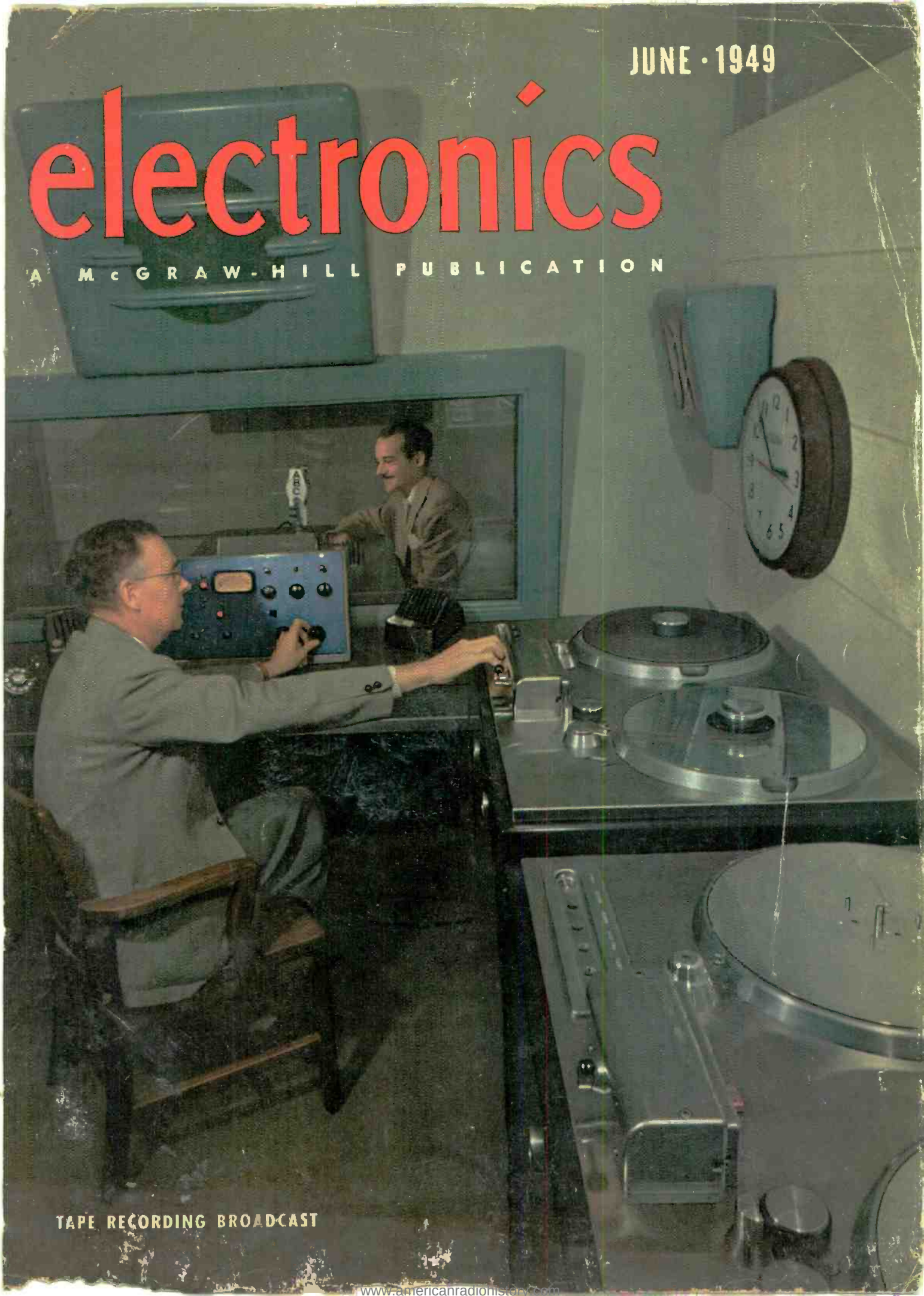
JUNE · 1949

electronics

A McGRAW-HILL PUBLICATION



TAPE RECORDING BROADCAST

for High Q Inductors...

For Maximum Stability
Permalloy Dust Toroids

The UTC type HQ permalloy dust toroids are ideal for all audio, carrier and supersonic applications. HQA coils have Q over 100 at 5,000 cycles . . . HQB coils Q over 200 at 4,000 cycles . . . HQC coils Q over 200 at 30KC . . . HQD coils Q over 200 at 60 KC. The toroid dust core provides very low hum pickup . . . excellent stability with voltage change . . . negligible inductance change with temperature, etc. Precision adjusted to 1% tolerance.

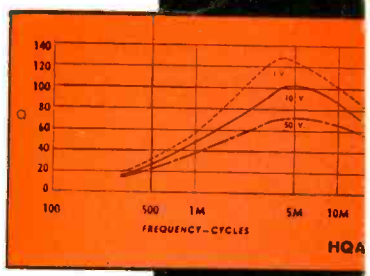
Inductance Value	Type No.	Net Price
5 mhy.	HQA-1	$7.00
12.5 mhy.	HQA-2	7.00
20 mhy.	HQA-3	7.50
30 mhy.	HQA-4	7.50
50 mhy.	HQA-5	8.00
80 mhy.	HQA-6	8.00
125 mhy.	HQA-7	9.00
200 mhy.	HQA-8	9.00
300 mhy.	HQA-9	10.00
.5 hy.	HQA-10	10.00
.75 hy.	HQA-11	10.00
1.25 hy.	HQA-12	11.00
2 hy.	HQA-13	11.00
3 hy.	HQA-14	13.00
5 hy.	HQA-15	14.00
7.5 hy.	HQA-16	15.00
10 hy.	HQA-17	16.00
15 hy.	HQA-18	17.00
10 mhy.	HQB-1	16.00
30 mhy.	HQB-2	16.00

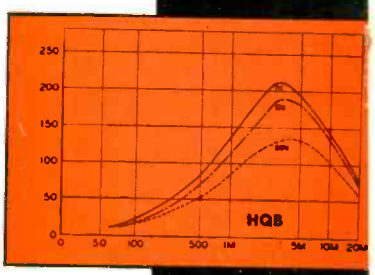
Inductance Value	Type No.	Net Price
70 mhy.	HQB-3	$16.00
120 mhy.	HQB-4	17.00
.5 hy.	HQB-5	17.00
1 hy.	HQB-6	18.00
2 hy.	HQB-7	19.00
3.5 hy.	HQB-8	20.00
7.5 hy.	HQB-9	21.00
12 hy.	HQB-10	22.00
18 hy.	HQB-11	23.00
25 hy.	HQB-12	24.00
1 mhy.	HQC-1	13.00
2.5 mhy.	HQC-2	13.00
5 mhy.	HQC-3	13.00
10 mhy.	HQC-4	13.00
20 mhy.	HQC-5	13.00
.4 mhy.	HQD-1	15.00
1 mhy.	HQD-2	15.00
2.5 mhy.	HQD-3	15.00
5 mhy.	HQD-4	15.00
15 mhy.	HQD-5	15.00

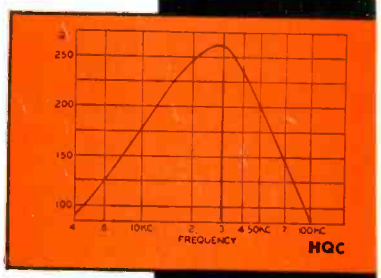
HQA, C, D
$1\frac{13}{16}$" Dia. x $1\frac{3}{16}$" High.

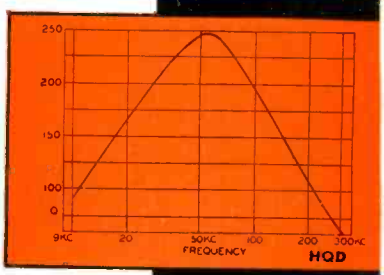
HQB
$2\frac{5}{8}$" L. x $1\frac{5}{8}$" W. x $2\frac{1}{2}$" H.

UNCASED TOROIDS
(Deduct $1.50 for uncased units)



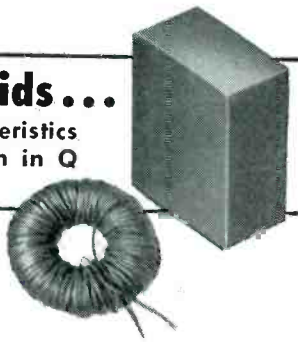






Sub-Ouncer Permalloy Dust Toroids...

Weight ½ ounce uncased. HQE coils have characteristics similar to HQA, C, and D coils with little reduction in Q considering minute size.



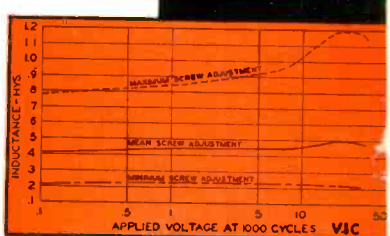
For Maximum Flexibility...
The VIC Variable Inductor

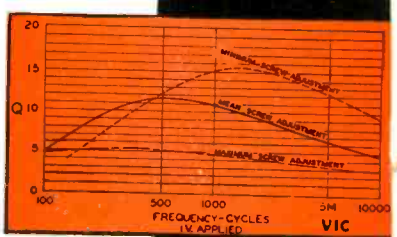
The set screw on VIC units permits positive adjustment of inductance to plus 90% minus 50% from rated value. Revolutionary approach for tuned audio circuits. Q and L vs. screw adjustment for a typical coil are illustrated.

Type	Mean Hys.	List Price
VIC-1	.0085	$11.00
VIC-2	.013	11.00
VIC-3	.021	11.00
VIC-4	.034	11.00
VIC-5	.053	11.00
VIC-6	.084	11.00
VIC-7	.13	14.00
VIC-8	.21	14.00
VIC-9	.34	14.00
VIC-10	.54	14.00
VIC-11	.85	14.00

Type	Mean Hys.	List Price
VIC-12	1.3	$14.00
VIC-13	2.2	14.00
VIC-14	3.4	14.00
VIC-15	5.4	16.50
VIC-16	8.5	16.50
VIC-17	13	16.50
VIC-18	21	16.50
VIC-19	33	16.50
VIC-20	52	16.50
VIC-21	83	17.50
VIC-22	130	18.50

$1\frac{3}{8}$" L. x $1\frac{1}{4}$" W. x $1\frac{1}{2}$" H.





United Transformer Co.

150 VARICK STREET • NEW YORK 13, N. Y.

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

Write for catalog PS-409

electronics

A McGRAW - HILL PUBLICATION

JUNE • 1949

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MARION helps TECHNOLOGY INSTRUMENT

measure Phase Difference

Type 320-A (electronic) Phase Meter by Technology Instrument Corporation is the first commercially available instrument for the direct measurement of Phase Angle as an independent quantity at audio and supersonic frequencies. Important fields of application are: Audio Facilities, Supersonics, Servomechanisms, Geophysics, Acoustics, Aerial Navigation, Electric Power Transformation and Signaling.

To make this instrument practical, T. I. C. had to have a special meter with special characteristics which would integrate extreme low frequency pulses and eliminate needle flutter. Other requirements included critical accuracy, an exceptionally long scale, readability, reliability, freedom from bearing failure, protection from heavy overloads and long life. By working in closest cooperation with Marion engineers and using all of Marion's extensive meter making experience and facilities a satisfactory type was finally developed.

When you need special- or general-purpose instruments for electrical or electronic measuring get in touch with us. Here at Marion we have solved many a complicated meter problem. We would appreciate the chance to help solve yours.

the name MARION means the most in meters

M·E·I

MARION ELECTRICAL INSTRUMENT COMPANY

MANCHESTER, NEW HAMPSHIRE

Export Division, 458 Broadway, New York 13, U. S. A., Cables MORHANEX

IN CANADA: THE ASTRAL ELECTRIC COMPANY, SCARBORO BLUFFS, ONTARIO

LOW CURRENT PAYS OFF...

with the GENERAL ELECTRIC PM-EM* FOCUS COIL!

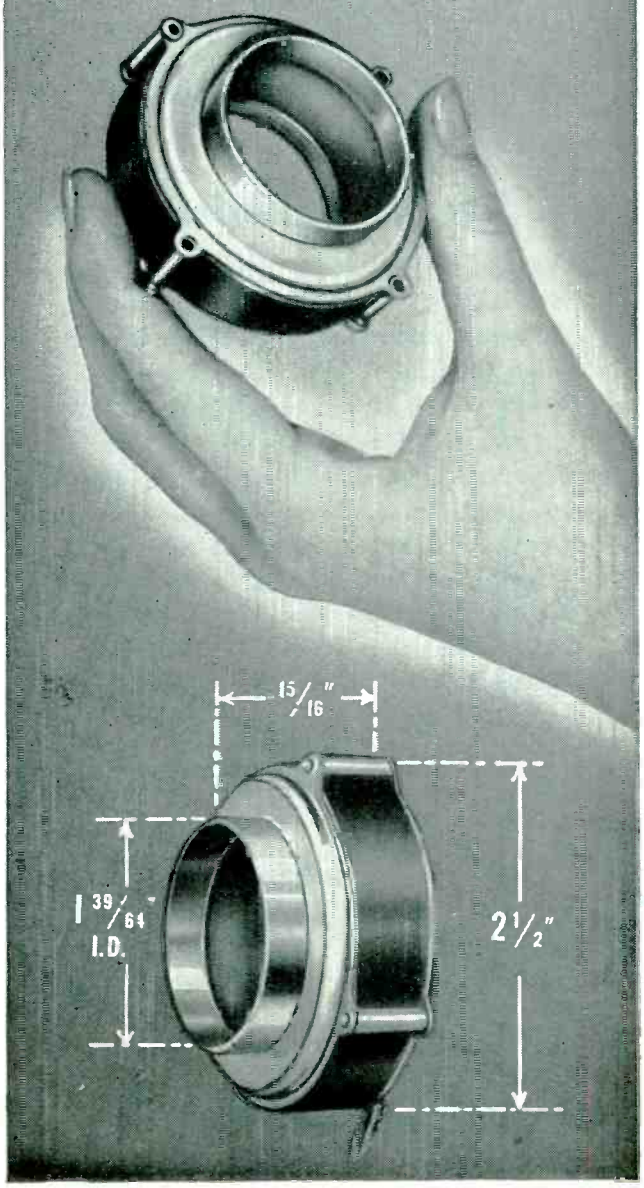
PERFORMANCE-ENGINEERED at Electronics Park, the General Electric Focus Coil is now being used by many leading television manufacturers. The reason for this widespread adoption of the G-E Focus Coil by design engineers is best explained by the following equation:

PEM $= I^2R = .109^2 \times 247 = 2.93$ watts
PEM–PM $= {}^2R = .029^2 \times 960 = 0.81$ watts
Power Saving $= 2.12$ watts

In addition to its low current requirements (which permit the use of lower-priced power supplies) the G-E focus coil is small, compact and light in weight. These features provide additional space which TV set designers can use to advantage.

For complete information on the G-E Focus Coil and other television components, write: *General Electric Company, Electronics Park, Syracuse, New York.*

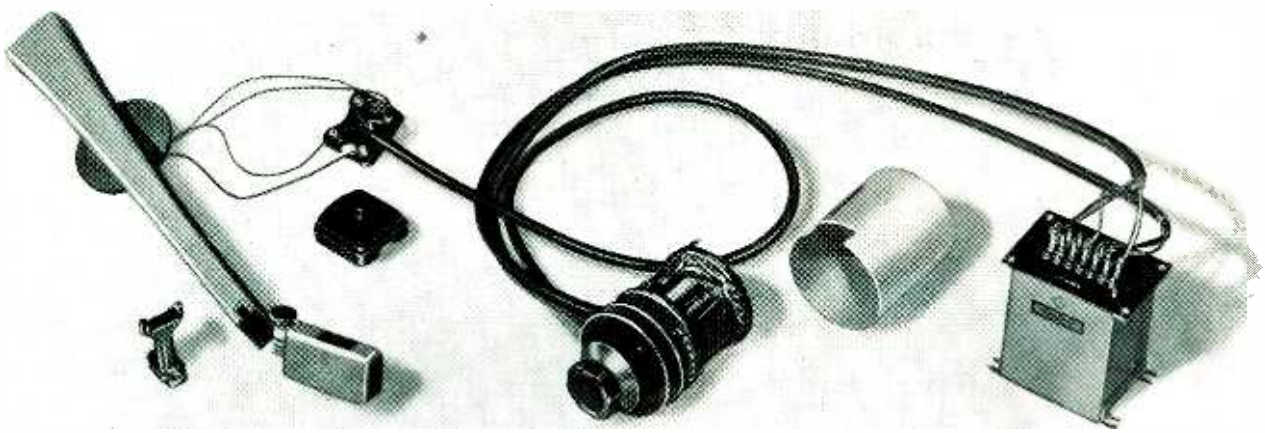
**Permanent Magnet—Electro-Magnet.*



You can put your confidence in—

GENERAL ELECTRIC

Two BIG reasons why you'll want...



...the 109 Type Reproducer Group!

1. Low intermodulation distortion

Naturally, the Western Electric 109 Type Reproducer Group gives you extremely low *harmonic* distortion. But here's a still more important point—its advanced design practically eliminates *intermodulation* distortion.

Intermodulation distortion is one of the important factors that cause the "fuzziness" so often heard in the reproduction of the higher frequencies. Tests *prove* that the moving coil principle of reproduction, used in the 9 Type Reproducer, introduces far less intermodulation distortion than other currently used methods. That's *one* reason why the 109 gives exceptionally "clean" reproduction!

2. Wide, uniform frequency response

The combination of the 9 Type Reproducer and the equalizer used in the 109 Group is carefully designed for uniform frequency response—and this 7-position equalizer permits correction for any of the more commonly used recording characteristics. With the 109 Group, you can match within close tolerances all vertical and most lateral transcriptions and 90% of phonograph records.

The 109 Type Reproducer Group is *available from stock*—place your order with your local Graybar Representative, or write Graybar Electric Company, 420 Lexington Avenue, New York 17, N. Y.

—QUALITY COUNTS—

Immediate replacements on 9 Type Reproducers

If your 9 Type Reproducer needs repairs, send it to your Graybar District Warehouse — you can get a *factory-rebuilt* replacement immediately from stock.

Distributed by Graybar — Offices in 100 Principal Cities

Western Electric

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ACCURATE TEST VOLTAGES

½ cps to 50 kc

-hp- 202B LOW-FREQUENCY OSCILLATOR

New, wider frequency range, improved circuits, higher stability—those are but a few of the time-saving new features of this improved -*hp*- Model 202B Low-Frequency Oscillator.

This -*hp*- instrument now covers the low-frequency, audio and supersonic spectra from ½ cps to 50 kc. Throughout this range it provides excellent wave form, high stability and an unusual degree of accuracy.

Like other -*hp*- instruments, this resistance-tuned oscillator features amazing simplicity and speed of operation. Frequency is set and read directly. Frequency range is selected from 5 ranges by a front-panel control. No zero-set is required during operation. Construction is simple yet rugged; the instrument is designed for long years of trouble-free operation in field or laboratory.

The -*hp*- 202B Oscillator is particularly designed for the following tests: Vibration or stability characteristics, electrical simulation of mechanical phenomena, performance checks on electro-cardiograph or encephalograph equipment, testing geophysical prospecting equipment, checking seismograph response. Its versatility makes it adaptable for almost any operation where an accurate low or audio frequency source is required.

SPECIFICATIONS

Frequency Range: ½ cps to 50 kc, 5 ranges.

RANGE	FREQUENCY
X1	½ to 5 cps
X10	5 to 50 cps
X100	50 to 500 cps
X1K	500 to 5,000 cps
X10K	5,000 to 50,000 cps

Calibration Accuracy: ±2%.

Frequency Stability: Better than ±5% under normal conditions including warm-up drift. Less than ±1% for power voltage changes of ±10%.

Output Voltage: 10 v into 1,000 ohm resistive load over entire range.

Internal Impedance: Approx. 25 ohms at 10 cps.

Frequency Response: ±1 db, 10 to 50,000 cps; ±2 db, 1 to 50,000 cps.

Distortion: Less than 1% total distortion, 1 cps to 50 kc.

Hum Voltage: Less than 0.1% of rated output voltage.

Data subject to change without notice

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1875-A Page Mill Road, Palo Alto, California
Export: FRAZAR & HANSEN
301 Clay Street, San Francisco, California, U.S.A.
Offices: New York, N.Y.; Los Angeles, Calif.

Person-to-Person Help With Your Measuring Problems

Almost anywhere in America, -*hp*- field representatives can give you personal help with your measuring problems. They have complete data on -*hp*- instruments, their performance, servicing and adaptability. Call the nearest -*hp*- field representative whenever, wherever you need help with a measuring problem.

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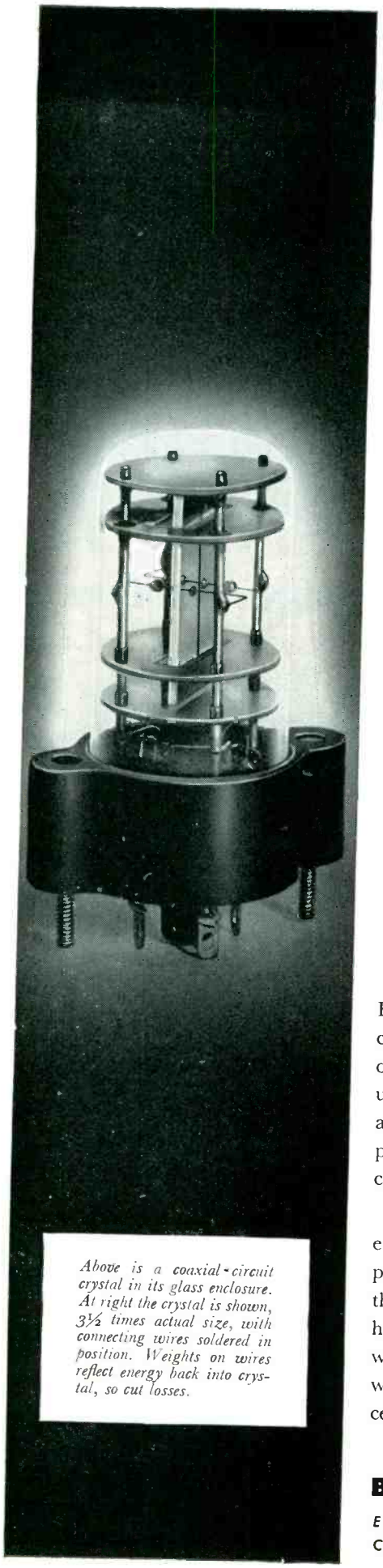
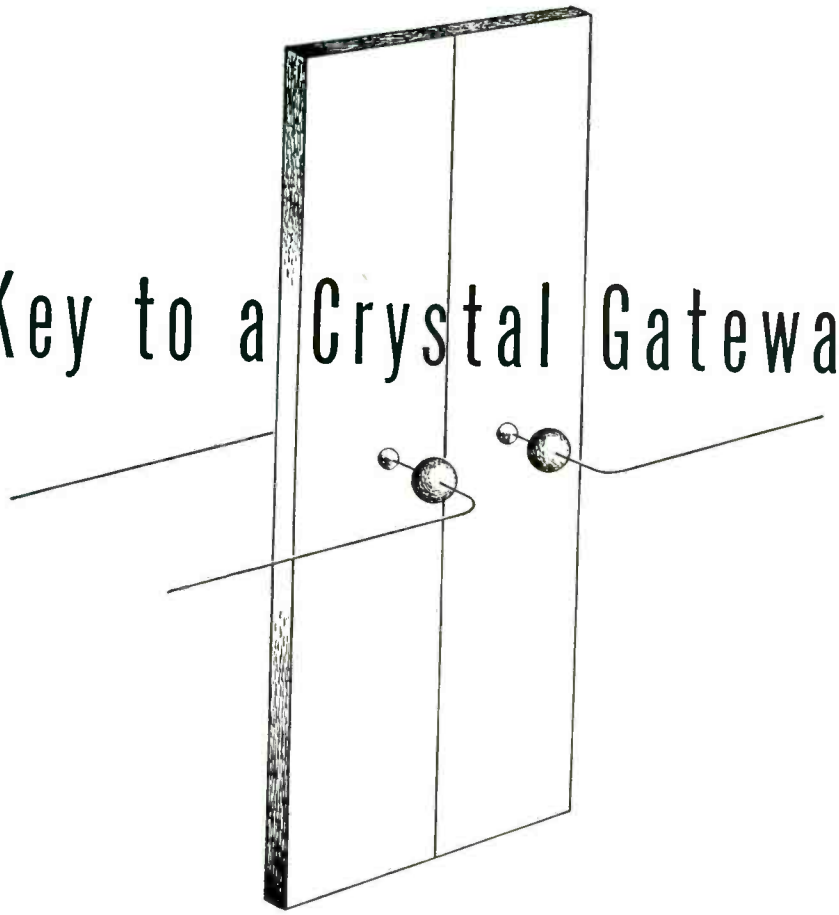
hp laboratory instruments
FOR SPEED AND ACCURACY



Above is a coaxial-circuit crystal in its glass enclosure. At right the crystal is shown, 3½ times actual size, with connecting wires soldered in position. Weights on wires reflect energy back into crystal, so cut losses.

Key to a Crystal Gateway



How would you solder a wire to a crystal? This must be done for most of those wafer-thin plates of quartz used in electrical circuits. They play a big part in the myriad-channel telephone system that utilizes coaxial cables.

This is how Bell Laboratories scientists solved the problem: A spot of paste containing silver is deposited on the crystal and bonded to it by oven heat. The crystal is then vapor-plated with a thin layer of silver. Then a fine wire is soldered to the spot by a concentrated blast of hot air. The result is a rugged electrical connection to the surface of the crystal which does not interfere with its vibrations.

Sealed in glass tubes, the crystals are precise and reliable performers in the telephone system. Each is a crystal gate to a voiceway, separating *your* conversation from the hundreds of others which may be using a pair of coaxial conductors, at the same time.

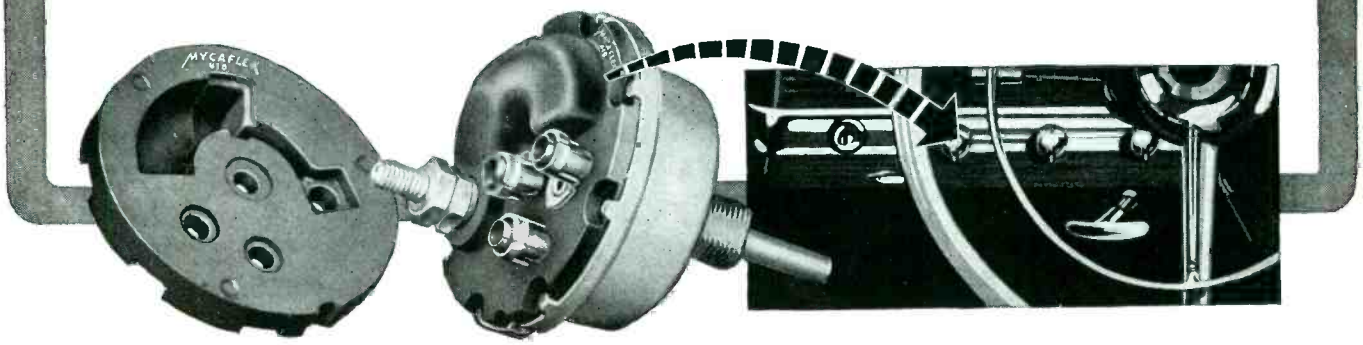
This spot of paste, this tiny wire, this puff of air are among the tremendous trifles which concern Bell Telephone Laboratories in finding new ways to improve your telephone service.

BELL TELEPHONE LABORATORIES

EXPLORING AND INVENTING, DEVISING AND PERFECTING, FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE

ONCE AGAIN, MYCALEX 410 GETS THE CALL . . .

Leading Automobile firm specifies MYCALEX 410 molded insulation for new dashboard lightswitch . . .



Sorry, we can't mention names, but this is the insulator body for a new type of dash-board light-switch being manufactured of MYCALEX 410 molded insulation for one of the leading lines of cars*. . . *names on request.

It's no great secret that automotive firms buy wisely and well . . . and it's justly proud we are that after making exhaustive tests and comparisons, this large maker of cars specified MYCALEX 410 molded insulation as ideal for the new type dash-board light-switch being introduced in their 1949 line.

Again, it was proved that on long run, round the clock production, MYCALEX 410 insulation parts, molded with or without metal inserts, are low-cost and competitive with less-effective molded insulation materials.

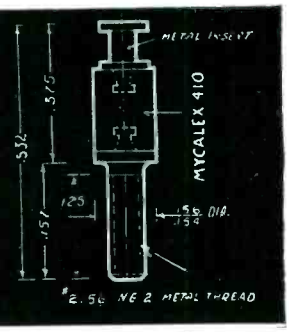
Again, MYCALEX 410 molded insulation demonstrated its absolute dimensional and electrical stability; low dielectric loss; high dielectric strength; high arc resistance; stability over wide humidity and temperature changes; resistance to high temperatures, moisture and oils; and great mechanical precision and strength. Inserts of common or precious metals may be injected in the MYCALEX 410 molding process.

Yes, MYCALEX 410 molded insulation meets the most exacting requirements of high frequency applications.

REMEMBER . . .

MYCALEX 410 MOLDED INSULATION IS THE EXCLUSIVE FORMULATION OF MYCALEX CORPORATION OF AMERICA.

We stock these
MYCALEX 410
Tiny Tie-In Terminals
for . . .
Sub-miniature
Transmitting Equipment



SINCE 1919 MYCALEX THE INSULATOR

MYCALEX CORP. OF AMERICA

"Owners of 'MYCALEX' Patents"

Plant and General Offices, CLIFTON, N. J. Executive Offices, 30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

Heat dissipation can be

for resistors

Heat dissipation can be mighty tough . . . but not for IRC resistors. They are universally engineered for the lowest possible operating temperatures and maximum power dissipation within the smallest size units consistent with good engineering practice.

Long experience with the widest line of resistor types in the industry has provided IRC with a wealth of "know-how" on resistor heat dissipation. In Power Wire Wound Resistors for example, the complete range of tubular and flat types manufactured by IRC utilizes a special cement coating to attain rapid heat dissipation. This dark rough surface does double duty by effectively guarding the windings against harmful atmospheric moisture and corrosion. Use the handy coupon to get complete data on proven advantages of IRC Power Wire Wounds.

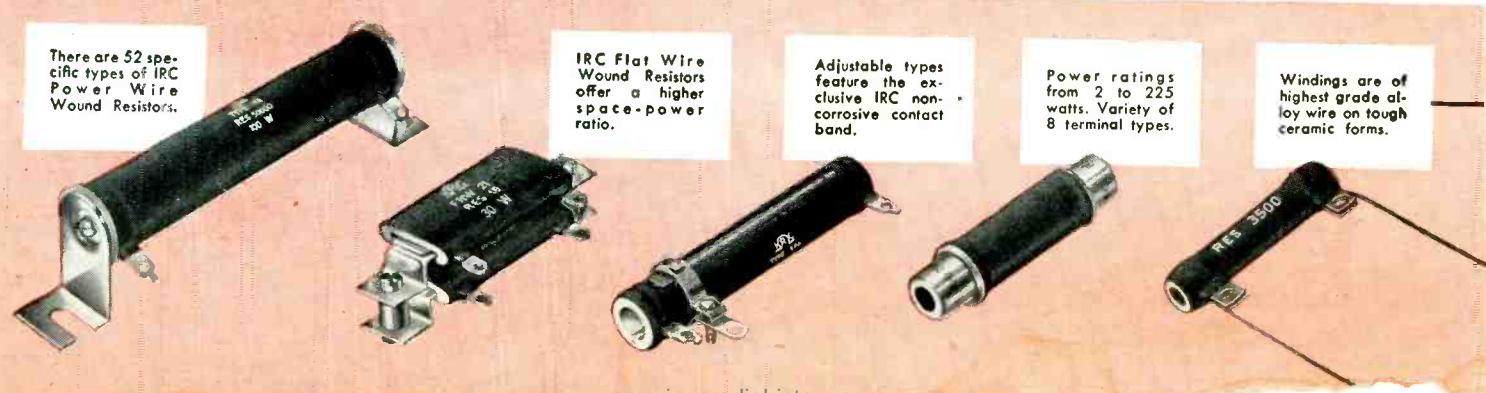
There are 52 specific types of IRC Power Wire Wound Resistors.

IRC Flat Wire Wound Resistors offer a higher space-power ratio.

Adjustable types feature the exclusive IRC non-corrosive contact band.

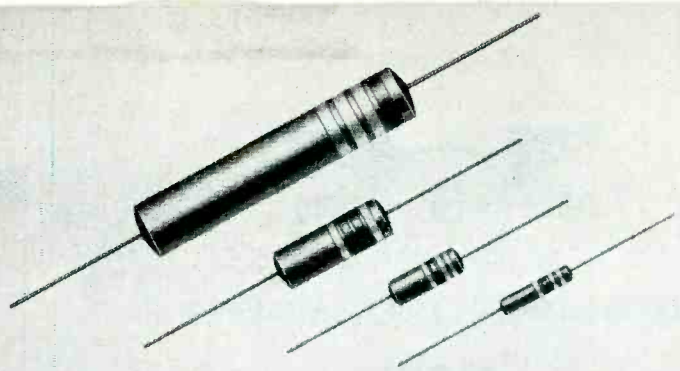
Power ratings from 2 to 225 watts. Variety of 8 terminal types.

Windings are of highest grade alloy wire on tough ceramic forms.

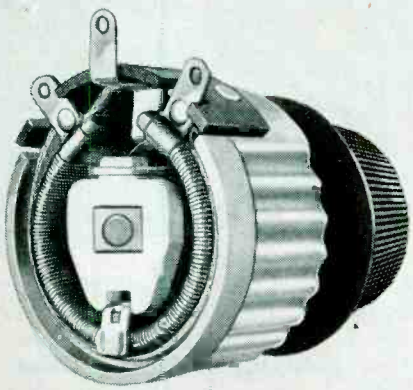


tough

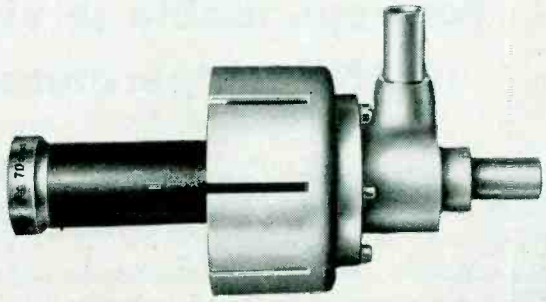
too!



New, ADVANCED BT Resistors obsolete present performance standards for fixed composition resistors. Extremely low operating temperature and excellent power dissipation in compact, light weight, fully insulated units at ⅓, ½, 1 and 2 watts. These ADVANCED resistors meet JAN-R-11 specifications. All the facts are included in 12-page technical data Bulletin B-1.



Heat dissipation properties of aluminum are used to full advantage in housing and winding core of IRC Power Rheostats, 25 and 50 watts. Type PR Rheostats operate at full rating at about half temperature rise of equivalent units. Can be operated at full power in as low as 25% of rotation without appreciable difference in temperature rise. Direct contact between rheostat and mounting panel allows rapid conduction to panel of a portion of heat dissipated. Send for Bulletin E-2.



Water-cooled LP Resistors utilize high velocity water stream flowing in spiral path against thin resistance film. High power dissipation is made possible by centrifugal force holding water in thermal contact with resistance surface. Resistance film less than 0.001'' thick with active length much less than ¼ wave length at FM and television frequencies, gives excellent frequency characteristics. Resistance values 35 to 1500 ohms; 15% tolerance standard; power dissipation up to 5 K.W. ac. Bulletin F-2 gives all the facts.

If you have the heat put to you for speedy service on small order resistor requirements for experimental work, pilot runs, etc., you'll appreciate the advantages of IRC's Industrial Service Plan. This enables you to get 'round-the-corner service from the local stocks of your IRC Distributor. He's a good man to know . . . we'll gladly send you his name and address.

IRC

Wherever the Circuit Says —WW—

Power Resistors • Voltage Dividers
Insulated Composition Resistors • Low Wattage Wire Wounds • Controls
Deposited Carbon Precistors • Precisions
HF and High Voltage Resistors
Voltmeter Multipliers • Rheostats

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Send me additional data on items checked below:

☐ Power Wire Wounds (tubular) ☐ Flat Power Wire Wounds
☐ Advanced BT Resistors ☐ Power Rheostats ☐ Water-Cooled Resistors
☐ Name and address of our local IRC Distributor

NAME .....

TITLE .....

COMPANY .....

ADDRESS .....

.....

AER -O- COM

ALL-WEATHER TRANSMITTERS

USE

ADLAKE RELAYS

For dependable service at ANY temperature!

The Adlake Mercury plunger Type Relay, with its +200° —38.8° temperature range, is naturally suited to power control and time delay in Aerocom's new VH-200 all-weather radiotelephone transmitter. Aerocom demands dependability, and dependability in relays means Adlake.

The mercury-to-mercury contacts in Adlake Relays completely eliminate failures caused by low contact pressure, contact burning, pitting, and sticking—and the inherent high surface tension of mercury gives an ideal snap action to the contacts.

In addition, Adlake Relays bring these advantages to any relay job:

- **Hermetically sealed contact mechanism, impervious to dust, dirt, and moisture.**
- **Silent and chatterless operation, producing high-fidelity modulation with a low noise level.**
- **Adlake armor design, which protects relays against outside vibration or impact.**

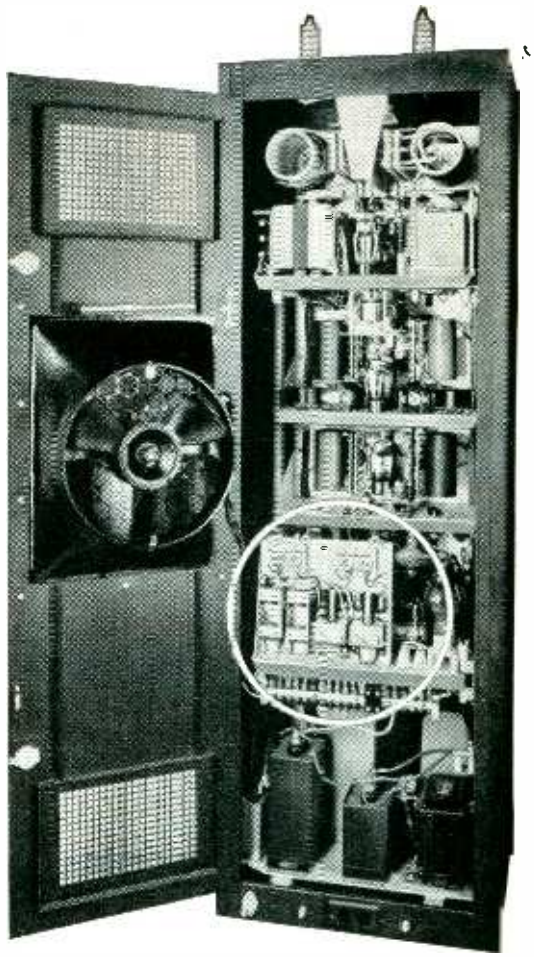
Whatever your relay needs, there's an Adlake Relay to do the job. You'll want to see our free illustrated folder for full details. Write for it today: The Adams & Westlake Company, 1107 N. Michigan, Elkhart, Indiana.

THE Adams & Westlake COMPANY

Established 1857 • ELKHART, INDIANA • New York • Chicago

Adlake TRADE MARK

Manufacturers of Adlake Hermetically Sealed Mercury Relays for Timing, Load and Control Circuits



ABOVE—Rear view of Aerocom's Model 12GLX-2A, showing installation of Adlake Relays. Relays are (from left to right) Model 1200-87-5, Model 1200-87-3, Model 1040-87-1BP, and Model 1040-85-3.

BELOW—The new Aerocom VH-200, all-weather transmitter.

HARDEST WORKERS ON YOUR COMMUNICATIONS TEAM

G-E BEAM POWER TRANSMITTING TUBES

GL-2E26

—always ready for dependable service—minutes or hours of it!

—need low drive, so ask less of your power supply

—replacements are convenient to obtain...you can secure new tubes fast from your local G-E tube distributor!

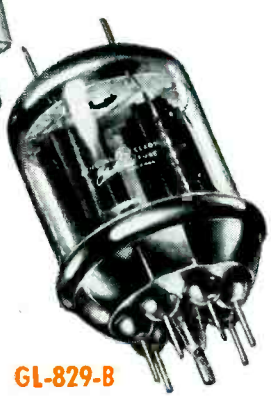
DESIGNERS of equipment give first place to General Electric beam power *economy* tubes. Their low drive requirements — a characteristic of this type — pay off in less space needed for the driving stages of a transmitter. That's Saving No. 1! And drain on the battery or other source of power supply is reduced . . . Saving No. 2.

If you operate police, taxicab, or ambulance radio equipment — if you maintain an airport, ship-to-shore, or other communications system — the benefits of a more compact transmitter and lower power consumption are matched by G-E tube dependability. These beam power types are amply proved in tough service!

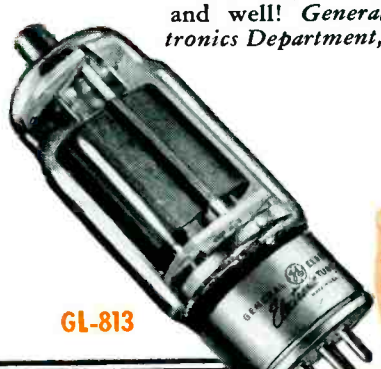
A complete line of General Electric tubes is available, spanning the range of outputs and frequencies in communications work. Designers and builders of equipment, through their nearby G-E electronics office, may call on experienced G-E tube engineers to help select the right types for new circuits.

Transmitter owners will find that same-day, often same-hour service is given by their local G-E distributor on tube replacements. From coast to coast, stocks are in readiness for *your* emergency call! Get to know your G-E tube distributor; he's equipped to serve you fast . . . and well! *General Electric Company, Electronics Department, Schenectady 5, New York.*

GL-807



GL-829-B



GL-813

Ratings (ICAS) for typical operation, Class C plate-modulated

Type	Plate voltage	Plate current	Driving power (approx)	Power output (approx)	Freq. at max ratings
GL-2E26	500 v	54 ma	0.15 w	18 w	125 mc
GL-807	600 v	100 ma	0.4 w	42.5 w	60 mc
GL-829-B	600 v	150 ma	0.9 w	70 w	200 mc
GL-813	2,000 v	200 ma	4.3 w	300 w	30 mc

Photo by courtesy N. Y. State Police

GENERAL ELECTRIC

180-H4

FIRST AND GREATEST NAME IN ELECTRONICS

AIR makes the BIG DIFFERENCE

in Federal's INTELIN K-109

Crimped Type Coaxial Cable

Offering a Unique Combination of Low Capacitance and Effective Shielding for

- **PERMANENT AUTOMOTIVE LEAD-INS**
- **INTERSTAGE HF COUPLINGS**
- **HF TEST EQUIPMENT CONNECTIONS**

AIR is the secret of this greatly improved, noise-free, ready-made automobile lead-in.

Federal's new production technique of crimping makes important use of the very low dielectric constant of air to obtain the low capacitance of Intelin K-109. The diagram shows the zig-zag crimp of the conductor—self-supported in air by equally spaced contacts with the polyethylene tube.

This ingenious device of introducing air in the cable dielectric makes it possible to shield Intelin K-109 and still maintain low loss and low capacitance. Thus, K-109 provides good impedance match—between antenna and receiver. This unique combination increases gain in the antenna coil for better reception . . . with improved signal-to-noise ratio.

Crimping, moreover, gives K-109 the mechanical flexibility of a buggy whip. Spring action of the crimp soaks up vibration—so the conductor won't break away from terminals.

The same electrical and mechanical characteristics can be used to advantage wherever there may be HF requirements of low loss and low capacitance *plus* effective shielding. Already Intelin K-109 is finding applications in HF test equipment . . . interstage HF couplings . . . other vital connections in electronic equipment. For information and prices, write to Department D-813.

KEEPING FEDERAL YEARS AHEAD... is IT&T's world-wide research and engineering organization, of which the Federal Telecommunication Laboratories, Nutley, N. J., is a unit.

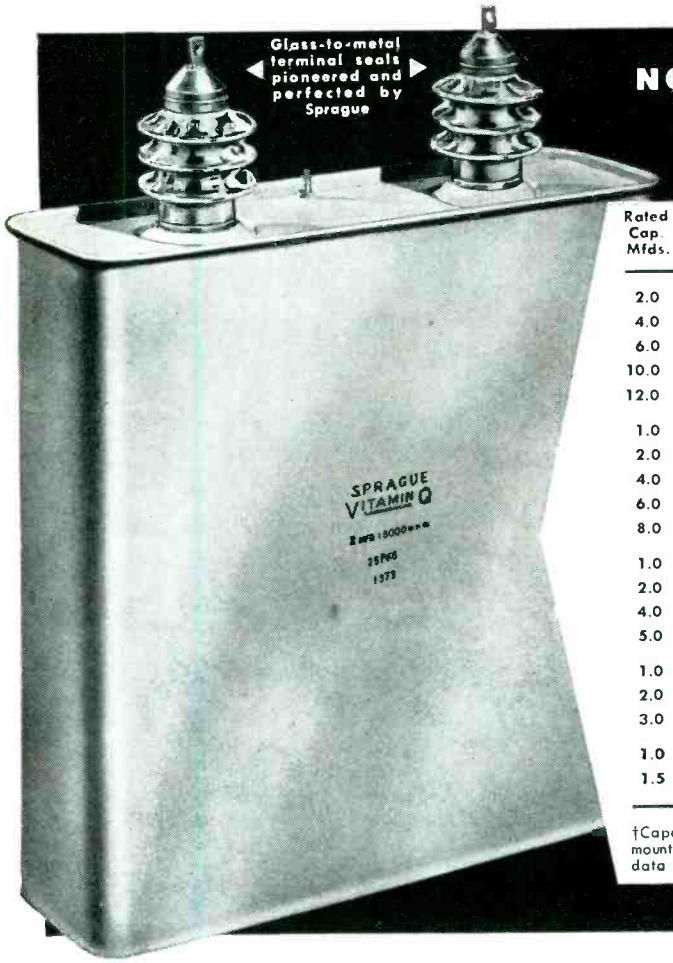
Federal Telephone and Radio Corporation

SELENIUM and INTELIN DIVISION, 900 Passaic Ave., East Newark, New Jersey

In Canada: Federal Electric Manufacturing Company, Ltd., Montreal, P. Q.
Export Distributors: International Standard Electric Corp. 67 Broad St., N. Y.

SMALLER, LIGHTER, LESS EXPENSIVE

HIGH VOLTAGE D-C CAPACITORS



NOTE THE SIZES AND RATINGS!

Standard Vitamin Q Capacitors. Many special sizes and ratings also available.

Rated Cap. Mfds.	D-C† Rated Voltage	DIMENSIONS Width	Depth	Can Height	Terminal Height	Cat. No.
2.0	8000	8⅛	4⅛	6	2¼	25P51
4.0	8000	8⅛	4⅛	9¼	2¼	25P52
6.0	8000	8⅛	4⅛	13	2¼	25P53
10.0	8000	13½	4¼	13⅛	2¼	25P54
12.0	8000	13½	5¼	12¼	2¼	25P55
1.0	10000	8⅛	4⅛	5½	3 11/16	25P56
2.0	10000	8⅛	4⅛	8½	3 11/16	25P57
4.0	10000	13½	4¼	9¼	3 11/16	25P58
6.0	10000	13½	4¼	13⅛	3 11/16	25P59
8.0	10000	13½	5¼	12⅞	3 11/16	25P60
1.0	12500	8⅛	4⅛	7½	3 11/16	25P61
2.0	12500	8⅛	4⅛	12¼	3 11/16	25P62
4.0	12500	13½	5¼	11½	3 11/16	25P63
5.0	12500	13½	5¼	13¾	3 11/16	25P64
1.0	16000	8⅛	4⅛	10½	4 11/16	25P65
2.0	16000	13½	4¼	12¼	4 11/16	25P66
3.0	16000	13½	5¼	13¾	4 11/16	25P67
1.0	20000	13½	4¼	11	4 11/16	25P68
1.5	20000	13½	5¼	12¼	4 11/16	25P69

†Capacitors with voltage ratings above 10 KV are recommended for upright mounting only. For mounting in other positions, please supply complete application data for recommendation by Sprague engineers.

USE an ordinary capacitor rated for 40°C. operation on a high-voltage d-c filtering circuit and chances are the higher temperatures encountered will necessitate a serious de-rating. In other words, you will have to buy a larger, heavier and costlier capacitor than you actually need.

Standard Sprague high-voltage capacitors impregnated with Vitamin Q, however, are rated conservatively for operation at 85°C. *They require no de-rating up to this temperature.* Special units can be supplied for continuous use up to 105°C. These capacitors are consistently superior in their ability to maintain a high degree of capacitance-temperature stability. Power factor is outstandingly low over a wide temperature range; d-c insulation resistance is notably high; and a-c ripple voltage at audio frequencies falls well within permissible limits. Equally important, Vitamin Q impregnated capacitors have a high safety factor at all temperatures, thus assuring long life.

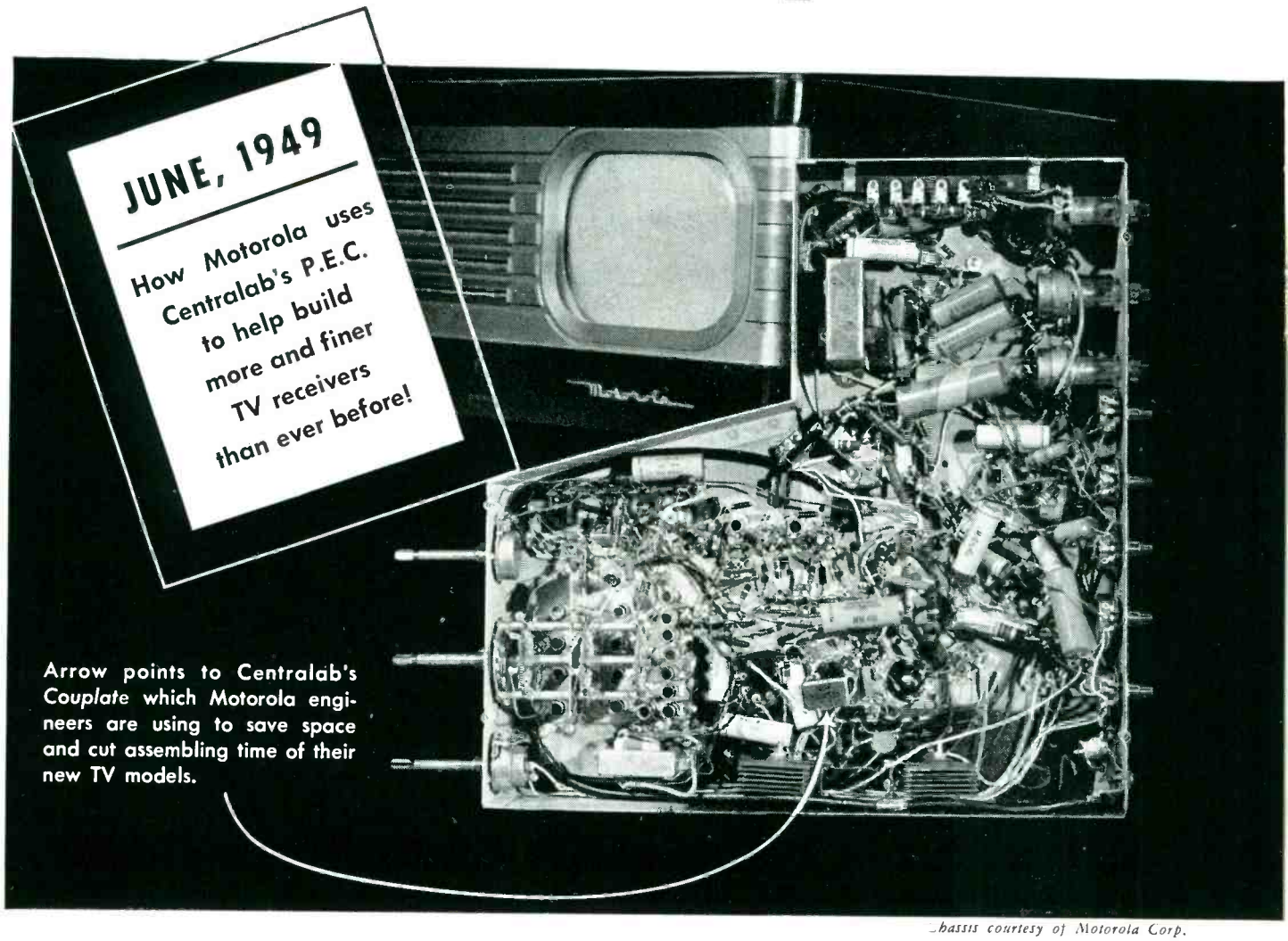
Write for Sprague Engineering Bulletin 203.

SPRAGUE VITAMIN Q* CAPACITORS

*Reg. U.S. Pat. Off.

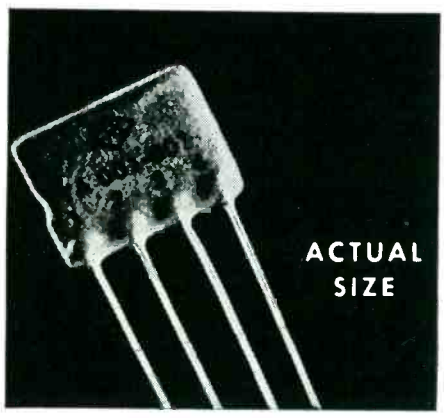
SPRAGUE ELECTRIC COMPANY • NORTH ADAMS, MASS.

Centralab reports to

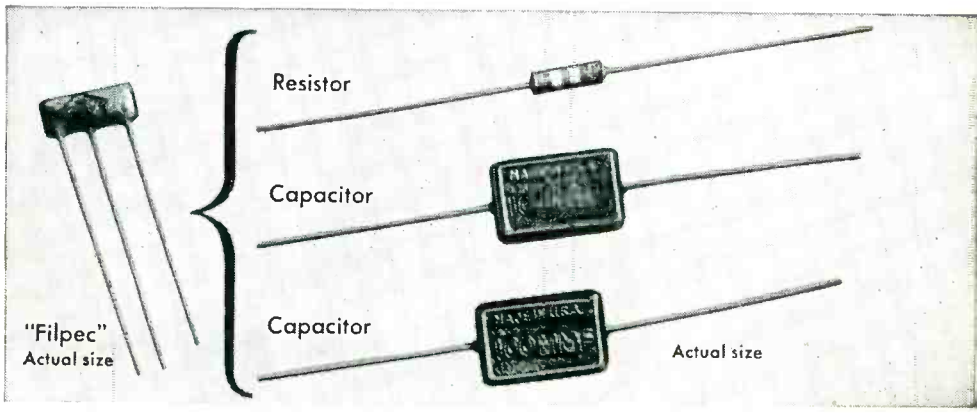


Chassis courtesy of Motorola Corp.

1 Speeded production and finer products go hand in hand where CRL's amazing *Printed Electronic Circuit* is concerned. Take the case of Motorola's new TV sets. Engineers at Motorola find that CRL's *Couplate* — a printed interstage coupling plate — saves production time by cutting in half the number of soldered connections... speeds assembly by simplifying wiring operations. They also find it helps produce finer receivers by eliminating loose or broken connections—from plate load resistor to coupling capacitor.

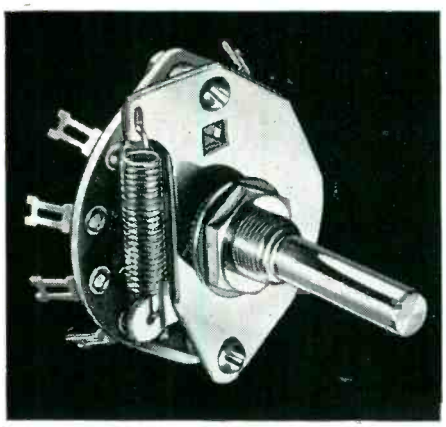


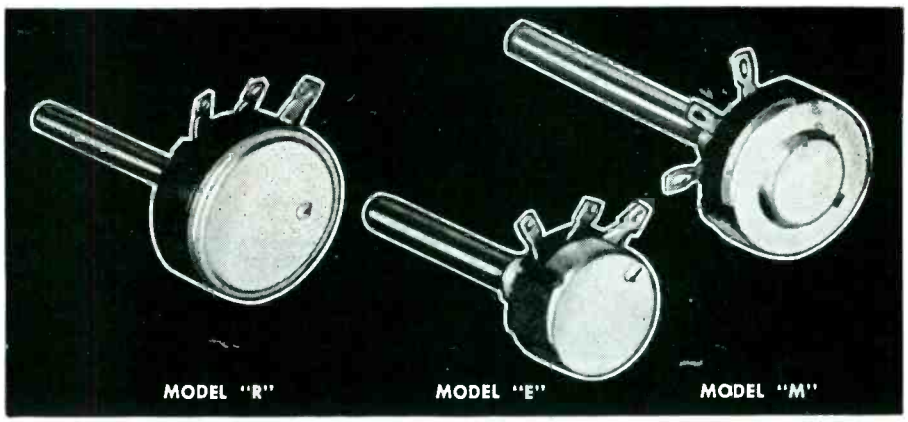
2 CRL's *Couplate* consists of a plate lead resistor, grid resistor, plate by pass capacitor and coupling capacitor. Write for Bulletin 42-6.



3 Centralab's *Filpec* is designed for use as a balanced diode load filter, combines up to three major components into one tiny unit, lighter and smaller than one ordinary capacitor. Capacitor values from 50 to 200 mmf. Resistor values from 5 ohms to 5 megohms. For complete information, write for Bulletin 42-9.

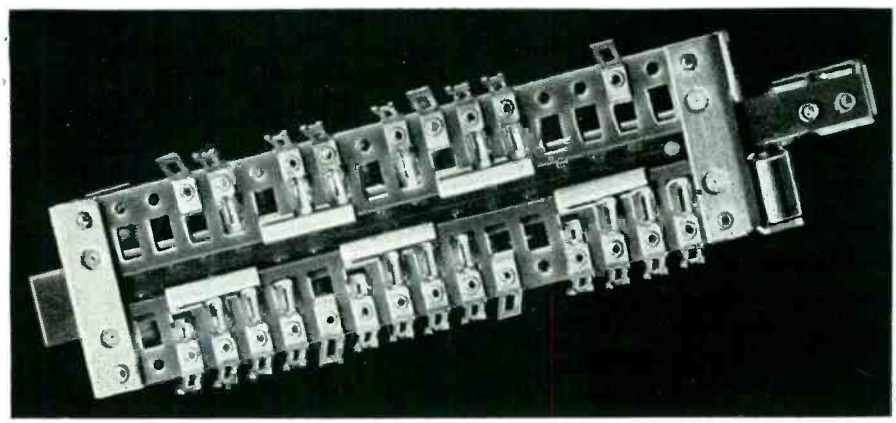
Electronic Industry

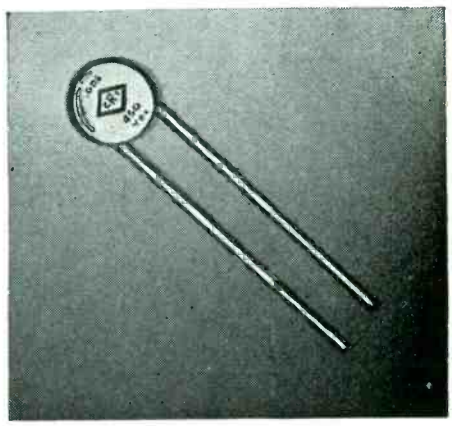




4 Great step forward in switching is CRL's New *Rotary Coil and Cam Index Switch*. Its coil spring gives you smoother action, longer life.

5 Let Centralab's complete *Radiohm* line take care of your special needs. Wide range of variations: *Model "R"* — wire wound, 3 watts; or composition type, 1 watt. *Model "E"* — composition type, ¼ watt. Direct contact, 6 resistance tapers. *Model "M"* — composition type, ½ watt. Write for Bulletin 697.





6 Centralab's development of a revolutionary, new *Slide Switch* promises improved AM and FM performance! Flat, horizontal design saves valuable space, allows short leads, convenient location to coils, reduced lead inductances for increased efficiency in low and high frequencies. Rugged, efficient. Write for Bulletin 953.

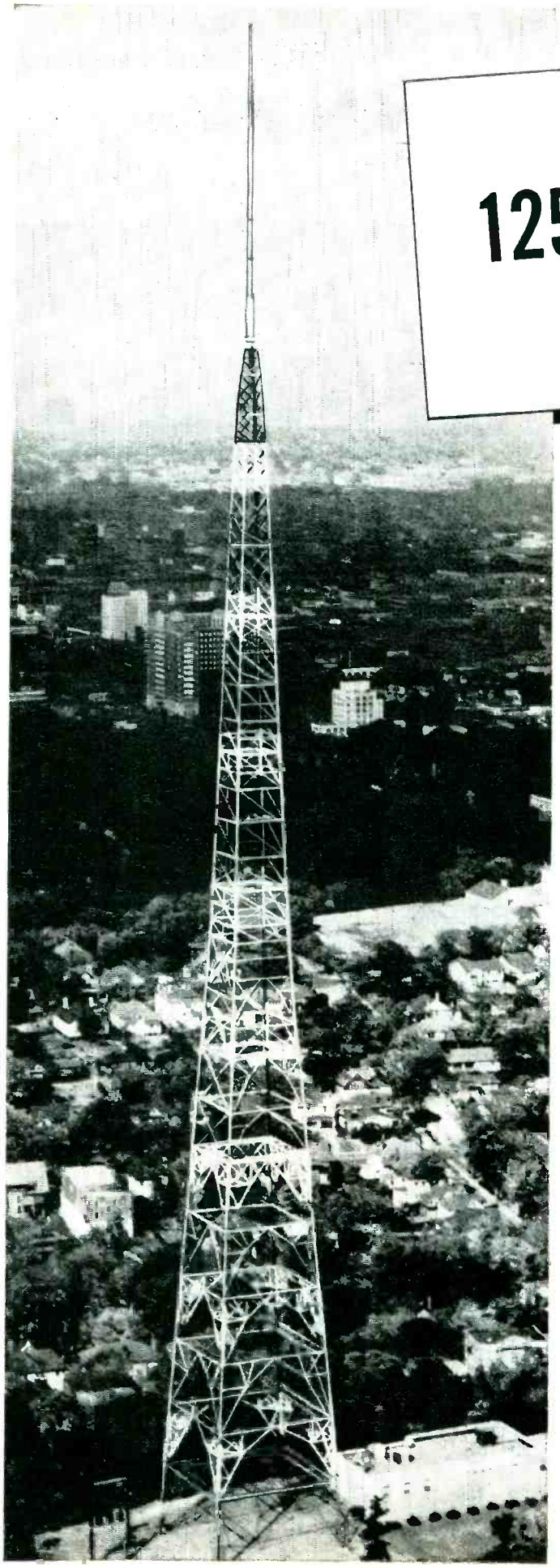
7 For by-pass or coupling applications, check CRL's original line of ceramic disc and tubular *Hi-Kaps*. For full facts, order Bulletins 42-3 and 42-4.

LOOK TO CENTRALAB IN 1949! ***First in component research that means lower costs for the electronic industry. If you're planning new equipment, let Centralab's sales and engineering service work with you. Get in touch with Centralab!***

Centralab

CRL ®

DIVISION OF GLOBE-UNION INC., MILWAUKEE, WIS.



A 125,000 SQ. MILE BLANKET!

The most powerful FM installation in the world recently completed on Red Mountain near Birmingham, Alabama for Station WBRC-FM brings static-free entertainment to residents in a transmission radius of 200 miles.

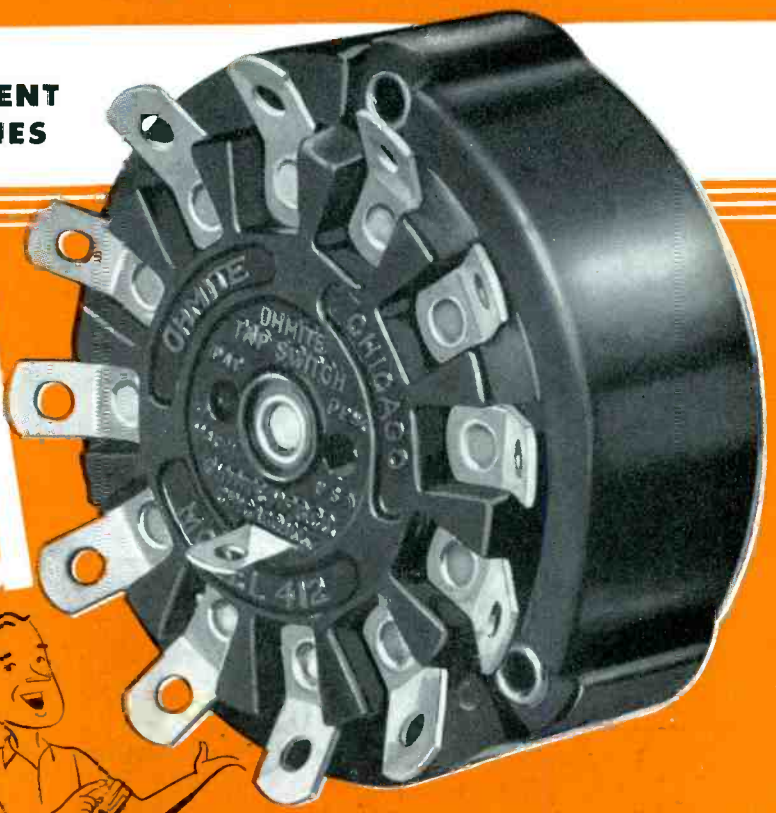
Important to this installation is the 450 ft. Blaw-Knox type N-28 heavy-duty tower supporting the 8-section Pylon FM antenna. Sturdy, safe and backed by the many years of Blaw-Knox design and engineering in the radio field, it will enable this great new FM Voice of the South to utilize the full capacity of its modern facilities.

BLAW-KNOX DIVISION of Blaw-Knox Company
2077 Farmers Bank Building, Pittsburgh 22, Pa.

BLAW KNOX

BLAW-KNOX
ANTENNA TOWERS

OHMITE HIGH-CURRENT TAP SWITCHES



preferred OVER EVERY OTHER MAKE

Where high-current, non-shorting tap switches are required, scores of equipment manufacturers prefer Ohmite over all others . . .

Because Ohmite tap switches combine high-current capacity and a large number of taps with unusual compactness . . .

Because their sturdy one-piece ceramic bodies provide permanent *non-arcing* insulation . . .

Because their heavy silver-to-silver contacts have a self-cleaning action . . . and provide continuous, dependable contact with low resistance . . .

Because their cam-and-roller mechanism has a positive "slow-break, quick-make" action—particularly suited for alternating current.

That's why more Ohmite high-current tap switches are purchased than all other makes combined . . . and why it will pay you to standardize on Ohmite in your product.

In addition to the types and sizes illustrated, Ohmite tap switches are supplied in open, all-ceramic, shorting and non-shorting types. All

- **COMPACT**
- **CONVENIENT**
- **DEPENDABLE**

AMPS.	MODEL No.	MAX. V. (A-C)	No. TAPS
10	111	150	2 to 11
15	212	150	2 to 12
25	312	300*	2 to 12
50	412	300*	2 to 12
100	608	300	2 to 8

*150 volts between taps

Ohmite tap switches can be mounted in tandem for multiple-pole operation.

Write on company letterhead for Ohmite Catalog and Engineering Manual No. 40.

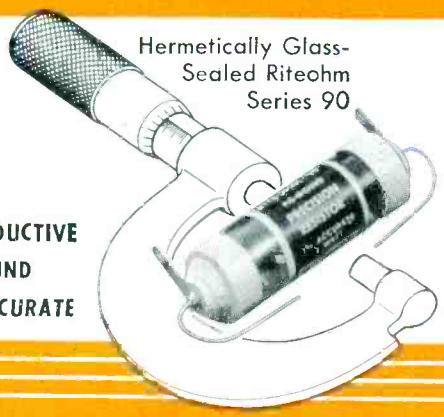
OHMITE MANUFACTURING CO., 4818 W. Flournoy St., Chicago 44, Ill.

Be Right with...

OHMITE

RHEOSTATS • RESISTORS
TAP SWITCHES

Industry's first choice



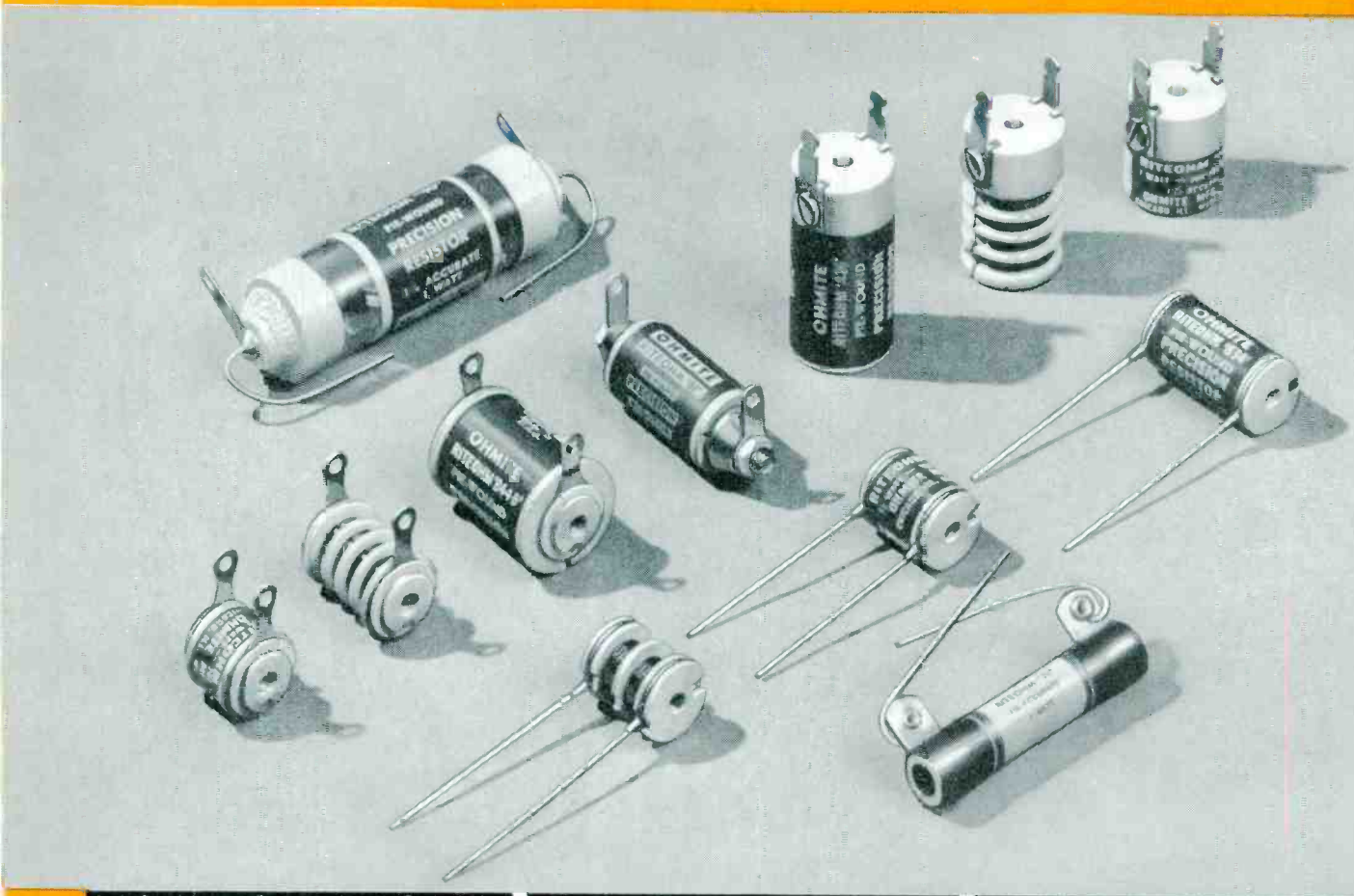
Hermetically Glass-Sealed Riteohm Series 90

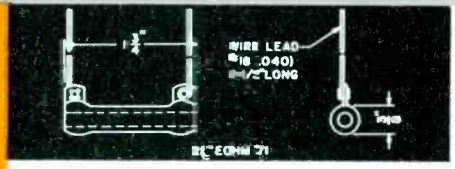
NON-INDUCTIVE
PIE WOUND
±1% ACCURATE

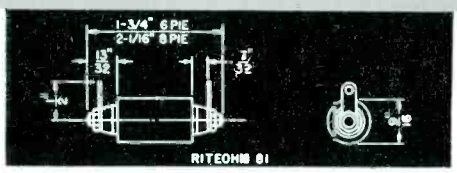
For Accuracy...

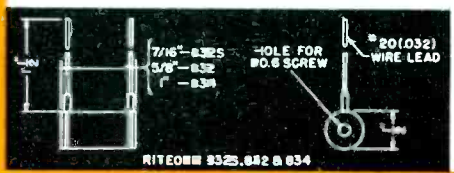
OHMITE

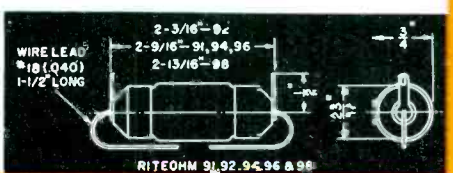
RITEOHM PRECISION RESISTORS









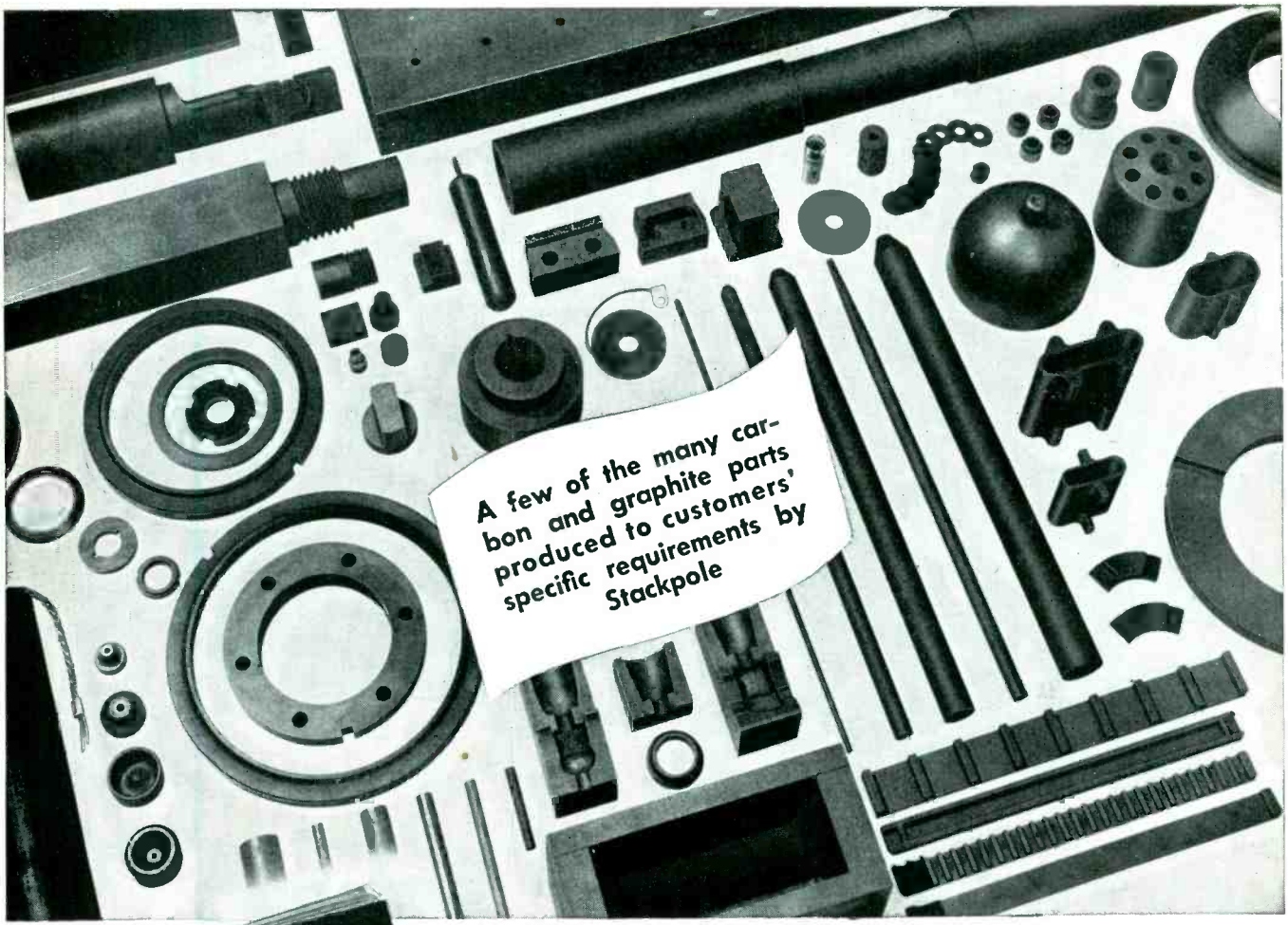


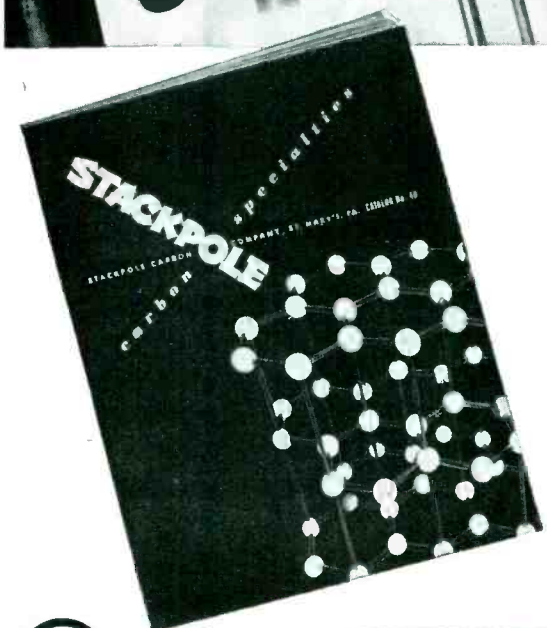
However critical the application, Ohmite Riteohm Precision Resistors assure reliability and consistent accuracy. They are ideal for use in voltmeter multipliers, laboratory equipment, test sets, and in electronic devices requiring extremely accurate resistance components. Available from stock in ½-watt and 1-watt units in a wide range of values and types . . . or made to order . . . as listed in Bulletin 126.

Write for Ohmite Precision Resistor Bulletin No. 126

OHMITE MFG. CO.
4818 Flournoy St., Chicago 44

Be Right with... **OHMITE**
RHEOSTATS · RESISTORS · TAP SWITCHES





STACKPOLE

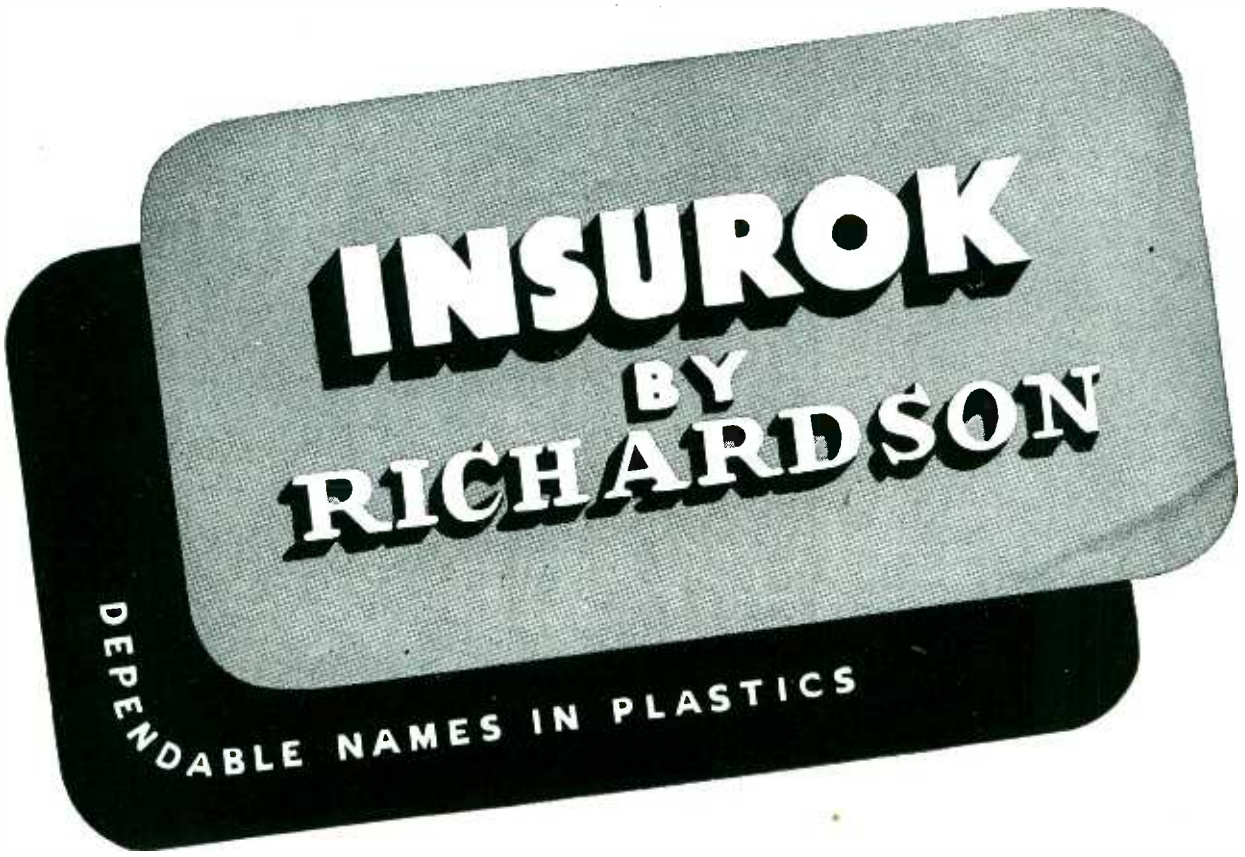
CARBON and GRAPHITE SPECIALTIES

Carbon and Graphite have been termed "the most flexible of Mother Nature's materials". . . and for more than two decades, Stackpole has been proving the accuracy of this statement as applied to engineering problems involving friction, temperature, arcing, corrosion, shaft sealing and other related factors. Stackpole will be glad to work with you and your organization on any specific problem which carbon, graphite or powdered metal specialties might help solve.

STACKPOLE CARBON COMPANY • ST. MARYS, PA.

WRITE FOR THIS BIG CARBON-GRAPHITE BOOK

Far more than being a mere catalog, the Stackpole CARBON SPECIALTIES BOOK contains a wealth of detailed information that should prove invaluable in helping you evaluate the unique possibilities of carbon, graphite, and powdered metal materials in solving a wide range of engineering and production problems. Write for your copy today using your company letterhead. Ask for Booklet No. 40.



WORTHWHILE EXTRAS

We've learned over the years that "extra" precautions pay big dividends for our customers in the planning and production of parts from Laminated and Molded INSUROK. For example:

Richardson suggestions have led many customers to alter their original designs and/or materials specifications and thus obtain plastic parts better suited to the job at hand, at lower costs.

And Richardson production experience has, in many cases, pointed the way to substantial savings and advantages for customers.

These and other Richardson "extras" are not specified on customers' purchase orders, but you get all of them . . . every time. Why? Simply because we've found that these extras make friends for us, and hold friends over the years.

If you now use, or contemplate using plastics, we sincerely believe you want and need considerate and experienced handling of your requirements. And we invite you to look, with confidence, to The Richardson Company for your needs in plastics.

Why not send us specifications today? Learn without obligation how Richardson would handle your next need for plastics.

INSUROK is a registered trade-mark of The Richardson Company

The RICHARDSON COMPANY

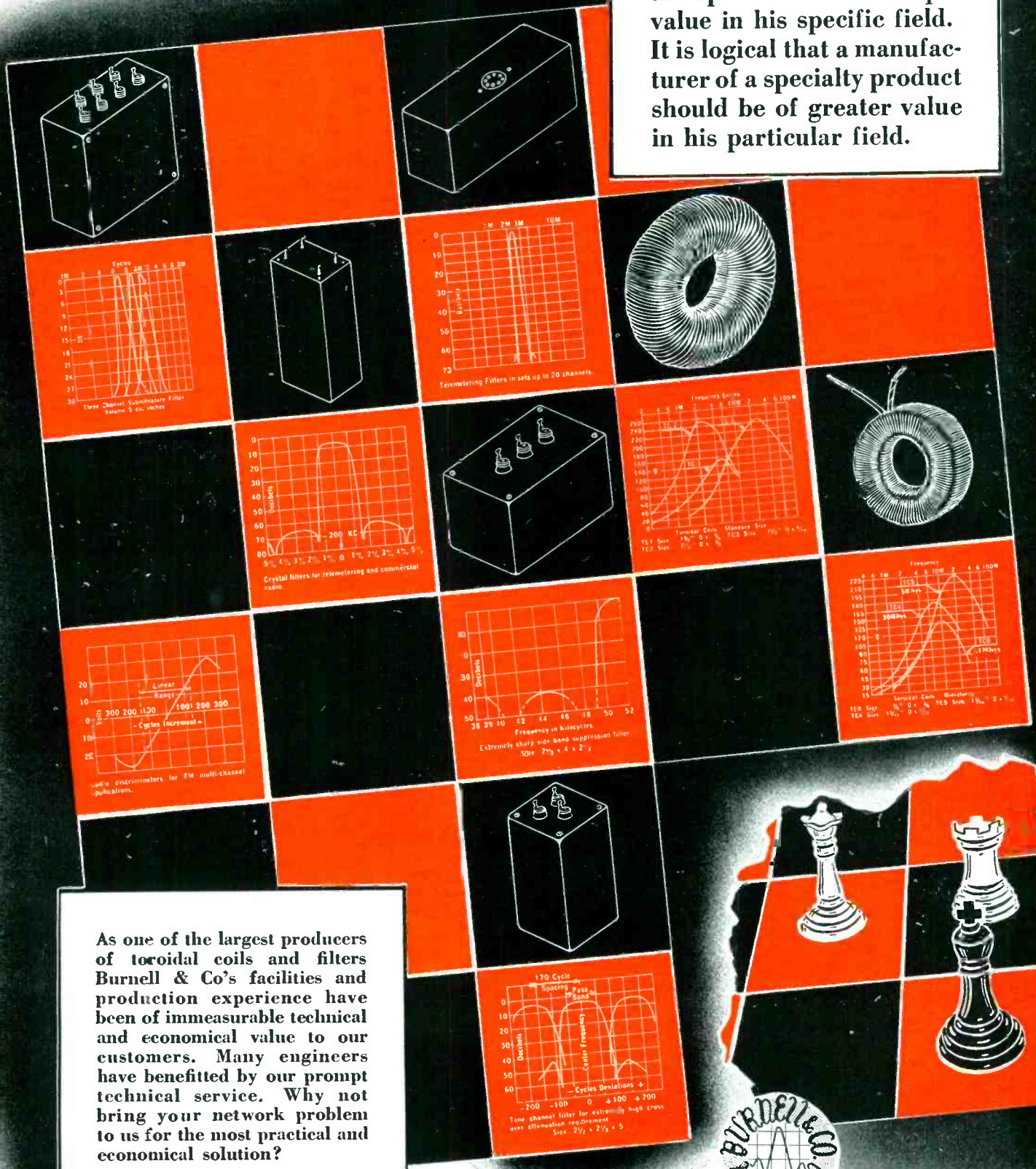
GENERAL OFFICES: LOCKLAND, OHIO FOUNDED IN 1858

Sales Headquarters: MELROSE PARK, ILLINOIS

CLEVELAND • DETROIT • INDIANAPOLIS • MILWAUKEE • NEW BRUNSWICK, (N. J.) • NEW YORK • PHILADELPHIA • ROCHESTER • ST. LOUIS

Check YOUR NETWORK PROBLEM WITH LOGIC

In any technical business the specialist has a unique value in his specific field. It is logical that a manufacturer of a specialty product should be of greater value in his particular field.



As one of the largest producers of toroidal coils and filters Burnell & Co's facilities and production experience have been of immeasurable technical and economical value to our customers. Many engineers have benefitted by our prompt technical service. Why not bring your network problem to us for the most practical and economical solution?

EXCLUSIVE MANUFACTURERS OF COMMUNICATIONS NETWORK COMPONENTS

WRITE FOR TECHNICAL INFORMATION
ALL INQUIRIES WILL BE PROMPTLY HANDLED

BURNELL & CO. INC.

Burnell & Company

YONKERS 2, NEW YORK

CABLE ADDRESS "BURNELL"

One of the Magnetrons made by Raytheon Manufacturing Co., Waltham, Mass. Most of the parts shown in the foreground are OFHC Copper.

Raytheon magnetron used in the "Microtherm," the microwave diathermy equipment.

Raytheon magnetron used in the "Radarange" for swift cooking by microwaves.

One of the Raytheon magnetrons used in airborne radar apparatus.

Raytheon *uses* OFHC COPPER *exclusively*

● So important is OFHC in the manufacture of vacuum tubes that Raytheon will have no other copper in its plant. Thus there is no danger of getting it mixed up accidentally with other types. This copper (Oxygen-Free, High Conductivity) carries a premium, but it is well worth it, since some of the completed tubes cost between $2,000 and $3,000 each, and the wrong metal could ruin one quickly. OFHC copper has a number of important qualities that are essential in vacuum tubes. Its freedom from oxygen protects the vacuum. Its conductivity of electricity and heat play a part in tube efficiency. It seals to glass perfectly, and can be machined and rolled down to the .0025" edge that is necessary for that purpose. Copper segments which make up the cavity of the magnetron are brazed together in a hydrogen atmosphere, in which oxygen would be detrimental... For its own part, Revere takes the greatest care to segregate OFHC copper in processing. Each lot and shipment is kept separate, and personally conducted through the mill. When you order OFHC from Revere you can be sure of getting it... The Revere Technical advisory service collaborates frequently with Raytheon, and will gladly work with you.

REVERE

COPPER AND BRASS INCORPORATED

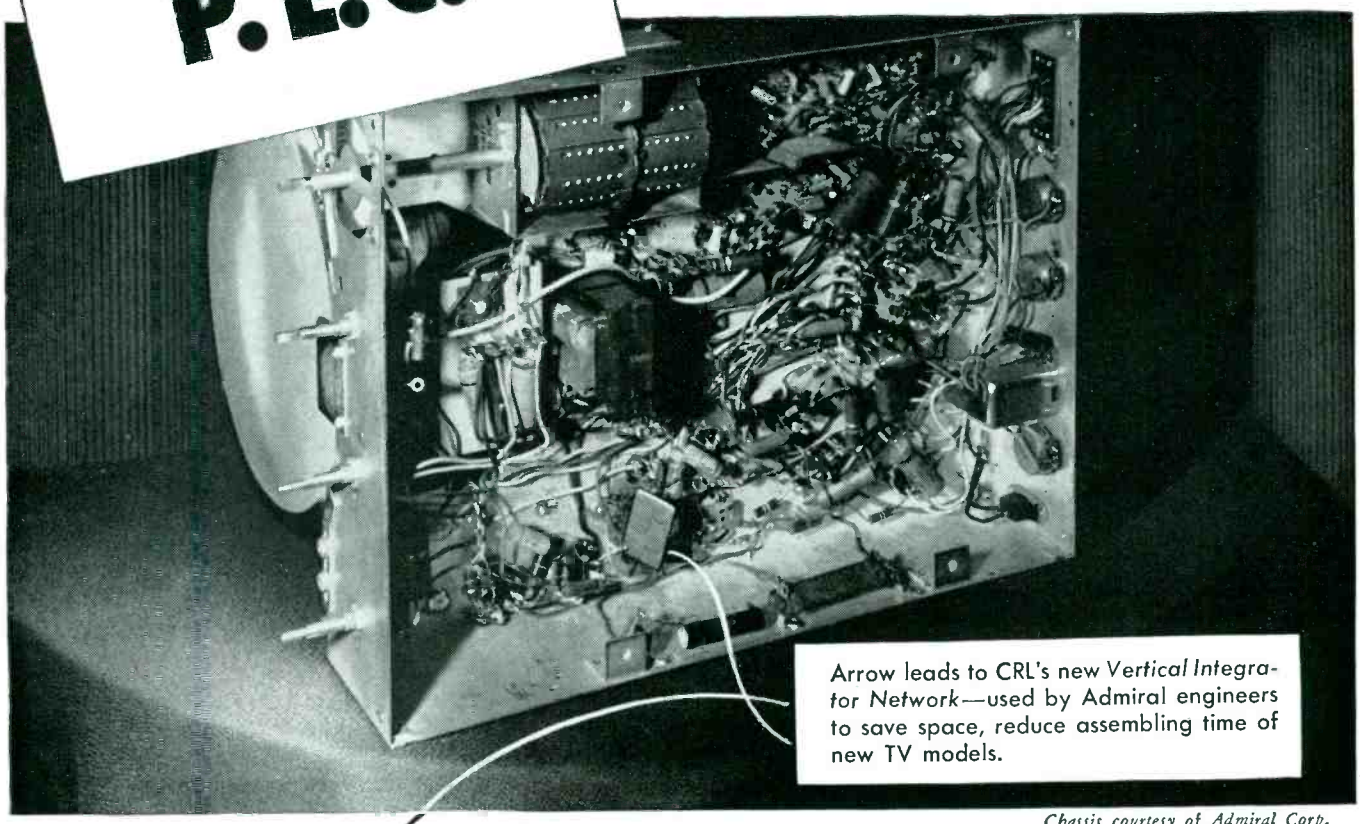
Founded by Paul Revere in 1801
230 Park Avenue, New York 17, N. Y.

* * *

Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.
Sales Offices in Principal Cities, Distributors Everywhere.

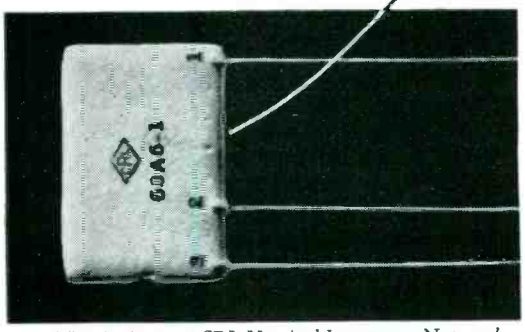
PROGRESS REPORT ON P.E.C.*

How Admiral is using CRL's new "P. E. C." *Vertical Integrator Network* to help build more and finer television sets

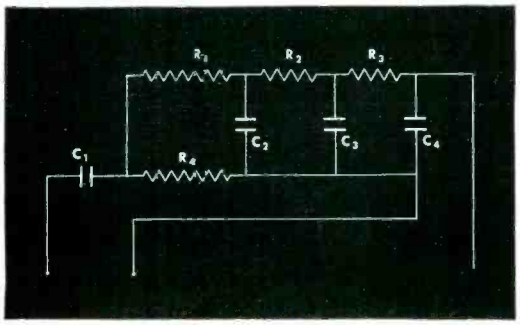


Arrow leads to CRL's new *Vertical Integrator Network*—used by Admiral engineers to save space, reduce assembling time of new TV models.

Chassis courtesy of Admiral Corp.



This is the new CRL *Vertical Integrator Network* used by Admiral, variations of which are available on special order. Circuit diagram of "network" used in new Admiral TV sets is shown below.



*Centralab's "Printed Electronic Circuit" — Industry's newest method for improving design and manufacturing efficiency!

WHEREVER Centralab's revolutionary Printed Electronic Circuits are used, you are sure to find speeded production . . . quality products. Just look at Admiral Corporation's fine new television receivers. A series of Admiral's video sets makes use of CRL's *Vertical Integrator Network* — a tiny, compact plate containing both capacitors and resistors. It saves production time . . . reduces sixteen soldered connections to three. Simplifies wiring operations for faster assembly. What's more, the *Network* helps produce better TV receivers . . . practically eliminates loose or broken connections.

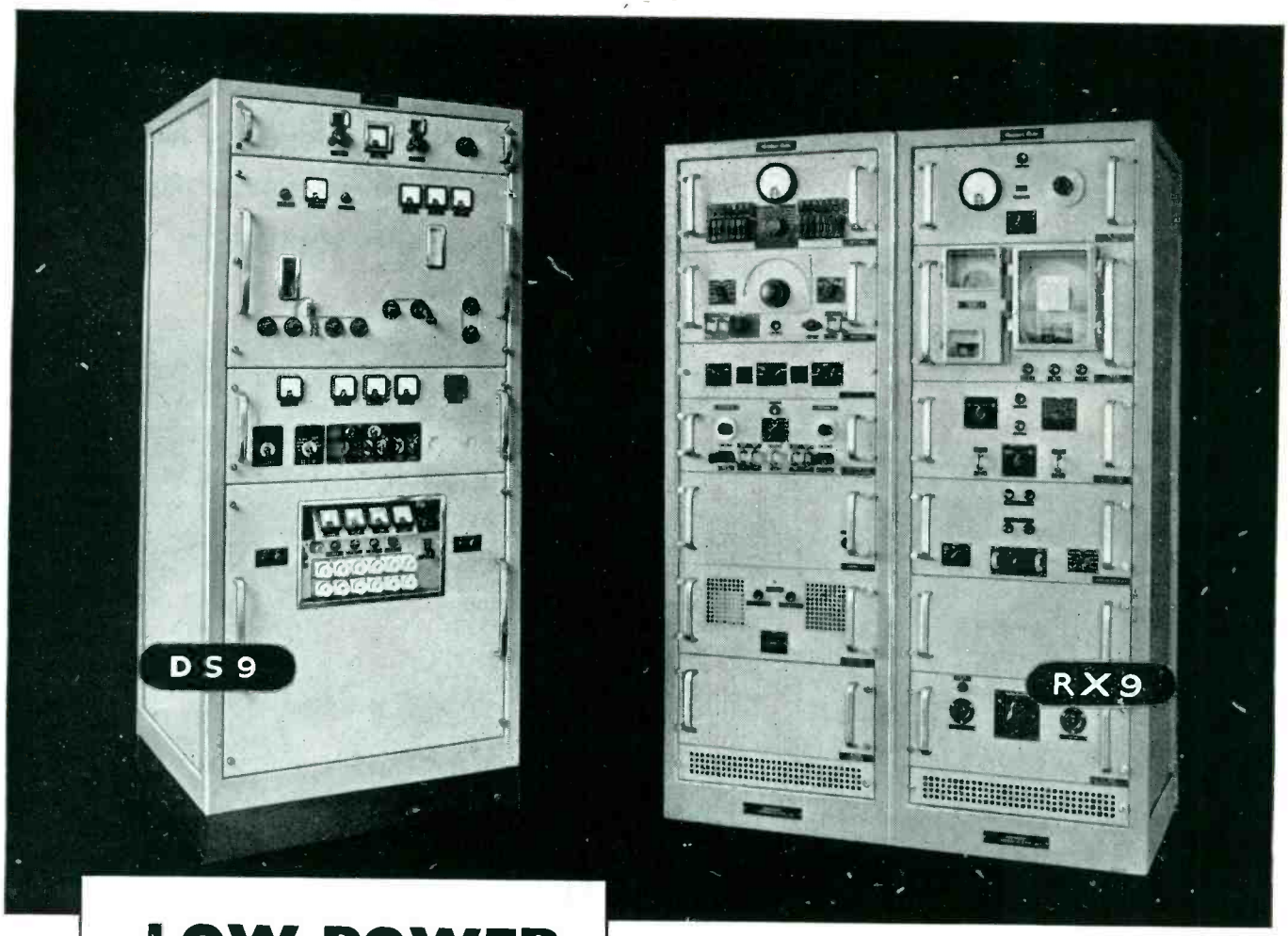
Integral Ceramic Construction: Each *Printed Electronic Circuit* is an integral assembly of *Hi-Kap* capacitors and resistors closely bonded to a steatite ceramic plate and mutually connected by means of metallic silver paths "printed" on the base plate.

For complete information about the *Network* as well as other CRL Printed Electronic Circuits, see your nearest Centralab representative, or write direct.

LOOK TO **Centralab** IN 1949!

CRL

Division of GLOBE-UNION INC., Milwaukee



LOW POWER
SINGLE SIDEBAND RADIO SYSTEM

The *Standard* DS9 Transmitter and RX9 Receiver at last make it possible to plan the *shorter* H.F. radio links to give the higher reliability, better quality and increased number of channels which characterize the Single Sideband System.

Type DS9 Single Sideband Radio Transmitter Frequency Range 4—22 Mc/s. Power Output 300 watts. Two independent sidebands with reduced carrier. Total sideband width adequate for 3 telephone channels, many teleprinter channels or various combinations of telephone and teleprinter. Sideband generating equipment built into transmitter. Compact design and rugged construction with maximum accessibility from the front only.

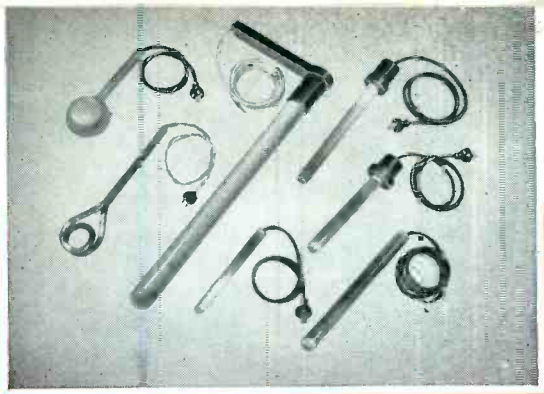
Type RX9 Single Sideband Radio Receiver Frequency range 4—25 Mc/s. Independent sideband single sideband and double sideband reception. Crystal selectivity combined with sideband acceptance matching DS9 transmitter. Precision automatic frequency control. Full front accessibility using withdrawable and tilting units for maximum ease of servicing.

DESIGNED and BUILT by *Standard*

Standard Telephones and Cables Limited RADIO DIVISION

An I. T. & T. associate

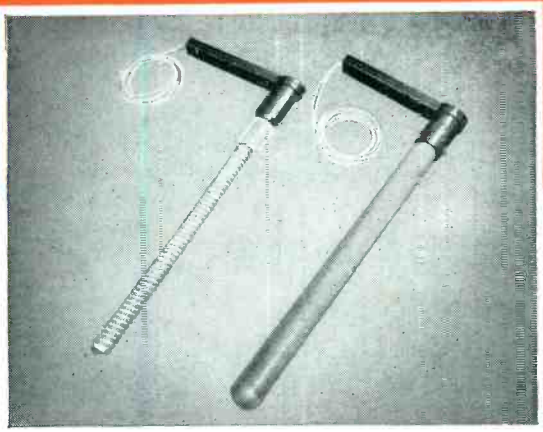
OAKLEIGH ROAD · NEW SOUTHGATE · LONDON N11 · ENGLAND



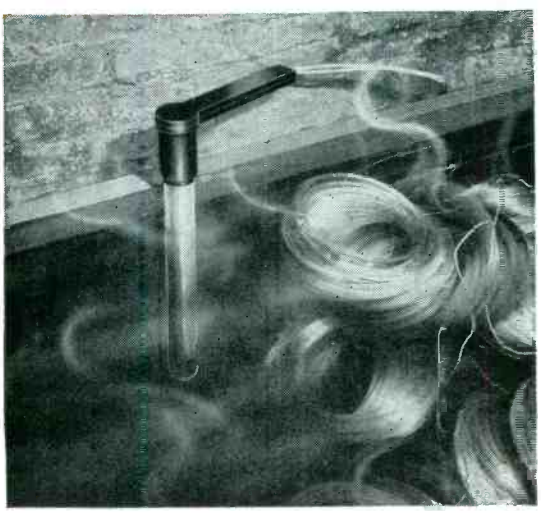
Amersil heaters are available in a variety of shapes and sizes for industrial and laboratory use.

NEW

SUPERIOR IMMERSION HEATER for corrosive chemicals employs fused quartz and NICHROME* V



Amersil heater—fused quartz shell, and element wound with high heat and corrosion-resistant Nichrome V.



Amersil corrosion-proof immersion heater, heating acid solution in a pickling tank.

Here is a new and superior unit for heating corrosive chemicals, manufactured by Amersil Company, Inc., Hillside, N. J.

A Nichrome V wire wound heating element is inserted into a shell of opaque fused quartz, which, in turn, is fitted with an acid-proof head or flange for operation in open or pressure sealed tanks.

The fused quartz shell is completely inert to corrosive chemicals, has a high rate of heat transfer, is a good electrical insulator, and is immune to thermal shock.

Since quartz filters out a very small percentage of infra-red heat waves, and the heat source is immersed, almost 100% efficiency is obtained. Moreover, the unusually compact design of the installation offers the added advantage of cutting heater obstruction within the tank to a negligible minimum—permitting freer flow of liquids.

Once the unit is assembled, it is good for a lifetime—because the shell is quartz and the heating element is ***high heat and corrosion-resistant*** Nichrome V.

This combination of features, makes the Amersil heater superior for service in chemical plant operations involving innumerable corrosive chemical heating problems.

If you have a product whose successful operation depends upon application of an alloy resistant to electrical heat and corrosion, send your specifications to us. In addition to world-famous Nichrome, there are more than 80 other Driver-Harris alloys specifically designed to fill the varied requirements of the electrical and electronic industries.

*Nichrome is manufactured only by

Driver-Harris Company

HARRISON, NEW JERSEY

BRANCHES: Chicago, Detroit, Cleveland, Los Angeles, San Francisco, Seattle
Manufactured and sold in Canada by
The B. GREENING WIRE COMPANY, LTD., Hamilton, Ontario, Canada

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TRADE MARK REG. U. S. PAT. OFF.
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*T.M. Reg. U. S. Pat. Off.

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Specify CORNISH

"NOFLAME-COR"

the TELEVISION *hookup wire*

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90° CENTIGRADE ——— **600** VOLTS

Preferred by leading producers of television, F-M, quality radio and all exacting electronic equipment. All sizes, solid and stranded; over 200 color combinations.

Production Engineers: Avoid high percentage of line rejects by specifying "NOFLAME-COR" *(not an extruded plastic)*. Insulation does not "blob" under heat of soldering iron.

✓ Flame Resistant ✓ High Insulation Resistance ✓ Heat Resistant
✓ High Dielectric ✓ Facilitates Positive Soldering ✓ Easy Stripping
✓ Also unaffected by the heat of impregnation— therefore, ideal for coil and transformer leads

RUBBER	75°
PLASTIC	80°
"NOFLAME-COR"	90°

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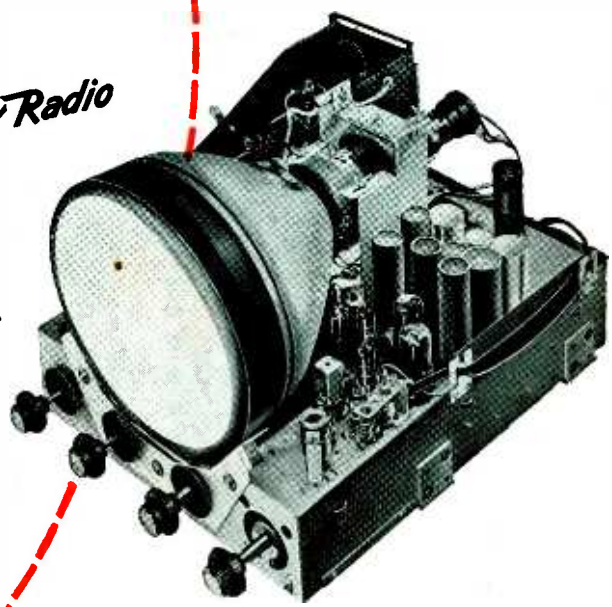
Magnavox
Farnsworth
CROSLEY
Andrea
DUMONT
Tele-tone

—and many others too numerous to list in this limited space.



Chassis of the popular EMERSON Model 611 Television set. **HI-Q** components contribute their part to dependable operation.

Look at the leaders in Radio, Television and Communications, and you'll find *they* look to **HI-Q** for quality components.

HI-Q engineers have worked closely with many of these companies in the development of electronic components demanded by the ever changing circuits of modern electronics.

These same engineers with their wide experience are available to your company for confidential consultation. Write—wire—or phone. Three (3) plants exclusively devoted to the manufacture of ceramic capacitors, resistors and choke coils assure prompt delivery of your orders.

HI-Q COMPONENTS
BETTER 4 WAYS

PRECISION Tested step by step from raw material to finished product. Accuracy guaranteed to your specified tolerance.

UNIFORMITY Constancy of quality is maintained over entire production through continuous manufacturing controls.

DEPENDABILITY Interpret this factor in terms of your customers' satisfaction . . . Year after year of trouble-free performance. Our Hi-Q makes your product better.

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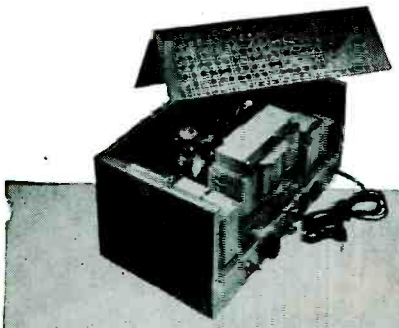
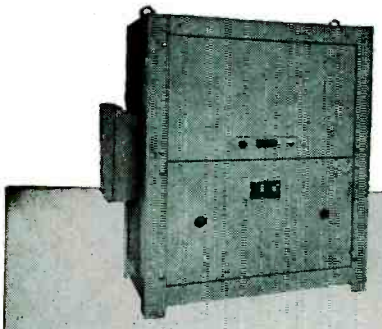


General Application

Model	Load Range Volt-Amperes	*Regulation Accuracy
150	25-150	0.5%
250	25-250	0.2%
500	50-500	0.5%
1000	100-1000	0.2%
2000	200-2000	0.2%

*Models available with increased regulation accuracy.



Extra Heavy Loads

Model	Load Range Volt-Amperes	*Regulation Accuracy
3,000	300-3000	0.2%
5,000	500-5000	0.5%
10,000	1000-10,000	0.5%
15,000	1500-15,000	0.5%

*Models available with increased regulation accuracy.

the first line of STANDARD electronic AC voltage regulators and nobatrons

GENERAL SPECIFICATIONS

- Harmonic distortion: max. 5% basic or 2% "S" models
- Input voltage range: either 95-125 or 190-250 volts
- Output: adjustable between either 110-120 or 220-240 volts
- Input frequency range: 50-60 cycles
- Power factor range: down to 0.7 P. F.

All AC Regulators and Nobatrons may be used at no load.

Special Models designed to meet your unusual applications.

Write for the new Sorensen catalogue. It contains complete specifications on standard Voltage Regulators and Nobatrons.

Special Transformers, D. G. Power Supplies, Saturable Core Reactors and Meter Calibrators made to order; please request information.

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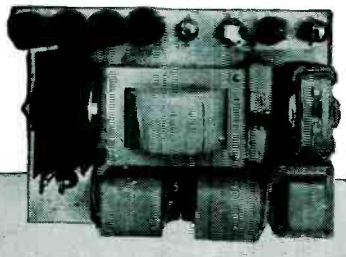

The NOBATRON Line

Output Voltage DC	Load Range Amps.
6	5-15-40-100
12	5-15-50
28	10-30
48	15
125	5-10

Regulation Accuracy—.25% from ¼ to full load.

400 Cycle Line

Inverter and Generator Regulators for Aircraft

Single Phase and Three Phase

Model	Load Range Volt-Amps.	Reg. Accuracy
D 100	10-100	0.5%
D 500	50-500	0.5%
D 1200	120-1200	0.5%
D 2000	200-2000	0.5%

3-Phase Regulation

Star-connected three-phase systems can be handled effectively. Other three-phase systems must be reviewed by our Engineering Dept. VA Capacities up to 45 KVA.

Federated ROSIN CORE SOLDER

Look for the orange package . . . the universally popular solder for use in electrical applications where bonding must be secure and free from corrosion.

The flux is in the solder . . . all you need is heat! Federated Rosin Core Solder is available in 1, 5, and 20-pound sizes.

Federated makes *every* commercial solder . . . Asarco Body Filler Metal, acid-core, solid wire, spray-gun, and bar . . . purity and composition guaranteed by the world's leading supplier of solder.

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OFFICES IN PRINCIPAL CITIES ACROSS THE NATION

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first in the
non ferrous
field
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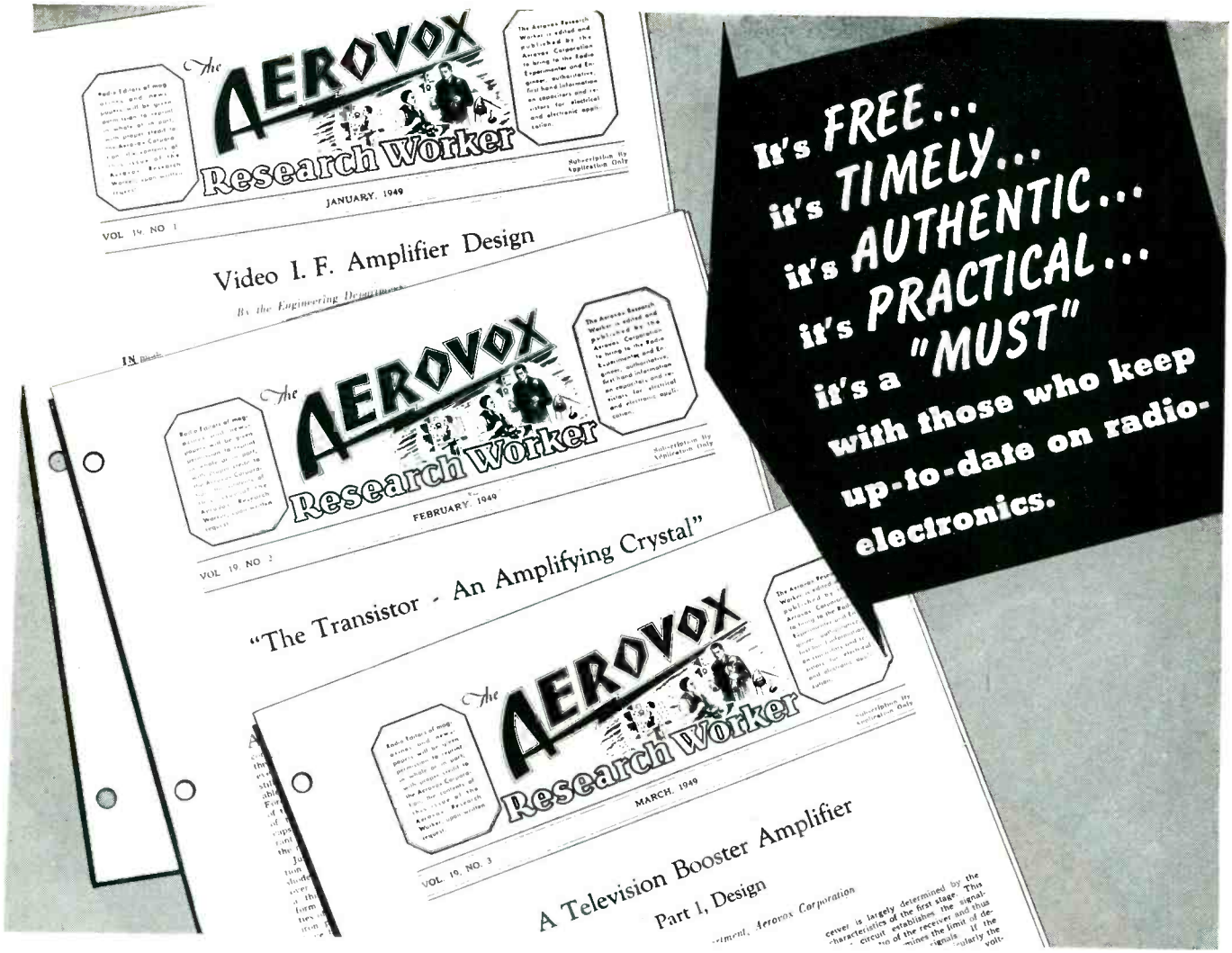

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Each monthly issue unfolds a new and useful phase of this round-the-calendar publication which aims to keep you informed on all that is new and significant. The editorial content anticipates the needs and interests of its readers. And it is always authentic.

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FOR RADIO-ELECTRONIC AND INDUSTRIAL APPLICATIONS

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SALES OFFICES IN ALL PRINCIPAL CITIES • Export: 13 E. 40th St., New York 16, N. Y.

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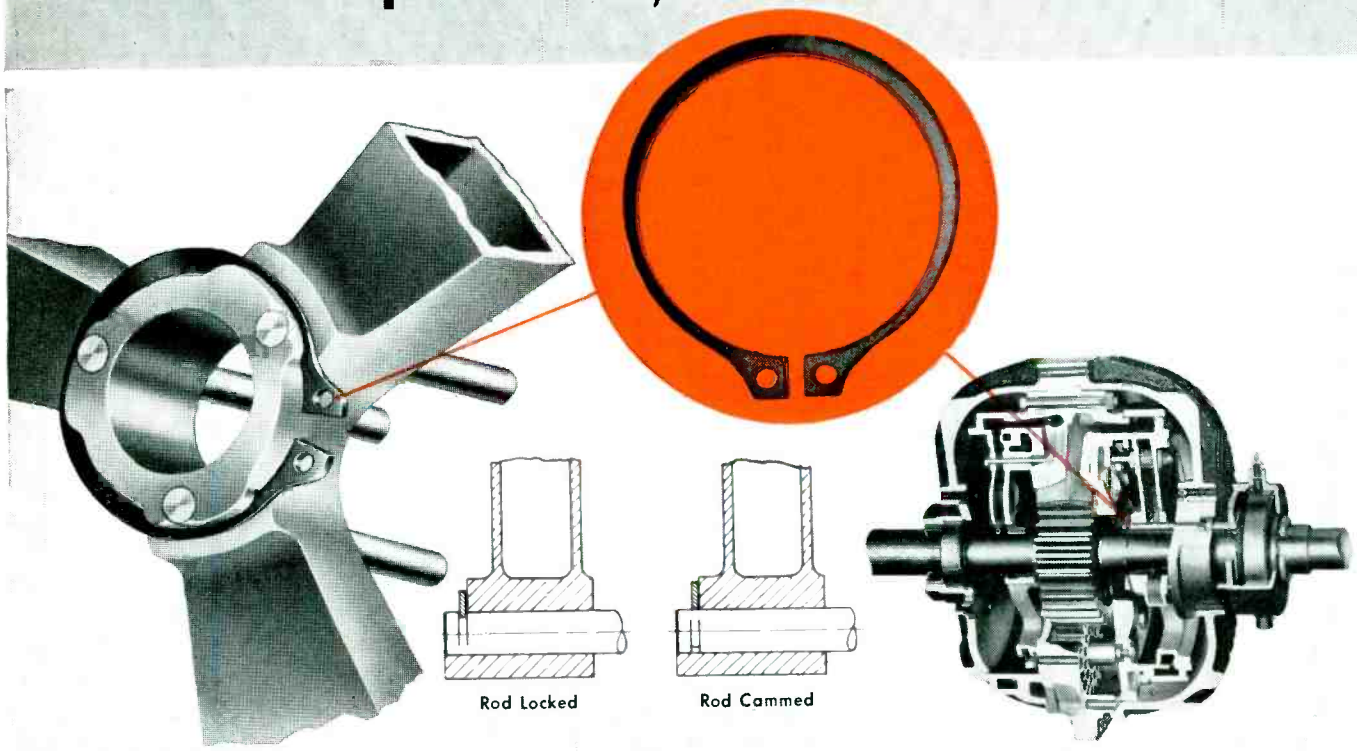
Single TRUARC ring holds 3 valve rods, saves $12 production, 10 hours maintenance



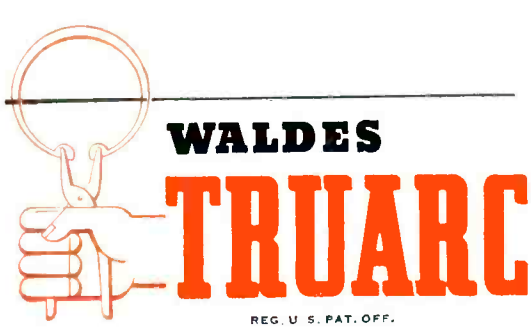
Unique feature of Thomas Varidraulic Drive design is this valve rod assembly, which permits removal and replacement of rods without disassembly of entire unit. One Truarc ring holds three rods, by engaging grooved recesses provided on one side only of each rod. When rotated 180°, rods act like cams . spread the ring . . . permit their easy removal. Ends of replacement rods are tapered for easy re-assembly. This design saves an average of 10 man hours of disassembly and assembly time, and eliminates the costly delay of returning the unit to the factory for repair.

Use of 8 Waldes Truarc Retaining Rings in the Varidraulic Drive results in an estimated production saving of $12.00 per unit, reports Thomas Hydraulic Speed Controls, Inc., of Wichita, Kansas.

Savings in production materials and time, plus simplification of repair procedure with Waldes Truarc Retaining Rings tell only part of the story for Thomas Hydraulic. In their own words: "Considerably less skill is required in numerous machining operations and at assembly of the drive than would have been required if the design did not use Truarc rings.

"Our use of Truarc rings has contributed substantially to a more economical design that permits sound sales pricing. Easier maintenance also provides an additional sales point."

Truarc can cut costs and improve your product, too. Wherever you use machined collars, nuts, bolts, snap rings, cotter pins—there's a Truarc ring that does a better job of holding parts together. Waldes Truarc Retaining Rings are precision-engineered, easy to assemble and dis-assemble. Only Truarc stays circular always, to give you a never-failing grip. Send us your drawings. Waldes Truarc engineers will be glad to show you how Truarc can help you.



WALDES

TRUARC

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RETAINING RINGS

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

WALDES TRUARC RETAINING RINGS ARE PROTECTED BY U. S. PATS. 2,302,948; 2,026,454; 2,416,852 AND OTHER PATS. PEND

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Please send 28-page Data Book on Waldes Truarc Retaining Rings.

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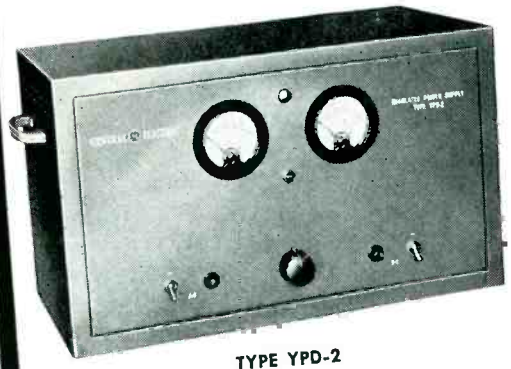
ELECTRONIC RESEARCH, ENGINEERING AND

REGULATED POWER SUPPLY



TYPE YPD-2

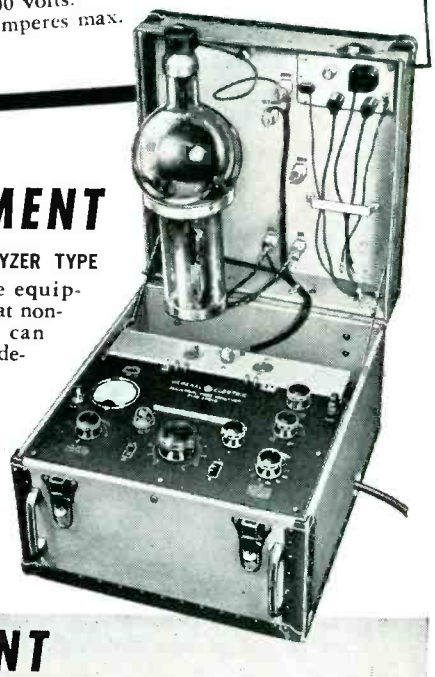
TYPE YPD-2—This G-E Regulated Power Supply is a superior quality, medium power, electronically regulated unit designed for use in laboratories, broadcast stations, and wherever a closely regulated d-c voltage of low ripple content is required.

SPECIFICATIONS:

DC Voltage Output	250-450 volts
DC Current Output	0-300 milliamperes

OTHER UNITS AVAILABLE

- YPD-4: 160-1500 volts. Current: 0-125 milliamperes.
- PS-4: Dual power supply, each unit supplying 250-400 volts. Current: 0-400 milliamperes max.
- 4ST1A1: 180-300 volts. Current: 0-60 milliamperes.



INDUSTRIAL TEST EQUIPMENT

INDUSTRIAL OSCILLOSCOPE TYPE YNA-4—For applications where test equipment is essential for installation and maintenance purposes. Insulated case, sturdy construction, versatile circuits with D-C amplifiers, and good magnetic shielding recommend this oscilloscope for use in industrial and educational laboratories and for production testing.

INDUSTRIAL TUBE ANALYZER TYPE YTW-3—This portable equipment is designed so that non-technical personnel can quickly and efficiently determine the performance of mercury vapor and gas rectifier tubes by measuring the arc drop voltage under load. The periodic testing of rectifier tubes can help prevent equipment failure and loss of operating time.

NUCLEONICS EQUIPMENT

BINARY SCALER TYPE 4SN1A1

Provides scale of two in self-contained unit that cuts installation and maintenance to a minimum. Permits flexible installations for industrial counting, interval timing, repeat cycling, photographic printing. Adequate speed for all ordinary nucleonics and computer applications.

DECADE SCALING UNIT TYPE YYZ-1
For high-speed counting

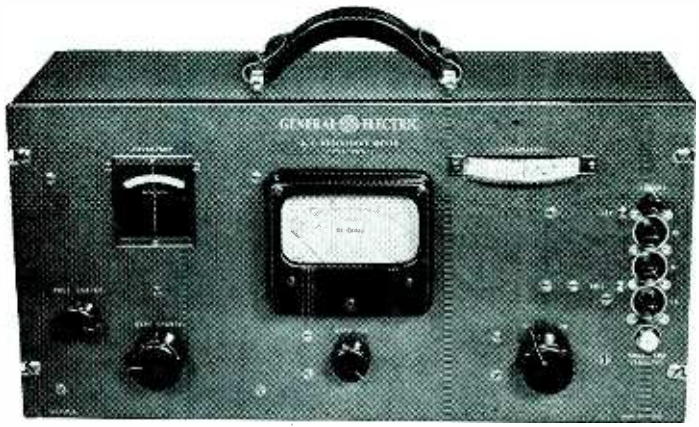
- Continuous counting rate up to 5 million counts per second.
- Direct reading with decimal indication.
- Two scales of ten for separate or cascade operation.

POCKET CHAMBER ELECTROMETER TYPE 4SN3A1

An extremely high-quality, self-balancing electrostatic potentiometer. A standard 3-inch meter provides direct measurement in two ranges—50 and 250 mr for rapid, accurate reading of "pencil" type pocket ionization chambers.

MAINTENANCE EQUIPMENT

BROADCAST, COMMUNICATION AND GENERAL PURPOSE TEST EQUIPMENTS



RADIO FREQUENCY RESISTANCE METER TYPE YKS-1

A direct-reading precision instrument, designed to permit rapid, accurate measurement of the radio frequency resistance of radio components and circuits. Operating over the exceptionally wide range of 50 kc to 80 mc, and from 0 to 200 ohms, it is adaptable for measurement of such constants as RF resistance of ordinary coils, capacitors, transmission lines and antennas, or even complex combinations of such devices. F, C and R are read directly. Reactance and Q determined from simple monograph.

SQUARE WAVE GENERATOR TYPE YGL-1

- Wide frequency range: 5 to 125,000 cycles.
- Output voltage 0-75 volts.
- Low output impedance.
- Rise time .3 microsecond.

CAPACITOMETER TYPE YCL-1

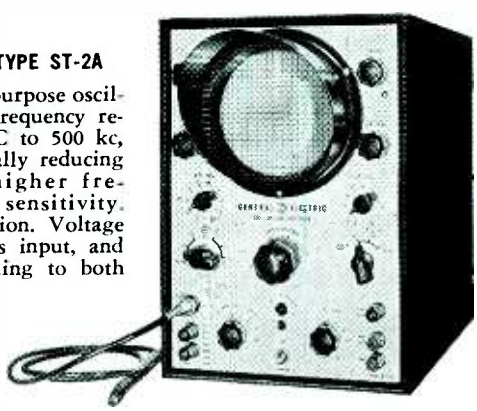
General Electric radio frequency capacitometer is a convenient, self-contained unit for rapid and extremely accurate measurement of inductance and capacitance.

DISTORTION AND NOISE ANALYZER TYPE YDA-1

A precision instrument designed especially for broadcast and laboratory use. Whenever information is required on distortion, audio noise, or hum, the YDA-1 will provide accurate measurement down to extremely low levels.

OSCILLOSCOPE TYPE ST-2A

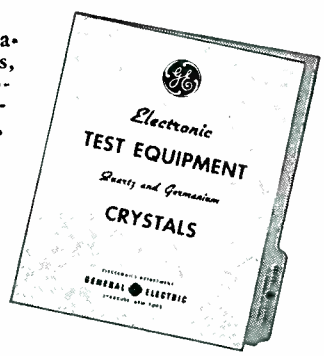
A new, general purpose oscilloscope. Wide frequency response—from DC to 500 kc, and with gradually reducing response to higher frequencies. High sensitivity. Sturdy construction. Voltage calibrator, Z-axis input, and DC input coupling to both amplifiers.



Send for this

FREE CATALOG!

Complete specifications, descriptions, charts and photographs of G-E electronic test equipment, quartz and germanium crystals. Write: *General Electric Company, Specialty Division, Electronics Park, Syracuse, New York.*



You can put your confidence in—

GENERAL ELECTRIC

Facts for Manufacturers of High Frequency Equipment

Power Loss = $55.5\varepsilon^1 \tan\delta \times f \times V^2 \times 10^{-6}$ Watts

ZIRCON PORCELAIN

Because they influence efficient and effective operation, low loss characteristics of Zircon Porcelain are most desirable in the manufacture of high frequency equipment.

Meeting the requirements of the power loss formula, Zircon Porcelain retains its low loss characteristics over a wide range of temperatures and frequencies. This factor is clearly demonstrated in the charts shown.

For applications in the field of radio, radar and other equipment of this nature, it will pay to get more detailed information. Write direct or discuss the use of Zircon Porcelain with one of our qualified field staff.

CHART 1

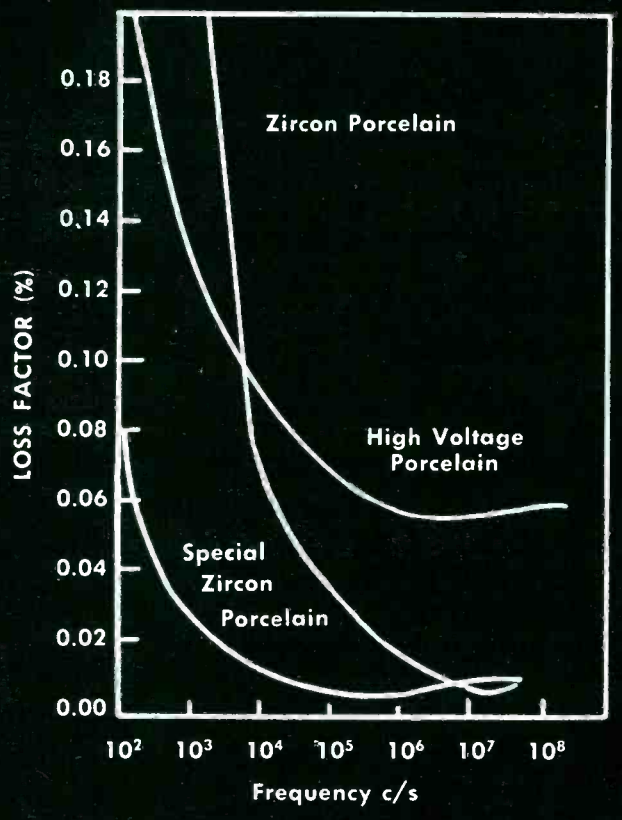
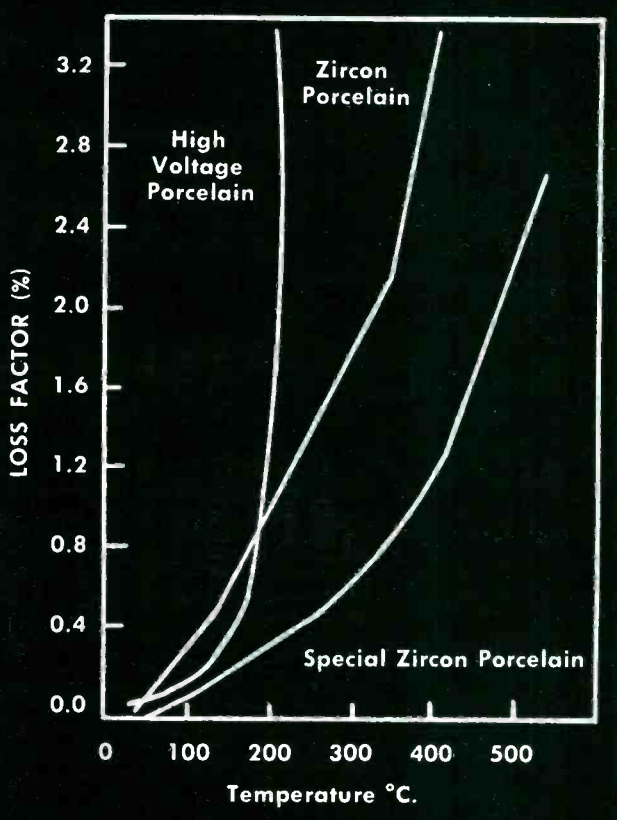


CHART 2



TAM

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"Give us the tools . . ."

The 81st Congress Can Halt the Administration's *SOCIALIST PROGRAM*

In his speech at Massachusetts Institute of Technology, Winston Churchill said that America's possession of the atomic bomb is all that has kept Soviet Russia from overrunning Europe and bombing London.

Our State Department knows that there has been another deterrent to aggressive warfare by Russia and a deciding one. That deterrent is the superior industrial strength of the United States. But once Russia approaches our industrial strength, then watch out! For Stalin or no Stalin, there will be trouble. Therefore, the simple table below is worth every American's careful reading. It shows in percentages what Russia did with her national income in 1948 and what we did with ours:

	USSR	USA
Civilian use	60%	79%
New capital equipment and public works	21%	12%
Foreign aid		2%
Defense	13%	5%
Building of inventories and war stock-piling	6%	2%

These figures for Russia come from *The* (London) *Economist,* Britain's influential economic journal.

These figures are estimates based on information from behind the Iron Curtain, and so cannot be checked directly. But they fit with what is known of Russian development.

The table shows that Russia is straining every resource to build up its industrial strength. When Russia's effort is measured in *dollars,* and compared to ours, the figures show:

Where we spent $20 to $21 billion for new industrial plants and equipment last year, the Russians spent $12 to $14 billion.

But while we used about $9 billion of this to *replace* old equipment, the Russians spent no more than $2 billion for replacing old equipment. The Russians had much less worn-out and obsolete equipment to replace. They could concentrate their efforts on expanding their industries and buying new equipment.

So—we used only $11 to $12 billion to *expand* our industries.

And the Russians used almost as much to expand theirs—$10 to $12 billion.

Russia is gaining industrial strength as fast as we are—and may soon be gaining faster. The more she gains and the faster she gains on us, the greater is the danger of war.

continued on next page

American industry is pushing modernization and expansion hard. It is doing an heroic job. McGraw-Hill's recent survey* shows that *industry* already has in hand plans to build plants and buy equipment in the next five years adding up to $55 billion. Industry plans that investment—*and much more—if it can get the money.*

On those plans of *industry* depend *our* national security.

If these plans of ours are cut back, the Russians will be years closer to their goal of industrial equality—the strength that they need to wage aggressive war successfully.

But more and more our industry's plans are being menaced by socialist policies in Washington. The President continues to urge a further increase in the tax on corporate profits, even though federal taxes alone now take 38 cents of every dollar of profit. He wants $3 billion more in taxes on corporate profits now, plus added personal taxes.

Last year corporations spent almost two-thirds of their profits—about $13 billion—for new plant and equipment. This year corporation profits will be lower than last year's $21 billion, perhaps by 20 per cent. Subtract a fifth or more from last year's profits. Then adopt the President's proposal and take $3 billion more in corporate taxes and you raise havoc with planned expenditures for new plant and equipment.

Approval by Congress of the President's tax program would cut industry's program of plant and equipment development by a third or more. That means a major blow to our prosperity as well as our national security. For as capital investment goes, so goes general prosperity.

Further serious damage would be done by Congressional approval of the President's industry-control bill. The so-called Stability Act of 1949 (the Spence Bill) would severely check industrial progress. That bill would put the federal government in the business of providing the added industrial capacity which the tax program would prevent private industry from doing for itself. It would be hard to conceive a better and surer way to dry up private investment in new plant and equipment. For every dollar of government investment will scare away many times more dollars of private investment. People will not want to risk their money in businesses competing with the U. S. Treasury. At the same time it will attack private investment in another way. It means that government would spend your income for you instead of allowing you to spend or invest for yourself. That is the high and quick road to socialism.

American industry needs right now great courage and incentives if it is to carry out its tremendous building program. It needs also a release from the program of a socialist administration in Washington with its systematic discouragement of enterprise and risk taking.

Above all, industry needs assurance by the actions of the 81st Congress itself that there is a future in this country for a system of dynamic capitalism, functioning in a free society. By acting now to strengthen the American people's faith in their industrial system, by providing needed incentives for management and investors, by protecting industry's capacity to buy new equipment, the 81st Congress can sustain American industrial progress and keep us united and strong.

But if we kill freedom of industrial planning and action by unneeded taxes and government controls we put ourselves—and our friends all over the world—in dire peril.

Nothing would please the Communists more.

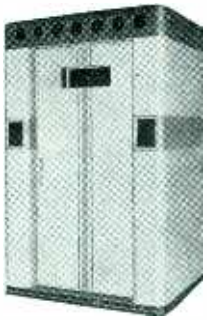
James H. McGraw, Jr.

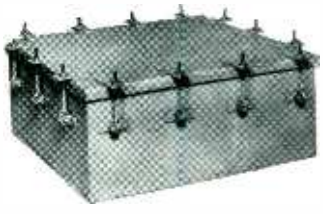
President, McGraw-Hill Publishing Company, Inc.

***A complete report on our national survey may be obtained by writing McGraw-Hill Publishing Co., 330 West 42nd St., New York 18, N. Y. This is one of a special series of editorials on industry's needs for new plants and equipment.**

Simple Jobs...

Intricate Jobs...





We Give Them All "High Hat" Quality

Whether you come to us for simple stamped-out chassis, ordinary metal boxes or the most intricate electronic apparatus housing, your job will receive the same Karp quality treatment, plus every possible economy.

The same long-experienced principals of our staff will give you intimate, personalized service, from planning and design to delivery. Your work will be done by highly skilled specialists, in a plant which is without an equal in its field for up-to-date machinery and modern facilities. Welding, when needed, will be done under precise timing controls . . . painting and finishing with the most modern equipment and conditions.

In most cases, our vast variety of dies will save you the cost of special dies and jigs. We will give your work accuracy and uniformity that will make your final assembly easy, time-saving and hence economical.

Try us for the plain or the precise . . . the everyday or the elaborate and de luxe . . . in modest or substantial quantity. Whatever your needs in sheet metal fabrication, it pays to get our estimate.

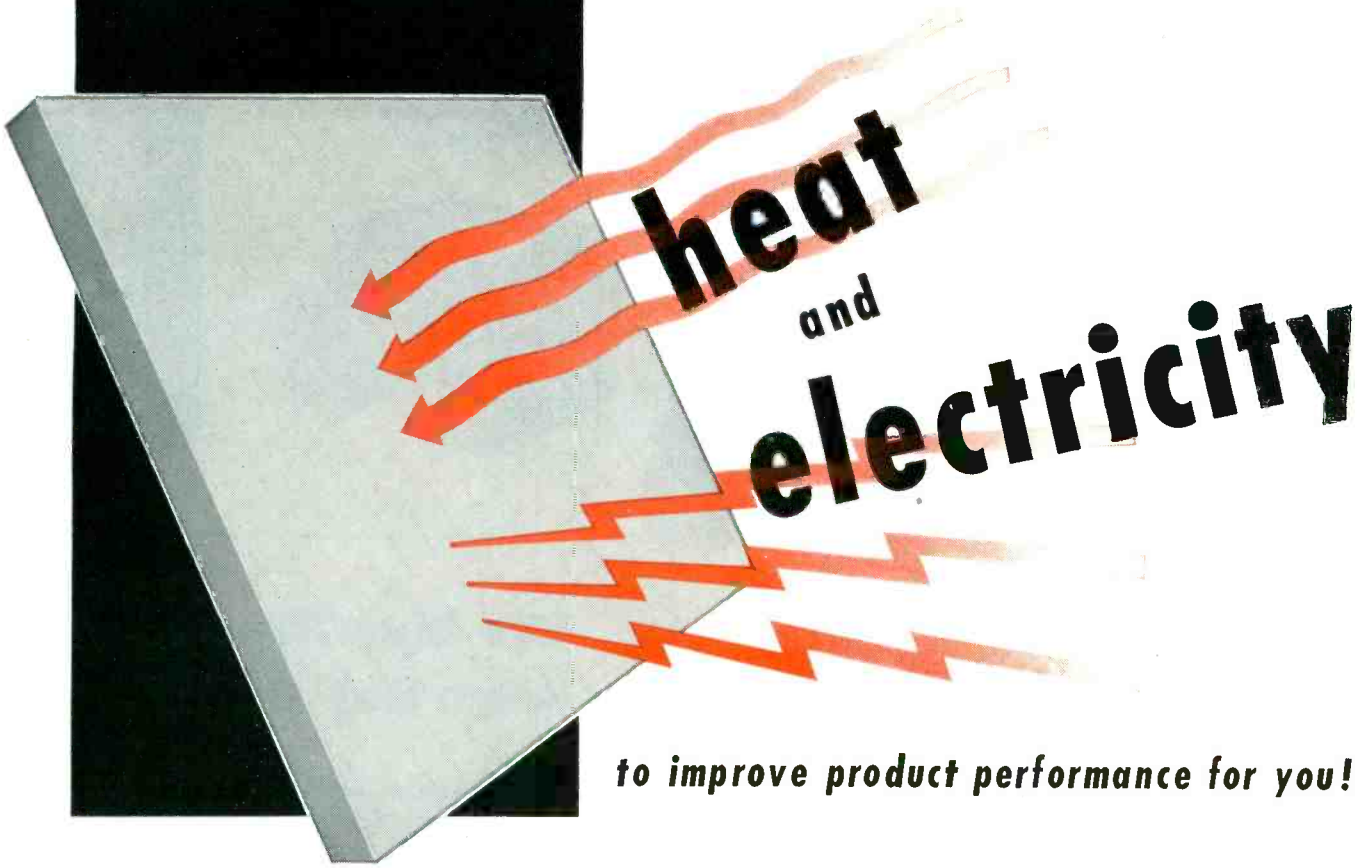
WRITE FOR NEW CATALOG

KARP METAL PRODUCTS CO., INC.

215 - 63rd STREET, BROOKLYN 20, NEW YORK

Custom Craftsmen in Sheet Metal

NEW C-D Silicone Dilecto withstands an inferno of heat and electricity



to improve product performance for you!

There are three new grades of C-D Dilecto* that can withstand temperatures as high as 250°C. They are chemically inert, silicone-glass laminated plastics that offer exceptionally high heat resistance and good arc resistance, extra strength, and positive moisture resistance! At Continental-Diamond we've literally lived and worked with Silicone Dilecto—perfecting it to a point where we believe it can be highly useful in helping to solve your production problems — and improve product performance.

And this remarkable plastic is but one of many in the C-D family. They provide practical combinations of mechanical, electrical, and chemical properties—structural strength, light weight, positive moisture, heat and corrosion resistance. In hundreds of plants, C-D Plastics—Fibre, Vulcoid, Dilecto, Celoron, and Micabond—offer proof that it pays to see C-D first in your search for the right plastic for the job. For interesting, useful information on Silicone Dilecto, and other C-D high strength plastics, call or write your nearest C-D office, soon.

your partner in producing better products

*Dilecto GB—112—S
Dilecto GB—128—S
Dilecto GB—261—S

DE-2-49

BRANCH OFFICES: NEW YORK 17 • CLEVELAND 14 • CHICAGO 11 • SPARTANBURG, S. C. • SALES OFFICES IN PRINCIPAL CITIES
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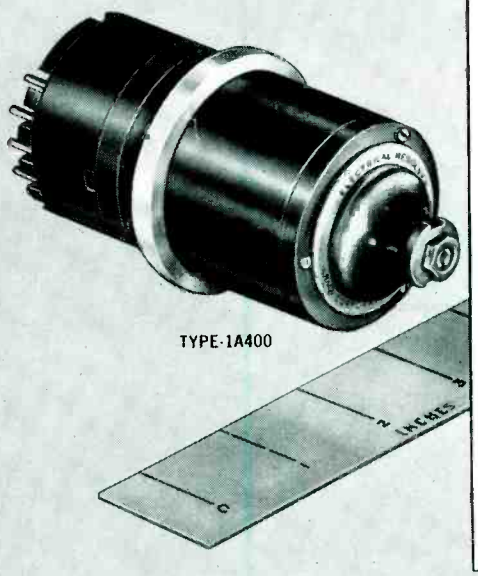
Continental-Diamond FIBRE COMPANY

Established 1895..Manufacturers of Laminated Plastics since 1911—NEWARK 16 • DELAWARE

To Top-Flight Development, Design and Instrumentation Engineers:



The accompanying table gives the characteristics of Arma Electrical Resolvers. The accuracy of these components is indicated by the tolerances in transformation ratio (S/P), phase shift, and angular accuracy.

TYPE	FREQ.	IN-PUTS	OUT-PUTS	INPUT VOLTAGE	RATIO (S/P)	PHASE SHIFT	REQUIRED AUXILIARY UNITS
E	60	1	2	8	0.9750 ±.0010	6°20′ ±5′	Compensator
H	60	2	2	8			Two Compensators
J	60	1	2	0.5-16	0.989 ±.015	4°35′ ±60′	None
K	60	2	2				None
1A400	400 ±10%	1	2	0.5-16	1.0000 ±.0006	0°0′±3′	Booster Amplifier
1E400		2	2	0.5-16			
1C400		1	1	0.5-16			
1C400		2	1	0.5-16			
P	400	2	2	0.5-16	0.98±.02	75′±20′	None

Maximum Angular Inaccuracy Is 0.1% x (S/P) x Input Voltage
Operating Temperature Range for All Resolvers = 0° to 55° C
**One Booster Amplifier may be used for two (2) Resolvers of this type.*

New Approaches to New Horizons Are Opened by These Resolvers*...

They offer an accurate and dependable means of solving problems involving the trigonometric functions . . . for applications in electromechanical computing and control equipment . . . until recently highly restricted.

Arma Resolvers Are Computing Components

The Arma Electrical Resolver is an electromagnetic unit designed to deliver two alternating voltages proportional respectively to $e_1 \sin A$ plus $e_2 \cos A$ and $e_1 \cos A$ minus $e_2 \sin A$, where e_1 and e_2 are the voltages applied to the two primaries and A is the angle through which the rotor has been turned from the position defined as electrical zero.

They Solve Problems Involving Triangles, Coordinates, Vectors

Problems such as the rotation of coordinates, solution of triangles for angles or sides, addition of angles, transfer between rectangular and polar coordinates, and the resolution, composition or addition of vectors are readily solved using Arma Electrical Resolvers. Angular inaccuracy defined in terms of difference between actual and theoretical output voltages for any rotor position is always less than 0.1% of (S/P) x input voltage.

The Results are Fast and Accurate

Arma Electrical Resolvers may be regarded as high-precision signal transformers with continuously variable ratio. In common with other electromagnetic devices there are changes in the inherent transformation ratio and phase shift caused by changes in frequency, temperature or primary voltage. Arma resolver design recognizes these factors and gives results of extreme accuracy.

Advantages of Arma Resolvers Over Wire-Wound (Potentiometer Type) Units

1. *Stepless operation — outputs are smooth accurate sine or cosine functions uninterrupted by "wire stepping."*
2. *Unlimited rotation with no circuit interruptions.*
3. *No wear; indefinite life with no change in accuracy.*

Use These Other Arma Components, Too

Here are possible applications of other Arma components released for private industry which invite interest: Tachometer-type Induction Generators for high performance servo systems; two-phase Induction Motors for servo mechanisms and control devices; Synchro Units (better than Navy "Specs") for remote control and indicating purposes; high-precision Mechanical Differentials for computer applications.

How Ideas Become Realities

For over 30 years Arma Corporation has been quietly taking on (under wraps) one complex development and design problem after another for the U. S. military establishments—problems concerned with instrumentation. In the initial stage these problems may be little more than a gleam in someone's eye, a vague hope, a "dream"! That's where Arma *starts*.

When Arma *finishes*, the problem is not only solved but the actual equipment to do the job, *built*—whether it be a complicated gun director, a gyro compass or a complex remote control system. Arma follows through to practical realities.

You are invited to request whatever information you may need to explore the possibilities of making use of any Arma product which has been released from security restrictions.

ARMA CORPORATION

254 36th STREET, BROOKLYN 32, N. Y.

SUBSIDIARY OF AMERICAN BOSCH CORPORATION

ARMA PRODUCTS RELEASED FOR PRIVATE INDUSTRY

ARMA ELECTRICAL RESOLVERS* · ARMA SYNCHROS · ARMA INDUCTION MOTORS · ARMA INDUCTION GENERATORS · ARMA MECHANICAL DIFFERENTIALS · ARMA ALTERNATING VOLTAGE COMPARATOR · COMPUTING MECHANISMS · INDUSTRIAL CONTROLS · STABILIZATION DEVICES · NAVIGATIONAL EQUIPMENT · LIMITRON AUTOMATIC INSPECTION SYSTEM

* Licensed for use under Arma patents Nos. 2,465,624 and 2,467,646. License information available.

QUALITY ARMA INSTRUMENT PRECISION

Digest

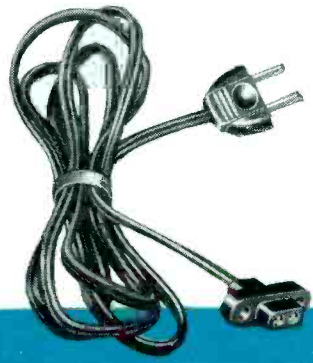
TIMELY HIGHLIGHTS ON G-E COMPONENTS

HOLDS OUTPUT VOLTAGE CONSTANT

This 500-va voltage stabilizer is suitable for a wide variety of electronic applications where constant voltage is demanded. Voltage variations from 95 to 130 volts are absorbed almost instantaneously and output voltage maintained at 115 volts (plus or minus 1 percent). There are no moving parts, no adjustments to make. This unit will operate continuously at no load or short circuit without damage to itself. It will limit the short circuit current to approximately twice stabilizer's normal full load current rating. Other sizes available range from 15 to 5000 va. For details, check bulletin GEA-3634B.

WANT TO TIME TUBE LIFE?

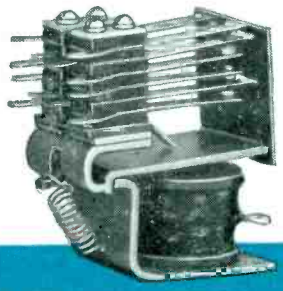
Suitable for installation in radio transmitters, these G-E time meters provide accurate record of tube operating time. They record in hours, tenths of hours, or minutes. Ratings range from 11 to 460 volts. Installation on a panel or switchboard is simplified by quick-wiring leads. Timer harmonizes with other panel instruments in appearance and size. Dependability is assured by Telechron* motor drive. Also available for portable use or conduit and junction box mounting. Check bulletin GEC-472.



FOR YOUR TELEVISION SETS

General Electric's television cord set comes in 6-foot lengths, made of 2/18 Pot-64 brown Flamenol* rip-cord. Set has brown plastic plug and new brown Flamenol connector molded on opposite end. Rip-cord has smooth finish, resists oil, water, acids, alkalies, or sunlight deterioration. Rating is 7 amps., no. 18 wire. Set is designed for assembly on television receiver rear panel, automatically disconnects when panel is removed. Write for further information.

*Trademark Reg. U. S. Pat. Off.



DEPENDABLE CONTROL FOR AUTOMATIC DEVICES

G.E.'s multi-contact relays are inexpensive units built specifically for appliances and vending machines. Construction features assure quiet, reliable operation, and compactness makes them adaptable to a variety of devices such as coin changers, phonographs, and television receivers. Single-circuit contacts or combinations of contacts for multi-circuit application are attached to the same sturdy frame and coil assembly, affording a multiplicity of relay forms. Ratings are 5 amperes at 115 volts or 24 volts, a-c or d-c. Get details from Bulletin GEC-306.

General Electric Company, Section G667-1
Apparatus Department, Schenectady, N. Y.

Please send me the following bulletins:

- ☐ GEA-3634B Voltage Stabilizers
- ☐ GEA-4357A D-C Capacitors
- ☐ GEA-5238 Selenium Rectifiers
- ☐ GEC-306 Multi-contact Relays
- ☐ GEC-472 Tube Timers

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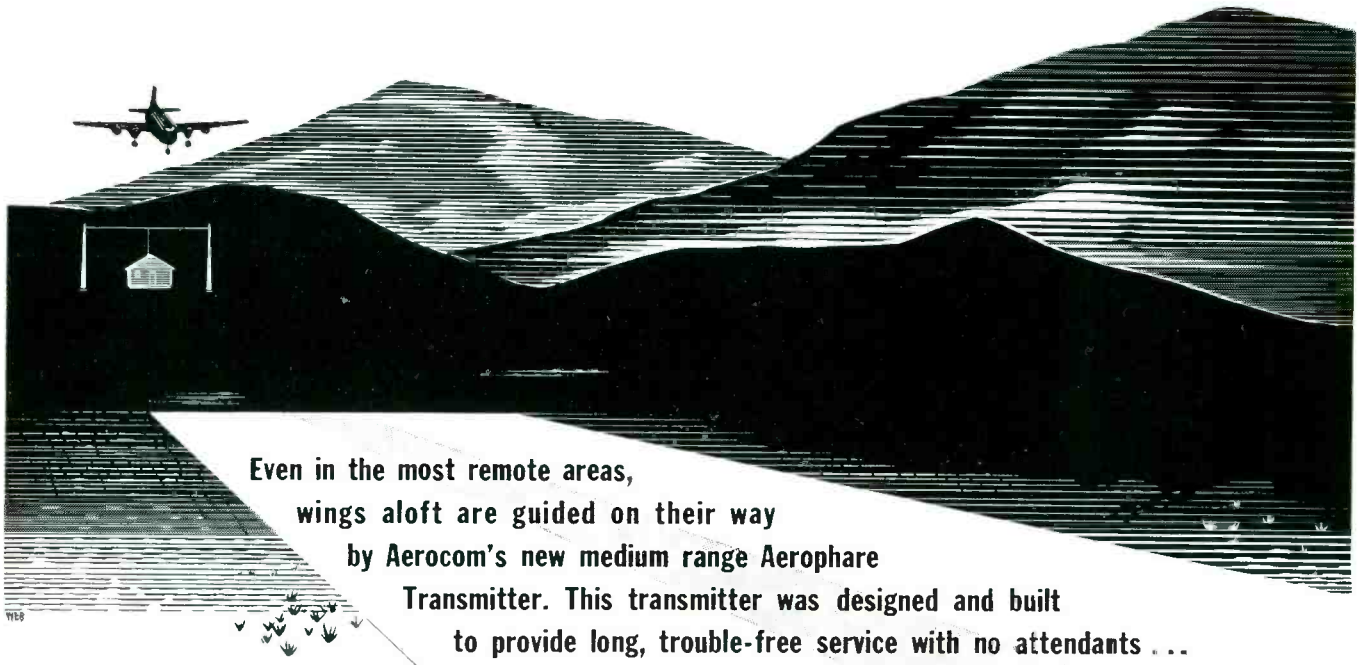

Even in the most remote areas, wings aloft are guided on their way by Aerocom's new medium range Aerophare Transmitter. This transmitter was designed and built to provide long, trouble-free service with no attendants . . . even where the total population is Zero.

AEROPHARE

The 100 Watt Aerophare illustrated consists of the following units--AK-3 automatic keyer; Model 100XL transmitter, (100 Watt carrier power, minimum of 30%-high level tone modulation for identification but with no provision for voice modulation); and antenna matching unit.

The smaller unit is similiar, except transmitter is of 50 Watts carrier power with 90% high level tone modulation for identification, or, 90% high level voice modulation. Microphone P-T-Switch, when depressed interrupts tone, permitting voice operation. This feature makes this unit ideal for airport operation where both aerophare and traffic control are needed.

Both units are completely "tropicalized" to allow operation under unusual climatic conditions. Each unit is ruggedly constructed and conservatively rated, providing low operating and maintainence costs. Engineering data on both units upon request.

CONSULTANTS, DESIGNERS AND MANUFACTURERS OF STANDARD OR SPECIAL ELECTRONIC, METEOROLOGICAL AND COMMUNICATIONS EQUIPMENT.

AER -O- COM
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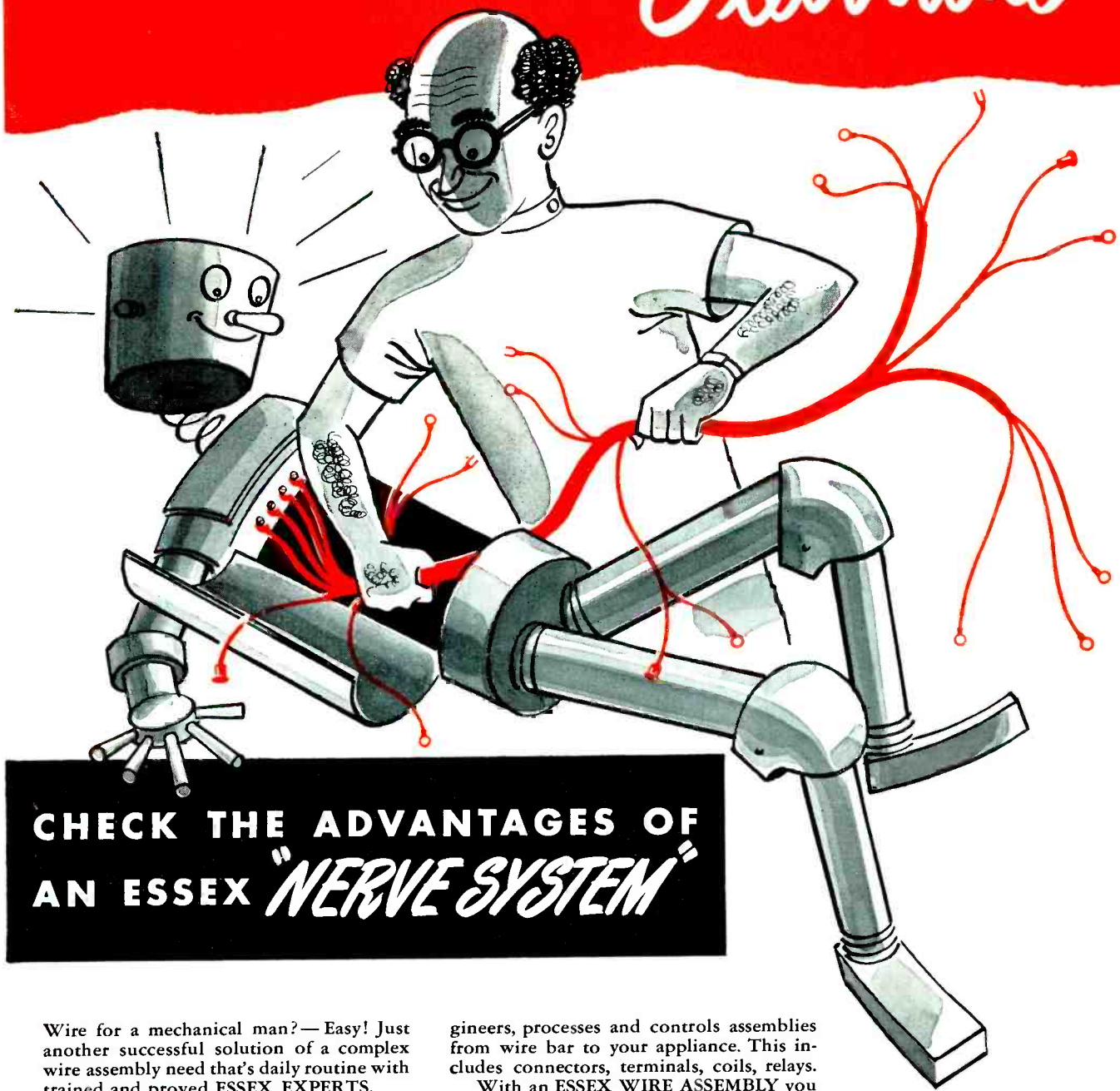
AERONAUTICAL COMMUNICATIONS EQUIPMENT, INC.
3090 Douglas Road, Miami 33, Florida

DEALERS: Equipeletro Ltda., Caixa Postal 1925, Rio de Janeiro, Brasil ★ Henry Newman Jr., Apartado Aereo 138, Barranquilla, Colombia ★ Radelec, Reconquista 46, Buenos Aires, Argentina

FOR

Whatever You Make That's Electrical



CHECK THE ADVANTAGES OF AN ESSEX "NERVE SYSTEM"

Wire for a mechanical man?—Easy! Just another successful solution of a complex wire assembly need that's daily routine with trained and proved ESSEX EXPERTS.

Drop a coin in a slot—out comes anything from a sandwich to a can of fishing worms. Is it any wonder people say these machines are almost human? There's a reason! ESSEX WIRE ASSEMBLIES operate such products dependably and accurately.

Thanks to experienced specialists and a network of twenty factories, ESSEX engineers, processes and controls assemblies from wire bar to your appliance. This includes connectors, terminals, coils, relays.

With an ESSEX WIRE ASSEMBLY you can stop your electrical worries and actually enjoy greater economy, proved dependability and precise uniformity. Essex engineers diagnose your problems and custom-build assemblies for your products. Essex will prove its points by furnishing you with a sample assembly built to your specifications. Get the facts today.

BUILT TO PERFECTION

WIRE ASSEMBLY AND

WIRE SX PRODUCTS

PROVED BY INDUSTRY

CORD SET DIVISION

Consult an Essex representative, or send your specifications to *the Service Engineering Department*, Wire Assembly and Cord Set Division.

ESSEX WIRE CORPORATION MONTICELLO, INDIANA

a power house
nothing in the field
can touch
the CORNELL-DUBILIER

BLACK CUB

BAKELITE MOULDED PAPER TUBULAR

A midget-sized gargantua . . . a powerhouse of a capacitor that's armored to take all the stress and strain, vibration, humidity and extremes of temperature that comes its way. If the paper tubulars you're now using lack any of these 8 strong points, you're being short-changed. Switch to C-D BLACK CUBS as other leading manufacturers have done!

1. "LEADWELD" CONNECTIONS! Sturdy welded joints between wire leads and foil of capacitor section. Permanent connections! No intermittents! No open circuit defects!

2. BAKELITE CASE! Capacitor element molded in high quality Bakelite provides maximum protection under most severe service conditions.

3. "POLYKANE" IMPREGNATION! Polymerized resin impregnant provides excellent electrical properties and cannot leak through case at any temperature.

4. HIGH TEMPERATURE OPERATION! Excellent electrical properties maintained after long service at temperatures up to 100° C.

5. EXCELLENT MOISTURE SEAL! Will withstand long storage and service under extremes of humidity with minimum effect on electrical performance or appearance of tubular.

6. STURDY CONSTRUCTION! Withstands extremes of handling, soldering temperature, vibration and shock without damage to case material, moisture seal, circuit connections or electrical performance.

7. HIGH INSULATION RESISTANCE! Resistance exceeds 10,000 megohms per unit at 25° C.

8. ALUMINUM FOIL ELECTRODES! Provides best electrical properties and maximum service life at high temperature.

C-D CAPACITORS — BEST BY FIELD TEST

Write, wire or phone for samples and further information on the type MBT Black Cub Tubulars. Catalog on request. Cornell-Dubilier Electric Corporation, Dept. K69, South Plainfield, N. J. Other plants in New Bedford, Brookline and Worcester, Mass.; Providence, R. I.; Indianapolis, Ind.; and subsidiary, The Radiart Corporation, Cleveland, Ohio.

CORNELL-DUBILIER
Consistently Dependable
capacitors • vibrators
antennas • converters

1910 CORNELL-DUBILIER CD CAPACITORS 1949

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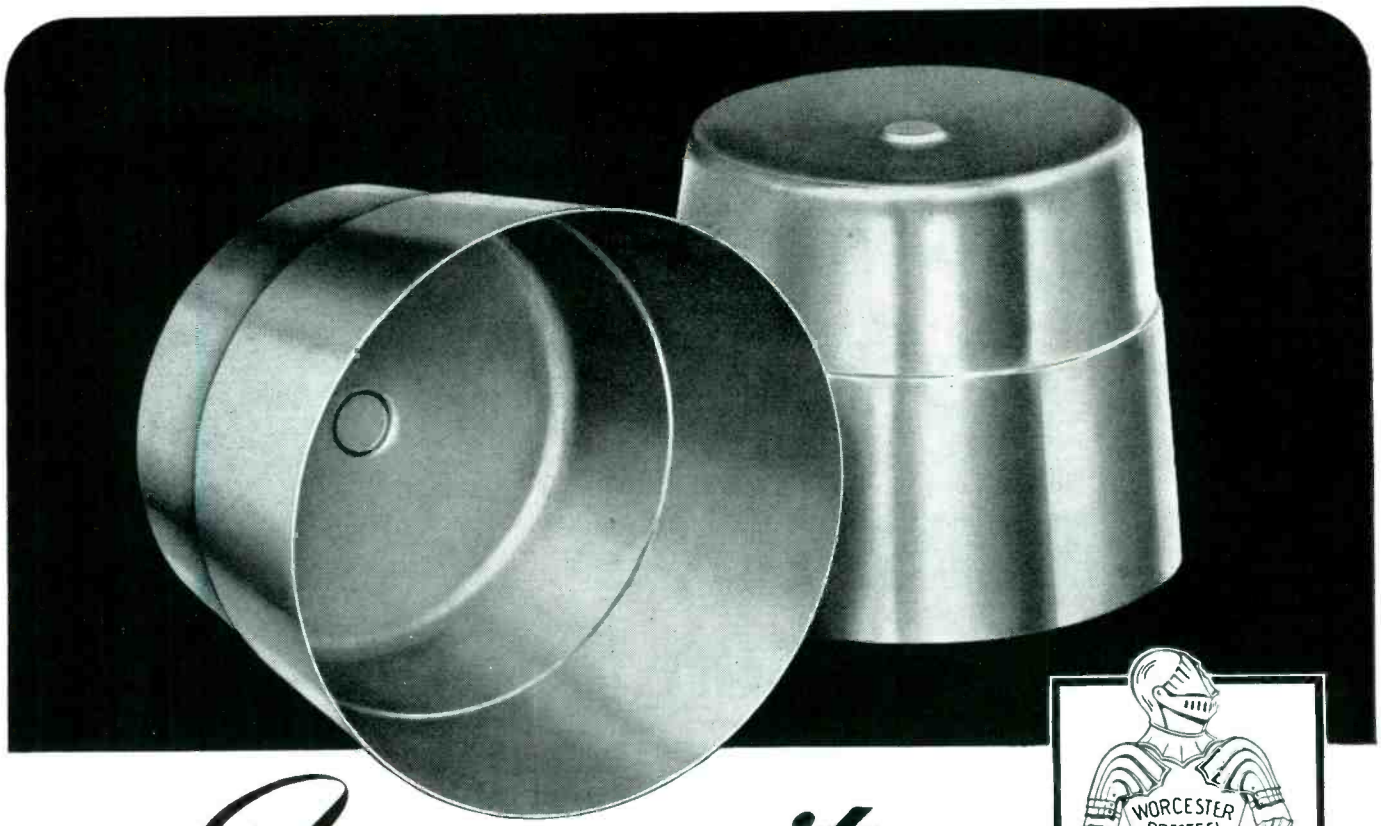

Ingenuity...

This appears to be a simple stamping. However, the combination of the tapered shape and the light gauge material makes it difficult to draw without wrinkles. Once introduced, it is almost impossible to eliminate a wrinkle.

Carefully planned tooling — the correct number of preliminary operations, plus an ingenious reverse draw — solved this difficult stamping problem.

Result... uniform parts with a minimum of die marks, permitting economical preparation of the surface for high lustre plating and polishing.

WORCESTER PRESTEEL

Representatives in

ALEXANDRIA, VA.
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ALLOY STEELS AND OTHER METALS COLD FASHIONED SINCE 1883

PRECISION METAL STAMPINGS FOR EVERY TYPE OF INDUSTRY

WORCESTER PRESSED STEEL CO.

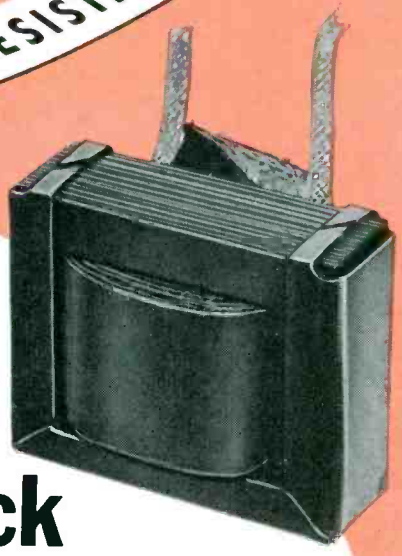
306 BARBER AVENUE
WORCESTER 6, MASS.

DIP TANK STABILITY

HIGH TEMPERATURE LIFE

MOISTURE RESISTANCE

FLEXIBILITY



IRVINGTON'S #100 clear #500 black INSULATING VARNISH

(Internal Drying)

Here are high dielectric strength varnishes that are "tops" in insulation protection for high heat applications requiring high temperature flexible life. These varnishes remain tough, flexible and stable under the most rugged operating conditions. They penetrate deeply, dry from the inside, bind coil windings into a unit acting mass, preventing movement of wires. They resist damaging heat, moisture, oil, acids, alkalies . . . and will not attack enamel coating on magnet wire.

Use #100 where a clear varnish film is required for instrument coils, field coils, transformers and similar wound structures . . . leads remain flexible and are easily identified where color coded.

Use #500 where an exterior black coating, plus all of the excellent properties of Irvington #100 are needed . . . fine for infra-red baking. This varnish is suited to motor coils, wound stators and field coils.

Both #100 and #500 can lower manufacturing cost, and improve product quality. Try them. Samples, with complete technical data, sent upon request.

"Look to Irvington for Continued Leadership in Insulation"

IRVINGTON *Varnish & Insulator Company*

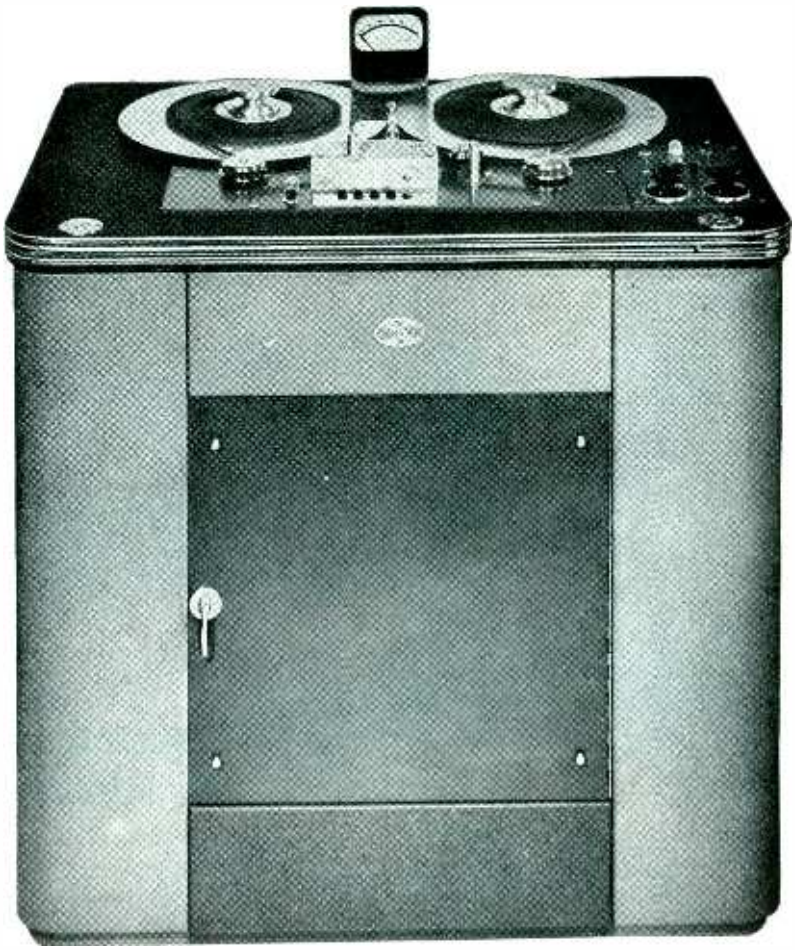
Irvington 11, New Jersey

Authorized distributors in Atlanta; Baltimore; Berkeley; Bluefield, W. Va.; Boston; Charlotte; Chicago; Cleveland; Dallas; Denver; Detroit; Los Angeles; Milwaukee; Minneapolis; New Hartford, N.Y.; New Orleans; Philadelphia; Pittsburgh; Portland, Ore.; St. Louis; Seattle; Hamilton, Ont., Canada.

Now! A Top Quality Tape Recorder at a Reasonable Price

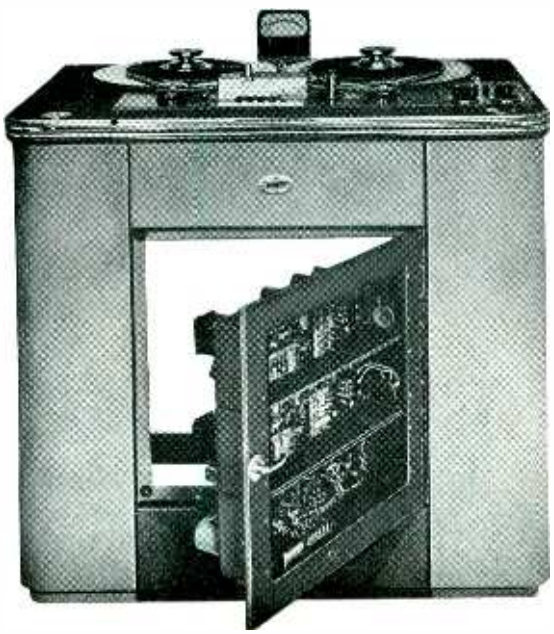
New PRESTO Magnetic Tape Recorder

AT LAST, a magnetic tape recorder that fully measures up to the most exacting requirements of broadcast network operations, independent stations and transcription producers, yet priced to have wide appeal.



Compare these specifications:

- Frequency response: 30 to 15,000 cps ± 1 db.
- Signal to noise ratio: Over 60 db below max. signal.
- Fast speed, 240 ft. per second forward and rewind, instantly reversible.
- Recording speeds 7½" or 15" per second (15" or 30" per second provided on request). Speed selection by special 2-speed motor.
- Reels direct mounted on motor shafts. Uses any type and size of reel up to 14".
- Erasing, recording and playback heads all mounted in separate housing – entire unit connected by plug-in for immediate replacement.
- Full-size illuminated scale V. U. meter on top panel.



Now! Greater Accessibility

Illustration shows how everything mechanical and electrical can be serviced from the front and top. Amplifiers and power supply are in swinging door behind removable panels. Mechanical units are mounted on top panel, hinged at rear so it can be opened upwards.

PRESTO

RECORDING CORPORATION

Paramus, New Jersey

Mailing Address:

P. O. Box 500, Hackensack, N. J.

In Canada:

WALTER P. DOWNS, Ltd., Dominion Square Building, Montreal

WORLD'S LARGEST MANUFACTURER OF INSTANTANEOUS SOUND RECORDING EQUIPMENT AND DISCS

NEW Miniature Telephone Type Relay

NEW LK RELAY

MOUNTING: End mounting for back of panel or under-chassis wiring. Interchangeable with standard "Strowger" type mounting.

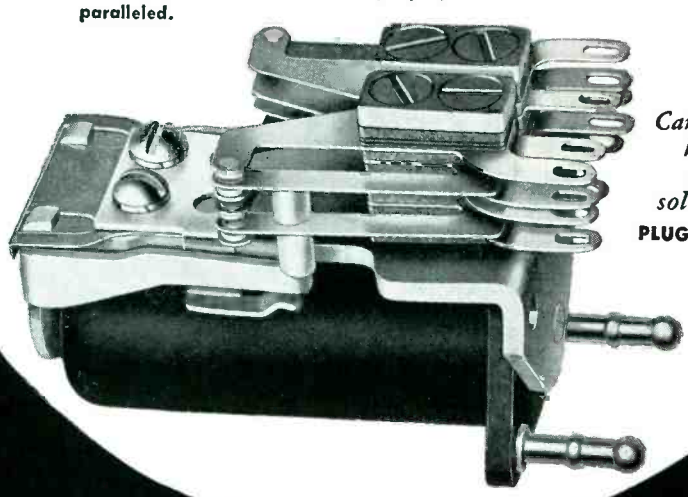
COIL POWER: From 40 milliwatts to 7 watts D.C.

CONTACTS: Standard 2 amperes, special up to 5 amperes. 2 amperes up to 6 P.D.T. 5 ampere contacts (low voltage) up to 4 P.D.T. Special 20 ampere power contacts S.P.S.T., normally open, paralleled.

DIMENSIONS:
1 5/8" HIGH, 2 7/32" LONG, 1 3/32" WIDE

These are the dimensions for the 6 pole relay.

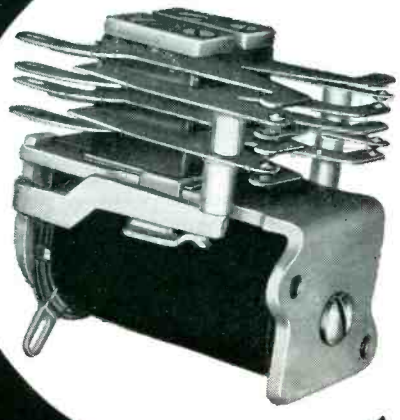
Will meet Army and Navy aircraft specifications as a component unit.



Can be furnished hermetically sealed with solder terminals.

PLUG-IN MOUNTING-SPECIAL.

SK RELAY



MOUNTING: Front of panel mounting and wiring.

COIL POWER: From 100 milliwatts to 4.5 watts D.C.

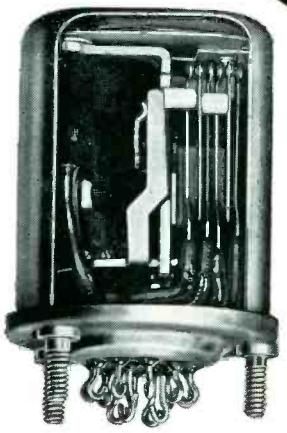
CONTACTS: Same as "LK".

DIMENSIONS: 1 1/2" HIGH, 1 9/16" LONG, 3 1/32" WIDE.

These are the dimensions for the 4 pole relay.

Will meet Army and Navy aircraft specifications as a component unit.

CAN ALSO BE FURNISHED HERMETICALLY SEALED WITH SOLDER TERMINALS. PLUG-IN—SPECIAL.



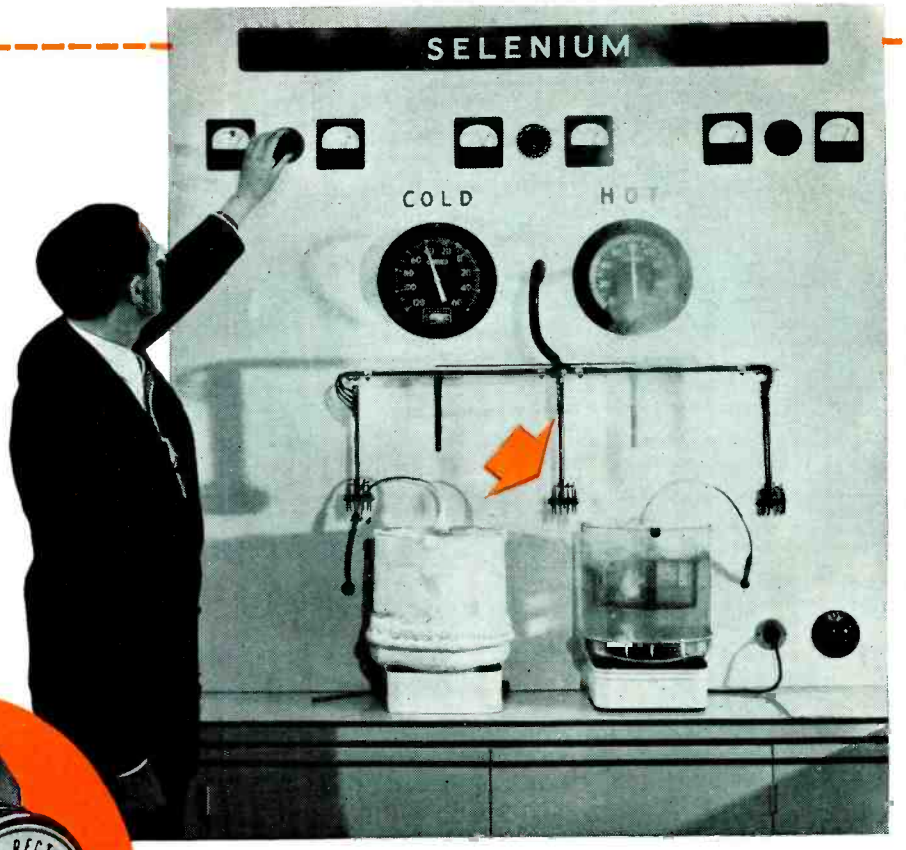
SK, HERMETICALLY SEALED

AL-132

ALLIED CONTROL CO. INC. 2 EAST END AVE., NEW YORK 21, N. Y.

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

Westinghouse



New Selenium Licks *HIGH TEMPERATURE* ...HIGH VOLTAGE

Here's good news. Westinghouse offers you these important plus features in selenium rectifiers.

Visitors at the IRE Exposition, held recently in New York City, saw this demonstrated by a unique hot-cold shock cycle test. Every 5 minutes during the 4 days, shock changes in temperature from 40° C below zero to boiling water were applied to a Rectox 24-Volt DC/33 RMS Plate Rectifier. Variation in output was extremely small. Extensive laboratory tests at stack temperatures up to 125° C further prove ability to meet unusual requirements.

Since each plate will stand more voltage, fewer plates are needed . . . smaller stacks may be used.

The exclusive Westinghouse process of manufacture also assures lowest rate of forward aging and constant, uniform cell performance.

TRY A SAMPLE.

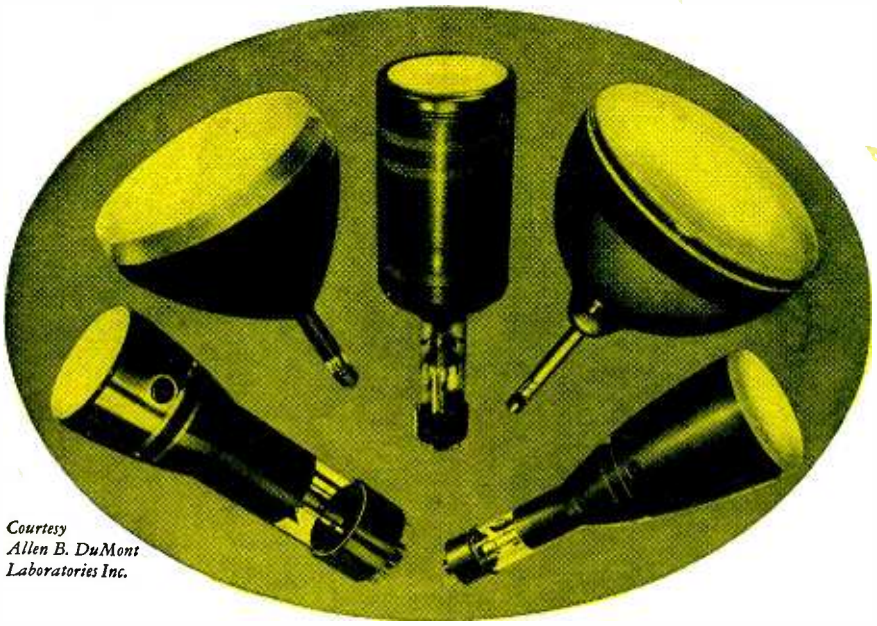
Test it under your own conditions. Call your local Westinghouse office for details. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Penna. J-21532

Westinghouse

Rectox

SELENIUM RECTIFIERS

The *NEW* "dag" CRT Wall Coating ...



Courtesy Allen B. DuMont Laboratories Inc.

for *all* CRT glass envelopes

Here's an entirely new CRT Wall Coating, developed by Acheson Colloids specifically and solely for use on CRT glass envelopes.

"dag" CRT Wall Coating is very easily applied . . . adheres tenaciously to all types of glass . . . does not yield objectionable by-products on heating.

Prominent cathode-ray tube manufacturers have already found this opaque, electrically conductive **"dag"** CRT Wall Coating eminently satisfactory, especially in tubes intended for television reception.

Let Acheson Colloids help you with your CRT wall coating problem. Mail the coupon today for information on this or other electronic applications of **"dag"** colloidal graphite dispersions.

Give me information on "dag" colloidal graphite dispersions for:

- Wall coating of CRT's ☐
- Electrostatic shielding ☐
- Corona prevention ☐
- Dry-film lubrication ☐
- Copper oxide rectifier disc coating ☐
- Electrical resistances ☐
- Filament cement ☐

F-5

40th Anniversary Year

Acheson Colloids Corporation

Port Huron

dag
REG. U.S. PAT. OFF.
COLLOIDS

Michigan

How to deal effectively with VIBRATION:

Locate it- ...with an MB PICKUP

Any trace of vibration comes to light when you attach this sensitive electrical pickup to your product. A rugged, precision-built product, it will withstand rough treatment.

When bolted to equipment under test, this velocity-type pickup faithfully converts vibratory motion to an electrical output. Signal can be visualized with an oscilloscope. Major industries today find it indispensable for accurate analyses. Write for bulletin 124.

Reproduce it- ...with an MB EXCITER

You can't beat this electro-dynamic exciter for shaking "bugs" out of products. With its frequency and force adjustments, you can "scan" a product for vibratory response—or fatigue-test it.

Take one case where a manufacturer of turbines was beset by blade failures. With an MB Exciter, he was able to resonate blades to destruction quickly—while studying their motions with stroboscopic light. In this way, he got to the cause of the trouble *visually!* More data in our bulletin 210B.

Isolate it- ...with ISOMODE* MOUNTS

Because Isomode mounts have equal spring rates in all directions, they're efficient at all angles — and they isolate all modes of motion!

That's why, by adopting Isomode units, one company was able to simplify suspension brackets and save on manufacturing costs in *addition to* improving vibration control! Another has been better able to cushion heavy duty engines—*without* redesigning the mounting system! Ask for bulletin 202 and Design Chart.

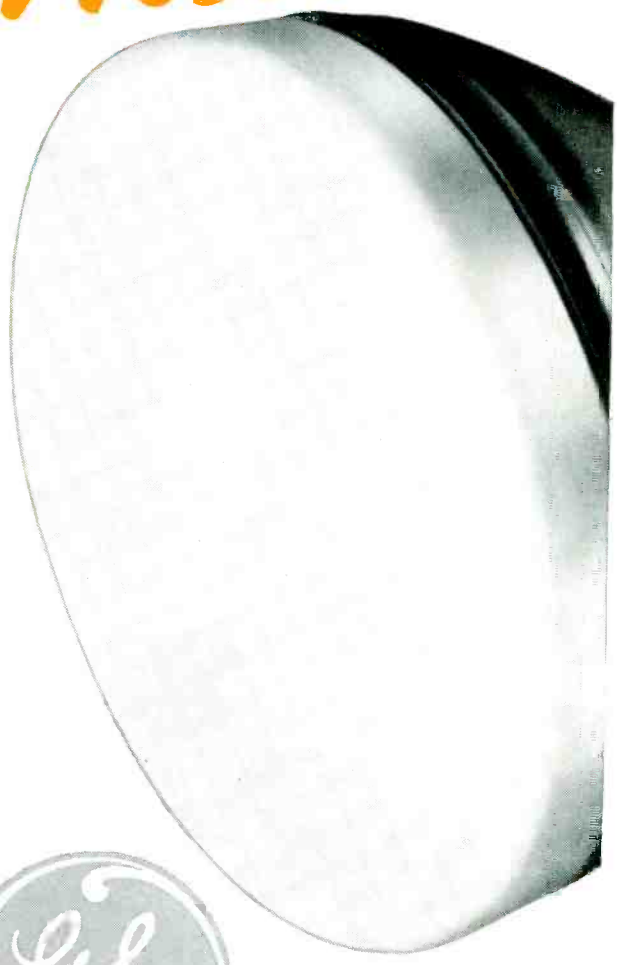
**Trade Mark Reg. U.S. Pat. Off.*

You can see why more and more engineers contact MB when they run into trouble with vibration. We'll be happy to cooperate with you on *your* problems. For more information and for bulletins on the above MB products, write to Dept. E5.

THE MB MANUFACTURING COMPANY, INC.
1060 State Street
New Haven 11, Conn.
VIBRATION ISOLATOR UNITS - VIBRATION TEST EQUIPMENT

VIBRATION DIVISION

2 GREAT NEW TUBES FOR



WITH television racing ahead to new records in popularity—to ever higher figures in dollar volume—choice of picture tubes takes priority with designers and builders of receivers. The picture tube is the heart of the TV set. Cost, picture size, brightness—these must be carefully weighed in the light of the particular market at which a new receiver is aimed.

Good news to designers is G.E.'s introduction of the two tubes shown here. One—the 8½-inch type (8AP4)—dovetails with requirements of the low-priced receiver market where costs must be scrutinized down to the last penny. The 12½-inch aluminized tube (12KP4) matches the needs of that field of sale—also large—where picture size and quality come first.

Both tubes are G-E-designed to embody tomorrow's advanced engineering concepts. Both tubes are G-E-built to highest precision standards of quality!

CHARACTERISTICS

	8AP4	12KP4
Max bulb diameter	8 11/16 inches	12 9/16 inches
Min useful screen diameter	7¾ inches	11 inches
Heater voltage	6.3 v	6.3 v
Heater current	0.6 amp	0.6 amp
Focusing method	magnetic	magnetic
Deflecting method	magnetic	magnetic
Deflecting angle (approx)	54 degrees	54 degrees
Screen fluorescent color	white	white
Over-all length	14½ inches (max)	18 inches (max)
Bulb contact	metal-cone lip	J1-21
Base	B7-51	B7-51

MAX RATINGS, DESIGN-CENTER VALUES

	8AP4	12KP4
Anode voltage	10,000 v	12,000 v
Grid No. 2, voltage	none	410 v
Grid No. 1, voltage	—125 v	—125 v

TYPICAL OPERATING CONDITIONS

	8AP4	12KP4
Anode voltage	9,000 v	11,000 v
Grid No. 2, voltage	none	250 v
Grid No. 1, voltage for cut-off	—45 v	—45 v
Focusing coil current, d-c (approx)	120 ma	135 ma

NOTE: on Type 8AP4, the electron gun is designed for use with an external ion-trap magnet.

MASS TELEVISION MARKETS

TYPE 12KP4—A 12½-inch cathode-ray tube, all-glass construction. Aluminized screen. Offers *the brightest picture*—93 percent brighter (average) than a standard tube at 11,000 volts! Offers *a big picture*—95 square inches when the entire tube face is scanned; 75 sq. in. when standard raster of 3-by-4 aspect is employed. These areas are nearly half again as large as with the popular 10-inch type. . . . Here's the tube for TV-set manufacturers who put quality first, who wish to build consumer acceptance based on superior performance, on a larger, brighter, sharper picture. . . . *Here's the tube that's setting the pace in 1949 television!*

TYPE 8AP4—An 8½-inch cathode-ray tube with metal-cone envelope. Has plenty of picture area—47 square inches when the entire tube face is scanned; 36¾ sq. in. when standard raster of 3-by-4 aspect is used. . . . *Half the weight* of an all-glass tube, so ideal for small TV receivers that are lifted and moved about. . . . *Shortness of tube* (14½ inches) saves valuable space for the cabinet designer . . . *Requires a simpler, less costly circuit,* because the 8AP4's triode construction does away with need for a Grid-No.-2 voltage supply. . . . *Low in price,* up-to-the-minute in design—a combination that's putting this tube in first place with builders of small TV sets.

Size responsibility; wide facilities for research, for manufacture—these identify a top source of supply for any manufactured article. Your source for picture tubes need be no exception. General Electric is actively engaged in every phase of television—has pioneered many important TV developments—brings to each tube type the knowledge gained from designing and building numerous other products in this field in which G-E leadership is acknowledged.

G-E tube engineers are ready at all times to consult with you on technical problems relating to the application of picture tubes to the receiver you may be designing. Your phone-call, wire, or letter will bring immediate, helpful response. General Electric's distributor-dealer facilities for replacing picture tubes in owners' sets are nationwide; your sales outlets and customers can count on tube service that is fast and reliable. Specify G-E picture tubes for value, quality, owner satisfaction! *Buy the best* for this best new market—television—that is generously rewarding the set builders who serve it well! *Electronics Department, General Electric Company, Schenectady 5, New York.*

You can put your confidence in—

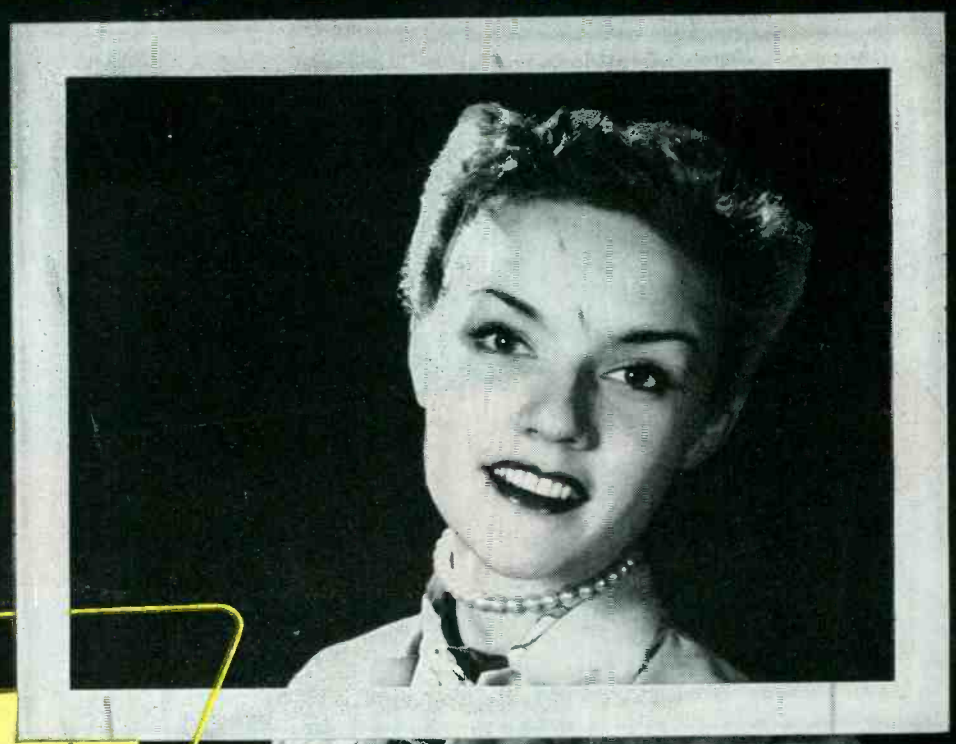
GENERAL ELECTRIC

101-M1

Norelco PROTELGRAM

LIFE-SIZE *more* LIFE-LIKE *Television!*

. . . from this 2½" tube



Chosen by these famous makers of quality projection TV receivers

ANSLEY • EMERSON
FADA • FISHER
PILOT • SCOTT
STEWART WARNER
INTERNATIONAL TELEVISION
BRUNSWICK

and others soon to be announced

PROTELGRAM is the result of nearly fifteen years of research by the world's greatest electronics laboratories. This scientifically designed, optically correct projection system makes possible, *for the first time*, a *life-size* distortion-free picture of nearly 200 square inches (20" diagonal) . . . a more *life-like* picture without glare or eyestrain. And from a tiny long-life, low-cost picture tube!

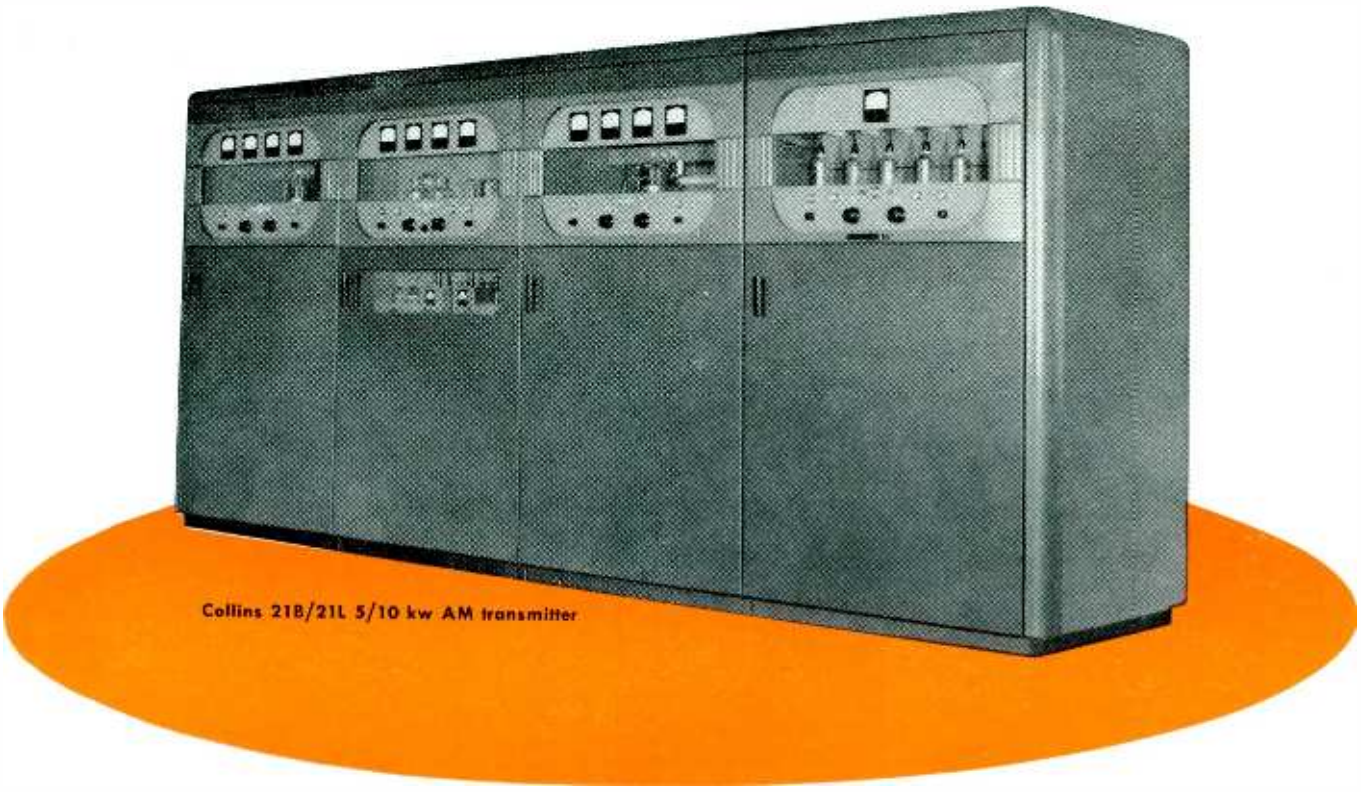
PROTELGRAM is the answer to the public demand for a bigger, clearer picture that is easier on the eyes. It produces a better than 16" x 12" non-reflecting picture that fills a flat screen *all the way to the corners*, and permits wide angle visibility, fatigueless viewing from 5 feet or 50! Small size and light weight make possible compact consumer units. Write to Dept. PA-6, North American Philips Company, Incorporated, 100 East 42nd Street, New York 17, New York.

PROTELGRAM for **life-size**, more **life-like** television

Norelco

An Exclusive Development of

NORTH AMERICAN PHILIPS



This ultra modern transmitter is engineered to save you money

. . . and we are not referring to initial investment, though both the Collins 21B (5 kw) and 21L (10 kw) AM transmitters are very competitively priced in their respective power classes.

We are speaking of maintenance cost, month after month, year after year. That is where the saving mounts up.

The 5 kw 21B is designed and constructed as a conservatively rated 10 kw transmitter, minus the additional 892R power tube and associated parts needed to convert for 10 kw operation. The factor of safety is so great that the possibility of failure in any circuit approaches the vanishing point.

In addition, a newly designed, highly efficient differential relay, working in conjunction with the transmitter's recycling system, acts as a positive protective device in the final amplifier circuit.

This one device can save you many hundreds of dollars in the cost of tube and component replacements, and outage credits to sponsors.

When you convert to the 21L for 10 kw operation, you lose none of your original investment. No major component replacements are necessary. And you lose no air time.

These are examples of many advantages gained by choosing the Collins 21B/21L. For more complete information, write us for a fully illustrated bulletin describing this equipment.

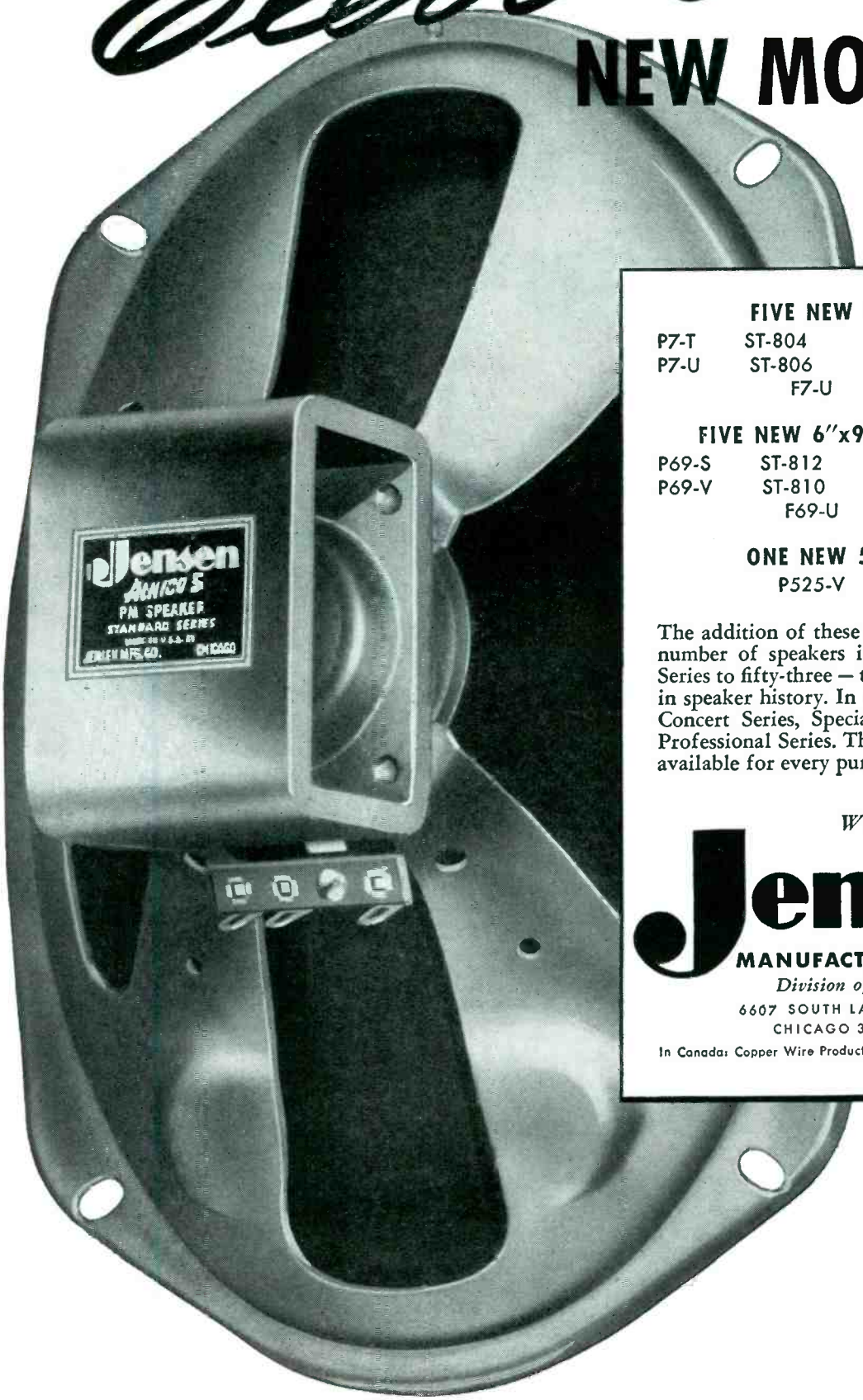
FOR BROADCAST QUALITY AND ECONOMY, IT'S...

COLLINS

COLLINS RADIO COMPANY, Cedar Rapids, Iowa

11 West 42nd Street, New York 18, N. Y. 458 South Spring Street, Los Angeles 13, California

Eleven NEW MODELS



FIVE NEW 7″ MODELS

P7-T	ST-804	P7-T	ST-807
P7-U	ST-806	F7-T	ST-809
	F7-U	ST-808	

FIVE NEW 6″x9″ OVAL MODELS

P69-S	ST-812	P69-T	ST-811
P69-V	ST-810	F69-T	ST-814
	F69-U	ST-813	

ONE NEW 5¼″ MODEL

P525-V ST-803

The addition of these new models brings the number of speakers in the Jensen Standard Series to fifty-three – the most complete array in speaker history. In addition are the Jensen Concert Series, Special Series, Coaxial, and Professional Series. There is a genuine Jensen available for every purpose.

Write for Catalog 1010-F

Jensen

MANUFACTURING COMPANY

Division of the Muter Company

6607 SOUTH LARAMIE AVENUE

CHICAGO 38, ILLINOIS

In Canada: Copper Wire Products, Ltd., 351 Carlaw Ave., Toronto

With more and still more telecasters it's Du Mont TV camera equipment because of outstanding

DEPENDABILITY

DU MONT
Type TA-124-B
Image Orthicon Chains

Many TV stations either on the air or under construction, are Du Mont-equipped throughout. That means the Du Mont Type TA-124-B Image Orthicon Chain for studio and remote pick-ups, alike.

But of even greater significance is the growing use of Du Mont cameras and auxiliary equipment by TV stations originally using other makes of equipment; by intra-store television demonstrations; by wired television installations; by movie producers experimenting with television production possibilities; by TV training schools; by government agencies both here and abroad.

The Du Mont advantages are many: Split-second action through quick set-up; finger-tip controls; superlative image pickup with precise electronic viewfinder checkup; accessibility for time-saving inspection and immediate maintenance; handy matched units, jiffy-connected, for all required power, synchronizing, amplifying and monitoring functions, plus the latest camera effects.

But the outstanding characteristic of this popular Du Mont Type TA-124-B Image Orthicon Chain is DEPENDABILITY. That, in the final analysis, is the all-important consideration. For "The show must go on," regardless.

$$SD+QW=\frac{D}{FWFT}$$

(Simple Translation)

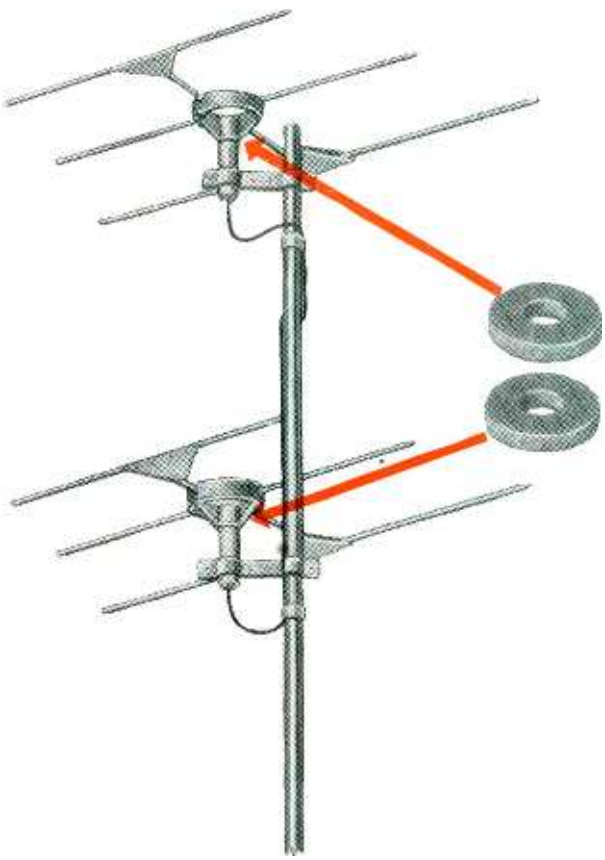
SUPERIOR DESIGN plus
QUALITY WORKMANSHIP equals
DU MONT

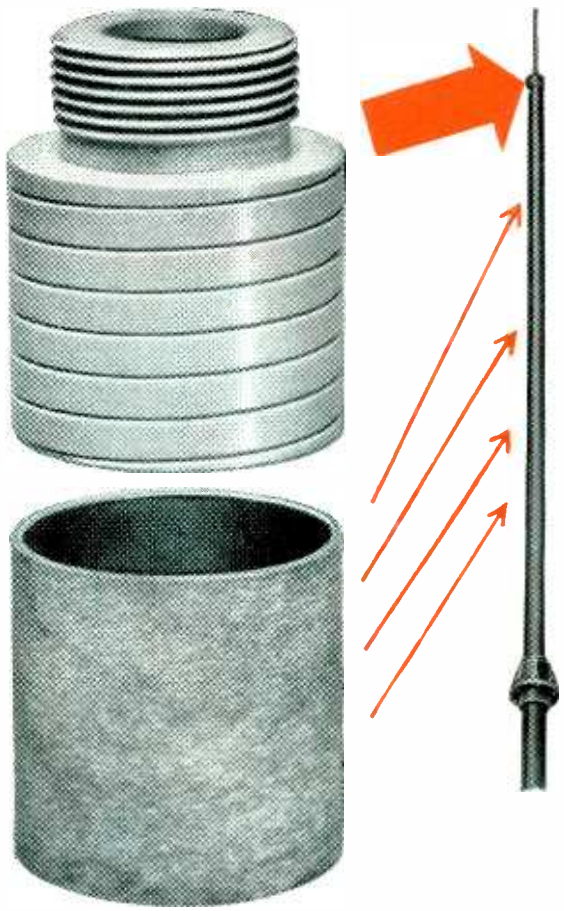
First With the Finest in Television

Consult us on your TV plans and requirements. Literature on request.

DUMONT *First with the Finest in Television*

ALLEN B. DU MONT LABORATORIES, INC. • TELEVISION EQUIPMENT DIVISION, 42 HARDING AVE., CLIFTON, N. J. • DU MONT NETWORK AND STATION WABD, 515 MADISON AVE., NEW YORK 22, N. Y. • DU MONT'S JOHN WANAMAKER TELEVISION STUDIOS, WANAMAKER PLACE, NEW YORK 3, N. Y. • STATION WTTG, WASHINGTON, D. C. • HOME OFFICES AND PLANTS, PASSAIC, N. J.





Workshop Associates, Inc., specialists in high frequency antennas, use Lamicoid sheet, tubing and rod for many parts in television, FM radio and high-gain beacon antennas.

Lamicoid

meets highest standards in custom-built TV and FM antennas

Workshop antennas are custom-built for exceptional performance. For dependability in parts serving structural and insulating functions, Workshop Associates rely on LAMICOID.

A thermosetting laminated plastic, LAMICOID combines tough-as-metal strength with lighter-than-wood weight. It has high dielectric strength, low power factor and good moisture and corrosion resistance. Made in sheet, rod and tube form, it can be readily fabricated by sawing, shearing, punching and machining into thousands of accurate shapes.

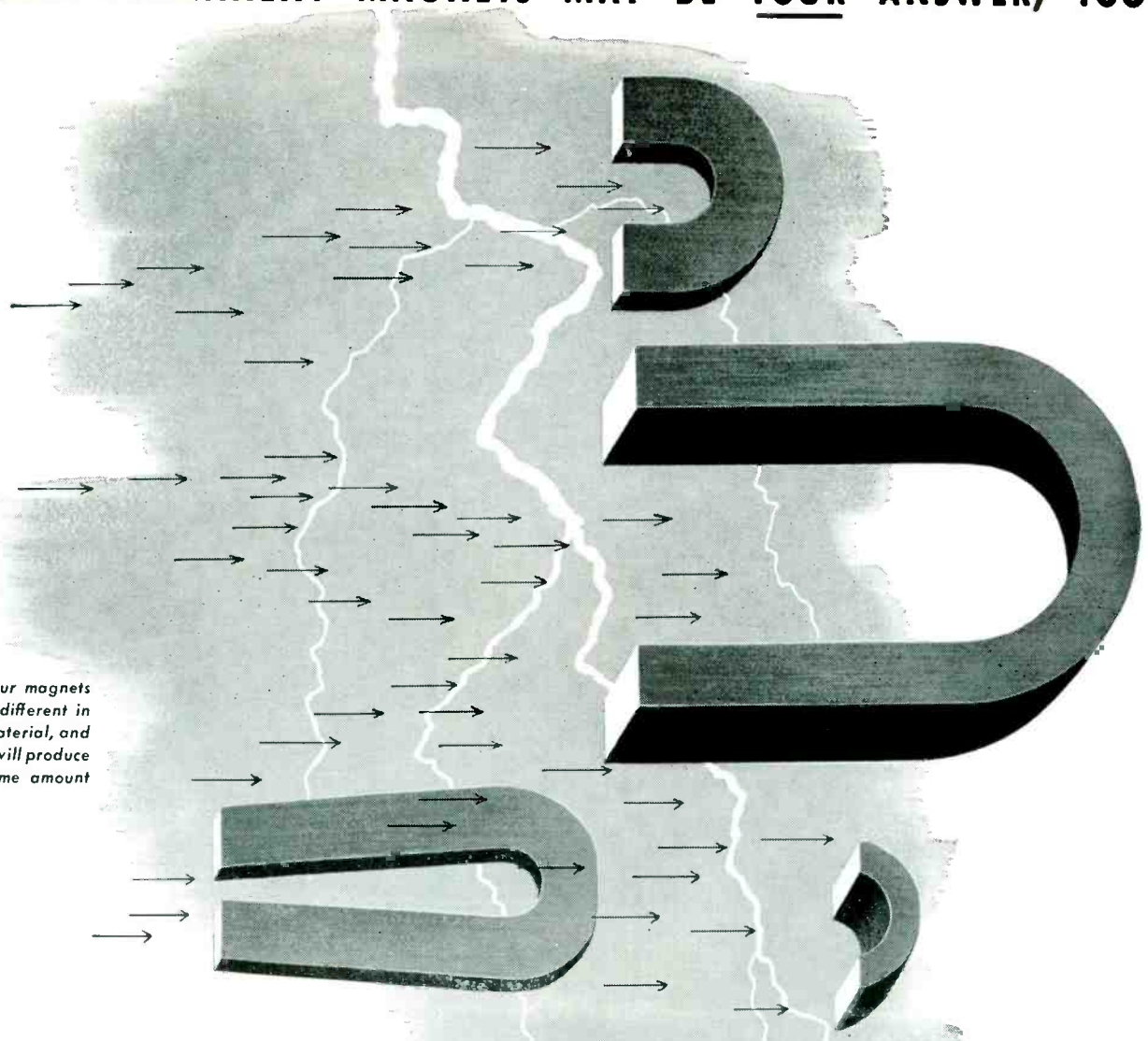
LAMICOID is made to the highest standards of quality, based on our 56 years of experience in making fine electrical insulating materials. Contact our nearest sales office or fabricator for further information.

MICA Insulator COMPANY

Schenectady 1, New York

Offices in Principal Cities

INDIANA PERMANENT MAGNETS MAY BE YOUR ANSWER, TOO



Each of the four magnets shown here is different in size, weight, material, and price; yet each will produce exactly the same amount of energy.

"PACKAGED ENERGY" SAVES SPACE, CUTS COSTS

INDIANA permanent magnets fit your need like a doctor's prescription—the right material, the right design, the *right* magnets to *do your job best.*

When you buy *Indiana* permanent magnets, you buy *product improvement* . . . new and higher efficiency . . . new versatility . . new economy. Today, *Indiana* magnets are performing operations that were impractical only a few years ago—actually replacing many mechanical and electrical devices—and with less weight, less bulk, *lower cost.*

For example, certain radar magnets of Alnico originally weighed 14 pounds. Through *redesign* by *Indiana,* their size was reduced materially and their weight cut to 3½ pounds. Both were of identical material; both produced the same energy. The substantial savings in weight and cost were accomplished wholly by a change in design. Consultation with our engineers may result in similar savings for you.

NEW! BOOKLET NO. 4-E6—TELLS ALL ABOUT PERMANENT MAGNETS. A NOTE ON YOUR COMPANY LETTERHEAD WILL BRING YOU A FREE COPY.

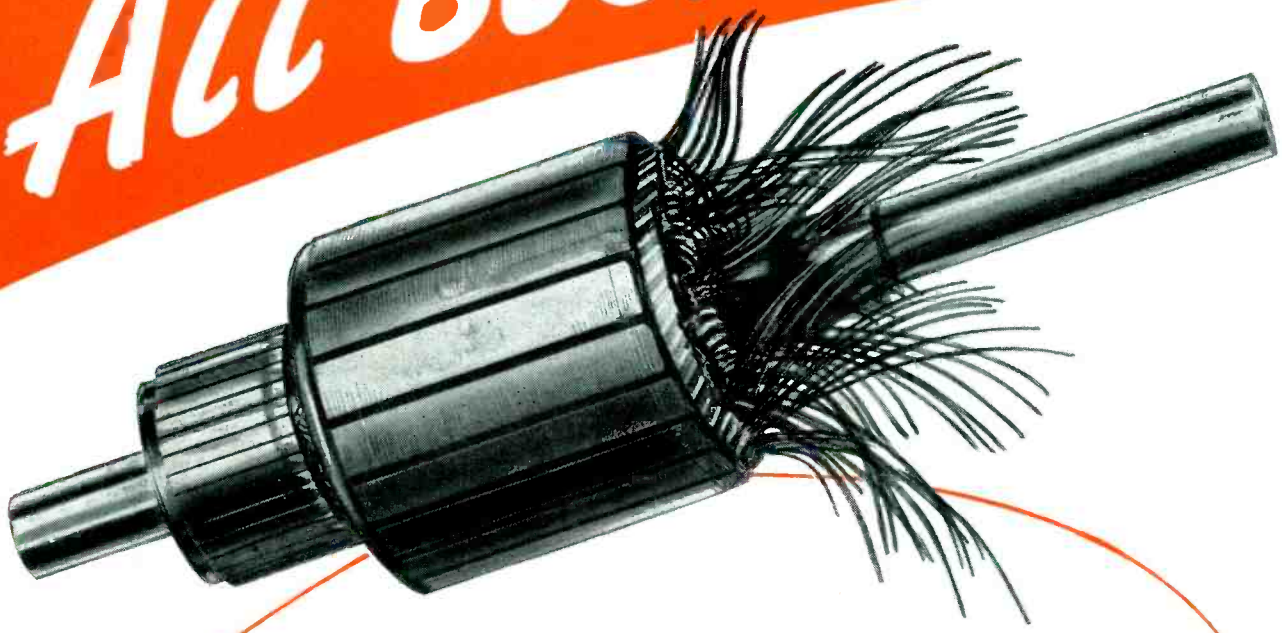
Indiana is the *only* manufacturer of all types of commercially used permanent magnet alloys. Continuous research and production control assure top quality and uniformity of *all* your *Indiana* permanent magnets, regardless of size or quantity. Call on our Special Design Service in solving *your* problems.

THE INDIANA STEEL PRODUCTS COMPANY

PRODUCERS OF "PACKAGED ENERGY"
6 NORTH MICHIGAN AVENUE • CHICAGO 2, ILL.

SPECIALISTS IN PERMANENT MAGNETS SINCE 1908
PLANTS: VALPARAISO, INDIANA; CHAUNCEY, N. Y.

All Busted Up?



USE SCHENECTADY VARNISH #150 *New*

for insulation at High Speeds

We are keeping pace with modern electrical design which stresses high operating speeds, high temperatures and smaller units. No. 150 answers this problem by offering an easy to apply varnish which has top insulating qualities. The mechanical strength of 150 varnish actually increases at elevated operating temperatures.

FOR COMPLETE SPECIFICATIONS OR TECHNICAL FIELD SERVICE . . . WRITE

SCHENECTADY VARNISH CO., INC.

200 CONGRESS ST., SCHENECTADY, NEW YORK

RESEARCH KEEPS SCHENECTADY . . . *"FIRST IN VARNISHES"*

BUSINESS BRIEFS

By W. W. MacDONALD

Early In The Morning on the day FCC announced that licenses to operate citizens band transmitters would be issued generally beginning June 1 (see p 128) the CIO's Political Action Committee tipped off its local leaders that sets might be used by pickets and by block workers getting out the vote. This is, indeed, action.

TV-Tube Implosions have so far been few and far between and we know of no specific instance in which anyone has been injured. Nor is there any reason why anyone should be if the tubes are left alone by laymen and handled with reasonable care by technicians.

Manufacturers interested in preserving the safety record are planning a cooperative campaign telling technicians how to handle picture tubes in the plant, in the service shop and, where necessary, in the home. Suggestions will probably include cradling tubes to distribute their weight more or less evenly rather than carrying them by the neck, wearing masks or goggles and protective aprons when working around them with tools and driving a spike through tubes in cartons rather than striking the cartons a blow with a blunt instrument for disposal.

Solderless Connectors are commonly used in electrical equipment, in many instances speeding up production and, in most, simplifying installation and maintenance. They are being used in more and more industrial electronic devices and acceptance is slowly growing even among designers of sensitive instruments and communications apparatus.

Manufacturers of solderless wiring connectors, however, say there is one barrier they cannot seem to hurdle, and that is the application of their products in low-level high-gain circuits. Is this an unjustified taboo, a hangover from the days when everything associated with tubes had to be soldered? Or is too much noise produced by fluctuation of contact resistance? Who has figures that tell how much noise is tolerable? How, indeed, should requirements be determined by test?

While soldering may be the easiest way to make most connections in low-level high-gain circuits we suspect that many could satisfactorily be made by means of solderless wiring devices and that there are production, installation and maintenance advantages. We also suspect that if noise standards were set up manufacturers could in most instances easily meet them.

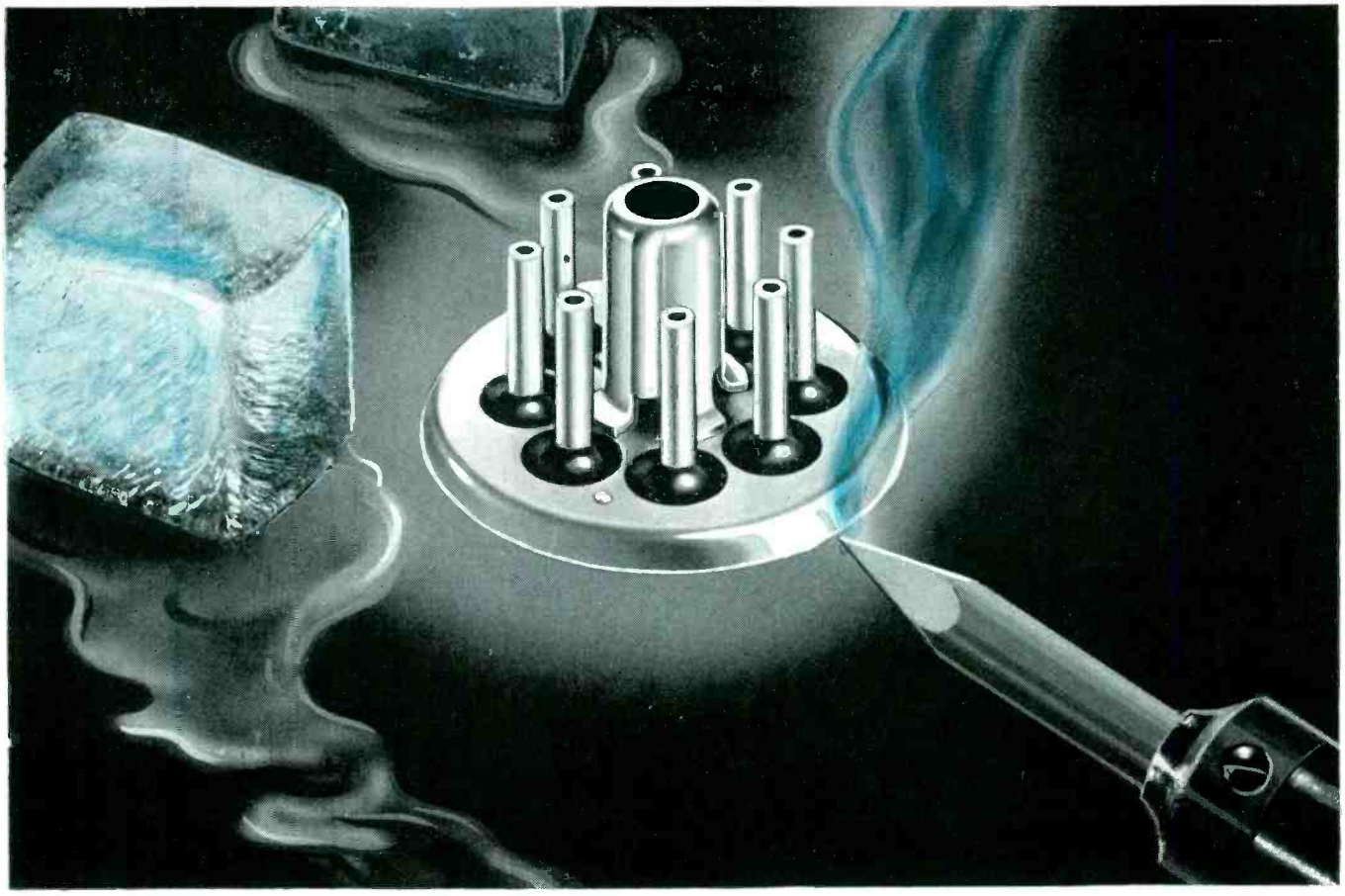
A Reader working for one of the major airlines tells us he has developed an electronic converter, having no moving parts, that should be useful as an alternating-current power source for such things as aircraft, mobile and portable radios, and also possibly in connection with Geiger counters and hearing aids.

We'll be glad to forward letters from any interested manufacturers.

Two-Year Program to reduce size and weight of electronic equipment in military aircraft has produced savings up to 50 percent. The importance of the program becomes apparent when it is realized that in one large bomber over 4,000 pounds of such equipment, of 17 different types, has heretofore been carried.

Crystal Business, good during the war and, by comparison, bad immediately after, is reported to be picking up. Just how much of the pickup is due to increased government business and how much to reduced competition is hard to say.

Membership Drive currently under way by the Society of Motion Picture Engineers, having 3,000 technicians including theatre projectionists on its roster, makes television-station engineers welcome. Similarly, we are told that SMPE will extend its bids for financial support beyond the movie



Let's Put the Chill on a Hot Subject . . .

As you read this message engineers the country over are hard at work planning, experimenting on fused hermetic sealing for their company's electrical product.

When the subject of a so-called glass terminal comes up (and it's bound to) they're apt to talk in terms of thermal shock. That's where Fusite Hermetic Terminals come in.

Take the interfusion of steel and inorganic glass that is a Fusite terminal. Apply the sizzling heat of a soldering or welding operation. And if you want to be ornery, shove it right out on the shipping dock on a zero day.

What happens?

Absolutely nothing. Your seal remains as tight as your production skill made it. All Terminals remain as smooth, as rugged, and uniform as only Fusite makes them.

Would you like to know more, or see samples? Write to Dept. E.

TERMINAL ILLUSTRATED 908HTO—For plug-in to standard "Octal" sockets. Available with two to eight hollow tube electrodes.

INSULATE ELECTRICALLY
GLASS TO METAL
FUSITE
TERMINALS
PROTECT PRODUCT PERFORMANCE
SEAL HERMETICALLY

THE FUSITE CORPORATION

CARTHAGE AT HANNAFORD, NORWOOD, CINCINNATI 12, OHIO

studios to television networks and makers of video gear. At the annual convention in New York in April the Society pulled the stops out and devoted the preponderance of its time to television.

TV Receiver Shipments by RMA-member companies in 1948 totaled 946,206, broken down as follows:

Alabama	23
Arkansas	61
California	81,536
Colorado	37
Connecticut	13,769
Delaware	2,557
District of Columbia	25,556
Florida	846
Georgia	4,831
Illinois	59,897
Indiana	4,414
Iowa	48
Kansas	9
Kentucky	3,119
Louisiana	3,983
Maine	14
Maryland	24,537
Massachusetts	33,276
Michigan	21,449
Minnesota	5,836
Mississippi	30
Missouri	12,337
Nebraska	31
New Hampshire	355
New Jersey	83,313
New Mexico	225
New York	232,684
North Carolina	231
North Dakota	1
Ohio	33,958
Oklahoma	28
Oregon	134
Pennsylvania	90,298
Rhode Island	4,378
Tennessee	3,146
Texas	8,706
Utah	1,001
Vermont	3
Virginia	2,921
Washington	4,569
West Virginia	167
Wisconsin	10,720
Areas Not Determined	26,991

Shipments, it should be noted, always trail behind production reports (some of the shipments listed above represent 1947 production). RMA-member companies produced 866,832 television receivers in 1948, and it is estimated that the whole industry made 975,000.

Sales Researcher Frank Mansfield of Sylvania, having so far interviewed 1,686 non-television owners in eight areas within video range, says at least 1,580,000 are wide open for sets in 1949 and that the industry ought to be able to sell as many as 2,710,000 if everything goes well.

Reading The Want Ads, we are always intrigued by the appearance of offers of jobs and offers of personal services almost on the same page. Like ships that pass. forlorn, in the night. At the moment many of the jobs offered engineers seem to be in the field of airborne electronics, while many

of the job seekers seem to be from the radio-receiver field. This, perhaps, indicates not a recession but a migration.

Money Intake by the Radio Corporation of America and its domestic subsidiaries totaled $357,617,231 in 1948 as against $314,023,572 in 1947, broken down as follows:

	1948	1947
RCA (inc. Victor, Labs., RCA Int.)	75.7%	74.3%
NBC	19.8	20.9
RCA Comm. and Radiomarine	5.9	6.1
Less inter-company transactions	*1.4*	*1.3*

Money outgo, including cash carried to surplus to balance the books against the intake totals shown, broke down this way:

Materials, talent, rent, adv., etc.	50.8%	53.2%
Salaries	34.5	34.4
Depreciation and amortization	1.8	1.5
Interest	.2	.2
Taxes	6.0	4.8
Dividends	2.8	2.3
Carried to surplus	3.9	3.6

Corporation profit after taxes was 6.7 percent in 1948, 6 percent in 1947.

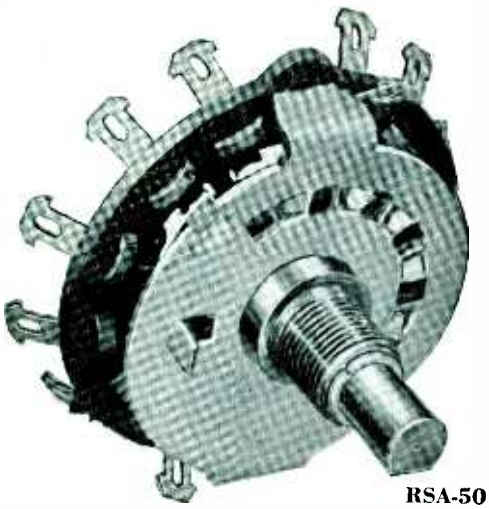
Philco's 1948 Business broke down as follows: 46 percent television, radios and phonographs; 40 percent refrigerators, freezers and air-conditioners; 9 percent vacuum tubes, parts, dry batteries and accessories; 5 percent government and industrial business.

C-R Tube Sales to the television-receiver market increased 361 percent in units and 312 percent in dollars in 1948 as against 1947, according to RMA. During the year 1,265,472 tubes, valued at $31,985,461, were sold. Of these, 1,179,444 went to set makers as original equipment, 84,230 were for renewal, 1,380 were bought by the government and 418 were exported.

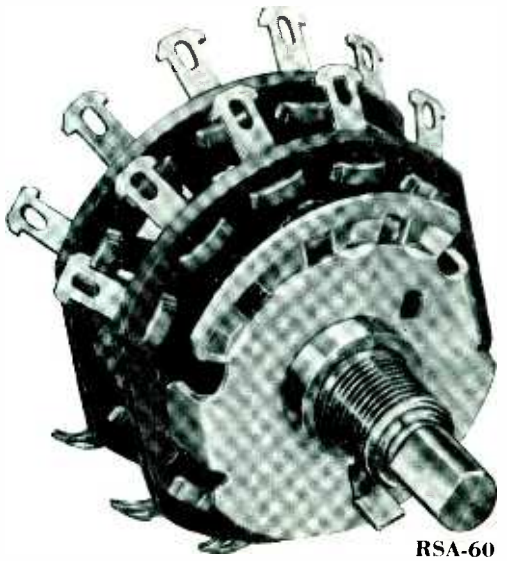
Tele Drive-In Theatres are getting a big play on the West Coast.

Saddest Sight of the month, witnessed by one of our associates in a retail store, was a demonstration of a new radio set of a certain make during which the contraption poured out glowing commercials concerning a television receiver made by the same company.

Two Single or Double Section Switches...



RSA-50



RSA-60

...of Space Saving Design and Mallory Precision Quality

Where space is a factor—dependability essential—the Mallory RSA-50 and RSA-60 switches fill the bill!

These circuit selector switches, with section and terminal design identical to that of the famous Mallory RS-50 and RS-60 switches, are designed for band and tone control switching in radio receivers and other electronic applications where medium and low torque indexing action is desired.

The index assembly is of durable design and constructed with a minimum of parts—affording dependable service life with low torque and positive indexing action.

Note these many features, inherent in all the Mallory RS series, which contribute to their dependability and quality:

- **Insulation of high-grade, low-loss laminated phenolic.**
- **Terminals and contacts of special Mallory spring alloy, heavily silver-plated to insure long life at low contact resistance.**
- **Terminals held securely by exclusive Mallory two-point fastening—heavy staples prevent loosening or twisting.**
- **Double wiping action on contacts with an inherent flexing feature—insures good electrical contact with the rotor shoes throughout rotation.**
- **Six rotor supports on the stator—insure accurate alignment.**
- **Brass rotor shoes, heavily silver-plated—insure low contact resistance.**
- **All shoes held flat and securely to phenolic rotor by rivets—prevents stubbing—insures smooth rotation—*minimum of noise in critical circuits.***

The RSA-50 and RSA-60 are both available in one or two section construction. The RSA-50 accommodates up to twelve terminals on either side of the section and provides from 2 to 6 positions. The RSA-60 accommodates up to ten terminals on either side of the section and provides from 2 to 5 positions. The RSA-60 has the narrow section design—ideal for under chassis mounting, where space saving is paramount.

ENGINEERING DATA SHEET

Send for the Mallory Engineering Data Sheet on the RSA-50 and RSA-60. It contains complete specifications for available circuit combinations with respective terminal locations, dimensional drawings—everything the engineer needs to adapt the RSA-50 or RSA-60 switch to a particular circuit.

SPECIFICATION SHEETS

Specification sheets for the RSA-50 and RSA-60 switches have also been prepared. These sheets are printed on thin paper to permit blueprinting. The sectional drawings indicate standard and optional dimensions—make it easy for you to order production samples built to your requirements.

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P.R. MALLORY & CO. Inc.

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Capacitors	Rectifiers
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Controls	Vibrators

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CROSS TALK

▶**SHADOW** . . . Electronic computers are often too fast for their own good, so much so that one of the principal problems now facing designers is a means of getting numerical information out of the computer as fast as it is computed. Magnetic tape is a great advance, over manual methods, but still limited in speed. Now comes word of the Charactron, a cathode-ray shadowgraph device, which passes a defocused beam through metal plates in which have been cut, stencil-fashion, the outlines of numbers. The beam, passing through the stencil outline, forms the corresponding number on the phosphor of the tube. By a selective deflection system similar in form to a honeycomb, it is possible to form multi-digit numbers, at selected positions on the tube face, at the rate of 20,000 characters per second, or about as fast as any computer can spew them out. A high-speed movie camera can photograph the output for storage and later study. The tube, developed by J. T. McNaney at Consolidated Vultee Aircraft Corporation, is also suitable for displaying other forms of printed information at high speed.

▶**SALARIES** . . . We are surprised to note that recent electrical engineering graduates (the majority of whom are electronics or communications majors) are not the best paid of the current crop of technical newcomers. So, at least, is the report of a survey conducted by New York University among its recent engineering graduates.

In 1947 the "electricals" headed the list with an average starting salary of $238 per month, followed by civil, chemical, mechanical and aeronautical graduates in that order. But in 1948, the highest pay went to the new crop of chemical engineers, followed by the mechanicals, civils, electricals and aeronauticals in that order. The salaries of all were higher in 1948 by from 5 to 16 per cent; the average starting salary of the electrical graduates went up 5.5 percent from $238 to $251. This is a rather small sample (177 men replied to the survey questionnaire), and perhaps not indicative of any general trend. But it bears watching.

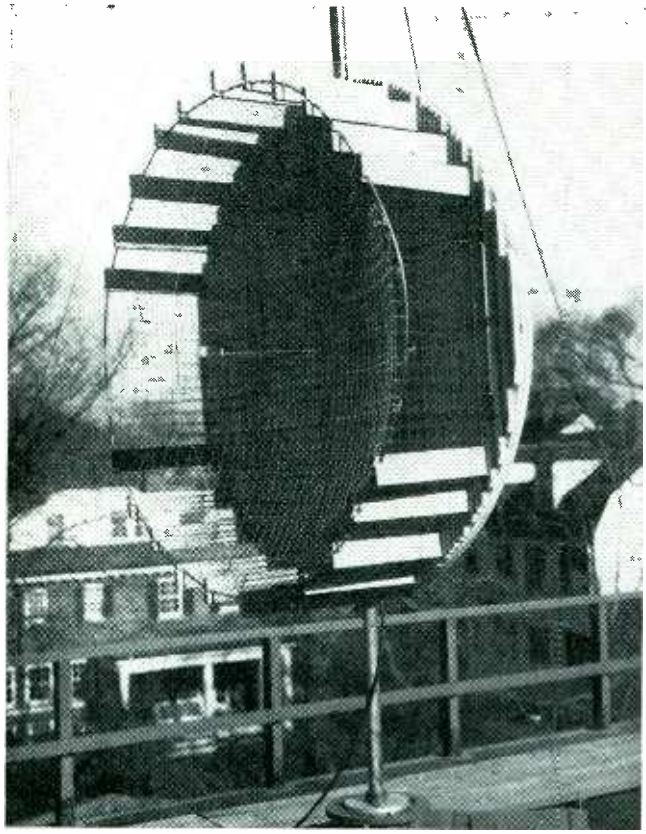
The professors have been predicting overpopulation among electronics engineers ever since the end of the war. If the supply of new men in electronics is catching up with the demand (and we still doubt it) the time is ripe for a reassessment, by educators and employers, of the real needs of our field. Our firm belief is that a great many more engineers can be employed, particularly in the development of new techniques, than are envisaged in the current plans for expansion of our industry. Let's not discourage the new talent.

▶**FREE TIME** . . . The common complaint that a television set in the house takes over too much precious leisure time has moved Paul Raibourn, vice-president of Paramount Pictures, to consider in a recent speech how a man spends his time. Of the 168 hours in a week, about 98 go to such essential needs as sleeping, eating, dressing, bathing, shaving and going to and from work. Time was, 100 years ago, when the remaining 70 hours were wholly occupied in work. Now, with the 40-hour work week, we have about 30 hours for leisure.

Surveys indicate that 7 to 8 hours per week go to radio listening, at a cost of $42 a year, 1½ hours a week for the movies at $35 per year, 1½ hours with newspapers at $40, magazines ¾ hour at $20, auto 3 to 6 hours at $400 yearly, and 15 hours of spectator and participant sports and games, hobbies and the like. So along comes television. It costs about $100 a year, all things considered, and the time it takes —well, you name it!

We might suspect Mr. Raibourn of whistling in the dark, were it not for his years of active support of television, when he remarked that a decrease in the work week from 40 to, say, 30 or 35 hours, might allow television to take its place without affecting other leisure-time-consuming industries. From where we sit, even that's not enough extra time.

Basic Research Projects



Parabolic reflector being used for tropospheric reflector studies at Cruft Laboratory

Jet aircraft model used at Cruft in connection with aircraft antenna research project

THROUGH the Office of Naval Research (ONR), the Department of the Navy is sponsoring basic research under an Act of Congress dated August 1, 1946. The objective of ONR is to plan, promote and coordinate Naval research. It is concerned mainly with basic research, while the Bureaus of the Navy are concerned with development and research directly associated with development.

ONR conducts a large amount of applied and basic research at the Naval Research Laboratory and other Naval laboratories. However, several divisions, including the Physical Sciences Division, are charged with basic and fundamental research for which it is expedient to utilize the facilities of universities and the talents of their civilian scientific personnel.

Placing work with universities achieves a number of objectives. These include the expansion of research facilities of smaller institutions and distribution of activity over a wide area. In addition, the program establishes a reservoir of scientists who have become familiar with important problems while working on ONR-sponsored research. The program also trains many graduate students, thus increasing the nation's scientific manpower resources. Past deficiencies here were forcefully revealed in the Steelman Report to President Truman on the nation's scientific activity.

Work sponsored by the Electronics Branch of the Physical Sciences Division of ONR is not contained only in large university projects. A particular effort is made to sponsor smaller programs, with the result that much effective work is done which could never have been initiated without external support.

The field of electronics has been divided into seven subfields or categories for ONR-sponsored research. These are Propagation, Radiation and Matter, Electron Ballistics, Physics of Components, Circuitry, Systems and Instrumentation.

All of the present projects under active sponsorship have been coordinated with the other services and are considered to be important from a scientific as well as a purely Naval viewpoint. Some projects, however, are more interesting than others from the standpoint of immediate application and specific results obtained. In the field of purely basic research this probably is more the exception than the rule. However, this article is primarily concerned with such projects and gives some indication of the practical benefits accruing.

Cruft Laboratory at Harvard

In the fields of electromagnetic radiation, propagation and microwave circuits, Harvard University's

Under ONR Contracts

Survey of extent to which Office of Naval Research is sponsoring fundamental research in small as well as large universities, and details of several current projects that promise early practical applications

By KARL R. SPANGENBERG and **WALTER E. GREENE**
Head, Electronics Branch
Physical Sciences Division, ONR
(On leave from Stanford University)

Lieutenant Commander
Electronics Branch, ONR
U. S. Navy Department

Cruft Laboratory is doing some interesting work.

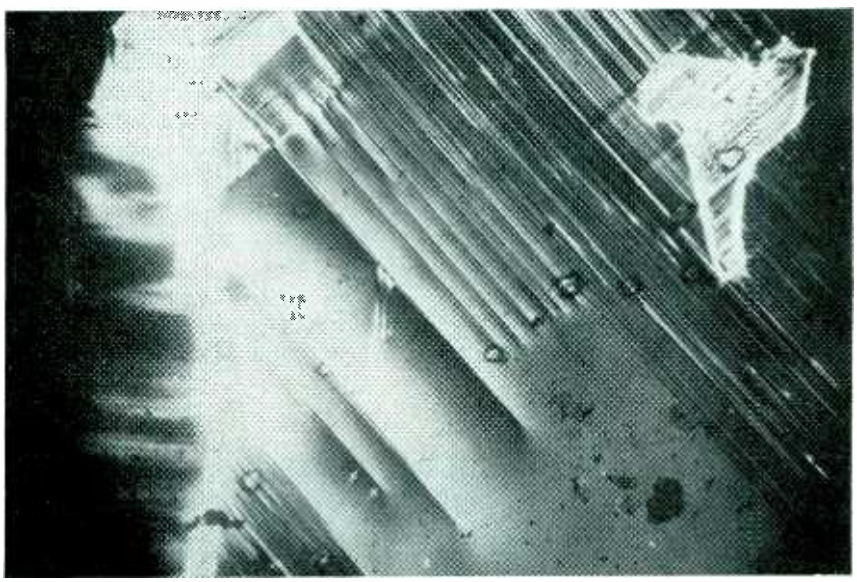
A rather large group there is involved in the recording and analyzing of sky-wave radio signals received over long distances. The objective of this group is to be able to predict the characteristics of radio transmission from point to point from a correlation of vertical and oblique ionospheric measurements. Signals of various frequencies received over long paths at Cambridge, Massachusetts, from Glenville, S. C., Las Cruces, N. M. and Lindau, Germany are being automatically recorded. On the Cambridge-Glenville circuit, it so happens that Sterling, Virginia, near Washington, is halfway between the ends of the circuit and directly under the point of grazing incidence of the skywave. It thus becomes possible to continuously examine at vertical incidence the point of reflection of a sky-wave from the ionosphere and correlate this vertical incidence data with signal strength and other factors at the receiving and transmitting sites.

Another group at Cruft is studying the stabilization of microwave oscillators. The ultimate goal of this group is setting up a new type of frequency standard, independent of most of the normal causes for inaccuracies in present standards. Such an accurate oscillator circuit could be used to operate an extremely precise chronometer. Present efforts are directed to the stabilization of such oscillators by an ammonia absorption line.[1] Circuits developed so far are delicate, complex and rather sluggish in their reaction time to a correcting impulse. As a consequence, there still remains a fertile field for investigation of this problem. Variation of the ammonia absorption spectrum with changes in temperature and pressure is being investigated also.

Important work of a highly practical nature is also going forward at Cruft in the field of aircraft antenna measurements. This group is investigating new methods for the study of various antenna systems on full-scale aircraft structures. Measurements over a wide frequency range have been made on a number of antennas, including the inverted-L, inclined wires and other configurations. Better radiation patterns will be developed as a result of such work as this.

Massachusetts Institute of Technology

In any discussion of basic research the question often arises as to just how basic can research be. The definition of basic research depends upon one's point of view. However, work in progress at the Laboratory for Insulation Research at Massachusetts Institute of Technology is probably as basic as any under the cognizance of the Elec-



Optical demonstration of lattice strains near wedge-shaped domains in barium titanate. Fine laminar wedges move back and forth in a varying electric field to produce initial susceptibility. Research on nonlinear ferroelectrics such as this has been assigned to the Laboratory for Insulation Research at MIT

tronics Branch of ONR today.

Some of the most interesting work done at the Laboratory for Insulation Research has been in the field of high-dielectric ceramics such as barium titanate and mixtures of barium and strontium titanates. These ceramics are nonlinear ferroelectric dielectrics similar in many respects to Rochelle salt. Investigating emphasis has been on properties pertinent to the design of nonlinear capacitors.

There is considerable indication of hysteresis in measurements on barium titanate, showing that it is truly ferroelectric over certain temperature ranges. The ferroelectric properties of these materials can be exploited in nonlinear circuits such as harmonic generators, modulators and possibly dielectric amplifiers.

Under certain conditions barium titanate can also be piezoelectric. Many practical uses can be found for this, such as microphone elements, phono pickups[2, 3] and pressure gages. Pickups and microphones using the ceramic as the generating element are already on the market.

The advantage of the ceramic type of generating element over the conventional element is that the ceramic is much more stable over wide ranges of heat, moisture and dryness. Ceramic units can be designed to have a very good frequency response characteristic and are comparatively rugged.

Stanford University

Among the projects at the Electronics Research Laboratory of Stanford University may be mentioned the traveling-wave tube and radar reflections from ionized meteor trails.

In traveling-wave tube work, attempts are being made to extend the use and understanding of this mechanism of continuous interaction between a traveling electromagnetic wave and an electron beam.[4] The outstanding features of this novel tube are its great bandwidth and high gain at microwave frequencies. Voltage gain—bandwidth products are approximately 1,000 times those of conventional low-frequency tubes and nearly 2,000 times those of klystrons. Some typical performance figures are: Amplification 23 db; bandwidth 1,000 mc; operating frequency 4,000 mc; operating voltage 1,600 volts; beam current 10 ma; power output 2 to 3 watts.

At the present stage of development the traveling-wave type of tube has a rather objectionable noise figure, and much effort is being put on the noise reduction problem. This type of tube will be of use in such applications as broadband receivers for television services, broadband ultrahigh-frequency i-f amplifiers, broadly tunable uhf receivers with simple wide-range tuning mechanisms, local oscillators for uhf receiver, radar services and many others.

Other successful traveling-wave tubes have been produced which operate in other portions of the spectrum, such as at 3 cm.

In the meteor ionization research at Stanford it is desired to learn about the electrical and physical properties of the ionosphere through the study of radio reflections from meteor ionization trails. The use of these reflections as a means of studying meteors themselves will also be investigated. Both pulse and Doppler (continuous wave) measuring techniques are being used.

It has been shown that as meteors pass through the outer envelope of air surrounding the earth, they leave behind a trail of ionized air. Even a minute particle may produce an ionized envelope one hundred kilometers long or more. This ionization can be great enough to readily reflect radio waves. Monitoring of short-wave radio stations is perhaps the simplest way to detect meteors by radio, although it is not completely satisfactory. The received signal strength must be of a certain value, the distance from the station to the receiver must be proper and the frequency must be coordinated with the above parameters. The research group is using laboratory transmitting, receiving and recording apparatus, and it is expected that much useful data on the earth's outer atmosphere will be obtained from this project.

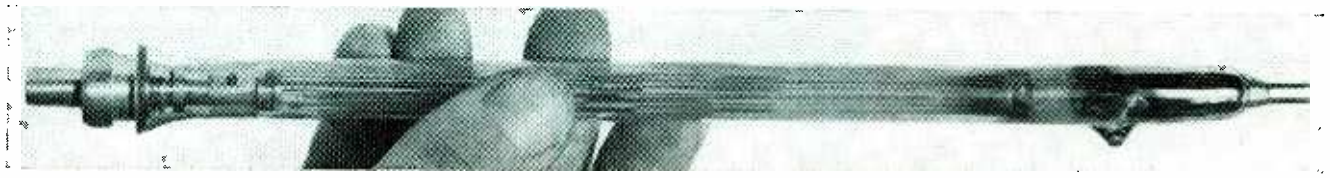
University of Illinois

The Department of Electrical Engineering of the University of Illinois has a project on Direction of Arrival of Radio Waves. Work is currently going forward on Antenna Arrays for Direction Finding, System Analysis, Data Presentation and Amplifier Development.

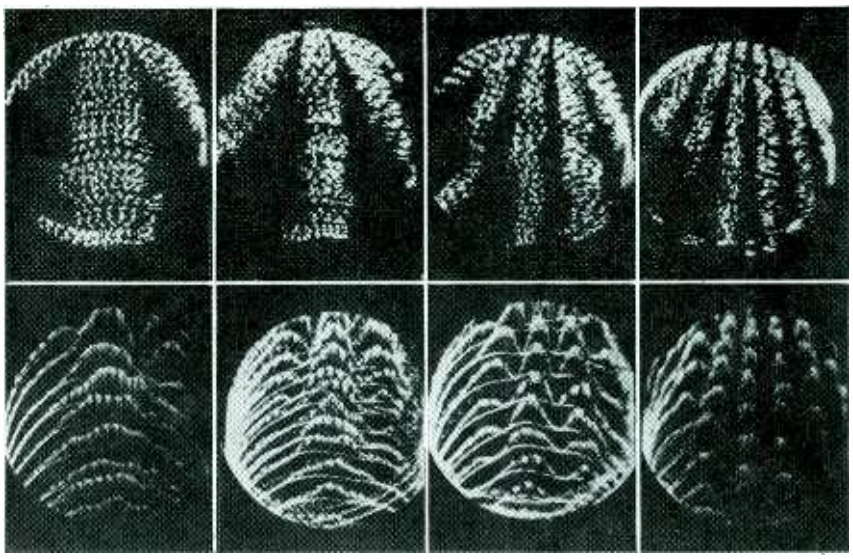
A rigorous mathematical analysis has shown that super-gain antenna arrays are not practical due to a very large decrease in radiation resistance and bandwidth and a consequent increase in ohmic losses and difficulty of tuning.

The Data Presentation group is concerned with the construction of an eight-gun cathode-ray oscillograph for use in simultaneous presentation of bearing information from eight or fewer sources.

The System Analysis group is presently working on characteristics of existing direction-finding systems. Construction work on the Antenna Simulator has proceeded sufficiently far to allow preliminary examination of several radio d-f



Three-centimeter wavelength traveling-wave tube being used at Stanford University in research aimed at reducing the noise figure of this broadband amplifying device



Oscilloscope patterns of wave interference in an electromagnetic field. Wavelength of both sources is 10 cm. Vertical columns from left to right are for distances of 1, 2, 3 and 5 wavelengths respectively between the interfering sources. University of Illinois photo

systems by this means. It is expected that much useful information will be forthcoming from this d-f work. The results should be of value to commercial organizations as well as the Armed Services.

Brooklyn Polytechnic Institute

The Brooklyn Polytechnic Institute has a program of investigation in the general field of nonlinear electrodynamics. One of their projects concerns an analysis of transient response of various circuits to f-m signals. The effect of the frequency swing-bandwidth ratio on the transient signal has been analyzed theoretically. It has been shown that the frequency swing should not exceed one-half the bandwidth for low distortion in conventional circuits.

Since in any f-m system the frequency discriminator is of great importance, considerable effort has been spent on analyzing various circuits. It was demonstrated that the balanced type of detector was most beneficial in reducing harmonic distortion.

Some effort is also being put on the mathematical analysis of iron-cored circuits, with emphasis on magnetic amplifiers. Analyses are being made to determine the effect of system parameters on the time constant and to investigate means whereby the overall speed of response of magnetic amplifier circuits may be increased without undesirable effects on other characteristics.

It is expected that the newer highly permeable core materials now becoming available will have a more profound effect on the overall characteristics of future magnetic amplifier control systems than any radically different circuit arrangements which may be developed.

Other Projects

The particular projects mentioned here are by no means the only projects of their kind under ONR sponsorship, nor do they represent the only productive work. For example, in the field of high-powered microwave generators, the 10-megawatt magnetron being developed by the MIT Research Laboratory for Electronics is one of several tubes under development. In other categories of research, much fine productive work is being done by many smaller institutions, but space limitations do not permit mention here.

More specific information on these and other interesting projects will be published by the research workers themselves in various scientific periodicals, since none of the work sponsored by the ONR Electronics Branch is of a classified nature. The scientists are encouraged to disseminate widely the results of their investigations. The thought behind this is that fundamental truths should be free to everyone in order to increase the efficiency of the transition from original basic considerations to practical, concrete applications.

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(2) L. Grant Hector and H. W. Koren, Ceramic Phonograph Pickup, ELECTRONICS, p 94, Dec. 1948.

(3) G. N. Howatt, J. W. Crownover and A. Drametz, New Synthetic Piezoelectric Material, ELECTRONICS, p 97, Dec. 1948.

(4) Wideband Microwave Amplifier Tube, ELECTRONICS, p 90, Nov. 1946.

(5) Chas. R. Burrows, Radio Astronomy, ELECTRONICS, p 75, Feb. 1949.

UNIVERSITIES WITH ONR ELECTRONIC CONTRACTS

CARNEGIE INSTITUTE OF TECHNOLOGY—Investigation of Magnetic Amplifiers
CORNELL UNIVERSITY—Microwave Astronomy[5]
DARTMOUTH COLLEGE—Electromagnetic Wave Polarization
HARVARD UNIVERSITY—Measurement of Recombination Coefficient; Propagation and Circuit Studies (Cruft Laboratory)
LINFIELD COLLEGE—The Field Emission of Electrons from Metals
MASSACHUSETTS INSTITUTE OF TECHNOLOGY—Research in Physics of Components
POLYTECHNIC INSTITUTE OF BROOKLYN—Nonlinear Electrodynamics
PRINCETON UNIVERSITY—Dielectric Properties and the Structure of Matter
STANFORD UNIVERSITY (Electronics Research Laboratory)—Special Microwave Tubes and Circuits
UNIVERSITY OF ILLINOIS—Investigation of Radio Direction-Finding Systems; Research on the General Problem of Broadband Amplification in the Microwave Frequency Range
UNIVERSITY OF MISSOURI—Solid-State and Surface Physics Research on Semi-Conductors and Insulators
UNIVERSITY OF TEXAS—Tropospheric Propagation at Ultra High Frequencies
WASHINGTON STATE COLLEGE—Facsimile Recording Paper
YALE UNIVERSITY—Characteristics of Split-Anode Magnetrons and Reflex Klystrons; High-Frequency Discharge Through Gases and Self-Sustaining Arcs; Microwave Propagation in Material Media

Minimizing Television Interference

Techniques for making possible the reception of programs in regions far removed from the normal service areas of transmitting stations by improving the effective sensitivity and selectivity of receivers. Types of interference are explained and suggestions made for decreasing their effect on reception

By P. S. RAND

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Remington Rand Inc.
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TELEVISION is growing up at a phenomenal rate and has already begun to experience growing pains. One of these is interference to the picture, commonly designated by the abbreviation tvi.

There is hardly a receiver sold that does not at some time receive tvi of some sort on some channel. Radio listeners long ago became accustomed to hearing static, whistles and other forms of interference on their broadcast receivers. It is unfortunate for television that the eyes are much more sensitive to interference.

The television industry is snowballing, doubling and redoubling production figures, turning out hundreds of thousands of receivers. New television transmitting stations are springing up all over the country and people in these new areas are clamoring for receivers. Each one expects to get bright, clear, movie-like pictures, despite the fact that the nearest television station is in some cases as much as 130 miles away.

Receiver Sensitivity

The receiver purchased may be designed to work satisfactorily in a primary coverage area of 5,000 microvolts signal strength, or in a rural area of 500 or more microvolts. Receivers are often installed in industrial areas where the signal strength may be as low as nine microvolts. Customers in such areas get plenty of snow or tube noise in pictures and undoubtedly will have the picture blanked out at times by various types of man-made interference.

Because of its relatively wide bandwidth, television is especially subject to interference. In a superheterodyne it is the function of the i-f amplifier to provide adequate rejection of undesired signals near the pass band, while the front end provides rejection of signals far removed from the pass band and especially signals at the intermediate frequency and image frequency.

Superheterodynes are inherently subject to interference from a multitude of signal frequencies and television superhets are no exception to the rule; in fact, because they must operate in the vhf region, they are more than usually susceptible to several types. Interference resulting from spurious responses most troublesome in television reception and the fault of receiver design includes:

(1) Direct i-f feedthrough.

(2) Image interference, arising from a combination of local oscillator frequency plus i-f.

(3) Signal image interference, resulting from local oscillator frequency plus signal frequency.

(4) Interference occurring at twice the oscillator frequency plus or minus the i-f.

(5) Direct reception of the oscillator signal from a nearby television receiver.

The practical remedies for these faults as they apply to the various interference manifestations will be discussed below.

Receiver Radiation

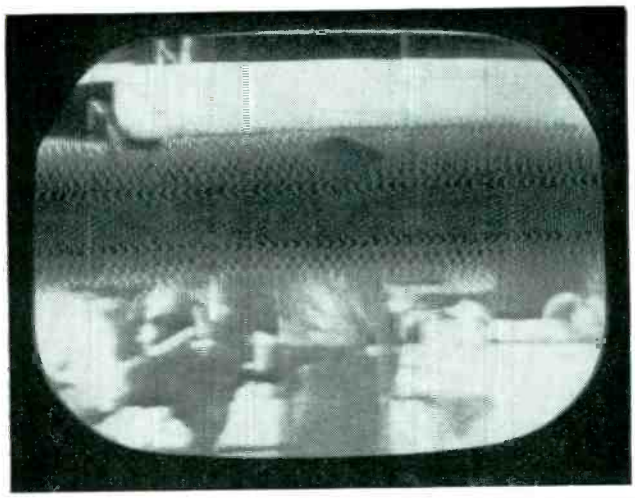
It is necessary to have a high frequency oscillator in a superheterodyne type of circuit. However, it is not necessary to couple it to the antenna. Figure 1 shows the circuit of a front end used by several manufacturers during the past few years. Radio-frequency energy is coupled from the oscillator coil to the mixer grid coil, where it is detected with the television signal to form the i-f signal. Being only slightly higher in frequency than the desired signal, it is also fed into the r-f stage plate circuit where it easily finds its way through the partly neutralized push-pull triodes and thence to the antenna circuit.

Receiver Design

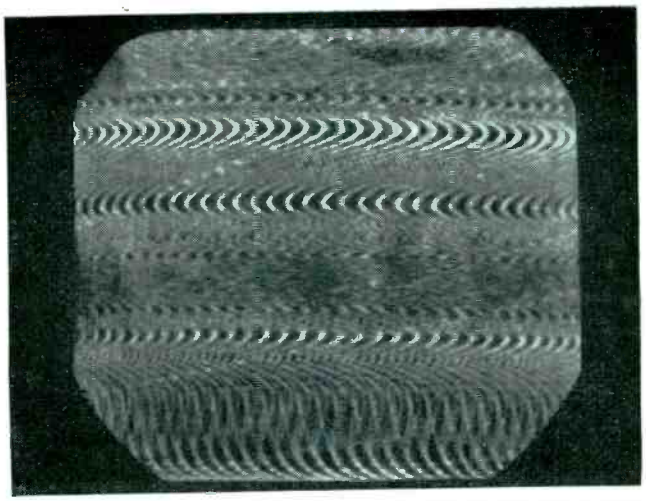
There are many causes of television interference that lie outside the realm of receiver design, particularly if reception in weak-signal areas is involved.

Where venetian-blind effect is removed by synchronization of carriers (*Electronics*, Feb. 1949) there will still be many viewers who see two pictures at the same time. Diathermy, spark-plug and home-appliance interference may be very troublesome. The author has, however, proved to his own satisfaction that the present-day production receiver can be modified so as to remove a very large part of even the uncontrollable interference.

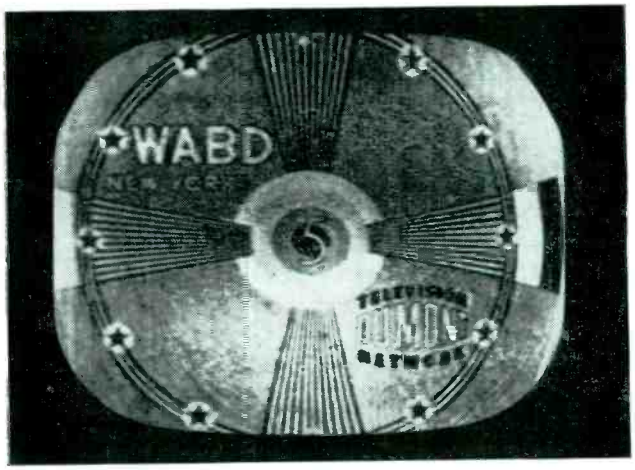
If television is to become a truly national service, the receiver manufacturer must continue to improve his product, not only for the urban viewer, but also for the millions in the uttermost fringe areas who are anxious to get almost any sort of reception so long as it moves and talks.
—The Editors



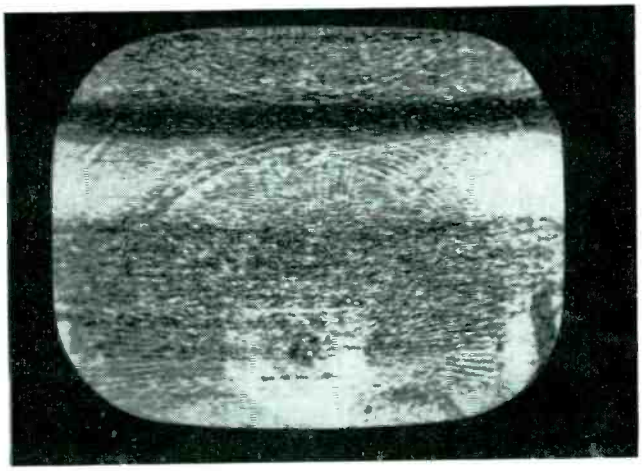
Mild diathermy interference. Single bar (60 cps) drifting slowly up and down



Severe diathermy type of interference at 120 cycles. Bars drift slowly up and down

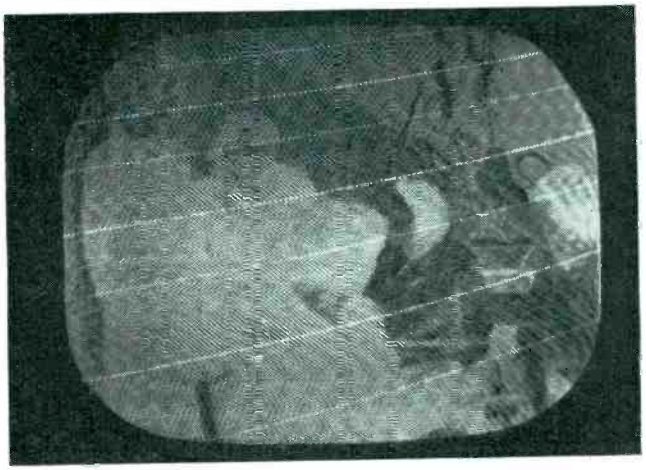


Sandpapery effect of mild electrical appliance noise



Strong electrical appliance noise causing loss of sync

Medium-strength interference caused by neighboring receiver



Very strong receiver radiation has turned picture to a negative

There being nothing to stop it here, it goes merrily on its way to be radiated from the antenna and eventually winds up in a nearby receiver tuned to a higher channel. Unless there is effective shielding, along with bypassing and filtering of power leads, it may also find its way to the receiver by direct radiation without a regular antenna.

One obvious solution to this problem is the use of a well-screened tube in the r-f amplifier, together with proper shielding, so that no energy from the oscillator coil can get into the r-f amplifier grid circuit. Since the oscillator frequency is some 20-odd megacycles higher in frequency than the desired television signal it is also helpful to have the r-f grid circuit tuned and switched for each channel instead of employing a wide-band device such as L_1. The above effect can be easily demonstrated by placing a booster amplifier using a screen-grid tube ahead of the

offending receiver. However, it is hard for a man to convince his neighbors that they should spend $20 or $30 for something the manufacturer should have engineered into the receiver in the first place. Even if they could be convinced, it is first necessary to locate the offending receivers.

Much of this type of interference will be eliminated if and when a new intermediate frequency in the vicinity of 40 mc is adopted. However, it will still be necessary to stop most of this radiation in order not to jam services 40 mc higher than the television channels.

Diathermy

The complete elimination of radiated signals from diathermy, induction heating and similar types of equipment is very difficult. Many industrial units actually generate more r-f than a high-power broadcast station and interference elimination requires careful double shielding of the entire work space, together with thorough filtering of all conductors entering the shielded area.

The FCC has laid down rules covering the situation and manufacturers of this type of equipment are working on models that will cause less interference. However, assume that all harmonics and other spurious radiations have been eliminated and the only radiated signal is a reasonably stable one that lands in the band of frequencies at 27 mc set aside for the purpose. If this radio signal is strong enough it will still cause serious tvi to nearby sets utilizing the circuit shown in Fig. 1. The 27-mc signal will be picked up by the feeder acting as a long wire antenna and will pass through the r-f amplifier and mixer as though they were in parallel instead of pushpull. This equivalent circuit is shown in Fig. 2. No one would consider tying a long wire antenna to the i-f amplifier through a small capacitor, the actual effect obtained here.

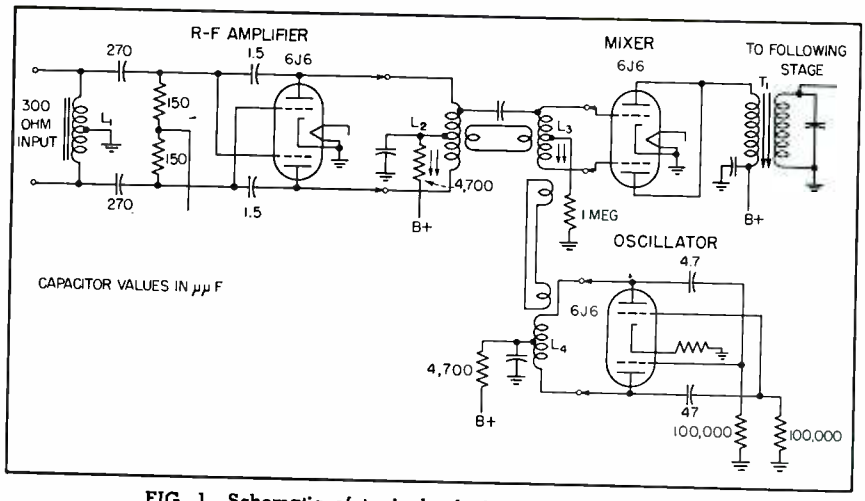


FIG. 1—Schematic of typical television receiver front end

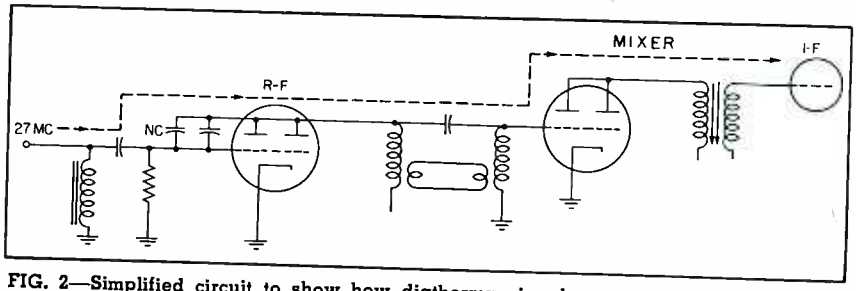


FIG. 2—Simplified circuit to show how diathermy signal passes circuit of Fig. 1 to show up as i-f interference

A tuned-grid, tuned-plate, push-pull 6J6 r-f amplifier, properly neutralized, is about the most effective thing to provide for these frequencies as far as sensitivity is concerned. However, a high-pass filter must be used ahead of it, with a Faraday screen and link coupling to the receiver. It is better in a production receiver to take advantage of the internal shielding offered by a screen-grid tube.

Spark-Plug Interference

Spark-plug impulses are of a wide-band nature and although they may peak in the vicinity of 50 to 60 mc they are strong all the way from 28 to 100 mc. The exact frequency on which they are most bothersome depends to a large extent on the length of the wiring of the particular car or truck. This type of interference should be suppressed at the source. However, there are plenty of other types of interference of a similar nature so that it is desirable to do as much as possible at the receiver. Fortunately, something can be done.

It is well known that the signal-to-noise ratio is a function of bandwidth; therefore it would be desirable to utilize as narrow a bandwidth as possible in the tuned grid of the first r-f stage. The best possible horizontal sync circuit should be used so that the receiver will not respond to random noise pulses and lose sync, as evidenced by horizontal tearing of the picture.

Nearby Radio Stations

Radio transmitters operating in the vicinity of a television receiver may or may not cause interference, depending largely on whether or not they are emitting harmonics that fall into television channels. Their fundamental may be overloading the receiver front end or feeding through it to the picture or sound i-f amplifiers. Harmonics and other such spurious emissions must be eliminated at their source. Methods for doing this have been shown by the author in *QST* for May and December 1948, February and May 1949, and *CQ* for May 1949. However, overloading or i-f pickup in the receiver must be cured at the receiver. This condition can largely be taken care of in the design of

Table I

Front End	Image Rejection	I-F Rejection
One tuned circuit	24 db	27 db
Two tuned circuits	58 db	41 db
Three tuned circuits	73 db	55 db

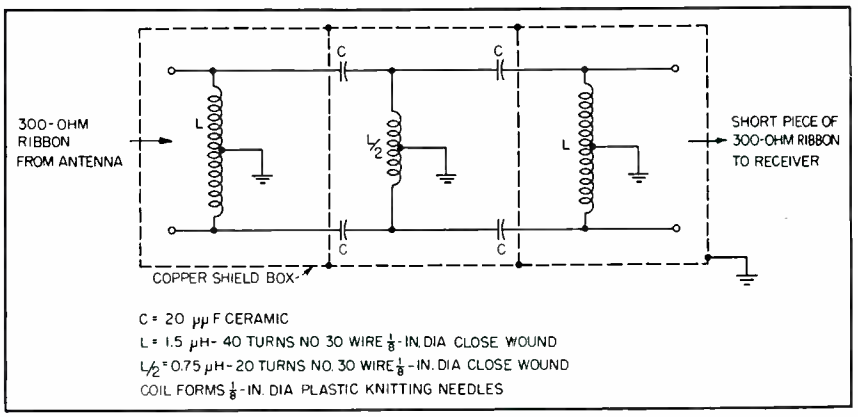


FIG. 3—Typical high-pass filter to attenuate interference below television frequencies

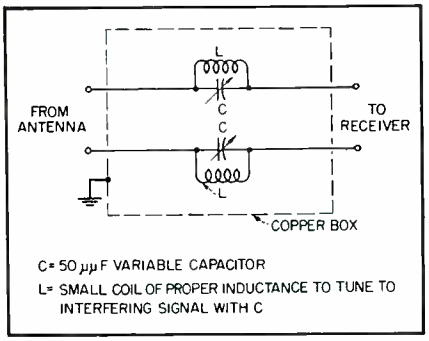


FIG. 4—Parallel-tuned wave traps to attenuate a specific frequency

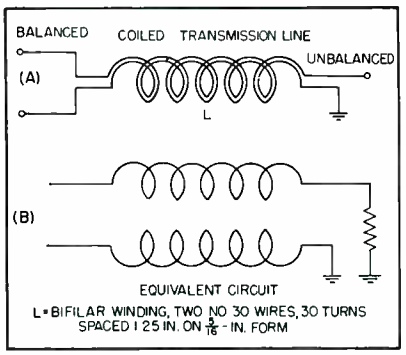


FIG. 5—Circuit for feeding grid from 300-ohm balanced line

the set but in the receiver of Fig. 1 external means must be employed.

The ideal arrangement would be to design a television receiver with a pass band of 5 mc for each channel and an infinite rejection of all other frequencies. Since this is not possible the next best is a design incorporating: (1) a network that will pass a balanced signal coming down the 300-ohm ribbon but will reject an unbalanced signal (prevent the ribbon from acting like a long-wire antenna); (2) a high pass filter that cuts off everything below 40 mc or so and yet passes all television channels; (3) two stages of tuned-grid tuned-plate r-f amplification ahead of the mixer; (4) good shielding and isolation of each of the tuned circuits; and (5) an oscillator well-shielded and filtered so that it cannot radiate an interfering signal to other receivers.

A receiver incorporating the above principles, connected to an indoor antenna, consistently receives channel 13, 60 miles away, in South Norwalk, Connecticut, with picture quality and signal strength approximately equal to WCBS-TV on channel 2, despite the fact that there is a 750-watt transmitter only two inches away from the receiver cabinet.

Figure 3 shows a high-pass filter that has been used successfully by the author to attenuate interfering signals on frequencies lower than the television channels. If it is desired to attenuate a specific frequency it may be accomplished through the use of parallel-tuned wave traps as shown in Fig. 4.

A device for matching a 300-ohm balanced feed line to a single-ended r-f grid is shown in Fig. 5. At (A) it is shown as a coiled transmission line while in (B) it is shown as it appears in the circuit. The coiled transmission line provides rejection to unbalanced energy by virtue of the inductive reactance of the coil, while balanced energy is not similarly attenuated.

Image Interference

Image interference is due to lack of sufficient selectivity in the r-f stage of the television set and its inability to reject a strong signal located some 40 to 50 mc higher in frequency than the desired channel. The improvement to be expected with more than one tuned r-f stage is indicated in Table I. Use of a higher intermediate frequency, or more selectivity in the front end, are needed. It is the writer's opinion that both changes are desirable. The use of two r-f stages will not only give better reception of pictures in the fringe areas but will also keep down oscillator radiation.

In addition, there will be a better signal-to-noise ratio and better adjacent-channel selectivity, as well as reduced image interference.

Such a design will also eliminate another type of interference, caused by oscillator voltage in the r-f grid on a low-channel signal mixing with a television signal on a high channel and producing a spurious response which then interferes on the low channel. The use of a higher intermediate frequency not only reduces interference due to receiver oscillator radiation and interference due to images but also reduces the possibility of direct i-f pickup from radio services operating in the 21 to 27 mc range.

Figure 6 shows the schematic of an r-f amplifier that has been used by the writer with considerable success. It is surprising how much off-frequency and direct feedthrough interference is eliminated in this manner. It is not unusual to receive a good picture from Philadelphia on channel 3 while both New York stations are operating on channels 2 and 4.

Electrical Appliances

Interference from household appliances is usually best attacked at the source; however, this is not always possible due to the difficulty in locating it and persuading the owner to spend some money for filters.

There are two possibilities at the receiver that often help. The first is an adequate r-f filter in the a-c line and the second is a bottom pan on the receiver chassis. Most receivers at least bypass the a-c line where it enters the chassis. However, in several cases an r-f filter has helped tremendously where the interference had been entering the set via the power cord. A schematic of the filter is shown in Fig. 7. Proper shielding of all exposed coils and wiring, plus a pan on the bottom of the chassis is definitely indi-

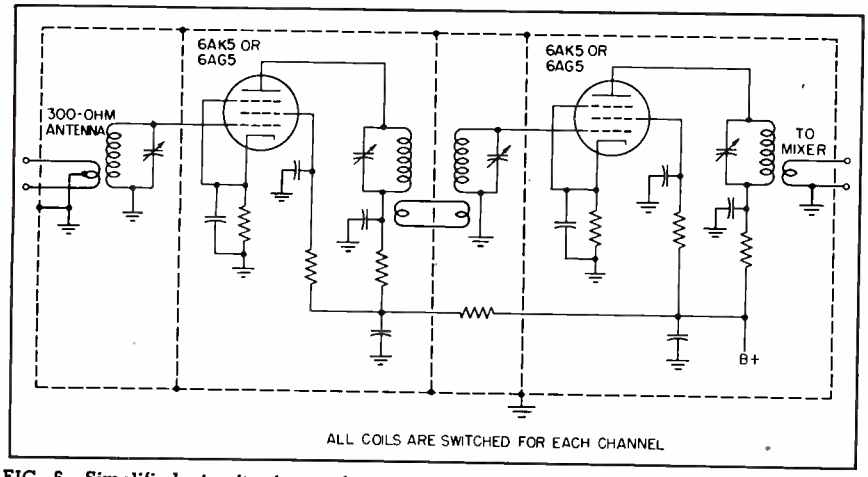


FIG. 6—Simplified circuit of an r-f amplifier used to improve reception. Construction of such a device requires careful placement of parts

cated as a precaution against direct pickup of interfering signals by the circuit wiring.

The Newer Receivers

In looking over the 1949 crop of television receivers, it is interesting to note that some of them are obsolete from an interference standpoint even before they are sold. Most of the 1948 and earlier sets also fall into this class. It is encouraging to find, however, that some of the manufacturers are taking a realistic view of the problem and are endeavoring to correct the situation. Many are changing from push-pull triodes to single-ended pentodes in the head end while others are using two stages of r-f, high-pass filters, and better sync circuits. There is even more talk of using higher intermediate frequencies.

Figure 8 shows a simplified circuit diagram of the front end of RCA 8-TS-241 production receiver.

The antenna terminals are arranged so that either a balanced 300-ohm ribbon or a 75-ohm unbal-

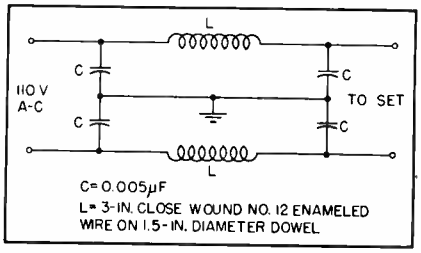


FIG. 7—Power-line filter for appliance interference

anced coax may be used as a feeder. This is accomplished through the use of a so-called "elevator" circuit consisting of two coiled 150-ohm transmission lines, previously shown in Fig. 5, wound on separate coil forms. These are connected respectively in series or parallel for 300 or 75 ohms. The balancing circuit is followed by an *m*-derived high-pass filter designed to attenuate at the input all interfering signals lower in frequency than channel 2, with maximum attenuation at the intermediate frequency. This includes diathermy at 27 mc and other radio signals that might overload the r-f stage and cause cross modulation.

Figure 9 shows the grid circuit of the r-f stage. It is drawn at A as a pi-network, while in B it is redrawn but still the same circuit. Figure 9C shows it with a tap on the coil instead of the capacitor; at D and E it is still essentially the same thing but in a more familiar form. The value of C_1 is 18 μμf, C_g is the input capacitance of the 6AG5 tube and L_1 is composed of many small inductances mounted between the contacts of the channel switch *S*. This circuit not only provides selectivity but also a step-up of voltage to the r-f grid.

Band-Pass Filter

Between the r-f plate and the mixer grid (Fig. 8) there is a band-pass coupled circuit with extremely low capacitance coupling. Extraordinary precautions were taken in the design to eliminate stray coupling and to provide the maximum rejection to spurious signals. The mutual inductance between the two circuits comprising the band-pass filter consists of a small inductance and capacitance in series. The series resonance of this combination is higher than the highest frequency for each group of channels and results in a very low coefficient of coupling in the vicinity of the oscillator and image frequencies. This is an important factor in obtaining the high image attenuation and the low oscillator radiation found in the design. The adjustment of the series capacitor of the mutual circuit allows for the adjustment of bandwidth for each of the two bands of television frequencies. Oscillator injection voltage is introduced to the mixer grid via link coupling from the push-pull 6J6 coil.

Another interesting innovation

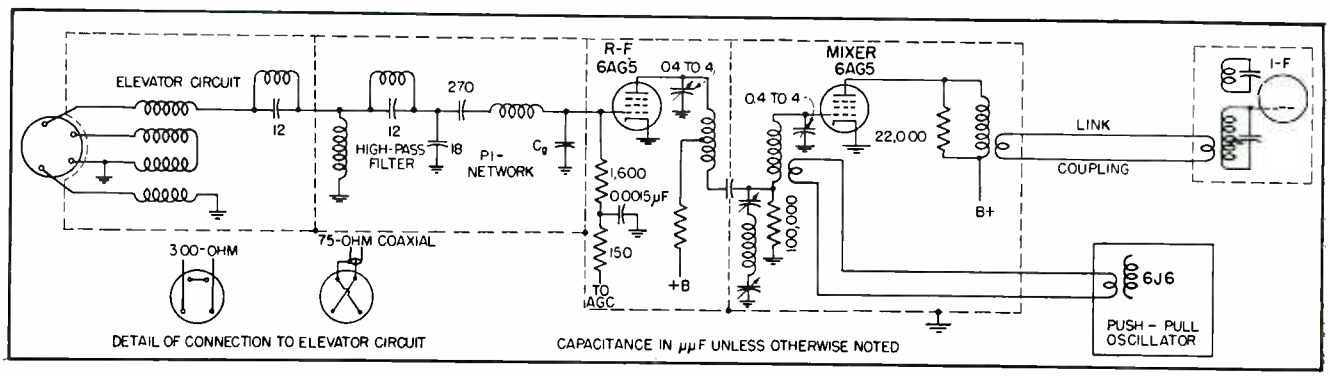
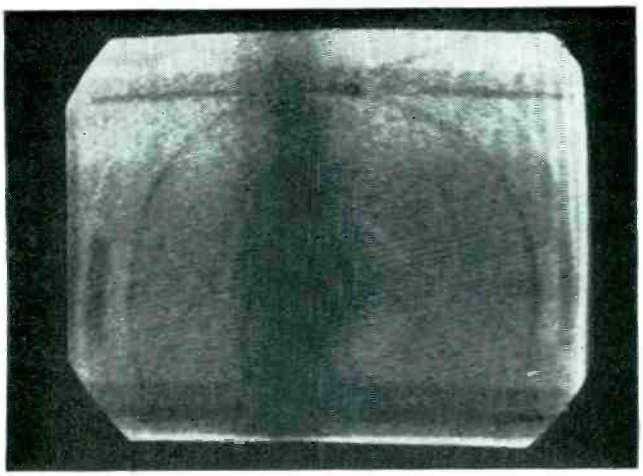
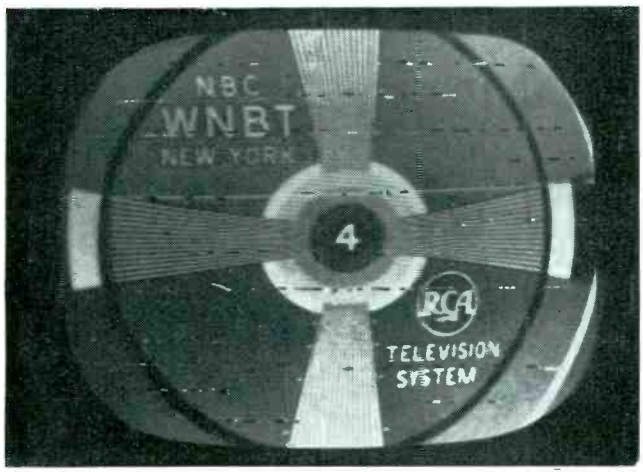


FIG. 8—Simplified circuit of the RCA 8-TS-241 receiver front end

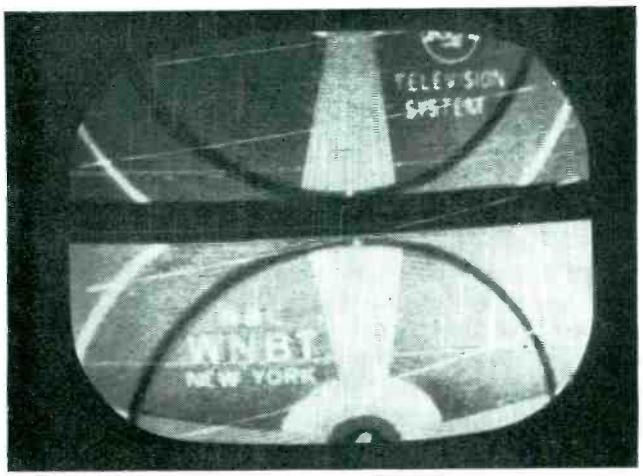
Venetian-blind effect on station 40 miles away by Baltimore station 220 miles away. The horizontal bars represent a visible beat between carriers



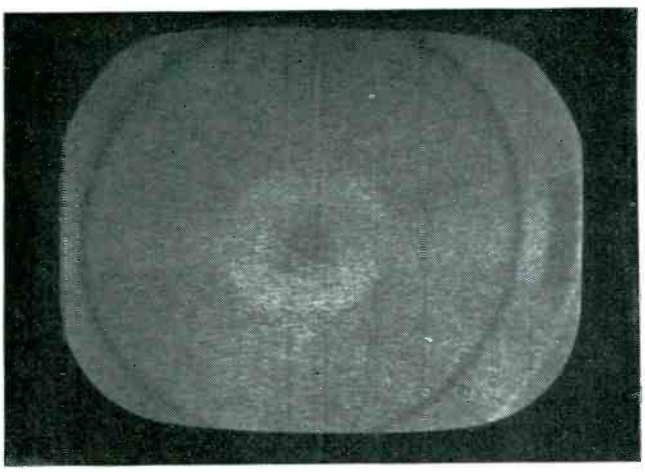
Simultaneous reception from Boston and New York at Middletown, Conn. Carriers are synchronized. New York pattern is seen with Boston moving across it



Spark-plug interference. Black streaks are spark impulses and white are torn portions of horizontal scanning line



Spark-plug interference causing loss of synchronization. Horizontal white lines are torn scanning lines



Reception of New York channel 13 at South Norwalk, Conn. after best possible commercial installation using standard antenna

Improvement in channel 13 reception after adding two-stage booster and erecting a good high-band antenna

and certainly one that helps reject interference is the link coupling between the mixer plate coil and the first i-f grid coil. This connection allows proper placement of components on the chassis in relation to the tuner (which usually occupies a separate chassis) without a long, hot interconnecting lead. Each tuned circuit in the i-f amplifier has coupled to it a suitable absorption trap tuned to remove a possible interfering signal. Even the triode video amplifier, an interesting circuit in itself, has an absorption trap tuned to 4.5 mc. This circuit is employed to remove the beat note that is caused by interaction between

the picture carrier and the sound carrier.

The horizontal oscillator and discharge circuits utilize a double triode, 6SN7GT, as shown in Fig. 10. The tube is connected as a blocking oscillator with a stabilizing tuned circuit in the plate supply. Plus B is derived from boosted B of the horizontal output stage. The horizontal drive control, C_{153B} provides means for varying the sawtooth amplitude which in turn effects horizontal linearity, width, and second anode voltage.

Sync Waveforms

Synchronization is accomplished as follows: A complex wave consisting of sync pulses, a parabola, and a partially integrated kickback pulse, is supplied to the grid of the first half of the 6SN7GT. The tube is biased from the oscillator grid to such value that plate current flows only during positive peak values of the complex wave. The cathode voltage of this tube is essentially a d-c voltage obtained from the pulses of current by filter action of the filter capacitors. Since a portion of this voltage is applied to the oscillator grid through R_{176}, its magnitude affects the frequency of the oscillator. The effect of the voltage is such that the oscillator will lock in synchronism automatically.

The plate current pulse of the 6SN7GT has a width equal to the width of the portion of the sync signal which appears on top of the parabola signal. As the phase between the oscillator and the sync signal tends to change, the width of the portion of the sync on top of the parabola also changes. This changes the width of the current pulses in the tube and the average cathode voltage. The cathode voltage then acts on the oscillator in such direction as to restore the correct phase.

A kickback pulse from the plate of the damper tube through the 560,000-ohm resistor and 5-μμf capacitor to the grid of the 6SN7 is particularly effective on weak signals. If the sync pulse becomes weak, the pip fed back keeps the horizontal oscillator in step.

Field tests on this type of horizontal oscillator have shown excellent immunity to noise and other types of interference.

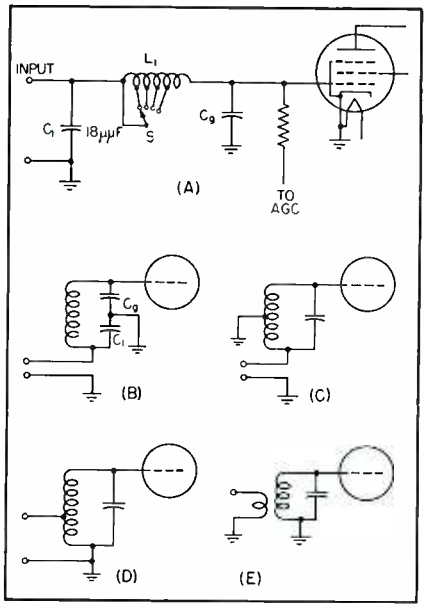


FIG. 9—Various conformations yielding essentially the same type of grid circuit used in the r-f stage

Acknowledgment

The writer wishes to thank RCA Victor Division, RCA Service Co, General Electric, and Hallicrafters, each of which supplied a television receiver for i-f interference tests conducted by the writer for FCC, RMA and ARRL. A complete report of these tests was mailed to RMA members Nov. 19, 1948 and was summarized in *QST* for December 1948.

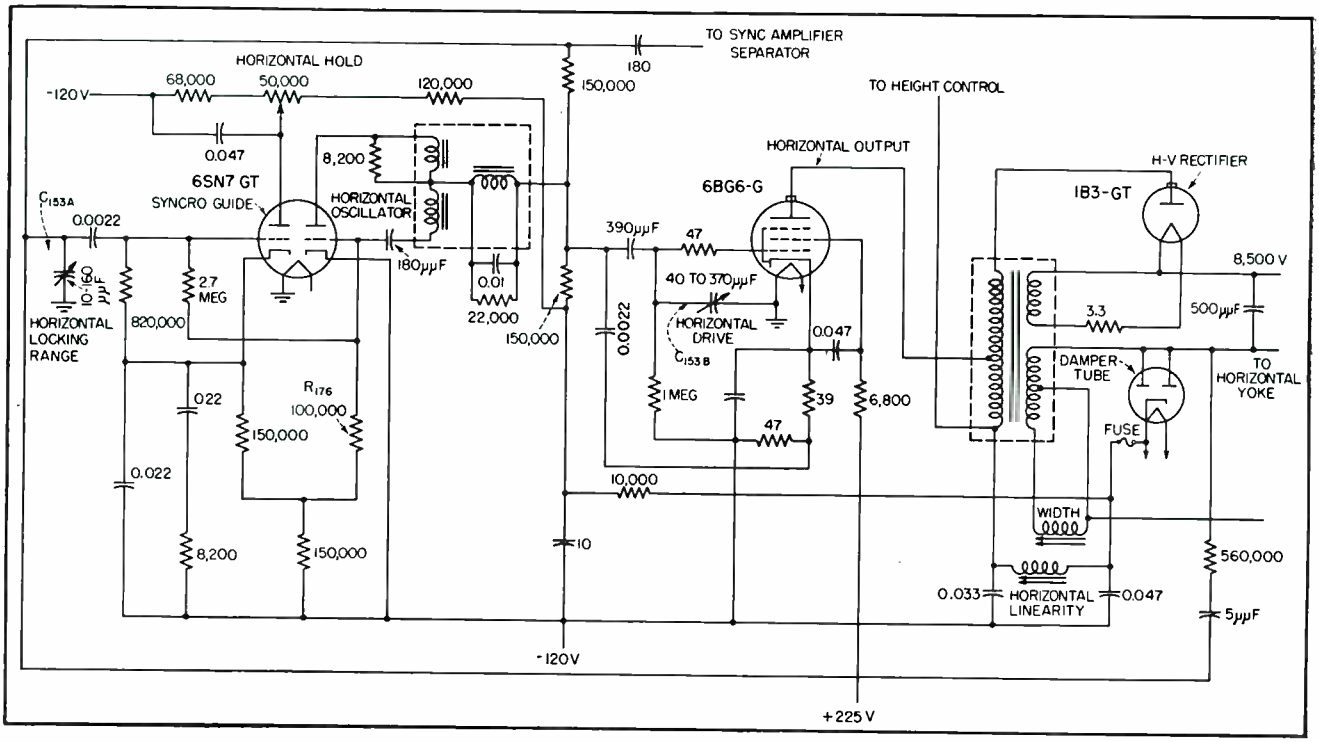
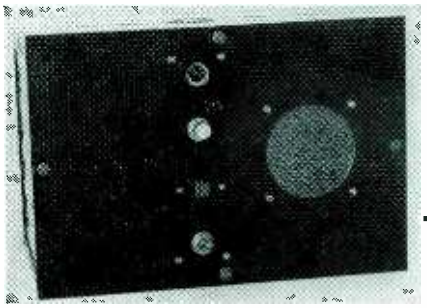


FIG. 10—The more important circuit elements used in a successful horizontal-synchronization circuit of a production receiver

Audio Smoke Alarm



Front view of audio smoke alarm

Compact phototube instrument produces signal which increases in pitch and intensity as smoke density exceeds predetermined level

By EARLE L. KENT

Electronics Division
C. G. Conn Ltd.
Elkhart, Indiana

PRESENTLY AVAILABLE smoke detectors have several limitations, the most obvious of which is the fact that they simply ring a bell or light a light when some predetermined level of smoke density has been exceeded. Frequently it is desirable that the boiler fireman know the degree by which his furnace is exceeding that certain level, and it is always convenient for him to know if his corrective efforts are having the desired effect on the smoke concentration.

The simple smoke detector described here produces an audio signal when the smoke exceeds normal density. As the smoke density increases, the intensity and frequency of the audio tone is increased proportionally, thus creating a disagreeable howl from a loudspeaker. The howling speaker not only provides the fireman with an incentive for correcting the cause of the excessive smoke but, as he makes his adjustments and improves the situation, the note subsides correspondingly and ceases altogether when the smoke condition is returned to normal.

The Circuit

A complete circuit of the unit is shown in the accompanying diagram.

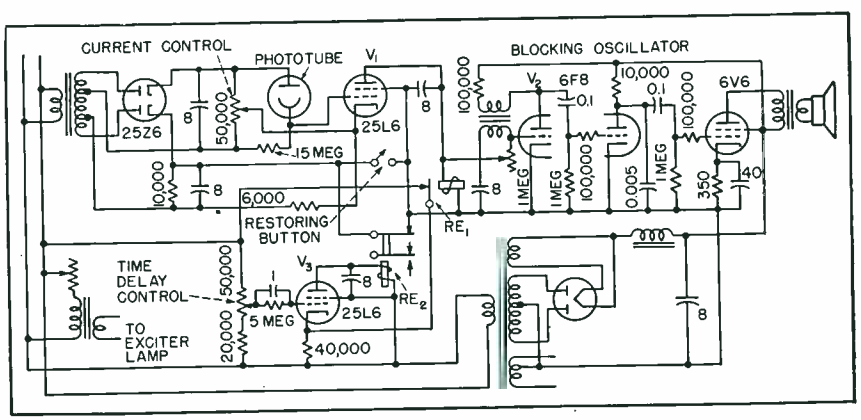
Under normal smoke conditions the phototube is conducting and the voltage drop across it, which determines the negative bias for V_1, is low; hence V_1 conducts. The voltage drop across the relay coil in the plate circuit of this tube appears as negative bias on blocking-oscillator tube V_2, and when normal smoke conditions prevail, this bias is sufficient to keep the tube from oscillating.

When a slightly increased concentration of smoke appears between the phototube and its light source, the phototube current decreases. This causes the negative bias on V_1 to be increased, thus the current through V_1 decreases. This results in a decreased voltage drop across the coil of RE_1 and consequently the negative bias on the blocking-oscillator tube drops to a value which permits oscillation at some low audio frequency. These oscillations are amplified and fed to the speaker which, due to its low efficiency at low frequencies, puts out a low-level sound indicating slightly increased smoke concentration.

As the current flow through the coil of RE_1 decreases further (as a result of increased smoke density), the bias on the blocking oscillator decreases and the pitch and intensity of the signal heard in the loudspeaker increases.

The signal continues to increase until the current flowing through RE_1 is no longer sufficient to hold its normally-closed contacts open. When the contacts of RE_1 close the a-c line voltage is applied to V_3 which contains the coil of RE_2 in its plate circuit. This tube then conducts on positive half cycles, at a time delayed somewhat by the time constant of the RC circuit in its grid circuit. The plate current flowing through V_3 energizes RE_2, opening its normally-closed contacts, and removing B+ from the plate circuit of V_1.

When V_1 is void of plate voltage, there is no plate current and consequently no bias on the blocking oscillator, so it oscillates vigorously at some high audio frequency and continues to oscillate until the restoring-button switch is depressed. If, when the restoring button is depressed, the smoke density has been reduced to a value which will cause RE_1 to be energized, the howl will begin to drop in frequency and intensity, and when the smoke density drops to the permissible value, the tone stops.



Voltage drop across coil of RE_1 determines blocking-oscillator frequency and halts oscillation when smoke density is within permissible limits

Citizens Radio Report

Activity on 465 mc has so far been surprisingly limited, considering possible public uses for short-range uhf equipment. Interest is increasing, however, and this summer will see many more transmitters on the air

ACTIVITY on the citizens radio band has so far been surprisingly limited, considering the many possible uses for short-range uhf equipment. Interest is increasing, however, and this summer should see many more transmitters on the air. (see p 128)

So far as ELECTRONICS has been able to determine in Washington, experimental licenses covering 41 stations are in force. These stations are scattered over 20 states. The status of 25 additional licenses, some of which are overdue for renewal, is in doubt. Between 200 and 300 new applications are reported to be in FCC files.

Licenses appear to be about evenly divided among hobbyists desiring a personal communications system, experimenters interested in studying such things as radio-wave propagation at these frequencies and people with modest commercial objectives. Most of the gear in use is designed to meet Class-B requirements and much of it consists of modified surplus BC645 transponder units. Many of the licensees also hold amateur radio tickets.

Wide Range of Interests

John Mulligan of Elmira, N. Y., credited with the first citizens-band construction permit, issued February 14, 1947, services 157-mc commercial equipment for a living. His first 465-mc gear consisted of a pair of battery-operated transceivers using one half of a 6J6 as a modulated oscillator or super-regenerative detector, the other half of the tube as a speech stage or first audio and a 3Q5 as modulator or second audio. The circuit was a conventional ultra-audion, and the two units jockeyed each other all over the band due to frequency shift when switching from transmit to receive. Distances up to four miles were nevertheless covered around town through trees and wood-frame buildings, using vertical antennas mounted on top of the transceiver cases.

Power was stepped up in two a-c-operated transceivers using a pair of HY615's as the oscillator-detector. Little improvement in coverage resulted, so a pair of surplus BC645 transponder units were modified and tried. Range fell off to ¾-mile, despite better transmitter output, due to the relative insensitivity of the receiver. Use of a super-regen receiver permitted reception of signals radiated from a 40-foot high fixed-station antenna in a car 16 miles away. Johnnie thinks the ultimate answer involves crystal-controlled f-m transmitters and receivers but is concerned about the cost.

Bill Lurie, who lives in Bronxville, N. Y., and works for an industrial and transmitting-tube manufacturer in Connecticut, has already described his transceivers in these columns. He is at present working on a 30-watt rig that starts with a surplus ARC-5 unit modified to turn out a 155-mc signal, uses an outboard 829B amplifier and triples in a 2C39 final. A simple and inexpensive wavemeter for the citizens band is also under construction and will, in response to a number of requests, soon be described.

Guy Cornish runs a sound service company out in Cincinnati. Back in 1939 he started announcing races and other public events over his receiver-equipped truck via radio on 310 mc to avoid the use of a microphone cable in congested areas. When that frequency was assigned to other services he shifted to 465 mc at the suggestion of the FCC. His transmitter uses a 955 oscillator and a 7C7 modulator.

Dick Benoit of Brooklyn, N. Y. is an engineer employed by the Watson Labs., Signal Corps, Red Bank, N. J. He applied for a citizens-band license in order to conduct uhf radio-wave studies of a classified nature in collaboration with associates *Cole, Kunze, Marks* and *Strom* of Long Branch, Allenhurst, Millburn and Belmar, N. J. He says the receiver of the BC645 unit drifts too much, and he is building a double superhet. The transmitter, not yet constructed, will use standard circuits designed for the 144-mc amateur band and converted to 155 mc. A multiplier driving a pair of 2C4's in the final will complete the transmitter. Directional antennas will be part of the setup.

Charles Moore works as a machinist in Trenton, but the minute his official day is over he boils into the job of selling more people the idea of applying for a citizens-band license, hoping some day to make this a business. Five converts are already working up to 4½ miles around town, using modified BC645 transponders and four-element beams.

"Skippy" Settle runs a radio shop in Dallas and is the moving spirit in what he hopes will be an extensive public network of stations for the construction of which he can charge $35 plus parts cost. Skippy has already installed five converted BC-645 units in the downtown area of

ELECTRONICS Articles

Transmitter	Nov. 1947
Receiver	Mar. 1948
Antennas	May 1948
Transceivers	Aug. 1948
Power Amplifier	Dec. 1948

the city, getting solid 10-block coverage and satisfactory communication up to 30 blocks under favorable conditions. Reception at 8½ miles has been reported in open country. Some 27 prospective customers have filed application for construction permits. Many of them expect to use their sets around Lake Dallas this summer.

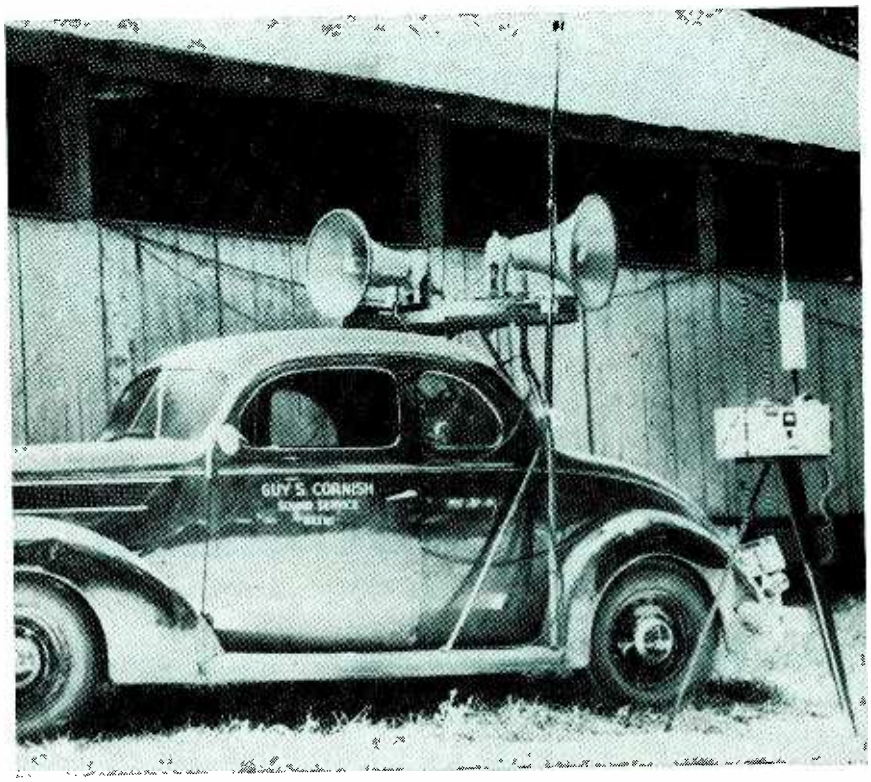
Harold McKay, a San Francisco consultant, is working in the band to acquire first-hand knowledge of technical requirements and propagation characteristics. Equipment includes two BC645 transponders, APR-4 tuning units operated into ARR-5 receivers and an experimental super-regen transceiver using two 955 acorns. A TS69A/AP meter is used for frequency measurement. The city's stucco-front houses having wire-mesh backing seem to pass some energy at 465 mc and also to reflect some. Thus it has been possible to work up to two miles at street level through buildings without difficulty and, in some instances, much more where long streets act like waveguides. As other experimenters have reported, trees attenuate signals quickly and earth masses stop them completely, but reflection from objects on top of the earth masses frequently fills in holes.

O. C. Vidden of Fertile, Minn., is an experimenter interested in the design of antennas. Using converted BC645 equipment he has, so far, had best results with parabolic types but finds them too bulky for strictly portable applications and is trying to develop something more effective for this purpose than the conventional dipole.

Common Stumbling Block

Major stumbling block in the path of most people interested in utilizing the citizens radio band during its experimental stage is the difficulty of finding others who are located within receiving range and qualified to conduct tests.

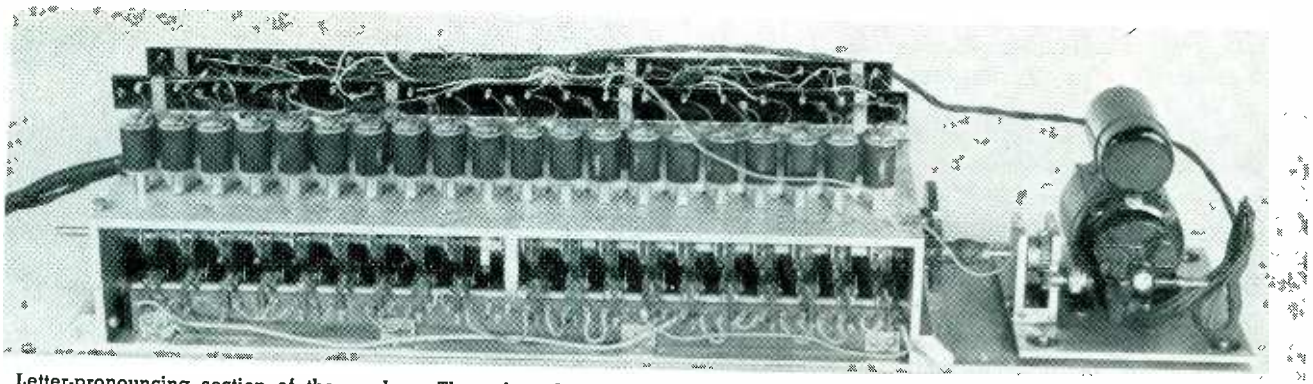
ELECTRONICS will be glad to serve as a clearing house for information such as new call assignments, operating schedules and technical ideas that improve equipment performance until activity at 465 mc progresses beyond the limit of its facilities.—W. MACD.



Guy Cornish of Cincinnati reports races and other public events over the tripod-mounted transmitter, pictured at the right, to a receiver-equipped sound truck that relays his voice to the crowd

EXPERIMENTAL LICENSES

CALIFORNIA	Fair Oaks	T. C. Mitchell	W6XST
	San Francisco	H. B. McKay	W6XRQ
FLORIDA	St. Petersburg	R. E. MacDonald	W4XJI
GEORGIA	Columbus	H. C. Lumnius	W4XER
	Columbus	W. R. Burrus	W4XWH
ILLINOIS	Western Springs	R. V. Dondanville	W9XAM
	Westmont	H. L. Garton	W9XEV
INDIANA	Indianapolis	H. C. Porter	W9XME
KANSAS	Oskaloosa	L. Meyerson	WøXME
MARYLAND	Brandywine	L. M. Conner	W3XGW
MINNESOTA	Fertile	O. C. Vidden	WøXRE
NEBRASKA	Scottsbluff	H. H. Poppert	WøXQI
NEW JERSEY	Long Branch	R. I. Cole	K2XEC
	Millburn	R. L. Marks	K2XEF
	Trenton	C. S. Moore	K2XAR
	West Allenhurst	A. A. Kunze	K2XDS
	West Belmar	C. A. Strom	K2XEV
NEW YORK	Bronxville	W. B. Lurie	W2XRW
	Brooklyn	R. C. Benoit	K2XEZ
	Comstock	O. E. Frisbee	W2XUC
	East Aurora	T. F. Huff	K2XEH
	Elmira	J. M. Mulligan	W2XQD
	Ithaca	Rural Radio	W2XBU
	New York	ELECTRONICS	W2XSN
	New York	F. Heubner	W2XRV
	Orchard Park	F. H. Unger	K2XEG
	Scotia	R. J. Henry	W2XJC
OHIO	Cincinnati	G. S. Cornish	W8XWI
	Dayton	A. L. Brandenburg	W8XPW
	Dayton	J. O. Stofer	W8XVW
	Dayton	F. X. Thilken	W8XTD
OKLAHOMA	Sand Springs	W. S. Martin	W5XAJ
RHODE ISLAND	Woonsocket	P. J. Donneau	W1XRH
TEXAS	Dallas	F. J. Ruetz, Jr.	W5XCV
	Dallas	N. C. Settle	K5XGF
UTAH	Salt Lake City	H. M. Goates	W7XVF
VIRGINIA	Richmond	J. E. Payne, Jr.	W4XLP
WASHINGTON	Seattle	F. G. Hiscox	W7XQM
	Seattle	T. R. Waters, Jr.	W7XQV
WEST VIRGINIA	Harman	S. J. Bucher	W8XJA
WISCONSIN	Thorpe	W. Hryniewicki	K9XAP



Letter-pronouncing section of the reader. The solenoids operate the magnetic tape recorders when tripped by the proper signals

Letter Reading Machine

Print scanned by a flying spot reflects varying amounts of light to a multiplier phototube. Binary counters operate appropriate trigger circuits and magnetic recordings pronounce the letters. Designed as an aid for the blind, the equipment could be modified for use in connection with printing and communication systems

THERE has recently been renewed interest in devices to replace the lost senses of those handicapped by blindness and deafness.

Loss of sight is probably the greatest obstacle to a normal existence. One device described in these pages[1] was designed to enable a blind person to read ordinary printed material. It translated the letters into coded tones that could be understood after sufficient training. In trying to minimize this training, one approach is to make the machine recognize the letters and actually pronounce them aloud to the user.

This paper describes an experimental form of such an instrument.

Operating Principles

In order to recognize letters, the scanner of the device divides the line of type into a number of horizontal bands, as shown in Fig. 1 each of which it explores with a spot of light. The light reflected from each band is converted to an electrical signal by a phototube.

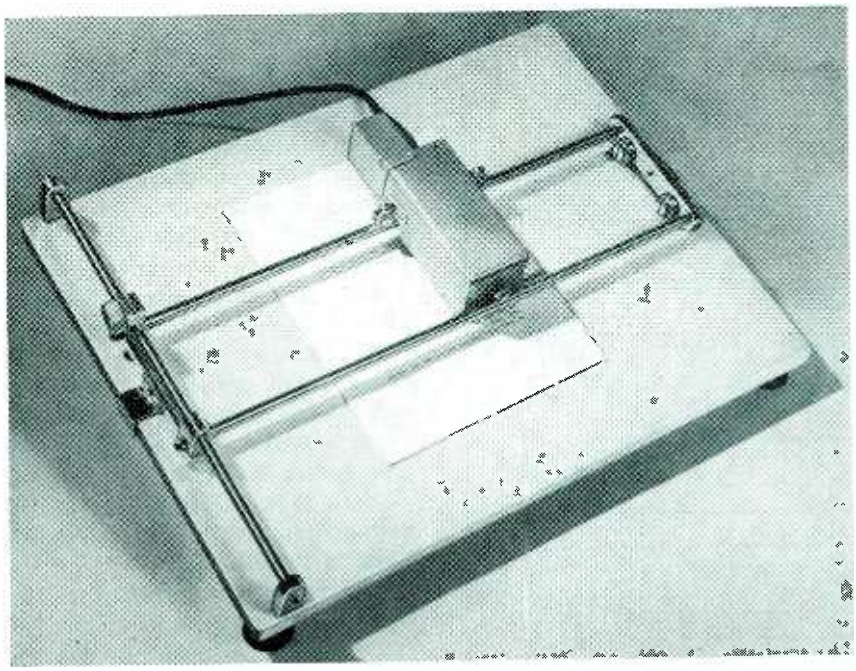
Counting circuits interconnected with the scanner count the number of times each light spot encounters part of a letter as it traverses its zone of the line of type recording the total number of black areas per letter per zone. From this information other circuits in the device recognize the letter or letters scanned and cause magnetic recordings of the correct letter sounds to be played back to the user.

Figure 2 is a block diagram of the apparatus. To avoid the bulk of eight light sources and phototubes, a combination of flying spot and time-division techniques is used. The internal arrangement of the scanner is given in Fig. 3. The small cathode-ray tube illustrated is the light source. It is provided, by the scanning generator, with a staircase deflection voltage having eight steps. The repetition rate is about 500 cycles per second. The beam is blanked except for a time interval of about 100 μsec during the horizontal part of each step. The visible result is a pattern of eight light spots in a line across the face of the tube. This pattern is projected onto the material to be read by a simple optical system. The eight spots bear the relation to the type indicated in Fig. 1. An advantage of this scheme is the ease with which the spot spacing may be varied to accommodate different type sizes.

Photoelectric Scanner

A type-931 multiplier phototube picks up light reflected from the paper. As the scanner is moved across the line of type, a series of interruptions in the amount of reflected light will be produced by the letters. If a particular scanning spot falls on blank paper, considerable light from it will reach the phototube, producing electrical pulses in its output. This will be referred to as the white signal condition, abbreviated WS. Conversely, if a particular scanning spot falls on a part of a letter less reflected light reaches the phototube. This will be referred to as the black signal condition, abbreviated BS.

The phototube output will contain information from each of the eight positions of the crt spot, and since the latter moves stepwise and in sequential fashion from each posi-



Scanning device used with the reader. It contains the phototube and scanner tube

By V. K. ZWORYKIN, L. E. FLORY, and W. S. PIKE

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tion to the next, a time-gating scheme may be used to separate out from the phototube output the signals corresponding to each spot position on the paper and thus to each horizontal band of the printed material. After separation the output from any one of the eight channels so formed may be thought of as a 500-cycle carrier which is present for WS, but which is suppressed or considerably attenuated under BS conditions in that channel.

Referring to Fig. 2, the channel separator time-gates the composite phototube output, routing the output of the various zones to individual demodulators and counters. Two-stage binary counters are used in channels 1 through 6 and single-stage circuits in channels 7 and 8. It must be remembered that the counters count the interruptions in the 500-cycle pulse trains of the several channels, not the individual pulses.

With eight scanning spots a unique interruption pattern exists for most letters of the alphabet. Referring to Fig. 1, the letter "b" interrupts channels 1 through 3 once, channels 4 and 5 twice, channel 6 once, and channels 7 and 8 not at all. Similar patterns exists for the other letters of the alphabet, and there are a few ambiguities. In many type faces "b" and "d" are mirror images of each other, thus providing identical count patterns. In the sample of Fig. 1 "c" and "z" produce identical count patterns. In general, the sequence of interruption will be different, however, and this property makes resolution of such ambiguities possible. Two sequence circuits for this purpose are indicated in Fig. 2.

The outputs of the channel counters and sequence circuits are applied to a function matrix similar to those used in electronic computers.[2] This circuit is a network consisting of a plurality of input circuits so interconnected with a plurality of output circuits that when the inputs are activated by a certain combination of potentials one and only one of the associated output circuits is energized. Conversely, no other combination of input circuit potentials will energize that particular output circuit. In the reading machine about thirty input circuits are required and a separate output circuit is provided for each letter of the alphabet, plus a few spares for short words and figures.

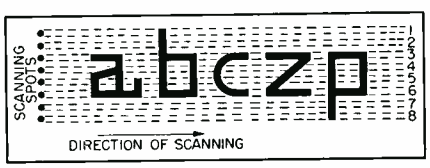


FIG. 1—Eight scanning spots are used in the letter reader

The output circuits of the master selector matrix are connected via thyratrons to a multichannel magnetic reproducer in which all the letter sounds have previously been recorded. Thus, when a letter is scanned one of the magnetic-tape recordings will be played back to the user through a conventional audio amplifier and loudspeaker. A view of the magnetic tape mechanism is illustrated. The letters are recorded on strips of magnetic tape fastened to small aluminum disks. On demand from the master selector matrix, a simple solenoid and pin arrangement releases the proper disk. Half of the solenoids may be seen along the top of the photograph. The associated disks are directly beneath them.

Also shown in Fig. 2 is a reset circuit which performs two additional functions. The more obvious purpose of the circuit is to reset the counters to a standard position after each complete operating cycle. Less obvious is the secondary function of holding the entire master selector matrix inoperative except for a short time at the end of each letter just before the counters are reset. This is necessary because certain letters of the alphabet when partially scanned will feed into the master selector matrix complete information for some other letter. Thus, "m" when scanned to a point just to the right of the middle vertical bar will feed information for "n" into the master selector matrix. By holding the output thyratrons of the master selector matrix cut-off until the final transition from BS to WS in all zones at the end of the letter, such false reading is prevented.

The scanning generator provides synchronizing signals for the entire

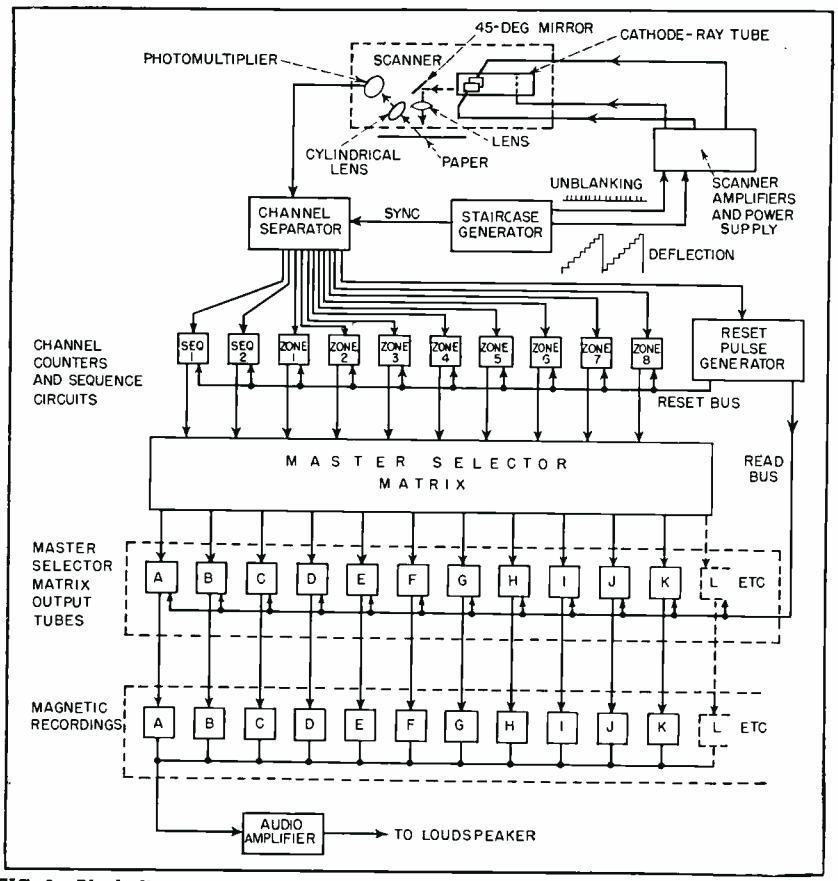


FIG. 2—Block diagram of the scanner, channel separator, master matrix and magnetic recorders that announce the letters

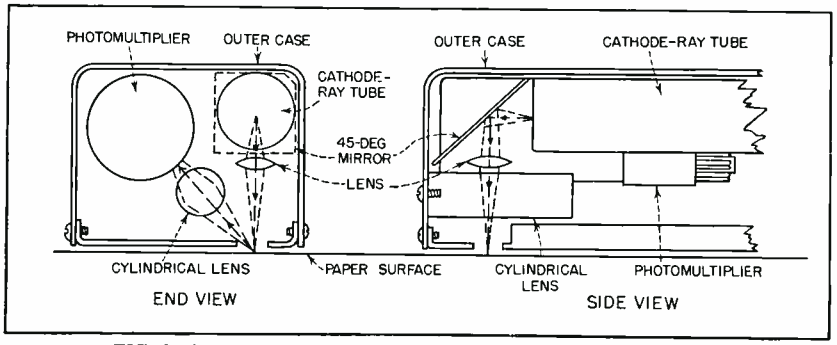


FIG. 3—Plan views of the scanner, showing placement of parts

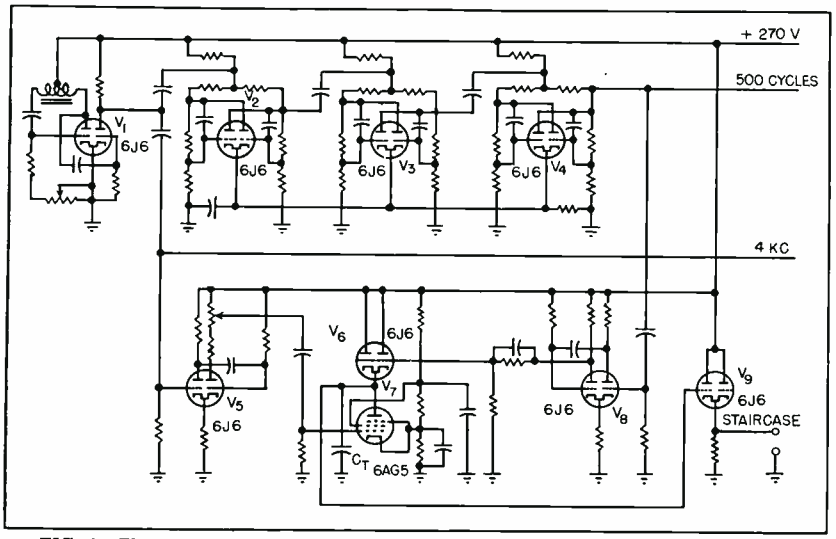


FIG. 4—The scanning generator that provides two tones and a staircase signal

instrument. The circuit is shown in Fig. 4. Oscillator V_1 and counter chain V_2, V_3, V_4 provide two pulse sources of 4,000 and 500 cycles per second which are locked together. An eight-step staircase wave is derived from these two pulse trains by partially charging capacitor C_t, at each 4-kc pulse and completely discharging it at every 500-cycle pulse. Pentode V_7 driven from pulse-shaping multivibrator V_5, charges the capacitor. Tubes V_8 and V_6 discharge the capacitor after every seventh charging pulse. The waveforms involved are shown in Fig. 7A through 7G. The staircase voltage is used to deflect the crt beam in the scanner.

The writers are indebted to J. M. Morgan of this laboratory for this circuit. Its advantages are the equality of the staircase steps, owing to the constant-current characteristic of V_7, and the ease with which the time interval corresponding to each step may be selected by auxiliary circuits.

Channel Separator

The composite signal from the scanner phototube consists of a series of pulses which occur during the horizontal portion of each step of the staircase wave. For WS conditions in all channels there is one pulse per step. The presence of a letter under the scanning head may cut off the pulses corresponding to one, several, or all steps. The channel separator time-gates these pulses, sending them to the proper demodulator and counter for the zone to which they correspond.

The circuit is shown in Fig. 5. Unblanking pulses are generated by multivibrator V_{20}, driven from the trailing edge of the delay multivibrator V_{21}, which is in turn driven from the 4-kc oscillator bus. The unblanking pulse is applied through cathode follower V_{19} to the grid of the crt. The action of the two multivibrators roughly centers the pulse in the time interval corresponding to each step. The phototube output resulting from the light pulses is amplified and limited by V_{17} and V_{18}. Figure 7 shows the waveform on the plate of V_{17} for conditions of all white (H) and one channel black (I).

The phototube pulses are supplied

to all eight channels of the separator circuit and in each channel a properly timed pedestal is placed under the desired pulses so that amplitude selection may be applied to them. The pedestal pulses are produced by a resistance matrix (the channel pulse selector matrix, Fig. 5) driven by the counter chain in the scanning generator.

Channel Circuit

A simplified circuit of one complete channel is shown in Fig. 6. Tubes V_{10}, V_{11}, V_{12} and V_{13} are common to all channels. The matrix resistors for this particular channel, RM_1, RM_2, RM_3 and RM_p are seen to resemble a resistance mixer such as is sometimes used in audio work. The waveform at C is the sum of the waveforms at A and B, and the output tube is arranged to conduct only on the topmost portion of this waveform. The resultant output is shown at D. To select a pulse corresponding to some other channel, waveform A is altered by changing the connections of one or more of the matrix resistors RM_{1-3} from the X_{1-3} counter output to the Y_{1-3} output.

As the scanning head of the instrument traverses a line of type BS conditions will occur, causing gaps in the train of pulses at the plates of V_{13}, V_{14}, V_{15}, V_{16}, and so on. The number of gaps per channel per letter must be counted, hence, the envelopes of the modulated pulse trains must be recovered. The low carrier frequency makes a demodulation by ordinary means impossible. A switched demodulator has been developed for this purpose. Switching pulses slightly narrower than the channel pulses and occurring at the same time are required by each of the eight demodulators. Tubes V_{22} and V_{23} provide these, with the assistance of a second resistance-mixer arrangement, the switch-pulse selector matrix. The switch-pulse selector matrix is identical to the channel-pulse selector matrix except that its input corresponding to the phototube signal is taken directly from V_{23}. No separate output tubes are provided for this selector matrix. Their place is taken by the gate tubes in the individual channel demodulators shortly to be explained. The output wave-

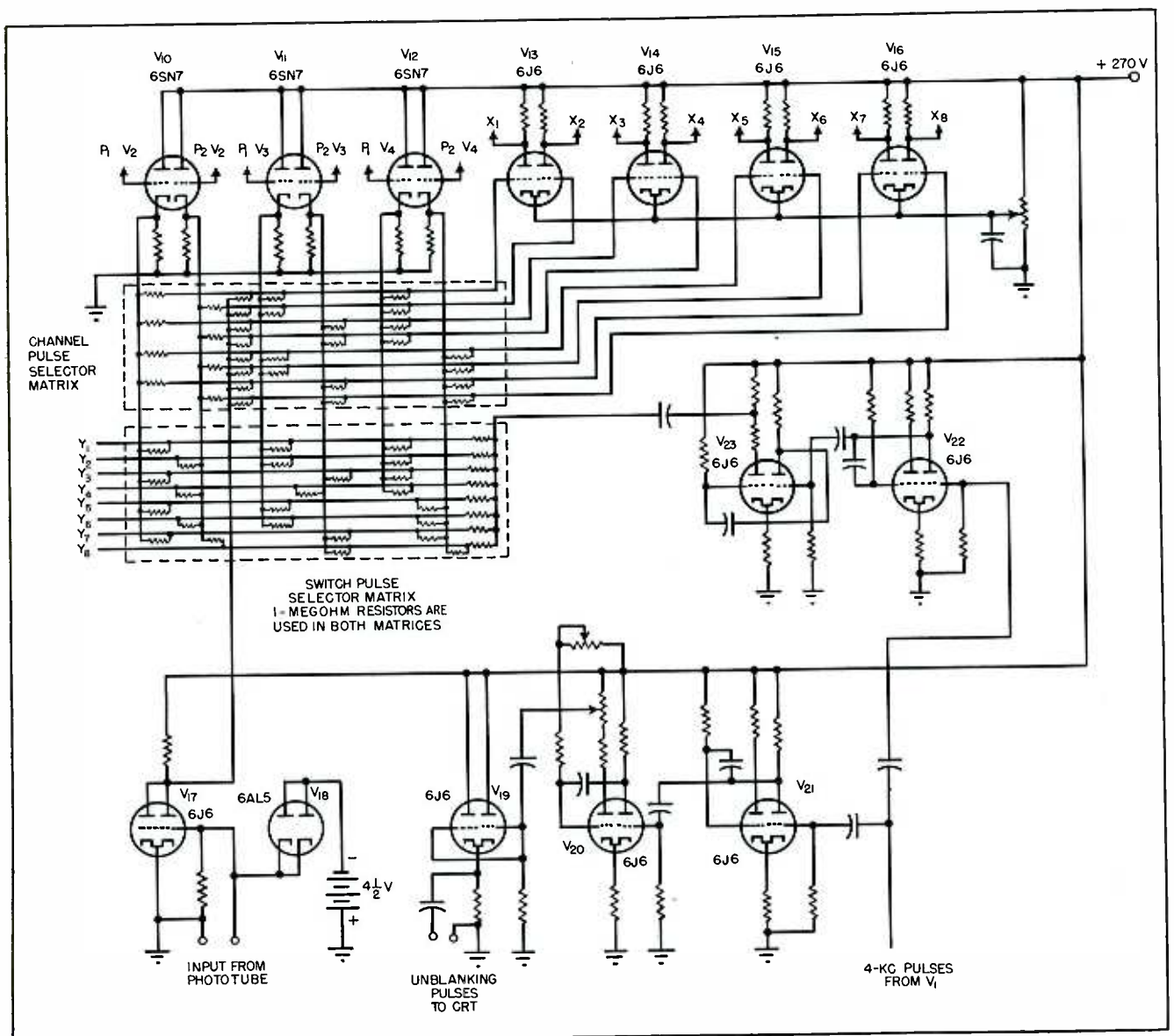


FIG. 5—Channel separator circuit, showing the channel-pulse selector and switch-pulse selector matrices

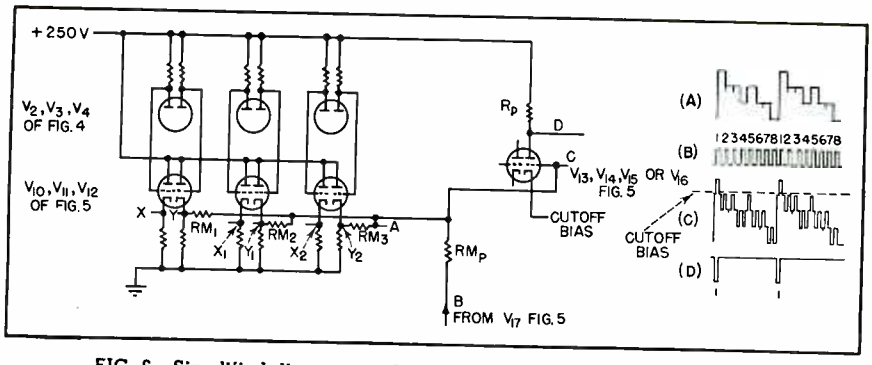


FIG. 6—Simplified diagram to show operation of the channel separator

forms at Y_1 through Y_8 are the switch pulse waveforms and are similar to Fig. 7J except that the topmost portion of each is narrower, occurs approximately in the center of the time interval occupied by the corresponding channel pulse, and that no change occurs when BS conditions occur in any or all zones. Figure 7P and Q indicate this relationship.

The Demodulators

One complete demodulator is shown in Fig. 8. There are eight such units, one per channel. The 6AS6 tube is normally cut off owing to its cathode connection. Neglecting the action of the channel pulses, it will conduct only on the positive spike of the switch-pulse waveform applied to the first grid.

Negative channel pulses are applied to grid three. When WS conditions are present they prevent the switch pulses from causing plate-current flow in the gate tube. Under BS conditions, the channel pulses cease, allowing the switch pulses to be amplified and inverted in the gate tube. The channel pulses are also applied through a diode to one grid of the 6SN7 flip-flop. If the channel pulses are present, the right-hand half of the 6SN7 will not conduct and the neon indicator will be dark, indicating that WS conditions prevail in that channel. The gated switch pulses from the 6AS6 are similarly applied to the other grid of the flip-flop and their presence during BS conditions will reverse the position of the flip-flop, lighting the neon indicator.

The output of the demodulator flip-flop can now be used to operate a counter to count interruptions in the channel pulse trains, or may be used to operate one of the sequence circuits, or both. The absence of even a single channel pulse will be registered in the associated counter by means of this circuit although at most reading speeds the interruptions of the various channel pulse trains are considerably longer.

Channel Counters

The circuit of a typical channel counter is given in Fig. 9. It is a two-stage binary counter with direct-coupled cathode follower output.

Six two-stage units and two single-stage units are used in the reading machine, the single-stage units being obtained by reconnecting a standard two-stage counter, one of which is illustrated. Both manual and automatic resets are provided, the latter via diodes (not shown) from the automatic reset bus bar which is energized at the appropriate time by the reset circuit.

Sequence Circuits

A circuit used for resolving the ambiguity between letters producing identical counting patterns but different count sequences is shown in Fig. 10. It is sensitive to the order in which interruptions occur in any selected pair of zones and consists of a dual clipper, a flip-flop and a dual cathode follower.

One grid of the flip-flop is connected via the clipper to the demodulator output of one of the selected zones and the other grid is similarly connected to the other selected channel. After a random series of interruptions in both channels the triode section of the flip-flop connected to the channel in which the last inter-

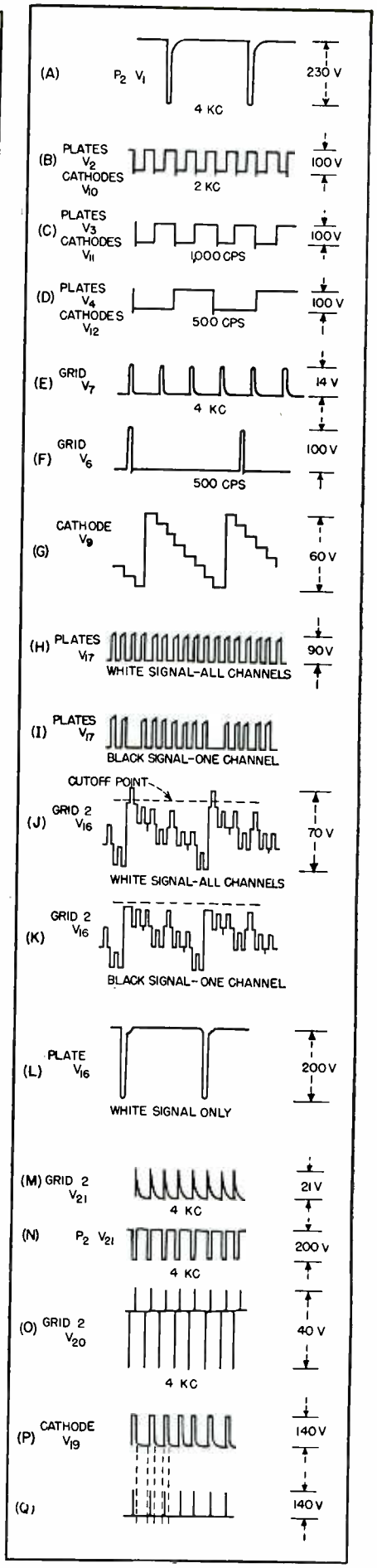


FIG. 7—Waveforms encountered in the reader circuits

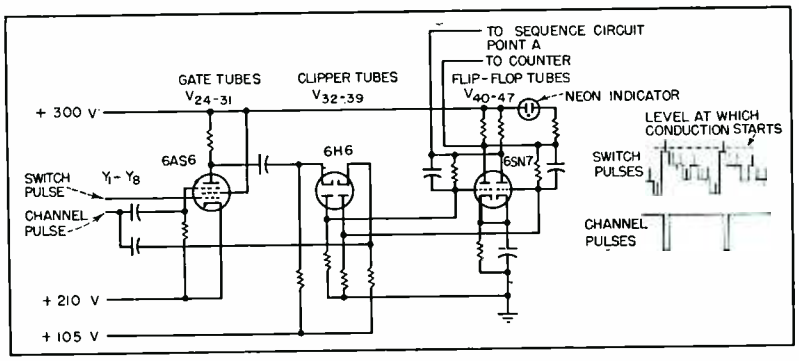


FIG. 8—Demodulator circuit, showing interaction of switch and channel pulses

ruption occurred will remain cutoff, thus providing the required information.

Master Selector Matrix

The foregoing circuitry provides a total of sixteen pairs of input bus bars feeding information into the master selector matrix. The latter is merely a much enlarged version of the channel pulse and switch-pulse selector matrices using a total of 960 resistors. It has an output thyratron for each letter of the alphabet.

The matrix connections, shown in Fig. 11, are such that when a given letter is scanned and its counting pattern is stored up in the counters, the first grid of the output tube for that letter is brought up to ground potential. At any other time it will be from 20 to 150 volts below ground, depending on the immediate past history of the counters. The output tubes are double-grid thyratrons and the second grids are all returned to the read bus bar which is normally biased negative but which is pulsed positive at the end of each letter, thus causing the output tube for that letter to fire, the negative first-grid potential holding off all other output tubes. Each thyratron has one of the release solenoids of the magnetic tape mechanism in its plate circuit.

The thyratrons are extinguished by an auxiliary circuit which opens a relay in the plate supply to them a short time after any one of them conducts.

Reset Pulse Generator

It is required that the reset circuit recognize the termination of each letter when WS occurs in all channels. Upon recognizing such, it must produce a positive read pulse to be applied to the read bus of the master selector matrix, followed a few microseconds later by a reset pulse which is applied to the automatic reset bus to reset the counters. A diode matrix[3] connected to the demodulators determines the all-white condition and conventional flip-flop circuits generate the required pulses.

For demonstration purposes the machine may be made to read a few simple words. The latter are recorded on disks in the magnetic reproducer like letters. A time-constant circuit is added to the reset circuit to slow up its operation. The result is that if the scanner is moved slowly over several letters normal operation ensues and the letters are pronounced. If the scanner is moved rapidly, the reset circuit cannot operate in the short space between letters but will trip on the wider space between words. If the total number of counts recorded is correct for the word scanned and corresponds with one of the words provided, the word will be pronounced. This feature has the practical limitation that one disk and one tube may be required per word. In some commercial applications, however, the principle might prove useful if certain groups of characters had to be recognized.

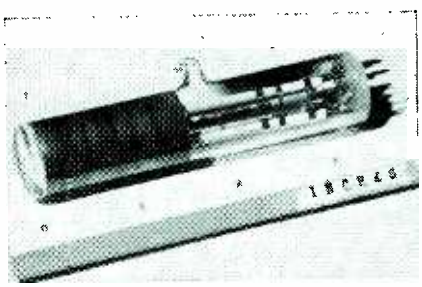
Perhaps the most serious limitation of this instrument is the accuracy with which the scanner may have to be aligned with the type. If the scanner spot pattern is displaced vertically from the position indicated in Fig. 1, incorrect counting patterns are likely to ensue. Hence, some form of mechanical guide for the scanner would be useful. One way of ameliorating this situation might be to use a much larger number of scanning spots and arrange the master selector matrix to trip whenever a certain percentage of channels contained the correct information. While this does not seem difficult in principle, it would increase the complexity of the system. On the other hand, it would make reading of slightly imperfect type more reliable.

Speed Limitations

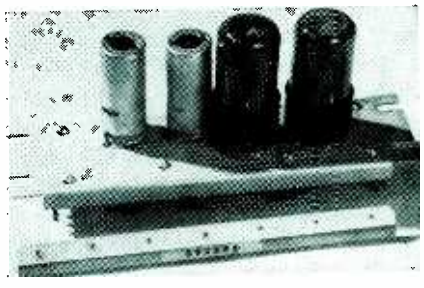
The operating speed of the instrument is limited only by the speed with which the letters can be intelligibly recorded on the disks and later understood by the user, which seems to be of the order of 60 words per minute. The limit set by the counters and other elements is much higher in the present model, 200 words per minute, and could doubtless be increased if necessary. The letters sound rather unnatural at speeds above about 40 words per minute, and for purposes of public demonstration a speed of around 20 words per minute has been used. There is considerable room here for experiment into the optimum sound for each letter.

Other Applications

When work on this device was started, one of the design requirements was that it should work on ordinary type. This requirement has been met in the experimental model, but several interesting pos-



Cathode-ray-tube light source



A representative binary counter

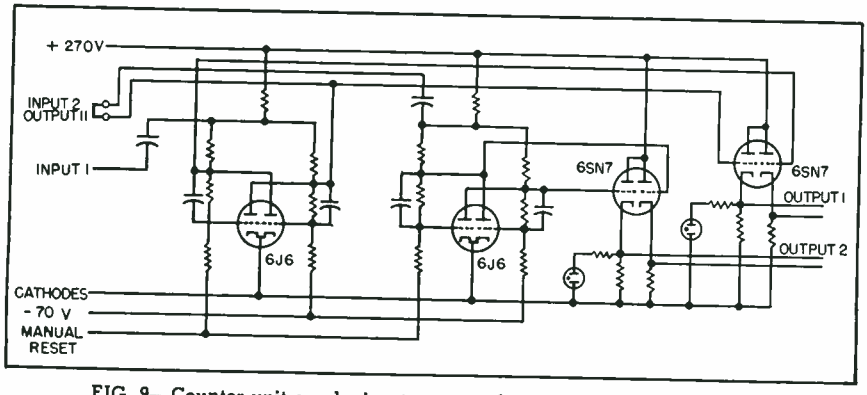


FIG. 9—Counter unit employing two-stage binary with cathode-follower

sibilities present themselves if the original design requirement is removed. For example, all the words of the English language are compounded of about thirty phonetic sounds. If, instead of recording letter sounds in the disks of the reading machine, these sounds were to be recorded and appropriate printed symbols for them devised, high-speed machine reading would become much more practical and the machine could actually read words.

Since the instrument is basically a device for recognizing printed patterns at a high rate of speed, its possibilities are not limited to those of a reading device. Coded information might be printed in a pattern much more distinctive than ordinary letters and in addition might be arranged on tape or cards which would make the alignment requirements much more easily met.

Applications visualized include such things as keying of transmitters directly from printed matter or coded information, transfer of information from printed cards to computing devices, operation of an automatic type-setting machine from printed copy, coding or decoding of material to be used in automatic machines or as a comparison device for checking such information against the original. Many of these operations are now performed by mechanical devices, but an electronic recognition system would in many cases remove the restriction in speed now imposed by mechanical systems.

A great portion of this work was done under Veterans Administration Contract Vam 21223, Subcontract 13, under the sponsorship of the Committee on Sensory Devices of the National Research Council.

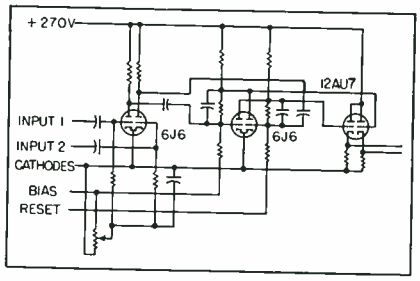


FIG. 10—Sequence circuit that removes ambiguity of identical-count letters

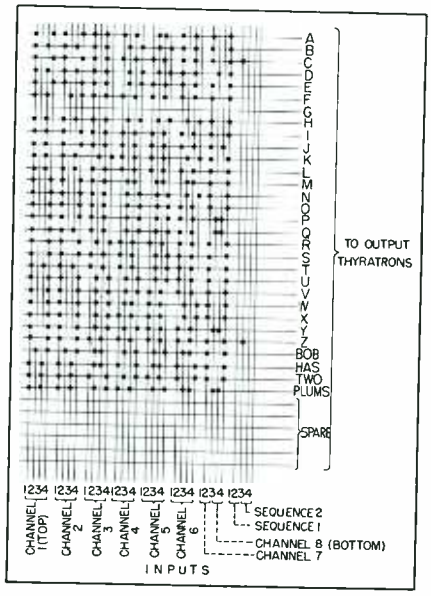


FIG. 11—Master selector matrix. The dots indicate connection through 5-megohm resistors. The crossed lines indicate no connection. Sequence-circuit 1 is connected between channels 5 and 6. Its No. 1 output bus is at 0 after scanning the letter C (lower case) and at —150 after scanning the letter Z. Reverse is true of bus 2

The writers wish to express their appreciation for the cooperation of this committee and in particular the former chairman Dr. George W. Corner. In addition, thanks are due to D. W. Epstein, F. H. Nicoll, and P. Herkart of RCA Laboratories, for the design and construction of the cathode-ray tube used here.

Table I—Master Matrix
(Channels 1-6)

Count	Bus 1	Bus 2	Bus 3	Bus 4
0 or 4 (Normal Pos.)	0	—150	—150	0
1	0	—150	0	—150
2	—150	0	—150	0
3	—150	0	0	—150

The input bus bars of the master selector matrix of channels 1–6 are connected to their respective counters so that their potentials are as shown in the table above.

Channels 7 and 8 are actuated only by letters such as Y, J, G, P, Q, which extend below the line of type, hence only half of a standard counter unit is used on each by breaking the link between the terminal marked input 2 and output 11 in Fig. 9.

The input bus bars of the master selector matrix of channels 7 and 8 are connected to their respective half counters so that their potentials are as shown in Table II, below.

Table II—Matrix
(Channels 7 and 8)

Channel 7

Count	Bus 1	Bus 2
0—Normal Position	0	—150
1	—150	0
2	0	—150
3	—150	0

Channel 8

Count	Bus 3	Bus 4
0—Normal Position	—150	0
1	0	—150
2	—150	0
3	0	—150

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(1) V. K. Zworykin and L. E. Flory, Reading Aid for the Blind, ELECTRONICS, August, 1946.
(2) J. A. Rajchman, U. S. Patent 2,428,811.
(3) C. F. West and J. E. DeTurk, A Digital Computer for Scientific Applications, *Proc. IRE*, 36, No. 12, p 1452, Dec. 1948.

PICKUP PLACEMENT

Equations for determining best mounting position for tone arm for use with records having groove radii other than those for which arm is intended

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PHONOGRAPH EQUIPMENT designers are confronted with three distinct problems pertaining to the geometry of phonograph arms.

The first of these is the design of arms to provide the least tracking error distortion on records of given dimensions with an arm of given length, or given distance between mounting centers.

The second problem deals with the design of arms where, as an additional restriction, the arm must overhang or underhang the center of the record by a specified amount, as in record changers, in order to assist the functioning of the tripping mechanism. In this instance, with a stated amount of overhang (or underhang) and a given arm length, or mounting-centers distance, it is desired to determine the offset angle of the pickup head to produce the least possible tracking-error distortion.

The third problem is that of finding the best position for mounting an existing arm with respect to records of groove radii other than those for which it was originally designed. A solution to this third problem is especially timely, as equipment originally designed for 78-rpm records has been modified and adapted for use with the slow-playing records recently announced by Columbia and RCA.

The equations listed below were derived to supplement those given in the article, Tracking Angle in Phonograph Pickups (ELECTRONICS, March, 1945) for the solution of these problems. The geometry of a pickup arm with respect to the record radius and mounting centers is shown in the accompanying figure. All linear dimensions are given in inches, and angles are measured in radians.

If an existing arm having length l and offset angle β is to be placed with respect to a record of groove radii r_1 and r_2 to produce the least distortion possible, the corresponding overhang D (or underhang $-D$) may be determined by finding β_o and β_i and then using Eq. 3 if $\beta \leqq \beta_i$, Eq. 4 if $\beta_i < \beta < \beta_o$ and Eq. 5 if $\beta \geqq \beta_o$.

$$\beta_0 = \frac{r_1\left(1+\frac{r_1}{r_2}\right)}{l\left[\frac{1}{4}\left(1+\frac{r_1}{r_2}\right)^2+\frac{r_1}{r_2}\right]} \qquad (1)$$

$$\beta_i = \frac{1}{l\left[\left(\frac{1}{r_1}+\frac{1}{r_2}\right)-\frac{r_1}{2}\left(\frac{1}{r_1^2}+\frac{1}{r_2^2}\right)\right]} \qquad (2)$$

$$D = \frac{\beta\left(\frac{1}{r_1}+\frac{1}{r_2}\right)-\frac{1}{l}}{\left(\frac{1}{r_1^2}+\frac{1}{r_2^2}\right)} \qquad (3)$$

$$D = \frac{r_2}{2}\left(\frac{r_2}{l}-\beta\right)\left[\left(1+\frac{\beta^2}{\left(\frac{r_2}{l}-\beta\right)^2}\right)^{1/2}-1\right] \qquad (4)$$

$$D = \frac{r_1}{2}\left(\beta-\frac{r_1}{l}\right)\left[\left(1+\frac{\beta^2}{\left(\beta-\frac{r_1}{l}\right)^2}\right)^{1/2}+1\right] \qquad (5)$$

If a new arm of length l is designed to provide the least distortion possible with a given overhang D (or underhang $-D$), the corresponding offset angle β may be determined by finding D_o and D_i and then using Eq. 8 if $D \leqq D_i$, Eq. 9 if $D_i < D < D_o$, and Eq. 10 if $D \geqq D_o$.

$$D_o = \frac{r_1^2}{l\left[\frac{1}{4}\left(1+\frac{r_1}{r_2}\right)^2+\frac{r_1}{r_2}\right]} \qquad (6)$$

$$D_i = \frac{r_1}{l\left[2\left(\frac{1}{r_1}+\frac{1}{r_2}\right)-r_1\left(\frac{1}{r_1^2}+\frac{1}{r_2^2}\right)\right]} \qquad (7)$$

$$\beta = \frac{D\left(\frac{1}{r_1^2}+\frac{1}{r_2^2}\right)+\frac{1}{l}}{\left(\frac{1}{r_1}+\frac{1}{r_2}\right)} \qquad (8)$$

$$\beta = 2\left(\frac{2D^2}{r_2^2}+\frac{D}{l}\right)^{1/2}-\frac{2D}{r_2} \qquad (9)$$

$$\beta = 2\left(\frac{2D^2}{r_1^2}+\frac{D}{l}\right)^{1/2}-\frac{2D}{r_1} \qquad (10)$$

If distance d is given instead of length l, find $l = d + D$, and proceed as before.

If a new arm is designed to have a length l and to provide minimum tracking-error distortion over a range of groove radii from r_1 to r_2, optimum offset angle and overhang may be found by using Eq. 1 and Eq. 6.

When d is given instead of l, the overhang D_o may be found from the following equation: $D_o =$

$$\left[\frac{d^2}{4}+\frac{r_1^2}{\left[\frac{1}{4}\left(1+\frac{r_1}{r_2}\right)^2+\frac{r_1}{r_2}\right]}\right]^{1/2}-\frac{d}{2}$$

Find β_o from Eq. 1 remembering that $l = d + D_o$.

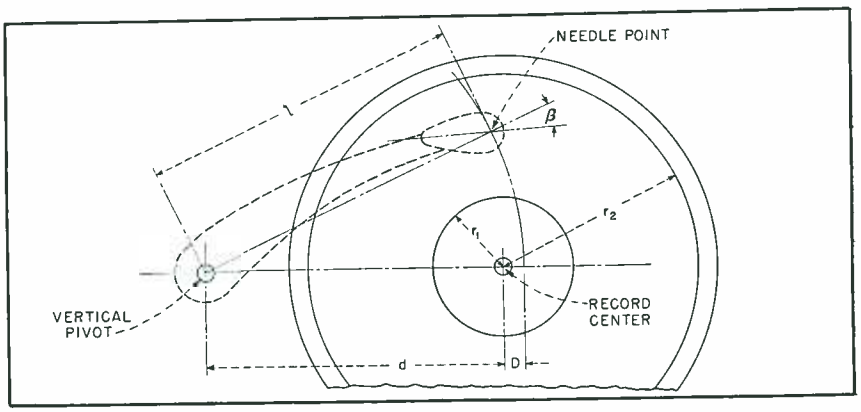
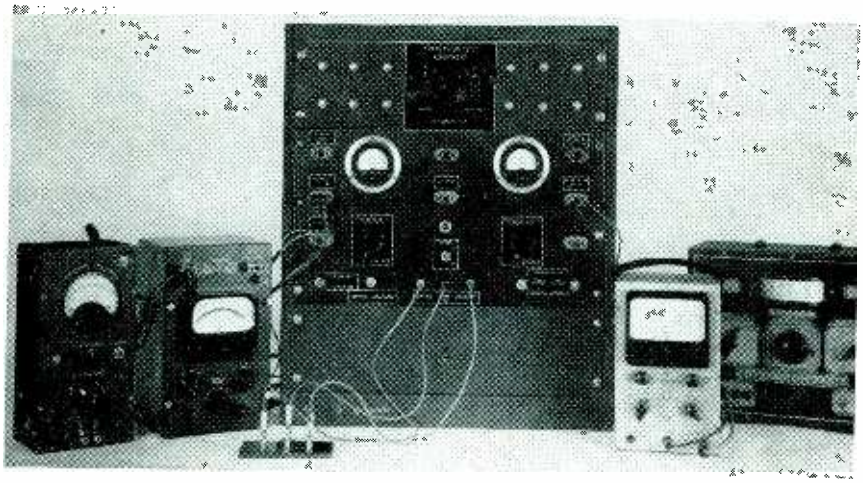


Diagram of typical phonograph layout

Testing Transistors

Simple test circuit using two pentodes gives direct currents and voltages at operating point, corresponding a-c values for zero and infinite collector load-resistance, and current and voltage amplification values. Resistance coefficients are then easily calculated



Complete equipment for testing transistors. Left to right: Electronic a-c voltmeter; vtvm for d-c emitter voltage; test unit, with transistor on three-terminal panel in foreground; vtvm for d-c collector voltage; audio signal generator. Jacks on test unit permit quick connection of additional precision meters and experimental connections to pentode grids

SINCE the transistor is now commercially available from different manufacturers, a simple method for testing which still yields rather extensive information becomes of wider interest.

If all a-c components are sufficiently small, a linear relation holds between the alternating current i_e through the emitter and the alternating current i_c through the collector on one hand, and the a-c voltage emitter-base v_e and the a-c voltage collector-base v_c on the other hand:

$$v_e = R_{11}\, i_e + R_{12}\, i_c$$
$$v_c = R_{21}\, i_e + R_{22}\, i_c \qquad (1)$$

The four coefficients, R_{11}, R_{12}, R_{21} and R_{22}, may be used to describe the operation of the transistor at a particular operation point, given for instance by the direct currents.[1] The coefficients are practically independent of frequency up to several hundred thousand cycles.

In Table I some of the most important circuit qualities of the transistor are expressed in terms of these coefficients. A convenient method of measuring the coefficients is described. It is hoped that it may contribute to the establishment of a standardized method for test and characterization of transistors.

Test Circuit

The characteristic feature of the test circuit is the use of a pentode in the emitter circuit and a pentode in the collector circuit, both operating in the saturation range. Thus the direct current through emitter and collector can be adjusted independently of the emitter impedance or the collector impedance of the transistor by a proper bias voltage at the grid of the pentodes. By modulation of the grid voltage of the pentode in the emitter circuit, an alternating current $i_e = 100$ microamperes rms at 5,000 cps is produced. This current is usually found to be sufficiently small so that distortion of the sine wave by the transistor may be neglected.

If the d-c bias at the grid of the pentode in the emitter circuit is changed, a small adjustment of the a-c grid voltage may be needed to keep the a-c emitter current constant. That can be avoided by using two pentodes in parallel in the emitter circuit, one as adjustable d-c current generator and the other as fixed a-c current generator.

For the calculation of the coefficients it is sufficient to measure v_e and i_c at zero collector load-resistance, and v_e and v_c at infinite collector load-resistance. The dpdt switch S_2 in position A shunts the pentode in the collector circuit by a capacitance of 1 μf and enables the a-c collector current to be measured at practically zero a-c load resistance (the collector impedance is of the order of 20,000 ohms).

With switch S_2 in position B, the pentode in the collector circuit is shunted by the capacitance in series with a 5-megohm resistance. This avoids sudden charge currents of the capacitance after changes in the switch position and provides a practically infinite a-c load resistance in the collector circuit.

Equipment Used

The test setup includes an electronic a-c voltmeter to measure the a-c components, a vacuum-tube voltmeter for the d-c emitter voltage, a vacuum-tube voltmeter for the d-c collector voltage and an audio signal generator which is connected internally to the grid of the pentode in the emitter circuit. The transistor is placed in a holder constructed to ground automatically the emitter and the collector input if the transistor is taken out.

The a-c components are measured on the same a-c voltmeter by throwing the appropriate switches. All

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a-c components are measured on the same range (10 to 100 millivolts) of the electronic a-c voltmeter by means of proper voltage dividers included in the test circuit.

Presentation of Results

It is convenient to arrange the measured values in the form shown in Table II. The first or left-hand group contains the direct currents and voltages, which describe the operation point. The second group contains in the upper line the alternating currents and voltages at zero collector load-resistance and in the lower line the corresponding values for infinite collector load-resistance. The third group gives the current amplification at zero collector load resistance and the voltage amplification at infinite collector load resistance. The fourth group contains the four coefficients, which are calculated from the a-c components in the second group according to

$$\begin{aligned} |R_{11}| &= (v_e/i_e)_\infty \\ |R_{12}| &= [(v_e)_\infty - (v_e)_o]/(i_c)_o \\ |R_{21}| &= (v_c/i_e)_\infty \\ |R_{22}| &= (v_c)_\infty/(i_c)_o \end{aligned} \qquad (2)$$

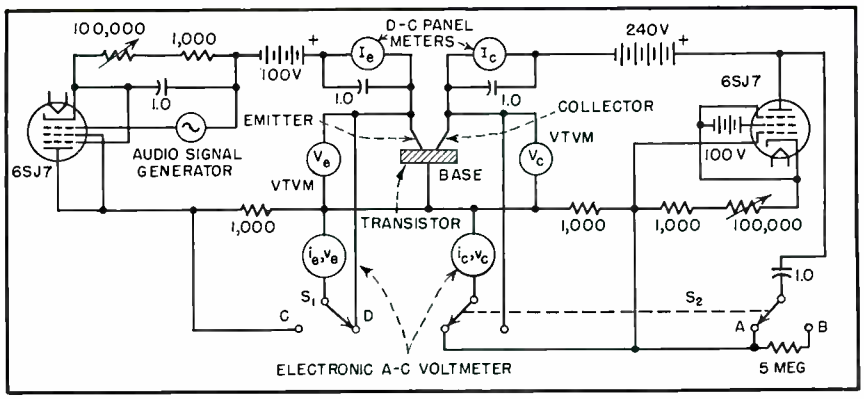
The above equations follow immediately from Eq. 1 if first $(i_c)_\infty$ and then $(v_c)_o$ are set equal to zero.

In Table III, numerical values obtained on a commercial Bell Telephone Laboratories germanium transistor are given in the arrangement of Table II.

For a quick test, one is often more interested in the maximum current amplification and the maximum voltage amplification than in the resistance coefficients. It is then an advantage of the circuit that the maximum current amplification is obtained without further calculation from the a-c collector current at zero collector load-resistance.

REFERENCE

(1) W. Bardeen and W. Brattain of Bell Telephone Laboratories used this representation of transistors in a lecture given in October 1948 in Princeton, N. J. for the local AIEE section.



Test circuit for transistors. Batteries are used throughout, with on-off switch in heater circuit. Collector and emitter leads are automatically shorted to base when transistor is removed

Table I—Important Circuit Qualities of Transistors

(1) Short-circuit stability	$\delta = \frac{R_{12}\,R_{21}}{R_{11}\,R_{22}} < 1$
(2) Input impedance (collector load-resistance is R_L)	$R_{11} - \frac{R_{12}\,R_{21}}{R_{22} + R_L}$
(3) Output impedance (external resistance in emitter circuit is R_g)	$R_{22} - \frac{R_{12}\,R_{21}}{R_{11} + R_g}$
(4) Power amplification (output power/input power)	$\frac{R_{21}^2}{R_{11}\,R_{22}}\,\frac{R_L}{(R_L + R_{22})}\,\frac{1}{(1 - \delta + R_L/R_{22})}$
(5) Maximum current amplification (zero load)	$\frac{R_{21}}{R_{22}}$
(6) Maximum voltage amplification (infinite load)	$\frac{R_{21}}{R_{11}}$

The following values refer specifically to $\delta < 1$ and a load resistance matched for maximum available power amplification:

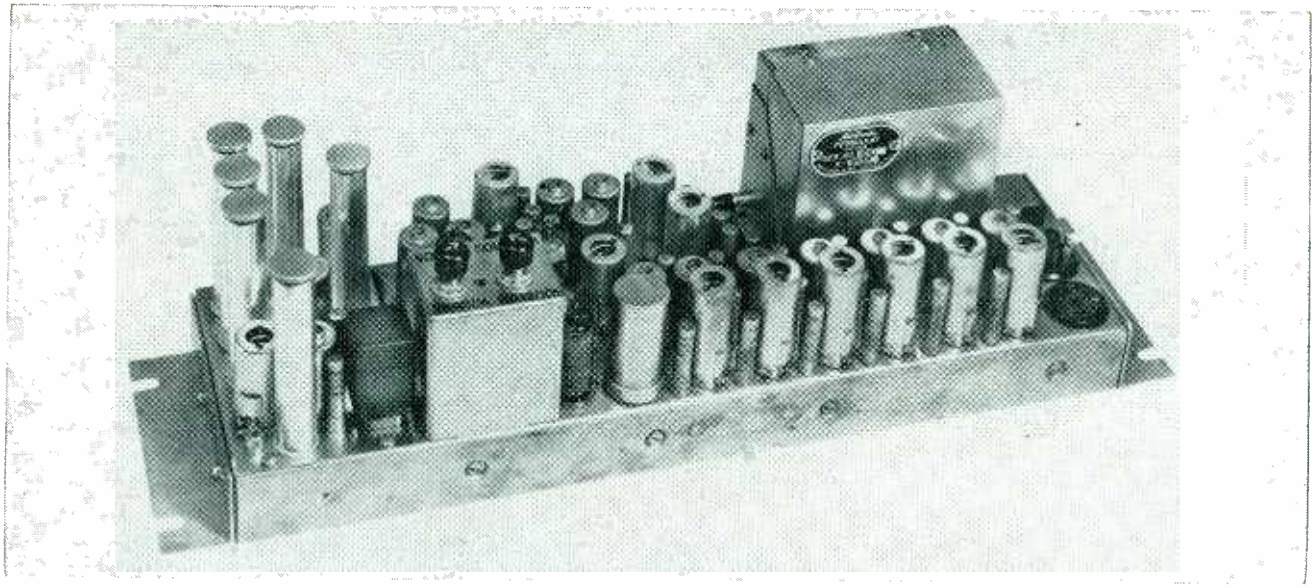
(7) Load resistance matched for maximum power amplification	$R_{22}\sqrt{1-\delta}$
(8) Input impedance at maximum power amplification	$R_{11}\sqrt{1-\delta}$
(9) Maximum power amplification	$\frac{R_{21}^2}{R_{11}\,R_{22}}\,\frac{1}{(1+\sqrt{1-\delta})^2}$
(10) Insertion gain at maximum power amplification	$\frac{R_{21}^2}{4R_{11}^2}\,\frac{1}{(1+\sqrt{1-\delta})^2}$
(11) Insertion gain (at maximum power amplification)/maximum power amplification	$\frac{R_{22}}{4R_{11}}$
(12) Current amplification at maximum power gain	$\frac{R_{21}}{R_{22}}\,\frac{1}{1+\sqrt{1-\delta}}$
(13) Voltage amplification at maximum power gain	$\frac{R_{21}}{R_{11}}\,\frac{1}{1+\sqrt{1-\delta}}$

Table II—Arrangement of Measured Values

I_e I_c	i_e	$(v_e)_o$	$(i_c)_o$	0	$(i_c/i_e)_o$	$\lvert R_{11}\rvert$	$\lvert R_{12}\rvert$
V_e V_c	i_e	$(v_e)_\infty$	0	$(v_c)_\infty$	$(v_c/v_e)_\infty$	$\lvert R_{21}\rvert$	$\lvert R_{22}\rvert$

Table III—Test Values for Commercial Germanium Transistor

0.5 ma 2.0 ma	100 μa	18mv	132 μa	0	1.32	420 ohms	182 ohms
0.13 v 22.5 v	100 μa	42mv	0	3.1v	74	31,000 ohms	23,500 ohms



Receiver unit designed for adjacent-channel operation. Midget cavities and special oscillator are at the left, i-f wave filters in can at right rear

Adjacent-Channel Operation of Mobile Equipment

AS THIS IS WRITTEN the Federal Communications Commission is reaching a decision removing mobile radio services from the experimental category and assigning permanent channels. It is contemplating standardization of rules and regulations to provide for full growth of these services while at the same time insuring efficient utilization of channels to be assigned.

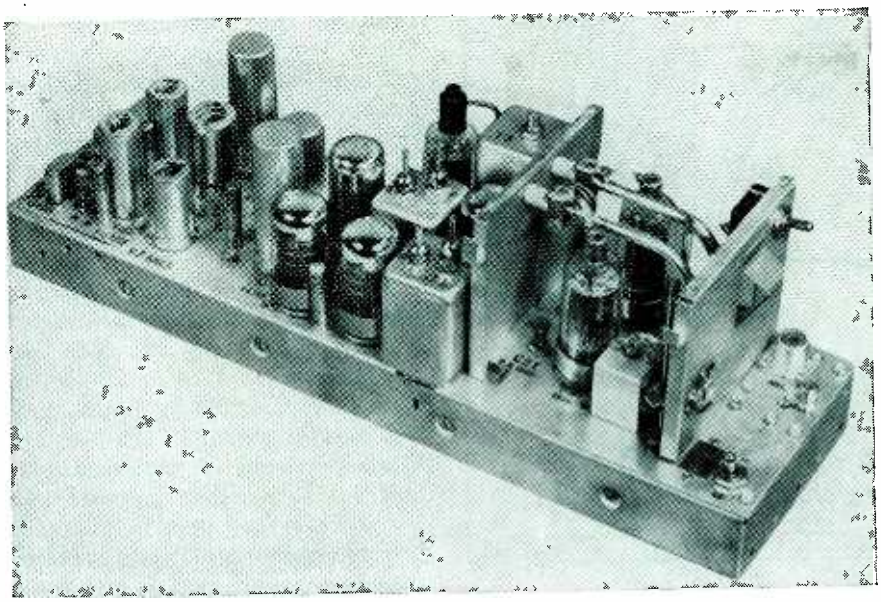
The move is indeed timely, since the need and demand for mobile-service channels is increasing at a very rapid rate, particularly in metropolitan areas. Here, especially, any waste of spectrum space cannot be tolerated, perhaps not even for guard bands that characterize the broadcasting industry, and it is this that prompts the writer to suggest that adjacent-channel operation of mobile-service stations in the same area may be a necessity.

The problem of adjacent-channel operation in the same area is not a simple one to solve, but there is reason to believe that with reasonable boundaries for the allocation limits a solution can usually be found.

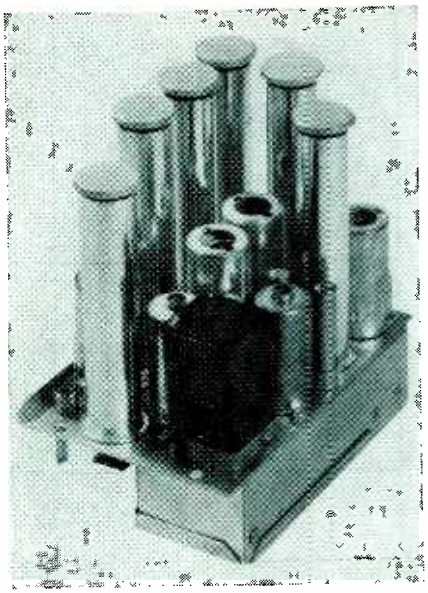
The Basic Problem

It is generally understood that i-f selectivity, usually the controlling selectivity in receiver design, is not the dominant and deciding factor in design for adjacent-channel operation. If it were possible to provide real r-f selectivity in the receiver, adjacent-channel operation would be limited only by the perfection of this parameter. However, until engineers can provide r-f selectivity of 100 db down, ±30 kc at 160 megacycles, it is vain to attack the problem from this angle. Even the massive stabilized cavities that are practicable for base-station installation will not provide attenuation of more than 20 or 30 db at 200 kc off resonance, and are of little value where the adjacent and alternate-channel stations are removed from the desired frequency by 60 and 120 kc, respectively.

Proper system design, together with controlled geographical assignment of channels, can do much to keep the boundaries of the problem within reasonable limits, so that straightforward engineering principles can be applied within the known art to make utilization of adjacent channels feasible. However, without some control of the system design, the problems of intermodulation or crosstalk may loom so large that no practicable equipment design can be found. The control of crosstalk in a 10-pair telephone cable for instance may be impracticable, unless some limits are placed upon the signal levels carried by the individual pairs and upon the gain of amplifiers asso-



Thirty-watt transmitter chassis. Instantaneous-deviation-control tubes are in second row from left



Closeup of receiver r-f deck. Crystal oven is in foreground

Increasing vhf activity requires more economical use of a limited radio spectrum. New equipment techniques and proper geographical separation of fixed transmitters reduce interchannel interference to a practical minimum. Guard bands may not be necessary

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ciated with the individual pairs.

Almost any desired degree of i-f selectivity can be attained, spurious radiation can be controlled and spurious responses in the receiver attenuated to a point where they may be forgotten. Transmitter deviation can be satisfactorily limited to prevent excursion into adjacent and alternate channels. With all these elements under control, there remains still a dominant difficulty to be surmounted. If a difficulty could be termed a masterpiece, this one should bear that designation. Months of work will yield an improvement of 20 db and elaborate equipment may add another 2 db, but 100-db improvement seems as remote as the twinkling stars. The name of this masterpiece of contrariness is intermodulation (meaning r-f intermodulation) and this one factor places greater limits upon successful adjacent-channel operation in the same area than all other technical factors combined.

Intermodulation may be of two types: (1) that produced within a transmitter group and (2) that produced in the front end of a receiver. Of the two types, the receiver intermodulation is far more important and considerably more difficult to control.

R-F Stage Intermodulation

Briefly, receiver intermodulation is the combining of two strong, undesired signals so that the beats resulting from nonlinear circuit characteristics produce modulation products directly on the frequency of the desired station. For example, consider transmitters A, B and C, spaced 60 kc apart. Considering station A the desired channel, when a mobile receiver is operated close to stations B and C strong signals in the front end of the receiver operate the mixer in its nonlinear region, resulting in beats between B and C. The second harmonic of station B generated within the receiver will beat with the fundamental of station C to produce a carrier or product exactly on the frequency of station A.

A	B	C
f	$f + \Delta f$	$f + 2\Delta f$

$2B = 2f + 2\Delta f$
$C = f + 2\Delta f$
$A = f$ (difference)

Unless the desired signal A is

NEW RULES

FCC announced new rules for the General Mobile Services May 3, effective July 1.

Details appear on page 128

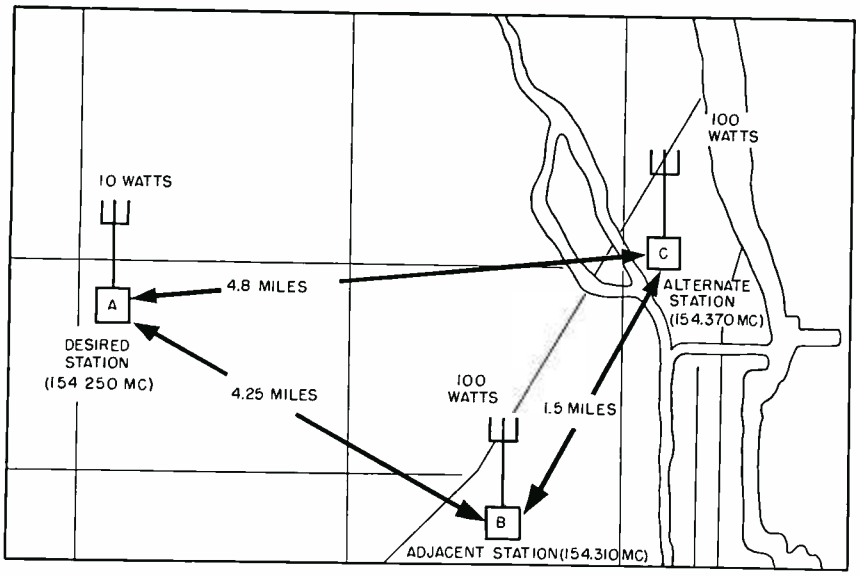

FIG. 1—Geographical layout of stations used in actual test

strong enough to wipe out this undesired product of intermodulation, the receiver will not respond to the desired station A, and modulation from both B and C will be heard. This is one combination which produces an interfering carrier, but there are many other combinations which will produce results equally disastrous.

There are two obvious solutions to the problem. Intermodulation could not take place in the r-f stage, the mixer, or any succeeding stages of the receiver, if stations B and C were not allowed to pass through the front-end selective circuits. Similarly, if all circuits (r-f, mixer, i-f, and other amplifiers) are designed so that they operate over a purely linear characteristic, no mixing or intermodulation can take place and the undesired signals will be rejected by the i-f selectivity. Both solutions are theoretically possible, but they are both practicably impossible to achieve unless well-defined limits are placed upon the levels of the signals involved.

A mobile unit operating in the vicinity of a 100-watt transmitter, radiating from a 100-ft antenna, may receive more than a volt on the grid of the first r-f tube. If stations B and C are close together geographically and each supplies a full volt on the grid of the first r-f amplifier, while the desired station A supplies a mere microvolt, a solution to the problem becomes impossible. Some r-f selectivity can be provided to offer slight attenuation to the station 120 kc removed from the frequency of station A and receiver design can improve the linearity of all amplifier and mixer stages to reduce the susceptibility to strong intermodulation signals. However, even the combination of maximum practicable r-f selectivity and the best possible design for linearity of amplifiers will not be sufficient to control the conditions outlined above.

Grouping of Stations

Several years ago, the writer proposed that one possible solution might be the locating of all three stations, or a group of stations, at one geographical position, so that the mobile unit would receive a strong desired signal, and on this basis it was argued that the products of intermodulation produced by B and C would always be weaker than the direct desired signal transmitted by A, so that the desired station signal would wipe out the undesired intermodulation products of B and C.

This solution has merit only where there are no other licensees in the area except those occupying the single block of channels. Severe interference would result in the channels above and below the concentrated block of stations and there would be danger of severe transmitter intermodulation, as well as a high level of receiver intermodulation on those channels. In addition, the standing-wave patterns produced by the various grouped radiators could not be matched exactly in space, with the result that a difference of received signal level of as much as 10-to-1 might exist between desired and undesired signals at particular locations.

The control of intermodulation even within a block of centralized stations is difficult, and both age and the use of a 10 or 20-db pad have been resorted to for holding the level of signal in the receiver below the point of nonlinear mixing. To the receiver engineer who has worked for years to raise the level of receiver sensitivity to better than a microvolt, the use of a 20-db pad to knock down signal levels is equivalent to repairing a watch with a sledge hammer.

The joint operation of stations at one location, then, is an impracticable, unsatisfactory solution, which does not lend itself to reasonable procedures for the administration of all channel assignments. Successful operation for all licensees can be achieved only when geographical separation controls relative signal levels within the tolerable limits dictated by receiver-design practicability.

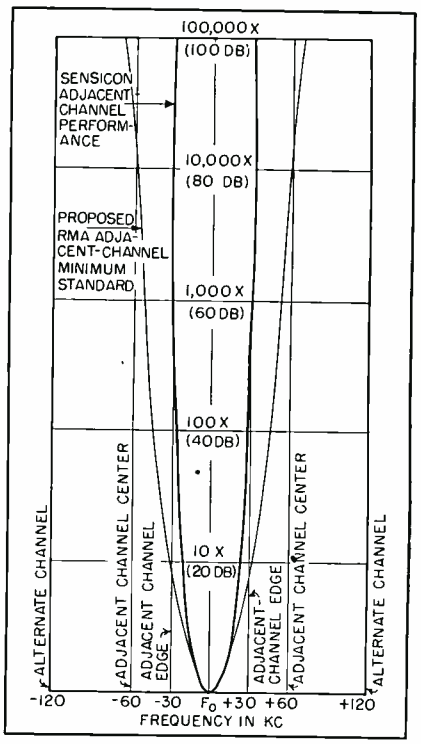

FIG. 2—Sensicon receiver selectivity curve

Consider again a group of stations A, B and C, (Fig. 1) operating on channels separated by 60 kc. We have already considered the case where A, B and C were operated at a single location, and the case where B and C were at one location and A at a distant location. Now consider the third possibility with A, B and C separated.

With Stations Separated

To make an actual test reasonably difficult, we separated B and C by approximately 1.5 miles, while A (the desired station) was placed 4.25 miles from B, the adjacent-channel station, and about 4.8 miles from C. The receiver was mounted in a mobile unit and required to communicate with station A while cruising in the immediate vicinity of B, and in the area between B and C.

With both B and C at one location, the receiver cruising in the vicinity of these stations would receive two strong signals, and the products of modulation would be large. But, for the case described above, with all three stations separated, the mobile unit cruising in the vicinity of station B receives one strong signal from B and a comparatively weak signal from C, with the result that the level of the intermodulation product is greatly reduced. A comparatively weak signal from station A will dominate the intermodulation product and wipe out the interference.

Figure 1 shows the geographical layout of the three stations. The frequencies and relative powers are marked. In a test car with the receiver tuned to station A, no interference was found except in a few spots in the immediate vicinity of station B, even when all three stations operated simultaneously. Cruising in the B area located certain signal-shaded points where the received signal from the undesired station B, less than a quarter of a block away, was abnormally strong while the shielding produced an abnormally weak signal from desired station A. By driving the car very slowly, it was possible to find interference areas, but the interference patterns were limited to a matter of yards. The squelch control could be set at a level sensitive enough for the response of the desired station, but insensitive enough to prevent opening by the operation of stations B and C, either simultaneously or independently.

It should be noted at this point that when tests are carried on in close proximity to interfering stations the problems of receiver desensitizing and intermodulation join. There is a question, perhaps somewhat academic, as to whether interference is caused by desensitizing or by intermodulation.

Needed Receiver Characteristics

The special receiver used in the test provided an i-f selectivity of more than 100-db attenuation at ±30 kc of the desired frequency as shown in Fig. 2. In other words, 100-db attenuation was provided between the channels or at the common boundary between channel A and channel B.

The receiver design principle brought the elements of r-f selectivity and intermodulation control to a maximum degree of effectiveness. Emphasis should, however, be given to the fact that the extraordinary degree of i-f selectivity in the test receiver was not the dominating factor that made adjacent-channel operation in the same area possible. The same degree of i-f selectivity in a receiver of conventional design, with conventional r-f and mixer circuits, did not provide satisfactory adjacent-channel operation under the conditions described. There is, nevertheless, the obvious limiting factor that the i-f selectivity must be sufficient to prevent the adjacent-channel signal from passing through the receiver at a level great enough to dominate the desired signal at the limiter.

Modern production receivers of a type in wide use provided excellent reception under the conditions outlined, except for the radius of approximately one-half mile around the adjacent channel station, while both B and C were on the air. Under all tests, the tendency towards interference with the older type receivers was lessened when only one of the opposing stations was on the air. One receiver of excellent selectivity characteristics, but without the new control of intermodulation, was tested. Interference reception over the entire mile-and-a-half separation path between stations B and C was received.

All of the observations pointed with emphasis to the fact that, by geographically separating the stations operating on the successively

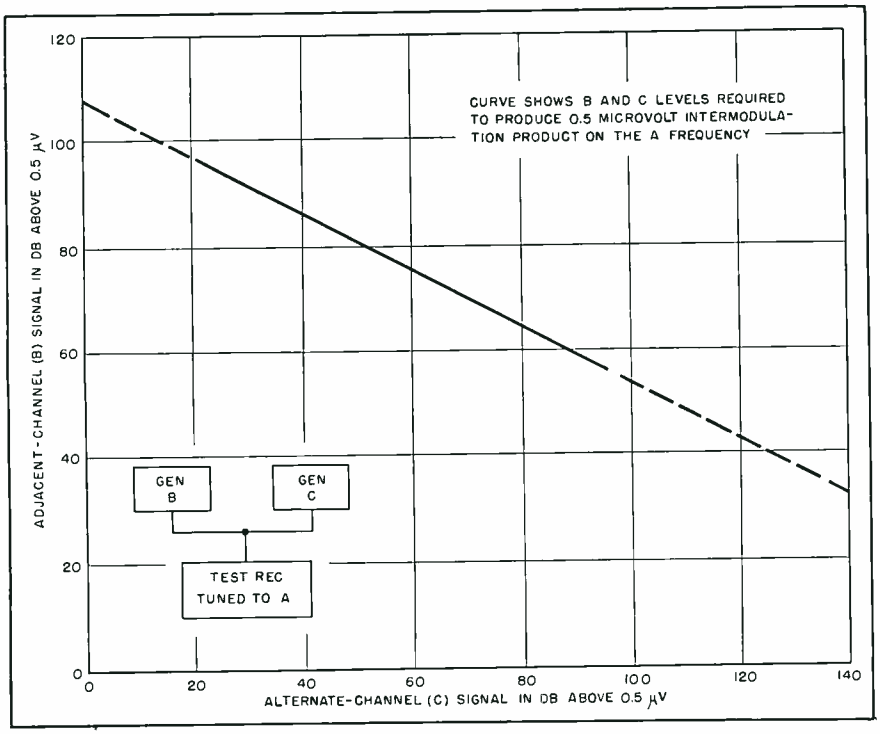

FIG. 3—R-f intermodulation characteristics of the receiver for various levels of adjacent and alternate-channel signals

adjacent channels the extreme limits of intermodulation production in the receiver could be brought under control to a point where the effects of special receiver design became significant.

Laboratory Tests

Intermodulation characteristics obtained by connecting two signal generators to supply signals to the test receiver simultaneously are shown in Fig. 3. Generator B supplied the signal 60 kc removed from the desired signal and generator C supplied a carrier 120 kc removed. By increasing the level of the two signals, the intermodulation product on the desired frequency equivalent to A produced 20 db quieting in the receiver.

Figure 4 clearly illustrates the need for base-station separation. The curve was taken with the generators B and C connected as in Fig. 3, but with the difference that the adjacent-channel signal B was held constant at 97 db above one-half microvolt, or with a constant input of more than 28,000 microvolts.

With the B signal (60 kc removed) fixed, the amplitude of the alternate-channel signal C was varied, while the amplitude of the intermodulation product appearing on the desired frequency A was recorded. Extrapolation of the curve of Fig. 4 will show that, for B and C both at 97 db above the reference level, an intermodulation interference product on channel A will be produced with an amplitude of approximately 2,800 microvolts.

This fact is so important in system design that it deserves restatement: With two base stations at the same location, each one supplying a signal to our receiver at 97 db above the reference level or more than 28,000 microvolts, the interfering product of modulation will have an amplitude of 2,800 microvolts and the desired station will need to supply a signal of not less than 5,600 microvolts to gain control. Because of the standing waves in space, even 5,600 microvolts from the desired station would not be ample to maintain control.

With the desired station located at the same point as stations B and C, we may assume a 28,000-microvolt signal on the desired channel, but again, because of the standing waves in space (which may be as great as 10-to-1) we may expect the desired signal to drop as low as 2,800 microvolts, while the interfering product remains at 2,800 microvolts. Because the intermodulation products are relatively high in amplitude for strong adjacent and alternate-channel signals, the installation of a group of successively adjacent channel stations at one location does not provide practicable operational limits within which it is possible to design satisfactory receiving equipment for systems that are not at the group location.

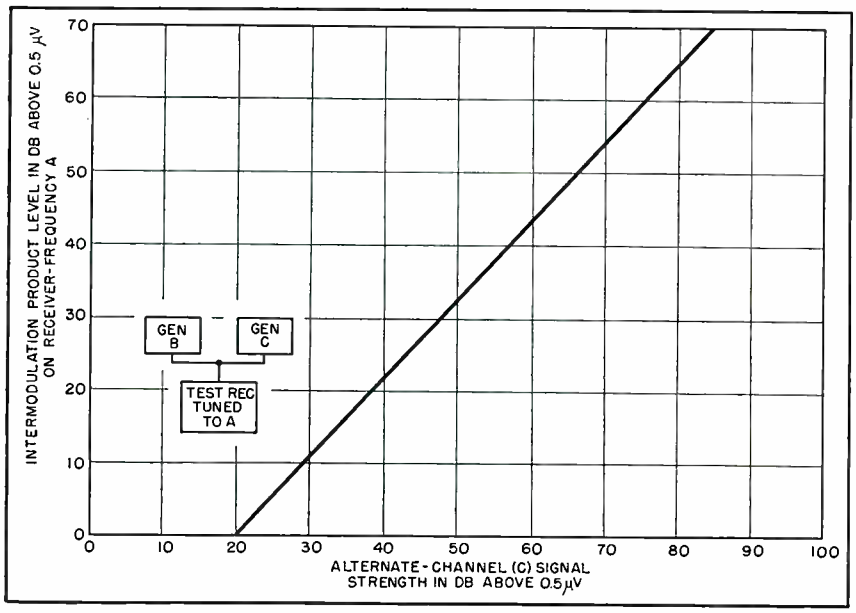

FIG. 4—R-f intermodulation characteristics of the receiver with adjacent-channel signal constant at 97 db above 0.5μv

Further Tests

By separating stations B and C geographically, so that at the mobile pickup point close to station B where a 28,000 microvolt signal is received the signal from station C may, for example, be limited to 500 microvolts, the product of intermodulation will be approximately 50 microvolts instead of 2,800 microvolts as indicated above. The threshold requirement of the desired station would then be 100 microvolts and, even on a 10-to-1 basis, only a 500-microvolt signal would be needed to dominate.

Further geographical separation of the two stations B and C may be employed to limit the input to the receiver from signal C when 28,000 microvolts is applied by station B. It can be shown from Fig. 4 that with 2.5 microvolts input from station C, no intermodulation products would be produced on the desired channel in the critical area near B.

The calculation of relative signal levels required for the control of intermodulation presents the problem in a more severe light than actually exists in practice. Because of the vertical directivity of the antenna pattern of the base station, the signal level close to the base of the antenna supporting structure is lower than the signal amplitude a few blocks away. Shielding effects introduced by buildings and other structures also alter the field pattern from all stations and, fortunately, the magnitude of interference produced by a group of separated stations in an urban area is less by practical test than that calculated on the basis of idealized radiation conditions. This statement is substantiated by the test conditions shown in Fig. 1, where stations B and C each radiating more than 100 watts produced an almost negligible pattern of interference with the mobile unit operating close to B, although station A radiated no more than 10 watts. The mobile unit received no interference as soon as it was moved away from an area of approximately a quarter of a block to one block from B, where reflections provided a strong

signal from B and a weak signal from A.

Data plotted in Fig. 4 further explains the significance of the Sensicon receiver intermodulation characteristic, and that characteristic may be stated in simple terms. For a strong adjacent-channel signal of 97 db above 0.5 microvolt, the level of the interfering product of intermodulation will always be approximately 20 db less than the amplitude of the alternate channel signal. If the desired signal and the alternate-channel signal are of equal amplitude, the desired signal (neglecting standing waves) will always have an advantage over the undesired product of modulation, under these conditions, of at least 10-to-1.

To understand the significance of this relationship, emphasis must be given to the fact that this condition of 20-db improvement for protection occurs only in areas where the mobile receiver is operating geographically close to the adjacent channel station B, but for all other areas where the mobile unit is some distance from station B (the adjacent-channel station) the protection will be substantially greater than 20 db. In other words, the curve of Fig. 4 shows the most severe conditions, applying only to areas close to the adjacent-channel station.

Receiver Design

To a controlling degree, the selectivity of the receiver illustrated in these pages is determined by the characteristics of the wave filter. Permeability-tuned components and compensating capacitors are permanently sealed and fixed electrically and mechanically by casting the entire filter structure in polyester styrene. This construction not only frees the filter from possible variation owing to moisture and vibration, but also prevents the loss of selectivity characteristics as a result of attempted tuning without necessary instrumentation.

Since the i-f center is fixed, the maintenance problems of the receiver are simplified and tuning is accomplished by adjusting the tunable crystal oscillator. A new circuit was developed, providing the necessary electronic tuning over the required range with compensation to insure stable performance over a wide temperature range. Stability must keep the signal at the center of the i-f bandpass. The crystal circuit maintains ±1 kilocycle of the assigned carrier frequency measured at 25 C, or from ±0.00058 percent to ±0.00066 percent over the 152-to-174-megacycle band for the ambient temperature range of −30 C to +60 C.

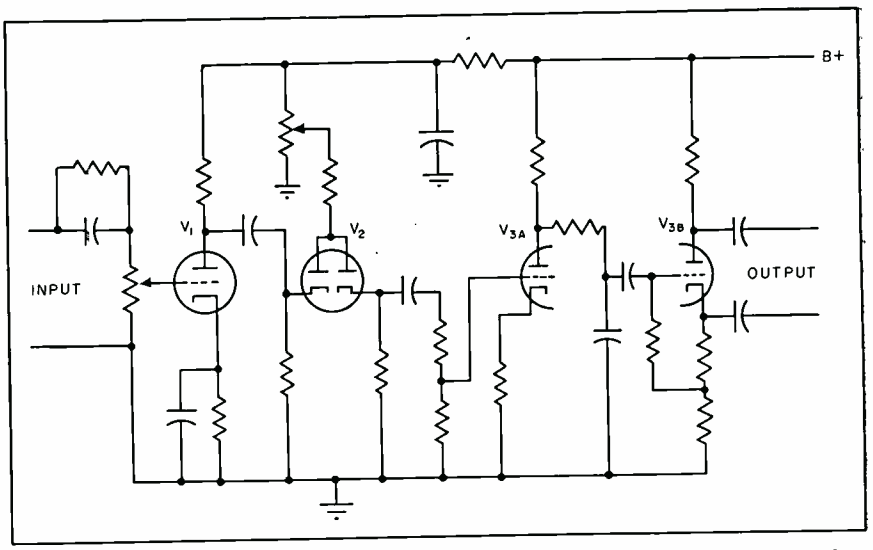

FIG. 5—Circuit diagram of the instantaneous deviation control used in the transmitter

Transmitter Design

Provision is made in the transmitter (illustrated) to supply from one to three separate crystal oscillators. Three-frequency transmitters may be provided for switching frequency without retuning the transmitter, so long as the maximum frequency change does not exceed 240 kc. The instantaneous deviation control requires two tubes. These are shown in Fig. 5 preceded by an amplifier.

The original approach to this circuit problem required that the voltage control in the compressor system be supplied through a frequency-sensitive circuit, so that the voltage would increase as a function of the frequency of the audio in the amplifier. Although this method worked, it was obviously a cumbersome device which did not lend itself to mobile communications equipment. The answer was found in the simple Winkler circuit arrangement by which the modulating wave first passed through a differentiating network, which emphasized all steep slopes or steep wave fronts, then through a clipper which automatically clipped the characteristic wave elements associated with the steep slopes, and finally through an integration network to restore the remaining audio characteristics to normal relationship. This instantaneous deviation control has no time lag and may be adjusted to provide a rigid limit to the maximum instantaneous deviation of the transmitter frequency.

Products of modulation will extend beyond the maximum excursion of the instantaneous frequency of the wave and, for this reason, it is desirable to hold the instantaneous deviation maximum well within the limits of the half-channel width to be occupied. In practice, a guard band of a mere two or three kilocycles will be satisfactory, since the speech sidebands producing maximum deviation are of a transient nature and the energy content of the products of modulation extending substantially beyond the limits of instantaneous deviation are low and may be neglected insofar as substantial interference to adjacent channel operation is concerned. The use of multiple-tuned circuits and circuit-isolation means holds the spurious output of the transmitter at least 70 db below the carrier output level.

Although this discussion has been concerned primarily with the 152-to-162-mc band, all of the reasoning applies equally to the bands from 30 to 50 mc.

Low-Frequency DISCRIMINATOR

A phase inverter having equal plate and cathode loads is used to drive a resistance-capacitance phase shifter. The output voltages that are developed behave as the voltages from conventional discriminators, thus this is a compact low-frequency circuit

THE NETWORK discussed herein was designed to produce the necessary deviation voltage for an automatic-frequency-control system. Through its use the separation frequency f_0 between two r-f oscillators is maintained within 10 percent of any of several selected values. The required separation in frequency lies between 20 and 500 cycles per second. Under some operating conditions, unwanted variations as great as 500 percent of values of f_0 normally occur without some such control.

Although the circuit functions as a discriminator, it differs from conventional discriminators in that it contains neither transformers nor inductors and, hence, no resonant circuits.

Discriminator Action

The circuit performance centers around a dual-purpose phase changer shown in Fig. 1, which supplies the following necessary control voltages. First, it produces two voltages 180 deg displaced from each other and of equal amplitudes; secondly, it produces a voltage which at one frequency is 90 deg displaced from the other voltages, but which at any other frequency tends to rotate towards either zero-deg phase condition or 180-deg phase condition.

The operation of the phase changer is as follows: Consider V_1 as a degenerative amplifier (part of Fig. 1A drawn in lighter lines). If R_K is made equal to R_L, the voltages developed across R_L and R_K will be equal in magnitude but in phase opposition, one being in phase with the input voltage E_0 and the other being 180 deg out of phase with E_0; if the reactances of C_2 and C_1 are small compared with R_1 and R_2 over the operating frequency range these same voltages can be assumed to appear as E_1 and E_2.

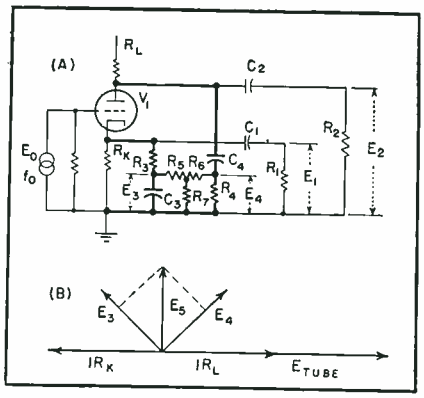

FIG. 1-(A) Phase changer acts as convenient low-frequency discriminator. (B) Phase relations in circuit

Next, consider the same tube operating as a 90-deg phase shifter (part of Fig. 1A drawn in heavier lines). The special conditions of this circuit are that $R_3 = X_{C3} = R_4 = X_{C4}$ for some frequency f_0. Since the reactance of $C_4 = R_4$, the voltage E_4 will lead that across R_L by 45 deg; similarly, the voltage E_3 will lag that across R_K by 45 deg. If $R_5 + R_6$ is much greater than either R_4 or the reactance X_{C3}, the aforementioned phase relationships between E_4 and E_3 will still exist and will produce in the common load resistor R_7 a resultant current 90 deg displaced from that flowing through R_L and R_K.

The vector relationships existing at a center frequency f_0 are shown

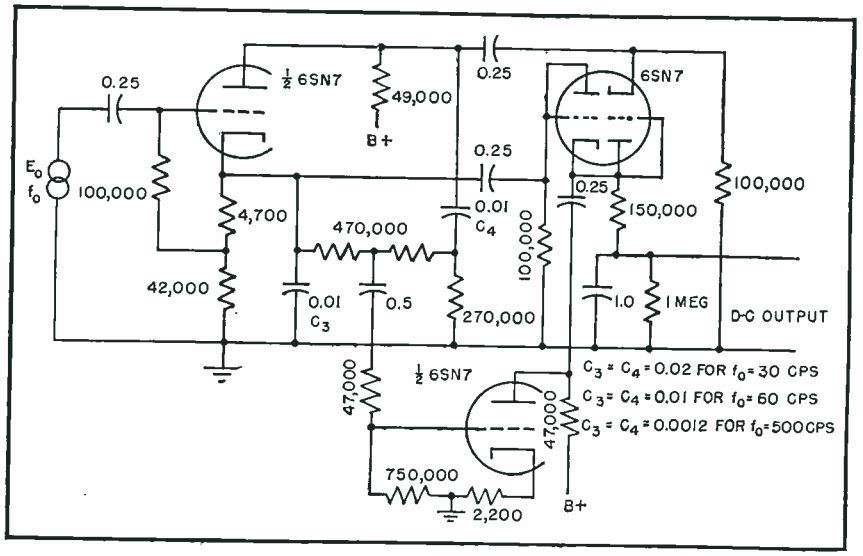

FIG. 2—Adaptation of phase changer provides amplification for weak voltage, and diode rectification, to deliver d-c proportional to shift from center frequency

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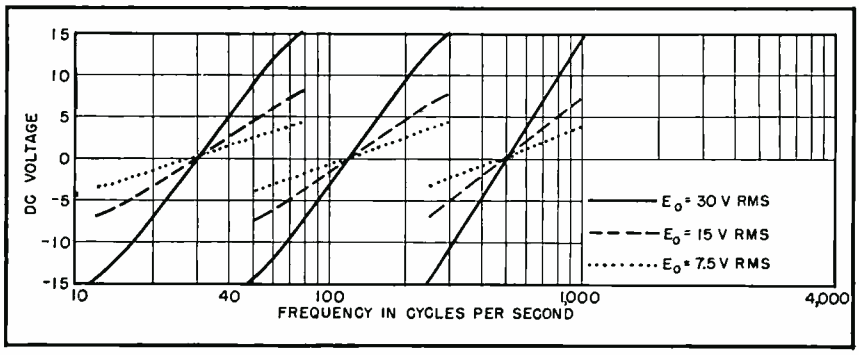

FIG. 3—Curves show discriminator action in presence of different levels of input and for different center frequencies

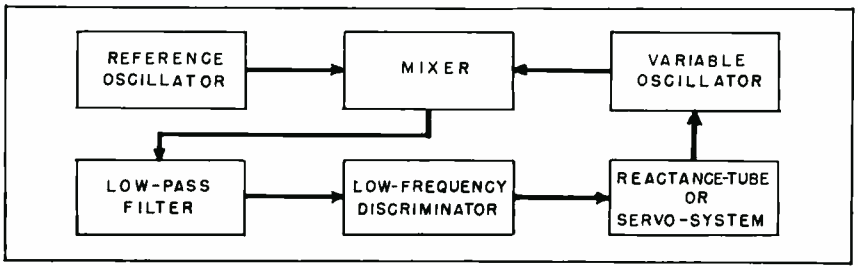

FIG. 4—To stabilize one r-f oscillator relative to the other, the low-frequency discriminator is used with a reactance tube or servo system

in Fig. 1B. For a frequency greater than f_0, the magnitude of E_4 increases and its phase displacement with respect to IR_L decreases; at the same time, the magnitude of E_3 decreases and its phase displacement with respect to IR_K increases. The combined effect is to pull the resultant vector E_5 more nearly in phase with IR_L. If the frequency becomes less than f_0, the above effects are interchanged and the resultant vector E_5 is pulled more nearly in phase with IR_K.

Circuit Performance

The desired discriminator action is obtained from a d-c comparator which compares the d-c energy components resulting from the conducting periods of two diodes. At the center frequency, each of the diodes conducts for approximately one-half cycle, and the net d-c voltage developed across the output of the diodes is zero. For any other frequency the diodes will conduct for unequal portions of a cycle and the d-c output voltage will have an amplitude proportional to the frequency deviation off the center frequency. The polarity of the output voltage will depend upon whether the frequency deviation is above or below the center frequency.

When only the basic elements of this circuit are used, the conversion efficiency, (d-c out vs a-c in times 100 percent for some frequency off center frequency), is somewhat low, being about 5 percent for a frequency departure one octave removed from f_0. This is due to both the low amplitude of E_5 and the high impedance across which this voltage must be developed. Such a low efficiency may be accepted if it is convenient to employ d-c amplification following the diode comparator. However, a cleaner approach is to employ a stage of amplification to boost the amplitude of E_5 and at the same time lower the impedance level. Using the latter scheme, the conversion efficiency is increased to approximately 50 percent under the conditions noted above. The final circuitry employed is shown in Fig. 2. Figure 3 shows the overall characteristic for three values of E_0 and three values of f_0.

Oscillator Control

As previously stated, this circuit was designed to maintain a specified frequency separation between two r-f oscillators independent of circuit conditions which would normally cause the oscillators either to drift apart or lock together, the latter case being the pronounced tendency of oscillators operating on slight frequency differences.

When employed in a system as outlined by the block diagram of Fig. 4 the above purpose is accomplished, the circuit operation being as follows: If it be desired that the variable-oscillator frequency be maintained apart from that of the reference oscillator by f_0, then the values of C_3 and C_4 would be so selected as to give zero output from the discriminator at f_0. When the difference frequency is other than f_0, the voltage out of the discriminator will be of such a polarity as to cause the reactance tube to correct this discrepancy. Obviously there is a definite limit to the amount of control that can be exercised by the reactance tube, so that if it is necessary to operate the two oscillators at a frequency separation several octaves away from some previously set value it is required that the variable oscillator be manually retuned somewhere within the pull-in range of the reactance tube in addition to changing the value of C_3 and C_4.

Other practical applications of this low-frequency discriminator circuit include its use as a frequency meter and its use as the control circuit for automatically maintaining the altitude of an aircraft. As a frequency meter it is only necessary to place a microammeter in series with the diodes' load and calibrate it in terms of frequency. For aircraft altitude control it must be used in conjunction with an absolute altimeter whose output is an audio frequency proportional to the altitude. These are basically f-m systems such as the APN-1. For this application each value of f_0 would represent a given altitude, above or below which control voltages would be developed.

This work was done under the sponsorship of the U. S. Navy Dept. under Contract NOrd 7958.

Cathode-Compensated Video Amplification

Theoretical and practical development of a circuit technique that combines virtues of lower cost, simplicity, extended frequency range and improved linearity. A two-part paper; part I gives the theoretical analysis and experimental verification, while part II covers input admittance relations and summarizes advantages

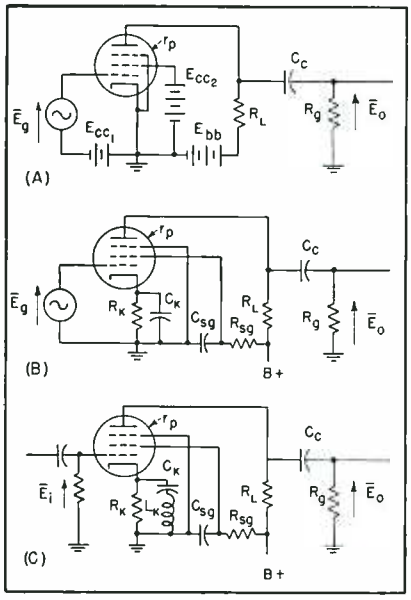

FIG. 1—Basic video amplifier circuit, cathode-biased version employed for determining proper compensation, and practical cathode-compensated circuit

It is well known that feedback can be used to modify the frequency, gain and linearity characteristics of amplifiers. The purpose of this paper is to show how feedback, properly obtained in the cathode circuit of a video amplifier, can be used to endow the amplifier with exceptional characteristics. Some of the important features involved are simplicity, reduction in cost, improvement in linearity, and practically constant amplitude and time delay over the useful frequency range of operation.

The compensating elements are of such values that neither the series inductance of the capacitors nor the stray capacitance of the inductors has any noticeable effect on the results. These elements are incorporated in a low signal level circuit and do not increase the stray capacitance over that which results with uncompensated operation. The large electrolytic capacitor normally used in the cathode circuit is eliminated, thus increasing the reliability of operation. The total cost of the small mica capacitor and the inductor used for compensation is considerably less than that of the electrolytic capacitor that was eliminated.

Compensating Procedure

To make proper use of the compensation discussed in this paper the procedure indicated below should be followed:

(A) Use the circuit of Fig. 1B. It is important that the suppressor and screen be returned to ground and not to the cathode.

(B) Determine the stray plate circuit capacitance C_s. This can be

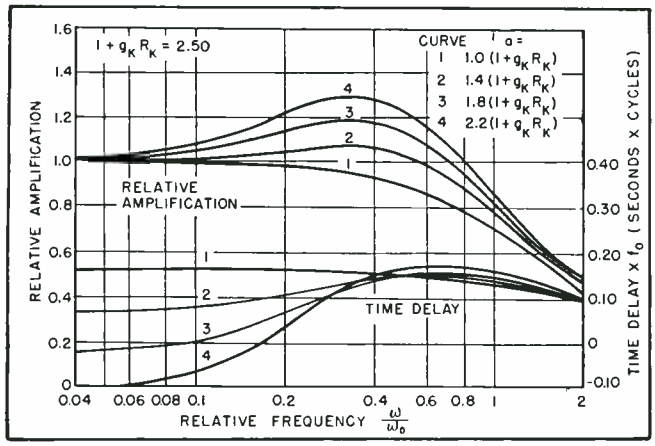

FIG. 2—Effect of variations in factor a when using only a capacitor in parallel with cathode resistor

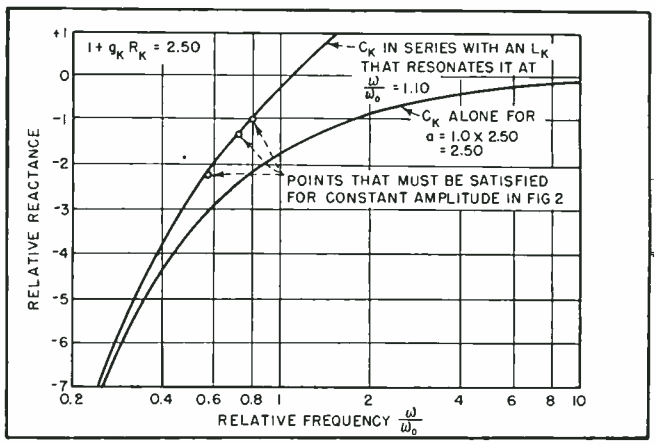

FIG. 3—Relative reactance values required to satisfy requirement of constant amplitude when using only shunt capacitor

Part I

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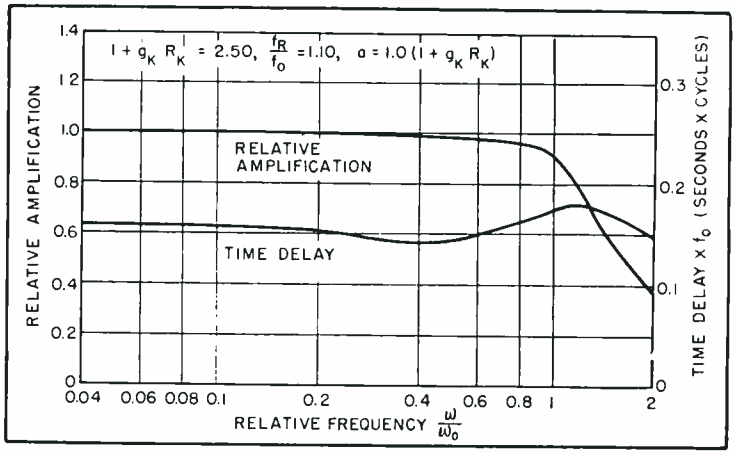

FIG. 4—Amplification and time delay characteristics for circuit constants and conditions of Fig. 3

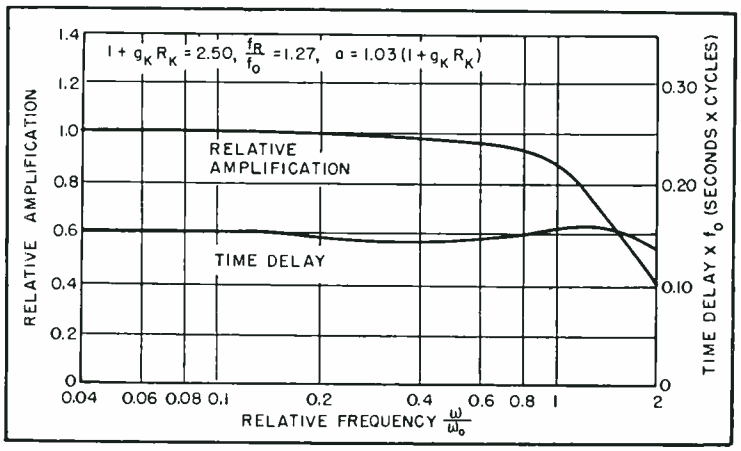

FIG. 5—Amplification and time delay characteristics for improved circuit based on curves of Fig. 6

done experimentally, if the screen and cathode are perfectly bypassed, by obtaining a gain-frequency curve for some value of R_L close to that which it is intended to use. By using the frequency f at which the gain is down 3 db from the middle frequency value and R_{eq} which is calculated from

$$\frac{1}{R_{eq}} = \frac{1}{R_L} + \frac{1}{r_p} + \frac{1}{R_g} \qquad (1)$$

we get

$$C_s' = \frac{1}{2\pi f R_{eq}} \qquad (2)$$

and then

$$C_s = C_s' - C_o \qquad (3)$$

where C_o is the capacitance introduced by the measuring circuit.

(C) Determine the middle frequency gain when the screen and cathode are perfectly bypassed to ground and a value of R_{L1} is used such that the gain is down 3 db at the high frequency

$$f_o = \frac{1}{2\pi C_s R_{eq1}} \qquad (4)$$

which is chosen for reference purposes.

Preferably this should be done experimentally, making allowance for the change in the frequency characteristic due to the capacitance introduced by the measuring circuit. The frequency can be computed analytically if g_m is known by using the expression

$$A = g_m R_{eq1} \qquad (5)$$

where R_{eq1} is obtained by substituting R_{L1} in place of R_L in Eq. 1.

(D) Determine the value of R_{eq2} which, when all cathode bypass capacitance is removed, will produce the same middle frequency gain that was obtained in part (C). Use this value of R_{eq2} to determine

$$(1 + g_K R_K) = \frac{R_{eq2}}{R_{eq1}} \qquad (6)$$

This should preferably be done experimentally by measuring the value of R_{L2} required and substituting it in Eq. 1 to get R_{eq2}. A close approximation can be obtained analytically if

$$g_K \cong g_m + g_{c2} = \frac{\delta i_b}{\delta e_{c1}} + \frac{\delta i_{c2}}{\delta e_{c1}} \qquad (7)$$

can be determined. The analytical value obtained in this manner will usually be a little low for it does not take into account the fact that g_m is reduced slightly when a higher value of R_L is used. Additional feedback also results due to the small a-c screen to cathode voltage that will be present. Both of these factors would tend to require a higher value of R_{eq2} than would be given by the analytical expression.

(E) Obtain values of $a/(1 + g_K R_K)$ and f_R/f_o from Fig. 6 for the value of $(1 + g_K R_K)$ given in (D).

(F) The cathode capacitor required is

$$C_K = \frac{a}{(1 + g_K R_K)} \frac{R_{eq2}}{R_K} C_s \qquad (8)$$

and the value of cathode inductor required is

$$L_K = \frac{1}{(2\pi f_R)^2 C_K} \qquad (9)$$

(G) Connect the components R_{L2}, C_K and L_K as shown in detail in Fig. 1C.

In a typical amplifier with $f_o = 3.54$ mc and $(1 + g_K R_K) = 2.13$ the required value of cathode capacitor was $C_K = 1{,}170$ μμf and the required value of cathode inductor was $L_K = 1.13 \times 10^{-6}$ henrys. The amplitude and time-delay characteristics for this amplifier are given in Fig. 8. Additional characteristics of this amplifier will be discussed in the concluding part of this paper. Its low-frequency gain will be that

which would have resulted in (C) if infinite cathode bypass capacitance had been used.

Theoretical Development

In an amplifier of the type shown in Fig. 1A the vector ratio $\overline{E}_o/\overline{E}_g$ is known as the voltage amplification or gain and is denoted by the symbol $\overline{A}$. In the middle and high frequency regions this can be expressed as

$$\overline{A} = -\overline{g}_m \overline{Z}_{eq} \qquad (10)$$

where $\overline{Z}_{eq}$ is the parallel impedance of the resistances r_p, R_L, and R_g and the stray capacitive reactance X_s.

If feedback is used and the symbol $\overline{A}_f$ is used to distinguish the voltage amplification with feedback from $\overline{A}$ which is the voltage amplification without feedback, then

$$\overline{A}_f = \frac{\overline{A}}{1 - B\overline{A}} \qquad (11)$$

where $\overline{B}$ is the vector portion of the output to ground voltage fed back in the grid-to-cathode circuit.

The batteries E_{cc1} and E_{cc2} shown in Fig. 1A are ordinarily replaced with the resistance-capacitance combinations shown in Fig. 1B. In this circuit if C_{sg} and C_K are assumed to have zero reactance there is no feedback and then $\overline{A} = -g_m\overline{Z}_{eq}$ as before.

If the parallel combination of r_p, R_L and R_g is called R_{eq} and $\omega_o = 2\pi f_o$ is so defined that

$$\frac{1}{2\pi f_o C_s} = \frac{1}{\omega_o C_s} = R_{eq} \qquad (12)$$

or

$$\omega_o = \frac{1}{C_s R_{eq}} \qquad (12a)$$

then $Z_{eq} =$

$$\frac{R_{eq}(-jX_s)}{R_{eq} - jX_s} = \frac{R_{eq}\left(-j\frac{\omega_o}{\omega}R_{eq}\right)}{R_{eq} - j\frac{\omega_o}{\omega}R_{eq}}$$

$$Z_{eq} = \frac{R_{eq}}{1 + j\frac{\omega}{\omega_o}} \qquad (13)$$

and

$$\overline{A} = \frac{-g_m R_{eq}}{1 + j\frac{\omega}{\omega_o}} \qquad (14)$$

This is the well-known relation which holds for resistance-capacitance coupled amplifiers in the middle and high-frequency ranges.

If we now assume that the reactance of C_{sg} is still zero while that of C_K is finite, then the flow of alternating plate and screen current through the parallel combination of R_K and C_K will develop an alternating voltage that appears in the grid-to-cathode circuit. In order to specify the cathode-circuit impedance in terms of the previously chosen symbols f_o and ω_o we will define a new arbitrary constant a so that

$$X_K = \frac{1}{\omega C_K} = \frac{1}{a}\frac{\omega_o}{\omega}R_K \qquad (15)$$

and therefore

$$a = \omega_o C_K R_K = \frac{C_K R_K}{C_s R_{eq}} \qquad (15a)$$

Using this definition of a we can express the cathode circuit impedance as

$$\overline{Z}_K =$$

$$\frac{R_K(-jX_K)}{R_K - jX_K} = \frac{-j\frac{1}{a}\frac{\omega_o}{\omega}R_K}{1 - j\frac{1}{a}\frac{\omega_o}{\omega}} = \frac{R_K}{1 + ja\frac{\omega}{\omega_o}} \qquad (16)$$

Since both the screen and plate alternating current flows through the cathode-circuit impedance while only the plate alternating current flows through the plate load impedance it is necessary to define a new term g_K such that

$$\overline{B} = \frac{g_K \overline{Z}_K}{g_m \overline{Z}_{eq}} \qquad (17)$$

Mainly

$$g_K = g_m + g_{c2} = \frac{\delta i_b}{\delta e_{c1}} + \frac{\delta i_{c2}}{\delta e_{c1}} \qquad (18)$$

but as defined in Eq. 17 it will also take care of additional minor factors such as the possibility that g_m itself might change between two conditions of operation and also that there may be other feedback effects due to the small a-c screen-to-cathode voltage. The voltage amplification with feedback is then

$$\overline{A}_f = \frac{-g_m\overline{Z}_{eq}}{1 - \left(\frac{g_K\overline{Z}_K}{g_m\overline{Z}_{eq}}\right)(-g_m\overline{Z}_{eq})} = \frac{-g_m\overline{Z}_{eq}}{1 + g_K\overline{Z}_K} \qquad (19)$$

If we substitute the values of $\overline{Z}_{eq}$ and $\overline{Z}_K$ obtained previously in this expression for $\overline{A}_f$, then

$$\overline{A}_f = \frac{-g_m\frac{R_{eq}}{1 + j\frac{\omega}{\omega_o}}}{1 + g_K\frac{R_K}{1 + ja\frac{\omega}{\omega_o}}}$$

$$= \left[\frac{-g_m R_{eq}}{(1 + g_K R_K) + ja\frac{\omega}{\omega_o}}\right]\left[\frac{1 + ja}{1 + j\frac{\omega}{\omega_o}}\right] \qquad (20)$$

Case I: If we let $a = \infty$

$$\overline{A}_1 = \frac{-g_m R_{eq1}}{1 + j\frac{\omega}{\omega_o}} \qquad (21)$$

and this of course is the case when the cathode is completely bypassed to ground.

Case II: If we introduce a new value of

$$R_{eq2} = (1 + g_K R_K)R_{eq1} \qquad (22)$$

this will make

$$\omega_{o2} = \frac{\omega_o}{(1 + g_K R_K)} \qquad (23)$$

and then

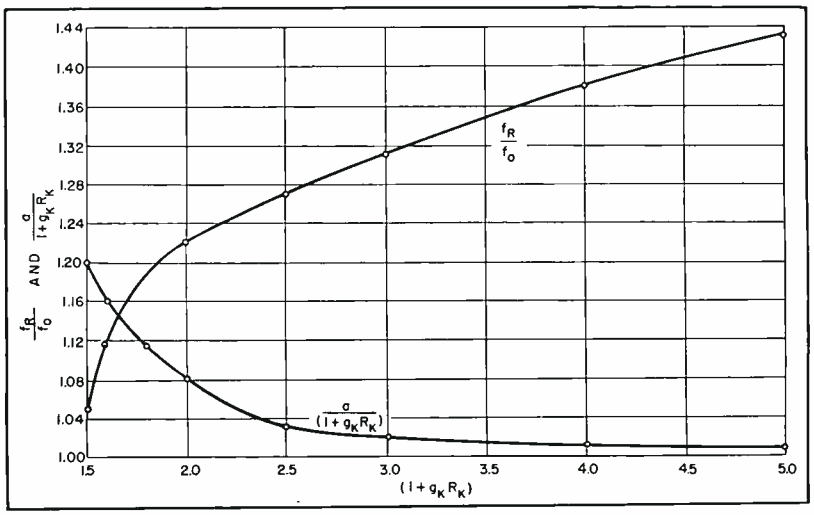

FIG. 6—Computed curves giving satisfactory constants for compensating circuit over a wide range of circuit values

$$\overline{Z}_{eq2} = \frac{(1 + g_K R_K) R_{eq1}}{1 + j(1 + g_K R_K)\dfrac{\omega}{\omega_o}} \qquad (24)$$

where ω_o is still defined in terms of R_{eq1}. Substituting this value of $\overline{Z}_{eq2}$ in the equation for $\overline{A}_f$ we get

$$\overline{A}_2 = \frac{\left[\dfrac{-g_m(1 + g_K R_K) R_{eq1}}{1 + j(1 + g_K R_K)\dfrac{\omega}{\omega_o}}\right]}{\left[1 + g_K \dfrac{R_K}{1 + j\,a\dfrac{\omega}{\omega_o}}\right]}$$

$$= \left[\frac{-g_m(1 + g_K R_K) R_{eq1}}{(1 + g_K R_K) + j\,a\dfrac{\omega}{\omega_o}}\right] \left[\frac{1 + j\,a\dfrac{\omega}{\omega_o}}{1 + j(1 + g_K R_K)\dfrac{\omega}{\omega_o}}\right] \qquad (25)$$

If we also let

$$a = 1 + g_K R_K \qquad (26)$$

then

$$\overline{A}_2 = \frac{-g_m R_{eq1}}{1 + j\dfrac{\omega}{\omega_o}} = \overline{A}_1 \qquad (27)$$

and this is exactly the same vector voltage amplification that we obtained in the original uncompensated case except that now

$$C_K = a\,C_s \frac{R_{eq1}}{R_K} = C_s \frac{R_{eq2}}{R_K} \qquad (28)$$

and is of the order of magnitude of 0.001 μf instead of being 200 or 300 μf as was required for good low-frequency response in the original case.

Case III: The fact that Case II gives the same vector voltage amplification as the original uncompensated amplifier is interesting, but not too useful. It is ordinarily desirable to improve both the amplitude and time-delay characteristics over those that are obtained with uncompensated amplifiers.

If values of a other than those indicated in Eq. 26 are used in Eq. 25 the amplitude and time-delay characteristics shown in Fig. 2 are obtained ($1 + g_K R_K = 2.50$ in this case). It will be observed from these characteristics that a wide range of performance can be obtained.

The ideal characteristic is one in which both the amplitude and time-delay characteristics are flat over the full range of operation. This requirement cannot be met but a compromise is possible in which one of the two characteristics is made as flat as possible and the other one is allowed to take care of itself.

It will be observed that the higher the value of a, the greater the value of ω/ω_o at which the amplitude characteristic crosses the $A/A_M = 1.0$ value. This would suggest that if we could make the cathode capacitance automatically vary the proper amount with change of frequency, then we could slide from curve to curve in covering the full range of operation. A similar procedure could be used with the time delay but it would probably require different values of a than those necessary for constant amplitude.

Satisfying this variable cathode capacitance requirement is not as difficult as it would appear to be at first thought. The method by which this is done is shown in the curves of Fig. 3. In this figure the circled points represent the relative capacitive reactance required at the different values of ω/ω_o. The lower of the two curves is the relative reactance of the capacitor C_K when $a = 1.0\ (1 + g_K R_K)$ [the condition required by Case II]. The upper one of the two curves is the relative reactance of a series combination of the capacitor C_{K2} corresponding to the lower curve, and an inductor L_K required to resonate this capacitor at a value of $\omega/\omega_o = 1.10$. The circled points are satisfied very nicely by the series combination of C_K and L_K chosen.

The amplitude and time delay characteristics that result from this choice are shown in Fig. 4. A more satisfactory choice of variables will give the response curves shown in Fig. 5. In this case the time-delay characteristic has been greatly improved with only a slight change of the amplitude characteristic.

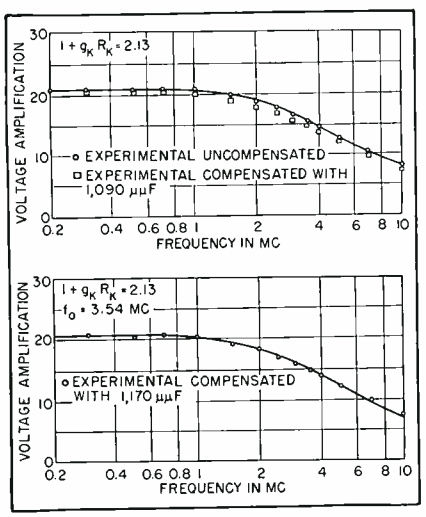

FIG. 7—Experimental verification of Case II and test of accuracy of method

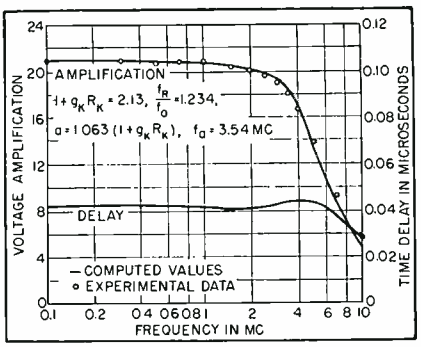

FIG. 8—Experimental verification of Case III

The variables for Fig. 5 were obtained from the two curves in Fig. 6. These two curves are the key to the compensation discussed in this paper and have been designed to produce a time-delay characteristic that will dip approximately four percent to the valley and then rise about six percent to the peak. Either flatter amplitude or time-delay characteristics can be obtained with slight variations in a and f_R/f_o but it is suggested that the response to be expected should be computed in each case.

The simplest procedure for making these computations involves the use of Eq. 25, replacing a by a_{eq} which is developed in the following manner:

If X_C and X_L are self resonant at f_R so that $X_{CR} = X_{LR}$, then at any other frequency the equivalent series reactance is

$$X_{eq} = X_C - X_L = X_{CR}\frac{f_R}{f} - X_{CR}\frac{f}{f_R} = X_{CR}\left(\frac{f_R}{f} - \frac{f}{f_R}\right) \qquad (29)$$

so that

$$C_{eq} = C_K \frac{\left(\dfrac{f_R}{f}\right)}{\left(\dfrac{f_R}{f} - \dfrac{f}{f_R}\right)} \qquad (30)$$

and

$$a_{eq} = a\frac{C_{eq}}{C_K} = \frac{a\left(\dfrac{\omega_R}{\omega}\right)}{\left(\dfrac{\omega_R}{\omega} - \dfrac{\omega}{\omega_R}\right)} = \frac{a}{\left[\dfrac{\omega_R}{\omega} - \dfrac{\omega}{\omega_R}\right]\left(\dfrac{\omega}{\omega_R}\right)} \qquad (31)$$

Sample computations for several of

the points in Fig. 8 are shown in Table I.

Experimental Verification

To verify experimentally the theory developed previously, the amplifier circuit of Fig. 1C, using a 6AG7 tube, was set up on a breadboard. The constants used in this circuit were:

R_{L1} = 2,040 ohms E_{bb} = 300 volts
R_K = 81.8 ohms E_{c2} = 125 volts
R_{sg} = 22,400 ohms E_{c1} = − 2.68 volts

The screen and cathode circuits were bypassed sufficiently well for frequencies above 10 kc and no measurements were made below 100 kc. The experimental frequency characteristic, shown by the curve drawn through the circled points in Fig. 7, was obtained. From this curve it was determined that f_o = 3.80 mc and C_s = 21.0 μμf.

When the cathode bypass capacitor was removed it was found that a new load resistor R_{L2} = 4,440 ohms was required to produce the same voltage amplification at 100 kc as was obtained previously. Using a value of r_p = 125,000 ohms and R_g = 500,000 ohms it was determined that R_{eq1} = 2,000 ohms and R_{eq2} = 4,260 ohms. Therefore

$$1 + g_K R_K = \frac{R_{eq2}}{R_{eq1}} = \frac{4,260}{2,000} = 2.13.$$

Analytically $g_K \cong g_m + g_{c2}$. These values can be obtained from the HB-3 series of RCA Tube Handbooks. For the operating values involved, interpolating between the 100 and 150 screen voltage curves, $g_m \cong 0.010$ mhos and $g_{c2} \cong 0.003$ mhos (obtained from the slope of the e_{c1} vs i_{c2} curves). Therefore $g_K \cong 0.013$ mhos and $1 + g_K R_K \cong 1 + 81.8 \times 0.013 = 2.06$. As was expected this value is slightly lower than the value obtained experimentally.

On this basis it was determined that

$$C_K = \frac{R_{eq2}}{R_K} C_s = \frac{4,260}{81.8} \times 21.0 = 1,093\ \mu\mu f$$

When a value of C_K = 1,090 μμf was used the experimental values shown by the squared points in Fig. 7 were obtained. The variation obtained was definitely outside the experimental error expected. A closer examination of the circuit showed that while R_{L1} was composed of a series combination of two 2-watt resistors, R_{L2} was composed of a series combination of two 2-watt resistors shunted by a ½-watt trimmer resistor. This ½-watt resistor was used to obtain the exact value of R_{L2} that was required. The extra resistor introduced an additional 1.5 μμf in the plate circuit, bringing the total stray capacitance to 22.5 μμf. This in turn reduced f_o from 3.80 mc to 3.54 mc and changed the required value of C_K from 1,093 μμf to 1,170 μμf.

The smooth curve in Fig. 7 shows the theoretical values expected under the new conditions. The circled points represent the experimental data obtained with C_K = 1,170 μμf. The agreement is definitely within the experimental error expected.

Stray Capacitance Effects

In the early stages of the investigation a similar circuit was used with the exception that the suppressor and screen were returned to the cathode instead of being returned to ground. While the theoretical analysis called for approximately 1,000 μμf compensating capacitance, it was found that the experimental value was much closer to 600 μμf.

A more thorough investigation of

Table I—Sample Calculations for Compensated Amplifiers (Data Plotted in Fig. 8)

Working Equations:

$$a_{eq} = \frac{a}{\left[\frac{\omega_R}{\omega} - \frac{\omega}{\omega_R}\right]\frac{\omega}{\omega_R}} \qquad \frac{\omega_R}{\omega} = \frac{f_R}{f_o} \times \frac{\omega_o}{\omega}$$

$$\frac{\bar{A}}{\bar{A}_M} = \frac{A}{A_M}\Big|\overline{\theta} = \left[\frac{(1 + g_K R_K)}{(1 + g_K R_K) + j\, a_{eq}\frac{\omega}{\omega_o}}\right]\left[\frac{1 + j\, a_{eq}\frac{\omega}{\omega_o}}{1 + j(1 + g_K R_K)\frac{\omega}{\omega_o}}\right]$$

$$T_d = \frac{\theta}{360} \times \frac{1}{f} \text{ seconds}$$

Circuit Constants:

$(1 + g_K R_K) = 2.13$, $\frac{f_R}{f_o} = 1.234$, $a = 1.063 \times 2.13 = 2.265$
f_o = 3.54 mc, A_M = 20.8

Quantity					
ω/ω_o	0.03	0.1	0.3	1.0	3.0
ω_R/ω	41.13	12.34	4.113	1.234	0.4113
ω/ω_R	0.0243	0.0809	0.243	0.809	2.430
$\omega_R/\omega - \omega/\omega_R$	41.11	12.26	3.870	.425	−2.019
a_{eq}	2.267	2.280	2.410	6.600	−.4615
$a_{eq}\ \omega/\omega_o$	0.0681	0.2280	0.7230	6.600	−1.384
$1 + j\, a_{eq}\ \omega/\omega_o$	1.0023	1.027	1.237	6.68	1.710
	∠ 3.91°	∠12.85°	∠35.85°	∠81.38°	∠54.12°
$(1+g_K R_K)+ja_{eq}\omega/\omega_o$	2.1311	2.142	2.245	6.930	2.540
	∠ 1.84°	∠ 6.11°	∠18.79°	∠72.10°	∠33.00°
$(1 + g_K R_K)\ \omega/\omega_o$	0.0639	0.213	0.639	2.13	6.39
$1 + j(1 + g_K R_K)\ \omega/\omega_o$	1.0020	1.022	1.188	2.352	6.46
	∠ 3.66°	∠12.03°	∠32.60°	∠64.82°	∠81.10°
$\bar{A}/\bar{A}_M$	0.9998	0.9994	0.987	0.875	0.222
	∠ 1.59°	∠ 5.29°	∠15.54°	∠55.54°	∠102.20°
T_d (microseconds)	0.0416	0.0415	0.0407	0.0436	0.0268
f (mc)	0.106	0.354	1.06	3.54	10.6

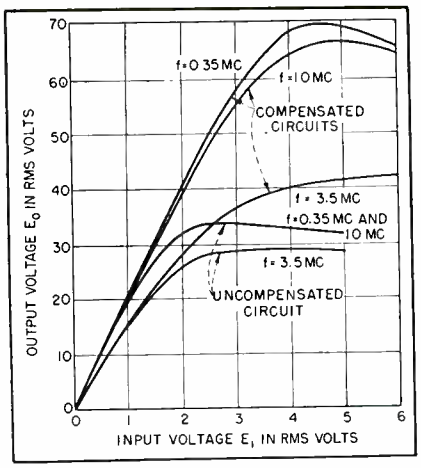

FIG. 9—Experimental characteristics showing improvement in linearity obtained with compensating circuit

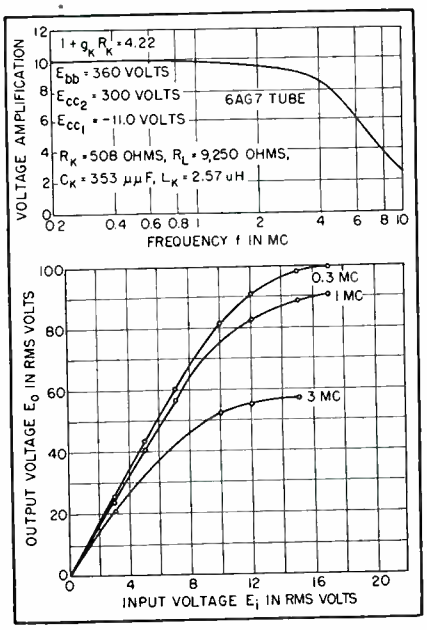

FIG. 10—Frequency and linearity characteristics of amplifier intended for high output voltages

the circuit showed that the stray cathode-to-plate capacitance acts as though it were multiplied by the voltage amplification and connected from cathode to ground. Most of this capacitance was due to the suppressor which was at cathode potential and the screen which was at cathode potential as far as the operating frequencies were concerned. The measured value of this stray capacitance was approximately 19 μμf and this multiplied by the gain of approximately 21 was equivalent to the missing 400 μμf. This effect could be used to obtain Case II type of compensation with lower values of capacitance than those required for C_K but if Case III type of compensation is used it simply tends to shunt the compensating circuit and make the determination of the proper element values more difficult. For this reason it is suggested that the suppressor and screen always be returned to ground. An additional advantage is that the alternating screen current then flows through R_K, producing additional feedback and requiring the use of $1 + g_K R_K$ instead of $1 + g_m R_K$. Since $1 + g_K R_K$ is greater than $1 + g_m R_K$, additional linearity benefits, which are discussed in detail below, will be obtained.

For the value of $1 + g_K R_K = 2.13$ it is found from the curves of Fig. 6 that proper Case III compensation is obtained when $a/(1 + g_K R_K) = 1.063$ and $f_R/f_o = 1.234$. On this basis we should use values of $C_R = 1.063 \times 4{,}260 \times 22.5/81.8 = 1{,}243$ μμf and a value of $f_R = 1.234 \times 3.54 = 4.37$ mc. The theoretical amplification and time delay to be expected are shown in Fig. 8 by the smooth curves. The experimental values of amplification obtained are shown by the circled points. The agreement is well within the experimental error expected.

Additional Advantages

An additional benefit that results from the type of compensation discussed in this paper is in the linearity and voltage-handling capability of the amplifier. Since the compensated amplifier has a larger value of R_L than the uncompensated one, its load line will not be as steep, and therefore larger voltage swings can be expected before either cutoff or positive grid conditions result. In addition to that a considerable amount of negative feedback is present in the compensated amplifier and this tends to reduce the tendency toward nonlinear distortion. These effects are brought out very nicely by the experimental curves in Fig. 9. It is obvious that in the middle frequency region with compensated operation the linear portion of the curve is more than twice as long as it is for the uncompensated operation. The advantage is lessened for frequencies close to f_o. This is not believed to be too important in video amplifiers intended for television purposes since the high-frequency components of the signal will always have lower amplitude than the middle and low-frequency components.

If it is desired to obtain a large linear range of output voltage the quantity $1 + g_K R_K$ should be made as large as is reasonably convenient. To test this condition the same 6AG7 tube was operated with the following constants:

R_L = 9,250 ohms E_{bb} = 360 volts
R_K = 508 ohms E_{cc2} = 300 volts
E_{c1} = − 11.0 volts

In this case the screen grid was operating at its rated dissipation of 1.5 watts while the plate was operating with about 3.5 watts, which is considerably below its rated dissipation. No attempt was made to determine any possible change in stray capacitance that might have resulted. The compensation was calculated on the basis of $1 + g_K R_K = 4.22$ as determined experimentally and $C_s = 21.0$ μμf as found in the original amplifier. The compensating elements used were $C_K = 353$ μμf and $L_K = 2.57 \times 10^{-6}$ henrys.

It can be seen from Fig. 10 that the middle-frequency gain has been reduced to about 10 but the frequency response has not been changed appreciably from the previous case. On the other hand, the linear range of operation, shown in Fig. 10, has been greatly increased. The remarkable thing about this case is that an amplifier which is relatively flat to 3.5 mc and has useful frequency response above 5 mc is able to develop a linear middle-frequency peak-to-peak output voltage of about 200 volts with less than 22 ma combined plate and screen current. Even at 3 mc the linear range is remarkably great.

The second part of this paper will cover the theoretical development of input admittance relations and present experimental verification. Cathode compensation as developed here will be compared with other types of video amplifier circuits on the basis of cost, simplicity, disturbance of normal circuit relations, gain, frequency response, time delay, linearity and input admittance.

SPARK-PLUG TESTER—

By CRAIG WALSH
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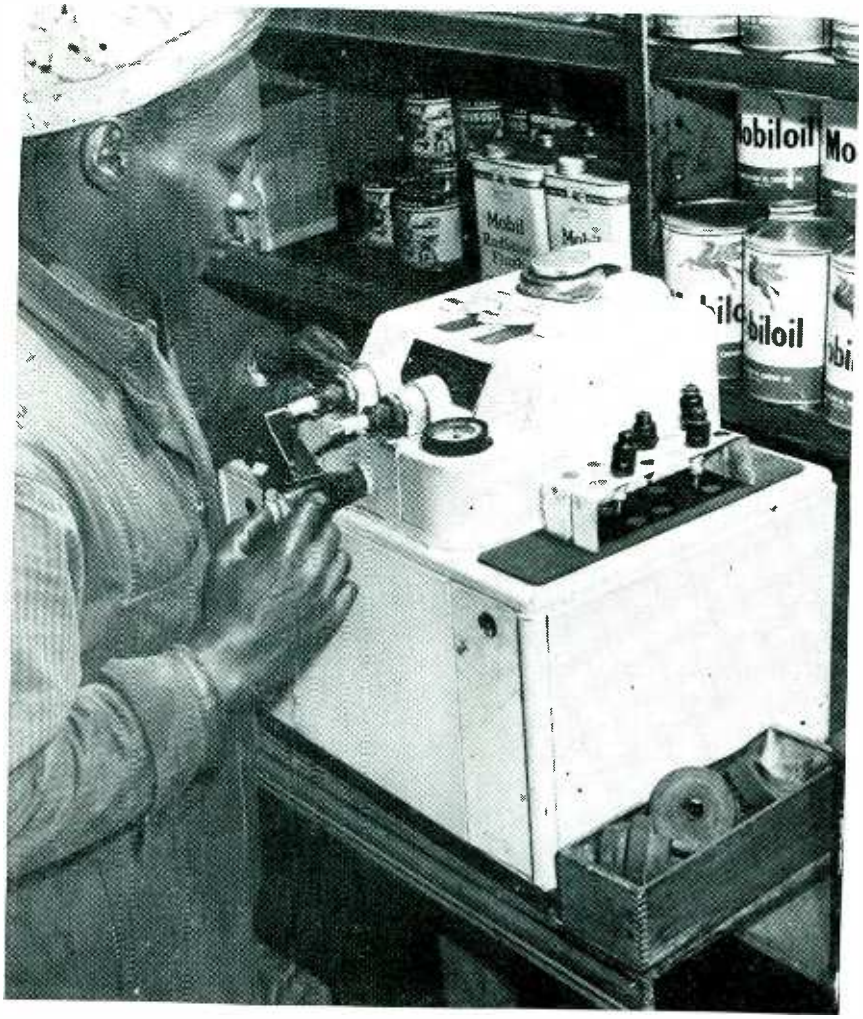


Typical spark-plug testing machine employing a compression chamber in which the plugs are fired

USING CONVENTIONAL METHODS, spark plugs are tested by comparing the sparking qualities of a plug under test with those of a new or fresh plug subjected to the same pressure and voltage.

This comparison is usually made by taking the reading at which increase of air pressure extinguishes the spark on the new plug and then switching over to the used plug and finding the point at which increasing pressure extinguishes the spark on that plug, the comparison of these values showing the relative effectiveness of the plug under test.

In these systems the necessary high voltage is provided by a magnetically operated vibrator and spark coil. The vibrators, because of their mechanical nature, have inherent disadvantages rendering them at times uncertain and unreliable for this highly specialized application.

The circuit shown in Fig. 1 eliminates the uncertainties and provides a simple system of few parts and low cost which maintains its reliability regardless of variations in line voltage and other such conditions which are not ordinarily avoidable.

As indicated in the wiring diagram, the unit comprises a grid-controlled gaseous rectifier such as a thyratron, a resistance-capacitance network R_1C_1 to store the electrical energy until released at the proper time, a second resistance-capacitance network R_2, R_3, C_2 to supply an out-of-phase, and variable as to phase, voltage to the control grid of the thyratron, a high-voltage output transformer T_2 and an input power transformer T_1 for supplying heater voltage and control-grid voltage for the tube and voltage and current for the energy storing resistance-capacitance network.

Two spark plugs, the new or fresh plug which is to serve as the standard of comparison and the used or test plug, are both screwed in an air compression chamber where they will be subject to the same pressure conditions, usually just finger-tight to allow for escape of ozone created in the chamber.

A changeover switch allows for connecting first one and then the other of the plugs in the test circuit. It is usual, also, to provide a variable pressure-reducing valve and a pressure gage which, in addition to showing actual pressure, may be calibrated in terms of spark-plug efficiency.

The input power transformer is an auto-transformer connected to the line and tapped to supply heater voltage of about 6.6 volts to the 2050 thyratron, to furnish control-grid voltage of about 40 volts and to supply anode voltage of approximately 230 volts. The latter circuit contains a safety switch to control the anode voltage to the output transformer.

Circuit Operation

The fast-firing characteristics of the thyratron tube provide an extremely sudden change in the current flow through the primary winding of the high-voltage transformer. The voltage in the secondary winding W_2 of the output transformer is a function of the rate of

Electronic unit provides high voltage for testing spark plugs under compression and eliminates the magnetically operated vibrating reed commonly used. Circuit technique could be extended to ignition systems for internal combustion engines and high-voltage power supplies for Geiger-Muller and cathode-ray tubes

change of the amount of magnetic flux in the core of the transformer and this in turn is dependent upon the rate of change in the current of the primary winding W_1 of the transformer. To obtain this very rapid change in current in the primary winding, this winding is connected in series with the anode circuit of the thyratron and energy storage network R_1C_1.

Sufficient electrical energy to operate the circuit is stored in the charging capacitor C_1 during the first quarter of the a-c cycle when the voltage across the input is rising from zero to maximum value. By proper choice of resistance and capacitance for a given input voltage, the maximum amount of energy is stored in the capacitor and a measure of this energy is the square of the ordinate of the voltage curve at any particular point during the cycle, as indicated in Fig. 2. When this energy is released by the firing of the thyratron, the current in the circuit changes from zero to its maximum value in an extremely short period of time, determined by the time required to ionize the gas in the tube after the critical grid voltage is reached and also by the inductance of the primary winding of the output transformer.

In certain newly developed tubes the ionization time is considerably reduced so that faster firing, and hence higher voltages and higher frequencies for given circuit conditions, may be obtained.

Phase Control

The time of firing of the thyratron is controlled by the application of out-of-phase voltage to the control grid so that the grid voltage reaches its critical firing value for the anode voltage of that particular instant when it is desired to fire the tube. The maximum voltage is obtained from the circuit when the tube fires at the time the instantaneous voltage applied to the charging capacitor is at its maximum value, and therefore when the stored energy is at maximum value.

High voltage less than the maximum value is obtained by permitting the tube to fire before or after the maximum amount of energy is stored in the charging capacitor. This is done by varying the resistance R_3 or the capacitance C_2, or both, of the phase-changing network in the grid circuit, which changes the phase of the grid voltage and therefore the time at which the critical value of grid voltage is reached, as will be clear from consideration of Fig. 2.

The voltage used in spark-plug testing is of the order of 20,000 volts. However, much higher voltage may be attained with this circuit. The output voltage is in the form of pulses of very short duration. This is because the current in the primary winding W_1 changes very rapidly from zero to its maximum value and then, for all practical purposes, remains at that maximum value long enough for the secondary voltage to drop to zero rapidly. Actually the primary current, once it reaches the maximum value, flows through the circuit as determined by the voltage waveform, the resistance and the inductance of the primary winding. The high-voltage pulses are extremely uniform in magnitude and therefore the demarcation between a spark plug sparking and not sparking is very sharp.

Tube Operation

When the sinewave of voltage is positive, a positive voltage is applied through resistor R_1 in the storage network to the top electrode of capacitor C_1 and through the primary winding W_1 to the anode of the thyratron. Because the tube is nonconducting at the time, no current can flow through this latter portion of the circuit and the entire current flow is into C_1, placing a positive charge on electrode E_1. Thus, during the first half of the

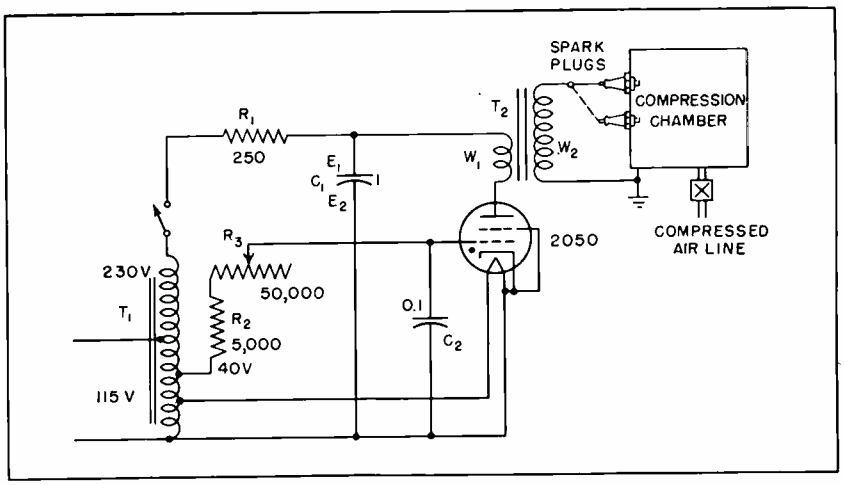


FIG. 1—Complete circuit of the electronic spark-plug tester

positive portion of the cycle, energy is stored in C_1.

Stored electrical energy is suddenly released through the primary winding to accomplish a very rapid rate of change from zero to maximum value. The purpose of such rapid rate of change of current is that the magnitude of output voltage is a function of the rate of change of magnetic flux in the core of the transformer. This in turn is a function of the rate of change of current in the primary winding. The high rate of change of current is obtained by making the tube conductive when a suitable amount of electrical energy is stored in C_1.

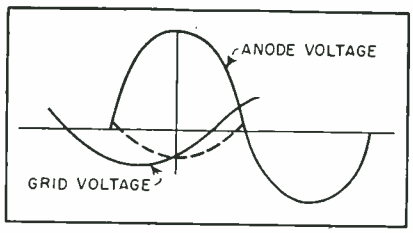


FIG. 2—Effect of the phase-shifting control

A suitable voltage, 40 volts, is impressed on the control grid of the thyratron so that the grid voltage is more negative than the critical firing voltage for the instantaneous voltage on the anode, until sufficient energy is stored in the capacitor. At this time the grid voltage is made equal to the critical firing voltage and the tube becomes conductive.

The impressed voltage is passed through the variable resistance-capacitance forming the phase-shifting network with the result that the sinusoidal grid voltage, Fig. 2, leads the sinusoidal anode voltage by an amount determined by the values of R_2 and R_3 and C_2. Resistor R_2 is provided to limit the grid current during conduction of the tube when R_3 resistance is zero.

Voltage Control

As shown in Fig. 2, the grid-voltage wave intersects the curve of critical grid voltage. To obtain maximum output voltage it is necessary to shift the phase of the grid voltage by approximately 90 degrees because the maximum amount of energy is stored in C_1 when the voltage wave passes through 90 degrees.

To obtain continuously variable voltages less than the maximum available, the value of R_3 is changed so that the phase shift of the grid voltage is reduced, causing the tube to fire at a different time. Less energy is stored in C_1 and therefore the rate of change of current increase is less. The time of change is constant and determined by the ionization time of the gas in the tube and the inductance of the primary winding W_1. With a smaller amount of energy available to produce a current in the same time, the maximum current is less and therefore the rate of change is less. Thus a lower voltage is then induced in the secondary of the output transformer T_2.

The output voltage is produced in a series of sharp pulses at the rate of one per complete cycle of input power. These pulses are uniform in voltage because the circuit conditions are very stable. For a given setting of R_3, the energy storage in C_1 is constant from cycle to cycle and the ionization time of the thyratron remains constant. The only variation may be caused by heating of transformer T_1, and this is practically negligible.

The purpose of resistor R_1 is as follows: Assuming maximum conditions, after the capacitor is charged and the thyratron made conductive, the energy escapes from the capacitor through the primary winding of T_2 and the tube. To accomplish this, the potential of the charged electrode E_1 of capacitor C_1 must drop in value. As it drops there is then a current flow in R_1 producing an IR drop equal to the drop in potential of E_1.

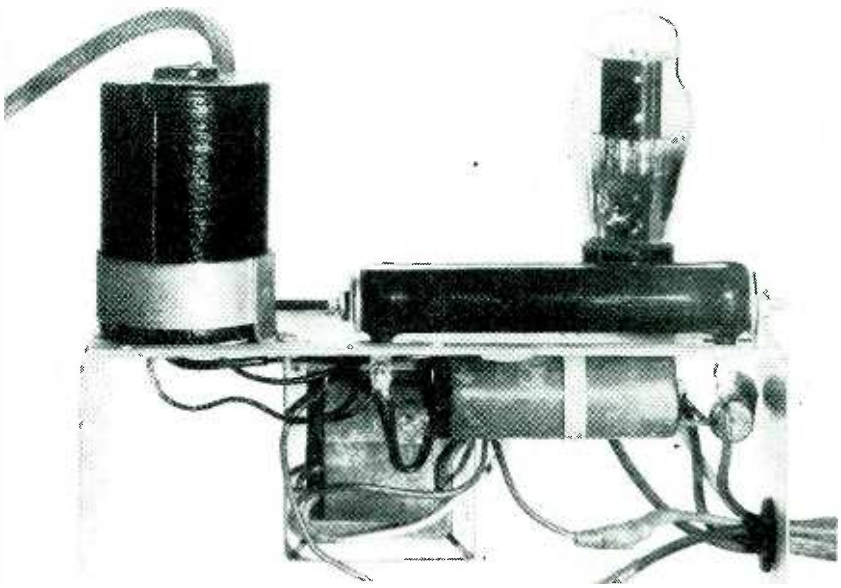
If resistor R_1 were not present, the potential of E_1 would follow the voltage wave supplied by transformer T_1 and there would then be no rapid rate of change of current, as desired.

By suitable circuitry it is believed that the number of pulses per cycle can be increased. A d-c version of the circuit is practical in which the pulse rate may be made variable.

Other Uses

The unit shown was originally developed to supply the high voltage necessary to test spark plugs. A natural extension of this is to use it for the ignition systems of internal combustion engines, both the reciprocating and the jet types.

A similar arrangement may be used in television circuits to supply the high voltage necessary for the picture tube. Perhaps a more immediate use would be in the synchronizing of standard motion-picture film to transmission by television. It may also have application in radar modulation circuits and in guided missiles.



Components of the electronic high-voltage supply. The output transformer is mounted at upper left

Vector Voltage Indicator

A complex quantity is shown on the screen of a cathode-ray tube and readings are taken in polar or rectangular coordinates. Applications include testing stability of feedback amplifiers, plotting wavefronts and checking phase-shift networks

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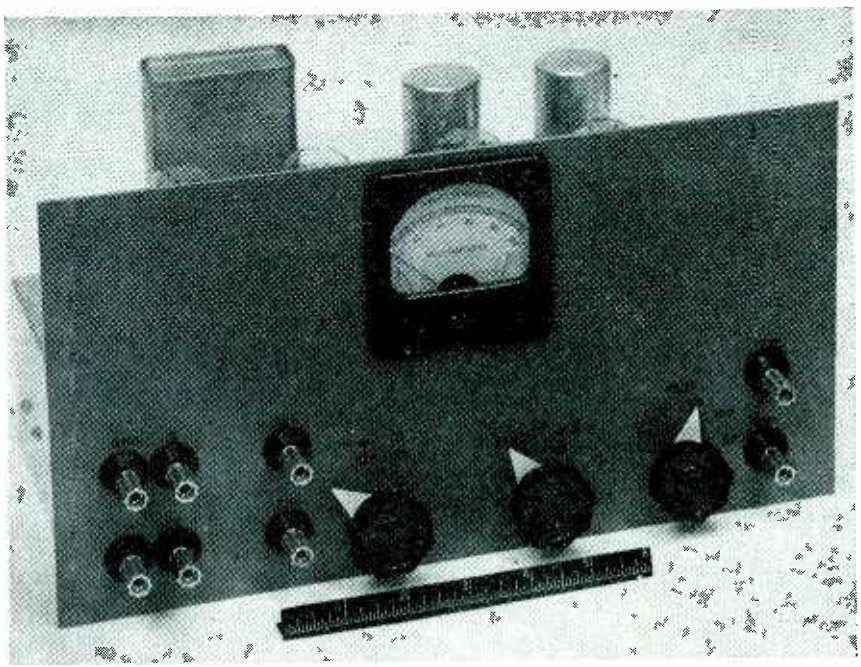
IT IS CUSTOMARY for the engineer to think in terms of vectors when he is dealing with complex quantities such as alternating currents, alternating voltages, or impedances. Unfortunately, most measuring devices do not present their information in such a convenient form.

This paper describes a comparatively simple adaptor which permits a complex quantity to be shown as a vector on the screen of an ordinary cathode-ray oscilloscope. Readings may be taken in polar coordinates (magnitude and phase angle), or they may be taken in rectangular coordinates (real and imaginary components), as desired. Although similar in function to a previously-described device[1,2], its principle of operation is quite different.

The frequency range of the present model is 50 to 5,000 cycles, which covers the greater part of the audio-frequency spectrum. The full-scale sensitivity is variable from 1 volt to 500 volts rms, with a phase accuracy of ± 3 degrees and an amplitude accuracy of ±10 percent of full scale.

If the voltage to be measured (referred to here as the test voltage) is applied to the vertical deflection circuit of an oscilloscope, a vertical straight line will be obtained. If the phase of a portion of that same voltage is shifted 90 degrees and applied to the horizontal deflection circuit, a circular trace will be obtained with the proper gain adjustment.

It is apparent that the diameter



Panel controls and terminals for input and oscilloscope connections

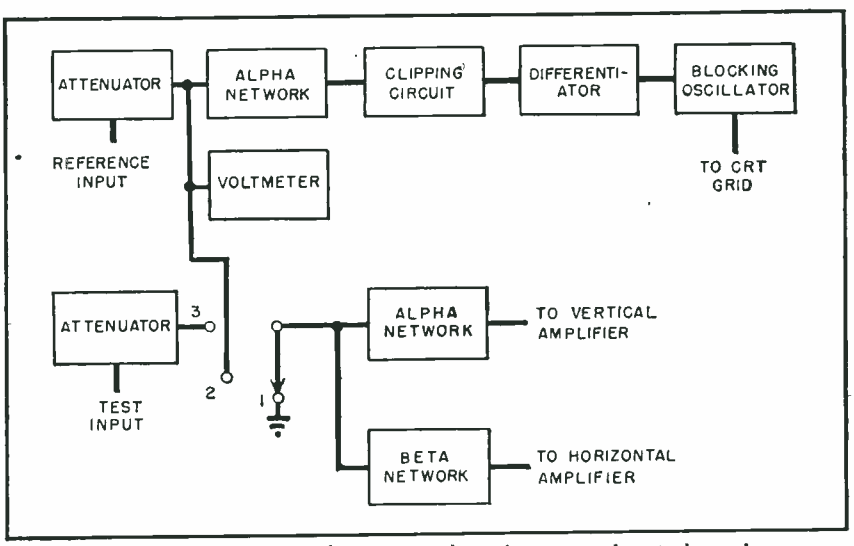


FIG. 1—Arrangement of stages in the reference and test channels

of the circle will be proportional to the amplitude of the test voltage, and hence can be used to indicate its magnitude. It is also apparent that the velocity of the spot tracing the circle will be constant, with the result that a linear phase scale will be obtained around the circle.

The position of zero phase angle on the circle must be established with the aid of some other voltage, here called the reference voltage. In practice, the reference voltage might be the input to a circuit under test, while the output voltage of the circuit would constitute the test voltage. The reference voltage is clipped and differentiated so that a pulse is obtained at its zero-degree position. With the circle blanked by means of the intensity control, the pulse is used to brighten the trace for a very short time. Therefore, the pattern consists of a single dot which denotes the tip of a vector drawn from the origin, which is placed at the center of the screen.

If a polar-coordinate scale is drawn on the screen, the length of this vector indicates the magnitude of the test voltage, while its angular position from the origin is the phase angle of the test voltage with respect to the reference voltage. If a set of rectangular coordinates is used, the real and imaginary components can also be read directly.

It appears to be impossible to produce the required 90-degree phase shift directly, over a wide range of frequencies, without the readjustment of component values. It is therefore necessary to use two phase-shifting networks, referred to as the alpha and beta networks, in such a way that the difference of the phase shifts is 90 degrees. Dome[3] and Norgaard[4] have described such networks.

Circuit Details

Figure 1 is a block diagram of the equipment. The reference channel includes an attenuator and voltmeter, an alpha phase-shifting network, clipping and differentiating circuits and a blocking oscillator. The attenuator is provided so that the input to the remainder of the channel can be set to the standard value of one volt with the aid of the voltmeter.

The cathode-coupled clipping circuit provides a square wave, which is differentiated by means of a series R-C circuit and applied to a cathode-follower stage. The cathode follower responds to the positive pulse produced by differentiation, and triggers the biased blocking oscillator, which produces a positive, 2-microsecond pulse for application to the cathode-ray-tube grid.

The test channel contains a step attenuator and two phase-shifting networks. The attenuator provides an output of one volt for inputs of 1, 5, 10, 50, 100 and 500 volts, which then become the full-scale sensitivities of the instrument. The alpha network, which drives the vertical deflection circuit, is identical to that placed in the reference channel with the result that the voltage applied to the clipping circuit is in phase with the vertical deflection. The beta network, which is also driven by the output of the attenuator, produces an additional phase shift of 90 degrees. Consequently, when the output of the beta network drives the horizontal deflection circuit a circular sweep is obtained.

A 3-position switch is provided in the test channel to permit a check of the calibration of the instrument. The first position grounds the input to the test channel so that the undeflected spot can be centered on the screen, thus establishing an origin. With the reference terminals connected to a suitable source of voltage, and the attenuator set for half-scale deflection of the meter, the switch can be turned to the second position. This connects the test channel to the reference channel, which applies an input of one volt to the test channel. The gain of the horizontal and vertical amplifiers in the oscilloscope can then be adjusted for full-scale circular deflec-

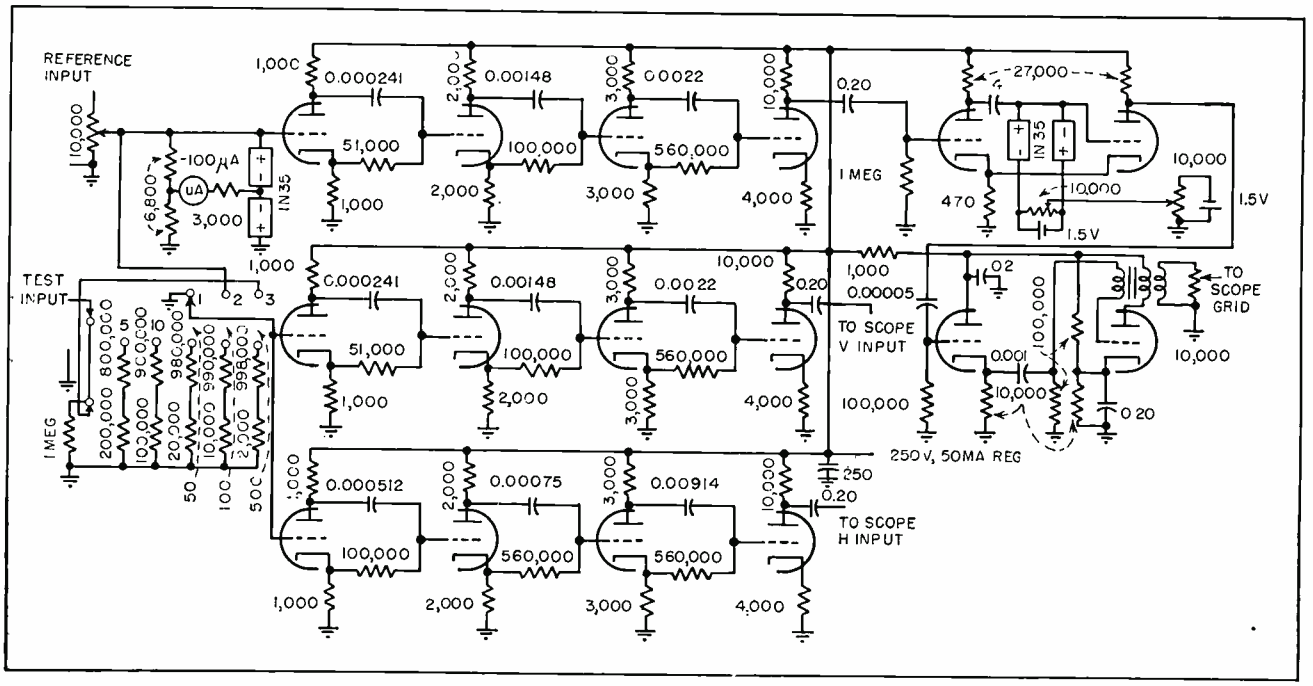


FIG. 2—Complete circuit of the instrument. All tubes are type 6SL7GT

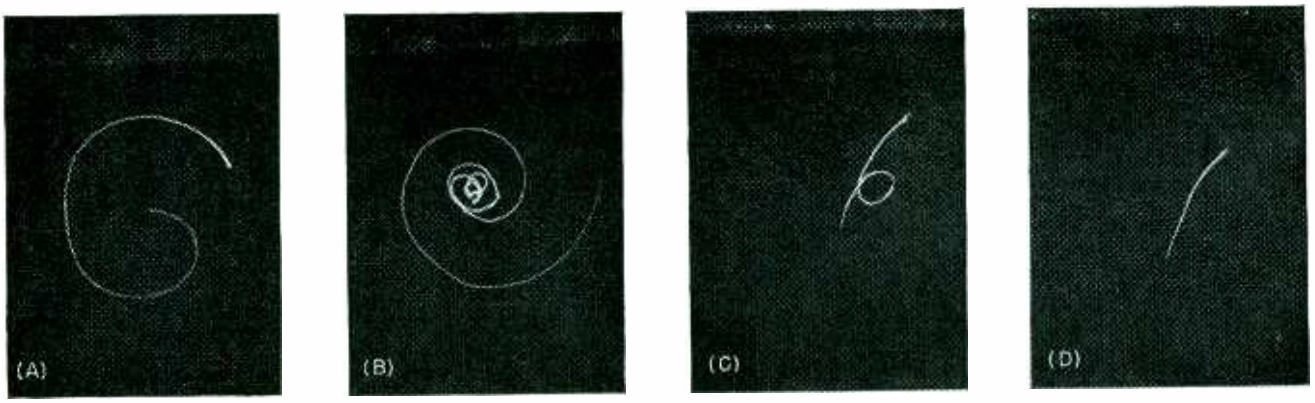


FIG. 3—Oscilloscope patterns obtained with the vector voltage indicator

tion. It is necessary, of course, to increase the intensity to obtain the entire circle. If the intensity is then turned down, a bright dot will be noted. The position of the dot denotes one volt at an angle of zero degrees, establishing the phase reference. Position three of the switch connects the test terminals to the test channel. The instrument is then ready for use.

Figure 2 is a schematic diagram which gives the details of the various circuits used. The phase-shifting networks have been fully described in the first two references, and will not be discussed in detail here. The maximum output for driving the oscilloscope deflection circuits is 0.7-volt rms. Therefore the sensitivity of the oscilloscope must be sufficient to provide full-scale deflection with this input.

The cathode-coupled clipper is of some interest, since it is a refinement of one previously described by Goldmuntz and Krauss [5]. The refinement consists of limiting the grid-voltage swing of the second tube by means of crystal-diode clippers with adjustable bias. As a result, it is possible to obtain a phase accuracy of ±2 degrees with an input of only one volt rms. It was found necessary to adjust both the clipping ratio (ratio of positive to negative grid voltage swings) and the clipping level (total limiter bias) to obtain high phase accuracy.

The pulse generator circuit was chosen for simplicity and wide frequency range. Although a sufficiently-short pulse could have been obtained by differentiation alone, it was found that a smaller number of tubes would be used by employing a biased blocking oscillator to shorten the pulse produced by differentiation.

A positive pulse at a maximum amplitude of 100 volts is available for application to the cathode-ray-tube control grid.

Results

Four patterns obtained with the vector voltage indicator are shown in Fig. 3. These photographs are time exposures which were made as the dot denoting the tip of the vector was swept through its locus by changing one of the circuit parameters.

Figure 3A shows the output voltage of a 500-cycle low-pass filter with constant-voltage variable-frequency input. As the frequency decreased, the vector rotated counterclockwise, indicating a phase lead and, shortened, indicating attenuation. The total phase shift through the transition range was nearly 360 degrees, which is to be expected with a two-section filter of this type.

Figure 3B was obtained by connecting a speaker to the reference voltage and using the output of a microphone as the test voltage. As the microphone was moved away from the speaker, an additional phase shift of 360 degrees was obtained for each wavelength traversed. This is indicated by each complete circuit around the origin. The increase in attenuation is also apparent. Under ideal conditions a logarithmic spiral would be obtained in an experiment of this sort. Unfortunately, reflections from nearby objects (including the writer's head) destroyed the symmetry of the pattern obtained.

Figure 3C shows a portion of the impedance semicircle of a headphone. This measurement was made by driving the headphone with a constant current, and measuring the voltage across it. As the frequency was raised, the magnitude of the impedance increased, the locus being along a small arc of a circle. This would be expected from the electrical characteristic of the unit. However, at the mechanical resonant frequency of the diaphragm a small loop is obtained, showing the motional impedance of the electromechanical system. Figure 3D shows the impedance of the same headphone with the diaphragm blocked. Consequently, the motional impedance is absent and the headphone behaves as a series R-L circuit whose complete locus would be a semicircle.

The vector voltage indicator has been found useful for many other experiments, such as plotting wavefronts, testing the stability of feedback amplifiers, checking phase-shift networks, and measuring distance. Although its inherent accuracy is not extremely high, it is capable of providing a large amount of information in a short time.

The writer wishes to acknowledge the support and encouragement of E. A. Walker and A. H. Waynick during the progress of the work.

References

(1) E. A. Walker, A. H. Waynick and P. G. Sulzer, A Polar Vector Indicator, presented at National Electronic Conference, Nov. 5, 1948.
(2) A. H. Waynick, E. A. Walker and P. G. Sulzer, Polar Vector Indicator, presented at AIEE Winter General Meeting, Feb. 1, 1949.
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(4) D. E. Norgaard, A New Approach to Single Sideband, *QST*, June, 1948.
(5) L. A. Goldmuntz and H. L. Krauss, The Cathode-Coupled Clipper Circuit, *Proc. IRE*, Sept. 1948.

STANDARD

By W. H. FENN*
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Brooklyn, New York

DURING WORLD WAR II, as use of higher power levels and higher frequencies for radar systems tended to make coaxial lines impractical, the design engineer searched for other ways of transmitting microwave energy.

The logical contender was the now-familiar rectangular waveguide, available on the required short notice only in the guise of commercial rectangular architectural brass tubing or copper gutter pipe. The choice was not a bad one, since the two-to-one ratio of outside dimensions of commercial tubing resulted in a nearly two-to-one ratio for the electrically-important inside dimensions. A few handy sizes were selected for single-mode transmission.

The tolerances on tubing intended for bannister rails were much too loose to apply to tubing intended for guiding microwaves. Accordingly, the first waveguide standards undertook to restrict the possible variations in certain of the dimensions and features of the rectangular tubing. In particular, the inside dimensions were selected as of primary importance (the two-to-one ratio of outside dimensions was retained), and a tolerance was placed on the wall thickness.

The commercial standard set up by the RMA calls for close control of outside waveguide dimensions (for mechanical reasons) as well as of inside waveguide dimensions (for electrical reasons). As a result, a somewhat greater variation in wall thickness is permitted (no tolerance, as such, being specified, since this may be derived from the tolerances on inside and outside dimensions). However, an additional specification is provided which limits the deviation of the wall thickness of any particular piece of tubing at a given cross-section from the actual mean value of wall thickness at that cross-section (the mean value being one-half the difference between the measured values of outside and inside waveguide dimensions). This in effect provides a sort of generalized eccentricity specification in a form permitting ready determination during inspection.

Another important feature of the standard is the specification of frequency limits for operation in the dominant ($TE_{1,0}$) mode of the various waveguides. The use of relatively narrow bands for wartime radars made unnecessary the task of specifying such frequency limits for the waveguides then in use. Broadband applications since the war make this a necessity if standardization is to be really meaningful.

The limits given are based on experience with the operation of waveguides over broad bands. The lower frequency limit is dictated by a desire to avoid the high attenuation and rapid increase in waveguide wavelength which occur as the cutoff frequency is approached. The upper limit is chosen so that the waveguide will be adequately below cutoff for the $TE_{2,0}$ mode. Each waveguide covers a band having an operating frequency ratio of approximately 1.5 to 1.

The standard consists essentially of two series of waveguide sizes, each covering a continuous, uniformly divided, but nonoverlapping band of frequencies. The sizes have been so graded in the two sets that each waveguide covers a frequency band which overlaps at approximately midrange with the band covered by each of the two adjacent sizes in the other set. This provides at least one standard size of waveguide suitable for operation over any portion of the microwave region twenty percent or less in width.

All of the waveguides currently listed in standards set up by the military services (although provided with the new system of tolerances) have been fitted into their proper places in the pattern. These sizes have been indicated with an asterisk on the RMA standard. Although not all of the RMA sizes have yet been adopted by the military services, it is their stated policy to select new sizes from this list as required. In addition, action is underway to change the method of specifying dimensions in the Service Standards to that introduced by the RMA.

Where new sizes have been indicated, the two-to-one ratio has been applied to inside, rather than to outside dimensions to reduce attenuation and increase power handling capacity while still avoiding the possibility of higher modes within the specified bands. Tolerances on outside and inside corner radii have been specified to facilitate connector assembly and to minimize electrical discontinuities.

Standard Data

Mean wall thickness is one-half the difference between corresponding inside and outside dimensions at any cross-section perpendicular to the axis.

Specified frequency range assumes operation in the dominant ($TE_{1,0}$) mode. Each specified frequency range is within 62 percent and 95 percent of the cutoff frequency of the $TE_{2,0}$ mode. To permit selection of optimum waveguide sizes, two overlapping series are specified.

Bow is the departure from a straight line between any two points two feet apart on the concave external surface of the waveguide. Bow should not exceed 0.010 inch edgewise and 0.020 inch flatwise. Measurement of bow should not be altered by gravity or any other forces.

Twist about the longitudinal axis should not exceed one degree per foot on any face of the waveguide either for inside or outside surfaces. Rectangularity should conform to best commercial practice.

The interior surfaces of the finished waveguide tubing are to be as free from burrs, die marks, chatter marks, inclusions, and scratches,

*Chairman, RMA Subcommittee on Microwave Transmission Lines.

for WAVEGUIDES

New commercial standard for rectangular waveguides, announced by Radio Manufacturers Association, establishes inside and outside dimensions and frequency limits for operation in the dominant mode for broad-band applications

as best commercial practice will permit. Waveguides should be commercially uniform in composition, as straight and smooth from end to end, as uniform in wall thickness, and as free from dirt, grease, scale and splinters as best commercial practice will permit. No folds or laps will be permitted.

The type designation is to be marked every six inches on one of the wide sides of each length of finished waveguide in such a way as not to deform inner surfaces.

Type designation for rectangular waveguides shall be in the following form:

W	R	770	B	D
Waveguide	Rectangular	$A \times 100$ Inches	Material and Dielectric	Method of Manufacture and Rigidity

Materials and dielectric symbols presently used are as follows:

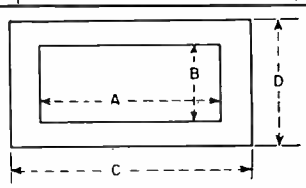
Symbol	Material	Dielectric
A	Aluminum	Air
B	Brass or Bronze	Air
C	Copper	Air
S	Coin Silver	Air

Manufacturing method and rigidity symbols presently used are as follows:

Symbol	Method of Manufacture	Rigidity
D	Drawn	Rigid
E	Electroformed	Rigid

Table I — Dimensions, Tolerances and Frequency Range for Rigid Rectangular Waveguides

RMA Designation	Frequency Range (Kmc/s) for Dominant (TE_{10}) Mode	DIMENSIONS IN INCHES								Maximum Inner Radius**
		Inner Dimensions			Outer Dimensions			Wall Thickness		
		A	*B*	Tolerance	*C*	*D*	Tolerance	Nominal	Deviation from mean	
WR770	0.96-1.45	7.700	3.850	±.005	7.950	4.100	±.005	0.125	±.005	3/64
WR650*	1.12-1.70	6.500	3.250	±.005	6.660	3.410	±.005	0.080	±.005	3/64
WR510	1.45 2.20	5.100	2.550	±.005	5.260	2.710	±.005	0.080	±.005	3/64
WR430*	1.70-2.60	4.300	2.150	±.005	4.460	2.310	±.005	0.080	±.005	3/64
WR340*	2.20-3.30	3.400	1.700	±.005	3.560	1.860	±.005	0.080	±.005	3/64
WR284*	2.60-3.95	2.840	1.340	±.005	3.000	1.500	±.005	0.080	±.005	3/64
WR229	3.30-4.90	2.290	1.145	±.005	2.418	1.273	±.005	0.061	±.005	3/64
WR187*	3.95-5.85	1.872	0.872	±.005	2.000	1.000	±.005	0.061	±.005	1/32
WR159	4.90-7.05	1.590	0.795	±.004	1.718	0.923	±.004	0.061	±.005	1/32
WR137*	5.85-8.20	1.372	0.622	±.004	1.500	0.750	±.004	0.061	±.005	1/32
WR112*	7.05-10.00	1.122	0.497	±.004	1.250	0.625	±.004	0.064	±.005	1/32
WR90*	8.20-12.40	0.900	0.400	±.003	1.000	0.500	±.003	0.050	±.005	1/32
WR75	10.00-15.00	0.750	0.375	±.003	0.850	0.475	±.003	0.050	±.005	1/32
WR62*	12.40-18.00	0.622	0.311	±.0025	0.702	0.391	±.003	0.040	±.005	1/64
WR51	15.00-22.00	0.510	0.255	±.0025	0.590	0.335	±.003	0.040	±.005	1/64
WR42*	18.00-26.50	0.420	0.170	±.0020	0.500	0.250	±.003	0.040	±.005	1/64
WR34	22.00-33.00	0.340	0.170	±.0020	0.420	0.250	±.003	0.040	±.005	1/64
WR28*	26.50-40.00	0.280	0.140	±.0015	0.360	0.220	±.002	0.040	±.003	1/64
WR22*	33.00-50.00	0.224	0.112	±.0010	0.304	0.192	±.002	0.040	±.003	0.010
WR19	40.00-60.00	0.188	0.094	±.0010	0.268	0.174	±.002	0.040	±.003	0.010
WR15*	50.00-75.00	0.148	0.074	±.0010	0.228	0.154	±.002	0.040	±.003	0.008
WR12*	60.00-90.00	0.122	0.061	±.0005	0.202	0.141	±.002	0.040	±.003	0.006
WR10	75.00-110.00	0.100	0.050	±.0005	0.180	0.130	±.002	0.040	±.003	0.006



*Military standard, see text

**For all sizes: Minimum outer radius 1/64 inch
Maximum outer radius 1/32 inch

ATTENUATION in Waveguides

Power-handling capabilities and attenuation for the $TE_{1,0}$ mode in the rectangular waveguides adopted as standard by the Radio Manufacturers Association

By HENRY LISMAN
Yeshiva University
New York, New York

IN A RECTANGULAR copper waveguide with air dielectric and for the $TE_{1,0}$ mode, the attenuation is given by the equation:

$$\alpha_{\text{copper}} = \frac{0.0117}{a^{3/2}}\left[\frac{\frac{1}{2}\frac{a}{b}\left(\frac{f}{f_c}\right)^{3/2}+\left(\frac{f}{f_c}\right)^{-1}}{\left\{\left(\frac{f}{f_c}\right)^2-1\right\}^{1/2}}\right]$$

where α_{copper} = attenuation in db per foot for copper waveguide, a and b are the larger and smaller inner dimensions in cm, f/f_c is the ratio of the frequency transmitted to the cutoff frequency.

If a metal other than copper is used, the attenuation given by the formula should be multiplied by a constant which is equal to the square root of the ratio of the resistivity of that metal to the resistivity of copper. A few values for commonly used materials are:

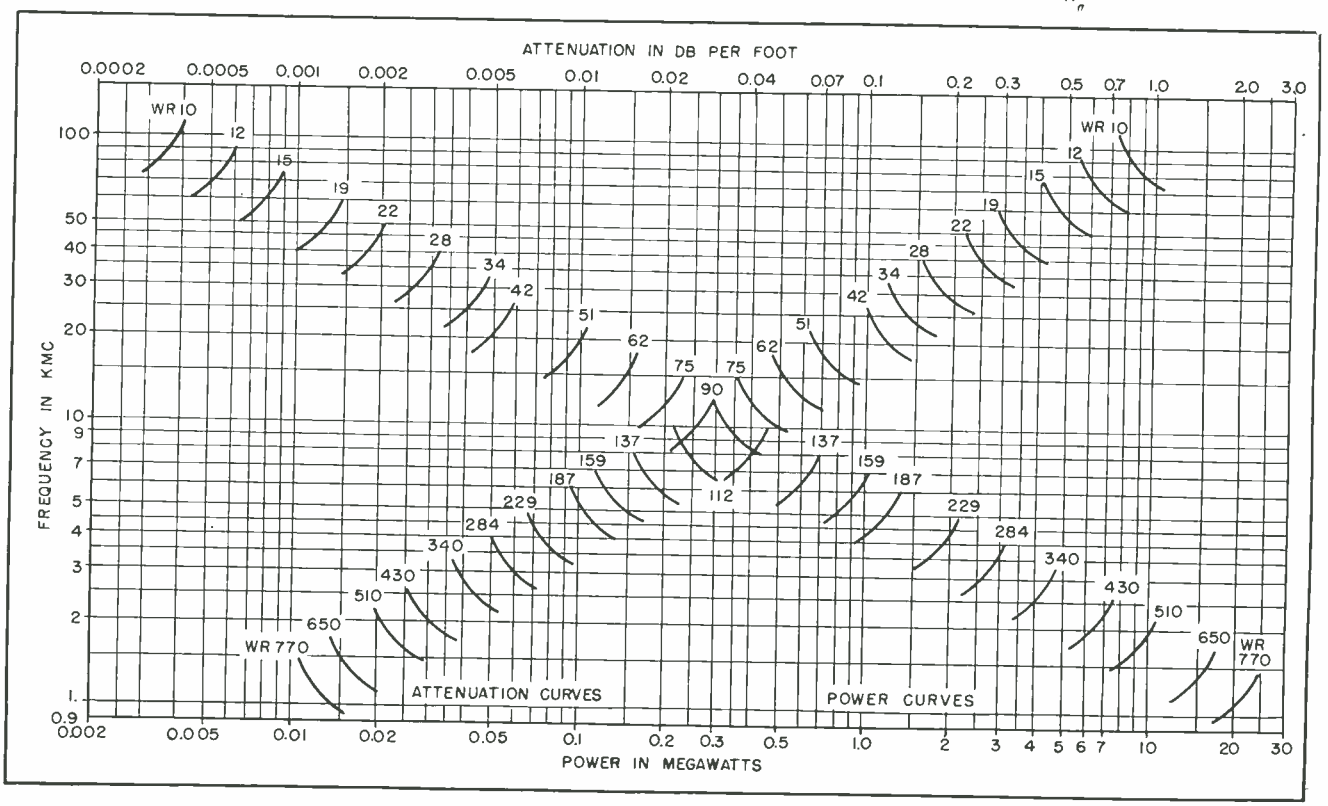
Aluminum	1.27	Chromium	1.27
Brass	2.00	Gold	1.18
Cadmium	2.04	Silver	0.95

In the graph, there is plotted a series of curves showing the variation of attenuation, in db per foot, with frequency for the same frequency ranges used in the power curves described below.

The maximum continuous-wave power that a waveguide can carry for the $TE_{1,0}$ mode is given by $P = (E_{max})^2\ 6.63\ (10^{-4})\ ab\ (\lambda/\lambda_g)$ where P = maximum power for the $TE_{1,0}$ mode in watts, E_{max} = maximum permissible voltage gradient (A value of 15,000 volts per cm has been assumed), a and b are the larger and smaller inner dimensions respectively in cm, λ/λ_g is the ratio of the free space wavelength to that in the guide.

This equation gives the theoretical maximum power that a waveguide can handle if the voltage standing-wave ratio is 1 and is valid for particular conditions of humidity and pressure only. Furthermore, the breakdown voltage is also affected by initial ionization, gap width, pulse width and repetition rate and surface points.

In the graph, there is plotted a series of curves showing variation of maximum power that can be transmitted through the various waveguides with frequency for the respective frequency ranges which are obtained from the condition that $1.18 < \frac{\lambda}{\lambda_g} < 1.67$.



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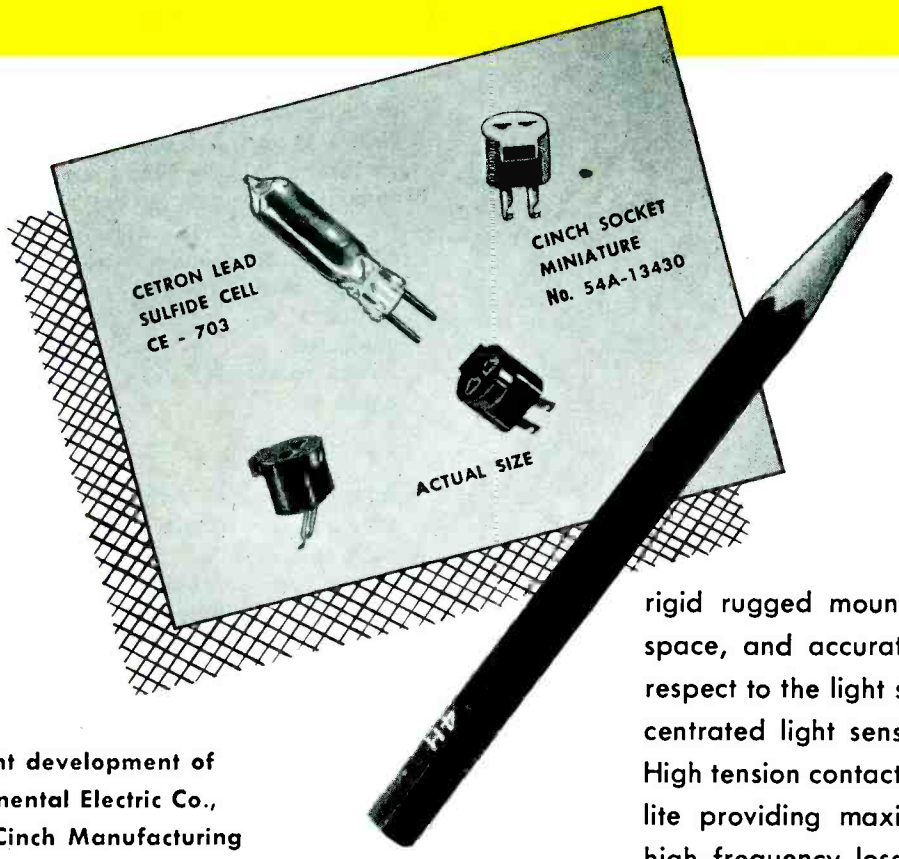

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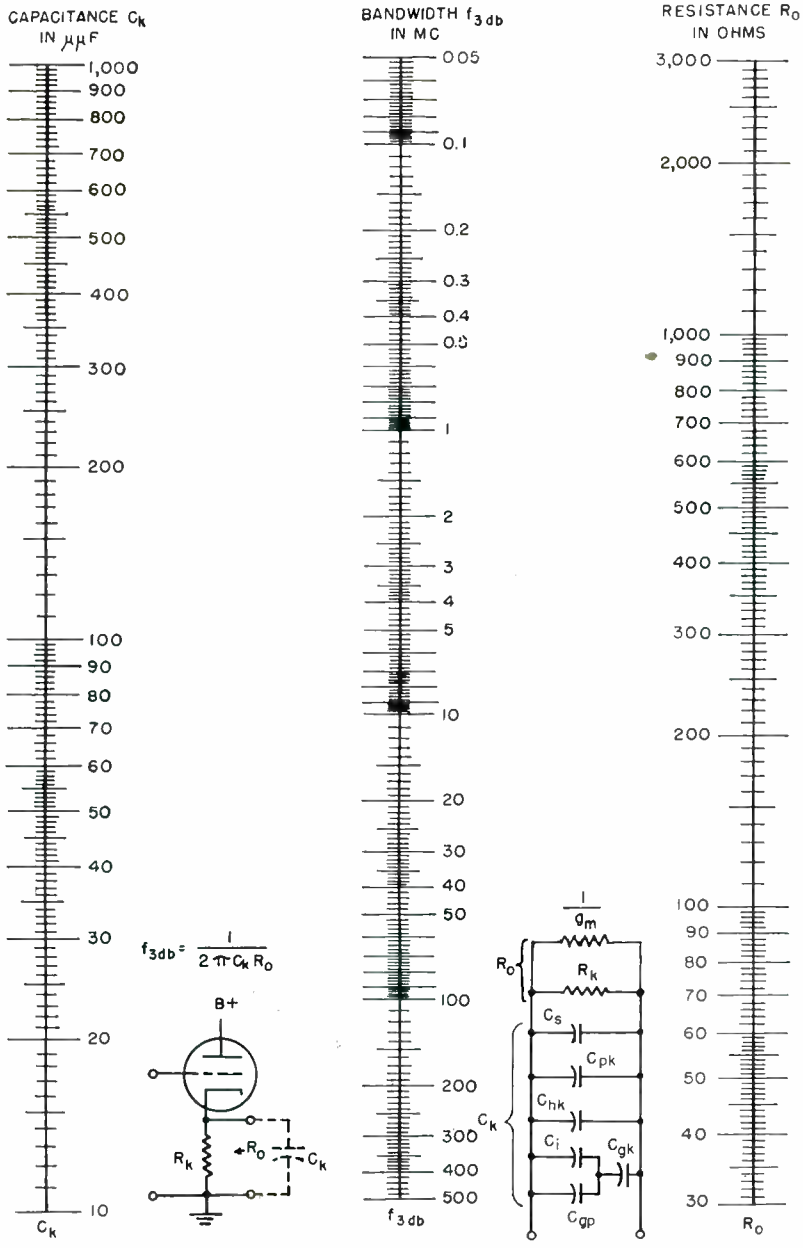
Cathode Follower Bandwidth

Nomograph gives upper frequency limit at which bandwidth is 3 db down, in terms of output resistance and total output capacitance of the circuit

By MELVIN B. KLINE
Head, Development Engineering Section
Instrument Division
Allen B. DuMont Laboratories, Inc., Clifton, N. J.

WHILE the cathode follower has come into widespread use in recent years as a major tool of the electronic engineer, and many of its characteristics are well-known, comparatively little has been published about its frequency-handling capabilities. A nomograph is given here relating bandwidth (−3 db point), output resistance and output capacitance for cathode-follower operation. Very fast negative pulses or other signals impressed on the grid may not allow the cathode to follow in some instances, due to the time constant of the cathode circuit.



The frequency at which the response is down 3 db is

$$f_{3db} = \frac{1}{2\pi C_k R_o} \qquad (1)$$

where f_{3db} is bandwidth in mc, R_o is output resistance in ohms and C_k is total output capacitance in μμf.

The nomograph is based on this equation. The value of C_k is determined approximately from

$$C_k \cong C_{hk} + C_{pk} + \frac{C_{gk}(C_i + C_{gp})}{C_{gk} + C_i + C_{gp}} + C_s \qquad (2)$$

where C_{hk} is heater-cathode capacitance, C_{pk} is plate-cathode capacitance, C_{gk} is grid-cathode capacitance, C_{gp} is grid-plate capacitance, C_i is input-circuit capacitance, and C_s is the sum of wiring and other capacitances connected externally across the output load. In the case of pentodes C_{gp} can usually be neglected.

The value of R_o can be computed from

$$R_o = \frac{R_k}{1 + G_m R_k} \qquad (3)$$

where R_k is the cathode resistance and G_m is the transconductance of the tube. The value of R_o can also be obtained from a previously published nomograph.[1]

This nomograph may also be applied to uncompensated R-C amplifiers by replacing R_o with the equivalent output resistance of the amplifier plate circuit. For this case, the nomograph scales can be extended by multiplying the R_o scale and dividing the f_{3db} scale by the same number. The C_k scale then becomes the output capacitance of the amplifier.

Reference

(1) Melvin B. Kline, Cathode-Follower Impedance Nomograph, ELECTRONICS, p 130, July 1947.

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TUBES AT WORK

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Edited by VIN ZELUFF

Automatic Chemical Analyzer

AFTER more than two years of intensive development work, the perfection of a practical instrument to supplement and extend chemical analysis and research has been announced. The instrument can analyze in a few minutes such mixtures as wood and grain alcohols dissolved in water, telling both what compounds are present and how much of each. Even complex mixtures of gasoline-like compounds obtained in refinery laboratories can be analyzed. In addition, the instrument produces records which give fundamental information about molecular structures of the chemicals analyzed. This information is of great value in research work on the preparation of new chemicals.

This development is based on the experimental work of the Indian physicist Sir C. V. Raman who found that many compounds give off a weak light that can be used to identify them when illuminated by a powerful beam of mercury light. The sample light is passed into a spectrograph containing prisms which break up the light into its colors. Each compound gives a unique pattern of lines which can be used to identify the substance in mixtures. Because the Raman light is weak, the early Raman work was done using a spectrograph with a camera system and photographic plates, exposures of many hours or days being required. A development of the Lane-Wells Co. of Pasadena, California, the instrument incorporates an improved mercury light source and a high-speed spectrograph so that exposures of a few minutes are now routine. In addition, this instrument now can also by-pass the photographic process altogether by using sensitive electronic tubes and amplifiers to measure the Raman light directly. The new pen-recording instrument produces directly a graph of a sample's Raman lines on a roll of chart paper. This new development has greatly improved the speed and accuracy of the analytical work. The photograph shows the instrument with the cover of the lamp house removed to show the interior.

Chemist places vial of unknown solution into chemical analyzer which will print curves that can be interpreted to yield chemical and molecular properties of solution in a matter of minutes

Packaged Electronic Control Unit

BY G. C. WILSON
G. C. Wilson & Company
Chatham, N. J.

EXPERIENCE and numerous interviews have led to the conviction that all control engineers have at least one problem that lends itself to solution using electronic elements. This may be due to the need for speed, sensitivity, compactness or because of the measuring elements available. Whatever the reasons, the solution of many control problems dictates the use of electronic elements if equipment is available at a reasonable cost. If electronic equipment is available only after expensive and time-consuming design and development, a substitute will be used with the consequent loss in the quality of control.

The unit shown in Fig. 1, which is called the Flexitrol, was designed to provide the control engineer with a packaged electronic device for use as an element in control systems. A variety of measuring elements can be connected to its input. Its output consists of contact closures suitable for virtually any need. Sensitivity controls and variable time delays permit adjustment over wide ranges. The time delays also adapt its use to processes with small time lags or lags up to several minutes.

The unit is approximately 9 inches long and 8 inches in diame-

SOLDERING TIPS

Recently many inquiries have been received as to the best material to use in a soldering iron tip. Below is a resume of reasons for the use of certain materials. The function of the soldering iron tip is to convey heat to the metal to be soldered, raising the temperature of the metal to a solder-alloying efficiency. The efficiency of the soldering tip depends upon its ability to transmit or conduct heat to the second metal. Silver has the greatest thermal conductivity, then copper and gold. Other known metals are far down the scale in comparison. Silver has been ruled out mainly because of its high cost. Throughout the ages, copper has remained the ideal tip material for reason of its comparatively low cost and its ability to conduct heat about twice as fast as other known metals.

Many inquiries have been received concerning the reason for the rapid wearing and pitting of soldering coppers. This very pitting denotes an efficient soldering tip. Any metal must be soluble in molten solder to function as a soldering tip; this action enables the tip to become solder-coated or tinned. The coating action continues to form and reform during the soldering operation, constantly exposing the tip to the solvent action of the solder. Constant solvent action is the cause of the pitting and must be expected if the soldering tip is to perform efficiently.

For years experiments have continued in an effort to find a coating material that would stop or slow down the solvent action of the solder on the soldering tip. Usually these experiments have resulted in a longer-wearing iron but have also resulted in an inefficient iron that would not properly transmit the heat.

"Soldering Tips" is continually on the lookout for improved methods of soldering. Recently several solder users have tried a new soldering tip plated by a formula known to the inventor only. Twice the amount of service from this tip was reported. The name of the manufacturer will be furnished on request.

"Soldering Tips" will welcome your questions concerning solder or soldering operations. Please address inquiries to "Soldering Tips", Kester Solder Company, 4204 Wrightwood Ave., Chicago 39, Illinois.

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THE FRONT COVER

DESIGNED to fit the requirements of f-m broadcast application, the Ampex tape recorder provides a 35-minute transcribing capacity at 30 inches of tape per second. Included are precision tape drive, completely-shielded plug-in head housing with separate heads for erase, record, and playback and separate record and playback amplifiers.

Frequency response of the unit is within ± 1 db between 30 and 15,000 cps. Distortion of the overall system is 4-percent intermodulation at peak meter reading. Ten db above peak meter reading the total rms harmonic distortion does not exceed 5 percent. Unweighted noise level is 60 db below 5-percent harmonic distortion for the system as a whole—including both amplifiers, bias, erase and stray pickup. Accuracy of playback timing is ± 0.2 percent.

The battery of test gear used in final production testing of the recorder is shown in the photograph above.

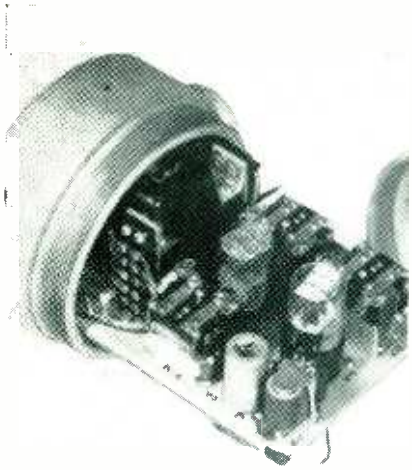


FIG. 1—Compact electronic control package in an explosion-proof housing

ter. A general schematic is shown in Fig. 2. Operation is as follows: A voltage is applied to the input terminals by the measuring element. If this voltage is equal to the voltage applied at A (which is adjustable), no signal appears across the secondary of the transformer. If the input increases, a signal appears on the secondary, and V_1 conducts causing RE_1 to operate. If, on the other hand, the input decreases, RE_2 pulls in. Variable cathode resistors control the sensitivity of V_1 and V_2. Operation of RE_1 reverses the connection of the cathode of V_3 and its grid begins to charge, initiating time delay 1. After a time delay determined by the grid-leak resistor and capacitor, and the grid charging voltage (determined by the setting of the time delay 1 control tube V_3 conducts, RE_3 operates and ends time delay 1.

When RE_3 operates, it reverses the connection of the cathode of V_4, initiating time delay 2. This delay is determined as for time delay 1 by its time delay control and the grid resistor and capacitor. At the end of time delay 2, V_4 conducts and RE_4 operates.

Measuring Elements

Some of the measuring elements for operating the device are shown in Fig. 3. A selsyn, or autosyn, may be used to measure angular position, since its output is proportional to the angular position of its pri-

(continued on p 132)

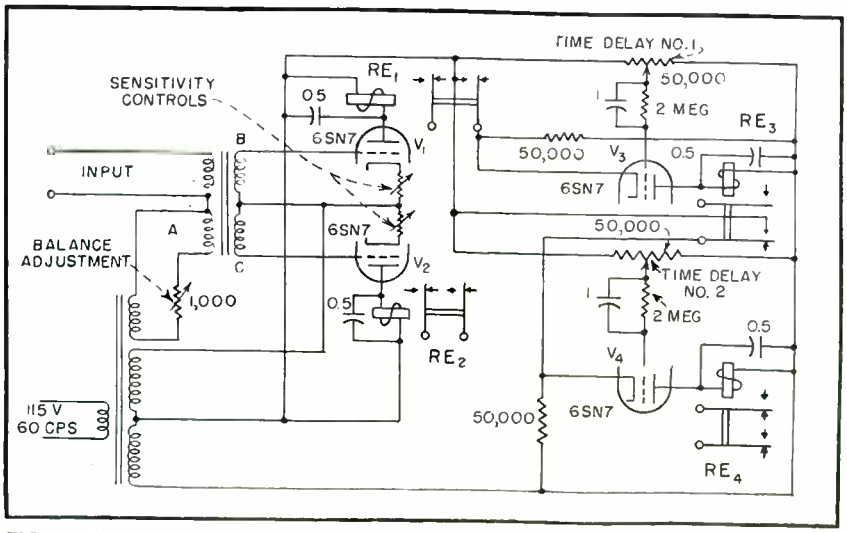
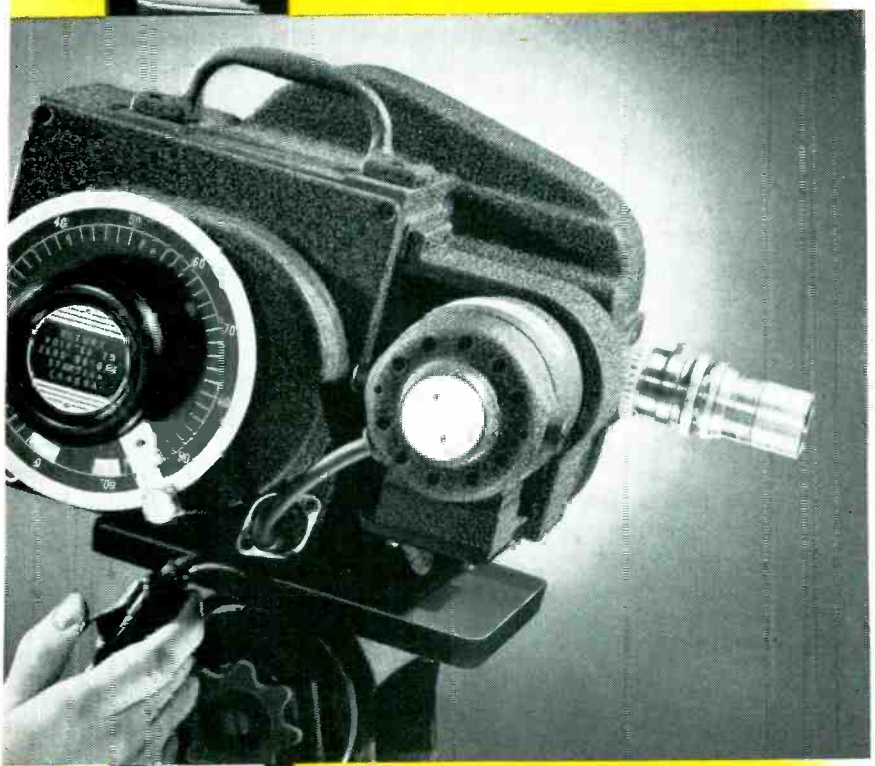


FIG. 2—Circuit diagram of control unit. Unconnected relay contacts are for external controlled circuits

It can show you the heartbeat of a car radio—



the Kodak *High Speed* Camera

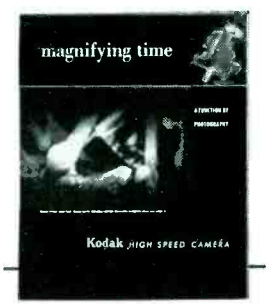
You could cover pages with calculations about a car radio vibrator. You could fill sheets with figures on inertia and elasticity of its vibrating elements—and yet not be sure exactly how the rapidly moving parts do behave in action.

This is where high speed movies come in—the kind of "slow motion" you get from the Kodak High Speed Camera. It's a simple, direct means to record and study high speed repetitive mechanical motion . . . the only way to see dynamically what happens in non-cyclic high speed action.

The Kodak High Speed Camera can take a second of action and spread it over three minutes. It can put flash marks along the side of the film that time the motion accurately. Its optical system gives the extra picture sharpness you need to see a vital point clearly.

This camera is a single unit with one motor, complete in itself and easy to operate. If you would like to know how it works and how it can help you, send the coupon.

EASTMAN KODAK COMPANY
Industrial Photographic Division
Rochester 4, N. Y.



"Kodak" is a trade-mark.

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Rochester 4, N. Y.
Gentlemen:
Please send me: ☐ your folder "Magnifying Time" which tells about the Kodak High Speed Camera. ☐ a 16mm. sample reel of high speed motion study, which I may borrow.

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City_____ State_____

48

Kodak

THE ELECTRON ART

Edited by JOHN MARKUS

New Value for e/m

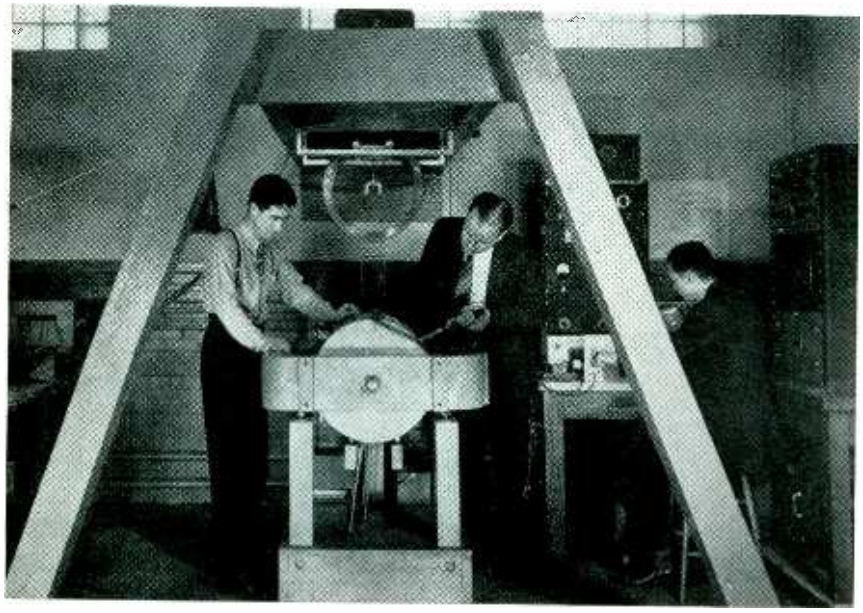
ACCURATE determination of the magnetic moment of the hydrogen nucleus, or proton, by NBS scientists has resulted in a new absolute value for the electron charge-to-mass ratio *e/m*.

This new measurement also provides an accurate secondary standard for magnetic fields, so that magnetic fields can now be measured more accurately than electric fields. The problem of magnetic field regulation arises widely in the use of scientific apparatus such as cyclotrons, mass spectrographs and beta-ray spectrometers—and in industrial equipment such as servomechanisms and electromagnets.

Method of Measurement

A typical experimental set-up for measuring the magnetic moment includes a water sample placed in a magnetic field of 4,700 gauss and surrounded by a small r-f coil with its axis perpendicular to the magnetic field. Thus, if the coil is excited by a 20-megacycle signal, an r-f field will be produced in the sample and protons in the normal spin state will absorb r-f energy and shift to the excited state. A sensitive Q-meter can be used to detect the reduction in the Q of the coil resulting from this energy absorption by the nuclei.

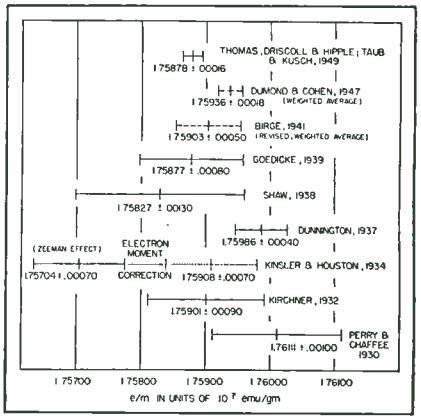
If the value of the field at the sample is varied at an audio rate, the r-f voltage across the coil will change sharply as nuclear resonance occurs. Resonance can then be detected without using a Q-meter since, if the voltage pulse from the coil is rectified and amplified, the resonance absorption line may be displayed as a stationary image on an oscilloscope screen. By including a differentiating circuit to obtain the time rate of change of the resonance pulse, the magnetic field strength can be regulated very closely through a power amplifier and feed-back circuit.



Experimental set-up for measuring the proton's magnetic moment at the Atomic Physics Laboratory of the National Bureau of Standards. Heavy wood beams provide rigid support for precision chemical balance that measures magnetic pull. Electronic equipment at right includes audio oscillator, power supplies and 20-mc r-f generator. Proton sample is ordinary tap water in glass ampule surrounded by r-f coil in magnet gap. NBS scientists working on this project are, left to right: R. L. Driscoll, J. A. Hipple and H. A. Thomas

Magnetic Pull Measurement

With the magnetic field stabilized, the frequency of the r-f voltage applied to the coil enclosing the proton sample was adjusted to produce magnetic resonance. The magnetic field strength was then determined to 1 part in 20,000 by measuring the force on a known length of current-carrying wire



Two decades of values for electron charge-to-mass ratio e/m

placed in the field. This wire was in the form of a nine-turn coil wound on the edge of a long rectangular glass plate with its lower end in the magnetic field. The plate was supported by an analytical balance so that the force resulting from the interaction of the coil current with the magnetic field could be accurately measured. The stray field at the upper end of the coil was reduced to zero by a pair of Helmholtz coils. Since the long parallel sides of the coil did not contribute any vertical force, the chemical balance measured only the force acting on the part of the coil along the lower end of the plate.

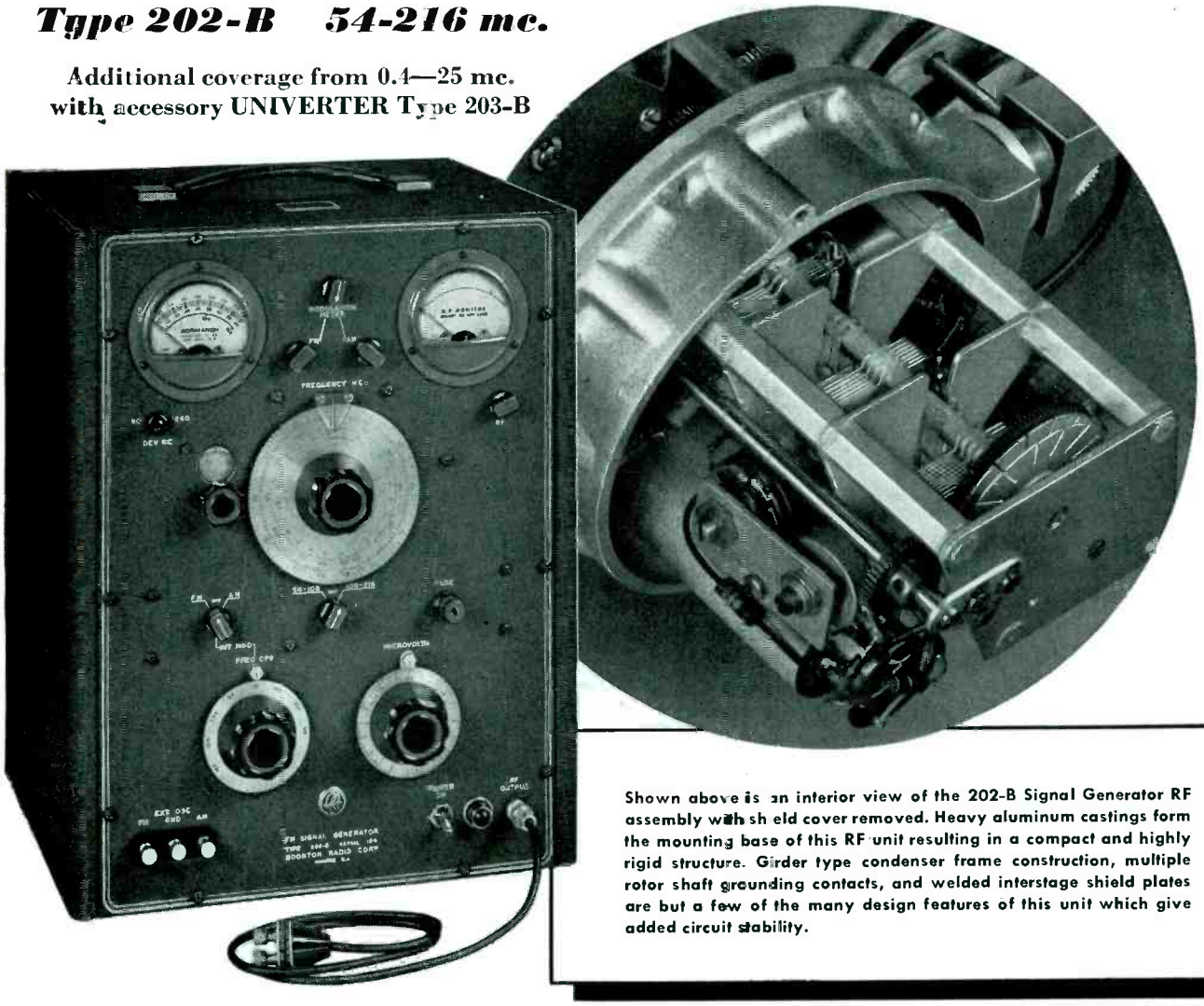
Results

The frequency of resonance absorption was measured to a few parts per million by heterodyning the r-f generator supplying the resonance probe against the standard

FM SIGNAL GENERATOR

Type 202-B 54-216 mc.

Additional coverage from 0.4—25 mc. with accessory UNIVERTER Type 203-B



Shown above is an interior view of the 202-B Signal Generator RF assembly with shield cover removed. Heavy aluminum castings form the mounting base of this RF unit resulting in a compact and highly rigid structure. Girder type condenser frame construction, multiple rotor shaft grounding contacts, and welded interstage shield plates are but a few of the many design features of this unit which give added circuit stability.

Designed to meet the exacting requirements set forth by leading FM and television engineers throughout the country, the 202-B FM Signal Generator has found widespread acceptance as the essential laboratory instrument for receiver development and research work.

Frequency coverage from 54 to 216 megacycles is provided in two ranges, 54 to 108 megacycles and 108 to 216 megacycles. A front panel modulation meter having three deviation scales, 0-24 kilocycles, 0-80 kilocycles and 0-240 kilocycles, permits accurate modulation settings to be made.

Although fundamentally an FM instrument, amplitude modulation from zero to 50%, with meter calibrations at 30% and 50%, has been incorporated. This AM feature offers increased versatility and provides a means by which simultaneous frequency and amplitude modulation may be obtained through the use of an external audio oscillator.

The internal AF oscillator has eight modulation frequencies ranging from 50 cycles to 15 kilocycles, any one of which may be conveniently selected by a rotary type switch for either amplitude or frequency modulation.

The calibrated piston type attenuator has a voltage range of from 0.1 microvolt to 0.2 volt and is standardized by means of a front panel output monitor meter.

The output impedance of the instrument, at the terminals of the R.F. output cable, is 26.5 ohms.

AVAILABLE AS AN ACCESSORY

is the 203-B Univerter, a unity gain frequency converter which, in combination with the 202-B instrument, provides the additional coverage of commonly used intermediate and radio frequencies.

- R.F. Range: 0.4 mc. to 25 mc.
- R.F. Increment Dial: ±250 kc. in 10 kc. increments.
- R.F. Output: 0.1 microvolt to 0.1 volt. Also approximately 2 volts maximum (uncalibrated).

UNIVERTER
Type 203-B

For further information write for Catalog F

BOONTON RADIO Corporation
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DESIGNERS AND MANUFACTURERS OF THE "Q" METER . . . QX-CHECKER . . . FREQUENCY MODULATED SIGNAL GENERATOR . . . BEAT FREQUENCY GENERATOR . . . AND OTHER DIRECT READING TEST INSTRUMENTS

frequency broadcasts from WWV. These measurements of radio frequency and magnetic field establish the value of the gyromagnetic ratio of the proton as $(2.6752 \pm 0.0002) \times 10^4$. The magnetic moment of the proton in absolute units is then $(1.4100 \pm 0.0003) \times 10^{-23}$ gauss cm^3.

The Bureau's research on the absolute proton moment has resulted in a new value for the electron charge-to-mass ratio e/m—$(1.75878 \pm 0.00016) \times 10^7$ emu/gm—with much greater accuracy than any previous measurement. In addition, this combination of results completely confirms the validity of the theoretical correction for the radiative effects of the electron's magnetic moment.

Angels are Flying Insects

MYSTERIOUS short-duration radar reflections called angels or blips, observable most frequently below heights of 3,000 feet, have been explained by scientists of Bell Telephone Laboratories. The cause: flying insects.

The tests and observations resulting in this conclusion were sponsored jointly by Bell Laboratories and the Naval Electronics Laboratory and were conducted at Gila Bend, Arizona.

In their attempts to synthesize the strange patterns on the radar scopes, the scientists exploded a small charge of nitro-starch in the air 500 feet above the radar antennas. They flew a plane low over the radar and looked for reflections from the exhaust gases. They built bonfires, upwind, so that the hot combustion gases and steam clouds formed by pouring water on heated rocks billowed into the beam. In all these experiments, the phenomenon was never observable.

Later, working at night, they threw out a strong searchlight beam, and stationed observers at different levels of a 200-foot tower. While the observers counted insects, the radar operators counted the appearance of angels on their scopes. For example, in one fifteen-minute period, twenty were counted, fifteen of which coincided with the sighting of an insect.

Insects fit most of the descriptions which have been applied to the mysterious reflections on radar scopes. They are small, they move at a speed comparable to wind velocity, sometimes with and sometimes against the wind, they are present both day and night, and there are more of them in warm weather than in cold.

Increasing Stability of Oscillators

BY ALBERT DANZIGER
Chief Engineer, Radio Engineering Co.
Instructor, Radio-Electronics Institute
New York, N. Y.

THE USUAL PRECAUTIONS employed in oscillator and tuned-circuit design which are meant to minimize frequency drift, such as mechanically-stable tuning capacitors, a stable tank coil and high ratio of C to L, are not adequate to prevent variations in resonant frequency due to changes in tube input capacitances. The tuning ratio in a high-frequency receiver (approximately 100 mc) requires a practical value of C_{max} of approximately 20 $\mu\mu$f; consequently the variation in shunt capacitances introduced by the oscillator or amplifier tube becomes a significant portion of the total tuning capacity of the circuit.

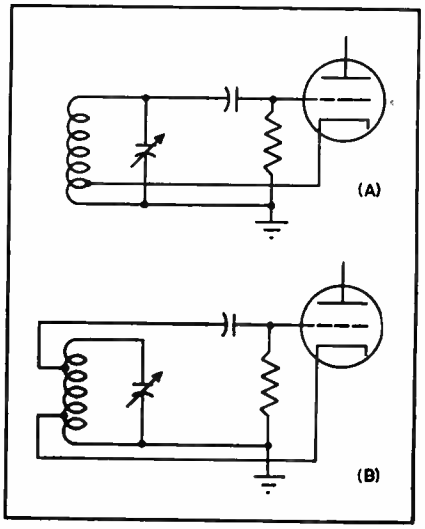
Since the input capacitance is made up of tuning capacitance and circuit shunt capacitance, changes in input capacitance will result from changes in either of these two parameters. If a mechanically-stable tuning capacitor is used, its changes will be relatively small compared to variations in tube input capacitances.

It is therefore seen that where the change in input shunt capacitance becomes a significant portion of the total tuning capacitance, the change in resonant frequency becomes an appreciable percentage of the resonant frequency.

When the tube input capacitance appears across the total tank coil, as shown in Fig. 1A, the change in resonant frequency is proportional to the square root of the change in total tuning capacitance. It was determined experimentally, however, that when the tube input capacitance appears across only a portion of the total tank coil, the change in resonant frequency is proportional to the nth root of the change in input shunt capacitance, the order of the root being determined by the position of the tap.

When the variations in input shunt capacitance appear across half the tank coil, the order of the root is approximately 8, and when the variations in tube input and other shunt capacitances appear across 25 percent of the tank coil, the order of the root becomes approximately 16. Of course, an incidental effect of tapping down on the tank coil would be to utilize only a portion of the voltage. The practical applications of this circuit arrangement utilize approximately 80 percent of the tank coil.

A practical method of utilizing this lowered dependency of resonant frequency on the variations in tube input and other shunt capacitances is shown in the oscillator circuit of Fig. 1*B*.



When tube input and stray shunt capacitances appear across only a portion of the tuned circuit (*B*) the circuit is substantially more stable than in the arrangement shown at (*A*)

Modifications of this method for obtaining a high degree of stability

(continued on p 152)

This New VARGLAS Tubing is better 5 ways!

Impregnated with General Electric's PERMAFIL for superior insulation...

Varglas Permafil Tubing excels oleoresinous and other synthetic coated tubing in several important performance characteristics. Outstanding among these are:

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Remains pliable even after severe flexing. This new tubing can be twisted, bent or tied in knots with no loss in its dielectric value (7,000 volts).

2 SOLVENT RESISTANCE

Is relatively immune to alcohol. Petroleum and aromatic hydrocarbons have only slight effect after long exposure.

3 HEAT AGING

Withstands more than 2,000 hours at 105° to 110° C., 1,000 hours at 125° C. and extensive periods at 150° C.

4 BAKING

Can be after-treated in baking and varnishing operations—reacts better than most oleoresinous materials.

5 AVAILABLE IN COILS

—in standard colors and wide range of sizes. Meets or exceeds all requirements of A.S.T.M. specifications.

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Varflex CORPORATION

Makers of Electrical Insulating Tubing and Sleeving

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Please send me full information as well as a free sample of your new Varglas Tubing impregnated with G.E. Permafil. I am particularly interested in samples suitable for.....

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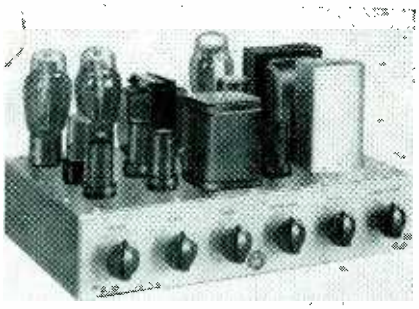
NEW PRODUCTS

Edited by A. A. McKENZIE

Noise Suppression

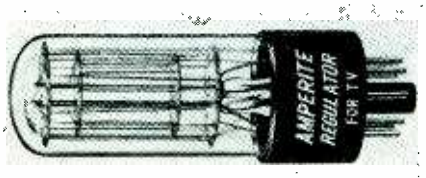
MINNESOTA ELECTRONICS CORP., 97 E. Fifth St., St. Paul 1, Minn., has added model NSA-20 noise suppres-



sion filter amplifier to its line. The filter attenuates the noise region at the rate of more than 20 db per octave above any selected frequency from 3,500 to 16,000 cps. There is continuous variable tuning over this entire range. Frequency response is maintained between 12,000 to 20,000 cps within 0.5-db roll-off. Power output is 10 watts.

Television Ballast Tube

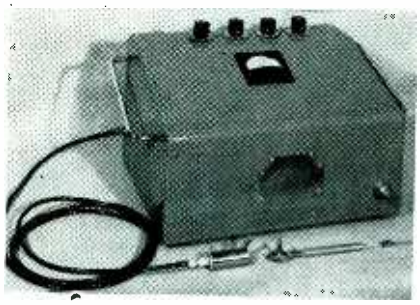
AMPERITE CO., INC., 561 Broadway, New York 12, N. Y., announces a television ballast tube that is hermetically sealed and filled with helium, and produced with as many



as five separate controlling elements. Some of the 2.5-watt elements are designed to withstand 40 watts, an overload of 2,000 percent. Voltage breakdown between elements is 1,300 volts d-c.

Manometer

TECHNITROL ENGINEERING CO.,INC., 3212 Market St., Philadelphia 4, Pa. Model 115-1 continuous-reading Lilly manometer is an electronic blood-pressure recording device. Five ranges of pressure selected



by the range switch cover from +25 to +400 mm or +25 to −400 mm of mercury. Output voltage range is −20 to +20 volts. The instrument operates on 115 v, 60 cycle a-c and consumes about 100 watts. Frequency response of the amplifier uncompensated is flat within 1 db from 0 to 2,000 cps. Volume displacement of pressure head is less than 10^{-7} ml per mm of mercury.

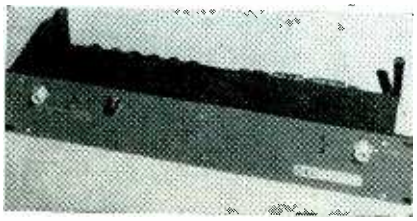
Tubular Twin-Lead

AMERICAN PHENOLIC CORP., 1830 S. 54th Ave. Chicago 50, Ill. Catalog No. 15–271 is a 300-ohm tubular twin lead for television and f-m

lead-ins. It holds moisture and dirt outside the concentrated field between conductors and, therefore, eliminates variation in transmission-line impedance and excessive dielectric losses.

Wide-Band Chain Amplifier

SPENCER-KENNEDY LABORATORIES, INC., 186 Massachusetts Ave., Cambridge 39, Mass. Model 202 traveling wave wide-band chain amplifier



is composed of two stages of six 6AK5 tubes, has a gain of 20 db and a bandwidth of 200 mc. With a standing wave ratio of less than 1.5 db adjusted for a pulse response, transmission characteristic is ± 1.5 db from 100 kc to 200 mc at a 200-ohm impedance level. The unit can be used in general laboratory measurements, oscillography and nuclear instrumentation.

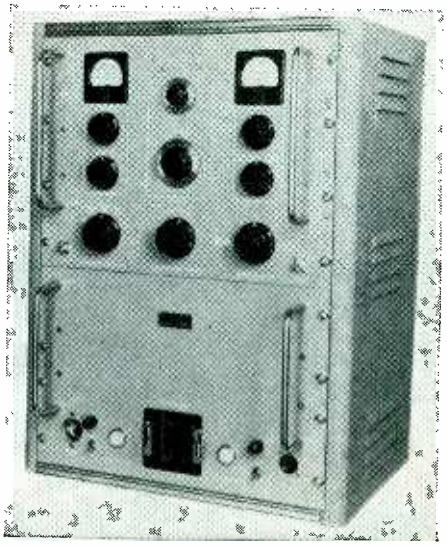
Filamentary Pentode

RAYTHEON MFG. CO., Newton, Mass. The type 1AD4 is a new subminiature sharp cutoff pentode, shielded

for r-f applications, with a nominal mutual conductance rating of 2,000 micromhos, and an average plate current of 3 ma, with 45 volts plate and screen supply. Filament rating is 1.25 volts, 100 ma.

Klystron Control

POLYTECHNIC RESEARCH AND DEVELOPMENT CO., INC., 202 Tillary St., Brooklyn 1, N. Y. Type 801 klystron power and modulation supply can operate a wide variety of klystron oscillators. The unit provides for c-w, square-wave, or sawtooth modulation or for external



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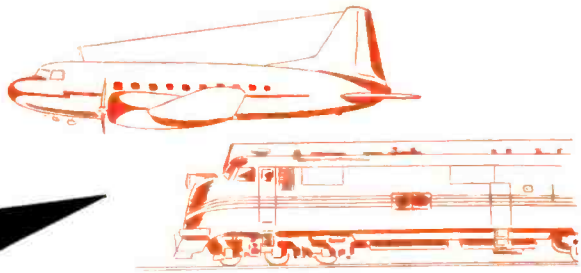
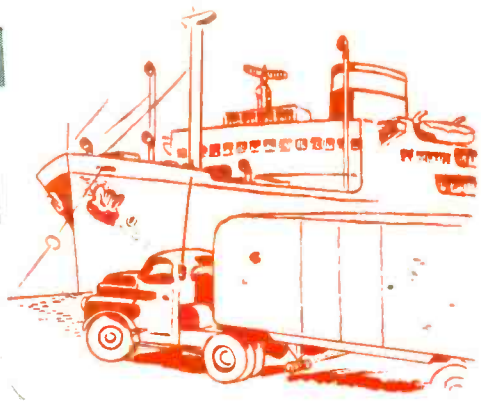


Type	Description	Typical Service	Prototype	Construction	Heater Volts	Heater Amps.	Plate Volts	Plate Ma.	Grid Volts	Screen Volts	Screen Ma.	Amp. Factor	Mut. Cond.
2C50	Dual Power Triode	Aircraft Control Equip.	—	Bantal	12.6	0.3	300	12.5	−24	—	—	9.5	1750
2C52	Dual Amplifier Triode	Aircraft Control Equip.	—	Bantal	12.6	0.3	250	1.3	−2	—	—	100	1900
6AK5W	Pentode RF Amplifier	Military Ruggedized	6AK5	7 pin miniature	6.3	0.175	120	7.5	Rk 200	120	2.5	—	5000
6AL5W	Dual Diode	Military Ruggedized	6AL5	7 pin miniature	6.3	0.3	Max. Peak Inv. 330 Volts Max.			Io 9 ma.dc.			
6AS6W	Pentode RF Mixer	Military Ruggedized	6AS6	7 pin miniature	6.3	0.175	120	5.2	−2	120	3.5	—	3200
6C4W†	RF Power Triode	Military Ruggedized	6C4	7 pin miniature	6.3	0.15	250	10.5	−8.5	—	—	17	2200
6J5WGT	General Purpose Triode	Military Ruggedized	6J5GT	Standard glass	6.3	0.3	250	9	−8	—	—	20	2600
6J6W†	Dual AF-RF Triode	Military Ruggedized	6J6	7 pin miniature	6.3	0.45	100	8.5	Rk 50	—	—	38	5300
6SA7WGT†	Pentagrid Converter	Military Ruggedized	6SA7GT	Standard glass	6.3	0.3	250	3.5	Rg 20000	100	8.5	—	450 Conv. Cond.
6SJ7WGT	Pentode RF Amplifier	Military Ruggedized	6SJ7GT	Standard glass	6.3	0.3	250	3.0	−3	100	0.8	—	1650
6X4W†	Fullwave Rectifier	Military Ruggedized	6X4	7 pin miniature	6.3	0.6	Max. Peak Inv. 1250 Volts Max.			Io 70 ma.dc.			
12J5WGT	General Purpose Triode	Military Ruggedized	12J5GT	Standard glass	12.6	0.15	250	9	−8	—	—	20	2600
CK5654	Pentode RF Amplifier	Commercial Aircraft Ruggedized	6AK5W	7 pin miniature	6.3	0.175	120	7.5	Rk 200	120	2.5	—	5000
CK5670	Dual Triode	Commercial Aircraft Ruggedized	2C51	9 pin miniature	6.3	0.35	150	8.2	Rk 240 per sect.	—	—	35	5500
CK5686	AF-RF Output Pentode	Commercial Aircraft Ruggedized	—	9 pin miniature	6.3	0.35	250	25	−12.5	250	3	—	2700*
CK5694	Dual Power Triode	Industrial AF-RF Amp.	6N7G	Standard glass	6.3	0.8	294	7	−6	—	—	35	3200
CK5725	Pentode RF Mixer	Commercial Aircraft Ruggedized	6AS6W	7 pin miniature	6.3	0.175	120	5.2	−2	120	3.5	—	3200
CK5726	Dual Diode	Commercial Aircraft Ruggedized	6AL5W	7 pin miniature	6.3	0.3	Max. Peak Inv. 330 Volts Max.			Io 9 ma.dc.			

†Available during the latter part of 1949. *2.5 watts Class A output. 10 watts Class C input power.

Note: All dual section tube ratings are for each section.

RAYTHEON Makes All These Tough Service Tubes — and tens of thousands of them are daily demonstrating their superior reliability and stamina in commercial aircraft, industrial and military service.



These Raytheon tubes are engineered and manufactured specifically for critical services where a single tube failure may lead to serious loss of life or dollars. We are interested in developing additional types for your tough service applications.

Over 300 Raytheon Special Purpose Tube distributors are ready to serve you on the above types. Application information on these tubes is available at Newton, Chicago and Los Angeles.

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SPECIAL TUBE SECTION · Newton 58, Massachusetts

SUBMINIATURE TUBES · SPECIAL PURPOSE TUBES · MICROWAVE TUBES · CATHODE RAY TUBES · RECEIVING TUBES

modulation. Beam voltage supply is adjustable in two steps from −800 to −3,600 volts d-c. Operation may be up to 1,500 volts at 65 ma or up to 3,600 volts at 25 ma. Reflector voltage is continuously variable from −20 to −750 volts.

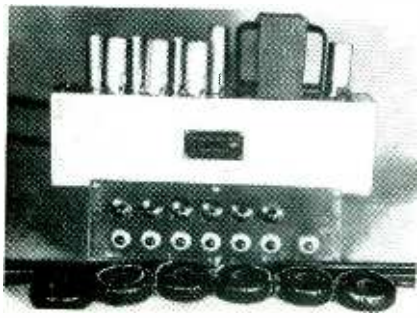
Portable Amplifier

GENERAL ELECTRIC Co., Syracuse, N. Y. Type BA-6-A portable audio amplifier features four microphone

channels, each with an individual preamplifier, and a program amplifier which raises the signal to the level required for telephone transmission. Noise level is 70 db at normal fader positions, while distortion is less than 1 percent at 50 to 15,000 cycles. Frequency response under similar conditions is within 1 db.

Arc-Back Indicator

THE WALKIRT Co., 5808 Marilyn Ave., Culver City, Calif. Type M1111 arc-back indicator instantly identifies a failing tube since it indicates the first tube to pass inverse current and will not indicate in the



event of sympathetic arc-back in other tubes of the rectifier. It can be installed in existing rectifiers and is insulated from the rectifier for a test voltage of 45 kv rms. Circuits are included for six indicating positions. Complete information is available in a recent brochure.

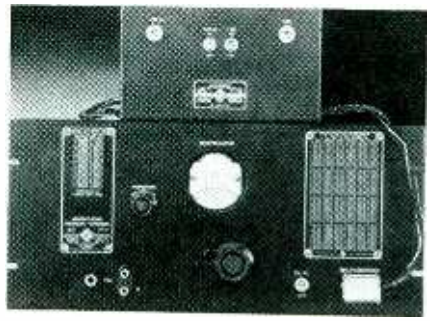
Platter Recorder

PRESTO RECORDING CORP., Paramus, N. J. Type 66-G recorder has been designed for both standard and microgroove recording. It is

equipped with a dual-motor gear drive with overhead cutting mechanism and turntable of the type 6-N. List price is $996 with $70 additional for the microgroove feature.

UHF Interpolator

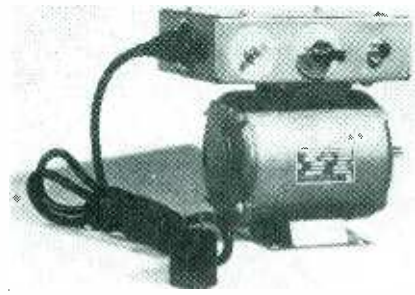
GENERAL RADIO Co., 275 Massachusetts Ave., Cambridge 39, Mass. Type 1110-A interpolator is designed for use with heterodyne frequency meters in making accurate



uhf measurements up to about 3,000 mc. The instrument provides a series of harmonics of a nominal 1-mc signal whose fundamental is adjustable over a range of 1 percent. When a frequency lying between 100 and 200 mc is measured approximately on a frequency meter, it can be matched and determined accurately using this unit.

Synchronous Motor

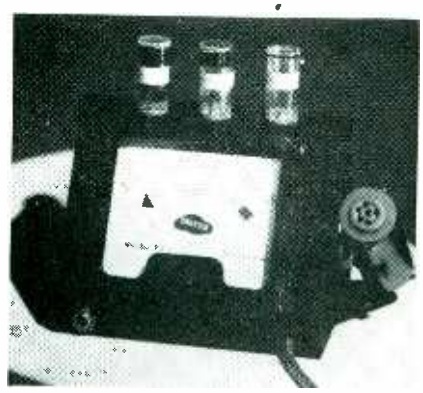
ELECTRIC INDICATOR Co., Stamford, Conn. Model GH-371 is a three-speed hysteresis-type synchronous motor for production and laboratory work. Operation is switch-con-



trolled providing clockwise or counter-clockwise rotation; it is not only reversible while running, but can also change from one speed forward to a different speed reverse. Rated at 1/100, 1/60 and 1/40 h-p, respectively, at 900, 1,800 and 3,600 rpm, the unit operates from 115 v, 60 cycle, single phase a-c. Technical data on this and nineteen other models are given in bulletin 49A.

Resonance Indicator

MCMURDO SILVER Co., INC., 1249 Main St., Hartford 3, Conn. Model 915 resonance indicator is designed



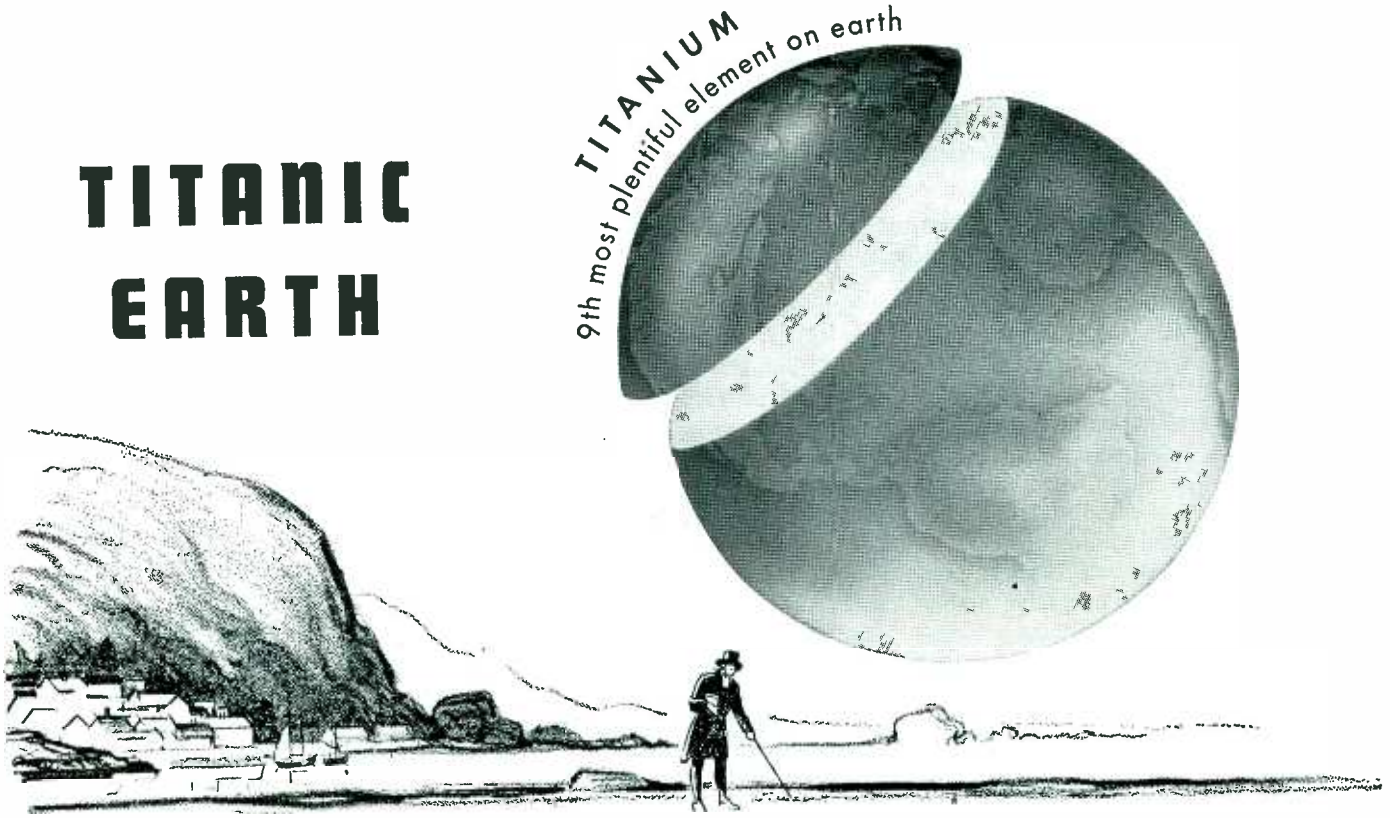
for use with model 906 signal generator. Employing three plug-in probe coils the instrument has a continuous frequency range from 100 kc through 300 mc.

Loudspeaker Safety

THE SIGNET DEVELOPMENT Co., 188 W. Randolph St., Chicago 1, Ill. Immediate applications for the fire and explosion-proof loudspeaker illustrated include mines, gasoline

(Continued on page 176)

TITANIC EARTH



TITANIUM DISCOVERED

Back in 1791 an English clergyman, William Gregor, who liked to stroll and think on the beaches of Cornwall, became curious about the black sand he saw there. This gentleman of the cloth was also an amateur chemist and in this sand he discovered a new element. Almost coincidentally an Austrian named Heinrich Klaproth (also discoverer of uranium and zirconium) extracted the same thing from rutile and named it "Titanic Earth" for the mythical Titans. Hence our name Titanium.

Thereafter titanium was found in various places including the Ilmen Mountains of Russia (ilmenite) but although it is the ninth element in order of earthly abundance, it remained a mere laboratory curiosity until 1908.

TITANIUM OXIDE

At that time Dr. A. J. Rossi, expert in the reduction of metals, mixed titanium oxide with salad oil to make a white paint. In another 10 years a pure oxide was being produced which quickly won success as a pigment. Paint, false teeth, face powder, tires, shoes, glassware, textiles, inks, plastics, paper consumed an increasing tonnage of titanium oxide but still the pure metal was beyond industry's reach.

TITANIUM METAL & NATIONAL RESEARCH

Titanium is an affectionate metal, over fond of oxygen and nitrogen when at high temperatures. Even a fraction of a per cent of either makes titanium of little value as a structural material. Until recently there was no means of preparing titanium metal in a form sufficiently free of these elements to indicate any potential commercial value. Dr. W. J. Kroll of the Bureau of Mines has initiated many of the recent developments in titanium metallurgy by finding a means of preparing powdered titanium metal.

Only by exclusion of these gases can it be kept from embrittling combinations and when Remington Arms Company, a Du Pont subsidiary, laid its plans to produce metallic titanium in cast and rolled shapes, they knew that at National Research Corporation they could find the knowledge of vacuum technique that they needed.

The melting and casting of titanium was a natural for National Research. We planned the process, designed the equipment and installed it. Today this National Research Corporation pilot equipment is handling the highest quality of commercial metal — not much compared with aluminum — nothing at all compared with steel — but so promising that millions will be spent by the industry within a few years to inerease the quantity and lower the price.

USES OF TITANIUM METAL

Titanium stands fourth in abundance among the structural metals and there is plenty in the U. S. A. Tremendous strength, light weight, and remarkable corrosion resistance (comparable only to that of the noble metals) is a unique combination. Coming at a time when long-sighted people are viewing our metallic resources with alarm, it has an assured future. With the price pulled down to a few dollars a pound or less, titanium will be of primary importance to manufacturers of aircraft, automobiles, electric devices, gas turbines, superchargers, marine hardware, rockets, optics, jewelry.

WHAT NEXT?

So, with the help of National Research's high vacuum know-how, another material has been taken from the test tube to the factory. Where else can good men and ideas help — where can they help you? At National Research the best in brains, organization, equipment, and an unequalled accumulation of unique experience are available.

INDUSTRIAL RESEARCH PROCESS DEVELOPMENT
HIGH VACUUM ENGINEERING & EQUIPMENT
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NATIONAL RESEARCH CORPORATION

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In the United Kingdom, BRITISH-AMERICAN RESEARCH, LTD., London S.W 7, England—Glasgow S.W. 2, Scotland

NEWS OF THE INDUSTRY

Edited by WILLIAM P. O'BRIEN

FCC Issues Permanent Rules for General Mobile Radio Service

PERMANENT rules for general mobile radio services, recently announced by the FCC, become effective July 1, 1949. The new rules place short-wave radio operations of electric, gas, water and steam utilities in a new power utilities radio service, a subdivision of the FCC's industrial radio service.

Power utilities radio is assigned 42 frequencies for exclusive operation in three important bands. These include 11 exclusive frequencies in the 30 to 44-mc band, 22 in the 44 to 50-mc (former television channel No. 1) band, and nine in the 152 to 162-mc band. In addition, the service will share the 2292-kc frequency with other industrial services; 4637.5 kc in daytime only; and 35.06, 35.10, 35.14 and 35.18 mc. The latter four frequencies are to be shared with the maritime mobile service, on a basis of no interference with the latter service.

For developmental use only, power utility radio will share 20 frequencies in the 456 to 458-mc bands, and may share 2450 to 2500 mc, 3500 to 3700 mc, 6425 to 6575 mc and 11700–12200 mc channels. Fixed stations in the power utility classification also may share the frequencies from 72.02 to 74.18 mc and 75.42 to 75.98 mc, provided they do not interfere with television on channels 4 and 5.

Present licensees in the power utility and petroleum pipeline service may continue operations until their licenses expire, or until they request a modification. Their licenses then will be reclassified. Holders of Class 2 experimental service licenses must apply for their new classification no later than 60 days before their licenses expire, or by November 1, whichever is earlier. They may apply any time after July 1. All experimental grants in this group will expire November 1.

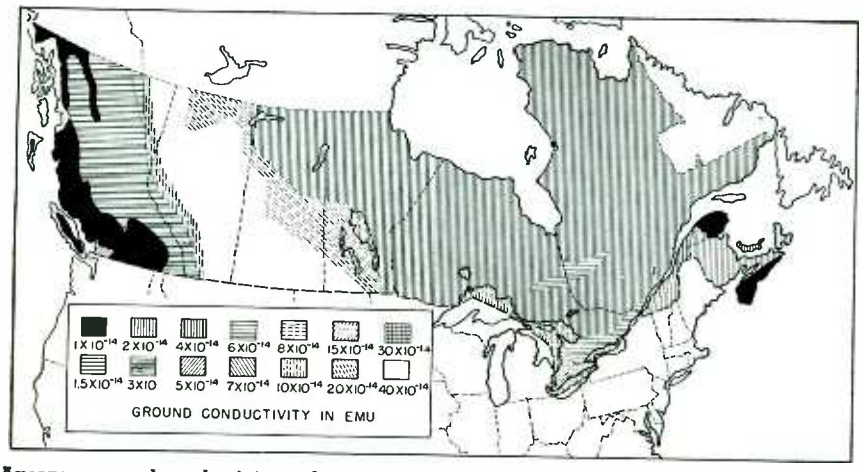
In addition to traditional electric, gas, water and steam utilities, the new power utility radio service will include cooperative organizations.

Petroleum pipeline radio service remains in the General Utility category under FCC's new rules. Transit utilities using short-wave communications were assigned frequencies in the Land Transportation Radio Service.

Ground Conductivity in Canada

THE ACCOMPANYING map showing ground conductivity in Canada is scheduled for inclusion by the FCC in their Standards of Good Engineering Practice Concerning Standard Broadcast Stations. The new map, prepared by the Canadian Department of Transport, is based on measured values contained in proofs of performance submitted by Canadian broadcast stations, on measurements made by CBC, and on orographical features and geographical formations.

The map represents mean values over large areas, and therefore cannot be used in making assumptions on conductivity in local areas. Where there are differences in conductivity on either side of the Canadian-U. S. border that cannot be explained by geophysical cleavages, the FCC proposes to treat such variations as real pending adjustment in U. S. and Canadian maps for such inconsistencies.



Average ground conductivity values in various sections of Canada. Conductivity in the prairie section is high, with local patches such as the Regina area going as high as 73. All lake areas appear to have values around 10

Citizens Radio Station Licenses

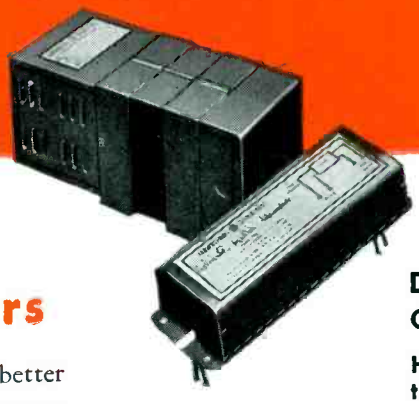
RULES for the licensing of citizens radio service stations were adopted by the FCC on March 30 and become effective June 1, 1949. After the effective date citizens radio licenses will be issued on a regular service basis, rather than under the commission's experimental rules as heretofore.

Under the new regulations licensing procedures are simplified, and persons desiring to operate type-approved transmitting equipment may apply on a single card form, soon to be available at the Commission's field offices and the Washington office. Generally, any citizen of the U.S. who is 18 years of age or older will be eligible. Licenses will be valid for a period of five years and are normally the only authorization required for operation of a station.

Possible uses of citizens radio stations are as communication on farms, such as between house and buildings or workers in remote locations, for outlying camps and work crews, and for industrial plants and construction projects. The service may also be used to communicate with vehicles within a limited area

115 VOLTS

regardless of line fluctuation



Automatic Voltage Stabilizers

Any piece of electrical equipment will operate better on steady input voltage. A quick, economical means of getting this is a General Electric Automatic Voltage Stabilizer. Small in size, it can easily be built into your equipment or apparatus to supply a constant 115 volts while line voltage varies from 95 to 130 volts.

There's no maintenance problem because these stabilizers have no moving parts—will operate continuously at open or short circuit without damage to themselves. Stabilization is virtually instantaneous (less than three cycles) and within ±1 per cent for fixed, unity-power-factor loads. Ratings from 15 va to 5000 va.

Your local G-E office will be glad to help you evaluate your problem. Or we can advise you by mail if you will give us data and a description of the circuit and load. Inquiries invited about special units. For general information, ask for Bulletin GEA-3634B. *Apparatus Department, General Electric Company, Schenectady 5, N. Y.*

DO YOU MAKE— OR USE—ANY OF THESE?

Here are just a few of the applications where you may find a G-E automatic voltage stabilizer valuable:

Radio Transmitters and radar equipment
Laboratory testing equipment and precision processes
Motion-picture projectors and sound equipment
Telephone apparatus
Precision photographic equipment and photometers
Phototube equipment
Calibration of electric devices
Color comparators
Electron-tube apparatus
Electro-chemical analysis
Rectifiers (full-wave)
Lighting circuits

GENERAL ELECTRIC

and in an emergency when wire line facilities are ineffective.

Citizens radio stations will not be permitted to charge for messages, carry broadcast material or transmit directly to the public. Stations in this service will be able to communicate with each other, but not with stations in other services or with foreign stations.

Temporary operation of a station by persons designated by the licensee is permitted, but the latter must be in control of and responsible for the station at all times. Manually operated telegraphy in the service is permitted only to the holder of a radiotelegraph license.

Two types of citizens stations may be authorized, with the distinctions based on technical and operating specifications, including input power of 10 watts for one type and 50 watts for the other. All operation will be in the 460 to 470-mc band previously allocated to this service.

MEETINGS

JUNE 20–24: AIEE Summer General Meeting, New Ocean House, Swampscott, Mass.

JUNE 27–29: Conference on Ionospheric Research, The Pennsylvania State College, State College, Pa.

JUNE 27-JULY 1: 1949 Annual Meeting of the American Society for Testing Materials, Chalfonte-Haddon Hall, Atlantic City, N. J.

AUG. 29-SEPT. 1: National Conference of Associated Police Communication Officers, Hotel New Yorker, New York City.

AUG. 30-SEPT, 1: Fifth Annual Pacific Electronic Exhibit sponsored by the WCEMA and the 1949 IRE western regional convention, Civic Center, San Francisco, Calif.

SEPT. 12–16: Instrument Society of America National Conference and Exhibit, Municipal Auditorium, St. Louis, Mo.

SEPT. 26–28: National Electronics Conference, Edgewater Beach Hotel, Chicago.

NOV. 14–18: 23rd NEMA Annual Meeting, Haddon Hall Hotel, Atlantic City, N. J.

Eight-Station Mountain Top

SOUTHERN CALIFORNIA is experiencing a television rush, as may be verified by the photograph of the summit of Mount Wilson shown on page 139, ELECTRONICS for April. From this point, an area containing over ⅓ of the entire population of California can be seen, and therefore reached by television. Transmission over a 130-mile radius is possible from Mount Wilson, allowing simultaneous transmission from Santa Barbara south to Balboa, California.

Super turnstile antenna for KECA-TV takes its place among the clouds atop Mount Wilson 6,000 feet above Southern California

At the present time, six stations are operating from this lofty spot, and two more are under construction. All of these stations are within a half mile of each other, because of the restricted area available on the top of the mountain.

One of the newest and most modern installations on the mountain is the $500,000 KECA-TV station for the American Broadcasting Company. As in all other Mount Wilson installations, quarters for the members of the transmitter staff are provided adjoining the transmitter building.

The transmitting antenna, which occupies the highest point on the mountain—6,000 feet above sea level, was built and erected by the C. D. Drauker Company of Los Angeles. For solid foundation support and added height, the tower is mounted on the station water supply tank. The super turnstile rests on top of the tower, some 303 feet above ground. The transmitting equipment for the KECA installation was especially designed by the General Electric company, with provisions for stepping up power without extensive changes. The transmitter employs low-level plate modulation and no high-level sideband filter is required.

It is expected that by the end of this year, all stations on the mountain will be in full operation, thus completing a television city—over a mile up—overlooking Southern California.

Isotope Lecture Published

THE 1948 ASTM Edgar Marburg Lecture "Isotopes and Their Application in the Field of Industrial Materials" by Paul C. Aebersold, chief of the Isotopes Division, Atomic Energy Commission, has been published in the form of a 28-page booklet.

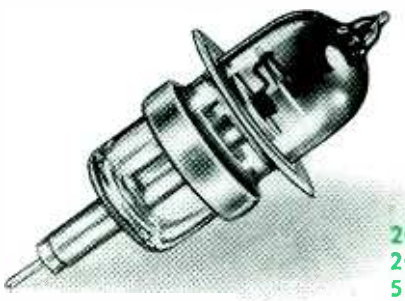
After some general comments on the significance and interrelation of atomic energy and industrial materials, the author discusses general research dividends, useful atomic power, induction of chemical and physical effects, and applications of radioactive and stable isotopes.

Copies of the booklet in heavy paper cover can be procured from ASTM headquarters, 1916 Race St., Philadelphia 3, Pa., at $1.00 each.

Military Standards Agency Reorganized

Under the terms of a charter recently signed by the assistant secretaries of the three military services, the Army-Navy Electronic Standards Agency has been reconstituted as the Armed Services Electro Standards Agency. This provides for official participation by the Air Force, which became a separate component in 1947. The

(continued on page 211)



2C36
2C37
5764
5765

5766

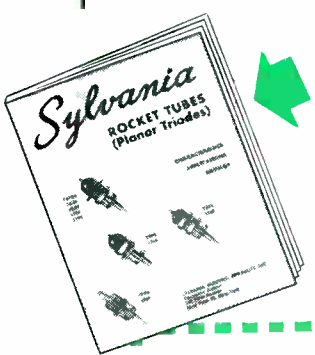
for UHF . . . Sylvania Rocket Tubes

5767

5768

Sylvania Rocket Tubes are especially designed for efficient operation at ultra-high frequencies. Whether you need amplifiers, or cw or pulsed oscillators, for operation at frequencies of 250 or 3300 mc, you'll find the types you need in Sylvania's line of Rocket Tubes.

The stretched, parallel-wire grid construction of these Sylvania tubes eliminates buckling – results in stable, uniform operation. Unique cathode design minimizes mechanical and electrical discontinuities in cathode structure. Disc-seal construction gives low inductance. Design permits continuous tuning over wide frequency ranges.



Bulletin gives characteristics, ratings and applications. Mail coupon for your copy.

SYLVANIA ELECTRIC

ELECTRONIC DEVICES; RADIO TUBES; CATHODE RAY TUBES; PHOTOLAMPS; FLUORESCENT LAMPS, FIXTURES, WIRING DEVICES, SIGN TUBING; LIGHT BULBS

Sylvania Electric Products Inc.
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Gentlemen:

Please send me your bulletin, "Sylvania Rocket Tubes." I am also interested in receiving literature on your other products in the fields of:

☐ *Communications, Television and Industrial Electronics*
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 (continued from p 118)

mary with respect to its secondary. An induction generator may be used as a speed measuring element; its output being proportional in amplitude to the speed of rotation of an aluminum or copper cup between an excited primary and the secondary winding.

A thermistor may be used as a temperature-measuring element; and a toroidal coil, which has a voltage output proportional to the current flowing through a wire which passes through the coil, may be used as a motor load-measuring element. Two typical complete control systems are described in the paragraphs below.

In pulverization, material is usually fed to the pulverizer by means of a motor-driven feed screw or vibrator. For obvious reasons, it is desirable to maintain maximum production without overloading the pulverizer.

Pulverizer Control

For this application, a toroidal coil is placed around one of the conductors to the pulverizer motor. The output of this coil is a voltage proportional to the pulverizer load. Referring to the circuit diagram, this coil is connected to the input terminals and, with the pulverizer motor drawing normal current, the sensitivity control is adjusted so that no voltage appears across the transformer secondary. As the load increases to overload, RE_1 operates initiating time delay 1. At the end of this delay, RE_3 operates. This latter relay is used to shut down the feed screw removing the feed to the pulverizer. (Time delay 1 prevents shut down from momentary, self-clearing overloads.) When the load on the pulverizer drops to a prearranged value, RE_2 operates, starting the feed. If, on the other hand the pulverizer remains overloaded even after the feed is shut down, RE_1 and RE_3 remain operated and time delay 2 is initiated. At the end of time delay 2, RE_4, which is connected to the pulverizer stop button, operates. This results in the complete shut down of the equipment.

If a variable-speed drive is connected to the feed screw, RE_3 and RE_4 may be connected to provide a floating control, using a torque motor to control the variable speed drive.

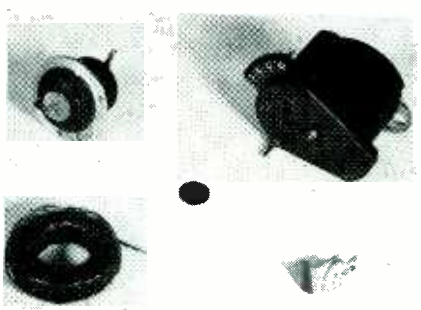


FIG. 3—Some measuring elements suitable for use with Flexi-Trol. They are toroidal coil, selsyn, induction generator and thermistor. Penny indicates relative sizes

Pressure Control

In processes where considerable lag is involved, it is possible to use the time delays to provide a small correction followed by a delay corresponding to the system lag. After this delay, a further correction is provided, if the system has not returned to the control point, followed by another delay. This is continued until the system has returned to control.

This is illustrated by pressure regulation. In this process the pressure is adjustable by regulating the flow. This flow is controlled by a motor-operated valve.

The pressure is measured by an autosyn connected to a pressure gage. The output of the autosyn is fed to the unit and the balance adjustment is rotated to give zero secondary voltage with the pressure at the control point. If the pressure increases, RE_1 operates. Referring to Fig. 4, which shows the valve motor and the relays, it will be noted that with the closure of RE_1, the valve motor is energized. The motor continues to run until the end of time delay 1 when RE_3 operates disconnecting power from the mo-

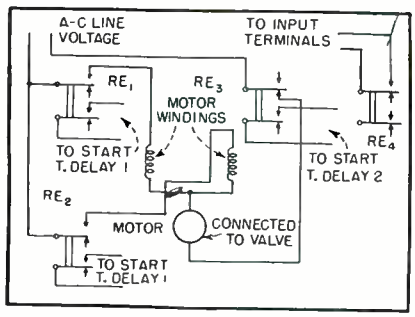


FIG. 4—Connections used for inching pressure control

tor. With operation of RE_3, time delay 2 is also initiated. At the end of time delay 2, RE_4 operates. This relay is connected to short circuit the input terminals. As RE_4 operates, the input is shorted which results in RE_1 dropping out and consequently RE_3 and then RE_4. After RE_4 has dropped out, if the pressure has not returned to the control point, the above sequence is repeated. This continues until the process has returned to the control point. For under-pressure, the operation is the same with RE_2 instead of RE_1 operating. Relay RE_2 is connected to operate the valve motor in the opposite direction and also to initiate time delay 1.

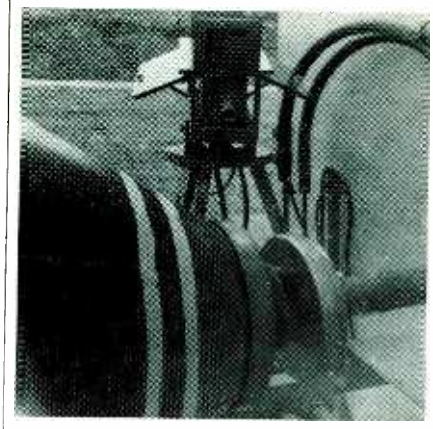
A review of the operations above will show that time delay 1 provides an inching control—in this case a motor operated valve—and time delay 2 provides a waiting period to see the effect of a correction before further corrections are undertaken. The time delays can be adjusted and range from 0.05 to 200 seconds.

Televise Dangerous Operation

ORDNANCE ENGINEERS now safely defuse, debooster, or disassemble hazardous high-explosive-filled bombs or projectiles from behind a protective barricade while keeping the operation under constant visual surveillance by means of a television viewing screen.

Personnel of the office of the Chief of Ordnance has always been confronted with the problem of how to protect individuals conducting highly technical and dangerous jobs of defusing, deboostering or disassembling explosive-filled ammunition items. All such disassemblies must be conducted with personnel behind a barricade and using tools which are manipulated from the safe side.

Early experiments involved the use of mirrors so arranged that engineers behind a barricade could observe the manipulation of the tools. These proved unsatisfactory because clear definition could not be maintained when personnel were removed to what was considered a safe distance from a potential ex-

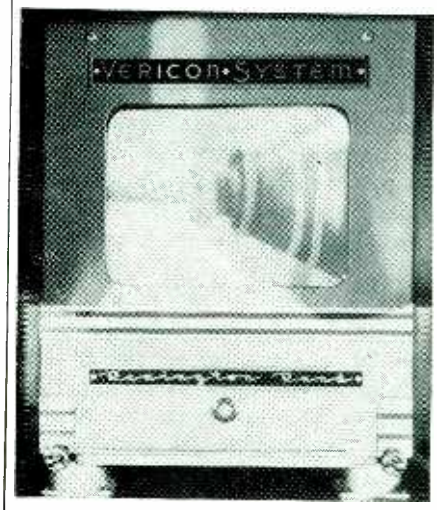


Television camera set up to view the coupling of a remotely controlled wrench to the nose of a bomb for defusing

plosion of the projectile.

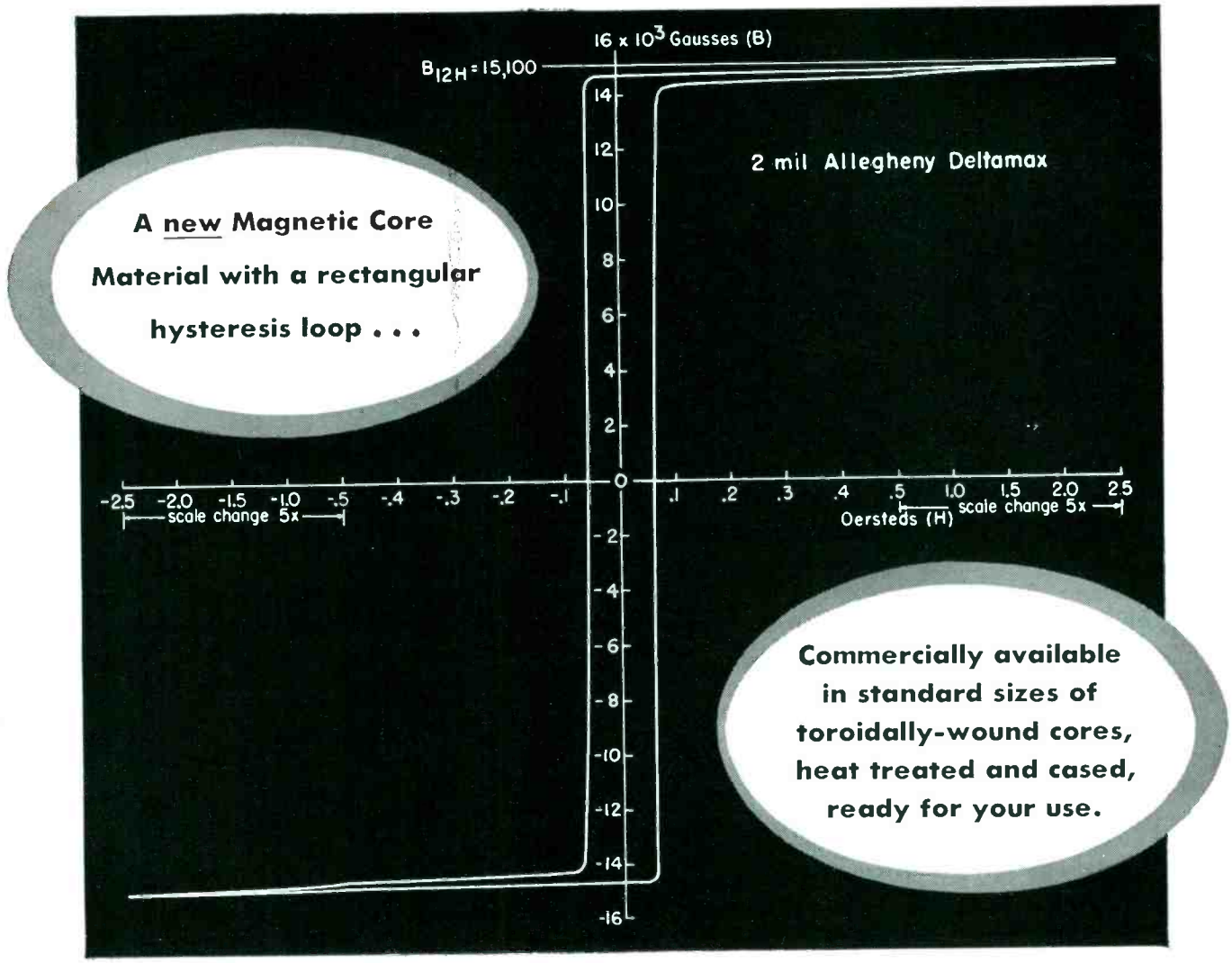
For the television method of observation, selection of the Remington Rand Vericon industrial television system was made. Construction of seven ammunition disassembly plants, using the Vericon system, has been completed and six more are under way. The system does not employ signals over the air but over a coaxial cable. The camera, receiver and power unit are all portable and require no expert or highly trained technicians to handle them. In many respects the image produced on the viewers is clearer than that of commercial television because there is no static interference in its transmission. The equipment is relatively inexpensive, both in original cost and maintenance, when compared to its commercial counterpart.

A single camera can transmit identical images to as many as ten



Safe in a protective shelter, the viewer sees this picture of the defusing operation on the screen of the c-r tube

DELTAMAX—now available!



Where can YOU use a Magnetic Material with these specialized, dependable characteristics?

The properties of Deltamax are invaluable for many electronic applications, such as new and improved types of mechanical rectifiers, magnetic amplifiers, saturable reactors, peaking transformers, etc. This new magnetic material is available now as "packaged" units (cased cores ready for winding and final assembly) distributed by the Arnold organization. Every step in manufacture has been fully developed; designers can rely on complete consistency in each standard size of core.

Deltamax is the most recent extension of the family of special, high-quality electrical materials produced by Allegheny Ludlum, steel-makers to the electrical industry. It is an orientated 50% nickel-iron alloy, characterized by a rectangular hysteresis loop with sharply defined knees, combining high saturation with low coercivity.

● *Call on us for technical data.*

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

147 EAST ONTARIO STREET, CHICAGO 11, ILLINOIS

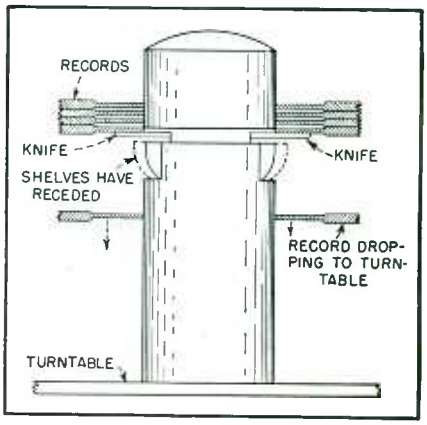
WAD 2379

different viewers located at separate points. The pulse power generator can be located as far away as 100 feet from the camera. A viewer may be extended as much as a mile away from the master viewer, and the master viewer can be set up as far as 1,000 feet from the camera.

Slow-Speed Record Changer

BASIC operating details of the RCA 45-rpm record changer are illustrated in the accompanying drawing.

When the changer mechanism is actuated, the record-supporting shelves recede into the body of the spindle and, at the same time, the separator knives slide into the space between the first and second records, thereby keeping the other records on the spindle from falling. When the record to be played has fallen clear of the support shelves, these shelves again protrude and



Eccentric-operated knife and shelf combination forms simple but speedy record-changer action on the 45-rpm unit

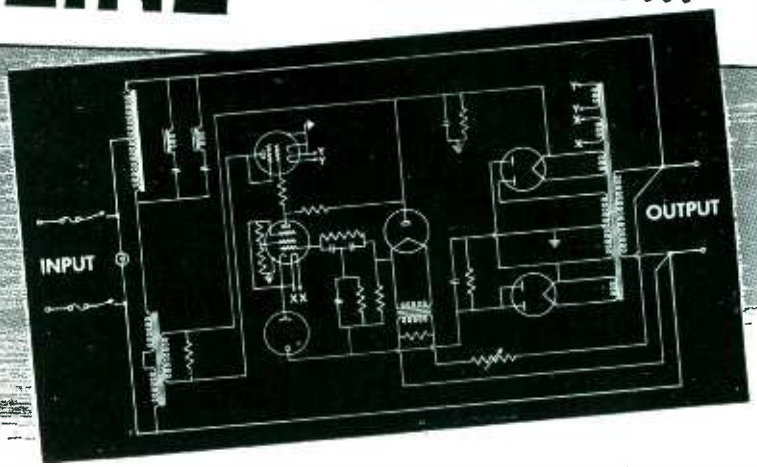
the knife separators are retracted into the spindle, allowing the remaining records to slip down onto the supporting shelves and making the unit ready for another changing operation.

Knife and shelf movement is caused by a pair of eccentrics mounted on a common shaft which runs axially through the changer spindle. This shaft is rotated at turntable speed by a small projection which mechanically couples the shaft to the turntable for one turn during the changing operation.

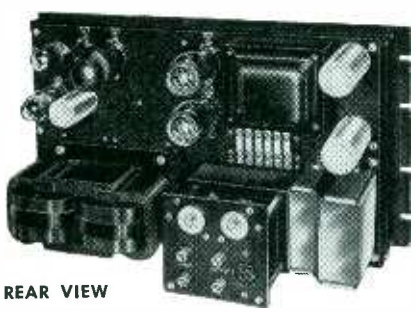
The spacing between records at

IN STABILINE INSTANTANEOUS ELECTRONIC VOLTAGE REGULATORS...

IT'S THE *ATTENTION TO DETAIL* THAT COUNTS



Attention to detail, from initial development to final inspection, is the "plus value" built into *every* STABILINE Type IE (Instantaneous Electronic) Automatic Voltage Regulator. It's your guarantee of superior performance and rugged construction. Compare these STABILINES with other voltage regulators. Your inspection will prove to you that every component of the STABILINE has been carefully selected and competently processed — from the iron core components to the black wrinkle-finished cabinet. A rigid performance test will prove that only the latest developments in circuit design — plus up-to-the-minute electronic theory and practice — have been incorporated. After a comparison we think you'll agree . . . *attention to detail counts.*



REAR VIEW

TYPE IE51005

Compact, well-organized construction — plus skillful manufacturing procedure — gives long, maintenance-free service. Superior workmanship means superior performance.

STABILINE VOLTAGE REGULATOR TYPE IE

RATINGS

Type	Input Voltage Range	Output Voltage Range	Frequency in Cycles	Load Range in Amperes	Load Power Factor Range	Rated Output KVA
IE51002	95-135	110-120	60 ± 10%	0-2.1	+ .5 to − .9	.25
IE51005	95-135	110-120	60 ± 10%	0-4.3	+ .5 to − .9	.5
IE5101	95-135	110-120	60 ± 10%	0-8.5	+ .5 to − .9	1.0
IE5105	95-135	110-120	60 ± 10%	0-43.5	+ .5 to − .9	5.0
IE5202	195-255	220-240	60 ± 10%	0-11.0	+ .5 to − .9	2.5
IEL51005	95-135	110-120	50 ± 10%	0-4.3	+ .5 to − .9	.5
IEL52005	195-255	220-240	50 ± 10%	0-2.1	+ .5 to − .9	.5
IEL5101	95-135	110-120	50 ± 10%	0-8.5	+ .5 to − .9	1.0
IEL5201	195-255	220-240	50 ± 10%	0-4.3	+ .5 to − .9	1.0

THE *NEW* 250VA STABILINE TYPE IE

The new STABILINE Type IE-51002 is *portable!* It's easy to carry around the shop or laboratory. It possesses all the superior inherent characteristics found in all STABILINE IE's — self-contained in a portable 11½" x 11½" x 10¼" case.

Remember — when you have a requirement involving automatic voltage regulation — you're assured of the following characteristics only in a STABILINE Type IE and found in *every standard* STABILINE Type IE — "built-in" by SUPERIOR ELECTRIC: Completely electronic operation; waveform distortion *never* exceeds 3%; stabilization of ± 0.1 of 1% of preset value; regulation of ± 0.15 of 1% for any load current change from zero to full load, or any load power factor change from 0.5 lagging to 0.9 leading.

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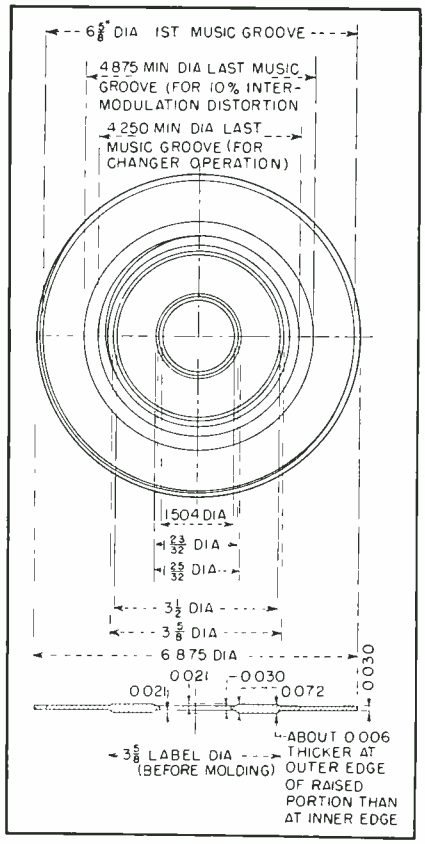
POWERSTAT VARIABLE TRANSFORMERS • VOLTBOX A-C POWER SUPPLIES • STABILINE VOLTAGE REGULATORS



Dimensions and contours of the seven-inch record

the spindle periphery is created by a thick portion of the record which also spaces the records at the grooved portion, thereby preserving the grooved surfaces.

Complete data and dimensions of the seven-inch record are shown in the second drawing.

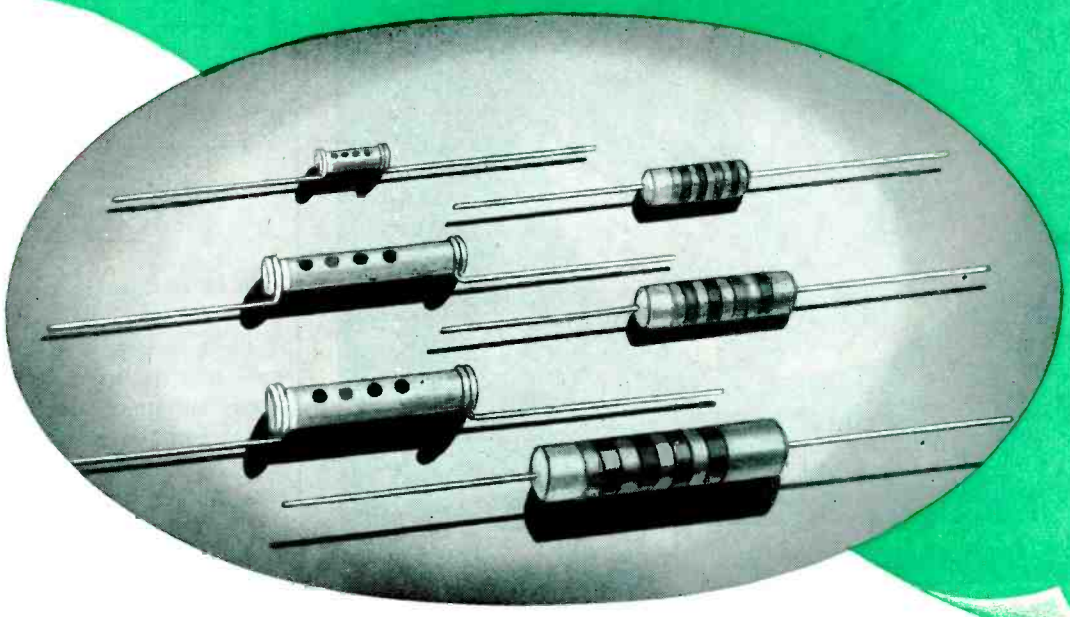
TV Matching Transformer

A SIMPLE solution to the 72-to-300 ohm matching problem, found so often in the television field, has been developed by The Workshop Associates, Inc., and is shown in the accompanying drawing. It is designed for use in the range of 50 to 225 mc, with vswr of 1.8 at 50 mc, 1.1 at 100 mc, and 1.3 at 225 mc. Voltage step-up is approximately 2 to 1.

The device consists of an r-f transformer with a specially designed Polyiron core. One end of the small aluminum container has a standard receptacle for RG-59/U 72-ohm coaxial cable, solderless connectors, and projecting out of the

Erie "GP" Ceramicons*

meet every demand for { ECONOMY and PERFORMANCE



QUANTITY production of "GP" Ceramic Condensers is achieved by limiting them to definite capacity values —with a consequent saving in cost without affecting quality. For by-passing and coupling applications which are not frequency determining, "GP" Ceramicons are unexcelled in performance.

General Purpose Ceramicons are sturdy, compact. They are easy to install in small spaces and their use increases production on the assembly line. This feature is proving especially valuable in assembling TV sets.

Erie "GP" Ceramicons are made in insulated and non-insulated styles in popular capacity values up to 10,000 MMF. Write for detailed information and samples.

*"GP" and Ceramicon are registered trade names of Erie Resistor Corporation.

Electronics Division

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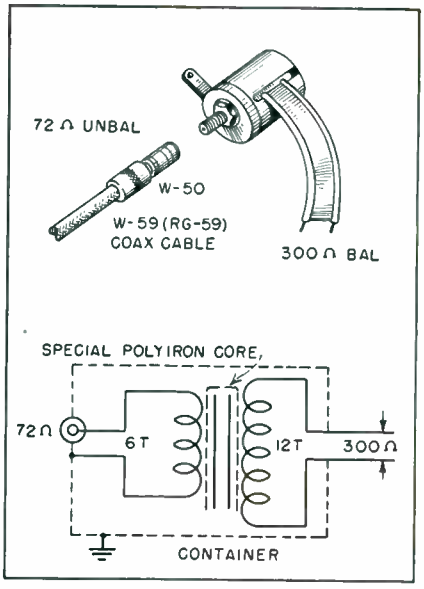
LONDON, ENGLAND **TORONTO, CANADA**



Matching transformer for television receiver antennas

side of the can is a 6-in. length of 300-ohm twin lead.

Thus receivers with 300-ohm inputs may be used with low-impedance antennas and transmission lines; and conversely, 72-ohm-input receivers may be used with balanced 300-ohm antenna equipment.

The physical shape of the device and the equivalent schematic are shown in the accompanying drawing.

High-Impedance Filament Transformers

HIGH-IMPEDANCE filament transformers are designed and manufactured to have much greater leakage inductance (or reactance) than the usual filament transformer. This type of transformer has one very useful property, it will limit the amount of current that may be drawn, particularly under short-circuit conditions.

Many transmitting tubes have filaments whose cold resistance is so low that short-circuit conditions are approached. Application of normal voltage to the cold filament would cause excessive current to flow which could damage or at least shorten tube life. The manufacturers of these tubes publish maximum values of current which should not be exceeded under any condition of operation.

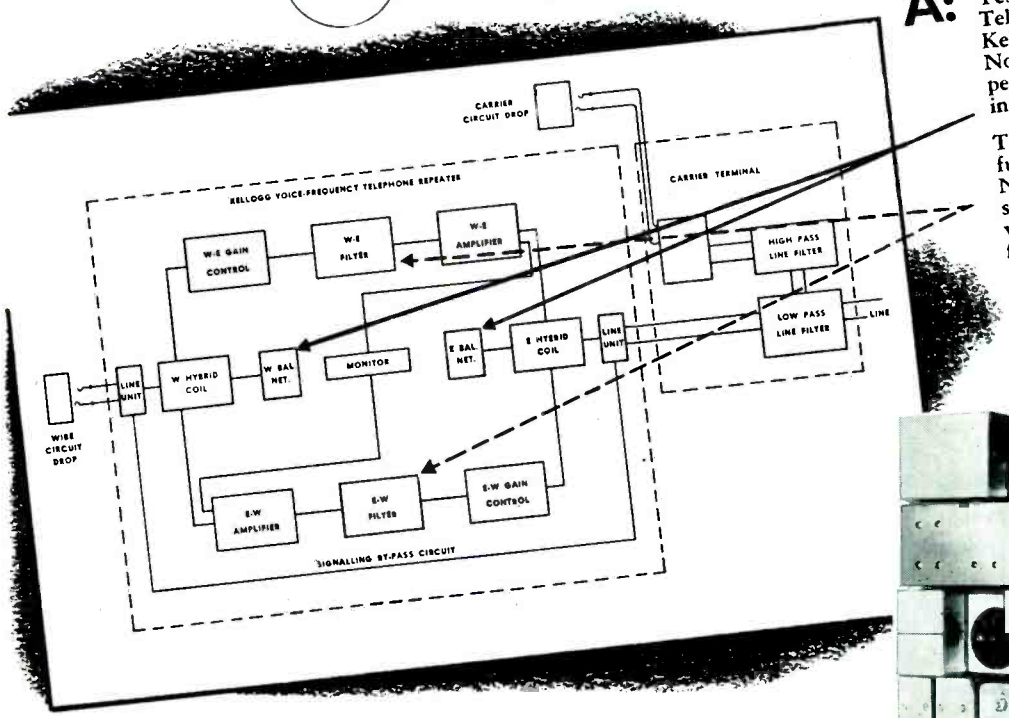
High-impedance filament trans-

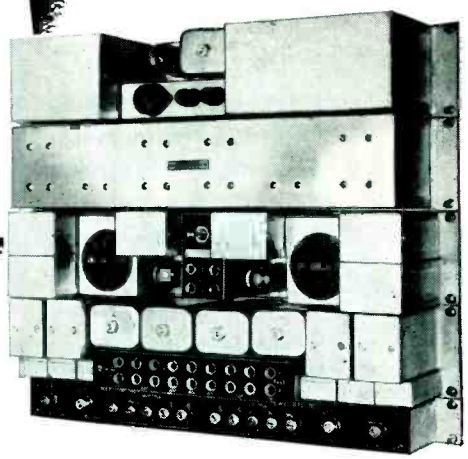
Here's a Question
—with an unexpected answer!

Q: Can a reasonable gain be realized from a telephone repeater installed on a wire line over which a carrier system is operating *without* using a special balance network?

A: Yes—if a *Kellogg* Voice Frequency Telephone Repeater is used. The Kellogg Repeater with the standard No. 1 balance network will compensate for the low-pass line filter in the carrier terminal.

This is possible because of the skillfully engineered and manufactured No. 204-2 Filter Unit, which consists of two sharp cut-off, straight-walled, 300-2700 CPS band-pass filters.





"Unit" construction facilitates adaptation to various circuit reqiurements, while a variety of line units may be obtained for different circuit or signalling functions. Kellogg Repeaters are available for operation from 24V or 48V battery or from a 105-125V 60-cy. AC power source.

By limiting the band of frequencies to be passed and amplified, the No. 204-2 Filter allows maintaining a high degree of balance with a relatively simple network. It thus permits maximum repeater gain on circuits upon which a carrier system is superimposed and on heavily-loaded cable lines. The No. 204-2 Filter also produces a quiet circuit. Its use greatly attenuates any noise voltages outside of the pass-band, eliminates carrier leak and cross-talk and 60-cy. hum induced by adjacent power lines.

Stable balance is easily obtained with maximum ease in the Kellogg Repeater with continuously variable potentiometers and a series of small capacity steps. An ordinary screwdriver quickly makes all adjustments, with no need for strapping. Gain adjustments are accurately calibrated in 1-db steps so gain is always known without necessity for measurement.

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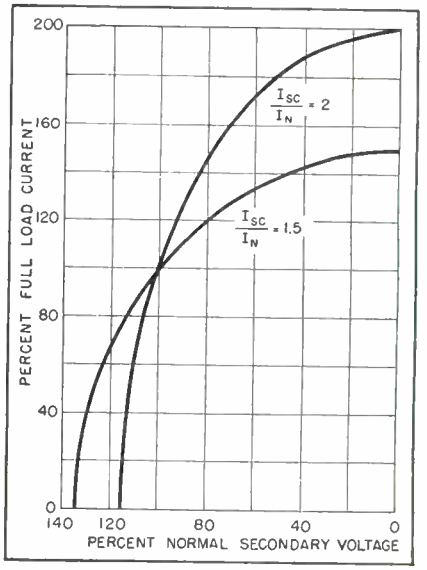
formers are designed to limit the maximum current which may be drawn by the tube to values within the recommended limits. As the filament gradually comes up to temperature, its resistance increases until proper operating values are reached. The high-impedance filament transformer, during this warm-up period, allows the applied voltage to increase, with a decrease in current, until the correct operating values are obtained.

High-impedance filament transformers are generally designed with the primary and secondary coils spaced from each other and with iron shunts across the window between the coils. The spacing between coils, plus the shunts, account for the characteristics of these



High-impedance filament transformer current-voltage characteristics for two common ratios of short-circuit current to normal load current

transformers. Such transformers are made by American Transformer Co. of Newark, N. J.

Briefly, under short-circuit conditions the flux travels through that part of the core which surrounds the primary and through the shunts, with only a small amount of flux linking the secondary turns. The small amount of flux that does link with the secondary is sufficient to cause the stated value of short-circuit current to flow. This current raises the temperature and the resistance of the filament. Due to the inherent characteristics of this type of transformer, as the load

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SPECIFICATION

Type T2

Overall Diameter	12.5/16"
Overall Depth	6⅜"
Fundamental Resonance	75 c.p.s.
Voice Coil Impedance	15 ohms at 400 cps.
Maximum Power Capacity	12 watts Peak A.C.
Total Flux	145000 Lines.
Net weight	12 lbs. 4 ozs.

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GOODMANS

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impedance increases, more flux links with the secondary, thus raising the output voltage. The output voltage continues to rise and the current reduces because of increased load impedance, until proper operating values are reached. The accompanying curves show the output characteristics for the two most common ratios of short-circuit current to normal load current, that is, 1.5 to 1 and 2 to 1. In general, the physical size of high-impedance filament transformers increases as the ratio of short-circuit current to normal load current decreases.

Notes for Remote Viewers

REPORTS from readers indicate that a number of remote television viewers have been built of the types described in ELECTRONICS for December, 1948. Most popular are the

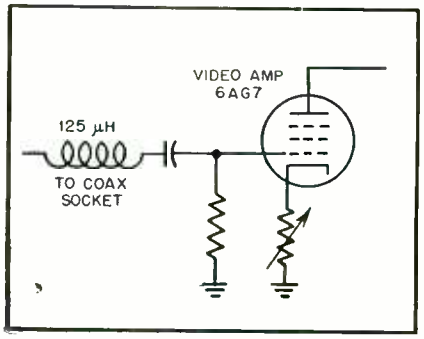


FIG. 1—When a viewer is connected to a very short cable a resistor or inductor may be needed at the input to the video amplifier to prevent oscillation

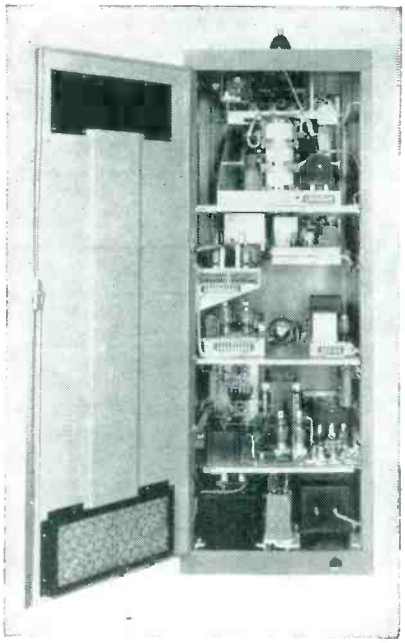
electrostatic types illustrated in Fig. 1 and 3 of that article. Further notes for the guidance of those who contemplate construction of the units for their own use are in order.

The slave viewer contains the vertical and horizontal deflection amplifiers, and these are driven by the respective oscillators at the receiver. Thus, if the receiver is turned off, the vertical and horizontal oscillators cease operating, and the slave amplifiers have no deflection-signal input. The electron beam then comes to rest at one point on the screen of the c-r tube and, if this condition should exist for a few minutes, a brown spot would probably develop on the

TRANSFORMERS AT WORK—KENYON

Airport Radio Beacon

ERCO RADIO LABORATORIES, INC., Garden City, New York. The ERCO Type 170-T



Transmitter is a versatile unit that serves as an airport radio beacon and can also be voice modulated. Indicative of the high quality of design are the 15 special KENYON Transformers used exclusively. Low hum modulation levels are assured by KENYON'S expert design of the telescopic, multi-shielded audio transformer, used in all low level stages. Ripple and regulation is always within specified limits on the power transformers and chokes. For more than 20 years KENYON Transformers have been specified by engineers for industrial, communication and electronic application. The KENYON organization is fully equipped to turn out "specials" to specification and size needs of individual jobs, at costs approaching catalog items. ERCO, too, specifies KENYON—for high quality, economy transformers.

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screen. To prevent this the slave viewers should be turned off before the master unit, or better yet, the power switch on the master viewer or receiver should open the power line to the slave units.

Some difficulty has been experienced by the author when a very short video cable has been used to connect an independent electrostatic viewer. Use of one of these as a test picture unit on a bench alongside of some experimental front-end

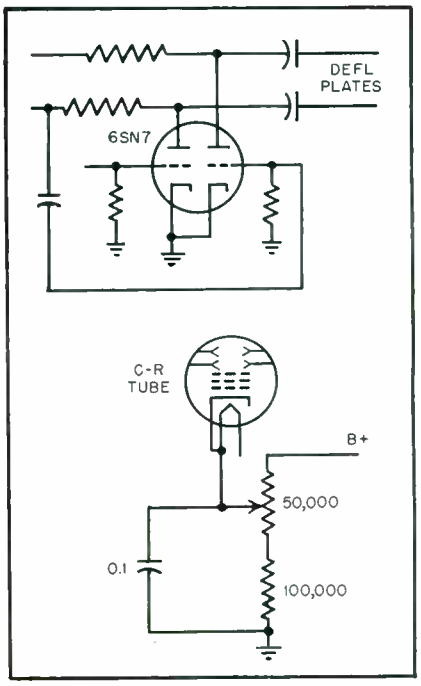


FIG. 2—Corrected circuits of the deflection amplifiers and brightness control

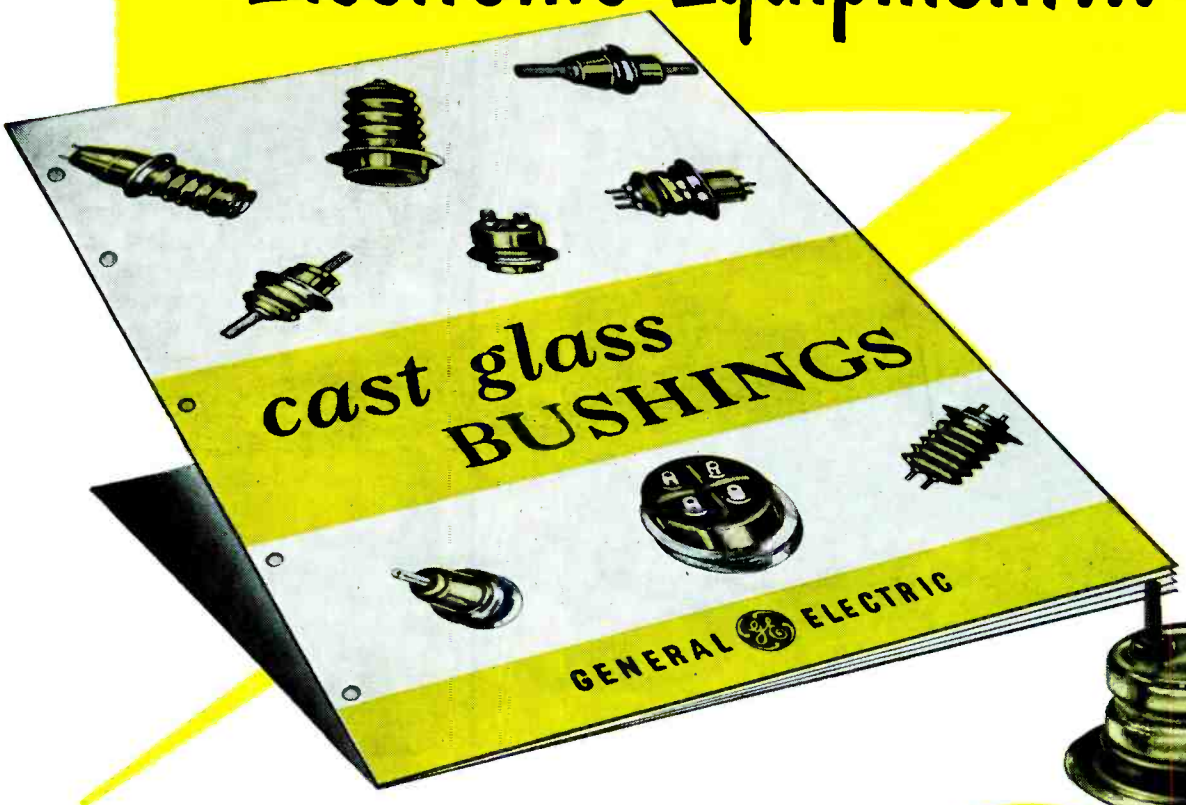
and i-f strips required only a five-foot length of cable. For the first five minutes of heating time oscillation was encountered in the video amplifier in the viewer.

Quite by accident it was discovered that the oscillation seriously interfered with a nearby receiver tuned to channel 7.

Search with a grid-dip oscillator disclosed that the plate leads of the video amplifier resonated around 175 mc and formed a high-Q circuit. Overcrowding of the deflection circuits around the video amplifier made it impractical to reroute leads quickly, so another solution was found.

Complete stability was achieved by insertion of a choke or a resistor between the coaxial input plug and the input coupling capacitor, as

If you manufacture Electronic Equipment...



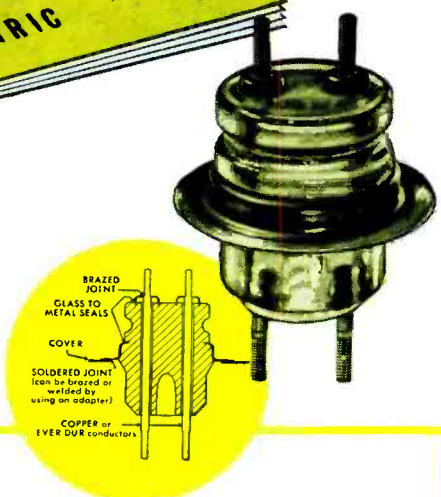
you'll want this NEW bulletin on glass bushings

General Electric is now offering to other manufacturers the cast glass bushings it has used so successfully on many types of electrical equipment.

These bushings are cast of a stable, low-expansion glass. Metal hardware is a special nickel-alloy steel, fused to the glass in casting. Bushings can be attached directly to the apparatus without gaskets—by soldering, welding or brazing.

The resulting joint between bushing and equipment is permanent, vacuum-tight, and of high mechanical strength. It is especially desirable for equipment subject to vibration, shock, attack by fungus growth or severe changes in temperature. It eliminates moisture problems and often permits more compact, light-weight design of equipment.

Our new bulletin, GEA-5093, contains a complete listing of standard designs now available—giving withstand voltages, current ratings and physical dimensions. A copy of this bulletin is yours for the asking. Just write *Apparatus Department, General Electric Company, Schenectady 5, New York.*



Glass bushings are currently available to meet dry, 60-cycle, flashover values of from 10 to 50 kv, and in current ratings of 25 and 50 amperes (large sizes up to 800 amperes). They may be single or multi-conductor and can be provided with a top flange to permit mounting tube sockets directly on the bushings. Diameters range from 1⅝ to 3⅜ inches and weight from 2½ oz. to 4 lb.

GENERAL ELECTRIC

401-57

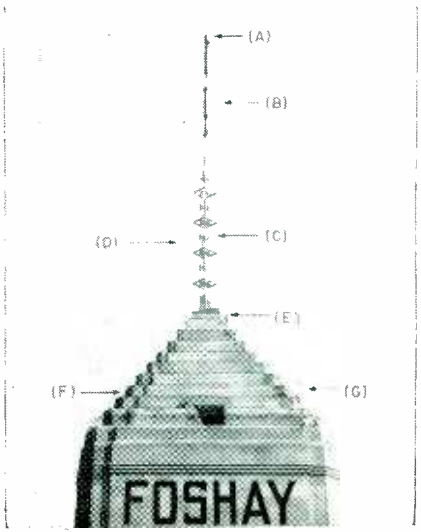
shown in Fig. 1. A resistance value from 3,000 to 20,000 ohms was satisfactory, but the inductor had the added advantage of noticeably increasing high-frequency response.

Attention must be called to drafting errors in the circuit of Fig. 3 in the original article. The plate circuits of the deflection amplifiers should be connected as shown in Fig. 2 on the preceding page. The brightness control in the cathode-ray tube circuit should connect to the B+ line and its arm should be bypassed as in the diagram.

The electromagnetic viewer (Fig. 5 of the original article) contained a 6SK7 for sync separation. With some tubes of this type sync jitter will be apparent when printed matter is received on the picture tube. Although selection of tubes may overcome the condition, substitution of a 6AC7 for this stage is an easy solution. The supply end of the 6,000-ohm plate resistor should be bypassed to ground through a 0.25-μf capacitor. If an additional tube can be tolerated, the double-triode and diode clipper circuit used in a number of conventional receivers can also be substituted for the pentode separator. Simplied versions of afc sync that have appeared recently are also adaptable.

Antennas Over Minneapolis

OVERLOOKING MINNEAPOLIS, this combination of antennas provide seven different services without



Seven different services are broadcast from this tower. See text for explanation of letters

Consider the possibilities of this combination of DU MONT CATHODE-RAY EQUIPMENT

TYPE 263-B
HIGH-VOLTAGE POWER SUPPLY

The Type 263-B High-Voltage Power Supply is designed to complement the Type 250-H Cathode-ray Oscillograph, a slightly modified version of the Type 250. This combination operates the Type 5RP-A Cathode-ray Tube in the Type 250-H instrument at accelerating potentials as high as 13,700 volts, permitting the photographic recording of writing rates as high as 40 inches per microsecond. The light output of the Type 250-H with the Type 263-B is 12 times greater than that of the Type 250 alone.

TYPE 250
CATHODE-RAY OSCILLOGRAPH

An excellent general-purpose cathode-ray oscillograph designed for observing and recording recurrent and transient phenomena. Contains both a-c and d-c amplifiers. Linear sweeps, driven and recurrent, from 1 cycle to 150 kc with automatic beam blanking on driven sweep. Deflection factor through a-c amplifier, 0.015 rms volt/in. max.; through d-c amplifier, 2 d-c volts/in. Built-in calibrator permits quantitative measurements. The high-current Type 5CP-A Cathode-ray Tube is operated at 3000 accelerating volts in this instrument to provide brilliance adequate for nearly all laboratory work.

The Types 5CP-A and 5RP-A Cathode-ray Tubes used in these instruments are manufactured by Du Mont, as are the cathode-ray tubes used in all Du Mont instruments.

TYPE 2542
PROJECTION LENS

With the addition of Type 2542 Projection Lens, the Type 250-H becomes a projection oscillograph capable of projecting its trace up to 30 feet for a picture size as large as 12 feet square. Advantages of such projections for lecture or demonstration work are readily apparent.

Lastly, the Du Mont Types 271-A and 314-A Oscillograph-record Cameras may be readily mounted on the Types 250 and 250-H for permanent recording.

DETAILED LITERATURE ON REQUEST

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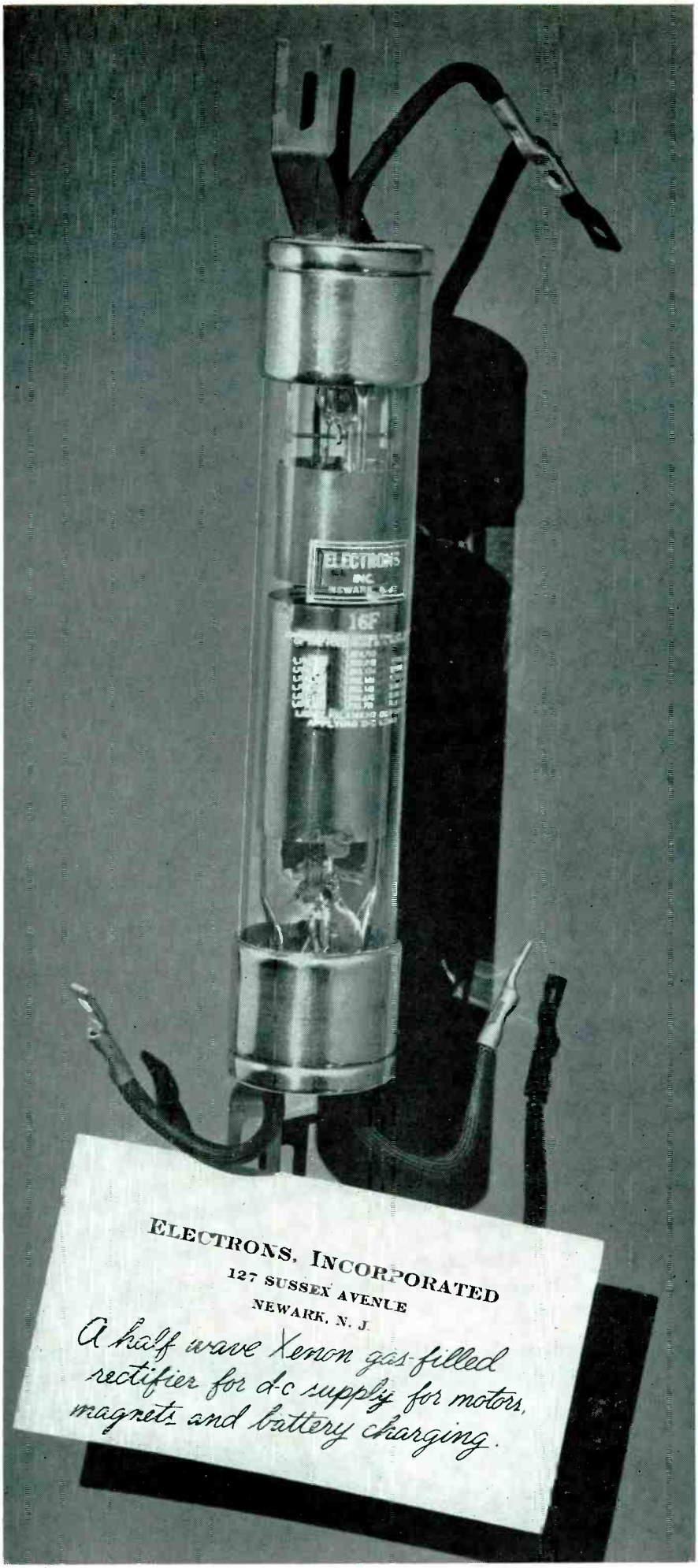


cross-interference; and according to reports on operation, each one is doing the job for which it is intended.

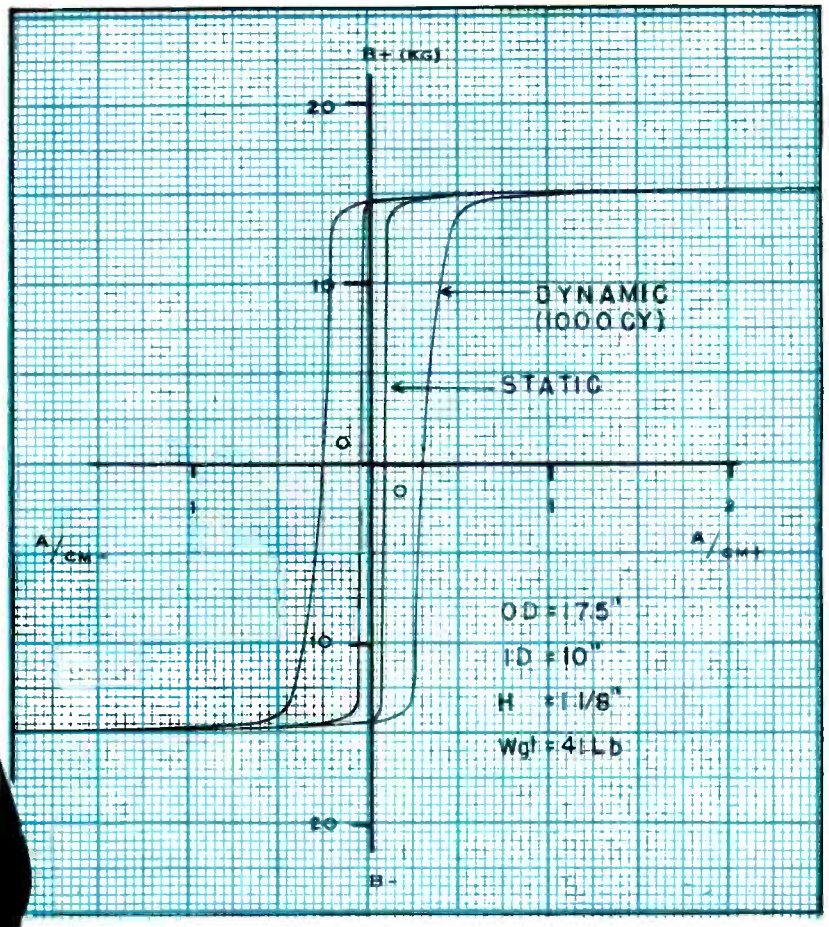
The whip mounted at the very top next to the beacon light (A) and the one mounted at the base of the super-tower (E) are used by KNGL, the Minneapolis mobile broadcasting service which operates on 153.53 mc, with 50 watts of f-m. The three-bay super turnstile transmits the video and aural signals of WTCN-TV (B), while immediately below that is the WTCN f-m transmitting antenna (C). The long-wire running diagonally from the middle of the tower to the top of the building (D) is WAFY's broadcast relay transmitting antenna which operates on 1,606, 2,022 and 2,102 kc (2,758 for talkback to KNGL mobile truck) with 50 watts a-m.

The parabola on the right-hand side of the building (G) is WXKK's television relay antenna which operates in the frequency range 6,950 to 6,975 mc—power 0.01 watt. Hidden behind the building (F) is another television relay parabola which operates under the same conditions as (G). WTCN-TV, f-m and other equipment, is located on the 28th floor of the building.

Tubes At Play

RIDERS who were unfortunate enough to take a toss at the Stow Maries (Essex) Point-to-Point Meeting (fox hunt simulation) held on Easter Monday, got first-aid and ambulance service with the utmost promptitude and despatch. Ambulance men, stationed at strategic spots around the course, were equipped with Marconi walkie-talkie sets. The St. John's Headquarters has a radio-equipped ambulance and all the St. John's personnel on duty at Stow Maries were able to keep in constant touch with the ambulance and each other.

When an accident occurred, this special radio network enabled help to be summoned immediately, thus saving precious minutes which may prove vital. The ambulance service at this meeting was probably the quickest on record.



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Get the full significance of the static and dynamic (1000 cycle) magnetization characteristics of this new alloy. Examine the dynamic curve particularly — as this indicates how the material acts under actual operating conditions.

Note these facts:

1. Magnetic saturation is achieved with only the slightest change in magnetizing current.
2. The extremely low magnetizing current makes it possible to build smaller magnetic amplifiers of extreme reliability.
3. The knees of the saturation curve are sharp, even at higher frequencies.
4. The most important fact: all Permeron cores have identical magnetization characteristics. The dynamic characteristic of each core is checked by a "Vectormeter," specially developed for this purpose. This consistency allows designers to predict amplifier performance accurately and positively.

Permeron Cores are available now

in widths of 20 mm. and 30 mm., in any specified inside and outside diameters. Cores are delivered heat treated and insulated. They are always furnished in housings designed to protect the magnetic material against deformation.

Take Another Look at Permeron — and continue to look to I-T-E to bring you better equipment and better designs . . . *first!*

* Formerly known as "Permanite"

For Additional Information write — I-T-E Rectifier Division or consult your local I-T-E Representative

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(continued from p. 122)

in oscillators and tuned circuits are readily applicable to receiver local oscillators, signal generators, and any other circuit where high-stability r-f energy is required.

Characteristics of Deltamax

By W. S. Spring
Electrical Engineer
Allegheny Ludlum Steel Corporation

To obtain optimum performance from a magnetic amplifier, the core material should saturate at as low a magnetizing force as possible to minimize control power. It should also saturate at as high an induction as possible, to reduce the size of the core since its volume will be inversely proportional to the flux density. The knees of the hysteresis loop should be as sharp as possible to develop maximum a-c voltage across the load. Since cores are generally used in matched pairs in magnetic amplifiers, it is essential that their magnetic characteristics should be as near identical as possible. In short, the core material must be consistent. The core losses must be kept at a minimum to prevent power loss and a change of output power as affected by the hysteresis loss.

A new oriented 50-50 nickel-iron magnetic core material known as Deltamax has been perfected by Allegheny Ludlum Steel Corporation to meet these stringent requirements, as evidenced by the hysteresis loop in Fig. 1. The material is being made available commercially by Arnold Engineering Company, Chicago, Illinois, in the form of toroidally wound cores suitable for applications in electronics.

Contact Converter Applications

The sharply defined knees, low coercive force, and a useful range of induction in excess of 26 kilogauses make Deltamax suitable also for choke coils of contact converters.

As a result of the development of a contact converter in Germany during World War II, a demand was created for choke cores having the magnetic characteristics described above. Because of the high range of induction required it

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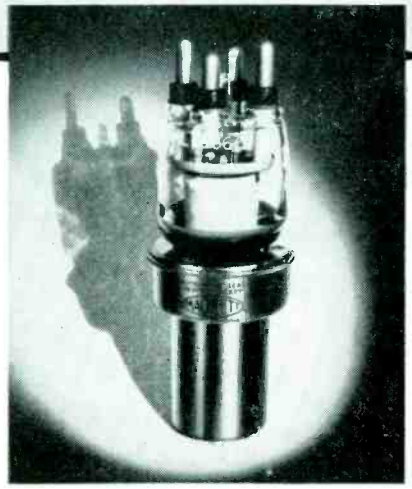
ML-5667

...gives demonstrably superior performance in 889RA sockets*



Use of the ML-5666 to replace 889A, carries the added advantage of the Machlett automatic-seal water jacket.

Government, communications, and industrial users of "889RA-type" tubes are now rapidly switching to the Machlett-developed 5667*.

If you are not already familiar with the unique qualities of this new tube, here is an opportunity to learn exactly why and how the ML-5667 ***(completely interchangeable with the 889RA)*** is convincingly superior by any standard of comparison.

GET ALL THE FACTS ABOUT THESE FEATURES:

- **Special anode construction and processing.**
- **Completely new and ruggedized structure.**
- **High R.F. conducting kovar seals.**
- **Cleaner internal parts and surfaces.**
- **Machlett high-voltage exhaust.**
- **New filament design.**

* Adopted by Military Services, U. S. Government Agencies, and other large users as the standard replacement for 889RA, the 5667 is now their preferred tube type for 889RA sockets.

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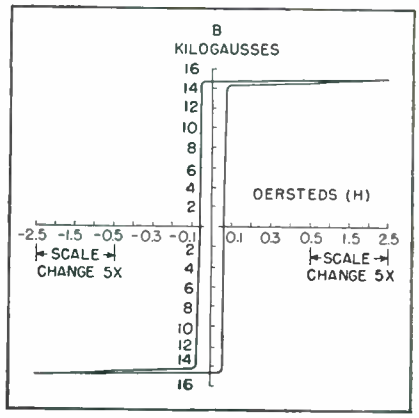

Fig. 1—Hysteresis loop of 2-mil Deltamax strip

seemed likely that an oriented nickel-iron alloy might yield the required properties because of its inherently high saturation. An alloy known as Permenorm 5000 Z was developed in Germany which had these properties. Information concerning the manufacturing process was released by the Signal Corps Engineering Laboratories in Technical Memo M1137 and by the Naval Ordnance Laboratory at its Magnetic Materials Symposium on June 15, 1948.

Manufacturing Process

The German methods were most exacting in that they required materials of extremely high purity which were subsequently melted under partial vacuum. To further reduce the impurities it was necessary to subject the material to hydrogen purifying anneals during the rolling of the material to strip. The 0.001 and 0.002-inch tape could not be slit to width in its final thickness without introducing strains which were detrimental to the required properties, hence the slitting was done at 0.014 inch and the narrow tape was then rolled to final gage.

Allegheny Ludlum undertook to develop commercial processes for producing an alloy similar to Permenorm 5000 Z. It was early recognized that there were at least two major steps in the German process which would prevent the economic manufacture of this material. These were the vacuum melting and the necessity for slitting at an intermediate thickness.

By carefully controlled practices, materials of high purity were suc-

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Zoo attendant says, "No more shocks for me now that I have my G-E Textolite feeding pole."

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For years electric eels have delighted in shocking zoo attendants. Now their game is up, thanks to the excellent electrical properties of General Electric Textolite.

● Naturally you aren't expected to believe this story about the eel. One part of it *is* true, however . . . *General Electric Textolite has excellent electrical properties.* In addition, it has outstanding mechanical, chemical, and thermal characteristics.

Why not put this valuable combination to work for you. It may help you to lick your production problems—to reduce your manufacturing costs.

Versatile G-E Textolite is produced in more than fifty grades. Each of these grades has an *individual combination* of properties. None are alike. With this wide selection to choose from you are assured of getting a non-metallic material that will do your job in the most economical and satisfactory way. Plastics Division, Chemical Department, General Electric Company, Pittsfield, Mass.

G-E TEXTOLITE LAMINATED PLASTICS IS SUPPLIED IN:


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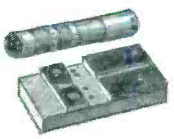

FABRICATED PARTS

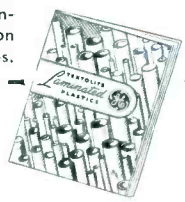

SHEETS, TUBES RODS

GENERAL ELECTRIC

CD49-J2

SEND FOR THIS HELPFUL BULLETIN TODAY— IT'S FREE

Write for your copy of "G-E Textolite Laminated Plastics." It lists grades, properties, fabricating instructions, and detailed information about Textolite industrial laminates.



General Electric Company
Chemical Department (8-6)
One Plastics Ave.,
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cessfully melted in the electric furnace. Subsequent improvement in annealing methods resulted in high retentivity, increased permeability and lower coercive force and permitted slitting in the final thickness. These characteristics as well as the squareness of the knees of the hysteresis loop can be further improved following the high temperature anneal by cooling the cores in the presence of a magnetic field.

Core Winding

An important sequence in the production of the toroids is the core winding technique itself. Each convolution must be separated from the next by means of a light coating of magnesium oxide to prevent sticking in the final anneal, which would cause a subsequent impairment of the magnetic characteristics. If the core is wound too tightly, strains may be introduced which cannot be removed by annealing. This will result in destruction of the rectangular hysteresis loop characteristics. Because of these limitations the lamination or stacking factor of these toroids is limited to a maximum of about 80 percent.

Strains introduced in the handling of the finished cores can result in impairment of the magnetic properties. It is recommended that the cores be encased in fiber or plastic before the electrical winding is applied. The void between the core and case can be filled with oil to act as a cushion in applications where the shock will be high.

Emergency Battery Chamber

By J. B. MULLEN

Application Engineering Dept.
Burgess Battery Company
Freeport, Ill.

WATER-ACTIVATED batteries are used in some signaling and emergency equipments. These silver-chloride-magnesium batteries are shipped and stored completely dry; for use they are saturated with fresh or salt water. For example, warning equipment that is powered by these batteries will produce its alarm automatically when it is flooded. The low-voltage batteries can be left in the liquid after acti-

the TRUTH about HEART TROUBLE

Why an electrocardiograph tells it

All around you, men and women are enjoying life today, who might have been cut down in the prime of life. But, thanks to the electrocardiograph, their span of life has been extended. By charting any abnormality of the heart's beat-strength or functioning, the electrocardiograph supplies the vital facts from which the physician determines whether, where or how severely the heart or heart muscles have been injured. Then he prescribes the proper treatment.

THE ELECTROCARDIOGRAPH CAN'T HAVE "HEART TROUBLE"

The heart of many of these life-savers is a Telechron Timing Motor . . . *instantly, constantly synchronous.* Only such an accurate, trouble-free motor can be trusted to time the chart that tells the truth about heart trouble.

WHAT IS YOUR TIMING PROBLEM?

If you have a variable that must be controlled or recorded with split-second fidelity, a standard Telechron Motor, correctly applied, may be all you need. Ask a Telechron Application Engineer. He can give you the benefit of the broadest experience in the industry. The earlier in your planning you call him, the better are your chances of saving time, trouble and money. In the meanwhile, fill in and mail the coupon below for complete data on Telechron Synchronous Motors. TELECHRON INC., A GENERAL ELECTRIC AFFILIATE.

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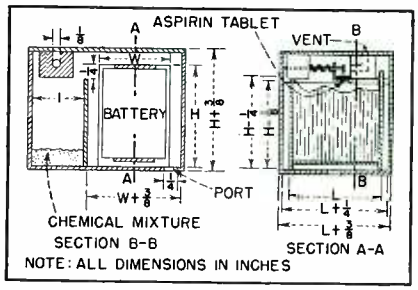

FIG. 1—Case for operating water-activated B-battery in dry atmosphere

vation, but, because of excessive leakage through the water, high-voltage batteries should be removed after 30 to 90 seconds immersion to preserve their life. A simple, reusable, two-compartment chamber, shown in Fig. 1, has been developed that provides the desirable environment for these batteries.

The chamber has vent and filling ports so that the battery compartment is flooded in 5 to 10 seconds. A filling port of ¼-inch diameter floods a 12-cubic-inch case in this time; the vent should be of about ⅛-inch diameter and approximately ½-inch long. As soon as the chamber is flooded, the water overflows into a second compartment where it reacts with an effervescent chemical mixture to generate carbon dioxide. In the meanwhile, a soluble plug dissolves, releasing a spring-loaded plunger that closes the vent. (An aspirin tablet will collapse in a few seconds after becoming immersed and so can be used for the plug.) The gas then drives the excess water out of the battery compartment through the filling port. A mixture of 3-grams sodium bicarbonate and 5-grams citric acid, which will generate over 25 cubic inches of carbon dioxide, safely clears a 12-cubic-inch case. (The mixture can be heated until the citric acid fuses and presses into a solid tablet that can be held in place

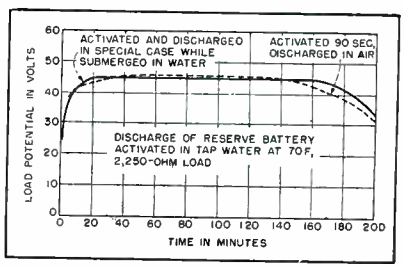

FIG. 2—Comparison of discharge of emergency battery in air and in special case

MODEL
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$24.50
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A *New* TRIPLETT POCKET-SIZE VOLT-OHM-MIL-AMMETER

with self-contained Resistance Ranges to 3 Megohms

Note the special features of this New handy-size tester

(1) RESISTANCE RANGES from 0-3000 Ohms (.5 Ohm low reading) to 3 Megohms, self-contained. Also A.C.-D.C. Volts to 5000, 10 ranges; and 3 Direct Current ranges.

(2) ENCLOSED SELECTOR SWITCH, molded construction. Keeps dirt out, and retains contact alignment permanently.

(3) UNIT CONSTRUCTION - Resistors, shunts, rectifier, batteries are housed in a molded base integral with the switch. Direct connections without cabling. No chance for shorts.

(4) RESISTORS are precision film or wire-wound types, each in its own compartment.

(5) BATTERIES EASILY REPLACED - Positive grip coil spring assures permanent contact. Makes replacement of batteries a simple procedure.

(6) STREAMLINED STYLING. Handsomely designed, pocket-size case. Only two controls, both flush with panel.

For Detailed Information
See your Radio Parts Distributor or write . . .

RANGES:

D.C. VOLTS: 0-10-50-250-1000-5000, at 1000 Ohms/Volt

A.C. VOLTS: 0-10-50-250-1000-5000, at 1000 Ohms/Volt

D.C. MILLIAMPERES: 0-10-100, at 250 Millivolts

D.C. AMPERES: 0-1, at 250 Millivolts

OHMS: 0-3000-300,000
. . . . . (20-2000 at center scale)

MEGOHMS: 0-3
. . . . . (20,000 Ohms center scale)

(Compensated Ohmmeter circuit for greatest accuracy over wide battery voltage variations.)

Precision first...to Last

TRIPLETT ELECTRICAL INSTRUMENT COMPANY • BLUFFTON, OHIO, U.S.A.
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TRIPLETT

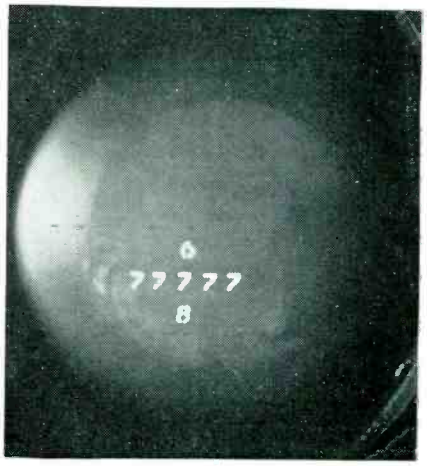
in the case of the battery.)

The battery compartment must be enough larger than the battery (or batteries) so that drops remaining on the surfaces of the battery and compartment will not touch and form leakage paths after activation. For the above sequence of events to take place, the filling port must be at the bottom of the battery compartment and the vent at the top of the chemical compartment. Figure 2 shows the discharge of a battery in such a case.

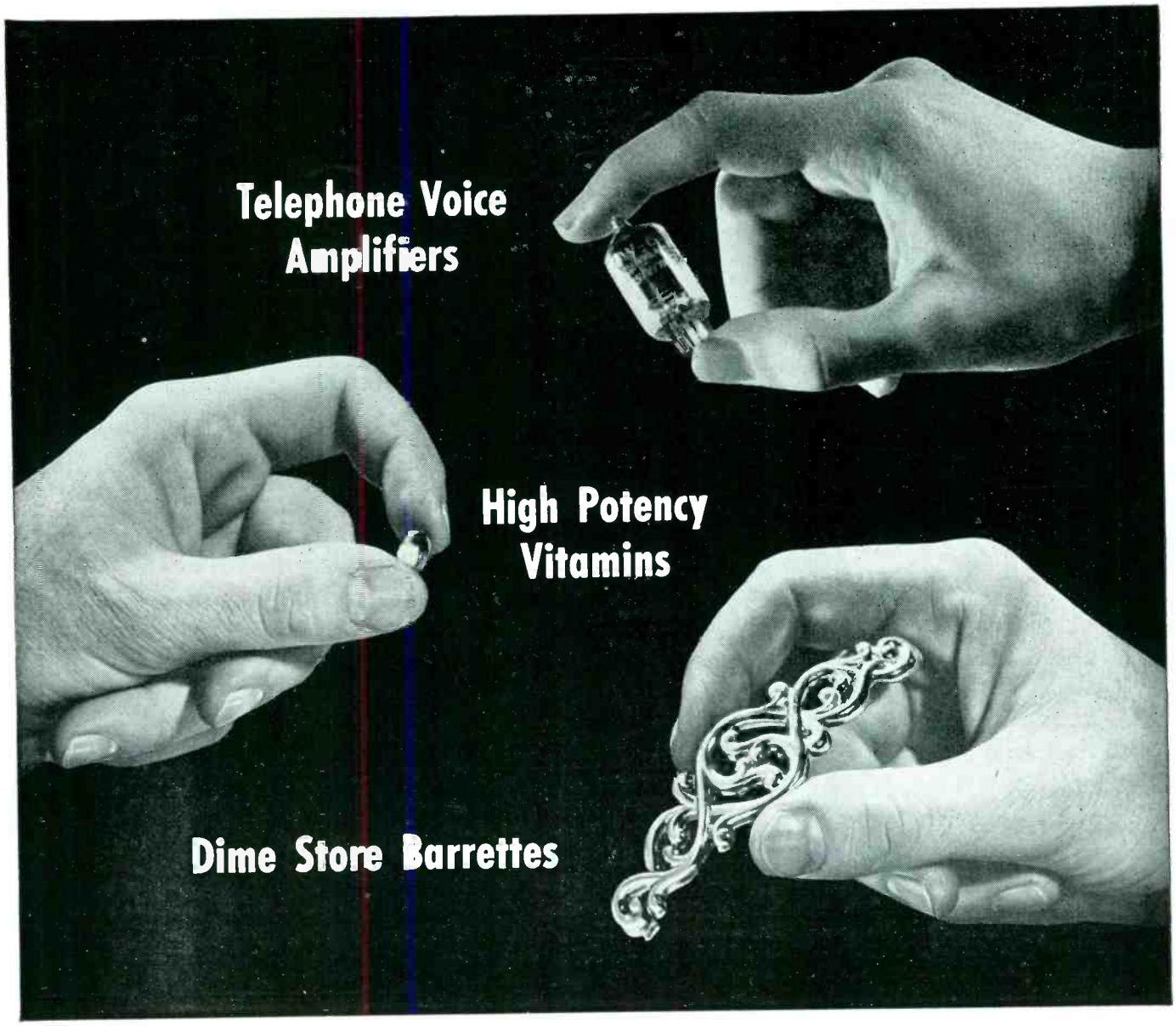
To prevent damage by premature moistening of the battery or chemical, the case should be sealed, with tape or foil over the ports, until the equipment is put into use. Silica gel can be placed in the case before it is sealed to absorb moisture that may be present.

Letter-Printing C-R Tube

BY INSERTING between screen and gun of an ordinary c-r tube a multiple deflecting electrode arrangement for passing the beam through a character-shadowing disc, any desired combination of letters and numbers can be produced on the screen at will. As indicated in the accompanying diagram, the shadowing disc has punched-out letters or numbers, each positioned behind its own set of deflecting plates. Some plates serve to route the beam through the desired hole, and others (presumbly on the other side of the disc) bend the formed beam so it



Example of numerals formed on c-r tube by passing beam in sequence through holes cut to shapes of numbers in metal shadowing disc



. . . products of High Vacuum

YOU 'phone from coast to coast and converse as easily as though you were in the same room. The reason, a tiny electronic repeater tube that prevents voice fading. It works only because a high vacuum pump has exhausted air from the glass tube to a degree that closely approaches perfect vacuum.

Important vitamins for food fortification, pharmaceuticals and doctors' prescriptions are available *at moderate cost* because of high vacuum. Distilled under high vacuum the extract is purer—can be concentrated to high potencies.

Contrasting sharply to applications in the fields of electronics and bio-chemistry is the use of high vacuum in depositing metallic vapors on glass, wood, cloth, paper and plastics. Inexpensive but beautiful novelty jewelry, ornaments, barrettes, etc., are coated inside huge chambers from which air has been exhausted . . . a plating process that gives better results, cuts costs and permits bargain prices to a mass market.

These examples serve to emphasize the scores of different ways DPI high vacuum equipment is enabling new products and better products to be made at lower costs.

Perhaps high vacuum can work for you. DPI can aid in research, in setting up pilot operations, and can advise on engineering and building complete installations for profitable commercial applications of high vacuum. We invite inquiry.

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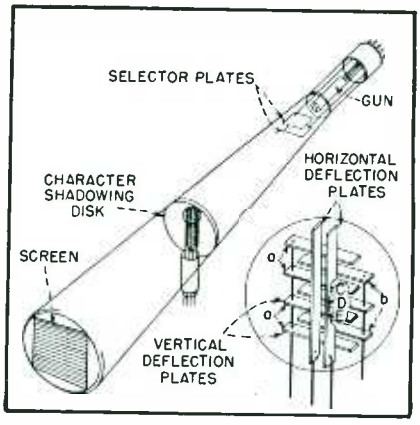
J. T. McNaney of Consolidated Vultee demonstrates his Electrontype system for producing messages or numerical results on screen of Charactron cathode-ray tube in response to coded signals applied to multiple deflecting electrodes



General details of character-forming c-r tube. Letters C, D and E are actually punched-out characters in character-shadowing disc

hits the screen at the desired spot.

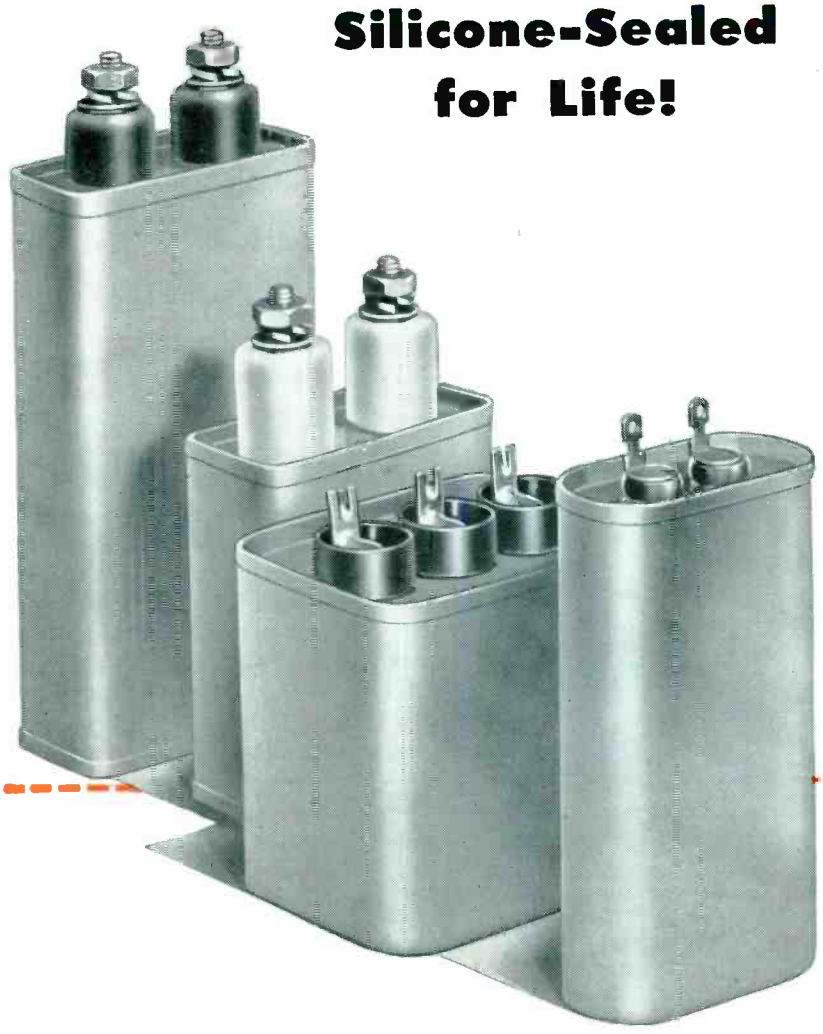
Experimental tubes already constructed in the Radio and Electrical Laboratories of Consolidated Vultee Aircraft Corp. have successfully produced a limited number of characters. On the basis of this, it is claimed that tubes can be built for use in conjunction with motion picture film to record results of electronic calculators at speeds up to 20,000 characters per second.

Improved Phase Meter

AN ELECTRONIC PHASE METER having significant advantage over previous instruments (see for example E. L. Ginzton's meter described in ELECTRONICS, p 60, May, 1942) has been developed by E. F. Florman and A. Tait of the

CAPACITORS

Silicone-Sealed for Life!



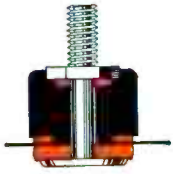
Silicone—the amazing new synthetic—made headlines when General Electric brought it out during the war. It's news again today—for G.E. has now made Silicone bushings and gaskets a *standard feature* of all its specialty capacitors up through 5000 volts.

This means that your new G-E capacitor is sealed positively, permanently—for maximum life. For Silicone seals by compression alone, without the use of contaminating adhesives. It will never shrink, loosen or pull away—it remains elastic at any operating temperature a capacitor will ever meet. Moreover, it is impervious to oils, alkalies and acids, and its dielectric strength is permanently high.

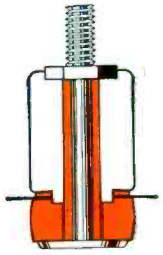
This exclusive G-E feature—with the use of highest grade materials, with strictest quality control and individual testing—make General Electric capacitors finer and more dependable than ever before. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

Silicone bushings used with capacitors 660-v a-c, or 1500-v d-c and lower.

Silicone bushings and plastic cups used with capacitors 660-v a-c, or 1500-v d-c and lower.



Silicone gaskets and plastic stand-offs used with capacitors rated 2000-v d-c and lower.



Silicone gaskets and porcelain stand-offs used with capacitors rated 2500-v to 5000-v d-c.

GENERAL ELECTRIC

Specialty Capacitors FOR

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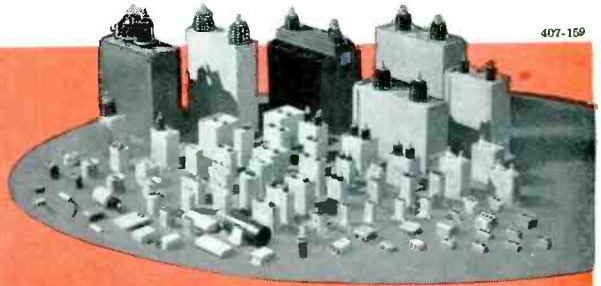
- Fluorescent lamp ballasts
- Industrial control
- Radio filters
- Radar
- Electronic equipment
- Communication systems
- Capacitor discharge welding
- Flash photography
- Stroboscopic equipment
- Television
- Dust precipitators
- Radio interference suppression
- Impulse generators

AND MANY OTHER APPLICATIONS



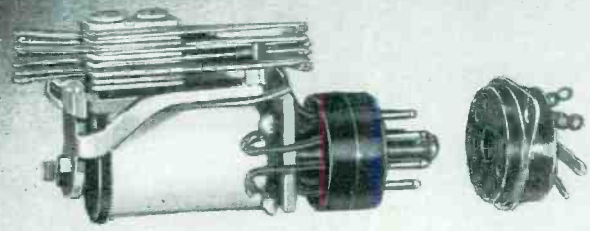
National Bureau of Standards. The chief improvement in the new instrument is an arrangement whereby the phase angle between two sinusoidal input voltages is indicated without ambiguity. Previous instruments gave indications that were ambiguous about the 180-degree value, that is, the same indication was given for a phase difference of 170 or of 190 degrees. The improved phase meter, which indicates phase differences from 0 to 360 degrees with a sensitivity of 0.5 degree, is independent of frequency and has a linear phase scale within 1 degree over the range from 100 to 5,000 cps and shows only a 1-degree phase change due to abrupt changes in amplitude of the input voltages from 1 to 20 volts.

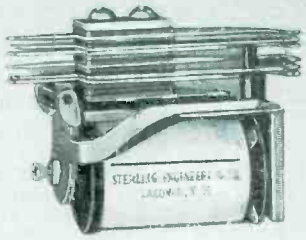
Two Methods of Indicating Phase

The accompanying diagram shows the basis of operation. The two input voltages whose phases are to be compared are converted to square waves by repeated amplification and limiting. These two square waves are then added by being applied to the grids of two tubes having a common plate resistor. The average current through this resistor is directly proportional to the phase angle between the two square waves and therefore proportional to the phase angle between the original sinusoidal input voltages. This average value is obtained by a diode rectifier, which feeds the indicating milliammeter through a balanced amplifier incorporating shunts to give several ranges centered ambiguously about 180 degrees.

A second phase measuring means is used to indicate on which side of 180 degrees the phase angle lies. For this indication, the square waves from the amplifier-limiter stages are amplified in tubes that have differentiating circuits for their plate loads. The resultant voltage spikes are applied to diode polarity discriminators which pass only the negative impulses to a flip-flop trigger circuit. A negative pulse applied to the grid of one of the pair of trigger tubes cuts that tube off, simultaneously firing the other one. When the second negative pulse arrives, it returns the trigger circuit to its

Industrial Relays by Sterling





During the past few years STERLING RELAYS have been adopted as standard equipment by hundreds of satisfied customers. These include manufacturers, military and naval services along with industrial and private laboratories.

Adaptability, convenience and dependability are some of the features which explain the general acceptance of STERLING RELAYS in industry.

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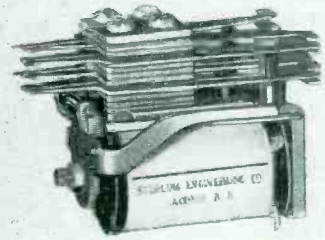
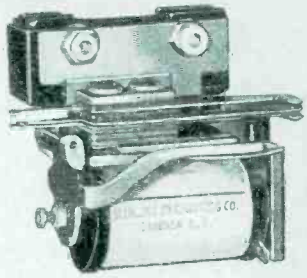
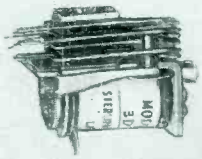


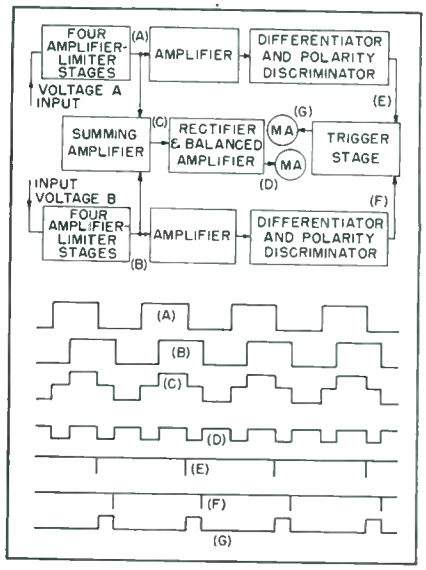


Type KS for aircraft applications



Sterling Engineering Company, Inc.

LACONIA, NEW HAMPSHIRE



Waveshapes show operation of phase meter that gives unambiguous indication

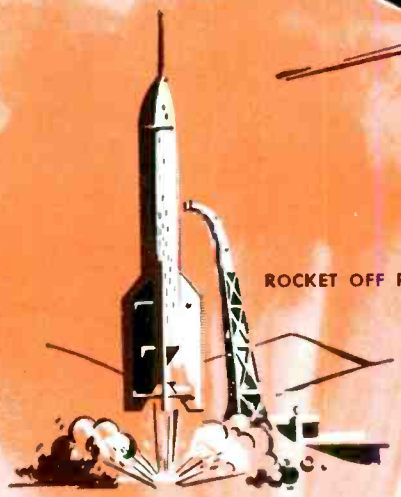
initial condition. As a result of this process, the average current in the plate circuit of the trigger tubes is proportional to the relative phase between the sinusoidal input voltages. This average current operates another milliammeter with shunts to adjust its scale. Although the indications of this circuit are unambiguous about 180 degrees, they are inherently unstable in the neighborhood of 0 and 360 degrees because the order of firing of the trigger tubes alternates irregularly.

Wide Range of Applications

This instrument has proved to be very stable over long periods. It is thus well adapted to serve as test equipment in industrial laboratories. Other possible applications include use in electronic distance measuring devices for surveying; altitude determination for aircraft; navigation systems depending on phase changes; studies of distortion in communication cables and measurement of the phase characteristics of transmission lines, filters and transformers.

At the Bureau of Standards it is being used in studies of low-frequency radio wave propagation to obtain quantitative information on the ultimately attainable accuracy of navigation systems using these frequencies. In this work, differential phase changes caused by changes in the propagating medium are studied by analysis of the relative phases of incoming waves re-

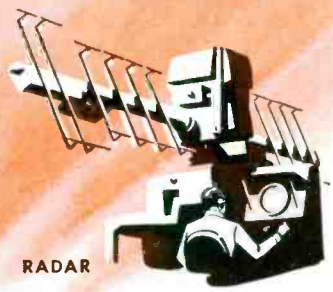
JET PLANE



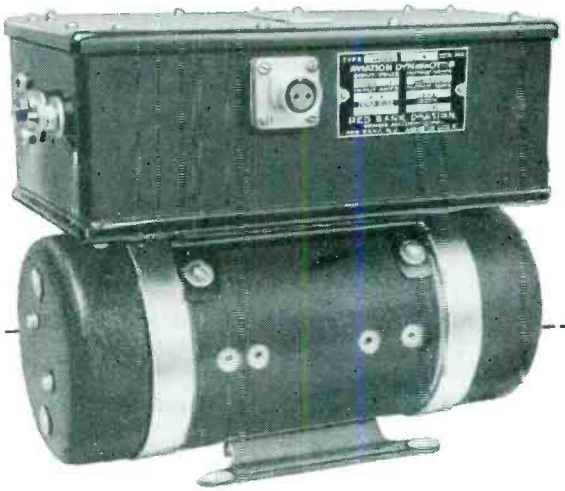
ROCKET OFF RAMP

AMPHIBIOUS TANK

EXPLOSION-PROOF, REGULATED DYNAMOTOR



RADAR



Bendix realizes that today's standards are tomorrow's discards. Our research program is designed to keep *ahead* of tomorrow's needs—to produce equipment that is *ready, when* it is needed. Typical of the results achieved by this far-sighted development work are explosion-proof dynamotors, regulated dynamotors, inverters and D.C. motors* manufactured by Bendix. In addition, Bendix research has produced rotating equipment that will withstand extreme conditions of altitude, temperature, humidity, immersion, shock, and acceleration. To those members of the electronic industry engaged in the design and development of guided missiles, telemetering apparatus, radio, radar, or other electronic devices, we suggest that you call on:

*Bendix motors meet specification ANM-40.

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- Voltage regulation
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Bendix AVIATION CORPORATION

Dynamotors • Inverters • Convertors • D. C. Motors • Carbon Pile Voltage Regulators

ceived at two separate stations. For this application a phase meter with long-period stability was needed, hence this development of the meter.

Ceramic-Wall Tubes

INVESTIGATION into the possibilities of using low-loss ceramics in place of glass for envelopes of tubes was described by Roger P. Wellinger of the University of Illinois EE Department at the 1949 IRE National Convention. The three sealing techniques investigated were sintering of metal on ceramic, compression of metal on ceramic and use of titanium hydride as a flux for hard solder. Ceramics considered thus far were magnesium silicates of either the steatite or forsterite variety.

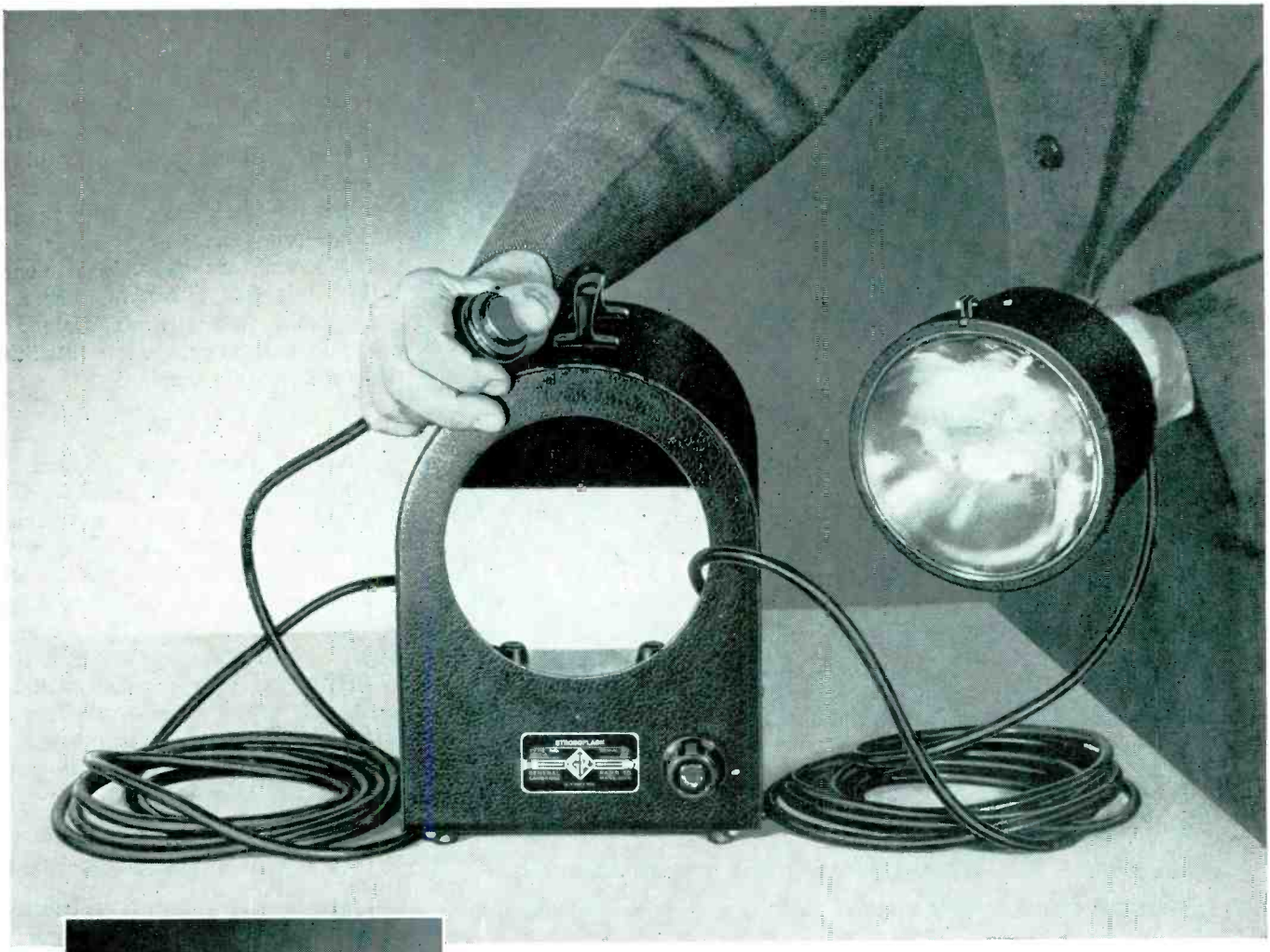
Sintered Seals

One method of metallizing ceramic parts to allow subsequent hard soldering of tube components involves painting the ceramic parts with a suspension of molybdenum powder with 1 to 3 percent iron in an organic binder and firing in tank hydrogen at 1,350 C for 20 minutes. The resulting dull-looking layer is burnished, painted with a thin layer of nickel powder, and again fired. After polishing, the metallized ceramic part is ready to be soldered to the tube parts.

Compression Seals

In directly sealing metals to ceramics by means of compression, the assembly is set in a furnace and heated to a temperature of approximately 1,000 C. The parts are then submitted to a high mechanical pressure (2,000 to 3,000 psi) to squeeze them together. The time during which pressure must be exerted varies from 2 hours for pure copper surface in vacuum or hydrogen atmosphere to 10 seconds for slightly oxidized copper surface (cuprous oxide) in pure nitrogen atmosphere. This method requires a furnace in which the atmosphere can be controlled accurately.

Plastic flow of sheet copper has been measured as a function of pressure and time. A shape factor has to be considered since the flow



The STROBOLUME normally is housed in the power-supply case, weighing, complete, 18½ pounds. The sealed-beam lamp and its case are removable from the supply assembly for use at the end of a 10-foot cable. The lamp housing is equipped with a standard tripod socket.

TYPE 1532-A STROBOLUME $225.00
TYPE 631-BS18 STROBOTAC (special, with flashing rate of 60 to 14,400 per minute) **$170.00**

Let us send full details.
WRITE FOR THE STROBOLUME BULLETIN

for *Extra HIGH* Light Intensity in *Slow-speed* Stroboscopic Applications

THE new STROBOLUME is designed to give an extra-brilliant, short-intensity stroboscopic light for observation of very slow-moving objects or machine operations . . . much slower than can be observed with our other Stroboscopes.

It is particularly suited to single- or multiple-flash stroboscopic photography, having a flash duration of approximately ten millionths of a second . . . about *one-twentieth* of that of the average commercial "speed lamp."

The STROBOLUME can be operated in several ways. It is equipped with a cord and push-button switch for firing at hand-controlled times. With an external contactor its flashing may be timed to correspond to the speed of a rotating shaft. When so used it will flash up to 1200 times per minute.

A special slow-speed STROBOTAC is available for operation with the STROBOLUME at flashes of from 60 to 1200 per minute. The STROBOTAC alone has a speed range of 60 to 14,400 per minute.

At flashing rate up to 45 per minute, the STROBOLUME may be operated continuously. At other speeds, up to its maximum of 1200, it can be operated for short periods before a built-in automatic circuit breaker calls for a brief rest period.

Many new fields for the stroboscopic study of slow moving machines are opened to research, design and production with the STROBOLUME.

GENERAL RADIO COMPANY Cambridge 39, Massachusetts

90 West St., New York 6 920 S. Michigan Ave., Chicago 5 1000 N. Seward St., Los Angeles 38

is different when the same specific pressure is applied to a solid disc or a long narrow band. The graph of this information is helpful in the design of the jig since it determines the total displacement the jig has to produce.

Disc seals are easy to realize once the equipment is set up. There is no doubt that circular seals are equally easy to realize, provided the proper jigs are employed.

Solder Seals

A seal between metal and ceramic is obtained when the ceramic part is painted with titanium hydride powder, the parts assembled with the right amount of solder and the whole assembly heated up to 1,000 C in high vacuum. The vacuum must be better than 10^{-4} mm Hg. Heating can be provided with an r-f coil, but care must be taken to avoid cracks due to uneven heating. The bond can be made with pure silver, pure copper or a silver-copper alloy.

Electrical Properties

The best location of a dielectric wall in a sealed cavity is the one at which the sum of the losses in the dielectric and those due to surface resistance of the seal interface are a minimum. Measurements of surface resistivities were confined to the region of 10,000 mc. A cavity was designed to secure the highest sensitivity. Seals encompassed both faces of the cavity. The surface resistivity was computed after the Q and the field distribution of the cavity were found.

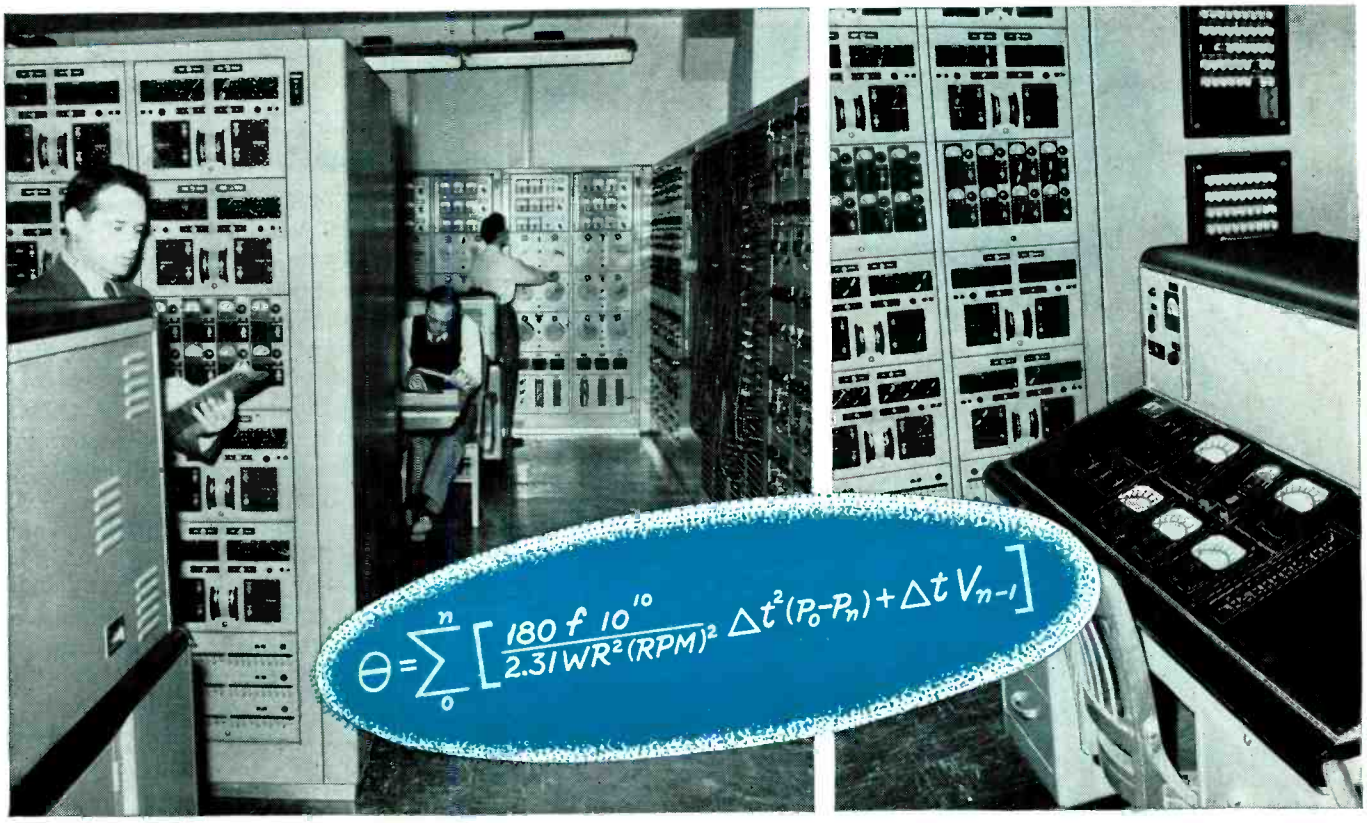
Generally, alloys have higher resistances than pure metals. The magnetic susceptibility of alloys does not follow general rules. The minimum amount of additional metals required to secure a good bond has been determined so as to be as near the ideal conditions as possible.

A very thin nickel layer, about 0.0001 inch, deposited electrolytically on the sintered moly-iron is enough to secure a good wetting action of the solder. By reducing the amount of nickel present in the seal, it is hoped to minimize the effect of its magnetic properties.

The compression type seal can be realized either with pure copper or

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

Westinghouse



WESTINGHOUSE INSTRUMENTS
Help Solve This Equation...in Minutes!

This A-C Network Calculator, at Texas A & M College, solves complex operating and design problems such as this, in a matter of minutes or hours . . . instead of weeks or months!

Precise electrical analogies required instruments built for accuracy and *complete reliability*. Westinghouse instruments more than live up to these requirements. They also provide the co-ordinated spacesaving designs so necessary to such exacting applications.

What are your electrical measuring problems? The wide scope of the Westinghouse line, and the vast experience that backs it up, provides the electrical measuring instruments to fill *your* needs exactly . . . no matter what the problem. That's why Westinghouse instruments have long been the choice of design engineers in every field of industry.

Westinghouse instrument specialists are available in the field for consultation. Call your nearest Westinghouse office or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Penna. J-40372

Westinghouse

Electrical Measuring Instruments

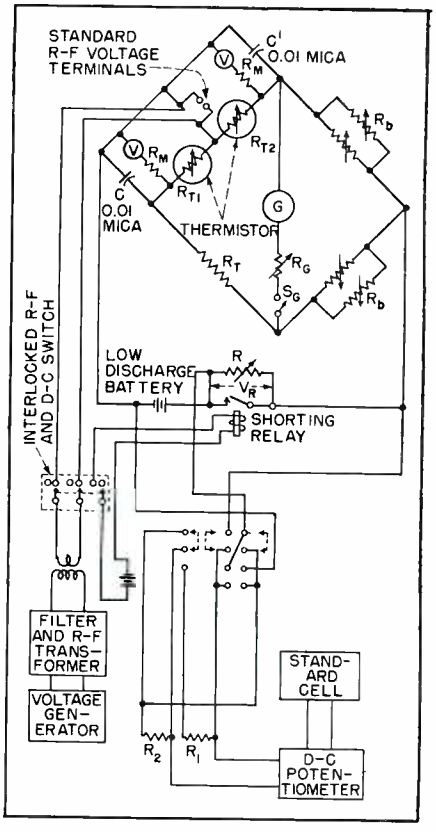
for Every Application

pure silver; no problems arise here. The minimum amount of titanium in the silver necessary to secure a good bond is about 2 percent by weight. The titanium seems to activate the migration of the silver through the surface layers of the ceramic.

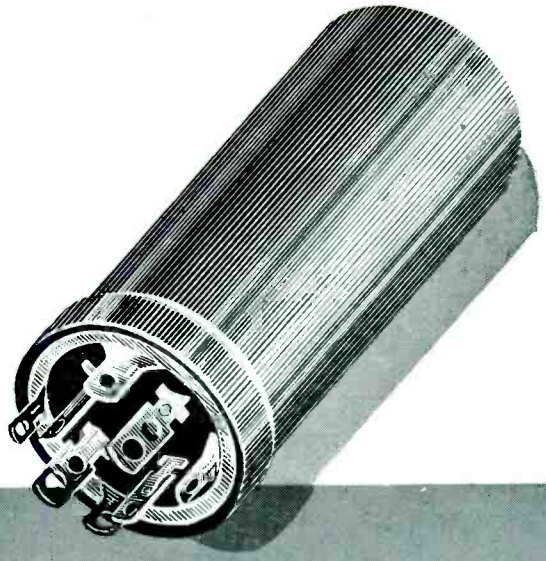
Primary R-F Voltage Standard

WORK in developing primary standards of voltage for radio frequencies up to several hundred megacycles is being done by M. C. Selby, under the direction of W. D. George of the National Bureau of Standards Central Radio Propagation Laboratory, as part of a broad program to develop national standards for electrical quantities at all radio frequencies.

The calibration of signal generators, field-intensity meters, radio receivers, and vacuum-tube voltmeters depends on the accuracy of available reference standards. A practical high-frequency voltage



Circuit of new bolometer bridge arrangement used in primary high-frequency voltage standard developed at National Bureau of Standards to provide accuracy comparable to that of standard d-c voltage cell



Complete line of metal-cased polarized dry electrolytic capacitors for filter and by-pass service . . . standardized into eight container sizes to simplify design and assembly problems.

For precision construction, long life and dependability — specify capacitors by Magnavox

finest for television

MAGNAVOX fabricated-plate electrolytic capacitors, designed for 85° C. operation, assure long, dependable years of corrosion-free life. These high purity anodic aluminum capacitors, with superior high-voltage surge characteristics, are compact . . . lightweight . . . economical in cost and operation. Satisfaction is guaranteed!

Pioneer-leader in the manufacturing of electrolytic capacitors, Magnavox has earned the complete confidence of America's leading engineers through years of constant research, product refinements and experience in fabricating over 30,000,000 units. When they need quality capacitors they specify Magnavox.

Write today for a free catalog and information on how Magnavox engineers will, from your specifications, design a capacitor to best meet your individual requirements. The Magnavox Company, Sales and Engineering Office, Components Division, Fort Wayne 4, Indiana.

Magnavox

has served the radio industry for over 34 years

standard must combine reliability with maximum precision and should approach as closely as possible the accuracy of the direct-current voltage standard—the standard cell. Reproducibility of results and agreement between individual primary-standard methods is required within ±1 percent, since measurements to that accuracy are considered to be of good precision in the h-f region.

One of the techniques developed by the Bureau which satisfactorily meets the basic requirements for a primary standard is the voltage-measuring bolometer bridge, utilizing the dependence of bolometer resistance on power dissipation. In this method, a d-c bridge with a bolometer in one of its legs is first balanced on d-c, r-f power is substituted for some of the d-c power and the bridge is rebalanced. The amount of r-f power equals the difference in d-c power required for balance in each case.

A type of bolometer remarkably suited to the job was fortunately available in the form of microscopically-small thermistors (0.015 inch diameter). The careful design of a special mount for a two-thermistor arrangement eliminates frequency corrections. This type of mount reduced the temperature-time lag of the thermistors and consequently reduced the time required to obtain a bridge balance. Special switching, shorting, and interlocking circuitry was developed to replace r-f power by d-c power instantaneously. This arrangement, shown in the accompanying diagram, provides for close and frequent checking of bridge balance with and without r-f, largely eliminating interference from incidental drifts of ambient temperature and d-c voltage sources. It also allows maximum precision in the measurement of very small increments of large d-c voltage values.

The thermistor bridge has been used so far in the voltage range from 20 millivolts to 1.5 volts at all frequencies from audio to 800 megacycles. The top frequency limit may be considerably higher, but this limit will not be established until other independent methods are available at the higher frequencies.

100,000,000 WATTS

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PLASTICON CAPACITOR

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PLASTICONS are preferred for Pulse Discharge Applications because:

- At all charge and discharge frequencies, losses are lower than in mica or paper capacitors.
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PLASTICON DISCHARGE CAPACITORS are used in:

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Condenser Products Company

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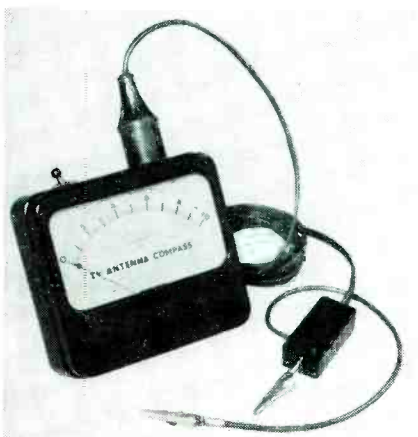
NEW PRODUCTS

(continued from p 126)

cracking plants, refineries, chemical plants and areas, and munition mills. It is incapable of igniting the gases or dust surrounding it should a breakdown in the voice-coil or field-coil occur. Units are available in both permanent magnet and electrodynamic models in sizes from 2 through 12-inch diameter, round, and also 4x6 inches and 6x9 inches oval shapes.

Tele Antenna Compass

SIMPSON ELECTRIC CO., 5200–18 W. Kinzie St., Chicago, Ill. Model 351 television antenna compass is connected by an insulation-piercing alligator clip to the video input of



the c-r tube in the receiver, and carried to the antenna site by an extension cord. With a test pattern tuned in on the area's weakest station the antenna is then rotated for maximum deflection of the compass. It also helps to peak the r-f and oscillator systems on the station itself.

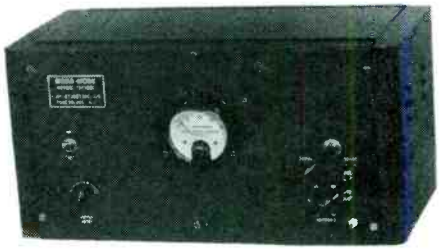
All-Record Changer

GENERAL INSTRUMENT CORP., 829 Newark Ave., Elizabeth 3, N. J. A new automatic record changer plays records of all sizes and speeds with the same pickup arm. It has a con-

KAY ELECTRIC COMPANY

FOUR NEW KAY INSTRUMENTS
INTRODUCED AT I.R.E. SHOW . . .

For High Frequency Laboratory Work and TV Receiver Development and Service.



THE MEGA-NODE (NOise dioDE) HELPS OVERCOME RF FRONT END PROBLEMS

- A Calibrated Random Noise Source
- Read the Noise Figure of Your Receiver Directly from a Panel Meter in db—
- Selection of Various Output Impedances by Panel Switch.

SPECIFICATIONS

Frequency Range: 1 to 220 mc
Output impedances: 50, 75, 150, 300 ohms and infinity unbalanced. 100, 150, 300, 600 ohms balanced selectable by panel switch.
Noise Figure Range: 0 to 17 db at 50 ohms
0 to 23 db at 300 ohms
Filament Voltage: Regulated d.c. used on filament of noise generating tube.
Power Supply: 117 Volts plus or minus 8 volts 60 cps
Dimensions: 8" x 16" x 8"

Price $295.00 F. O. B. Factory

THE MEGALYZER JR. A SENSITIVE VISUAL VOLTMETER AND SPECTRUM ANALYZER ATTACHMENT

- Used in Combination with Mega-Sweep and Standard Oscilloscope as a High Frequency Spectrum Analyzer.
- With Same Combination plus Calibrated Signal Generator, Voltage Measurements over Wide Frequency Range can be Made.

SPECIFICATIONS

Frequency Range 30 to 500 mc Useful to 1000 mc.
Frequency Sweep on Display: Up to 30 mc
Frequency Resolution: 100 KC
Sensitivity: 100 to 10,000 microvolts. Range can be extended upward by external pads.

Price $250.00 F. O. B. Factory

THE MEGALIGNER PROVIDES TUNABLE C W TYPE "BIRDIE" MARKER OR TUNABLE PIP MARKER

- A Television Marker Generator
- Covers All Present and Proposed Television IF Frequency Bands
- Pip Type Marker Does Not Go Through Receiver. Does Not Overload Receiver in Pass Band Nor Disappear in Traps.
- Accuracy .5% of Full Scale.

SPECIFICATIONS

Frequency Range: Two Bands 19 to 30 mc; 30 to 49 mc
Marker Outputs: CW "Birdie" or "Pip" Type
Power Supply: Self Contained
Amplitude Control: Both Outputs Adjustable by Panel Controls
Accuracy: .5% Full Scale
Mixing System: Self Contained Mixer System for Use with Sweeping Oscillator to Obtain "Pip"

Price $150.00 F. O. B. Factory

THE MICROWAVE-MEGA-MATCH DISPLAYS REFLECTED ENERGY IN X-BAND

- Displays Amount of Reflected Energy Over a Wide Frequency Range
- Sweep Frequency Width on Display up to at least 30 mc
- Rapid Adjustment of Microwave Antennas and Matching Sections is possible.
- Indications of Reflection Coefficient Change Down to .02.
- Approximately 75 feet 1" x ½" Waveguide Occupying Space 8 feet by 1 foot by 17 inches Supplied as Delay Waveguide.

SPECIFICATIONS

Frequency Range: 8500 to 9700 mc (X-Band)
Frequency Sweep on Display: Up to at least 30 mc
Frequency Measurement: Calibrated Microwave Wave meter
Sensitivity: Reflection Coefficient Changes Indicated Down to .02.
Equipment Includes Power Supply and Control Box, Approximately 75 Ft. 1" x ½" Delay Waveguide in 8' by 1' by 17" space

Price $895.00 F. O. B. Factory

FOR FURTHER DETAILS WRITE

KAY ELECTRIC CO., 25 MAPLE AVE., PINE BROOK, N. J.

Tel· Caldwell 6-4000

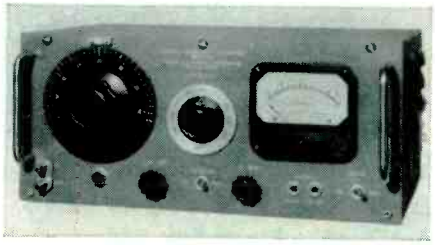
Manufacturers of: Mega-Sweep, Mega-Marker, Mega-Piper, Mega-MarkerSr., Mega-Match, Mega-Pulser, Megalyzer, Micro-Pulser, Kay Sound Spectrograph, Sonalator.

INSTRUMENTS

ventional spindle diameter and has plastic adaptor buttons for 45-rpm records. Featured is a nonpulsing velocity trip mechanism which eliminates the pulsing noise which might otherwise be reproduced in the loudspeaker.

Carrier-Frequency Voltmeter

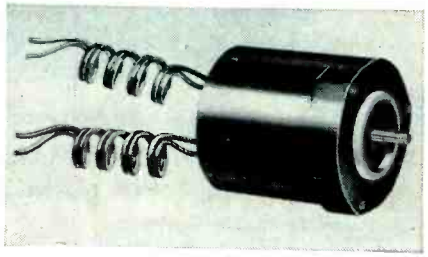
SIERRA ELECTRONIC CORP., 1211 Old Country Road, Belmont, Calif. Tunable over the carrier-frequency spectrum from 3 to 40 kc, the model



103 voltmeter measures from 77 μv to 77 volts or −80 to +40 dbm, read on a 4-inch indicating meter. A signal is 10 db down 1 kc off resonance, 21 db at 2, and 50 at 4. The unit consumes 80 va operating from 105 to 125 volts, 60 cycles, through a built-in regulated power supply.

Servo Motor

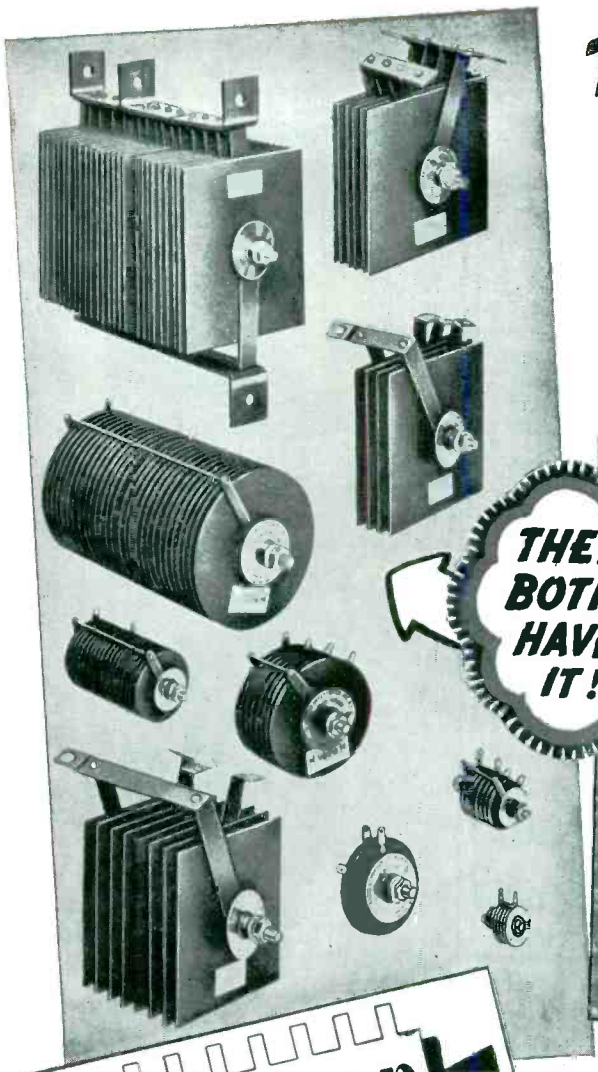
KOLLSMAN INSTRUMENT DIVISION OF SQUARE D CO., 80-08 45th Ave., Elmhurst, N. Y., has developed a 400-cycle, 115-volt, two-phase, four-



pole induction motor with a torque-to-inertia ratio of 26,300 radians per second per second. Reversal time at 11,200 rpm is 0.2 second. The unit delivers 2½ ounce-inches stall torque which varies directly with the control winding voltage.

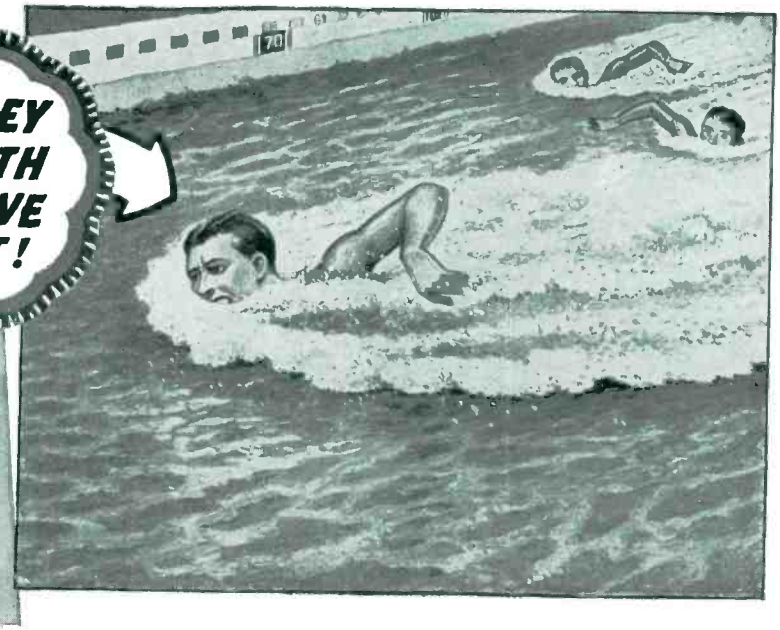
Portable Tape Recorder

RADIO CORP. OF AMERICA, Camden, N. J. Type RT-3A portable magnetic tape recorder has a frequency response of 50 to 15,000 cycles. Designed for recording programs at remote points with the same high



The "EXTRA SOMETHING" that spells TOP PERFORMANCE

THEY BOTH HAVE IT!



SLASHING his way to victory by powerful, telling strokes the swimming champion is first at the finish line by a safe margin—a winner because he has the "extra something" in skill and endurance that spells TOP PERFORMANCE.

Top performance in every rectifier application is assured to users of Seletron Selenium Rectifiers by reason of the "Extra Something" we put into them.

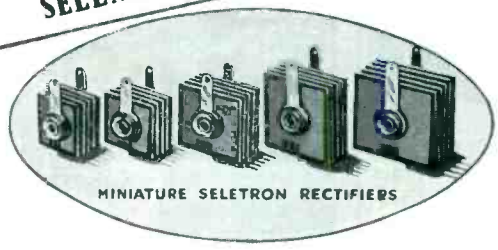
All chemicals of high purity to meet rigid special specifications.

Precision methods in all mechanical and chemical processes plus scrupulous care in assembling give them "Extra Something No. 2."

And to clinch all, every Seletron Selinium Rectifier must pass through an uncompromising series of tests and inspections, before we give it our OK for shipment to you.

Fabricated under such rigid rules, it is easy to understand why Seletron Rectifiers have won a nation-wide reputation for long dependable service in AC to DC applications of every type.

Seletron
SELENIUM RECTIFIERS



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SPECIFY "SELETRON MINIATURES"

They insure dependable service.

Code Number	5M4	5M1	5P1	5R1	5Q1	5S1
Current Rating	75 ma.	100 ma.	150 ma.	200 ma.	250 ma.	500 ma.
Plate Height	1"	1"	1 3/16"	1 1/2"	1 1/2"	2"
Plate Width	1"	1"	1 3/16"	1 1/4"	1 1/2"	2"

Furnished in a variety of assemblies to cover a wide range of currents and voltages.

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Since 1922 in Radio and Electronics
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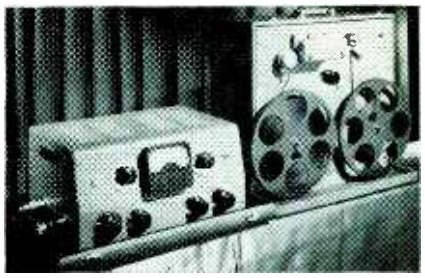


fidelity that is obtainable in the studio, it consists of two units, a tape recorder and amplifier. A synchronous motor with two windings and a speed control switch make possible instantaneous change of recording speed from 15 inches of tape per second at 15-kc response to 7½ inches per second with 7-kc response. The amplifier unit includes circuits for erase, a recording amplifier and a playback amplifier.

Spectrum Analyzer

KAY ELECTRIC CO., Pine Brook, N. J. The Megalyzer is used in combination with the Megasweep and a standard oscilloscope for

high-frequency spectrum analysis. It is used for measurement of voltages ranging from 100 to 10,000 microvolts. The range of sensitivity can be increased to include greater input voltages by attaching external pads. The instrument has a frequency range from 30 to 500 mc and a frequency sweep on display of at least 30 mc. Frequency resolution is 100 kc.

Soldering Pliers

DURST MFG. CO., 11110 Cumpston St., North Hollywood, Calif. Utility model CA-6-199 electric soldering pliers designed for wiring and soldering are especially adaptable to compact assemblies. Wires or parts to be soldered are held by the pliers, and the foot switch is depressed for an instant to heat the

contact point enough to melt the solder. The current-resistance principle heats the work instantly only at the point of contact. Pliers remain cool at all times.

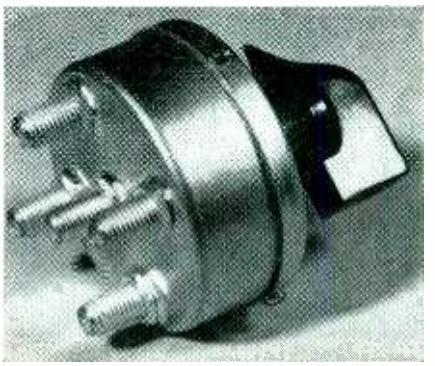
Flutter Meter

AMPLIFIER CORP. OF AMERICA, 398–25 Broadway, New York 13, N. Y. Model 491, type A, flutter, wow and drift percentage analyzer gives readings on various-speed discs, 16 and 35-mm sound film mechanisms, acetate film recorders,

magnetic wire and tape recorders and playback equipment. Built-in preamplifier and input attenuator will accept voltages ranging from 1 mv to 100 volts. The unit can also be used to test f-m distortion in loudspeakers. Net price is $495. Complete descriptive literature and technical specifications are available.

Coax Switch

THE WORKSHOP ASSOCIATES, Newton Highlands, Mass., has announced Model R-4A, a single-posi-



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In potentiometers, "Fairchild" and "Precision" are synonymous. Because in Fairchild Potentiometers, close-tolerance machining of all parts goes hand-in-hand with the careful selection of the right contact materials and the right resistance wire. This, plus painstaking assembly by skilled craftsmen and the exact adjustment of wiper arm pressure, adds up to potentiometer performance that assures sustained accuracy over a service life far exceeding the guaranteed 1,000,000 cycles of operation.

Fairchild engineers will be glad to help in the selection of both linear and non-linear potentiometers to meet your particular needs. Address: Dept. L, 88-06 Van Wyck Boulevard, Jamaica 1, New York.

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FIRST BASIC PICKUP ADVANCE in 10 years!

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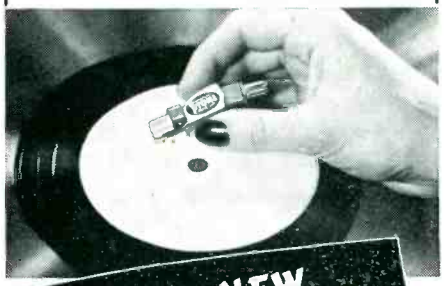

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- FIRST BASIC PICKUP ADVANCE IN 10 YEARS—the original piezoelectric ceramic pickup!
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- TRANSCRIPTION TONE QUALITY! *Full* frequency to 10,000 cycles! Bell-like supertone makes even old players thrilling!
- SURE-FIRE IN HUMID CLIMATES! Utterly unaffected by climate, moisture, fungus! Booms sales, wins back customers.
- *DOUBLES* RECORD LIFE AND PLEASURE! Gives "ordinary" records sparkling quality—revives worn favorites. Will play down to ½ normal pressure, NO "needle talk!"
- RUGGED! PERMANENT! No crystals, magnets, filaments to fail! No pre-amplifiers. Ceramic TITONE performs perfectly for years!

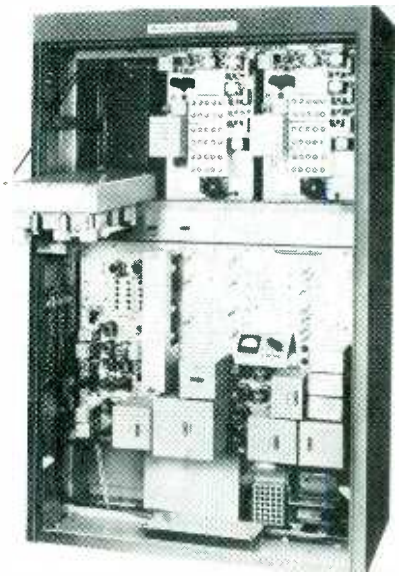
NO TONE LIKE TITONE

CALL YOUR JOBBER or write to SONOTONE
Box T-4, Elmsford, N. Y.

tion, four-throw switch designed especially for use with television transmission lines. It can also be used in r-f applications up to 350 mc and in low-level audio systems.

Marine Radiotelephone

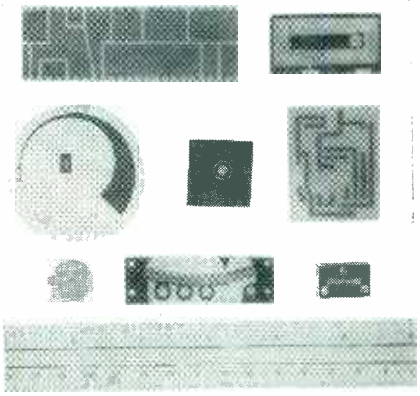
WESTERN ELECTRIC CO., INC., 195 Broadway, New York 7, N. Y. Model 248-A is a 250-watt marine radiotelephone designed to facilitate ship-to-ship and ship-to-shore communications for ocean-going



vessels. Thirty transmitting frequencies are provided, three from each of the ten marine service bands between 2,100 kc and 18,000 kc. Transmitter and receiver units pictured here are controlled from a small remote unit that can be mounted anywhere on the ship.

Printed Circuits

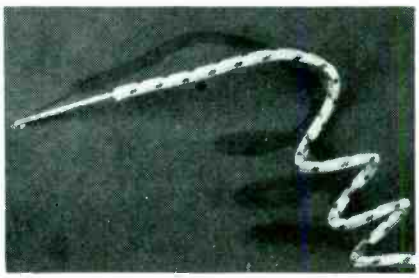
KENYON INSTRUMENT CO., 1345 New York Ave., Huntington Station, L. I., N. Y., announces three new processes for the fabrication of



electrical, electronic, and optical parts at low cost in either small or large quantities. Principal tooling up is the production of an enlarged drawing of a part which is then reduced and duplicated by essentially photographic processes. Literature is available.

Insulated Wire

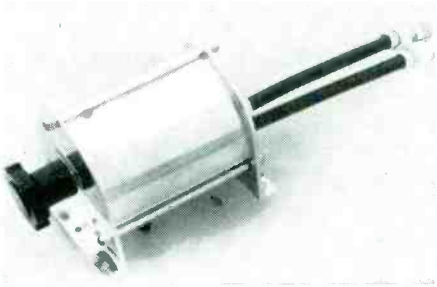
WILLIAM BRAND AND CO., 276 Fourth Ave., New York 10, N. Y. Turbotherm REL-16A insulated



wire carries 105 C rating with continuous operation for 300 and 600 volts. It comprises a vinyl dielectric with a closely braided lacquered glass jacket. Operating range is −10 to 105 C.

R-F Step Attenuator

A. F. SMUCKLER & CO., INC., 202-208 Tillary St., Brooklyn 1, N. Y. The r-f step attenuator illustrated is of the coaxial turret type and



gives 80 db of attenuation in four equal steps. Input impedance is 50 ohms resistive when terminated by a 50-ohm output resistive impedance. Error due to frequency characteristics is ±0.25 db from 0 to 600 mc.

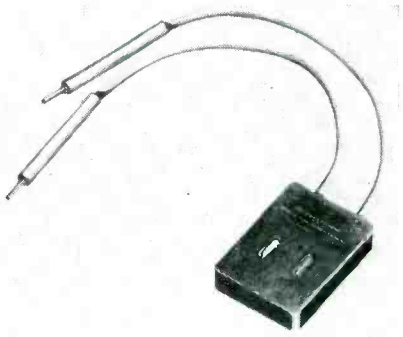
DPDT Relay

LEACH RELAY CO., 5915 Avalon Blvd., Los Angeles, Calif. The 637-57A hermetically sealed relay is provided with a standard octal plug having a metal locating pin and

glass-to-metal seal on the plug pins. Equipped with a 235-ohm continuous duty coil, the new relay is double pole, double throw having ⅜-inch contacts rated at 10 amperes resistive load.

Voltage Tester

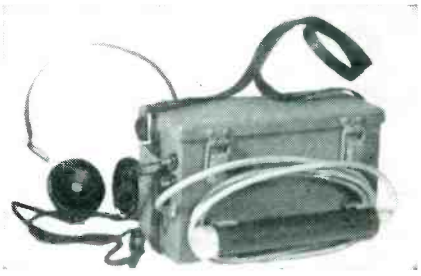
FOX VALLEY INSTRUMENT CO., Ingleside, Ill. The Polyvoltester positively identifies 110 and 220-volt lines, whether a-c or d-c, and polarity. It tests fuses, shorts and



grounds. Test leads are made of wound nichrome wire protected by two vinyl coverings. Possibility of a short circuit occurring through the tester is eliminated by the 11,000 ohms resistance in the leads.

Radioactivity Detector

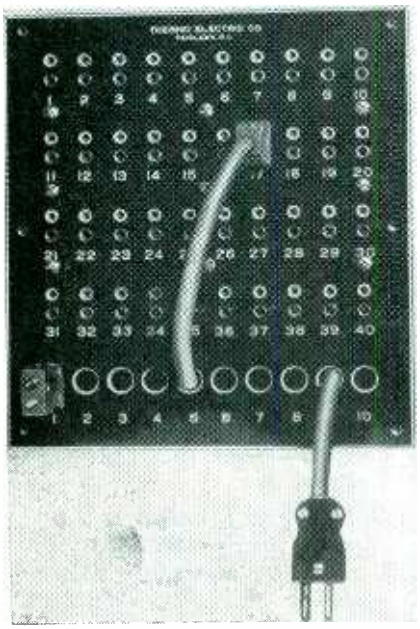
NUCLEAR DEVELOPMENT LABORATORY, P. O. Box 7601, Kansas City, Mo. Model PRD1 is a midget portable radioactivity detector for radi-



ation survey work and uranium prospecting. A waterproofed probe containing a sensitive metal-shell beta-ray Geiger counter and scaling circuit is connected to the battery box by a 5-foot flexible cable. Expected life of the counter tube is over 10^8 counts, and life of the batteries and other components is more than 10,000 hours. Maximum radiation intensity covered is limited by the scaling ratio (25 to 1) to about 5,000 counts per minute.

Thermocouple Connector Panel

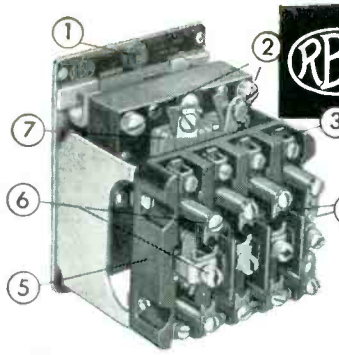
THERMO ELECTRIC CO., Fair Lawn, N. J. The panel illustrated provides a quick and flexible method for con-



necting any thermocouples of a group to any position on multiple recorders or indicating and controlling pyrometers. It is suitable for pilot plant use or for checking temperatures in many industrial heat-treating processes, aircraft engines, chemical processes, power plants and oil refineries.

Dual Recorder

RAHM INSTRUMENTS INC., 12 West Broadway, New York 7, N. Y. Model RO2B is a dual-channel direct-recording oscillograph. It will draw an instantaneous graph of any two electrical signals within its frequency range and display their wave shape, amplitude and frequency for immediate



RBM INDUSTRIAL CONTACTORS

2 TO 8 POLE
600 VOLT A. C.
10—15 AMPERE SIZES
REVERSING—NON-REVERSING TYPES
INTERCHANGEABLE CONTACTS

1. Heavy steel base.
2. Coil readily replaced by removing 2 heavy screws holding E-shaped magnet frame.
3. Accessible solderless type terminals are conveniently located. All line terminals at top; load terminals at bottom.
4. Any pole can be changed from normally open to normally closed, or vice-versa, without additional parts.
5. Melamine stationary contact block and movable contact carrier.
6. Stationary and movable contacts can be readily replaced with use of screw driver only and without removing wiring.
7. Vacuum impregnated magnet coil designed for continuous 50/60 cycle service.

For descriptive bulletin No. 600 write Dept. D-6

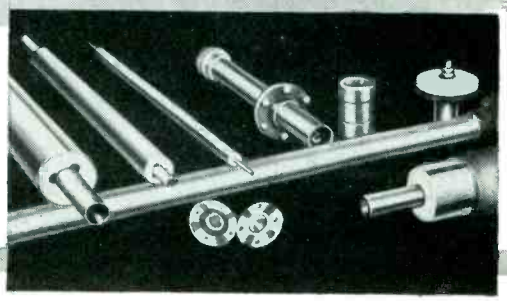
R-B-M DIV., ESSEX WIRE CORP.
LOGANSPORT, INDIANA

RBM

MANUAL AND MAGNETIC ELECTRIC CONTROLS
—FOR AUTOMOTIVE, INDUSTRIAL, COMMUNICATION AND ELECTRONIC USE

wave guide & coaxial assemblies

- RAPID INSTALLATION
- HIGH EFFICIENCY
- UNIFORM IMPEDANCE
- COMPLETE LINE OF FITTINGS



GENERAL

Transmission line in all types including standard RMA sizes for FM and TV

GENERAL CERAMICS Transmission Lines are available in sizes to meet any installation requirement. All lines are of the bead supported type, in standard lengths. Fabrication to close tolerance assures highest efficiency. Special "clover leaf" spacer beads effectively reduce capacity effects and arcing. Carefully designed end seals assure permanently gas-tight terminations. Pressurizing equipment, including gauges, valves, etc., impedance matching units, wave guide and coaxial assemblies for antennae and R.F. sections are supplied to exact requirements.

Our engineers are always pleased to check any project and furnish quotations.

General CERAMICS and STEATITE CORP.

GENERAL OFFICES and PLANT: 22 CROW'S MILL ROAD, KEASBEY, N. J.

MAKERS OF STEATITE, FERRAMIC ZIRCON PORCELAIN, LIGHT DUTY REFRACTORIES AND CHEMICAL EQUIPMENT

3½ KW VACUUM TUBE BOMBARDER or INDUCTION HEATING UNIT

Only $975

Never before a value like this 3½ KW bombarder or high frequency induction heater . . . for saving time and money in surface hardening, brazing, soldering, annealing and many other heat treating operations. Is

> Portable . . . mounted on four rubber coasters. Width 14½"; depth 27"; height 42½"; weight 300#.

Operates from 220 volt line. Complete with foot switch and one heating coil made to customer's requirements. Send samples of work wanted. We will advise time cycle required for your particular job. Cost, complete, only $975. Immediate delivery.

Scientific Electric Electronic Heaters are made in the following ranges of power: 1-2-3-5-7½-10-12½-15-18-25-40-60-80-100-250. KW.

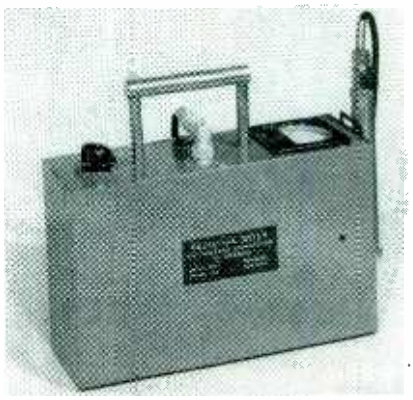
Scientific Electric

Division of
"S" CORRUGATED QUENCHED GAP CO.
105 - 119 Monroe St., Garfield, N. J.

analysis and synchronization. The unit has a 3,400-ohm impedance, center tapped. Frequency response without amplifier is flat from 0 to 70 cps; down one-half at 100 cps. Descriptive literature and price list are available.

Radiation Meter

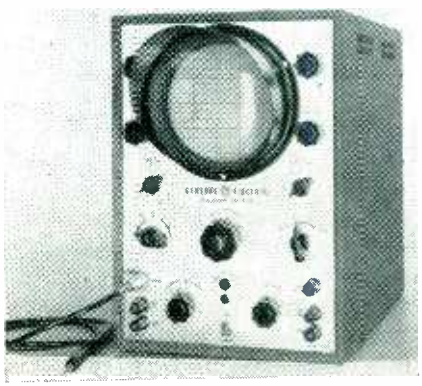
THE NUCLEONIC CORP. OF AMERICA, 497 Union St., Brooklyn 31, N. Y. Model RM-1 radiation meter features a continuously variable high-



voltage supply. A meter range covers three ranges of activity—5,000, 50,000, and 500,000 counts per minute. Meter accuracy is better than 2 percent, full scale.

Tele and Lab Scope

GENERAL ELECTRIC CO., Syracuse, N. Y. Type ST-2A five-inch oscilloscope was designed for use in tele-



vision and general laboratory applications. Straight resistive coupling is used to obtain its wide frequency response, and there is no positive slope to the frequency response curve, which falls off so gradually that the scope can be used on input frequencies up to 3 mc. The input attenuator to the vertical amplifier will attenuate voltages by as much as 1,000 to 1 without frequency discrimination. Intensity of the c-r beam can be modulated.

Multipurpose Oscillograph

PRECISION APPARATUS CO., INC., 92–27 Horace Harding Blvd., Elmhurst, L. I., N. Y. Series ES-500 is

a 5-inch high-sensitivity c-r oscillograph with extended-range, voltage-regulated amplifiers for multi-purpose a-m, f-m and television applications. It features an extended range vertical amplifier response to 1 mc, a 2-megohm approximate input resistance, a 20-μμf input capacitance and a 20-mv vertical amplifier sensitivity. Net price is $149.50.

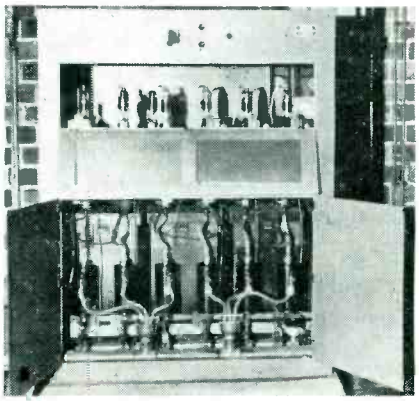
Electron Diffraction

GENERAL ELECTRIC CO., Schenectady 5, N. Y. The electron diffraction instrument illustrated uses a stream of electrons to study a layer of metal less than a quarter-millionth of an inch thick in jet engine research. Chemical changes invisible to an ordinary microscope can be detected. In operation, electrons from a tungsten filament are focused by a magnetic lens. The beam is directed to a metal surface at an angle and the tiny projections

that are characteristic of the material or its experience form the image. Alternatively, the beam can be passed through a very thin section of metal to produce an image on a fluorescent screen or a photographic film.

Automatic Speed Control

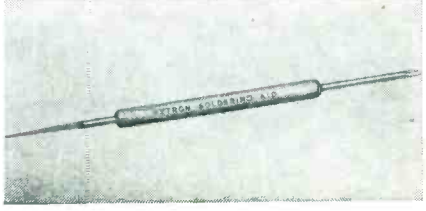
INDUSTRIAL ASSOCIATES, 8845 W. Olympic Blvd., Beverly Hills, Calif. The Varitronic drive is a new electronic automatic speed control unit for machinery prime movers. The



system uses the flexible performance characteristics of d-c motors but is operated from a-c. It embraces either constant torque or constant h-p, and control can be held to as close as two percent of basic speed. The unit is manufactured by Electron Equipment Corp., South Pasadena, Calif.

Soldering Aid

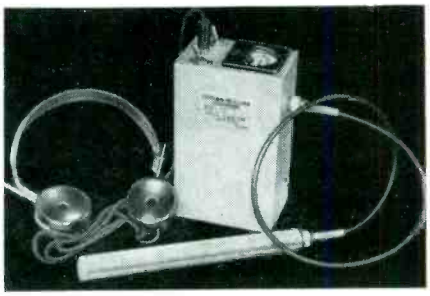
HYTRON RADIO & ELECTRONICS CORP., Salem, Mass. While the iron keeps the joint hot, the fork tip of the soldering aid straddles and



grips the end of the wire, and effortlessly unwraps it. Shifting to the other side of the lug, it grips and pulls wire free. A spade-type-reamer tip clears the lug hole of solder or pushes other wires aside for new wire. The fork tip guides the new wire through and around the lug, holding it in place for soldering.

Lightweight Geiger Counter

OMAHA SCIENTIFIC SUPPLY CO., 3601 N. 24th St., Omaha 10, Nebraska. The TX-8 Geiger counter



weighs less than four pounds and incorporates a rate meter. Designed especially for prospectors of radioactive minerals it has a battery life of at least six months.

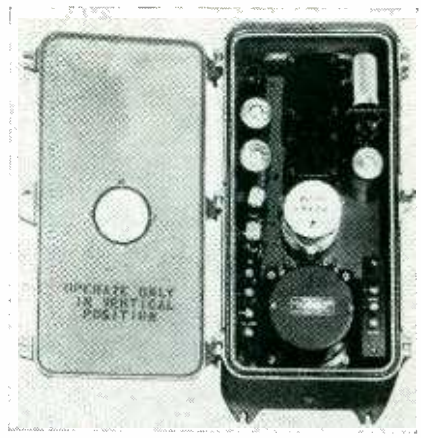
Transmission Measurement

THE DAVEN CO., 191 Central Ave., Newark 4, N. J. The 11-A transmission measuring set uses only one transformer, one meter and one meter range control. Designed for

a-m and f-m broadcasting stations and laboratory use with an external audio signal generator, the set is calibrated on the basis of 1 mw into 600 ohms and utilizes the standard vu meter.

Industrial Integrator

WESTON ELECTRICAL INSTRUMENT CORP., 617 Frelinghuysen Ave., Newark 5, N. J. Model 808 integrator, designed for use in general industrial and research applications, provides means for simple and effective integration of d-c potentials or



currents with respect to time. Fundamental elements are an integrating relay, an electronic relay circuit with associated sealed reed type relays, and a counting mechanism. Literature is available.

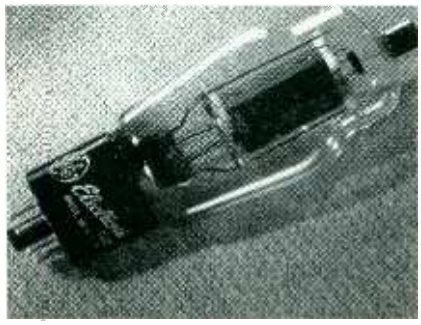
Voltage Regulator

THE SUPERIOR ELECTRIC CO., 77 Hannon Ave., Bristol, Conn., offers the Stabiline type IE51005, a 500-va instantaneous electronic voltage regulator, with an input from 95 to

135 volts and an output adjustable between 110 and 120 volts. Stabilization is ±0.1 percent and regulation, ±0.15 percent of preset value. Recovery time is 3 to 6 cycles.

Power Amplifier Tube

GENERAL ELECTRIC CO., Syracuse, N. Y. Type 19BG6-G new beam power amplifier tube is especially useful in horizontal-deflection circuits of television receivers and



Silicone News

DC SILICONES

100% more pull per unit size

We're dependent upon mechanical muscles in the form of solenoids activated by automatic or finger-tip control. But there's a limit to the amount of work even mechanical muscles can do. That limit is set by restrictions on size or weight and by the heat stability of the insulating materials used in winding the coil.

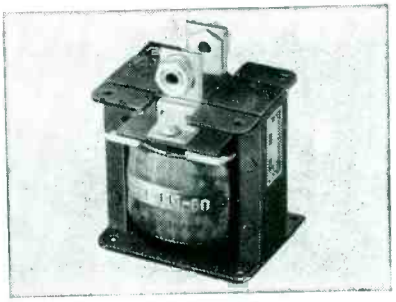


PHOTO COURTESY B/W CONTROLLER CORPORATION

Silicone insulated "Hi-Power" small space solenoids operate continuously in either 25 cycle 110 to 220 volt or 60 cycle 110 to 550 volt service.

Use of heat-stable Silicone Insulation has enabled engineers at B/W Controller Corporation of Birmingham, Michigan, to give you almost twice as much power without increasing the size or weight of their small space solenoids. For example, the new B/W "Hi-Power" solenoid has a push or pull of 32 pounds at 100% voltage compared with 17-18 pounds for a comparable Class "A" solenoid.

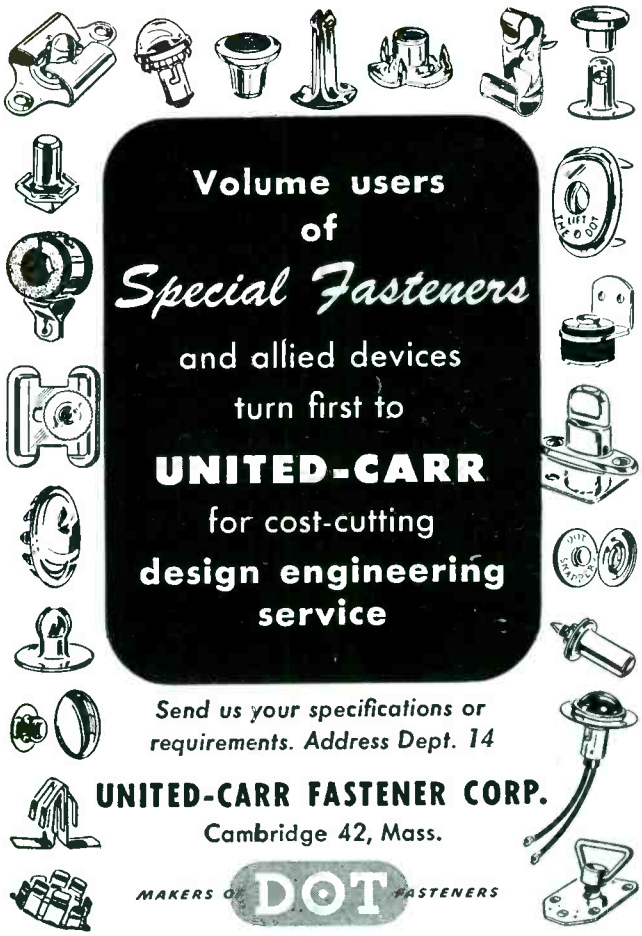
This increase in power per unit size is made possible by the exceptional heat stability of Dow Corning Silicone Insulation. This new class of electrical insulation gives long and continuous service at temperatures in the range of 200-260° C. "Hi-Power" solenoids operate continuously in 25 cycle 110 or 220 volts as well as in 60 cycle service up to 550 volts. DC Silicone Insulation also assures efficient operation in spite of high ambient temperatures.

And Dow Corning Silicone electrical insulation gives you more power per pound in other kinds of electrical equipment including motors, transformers, and generators. For more information, call our nearest branch office or write for our new collection of case histories on Silicone Insulation, pamphlet No. G7-N5.

DOW CORNING CORPORATION
MIDLAND, MICHIGAN

Atlanta • Chicago • Cleveland • Dallas
New York • Los Angeles
In Canada: Fiberglas Canada, Ltd., Toronto
In England: Albright and Wilson, Ltd., London

Dow Corning
FIRST IN SILICONES



More than 50 years of leadership and experience in developing special purpose cloths for industry. With such a background of experience it is little wonder that Holliston Tracing Cloth is second to none. Try MICRO-WEAVE.

To say that repeated erasures and redrawings on tracing cloth leave *absolutely* no semblance or trace of feathers to snare the unwary pen is — well, that is a bit too strong a statement. This applies to all tracing cloth.

But we do say this, without fear of contradiction — repeated erasures and redrawings made on Holliston MICRO-WEAVE Tracing Cloth leave a *minimum* of feathering.

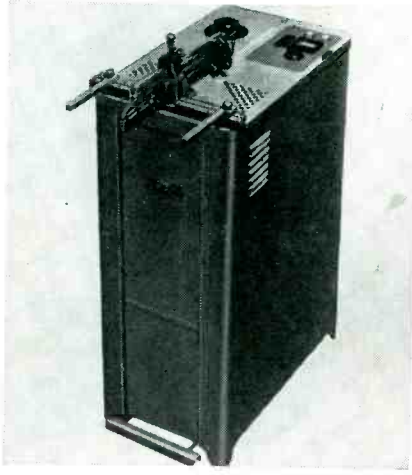
Exaggeration wins no customers. Modest claims — maximum uniform transparency, ready erasability, cleaner sharper blueprints, no pin holes or thick threads — are made for both MICRO-WEAVE Pencil and Ink Tracing Cloth. These qualities can easily be verified and proved on your own drawing board. Write for generous sample. Test and be convinced.

THE HOLLISTON MILLS, INC.
CHICAGO NORWOOD, MASS. NEW YORK

may be used with picture tubes operating at less than 10 kv. The d-c plate voltage is 500 v, while d-c plate current is 100 ma. Peak heater-cathode voltage is 250 v with heater positive or negative in respect to cathode.

Sealing Device

SPECTRUM MFG. CO., 540 N. 63rd St., Philadelphia 31, Pa., has announced a complete redesign of the electronic corner stayer, a device



used for sealing corners of transparent boxes without cement. It may be used for the production of acetate tubes and handles any size container with maximum seam length of 5 inches. Current consumed averages under 200 watts and the unit operates on 110 volts a-c.

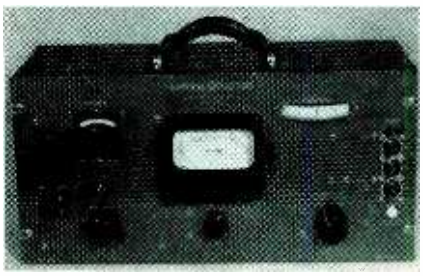
Tiny Resistors

WILKOR PRODUCTS, INC., 3852 W. 150th St., Cleveland 11, Ohio, is producing a line of tiny Carbofilm resistors for use in miniature electronic units. They are available in sizes ¼ to 1 watt, in values from 20

ohms to 5 megohms and with tolerances of 0.5 to 1 percent. The smallest type measures $\frac{1}{16}$ inch diameter over caps, $\frac{3}{8}$ inch overall length, with $1\frac{1}{2}$ inch tinned copper leads.

R-F Ohmmeter

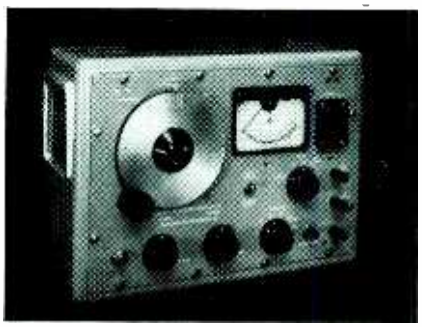
GENERAL ELECTRIC CO., Syracuse, N. Y. Type YKS-1 radio-frequency ohmmeter, designed for rapid and



accurate measurement of r-f resistance in radio components, has a range of from 50 kc to 80 mc. A nomograph is supplied with the unit for quick conversion of power factors and Q.

BFO

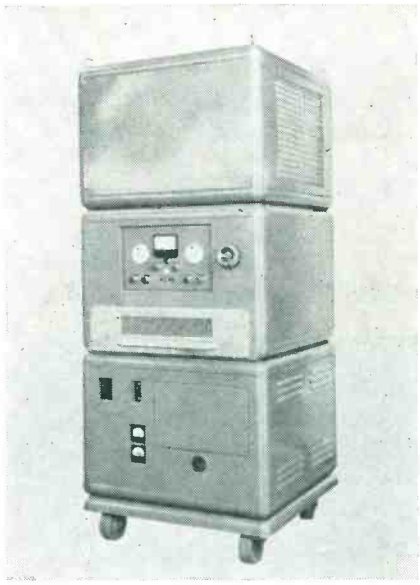
MARCONI INSTRUMENTS LTD., St. Albans, Herts., England. Type TF 894 audio tester is a beat frequency oscillator calibrated directly over



the range 50 to 12,000 cycles. Maximum output is 300 milliwatts in 600 ohms. The continuously variable level is indicated by an output meter and is made available across either the 0-to-50 db 600-ohm attenuator, or a 5,000-ohm impedance.

Dielectric Heating Unit

THERMEX DIVISION OF THE GIRDLER CORP., Louisville, Ky. Model 15R h-f dielectric heating unit is designed for preheating large rubber and plastic preforms. It will raise the temperature of 10 pounds of average material from 70 to 250 F in one minute. Oscillator, preheater and rectifier sections are contained



in individual cabinets, mounted one upon the other. The unit operates on either 230 or 440 volts.

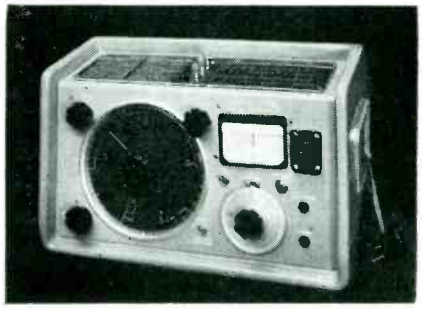
I-F Aligner

KAY ELECTRIC CO., Pine Brook, N. J. The Megaliner provides a tunable c-w signal over the frequency range from 19 to 49 mc for the alignment of television and

other similar i-f amplifiers. Provision is made to place marker pips on the trace of an oscilloscope display when ancillary equipment is used with the new instrument.

Universal Bridge

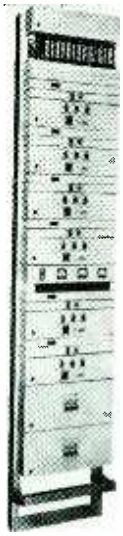
MARCONI INSTRUMENTS LTD., St. Albans, Herts., England. The universal bridge type TF 868 employs



a single dial for the direct measurement of inductance, capacitance, and resistance. The instrument incorporates three separate bridge systems, a phase-balance control, and 1,000-cycle oscillator. Inductance can be measured over the range 1 μh to 100 h; resistance 0.1 ohm to 10 megohms. The capacitance range is 1 μμf to 100 μf. The Q or tan δ are given directly on the phase-balance control from which power factor can be derived.

Multichannel Carrier

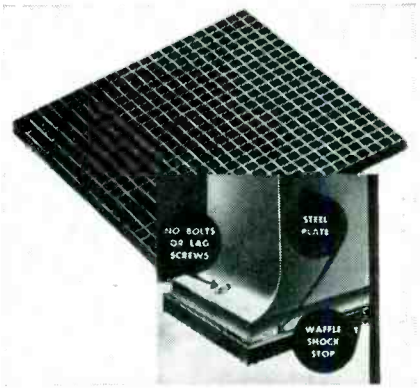
FEDERAL TELEPHONE AND RADIO CORP., 100 Kingsland Rd., Clinton, N. J., has developed the FTR 9-E-1 multichannel telegraph system pro-



viding up to 18 duplex circuits, or speech plus 6 duplex circuits, for each 4-wire voice channel. It can be supplied either amplitude or frequency modulated. The f-m system is designed for circuits where the noise level is high and signal level changes in the transmitting medium are abrupt and great.

Vibration Dampeners

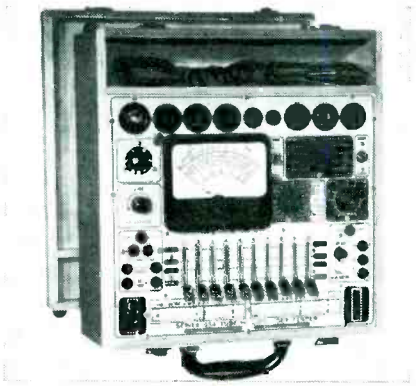
THE CONNECTICUT HARD RUBBER CO., 407 East St., New Haven 9, Conn. Shock Stops, a new type of vibration dampener with a semi-pneumatic action, reduce vibrations from 75 to 90 percent where the disturbing frequency runs between 1,000 and 3,000 cycles per minute. Effective in protecting balances, electronic devices and similar delicate equipment from vibrations coming in from the outside, they are available in square sheets as



large as 18x18 inches or in round shapes either 3¼ in. or 2¼ in. in diameter.

Tube and Set Tester

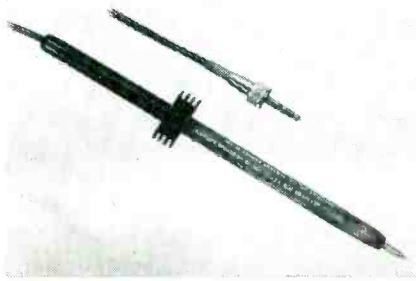
PRECISION APPARATUS CO., INC., 92–27 Horace Harding Blvd., Elmhurst, L. I., N. Y. Series 654-P is a portable combination of a cathode



conductance tube tester, dynamic battery tester and high-sensitivity a-c and d-c circuit tester (20,000 ohms per volt). It offers full rotary selective ranges and functions and requires use of only two pin jacks for all standard ranges.

High-Voltage Probes

REINER ELECTRONICS CO., INC., 152 W. 25th St., New York 1, N. Y. The new type HVM probes, in conjunction with any vtvm, measure high voltages in television sets, x-ray machines and other apparatus. Rated for use up to 30,000 volts they contain multipliers which ex-



tend the range of vacuum tube voltmeters times 100; for example, a reading of 270 volts with the multiplier indicates an actual 27,000 volts. They are supplied with the proper connector ready to attach to the individual instrument specified.

Literature

Ultrasonic Measurement. Sperry Products, Inc., Danbury, Conn. Bulletin 3700 describes the theory and general application of the Reflectogage to nondestructive measurements of plate and sheet stock, tanks, boilers, pipe and other formed parts and assemblies of metals and plastics up to four inches in thickness.

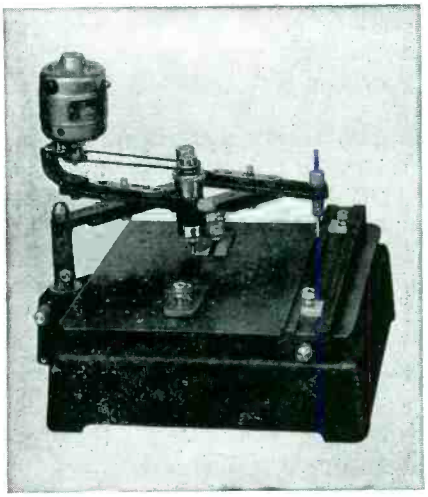
Automatic Tester. Industrial Instruments Inc., 17 Pollack Ave., Jersey City 5, N. J. Description, operation and chief features of the Auto-Bridge are outlined in catalog No. 18. The instrument treated is an automatic impedance bridge operating at high speed for production testing, sorting and testing by unskilled personnel, of resistors, capacitors or other components.

Television Equipment. Polarad Electronics Co., 9 Ferry St., New York 7, N. Y. A four-page folder illustrates and gives chief features and specifications of a line of television equipment for studio, laboratory and manufacturer.

Timing Motors. Haydon Mfg. Co., Inc., Torrington, Conn. Engineering bulletin No. 1 devotes eight pages to information and technical data on the 9200 series d-c motors for timing applications. Specifications include voltages, rotation, shafts, pinions, current drain, leads, torque, weight and speeds.

Output Transformer Chart. Standard Transformer Corp., 3580 Elston Ave., Chicago 18, Ill. A handy two-page reference chart simplifies selection of the proper transformer for use as replacement in radio receivers or in the construction of audio amplifiers. Ninety tubes are listed with correspond-

—MICO—
2 & 3-DIMENSIONAL ENGRAVER



Used in making small molds and dies or engraving panels and nameplates of metal or plastic.

Permits accurate reproduction of three-dimensional master on any of four reduction ratios.

Catalog on Request

MICO INSTRUMENT CO.
76E TROWBRIDGE STREET
CAMBRIDGE 38, MASS.

Ideal for
ANTENNA CONNECTIONS
PHOTO-CELL WORK
MICROPHONE CONNECTIONS

JONES
SHIELDED TYPE PLUGS & SOCKETS

LOW LOSS PLUGS AND SOCKETS FOR HIGH FREQUENCY CONNECTIONS. SUPPLIED IN 1 AND 2 CONTACT TYPES:

101 Series can be furnished with ¼", .290", 5/16", ⅜" or ½" ferrule for cable entrance. Knurled nut securely fastens unit together. Plugs have ceramic insulation and sockets have bakelite. Quality construction. Fine finish. Assembly meets Navy specifications.

For full details and engineering data ask for Jones Catalog No. 17.

JONES MEANS *Proven* QUALITY

HOWARD B. JONES DIVISION
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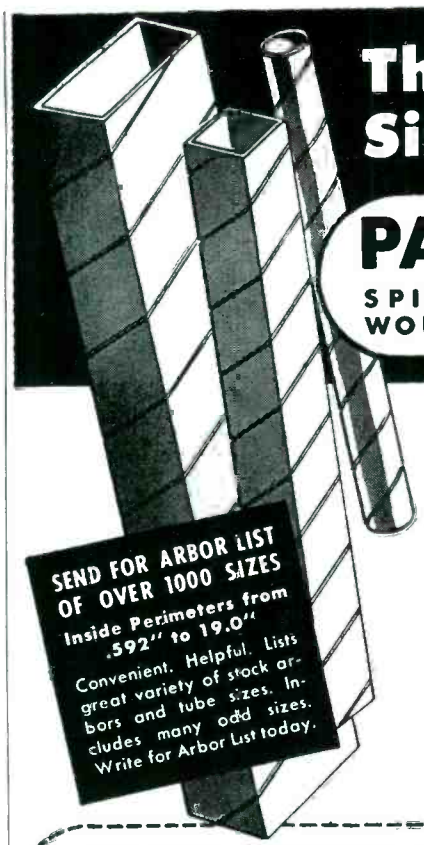

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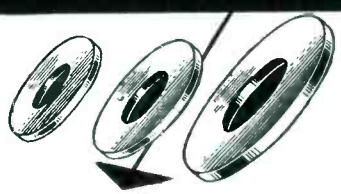

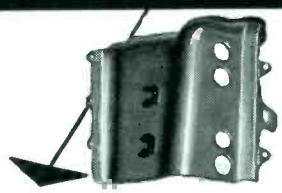

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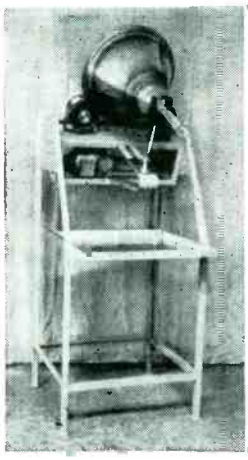

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A New way of turning tubes for inside coating

- Takes 16" metal and 10" or 12" glass blanks with simple adjustment
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- Fixed linear speed for easy brushing
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- Cannot jam — eliminates tube breakage

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ing output transformers.

Picture Tube Data. Vacuum Tube Products, 302 North Clementine St., Oceanside, Calif. A one-page data sheet gives the general characteristics, typical operation and an illustration of the type 12LP4 television picture tube.

High-Vacuum Apparatus. Central Scientific Co., 1700 Irving Park Road, Chicago 13, Ill., has issued a 48-page booklet containing extensive explanatory data on various high-vacuum apparatus and a complete listing of accessories.

Tube Testers. The Hickok Electrical Instrument Co., 10527 Dupont Ave., Cleveland 8, Ohio. A new 4-page folder describes and illustrates the latest complete line of dynamic mutual conductance tube testers. Technical and exclusive features are listed.

Metallized Capacitor Paper. Smith Paper, Inc., Lee, Mass., has published a brochure dealing with the new zinc metallized capacitor paper which is space-saving, self-healing and eliminates the use of foil electrodes.

Switches. The Daven Co., 191 Central Ave., Newark, N. J., recently released a four-page circular giving general information on a line of switches for use in broadcast and communications, industrial fields and in laboratory tests.

Electronic Counters. Potter Instrument Co., Inc., 136-56 Roosevelt Ave., Flushing, N. Y. A new four-page condensed catalog covers special electronic frequency measuring and computing equipment. Also included are a discussion of the counting principle, methods and typical applications.

Resistor Catalog. Clarostat Mfg. Co., Inc., Dover, N. H. Catalog 49 presents a complete line of resistors, controls and resistance devices. Listings concentrate on universal numbers where feasible so that replacement needs will require a minimum inventory.

Variable Capacitors. E. F. Johnson Co., Waseca, Minn. Catalog

701 covers, along with the standard variable capacitors, the new miniature air dielectric variables. It also includes data on the new type L variable with ceramic soldering and bright alloy plating.

Insulated Chokes. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa. Bulletin H-1 contains four pages of catalog data on the types CLA and CL-1 insulated chokes. Charts showing inductance, d-c resistance and current rating, along with dimensional drawings and a color coding list are included.

Tubing and Sleeving. Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill. Technical information on varnished tubings and saturated sleevings is presented in a four-page folder. Three Dieflex types are covered and different grades of products are fully described. Information on inside diameters, available grades and colors, and telescoping data is given in tabular form.

Shaded-Pole Motors. Russell Electric Co., 4501 S. Western Blvd., Chicago 9, Ill. Bulletin No. 4000 describes and illustrates the type 470 six-pole motor with ratings from 1/30 to $\frac{1}{8}$ h-p at 1,100 rpm. Also included are a performance curve and dimensional drawings.

Scaling Devices. Berkeley Scientific Co., Sixth and Nevin Ave., Richmond, Calif. Two recent pamphlets describe and illustrate the Model 2000 automatic scaler and the Model 1000-B Geiger-Muller scaler for nuclear measurements. Technical data, accessories and replacement unit information for each are given.

Coaxial Switch. The Workshop Associates, Inc., 66 Needham St., Newton Highlands, Mass. A single-page leaflet R-4AI gives detailed mounting instructions, specifications and circuits for the model R-4A coaxial switch.

VHF Radiotelephone. National Electronics Laboratories, Inc., Alexandria, Va. Complete illustrated

description and specifications for the NEL-200 Utiliphone are given in an 8-page folder. The unit described is a vhf two-way radiotelephone for communication between airport control tower and ground units employing the 121.7 or 121.9-mc range.

Television Components. Standard Transformer Corp., 3580 Elston Ave., Chicago 18, Ill., has issued bulletin DD337R giving illustrations, detailed specifications and prices of a line of television components including the recent A-8117 and A-8118 horizontal output transformers.

Thin Resistors. Ohmite Mfg. Co., 4835 Flournoy St., Chicago 44, Ill. Bulletin 138 describes the new, thin-type, wire-wound, vitreous-enameled resistors. Dimensional drawings and specific-value tables are included.

Radioactivity Measurement. Nuclear Instrument & Chemical Corp., 223 W. Erie St., Chicago 10, Ill. Catalog J consists of thirty-six pages covering instrumentation for radioactivity measurement. Included are a wide range of scaling units, counting systems, monitoring instruments, detectors and accessories, together with information about applications, manufacturing methods and other pertinent data.

Cathode-Ray Tubes. Allen B. DuMont Laboratories, Inc., Clifton, N. J. The new edition of the c-r tube booklet contains 63 pages on the history development, design and structure, and the uses of the tube, along with 68 illustrations. In addition there are chapters on the c-r oscillograph, television and radar. Price is 50¢ through jobbers.

Servo Leaflet. Duncan & Bayley, Inc., 785 Hertel Ave., Buffalo, N. Y. Two sides of a page give an illustrated description of the fluid magnetic series FM-5 proportional torque controllers. The unit described provides the servo engineer with an ultrahigh speed two-

NEW PRODUCTS (continued)

direction control means that serves as an amplification stage itself.

Television Components. Radio Corp. of America, Harrison, N. J. Form CTV-1004 is a 32-page booklet providing technical data including characteristics and dimensional outlines for 18 components used in receiver designs employing the new 16-inch metal-cone picture tube, 16AP4. Also included are typical deflection circuits and associated circuit of a pulse-operated, h-v supply for the same unit.

Central Station Unit. Philco Corp., Philadelphia 34, Pa. A recent four-page folder illustrates and describes with technical data a new compact central station unit for use in f-m radiophone communications systems in the 30-to-44 mc and 152-to-162 mc bands.

Timing Devices. The A. W. Haydon Co., Waterbury 32, Conn. Latest bulletin issued for insertion in the timing-device catalog covers the d-c timing motors with chronometric governor. The motor described is suited for applications such as chart drive elements for recorders in aircraft, trucks, buses and ships.

Flexible Electronic Control. Reliance Electric & Engineering Co., 1111 Ivanhoe Rd., Cleveland 10, Ohio. Bulletin K-2025 explains how the VSC electronic excitation control system provides functional adaptability for production or processing operations requiring timed-rate, smooth acceleration and deceleration. The two-page sheet also points out the unit's advantages, the ampere ratings for which it is made, the a-c supply voltages for which it is available and other data.

Spectrum Chart. Mullard Electronic Products Ltd., Century House, Shaftesbury Ave., London WC 2, England. Frequency allocations agreed upon at the Atlantic City conference are shown in color on a wall chart now available. Price is $1.50 postpaid or $1 each for ten or more.

new agency occupies five buildings outside Fort Monmouth, N. J.

The mission of the Standards Agency is fourfold: to reduce the number of styles and types of electronic components used in the manufacture of military equipment; to insure their quality and dependability; to achieve a high degree of interchangeability; and to designate approved sources of supply.

A procedure for obtaining industry agreement on proposed JAN specifications was worked out by RMA and the Agency at a meeting held in New York at the time of the IRE convention in March. Representing the RMA were W. R. G. Baker and Virgil M. Graham; the Agency, L. J. Taton and H. E. Bernstein.

Considerable progress in alleviating the war-born confusion over electronic parts is being made. For instance, three standard crystal holders, to meet any foreseeable requirement, have been adopted to replace 350 different holders which were formerly used. A single standard wire-wound resistor takes the place of 33 former non-standard types. Audio and power transformers that required more than 10,000 different sizes and shapes of cases can now be accommodated in only 22 standard containers. Measuring instruments and tubes have received the benefit of special attention. More than 37,500 types of meters have been reduced to 3,700 standard types, and 3,000 types of vacuum tubes have been cut down to 800 for replacement purposes and to about 200 for new applications.

Numerical Analysis Symposia

THE NATIONAL BUREAU OF STANDARDS is planning two symposia on the effective utilization of automatic digital computing machinery, to be held late in June 1949 at the Bureau's Institute for Numerical Analysis in Los Angeles, Calif.

Construction and application of conformal maps will be the topic of the first session. Applications in such fields as aerodynamics and electronics will be emphasized, with special attention to the current

needs of research workers. Particular reference will be made to the electronic machine now being designed at the Institute under Harry D. Huskey.

The second symposium will cover probability methods in numerical analysis, with emphasis on applications of the Monte Carlo method which has been used in the solution of mathematical physics problems. This session is being arranged jointly by the Institute for Numerical Analysis and the Rand Corp., with the assistance of the Atomic Energy Commission.

Anyone interested in attending either symposium may obtain further information from J. H. Curtiss, Institute for Numerical Analysis, Los Angeles 24, Calif.

Official FCC Lists Available

BIDS from private duplicating companies have been invited by the FCC for reproduction, at no expense to the government, and to offer for sale to the public, copies of radio frequency lists, call lists and other special lists prepared by the Commission for official use which are of interest to the industry and general public.

Prospective bidders may obtain forms and other information upon request to the Secretary of the FCC, Washington 25, D. C.

Electrical Indicator Standard

REQUIREMENTS for the individual sizes of panel and switchboard instruments have been presented in the new American Standard for Electrical Indicating Instruments, C39.1-1949. The standard was prepared by a committee of the national associations concerned with manufacture, use and technical development of electrical instruments, under the procedure of the American Standards Association.

One of the important contributions in the standard is the section on definitions which covers many new definitions not included before. The term "sensitivity" has been omitted and the word "loss" is used as descriptive of the energy taken to operate instruments. With special definitions this standard can

be used to cover the various requirements. For example, a voltmeter has a "current loss" whereas a current measuring instrument has a "voltage loss." Adding "volt-ampere loss" and "power loss" in watts, the story becomes complete with no reciprocal functions involved.

Besides definitions and the detailed requirements for each type of instrument, the text includes general requirements and test requirements for temperature, effect of overload, shock, vibration, humidity and dielectric test.

The standard may be obtained from the American Standards Association, 70 E. 45 Street, New York 17, N. Y., at $1.50 per copy.

BUSINESS NEWS

MOTOROLA INC., Chicago, Ill., recently opened a new research laboratory in Phoenix, Arizona, to be devoted exclusively to electronic research in military fields.

SYLVANIA ELECTRIC PRODUCTS INC., Towanda, Pa., is constructing a plant addition that will increase its space by approximately one third to meet increased demand for tungsten and chemical products for the television industry.

WARD LEONARD ELECTRIC CO., Mount Vernon, N. Y., has moved its general office from the factory building to a new office building at 115 South MacQuesten Parkway, Mount Vernon, N. Y.

RESISTORS, INC., manufacturer of resistors for radio and electronic

New Resistors, Inc. Plant

circuits, has moved into its new plant at 5226 W. 26th St., Chicago, Ill.

THE THEATRE OWNERS OF AMERICA has become a sustaining member of the Society of Motion Picture Engineers to explore fields of mutual

interest in theatre engineering, including theatre television.

ELECTRONIC INSTRUMENT CO., INC., Brooklyn, N. Y., manufacturers of test equipment, recently moved to new and larger quarters at 276 Newport St., Brooklyn 12, N. Y.

ELECTROVOX CO., INC., has moved its factory and general office to 60 Franklin St., East Orange, N. J., due to expanding business in the phonograph needle and television fields.

PERSONNEL

SAMUEL LUBKIN, formerly engineer-in-charge of the digital computer section of the Reeves Instrument Corp., has been appointed consultant to the Machine Development Laboratory, National Bureau of Standards.

EVERETT GILBERT, with Radio Frequency Laboratories, Inc., Boonton, N. J. as special projects engineer since 1945, has been promoted to vice-president for engineering at RFL.

E. Gilbert

R. T. Pennoyer

R. T. PENNOYER, with General Electric Company in various engineering and management capacities since 1933, was recently appointed manager of GE's Buffalo Tube Works, where television picture tubes are now the chief product.

J. GILMAN REID, former chief engineer for the Electronic Instrumentation Laboratory of the National Bureau of Standards, was recently named chief of the Bureau's Engineering Electronics Laboratory.

WILLIAM B. LODGE, vice-president in charge of engineering for CBS, has been appointed to the board of

governors of the Society of Motion Picture Engineers. He is the first television engineer to receive a major appointment in this society.

STEPHEN V. HART, formerly development engineer at RCA Victor, was recently appointed to the newly-created position of chief engineer at Industrial Electronics, Inc., Detroit, Mich.

GEORGE C. SCHLETER, formerly engaged in microwave research at the Naval Research Laboratory, has been appointed to the staff of the National Bureau of Standards to conduct an engineering development program on guided missiles, including missile systems and components.

WILBUR S. HINMAN, JR., now responsible for research and development in the field of proximity fuzes at the National Bureau of Standards, has been appointed assistant chief of the Bureau's electronics division, where he will aid in directing research and development of electronic apparatus, instruments, controls, circuits, tubes and ordnance devices.

W. S. Hinman, Jr.

W. R. Patton

WILLIAM R. PATTON, former radio engineer at United Air Lines, has joined Lenkurt Electric Co., San Carlos, Calif., as a field engineer in the carrier equipment division.

NICHOLAS BALES, formerly associated with the Tungsram Lamp Works of Hungary as development engineer, has been engaged as chief engineer by Electronic Essentials Corp., Jersey City, N. J., television component manufacturers.

EVERARD M. WILLIAMS, 1946 Eta Kappa Nu Award winner, has been promoted to a full professorship of electrical engineering at Carnegie Institute of Technology.

PREMAX

Why the Adjustable "V" Antenna Is Best for TV

Premax Adjustable V Dipole Antennas permit the proper vertical or horizontal adjustment of the elements to prevent, as generally happens with horizontal type dipoles, the combining of a "direct" with a "reflected" signal which results in a cancellation of both signals and poor reception.

The Premax V can be adjusted to the proper vertical or horizontal position to make the two signals combine in phase, thereby increasing rather than reducing the received signal.

Another Premax feature is that, properly mounted, it permits a sufficient signal energy at the antenna terminals to minimize the importance of the otherwise difficult task of perfect impedance matching.

Service men, installing the Premax V, find it insures optimum reception of signals from ALL of the TV stations within the line of sight.

Premax V is a low-cost antenna, easy to install and profitable to the service man. Send for details.

PREMAX PRODUCTS
DIVISION CHISHOLM-RYDER CO., INC.
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Swinging-Smoothing
ALL WITH ONE

THORDARSON CHOKE!

REDUCED RIPPLE — BETTER REGULATION

The greatest advance in power supply filter circuits has now been accomplished by THORDARSON engineering skill. Ripple is substantially reduced throughout the useful current range of the power supply by employing one or two of the same type universal chokes in the conventional power supply. Unlike conventional swinging chokes, these THORDARSON chokes do not waste useful inductance at higher current values.

This achievement offers the best possible filtering and regulation in a minimum size consistent with conservative rating.

One choke may be used in a single section filter with all the advantages of the radically swinging type. Two similar units may be employed in a two section filter to better advantage than the obsolete "swinging and smoothing" system — and deliver far better performance.

For complete details, write for a free copy of the new IDS6B THORDARSON Universal Choke-Reactor Technical Bulletin.

See Them at Your Jobber and Write for the New THORDARSON Complete Catalog

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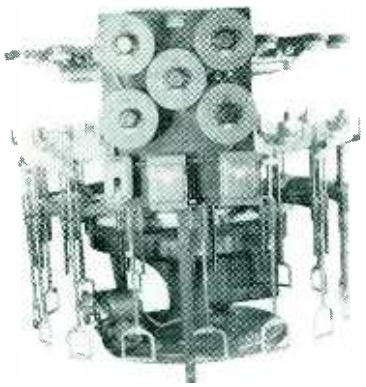
Kahle specialists in custom-built, ultra-precision
ELECTRON TUBE MACHINERY

From big 20" to tiny sub-miniature tubes, from laboratory to high speed production, Kahle custom-builds the machine that does each specific job most efficiently. To assure trouble-free high precision operation, each Kahle unit is first put through exhaustive trial runs in our own plant.



#1363 Basing Machine For Cathode Ray Tubes

16 heads taking up to 12" tubes or 12 heads taking up to 16" tubes.

We specialize in cost-cutting, production-boosting, labor-saving equipment for complete manufacture of cathode ray tubes, standard, miniature, and sub-miniature radio tubes, sub-miniature tubes, fluorescent lamps, photocells, x-ray tubes, glass products.

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NOW YOUR engineers can design Printed Circuits into your products with our Super Kit, S21, of air-drying conducting and resistance paints plus our Manual "Design and Repair of Printed Circuits. Only $7.27 from distributors or our factory.

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COMPARE these Features

- Identical Vertical and Horizontal Amplifiers
- Bandwidth 2 cycles to 450 kc (3 DB Down)
- Sensitivity .15 RMS Volts/inch
- Decade Attenuators (Frequency Compensated)
- Direct Connection to Deflection Plates
- Z Axis Input
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IDEAL FOR TV WORK—CUTS EQUIPMENT COSTS
A QUALITY INSTRUMENT—AN AMAZING LOW PRICE

Suitable for pulse work to 1 MC., cased in hammertone grey cabinet with aluminum front panel, complete with instructions.
GUARANTEED..... Model 450-A

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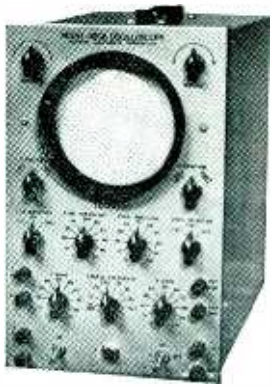

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NEW BOOKS

Frequency Modulation

BY NATHAN MARCHAND. *Murray Hill Books, Inc., New York, 1948, 409 pages, $5.00*

STARTING with the assumption that the reader is already familiar with conventional a-m practice, the author in 18 well-written chapters treats the special techniques and equipment employed in f-m work. The scope and purpose of the book are such that the service man and station engineer alike will find it useful as a reference or study text. The mathematical treatment of the basic fundamentals of f-m is conventional except for the introduction of the term phasor. This is not, as might at first appear, a device or circuit used to obtain a given phase difference between two or more voltages (or currents), but rather a new name for the old familiar plane vector. As used here, the difference between the two terms is very slight and not worth the introduction of a new term that might prove confusing.

The brief explanation of Bessel Functions which the author gives in conjunction with his discussion of fidelity and bandwidth requirements should prove helpful to those who wish to thoroughly analyze basic circuit action.

Six phases of f-m are thoroughly covered. The author begins with basic concepts and methods of modulation, and then takes up f-m transmitters, including the phase-to-frequency as well as the direct frequency-modulated types. Following this, f-m receivers are discussed in considerable detail and mobile installations are treated. Installation problems, layouts and cable diagrams are included wherever this can be used to advantageously supplement the text. One chapter is devoted to transmitting antennas, and another to receiving antennas. The final phase of f-m to be discussed is the servicing of f-m receivers. Here the author is careful to point out all similarities and differences between a-m and f-m techniques and equipment.

At the close of each chapter will be found a list of the various references given in the text, and a series of questions for self-study. Answers to questions that require a calcula-

tion are located in an appendix, which also includes extra information on vectors. Throughout the book the subject matter and treatment are such that it could be used as a textbook for a course in f-m. As first pointed out, however, the student must already be familiar with radio fundamentals.—R. H. SCHAAF, *National Radio Institute, Washington, D. C.*

Waveforms

Volume 19 of the MIT Radiation Laboratory Series. EDITED BY B. CHANCE, V. HUGHES, E. F. MACNICHOL, D. SAYRE, AND F. C. WILLIAMS. *McGraw-Hill Book Co., New York, 1949, 785 pages, $10.00.*

ALTHOUGH many volumes of this series have been published at about the same time as other books covering much the same material, this volume stands alone as the sole coordinated collection of circuitry in the field of waveform generation and uses. This book brings together in a well-planned form a mass of information which has existed before only in widely scattered classified reports in England and the United States, or which has appeared sketchily or in a disjointed manner in the literature. As such, one will view the book somewhat more critically than if it merely added to the existing literature.

The editors are to be commended, as usual, for the smooth flow of style—it does not read as if it were merely a collection of independent articles, but as a text with a single author. Typographic errors are practically nonexistent. The illustrations are probably one of the outstanding features of the book—almost every circuit mentioned is presented in schematic form with component values indicated. In addition, the manufacturers' type numbers have been noted on special components. These schematics will be a gold-mine for university laboratory work, as well as to the design engineer.

Whether the book may be easily used as a source book is another matter. A good reference in a field which is practically barren would be welcomed. It would seem to this reviewer that, although the concept of the volume included the desire to supply this missing link, it was not achieved. The book is for

the initiate, not the neophyte; it is written from a very sophisticated point of view, which sometimes gives rigor, but more often serves only to confuse and to slow the absorption of technical material. The nomenclature is often not that familiar to the electronic engineer, but is the language of the physicist or the mathematician. This is not written derogatorily, but is a criticism of a method of attack; the book will be used predominantly by engineers and should, therefore, be written for them, if accuracy is not lost by so doing. A classic example occurs on page 42, where in discussing the indication of equality of two voltages in amplitude, they speak of "the moment of equality of the amplitude of a sinusoidal wave to a parametric voltage". It may be picayune to resent this usage, but "reference voltage" would allow the average engineer to continue reading the next sentence without having to reread the above to make sure that "reference" was really meant.

The book obviously has been put together by people who are extremely conversant with their art—in fact, have contributed many of its fundamental concepts and circuitry. But all who are not as familiar with the field as the authors will use it with some difficulty which should not have been necessary.

Taken in all, however, the book is an absolute must for those who have any connection with the design of electronic circuits.—M. T. LEBENBAUM, *Receiver Section, Airborne Instruments Laboratory, Mineola, N. Y.*

Standard Handbook for Electrical Engineers

ARCHER E. KNOWLTON, *Editor-in-Chief. McGraw-Hill Book Co., Inc., New York, 1949, Eighth Edition, 2,311 pages, $12.00.*

AS ELECTRICAL ENGINEERING and radio merge more and more in their common meeting ground of industrial electronics, this famous handbook increases in value to the electronic engineer with each new edition.

The 26 sections distinctly show the tremendous strides made since

publication of the previous edition in 1941, by important new material on radar, microwave techniques, nuclear energy and electronic heating. Revisions and additions throughout bring the book into conformity with newly adopted standards and newly acquired practical working data on the electrical equipment that forms the basis for many industrial electronic controls.

Definitely all-electronic are Section 23—Electronics and Electron Tubes, and Section 24—Radio, Radar and Carrier Communication, by Donald G. Fink, Editor of ELECTRONICS, except for six pages on radio interference by M. D. Hoover and eight pages by S. C. Bartlett on electronic applications to power stations. The clear and concise coverage of both theory and practice in all these fields in slightly more than a hundred pages provides optimum reference value for electrical and electronic engineers alike.

The excellent data-filled chapters on conductors, insulating materials and magnetic materials also deserve mention for their all-around usefulness.—J. M.

• • •

Books Received for Review

THE AMPLIFICATION & DISTRIBUTION OF SOUND. By A. E. Greenlees. The Sherwood Press, Pacoima, Calif. (U. S. distributors), Second Edition, 1948, 302 pages, $6.00. Revision, rearrangement and enlargement of original edition, with minimum mathematics and emphasis on practical considerations of interest to radio servicemen, public address engineers, and radio students. British terminology and equipment, but readily applicable to American practice.

PATENT LAW. By Chester H. Biesterfeld. John Wiley & Sons, Inc., New York. Second Edition, 1949, 267 pages, $4.00. Extensive revision of 1943 edition to cover recent decisions, with major changes in chapters on Infringement, Disclaimers, Liability for Infringement, Trade Secrets and Double Patenting.

PATENT LAW FOR THE EXECUTIVE AND ENGINEER. By H. A. Toulmin, Jr. Research Press, Inc., Dayton, Ohio, Second Edition, 1948, 231 pages, $2.95. Revision of 1928 edition, retaining the understandability required by the ordinary business man and nonlegally-inclined engineer who has occasion to obtain, purchase or evaluate a patent, protect himself against infringement suits, or deal with other aspects of the U. S. patent system.

INTRODUCTION TO ATOMIC PHYSICS. By Otto Oldenberg. McGraw-Hill Book Co., Inc., New York, 1949, 373 pages, $5.00. For college students who have taken a one-year introductory physics course and are familiar with elements of chemistry. Main emphasis is on understanding, as opposed to accepting on authority, to stimulate interest of student and impress him with physical ideas rather than mathematical performance. Main divisions include Structure of Matter, Gases, Structure of Electricity, Structure of Light, Electronic Structure of Atoms, Nuclear Structure and Wave Nature of Matter.

Backtalk

Uhf Television

DEAR SIRS:

T. T. GOLDSMITH'S TALK before the recent IRE convention on the uhf television situation was most interesting. However, I feel that several of his statements are open to serious question. The first is with respect to his answer to a question from the floor concerning the possibility of reducing local oscillator radiation in the uhf band. He stated that there was no way in which this could be done without interfering with other services. I believe my proposal makes his position on this question untenable.

His other statements concerning receiver design are not Class A answers in my opinion. He said that double conversion receivers were not satisfactory due to heterodyne beats between the two local oscillators. Examination of the state of the art indicates that a number of double conversion receivers are in commercial use in which this difficulty has been eliminated. Inasmuch as these receivers have sensitivities of the order of one microvolt it would seem reasonable to assume television receivers could easily be built to avoid this difficulty. I would also like to point out that only two such beat notes can occur in the uhf band if 200 mc is used as the first i-f frequency.

I also believe the following to be Class A facts:

1. The higher the i-f frequency the better the image ratio and image attenuation.

2. Image attenuation must equal cochannel attenuation.

3. The greater the frequency separation between images, the easier allocation becomes and better frequency utilization follows.

4. Before any allocation plan can be made, it will be necessary to standardize on a "first i-f" frequency.

5. To be safe, the use of 40 to 60-mc i-f frequencies will require treatment of the image frequencies of local stations on an adjacent channel basis. Also allocations from 420-475 mc must be given special consideration by FCC. The use of i-f frequencies from 40 to 60 mc also poses some other problems. The use of frequencies below channel 2

would require double converters with existing receivers. If channel 2 were used as an i-f frequency, receivers close to channel 2 stations would be subject to serious interference problems. The same holds for channels 3 or 4. Oscillator radiation will become a serious problem throughout the uhf band.

6. If an i-f frequency of approximately 200 mc is used, the images fall outside the uhf band. This of course requires discretion on the part of FCC in frequency assignments to other services with relation to local television allocations between 375 mc, 475 mc and 890-1,080 mc. The best image attenuation will be obtained, which should make this relatively easy. The allocation can be made without consideration of image interference between television stations. No local oscillator radiation trouble will be encountered.

The use of channel 12 or 13 (depending on local use) is the only way in which a guarded i-f channel can be obtained without making the uhf allocation subject to consideration of image response on a considerable scale.

While the consideration of the problems outlined above may dwarf the importance of the sound channel, I believe that the use of present tv sound standards in the uhf band is very much a Class C question. The General Electric Company and ourselves are currently working on the problem of afc control on different models of their 1,700-mc receivers used in meteorological work by the Signal Corps. We are not yet in a position to give facts and figures, but should be able to do so in thirty days.

I wonder how many television receiver manufacturers would undertake a government contract to provide receivers with sufficient frequency stability to guarantee audio distortion of 10 percent or less in the uhf band using present tv sound standards. It would appear that frequency stability of the order of 0.001 percent would be required. The public is entitled to reasonable sound quality without continuous retouching of the tuning control. Can this be accomplished at a reasonable cost? The use of an a-m sound channel, possibly with a

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superregenerative audio detector, might prove to be a better answer to this problem. Receiver performance on the sound channel with present vhf standards can be determined easily as it can be computed from the stability of the high-frequency oscillator. I believe television receiver manufacturers should prove their ability to produce the required stability on a mass production basis before present tv round standards are adopted.

DANA A. GRIFFIN
President
Communication Measurements Laboratory, Inc.
New York, N. Y.

Bugaboos

DEAR SIRS:

I READ with considerable interest the article by A. P. Schreiber of Tracerlab on radioisotopes for industry (p 80, Jan. 1949) and my eye was attracted by the editorial box entitled, "Bugaboos."

Your list is good, but I feel that it is not complete. One major bugaboo that I have come across is the lack of cooperation which I have encountered in obtaining information as to the best isotopes to use in meeting a certain problem, and in developing industrial control equipment using radioactive isotopes. While my experience is very limited, it certainly indicates no desire on the part of the private isotope industry to assist persons who wish to develop industrial control equipment. The reason may be that they want to develop everything themselves, but that is hardly a way of obtaining the maximum progress.

It is probably unfair to generalize on the basis of a single experience. It may be that only one firm has the policy of impeding development by other concerns, but since these firms that distribute the isotopes have a privileged position with a Government Agency, the Atomic Energy Commission, would it not be desirable for that administration to insure and require that firms distributing isotopes also be willing to cooperate and stimulate individual application and that their privileged position be cancelled if they are unwilling to do so.

RAYMOND M. WILMOTTE
Washington, D. C.

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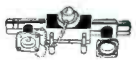

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WAVEGUIDE, 1" x ½" ID, per ft. $1.50
TR CAVITY for 724-A TR tube $3.50
3" FLEX SECTION, square flange to circular flange adapter $7.50
724 TR tube (41-TR-1) $2.50
SWR MEAS. SECTION. 4" L with 2 type "N" output probes MTD full wave apart. Bell size guide. Silver plated $10.00
ROTARY JOINT with slotted section and type "N" output pickup $17.50
WAVEGUIDE SECTION, 12" long choke to cover 45 deg. twist & 2½" radius, 90 deg. bend $4.50
SLUG TUNER/ATTENUATOR. W.E. guide, gold plated $6.50
TR/ATR DUPLEXER section with iris flange ... $8.00
TWIST 90 deg. 5" choke to cover, w/press nipple . $6.50
WAVEGUIDE SECTIONS 2½ ft. long, silver plated with choke flange $5.75
WAVEGUIDE, 90 deg. bend E plane. 18" long .. $4.00
ROTARY JOINT, choke to choke $17.50
ROTARY JOINT, choke to choke, with deck mounting $17.50
S CURVE WAVEGUIDE, 8" long cover to choke . $3.50
DUPLEXER SECTION for 1B24 ..... $10.00
CIRCULAR CHOKE FLANGES, solid brass ..... .55
SQ. FLANGES, FLAT BRASS ..... ea. .55
APS-10 TR/ATR DUPLEXER section with additional iris flange $10.00
FLEX. WAVEGUIDE ..... $4.00/Ft.
723 A/B Klystron Mount shielded, on X Band Guide w/rough attenuator output ..... ea. $75.00

MASTER OSCILLATOR UNITS

M.O. units designed for oper 2-18 mc TBK. Flexible plug in units using type 860 tube in ECO circuit. Tunes 2000 to 4565 kc in 6 bands. Freq. Determining elements are enclosed in shock mounted oven assembly, and has frq monitor PU link coupled to output. Net Wt: 138 Lbs. Dim: 21 in. d x 14½ in. W x 25½ in. H. New (with tube) $150.00

MICROWAVE ANTENNAS

APS-15 Antennas. New $99.50
AN MPG-1 Antenna. Rotary feed type high speed scanner antenna assembly, including horn parabolic reflector. Less internal mechanisms, 10 deg. sector scan. Approx 12'L x 4'W x 3'H. Unused. (Gov't Cost—$4500.00) $250.00
APS-4 3 cm antenna. Complete. 14½" dish. Cutler feed dipole directional coupler, all standard 1" x ½" waveguide. Drive motor and gear mechanisms for horizontal and vertical scan. New, complete .. $65.00
AN/TPS-3. Parabolic dish type reflector approx. 10' diam. Extremely lightweight construction. New, in 3 carrying cases $89.50
RELAY SYSTEM PARABOLIC REFLECTORS: approx. range: 2000 to 6000 mc. Dimensions: 4¼' x 3', rectangle, new $85.00
TDY "JAM" RADAR ROTATING ANTENNA, 10 cm. 30 deg. beam, 115 v.a.c. drive. New $100.00
SO-13 ANTENNA, 24" dish with feedback dipole 360 deg. rotation, complete with drive motor and selsyn. New $120.00
Used $45.00
DBM ANTENNA. Dual, back-to-back parabolas with dipoles. Freq. coverage 1,000-4,500 mc. No drive mechanism $65.00
AS125/APR Cone type receiving antenna, 1000 to 3200 megacycles. New $4.50
140-600 MC. CONE type antenna, complete with 25' sectional steel mast, guys, cables, carrying case, etc. New $49.50
ASD 3 cm. antenna, used, ex. cond $49.50

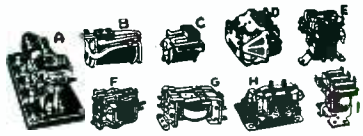
COMMUNICATIONS EQUIPMENT COMPANY
CABLE ADDRESS: COMSUPO
PHONE DIGBY 9-4124
131 LIBERTY ST. DEP'T. E
NEW YORK 7, N.Y.
C.E.C. MONEY BACK GUARANTEE, & 3 MIN. ORDER.
F.O.B. N.Y.C. SEND MONEY ORDER OR CHECK, ONLY SHIPPING CHARGES SENT C.O.D.
RADAR TELEVISION ELECTRONICS
FM MICROWAVE RADIO SONAR

932 PHOTOTUBE

This tube is a gas phototube having 5-1 response, particularly sensitive to red and near infrared radiation. Can be used with incandescent light source. Send for data.
PRICE $1.25

GREAT TUBE VALUES

01-A	$.45	12K8Y	$.65	843	$.59
1B26	4.85	12SF7	.49	860	15.00
2C21	.69	12SR7	.72	861	40.00
2C22	.69	15P	1.40	874	1.95
2J21-A	25.00	28D7	.75	876	4.95
2J22	25.00	30 (Spec.)	.70	1005	.35
2J26	25.00	45 (Spec.)	.59	1619	.21
2J27	25.00	39/44	.49	1624	.85
2J31	25.00	35/51	.72	1629	.35
2J32	25.00	227A	3.85	1961	5.00
2J38	35.00	225	8.80	9002	.65
2J39	35.00	268-A	20.00	9004	.47
2J55	35.00	355-A	19.50	CEQ 72	1.95
2J40	65.00	417A	25.00	EF 50	.79
2J49	85.00	530	90.00	F-127	20.00
3J31	55.00	531	45.00	FC 258A	165.00
2X2/879	.69	532	3.95	GL 532	7.50
3BP1	2.25	559	4.00	FC 271	40.00
2C24	.60	562	90.00	GL 562	75.00
3C30	.70	615	.89	GL 623	75.00
3D6	.79	703-A	7.00	GL 697	75.00
3CP1	3.50	704-A	.75	ML 100	60.00
3D21-A	1.50	705-A	2.85	QK 59	65.00
3DP1	2.25	†707-B	20.00	QK 60	65.00
3EP1	2.95	714AY	25.00	QK 61	65.00
3FP7	1.20	715-B	12.00	QK 62	65.00
3Q5	.79	720BY	50.00	VR 91	1.00
5BP1	1.95	720CY	50.00	VR 130	1.25
5BP4	4.95	721-A	3.60	VR 135	1.25
5CP1	3.75	723-A/B	12.50	VR 137	1.25
5FP7	3.50	724B	1.75	VU 120	1.00
5J30	39.50	725-A	25.00	VU 134	1.00
6G	2.00	726-A	15.00	WL 532	4.75
6SC7	.70	800	2.25	WN 150	3.00
7C4	1.00	801-A	1.10	WT 260	5.00
7E5	1.00	804	9.95		
7E6	.72	815	2.50	†With cavity:	
10Y	.60	836	1.15	Cavity only	5.00
12A6	.35	837	1.95		



RELAYS

	Type	Con-tacts	Rating	Res. Coil	Mfg	Price
H	DPDT (8A)	24-28V	vdc	170 ohms	GECR2791B 100F3	$1.75
H	SPDT	28 vdc		175 ohms	GECR2791B	1.25
H	3PDT	24-28 vdc		175 ohms	GECR2791B	1.75
H	4PST	24 vdc		180 ohms	GECR2791G	1.75
G	DPDT SPST	12 vdc		44 ohms	Leach 1067-490	1.45
G	DPDT	22-28 vdc		160 ohms	Leach	1.25
D	SPST	28 vdc		250 ohms	Allied BO48	1.39
I	DPST	14 vdc		85 ohms	Price X20-A	1.50
D	3PDT	24-28 vdc		280 ohms	Allied DOX-3	2.50
H	SPST	24-28 vdc		2490	GM 12917-1	2.00
D	DPDT	24 vdc		280	Allied BO635	2.00
D	3PDT	26 vdc		280	Allied KS	1.10
D	DPDT	28 vdc		280	Allied BO	2.10
D	SPST (NC)	75MA		60	Allied KS 5862	1.10
H	DPDT	20-30 vdc			Ounce 50XB	2.00
H	DPDT	10 14 vdc			Ounce 100AB	2.00
H	DPDT	24-28 vdc			PB21C057-A	1.75
H	3PDT	24-28 vdc			GECR2791	2.00
H	SPDT	24-28 vdc			GECR2791	1.75
A	DPDT (6A)	12 vdc			Ounce CX3190	2.40
A	SPDT	10-12v 60 cy		125	Ounce CX2120	2.40
H	DPDT	27.5 vdc		400	Allied	1.10
D	DPDT	9-14 vdc			Allied	1.10
H	DPDT	24v60cy		50	Allied	1.40

ARC 3 MINIATURE RELAYS

Sealed Can SPDT 5 Prong. GECR2791C104 2.25

C	SPDT, 28 vdc DPST	300 ohms	RBM55342	45¢
C	6 PST	22-28 vdc	300 ohms	RBM55528	45¢
C	SPST	22-28 vdc	300	RPM55251	45¢
C	DPDT, 22-28 vdc DPST	300	RBM55531	45¢
C	SPDT, 22-28 vdc SPDT	300	RBM55526	45¢

RADAR SETS

RC 145 IFF SET. Consists of BC 1267 xmtr-rcvr. remote antenna controller and indicator I-221, power supply RA 105-A. 1 kw. pulse oscillator operates on 154-186 mc. Operates from 117 v., 60 cy. New $190.00

SN RADAR-GE, low power, 5 and 25 miles ranges. Uses GL446 as pulsed oscillator, 5" "A" scope, "S" band. Extremely compact, ideal for demonstration and laboratory work. 115V 60C operation. Used. Excel. cond. $600.00

SE 10 CM SURFACE SEARCH RADAR, W.E., 20,000 to 80,000 yds. range. 250 KW. pk. power input to 706 magnetron. Thyratron modulator, variable pulse rate. Complete set including spare parts, tubes, waveguide and fittings. Send for price and additional information.

R85TPL-I RADAR RCVR, Sperry.....$85.00

COMMUNICATIONS EQUIPMENT COMPANY *for your needs*

UPRIGHT OIL CAPACITORS

STANDARD BRANDS

Fig.	Mfd	Voltage	Terminals	Price
B	.1	600VDC	2	35¢ 3 for $1.00
E	.25	400VDC	2	39¢ 3 for 1.10
E	.5	600VDC	2	35¢ 3 for 1.00
E	1	600VDC	2	39¢ 3 for 1.10
D	2 x .5	600VDC	3	49¢ 3 for 1.45
B	3 x .1	600VDC	3	55¢ 2 for 1.05
B	.25	400VDC	2	39¢ 3 for 1.10
B	.5	600VDC	2	35¢ 3 for 1.00
B	.5	600VDC	2	35¢ 3 for 1.00
E	1	400VDC	2	35¢ 3 for 1.00
B	.1	400VDC	2	40¢ 2 for 75¢
B	.4	600VDC	2	39¢ 3 for 1.10
D	.1	600VDC	2	45¢ 2 for 85¢
B	2 x .1	600VDC	2	50¢ 2 for 95¢
E	1.75	400VDC	2	35¢ 3 for 1.00
D	3 x .1	600VDC	3	55¢ 2 for 1.05
A	2 x .5	600VDC	3	49¢ 2 for 95¢
B	.1	600VDC	2	45¢ 2 for 85¢
B	.1	600VDC	2	45¢ 2 for 85¢
D	1	500VDC	2	45¢ 2 for 85¢
A	1	500VDC	2	45¢ 2 for 85¢
B	.1	600VDC	2	45¢ 2 for 85¢

Send for Lists of Other Values

H. V. MICAS

Fig.	Mfd	Voltage	Price
D	.01	1200WVDC	50¢ 2 for 95¢
E	.00025	2500TVDC	29¢ 2 for 55¢
D	.00004	2500WVDC	39¢ 2 for 75¢
E	.000047	2500WVDC	39¢ 2 for 75¢
E	.01	500WVDC	25¢ 4 for 95¢
C	.002	3000WVDC	$1.05 2 for $2.00
C	.01	2000WVDC	1.50 2 for 2.90
C	.00003	2000WVDC	49¢ 2 for 95¢
C	.00009	3000WVDC	75¢ 2 for 1.45
C	.00082	3000WVDC	1.00 2 for 1.95
C	.002	3000WVDC	1.00 2 for 1.95
C	.005	5000WVDC	1.65 2 for 3.25
C	.0004	6000WVDC	1.50 2 for 2.95
C	.0006	3000WVDC	1.00 2 for 1.95
C	.0008	3000WVDC	95¢ 2 for 1.85
E	.0016	3000WVDC	65¢ 2 for 1.25
E	.000090	3000WVDC	40¢ 2 for 75¢
B	.08	1500WVDC	10.00 2 for 19.50
B	.03	2000WVDC	12.00 2 for 23.50
B	.045	2000WVDC	12.00 2 for 23.50
B	.00015	20KVDC	24.00 2 for 47.50
B	.0001	20KVDC	24.00 2 for 47.50
B	.002	15KVDC	19.00 2 for 37.50
C	.006	2500WVDC	1.45 2 for 2.85
E	.00027	2500WVDC	35¢ 2 for 65¢

Send for Lists of ers

400 CYCLE TRANSFORMERS

352-7273: Pri: 115 v, 400 cy. Sec: 6.3 v, 2.5 amp; 6.3 v, .06 amp; 6.3 v, .9 amp; 5 v, 6 amp; 700 vct ... 2-5U4's. For APS-15. T201.....$4.75

352-7176: Pri: 115v, 400 cy. Sec: 6.3 v, 20 amp; 6.3 v, .5 amp; 6.3 v, .5 amp; 320 v (2-6X5's). For A1'S-15. T202.....$5.25

352-7278: Pri: 115 v, 400 cy. Sec: 2.5 v, 1.75 amp, 3500 v (2X2). For APS-15. T203, (Anode #2 5FP7).....$5.85

352-7070: Pri: 118 v, 440 cy. Sec: 2.5 v, 2.5 amp; 2.5 v, 2.5 amp; (2000 v ins.): 6.3 v, 2.25 amp; 1200 v tapped at 1000 and 750 v, p/o AN/APS 15....$4.95

#7469105: Pri: 115 v, 400 cy. Sec: Tapped to give 742.5 v, 50 ma; 709 v, .0477 amp; 671 v, .045 amp $2.95

M-7474319: Pri: 115 v, 400 cy. Sec: 6.3 v, 2.7 amp; 6.3 v, 66 amp; 6.3 v, 21 amp.....$2.95

32332: Pri: 115 v, 400-2400 cy. Sec: 400 vct, 35 ma; 6.4 v, 2.5 amp; 6.4 v, .15 amp.....$2.25

332-7138M: Pri: 115 v, 400-2400 cy. Sec: 640 v, .5 ma; 2.5 v, 1.75 amp.....$3.85

352-7179: Pri: 115 v, 400-2400 cy. Sec: 6.5 v, 12 amp ct; 250 v, 100 ma; 5 v, 2 amp.....$3.50

#9069: Pri: 115/80 v, 400-2600 cy. Sec: 650 vct, 50 ma; 6.3 vct, 2 amp; 5 vct, 2 amp.....$2.15

352-7096: Pri: 115/80 v, 400-2400 cy. Sec: 2.5 v, 1.75 amp, 3 KV ins; 5 v, 3 amp; 6.5 v, 6.5 amp; 6.5 v, 1.2 amp.....$3.95

KS 9607: Pri: 115 v, 400-2400 cy. Sec: 734 vct, 177 ma, 1710 vct, 177 ma.....$5.95

D-166333: Pri: 115 v, 400-2400 cy. Sec: 6.3 v, 0.9 amp; 7.7 v, 0.365 amp.....$2.79

#GE #7471957: Pri: 100/110/120/130 v, 400-2400 cy. Sec: 2.5 v, 20 amp, HV ins.....$4.85

D-163254: Pri: 115 v, 400 cy. Sec: 6.3 v, 12 amp; 6.3 v, 2 amp; 6.3 v, 1 amp. P/O AN/APQ-5.....$5.85

KS-9665: Pri: 115 v, 400-2400 cy. Sec: 6.4 vct, 7.5 amp; 6.4 v, 3.8 amp; 6.4 v, 2.5 amp.....$4.35

PLATE XFMR: Pri: 115 v, 400 cy. Sec: 9800 v, or 8600 v, @ 32 ma dc.....$12.50

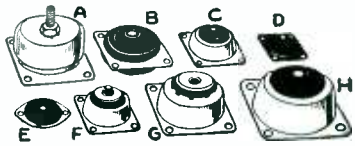
#12033: Plate Xfmr, Pri: 115 v, 800 cy. Sec: 4550 vct, 250 ma.....$7.95

WRITE TO C.E.C. FOR YOUR 400 CYCLE NEEDS

BATHTUB CAPACITORS

Fig.	Mfd	Voltage	Terminals	Price
D	3 x .1	600VDC	3	33¢ 4 for $1.29
E	3 x .1	400VDC	3	33¢ 4 for 1.29
C	.1	400VDC	2	20¢ 5 for 95¢
C	2 x .1	600VDC	3	29¢ 3 for 85¢
E	.025	600VDC	2	18¢ 5 for 85¢
A	2	400VDC	2	40¢ 2 for 75¢
C	.1	600VDC	2	25¢ 4 for 95¢
E	2 x .25	600VDC	3	29¢ 3 for 85¢
A	.5	1000VDC	2	45¢ 3 for 1.30
D	.1	600VDC	2	25¢ 4 for 95¢
E	3 x .1	600VDC	3	35¢ 3 for 1.00
E	.5	200VDC	2	20¢ 5 for 95¢
C	.05	600VDC	2	21¢ 5 for 1.00
E	.5	600VDC	2	25¢ 4 for 95¢
C	.5	120VDC	2	18¢ 5 for 85¢
E	.1	600VDC	1	20¢ 5 for 95¢
E	4	50VDC	2	25¢ 4 for 95¢
E	1	400VDC	1	25¢ 4 for 95¢
D	1	600VDC	2	30¢ 3 for 75¢
C	3 x .1	600VDC	3	33¢ 4 for 1.29
E	2 x .25	400VDC	3	27¢ 4 for 1.05
D	.5	600VDC	2	25¢ 4 for 95¢
D	2 x .1	600VDC	3	29¢ 3 for 85¢
D	.5	600VDC	1	20¢ 3 for 95¢
E	2 x .1	200VDC	2	20¢ 5 for 95¢
C	.5	400VDC	1	20¢ 5 for 95¢
	1	100VDC	2	15¢ 7 for 1.00
A	.02	1500VDC	2	45¢ 2 for 85¢
C	.5	600VDC	2	25¢ 4 for 95¢
C	.5	200VDC	2	20¢ 5 for 95¢
E	.4	50VDC	2	30¢ 3 for 85¢
E	.20	50VDC	2	25¢ 4 for 95¢

Write for Lists of Other Values



SHOCK MOUNTS

D	Lord	#1	1 1/4x1 1/4x3/8H	10¢
D	Lord	#6	1 1/4x1 1/4x3/8H	10¢
D	Lord	#5	1 1/4x1 1/4x3/8H	10¢
B	Lord	#15	1 3/4x1 3/4x5/8H	15¢
B	Lord	#12	1 3/4x1 3/4x9/16H	15¢
B	Lord	#35	2 1/4x2 1/4x1"H	18¢
G	U. S.	#5150-C	2 3/8x2 3/8x1 1/8H	55¢
F	Lord	#4	1 23/32x1 23/32x1"H	35¢
F	Lord	#1	1 11/16x1 11/16x3/4"H	14¢
C	Lord	#10	2 3/8x2 3/8x1 1/16H	25¢
C	Lord	#8	2 3/8x2 3/8x1 1/16H	20¢
H	Lord	#35	3x3x1 1/2H	45¢
H	Lord	#20	3x3x1 5/8H	39¢
H	Lord	#25	3x3x1 5/8H	45¢
H	Henrite	#55	3x3x1 5/8H	49¢
H	Lord	#15	3x3x1 1/2H	35¢
H	Lord	#45	3x3x1 1/2H	49¢
A	Barry	#C2070	3x3x1 1/2H	55¢
A	Barry	#C2060	3x3x1 1/2H	55¢
A	Barry	#C2090H	3"x3x"1 1/2H	55¢

Shaft 6 1/8"1x3/8" Dia Thread both sides with nuts washer, and two woven leads..... ea. 35

30' U. S. ARMY SIGNAL CORPS RADIO MASTS

Complete set for the erection of a full flat top antenna. Of rugged plymold construction telescoping into 3 ten-foot sections for easy stowage and transportation. Supplied complete: 2 complete masts, hardware, shipping crate. Shipping wt. approx. 300 lbs. Sig Corps #2A289-223-A. New .....$35.00 per set of 2

TELEPHONE EQUIPMENT

F.T. & R. 101-A APPLIQUE

Provides necessary balancing facilities for four wire repeater when used on two wire lines which may be voice-frequency telephone lines of open wire, or non-loaded or loaded cable. Std. 19" channel iron rack mtg. Price, new, complete with tech manual....$54.00

SB-19/GT CONSOLE

Provides facilities for patching and monitoring network of lines for telephone intercom, radio reception, telegraph reception, recording, etc. Complete central office supervising position $350.00

BC 686 LINE AMPLIFIER

With magneto ringer, 3-tube 25L6 amplifier. For local point-to-point telephone operation, remote operation of Phone Xmtr. remove reception of receiver output, monitoring facility. Requires only 24 vdc for tube "B" plus supply for full operation.
New, less tubes, in wooden chest.....$18.50
Per pair for 2-way pt-to-pt operation.....$35.00

F.T. & R. 102-B REPEATER EE-99

May be used as Terminal or Intermediate Repeater, 20 cycle ringing & DC Telegraph. Applicable on simplex operations. Monitoring facilities, equalizing facilities. Dry or storage battery operation. New...$55.00
Telephone switchboard lamp holders: 10 lamp holders per strip $4.25

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CABLE ADDRESS: COMSUPO
PHONE DIGBY 9-4124
131 LIBERTY ST. DEPT. E
NEW YORK 7, N.Y.
RADAR TELEVISION ELECTRONICS
FM MICROWAVE RADIO SONAR
C.E.C. MONEY BACK GUARANTEE. $3 MIN. ORDER. F.O.B. N.Y.C. SEND MONEY ORDER OR CHECK, ONLY SHIPPING CHARGES SENT C.O.D.

NEW LOW PRICES!

ALL BRAND NEW
STANDARD BRAND
WATCH THIS LISTING EACH MONTH FOR LATEST CHANGES

MINIMUM ORDER $5.00
QUANTITY PRICES ON REQUEST

Type	Price
1B22	$4.95
1B23	9.50
1B24	4.95
1B25A	4.95
1B27	4.95
1B29	.89
1B32	4.95
1B36	4.95
1B38	49.50
1B40	4.95
1B60	9.95
1P23	1.95
1S21	1.96
2AP1	3.95
2B4	.98
2C4	1.18
2C21	.98
2C22	.39
2C26A	.28
2C34	.59
2C40	1.98
2C43	7.50
2C44	1.75
2C46	7.50
2D21	1.18
2E22	1.50
2E24	4.95
2E25	4.25
2E26	3.95
2E30	2.39
2J21A	12.95
2J26	8.95
2J31	10.95
2J32	13.95
2J33	24.95
2J34	24.95
2J37	17.95
2J38	13.95
2J49	24.95
2JB51	4.95
2J54B	17.95
2K23	24.95
2K25	24.95
2K28	24.95
2K41	24.95
3AP1	4.95
3B22	4.95
3B23	4.95
3B24	1.98
3B26	1.89
3B27	3.95
3B28	5.95
3BP1	3.95
3C22	18.95
3C23	4.95
3C24	.69
3C30	1.50
3CP1	3.00
3D21A	1.50
3DP1	3.95
3EP1	3.95
3E29	4.95
3FP7	3.95
3J31	49.50
4-65A	14.50
4-125A	27.50
4-250A	37.50
4A1	1.98
4AP10	6.95
4B24	4.95
4C35	19.95
4E27	12.95
4J26	110.00
5AP1	4.95
5AP4	5.95
5BP1	2.95
5BP4	4.95
5CP1	3.95
5CP7	13.95
5D21	29.95
5FP7	3.95
5GP1	9.95
5HP4	9.95
5JP2	11.95
5LP1	11.95
5LP5	14.95
5NP1	2.95
6AF6G	.88
6C21	24.95
6D4	2.75
6F4	5.95
6J4	6.50
7BP7	4.95
7C23	75.00
7C24	80.00
7C25	90.00
9C23	250.00
9GP7	15.00
9JP1	7.95
9LP7	15.00
9NP1	7.95
10Y	.69
10SPEC	.69
10BP4	34.95
10CP4	39.50
12CP4	55.00
12DP7	14.95
12DP8	14.95
12FP7	14.95
12GP7	14.95

Type	Price
12HP7	14.95
15E	1.50
15R	1.50
23D4	.49
24G	.98
35T	4.95
45SPEC	.49
75TL	3.95
100TH	12.95
100TS	3.00
114A	.69
114B	1.25
120	5.95
121A	2.65
203A	16.95
205B	4.50
211	.98
215A	3.00
217C	7.30
218	49.50
221A	2.95
231D	1.49
242C	6.95
249C	3.49
250R	7.95
250TH	19.50
250TL	19.50
252A	4.95
254	19.95
259A	4.95
262A/B	3.50
274A/B	1.25
282A/B	9.95
290A	4.95
291A	4.95
294A	4.95
304B	5.95
304TH	6.95
304TL	1.49
307A	4.95
316A	.69
327A	4.95
338A	4.93
339A	24.95
350A/B	2.95
354C/D	19.95
368AS	4.93
371A/B	.89
393A	7.95
394A	7.50
399A	2.50
400A	3.25
401A	1.95
403A/B	1.75
417A	24.95
434A	7.95
446A/B	1.95
450TH	24.95
527	12.95
531	24.50
532A	4.95
575A	14.95
701A	4.95
703A	4.95
705A	2.95
706CY	18.95
707A/B	24.95
708A	7.95
710A	2.95
713A	1.65
714AY	6.95
715A/B	9.95
715C	24.95
717A	.99
720DY	34.95
721A/B	4.35
723AB	7.95
724A/B	4.95
725A	9.95
726A	23.50
750TL	49.50
800	2.25
801A	.98
802	3.75
803	8.95
804	12.95
805	5.95
807	1.25
808	1.89
809	2.93
810	7.95
811	2.45
812	2.95
812H	6.90
813	8.95
814	3.95
815	2.95
816	1.19
826	.69
828	6.95
829A/B	7.95
829/3E29	4.95
830	2.95
830B	5.25
832/A	4.95
833A	34.50
834	5.95
836	1.15
837	2.50
838	3.95

Type	Price
841	.69
843	.69
845/W	4.95
851	75.00
860	3.00
861	49.95
864	.69
865	2.98
866A	.99
866JR	1.19
869B	75.00
872A	2.95
874	2.49
878	2.49
884	1.49
885	.98
891	110.00
892	175.00
902P1	7.95
904	9.95
905	11.95
923	.98
925	1.40
931A	4.95
950	.98
954	.75
955	.75
956	.75
957	.75
958A	.75
959	2.95
991	.75
1608	4.95
1611	.98
1613	.75
1614	1.75
1616	1.39
1619	.75
1620	4.95
1622	1.75
1624	1.75
1625	.49
1626	.49
1628	4.95
1629	.69
1631	1.50
1634	.79
1635	1.10
1636	5.95
1638	.98
1641	.79
1642	.98
1644	1.49
1851	1.25
1852	1.06
1853	1.06
1960	.95
2050	1.19
2051	.98
5514	4.95
5516	5.95
5562	10.90
7193	.39
8003	5.95
8005	4.95
8011	2.95
8012A	4.95
8013A	2.95
8014A	24.95
8016	1.49
8020	3.95
8025	7.95
C5B	12.95
C6J	12.95
CEO72	1.95
CK1005	.35
CK1090	4.95
EF50	.79
EL1C	4.95
EL3C	4.95
F123A	12.95
F660	150.00
FG17	3.25
FG27A	9.95
FG33	8.95
FG67	12.95
FG81A	6.95
FG105	19.95
FG172A	32.50
FG235	59.50
FG238B	160.00
GL146	11.00
GL502A	1.98
GL530	49.50
GL559	5.35
GL697	150.00
HF100	3.95
HF200	12.95
HF210	17.95
HY65	2.49
HY69	2.49
HY75	1.25
HY615	1.25
HYE1148	.48
KU610	9.95
ML101	150.00
REL36	.98
RK22	4.95
RK23	4.95
RK25	2.95

Type	Price
RK33	.98
RK34	.59
RK39	1.75
RK59	3.95
RK60	.79
RK68	24.95
RK72	1.95
RK7	3.95
RX120	10.00
SD8J9	4.95
T205	1.50
T35	3.95
T200	10.95
TZ20	1.50
TZ40	2.95
UH50	5.95
V70D	6.95
VR75	.98
VR78	.75
VR90	.75
VR91	1.49
VR105	.98
VR150	.75
VT127A	3.00
VU111	1.19
WL460	14.95
WL468	14.95
WL532A	4.95
WL562	150.00
WL616	105.00
Z225	1.95
ZB120	6.95
ZP477/12DP8	14.95
0A2	1.69
0A3/VR75	.98
0A4G	1.06
0B2	2.05
0B3/VR90	.75
0C3/VR105	.98
0D3/VR150	.75
OY4	.88
0Z4	.88
OZ4G	.88
O1A	.50
1A3	.72
1A4	1.28
1A4P	1.56
1A5GT	.72
1A6	1.28
1A7GT	.80
1B3GT	1.49
1B4	1.56
1BB2/25S	1.28
1B7GT	1.06
1C5GT	.88
1C6	1.28
1C7G	1.28
1D5GP	1.55
1D7G	1.28
1D8GT	1.56
1E5GT	1.38
1E7G	1.56
1F4	1.06
1F5G	1.06
1F6	1.56
1F7G	1.56
1G4GT	1.06
1G6GT	1.06
1H4G	.88
1H5GT	.66
1H6G	1.28
1H6GT	1.28
1J6GT	1.28
1L4	.80
1LA4	1.06
1LA6	1.06
1LB4	1.96
1LC5	1.06
1LC6	1.06
1LD5	1.06
1LE3	1.06
1LG5	1.06
1LH4	1.06
1LN5	1.06
1N5GT	.80
1P5GT	1.06
1Q5GT	1.06
1R4	1.06
1R5	.80
1S4	.96
1S5	.72
1T4	.80
1T5GT	1.06
1U4	.80
1U5	.72
1V	.88
2A3	1.28
2A4G	1.28
2A5	.88
2A6	1.06
2A7	1.06
2B7	.88
2V3G	1.98
2X2A	1.25
3A4	.39
3A5	1.49
3A8GT	1.98
3B7	.36
3D6	.36
3LF4	1.28

Type	Price
3O4	.88
3Q5GT	.96
3S4	.80
3V4	.80
5AZ4	.50
5R4GY	1.15
5T4	1.28
5U4G	.60
5V4G	.96
5W4	1.06
5W4GT	.60
5X4G	.72
5Y3GT	.42
5Y4G	.60
5Z3	.72
5Z4	1.06
6A3	1.28
6A6	1.06
6A7	.80
6A8	.80
6A8GT	.80
6AB5/6N5	.88
6AB7/1853	1.06
6AC5GT	1.16
6AC7/1852	1.16
6AD6	.88
6AD7G	1.28
6AF6	1.25
6AG5	1.06
6AG7	1.28
6AH6	1.56
6AJ5	.99
6AK5	1.56
6AK6	.96
6AL5	.80
6AL7GT	1.06
6AQ5	.80
6AQ6	.72
6AQ7GT	.88
5AR5	.66
6AS7G	4.95
6AT6	.60
6AU6	.80
6AV6	.60
6B4G	1.28
6B5	1.56
6B6G	.88
6B7	1.28
6B8	1.28
6B8G	1.28
6BA6	.80
6BE6	.72
6BG6G	1.92
6BH6	.80
6BJ6	.80
6C4	.39
6C5	.66
6C5GT	.66
6G6	.80
6C7	1.28
6C8G	1.28
6D6	.66
6D8G	1.28
6E5	.85
6E6	1.06
6F5	.66
6F5GT	.66
6F6	.80
6F6GT	.66
6F7	1.06
6F8G	1.28
6G6G	1.06
6H6	.60
6H6GT	.60
6J5	.54
6J5GT	.54
6J6	1.16
6J7	.80
6J7GT	.80
6J8G	1.28
6K5GT	.96
6K6GT	.60
6K7	.66
6K7GT	.66
6K8	.96
6K8GT	.96
6L5G	1.06
6L6	1.42
6L6G	1.16
6L6GA	1.16
6L7	.96
6L7G	1.16
6N6G	1.56
6N7	.96
6N7GT	.96
6P5GT	.96
6Q6G	1.06
6Q7	.80
6Q7GT	.72
6R7	1.06
6R7GT	1.06
6S7	1.28
6S7G	1.28
6S8GT	1.06
6SA7	.66
6SA7GT	.66
6SB7Y	.88
6SC7	.72
6SD7GT	.49
6SF5	.66

Type	Price
6SF5GT	.72
6SF7	.80
6SG7	.80
6SH7	.39
6SJ7	.66
6SJ7GT	.66
6SK7	.66
6SK7GT	.66
6SL7GT	.96
6SNGT	.88
6SQ7	.60
6SQ7GT	.60
6SR7	.72
6SR7GT	.72
6SS7	.66
6ST7	.88
6SV7	.88
6T7G	1.24
6U/5G5	.72
6U6GT	.72
6U7G	.72
6V6	1.28
6V6GT	.80
6V7G	.88
6X4	.60
6X5GT	.60
6Y6G	.96
6Y7G	.88
6Z7G	1.28
6ZY5G	.88
7A4/XXL	.72
7A5	.72
7A6	.72
7A7	.72
7A8	.72
7AD7	1.06
7AF7	.72
7AG7	.88
7AH7	.88
7B4	.72
7B5	.72
7B6	.72
7B7	.72
7B8	.72
7C4/1203A	.39
7C5	.72
7C6	.72
7C7	.72
7E5/1201	1.66
7E6	.72
7E7	.88
7F7	.88
7F8	1.06
7G7/1232	1.06
7H7	.80
7J7	1.06
7K7	1.06
7L7	.88
7N7	.88
7O7	.72
7R7	.88
7S7	1.06
7V7	1.06
7W7	1.06
7X7/XXFM	1.06
7Y4	.72
7Z4	.72
10	.69
12A	.60
12A6	.39
12A6GT	.29
12A7	1.28
12A8GT	.80
12AH7GT	.88
12AL5	.80
12AT6	.60
12AT7	1.16
12AU6	.80
12AU7	.96
12BA6	.72
12BE6	.72
12C8	.69
12F5GT	.72
12H6	.39
12J5GT	.39
12J7G	.80
12J7GT	.80
12K7GT	.66
12K8	.88
12K8GT	.96
12Q7GT	.72
12SA7	.66
12SA7GT	.66
12SC7	.72
12SF5	.80
12SF5GT	.80
12SF7	.80
12SF7GT	.80
12SG7	.72
12SH7	.39
12SJ7	.66
12SJ7GT	.66
12SK7	.66
12SK7GT	.66
12SL7GT	.88
12SN7GT	.80
12SQ7	.60
12SQ7GT	.60
12SR7	.39
12SR7GT	.39

Type	Price
12X3	.98
12Z3	.88
14A7/12B7	.88
14AF7/XXD	.88
14B6	.88
14B8	.88
14C5	.88
14C7	.88
14E6	.72
14E7	.88
14F7	.88
14F8	1.06
14H7	.88
14J7	1.06
14N7	1.06
14Q7	.88
14R7	.88
14S7	1.06
14W7	1.06
14X7	1.16
14X4	.89
19	1.28
19T8	1.56
22	1.28
24A	.88
25A6	1.06
25A6G	1.06
25AC5GT	1.16
25L6GT	.66
25Y5	1.16
25Z5	.60
25Z6GT	.60
26	.72
27	.60
28D7	.39
30	.36
31	.39
32	1.28
32L7GT	1.28
33	.39
34	.38
35/51	.80
35A5	.72
35B5	.80
35L6GT	.66
35W4	.46
35Y4	.72
35Z3	.72
35Z4GT	.60
35Z5GT	.50
36	.39
37	.39
38	.39
39/44	.39
41	.66
42	.66
43	.66
45	.66
45Z3	.60
45Z5GT	.72
46	1.06
47	.96
49	.88
50	1.56
50A5	.88
50B5	.66
50L6GT	.66
50Y6GT	.72
53	1.06
56	.72
57	.80
58	.80
59	1.06
70/7GT	1.56
71A	.80
75	.66
76	.66
77	.66
78	.66
79	.88
80	.46
81	1.56
82	1.06
83	1.06
83V	1.28
84/6Z4	.72
85	.88
89	.72
89Y	.39
117L7GT	1.56
117M7GT	1.56
117N7GT	1.56
117P7GT	1.56
117Z3	60
117Z4GT	1.16
117Z6GT	.96
FM-1000	1.28
UX120	1.38
UX200	1.28
9001	.89
9002	.39
9003	.69
9004	.49
9005	.98
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0-130 AC V, W.H. 3½" rd, blank sc.....$3.00
0-150 AC V, Burl 2½" rd.....$2.95
0-150 AC V, Burl 2½" rd met cs.....$2.95
0-150 AC V, Hick 2½" rd met cs.....$2.95
0-150 AC V, Weston 2½" rd met cs bl sc, 400 cy.....$2.50
0-150 AC V, G.E. 3½" rd bl sc.....$4.50
0-150 AC V, G.E. 3½" rd 400 cy.....$4.00
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0-1 RF A, G.E. 2½" rd.....$3.50
0-1 RF A, G.E. 2½" rd met cs.....$3.00
0-1.5 RF A, Weston 2½" rd met cs bl sc....$2.50
0-1.5 RF A, Weston 3½" rd.....$8.25
0-2 RF A, Weston 3½" rd.....$8.50
0-2 RF A, Simp 2½" rd.....$3.50
0-2.5 RF A, Weston 3½" rd.....$8.50
0-2.5 RF A, Simp 3½" rd.....$4.95
0-2.5 RF A, W.H. 3½" rd.....$5.50
0-2.5 RF A, McClintock 3½" rd.....$4.50
0-3 RF A, W.H. 3½" rd.....$5.50
0-4 RF A, G.E. 2½" rd bl sc.....$2.95
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0-500 DC Micro, Simp 2½" rd.....$3.50
0-500 DC Micro, Trip 2½" rd.....$3.50
0-500 DC Micro, W.H. 3" sq Spec scale.....$4.95
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0-1 DC MA, DeJur Amsco 2½" rd Spec sc....$2.50
0-1 DC MA, G.E. 2½" rd Spec sc.....$3.00
0-1 DC MA, G.E. 2½" rd bl sc Spec sc.....$3.00
0-1 DC MA, G.E. D0-41 3½" rd.....$5.50
0-1 DC MA, McClintock @S-1811 3" sq, 65 ohms, Spec sc.....$3.50
0-1 DC MA, McClintock 3½" rd.....$3.50
0-1 DC MA, W.H. 3½" rd 53.7 ohms resist, MR35W001DCMA.....$7.50
0-1.5 DC MA, Hick 2½" rd met cs.....$2.00
0-2 DC MA, R.S. 20 MV mvt Spec sc.....$2.50
0-2.7 DC MA, Gruen GW 587 2½" bake case with Spec sc.....$1.95
0-3 DC MA, Gruen 2½" rd.....$2.00
0-3 DC MA, Gruen 2½" rd Spec sc.....$2.00
0-3 DC MA, Simp 2½" rd.....$2.25
0-3 DC MA, Weston 2½" rd met cs.....$2.50
5-0-5 DC MA, W.E. 3½" rd fl conc style bake case sc cal 50-0-50.....$3.50
0-10 DC MA, Hick 2½" rd met cs Spec sc.....$2.50
0-10 DC MA, McClintock 3" bake case, white sc.....$3.50
0-12.5 DC MA, RS 1¾" sq 50 MV.....$4.50
0-15 DC MA, Simp 3½" rd.....$4.50
0-20 DC MA, G.E. 2½" rd bl sc.....$3.00
0-20 DC MA, G.E. 3" sq.....$3.75
0-25 DC MA, Weston 3½" rd.....$4.95
25/250 dual range Weston Model 264 Portable, Vertical reading, with test cord and plug, Press for low reading.....$9.00
0-30 DC MA, G.E. 3½" rd.....$3.50
0-50 DC MA, G.E. 3½" rd.....$3.95
0-80 DC MA, G.E. 3½" rd.....$3.75
0-150 DC MA, Gruen 2½" rd.....$3.00
0-200 DC MA, Gruen 2½" rd.....$3.00
0-200 DC MA, Marion 3½" rd.....$4.00
0-200 DC MA, Simp 3½" rd.....$4.50
0-200 DC MA, W.H. 3½" rd.....$4.50
0-300 DC MA, G.E. 3½" rd.....$4.95
0-500 DC MA, W.H. 2½" rd.....$3.95

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0-1.5 DC A, G.E. 3½" rd.....$4.95
0-5 DC A, Gruen 2½" rd.....$3.50
0-15 DC A, Sun 3½" rd.....$4.00
0-15 DC A, Trip 3½" rd.....$4.00
0-15 DC A, W.H. 3½" rd surf mtd.....$3.50
0-30 DC A, Hoyt 2½" rd met cs.....$2.50
30-0-30 DC A, Beede 2½" rd met cs.....$2.95
30-0-30 DC A, G.E. 2½" rd met cs.....$3.50
30-0-30 DC A, U. S. Gauge 2" met cs bl sc...$1.50
0-200 DC A, Weston 506 2½" rd W 50 MV shunt.....$7.50
0-200 DC A, G.E. D0-41 3½" rd fl bake case with shunt.....$9.50
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0-500 DC A, G.E. DW-51 2½", Special sc....$3.50

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0-3 DC V, Simp 2" rd met cs ring mtd.....$2.00
3-0-3 DC V, W.H. 2½" rd surf mtd 200 r/v..$1.25
0-5 DC V, W.H. 2½" rd 200 r/v.....$3.50
0-10 DC V, Sun 2½" rd 100 r/v.....$2.50
0-15 DC V, Gruen 2½" rd.....$3.50
0-15 DC V, McClintock 2½" rd bl sc 1000 r/v.$3.00
0-20 DC V, Weston 2½" rd 1000 r/v.....$3.50
0-30 DC V, G.E. 2½" rd 250 r/v.....$2.95
0-30 DC V, DE Jur Amsco 2½" rd.....$2.50
0-50 DC V, Readrite 2½" rd stamped met cs.$1.00
0-15 KV DC, G.E. 3" sq 500 ua mvt, less mult $4.95
0-15 KV DC, W.H. 3½" rd 1 MA mvt, less mult.....$4.50

MAGNAFLUX INSPECTION UNIT

440 Volt 3 phase 60 cycle input, main transformer has taps for 220 volt operation. Variable tap primary transformer to regulate D.C. output. Air cooled rectifier, 5,500 Ampere output. Magnaflux Corp. Type #CQ5.5.

Brand New—In original crates—Net wt. approx. 1600 lbs.

Only Two Units available.

Each $450.00

"VIBROTEST" INSULATION RESISTANCE and A.C. - D.C. VOLTAGE TESTER

RESISTANCE RANGE: 0-200 Megohms (at 500 volt test potential) 0-2000 ohms.
VOLTAGE RANGE: 150-300-600 Volts D.C.
150-300-600 Volts A.C.

Push button action for resistance readings. Operates from internal power supply off two #6 dry cells. Large 4" meter and knife edge pointer insure accurate readings. Complete with test leads and instructions in metal carrying case.

Associated Research Model #201.
(Slightly used—excellent condition—guaranteed).
Your Net Price $38.00

PORTABLE CHRONOMETRIC TACHOMETER

Measures shaft speeds from 10 RPM to 20,000 RPM. Measures lineal speeds 5 FPM to 10,000 FPM. Meets Navy Specs. ½ of 1% accuracy. With accessories and case 5" x 3½" x 1½". List price $75.00. Net Price.....$24.50

PORTABLE TACHOMETER MULTIPLE RANGE

Continuous Indicating Shaft or lineal speeds from 300-1200, 1000-4000, and 3,000 to 12,000 RPM. Meets Navy spec. 18-T-22 Type B, Class A. With accessories in case 7⅛" x 4" x 5". List Price $75.00. **NET PRICE**.....$24.50
TACHOMETER same as above, except ranges are 300 to 1500, 1,000 to 5,000 and 3,000 to 15,000.
Your Net Price $25.50

All meters are in round flush bakelite case with white scale and are standard in every respect unless otherwise specified. All items are Surplus—New — Guaranteed unless specified otherwise.

MARITIME SWITCHBOARD

(Worth 4-8217)

336 Canal St. New York 13, N. Y.

Orders accepted from rated concerns, public institutions & agencies on open account, others please send 25% deposit, balance C. O. D. or check with order. All prices FOB our warehouse, N.Y.C.

IMMEDIATE DELIVERY — LOW PRICES — FULLY GUARANTEED

D.C. MOTORS

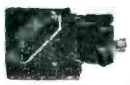
Blower Assembly MX-215/APG

John Oster C-2P-1L 28 v. DC. 7000 RPM 1/100 hp. #2 L-R Blower.

Stock #SA-202.
Price $2.95 each

Universal Electric DC

W.E. KS-5603-L02. 28 v. DC. 0.6 amps. 1/100 hp. 4 lead shunt. Stock #SA-233.
Price $1.95 ea. plus 15c p.p.



Delco 5069466 Motor

Alnico PM field. 27.5 v. DC. 1" x 1" x 2" lg. Pinion gear on shaft. Stock #SA-65.
Price $2.95 each plus 15c p.p.

DELCO CONSTANT SPEED MOTOR A-7155

1/30 hp. 3600 rpm. Cont. duty. 2½" diam. x 5½" lg. ⅞" shaft extension, 5/32" diam. 4 hole base mounting. Stock #SA-94. **Price $4.75 each.**

Delco 5069625 Constant Speed DC Motor, 27 v. DC. 120 rpm. Governor controlled. Stock §SA-249. **Price $3.95 each.** Qty. prices on request.

ALSO IN STOCK

400 CYCLE MG SETS
AMPLIDYNES, AUTOSYNS
AC AND DC RATE GENERATORS

MICROWAVE ANTENNA

AS-217/APG 15B. 12 Cm dipole and 13 inch Parabola housed in weatherproof Radome 16" dia. 24 v. DC spinner motor for conic scan. Stock #SA-95. Shipping wt. 70 lbs.

Price $9.50 ea.

GYRO SERVO UNIT

Pioneer 12800-1-D. 115v. 400 cy. Low inertia motor and follow-up Autosyn. Stock #SA-160. **Price $6 95 each**

DYNAMOTOR

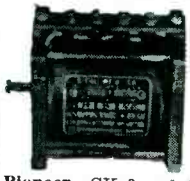
D-101 27 v. DC in @ 1.5 amps. DC out. 285 v. @ 0.60 amps. Stock #SA-187.
Price $1.50 each

RECORDER

Brown Instrument Co. "Electronik Recorder" 12 in. chart. One rev. per 10 min. Center O. 200 micro volts DC for full chart. Use as recording galvanometer, or modify for use with strain gauges, etc. Charts included. Operates from 110 volts 60 cycle line. Unit supplied complete with amplifier and tubes. Stock #SA-261.

Price $89.50 each

AC-SERVO MOTORS



Pioneer—CK-2 and 10047-2A for 400 cy.
Kollsman—776-01 for 400 cycles.
Diehl—FP-25-3. **FPE-25-11** (CDA-211052) and ZP-105-14 for 60 cycles.

Prices on Request

Remote Position Indicating System

6-12 v, 60 cycles 5 inch indicator with 0 to 360° dial. Heavy duty transmitter. Stock #SA-115. **Price $9.95 per system**

LP-21-LM Compass Loops

New

QUANTITY PRICES ON REQUEST

MERCURY CONTACT RELAY

W.E. D-168479

Millisecond switching at up to 60 c.p.s. Technical data on request. Stock #SA-259. **Price $4.75 ea. Special qty. prices.**

SPECIALS

400 Cycles
Three Phase

INVERTERS

Holtzer Cabot MG-153—Input 28 volts DC at 52 amps. Output three phase 115 volts 400 cycles at 750 va. 0.90 P.F. Also second output of 26 volts 400 cycles at 250 V.A. Voltage and frequency regulated.
New—Perfect ..... **$99.50 ea.**
New—Surface Damages ..... **59.50 ea.**

Leland SD-93—(10285)—Input 28 volts DC at 60 amps. Output 115 volts three phase 400 cycles at 750 va. 0.90 P.F. Second output voltage of 26 volts 400 cycles at 50 V.A. Voltage and frequency regulated. Designed for use with various autopilots. Stock #SA-209. **Price $79.50 each**

Holtzer Cabot MG-149H—Similar to MG-149F but draws 44 amps DC at 28 v. Output ratings are at 0.90 P.F. Equipped with high altitude brushes. Stock #SA-4.
Price $34.50 each

General Electric 5D21NJ3A — Input 28 volts DC at 35 amps. Output 110 volts 400 cycles. 485 V.A. at 0.90 P.F. Weight 15 lbs. Stock #SA-41. **Price $12.50 each**

Air Research Actuator—25080 (Manual Flap). 24V. DC. Rated Load Lbs. Stat. 2800, Ten 1750, Comp. 850. Stock #SA-264. **Price $12.50 each.**
Air Research Actuator—25040. (Automatic Flap). Similar to above. Stock #SA-263. **Price $12.50 each.**

Air Research Actuator — 25800-24 — (Air Valve Actuator.) Rated Load Lbs. stat. 200, Ten. 75-100, Comp. 75-100. Stock #SA-227. **Price $6.75 each.**

Bodine NYC-13 AC Motor

115 v, 60 cycles, 1/40 hp. 1800 rpm. Cont. duty. .55 amps. Stock #SA-245.
Price $9.50 each.

SYNCHROS

Navy Types

1G, 1F, 1CT, 5C, 5F, 5CT, 5DG, 5HCT, 5SF, 5HSF, 5SDG, 6DG, 6G, 6DG, 7G, etc.

Prices on Request

All prices F.O.B., Paterson.
Teletype PAT. 199
Phone ARmory 4-3366
Write for Listing.

Servo-Tek products co
4 Godwin Ave. Paterson, N. J.

TRANSFORMERS AND CHOKES

115V 60cy. INPUT
Equip. Conservatively Rated

FILAMENT TRANSFORMERS

5 Volts/6 Amp		$2.25
F083:	6.3VCT/6A, 5V/2A	1.85
F-	2.5VCT/6.5A	3.25
F-	6.3VCT/2A, 6.3VCT/2A	2.45
F087:	6.3VCT/1A, 6.3VCT/7A	2.75
F103:	6.3V/1A, 6.3V/1A	1.95
F123:	6.3VCT/5A, 6.3V/1A	2.25
F127:	6.3VCT/3.2A, 6.3VCT/1A	2.25
F674:	8V/1.5A	2.75
F-	2.5/1.75A, 6.5/8A, 5V/3A, 6.5/ 6A	3.95
F414:	2 x 2.5VCT/6.5A	3.25
F161:	6.3VCT/7A, 6.3VCT/5A, 5VCT/6A 2 x 6.3V/.6A, 6.3V/.3A	3.95
F829:	6V/2.5A	1.75
F38A:	6.3V/2.5A, 2 x 2.5V/7A	3.25
F112:	2 x 2.5VCT/6.5A, 2.5V/6.5A	4.25
F14A	6.3/6A	1.95

PLATE TRANSFORMERS

P410:	800VCT/40MA, 760VCT/500MA	6.50
P415:	690V/450MA	4.95
P699:	2 x 300VCT/150MA	2.25
P403:	70V/1A	2.25
P413:	510VCT/150MA, 650VCT/15MA	4.95
P842:	600VCT/.0166A, 250VCT/.077A	2.95
P885:	1620VCT/400MA HV INS	11.95
P894:	2 x 200V/350MA, 2 x 20V/.01A	1.95
P450:	2 x 150V/940MA	4.50
P371:	246VCT/830MA	3.95
P345:	1470VCT/1.2A, 3500T	24.00

COMBINATION TRANSFORMERS

C965:	78V/600MA, 6.3V/2A	$3.95
C111:	2 x 300V/42MA, 55V/125MA 45V/3.5 Amp	3.95
C608:	880VCT/150MA, 5V/3A, 6.3V/6.25A	5.00
C931:	585VCT/86MA, 5V/3A, 6.3V/6A	3.95
C055:	525VCT/75MA, 5V/2A, 6.3V/1.8A 10V/2A	4.45
T102:	1080VCT/55MA, 2 x 6.3V/2A	5.95
C848:	600VCT/155MA, 6.3VCT/5A 5VCT/3A HV Ins	3.95
C899:	2 x 110VCT/.01A, 6.3V/1A 2.5VCT/7A	4.50
C760:	6.3VCT/10A, 65V/.1A, 100VCT/.1A, 40V/.1A, 18VCT/.1A, 18V-6V/.1A, 6.3V/.1A	5.50
C354:	825VCT/190MA, 5VCT/3A	3.95
C367:	5VCT/3A, 580VCT/.040A	2.95
T160:	1120VCT/770MA, 590VCT/.082A HV Ins	12.75
C579:	24V/900MA, 770V/.0025, 2.5V/3A HV Ins	4.25
T378:	2300V/.004A, 2.5V/2A HV Ins	8.95
C375:	1120VCT/60 MA, 2 x 5VCT/6-2A 6.3VCT/3A, 6.3V/300MA	14.95
C364:	6.3VCT/3A, 5VCT/6A, 610VCT/ 330MA	4.75
C434:	40V/.01A, 6.3V/1.25A	1.95
C383:	215VCT/300MA, 5VCT/6A	2.29
C360:	640VCT/.080A, 5VCT/3A, 6.3VCT/ 3.2A	3.95
C821:	1500V/.4A, 6.3V/.6A, 2.5V/1.75A, 3500T	8.95

FILTER CHOKES

.03HY/2A	$1.25	8.5HY/125MA	$1.50
25HY/65MA	1.00	6HY/150MA	1.50
Dual 7HY/75MA, 11HY/65MA			1.65
7HY/140MA	1.60	Dual 2HY/100MA	.75
Dual 2.5HY/130MA	1.25	.116HY/150MA	4.25
.01HY/2.5A	1.45	.35HY/350MA	7.25
Dual .5HY/380MA	1.00	5HY/40MA	.55
2HY/200MA	.75	Dual 120HY/17MA	2.45
30HY 20MA	.85	5HY/200MA	1.45
2.1HY/200MA	1.20	2 x 2.2HY/.55A	9.95
25HY/75MA	1.10	20HY/300MA	7.95
Dual .22HY/600MA, .44HY/400MA			1.95
Swing 1-3HY/.225-.02A, 1.75HY/225MA			2.25
Tapped Choke 2 x 1.52HY/167MA			2.25
.033HY/7A	9.50	Dual 10HY/150MA	3.50
Dual 1.52HY/167MA	2.49	Dual 2.2HY/550MA	5.95
5HY/200MA	1.49	1.35HY/1.1A	4.95
12HY/100MA	1.75	1HY/100MA	.60
2x2.5HY/700MA	6.95	Send For	
3.5HY/400MA	5.95	Lists of Others	

POWER EQUIPMENT

- Fil. Trans. 110v 60 cy in., 5vct/30A out ... $9.95
- In 110v 60 cy out 6.3vct/20A, 6.3v/1.8A, 6.3v/600 MA ... $4.95
- In 110v 60 cy out 2x5vct/6.75A, 5vct/13.5A, 3500 Test ... $6.95
- In 110v 60 cy out 10vct/13A, 10vct/6.5A, 6.3vct/2A ... $7.95
- In 115v 60 cy out 760vct/500MA, 800vct/40MA ... $10.95
- In 110v 60 cy out 690vct/400MA ... $6.95
- Tapped in. 107 to 127v out 160v to 200v/700MA 12 Taps ... $12.95
- In 110v 60 cy out 4v/16A, 2.5v/1.75A ... $4.75
- In 110v 60 cy out 17000v/144MA, w/choke 26" x 29"x13" oil immersed ... $65.00
- In 115v 60 cy out 2x5v/5.5A 29kv ins ... $24.50
- In 115v 60 cy out Tapped to give 2750/2470/2240/@ 750 MA 7000v ins ... $34.50

SPECIAL TRANSFORMERS

- In 440/220/110v 60 cy 3kva out 115v 25kv ins. 12"x12"x7" ... $40.00
- In 220v 60 cy .05kva out 5vct 34kv Test ... $24.50
- In 115v/230v 50-60 cy out 21000v 100MA ... $120.00
- In 220v 60 cy out 220v/360MA, 3x2.5v/5A, 2.5v/15A ... $6.75
- In 220v 60 cy out 10vct/13A, 7.5vct/2.5A ... $5.25
- In 220v/440v 60 cy out 123vct/2.85A ... $7.50
- In 240v 60 cy 7000vct/900MA, 4800vct/750 MA ... $135.00
- In 210/15/20/25/30/35/240v 60 cy out 11vct/35A, 10vct/35A, 7.5vct/35A, 5vct/35A ... $37.50

COMMUNICATIONS EQUIPMENT COMPANY — for your needs

DYNAMOTORS

Type	Input Volts	Input Amps	Output Volts	Output Amps	Radio Set	Prices*
PE 86	28	1.25	250	.060	RC 36	$3.95
DM 416	14	6.2	330	.170	RU 19	15.95N
DY-2/ARR-2	28	1.1	250	.060	ARC-5	4.75N
DM 36	28	1.4	220	.080	SCR 508	8.75N
DM 53AZ	14	2.8	220	.080	BC 733	7.00N
PE 73CM	28	19	1000	.350	BC 375	N
DM 21	14	3.3	235	.090	BC 312	3.45N
DM 21CX	28	1.6	235	.090	BC 312	3.45N
DM 25	12	2.3	250	.050	BC 367	2.49LN
DM 28R	28	1.25	275	.070	BC 348	8.95N
DM 33A	28	7	540	.250	BC 456	5.50N
DM 42	14	46	515	.110	SCR 506	6.50LN
			1030	.050		
			2/8			
PE 101C	13/26	12.6	400	.135	SCR 515	5.25N
		6.3	800	.020		
BD AR 93	28	3.25	375	.150		4.95N
23350	27	1.75	285	.075	APN-1	3.50N
35X045B	28	1.2	250	.060		3.50N
ZA .0515	12/24	4/2	500	.050		3.95N
ZA .0516	12/24	8/4	12/275	3/.110		5.50N
B-19 pack	12	9.4	275	.110	Mark II	9.95N
			500	.050		
D-104	12		225	.100		14.95N
			440	.200		
DA-3A*	28	10	300	.060	SCR 522	8.95
			150	.010		
			14.5	.5		
#5053	28	1.4	250	.060	APN-1	3.95N
DA-7A	26.5		1100	.400	TA-2J	25.00N
CW 21AAX	13	12.6	400	.135		17.50N
	26	6.3	800	.020		
			9	1.12		
BD 77KM	14	40	1000	.350	BC 191	N
						14.00LN
PE 94	28	10	300	.260	SCR	15.00N
			150	.010	522	
			14.5	.5		

N—New. LN—Like New. *Less Filter Box & Relays
Replacement dynamotors for PE-73, less filter box $12.00

HAND GENERATORS

GN 35: 350 v, 60 ma; 8v, 2.5 A. New, with hand cranks ... $12.50

GN 45: 500 v, 100 ma; 6v, 3 amps. Slight use, ex. con., with cranks ... $12.50

MICROWAVE GENERATORS

AN/APS-15A "X" Band compl. RF head and modulator, incl. 725-A magnetron and magnet, two 723A/B klystrons (local osc. & beacon), 1B24 TR, rcvr-ampl. duplexer, HV supply, blower, pulse xtmr. Peak Pwr Out: 45 KW apx. Input: 115, 400 cy. Modulator pulse duration .5 to 2 micro-sec. apx. 13 KV Pk Pulse. Compl with all tubes incl. 715-B, 829B, RKR 73, two 72's. Compl. pkg., new ... $210.00

APS-15B. Complete pkg. as above, less modulator ... $150.00

"S" BAND AN/APS-2. Complete RF head and modulator, including magnetron and magnet, 417-A mixer, TR, receiver, duplexer, blower, etc., and complete pulser. With tubes, used, fair condition ... $75.00

10 CM, RF Package. Consists of: SO Xmtr.-receiver using 2J27 magnetron oscillator, 250 KW peak input. 707-B receiver-mixer. Rotating York PPI for above ... $150.00

Modulator-motor-alternator unit for above ... $ 75.00
Receiver-rectifier power unit for above ... $ 25.00
Rotating antenna with parabolic reflector for above. New ... $ 75.00

INVERTERS

PE 218-E: Input: 25-28 vdc, 92 amp. Output: 115 v, 350-500 cy, 1500 volt-amps. Dim: 17" x 6½" x 10". New, export packed ... $49.95

PE 218-H: Same as above, except size: 16½" x 5¾" x 10" ... $49.95

PE 218-H: Used, good cond. ... $25.00

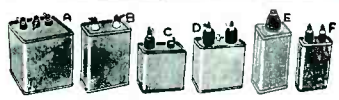
PE 205: Input: 28 vdc, 38 amps. Output: 80 v, 800 cy, 500 volt-amps. Dim: 13" x 5⅝" x 10½". New ... $ 2.50

GE 5D21NJ3A: Input: 28 vdc, 35 amp. Output: 115 v, 400 cy, 485 volt-amps. Dim: 9" x 4½" diameter. New ... $49.95

COAX CABLE

RG 17/U. 52 ohm imp. ... $.50/ft.
RG 18/U. 52 ohm imp. armored ... .51/ft.
RG 23/U. twin coax, 125 ohm imp. armored ... .50/ft.
RG 28/U. 50 ohm imp. pulse cable. Corona min. starting voltage 17 KV ... .50/ft.
RG 57/U. 95 ohm imp. twin coax ... .35/ft.

Typewriter Desk Wells Mounted on Steel Panel for Standard Rack Mtg. 10½" H x 19" W x ⅛" Thick. Well is 22" Wide, 20" Deep. Affording Full Working Space. Grey Crackle Finish. New ... ea. $6.95



OIL CONDENSERS

(Standard Brands)

.0016 MFD	15000 VDC	$8.00
.015 MFD	16000 VDC	7.00
.01-.005-.005 MFD	10000 VDC	4.75
.1 MFD	2500 VDC	1.25
.1-.1 MFD	7000 VDC	3.49
.1 MFD	6000 VDC	2.97
.1 MFD	7500 VDC	3.00
2 x .1 MFD	4800 VDC	3.00
.15 MFD	4000 VDC	3.00
.15-.15 MFD	6000 VDC	4.00
2 x .15 MFD	8000 VDC	5.00
.25 MFD	20000 VDC	17.50
.25 MFD	1500 VDC	1.05
.4 MFD	5000 VDC	3.00
.5 MFD	1000 VDC	.70
.5 MFD	750 VAC	1.75
.5-.5 MFD	400 VDC	.60
1 MFD	600 VDC	.49
1 MFD	2000 VDC	1.00
1 MFD	1500 VDC	.89
1.5 MFD	1500 VDC	.95
1.5 MFD	1000 VDC	.75
2 MFD	1500 VDC	1.05
4 MFD	1000 VDC	.98
6 MFD	600 VDC	1.05
6 MFD	1500 VDC	2.25
7 MFD	600 VDC	1.05
7 MFD	800 VDC	1.25
10 MFD	1000 VDC	1.95
15 MFD	220 VAC	2.29
15 MFD	1000 VDC	2.25
1.5 MFD	6000 VDC	10.00
1 MFD	15000 VDC	32.50
.5 MFD	25000 VDC	37.50
1 MFD	25000 VDC	85.00
.1 MFD	10000 VDC	15.00
.06 MFD	15000 VDC	8.00
25 MFD	20000 VDC	17.50

TRANSTATS (AMERTRAN)

Input: 0.115 v, 50-60 cycle. Max. output: 115 v, 100 amp. All units are new, guaranteed $95
2 KVA: 90-130 v input, 50-60 cycles, output 115 volts.
2 KVA Type RH Amertran ... $29.95 each

CIRCUIT BREAKERS

Fig. A, 50A	28V	79¢	
Fig. A, 100A	28V	79¢	
Fig. A, 150A	28V	79¢	
Fig. A, 10A	24V	79¢	
Fig. B, 3A	117V	$1.95	
Fig. C, 100A	250V	3 Pole 6.95	

CARTRIDGE FUSES

Send for C.E.C Flyer of Fuses You Need. Do not delay. Write today.

PRECISION CAPACITORS

D-163707: 0.4 mfd @ 1500 vdc. —50 to plus 85 deg C ... $4.50
D-163035: 0.1 mfd @ 600 vdc, 0 to plus 65 deg C ... $2.00
D-170908: 0.152 mfd, 300v, 400 cy, —50 to plus 85 deg C ... $2.50
D-164960: 2.04 mfd @ 200 vdc, 0 to plus 55 deg C ... $2.50
D-168344: 2.16 mfd @ 200 vdc, 0 to plus 55 deg C ... $3.00
D-161555: .5 mfd @ 400 vdc, —50 to plus 85 deg C ... $3.00
D-166602: 16 mfd @ 400 vdc, temp comp 50 to 85 deg C ... $12.50
D-161270: 1 mfd @ 200 vdc, temp comp —40 to plus 65 deg C ... $12.50

CERAMICON CONDENSERS

$7.50 per 100

3 mmf	±5%	60 mmf	±3%
5 mmf	±5%	67 mmf	±20%
4 mmf	±5 mmf	115 mmf	±2%
8.5 mmf	±5 mmf	120 mmf	±5%
11 mmf	±5%	240 mmf	±3%
15 mmf	±2.5 mmf	250 mmf	——
50 mmf	±20%	1000 mmf	±5%

Silver-Mica Button Capacitors (Standard Brand) $9.50 per 100

185 mmf	±2.5 mmf
175 mmf	±2.5 mmf
500 mmf	±10%

THERMISTORS

D-167332	(tube)	$.95
D-170396	(bead)	$.95
D-167613	(button)	$.95
D-166228	(button)	$.95
D-164699	for MTG. in "X" band Guide	$2.50
D-167018	(tube)	$.95

VARISTORS

D-171631	$.95
D-167176	$.95
D-168687	$.95
D-171812	$.95
D-171528	$.95
D-168549	$.95
D-162482	$3.00
D-166277	$2.50
D-161871A	$2.85
D-16187A	$2.85
D-163075	$1.25
3A(12-43)	$1.50
D-167020	$3.00

COAX PLUGS

83ISP	$.35
83IAP	$.35
83IHP	$.15
UG 21/U	$.85
UG 86U	$.95
UG 254/U	$.75

MAIL ORDERS PROMPTLY FILLED $3.00 MIN. ORDER

COMMUNICATIONS EQUIPMENT CO.

131 Liberty St., New York, N. Y., Dept. E6, Mr. Chas. Rosen, Ph. Digby 9-4124

SEND MONEY ORDER OR CHECK ONLY. $3.00 MIN. ORDER

ALL MERCHANDISE GUARANTEED — ALL PRICES F.O.B. NEW YORK CITY — SHIPPING CHARGES SENT C.O.D.

MODEL AN/APA 10 PANORAMIC ADAPTER

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 455kc, 5.2mc, or 30mc. With 21 tubes including 3" scope tube. Converted for operation on 115 V. 60 cycle source.

Includes 80 page T. M..... $195.00

8,000-Volt TRANSFORMERS

Primary: 115 V., 60 cycles.
Secondary: 8000 V., C.T., 800 V.A.

Brand new in sealed cans....$27.50

SHOCK MOUNTS

Lord #20. 3" x 3" x 1¾".....	.40
U. S. Rubber #5150 C, 2⅜" x 2⅜" x 1⅛".....	.30
Lord 15, 2⅜" x 2⅜" x 1⅛".....	.25
Lord #10, 1¼" x 1¼" x ⅝".....	.10
Lord #3, 1¼" x 1¼" x ⅜".....	.10

PARABOLOIDS

17½" diameter, spun magnesium dishes, 4 inches deep. Reinforced perimeter. Two sets of mounting brackets on rear. Opening at apex for waveguide dipole assembly 1½" x 1⅝".

Brand new, per pair, $8.75

SOUND POWERED TEL. FIELD SETS

Type TP3

For two-way signalling for voice communication. No batteries needed. May be used on metallic or grounded circuits, open-wire lines, cables or circuits using local-battery telephones, switchboards; two-way-ring-down trunk circuits of common battery switchboards, etc. Contained in treated waterproof fabric cases with adjustable carrying straps.

Brand new $29.50

25,000 VOLT CAPACITORS STANDARD BRANDS

Inerteen Type FP 25,000 volts .5 MFD. Size 13½"x 16½"x4½" with mounting brackets.

Brand new $23.50

15,000 Volts 1MFD. Cat. No. 1463. Size 12"x16½" x4". With mounting flange.

Brand new $14.50

LINEAR SAWTOOTH POTENTIOMETER

W.E. No. KS 15138

Input 24 volts D.C. Output varies in accordance with linear sawtooth wave.

Brand new $5.75

RELAY

Clare octal base Relay No. 30FMX 115V. 60 cy. 0.140 amp. Res. 75 ohms. Makes two breaks one.

Brand new $2.45

SELENIUM RECTIFIER

Bridge Type

Input: 36 V. AC.
Output: 28 V. DC., 1.1 Amps.

Brand New $2.75

WESTERN ELECTRIC MERCURY CONTACT RELAYS

TYPE D-168479

These relays are glass sealed, mercury-wetted contact switches surrounded by operating coils and encased in metal housings, mounted on an octal tube base.

TYPICAL APPLICATIONS

- High speed keying
- Tabulating, sorting and computing machines
- Relay Amplifiers
- Vibrator Power Supplies
- Servo-mechanisms

CHARACTERISTICS

- High speed of operation
- Constant operating characteristics
- Freedom from chatter
- High current capacity
- Long, trouble-free service

Single Pole, Double Throw Contacts. Two coils of 700 ohms and 3300 ohms. Operating current with coils connected in series 6.6 ma. Release current 5.2 ma.
When operated under specified conditions this relay has a life expectancy of 1000 hours at 60 operations per second.

Overall length—3-3/8". Overall dia.—1-5/16"

Brand new Priced at a fraction of Government cost **$4.75**

Send for 4 page Technical data.

RADAR COMPONENTS

CRP-23AGC Load Dividers for use with S.G. Modernization Kits. New

CBM-50AFO Navy type Radar Repeater Adapters. New and complete with 14 tubes, coax fittings, installation plans and wiring diagrams.

SO Series Radar P.P.I. Units and accessory Control Panels. New

Synchro Amplifiers. New

Type CARD 23AEK Bearing Control Units. New

Type T.D.Y., SO-1, SO-13, SO-3 Radar Antenna Assemblies. New

T.D.Y. Antenna Control Units

Radar Tubes, types 4C35, 7BP7, 3B24, 3C45, 721A, 2J62, 9LP7, 3B22, 1B24, IN21B Crystals, etc.

Radar Crystals Raytheon 98.35 KC

Type SO-11 Radar Modulator

Type SO-1 and SO-3 Transmitter Receivers

STEPDOWN TRANSFORMERS

Input: 115V. 60 cycles.
Output: 20 V., at 10 amps.
Also tapped at 6V., for pilot light. Ideal for Selenium Rectifier Applications, etc.

Brand New $2.45

MOTOR GENERATORS

Allis Chalmers 115V. D.C. to 120V. 60 cy. 1 Ph. 1.25 K.V.A., P.F. .80 Centrifugal starter. Fully enclosed.

New $97.50

Same as above but for 230V. D.C. input **$125.00**

Diehl 120V. D.C. to 120V. A.C., 60 cy., 1 Ph., 2.5 K.V.A., P.F .4. Complete with magnetic controller, 2 field rheostats and full set of spare parts including spare armatures for generator and motor.

New $185.00

O'Keefe and Merritt, 115V. D.C. to 120V. A.C. 50 cycles, 2 K.V.A., Pf .9 Idles as a 3 phase synchronous motor on 208V. 50 cy.

New $165.00

Electrolux Dynamotor 105/130V. D.C. at 6 amps. to 26 or 13V. D.C. at 20 amps or 40 amps. respectively. Fully filtered for radio use and complete with Square "D" lineswitch. Navy type CAJO-211444.

New $74.50

RADAR EQUIPMENT

Navy Yard Spares for Model SG Radar Consisting of the following:

2—CRP-20ABM Rectifier Power Units for modulation generators.
2—CRP-20ABM Rectifier Power Units for Radar Receivers
2—CRP-35AAH Modulation Generators
2—CRP-46ABD-1 Radar Receivers (including R-906 Gain Controls for Range and Train Indicators)
2—CRP-60AAN Signal Monitors
2—Complete Transmitter R.F. System coupling assemblies including—10087 magnets and Duplexing tube cavity assemblies.
1—Complete Power Control Chassis
2—Complete Driver and modulator assembly including driver chassis with delay line, Modulator and Driver Rectifier Tube Assembly and Driver Rectifier Power Unit
2—Complete sets of equipment spare parts consisting of R.F. Assemblies, motors and accessories, switches, interlocks, fuses, fuse holders, fuse links, relays, contacts, crystals, thermostats, R.F. inductors, capacitors, sockets, test equipment, cables, resistors, etc., as listed in Navy Spare Parts List WX3885

All above in new and unused condition packed in original metal spare parts boxes.

Total price for whole lot, $950.00

THERMOSTATIC TIME DELAY RELAYS

Amperite type 115 No-45.

Heater voltage 115V. Normally open SPST contacts. 45 sec. delay. Contact rating 115V-3A., A.C. (or 440V., A.C. 2A.) max. voltage on contacts—1000. max voltage bet. contacts and heater—1500. Size 3 9/32 x 1 ¼" overall. Made for U. S. Navy.

New surplus $1.10

All prices indicated are F O B Tuckahoe, New York. Shipments will be made via Railway Express unless other instructions issued.

ELECTRONICRAFT

INC.

5 WAVERLY PLACE TUCKAHOE 7, N. Y.
PHONE: TUCKAHOE 3-0044

All merchandise guaranteed. Immediate delivery, subject to prior sale.

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RELIANCE SPECIALS

STEEL JUNCTION BOX

Water-tight, 14 ga. steel. 17"x25"x6½". Screw type brass hinge on lid. 50 lb. Reduced to **$2.95**

SELSYNS

115 V., 60 Cyc.
3¼" dia. x 4½" body
#C78248

$7.25 pair

DIFFERENTIAL

115 V., 60 Cyc.
#C78249

$2.25 ea.

Used between two #C78248's as dampener. Can be converted to a 3600 RPM Motor in 10 Minutes. Conversion sheet supplied.
Mounting Brackets—(Bakelite) for selsyns and differentials shown above.....**25¢ pair**

WW PRECISION RESISTORS 1%

¼ WATT—25c

6.68Ω	12.32Ω	16.37Ω	123.8Ω	414.3Ω
10.48	13.02	20	147.5	705
10.84	13.52	62.54	220.4	2193
11.25	13.89	79.81	301.8	10,000
11.74	14.98	105.8	366.6	59,148

½ WATT—25c

.250Ω	11.1Ω	235Ω	4,451Ω	15,000Ω
.334	13.15	260	5,000	15,750
.502	46	270	5,900	17,000
.557	52	298.3	6,500	20,000
.627	55	400	7,000	30,000
.76	75	723.1	7,500	100,000
1.01	97.8	2,500	8,000	150,000
1.53	125	2,850	8,500	
2.04	180	3,427	10,000	
2.25	210	4,000	14,825	

1 WATT—30c

1.01Ω	5.21Ω	1,250Ω	9,000Ω	55,000Ω
2.58	10.1	3,300	18,000	65,000
3.39	10.9	7,000	50,000	70,000
5.05	270			75,000

1 WATT—40c

100,000Ω	128,000Ω	180,000Ω	470,000Ω	525,000Ω
120,000	130,000	250,000	522,000	600,000
125,000	160,000	320,000		700,000

1 Megohm, 1 Watt, 1%—65c.; 5%—40c

CAPACITORS

POSTAGE STAMP MICAS

8.2mmf	56mmf	200mmf	560 mmf	.0015mfd
10	60	220	600	.002
18	70	250	650	.0026
20	90	270	680	.003
22	100	350	800	.0039
25	140	370	.001mfd	.005
40	150	400	.0012	.007
47	160	470	.0013	.008
50	180	500	.00135	.01

Price Schedule
8.2mmf to .001mfd 5¢ .003mfd to .008mfd 12¢
.0012mfd to .002mfd 7¢ .01 mfd 18¢

SILVER MICAS

10mmf	125mmf	400mmf	665mmf	.0024mfd
22	150	430	700	.0025
39	180	466	750	.0027
50	200	470	800	.003
62	240	488	820	.0033
66	250	500	.001mfd	.0039
68	330	510	.0012	005
100	360	525	.0013	.0051
110	370	540	.0015	0068
120	390	560	.002	.01
		600		

Price Schedule
10mmf to .001mfd 10¢ .003mfd to .0068mfd 50¢
.0012mfd to .0027mfd 20¢ .01mfd 65¢

CERAMICS

3mmf	10mmf	22mmf	50mm	91mmf	200mmf
3.44	15	27	56	110	220
4.7	16	33	68	140	1000
6.8	18	40	75	150	1090
8	20	47	82	180	**$6.00 per 100**

OIL FILLED

MFD	V.D.C.	Price	MFD	V.D.C.	Price
.1	25,000	$14.95	.1	7,000	1.75
.012	25,000	6.20	.02-.02	7,000	$1.65
03	16,000	4.50	1	6,000	8.50
(.375@	16,000 and		.1	6,000	1.75
.75@	8,000(dual)	8.95	.03-.03	6,000	1.65
.15-.15	8,000	2.85	2	4,000	4.50
5	7,500	23.95	.25	3,000	1.70
1	7,500	8.50	.2	750 V.A.C.	
.1	7,500	1.85	(2.200	V.D.C.)	.39
.1-.1	7,000	1.95	1	2,000	.95
			4	1,000	.90
			3	1,000	.80
			2	1,000	.65
			.05	1,000	.29
			1	800	.40
			10	600	1.00
			4	600	.69
			2	600	.39
			1	500	.19
			5	500	.24

2 mfd. 4,000 V. D. C. #23F47 SPECIAL! $4.50

COAXIAL CABLE

RG 8/U 52 Ohm—New—On Reels

500-999 feet ..... 5¢ per foot
1,000-19,999 feet ..... 4¢ per foot
20,000-feet and up.....3½¢ per foot

RG 62/U 93 Ohm—New

200—4,500 feet .....6¢ per foot
5,000 feet and up.....4¢ per foot
RG 22/U.....New.....12¢ per foot

COAXIAL FITTINGS

Angle Adapter 22¢ M-359 83-IAP	Plug 28¢ PL-259 83-ISP	Socket 28¢ SO-239 83-IR	Hood 9¢ 83-IH

PL-259-A or 83-SPN; .28¢—83-1F; .75¢—83-1J; .65¢—83-2R; 83-2AP; UG 13/U; UG 21/U; UG 22/U; UG 24/U; UG 27/U; UG 59/U; UG 87/U; also UG 85/U and UG 281/U with short length of coax attached.
EACH ONLY .50¢

PULSE TRANSFORMERS

X 124 T2, UTAH, marked 9262 or 9280, small gray case 1⅞" high x 1¼" x ⅝" with two 6-32 mtg. studs. Ratio 1:1:1, hypersil core....**$1.50**
Spec.—10, 111, Chicago Transformer equivalent of 9262 (above) **$1.50**
7172 07, GE. core ⅝" x 1⅜" x 3/16", 2 windings (0.6 ohm and 0.08 ohm DC).....**$1.25**
D161310, 50 Kc to 4 Mc. 1¾" dia. x 1⅞" high, 120 to 2350 ohms.....**$2.00**
352-7250-2A, cased 15/16" dia. x 1⅝" high, DC 10 ohm, 3½ ohm, 140 c.. to 175 Kc.....**$1.25**
352-7251-2A, similar—shorter pulses.....**$1.25**
300 KVA GE 7557296, 50 ohm pulse cable connection; 3,850 V. in., 17,300 V. out. (250 KVA @¼ microsecond) **$15.00**
800 KVA G.E. K2731, 28,000 Volt pk. output. Bifilar, pulse width; one-microsecond..**$19.50**

JONES BARRIER STRIPS

Type	Price	Type	Price	Type	Price
2-140Y	$.05	9-141Y	.42	6-142	.25
3-140 3/4W	.12	10-141	.36	8-142	.38
3-140	.10	10-141 3/4W	.47	9-142	.37
5-140Y	.19	11-141	.36	10-142Y	.64
15-140	.42	12-141	.43	10-142 3/4W	.58
2-141	.09	15-141Y	.69	12-142	.48
5-141Y	.25	17-141	.60	12-142Y	.68
7-141	.26	17-141Y	.78	17-142	.67
8-141	.27	20-141Y	.93	17-142Y	.97
8-141 3/4W	.38	5-142	.21	18-240	.35

Any order for 100 pieces—10% off; for 1,000 pieces—20% off.

PRECISION POTENTIOMETERS

6 WATT

20,000Ω	Muter	314A	$1.70
20,000	GR	314A	2.50
10,000	De jur	292	.95
6,000	GR	314A	2.50
6,000	De jur	260	1.70
6,000	Muter	314A	1.70
5,000	Muter	314A	2.50
5,000	GR	314A	2.50
5,000	GR	214A	1.40
2,000	De jur	260	1.70
600	GR	314A	2.25
200	GR	214A	1.40
40	GR	214A	1.40

4 WATT

500Ω	Centralab	48-501	$.90
50	De jur	292	.75
50	GR	301	1.10
25	GR	301	1.10
20	De jur	292	.75
20	GR	301	1.10

12 WATT

10,000Ω	GR	471-AS15	3.50
10,000	GR	371T	2.50
10,000	GR	471A	3.50
10,000	Muter	371T	2.50
10,000	De jur	271T	2.00
5,000	De jur	271T	2.00

ALLEN SET SCREWS

4-40 x 1/8	6-32 x 1/8	8-32 x 3/16
4-40 x 3/16	8-32 x 1/8	8-32 x 5/16

ALL SIZES .....**$1.50 per 100**

CHROMALUX STRIP HEATER, 115 V. A. C., 60 Cyc. 750 wattcurved, 20" x 1½"..**only 95¢**

SPAGHETTI SLEEVING—Asst. sizes and colors, 3 ft. lengths.....99 feet—**Only $1.00**

VERNIER DIALS—For BC221, 2⅝" dia. 0-100 **85¢**

UNIVERSAL JOINT

ALUMINUM
1⅛" long x ½" O.D. ¼" ID
ONLY **40c**

PHASE SHIFT CAPACITOR

4 Stators — single rotor — 90° quadrants—
4 taps—360° rotation.
ONLY $2.79—Lots of 10.....$25.00

TOGGLE SWITCHES

H & H D.P.D.T.: 3A., 250 v., Molded Body, Bat Handle .....Only **60¢** ea.
$50 per hundred
H & H S.P.D.T.; 6A., 125 v., Molded, Ball Handle .....**30¢** ea.
C-H D.P.S.T.; 6A, 124 v., Molded, Bat Handle **35¢** ea.
C-H D.P.S.T.; 20A., 250V., Molded Bat Handle **$1.95**
H & H Power switch. D.P.D.T., 10A., 125 v., Ball Handle .....**$1.60** ea.
C-H D.P.D.T.; Center Off, 20A., 125 v., Bat Handle .....**$1.75** ea.

115V RELAYS 60 cyc.

Mfg.	No.	Contracts	Price
SD	TD 435 (time delay)	SPST. N.O.	$2.75
Leach	1355	DPST. N.C.	1.90
Leach	2124 SMX (Micalux)	4PST. N.O.	3.50
Advance	965 B	DPST. N.O., 10A	2.10
Advance	SA 3000X (Isolantite)	DPDT. 10A	2.95

HANDLES—Brass 5/16" round stock, 4¾" long, 1½" high; black, tapped 8-32.....**10¢**
GEAR ASSORTMENT—Experimenter's dream. Approx. 100 pieces, many stainless.....**$6.50**
#18 SHIELDED WIRE—65 ft., **$1**; 1,000 ft., **$9.95**
Glyptal Cement—5 gal. **$11**, 1 gal. **$2.50**, 1 qt. **75¢**
Thermal Circuit Breakers—2 Amp; 3 Amp; 5 Amp; 6 Amp.....**EACH 50¢**
G.E. D.C. MOTOR 1/6 H.P., shunt wound armature, 250 VDC @ 0.7 Ampere field, 60 VDC @ 0.37 Amp. **$12.00**

BATHTUB CONDENSERS

4 mfd	50 VDC	.21¢	3x.1	600 VDC	.30¢
.1 mfd	200 VDC	.08¢	.176	600 VDC	.21¢
.2 mfd	200 VDC	.14¢	.25	600 VDC	.23¢
3x.1 mfd	400 VDC	.15¢	.5	600 VDC	.25¢
.2 mfd	400 VDC	.15¢	1	600 VDC	.30¢
.25 mfd	400 VDC	.15¢	2x1	600 VDC	.36¢
.1 mfd	500 VDC	.17¢	2	600 VDC	.36¢
.05 mfd	600 VDC	.15¢	.06	1000 VDC	.17¢
.1 mfd	600 VDC	.20¢	.1	1000 VDC	.25¢
2x.1 mfd	600 VDC	.27¢	1	1000 VDC	.36¢

Wrapped—BALL BEARINGS—New

Mfg.	ID	OD	Width	Price
Fafnir 33K5	3/16"	1/2"	5/32"	25¢
ND5202C13M	1/2"	1 3/8"	1 3/8"(dual)	1.25
Fafnir 545	2 1/6"	2 5/8"	15/32"	1.00
ND 38	5/16"	1 3/64"	9/32	.45¢
Fafnir K8A	1/2"	1 1/8"	5/16"	.60¢
ND 3201	15/32"	1 1/4"	3/8"	.60

NEEDLE BEARINGS

B88 1/2" wide	1/2"	11/16"	25¢
B108 1/2" wide	5/8"	13/16"	30¢
GB34X 1/4" wide	3/16"	11/32"	25¢

BC 1072A IFF X'MITTER

150 to 200 Mcs. 115 V. 60 Cyc.

POWER SUPPLY gives; 0-5000 v.d.c. (variac control) 312 v.d.c., 700 v.d.c., 6.3 vac. (Also contains: 11 tubes 6J5, 826, 6SN7, 5U4G, etc.). 5 KV. meter, Blower, Condensers and many other useful parts too numerous to list. Slightly used. Shipping Wt. 245 lbs.

All This ONLY $22.50

POWER TRANSFORMER

Pri. 440/220/110 Volts, 60 cyc.
Sec. #1, 300 V. @ 4A.
Sec. #2, 300 V. @ 4A.
ONLY $17.50

400 MA CHOKE

12 H
90 Ω
6,000 V. D.C. TEST
$3.85

TRANSFORMERS

Pri., 115 V.A.C., 60 Cyc.

Sec.; 24V., 10A. $4.75 ea.—10 for $45.00

Sec. #1 2.5 V. CT, 6.5A.
Sec. #2; 2.5 V. CT, 6.5A
$2.45 ea.—10 for $22.00

Sec.; 5 V. CT, 60A. $6.75 ea.

AMMETER

Hoyt Model 515

0-15 A. DC in metal carrying case (Mirror scale) — Test leads included.
$3.85 ea.—10 for $35.

MINIMUM ORDER $3 — All orders f.o.b. PHILA. PA.

RELIANCE MERCHANDIZING CO.

12th St. Cor. Buttonwood, Phila. 23, Pa. — *Telephone MArket 7-2401*

RELAYS

FOR EVERY PURPOSE

Over a Million in Stock!

Whether you require large quantities of relays for production runs or single units for laboratory or amateur work, Wells can make immediate delivery and save you a substantial part of the cost.

Our capable engineering staff is prepared to offer assistance in the selection of correct types to suit your exact requirements.

Each relay is brand new, standard make, inspected, individually boxed and fully guaranteed.

The following list represents only a tiny portion of our relay stock. Write or wire us for information on types not shown.

STANDARD DC TELEPHONE RELAYS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-101	24V	1500.	DPST (ND)	Auto. Elec.	$1.35
R-102	24V	400.	SPDT	Auto. Elec.	1.10
R-103	24V	DUAL-1000	3PST (NO)	Auto. Elec.	1.35
R-105	24V	600.	3PST (NO)	Clare	1.20
R-106	24V	1300.	3PST (NC)	Clare	1.25
R-152	12V	50.	DPDT-SPST (NO)	Guardian	1.10
R-153	12V	200.	SPDT-SPST (NO)	Stromberg	1.25
R-154	12V	200.	SPST (NO)	Clare	1.20
R-155	12V	100.	SPST (4NO4NC)	Auto. Elec.	1.15
R-158	6V	50	4PST (NO)	Stromberg	1.10
R-159	6V	50	DPST (NO)	Stromberg	1.10
R-160	6V	12	3PDT-3PST (NO)	Auto. Elec.	1.05
R-161	6V	10	3PST (2NC-1NO)	Auto. Elec.	.90
R-121	150V	5000	2PST (NO) SPDT	Clare	1.65
R-123	150V	6300	SPST (NO)	Clare	1.75
R-602	150V	6500	3PST (NO)	Clare	1.75
R-515	24V	750	SPST (NO)	Clare	1.25
R-517	12V	250	DPST (NO)	Clare	1.20
R-519	250V	14000.	SPDT	Auto. Elec.	1.95
R-520	250V	14000	DPDT	R.B.M.	2.10
R-521	32V	1000.	DPDT	Kellogg	1.20
R-166	24V	DUAL-200.	DPDT-SPST (NO)	Stromberg	1.59
R-168	24V	DUAL-200	4PST (NO)	Auto. Elec.	1.20
H-240	250-350V	40000	DPST (NO)	Auto Elec.	2.95
H-241	48V	650	SPDT-SPST (NO)	Clare	1.25

TYPE 18 DC TELEPHONE RELAYS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-109	24-48V	4000.	SPDT	Auto. Elec.	$1.50
R-110	24-32V	3500	SPDT	Auto. Elec.	1.50
R-112	90-120V	6500	SPST (NC)	Auto. Elec.	1.75
R-114	24V	500	4PST (NO)	Auto. Elec.	1.30
R-603	24V	400	DPST (NO)	Auto. Elec.	1.25
H-238	24V	150	DPDT-SPST (NC)	R.B.M.	1.25
H-239	24V	180	DPST (NO)	Auto. Elec.	1.25

SEALED DC TELEPHONE RELAYS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-125	24V	300.	DPDT	Clare	$2.75
R-126	90-120V	2000	DPDT	Clare	3.00
R-504	24-70V	2800	SPDT	GE-C103C25	3.00

V TYPE DC TELEPHONE RELAYS

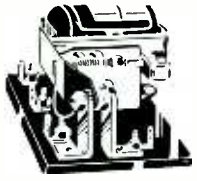
Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-164	24-32V	1000.	SPST (NO)	W. E.	$1.20
R-512	24-48V	3500	DPDT	W. E.	1.30
R-513	12-24V	300	DPDT-DPST (NC)	W. E.	1.20
R-514	4-6V	60	SPDT	W. E.	1.05
R-526	6V	35	DPDT-SPST (1NC-1NO)	W. E.	1.05

AC-STANDARD TELEPHONE RELAYS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-212	90-135V	—	NONE	Clare	$0.95
R-213	5-8V	—	DPST (NO)	Clare	1.50
R-605	24V	—	3PST (NO)	Auto. Elec.	.95
R-606	24V	—	DPST (1NO-1NC)	Auto. Elec.	.95
R-607	24V	—	SPST (NO)	Auto. Elec.	.95

DIRECT CURRENT MIDGET RELAYS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-132	24V	300	DPDT	Clare	$1.20
R-133	24V	300	NONE	Clare	.60
R-134	24V	250	4PDT	Clare	1.20
R-135	24V	300	SPST (NC)	Clare	1.15
R-137	24V	300	SPDT	Clare	1.15
R-138	24V	300	4PST (NO)	Clare	1.15
R-139	24V	200	4PDT	Clare	1.15
R-140	24V	280	SPDT	R.B.M.	1.15
R-141	24V	280	3PST (NO)	R.B.M.	1.15
R-142	24V	400	DPDT	Allied Cont.	1.20
R-143	24V	280	SPST (NO)	R.B.M.	1.15
R-144	24V	250	SPST (NO)	Allied Cont.	1.15
R-145	24V	300	DPST (NO)	Allied Cont.	1.15
R-146	12V	126	DPST (1ND) (1NC)	Clare	1.10
R-147	9-14V	75	SPDT	Guardian	1.05
R-148	12V	100	DPDT-SPST (NC)	Price Bros.	1.10
R-149	6-8V	45	SPST (NC)	Clare	1.00
R-150	6V	30	SPST (NO)	E-Z Elec.	.95
R-522	2-6V	2.	SPST (ND)	R.B.M.	.65
R-523	90-125V	6500	DPDT	Clare	1.90
R-222	12V	100	DPST (NO)	P & B	.95
H-242	24-32V	300	DPDT	R.B.M.	1.20
H-243	24-32V	300	4PDT	R.B.M.	1.20



SENSITIVE DC RELAYS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-218	4-6V	1800.	SPDT	Kurman 220C	$1.95
R-220	75V	5000	SPDT	Allied Cont.	1.20
R-221	18-24V	5000	SPST (NO)	Allied Cont.	1.15
R-174	250V	5000	DPST (NO)	G.M.	1.85
R-175	350V	11000	DPDT-DPST (NO)	G.M.	2.95
R-176	24V	250	DPST (NO)	G.M.	1.50
R-177	24V	300	4PDT	G.M.	1.65
R-600	8-12V	5000	SPDT	S-Dunn-KS	2.10
R-507	24-48V	1000	SPDT-DPST (NC)	Guardian	1.15

TYPE BO DC RELAYS

Stock No	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-169	24V	250	SPST (NO)	Allied Cont	$1.95
R-171	24V	230	DPDT	Allied Cont.	2.15
R-172	5-8V	30	DPDT-SPST (NO)	Allied Cont	1.70
R-173	2-6V	5	SPST (NO)	Allied Cont	1.25
R-529	24-48V	1000	DPDT	Allied Cont.	2.50

TYPE BJ DC RELAYS

Stock No	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-204	12V	65	DPST (ND)	Allied Cont	$1.15
R-205	24V	260	DPDT	Allied Cont.	1.25
R-224	12V	75	SPST (NO)	Allied Cont.	1.15
H-237	27V	230	DPDT	Allied Cont.	1.25

HEAVY DUTY KEYING RELAYS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-248	28V DC	150	SPST (NO) 10A.	Guard 36471	$1.05
R-244	75V AC	265	SPST (NO) 20A.	Leach 1327	1.75
R-206	24V DC	150	5PDT-3 AMP.	P&B-KL	1.20
R-207	24V DC	210	4PDT-3 AMP	P&B-KL	1.10
R-219	50V DC	1500	DPST (NO) 15A.	P&B-SP	1.25
R-217	115 AC	600	SPDT-10 AMP	St Dunn 1XAX	2.25
R-525	24V DC	200	DPDT-10 AMP.	Guard. 34464	1.25
R-508	110 AC	600	SPDT-6 AMP	Guard 37189	1.95
R-506	24 V DC	300	DPST (NO) 6A.	—	.95
R-510	24 V DC	200	3PDT-10 AMP	Guard 516983	1.05
R-604	24 V DC	200	SPST (NO) 30A	St Dunn B2A	1.25
H-608	115 AC	—	SPST (NO) 20A	St Dunn 1HXX	2.25
R-620	12V DC	35	3PST (NO) 10A.	Guard BK2	1.05
R-223	28V DC	150	SPST (NO) 40A	Price Bros	1.35
H-230	12-24V DC	80.	DPST (NO) 10A.	—	1.20
H-231	24V	230.	DPST (NO) 5A	R.B.M.	1.15

DC-TYPE 76 ROTARY RELAYS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-197	9-16V	70	DPDT	Price Bros.	$1.65
R-198	9-16V	125	6PST (3NO) (3NC) SPDT	Price Bros.	1.65
R-199	24-32V	250	SPDT-DPST (NC)	Price Bros.	1.65
R-200	24-32V	275	3PDT-SPST (NC)	Price Bros	1.65
R-201	24-32V	250	DPST (NO) SPDT (NC) DPDT	Price Bros.	1.65
R-601	9-14V	60.	3PST (NO)	Price Bros	1.65

DIRECT CURRENT KEYING RELAYS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R 190	12V	65	DPDT 10 AMP	Advance Elec. Type 2000-A	$1.15
R-191	28V	125	DPDT 10 AMP	Guardian	1.20
R-192	12V	44	3PDT 10 AMP	Allied Cont. Type NB5	1.35
R-193	5-8V	11	DPDT 10 AMP	Leach	
			SPST (NO)	Type 1027	1.05
R-194	24V	265	DPST (NO) 10 AMP	Leach Type 1054SNW	1.25
R-195	6V	32	DPDT 3 AMP	G.E.Co.	1.15
R-196	12V	50	DPDT 10 AMP SPST (NC)	Guardian	1.15
R-242	24V	170	SPDT 2 AMP	Leach Type 1253DEW	1.25
H-236	5-8V	18.5	SPDT 10 AMP	Leach-BFM	1.05

CUTLER HAMMER HEAVY DUTY CONTACTORS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-178	24V DC	100	SPST (NO) 100A.	6141H34A	$3.85
R-179	6V DC	6.5	SPST (NO) 50A.	6041H83A	3.00
R-180	12V DC	25.	SPST (NO) 50A.	604H308	3.25
R-181	24V DC	65	SPST (NO) 100A.	6041H88	3.85
H-232	24V	55.	SPST (NO) 50A.	Metal Cased	3.25
H-233	6V	15	SPST (NO) 50A.	Metal Cased	3.15
H-235	24V	70.	SPST (NO) 100A.	Type B6	3.85

DIRECT CURRENT AIRCRAFT CONTACTORS

Stock No	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-182	28V	80	SPST (NO) 25 A.	Guardian	$1.85
R-183	24V	60	SPST (NO) 50 A.	Allen Bradley Type B6A	2.75
R-184	28V	50	SPST (NO) 100A.	General Elec.	2.95
R-185	24V	100	SPST (NO) 50 A	Leach 5055ECR	2.75
R-186	24V	132	SPST (NO) 50 A	Leach 7220-3-243	2.50
R-187	24V	100	SPST (NO) 50 A.	Allen Bradley	2.95
R-188	24V	200	SPST (NO) 75 A.	Allied Cont.	2.95
H-234	14V	45	SPST (NO) 30 A.	—	1.65

ANTENNA CHANGEOVER RELAYS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-192	6-12V DC	44	2PDT 10 AMP	Allied-NB5	$1.35
R-231	12VDC	100.	DPDT 6 AMP	G. E.	1.95
R-256	24-32V DC	—	SPDT-DPST (NC) 1KW	Guardian	1.45
R-501	110 AC	4.	DPDT (1kW)	G E	2.45
R-503	12-32V DC	100	SPDT-5PST	G E.-500 W.	1.95

COMBINATION PUSH BUTTON AND REMOTE RELAY

Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
H-244	12-24 V DC	Dual-60	SPDT	CR2791-R106C8	$1.65

ADJUSTABLE TIME DELAY RELAY

Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-246	115 AC	—	SPST (NO) or (NC) 10 AMPS	R. W. Cramer 1-120 Sec.	$8.95

DC MECHANICAL ACTION RELAYS

Stock No	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-245	12V	25.	4" Lever	G.M.	$0.95
R-527	6-12V	200.	2" Lever	—	.95

TYPE C.M.S. RELAY

Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-511	24V DC	200	MICRO-SW. SPST (NO)	Clare	$2.45

DC CURRENT REGULATOR

Stock No	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-509	6-12V DC	40	SPST (NC)	G. E.	$0.85

LATCH AND RESET RELAY

Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-500	12V DC	10.	DPDT-10 AMP	St. Dunn-CX-3190B	$2.85

DC-ROTARY STEP RELAY

Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-621	6-12V	30.	3 POLE 23 POSITION	W. E.	$10.95

DC-RACHET RELAY

Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-230	5-8V	2.	SPDT-DPST (NO)	Guardian	$2.15

Special Sample Engineering Offer

Any ten relays listed (one of each type) with the exception of Stock Nos. R-621 and R-246—only $10.00.

ORDER DIRECTLY FROM THIS AD OR THROUGH YOUR LOCAL PARTS JOBBER

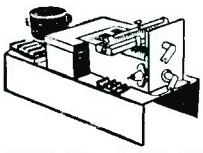
Manufacturers: Write For Quantity Prices.

Distributors: Write For The New Wells Jobber Manual.

WELLS SALES, INC.

320 N. LA SALLE ST., DEPT.-SL, CHICAGO 10, ILL.

GUARANTEED GOVT SURPLUS



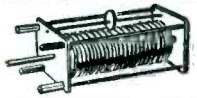
420—750 MC OSCILLATOR.

Compact, beautifully built line oscillator employing two W.E. 368AS (703A) "doorknob" tubes in push-pull. Exceptionally stable. 5W output at 420mc, 2W at 700mc. Independent grid and plate tuning. Adjustable output coupling and tuning assembly. Coaxial output connection. Built-in blower may be operated from 110VAC. Power requirements: 300VDC/150ma, 1.2V/4A, 1.2V/4A. 5¼"x6½"x11½". 7 lb. Supplied complete with tubes. Ideal for 420mc amateur operation or for use in the 460-470mc citizens radio band. **Stock No. APO-66**...**$6.95**
Spare 368AS/703A tubes.....**$1.69 ea.**

UHF 50 OHM COAXIAL POWER MEASURING ASSEMBLY. Panel mounting, silver-plated assembly with integrally coupled crystal mount. Type "N" UG-58U female receptacle (easily replaced by SO-239). Originally designed for power measurement at frequencies up to 700mc. **Stock No. APM-89**.....**$3.95**
MATING TYPE "N" MALE PLUG. For use with above. **Stock No. PCM-17**.....**$0.49**

SPERRY MODEL 12 KLYSTRON TUNER for use with 2K39, 2K42, 2K43, 2K44, 417A. **Stock No. VKT-27**.....**$1.95**
MAGNETRON MAGNET 1900 GAUSS. Pole dia. 1-⅝. Gap 1½". **Stock No. UMM-21**.....**$5.75**
MAGNETRON MAGNET 4800 GAUSS. Pole tip dia. ¾". Gap 0.635". **Stock No. UMM-18**.....**$7.00**

50 OHM COAXIAL RELAY. Double coil actuating relay operates from either 12VDC/120ma or 24VDC/60ma. May be operated in plate return circuits to provide automatic transmitter-receiver antenna changeover. Supplied with British type connectors which are easily replaced by standard SO-239 (83-1R) receptacles or soldered to directly. Completely enclosed in compact housing. 2-¾" x 3" x 4-¾". An outstanding buy at $2.49. **Stock No. KDC-723.**



VARIABLE INDUCTOR. 67 microhenries max. Minimum near zero. Wheel type sliding short. Ceramic insulation. Quality construction. Barker-Williamson #1565. Originally used as transmitter plate tank coil to tune from 1½ to 20mc. Ideal for pi-networks, antenna tuners and plate tanks. **Stock No. LRF-32**.....**$1.95**

APC AIR TRIMMER. 35 mmf max. Screw slot adjustment. **STOCK NO. CAV-105. 10 for $1.00**
APC AIR TRIMMER. Two separate trimmers on ceramic base. Shield between sections. Each section 25 mmf max. **Stock No. CAV-104**.....**10 for $1.00**
AIR CAPACITOR 100 MMF MAX. ¼" dia. **shaft. Receiving type. Ceramic insulation.** Standard Brand. Similar to MC-100-M. Straight-line capacity. **Stock No. CAV-15**.....**$0.72**

SUPER-FLEXIBLE PIGTAIL WIRE. Sperry Special. Part No. P55357. Consists of 350 strands of 0.002" diameter soft copper wire. Total diameter: 1/32". Useful in applications where electrical connection is to be made to moving parts, e.g., variometers, variable capacitors, motor-brushes, etc. **Stock No. WFP-350. 10 foot rolls. $0.69 per roll.**

750 CPS BANDPASS TRANSFORMER. Center frequency adjustable over a small range. Input 23,000 ohms. Output 225,000 ohms. Triple alloy shielded. 1½" x1½"x2". **Stock No. ZBP-750**.....**$2.49**

BLOCKING OSCILLATOR TRANSFORMER. Two winding 1.35:1. Ideal for television sweep oscillators. Compact. **Stock No. TFF-64**.....**$0.95**

NON-INDUCTIVE CERAMIC RESISTOR. 350 ohms/24 watt. Standard Brand. **Stock No. RCF-52**.....**8 for $1.00**

Tube Specials

1A7GT	$0.72	6Q7	.72	215A	.95
1G6GT	.49	6SA7GT	.60	304TH	7.75
1V	.49	6SC7	.69	304TL	1.95
2A3	.98	6SF7	.72	316A	.89
2C4	.95	6SH7GT	.39	350A	2.95
2C21/1642	.29	6SJ7	.59	417A	14.95
2C34/RK34	.29	6SJ7GT	.49	559	1.19
2C40	1.98	6SK7	.72	705A	2.95
2C44	.75	6SL7GT	.69	723A/B	9.95
2D21	1.49	6SN7GT	.79	725A	14.95
2J26	14.95	6SR7	.67	730A	12.50
2J38	14.95	6SU7GT/Y	1.29	801	.79
2J48	15.95	6V6GT	.79	803	8.95
2J55	39.75	6V6	1.09	805	3.95
2K28	12.95	6X4	.69	807	1.19
2X2	.69	6X5GT	.63	811	1.95
3B7/1291	.39	6Y6G	.88	813	7.95
3C23	2.95	6ZY5G	.81	814	3.95
3D21A	1.95	7C7	.81	815	1.95
3E29	3.49	7E6	.72	836	.89
3FP7	1.95	7G7	1.06	837	1.49
3Q4	.69	7H7	.72	861	15.00
4A1	.49	7Q7	.72	866A	.95
5BP1	1.95	7V7	.72	872A	1.69
5CP1	1.95	7Y4	.72	874	.59
5R4GY	1.09	7Z4	.72	902A	3.95
5U4G	.65	12SF7	.59	931A	3.95
5V4G	1.09	12SG7	.59	954	.39
5Y3GT/G	.49	12SH7	.59	955	.39
6AC7	.79	12SJ7	.59	956	.49
6AE5GT	.79	12SL7GT	.79	957	.39
6AG7	1.29	12SQ7	.65	958A	.39
6AK5	1.29	12SR7	.72	959	.39
6AU6	.95	14F7	.72	991/NE-16	.29
6C4	.49	14H7	.79	1625	.49
6C8G	.72	14N7	.72	1626	.39
6F6	.89	RK21	.95	1629	.29
6F8G	.89	25Z5	.59	1641/RK60	.95
6G6G	.49	25Z6GT	.59	2050	.79
6H6	.49	35W4	.49	8013	1.49
6H6GT/G	.29	46	.72	9001	.39
6J5	.57	EF50	.49	9002	.39
6J6	1.15	RK69	1.49	9003	.39
6J7	.69	RKR72	1.49	9004	.39
6K6GT/G	.65	RKR73	.39	9005	.79
6K8	.88	80	.45	9006	.39
6L6	1.28	85	.72	VR90	.69
6L6GA	.89	89Y	.54	VR105	.69
6L7	.98	117Z6GT/G	.88	VR150	.59
6N7	.95	FG178	1.95		
6N7GT	.79	211	.69		

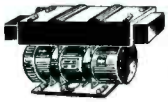
OIL—FILLED CAPACITORS

Mfd	Rating	Price	Mfd	Rating	Price
2-2	600 VDC	$0.75	0.1	5000 VDC	$1.95
4	600 VDC	.84	2	5000 VDC	7.30
7	600 VDC	1.15	1	6000 VDC	6.95
10	600 VDC	1.37	.1-.1	7000 VDC	1.95
50	330 VAC	4.95	.05	7500 VDC	1.75
2	1000 VDC	.95	2½	7500 VDC	11.95
4	1000 VDC	1.19	.02	10 KV DC	2.95
8	1000 VDC	1.71	1	15 KV DC	19.95
0.25	2500 VDC	1.06	0.25	20 KV DC	15.95
2	4000 VDC	4.95	15	440 VAC	
3	4000 VDC	5.95		1500 VDC	2.95

Note: 10 or more capacitors of a type 10% dis.

RF and DC PANEL METERS

Stock	Description	Price
MAD-251	0-2 ma DC Westinghouse 3½" round	$3.95
MAD-262	0-20 ma DC Westinghouse 3½" round	3.95
MAD-265	0-80 ma DC W.E 3½" round	3.49
MAD-503	0-1000 ma DC DeJur 3½" round	3.95
MAD-276	0-30 ADC GE 2½" round	2.95
MRT-355	0-100 ma RF Weston 425 3½" round	11.95
MRT-372	0-120 ma RF Weston 507 2½" round	8.95
MRT-367	0-1A RF GE 2½" round	2.95
MRT-394	0-20A RF GE 3½" round	6.95



INVERTER PE 218D. Output 115V/400 cps/1500VA/1ph. Input 24-28 VDC. Made by Wincharger. Complete with starting relays, hash filters, voltage and speed regulators. 5½"x11"x15". Brand new in original packing. **Stock No. GAC-10**..**$27.50**

Delivery: Immed. from stock (subj. to prior sale).
Minimum Order: $5.00.
Terms: Rated organizations (U. S. and Canada). Open account.
Others: Cash with order, or 20% with order, balance C. O. D.
Foreign: Payment in U. S. funds with order or irrevocable letter of credit payable against documents in U. S. funds at New York.
Condition of material: The major portion of the material listed above is brand new. Some of the items have been removed from new equipments. We guarantee material to be clean and in perfect operating condition.
All prices above are quoted domestic packed f.o.b. our warehouse, Corona, New York.

Wide Range Butterfly Wavemeter & Oscillator Elements

Precision wide range butterfly circuit elements. Sturdily constructed. Mounted in ball bearings. Suitable for motor drive. Ideal for use as wavemeters and oscillators (see description below).

Stock No.	Freq. (mc.)	Notes*	Unit Price
TN-20	105-330	1, 3	$2.95
TN2A	75-300	1, 4	2.95
TN-30	135-485	2, 3	3.95
TN3A	300-1000	2, 5	4.95

Brand new, in original packing.

*NOTES: 1) Aluminum construction
2) Silver-plated brass
3) Designed as oscillator element (955 acorn triode)
4) Has diode socket mounted on unit (955 as diode)
5) Has crystal diode mount for 1N21 crystal

BLILEY SMC-100 100 AND 1000KC CRYSTAL. Regularly sells for $8.75. **Stock No. QCM-19**.....**$5.95**

HAMMARLUND CERAMIC ACORN SOCKETS. 5 contact. Silver-Plated. **Stock No. XRT-25**.....**20 for $1.00**

CINCH MICA FILLED OCTAL SOCKETS. 1" dia. 1-5/16" mtg ctrs. **Stock No. XRT-20. 20 for $1.00**
1-⅛ dia. 1½ mtg. ctrs. **Stock No. XRT-10. 20 for $1.00**

DELAY LINE. 2 microsecond (one direction). 1500 ohms. Bandwidth 1mc. 8 section tapped. **Stock No. ZAL-22**.....**$1.69**
DELAY LINE. 1¼ microsecond (one direction). 1500 ohms. Bandwidth 1mc. 6 section tapped. **Stock No. ZAL-13 $1.49**
DELAY LINE. 5 microsecond (one direction). 1500 ohms. Bandwidth ½mc. **Stock No. ZAL-14**.....**$0.89**

4200 VOLT TELEVISION OR SCOPE TRANSFORMER. Primary: 115V/60c. Secondary: 3000VRMS (4200 Volts Peak) 10ma. Hermetically sealed. 4½"x4-¾"x5½". **Stock No. TFF-83**.....**$5.95**

HV TFMR. 10,000-0-10,000 VOLTS @42 MA. Oil-filled, hermetically sealed. 11"x13" x6". Pri. 115V/50-60cy. **Stock No. TFF-451 $29.95**

FILTER CHOKES

Stock No.	Description	Price
LFF-45	10H/120ma/600 ohms	$0.95
LFF-21	20H/300ma/125 ohms/5000V	9.95
LFF-144	2|H/700ma/16 ohms/1500V	4.95

MULTIPLIER PHOTOTUBE HOUSING. Cast aluminum cylindrical housing containing a submagnal 11 pin socket (for 931A, 1P21, 1P22) and a dynode voltage divider network. Moisture proof construction. An integral 6 volt pilot lamp provides light source when used as a noise generator. A window may be drilled in the housing for use with an external light source. Operates with approximately 700 volts at 3-4ma. 2" dia. x 4" long. Supplied less phototube. **Stock No. AMP-65**.....**$3.95**

PRECISION HIGH TORQUE TYPE 5 SELSYNS. Bronze housing 4½" dia. x 5" long. 115V/60c operation. Brand new in original packing. **Stock No. SEL-44**.....**$4.95 each**

110/60CPS/0.38A BLOWER. Exceptionally quiet. 50 cu. ft. min. **Stock No. BLR-314**..**$8.95**

3" SCOPE INDICATOR. 3BP1 cathode ray tube mounted in a mu-metal housing with an adjustable light shield. May be mounted on a panel, table-top or clamped to a bar. When mounted on a table top or wall, the scope housing may be tilted at any angle up to 45° from the mount for comfortable viewing. Ideal for remote scope indicators. An outstanding buy at **$5.95.** Stock No. ASI-35.

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Cable: "Dublectron, New York". We will be pleased to send our bulletins to you regularly. Write or phone Dept. E-6 for our latest catalog.

ELECTRONICS CO. INC., 103-02 NORTHERN BLVD., CORONA, N. Y.

Finest of Surplus PEAK ELECTRONICS CO. Fraction of Cost

H.V.-H. CURRENT PLATE TRANS.

1500-0-1500 volts at 1.5 amps. Tapped at 1350 and 1250, Pri. 110/220 volts 50/60 cycles in 2 Separate windings. Built to rigid Navy specs by Amertran. Suitable for broadcast transmitters, induction heating, etc. Continuous duty. 10 x 10 x 7. swt 125 lbs.

New only 39.50

BARGAIN OF THE MONTH

As illustrated above. 1500-8-1500 volts at 600 ma. Pri. 110/220 v. 50/60 cycles. 8 x 8½ x 7 s.w.t. 78 lbs. Made by Amertran. Only.....19.95

HIGH CURRENT TRANSF. 820 Volts CT at 775 Ma. Pri. 110/220 Volts 60 cycles. Fully Cased 6.95

SELSYN MOTOR

115 volts 60 cycles. Made by Bendix and Diehm. Large size—Type 5. Transmitters only. $6.95 per pair.

UTC type PA 5000 ohm plate to 500 ohm line and 6 ohm voice coil. 10 watts. 60 to 10,000 cps ±1 DB. GREAT VALUE.....ea. $2.75

THORDARSON PLATE TRANSF. 2370 volts CT at 250 MA tapped at 300-0-300 volts, plus 215 volts 55 MA bias winding. 110 volt 60 cy. pri. Fully shielded .....ea. $11.95

GENERAL PURPOSE TRANSFORMERS

Ideal for Bias, Filament, Isolation, Stepdown, etc. 2 isolated 110v pr. sec. 110v at 900 ma plus 6.3 @ 2 amps. Fully cased.....Now $1.49 ea.

SCOPE TRANSFORMERS

Pri 110V 60Cy — Hermetically Sealed

2500V @ 12Ma.....$3.95
2300 @ 4Ma, 2.5 Volts @ 2 Amp.....4.95
1050V @ 20Ma, 20V 4.5A, 2.5V 5A.....4.75
4500V @ 4 Ma.....8.50

SOLA CONSTANT VOLTAGE TRANS.

Pri. 95-125 Volts 60 Cy See 115V. 120VA.....17.95

PLATE AND FIL. TRANSF. PRI 110v 60 cy. sec. 1120 volts CT @ 600 ma. 6.3v CT # 3A. 2x5VCT @ 6A Hermetically sealed.....$9.95 ea.

1500, 5000 Ohm 100 Watt Ferrule Resistors. 20,000 Ohm 50 Watt Ferrule Resistors. Any Types only .10 ea. Min. order 50.

HS 30 HEADPHONES

250 ohms imp. Can be used for sound power Telephones.

Brand new .....69 ea.

LARGE QUANTITY AVAILABLE

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220/110 volts, 100 watts. Fully encased. 5⅛ x 4¼ x 5⅛. 110V. 60 cycle.....$2.49 each

PHASE SHIFT CAPACITOR

4 Stator Single Rotor. 0-360 Degrees Rotation .....Only $2.95 each

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.004 4000 VDC Micas .....9 for .99
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1000 MFD 25 Volt Electrolytic.....2 for .99
25 MFD 25 Volt Elect. Tubular.....6 for .99
JAN 6CX Tubes, New, Boxed.....4 for .99
3:1 PP Input, Hermetic Seal.....2 for .99
.05 600 VDC Oil Tubular.....10 for .99
10 MMF Midget Variable Cond.....4 for .99
Heineman 5 Amp 110 VAC CKT Breaker.....99
Heineman 25 Amp 110 VAC CKT Breaker.....1.49
2 MFD 250 VAC Oil Cond.....5 for .99
Solar .02 600 VDC Dominoes.....9 for .99
Erie .0005 N750D Ceramicons.....15 for .99
.1x.1 2 KV DC Oil-Condenser.....79
H&H SPST P.B. Switch N.O.....5 for .99
Weston 507 RF Meters, Less Thermo.....99
1/40 Amp (25 Ma) Littlefuses.....15 for .99
.25 MFD 600 V. Tubulars.....6 for .99
C-D 1 MFD 400 V Oil Tubulars.....9 for .99
Butterfly Cond 2-11 MMF Ball Bearings...2 for .99
50 MFD 50 Volt Elect. Tubulars.....5 for .99
.0015 5% Silver Micas.....9 for .99
Midget Closed CKT Jacks.....7 for .99
CD Type 4 .001 600 VDC Micas.....50 for 4.99

A FEW SUPER SPECIALS

10 Mfd 600 VDC Oil Cond.....89 ea.
CD .025 2500 VDC Mica.....69 ea.
50,000 ohm 1% Precision Wire Wound Resistors .....7 for .99

PANEL METERS—BRAND NEW

2" WESTON .0-1 Ma Dc 26 ohms res.....$3.50
2" GE 0-1 Ma DC (volt scale).....2.95
2" GE 0-5 Ma DC (amp scale).....1.95
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2" GE 0-500 Ma DC.....1.95
2" GE 0-10 Volts AC.....2.50
2" GE 0-30 Volts DC 1000Q/v.....2.50
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2" WESTON 150-0-150 Microamps DC.....3.49
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2" GE 0-1 Amp RF (Internal Thermo).....2.45
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3" McCLINTOCK 0-1 Ma DC. (MA Scale).....3.95
3" WESTINGHOUSE 0-2 Ma DC.....3.95
3" GE 0-15 Ma DC (Square Case).....3.95
3" WESTERN ELECTRIC 0-80 Ma DC.....2.95
3" DEJUR 0-100 Ma DC.....2.95
3" GE 0-200 Ma DC.....3.95
3" WESTINGHOUSE 0-50 Amps AC.....3.95
3" WESTON 0-50 Amps AC.....4.95
3" TRIPLETT 0.75 Amps AC.....2.95
3" WESTINGHOUSE 0-20 Ma DC.....3.95
3" WESTINGHOUSE 0-150 Volts AC.....3.95

2" GE 0-200 MICROAMPS

Model DW51 .....$4.50 ea.

FILAMENT TRANSFORMERS

110V 60Cy Pri. Fully Cased.

5 Volt 15 Amp.....$2.75
2.5 Volt 10 Amp.....3.49
2.5 Volt CT 21 Amp.....4.75
6.3 Volt 10 Amp.....1.89

MULTIPLE SECONDARIES

5¼V CT 21A, 7.5V 6A, 7.5V 6A.....$4.95
6.3V 21 Amp. 6.3V 2A, 2.5V 2A.....3.95
5 Volt 4A, 6.3V, 3A.....2.45
2.5V CT 20A, 2.5V CT 20A.....6.95
2.5V CT 10A, 10V 3A, 5V 3A, 5V 3A.....3.95

CHOKE BARGAINS

6 Henry 50 ma 300 ohms .....3 for $0.99
6 Henry 80 ma 220 ohms .....2 for .99
8 Henry 160 ma 140 ohms.....99
1.5 Henry 250 ma 72 ohms.....59
6 Henry 300 ma 65 ohms.....3.75
4.3 Henry 620 ma 42 ohms.....6.95
Swing. Choke 1.6/12 Henry 1 Amp/100 ma 15 ohm 19.95
.07 Henry 7 amps .5 ohm.....4.50

U. H. F. COAX. CONNECTORS

831AP-UG12U—UG21U-UG-14U-831 R-831SP .39 ea.

FEDERAL ANTI-CAPACITY SWITCH. Double Pole. Double Throw .....85¢ each; 10 for $7.50

MEGOHM METER

Industrial Instruments model L2AU 110/220 volts 60 cycle input. Direct reading from 0-100000 megohms on 4" meter can be extended to 500000 megohms with external supply. Sloping hardwood Cabinet 15"x8"x10". Brand new with tubes plus running spare parts including extra tubes. Great value Only $69.50.

VARIABLE CERAMICONS

1.5 to .7 MMF 21
3 to 13 MMF.....24
4 to 30 MMF.....24
7 to 45 MMF.....24

FIXED CERAMICONS

Capacity in MMF: 1-2-3-4-5-8-10-12-15-17-18-20-25-30-35-40-50-60-85-120-200-500. Your cost any capacity .....09 ea.

ADVANCE D.P.D.T. ANTENNA RELAY

110 V. 60 cycle coil Steatite insulation. Only $1.95 each.

As above but 3 P D T.....$2.75

DUNCO RELAY 6 volt 60 cycle coil DPST....$1.39
DPDT $1.69

WIRE WOUND RESISTORS

5 Watt type AA. 20-25-50-200-470-2500-4000 ohms .....09 ea.
10 watt type AB. 25-40-84-400-470-1325-1900-2000 4000 ohms .....15 ea.
20 watt type DG. 50-70-100-150-300-750 1000-1500-2500-2700-5000-7500 10000-16000-20000-30000 ohms .....20 ea.

30 WATT WIRE WOUND RESISTORS

Ohms: 100-150-1500-2500-3k-4k-4500-5k-5300-10k-15k-18k-40k .....15 ea. 8 for .99

ADJUSTABLE RESISTORS

20 Watt: 1, 5, 50 Ohms.....25
50 Watt: 80, 100, 500 Ohms.....35
75 Watt: 40, 80, 100, 150, 200 Ohms.....39
100 Watt: 20, 50, 75, 120, 180 Ohms.....49
150 Watt: 50, 100 Ohms.....59

1% PRECISION RESISTORS

2000-2500-5000-8500-10,000 ohms .....ea. .25
50000-95000 ohms .....ea. .29
10000-750000-1 meg .....ea. .69

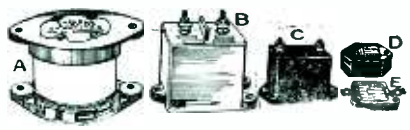
Precision 15 Meg. 1% Accuracy Resistor. Non-inductive, 1 watt, hermetically sealed in glass. .29 ea. 10 for.....$2.50

50 megohm 35 watt Resistor with mount...$1.95 each; 10 for $15.00

W. W. POWER RHEOSTATS

25 Ohms 25 Watt 49
150 Ohms 50 Watt 59
250 Ohms 50 Watt 59
300 Ohms 50 Watt 59
Dual 200 Ohms 50 Watt.....79
8 Ohms 150 Watts.....1.79

HIGH VOLTAGE—CURRENT MICAS



	MMF	VDC	Price		MMF	VDC	Price
D	.001	600	$.18	C	.0005	5 KV	$ .85
E	.01	600	.24	C	.0015	5 KV	1.60
E	.02	600	.26	C	.003	5 KV	1.90
E	.027	600	.26	C	.005	5 KV	2.50
D	.039	600	.30	B	.007	5 KV	2.75
C	.01	1 KV	.45	B	.002	6 KV	3.50
C	.056	1 KV	.50	B	.003	6 KV	3.75
C	.07	1 KV	.55	A	.004	6 KV	4.95
D	.02	1200	.35	B	.006	6 KV	4.25
C	.024	1500	.65	B	.0085	8 KV	2.90
C	.033	1500	.75	B	.001	8 KV	3.25
C	.015	2 KV	.80	B	.002	8 KV	4.00
C	.02	2 KV	.90	B	.003	8 KV	4.75
D	.002	2500	.45	B	.004	8 KV	5.50
E	.005	2500	.55	B	.005	8 KV	5.75
C	.025	2500	1.25	A	.006	15 KV	26.50
C	.001	3 KV	.90	A	.0098	15 KV	32.50
C	.002	3 KV	.95	A	.0059	18 KV	28.50
D	.005	3 KV	.70	A	.005	20 KV	33.50
C	.005	3 KV	1.24	A	.0013	30 KV	36.50
C	.006	3 KV	1.50	A	.00025	35 KV	26.50
D	.002	3 KV	.70	A	.0001	10 KV	4.95
C	.0001	5 KV	.76				

OIL CONDENSERS

20 mfd 330 vac—1.85
5 mfd 150 vac— .49
1 mfd 600 vdc— .29
2 mfd 600 vdc— .39
4 mfd 600 vdc— .59
6 mfd 600 vdc— .79
3/3 mfd 600 vdc— .79
2 mfd 1000 vdc— .79
4 mfd 1000 vdc— .95
15 mfd 1000 vdc—2.95
2 mfd 1500 vdc—1.25
6 mfd 1500 vdc—2.95
1 mfd 2000 vdc—1.45
2 mfd 2000 vdc—2.25
4 mfd 2000 vdc—3.65
6 mfd 2000 vdc—3.95
2 mfd 4000 vdc—4.95
1 mfd 5000 vdc—4.50
.1/.1 mfd 7000 vdc—2.25
.1 mfd 7500 vdc—1.95
1 mfd 7500 vdc—9.25
.01/.01 mfd 12 kv dc—5.75
.005/.01 mfd 12 kv dc—5.50
.015 mfd 16 kv dc—5.75
.05 mfd 12,500 vdc—12.95
.75/35 mfd 8/16 kv—7.95
2 mfd 18 kv dc—59.50

WESTINGHOUSE

Type MN Overcurrent Relay, Adjustable from 250 ma. to 1 amp. External Push Button Reset. Enclosed in glass case. Hand calibrated adjustments, only $6.75

Tremendous stocks on hand. Please send requests for quotas. Special quantity discounts. Price f.o.b. N. Y. 20% with order unless rated, balance C. O. D. Minimum order $5.00.

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188 Washington St., New York 7, N. Y.

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SPECIAL SURPLUS BROADCAST OF OUR SUPER SPECIALS!!!

VIBRATOR POWER SUPPLY (PE 204A)

Used with Telephone Repeater EE-99A. Input 12 VDC. Output 2 windings @ 4.3 VDC @ 50 MA; 2 @ 45 VDC @ .5 MA; 2 @ 85 VDC @ 5 MA. Loaded with parts. New $1.00

I. F. F. TRANSMITTER ASB-7A

Uses 2 transmitting UHF tubes, 15E and contains 400 cycle blower unit, etc. Freq. range 500 MCS. 18x8x7½ $12.95

DECK ENTRANCE INSULATORS (Bowl and Flange Type)

Mfd. by Ohio Brass Co. heavy galv. metal flange 10½" D., porc. bowl set in rubber gaskets. Top bell 7¾" D. brass feed thru rod 10½" L. Insul. dist. between top bell and flange 6½". $2.50

BATTERY CHARGING PANEL

Mfd. by Price Bros. Two Trumbull 3PDT Knife Switches mounted on 8 x 10 x ½ masonite panel. Wired to heavy duty metal conn.....$2.00

DC SERVO MOTORS

White Rodgers Elec. Co. (6905X-46). 24 VDC @ .65 Amps, Torque 50 in/lbs. ½ RPM reversible, comp. w/limit switch, relays and selenium rectifiers on top of motor, to keep AC out of motor. 5x5x4 $7.95

6904X-27, 24 VDC @ 1 Amp., 150 in/lbs. torque, 2½" RPM reversible. Complete w/limit switch, relays and selenium rectifiers same as above.....$7.95

DAVEN SOUND ATTENUATORS

Type 350-A, Network, ladder, linear, imped. 30/30 ohms, 2DB attenuation, 10 W dissipation. Brand new..$2.50

UNDERWATER SOUND EQUIPMENT

Model QBE driver rectifier, 30 W. Emission A 1. Freq. 18-25 KC., supply 115/1/60. 19x13x10. $32.50

Type CBM 46169. Receiver amplifier, P/of QBE-1, Freq. 18-25KC., Input 115/1/60. 75 lbs. 19 x 13 x 10½....$26.50

Type CBM 55081 Indicator Unit—p/of QBE-1. Ranges 0-1000 yds. and 0-5000 yds., input 115/1/60. 20 x 16 x 8½ $25.00

SPERRY A-5 VERTICAL GYRO UNIT

#644841. 115 V. 400 CY 3 phase. Contains gyro assembly, erection motor, erection relay assembly, pick-off assembly, elevator and aileron limit switches, and roll axes. 15 x 12 x 9. New. $27.50

WESTINGHOUSE FLEXARC WELDERS

Type WC-2, trans. type for single oper. Style 36R117. Pri. 550/440 v. 60 cy. 1 ph. Welding current output 300 amps. Cont. for 1 hr. Load volts 40. Rotating handle on top for current adj. Self cooling. Built in circuit breaker to deenergize the welder and give overload or short circuit protection. 37" H. 18" D. 26" W.....$100.00

GENERAL PURPOSE TANK

Ideal for holding 5 gal. any liquid. Easy to handle. Aluminum construction. 19" L x 9" D $1.00

BATTERY CHARGER

Ideal for your car, for the serviceman and ham. Selenium—transformer type, 7½ x 4½ x 4¾. Portable metal container. Input 115 VAC output 7.5 V. @ 6 amps.....$8.00

TRANSTAT VOLTAGE REGULATOR

Amertran type R11. Input: 115 V. 400 cy. 0.5 KVA. 5.5 max. amps. Output: 92-115 V. 5½x4½x3¼. $1.95

WESTINGHOUSE MOTORS

24 VDC. ⅛ HP, 6.5 A., 5800 RPM. Series W. Cont. duty. 4-⅜" L. x 3-⅛" D. Shaft 1-¼" L. x 5/16" D.....$5.00

W. E. HIGH VOLTAGE POWER SUPPLY

RA50-A, used with SCR 296A. Secondary of hi voltage trans. supplies 20,000 volts @ 45 MILS to two 705A'S; the filaments are heated from 5 V. 10 A. trans. Also 0.05 mfd 12,500 V. cond. 21½ x 17 x 11½.....$49.95

INDUCTION VOLTAGE REGULATOR

Type IRT, form M, 1.64 KVA, 3 phase, 60 cycles, cont. duty. Outdoor service. Primary: 208 V., 10.5 load amps. Oil-filled. Wgt. 365 lbs. 33 x 17" x 14".....$53.50

G. E. MOTOR CONTROLLED VOLTAGE

Cat. #837625, Type 'Airs', Form M, .568 KVA, cont. duty, 60 cy., primary volts 115, Load Amps 16.2. Indoor service. Voltage controlled by mtr. 120/1/60.1/40 HP..$34.50

DYNAMOTOR GENERATOR

Model 3975-1. Electric Sprayit Co., p/o "Gibson Girl". Input 28 VDC @ .175 amps. Output 300 VDC @ .040 amps. 5" L. 3¼" D. .....$1.50 ea.

RCA TRACK LIGHTING & CONTROL PANEL

Model 713-AS, comp. wire ready for immed. oper. Controls the filament volt. on vacuum tubes in the process of being exhausted on rotary turn table equip. 7" H, 15" D, 32" W. Units complete with meters, variac dist. transformers, switches, rheostats, etc. $275.00

FITCH CRYSTAL DUPLICATOR

Calibrates crystal plate of unknown freq. against standard plate of desired freq. Consists of standard and test oscillators whose outputs are mixed to produce an amplified beat note; the freq. is shown on 500, 5000, 50,000 cycle meter. Metal cabinet w/hinged cover. 9" H. x 13" W. x 19" L. Comp. w/4" sq. activity and frequency meter $22.50

MILLIAMETERS

150-0-150 MA DC. Accuracy ½ of 1%. Scale length 4⅛", Wt. 3½ lbs. 6" x 2½" x 4⅛". L. N. $2.50

TRANSTATS

11.5 KVA 50/60 cy. Commutor range 0-115 V. Max. Amps 100. Reconnection diagram available for 230 V 50A oper. Brand New. $100.00

.25 KVA Fixed winding 115/1/60. Commutator range 103-126 V. 2.17 Max Amps..$9.45

RETARD CHOKE COILS

Amertran, Disc Type. Line voltage 15,000; ripple freq. 120. Oil-filled; .020A DC @ 9001I @ 48% ripple, 52A DC @ 2511 @ 48% ripple. 17"x17"x22" w/term. 10" above case. 40°C temp. rise.....$34.00

NEW SWITCH INTERLOCKS

B857 B986 B1536

Cory Type B857, Single Key Oper. Interlocking of doors, vaults, reactor or resistor enclosures, oil circuit breakers, etc. $1.98

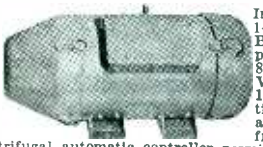
Cory Type B986, Single Key Oper, SPST SW w/Yale Cyl Lock 60A tumbler lock.....$2.49

Cory Type B1536, Supervisory Oper. 2 key type..$2.95

B. C. 604 F. M. TRANSMITTER

Wide or narrow band FM, 30 watt power output. Excellent possibility for ten or eleven meter exciter. Freq. 20-27.9 MC. Working space permits modification. 7 tubes but less power supply and xtls. LN $11.50. Complete with Crystals $27.50

ALLIS CHALMERS MOTOR GENERATORS



Input: 115 VDC at 14 amp, 3600 RPM. Ball Bearings. Output: 1.25 KVA 80% P.F.; 120 VAC 60 cy. 1 ph., 10.4 Amp. Resistive control of voltage output and freq. built-in. Centrifugal automatic controller permits line-start oper. Fully enclosed. BRAND NEW! $100.00. Same machine for 230 V.D.C. Operation.....$120.00

Spare parts kit of brushes, brushholders, ball bearings, field coils, etc., in steel case for above M/G's $10.00

AMERTRAN HEAVY DUTY TRANSFORMERS

Pri.: 115/230 VAC 60 cy. Sec.: 4730/2365 V. 1.66KVA. RMS. 12 KV. Wgt. 150#. 11"x11"x9". 700 Ma. New $27.50

Standard Brand RHEOSTATS

High shock rheostats, four 13" plates, 100 ohms 8-2A, 175-345 V connected in series. Assembled for back of board mtg. or by reversing the supporting brackets for floor or table oper. New $19.75

INTER COMMUNICATION SETS

Mfd. by Dictograph. Designed to bring to homes and offices the conv. of two-way conversation w/o the use of telephone, household electric current, or radio. Efficient up to 800 ft. off flashlight batteries. New Pair.....$9.95

SELECTOR SWITCHES

Heavy duty, U. S. N. Control any type of multi-circuit devices. Removable contacts enabling any comb. of closed and open circuit. The following available: 5 section-10 pole or 10 section-20 pole, $1.50 ea. Case lots of (8) $8.00 or (5) cases, special....$32.50

MARATHON MOTOR GENERATORS

Input at 110 VDC Output 110VAC, 1 phase, 60 cy. 500 VA. Marine Type with voltage regulator and frequency controller. Rebuilt LN. $65.00

Same unit as above with 32 VDC Input and 300 VA Output $54.00

KATO ROTARY CONVERTERS

Type 1205A Model 26KA54. Input: 24 VDC, 28A. 1800 RPM. Output: 115 VAC 1 phase 60 cy. 1 KVA. Compact and ruggedly built for cont. duty oper. Filtered. Shock mounted. New.....$90.00

MINE DETECTOR SCR 625

Detects metallic objects (ferrous or nonferrous) to a depth of approx. 6 ft. Find outboard motors on the bottom of lakes, locate underground piping, treasure, metallic fragments in lumber, etc. New, complete with inst. book, $65.00. Used but like new.....$45.00

SPERRY A-5 AMPLIFIER RACK

#644890, contains Weston Model 833 Voltmeter 0-130 and Weston Model 637 Frequency Meter 350-450 cycles. Several 24 VDC relays, transformers and condensers. New $12.95

ALL PRICES F.O.B. BOSTON. ORDERS ACCEPTED FROM RATED CONCERNS ON OPEN ACCOUNTS NET 30 DAYS. MINIMUM ORDER $3.00

ESCO ELECTRO Sales Co.

110 PEARL ST., Dept. E6, Boston 10, Mass. . . . Liberty 2-5589 . . . HAncock 6-5069

SELENIUM RECTIFIERS
AND SPECIALIZED ELECTRONIC COMPONENTS

VACUUM CAPACITORS
Standard Brands

12 Mmfd 20 Kv	$4.95
50 Mmfd 20 Kv	4.95
50 Mmfd 32 Kv	5.95

SILVER CERAMIC TRIMMERS

Type 820-Z 5–20 Mmfd Zero Temp	24¢
Type 822-N 5–20 Mmfd Neg. 300	24¢
Type 822-AZ 4 5–25 Mmfd Zero Temp	24¢
Type 823-AN 20–125 Mmfd Neg. 650	33¢

FENWAL THERMOSWITCH
Normally closed. Opens with temp. rise Adjustable from —40° to +400°F **$1.25**

OIL CONDENSERS

2 Mfd 200 VDC Bathtub	20¢
.5 Mfd. 400 VDC	20¢
2 Mfd 400 VDC Bathtub	30¢
2x.1 Mfd 600 V	39¢
6 Mfd 600 VDC w/mtg clamp	79¢
10 Mfd 440 VAC/1500 VDC	1.55
8 Mfd 660 VAC/2000 VDC	3.50
2x.15 Mfd 8000 VDC	3.95

ELECTROLYTIC CONDENSERS

Cap	WV DC	Each	Lots of 10	Lots of 100
100 Mfd	50	.27	2.20	19.00
40 Mfd	150	.23	1.80	17.50
8–8–20 Mfd	350/150	.40	3.50	30.00
20–20 Mfd	400/250	.35	3.00	25.00
10 Mfd	450	.30	2.50	20.00
15 Mfd	450	.30	2.50	20.00
40 Mfd	450	.50	4.20	36.00

Full Wave Bridge Types

Input 0–18VAC	Output 0–13*VDC	
Type#	Current	Price
B1–250	250 MA	$.98
B1–500	500 MA	1.95
B1–1	1 AMP.	2.49
B1–1X5	1.5 AMP.	2.95
B1–3	3 AMP.	3.49
B1–5	5 AMP.	5.95
B1–10	10 AMP.	9.95
B1–15	15 AMP.	13.95
B1–20	20 AMP.	15.95
B1–30	30 AMP.	24.95
B1–40	40 AMP.	27.95
B1–50	50 AMP.	32.95
B1–60	60 AMP.	36.95
B1–80	80 AMP.	44.95

Full Wave Bridge Types

Input 0–18VAC	Output 0–40*VDC	
Type#	Current	Price
B3–150	150 MA.	$1.25
B3–250	250 MA.	1.95
B3–600	600 MA.	3.25
B3–5	5 AMP.	13.95
B3–10	10 AMP.	24.95

Input 0–74VAC	Output 0–54*VDC	
Type#	Current	Price
B4–600	600 MA.	$3.95
B4–3	3 AMP.	14.95
B4–5	5 AMP.	17.95
B4–10	10 AMP.	32.95

Input 0–115VAC	Output 0–110*VDC	
Type#	Current	Price
B6–150	150 MA.	$1.95
B6–250	250 MA.	2.95
B6–1	1 AMP.	7.95
B6–3x5	3.5 AMP.	18.95
B6–5	5 AMP.	24.95
B6–10	10 AMP.	36.95

Input 0–234VAC	Output 0–180*VDC	
Type#	Current	Price
B13–600	600 MA.	$12.95
B13–1	1 AMP.	16.95
B13–3	3 AMP.	35.95
B13–5	5 AMP.	54.95
B13–10	10 AMP.	69.95

Full Wave Bridge Types

Input 0–36VAC	Output 0–26*VDC	
Type#	Current	Price
B2–150	150 MA.	$.98
B2–250	250 MA.	1.25
B2–300	300 MA.	1.50
B2–450	450 MA.	1.95
B2–1	1 AMP.	3.95
B2–2	2 AMP.	4.95
B2–3x5	3.5 AMP.	6.95
B2–5	5 AMP.	9.95
B2–10	10 AMP.	15.95
B2–15	15 AMP.	24.95
B2–20	20 AMP.	27.95
B2–30	30 AMP.	36.95
B2–40	40 AMP.	44.95

Three Phase Bridge Types

Input 0–126VAC	Output 0–130*VDC	
Type#	Current	Price
3B7–4	4 AMP.	$32.95
3B7–6	6 AMP.	48.90
3B7–15	15 AMP.	70.00

Input 0–234VAC	Output 0–25*VDC	
Type#	Current	Price
3B13–4	4 AMP.	$56.00
3B13–6	6 AMP.	81.50
3B13–15	15 AMP.	120.00

CENTER TAPPED TYPES

Input 12–0–12VAC	Output 0–8*VDC	
Type#	Current	Price
C1–10	10 AMP.	$6.95
C1–20	20 AMP.	10.95
C1–30	30 AMP.	14.95
C1–40	40 AMP.	17.95
C1–50	50 AMP.	20.95
C1–80	80 AMP.	26.95
C1–120	120 AMP.	34.95

* Select Proper Capacitor From List Shown Below, to Obtain Higher D. C. Voltages Than Indicated

RECTIFIER MOUNTING BRACKETS

For Types B1 through B6, and Type C1	$ .35 per set
For Types B13	.70 per set
For Types 3B	1.05 per set

Rectifier Transformers
All Primaries 115VAC 50/60 Cycles

Type†	Volts	Amps.	Price
XF15–12	15	12	$3.95
TXF36–2	36	2	3.95
TXF36–5	36	5	4.95
TXF36–10	36	10	7.95
TXF36–15	36	15	11.95
TXF36–20	36	20	17.95
XFC17–10	17	10	4.95

All TXF Types are Tapped to Deliver 32, 34, 36 Volts. XFC Type in Primary Tapped to Deliver 15, 16 or 17 Volts Center-Tapped.

RECTIFIER CHOKES

Type		Amps.	Price
HY2	.03 Hy	2	$2.25
HY3	.03 Hy	3	2.95
HY5	.02 Hy	5	3.25
HY8X5	.02 Hy	8.5	7.95
HY10	.02 Hy	10	9.95
HY12	.02 Hy	12	12.95
HY15	.015Hy	15	13.95

RECTIFIER CAPACITORS

CF-13	6000 MFD	10VDC	$2.49
CF-14	3000 MFD	12VDC	1.69
CF-15	6000 MFD	12VDC	2.95
CF-1	1000 MFD	15VDC	.98
CF-2	2000 MFD	15VDC	1.69
CF-20	2500 MFD	15VDC	1.95
CF-3	1000 MFD	25VDC	1.25
CF-4	2X3500 MFD	25VDC	3.45
CF-5	1500 MFD	30VDC	2.49
CF-6	4900 MFD	30VDC	3.25
CF-7	3000 MFD	35VDC	3.25
CF-8	100 MFD	50VDC	.98
CF-19	500 MFD	50VDC	1.95
CF-16	2000 MFD	50VDC	3.25
CF-9	200 MFD	150VDC	1.69
CF-10	500 MFD	150VDC	3.25
CF-11	100 MFD	350VDC	2.25
CF-12	125 MFD	350VDC	2.49

VARIABLE AIR TRIMMERS
Standard Brands—Screw Driver Adjustment

	Lots of 10	Lots of 100
7.5 MMF	$2.90	$27.00
25 MMF	3.10	29.00
50 MMF	3.30	31.00
100 MMF	4.10	39.00
140 MMF	4.90	47.00

METERS

O-15 MA.D.C. Weston #506 2" Rd	$2.95
O-6 A.D.C. Vane-type 2⅜" sq	2.49
O-12 A.D.C. Vane-type 2⅜" sq	2.49
O-120 A.D.C. West. w/shunt. 2½" Rd., aircraft type	4.95
O-15 V.D.C. Vane-Type 2⅜" sq	2.49
O-30 V.D.C. West. 2½" Rd., aircraft type	2.95
O-300 V.D.C. 2½" Rd., Bakelite Case Basic O-1 Ma.	2.95

To avoid shipping errors, kindly order by type #. All prices subject to change without notice.

ATTENTION ! ! !
INDUSTRIALS, EXPORTERS, SCHOOLS
GOV'T AGENCIES, LABORATORIES
Our engineering staff is at your service to facilitate the application of rectifiers to your specific requirements.
Write for quantity discount on company letterhead.

Minimum order $3.00. No C.O.D.'s under $25.00. 25% deposit on C.O.D. Add 10% for Prepaid Parcel Post and handling. Terms: Net 10 days to rated concerns only.

Orders Promptly Filled From Our Stocks
All Prices F.O.B. Our N.Y.C. Warehouse

OPAD-GREEN COMPANY
71 Warren St. *Phone: BEekman 3-7385* New York 7, N. Y.

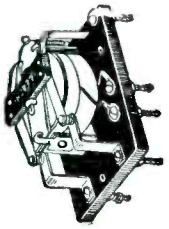
GRAIN of WHEAT LAMPS

Used for illuminating meters, compass dials, airplane instruments, etc. Soldering iron removes lamp from base to use in models, doll houses, miniature trains, Xmas trees, etc.
Mazda G.E. 323 3V..19 A Mazda G.E. 328 6V..2 A
Photo, actual size. Glass Bulb ⅛"x⅜"
Either type doz. $1.50 75.00 per M.

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 **$3.90**

Also available in 15 min.-30 min.-1 hr. at $6.55

D.P.S.T. LEACH RELAY
Split coil 12 or 24 V.D.C. 10 amp. 45c each, 3 for $1.00, 7 for $2.00, 15 for $4.00. Min. shipment. $1.00



ISOLATION TRANSFORMER
Nat. known Mfgrs. 50 watt 2 windings, 115 V. to 115 V. 60 cy. Ideal to prevent shocks from small radios and medical and electronic devices **$1.95** Shipping Weight 5 lbs. Other sizes and 220-110 in stock.

A newly Written (1948) Book on Photoelectric (Electric Eye) Circuits..... 10 for $7.50 **$1.00**

Kilowatt Demand Meter Totalizer containing heavy-duty telechron B-7, 1 RPM motor and hundreds of watch size gears, clutches, springs, etc. Shipping weight 2 lbs. 5 for $10.00. **$2.50**

We are Authorized Wholesalers for Micro Switch Corp. and carry the largest stock of Allen-Bradley Solenoids. Potter & Broomfield Relays. Guardian Electric Co. Solenoids and Relays and Haydon Clock Motors in all speeds.

EST. 1923 **BLAN** EST. 1923

Experimenters and Inventors Supplies
64P Dey St., New York 7, N. Y.

PRICE WAR!

SO 239 **28¢**

PL 259 **26¢**

UG 87U, baby 'N' receptacle 35¢

SPECIAL OPENING OFFER
50 foot CORD-O-MATIC reel, brand new in factory carton including two conductor rubber covered cord. Used with B&H projector for speaker. Ideal for garages, etc. Reg. price $26.50. Opening offer..... **$9.95**

HAROLD H. POWELL
338 Windermere Ave. Lansdowne, Pa.

LABORATORY SURPLUS

RCA 100 KC CRYSTALS, 140 brand new hermetically sealed high precision standards in Mfg. cartons, $3.35 ea., 10 for $27.00. RESISTANCE DECADE BOXES, 0.1% accurate, low Res. silver-contact switches, oak boxes, engraved panels, used but perfect; 5 boxes, 10 ohms to 10 megs in 10 ohm steps, $30.00 ea.; 5 boxes, 1 to 9 megs in 1 meg steps, $7.00 ea.; 1 large 30-decade box, 5 separate branches each 0.1 ohm to 0.1 meg in 0.1 ohm steps, $75.00. GALVANOMETERS: 4 Weston #440, 15 microamps, $9.00 ea. FREQ. METER; perfect BC-221 with set of spare tubes, built-in regulated power supply and heavy fabric carrying bag, $55.00.

G. V. HILL
210 Park Drive Norman, Oklahoma

Yes Sir! the **HOTTEST LIST** in the LAND. brim full of electronics, hydraulics, aircraft parts, gadgets Rush me your name TODAY

AC/DC SELSYN SYSTEM

Here's the perfect remote position indicating system—very accurate—operates from 6-12 volts d.c. or 110 a.c. with 75 ma. half wave rectifier and resistor. Diag. furnished.

Per set **$4.95**

MIDGET SELSYNS

AY type operates from 6-12 V. 60 cycle. (26 V 400 cycle) use for either transmitter or receiver ..... **ea. 98c**

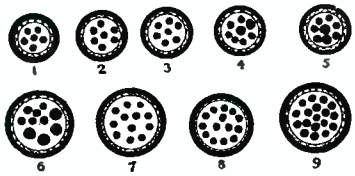
500 CYCLE GENERATOR

4 KVA 110 Volt single phase p/f 1 3400 RPM. Just the thing to hook up to a 60 cycle motor as a power source to operate surplus 400-500 cycle equipment. Has 1 ⅛" keyed drive shaft. Built in exciter and separate DC output of 14 volts @ 40 amps. OD 25 ½ x 12" dia. Wt. approx. 200 lbs. Brand New. FOB EVERETT OR MID WEST. **ea. $79.95**

AMPLIDYNE

GE #5AM31NJ9A 28 VDC input 60-0 60 VDC output at 8.8 Amps. 1 watt field power controls 530 watts output power. The ideal DC motor speed control & AC generator voltage control. Brand New ..... **ea. $2.95**

CONTROL CABLE



1. **6 cond. #18 stranded,** shielded, rubber covered .440 OD ft. ..... 8¢
2. **7 cond. #20 stranded,** shielded, rubber covered. .440 OD ft. ..... 8¢
3. **7 cond. #16 stranded,** plastic covered ft. ..... 9½¢
4. **8 cond. (2 #14, 6#20) stranded,** shielded, plastic covered ft. ..... 9½¢
5. **8 cond. (2#16, 6#20) stranded,** shielded, plastic covered, ft. ..... 10½¢
6. **10 cond. (4#12, 2#16, 4#18) stranded,** shielded, plastic covered. .730 OD., ft. ..... 14¢
7. **12 cond. #18 stranded,** shielded, plastic covered, ft. ..... 15¢
8. **16 cond. #18 stranded,** shielded, plastic covered, ft. ..... 16¢
9. **18 cond. (2#16, 16#20) stranded,** shielded, plastic covered, ft. ..... 16¢

All conductors color coded. Write for other sizes and types of control cable.

Include return address. Satisfaction Guaranteed or your money back. Hundreds of bargains in our free illustrated list.

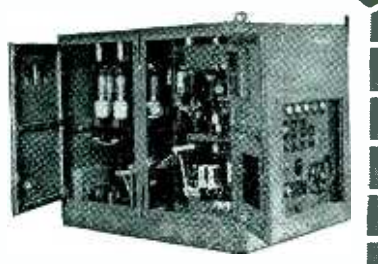
DICK ROSE ERECO
2912 Hewitt Ave. Everett 20, Wash.

INDUSTRIAL POWER SUPPLY EQUIPMENT

for worthwhile savings to you

10 KW 0-15 KV OUTPUT RECTIFIER POWER SUPPLY

NEW RA-38 HIGH VOLTAGE POWER SUPPLIES: 0-15,000 volts d-c @ 500 ma. Ripple ½% @ 100 ma; 3% @ 500 ma. Regulation 15,800 volts @ 100 ma. 15,000 volts @ 500 ma; 6,800 volts @ 100 ma, 5,000 volts @ 500 ma. Input 115 volts 60 cycle single phase. Full wave bridge rectifier using 4 371B tubes is utilized. Units are designed for continuous duty operation. Units have a full complement of controls, meters and safety devices. A remote control and spare set of tubes is included with each unit. Units are assembled in steel cabinets 62-½" long by 53-¾" wide by 56-¾" high. The cabinets are rubber shock mounted on skids. Weight 2040 lbs. Priced at less than 25% Government acquisition cost. Complete detailed information on request.



ASD RADAR TRANSMITTER

3 centimeter, complete w/725A magnetron, cavity, two 723A/B klystrons, RKR 73, four 72's, 715B, 829B, two 724B's, two 6AC7's, IN23 crystal diode, high voltage supply, cooling blowers, etc. Input: 115 v 400 c. N-2 condition **$110.00**

PARTS FROM ABOVE EQUIPMENT

Pre. Amp. Assembly: includes plumbing, two 723A/B Klystrons, two 6AC7's, two 724B's, IN23 crystal diode etc... $37.50
Power transformer: D9178, two 2.5 volt windings, 6.3 volt winding and high voltage winding, 115 v. 400 cy. Pri..... $11.50
725 Magnetron 12.50
Magnet for 725A. Pole dia. ¾", spacing ⅝" 4850 Gauss.... 7.50
Tubes, filaments guaranteed: CRP 72..$1.10; RKR73..$1.30; 715B ..$5.25; 829B..$2.50.
Capacitor: Vitamin Q, .30 mfd @ 2,000 v d-c ..... .85
Capacitor: Vitamin Q, 2 x .15 mfd @ 8,000 v or .075 mfd. @ 16,000 volts 2.90
Telephone Type Relays: #1 DPST normally open; #2 same as #1 plus a SPDT contact; 1,000 ohm coils both mounted in metal case 3¼ x 3¼ x 4½..... 2.50
Motor blowers: 28 v a-c/d-c.. 2.95

NEW CAPACITORS

STANDARD BRANDS

OIL

2 mfd 600 v d-c tubular: $.30 each 10 for $2.50
3.5/.5 mfd 1000 v d-c.....90 each 4 for 3.00
3 x 1.0 mfd 3 kv d-c test, 1.2 kv d-c wk. Isolated sections. 1.20
1.25/1.25 mfd 7.5 kv d-c or .625 mfd 15 kv d-c Pyranol....12.50
.25/.25 mfd 6 kv d-c or .125 mfd 12 kv d-c..... 3.75
1.0 mfd 25 kv d-c; 65 lbs net; Pyranol 36.00

ELECTROLYTIC

500 mfd 200 wv d-c, insulated terminals ..... .95

MICA

.001 mfd 25 kv d-c; 25 a @ 3,000 kc, 18 a @ 1,000 kc, 11 a @ 300 kv 25.00

VACUUM

50 mmfd 32 kv d-c; tubular 4.95

SPECIALS

WESTINGHOUSE METER MULTIPLIER: 1 meg; ½% accuracy; wire wound; noninductive $1.25
RUNNING TIME METER: R. W. Cramer Type RT3H; 220 v 60 c; 3" square face; 5 figure indicator. (new) 6.95
FILAMENT TRANSFORMER: Constant current type, pri. 110/220 v 50/60 c, sec. 21.5 v 40.5 amps.... 17.50
TUBE WL 386/ML-3W; 125 kv X-ray rectifier; oil immersion type; filament; 10 v # 11.6 amps..... 32.00
CRAMER TIME DELAY RELAY type TD2 120S: 0-120 seconds 115 v 60 c; synchronous motor driven; contact rating 10 amps 115 v; single pole normally open 4.95

VOLTAGE REGULATORS

TRANSTAT: 115 v 50/60 cycle input: 0-115 v 100 amps 11.5 KVA output $95.00
TRANSTAT: 115/230 v 50/60 c input: 0-260 v output @ 2.5 amps...$21.50
TRANSTAT: 115 v 50/60 c input: 0 to 130 v output @ 10 amps..$24.50

METERS

Weston or Westinghouse

3" 0-120 a-c amps, w/current transf $ 8.50
3" 0-20 kv d-c w/precision multiplier 18.00
3" 0-4 kv d-c w/precision multiplier 9.50
3" —10 to +6db, 6 mm 600 ohms 6.50

CONSTANT VOLTAGE TRANSFORMERS

SOLA

95 to 125 volt 50 cycle single phase input; 115 volt output:
60 va ...$ 8.40 380 va ...$27.00
120 va ....13.20 500 va 34.00
250 va 18.00
190 to 250 volt input; 220 volt output:
60 va .... 8.40 250 va 16.00

RAYTHEON

198 to 242 volts 50/60 cycle single phase input; 220 volt 500 watt output $38.00

POWER FACTOR Correction

9:12 mfd 1265 v a-c, 60 c, 1 ph, 5 kilovolt amps reactance. New G. E. Pyranol $17.50

TUBES

NOTICE: All Tubes are New, of Standard Mfg., in original boxes

Type	Price
1B22	$5.75
1B23	9.75
1B24	4.75
2021	1.25
2J62	47.50
3B22	2.75
3B24	1.75
3C23	3.75
4B28	2.75
6Q5G	1.25
15E	1.25
250R	7.50
250TH	19.50
250TL	19.50
*304TL	7.50
307A/RK75	4.50
316A	.75
371B	2.75
388A	2.75
450TH	22.50
700A	37.50
701A	4.75
702A	3.75
703A	4.75
704A	2.25
705A	2.25
706BY	17.50
706EY	19.50
707A	14.75
707B	16.50
708A	4.75
713A	1.25
714AY	5.75
715A	9.50
717A	.75
721A	2.75
722A	13.75
725A	17.50
730A	19.50
750TL	47.50
811	1.75
830B	4.75
872A	2.25
921	1.25
931A	2.75
C5B	8.50
C6A	8.50
C6J	9.50
FG81A	4.75
WE-203A	4.75
WL-531	17.50
WL-533	17.50

*Includes 115 v 60 c H.V. fil. trans & socket.

T-102—Filament Transformer, American Transformer Co. Spec. 29106, Type WS .050 KVA, 50/60 cyc. Single phase, 35 KVA test, 12 KV D.C. operating. Primary 115 V., secondary 5 V., 10 amps with integral standoff insulator and socket for 250 T, 371, 872 and 5563, etc. rectifier tubes $12.50 Net Wt. 15¾ lbs. Dim 6½" W x 6" D x 12" H.O.A

MOTOR GENERATORS

G.E. Type CC-21991 input 115 v d-c., @ 5.7 amps. Output 115 v a-c 60 cycle, single phase 350 V.A. @ 85% $58.00
G.E. Type CC-21990 input 32 v d-c., @ 22 amps. Output 115 v. a-c 60 cycle, single phase. 350 V.A. @ 85% P. F. $63.00
Leland Type CLL-21985 input 115 v d-c @ 4.2 amps. Output 115 v a-c 60 cycle, single phase 240 V.A. @ 86% P. F. $47.00

All merchandise in "as new" condition. Add approx. 20% to net weights for estimated shipping weights. Terms are 30% with order, balance C. O. D. All prices f.c.b. Los Angeles Warehouse. Write for additional detail information on any of the above items and for special quantity discounts. **Telephone MAdison 8-5391**

1527 E. SEVENTH ST. EPCO LOS ANGELES 21, CALIF.

ACORN

SERVES LABS, SCHOOLS, INDUSTRIALS, —SAME DAY SERVICE.

JENSEN 10" SPEAKER
PIOT—ST119. Perfect for PA work and monitoring. Voice coil 6-8 ohms imp. Each **$4.49**

JENSEN 12" SPEAKER—
PM 12SH Extended range 50 to 10,000 cy. 6-8 ohms v.-c. Each **$8.45**

MAGNAVOX SPEAKER
8" PM—22 oz. magnet. Voice coil—8 ohms imp. Not surplus. Each **$2.99**

STANCOR POWER TRANSFORMER
115v-60 cy. Pri. 800v ct. @ 200 mils 6.3 @ 6 amp. 5.0 v @ 6 amp.
Upr. mt. **$4.79**

HEAVY DUTY POWER TRANSFORMER
Pri. 110/220 volts 60 cy.
Sec. No. 1—410-0-410 @ 400 mil.
No. 2—6.3v @ 3 amps.
No. 3—6.9v @ 13.5 amps.
No. 4—5v @ 3 amps.
No. 5—2.5v @ 1.7 amps.
Dimensions H-6½", W-6½", D-5½". Wt. 33 lbs. Made by GE for U. S. Navy. A Tremendous Value. Each **$7.49**
3 for $20

ALLEN-BRADLEY CONTROLS

Ohmage	Shaft	Bushing
50	5/8" reg.	3/8" L.B.
500	3/8"	1/4"
500	1/4" s.s.	3/8"
1000	3/8"	3/8"
1000	3/16" s.s.	1/2" L.B.
2000	1/8" mill	1/4"
2500	3/8" reg.	3/8"
3000	1/2" mill	1/4"
5000	2 13/16"	1/2"
5000	1/8" s.s.	1/4"
6500	1/8" s.s.	1/4"
10,000	1/8" s.s.	1/2" L.B.
15,000	1/8" s.s.	1/4"
20,000	1/8" s.s.	1/2" L.B.
25,000	1/8" s.s.	1/2" L.B.
40,000	1/8" s.s.	1/2" L.B.
50,000	5/8" reg.	1/2" L.B.
50,000	1/8" s.s.	1/2" L.B.
50,000	1 3/16" mill	3/8"
50,000	3/8" reg.	1/4"
60,000	1/2" mill	1/4"
100K	1/8" s.s.	1/2"
250K	1/8" s.s.	1/4"
500K	1/4"	1/2"
500K	1/2"	1/4"
1 meg.	1/8" s.s.	3/8"
1 meg.	1/8" s.s.	1/2"
6.25 meg.	3/8"	1/4"

69c each 100 for $55.

ERIE TS2A & CENTRALAB SILVER CERAMIC TRIMMERS
1½ to 7 mmfd.
2½ to 6 mmfd.
4 to 30 mmfd.
5 to 20 mmfd.
7 to 45 mmfd.
20 to 125 mmfd
35 to 55 mmfd.
23c ea. 10 for $2.19

STANCOR FILTERCHOKE
15 henry 250 mils—55 ohms DC. Upr. mt. **$2.79**

NPO ERIE CHASSIS MOUNT SILVER TRIMMERS
5 to 25 mmfd. **23c ea.**
8 to 50 mmfd. **10 for $2.19**
to 12 mmfd.

SPRAGUE PULSE NETWORK
15 A-1-400-50. H-500. 15,000 volts. 50 ohms imp. 1 microsecond delay. 400 pulses per sec. ea. **$12.95**

Standard Brand Button Condensers 24c each
30 mmfd.
280 mmfd.
500 mmfd.
1000 mmfd.
10 for $2.21

MICA TYPE F CONDENSERS
CM 65 & CM 70—Very Special Low Price

Cap.	Volt.	Each	Cap.	Volt.	Each	Cap.	Volt.	Each
.1	1000	$1.58	.00025	3000	.91	.0004	5000	.96
.05	1500	1.65	.0004	3000	.91	.0005	5000	1.05
.075	1500	1.70	.00075	3000	.96	.0006	5000	1.05
.00008	2000	.63	.001	3000	.99	.0008	5000	1.05
.01	2000	1.35	.0035	3000	1.35	.001	5000	1.17
.00003	3000	.72	.0001	5000	.96	.0012	5000	1.17
.000075	3000	.72	.0002	5000	.96	.0015	5000	1.17
.0001	3000	.72	.00025	5000	.96	.00004	6000	1.39
.0002	3000	.91	.00032	5000	.96			

FP CONDENSERS — STANDARD BRANDS

SINGLE SECTION

Cap.	Volt.	Each
2,000	15	$.79
1,000	25	.74
10	450	.34
20	450	.39
20	475	.47
30	450	.49

DUAL SECTION

Cap.	Volt.	Each
40-20	25	$.39
80-80	25	.49
20-20	250	.54
40-40	250	.79
10-40	300-25	.49
90-10	350	.69
40-20	450	.79
40-40	450	1.09
20-20	450	.49
50-50	450	1.19

TRIPLE SECTION

Cap.	Volt.	Each
90-90-20	200-200-50	$.89
30-15-10	350-300-25	.59
10-10-20	350-350-25	.51
30-15-10	350-300-300	.69
15-10-10	400-400-350	.62
15-10-10	350-350-250	.64
40-40-20	400-300-250	.89
10-10-20	450-450-25	.69
15-15-10	450-400-350	.73
30-10-10	450-450-350	.79
30-30-10	450-450-25	.89
60-20-20	450-450-400	1.19

QUADRUPLE SECTION

Cap.	Volt.	Each
80-30-100-40	150-150-25-25	$.79
40-40-20-200	150-150-50-10	.79
40-50-20-20	300-250-250-25	.79
10-30-20-20	350-300-25-25	.69
40-20-10-40	300-300-300-250	.89
20-20-20-20	450-450-450-450	1.29
20-20-20-20	475-475-475-450	1.34

OIL CONDENSERS

Cap.	Volt.	Each
4	600	$.59
5	600	.69
6	600	.79
7	600	.89
2	1000	.79
4	1000	.99
8	1000	1.29
8x1	1000	1.39
10	1000	1.69
15	1000	2.89
2x4	1500	1.95
.25	3000	1.19
1.0	3000	1.95
0.1	3500	.79
.15	4000	1.49
0.5	5000	1.99
2	5000	5.95
30	90v AC 3 Phase	3.95

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DRIVER UNIT with REFLEX PROJECTOR

WAY BELOW MANUFACTURERS' COST

$19.95 F.O.B. N.Y.C. 4 FOR $75.00

A Blast-Proof, Blare-Proof Reflex Speaker, with a Projector especially designed for use with the famous *WESTERN ELECTRIC DRIVER UNIT*.

Heavy gauge metal construction throughout, including the main trumpet section, gives you peak performance without blaring or blasting.

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230 V.DC to 120 V.AC
60 Cycles, 7½ KVA Output MOTOR GENERATORS at Sensationally LOW PRICE!

NEW, UNUSED, mfd. by Star Electric Motor Company of Bloomfield, N. J. Motor volts—230 DC, 7½ HP, compound wound, 1800 RPM, equipped with 8" large flat contact field rheostat. Generator—7.5 KVA at 1800 RPM, 120 volts, single phase, 60 cycles, equipped with 13" large flat contact field rheostat. Ideal for ships, shipyards, industrials or wherever DC to AC conversion is desired. Domestic packed, FOB warehouse NYC. EACH.....$345.00

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0-100 ua 4½" round Weston 643... 14.00
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0-200 ua 3" sq. G.E. DO 50..... 8.00
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0-2 Ma 4½" r. Weston (vacuum) 26.00

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SN RADAR

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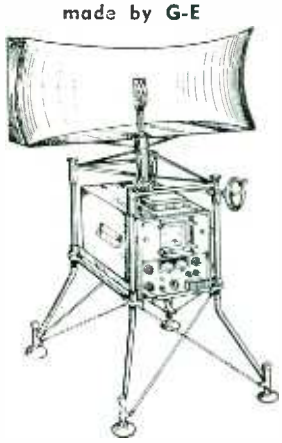

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Good, used condition . . . an outstanding price. Complete **$250.00**

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115V, DC input . . . 115V, 60 cycle AC output. Has frequency regulator. Highly desirable for all-round radio use . . . can be used with above radar . . NEW! **$60.00**

1 MFD., 15,000 WV OIL-FILLED CAPACITORS

A very husky HV unit suitable for welders, power-factor, transmitters, schools, labs . . . New, individually boxed for export....**$12.45**

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Frequency range, 300kc to 18,100 kc. A1, A2, A3 emission. 110V, DC or 220V, DC models available. Good condition . . . with tubes **$295.00**

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Excellent condition **$250.00**

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8000 ohm coil, SP-DT. 5 prong, plug-in type . . . A real buy at.....**$1.95**

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815 tubes **$1.95**
833A **$25.00**

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ECHO BOX CUO-14AAY FOR OBU-RADAR

TS-110/AP S BAND ECHO BOX.

APR-1 RADAR SEARCH RECEIVER, complete with tuning units for range of 80-4000 mc, 30 mc I.F., 2 mc wide.

TUNING UNITS FOR APR-1 or APR-4 RECEIVERS (can be used with any 30 mc amplifier):
TN-16, range 30-90 mc
TN-17, range 80-300 mc
TN-19, range 1000-2000 mc
TN-54, range 2000-4000 mc

A LOW COST SUBSTITUTE FOR APR-4 RECEIVER, consisting of an APR-4 power supply and 30 mc I.F. with video amplifier chassis of BC8000AH, complete with tubes and necessary schematic. Equipment is new, but requires minor changes in wiring..complete, .. **$60.00**

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TEST SET TS-278/AP, for AN/APS 13, synchronized, delayed pulse signal generator, 400-430 mc, calibrated waveguide below cut-off attenuator, synchronized marker generator, 115 v 60 cps, new complete

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LOSSY LINE ATTENUATOR, consisting of RG-21/U cable rolled in metal box with UG-10/U connectors, furnished in any attenuation up to 20 db at 3000 mc **$15.00**

SHIPBOARD RADAR—SQ, SN, SD-3 and SA-1

GENERAL RADIO PRECISION WAVEMETER, type 724A, range 16 kc to 50 mc, 0.25% accuracy, V.T.V.M. resonance indicator, complete with accessories and carrying case, new.....**$175.00**

RDF EQUIPMENT DP-15, 100-1500 kc, for ship use, complete with pedestals, azimuth scale, loop assembly, used 110 v 60 cps **$250.00**

TRANSFORMERS, 115 volts, 60 cps primaries:
1. 6250, 3250 and 2000 volts, tapped primary, voltage doubler, 12.5 kv ins **$14.00**
2. 6250 volts 80 ma, ungrounded, G.E. voltage doubler, 12.5 kv ins....**$12.00**
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PULSE INPUT TRANSFORMER, permalloy core, 50 to 4000 kc impedance ratio 120 to 2350 ohms.....**$3.00**

PULSE TRANSFORMER, UTAH 9280 **$1.50**

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HYPERSIL CORE CHOKE, 1 Henry, Westinghouse L-422031 or L-422032 **$3.00**

PULSE FORMING NETWORK, 20 kv, .92 microsecond, 50 ohms, 800 p.p.s..**$40.00**

Clough Brengle Resistance Capacity Bridge, model 230A, new.....**$50.00**

Audio Signal Generator, Hickok 198, RC tuned 20-20,000 cps.....**$45.00**

CONNECTORS:

UG-10/U	.80	UG-190/U	1.00
UG-12/U	.80	UG-201/U	2.00
UG-21/U	.80	UG-245/U	.60
UG-22/U	.80	SO-239	.28
UG-24/U	.80	PL-259	.28
UG-25/U	.80	(for small cable)	
UG-27/U	.50	M-359	.28
UG-29/U	1.00	UG-266	1.00
UG-30/U	1.00		
UG-30/U special	1.00	PL 54	.10
UG-58/U	.60	PL 81	.50
UG-59/U	1.00	AN-3102-14S-5P	.25
UG-83/U	1.00	AN-3102-14S-2P	.25
UG-86/U	1.00	RC-10066-20-IP	.50
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METERS:
0-350 VOLTS. WESTINGHOUSE NX-35 METER, 1000 ohms per volt, 3½" **$4.50**
0-8 AMPS R.F. SIMPSON IS-89, 2% to 10 mc **$4.50**
0-10 AMPERES, TRIPLETT 327-A, 3" square **$4.00**

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Feed thru, ceramic, 55 mmfd, 1000 VDC, threaded ..... **.10 each**
Feed thru, silver mica, disc type, 300 mmfd, 500 v..... **.20 each**
Ceramic double cap. 55 mmfd, 10,000 v **.50 each**
Mica .005, 2500 W.V. DC.....**10 for 5.00**

TRANSMITTING OIL-FILLED CAPACITORS:

2 MFD 600 WVDC ROUND CAN	10 for **$2.**		
2 Mfd	1000 WV.....	**1.00**	
1 mfd	2500 WV.....	**1.50**	
.25 mfd	4000 WV.....	**.90**	
.15 mfd	4000 WV.....	**1.00**	
2 mfd	4000 WV.....	**5.00**	
.1 — .1 mfd....	7000 WV.....	**2.00**	
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1 mfd 15000	WV.....	**25.00**	
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VIBRAPACKS & CONVERTERS

AVA-126A VIBRAPACKS, MFGED. BY RCA FOR AIRCRAFT USE. DELIVERS 330 VOLTS AT 100 MA TO RUN AVT-112A TRANSMITTER & AVR-20A RECEIVER. SUPPLIED WITH 6 AND 12 VOLT VIBRATORS, OZ4GT RECTIFIER, STEEL CASE AND BAG OF HARDWARE. COMPACT WITH 3 BUILT-IN RELAYS & FILTERS. **PRICE**.....$14.95

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SD-4 COMPLETE WITH TRANSMITTER, RECEIVER, DUPLEXING UNIT, ANTENNA, TUBES AND SPARE PARTS. FOR 110 V. AC USE. EXPORT PACKED, NEW, **PRICE**.....$900.00

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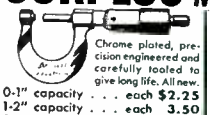

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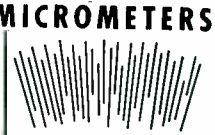

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(Additional Wanted Advertising on page 229)

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Made By Well Known Manufacturer

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Ranges:
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0—1800°F C/A
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1000—2000°F C/A
1000—3000°F Plat. 10%R

$210.00

STEP DOWN TRANSFORMERS SPECIAL

Made by GE, heavy duty, considerable overdesign, open frame, ideal for rectifier application, size: 3½" x 3½" x 4".
PRI—115 Volts 60 Cycles
SEC—15 V at 12 Amps **$3.75**

HIGH VOLTAGE CAPACITORS

1 MFD 20 KV DC 18"x13½"x5" $25.00
.1 MFD 25 KV DC-13"x7"x4" 9.85
.001 MFD 50 KV DC-5¼"x7¾"x4" insulators 4" dia. x 7" high 12.50

Cap Mfd.	Volts D.C.	Height	Width	Length	Price
10	1000	5-7/8 x	1-3/4 x	3-7/8"	$1.85
4	1000	5-7/8 x	2-3/4 x	1-1/4"	.85
1	1000	3-5/7 x	2 x	1-1/16"	.50
1	500	2" x	1-1/4" x	1-1/16"	.25
.25	1000	1-1/2 x	1" x	3/4"	.25

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42" H x 22" W x 16½" D
Heavy Gauge Metal, Black Wrinkle Finish, shipped knocked down, ready to assemble with rear door and hardware. Front Panel not included. Panel size 19⅛" x 36¾". Shipping weight 99 lbs.
NEW! A REAL BUY $17.50

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Weston	517	0-10	2" R-M	2.95
Weston	517	0-15	2" R-B	2.95
Weston	517	0-150	2" R-B	3.50
Whse	RA35	0-7.5	3" R-B	3.95
Weston	476	0-8	3" R-B	3.95
Trpltt	331JP	0-150	3" R-B	4.50
Whse	RA37	0-300/600	4" S-B w/2 to 1 Potential Transformers	9.75

AC AMPS

Trpltt	332JP	0-30	3" R-M	4.95
Weston	642	0-75	4" R-M SF or F	7.50
Whse	RA37	0-75/150	4" S-B w/external Current Transformers	9.75

DC MICROAMPS

Weston	301	0-100	3" R-B	12.50

DC MILLIAMPS

McClntk	2001	0-1	2" R-B	3.95
GE	DW41	0-25	2" R-B Wide Flange	3.50
Simpson	25	0-1	3" R-B Spec Scale	4.50
GE	DO41	0-1	3" R-B Black Spec Scale	4.50
Weston	301	0-1	3" R-B Spec Scale	7.50
Weston	301	0-25	3" R-M	5.95
Weston	301	0-200	3" R-B	6.50
Weston	301	0-300	3" R-B	6.50
Weston	301	0-500	3" R-B	6.50

DC AMPS

Weston 506	50-0-50MV		2" S-B Spec Scale	3.95
GE DO50	50MV		3" S-B Spec Scale	2.95
Weston 301	0-1		3" R-M	6.50

DC VOLTS

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Simpson	125	0-35	2" R-M	2.50
Weston	301	0-150	3" R-M Blk Scale	5.95

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NEW! $57.50

WESTON Model 772, Type 6 with televerter to extend DC range to 5000 V.
SENSITIVITY—
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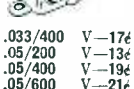

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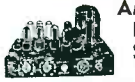

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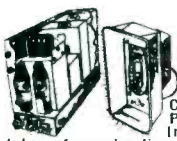

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9GP7/9MP7	13.98
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D170396 HF pwr meas.....90¢ 3 for $2.50
IC Bulb Time Delay.....90¢ 3 for $2.50
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18	14	5.	4.25
36	28	3.5	6.49
36	28	5.	7.25

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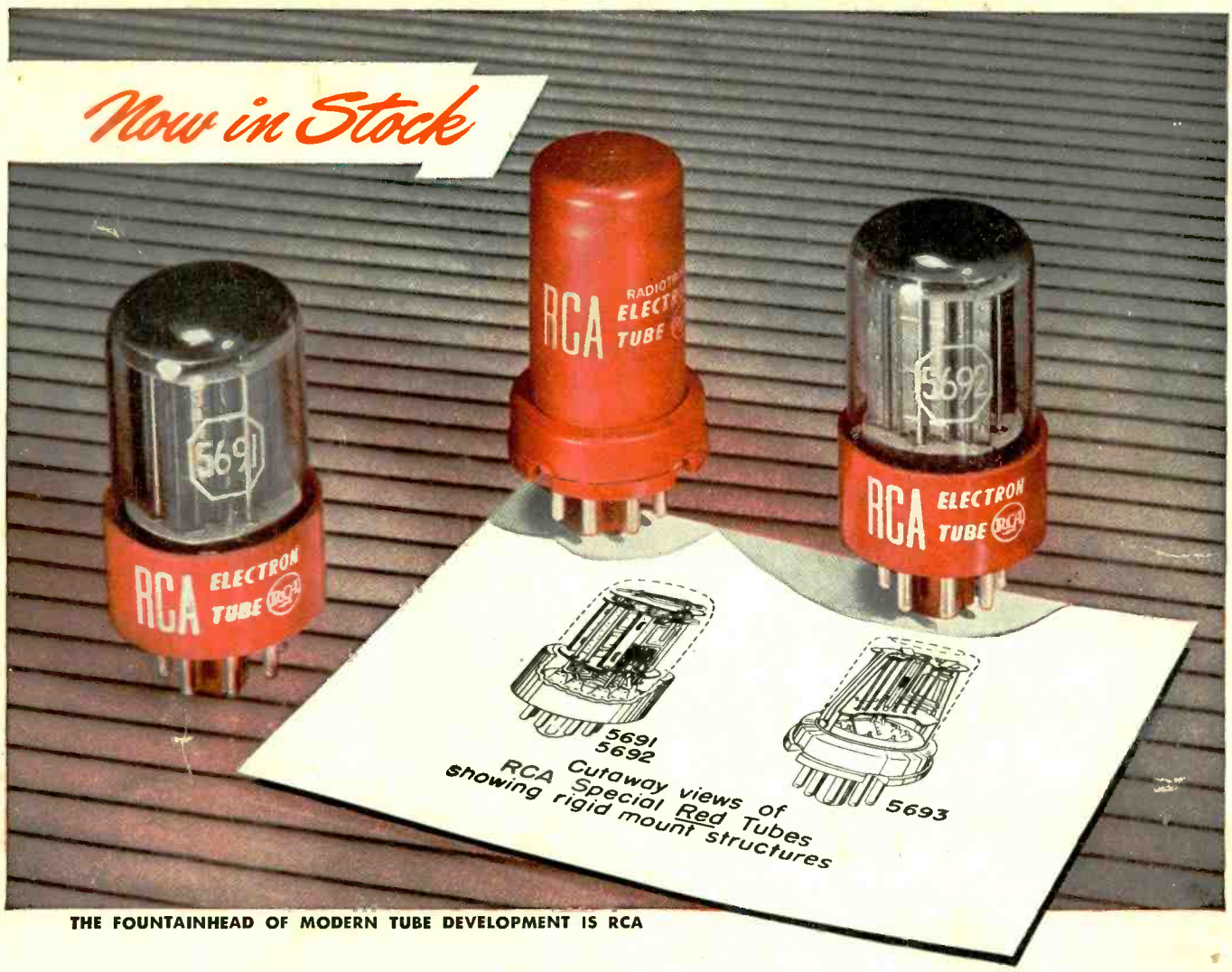

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