experience preferred.

★ MECHANICAL ENGINEERS

Electro-Mechanical designers. Assignments involve the design and layout of small mechanical devices at the development level.

★ COMMUNICATIONS ENGINEERS (MILITARY)

Applied development and design of radar and other specialized military systems.

★ AUTOMATION ENGINEERS

A special opportunity exists in the field of applying automation and printed circuit techniques in the above categories. Your imagination and engineering talents can be used in furthering this development.

Good starting salaries and working conditions with complete program of employee benefits. Opportunity for professional development with excellent facilities in Chicago area to carry on University graduate work while working full time.

● Send complete resume to Mr. Walter Wecker, Personnel Department, to get more information on these opportunities.

Admiral Corporation
3800 W. Cortland St.
Chicago 47, Illinois

ENGINEERS

The APPLIED PHYSICS LABORATORY OF THE JOHNS HOPKINS UNIVERSITY offers an exceptional opportunity for professional advancement in a well-established laboratory with a reputation for the encouragement of individual responsibility and self-direction. Our program of

GUIDED MISSILE
DEVELOPMENT

provides such an opportunity for men qualified in:

ELECTRONIC CIRCUIT DESIGN AND ANALYSIS
DEVELOPMENT AND APPLICATION OF TRANSITOR CIRCUITRY
SERVOMECHANISMS AND CONTROL
SYSTEM ANALYYSIS
ELECTRONIC EQUIPMENT PACKAGING
INSTRUMENT DESIGN
MISSILE SYSTEMS DEVELOPMENT
FLIGHT TESTING

Please Send your resume to

Professional Staff Appointments
APPLIED PHYSICS LABORATORY
THE JOHNS HOPKINS UNIVERSITY
8621 Georgia Avenue
Silver Spring, Maryland

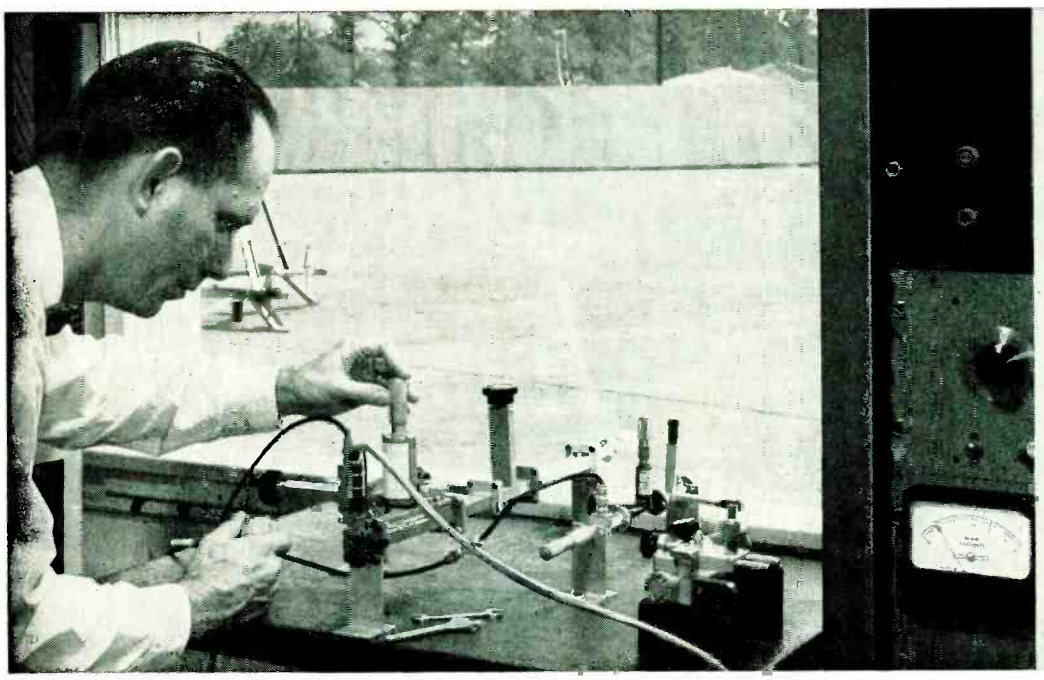
Electronic Engineers
Mechanical Engineers
Physicists

• • • • • •

Expanding operations in ORDNANCE DEVELOPMENT including guided missiles, fuzes and safety and arming devices assures permanent positions. Openings for both experienced and inexperienced men in these challenging and rapidly expanding fields. Opportunities to participate in this new concept of electro-mechanical miniaturization.

write

ALLIED PRODUCTS DIVISION
HAMILTON WATCH CO.
LANCASTER, PA.



Research Specialist Edward Lovick measures reflection coefficient of dielectric materials in the K-band region. Lockheed is expanding K-band studies to meet future radar requirements.

Lockheed expands airborne antenna program

Lockheed's diversified expansion program is causing a major increase in airborne antenna research and development. Antenna design is one of the fastest growing areas at Lockheed, with research and development being applied to: extremely high-speed fighters, advanced jet trainers and jet transports; advanced versions of vertical-rising aircraft, turbo-prop transports, radar search planes (developed and produced exclusively by Lockheed) and a number of significant classified projects.

New positions at Lockheed

The program presents Physicists and Electronic Engineers qualified for airborne antenna design with a wide range of assignments in communication, navigation and microwaves.

In addition to the compensation of challenging work, Lockheed offers you increased salary rates now in effect; generous travel and moving allowances; an opportunity to enjoy Southern California life; and an extremely wide range of extra employe benefits which add approximately 14% to your salary in the form of insurance, retirement pension, etc.

Electronics Research Engineer Irving Aine records radiation antenna patterns. Twenty-two foot plastic tower in background eliminates ground reflections, approximates free space. Tower is of Lockheed design, as are pattern integrator, high gain amplifier, square root amplifier, logarithmic amplifier.

E. O. Richter, Electronics Research department manager (seated), W. R. Martin, antenna laboratory group engineer (standing), and J. L. Rodgers, electronics research engineer, discuss design of corrugated surface antenna.

Lockheed
AIRCRAFT CORPORATION
BURBANK **California**

ENGINEERS • *Electronic* • *Electromechanical*
PHYSICISTS
SALES ENGINEERS

Burroughs
Research Center, Paoli, Pa.
Invites You

To Inspect Its Openings on Both Commercial & Sponsored Projects

If you possess an educational and/or work background in Communications, Data Handling, Electronic, or Electro-Mechanical Business Machines... including such specifics as High Speed Mechanisms, Paper Handling Devices, Magnetic-Tape Transport Mechanisms, Magnetic-Drum or Tape Applications, Radar, Telemetering, Guided Missiles, Process Control Instrumentation, Digital and Analog Computers, Transistor and Magnetic Circuit Design and Analysis, Magnetic Amplifiers, Servo Mechanisms, and Electronic Packaging Design . . .

CONSIDER THESE OPENINGS AS

- **ELECTRICAL ENGINEERS; Junior & Senior**
- **MECHANICAL ENGINEERS; Junior & Senior**
- **LOGICAL DESIGNERS • PHYSICISTS**
- **PROJECT ENGINEERS**

- **SALES ENGINEERS** to sell E-101 electronic desk computers in all sections of the country. Sales & Technical experience in allied lines desirable.

Enjoy These Advantages!

In addition to paid vacations, liberal pension plans and numerous other valuable health and hospitalization benefits for you and your family, we provide cooperative educational aid at one of the many technical schools in the Philadelphia area for qualified applicants who find our center an ideal work-shop in which to secure the desired recognition in their chosen fields.

Your family, too, is important! And, here at Paoli, a delightful suburban community, thirty minutes from Philadelphia, you will find the cultural atmosphere as well as the educational facilities required for your children.

We will pay travel expenses for all applicants invited to visit our NEW Research Center to consider the application of their educational and/or work background to the many challenging problems we are engaged in for industry and the nation's welfare.

If you want the BEST for yourself and your family, consider NOW your qualifications for the openings listed on the right and —

Write **L. E. DICK,** *Personnel Manager*
BURROUGHS RESEARCH CENTER
Paoli, Pa.

Located on
PHILADELPHIA'S "MAIN LINE"

ELECTRONIC ENGINEERS

You can work in the stimulating atmosphere of an applied research and development laboratory where ideas are important, initiative is encouraged and associates are competent. The project areas listed below are typical of our extensive electronics interest; a complete list would include almost every branch of modern electronics. We are interested in men of all levels with sound training, imagination and potential, regardless of their specialty.

Communications

Dynamic Control Systems

Aircraft Instrumentation

Radar

Computers

Electrical Measurements

Varied Electronic Circuits

Servo-Mechanisms

Missile Guidance

Microwave

ENGINEER WRITER

Must be a competent Electronics Engineer with an avocation for technical writing. Writing will include specifications, test procedures, operating procedures and reports.

If you are interested in working at your maximum professional level in an organization that combines the most desirable elements of academic and industrial research and development, we invite you to communicate with our Employment Manager.

B.S. degree and experience required; advanced degree with experience to back it up is even better.

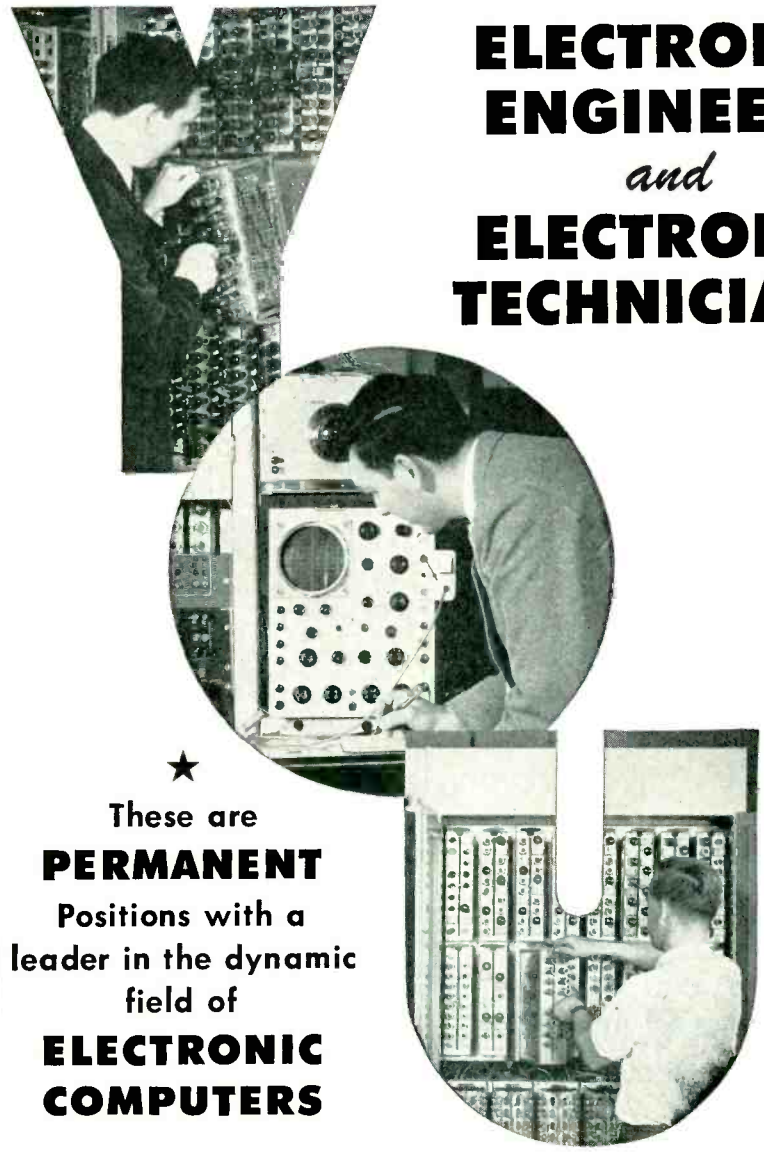
Hospitalization, surgery; group life, sickness, accident, and retirement insurance is available with most of the cost paid by the Laboratory. Salaries are comparable with industry. Merit reviews occur semi-yearly assuring recognition of work well done and expediting advancement. Other personnel policies are very liberal, such as our self-sponsored internal research program. Graduate study at University of Buffalo is encouraged through generous tuition refund program.

Cornell Aeronautical Laboratory

Buffalo 21, New York

wholly owned by Cornell University

OPPORTUNITY FOR ELECTRONIC ENGINEERS *and* ELECTRONIC TECHNICIANS



★

These are PERMANENT Positions with a leader in the dynamic field of ELECTRONIC COMPUTERS

Your best chance for increasing responsibility and rapid advancement in the electronic field is in the challenging field service work associated with digital computers. *Computer experience is not necessary.* You will receive extensive training in computer logic and circuitry and specialized training on specific computers. Good salaries start with the training period. After training you will be assigned to one of our large computer installations in continental United States. You will enjoy liberal travel allowances and other employee benefits.

The practical knowledge of computers obtained from actual experience at field installations will aid you greatly in advancement.

Minimum qualifications for ELECTRONIC ENGINEERS
Bachelor Degree—2 years electronic experience

Minimum qualifications for ELECTRONIC TECHNICIANS
High school plus electronic school (armed forces acceptable) and four years electronic experience

For further information regarding our computers and training programs, send a brief resumé of your education and experience to **Mr. R. A. Nelson, Employment Manager.** Interviews at our expense by arrangement. All contacts are held in strict confidence.

Remington Rand INC

ENGINEERING RESEARCH ASSOCIATES DIVISION

1890 W. MINNEHAHA AVENUE • ST. PAUL W4, MINNESOTA

ENGINEERS

for immediate placement

ELECTRONIC ENGINEERS
ELECTRICAL ENGINEERS
MECHANICAL ENGINEERS
MECHANICAL DRAFTSMEN

ENGINEERING AT NCR:

1. Immediate, permanent positions in Mechanical and Electrical Engineering Divisions.

2. Engineering project work involving design and development of mechanical, electronic, electromechanical devices, and electronic data processing equipment in Business Machine applications.

3. Some experience in development, design, and application of high-speed, light-weight mechanisms of the intermittent motion type is desirable.

4. Opnings also for Mechanical and Electrical personnel for writing technical and application literature describing newly-developed machines.

5. Ample training and indoctrination is available to all employees.

AS AN NCR ENGINEER you, with your family, will enjoy:

1. UNLIMITED OPPORTUNITY in the broad, ever-expanding field of Business Machine Engineering.

2. AN EXCELLENT SALARY, plus exceptional benefits of lifetime value for you and your family.

3. A RECREATIONAL PROGRAM for year-round enjoyment of the entire family including a new Country Club with 36 holes of golf, and a 166-acres park for outings with swimming, boating, and supervised play for the children.

4. LIVING IN DAYTON . . . considered one of the cleanest and most attractive cities in the Midwest with outstanding school facilities.

5. YOUR WORK AT NCR with its friendly, family atmosphere, with its employee morale at a very high level, and with people who, like yourself, have decided to build their professional future with NCR.

ACT AT ONCE—Send resume of your education and experience to: EMPLOYMENT DEPARTMENT, TECHNICAL PROCUREMENT SECTION

THE NATIONAL CASH REGISTER COMPANY
Dayton 9, Ohio

IMMEDIATE Openings:

PROJECT ENGINEERS
COIL PRODUCTION ENGINEERS

with experience in the design, development and production of delay lines, pulse transformers and allied electronic components. Salaries commensurate with ability and experience.

Enjoy the security and exceptional advancement opportunities of a large company—with small company environment—in the West Los Angeles division of Gudeman, a large, progressive and expanding national organization. Superior climate, housing accommodations and leisure-enjoyment facilities near to your employment. Send complete resume of your qualifications to: Donald H. Allen, Gen'l Mgr.

The GUDEMAN Company of California, Inc.
9200 Exposition Blvd., Los Angeles 34, Calif.

Home office: Chicago. *Branches:* Terryville, Conn., Chelsea, Mich., Los Angeles, Sunnyvale, Monrovia, Cal.

Bendix needs

ELECTRONIC ENGINEERS

in SOUTHERN CALIFORNIA

Unusual engineering positions in Radar, Sonar and Telemetering are available at Pacific Division, Bendix Aviation Corporation in North Hollywood, California. These positions, which are directly associated with our long-range projects for industry and for defense, are available at all levels.

Please address inquiries to:
W. C. WALKER
Engineering Employment Manager

Pacific Division
Bendix Aviation Corporation
NORTH HOLLYWOOD, CALIF.

ENGINEER

SERVOMECHANISMS

A California opportunity for a top engineer on electromechanical design and development in an expanding medium-sized company of 25 years' reputation in instruments. Broad background necessary in precision instruments, miniature motors, transducers, potentiometers, servo packages, Address particulars attention Personnel Dept.

Burton Manufacturing Co.
11201 W. Pico Blvd. Los Angeles, Calif.

ELECTRONIC ENGINEERS

Excellent opportunities with expanding Radiation Instrument Development Group for recent graduates in E.E. or Physics and for engineers with 1-5 years circuit experience. Send resume and salary required to

TRACERLAB, INC.
Western Division
2030 Wright Ave. Richmond 3, California

TAPE RESISTOR SPECIALISTS

Openings at junior and supervisory engineering levels for men qualified to conduct advanced research and development work in the tape resistor field beyond the present state of art for printed circuit applications. Mid-west location. Salary open. Will assume moving expense. Inquiries held in confidence. Send complete background information to:

P-5752, Electronics
520 N. Michigan Ave., Chicago 11, Ill.

YOUR CALLING CARD FOR A BRILLIANT FUTURE...

Bendix Missile Section is a major contractor in the U. S. Navy's guided missile program--a part of the "new look" in our defense plan. Our expanding program has many opportunities for senior engineering personnel: Electronics Engineers, Dynamicists, Servo-Analysts, Stress Analysts, Project Coordinators, and Designers. Take time now to look into the opportunities which Bendix can offer you. Write Employment Dept. M, 401 Bendix Drive, South Bend, Indiana.

FIRE CONTROL ANALYSTS

Mathematicians • Electrical Engineers • Physicists

needed for immediate openings in all levels of employment. These are top ranking technical positions together with training positions leading to top responsibility in mathematical analysis for electronic fire control, computers, and servomechanisms.

- Household goods moved
- Liberal employee benefits
- Interview expense paid

Send written resume to

REMINGTON RAND, Inc.
ERA Division
1902 W. Minnehaha Ave. St. Paul 4, Minn.

When you WANT or OFFER

- *EMPLOYMENT*
- *EQUIPMENT*
  (Used, or Surplus New)
- *PRODUCTS*
  to manufacture
- *CAPITAL*
- *INDUSTRIAL PROPERTY*

USE THE SEARCHLIGHT SECTION

RATES

DISPLAYED—RATE PER INCH

The advertising rate is $16.10 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

AN ADVERTISING INCH is measured 7/8 inch vertically on one column, 3 columns—30 inches—to a page.

UNDISPLAYED RATE

$1.80 a line, minimum 3 lines. To figure advance payment count 5 average words as a line

POSITION WANTED undisplayed advertising rate is one-half of above rate, payable in advance.

BOX NUMBERS count 1 line additional.

DISCOUNT 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

EQUIPMENT WANTED OR FOR SALE Advertisements acceptable only in Displayed Style.

CLOSING DATE INFORMATION

Searchlight Section closes
April 4th for the May issue.

"SEARCHLIGHT" is LOW-COST NATIONAL CLASSIFIED ADVERTISING

Send NEW ADVERTISEMENTS to N. Y. Office, 330 West 42 St., N. Y. 36, N. Y. The publisher cannot accept advertising in the Searchlight Section, which lists the names of the manufacturers of resistors, capacitors, rheostats, and potentiometers or other names designed to describe such products.

M. I. T.

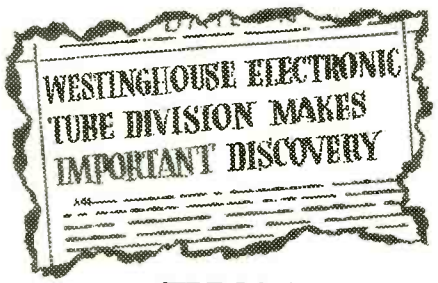
LINCOLN LABORATORY

Staff research positions available for exceptional **electrical engineers** with advanced training or experience in **electronics** as applied to . . . Radar, Communications and High Speed Digital Computers.

Please reply to:

Personnel Department, P. O. Box 73,
Lexington 73, Mass.

ENGINEERS . . .



make history

with **Westinghouse**

at the ELECTRONIC TUBE DIVISION in Elmira, N. Y.

During this important era, when Westinghouse is working on historically significant advances in the electronic field, your talents can be a contributing factor. Your creative achievements, based on merit, will receive financial, as well as professional recognition. All this, together with the friendly atmosphere of this pleasant historical city, adds up to the good life.

Opportunities for:

DESIGN, DEVELOPMENT and APPLICATION ENGINEERS: Receiving image orthicon or vidicon tubes; solid state devices.

MICRO-WAVE TUBE DESIGN ENGINEERS: 2 or more years experience, for designing magnetrons, traveling-wave tubes, TR and ATR tubes, reference cavities, etc.

Above openings are for Engineers and Physicists with Bachelor's, Master's or Doctor's degree. Also . . .

ELECTRICAL ENGINEERS, for EQUIPMENT DESIGN: designing, costing, and guiding construction of processing and testing equipment, e.g. atmosphere furnaces, electrical welders, induction heaters, X-ray seasoning and test units, waveguide apparatus, transistor life test units.

Interviews arranged in your area, or travel expenses paid if invited to Elmira for interview. Send resume:

WESTINGHOUSE ELECTRIC CORP.
Electronic Tube Division • P.O. Box 284, Elmira, N. Y.

COMMUNICATIONS ENGINEERS and TECHNICIANS

EXCELLENT SALARIES
MINIMUM PREREQUISITES

ENGINEER — EE Graduate with 3 years experience

TECHNICIAN — 2 years technical school in communications and 3 years experience.

Require installation adjustment and maintenance experience with communication receivers and associated terminal equipment. Also, men with similar experience with high-powered transmitters, antennas, transmission lines.

Must be willing to travel in United States and Overseas.

Page Communications Engineers, Inc.
710 Fourteenth St.,N.W., Washington 5, D.C.

PRINTED COMPONENTS SPECIALIST

A mid-western electronics company has an excellent opportunity for an engineer possessing a comprehensive background in the printed circuit component field.

The technical requirements for this position include:

1. Extensive general knowledge of currently used printed circuit manufacturing processes.
2. Extensive detailed knowledge of tape resistor and deposited film resistor manufacturing processes. Ability to conduct advanced research and development in this field.
3. Extensive detailed knowledge of currently used printed circuit capacitor manufacturing processes. Ability to conduct advanced research and development in this field.

Salary open. Will pay moving expense.

Inquiries treated confidentially.

P-5750, Electronics
520 N. Michigan Ave., Chicago 11, Ill.

REPRESENTATIVES WANTED

Manufacturer of electronic test equipment for military and commercial applications needs technically qualified representatives. Write giving qualifications, lines handled, territory covered.

RW-2178, Electronics
1111 Wilshire Blvd., Los Angeles 17, Calif.

EMPLOYMENT . . . EQUIPMENT . . . BUSINESS

OPPORTUNITIES

Whatever your need—
think "SEARCHLIGHT" FIRST

GENERAL ELECTRIC

PLANS FAR INTO THE FUTURE

ENGINEERS PHYSICISTS

Positions available in the following fields:

Advanced Development, Design, Field Service and Technical Writing in connection with:

MILITARY RADIO & RADAR
MULTIPLEX MICROWAVE
MOBILE COMMUNICATION
COMMUNICATIONS
ELECTRONIC COMPONENTS
TELEVISION, TUBES & ANTENNAS

Bachelor's or advanced degrees in Electrical or Mechanical Engineering, Physics, and experience in electronics industry necessary.

The development of new technologies at General Electric has opened the door on a program of advanced electronics work requiring the skills of top engineers and physicists. To engineers this means long-range, continuing opportunity enabling them to build a solid future as they enjoy the vast facilities, stimulating challenges and many incentives and rewards offered by General Electric.

Please send resume to: Dept. 4-5-E, *Technical Personnel*

GENERAL ELECTRIC

Electronics Park, Syracuse, N. Y.

ELECTRONIC ENGINEERS

TO DEVELOP

TRANSISTOR CIRCUITRY

Opportunity to study fundamental transistor circuit problems and to apply transistors in the design of receiver, guidance and control systems of guided missiles.

Transistor experience desirable but not essential.

Located in residential suburb of Nation's Capital. Advanced educational facilities available. Moving expenses paid. Other liberal benefits.

Send resume to
Professional Staff Appointments
APPLIED PHYSICS LABORATORY
THE JOHNS HOPKINS UNIVERSITY
8621 Georgia Avenue
Silver Spring, Maryland

ENGINEERS, EE

You'll Find These Advantages at Kollsman:

1. An organization small enough to provide diversity & recognition of achievement, large enough for stability and continuing growth.
2. Intricate design and development work on America's finest aircraft instruments, with the best facilities available in a modern plant.
3. Convenient location in a quiet residential section only 20 minutes from Times Square by IND subway to Elmhurst Ave. local station—2 short blocks to plant.

A Few Positions Available for Work Associated with Airborne Navigational Systems

1. Systems Work
2. Field Service
3. Handbook Preparation
4. Preparation of Test Procedures and Specifications

Some previous experience with electronic and electromechanical computers and instruments desirable.

For appointment, send resume to the Employment Manager. Or if in the New York Metropolitan area, phone

NEwtown 9-2900

KOLLSMAN Instrument Corp.

Subsidiary STANDARD COIL PRODUCTS CO., INC.

80-08 45th Ave.,
Elmhurst, L. I., New York

SYSTEMS ENGINEERS | APPLIED PHYSICISTS

PERMANENT ASSIGNMENTS

•

DEVELOPMENT PROGRAM IN

MILITARY WEAPONS SYSTEMS

Missiles	Reliability Studies	Sonar
Fire Control	Radar	Underwater Ordnance

REAL CAREER OPPORTUNITIES

You'll enjoy the advantages of a small company atmosphere in the Silver Spring Laboratory . . . along with the stability of being part of the rapidly growing Vitro Corporation of America with 5 diversified operations throughout the United States.

- Suburban Location in residential community adjacent to Washington, D.C.
- Plentiful housing—modern apartments, houses to rent or buy
- Advanced courses available at 4 major universities
- Cultural advantages of the nation's capitol

Similar opportunities also available at West Orange, N. J. and Eglin Field, Florida Laboratories

Write to Personnel Manager

VITRO LABORATORIES

962 WAYNE AVE. SILVER SPRING, MD.

Vitro

SUPERVISOR **Guidance Design**

Attractive supervisory assignment now available for an experienced electronics engineer to direct the analysis, design and flight test of systems for the guidance of pilotless aircraft. Applicants must possess supervisory experience and specialized knowledge of U.H.F. and microwave frequencies.

Requirements include Bachelor degree with advanced study preferable. Minimum of eight years of experience necessary.

Generous travel allowance; insurance, hospitalization and retirement programs.

For detailed information and to arrange for a personal interview, submit resume of education and experience with salary desired to

G. H. Orgelman, Supervisor — Engineering Personnel

CHANCE VOUGHT AIRCRAFT INCORPORATED

P. O. Box 5907 • Dallas, Texas

ENGINEERS
PRODUCT DEVELOPMENT

E.E. Degree plus demonstrated ability in design of electronic equipment. Experienced in development of AC and DC Amplifiers, Transducers and Carrier Amplifiers, Switching and Control Circuits and Electronic Counters. Practical production background also desirable.

Positions offer secure futures with aggressive and expanding organization. Excellent working conditions and associations. Starting salaries commensurate with training and experience.

Send your complete resume in confidence to:

BRUSH ELECTRONICS COMPANY

3631 Perkins Avenue Cleveland 14, Ohio

(Division of Clevite Corp.)

FOR SALE

(Additional For Sale Advertising on page 403-418)

TEST EQUIPMENT

UNUSED—FULLY GUARANTEED

HEWLETT-PACKARD 200B Audio Oscillator (Rack Mounting type) 20 to 20,000 cycles

Reg. price—$120 — Special $75

HEWLETT PACKARD 400A Vacuum Tube Voltmeter—

Reg. price—$185 — Special $95

FURST ELECTRONICS MODEL 1210 Electronically Regulated Multiple Power Supply (Rack mounting with meter)

Input—115 VAC 60 cy.

Outputs— + 200 to + 470 VDC, 0-1 ma
+ 50 to + 200 VDC, 0-70 ma
— 50 to — 150 VDC, 0-10 ma

All outputs 1% regulation—less than 5 mv RMS ripple **Special $55**

All prices net FOB Phila., Pa.

Send for latest catalog

LECTRONIC RESEARCH LABS.
715 ARCH STREET
PHILA. 6, PA. **Phone MA. 7-6771**

Wholesale SURPLUS ELECTRONICS

D.C. AMMETER: Westinghouse type NX-35. 0-2A int shunted. 3" rd flush mount. 500 units. Price $3.75 ea.

Small DC MOTORS and other rotary devices. Large quantities available. Let us know your needs.

AN HARDWARE: Screws, nuts, bolts, fittings, etc. Large Chicago stock at surplus prices.

RELAYS: The following lot of new relays & parts only $750.

RBM #23023 = Collins #972-1002-00 1,600 pcs
RBM #23024 = Collins #972-1003-00 600 pcs
RBM #23025 = Collins #972-1004-00 150 pcs
plus 10,000 coils, brackets, etc for above relays

AN CONNECTORS (by the lot.) NEW.

5,000 pcs AN3106-18-22S $550.00
6,000 pcs AN3108-18-5S $660.00

We also have in our Chicago warehouse some quantities of surplus electronic end equipment. Both new & used. Receivers, transmitters, junction boxes, etc.

HARBER INDUSTRIALS
1312 W. Arthington St. Chicago, Illinois

WANTED

(Additional Wanted advertising on page 417)

Switchboard, CAX, 300 lines, expandable to 500 lines, 30 trucks. Carrier telephone equipment, C1 and CF1A. Magneto telephones (desk types); direction finders; telephone cables, 25, 50, 100, 200, 400 pairs. *Send diagrams & complete details to:*

MOFFEX CORP.
347-5th Ave. N.Y. 16, N.Y.

IF THERE IS

Anything you want

that other readers of this paper can supply

OR—

Something you don't want

that other readers can use, advertise it in the

Searchlight Section

SAVE ON TUBES BRAND NEW TUBES GUARANTEED TUBES

OA2	$ .75	2J51	150.00	4J28	49.50	12DP7	10.00	QK235	149.54	GL434A	4.00
OA3/VR75	1.00	2JB51	.80	4J29	49.50	12GP7	15.00	QK249	150.00	WE438A	45.00
OB2	.75	2J55	45.00	4J30	49.50	12SP7	24.00	249B	3.00	446A	.70
OC3/VR105	.75	2J56	50.00	4J31	79.50	15E	1.00	250TL	10.00	446B	2.25
OD3/VR150	.75	2J61	19.50	4J34	25.00	FG17	3.00	251A	25.00	450TH	40.00
1B23	3.50										
1B24	5.00										
1B26	1.25										
1B27	12.50										
1B35	4.50										
1B42	5.00										
1B51	7.50										
1B63A	20.00										
1C21	1.25										
1D21/SN4	3.50	2J62	6.00	4J36	79.50	RK21	1.00	252A	10.00	WL456	59.50
1N21B	1.90	2J62A	59.50	4J42	25.00	RX21	4.95	QK253	149.50	464A	2.50
1N23B	1.75	2K22	15.00	4J50	99.50	HK24	2.70	FG258A	130.00	**CK512AX**	**1.10**
1N26	**4.00**	**2K25**	**12.50**	4J51	149.50	28D7	.90	254A	6.50	527	15.00
1N34A	.79	2K26	45.00	**4J52**	**50.00**	35T	4.00	274B	1.00	ML531	4.00
1N35	1.50	2K28	25.00	4J57	149.00	35TG	5.95	282B	2.25	559	.75
1N44	.99	2K33A	65.00	4X150A	27.50	D42	40.00	QK283A	149.50	**KU610**	**6.00**
1N47	4.50	2K33B	150.00	4X500A	60.00	**HK54**	**3.00**	QK284A	149.50	WL616	99.50
1N55	2.75	2K34	139.50	5AP1	2.00	QK59	49.50	**304TH**	**6.95**	KU627	10.00
1N63/K63	1.75			5BP2A	3.95	QK60	35.00	304TL	6.95	KU628	12.50
1N69	.69	**2K41**	**90.00**	5BP4	2.00	QK62	29.50	307A/RK75	1.00	WL651	39.50
1P21	35.00	2K42	149.50	5CP1	2.00	RK60/1641	1.95	312A	2.95	WL652	25.00
1P22	6.50			5CP1A	7.50	RK65/5D23	10.00	316A	.50		
						FG67/5728	10.00				

832A	5.50	5634	7.50	849	24.50	1P28	9.00	2K45	65.00	5C22	29.50
833A	34.50	**5636**	**5.00**	851	14.00	1P29	2.00	2K48	90.00	5C30/C5B	1.75
836	2.50	5637	7.00	852	7.50	1P36	2.50	2K54	17.50	5D21	7.50
837	1.00	5641	7.50	860	3.50	1P39	1.20	2K56	60.00	5FP14	5.00
838	**1.50**	5643	6.95	861	7.50	1W5	1.25	2X2A	1.10	5JP1	14.00
		5647	6.00	865	.50	1Z2	2.00	3AP1	5.00	5JP2	7.50
		5651	1.40	869B	15.00	VS-2	7.50	3A4	.50	5JP4	7.50
		5654	1.40	**872A**	**1.00**	2AP1	6.50	3BP1A	6.50	5JP5	7.50
		5656	9.00	874	.60	2AS15	4.50	3B22	1.50	5J23	20.00
		5657	125.00	878	.60	2BP1	5.00	**3B24**	**1.75**	5J26	85.00
		5663	1.50	**880**	**200.00**	2C21/1542	.69	3B26	3.50	5J29	10.00
		5667	150.00	884	1.00	2C36	25.00	3B29	6.95	5J30	10.00
		5670	2.25			2C39	9.00	**3C22**	**60.00**	5J33	7.50
		5672	1.25			**2C39A**	**9.00**	3C23	4.00	5LP1	9.95
		CK5678	1.00			2C40	7.25	3C24/24G	1.00	5MP1	3.95
		5686	2.00			**2C43**	**11.00**	3C33	9.95	5NP1	5.00
		5687	3.50			2C44	.50	3C45	7.50	**5R4GY**	**1.00**
		5696	1.10			2C46	9.00	3E29	9.00	5R4WGY	1.60
		5702	2.00			**2C51**	**3.25**	3FP7	1.95	C6J	6.50
		5703	**1.25**			2C52	3.50	3GP1	1.95	C6L/5528	4.00
		5704	1.80			2D21	1.00	3J30	60.00	6AJ5 JAN	1.50
		5718	**3.00**			2D21W	1.75	3J31	60.00	6AL5W	1.00
		5719	2.50			2E22	2.50	3K23	125.00	6AR6	1.70
		CK5721	189.50			2E26	3.25	3K30	125.00	6C21	12.50
		5725	2.00			2J31	15.00	3RP1	7.50	6F4	2.75
		5726	1.00			2J32	15.00	4C27/CV92	4.00	**6J4**	**3.95**
		5727	1.75			2J33	15.00	4C35	15.00	6K4	2.75
		5744	1.00			2J34	15.00	**4E27**	**11.00**	6L6WGB	4.50
		5750	3.10			2J36	50.00	4J22	49.50	6SN7W	2.00
		5780	199.50			2J42	99.50	4J26	49.50	7C22	50.00
						2J48	49.50	4J27	49.50	7C23	69.50

RKR72	.50	CAA322	12.50	**701A**	**1.95**	GL889	60.00	CK5787	4.95
RKR73	.50	323B	5.00	703A	1.50	GL889A	74.50	5814	1.60
75TL	5.00	327A	3.50	706AY-GY	15.00	902A	5.00	5840	5.00
FG95/5560	14.00	338A	6.00	707B	5.00	902P1	5.00	5844	4.50
FG104	29.50	350A	3.00	714A	12.50	922	1.25	**5851**	**4.00**
FG105	12.50	**350B**	**3.00**	715A	1.50	923	1.30	5893	12.50
VT-127A	2.00	354A	15.00	715B	6.00	927	1.25	5896	6.50
VT158	12.00	354C	5.00	717A	.50	931A	2.75	5899	7.50
WL200	75.00	368AS	3.00	719A	10.00	935	4.00	**5901**	**6.50**
207	25.00	393A	4.50	720AY-EY	25.00	SN944	4.50	5902	8.00
211/VT4C	.50			721A	1.00	SN949C	4.50	5905	8.95
				721B	9.00	SN953D	4.50	5907	7.90
				722A	.75	955	.40	5908	7.95
				723A	5.00	956	.40	5932	5.00
				723A/B	8.50	957	.40	5933/807W	5.75
				724B	.75	958A	.40	5963	1.00
				725A	4.00	959	1.00	6005	2.00
				726A	8.00	SN977CX	4.50	6021	4.00
				726B	25.00	SN930	4.50	6072	4.00
				726C	**25.00**	CK1006	1.75	6080	3.50
				730A	10.00	1500T	60.00	6080WA	4.25
				750TL	30.00	1616	.75	6111	6.50
				802	2.75	1620	2.95	6121	8.95
				803	**1.50**	1623	1.10	6177	79.50
				805	2.75	1624	1.00	8002R	8.00
				807	1.00	1625	.23	8005	4.95
				809	2.75	1630	.50	8012	1.00
				812	2.50	1636	1.25	8013	4.95
				813	9.95	2050	1.00	8014A	50.00
				814	**2.00**	2051	.70	**8025A**	**2.50**
				815	1.50	ZB3200	85.00	9001	.90
				827R	150.00	5586	150.00	9002	.70
				829B	9.50	5591/403B	2.30	9003	1.00
				830B	.95	5611	99.50	9004	1.25
						5633	7.50	9005	1.10
								9006	.40

212E	17.50	394A	3.00		
WL218	17.50	403B/5591	2.30		
220C	182.00	WL417A	5.00		
FG-235A	35.00	421A	12.50		
QK221/6002	125.00	422A	9.50		
		WE428A	45.00		

AT OUR NEW LOCATION!

1108 VENICE BLVD. PHONE PRospect 7644

Los Angeles, 15, Calif.

SPECIAL!

Vacuum Capacitors

6 mmfd.	30 KV	10.00
50 mmfd.	32 KV	12.50
50 mmfd.	40 KV	14.50
75 mmfd.	20 KV	12.50
100 mmfd.	10 KV	12.00
150 mmfd.	20 KV	14.00

WE PAY CASH FOR YOUR TUBES, OR TRADE!

YOUR SURPLUS WANTED
We Pay Highest Prices!

QUANTITIES LARGE OR SMALL—WE BUY THEM ALL!

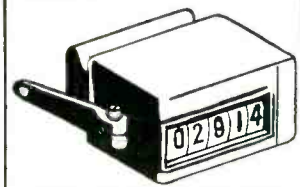
SPECIAL!

5" DUAL GUN TUBE

Long persistency face. Valued at $200.00. This tube has been rejected for military use..

Tested Before Shipped & Fully Guaranteed. Only **$17.95**

VEEDER ROOT COUNTER



5 figure. Adds ten for each revolution of shaft in one direction; subtracts ten for each revolution in opposite direction. Size ¾"x¾"x1" dovetail mounting; lever arm removable. Each..... **$1.25**

THIS IS ONLY A PARTIAL INVENTORY. CHECK WITH US FOR YOUR REQUIREMENTS.

Thousands of other types in stock.. Send us your requirements. RECEIVING TUBES! We carry a complete line in stock. Standard brands only.

jsh SALES CO.

ELECTRONICS
Dept. EO
1108 Venice Blvd.
Los Angeles 15
California

All Prices F.O.B. Los Angeles, subject to change without notice. Minimum order $5.00. *Check with us for items not listed.*

COMMUNICATIONS EQUIPMENT CO.

MICROWAVE COMPONENTS

10 CM.—RG48/U Waveguide

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
BEACON LIGHTHOUSE cavity p/o UPN-2 Beacon 10 cm. Mfg. Bernard Rice, each $27.50
MAGNETRON TO WAVEGUIDE Coupler with 721-A Duplexer Cavity, gold plated $31.50
721A TR BOX complete with tube and tuning plungers $12.50
McNALLY KLYSTRON CAVITIES for 707B or 2K28, 2700-2900 Mc. $4.00
AS14A AP-10 CM Pick up Dipole with "N" Cables $4.50
HOLMDELL-TO-TYPE "N" Male Adapters, W. E. #D167284 ..... $2.75
I.F. AMP. STRIP: 30 MC, 30 d.b. gain, 4 MC Bandwidth, uses 6AC7's—with video detector. A.F.C. less tubes $17.50
BEACON ANTENNA, AS31/APN-7 in Lucite Ball. Type "N" feed $22.50
ANTENNA, AT49A/APR: Broadband Conical, 300-3300 MC Type "N" Feed $12.50
"E" PLANE BENDS. 90 deg. less flanges $7.50

3 CM.—RG 52/U Waveguide

3 CM Motor-Driven Echo Box

Cavity Q 10 30,000. Tuning range 80 mc Motor operates from 24 VDC Type, "N" INPUT $32.50

3CM. DIPOLE FEED, 15" L. for APS-15 ..... $14.50
MITRED ELBOW, Cast aluminum, 1¼"x⅝" W.G. W.E. Flanges. **"E" Plane** $3.50
FLEX. WAVEGUIDE SECTION, 1 ft. long. With UG-40/UG-39 flanges. Attenuation is less than 0.1 db. at 9375 mc. and VSWR is less than 1.02 ..... $7.50
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
RG52/U Waveguide in 5' lengths, fitted with UG 39 flanges to UG40. Silver plated ..... **per length $5.00**
Rotating-Joints supplied either with or without deck mountings. With UG40 flanges ..... **each. $17.50**
Bulkhead Feed-thru Assembly $15.00
Pressure Gauge Section with 15 lb. gauge $10.00
Directional Coupler, UG-40/U Take off 20db $17.50
MAGNET AND STABILIZER CAVITY For 2J41 Magnetron $24.50
Rotary joint choke to choke with deck mounting. $17.50
ADAPTER, waveguide to type "N", UG 81-U, p/o TS 12. TS-13, Etc. $7.50
ADAPTER, UG-163/U round cover to special BTL, Flange for TS-45, etc. $2.50 ea.

1¼" x ⅝" WAVEGUIDE

CG 98B/APQ 13 12" Flex. Sect. 1¼" x ⅝" OD.. $10.00
X Band Wave GD. 1¼" x ⅝" O.D. 1/16" wall aluminum ..... **per ft. 75¢**
Slug Tuner Attenuator W.E. guide, Gold plated.. $6.50
Bi-Directional Coupler, Type "N" Takeoff 25 db coupling $27.95
Bi-Directional Coupler. UG-52, Takeoff 25 db Coupling $24.95
Waveguide-to-Type "N" Adaptor. Broadband... $22.50

K BAND—½" x ¼" W.G.

Right Angle Bend E or H Plane, specify combination of couplings desired $12.00
45° Bend E or H Plane, choke to cover $12.00
Mitered Elbow, cover to cover $4.00
TR-ATR-Section. Coke to cover $4.00
Flexible Section 1" choke to choke $5.00
"S" Curve Choke to cover $4.50
Adapter, round to square cover $5.00

JAN WAVEGUIDE FLANGES

UG 39/U	$1.10	UG 51/U	$1.85
UG 40/U	$1.25	UG 52/U	$3.40
UG 40A/U	$1.85	UG 52A/U	$3.40

I. F. AMPLIFIER STRIPS

Model 15: 30 Mc Center frequency. Bandwidth 2.5 Mc. gain figure: 65 db. Uses 5 stages of 6AC7's. Has D. C. Restorer and Video Detector A.F.C. Strip included. Input impedance: 50 Ohms. Less tubes $17.50
60 MC. Miniature IF strip, using 6AK5's 60 Mc center Freq. Gain: 95 db at Bandwidth of 2.7 Mc. New. Complete with tubes $17.50

BARGAIN SPECIALS

500 MC. RECEIVER, Type ASB, Uses lighthouse cavity-tuned RF Amp. and Mixer, plus GL-446 oscillator. I.F. is 60mc. New, less tubes **$12.50**
CAPACITOR, Split Stator, 30-200 MMF. per section, 6 KV, working, air space—0.168". Mfg. Cardwell **$14.50**
NF1-1 Noise Filters. Rated 100A./35 volts DC. AAF = 3300-399857005, Mallory .79c
POWER SUPPLY and modulator, MP-28. For TA-12 transmitter. Dynamotor rated: Input: 28 VDC/14.8A. Output 540V/450 MA. New, complete with tubes **$21.50**
TU-6 Tuning Units for BC 375 transmitter. Brand New, complete with case... **$3.95**
RANGE CALLIBRATOR, Sickles, Mod III, For Accurate checking of Sweeps, Markers, and Range Scopes ..... **$185.**
RA-58 Power Supply, Input: 115 VAC, 60 cy, 1 phase. Output: 10KV/35 MA. Ideal as Hi-Pot Supply ..... **$85.**
CONVERTER: Navy Type CAJO-211444. Input: 115 VDC. Output 28V DC/20 A or 12 V DC/40 A. New, complete with Filter, Starting Box, etc. **$67.50**
WIRE: TYPE WD3/TT. Similar to W-130, except cotton-braid covered. On 1-mile reels ..... **$5 per reel**

DYNAMOTORS

TYPE	INPUT VOLTS	INPUT AMPS	OUTPUT VOLTS	OUTPUT AMPS	Price
BDAR 83	14	...	375	.150	$6.50
35X-059	19	3.8	405	.095	4.35
POSX-15	14	2.8	220	.08	8.95
DM 33A	28	7	540	.250	3.95
2335D	27	1.75	285	.075	3.95
B-19	12	9.4	275	.110	6.95
			500	.050	
DA-3A*	28	10	300	.260	3.95
			150	.010	
			14.5	5.	
PE 73CM	28	19	1000	.350	17.50
BD 60‡	14	2.8	220	.08	8.95
DAG-33A	18	3.2	450	.06	2.50
DM 25†	12	2.3	250	.05	6.95
BDAR 93	28	3.25	375	.150	6.95

‡ Less filter. * Replacement for PE 94.
† Used, Excellent.
PE 94-, Brand New 5.95

INVERTERS

800-1B Input 24 vdc, 62 A. Output: 115 V, 800 cy, 7A, 1 phase. Used, excellent $18.75
PE-218H: Input: 25/38 vdc, 92 amp. Output 115V 350/500 cy 1500 Volt-ampere. NEW $32.50
PE206: Input: 28 vdc, 36 amps. Output: 80 V 800 cy, 500 volt-amp. Dim. 13 x 5½ x 10½. New $22.50
EICOR—ML 3011-5. Input: 13.75V; 18.4A. Output: 115 V/400~, 3ϕ, 0.95 PF. New $59
PU 7/AP. Input: 28 vdc/160A. Output: 115 VAC, 400~, 1ϕ, 500 VA., 21.6 Amp. Volt, and Freq. Reg. Used, Exc. $75

CRYSTALS—CR1/AR*—59¢ ea.

6370KC	6470KC	6730KC	7290KC
6410	6670KC	7270	7300
6450	6690	7280	

*For ARC-3, ARC-1, etc.

VACUUM TUBES

1N21	28¢	5J23	$34.50	70DD	$8.75
1P5GT	45¢	5J30	$14.50	703A	$1.50
1P30	$1.10	C5B/5C30	$1.10	704A	95¢
2C21	35¢	7C4/1203A	5.18	705A	75¢
2C22/7193	7¢	9GP7	$3.45	706A	$9.75
2C26A	8¢	10Y	10¢	706D	$14.75
2J21A	$2.90	15R	15¢	706EY	$9.75
2J22	$2.50	39/44	8¢	706CY	$9.75
2J26	$2.50	QK59	$60.00	708A	$2.10
2J27	$3.00	QK60	$35	709A	$2.45
2J29	$18.50	QK61	$50	713A	85¢
2J31	$15	QK62	$54	C-722A	90¢
2J32	$14.50	ML-100	$69.50	730A	$8.50
2J38	$9.00	HY/14B	25¢	800	65¢
2J39	$8.25	227A	$2.50	801	25¢
2J48	$22.50	268A	$2.25	837	85¢
2J56	$48.50	316A	50¢	843	19¢
2J62	$7.50	355A	$12.50	861	$15
3EP1	$1.75	356B	$10.50	864	19¢
3FP7	$1.10	393A	$4.50	876	75¢
4J34	$23.50	417A	$6.10	CK1005	35¢
4J38	585	CL471A	$2.10	1625	20¢
4J42	$47.50	WL531	$2.75	1619	15¢
5FP7	$1.10	532/1B32	$1.10	1626	10¢
5GP1	$4.50	GL559	75¢	1629	10¢
5HP4	$3.50	700B	$8.75	8012	$1.75

PULSE TRANSFORMERS

RAYTHEON WX 4298E: Primary 4KV., 1.0 USEC. SEC: 16KV-16 AMP DUTY RATIO: 001 400 CYCLE FIL. TRANS. "BUILT-IN" $42.50
WECO: KS 9948; Primary 700 ohms; Sec: 50 ohms. Plate Voltage: 18 KV. Part of APQ-13 ..... $12.50
WECO: D-163247 For Modulator of SCR 720 ..... $22.50

GE #K-2449A
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
Biflar: 1.5 amps (as shown) $62.50
GE #K-2718-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. Biflar rated at 1.3 Amp. Fitted with magnetron well $24.50
K-2745 Primary: 3.1/2.8 KV, 50 ohms Z. Secondary: 14/12.6 KV 1025 ohms Z. Pulse Length: 0.25/1.0 usec @ 600/600 PPS. Pk. Power 200/150 KW. Biflar: 1.3 Amp. Has "built-in" magnetron well $32.50
K-2461-A. Primary: 3.1/2.6 KV—50 ohms (line). Secondary 14/11.5 KV—1000 ohms Z. Pulse Length: 1 usec @ 600 PPS. Pk. Power Out: 200/130 KW. Biflar 1.3 Amp. Fitted with magnetron well $29.50
K35J45—Pulse Inversion: PRI: 5 KV PK. Pulse Negative. Sec: Pos. Pulse, 4 KV; 1 usec. and .001 DUTY RATIO $6.50
541J318-1—3 wdgs. Ratio: 1:1:1, 1.10 uh. /wdg., 2.5 ohms DCR $3.50
UTAH X-151T-1: Dual Transformer, 2 Wdgs. per section 1:1 Ratio per sec 13 MH inductance 30 ohms DCR $5.00
UTAH X-150T-1: Two sections, 3 Wdgs. per section, 1:1:1 Ratio, 3 MH, 6 ohms DCR per Wdg. $5.00
68G711: Ratio: 4:1 Pri: 200V, Sec. 53V, 1.0 usec Pulse @ 2000 PPS, 0.016 KVA $4.50
TRI049 Ratio 21 Pri. 220 MH, 50 Ohms, sec. 0.75 H. DCR 100 Ohms $6.75
K-904695-501: Ratio 1:1, Pri. Imp. 40 Ohm. Sec. Imp. 40 Ohms. Passes pulse 0.6 usec with 0.05 usec rise $8.95
RAYTHEON, UX-7350, UX-7307 ..... $5. ea.

DELAY NETWORKS

D-168184: 0.5 usec. up to 2000 PPS, 1800 ohms... $4.00
D-170499: 0.25/.5/.75/usec. 8 KV., 50 ohms..... $12.50
D-165997 Delay 1.25 usec $6.50
RCA #255686-502: 1.7 usec, 1400 ohm impedance. $2.00
D-162311 Delay of 0.5 usec, 72 ohms with 4 MC. Bandwidth $4.75
D-168435. Delay 0.5 usec, 555 ohms, 5mc. BW.... $4.50

PULSE NETWORKS

D-172578. 416 ohms imp., 0.22 usec. Delay..... $4.75
D-150979: Oscillating network. Oscillates at 81.955 kc. When normal current of 10ma. is interrupted. Has built-in temperature control for stability. Assembled in shielded can 4" L x 4" Diam $4.50
15A—1-400-50; 15 KV, "A" CKT, 1 microsec, 400 PPS 50 ohms imp $22.50
G.E. #3E (3-84-810) (8-2.24-405) 50P4T; 3 KV "E" CKT Dual Unit; Unit 1, 3 sections, 0.84 Microsec. 810 PPS. 50 ohms imp; Unit 2, 8 Sections, 2.24 microsec. 405 PPS 50 ohms imp $6.50
7-5E3-1-200-67P, 7.5 KV "E" Circuit, 1 microsec, 200 PPS, 67 ohms impedance 3 sections $7.50
7-5E4-16-60. 67P, 7.5 KV "E" Circuit, 4 sections 16 microsec. 60 PPS. 67 ohms impedance $15.00
7-5E3-3-200-67P, 7.5 KV. "E" Circuit, 3 microsec, 200 PPS, ohms imp. 3 sections $12.50
H-616 10KV. 2.2 usec., 375 PPS, 50 ohms imp.. $27.50
H-615 10KV, 0.85 usec., 750 PPS, 50 ohms imp.. $27.50
KS8865 CHARGING CHOKE: 115-150 H @ .02A. 32 40H @ .08A, 21 KV Test $37.50
G.E. 25E5-1-350-50 P2T, "E", CKT, 1 Microsec. Pulse @ 350 PPS. 50 OHMS Impedance $69.50
KS9623 CHARGING CHOKE: 16H @ 75 MA, 380 Ohms DCR. 9000 Vac Test $14.95
G.E. 6E3-5-2000, 50 P2T; 6KV., "E" Circuit 0.5 usec /2000 PPS/50 ohms/2 sections $7.50

PULSE MODULATORS

MIT. MOD. 3 HARD TUBE PULSER: Output Pulse Power 144 KW (12 KV at 12 Amp.) Duty Ratio: .001 max. Pulse duration: 5, 1.0, 2.0 microsec. Input voltage: 115 v. 400 to 2400 cps. Uses: 1-71B, 4-89-B, 3-"72's, 1-"73. New ..... Less Cover—$135
ASD Modulator-Units, mfd. by Sperry. Hard tube pulser delivers Pk. pulse of 144 kw. Similar to Mod 3 unit. Brand new, less tubes $85.00
Airborne RF head, model A1A, delivers 50 Kw peak output at 9000 mc. at .001 duty. Complete with pulser unit and all tubes $185.00

H.V. SWITCH

15 KV Switch (For RA-38). Operates from 115V AC, 60 cy. Contacts will handle 100 Amp. Provision for Fuses, Etc. New **$24.95**

THERMISTORS

D-164699 Bead Type DCR, 1525-2550 Ohms @ 75 Deg. F. Coefficient: 2% Per. Deg. Fahr. Max. Current 25 MA AC/DC $1.00
D-167332 Bead Type DCR is 2525-2550 Ohms. Rated 25 MA at 825-1,175 VDC $1.00
D-167613 Disk Type DCR: 355 Ohms @ 75 Deg. F.P.M. 2.5%, 1 Watt $1.00
D-166228 Disk Type 7120 Ohms @ 60° F. 4220 Ohms @ 80°F. 2590 Ohms @ 100°F., 1640 Ohms @ 120°F $1.00

MAIL ORDERS PROMPTLY FILLED ALL PRICES F.O.B. NEW YORK CITY. 25% DEPOSIT WITH ORDER. BALANCE C.O.D. RATED CONCERNS SEND P.O.

131 Liberty St., New York 7, N. Y. Dept E-4 Chas. Rosen Phone: Digby 9-4124

COMPASS ELECTRONICS SUPPLY

A Division of Compass Communications Corporation

WE MAINTAIN OUR OWN FULLY EQUIPPED TESTING LABORATORY TO TEST AND GUARANTEE ANYTHING WE SELL

Wholesale, Industrial and Institutional Sales Only

TEST SETS
TS-3A*AP
TS-10A and B
TS-12*AP
TS-13*AP
TS-14
TS-16*AP
TS-36*AP
TS-61*AP
TS-62*AP
TS-74*UPM
TS-89*AP
TS-101*AP
TS-125*AP
TS-173*UR
TS-278
TS-323
TS-UPM-1
OAA
OAP
OBU
LAE
LM
LU
IE-19
1-46
1-56
1-208
1-222
SCR-211
AND OTHERS

RECEIVERS
ARB
ARC-1
ARC-3
ARC-4
ARC-5
AR-88
ART-13
CR-91
SLR
RAK
RAL
RAO
RBB
RBO
RBG
RBL
RBA
RBM
RCH
BC-224
BC-312
BC-314
BC-344
BC-348
AND OTHERS

TRANSMITTERS
TAJ
TAQ
TBL
TBK
TBM
TBN
TCE
TCP
TDE
TDQ
TDO
AND OTHERS

FIELD EQUIPMENT
SCR-274
284
300
399
503
536
808
828
BC-191
375
603
604
610E
683
684
923
924
1000
1306

TEST SETS

TS-13/AP-X BAND RADAR TEST SET—Measures power, freq. signal-to-noise ratio, I.F. Bandpass, etc. Input—115/1/60—800 ..... WRITE

TS-35A/AP-X-BAND—Measures transmitted power & frequency of Radar Transmitters, also used for receiver adjustments. ..... NEW . . $375.00

TS-69/AP—FREQ. METER, Absorption type—340-1000 mcs with calibration charts & antenna. Uses 0.200μ ammeter ..... EXC.—$75.00

TS-100/AP—TEST SCOPE, type A, R, J & X indications, gated & ungated sweep, Int. or Ext. trigger ..... WRITE

MICROWAVE ACCESSORIES

15 LB. ALNICO-V MAGNET—approx 4800 gauss $16.00

WAVEGUIDE, FLEX. with flanges, 3 cm., 12"l ..... $12.50 ea. 3 CM., 24"l.—$14.00 ea. 10 CM., 60"l.—$22.50 ea.

BENDS, E. & H. plane; 3 & 10 CM ..... WRITE

DUPLEXER, Mixer & Preamp Ass'y., 3 CM ..... WRITE also cavitys, klystron mounts, rotating joints, circular waveguide stubs, etc. ..... WRITE

WESTERN ELECTRIC VARISTORS, THERMISTORS, Res. Networks, Relay Ass'y, Precision Potentiometer, #60 A Key Selectors, etc. ..... WRITE

RADAR BEACONS

YJ and YG . . . for shipboard use AN/CPN-8 ..... 10 cm.
AN/CPN-6 ..... 3 cm. AN/APS-2, APS-3, APS-4, APS-6, APS-15

Also SA, SF, SG, SD, SJ, SK, SN, SQ—both equipment and spare parts

SA-2 RADAR Used for air traffic control, tracking and search, both land-based and ship-borne, 5 microsec. pulse, PPI indication, operates at 200 mcs, peak power of 150 K.W. Input 110/120 volts a.c. 4 complete installations in stock.—Write for price.

Write for More Details on Any Particular Item in Which You are Interested
These are partial listings only of our stock. Please write for other types.

393 Greenwich St. New York 13, N. Y.
BEEKMAN 3-6510 *Cable:* **COMPRADIO, N. Y.**

MOTOR GENERATORS AND CONVERTORS

50, 60, 400 and 800 cycle and DC Power Supplies

28dc to 110/1/800@1kva **$49.50** (Overall length: 12 inches)
110dc to 110/1/800@350va **150.00**
110ac to 110/1/800@350va **235.00**
110dc to 110/1/400@2kva **395.00**
110/1/60 to 110/1/400@2kva **435.00**
220/1/60 to 110/1/400@2kva **435.00**
440/3/60 to 110/1/400@2kva **435.00**
32dc to 110/1/60@350va **100.00**
110dc to 110/1/60@350va **100.00**
110dc to 28dc@250va **95.00**
110/1/60 to 28dc@250va **115.00**
220/1,3/60 to 28dc@250va **115.00**
110dc to 110/1/60@1.25kva **135.00**
220dc to 110/1/60@1.25kva **145.00**

Partial listings write for others

SYNCHROS & SELSYNS

5F ..... **$40.00** 7G **$70.00**
5G ..... **45.00** 2J1F1 ... **10.00**
5CT ..... **45.00** 2J1G1 ... **10.00**
5SDG ... **27.50** 2J1H1 ... **10.00**
6G **55.00**

115 V AC BLOWER

w/motor, 1/150 h.p. 3000 RPM **$10.00**

SPECIAL PURPOSE TUBES

Write for Latest Listing at Great Savings, of New Tubes, Standard Brands Only—Guaranteed!

AN/APR-4 LABORATORY RECEIVERS

Complete with all five Tuning Units, covering the range 38 to 4,000 Mc; wideband discone and other antennas, wavetraps, mobile accessories, 100 page technical manual, etc. Versatile, accurate, compact—the aristocrat of lab receivers in this range. Write for data sheet and quotations.

We have a large variety of other hard-to-get equipment, including microwave, aircraft, communications, radar; and laboratory electronics of all kinds. Quality standards maintained.

NEW TS-13/AP X-BAND SIGNAL GENERATORS with manual $575.00; T-47A/ART-13 Transmitters, $450.00; H-P, Boonton, G-R, Measurements, many others in stock.

ENGINEERING ASSOCIATES
434 PATTERSON ROAD **DAYTON 9, OHIO**

TS-56A/AP TEST EQUIPMENT

Slotted line test equipment designed for operation over a frequency of 500-675 MC. Has impedance of 51 ohms. Ideal test set for matching antennas, measurement of characteristics of transmission line. With instructions manual. New. Shipping wt.: 41 lbs.. **$95.50**

RADAR TEST SET

Phantom Target RF4/AP is used for permanent installation in planes equipped with radar set in the S band while plane is in flight. With instruction book, new condition. Wt. 10 lbs. **$49.50**

ECHO BOX

A hand tuned ring box with an associated dipole which picks up the RF energy from the radar set. Frequency range of 3140-3640 MC. Ideal unit for experimental lab. Wt. 7 lbs. New Condition **$4.95**

NEW CATALOGUE NO. 114
1955 ISSUE
LISTS LATEST INVENTORY OF AIRCRAFT, INDUSTRIAL AND MILITARY ELECTRONICS EQUIPMENT. SEND FOR YOUR COPY TODAY!

ARROW SALES INC.

Western Division
Mailing Address: P.O. BOX 3878-E, N. HOLLYWOOD, CAL.
Office-Warehouse: 7460 VARNA AVE., N. HOLLYWOOD, CAL.
Phones: STanley 7-6005 • POplar 5-1810
Sales-Showroom: 2005 EMPIRE AVENUE, BURBANK, CAL.
Phone: Victoria 9-2834
Cable Address: ARROWSALES, NORTH HOLLYWOOD
Telegraph Address: WUX, NORTH HOLLYWOOD

Central Division
Mailing Address & Sales-Showroom:
2441 S. MICHIGAN AVE., CHICAGO 16, ILLINOIS
Phone: CAlumet 5-4750

SELLING OUT OUR MOTOR INVENTORY

Delco—Permanent Magnet Alnico Field Motor with Brake #5070200—12 V. 140 RPM ..... @ $8.00 each
Delco—#5072400 with Worm Gear—27V. D. C ..... @ 7.50 each
Diehl—#SSFD6-25 with and without Follower—27V. D. C ..... @ 6.50 each
Oster—#1/67 HP—27V. D. C.—5000 RPM ..... @ 1.25 each

RAWAY SALES
4 Forsyth St. *WAlker 5-8150* **New York 2, N. Y.**

SPECIAL PURPOSE TUBES

OA2 .75	3B22/EL1C 1.50	6SK7Y .50	WE-249C 3.00	708A 1.00	918 2.00
OA3/VR75 1.00	3BP1 2.00	6SN7WGT 2.00	250R 4.75	709A 1.00	920 2.50
OA5 4.00	3B24 2.00	7BP7 2.50	250TH 17.50	713A .25	922 1.00
OB2 .75	3B24W 5.75	7C29 50.00	250TL 15.00	714AY 17.50	923 1.00
OB3/VR90 .75	3B25 3.00	7CP1 15.00	WE-251A 30.00	715A 1.25	925 1.75
OC3/VR105 .75	3B26 3.25	9GP7 5.00	WE-252A 7.50	715B 5.00	927 1.00
OD3/VR150 .75	3B28 3.50	9LP7 3.50	WE-253A 3.50	715C 15.00	931A 2.75
ELC1B 3.00	3C23 5.00	9MP7 7.50	WE-254A 5.00	717A .50	933 2.00
1B22 1.00	3C24/24G 1.00	10Y .25	WE-257A 2.00	719A 10.00	954 .25
1B24 4.50	3C45 7.00	12A6 .50	WE-264C 3.00	721A 1.00	955 .25
1B27 8.75	3D21A 6.00	12GP7 14.00	WE-267B 6.00	721B 8.75	956 .25
1B32 1.00	3D22 9.75	12J5WGT 2.50	WE-271A 7.50	722A 1.00	957 .25
1B35 4.75	3DP1 3.75	12K8Y .50	WE-272A 5.00	723A/B 8.75	958A .25
1B42 4.50	3DP1A 7.50	12L8GT 1.00	WE-274A 4.75	724B .75	959 1.00
1B59 10.00	3E29 10.00	LM-15 200.00	WE-274B 3.00	725A 3.50	991/NE-16 .35
1C21 1.50	3EP1 1.50	15E 1.50	274B .50	726A 7.50	CK-1005 .25
1P23 2.00	3FP7 1.50	15R .25	WE-275A 5.00	726B 25.00	CK-1006 1.50
1P24 1.50	3FP7A 5.00	FG-17/5557 3.00	276A 3.00	726C 25.00	R-1100 5.00
1P30 2.25	3GP1 2.50	RK-19 1.25	WE-282A 2.50	730A 7.50	1500T 75.00
1P34 1.75	3HP7 3.00	RK-20A 12.50	WE-283A 3.50	801A .25	1608 3.50
1P36 2.50	3KP1 7.25	TZ-20 2.00	WE-286A 6.00	802 2.50	1611 2.00
VG-2 10.00	4AP10 3.75	RK-21 1.00	304TH 6.75	803 1.75	1613 1.00
2AP1 5.00	4B22 6.50	RK-23 3.00	304TL 6.00	804 9.75	1614 1.50
2C21/1642 .50	4B26 3.50	HK-24 2.00	WE-305A 3.50	805 2.75	1616 .50
2C22 .50	4B27 3.50	HK-24G 1.00	307A/	806 9.50	1619 .25
2C26A .50	4B31 25.00	CE-25A/B 2.00	RK-75 1.00	807 1.25	1622 1.50
2C33/	4C22/	RK-25 2.50	WE-310A 3.50	808 1.50	1624 1.00
RX-233A .75	HF-100 7.50	28D7 .75	WE-311A 5.00	809 3.50	1625 .25
2C34/RK-34 .25	4C27 3.50	28D7W 1.25	WE-313C 2.50	810 10.00	1630 .50
2C39A 7.50	4C35 20.00	TWIN 30 10.00	316A .50	811 3.50	1851 1.50
2C40 7.50	4E27 10.00	FG-32/5558 7.25	WE-323A 10.00	811A 4.00	1852 .75
2C43 12.00	4J30 45.00	FG-33/572011.50	323B 5.00	812 2.25	1853 .75
2C44 .50	4J34 20.00	35GT 5.75	327A 3.50	813 12.00	2050 1.00
2D21 .75	4J35 75.00	RK-39 2.50	WE-328A 2.75	814 1.75	2051 .50
2D21W 1.25	4J42 20.00	FP-54/	WE-348A 6.00	815 1.00	ZB-3200 100.00
2E22 2.50	4J52 50.00	5740 60.00	WE-349A 7.50	822 15.00	R-4330 7.50
2E24 2.25	5AP1 2.00	HK-54 2.50	350A 3.50	826 1.00	GL-5545 30.00
2E26 3.25	5B21 2.00	RK-60/1641 1.50	350B 3.50	828 7.50	5551/652 40.00
2G21 2.75	5BP1 2.00	RK-62 1.75	WE-352A 10.00	829 5.75	5556/PJ-8 6.75
2J21A 3.50	5BP2A 2.50	FG-67/	WE-353A 3.50	829B 10.00	5610 1.25
2J26 2.25	5BP4 2.00	5728 10.00	WE-354A 15.00	830B 1.00	5645 6.50
2J27 2.50	5C22 28.00	RK-72 .75	WE-355A 15.00	832 4.00	5656 8.00
2J29 25.00	5C30/C5B 1.00	RK-73 .75	368AS 4.00	832A 5.50	5696 1.00
2J30 50.00	5CP1 2.75	75T 5.00	371A .75	833A 35.00	5703 1.00
2J31 15.00	5CP7 7.50	75TL 5.00	WE-393A 7.00	834 7.50	5725 2.00
2J32 15.00	5D21 6.50	VR-78 .50	394A 2.00	835 10.00	5801/
2J33 15.00	5FP7 1.50	FG-81A 5.00	410R 100.00	836 2.25	VX-33A 2.50
2J34 15.00	5FP14 5.00	FG-95/	WL-417A 4.50	837 1.00	5820 (See 2P21)
2J36 50.00	5GP1 5.00	5560 14.00	GL-434A 3.00	838 1.25	5827X 2.50
2J37 10.00	5J23 25.00	100R 7.50	446A .50	842 2.50	CK-5829 1.50
2J38 15.00	5J29 7.50	100TH 5.75	446B 2.00	843 .25	5933 6.50
2J39 10.00	5J30 7.50	RX-120 15.00	WL-460 5.00	845 6.50	5963 1.00
2J40 25.00	5J32 25.00	WE-121A 3.50	464A 2.25	845W 10.00	5981/5650 50.00
2J50 35.00	5JP1 12.50	WE-123A 3.50	WL-468 10.00	846 50.00	R-7301 10.00
2J55 50.00	5JP2 7.50	WE-124A 3.50	SS-501 7.25	849 20.00	8002R 10.00
2J56 50.00	5JP4 7.50	VT-127A 2.00	CK-510AX .75	850 10.00	8005 4.00
2J61 15.00	5JP5A 7.50	F-128A 25.00	527 15.00	851 12.50	8011 .25
2J62 5.00	5JP11 25.00	HK-154 5.00	WL-530 15.00	860 2.50	8012 1.00
2J-B51 1.00	5LP1 9.75	VT-158 10.00	WL-531 5.00	861 7.50	8012A 2.50
2K25 12.50	5NP1 5.00	FG-190 3.50	559 .50	864 .25	8013 2.75
2K30 100.00	5R4GY 1.00	HF-200 9.50	575A 12.50	65 .50	8013A 3.75
2K33A 75.00	C6A 10.00	203A 2.00	WL-579B 10.00	866A 1.00	8014A 50.00
2K41 90.00	C6F 10.00	203Z 5.00	HY-615 .50	868/PJ-23 2.00	8020 1.25
2K54 15.00	C6J 5.00	204A 5.00	WL-632A 15.00	869B 17.50	8025 1.75
2K55 10.00	C6L/5528 3.75	WE-205B .50	WL-670A 8.75	872A 1.00	8025A 2.75
2P21(Image	6AC7W 1.25	207 35.00	WL-681/	GL-872A 2.00	8026 3.50
Orthicon)	6AJ5 1.25	211 .50	686 25.00	874 .50	PD8365 50.00
250.00	6AJ6 2.50	WE-212E 25.00	701A 3.00	876 .75	9001 .75
2V3G 2.25	6AN5 3.00	217A 1.50	702A-B .50	878 .50	9002 .75
2X2/879 .25	6BM6 35.00	WL-218 25.00	703A 2.00	884 1.00	9003 1.00
2X2A 1.00	6C21 15.00	220C 182.50	704A .75	885 1.25	9004 .25
EL3CJ 7.50	6J4 3.75	221A .75	705A .75	902P1 4.50	9005 1.00
3A4 .50	6Q5G 3.25	CE-235 5.00	706AY-GY 10.00	905 3.00	9006 .25
3A5 .50	6SB7Y 1.00	WE-242C 5.00	707A 3.50	917 2.00	9906R 1000.00
3AP1 5.00	6SC7GTY 2.00	WE-249B 3.00	707B 3.00		

western engineers

ELK GROVE, CALIFORNIA

GEORGE WHITING, OWNER

** Prices do not include transportation*

** Fully guaranteed*

WANTED
BC-788, T-47A/ART-13, BC-348R, R-5/ARN-7, RT-18/ARC-1

RADALAB

87-17 124th STREET
Richmond Hill 18, New York
Phone VIrginia 9-8181-2-3

Prices FOB NYC. Rated firms open account. Prices subject to change without notice.
CABLE: Radalab, NY
TELETYPE: NY-4-4361

AN/ARC-2
2-9.5 mc autotune transmitter-receiver. This equipment will provide 8 channel autotune operation on voice or C.W. power output is app. 30 watts. This set is similar to ART-13 but incorporates a receiver which is automatically tuned to the trans. freq. as channels are changed, providing a very compact communication pkge. for air or ground use. Power input is 28v DC. POR.

TDQ VHF GROUND STATION
100-156 MC Ground to Air 50 watt Transmitter. Can be supplied with remote telephone control panel. 110 V 60 cy. input. POR.

AN/TXC-1, RC-120 FACSIMILE SETS
Page sending and receiving equipment. These sets will transmit and receive a 12 by 18 inch or a 7 by 8 inch page of written or picture material over a telephone line or a radio circuit in 20 minutes. The copy may be sent on or received on either photographic printing paper or on direct recording paper. Power input is 110v 60 cyc. POR.

AN/ASQ-1 and 1A MAGNETOMETERS
This is an airborne magnetometer used to measure the magnetic flux of the earth and to locate submarines and other metallic objects by their distortion of the magnetic field. Sensitivity 2-3 gamma or better. POR.

SCR-506A
2-6mc mobile or field radio transmitting and receiving equipment. This equipment is a currently used mobile communication set by many govts. The power output is 90 watts CW and 25 watts phone. The trans. may be set to 4 pre-selected channels or tuned manually. Power input is either 12 of 24v DC. POR.

SCR-694
3-6mc. portable field radio. This equipment provides reliable communications in the field or vehicle. Provisions are made for 2 preset channels, or the set may be tuned manually. Power output is 5 watts phone and 20 CW. This set can be supplied with either a vibrapack for 6 or 12 volt operation in a vehicle; or a hand generator for field use. POR.

AN/TRC-1
70-100 mc point to point VHF radiotelephone equip. This is a frequency modulated 50 watts point to point radio trans. and receiver. The range is approx. 60 miles line of sight. The set is completely portable and operates from 110v 60 cyc. POR.

TUBE SPECIALS

2J41	$149.50	4J31	$79.50
2J55	49.55	7C22	50.00
3B24	2.50	723AB	7.25
3C22	64.75	725A WE	5.50

All Tubes Completely Guaranteed.
New Standard Brands

AN/ARN-6 RADIO COMPASS
This is a very compact light weight automatic radio compass covering 100 KC to 1750 KC in 4 bands. All components are miniaturized including the loop for use in high speed aircraft. Complete sets and components are available. Input 110 Volts 400 cyc. and 28 Volts DC. POR.

AN/GSQ1-A SPEECH SCRAMBLERS
Speech scrambler for use on any comm. channel to insure privacy. We can supply complete installations of this equipment 28v DC input. Also 110v, 60 cyc.

RC-115B 75 MC FAN MARKER
This is a 75 C Marker Beacon Ground Station. This equipment comes mounted in a transporting trunk. The set can emit either inner, outer, or airways signals. The transmitter is crystal controlled and operated from 110 Volts 60 cyc. POR.

SCR-291A
Automatic ground direction finder covering 1.5mc-30mc. Provides instant bearings on a C.R. indicator of any signal in its range. This equipment is transportable and can be set up quickly. 110v 60 cyc. POR.

AN/ARC-1
100-156 mc. VHF transmitter-receiver. This equip. provides phone operation in 10 crystal controlled automatically selected channels from 100-156 mc. with one guard channel. We can also modify these sets for 20 and 50 channel operation and can supply complete sets for ground operation from 110v 60 cyc supply. Normal input 28v DC. POR.

SCR-682 A RADAR
10CM high power long range harbor surveillance and early warning RADAR. This equipment is a 3000 mc mobile search radar that can be transported in a truck. The equipment incorporates a 7" PPI for operation up to 240,000 yards. Azimuth accuracy is ± 1%. Range accuracy is 100 yards at 10,000 yard range and 5000 yards at 240,00 yard range. Trans. output is approx. 225KW, pulse width is one microsecond. Antenna beam width is 6". Input is 110v 60 cyc. Can be supplied with or without operating shelter or antenna tower. POR.

AN/APQ-15
Multiple echo equipment. This set will pick up signals from a ground search radar and re-transmit from making the plane carrying it look like an entire fleet of planes on the ground radar .....POR

AIRCRAFT TOGGLE SWITCHES

SINGLE POLE

STOCK NO.	CONTACT ARRANGEMENT	MFG. TYPE NUMBER	GOVT. NUMBER	LUMINOUS TIP
4B86	SPST H	C. H.		X
4C120	SPST H w/leads	KUKLA		
4A18	SPST H	8201K4	B5A	
*4B13	SPST H	168553		X
4A8	SPST M N.O.	8211K6		
4B34	SPST M N.O.	8211K5	B6B	X
4A12	SPST M N.O.	3905K528		
*4B7	SPST M N.O.	8211K8	3022-8B	X
4A5	SPDT H	8210K5	B1B	
4B5	SPDT M	8215K1		
4B19	SPDT M	8215K3	B21	X
4A6	SPDT M CO H	8208K4	B7A	X
*4A13	SPDT M CO H	8208K7	3022-6B	X
*4B10	SPDT M CO H	8209K7	3022-5B	X
4B22	SPDT M CO H	8214K2	B14	X
4A20	SPDT H CO	C. H.	B9A	X
4A17	SPDT H	8200K5	3022-1B	X
*4A4	SPDT H CO	8200K8		

ALL ABOVE SWITCHES RATED 5 AMP. 125V OR 20 AMP. 24V.

1 TO 100 **30c** | OVER 100 **25c** | OVER 1,000 **22c**

DOUBLE POLE

STOCK NO.	CONTACT ARRANGEMENT	MFG. TYPE NUMBER	GOVT. NUMBER	LUMINOUS TIP
4B12	DPST H	8701K2	C5A	X
4B16	DPST H	8721K1	C1	X
4C130	DPST H	8701K3		X
4B6	DPST M N.O.	8711K2	C6B	
4B11	DPST H	8711K3		X
4B4	DPDT M	8715K3		
*4B20	DPDT M	8715K5	3023-10B	X
*4C132	DPDT M CO H		3023-6B	X
4B18	DPDT M	8715K2		X

ALL ABOVE SWITCHES RATED 20 AMP. 125V.

1 TO 100 **55c** | OVER 100 **45c** | OVER 1,000 **35c**

H—HOLD N.O.—NORM. OPEN M—MOMENTARY
CO—CENTER OFF *HAVE WELD MOUNTING NUTS.

WELLS SALES, INC.

Write for the new Wells Sales 1955 CATALOG of electronic components at lowest prices

833 W. Chicago Avenue
Dept. 7, Chicago 22, Ill.

S BAND

GUIDED MISSILE F-28/APN-19 FILTER CAVITY
2700-2900mc. Max. 1.5-db loss at ctr. freq. over band, 3db at 15 mc band ends. JAN spec. Ideal as standard reference cavity. Brand new. Guaranteed, $37.50.
AN/APN-60 Crystal Mounting, $19.50.
COAXIAL CRYSTAL MOUNT. Type N fittings, tuneable silver plated. Holds any IN21 type Xtal, $9.50.
LIGHTHOUSE CAVITY. For 2C40 tube. Tuneable 2700-2900mcs w/suitable grid cyls. Can be freq. modulated, $22.50.
FEEDBACK DIPOLE ⅞" coax. 11¾" o.a. $14.50.
ECHO BOX. TS-207/UP. 2700-2900mc. $64.50.
ECHO BOX. OBU-3. Precision w/detector and meter, $325.00.

60MC. IF STRIP
Uses (6) 6AK5 Mfg. Western Electric. Price, $14.50.

X BAND

MITRED BEND. Vy Short Radius. E plane, $10.00.
TRANSITION, 1"x½" to 1¼"x⅝" Lgth 3½", $6.50.
TWIST 90 DEGREE, UG39 to UG40. Silver plated, $6.50.
CRYSTAL MOUNT. Hold any IN23 type xtal. 1" x ½" guide std coax output. UG40 flg. input, $15.00.
DIRECTIONAL COUPLER. Uni. or Bi directional types 20db coax "N" output, UG39 flg. to UG40 chk., $24.50.
FLEX. SECT. 6". UG39 flgs. $10.00, 12" at $17.50.
ROTARY JOINT, 3 types available, miniature 180 deg. input output, miniature 90 deg. input output, large 90 deg, input output 360 deg. rotary coupling for lab or high speed scanner VSWR 1.2 or better, $15.00.
LINE STRETCHER, VSWR matching device for XMSN Lines, $34.50.

K BAND

MAGIC TEE, precision.....$22.50
DIRECTIONAL COUPLER bi-dir. UG-115/U flanges, $22.50.
KLYSTRON OUTPUT COUPLING for 2K50. RG 66/U guide, $6.50.
H BEND 90 deg. CG346/U.
E BEND 90 deg. CG345/U. Cplg. UG-117 to UG-116. RG66 guide, $12.50.
ADAPTERS 1½" lg UG116 to UG116, UG117 to UG117 ea.....$5.00

W.E. STEPPING RELAY
44 Step, 2 Levels, Bridging Wipers, Gold Plated Contacts, Oper. Voltage 5.5 to 12 V.D.C. 4.4 Ohms, Inter. Contact 1 Break-Make. Price One to 10 Pieces $12.00 Each. Brand New. Quan. Discounts.

RADIO-RESEARCH INSTRUMENT Co.
550 - 5 Ave., N. Y. 36, N. Y. *Tel: JU 6-4691*
PAUL J. PLISHNER

AMPLIFIER UNIT MAGNETIC

Mfr. Pioneer Instrument Type 12071-1-A; 110 volts, 400 cycles; 26 volts, 400 cycles; 4 tube (12AH7-GT); take-off for four autosyns . . .

$29.95 ea.

TELEGON OSCILLATOR

Input: 115 volts, 60 cycle
Output: 26.5 volts, 400 cycle
3-watts @ 250 ohm load
Ideal for laboratory use . . . approx. 10" x 7" x 8", wt. 16 lbs. . . .

$29.95

PIONEER TORQUE UNITS

Type 12602-1-A. Includes CK 5 Servo motor coupled to output shaft thru 125:1 gear reduction train. Output shaft coupled to autosyn follow-up (AY-43). Ratio of output shaft to follow-up autosyn is 30:1. Includes base mounting type cover for motor and gear train . . .

$34.95 ea.

TRANSTAT 100 AMP

Voltage Regulator

Prim: 115 VAC; 60 cycle; 11.5 KVA; Sec: 0-115 VAC; 60 cycle; 100 amp. Max. MFD. Amertron.

Only $125.00

SPIDER DIFFERENTIAL

Three spur gears. Size: 7½" long x 1¾" wide x 2¾" high.

Stock No. 105 **$5.00 ea.**

GEAR DRIVE SPIDER DIFFERENTIAL

System includes seven gears and spider. Size: 5¼" long x 3½" wide x 3" high.

Stock No. 108 **$5.00 ea.**

INVERTERS

MG 149F HOLTZER CABOT
OUTPUT: 26 VAC @ 250 VA; 115 V. @ 500 VA; single phase; 400 cycle; INPUT: 24 VDC @ 36 amps. . . $49.50

PIONEER 12123-1-A
OUTPUT: 115 V; 3-phase; 400 cycle; Amps .5; INPUT: 24 VDC; 12 amp. $69.50

PIONEER 12126-2-A
Output: 26 volts; 3 phase; 400 cycle; 10 VA; .6 PF Input: 27.5 volts DC; 1.25 amps $24.50

DMF2506M CONTINENTAL ELECTRIC
24-30 volts input; 5.5-4.5 amps; cont. duty. Output: 115 volts; .44 amps; 400 cyc; 1 phase; PF 1.0; 50 watts. $39.50

10563 LELAND ELECTRIC
Output: 115 VAC; 400 cycle; 3-phase, 115 VA; 75 PF. Input: 28.5 VDC; 12 amps. $39.50

PIONEER 12117
Output: 26 volts; 400 cycles, 6 volt amperes, 1 phase. Input: 24 VDC; 1 amp. $19.95

PE 218 LELAND ELECTRIC
Output: 115 VAC; Single Phase PF 90; 380/500 cycle; 1500 VA. Input: 25-28 VDC; 92 amps; 8000 rpm; Exc. Volts 27.5 BRAND NEW. $39.95

PE 109 LELAND ELECTRIC
Output: 115 VAC, 400 cyc; single phase; 1.53 amp; 8000 rpm. Input: 13.5 VDC; 29 amp. $65.00

MG153 HOLTZER-CABOT
Input: 24 VDC; 52 amps. Output: 115 volts—400 cycles, 3-phase, 750 VA and 26 volt—400 cycle, 250 VA. Voltage and frequency regulated. $95.00

PIONEER 12130-3B
Output: 125.5 VAC; 1.5 amps. 400 cycles single phase, 141 VA. Input: 20-30 VDC, 18-12 amps. Voltage and frequency regulated $69.50

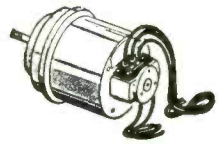
12116-2-A PIONEER
Output: 115 VAC; 400 cyc; single phase; 45 amp. Input: 24 VDC, 5 amp. $39.95

10285 LELAND ELECTRIC
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

10486 LELAND ELECTRIC
Output: 115 VAC; 400 cycles; 3-phase; 175 VA; .80 PF. Input: 27.5 DC; 12.5 amps; cont. duty. $90.00

PIONEER 10042-1-A
DC input 14 volts; output: 115 volts; 400 cycle, 1-phase; 50 watt. . . . $39.50

10339 LELAND ELECTRIC
Output: 115 volts; 190 VA; single phase; 400 cycle; .90 PF and 26 volts; 60 VA; 400 cycle, .40 PF. Input: 27.5 volts DC 18 amps cont. duty, voltage and freq. regulated $49.50



SYNCHRONOUS SELSYNS

110 volt, 60 cycle, brass cased, approximately 4" dia. x 6" long. Mfd. by Diehl and Bendix

QUANTITIES AVAILABLE
REPEATERS . . . . . $20.00 ea.
TRANSMITTERS . . . . . $20.00 ea.

SYNCHROS

GENERAL ELECTRIC MOD. 2J15M1; 115-57.5 volts, 400 cycle. $22.50
KOLLSMAN AUTOSYN MTR. TYPE-403; 32 VAC; 60 cycle; single phase. $9.95
BENDIX AUTOSYN MTR. TYPE-851; 32 VAC; 60 cycle, single phase. . $9.95
MICROSYN UNIT TYPE IC-006A. $15.00
IF SPECIAL REPEATER; 115 volt-400 cycle $15.00
2J1F3 GENERATOR; 115 volt-400 cycle $10.00
5CT CONTROL TRANSFORMER; 90-50 volt; 60 cycle $45.00
5F MOTOR; 115-90 volt; 60 cycle $45.00
5SDG DIFFERENTIAL GENERATOR; 90-94 volts; 400 cycle. . . $30.00
BENDIX TRANSMITTER TYPE C-78248; 115 volt; 60 cycle. $22.50
DIFFERENTIAL TYPE C-78249; 115 volt; 60 cycle. $5.00
BENDIX REPEATER TYPE C-78410; 115 volt; 60 cycle. $37.50
REPEATER, Type C-78663, AC Synchronous 115 volt, 60 cycle. $9.95
DIEHL REPEATER TYPE FJE 22-2; 115 volt; 400 cycle; secondary 90 volt. $27.50
5G GENERATOR; 115/90 volt; 60 cycle $45.00
7G SYNCHRO GENERATOR; 115/90 volt; 60 cycle. $75.00
6G SYNCHRO GENERATOR; 115/90 volt; 60 cycle. $60.00
6DG SYNCHRO DIFFERENTIAL GENERATOR; 90/90 volt; 60 cycle. $50.00
2J5F1 SELSYN CONTROL TRANSFORMER; 105/55 volts; 60 cycle $22.50
2JD5HA1 SELSYN GENERATOR; 115/105 volts; 60 cycle. $50.00
2J1F1 GENERATOR; 115/57.5 volts; 400 cycle $12.50
2J1H1 DIFFERENTIAL GENERATOR; 57.5/57.5 volt; 400 cycle. $12.50
2J1G1 CONTROL TRANSFORMER; 57.5/57.5 volts; 400 cycle. $7.50
2J5H1 SELSYN GENERATOR; Mfr. G.E.; 115/105 volts, 60 cycle. . . $27.50

SIMPLE DIFFERENTIAL

Size: 2-5/32" long x 1¼" dia.; bearing one end ½" O.D.; Shaft Size: 1" long, threads 8-32-¾" long, with bearing shaft ⅛" dia. x ¼" long. Gear on shaft end 1-7/16" dia., gear on bearing end 1¼" dia. Drive gear 25/32" dia.

Stock No. 101 **$3.95 ea**

SPIDER DIFFERENTIAL

Size: 6½" long x 1¾" wide with 3/16" shaft.

Stock No. 107

$2.50 ea.

DUAL SIMPLE DIFFERENTIAL

1:1 reverse ratio on both. Size: 3¼" long x 1-7/16" dia. Shaft size: ⅛" and 5/32".

Stock No. 110

$7.50 ea.

SIMPLE DIFFERENTIAL

1:1 reverse ratio. Size: 6¾" long x 2¾" dia. Shaft size: 11/32".

Stock No. 111

$7.50 ea.

SIMPLE DIFFERENTIAL

Size: 5½" long x 2¼" dia. Shaft size: ⅜" on one end and 11/32" on other end. Hub is 1-3/32" dia. on each end.

$7.50 ea. *Stock No. 112*

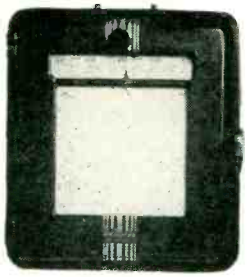
PRECISION PLANETARY DIFFERENTIAL

1:1 reverse ratio, ring gear 3" dia., 120 teeth. Overall length 5¼". shaft dia. 11/32". ⅛" key on one end

Stock No. 114

$7.50 ea.

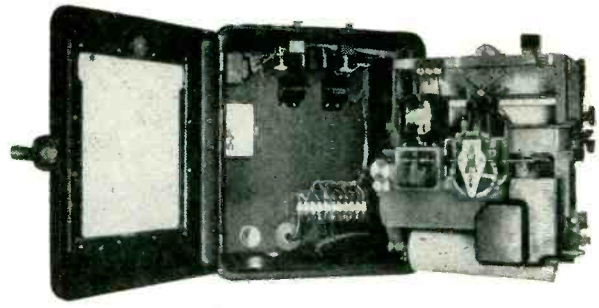
SURPLUS—SAVE! SAVE!
MICROMAX RECORDERS
For Spec. Plat. Thermohm. AC Galvinometer Type.



For fast and sensitive recording or controlling one or more points throughout a wide variety of processes. Used originally for temp. ranges of 350-550 Degrees cent. but may be changed for other applications by suitable control units. Control units not incl. with instrument.

Guaranteed to satisfy or money back.

Removed from new Gvmt. equip. Sold as used but many have never had ink in pens.



Price - - $139.50

BAILEY METER RECORDER, as pictured, used and guaranteed $65.00

BRAND NEW RC-58-B FACSIMILE SETS $350.00 EA.

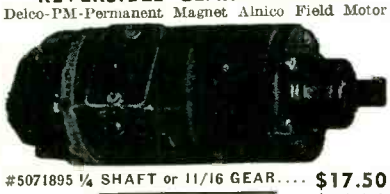
New in original boxes complete with spare parts box, BC-908-B Amplifier, BC-918-B Recorder-Scanner, writing stand, and 48 rolls recorder tape. Ideal for banks & business to varify signatures, etc. 12 V. DC operated. Operates by wire or radio.

All mdse. guaranteed to satisfy or money back if returned prepaid.

ESSE RADIO COMPANY

42 W. South Street — Indianapolis 25, Ind.

REVERSIBLE GEARED-MOTOR
Delco-PM-Permanent Magnet Alnico Field Motor

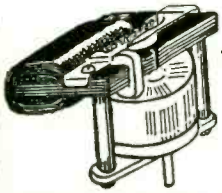


#5071895 ¼ SHAFT or 11/16 GEAR.... $17.50
#5069000..... $18.50
Clamps to hold motor: $1.50 ea.

GRAIN OF CORN LAMPS
10 for $3.00 — 100 for $25.00

#328, 6 Volts #326, 2½ Volts #321, 28 Volts

TELECHRON Motors



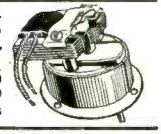
4 RPM on 50 cycles or 4¾ RPM on 60 cycles.. 2.85
2 RPM $2.90
3 RPM 3.90
4 RPM 2.90
3.6 RPM 3.15
1 RPM 3.95
3 R.P. Hr 2.85
1 R.P. 2 Hr... 2.80
1 R.P. 12 Hr . 3.25
60 RPM 4.85

Laboratory Special 1 of Each Above $25.00

BLOWERS 115 Volts A. C. 60 c.

REDMOND 5" 18 watts..... $8.95
DELCO 60 cfm. 40 watts....$14.50
#5062369 used in 584 RADAR EASTERN AIR DEVICES 70 watts. 3400 RPM. labeled 80 cfm, but blows like blazes!.....$17.50

HAND WOUND 10 Sec. to 24 Min. TIMER SWITCH..$1.25



6 Watt Most POWERFUL TELECHRON 1 RPM 110 volts 60 cy $6.50
10 for $50.00

3" Round Elapsed Time Meter $13.75
Square Case $14.50

MARKTIME 5 HOUR SWITCH
A 10 amp. timing device. Pointer moves back to zero after time elapses. Ideal for shutting off radios and TV sets when you go to bed. Limited supply at this special PRICE..... $4.90
Also available in 15 min., or 30 min. or 1 hr. at $6.50

HAYDON TIMING MOTORS

110v. 60 cycle 30 RPM... $2.60
110v 60 cycle 1 RPM..... 2.85
230V 1 RPM..... 1.00
60C 2 RPM..... 1.00

please include postage

BLAN EST. 1932

64K Dey Street
New York 7, N. Y.

TIME DELAY

Haydon relay 115v 60 cy adjustable in 5 sec. steps to 40 seconds max. 3½x3½x2½.....$4.50

4PDT RELAYS:

Midget (Price 5700) 12vdc 70Ω.....$1.65
—24vdc 280Ω or 425Ω.$2.45. Herm. seal.2x1½x1¼:
—Allied SKHX or Price 5724-1 HSX.....$3.45
ALLIED LKHK 4500Ω 5 made 2AIB or 2BIA.$3.45
SPDT 6vdc 35Ω Dunco 181 xax 100 cer. Insul.$1.25

ERIE #557 cer. trimmer 3-12 NPO or 8-50 150./M
Hundreds of other items. Write for listings.

EMPIRE ELECTRONICS CO.
409V Ave. L Brooklyn 30, N. Y. CL 2-4000

New "Searchlight" Advertisements

received by April 4th will appear in the May issue subject to limitation of space available. Address copy to the

ELECTRONICS
330 W. 42nd St., New York 36, N. Y.

FOR RESISTORS
POTENTIOMETERS
CAPACITORS
phone: Yonkers 9-6000

All Best

SAMPLES AT—NO CHARGE—NO OBLIGATIONS

LEGRI S COMPANY

391 RIVERDALE AVENUE YONKERS 5, N. Y.

FAY-BILL DISTRIBUTING CO.

PARTIAL LISTING ONLY

LARGEST SURPLUS TUBE DEALER IN THE COUNTRY
STANDARD BRANDS—TRANSMITTING & RECEIVING

Type	Price
AB-150	$2.95
CEP-220	.94
CEP-120*ZB	.94
CK-507AX	.99
CK-521AX	.99
CRP-72	**.79**
DG-1290	3.99
EF-50	.39
E-1148	.39
EC1	.39
F123A	5.99
F127A	3.99
F128A	**29.50**
HF-100	6.99
HF-150	15.99
HF-200	10.99
HF-300	19.99
HK-24	**3.99**
HK-54	4.59
HY-114B	**.29**
HY-615	**.29**
KU-610	**4.99**
QK-59	41.50
QK-61	**63.50**
QK-62	**69.00**
QK-185	**110.00**
RK-34	**.29**
RK-38	1.89
RK-59	1.89
RK-60	2.49
RK-65	**14.99**
RX-21A	**8.99**
RX233A	2.19
UV-217C	3.50
UH-50	1.99
10S/VT-25A	.29
VR-78	.89
VR-90	.82
VR-105	.89
VR-150	.80
VT-52	.29
30S/VT-67	.19
VT-127A	2.99
VT-158	15.99
VU-111	**.19**
OA2	.74
OB2	.74
1B22	1.19
1B24	**5.99**
1B26	1.46
1B27	10.45
1B29	2.59
1B32/532A	1.19
1N21	.69
1N22	.39
1N23	2.10
1N27	.89
1P28	11.70
1P30	2.99
2AP1	6.44
2B22	1.49
2BP11	7.99
2C22	.36
2C26	**.22**
2C30	4.95
2C33/RX233	1.69
2C39A	**11.99**
2C40	7.29
2C43	**14.77**
2C44	.85
2C46	9.99
2C51	3.01
2D21	.79
2D21W	2.85
2E22	2.49
2E24	3.29
2E36	1.89
2G-22	1.19
2J-21	**2.49**
2J-22	**2.99**
2J-26	**4.99**
2J-27	**6.99**
2J-31	14.99
2J-32	15.99
2J-33	16.99
2J-34	16.99
2J-38	16.50
2J40	29.50
2J-42	69.95
2J-49	49.50
2J-61	15.99
2J-62	6.99
2K-22	**16.99**
2K-23	**17.95**
2K25	**12.99**
2K28	**28.99**
2K-33A	**69.50**
2K41	75.00
2K45	**69.50**
2K52	59.50
2K54	**23.90**
2K55	**39.95**
2x2/879	.26
2V3	1.29
3A5	.69
3BP1	4.99
3B22	1.49
3B23	3.99
3B24	**2.49**
3B24W	**4.44**
3B25	3.39
3B27	11.69
3B28	3.69
3C21	.94
3C22	**64.95**
3C23	7.45
3C24	.99
3C28	**4.99**
3C30	1.42
3C45	7.95
3D23	4.99
3E99	8.99
3EP1	2.99
3FP7	1.99
3GP1	1.89
3HP7	1.77
3J21	79.95
4A-11	**.19**
4AP-10	2.99
4B22	7.22
4B25/EL6C	8.95
4B28/CE225	2.99
4-125A	18.99
4B36	3.69
4C27	8.95
4C28	33.50
4C35	**14.99**
4D22	19.95
4D32	19.89
4E27	12.55
4E27A	29.95
4J22	79.60
4J23	79.60
4J26	**79.50**
4J28	**79.50**
4J31	99.50
5AP1	4.99
5BP1	1.96
5BP4	**2.99**
5CP1	2.29
5CP1A	10.50
5CP7	8.99
5CP11A	15.50
5C21/C6J	8.49
5C22	**28.99**
5D21	**7.99**
5FP7	1.99
5HP4	3.99
5HP1	3.99
5JP1	14.50
5JP5	7.49
5RP2	16.50
5J29	**9.00**
5J30	16.65
5J33	**5.90**
5LP1	9.05
5NP1	11.95
5R4GYW	**2.05**
5R4GY	.91
5R4WGY	2.22
6-4	.19
6C21	16.99
7C22	**49.40**
7C25	**89.50**
7BP1	6.99
7BP7	6.99
9LP7	5.50
10Y	**.21**
12X3	1.66
15E	1.09
15R	.19
18C	.19
24R	1.99
25TG	4.44
53A	1.99
89Y	**.10**
100TH	6.99
100TL	8.99
203	3.99
204A	9.49
205B	.89
207	**36.50**
211	.89
215A	3.49
217A	2.49
217C	6.99
221A	2.99
231D	2.39
242C	6.99
249B	4.39
249C	3.99
250R	4.99
250TH	19.50
250TL	21.50
253A	7.99
258B	4.49
259A	6.99
264C	4.19
271A	12.99
274A	.99
274B2	.99
282A/B	2.99
286A	7.49
287A	6.51
304TH	8.99
304TL	8.99
307A/RK75	1.29
310A	3.60
316A	.46
327A	3.49
329A	4.69
336A	4.99
347A	3.99
350B	4.99
371B	.89
388A	1.49
393A	4.45
394A	4.99
417A	**4.99**
434A	**8.66**
446A	1.49
446B	2.89
450TH	59.99
450TL	59.95
WL460A	9.99
WL464A	2.77
GL471A	2.35
527	16.50
WL530	14.99
WL531	4.99
WL532	.99
GL559	.99
700A/B/E/D	9.99
701A	1.98
702A	1.99
703A	1.44
704A	1.09
705A	.96
706B	18.95
706C	18.95
707A	3.99
707B	**6.99**
708A	2.45
709A	1.19
713A	.96
714AY	27.99
715A	1.49
715B	7.75
715C	15.75
717A	.69
718AY/BY/CY/EY	21.99
719A	16.95
720AY/CY/EY/DY	29.75
721A	.96
721B	9.95
722	1.99
723A/B	10.44
724A/B	1.99
725A	7.50
726C	**39.50**
730A	12.99
800	.98
801A	.44
802	3.59
803	1.85
805	2.99
807	1.21
808	2.45
809	3.49
810	10.69
812	3.69
813	9.95
814	2.66
815	2.99
816	1.39
827R	79.50
828	9.75
829B	9.50
830B	1.99
832A	**7.49**
833A	37.49
836	3.20
837	1.22
838	1.69
841	**.19**
843	**.19**
845	11.99
849	49.69
851	24.99
860	3.99
861	8.05
864	**.19**
865	1.89
866A	.99
869B	**29.99**
872A	1.26
874	.86
876	.96
878	1.29
884	1.19
885	1.49
891R	199.50
892	199.50
9-3	**.19**
902A	6.49
918	2.10
927	1.95
931A	2.99
954	**.16**
955	**.29**
956	.26
957	.26
958	.59
959	1.99
991	.44
1500T	84.50
CK1005	.49
CK1006	3.19
1608	.99
1613	1.70
1614	1.99
1616	.99
1622	1.55
1624	1.64
1625	**.19**
1626	**.11**
1629	**.16**
1630	.69
1632	.49
1633	.59
1639	.89
1641	**2.49**
1642	**.29**
1644	.69
1806P1	3.99
1851	1.39
1960	.99
2050	1.19
2050W	2.20
2051	.81
1A3	.69
1B3	.89
1G6GT	.69
1LC5	.94
1LD5	.94
1L4	.84
1T4	.69
1A5	.79
1H5	.69
1N5	.89
1R5	.69
1S4	.84
1S5	.69
1U4	.69
1U5	.65
1X2A	.89
1V2	.69
2A3	.99
2A4	.99
3B7	.39
3D6	.39
3V4	.73
3Q4	.83
3S4	.69
5U4	.59
5Y3	.50
5T4	.91
5V4	.89
5Z4	1.19
5W4	.89
6AC7	.89
6AB7	.99
6AF4	1.29
6AG5	.84
6AG7	1.19
6AH6	.89
6AL5	.59
6AJ5	1.69
6AK5	.74
6AK6	.79
6AN4	1.35
6AQ6	.59
6AR6	2.70
6AS5	.76
6AS7G	3.69
6AX4	.79
6B4G	.99
6BA7	.89
6B5	.99
6B8	.69
6BG6G	1.99
6BH6	.79
6BE6	.69
6BJ6	.69
6BK7A	1.21
6BL7	1.10
6BN6	1.24
6BQ6	1.19
6BQ7A	1.19
6BX7	1.24
6CD6	1.72
6CB6	.69
6C4	.40
6C5	.49
6C6	.49
6C8G	.99
6D4	2.75
6E5	.79
6F5	.49
6F6	.99
6F6G	.69
6J4	3.99
6J6	.72
6J7	.94
6J8	.96
6K4	2.69
6K5	.79
6K6	.69
6K7	.79
6K8	1.19
6L6M	1.49
6L6G	.99
6L7	.99
6N7	1.10
6R7GT	.69
6S4	.59
6SC7	.74
6SF5	.74
6SG7	.69
6SH7	.79
6SK7	.64
6SL7	.79
6SR7	.59
6SS7	.79
6W4	.69
6W6	.84
6V6GT	.66
6X4	.49
6X5	.49
6T4	1.44
6T8	.99
7A5	.95
7A6	.85
7A7	.79
7A8	.79
7B5	.69
7C4	.39
7C5	.79
7F7	.89
7G7	.89
7H7	.69
7N7	.89
7Q7	.99
7Y4	.69
7Z4	.69
12A6	.59
12AT6	.49
12AU7	.79
12AT7	.99
12AV7	.94
12AX4	.83
12AX7	.79
12AY7	1.31
12BA6	.64
12BA7	.64
12C8	.69
12SC7	.89
12SQ7	.59
12SR7	.59
12SF7	.82
12SG7	.85
12H6	.65
12SH7	.69
12SJ7	.69
12K8	.69
12SK7	.69
12SN7	.79
12SL7	.89
12Z3	.49
14A7	.79
14B6	.69
14B8	.79
14N7	.99
14R7	.99
14W7	.99
19T8	.99
25L6	.64
25Z6	.61
26D6	1.75
28D7	1.21
35L6	.69
35Z3	.69
35Z5	.51
35Y4	.69
50A5	.69
50B5	.69
50C5	.69
50L6	.69
77	.49
78	.59
80	.49
83V	.99
5516	5.49
5559	18.99
5560	24.40
5633	7.49
5634	6.99
5638	8.70
5651	1.71
5654	1.10
5670	2.39
5687	3.49
5718	5.69
5763	1.59
5796	7.99
5814	1.27
5964	1.15
7193	.09
8002R	17.49
8005	4.90
8012	1.94
8013A	4.69
8020	2.59
8025	2.95
8602	.69
9001	.79
9002	.59
9003	1.29
9004	**.19**

WE BUY YOUR SURPLUS TUBES. SEND US YOUR LIST FOR HIGHEST QUOTATION
LARGEST BUYERS IN THE COUNTRY

All boxed and fully guaranteed. Special quantity discount—10% on 100 or more of same type. Minimum order $10.00. Thousands of other types in stock . . . Send us your requirements F.O.B. New York 25% deposit with order or if paid in advance save C.O.D. charges. Rated firms net 10 days. Prices subject to change without notice. For fast service ask for Sy.

CABLE FITTINGS, PLUGS & CONNECTORS

(AN-3108-18-5S)	.35 EA.
AN-3108-18-20P	.35 EA.
97-3108-18-20P	.35 EA.
AN-3108-18-20S	.35 EA.
97-3057-10-6	.15 EA.
PLUG—Navy Type No. 49195 PL259A	.44 EA.
ADAPTORS—Right Angle M359A	.36 EA.
CHASSIS CONNECTOR—SO 239A	.39 EA.
PL-Q62	.69 EA.
PL-183	.59 EA.

FAY-BILL DISTRIBUTING CO. DEPT. E1
418 Broome St., N. Y. 13, N. Y.
Telephone CAnal 6-8404

APN-9A AUTOMATIC COUNTER LORAN

This set provides greatly simplified operation over the regular APN-9 or APN-4. To take a bearing it is necessary only to match PPI'S on the screen and read the time difference directly on a dial, no interpolation is necessary.

Accuracy within 1%. Furnishes position information at far greater distance from transmitting stations than possible by any other means. The unit consists of the R249/APN-9A, receiver—Indicator. Input is 110V. 400 cyc. Large quantity available. Each Loran is completely checked out and guaranteed. PRICE

$365.00

FLUXMETER

Used to calibrate field strength of magnets from 500 to 4000 gauss and indicate polarity. Probe has gap of 1¼". Beautifully built in hardwood case with hinged cover. Instructions for operation on under side of cover. Size 12¾ x 9 x 6 in. Ideal for lab and school use. New. An exceptional value at..... $24.50

RADAR ANTENNAS

SO-1 (1CM) assembly with reflector, waveguide nozzle and drive motor.....$279.50
SO-3 (3CM) Surface Search type with reflector and drive motor, but less plumbing.....$99.50
SO-13 (10CM) Complete assembly with 24" dish, dipole, drive motor and gearing.....$49.50

RA38 RECTIFIER

Variable output 0-15000 V DC @ 500 MA. Input 115V 60 cy. 1 ph. Size 63 x 53 x 56 in. Write for detailed information.

NEW SCR-522A EQUIPMENT

Complete BC-624C receivers and BC-625AM Transmitters including mounting racks, plugs, connectors, dynamotor. Brand new equipment with instruction manuals. Write for full details.

HIGH POT TRANSFORMER

Westinghouse. Pri: 115, 60 cy. Sec: 15,000V C.T., @ .060A, C.T. ungrounded. Excellent for high-potting tests. Size OA 12H x 8½W x 9¼D. Weight 67 lbs. Fully enclosed steel case. Price.....$29.50

30-10,000 CYCLE MODULATION TRANSF.

For RCA, Type 250-K Broadcast Transmitter (MI-7242) P to P Primary Imp. 15,000 ohms. Secondary Loads 5,030 ohms. Size 11¼x9½x13". Wt. 143 lbs. New $39.50

6 KVA. STEPDOWN TRANSFORMER

G. E. Step-Down. 6KVA. Pri: 230/460. Sec: 115/125, 60 cy. Size: 20" x 11" x 9½". Weight 225 lbs. Navy grey finish, integral junction box and mounting brackets $49.50

PANORAMIC ADAPTER AN/APA-10

Provides 4 Types of Presentation:
(1) Panoramic (2) Aural
(3) Oscillographic (4) Oscilloscopic

Designed for use with receiving equipment AN/ARR-7, AN/ARR-5, AN/APR-4, SCR-587 or any receiver with I.F. of 455 kc. 5.2mc or 30 mc. 21 tubes including 3" scope tube..... $97.50

INSTRUCTION MANUAL. 80 pages of technical data covering the panoramic adapter, AN/APA-10 including circuit analysis, parts lists, sectional photographs, etc. $2.75

HIGH VOLTAGE OIL CAPACITORS

Mfd.	Volts		Price
.001	50	KV	$22.50
.025	50	KV	17.95
2 x .025	50	KV	34.50
.135	7.5	KV	6.95
.2	50	KV	29.50
.25	15	KV	13.95
.25	20	KV	$15.95
.25	50	KV	44.50
1.	15	KV	29.50
2.	5.5	KV	9.50
3.	6	KV	12.50

SPECIAL! 1.0 MFD. 7500 VDC Oil filled capacitor Cat. No. 26F681. Only..... $6.95

.02 mfd. 20KV. Size OA-10½" L x 2½ Dia. Special $6.75

G.E. SERVO AMPLIFIER

Used in B29 planes for Central Station Fire Control Systems B2, B3 and B4. Used to drive Amplidyne 5AM31NJ9A and Control Motor 5BA50LJ2A listed below. New less tubes.....$29.50

AMPLIDYNE

G.E. 5AM31NJ9A. 530 Watts. 7500 RPM. Input: 27 VDC. Output: 60VDC. Weight 34½ lbs...$23.50

CONTROL MOTOR

G.E. 5BA50LJ2A. Armature 27VDC at 8.3 Amps. Field 60VDC at 2.3A RPM 4000. H.P. 0.5 New $27.50

WRITE WIRE PHONE

The equipment advertised above represents but a few of the hundreds of items carried in stock in our two large warehouses. This material includes antennas, capacitors, dynamotors, generators, radars, synchros, test equipment, and a wide variety of components. Your requests for quotations will receive our prompt attention.

Phone: DEerfield 7-0044

ELECTRONICRAFT INC
27 MILBURN ST. BRONXVILLE 8, N. Y.

NEW—G. E. SWITCHETTES
2 Circuit - 1 Open - 1 Closed
¾ H.P. - 230 V. AC
2" x 1¾"
100 for 75.00 — 1.00 each

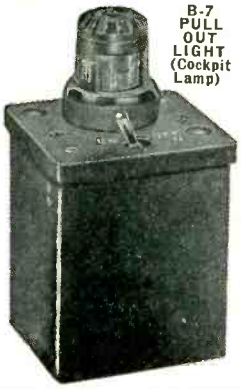
B&B DISTRIBUTORS

222 Fulton St., N. Y. 7, N. Y.
Rector 2-0432

NEW SYLVANIA GERMANIUM DIODES
IN 56A - 10 for 8.50
100 for 75.00

SWITCHES RELAYS — *SPECIALTY ITEMS AT LEAST 75% OFF LIST* — MOTORS BLOWERS

SIGNAL LIGHT — Portable, Multi-purpose. Consists of a spot light w/5" parabolic reflector, w/5" louvered signal tube. Pistol grip w/switch for buzzer comb. has remote control sw. & cord also 25' xtra cord. Can be operated on 110 VAC or 6 to 9 volt battery complete with case & brackets. Also can be used as red indicator trouble light on highway by placing red celophane over light. COMPLETE .....$7.95 ea.



B-7 PULL OUT LIGHT (Cockpit Lamp)

IMMERSION HEATER—24 V AC or DC 50 watt w/8' SJ/16-2 cord & armored Male plug. Immersion element 11" long .....$2.45 ea.

B-7 PULL OUT LIGHT
(Cockpit Lamp)

For Aircraft, Boats, Cars & Workshops. Gives white or Red Light. Unit pulls out 6' from self-rewind reel. Any Voltage. Mounts anywhere. Small 3x3¼x4¼..$1.90 ea. SYNCHRONOUS TIMER, CRAMER 110 V 60 cyc. Normally open or closed circuit ½ RPH Synchronous Motor. Time cycle 60 Min. One contact opens or closes on the hour interval. Can be wired to repeat cycle. Dial can be mounted for elapsed time indication. This timer made to sell for $19.50. Our sale price.....$2.45 ea.
25 or more .....$2.10 ea.

RELAYS — RELAYS — RELAYS — RELAYS — RELAYS — RELAYS

AC—115 V 60 Cyc. GE DPDT 15 Amp contacts.....$2.95 each
Dunco 3PST 30 Amp contacts #8CXX Heavy Duty..... 9.95 each
W-L SPST Dbl. Brk. 15 Amp Cont..... 2.15 each
GUARDIAN—DPDT 15 Amp Cont..... 2.65 each
DC—24 V Sealed Relays—Sigma—Potter & Brumfield—S-D—Allied.....Bargain Price
DC—24 V Open Frame type Leach #1224-322, 1024 GM, 1254 M.....$1.50 each
DC—24 V Allied PO (Same as BO) #51 4PDT.....$2.25 each — 100 for $195.00
CAPACITORS—ALL SIZES—BIG ASSORTMENT.
SPECIAL—2 Mfd. 1,000 volt DC w/bracket....89¢ ea. — $75 per 100
LAMPS, MAZDA #318 3 volt Min. lamp.....10 for $2.50 — $19.50 per 100

All items subject to prior sale. All mdse. shipped FOB NY. Include postage with remittance.
EXCESS INVENTORIES PURCHASED

PROOF POSITIVE

Yes here is *positive* proof that advertising in the SEARCHLIGHT SECTION of ELECTRONICS produces results! Following are a few lines from some letters that were sent to us voluntarily:

"Very satisfactory response to our previous insertions"

"Continue the advertising. We have had a great many replies"

"Our two inch ad sold $2,630 worth of equipment in one week"

"Ran a single 4" ad and sold all equipment advertised. Thanks"

"The results were very, very good"

Such enthusiasm proves what we have been saying all along: when you want to sell surplus new or used electronic components and equipment, you can do it best through the

SEARCHLIGHT SECTION
of
ELECTRONICS

INTERSTATE—YOUR SOURCE OF SUPPLY

FOR YOUR MILITARY COMPONENT REQUIREMENTS

MIL-C-5015B	MIL-C-R-93	MIL-C-R-1059A	JAN-S-28A	JAN-C-62
MIL-C-R26	MIL-C-R-94	MIL-I-631A	JAN-S-23A	JAN-C-5
MIL-C-R-11A	MIL-C-R-184	JAN-R-19A	JAN-C-25	JAN-C-76

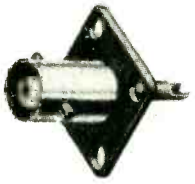
DEFINITELY DEPENDABLE FOR

UG—CONNECTORS—AN

GUARANTEED DELIVERIES *WITHIN 48 HOURS* **ON OVER 900 TYPES**

CERTIFICATE OF COMPLIANCE CAN BE FURNISHED

APRIL SPECIALS



UG 290/U 39¢ EA. | **UG-206/U** 49¢ EA.

SUBJECT TO PRIOR SALE

ALL MERCHANDISE BRAND NEW

Mail orders promptly filed. All prices F.O.B. NYC. Rated Firms Send P. O. Others, 25% with Order. Balance C.O.D.

Interstate Electronics, Inc.

227 Fulton St. BEekman 3-8780 New York 7, N. Y.

SELLING

Receivers
Transmitters
Radar
Special Purpose Tubes
Relays
Meters
Switches
Connectors
Rectifiers
Transformers
Motors & Generators
Wiring Cable
Instruments and
All Electronic Components

WILL BUY ALL

New or Used

Leach Relay #5059-R, #5058, #5055, #5053-SM, #5053

Price Bros. Relay #10
Relay #5586, #5587

Antenna Switching Relay Box # CBY 23049, # BG-AN-198, # BC -408

Tubes #53A, VT-127A, 35T, WL-530

Highest prices paid for most all types of aircraft sparkplugs any condition

Wholesale Only

RADIO & ELECTRONIC SURPLUS
13933-9 BRUSH STREET
Detroit 3, Mich. TO 9-3403

Wholesale Only

METERS

PANEL, SWITCHBOARD, PORTABLE
AIRCRAFT AMMETERS
AIRCRAFT VOLT-AMMETERS
SHUNTS
CURRENT TRANSFORMERS
INSTRUMENT POT. TRANSFORMERS

COMPLETE STOCK ON HAND
CIRCULARS ON REQUEST
STATE YOUR REQUIREMENTS

MARITIME SWITCHBOARD
336-340 Canal St, N. Y. 13, N. Y.
WORTH 4 8216, 8217

2K28

Tubes - Fully Guaranteed **$28.50**

Write for Quotations on Any Types

ALLIED ELECTRONIC SALES
74 COURTLANDT ST—NY. 7, N.Y.
BArclay 7-5839

FOR SALE
Transmitter Tubes
Eimac - Machlett - 750TL
List $137.00. Our price $32.50
J. BEEBER CO. INC.
838 Broadway *AL 4-3510* New York

BRAND NEW GUARANTEED

SAVINGS FROM **70-85%**

POWER RHEOSTATS

"Be Right with" Famous Make

MODELS H-J-G-K-L-N-P-R

Ohm	Watt	Each	Ohm	Watt	Each	Ohm	Watt	Each
.1	150(L)	$5.54	50	50	1.47	500	100(K)	3.55
.25	50	1.64	60	25	1.30	500	150(L)	6.98
.5	100(K)	3.79	75	25(H)	1.86	500	150	4.20
.5	150(L)	5.34	75	25	1.30	500	300(N)	8.42
1	25	1.47	75	50	1.47	585	150(L)	5.05
1	50(J)	2.34	75	75(G)	3.15	750	25(H)	1.86
1	50	1.64	75	300	6.30	750	150	4.20
1*1	50	1.64	80	50(J)	2.10	780	100(K)	3.55
2	25(H)	1.86	80	500(R)	12.18	800	25	1.30
2	100(K)	3.79	100	25(H)	1.86	1000	25(H)	2.10
3	100(K)	3.79	100	25	1.30	1000	25	1.47
3	225(P)	6.99	100	50	1.47	1000	50(J)	2.22
5	25	1.30	100	100(K)	3.55	1200	225(P)	6.99
5	50(J)	2.10	100	150(L)	5.05	1200	300	6.30
5	100(K)	3.79	125	25(H)	1.86	1250	50(J)	2.22
6	25(H)	1.86	125	25	1.30	1250	150(L)	5.34
6	50(J)	2.10	150	50(J)	2.10	1500	25(H)	2.10
6	75(G)	3.15	175	25	1.30	1500	25	1.47
7	25	1.30	175	25(H)	1.86	1500	50(J)	2.22
7.5	75(G)	3.15	175	500(R)	12.18	1600	50(J)	2.22
7.5	225(P)	6.99	185	25	1.30	1800	50(J)	2.22
8	50(J)	2.10	200	25(H)	1.86	1800	150(L)	5.62
8	50	1.47	200	25	1.30	2000	25(H)	2.10
10	25(H)	1.86	200	50	1.47	2000	50	1.55
10	50	1.47	200	100(K)	3.55	2250	150(L)	5.62
10	100	2.97	200	150(L)	5.05	2300	25	1.47
12	25(H)	1.86	250	25(H)	1.86	2500	50(J)	2.22
12	50	1.47	250	25	1.30	2500	100(K)	3.71
13	100(K)	3.55	300	50(J)	2.10	2500	150	5.62
15	25(H)	1.86	300	50	1.47	2500	500(R)	12.18
15	25	1.30	300	75(G)	3.15	3000	25	1.47
15	50	1.47	350	25(H)	1.86	3000	100(K)	3.79
15	50(J)	2.10	350	25	1.30	3500	25	1.47
15	75(G)	3.15	350	150(L)	5.05	5000	25(H)	2.22
15	100	2.97	370	25	1.30	5000	50(J)	2.34
15	150(L)	5.05	378	150(L)	5.05	5000	100(K)	4.04
16	50	1.47	400	25	1.30	7500	50(J)	2.34
20	25(H)	1.86	400	75(G)	3.15	7500	100(K)	4.30
20	50(J)	2.10	500	25(H)	1.86	10 K	50(J)	2.50
25	25(H)	1.86	500	50	1.47	10 K	100(K)	4.54
30	50	1.47	500	75(G)	3.15	15 K	25	1.93
50	25	1.30				20 K	4	.75

AVAILABLE IN ALL SHAFT SIZES

MEDIUM POWER TRANS. MICAS

MFD	VDCW	Type	Each
.00005	3000	F1	3.15
.00005	5000	F2	4.33
.00009	8000	F1	3.15
.0001	3000	F1	3.15
.0001	9000	F3	8.81
.00015	5000	F2	4.33
.0002	5000	F2	4.33
.00022	3000	F1	3.15
.00025	5000	F2	4.33
.00025	8000	F3	8.81
.0003	3000	F1	3.15
.00035	3000	F2	4.33
.0004	3000	F1	3.15
.0004	6000	F2	4.33
.0005	8000	F3	8.81
.0006	2500	F1	3.15
.00062	3000	F1	3.15
.0007	6000	F2	4.33
.00072	5000	F2	4.33
.00075	2500	F2	4.33
.0008	1000	F2	4.33
.0008	5000	F2	4.33
.00085	2000	F2	4.33
.0009	5000	F2	4.33
.001	3000	F1	3.15
.001	3000	F2	4.33
.0011	5000	F2	4.33
.00125	2000	F1	3.15
.0016	1000	F2	4.33
.0016	2500	F1	3.15
.002	3000	F1	3.15
.002	3000	F2	4.33
.002	5000	F2	4.33
.0025	2000	F1	3.15
.003	3000	F2	4.33
.004	3000	F2	4.33
.005	3000	F2	4.33
.005	8000	F3	12.15
.006	2000	F1	3.15
.0075	1500	F1	3.15
.008	3000	F2	4.33
.01	8000	F3	13.80
.02	2000	F2	4.33
.024	1500	F2	4.33
.025	1200	F2	4.33
.025	1500	F2	4.33
.033	1500	F2	4.33
.062	1000	F2	4.33

"J" .95
"JL" $1.10
Ohms
50
100
150
200

250
300
400
500
1000
1500
2000
2500
3000
4000
5000
10K
15K

20K
25K
30K
50K
100K
150K
200K
250K
500K
1meg
2meg
3meg
5meg

"JJ" $2.95
Ohms
50
600
2K
10K
40K
100K
150K
250K
500K
1meg
2meg
4meg

TREMENDOUS VARIETY IN STOCK

LOW POWER TRANS. MICAS

TYPE "4"

TYPE "9"

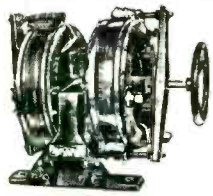
MFD		W.V.D.C. 600	1200	2500	MFD		W.V.D.C. 600	1200	2500
.00001	9	.29	.32	.38	.003	4	.29	.61	.98
.00003	9	.29	.32	.38	.003	9	.37		1.02
.00004	4	.24			.004	4	.30	.61	1.13
.00004	9	.29	.32	.38	.004	9	.40	.62	1.13
.00005	4	.24	.32	.38	.005	4	.31	.66	1.28
.00005	9	.29	.32	.38	.005	9	.42	.66	1.24
.00008	4	.24	.32	.38	.006	4	.36	.66	
.0001	4	.24	.32	.38	.006	9	.44	.69	1.27
.0001	9	.29	.32	.38	.008	4	.38	.77	
.0002	4	.24	.32	.38	.008	9	.49	.82	1.37
.0002	9	.29	.32	.43	.01	4	.43	1.02	
.0003	4	.24	.32	.45	.01	9	.56	.94	1.46
.0003	9	.29	.32		.02	4	.51		
.0004	4		.32	.47	.02	9	.71	1.41	
.0004	9	.29	.32	.48	.025	4	.72		
.0005	4	.24	.32	.50	.025	9	.87	1.58	
.0005	9	.29	.32	.51	.03	4	.89		
.001	4	.24	.36	.56	.03	9	.91	1.62	
.001	9	.29	.38	.58	.04	4	1.08		
.002	4	.26	.48	.83	.04	9	1.17		
.002	9	.33	.50	.85	.05	9	1.42		

A. MOGULL CO.

17 Warren St., N. Y. 7, N. Y.
Phone: WORTH 4-0865

APRIL SPECIALS

TRANSTAT 100 AMP

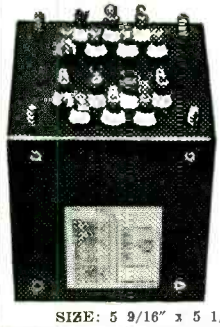


ONLY **$149.**

Pri. 115 VAC 60 cy.

11.5 KVA Sec. 0-115 VAC 60 cy 100 Amp Max. MFD. Amertron.

ALL PURPOSE FILAMENT TRANSFORMER



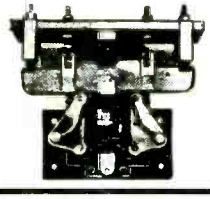
$4.95

PRI-115AC 60 CY.

Sec.
6.4v 12 amp.
6.4v 10 amp.
5v 3 amp.
5v 3 amp.
5v 3 amp.
2.5v 1.75 amp.

SIZE: 5 9/16" x 5 1/16" x 5¾" H.

CONTRACTOR RELAY



$9.95

110 VAC 60 cy D. P.-D. T. 15 Amp. Contacts 2500 V. RMS to Ground Mycalex Ins. Brand New.

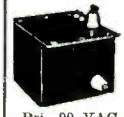
VACUUM SWITCH

Type VS-2

NEW PRICE **$2.75**

15000 V Contacts 30 Amp Operates with DC Coil Spdl Mfg. by Eimac

PLATE TRANS.



Only **$9.95**

Pri. 90 VAC 60 cy 3 Amp. Sec. 6400 V. .1 Amp 6¾ x 5¾ x 6¾ H.

TYPE A

196 to 320 MC. Can Use 955 Type Tube.

TYPE B

435 to 485 MC Silver Plated.

TYPE C

300 to 1000 MC Can Use 368AS Tube. Silver Plate.

YOUR CHOICE

$9.95

BRAND NEW

TYPE D

300 to 1000 MC Has Clip For Xtal Detector

HERSHELL RADIO CO.

5245 GRAND RIVER

DETROIT 8, MICHIGAN

PHONE TYLER 89400

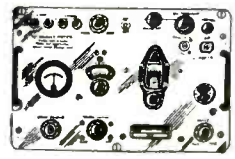
ALL PRICES NET F.O.B. DETROIT

NEW YORK'S RADIO TUBE EXCHANGE

NEW TUBES

Standard brands. First grade only. No pull outs. No rejects. No rebrands. At lowest prices. Wholesale and export only.

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
OA2	$1.00	2J38	8.95	4C28	35.00	20-4	.75	MX408U	.50	802	3.95	HK1554	75.00
OA3	1.10	2J39	8.59	4E27	16.00	KY21A	8.25	417A	15.00	803	5.95	1603	5.00
OB2	.99	2J40	29.00	4J25	150.00	RX21	8.00	434A	15.00	805	4.95	1612	1.50
OB3	1.10	2J42	135.00	4J26	150.00	KU24G	1.50	446A	1.95	807	1.25	1613	1.25
OC3	.96	2J49	60.00	4J27	150.00	25T	2.95	446B	3.95	808	1.95	1616	1.25
OD3	.89	2J50	55.00	4J28	150.00	RK39	2.75	450TL	45.00	809	2.95	1619	.45
C1B	2.95	2J55	150.00	4J29	150.00	HF50	1.75	450TH	52.50	810	10.50	1622	1.50
1B22	1.50	2J60	110.00	4J30	150.00	HK54	4.50	464A	7.50	811A	3.75	1624	1.75
1B23	6.95	2J61	35.00	4J31	150.00	RK72	1.00	471A	1.25	812A	3.95	1625	.35
1B24	12.00	2J62	35.00	4J32	150.00	RK73	1.00	527	18.00	813	13.75	1626	.25
1B26	1.75	2K22	29.00	4J33	150.00	FG95	19.95	WL530	23.00	814	3.75	1851	1.80
1B27	12.50	2K23	15.00	4J34	100.00	100TH	7.95	WL531	22.50	815	3.25	2000T	150.00
1B38	35.00	2K25	19.50	4J35	150.00	FG105	20.00	WL538	15.00	816	1.45	2050	1.80
1B40	23.00	2K26	68.00	4J36	150.00	122A	1.75	HK854	35.00	829	11.00	2051	1.00
1B51	7.50	2K28	35.00	4J37	150.00	203A	7.50	700A/D	10.00	829A	12.00		
1B56	35.00	2K29	35.00	4J38	150.00	211	.95	701A	4.50	829B	12.50	**Various** 5000 and 6000 series of new production	
1B60	35.00	2K33A	75.00	4J39	150.00	217C	12.00			830B	2.00		
1N21	1.25	2K39	140.00	4J40	150.00	242C	10.90	703A	3.95	832A	9.95		
1N21A	1.75	2K41	135.00	4J41	150.00	244C	9.50	704A	1.95	833A	45.00		
1N21B	2.75	2K45	80.00	4J42	190.00	249C	4.25	705A	2.75	834	7.50		
1N21C	14.50	2K50	275.00	4J51	190.00	250TH	19.95	706AY/FY		836	3.95	5280	475.00
1N22	1.00	2K54	35.00	4J52	225.00	250TL	12.00	25.00		837	2.75	8012	2.00
1N23	1.95	2K55	25.00	4J53	225.00	252A	3.00	707A	9.75	838	5.95	8012A	2.50
1M23A	2.75	2K56	72.00	5BP1	3.95	274B	2.75	707B	15.00	849	35.00	8013	3.00
1M23B	2.75	3AP1A	10.00	5BP2A	12.00	304TH	10.00	714AY	18.00	860	3.50	8013A	3.50
1N23C	7.50	3BP1	7.20	5BP4	3.95	304TL	10.00	715A	4.50	861	25.00	8019	1.75
1N25	6.50	3B24	5.50	5CP1	7.50	307A	3.50	715B	4.00	868A	1.50	8020	1.80
1N26	6.75	3B25	5.50	5CP7	9.95	310A	4.50	715C	22.50	869B	67.50	8025	3.75
1N27	3.50	3B26	5.00	5CP7A	18.00	310B	4.95	717A	1.50	869BX	50.00	PD8365	96.00
1N34A	.79	3B28	8.00	5D21	10.00	311A	6.50	719A	22.50	872A	3.50	9001	1.52
1N43	2.25	EL3C	5.50	5JP1	27.50	312A	3.50	720AY/GY		878	1.50	9002	.90
2C40	9.00	3C22	75.00	5JP2	19.50	323A	15.00	50.00		879	.50	9003	1.25
2C43	14.50	3C24	1.75	5JP4	27.50	327A	3.75	721A	1.50	884	1.50	9004	.35
2C44	.60	3C31	2.95	5J23	25.00	323A	6.75	721A	1.50	885	1.50	9005	2.75
2C46	7.50	3DP1	7.50	C6A	11.00	350A	4.50	723A/B	18.00	931A	5.00	9006	.25
2J21A	12.00	3DP1A	10.00	C6J	7.50	350B	5.95	724A	1.95	954	.35		
2J22	9.00	3DP1A-52	10.00	7BP7	5.00	HK354C	15.00	724B	2.25	955	.50	**Thousands of other tubes**	
2J26	15.00	3EP1	5.00	7DP4	9.00	357A	15.00	725A	18.00	956	.75		
2J27	15.00	3E29	15.50	12AP4	50.00	368AS	4.95	726A	18.00	957	.25		
2J31	24.00	3GP1	5.00	12DPTA	59.00	371B	1.50	726B	45.00	958A	.60		
2J32	29.00	3J21	75.00	LM15	225.00	388A	4.50	726C	45.00	959	2.25		
2J33	32.00	4B26	5.40	15E	1.75	388A	1.80	730A	22.50	E1148	.25		
2J34	36.00	4C27	10.00	15R	.75	393A	7.50	750TL	45.00	1280	.95		
2J35	90.00			NE16	.59	394A	3.95	801A	.90	1500T	135.00		



NEW TS-147 B AND C/UP TEST SET SIGNAL GENERATOR

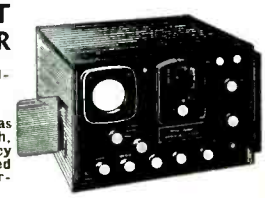
Hard-to-get X-Band Now Available

Test Set TS 147 UP is a portable Microwave Signal Generator designed for testing and adjusting beacon equipment and radar systems which operate within the frequency range of 8500 MC to 9600 MC.

NEW UNUSED SURPLUS TS 259 K BAND

23400-24500 MEGACYCLES SIGNAL GENERATOR

NEW MICROWAVE TEST EQUIPMENT TS148/UP SPECTRUM ANALYZER



Field type X Band Spectrum Analyzer. Band 8430-9580 Megacycles.

Will Check Frequency and Operation of various X Band equipment such as Radar Magnetrons, Klystrons, TR Boxes. It will also measure pulse width, c-w spectrum width and Q or resonant cavities. Will also check frequency of signal generators in the X band. Can also be used as frequency modulated Signal Generator etc. Available new complete with all accessories, in carrying case.

SPECIAL! 5,000 V. POWER SUPPLY

For IP25 Infrared Image Converter from 3 V. Battery Source. NEW, Complete with RCA 1654 Tube..... **$990**

OTHER TEST EQUIPMENT USED CHECKED OUT, SURPLUS

TSKI/SE	T35/AP	TS108	TS182	APA38
TS3A/AP	TS36/AP	TS110/AP	TS226	APS 3 APS 4
RF4/AP	1-96A	TS125/AP	TS239A-TS239C	APR4
TS12/AP	TS45	TS126/AP	TS251	APR5A
TS13/AP	TS47/APR	TS147	TF890/1	APT2-APT5
TS14/AP	TS69/AP	TS270	834	
TS33/AP	TS100	TS174/AP	SURPLUS EQUIP.	
TS34/AP	TS102A/AP	TS175/AP	APA10	

You Can Reach Us on TWXNY1-3235

Large quantities of quartz crystals mounted and unmounted.
Crystal Holders: FT243, FT171B others.
Quartz Crystal Comparators.
North American Philips Fluoroscopes Type 80
Large quantity of Polystryrene beaded coaxial cable.

Minimum Order 25 Dollars

***Phone:* WOrth 4-8262**

LIBERTY ELECTRONICS, INC.

135 LIBERTY STREET, NEW YORK 6, N. Y.

Cables: TELSERUP

E-PUT METER

Berkeley Scientific Model 554

For sale. Good condition, bought new 1952, and used very little.

DELTA NUCLEAR INSTRUMENT CO.
530 W. 6th St. Los Angeles 14, California
Vandike 2393

INDUSTRIAL X-RAY INSPECTION EQUIPMENT

General Electric OX-200, XRD Diffraction, Picker, Standard, Westinghouse and Keleket units from 100 KV up. Special inspection booths made to order.

MEDICAL SALVAGE CO., INC.
217 E. 23rd St. N. Y. 10, N. Y.

PLUG SALE

.25 each

THESE MAY BE IN

PL - PLG - PLS - PLP

take your pick

PL 47	PL 99	PL 169	PL 258
48	104	165	264
54	107	167	265
55	108	169	291
56	110	171	310
58	112	172	354
59	114	175	540
61	117	179	
62	123	181	
63	147	182	
64	148	183	
65	150	184	
72	151	191	
75	152	205	
76	153	211	
77	154	216	
81	156	219	
82	160	231	
83	163	250	
	164	258	

also have

RED SHELLS FOR PL 54 and PL 354 ..... $.05

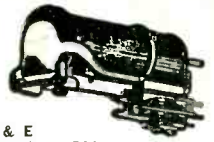
PL 68	$ .40
PL 103	1.00
PL 118	1.00
PL 122	1.50
PL 126	1.00
PLP170	1.00
PLG173	1.00
UG 21/U	.25
UG 245/U	.25
10H/528	.25

TALLEN CO., INC.

159 Carlton Ave. Brooklyn 5, N. Y.

TRiangle 5-8241

TELEPHONE RELAYS



Large Stock of
CLARE, TYPES C D & E
COOKE, AUTOMATIC—ELECTRIC
ALL TYPES of COILS and PILE-UPS
Send Us Your Specs. for Our Quote

CLARE TYPE G HALF SIZE SENSITIVE TELEPHONE RELAYS

	Coil	Contacts	Operates at	Price
1)	6500 ohms	2A	5 MA	$2.50 ea.
2)	5800 ohms	3A	4 MA	2.50 ea.
3)	5800 ohms	2B-1C	5 MA	2.50 ea.
4)	4850 ohms	1C	4 MA	2.50 ea.
4)	3600 ohms	1C	6 MA	2.00 ea.
5)	4850 ohms	1A	5 MA	2.00 ea
6)	3300 ohms	(None)	ACTUATOR	1.50 ea.
7)	3300 ohms	1A	Micro-Switch	2.50 ea.
8)	3000 ohms	1C	5 MA	1.75 ea.
9)	3000 ohms	1B	5 MA	1.50 ea.

All above Relays may be used for continuous duty operation on 110V. D.C.

OTHER TYPE G TELEPHONE RELAYS

1)	1300 ohms	1A-1C	24 or 48V	$2.50 ea.
2)	400 ohms	1A	24V	1.65 ea.
3)	500 ohms	1D	24V	1.65 ea.
4)	200 ohms	1A	24V	1.50 ea.

CLARE TYPE C STANDARD SIZE D.C. TELEPHONE RELAYS

	Coil	Contacts	Operates at	Price
1)	1300 ohm	1B	24 to 85V	$2.25 ea.
2)	1300 ohm	2A-1B	24 to 85V.	2.75 ea.
3)	1300 ohm	2C-1A	24 to 85V	3.00 ea.
4)	1300 ohm	4C-2A	30 to 85V.	4.00 ea.
5)	1300 ohm	2A-1B-1C-1D	30 to 85V	3.00 ea.
6)	1300 ohm	6C	30 to 85V	4.50 ea.
7)	2500 ohm	1A	24 to 110V.	2.25 ea.
8)	2000 ohm	2C-1A	24 to 110V.	3.00 ea.
9)	2000 ohm	4C-2A	30 to 110V.	4.00 ea.
10)	2000 ohm	6C	30 to 110V.	4.50 ea.
11)	2000 ohm	8A	36 to 110V.	3.50 ea.
12)	3000 ohm	3A	24 to 150V.	2.75 ea.
13)	3300 ohm	1A	24 to 150V.	2.50 ea.
14)	3600 ohm	2C-1A	24 to 150V.	3.00 ea.
15)	110V. A.C.	2C-1A	110V. A.C. 60cy	3.50 ea.

CONTACT SYMBOLS

A=Norm. Open B=Norm. Closed C=S.P.D.T.
D=Make Before Break

Allied Type LKX-58 Tel. Relay. Coil-5,000 ohm contacts—3A Operates at 6 MA. Price—$2.50 ea.

Signal Wheelock Relays #KS9665 Coil—2,000 ohms Contacts-1A, 1B, 1C Oper. at 9 Ma. Price—$2.75 ea.

MINIATURE TEL. RELAY, 300 ohms, 24 volt SPDT ..... $1.65 ea.

FIVE Prong CR-2791 G.E. Plug In Relays.
1) C-103C25 2200 ohms SPDT 4.5 MA.... $4.00 ea.
2) C-104B28 700 ohms SPDT 6 MA..... $3.00 ea.

Bulletin #700 Allen Bradley Contactors 110V AC 60 cy. D.P.S.T. N.O. 25 Amps..... $7.50 ea.

ALLIED BJ6D36 MINIATURE RELAYS

1)	24V.	260 ohms	DPDT	$1.25 ea.
2)	24V.	100 ohms	DPST NO	1.00 ea.

Clare SK-5032 (Herm. Sealed) Plug-In Relays. Coil —30 ohms 6 volts contacts—DPDT. Price $4.00 ea.

SIGMA TYPE 5F SENSITIVE RELAYS. Has two 70 ohm coils. Contacts—SPDT....Price—$3.00 ea.

POWER RELAYS

1) GM #13017 Relays, 24 volts 150 ohm. Contacts—3PDT 10 Amp.....Price—$2.00 ea.
2) Leach Relays Type 1025-SN-BF, Coil—24V. 425 ohms. Contacts—D.P.S.T. Norm. closed. Rated at 10 Amps.....Price—$1.25 ea.

Chase

Electronic Supply Co.
105-07 225 St.
Queens Village, N. Y.
HOllis 4-5033

TRANSFORMER "C" CORES

SIMPLE ASSEMBLY ENABLES EXPERIMENTERS TO BUILD THEIR OWN TRANSFORMERS, CHOKES, ELECTRO-MAGNETS, VARIOMETERS, AND ETC. Usable Gov't rejects at savings from 50 to 75% of cost. From 0.1 to 100 lbs. A few typical cores and their approximate dimensions are:

STK. No.	D	E	F	G	Wt.	Price
C-4	1.2"	0.4"	0.8"	2.3"	0.9 lb.	$1.00
C-6	1.5	0.5	1.0	2.6	1.5	1.25
C-7	1.0	0.7	0.7	2.4	1.5	1.00
C-11	2.0	0.7	1.4	3.0	4.2	1.75
C-12	2.2	0.7	1.4	3.1	4.7	1.75
C-14	1.6	1.1	1.6	4.3	7.0	2.50
C-17	2.8	1.1	1.6	4.3	12.0	3.50
C-21	3.2	1.3	2.0	6.5	23.0	5.95
C-25	4.1	1.4	2.5	6.6	35.0	8.75
C-28	4.0	1.3	2.4	7.7	35.0	8.95
C-35	3.3	1.8	3.2	11.5	54.0	13.50
C-42	4.9	1.6	2.9	10.4	65.0	15.95

HEAVY DUTY TRANSFORMERS

Cat. #1239.—1.1 KVA. Input 117 volts 60 cycle. Output: 13.0 and 14.0 volts at 80 amps. Pri. leads 22" long. Sec. leads 6". Size 5¾x6x5½". Wt. 15½ lbs. Note: Two of these can be connected to obtain 26 and 28 volts or three to obtain 39 and 42 volts at 80 amps, respectively. Price Brand NEW.....$8.95

36 VOLT TRANSFORMER KIT

Stk. #K-228.—1.8 KVA. Input 115/230 Volts 60 Cy. Output 36 Volts at 50 Amperes. All materials needed to build this transformer in just a few hours utilizing a low-loss Hypersil C-Core. Kit includes primary & secondary magnet wire, coil form, insulation, first-quality core, and directions. Complete Kit Brand NEW ONLY.....$29.50
Stk. #T-2280.—Same transformer as above but completely factory assembled, dipped & baked. Price BRAND NEW $39.50

GLASS INFRA-RED FILTERS

Special Designed filter that blocks and filters out visible light but freely passes invisible infra-red rays. U. S. Army Snooperscope Part No. A-1529. 5⅜" Dia. by ⅛" thick. BRAND NEW....PRICE ten for $10.00 or.....$1.50 ea

BATTERY CHARGERS

ASSOCIATED-HARTMAN CORP.—Made for them by MALLORY. Feature heavy-duty construction and parts, oversize transformers, and full-wave MALLORY Selenium Rectifiers. Fresh '55 Stock. SEE OUR MARCH AD FOR COMPLETE LISTING & PRICES.

ALL MERCHANDISE FULLY GUARANTEED
PROMPT SHIPMENT ON ALL ORDERS

Terms: Prices FOB St. Louis. Cash with orders. Well Rated Concerns (D&B) Net 10 Days Cash.

McNEAL ELECTRIC & EQUIPMENT CO.
4736 Olive St. St. Louis 8, Mo.

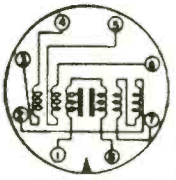
ART-13 APR-4 BC-610-E

BC-348, BC-312, BC-342, RAK, RAX.
BC-221, TS-174, #241 Scope, LM
ARC-1, APA-10, DY-17, DY-11

Alltronics, Box 19, Boston 1, Mass.
Telephone: Richmond 2-0048, 2-0916

PULSE TRANSFORMER

Tube base plug in type



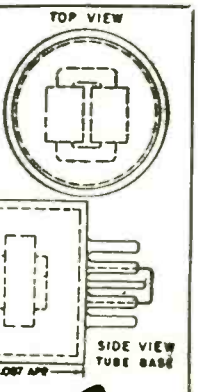
TYPE UX 7350
Each Coil—50-T#36E
Max. DC Res. Ohms
1 & 8= 4.02Ω
2 & 7=4.542Ω
3 & 4=2.357Ω
5 & 6=2.185Ω

Here are precision made, high quality compact pulse transformers wound on hypersil cores. They are built in octal bakelite tube bases and can be adapted to many uses. They are completely impregnated and sealed.

SUGGESTED USES

★—Blocking Oscillator, Multivibrator and Scope Circuits.
★—Wherever Accurate Timing and Trigger-ing are necessary.
★—Unexcelled in circuit applications for generating low power and low voltage pulses.
★—Can be used in circuits utilizing repetition rates from 0 to well over 1 MC and pulse widths ranging from .05 Microsecond up.

Price **$4.50** each



Cramer Electronics, Inc.

811 Boylston St., Boston 16, Mass. CO 7-4700

Component Bargains!

LARGE QUANTITY

3A5	RCA, Individ. JAN Box	$ .25
3BP1	RCA, Sylvania, Individ. Box	1.00
5BP1	Standard Brand, Individ. Box	2.00
316A	Standard Brand, Individ. Box	.25

Quantity Prices on Request

CARBON RESISTORS	½ W	$10 per M.	Min. Order
	1 W	20 per M.	100 of
	2 W	30 per M.	Each

CHOKES—6752, 2½ Henry, 3⅝" MTG Centers. 50¢

CONTROLS—½ & 1 meg w/switch. 28¢

CERAMIC CONDENSERS — Tubular, All Sizes $25 per M. Min. order 100

12" DYNAMIC SPEAKERS — New — with/without output trans. 2000, 680, 625 Ω Min. order 4 each $1.75

And Many Other Items

We Also Purchase Your Surplus Inventory

BELVISION, INC

254 Greenwich St., N. Y. 7, N. Y. BA 7-6063

FOR SALE

3	AVIATION NAVIGATIONAL TRAINERS MARK IV	Make offer
80	GROVE AUTOMATIC PRESSURE REDUCING VALVE, Adjustable 5 to 1500 lbs. P.S.I.	$14.00 ea.
40	RECTIFIER HALF WAVE 18 V.A.C. 26.8 amps. D.C. Vickers 22-164	7.00 ea.
150	33.5 amps. D.C. Vickers 22-886	9.00 ea.

Please Write for Other Listings

ELECTRONICS STORES

Cornell University Service Building

ITHACA, NEW YORK

TUBE TESTING LABORATORY

TEST YOUR TRANSMITTING, RECEIVING, AND SPECIAL-PURPOSE TUBES TO

JAN, MIL-E-1B AND/OR COMMERCIAL SPECS.

LAB. CERTIFICATES SUPPLIED

BARRY ELECTRONICS CORP.

512 BROADWAY, N. Y. 12, N. Y. WAlker 5-7000

WANTED

Operating plant or equipment to manufacture variable transformers similar GR Variacs, Superior Powerstats, Staco Adjust-a-volt.

W-5747, Electronics
330 W. 42nd Street, New York, N. Y.

WILL BUY ALL

ART-13 T47A Transmitters	$225.00	BC-348 Rec'r modified	$25.00
ART-13 T-47 Transmitters	$150.00	BC.348 Rec'r unmodified	$50.
BC-788C Altimeters	$150.00	ARC-1 Radio complete	$200.00
RS/ARN7 Radio Compass	$160.00	BC-312 Receiver	$40.00
ARC-3 Complete	$185.00	BC-342 Receiver	$50.00

Ship via Express C.O.D., Subject to Inspection to:

H. FINNEGAN

49 Washington Ave. Little Ferry, N. J.

WANTED

ART-13 transmitters, parts, and components, DY-12 and DY17 dynamotors, CU-25 etc. Also ARC-1 and ARN-7 material.

Advise price, condition first letter.

FLORIDA AIRCRAFT RADIO & MARINE, INC.
International Airport Branch
P. O. Box 205 Miami 48, Florida

WANTED

Type R19/TRC-1 Receivers

W-3652, Electronics
330 W. 42 St., New York 36, N. Y.

BLOWERS:

12/24 VDC—AC CAST ALUMINUM BLOWER (Pictured at left)—100 CFM: 3" intake; 2" outlet. Shunt Motor 4"x2"; 3000 RPM @ 24 VDC. . $5.95

6 VDC SINGLE—100 CFM—No. 6100 . . . . . $4.95

6 VDC FLANGE—150 CFM—No. 6150 . . . . . $6.95

24 VDC DUAL—20 CFM—Min.—No. 2420. . . . . $7.95

10 CFM BLOWER (Pictured—right)—27.5 VDC; 1/100 HP.; 7000 RPM; Oster Motor C2BP-1A; L-R Mfg. Co. Bakelite Blower #2, overall size: 3-½" x 4-½". Price. $5.95
Same as above, 12 VDC operation: Price $5.95

115 V. 400 CYCLE—10 CFM—Eastern Air Devices Motor J31A—7200 RPM, 1/100 HP. L-R #2 Blower Assy. Overall Size: 4-½" x 3-½". No. 3110. . . . . $5.95

10 CFM BLOWER (Pictured at left)—28 VDC—.6 A.; 5000 RPM. Pioneer Motor SS-2345. Aluminum Blower Housing; Overall Size: 4-½" x 3-¼". Price $5.95

115 V. 60 CYCLE BLOWERS:

115 VAC 60 cycle SINGLE TYPE—100 CFM: 2-¼" intake; 2" outlet. Complete size: 5" x 6" —No. 1C939 . . . . . **$8.95**

115 VAC 60 cycle DUAL TYPE—100 CFM: 4" intake; 2" Dis. Each Side. Complete size: 8" x 6"—No. 1C880. . . . . **$13.95**

115 VAC 60 cycle COMPACT TYPE—108 CFM: Motor built inside squirrel cage; 4-½" intake; 3-⅝" x 3" Dis. Complete size: 4-¼" W x 8-⅝" H x 8-⅛" D—No. 2C067. . . . . **$14.95**

115 VAC 60 cycle FLANGE TYPE—140 CFM: 3-½" intake; 2-½" Dis. Complete size: 7-½" W x 7-⅜" H x 6-¾" D—No. 1C807. . . . . **$13.95**

115 VAC 60 cycle FLANGE TWIN—275 CFM: 4-½" intake; 3-¼" x 3" Dis. Complete size: 11-¾" W x 3-⅜" H x 8-1/16"D—
No. 2C069 . . . . . **$21.95**

DYNAMOTORS:

INPUT VOLTS:	OUTPUT: VOLTS:	MA	STOCK No.:	PRICES: USED:	NEW:
14 VDC	230	90	DM-21	$6.95	
14	330	150	BD-87	3.95	$6.95
14	250	50	DM-25	6.95	8.95
14	1000	350	BD-77	14.95	29.95
14	500	500	BD-500		12.95
14	600	300	BD-86		12.95
14	1030	260			
	515	215	DM-42	8.95	12.95
28	1000	350	PE-73	8.95	
12 or 24	500	50	USA/0515		4.95
12 or 24	275	110	USA/0516		4.95
12	230	90	PE-133	4.95	6.95
14 VDC	375	150	BD-83	3.95	4.95

POWER SUPPLY — 24 VDC — 3 Amp output; 115 Volt 60 cycle input. Completely filtered with 0-75 VDC Output Meter & Tungar Bulbs—Used. Tested. . $12.95

METERS:

DC AMMETER HOYT

(Pictured) In portable Metal Case, with Test Leads, 4-½" Fan, Mirrored Scale — 0-15 ADC $4.95

WESTON AC Ammeter:

In portable leather case, with Test Leads, 2-½". 0-15 AC and 0-3 AC Scale. $5.95

0-3 RF AMMETER IS-128—2-½" Rd. . . NEW: . $2.95

0-5 MA DC WESTINGHOUSE—2-½" Sq. 3.95

D-B METER—10 to Plus 6—G.E.—3-½" Rd. . . 4.95

TS-291/U VOLTOHM MULTIMETER. . . . NEW: 7.95

MOTORS:

24 VDC REVERSIBLE MOTOR — 3.7 RPM, 40 lb. Torque Motor size: 5-½" x 4-1/32" x 3-5/16". Shaft size: 21/32" x 5/16". Also operates 24 VAC. Philco No. 441-1008. . . . . $6.95

27.5 VDC—6000 RPM. 1.5 oz. in Shaft size: 1⅛" x ⅜". Motor size: 2⅛" x 1¼". No. 5069-267. . $4.95

26 VOLT 60 CYCLE—60 RPM Synchronous Cramer Motor #1147. Shaft size: 1" x ⅛". $1.95

110 VDC 1/70 HP., 1550 RPM. Motor size: 4" x 2¼". Shaft size: 1" x 3/16". Redmond # 157. . . . . $4.95

6 VDC 1/20 HP., 4000 RPM. Motor size: 5" x 3". Shaft size: ¾" x ¼". Redmond #E-56. . . . . $4.95

12 VDC 1/30 HP., 4500 RPM. Motor size: 3" x 2½". Shaft size: 1" x 3/16". Delco #5047520. . . . . $4.95

27 VDC 1/10 HP., 3500 RPM. Shaft size: ⅝" x ¼". Motor size: 4" x 3-½". Air Assoc. No. EE-783. $6.95

80 VDC 1/50 HP., 3000 RPM. Shaft size: ⅝" x ¼". Motor size: 5" x 3". G.E. #5-PN38HA10. . . . . $8.95

28.5 VDC 1/35 HP., 2200 RPM. Shaft size: 1½" x ¼". Motor size: 4½" x 3¾". Electrolux #16876 . . . . . $5.95

GEARED HEAD MOTOR — 110 Volt 60 cycle, 24 RPM, 1/100 HP., Right Angle Drive—Size: 7½" x 4" x 4". Shaft size: 3/16" x ¾". . . . . New: $9.95

115 VAC 60 Cycle INDUCTION MOTOR — 1.9 RPM. 75 Torque oz. in; 9 Watts—with variable Multi Disc. Coder Wheel & Micro Switch, mounted on bracket assay. Holtzer Cabot Motor Type RWC 2505 . . . . . $9.95

GEARED HEAD MOTOR — Heavy duty. 24 VDC 8 Amp. 2½ lb. Torque, 100/200 RPM. Shaft size: 5/16" x 1". Right Angle Drive. $8.95

27 VDC GEAR HEAD MOTOR—960 RPM; 1/75 HP; 1.75 A. Size: 5" x 3". Shaft: ¼" x ⅝". Air Assoc. #EE120M1 . . . . . Price: $7.95

27.5 VDC GEAR HEAD MOTOR—324-1 Ratio; 4050 RPM; Right Angle Drive Motor, Size: 5" x 3-½". Shaft: 5/16" x ⅝". Bodine Type #V-10-R. Price $7.95

24 V. GENEVA LOC ACTUATOR MOTOR ASS'Y.—1/25 HP.: 15000 RPM, w/Gear Head & Limit Switches. Motor Size: 5-½" x 3-½"; Angle Drive Shaft; ¼" x ½". Bendix #LM-106524. Price. $7.95

27 VDC MOTOR—1.5 A.; 1/50 HP.: 3000 RPM Shunt Motor; Motor Size: 3" x 2-¼". Shaft: 5/16" x ¾". Oster #D8-1 or WEVS-5876. . . . . Price: $2.95

27.5 VDC MOTOR—1/100 HP; 7000 RPM; Motor Size: 3" x 1-¾"; Shaft: ¼" x ¾" L. Oster #C2BP-1A—Price $2.95

27.5 PERMANENT MAGNET ALNICO FIELD MOTOR—.03 Amp.; 10000 RPM; Size: 1" x 1-⅛" x 2". Shaft: ⅛" x ½". Delco #5068571. . . . Price: $7.95

FAIR RADIO SALES • 132 SOUTH MAIN ST. LIMA, OHIO

WANTED

Radio Interference —Field Intensity Meters

Stoddart model NM-10A; NM-20B; NM-30A; NM-50A

Microwave Power Measuring Equipment

H.P. model 476A; 430B

G.R. model 874EK; 1231B; 1651A

Oscilliscopes

Tektronix model 315D

Dumont model 322A; 321

RCA model WO-56A

Signal Generators

General Radio model 1001-A; 1021-A

Hewlett Packard model 200AB; 200CD

Measurement model 80

Miscellaneous Equipment

Boonton 'Q' meter

Regulated power supply. Lambda model 50 or 71

R.F. Bridge G.R. model 916A

Impedance Bridge G.R. model 650A

VTVM Ballentine model 314

The above equipment or equivalents urgently needed.

HOPKINS ENGINEERING CO.

2082 Lincoln Ave., Altadena, Calif., SYcamore 8-1185

8-247 Gen. Motors Bldg., Detroit, Michigan. TRinity 1-9260

1329 E Street, Washington 4, D.C., REpublic 7-7975

"TAB" THAT'S A BUY

POWER YOUR GOV'T

Surplus Recr's & Xmitters from the Set Power Pack or Dynamotor from 115 or 230 VAC

B28V/5A for ARC5, BC312, BC342, BC348 $35.00
B28V/24A for BC654 or BC375 .... 110.00
B12V/50A for BC191 .... 110.00
B28V/100A for ART13 .... 395.00

NEW RECTIFIER Xfmrs

PRIMARY 115V 60cyc
SEC 18–15–9–0–9–15–18 Volts
5 amp ...... $8.65; 2 for $15.75
12 amp ..... $16.65; 2 for $29.95
*24 amp .... $35.75; 2 for $69.95
*50 amp .... $59.00; 2 for $112.00
*100 amp .... $108.; 2 for $210.00
18 Volt 2 amp .... $1.98 @, 3 for $5, 12 for $18
25.2V/2A or 12.6V/4A or 2X12.6V/2A Cased 2⅝ W/3⅛ H/2¾"D .... $3.59; 3/$10; 12/$36
*DUAL PRIMARY 115 & 220V 60cyc

New Rectifier Chokes

CH1/1 Amp/0.1 HY/1.4 *Ohm*/3 Lbs $3.95
CH2/2 Amp/0.1 HY/.67 *Ohm*/3 Lbs $5.95
CH07/5 Amp/.07 HY/.6 *Ohm*/10 Lbs $7.95
CH01/12 Amp/.01 HY/.1 *Ohm*/12 Lbs $14.95
CH004/24 Amp/.004 HY/.025 *Ohm*/20 Lbs $29.95

FLEXIBLE WAVE GUIDES

CG166U/42"/UG52U(E165003) .... $7, 3/$18
CG166U/12"/UG52U(E137858) .... $2, 3/$5
X-band to UG39 (3") plain F .... $2, 3/$3
HORN ANTENNA & WG UG135U1/flange 90° twist to XWG to 180° Elbow & enclosure WGR-H1 .... $7 @ 3 for $18
MAGNETRON TRAN 6.3V/40A/60KV $36

VARIABLE VOLTAGE XFMRS

SUPERIOR-GR-STACO-UTC
0–132V/1.25A* $7.99
0–135V/3A* 11.99
Cased/0–135V/7.5A* 21.95
Uncased/0–135V/7.5A* 17.25
Cased/0–270V/3A* 24.95
Uncased/0–270V/3A* 18.95
Cased/0–135V/15A* 41.98
Cased/0–270V/9A* 41.98
Uncased 0–270V/7.5A† 54.67
Cased 0–270V/9A† 86.50
Cased 0–270V/12A† 103.00
Cased 0–270V/15A† 132.00
Cased 0–270V/30A† 163.00
GR50A/0–135V/45A/LN 100.00
GR50B/0–270V/31A/LN 115.00
(LN) Like New. (*) New. (†) 3 Phase New
Industrials: 6 or more 10% disc.

NEW AC & DRY BATTERY KIT

106 Watt See Photoflash

Includes condensers two/525MFD/450V total 103W secds. Resistors, Capacitors, Rectifiers, Flash Tube in indicating flash gun, guide #40 on Kodachrome. Does not Incl. Batteries, **AC Only** $33.98
SIX-90V (N60) Batteries @ $14.98
Flash Lamp Gun, Holder & 8" wide range. Reflector $4.98 w/Lo or Hi volt Flash Trigger Coil lamp $12.98
525MFD/450V/53W'Secs conds new low leakage famous mfgr DATED .... $9 @ 2/$16
16MFD/2500VDC/60WS Conds Oil ... $6/@ 2/$10
16MFD/1.8 to 2.8KV/60WS Cond ... $5 @ 2/ $8
Electronic Flash Handbook ckt data 50c

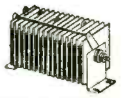
PHOTOFLASH & STROBE LAMPS

"TAB" No.	Replaces	W-Sec Max	Each
TLH	FA 104/FT118	150	$5.98
THI	Amglo 5304X	100	10.98
23ST	GE FT 210	200	9.98
THVA	SYLV. 4330	200	9.98
V4X4	X400	200	10.98
TLX	DX & FA10Q	150	9.00
TDX	DXC/250–350	150	10.00
353GTQ	FT 503	2000	49.98

TRIGGER COIL LO & HI VOLT FLASH $1.47
Write for "TAB" Flash Tube Data 50c

NEW "TABTRON" SELENIUM RECTIFIERS

ENGINEERED for INDUSTRY



"TAB" manufactures power rectifiers to your specifications. From one amp up to and above 1000 amps. convection or fan cooled. single or 3 phase. "NEMA" & JAN Specs. Write for catalog.

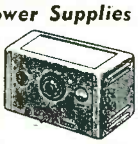
***FULL WAVE BRIDGE • DATED & ONE YEAR GTD**

Max Amp	18VAC* 14VDC	36VAC* 28VDC	54VAC* 42VDC	72VAC* 56VDC	130VAC* 100VDC	266VAC* 217VDC	Ctr Tap AC/DC 30/12	3 Phase 120VAC 150VDC	Bridge 240VAC 300VDC
1	$1.35	$2.35	$3.75	$4.50	58.35	$22.25	$2.10	$14.90	$28.95
2	2.00	2.75	5.35	5.90	10.30	28.85	Q	15.90	30.90
3	2.95	4.15	5.85	7.90	12.90	36.85	Q	Q	Q
4	3.50	7.35	11.35	14.35	25.00	38.75	2.95	18.90	36.95
6	4.25	8.75	12.85	17.30	32.80	54.85	3.25	20.90	39.95
10	6.30	12.85	19.50	24.80	41.50	84.85	4.75	36.90	71.95
12	7.90	15.75	22.10	29.75	45.75	99.85	5.95	41.90	81.95
20	13.05	25.05	37.25	48.75	78.50	160.85	7.95	50.90	97.95
24	16.05	31.95	44.50	57.65	85.00	190.85	9.95	89.90	159.95
30	19.50	37.60	56.50	71.00	110.00	235.85	Q	117.90	225.95
36	23.75	47.75	65.00	86.95	135.00	295.85	14.95	134.90	269.95
50	31.00	61.50	Q	105.75	175.00	405.85	23.95	179.90	359.95

RECTIFIER BOOKS: "BRADLEY" 1.96, "SARKES TARZIAN" .96

High Current Power Supplies

ONE YEAR GTD



Variable 0–28VDC. Completely Built. Ready to Go Full Wave Selenium Rectifier, Transformer, Variac, Volt & Amp. Meters, Switch Terminals & Fuse. In Hvy Duty Steel Cabinet Std 115V/60cy Input 110 & 220V† (3 Phase) to order.

Stock Number	Continuous Rating	With Meters
T28V5A	0–28WVDC at 5 Amp	$45.00
T28V5ACC	5 Amp (1% Ripple)	69.00
T28V12A	0–28 VDC at 12 Amp	108.00
T28V12ACC	12 Amp (1% Ripple)	145.00
T28V24A†	0–28 VDC at 24 Amp	135.00
T28V/24ACC†	24 Amp (1% Ripple)	195.00
T28V50A†	0–28 VDC at 50 Amp	260.00
T28V50ACC†	50 Amp (1% Ripple)	370.00
T28V100A	0–28 VDC at 100 Amp	469.00
T28V/100ACC†	100 Amp (1% Ripple)	650.00

Variable 75 to 135 VDC Completely Built. Ready to go. Includes F. W. Selenium Bridge Rectifier, 4" Rectangular Volt & Ammeter, Overload cutout Dsgnd for cont. service
Specify for 115 or 230VAC/1 phase, 60 cy Input.

T120V5AC	75 to 135WVDC at 5 Amp	$169.50
T120V5ACC	75 to 135WVDC at 5 Amp (1% Ripple)	217.60
T120V10AC	75 to 135WVDC at 10 Amp	215.50
T120V10ACC	75 to 135WVDC at 10 Amp (1% Ripple)	265.60

New! Basic Supplies, 115 VAC In

Stock No.	Cont. Rating	Basic
B115P5A	115 WVDC at 5 Amp	89.55
B115P10A	115 WVDC at 10 Amp	189.75
B230P5A	230 WVDC at 5 Amp	187.55
B230P10A†	230 WVDC at 10 Amp	282.75

NEW!! Sonic Sound GENERATOR

115 VAC Input
Washes & Mixes
Agitates!
Cleans!
"TAB" SPECIAL **$29.95**
Sold On $, $ Back Gtd
Write for Details

SENSATIONAL OFFER!!

1% Precision Resistors GTD

Western Elec—IRC—Wilkor—Mepco
No Mfg Choice--We ship tubes in Stk

0.116	240	1924	7320	42000	270000
0.42	250	1980	7500	47000	275000
0.7	270	2000	7717	50000	294000
1.03	300	2080	7900	51000	300000
2.5	320	2150	8000	52000	314000
3	350	2187	8200	55000	316000
3.83	360	2195	8500	56000	325000
4	390	2200	8770	57065	330000
5	426.9	2250	9100	60000	350000
7	430	2300	9900	61430	360000
7.8	470	2400	10000	62000	375000
8	500	2500	10500	64000	380000
10.38	520	2600	11000	68000	390000
12	540	2700	11600	70000	400000
14.2	560	2860	12000	80000	420000
16	580	2900	12500	82000	425000
17	588	3000	13000	84000	430000
20	620	3290	14000	85000	450000
23	750	3300	14400	88000	458000
25	800	3333	15000	90000	470000
28	820	3500	16000	91000	478000
30	850	3600	16500	93000	500000
48	910	3730	18000	95000	510000
50	917	3760	19000	100000	520000
51.78	978	3900	20000	110000	543000
55	1000	4000	21500	120000	550000
56	1056	4220	22000	130000	560000
62	1100	4300	23000	135000	570000
68	1110	4440	24000	145000	575000
74	1200	4500	25000	150000	600000
75	1225	4700	26000	160000	660000
82	1260	4900	27000	169000	680000
95	1300	5000	28000	175000	690000
100	1488	5100	29000	180000	700000
110	1500	5600	29990	190000	750000
120	1518	5730	30000	200000	800000
125	1600	5770	31000	205000	813000
130	1640	6000	32000	215000	820000
134	1800	6100	33000	220000	850000
150	1850	6200	35000	225000	900000
180	1892	6300	36000	229000	910000
200	1900	6500	37000	230000	930000
210	1905	6800	39000	240000	950000
220	1910	6990	40000	250000	
235		7000	41400	265000	

MEGOHMS

1	1.5	1.8	5.5	8.5	12
1.1	1.57	2	6	9.05	12.89
1.2	1.6	3	6.6	9.5	13
1.3	1.65	3.5	7	10	13.85
1.35	1.75	5	8	11.55	51

"TAB" Spec. .25 ea. .... **.20 ea.**
10 of 1 value ....
100 of 1 value $15
10 ass'td values $2.50

Write For Our Complete Listing

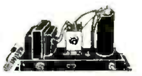
Convert Your 6V "Fast" Charger to 12V/50A as well as 6V/100A Use

Details & Rectifier .... $22 ea; 3/$60
BCT 2/1A 2V Battery "TR" Chgr $3.98
BCT 6–12/2A 6 & 12V Battery TR Chgr ... $7.98

New Rectifier & Transformer Combo. Sel/Bridge 115 V 60 Cyc Input

up to 14VDC at 12 amps Cont. Duty ... $19.98
up to 28VDC at 5 amps Cont. Duty 15.65
up to 28VDC at 12 amps Cont. Duty 29.98
***up to 28VDC at 24 amps Cont. Duty** 59.98
***up to 28VDC at 50 amps Cont. Duty** ... 117.98
***up to 28VDC at 100 amps Cont. Duty** .. 199.00
***TRANSFORMER HAS DUAL INPT 115&230V**

DC Power Supply



Variable DC Power Supply Full Wave Rectification 6000MFD Condenser Filter Ready to Operate Input 115V 50cy Output 6.3V or 12.6V 2 Amp.
Model 2DCF (2 amp) $12.98
Model 5DCF (5 amp) $29.95
5DCF ACC/5 amp/1% Ripple $38.95

CIRCUIT BREAKERS

Heinmann Magnetic Bkrs, Amps: .220, 2, 7, 9, 12, 30, 35, 40, 90, 180 EA: **1.98; 12/$20; 50/$75**
Sq. D & CH Toggle Sw Bkrs. Amps: 5, 10, 15, 20, 25 **98c: 50 for $39**
Klixon Therma Push Button Bkrs Amps: 5, 10 15, 20, 25, 30 **89c; 10 for $7.98; 50 for $34**
Asstd one each Twelve Types $9

230 TO 115V AUTOFORMERS

For 220–240V/50–60 cy Input. To 110–120V or Step-up with Cord Plug & Receptacle.
TPA050/50W $2.55
TPA100/100W 4.00
TPA250/250W 6.75
TPA500/500W 8.25
TPA075/75W 3.65
TPA200/200W 5.75
TPA300/300W 7.25
TPA750/750W 11.75
Model TPA1000/1000 Watts/1 KW 16.95
TPA1500/1500W .. $22.50; TPA2000/2KW .28.95
Model TPA3000/3000 Watts/3KW 49.95

INFRARED SNOOPERSCOPE

SEE IN DARK TUBE

Image-Converter Tube Hi-Sensitivity simplified design 2" dia Willemite screen—Resolution up to 350 lin/in. Tube & Data
"TAB" Special .... $10 2 for $18
Snooperscope Pwr Supply 1800VDC/35MA. Using Doubler Crkt. Transformer, Rectifiers, Sockets, Resistors, Capacitors and Diagram 115V/60cy Oper ... $6.98

THERMOSWITCH FENWAL Type 1711–4 operates −100 to +400 deg. Fahrenheit. Rated 115VAC/10A and 230VAC/5A. Inverse tension operated. Unit closes at higher temp. Sensitivity ± 01 deg/F. Locking device on adjusting sleeve. Reg. $13.90.
Special .... $5.95; 2/$10; 12/$50
METAL PARTS CABINET, 50 Draw Hvy Gauge Steel; 34½H, 13W, 9L. Draw 3W, 2½H, 8"L, 65 lbs $35
100 Draw, as above, 135 lbs $59
27 Draw, 27H, 30¾W, 14"L, Draw 3H, 9W, 12"L, 120 lbs $34
OIL CONDS, 4MFD/1200VDC or 10MFD/600 VDC (or asst'd) Lots of 12 @ $1.50, **Singly** $1.79

NEW VARIABLE 6 & 12 VOLT/12A DC POWER SUPPLY

Completely Built (Not a Kit)
Model T612V12AC **$29.95**
Battery Eliminator, Charger, Model RR, Plater, Aircraft, Marine & Any DC Req. Contains Xtra size Selenium Rectifier. Hvy duty Vari Pwr Transf, Volt & Amp Meters, Switches, Circuit Breakers, Fuse, Capacitor, Cord & Plug. Designed for continuous service. Housed in Hvy duty Black crackle finish Steel Cabinet.

NEW RELAY LIST

R7CL1 Clare SK 5010 VACUUM SEALED/DPDT/18–28 VDC/3A CTS Octal Base .... $2.98, 3/$7.50
G. E. 117A3/SPST/28VDC/50A CTS $1.98
Stevens A Resonant 139 Freq 240 cy $3.98; 3 for $10
R10SD1 SPST/115VAC/6–30 ACTS $2.00
R11AC2 Allied-BJ DPDT/115VDC/5A CTS $1.39
R12AC3 Allied-BJ DPDT/6VDC/5A CTS .. $1.49
R18LE2 Leach/DPST/70VDC/10A CTS $1.49
R14AU1 DPDT & SPNO/12VDC/10A CTS $2.25

• 1ST QUALITY • NO ELECTRICAL OR MECHANICAL REJECTS •
• HICKOCK MU TESTED • FULL RETMA WARRANTY •

TUBES

Tube Orders Over $25 With Full Payment, Prepaid to You in U.S.A. To Get This Deal, Mention 4E5

YR GTD

OA2	$ .74	2K41	125.00	6W4	.38	710A	1.68	5726	1.30	3BP1A	6.55
OA2WA	4.15	2K43	130.00	7C22	50.25	715B	11.90	GL5727	1.77	3CP1S1	5.98
OA3	.98	2K44	130.00	7C23	69.57	715C	17.98	5732	3.94	3DP1	4.81
OA4	1.05	2K45	75.05	7C25	120.25	717A	.46	5736	159.95	3DP1A	6.80
OB2	.74	2K50	315.00	7C29	69.95	721A	.98	5744	2.39	3EP1	4.71
OB2WA	4.15	2P23	298.00	8D21	2.98	723A	7.92	5749	1.72	3FP7	1.91
OC3	.88	3B22	1.51	8DC15	4.98	723AB	17.98	5750	3.10	3FP7A	6.91
OY4	1.99	3B24	2.55	VX10	4.95	724A	2.94	5751	3.09	3GP1	1.91
C1A	5.95	3B26	3.55	10Y	.40	725	8.94	5763	1.59	3GP1A	12.95
O1A	.69	3B29	7.00	12AT6	.46	726B	47.50	5764	55.99	3GP4	16.50
VS-1	12.49	3C22	65.09	12AT7	.82	726C	48.00	5765	55.99	3GP5	18.00
1A4	.79	3C24	3.98	12AU7	.58	750TH	99.99	5769	298.00	3GP7	18.00
1A5	.64	3C31	2.95	12AX7	.78	750TL	32.55	CK5783	5.55	3HP7	3.91
1AJ5	1.15	3C33	9.99	12BY7A	1.05	801A	.45	CK5784	7.45	3HP14	14.98
1AX2	.97	3C34	4.90	12SA7	.64	807	1.24	CK5787	4.95	3JP1	16.55
ELC1B	3.45	3D21A	7.99	12SK7	.62	807W	4.98	5794	8.99	3JP1A	24.50
1B3	.79	3D23	5.90	12SN7	.81	809	3.75	5799	3.70	3JP12	11.55
1B22	1.68	C3J	12.05	12SQ7	.54	811A	3.89	5802	6.70	3JP14	16.95
1B23	4.11	3K23	149.59	24G	1.96	814	2.48	5803	6.70	4AP10	4.31
1B24	4.98	3K27	175.05	HK24	3.07	815	3.98	5812	2.99	5AP1	2.21
1B26	1.79	4-65A	19.49	25BQ6	1.30	SD828	.98	5814	1.28	5BP1	1.98
1B32	2.94	4-125A	19.09	FG27A	8.25	829	11.75	5819	49.99	5BP1A	16.90
1B35A	6.90	4-250A	35.50	28D7	1.29	829B	12.95	5820	148.00	5BP2A	2.95
1337A	8.75	4B23	16.98	HY31Z	3.65	832	8.75	5823	1.29	5BP4	2.30
1B40	3.99	4B27	4.98	35TG	5.95	832A	9.01	5825	11.99	5CP1	2.91
1B41	3.99	4B32	10.50	35T	4.99	836	4.15	5828	6.70	5CP1A	14.49
1B46	1.88	4C25	5.98	REL36	.49	841	.50	5840	5.05	5CP5	3.55
1B51	7.60	4C27	5.15	RK39	2.99	864	.34	5841	4.30	5CP7	9.55
1B58	120.00	4C35	15.05	T40	3.75	865	.48	5842	13.49	5FP4	40.00
1B63A	42.50	4C36	15.98	HY40Z	3.75	866A	1.25	5844	4.48	5FP7	1.91
1B67	74.99	4D21	18.99	50A5	.72	872A	1.29	CK5851	3.05	5FP7A	10.50
1B68	16.99	4E27	12.55	50B5	.71	874	.62	5852	7.57	5HP1	3.91
1B86	7.99	4J22	49.59	50C5	.54	884	1.38	5857	59.50	5HP4	3.95
1B87	7.99	4J26	79.55	HK54	2.09	931A	3.05	5863	49.95	5JP2	7.49
ELC1	2.70	4J29	79.55	RK60	5.25	954	.18	CK5875	2.05	5JP4	7.55
1C21	3.69	4J30	99.55	FG67	12.51	955	.65	5876	12.49	5JP5	7.55
1D8	.89	4J34	79.55	HY69	5.49	956	.81	5879	1.59	5JP7A	39.00
1D21	3.49	4J42	29.55	71A	.74	957	.51	5881	2.70	5LP1	9.91
1L4	.48	4J52	649.95	HY75	4.59	958A	1.20	5886	2.55	5LP1A	30.00
1LD5	.98	4T4/2	5.89	75T	5.07	SD969	.98	5893	7.55	5LP2	27.50
1LN5	.78	4X150A	45.00	75TH	5.07	973	16.98	5899	6.55	5LP4A	33.00
1P21	33.00	4X500A	75.15	75TL	13.20	CK1005	.56	5901	6.55	5LP7	29.95
1P28	9.50	4X500F	93.45	FG81A	17.95	CK1090	2.98	5902	6.99	5LP11A	4.00
1P29	2.99	5AN8	1.05	83V	1.22	R1100	5.00	5905	9.00	5RP7A	89.50
1P30	3.19	5AX4	1.22	FG95	14.05	R1130	8.24	5907	8.00	5SP7	100.00
1P39	1.69	C5B	3.95	FG98	25.99	E1148	1.34	5908	8.00	5UP1	15.05
1P42	10.97	5C21	9.89	HF100	16.50	1201	.78	5909	Q	7BP1	8.65
1Q23	150.00	5C22	29.57	100TH	7.94	1203A	1.68	5910	.74	7BP7	6.50
1Q26	69.00	5C30	1.79	100TL	9.00	HY1231	5.28	5927	89.45	7EP4	18.39
1S21	6.55	5D21	9.48	102D	2.98	HY1269	5.45	5932	5.00	9GP7	12.75
1V2	.68	5J30	19.97	HY114B	1.95	1290	.91	5950	6.45	9LP7	2.98
1X2A	.88	5J33	7.55	CK118	3.35	1612	1.98	5959	37.25	12DP7	10.05
VS-2	5.07	5R4GY	.96	T125	12.49	1613	1.27	5965	2.51	12GP1	49.98
2AC15	7.47	5U4	.54	VT127A	2.75	1614	1.95	5979	Q	12GP7	15.05
2AS15	7.47	5V4	.89	V130	4.89	1616	.79	6005	2.80	12HP7	14.75
2C21	.75	C6A	6.59	CV147	6.98	1619	.34	6027	179.95		
2C22	.32	6A5G	2.98	CV148	6.98	1620	5.01	6030	Q	**XTAL DIODE**	
2C26	.36	6AB4	.62	150T	14.50	1621	1.90	6072	3.99	1N21	.32
2C33	1.35	6AC7	.68	152TH	27.99	1622	1.60	6080	5.95	1N21A	1.48
2C34	.40	6AF4	1.35	152TL	27.99	1624	1.05	6096	Q	1N21B	2.02
2C36	25.09	6AG5	.71	QK155	699.99	1625	.44	6099	1.55	1N21C	9.99
2C39A	16.90	6AH4	.87	VT158	12.05	1626	.16	6101	1.55	1N23	1.48
2C40	7.22	6AH6	.88	FG172	19.91	1629	.22	6110	6.55	1N23A	1.78
2C42	10.05	6AK5	.62	HF200	22.99	1632	.68	CK6111	8.95	1N23B	2.18
2C43	9.09	6AL5	.48	QK202	99.99	1633	.98	6117	Q	1N25	4.68
2C44	.59	6AM8	1.27	203A	7.38	1634	1.39	6119	6.45	1N26	4.05
2C46	10.07	6AN4	1.55	CE206	5.95	1636	1.29	6121	9.00	1N32	19.29
2C50	11.25	6AN5	3.60	211	.94	1642	.62	GL6136	1.89	1N34	.45
2C51	3.01	6AN6	3.19	WE215A	.22	1644	.99	6143	6.45	1N34A	.88
2C52	3.01	6AN8	1.25	QK221	125.15	1851	2.55	6146	4.87	1N35	1.55
2C53	11.50	6AQ5	.52	250TH	35.00	2050	.98	6147	3.55	1N38	1.55
2D21	.80	6AT6	.42	250TL	10.11	2050W	2.48	6163	24.95	1N38A	2.29
2D21W	2.99	6AU6	.48	250R	10.95	2051	.68	6164	64.95	1N39	4.51
2E22	1.89	6AV5	.84	254A	6.55	R4210	18.99	GL6172	Q	1N41	9.45
2E24	2.48	6AV6	.48	274B	1.09	R4330	14.99	6174	Q	1N42	17.25
2E25	5.15	6AX4	.81	276A	14.99	5514	4.69	6199	49.99	1N43	1.75
2E26	3.78	6BA6	.48	304TH	10.99	5516	5.51	6201	3.99	1N44	1.25
2E30	2.58	6BC5	.75	304TL	10.98	5517	2.22	H6216	Q	1N45	1.04
2E31	2.07	6BE6	.54	307A	.98	5586	150.25	6232	89.95	1N46	1.05
2E32	2.07	6BG6	1.58	CE309	4.98	5588	119.99	6270	199.95	1N47	4.00
2E42	1.49	6BH6	.62	316A	.48	5594	6.65	6271	159.95	1N48	.47
2E43	1.49	6BK5	.95	327A	3.51	5608A	3.10	6273	199.95	1N51	.51
2J21	8.75	6BK7A	1.11	WE331A	9.80	5634	7.50	6274	199.95	1N52	1.10
2J22	8.95	6BL6	57.99	350A	3.01	5636	5.00	6275	199.95	1N54	.78
2J26	14.75	6BM6	67.99	393A	4.55	5638	9.99	6334	124.95	1N54A	1.00
2J27	15.79	6BN6	1.19	FP400	15.98	5640	11.57	6369	24.95	1N55	2.39
2J30	50.50	6BQ6	.98	WE404A	14.99	5641	6.59	6393	24.95	1N55A	3.89
2J31	15.11	6BQ7	1.25	WE416A	29.99	5642	.99	6396	24.95	1N56	.89
2J33	15.19	6BZ7	1.27	WE417A	13.49	5654	1.72	6444	Q	1N58	1.19
2J34	15.11	ELC6	16.98	434A	3.94	5656	9.98	6653	Q	1N58A	1.15
2J36	55.05	6C4	.46	446A	.75	5663	1.06	C7473A	Q	1N60	.40
2J38	17.55	6C21	12.59	446B	2.98	5670	2.24	8002R	17.55	1N63	2.49
2J39	15.05	6CB6	.58	450TH	75.49	5672	1.55	8005	4.97	1N64	.69
2J42	99.50	6CD6	1.58	450TL	76.95	CK5678	1.59	8008	4.45	1N69	.98
2J48	37.55	6CL6	1.65	GL502	1.70	5684	13.55	8012	1.09	1N70	2.98
2J50	49.50	6CM6	.95	CK503	1.30	5686	2.99	8013	4.91	1N70A	3.50
2J55	45.09	6J5	.46	CK505	1.85	5687	3.59	8014A	50.15	1N71	6.25
2J56	50.01	6J6	.58	CK512	1.35	5692	6.48	8020	1.30	1N72	.90
2J61	19.55	6K4A	3.68	CK531	7.50	5693	5.49	8025A	2.99	1N73	27.95
2J62	6.05	6K6	.61	CK532	2.50	CK5694	3.70	9001	.88	1N74	21.00
2K22	15.07	6S4	.99	CK533	2.35	5696	1.15	9002	.96	1N81	2.07
2K23	17.50	6SA7	.67	CK543	.99	CK5697	3.70	9003	.98	1N81A	3.15
2K25	15.09	6SJ7	.69	NL600	8.15	CK5702	2.05	9004	.28	1N92	2.85
2K26	45.15	6SK7	.54	HY615	.46	CK5703	.97	9006	.24	1N111	4.30
2K28	29.50	6SL7	.62	KU627	12.55	5713	173.50			1N112	3.40
2K29	27.59	6SN7	.59	WL652	25.15	5718	5.99			1N113	3.95
2K30	130.00	6SQ7	.56	702A	1.97	5719	5.99			1N114	3.25
2K33A	165.00	6T8	.82	703A	1.48	5721	189.55			1N115	1.80
2K34	139.55	6U8	1.09	704A	.98	5722	6.39			1N125	1.05
2K39	160.00	6V6	.56	705A	.98	5725	2.25			1N133	.95

THAT'S A BUY "TAB" THAT'S A BUY
Dept. 4E5 111 Liberty St., New York 6, N. Y., U. S. A.
PH. RECTOR 2-6245
CABLE: "TABPARTS"

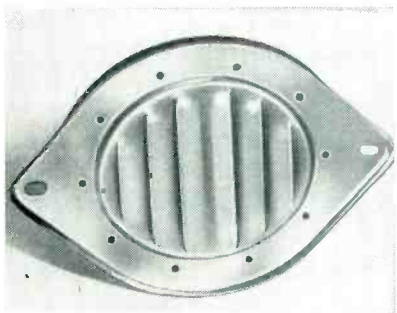
Money Back Guarantee (Cost of Mdse. Only) $5 Min. Order FOB N. Y. C. Add shpg. charges or for COD 25% Dep. Prices Subject to Change Without Notice.

INDEX TO ADVERTISERS

SEARCHLIGHT ADVERTISER INDEX

This index is published as a convenience to the readers. Every care is taken to make it accurate, but ELECTRONICS assumes no responsibility for errors or ommissions.

is a self-balancing, digital potentiometer for measuring d-c voltages from 0.001 to 999.9 v. Maximum error is less than 0.1 percent of the applied voltage. Resolution is 0.001 v in low range. The instrument makes an average of 100 zero-to-full-scale readings per minute, with automatic indication of polarity and decimal position. The measured voltages are displayed as a single, horizontal line of 4 illuminated numerals and polarity sign 1 in. high, with the decimal point positioned automatically. An internal 1.018 v d-c Weston standard cell is switched manually into the input circuit for calibration adjustment. A direct and functional application of the principles and advantages of etched circuitry contributes to the compactness and sturdy design of the instrument. All major assemblies are plugged into connectors on the chassis.

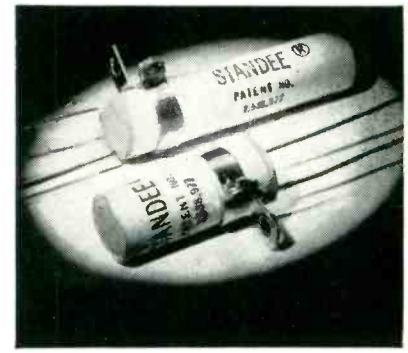


LOUDSPEAKER
is the electrostatic type

KINGDOM PRODUCTS LTD., 23 Park Place, New York 7, N. Y. The SKL 100 electrostatic h-f loudspeaker was developed to meet the need for a low-cost reproducer of the tweeter class. It requires a bias d-c voltage to stress the dielectric which is then modulated by the a-c signal. Maximum d-c bias should not exceed 300 v. To maintain minimum distortion, particularly at lower frequencies, the ratio of a-c (rms) to d-c bias voltage should be below 0.25. Inherent in the design of this type of loudspeaker is the limited mechanical displacement of the dielectric acting as the diaphragm. This tends to establish a limit to the l-f response. Signals below 5,000 cps entering the loudspeaker must be by-passed with an efficient filter network. Circuits are

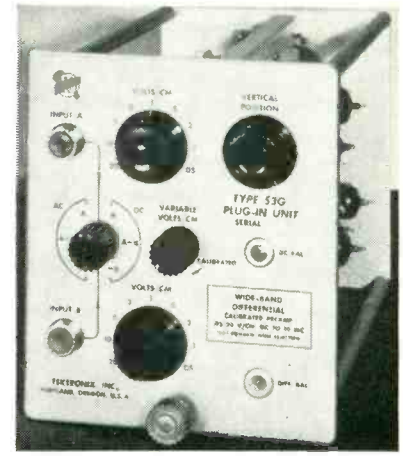
For additional information on all items on this page, use post card on last page.

shown on a single page bulletin now available.



POWER RESISTOR
are above-chassis-mounted

CLAROSTAT MFG. CO., INC., Dover, N. H. Standee or above-chassis-mounted power resistors are now further simplified by the adaptation of wire leads, when preferred to solder-lug terminals. These components feature a resistance element wound on a glass fiber core inserted and sealed in a ceramic tube. The Standee resistor protrudes above the chassis for maximum heat dissipation while hot terminals are accessible below the chassis. These resistors are available in 10, 15, 20, 25 and 30-w ratings, and in resistance values up to 6,000, 9,000, 12,000, 15,000 and 20,000 ohms respectively. Intermediate taps can be provided.



PREAMPLIFIER
is wide-band, plug-in type

TEKTRONIX, INC., P. O. Box 831, Portland 7, Oregon. Type 53G differential wide-band d-c preamplifier features d-c to 10-mc fre-

For maximum resistance in minimum space!

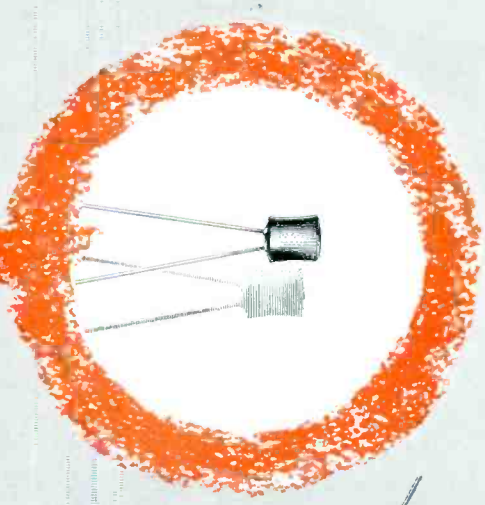
NEW Lollypop Precision Resistor
Davohm Type 1273

It's no trick at all with Daven's unique and extremely small size resistor to achieve ease of mounting in new printed circuit and transistor assemblies. The trick is **inside** this tiny unit . . . it's a completely new specialized winding technique developed by Daven, which enables them to use extremely fine sizes of resistance wire to obtain two or three times the resistance value that was previously supplied on a bobbin of this size.

You can't lick Daven's new wire-wound Lollypop Resistor

Only 1/4" in diameter by 5/16" long, yet is available in values as high as 400,000 ohms:

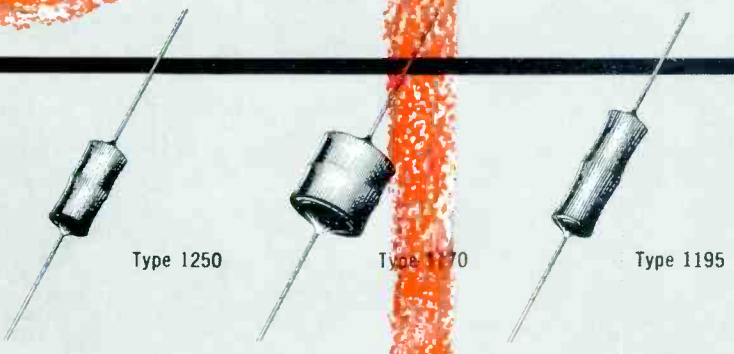
- Fully encapsulated
- Exceeds all humidity, salt water immersion and cycling tests as specified in MIL-R-93A, Amendment 2
- Operates at 125°C continuous power without de-rating
- Can be obtained in tolerances as close as ±.02%
- Standard temperature coefficient is ±20 PPM/°C. Special coefficients can be supplied on request



Below are other miniature encapsulated Daven resistors, part of the largest selection of precision wire-wound resistors available:

	Type 1250	Type 1170	Type 1195
Max. Ohms	450K	2 Meg.	760K
Dia.	1/4	1/2	1/4
Length	1/2	1/2	3/4
Max. Watts	1/8	1/3	1/4

All Daven resistors can be operated at 125°C continuous power without de-rating.



Write for complete resistor catalog.

THE DAVEN CO.

191 Central Avenue, Newark 4, New Jersey

WORLD'S LARGEST MANUFACTURER OF ATTENUATORS

RCA DATA FOR DESIGNERS

RCA OSCILLOGRAPH TUBES
RCA-5ABP1, 5ABP7 and 5ABP11 flat-faced cathode-ray tubes feature electrostatic focus, electrostatic deflection, and post-deflection acceleration. These 5-inch oscillograph tubes differ only in spectral-energy emission and persistence characteristics of their respective phosphors. Outstanding features: very high deflection sensitivity, high spot intensity, and high grid-modulation sensitivity. The exceptionally high deflection sensitivity and low capacitance of the pair of deflecting electrodes provided for vertical-deflection, make this pair of electrodes especially suited for operation from wide-band amplifiers. The small size and high brilliance of the fluorescent spot give finer detail in oscillographic traces . . . even with high-speed phenomena.

RCA-2D21—a sensitive, four-electrode thyratron, of the indirectly heated cathode type for use in relay applications. It has a high control ratio (essentially independent of ambient temperature over a wide range), extremely small pre-conduction or gas-leakage currents right up to the beginning of conduction, very low grid-anode capacitance and grid current. The 2D21 is not affected appreciably by line-voltage surges and, in a high-sensitivity circuit, can be operated directly from a vacuum phototube.

RCA-5879—is a sharp-cutoff pentode of the 9-pin miniature type intended for use as an audio amplifier in applications requiring reduced microphonics, leakage, noise, and hum. It is especially well-suited for input stages of medium-gain public address systems, home sound recorders, and general-purpose audio systems.

RCA-4X150-A—a very small and compact forced-air-cooled beam power tube for use in power amplifier or oscillator service at frequencies up to 500 megacycles and also as a wideband amplifier in video applications. The 4X150-A has a maximum plate dissipation of 150 watts. Terminal arrangements of this power tube facilitate its use with tank circuits of the coaxial type. Additional features: unipotential cathode . . . integral radiator . . . coaxial-electrode structure. Max. length: 2.468", max. diameter: 1.645"

For technical information, write RCA, Section D19R, Commercial Engineering, 415 S. 5th Street, Harrison, N. J. Or call your nearest RCA Field Office:

EAST—HUmboldt 5-3900
744 Broad St.
Newark, N. J.

MIDWEST—WHitehall 4-2900
589 E. Illinois St.
Chicago 11, Ill.

WEST—MAdison 9-3671
420 S. San Pedro St.
Los Angeles 13, Calif.

ELECTRON TUBES—SEMICONDUCTOR DEVICES—BATTERIES—TEST EQUIPMENT—ELECTRONIC COMPONENTS

RADIO CORPORATION of AMERICA
TUBE DIVISION ***HARRISON, N.J.***

ELECTRONICS Charter-Year Advertiser