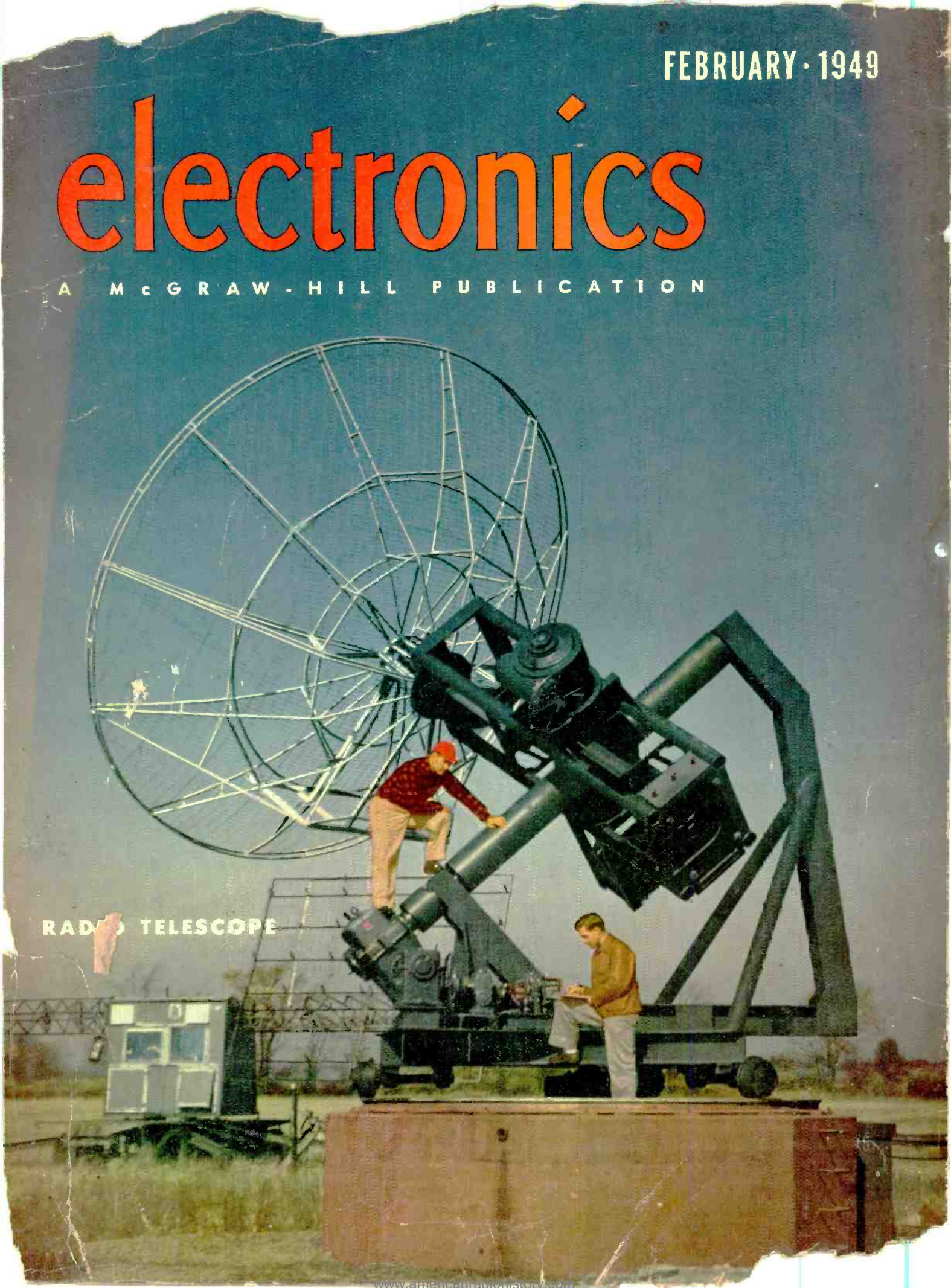
FEBRUARY · 1949

electronics

A McGRAW-HILL PUBLICATION



RADIO TELESCOPE

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For Miniature Components

FROM STOCK

U. T. C.
OUNCER SERIES

Weight 1 ounce . . . ⅞ Dia. . . .
1-3/16 overall height . . .
40 to 15000 cycles . . . 13 types*

Type	Application	Pri. Imp.	Sec. Imp.	List Price
O-1	Mike pickup or line to 1 grid	50, 200, 500	50,000	$13.25
O-4	Single plate to 1 grid	8,000 to 15,000	60,000	10.50
O-6	Single plate to 2 grids	8,000 to 15,000	95,000	12.00
O-8	Single plate to line	8,000 to 15,000	50, 200, 500	13.25
O-12	Mixing and matching	50, 200	50, 200, 500	12.00
O-13	Reactor, 200 Hys-no D.C., 50 Hys-2MA D.C.			9.50

U. T. C.
SUB-OUNCER SERIES

Weight ½ ounce . . .
9/16 x ⅝ x ⅞ . . . Nylon bobbin structure . . . 200 to 5000 cycles.

Type	Application	Level	Pri. Imp.	D.C. in Pri.	Sec. Imp.	List Price
SO-1	Input	+ 4 V.U.	200		250,000	
			50	0	62,500	$5.60
SO-2	Interstage/3:1	+ 4 V.U.	10,000	0	90,000	5.60
SO-3	Plate to Line	+ 23 V.U.	10,000		200	
			25,000	3/1.5 mil.	500	5.60
SO-4	Output	+ 20 V.U.	30,000	1.0 mil.	50	5.60
SO-5	Reactor 50 Hy at 1 mil. D.C.		3000 ohms	D.C. Res.		5.10

For complete list, write for Catalog PS-409

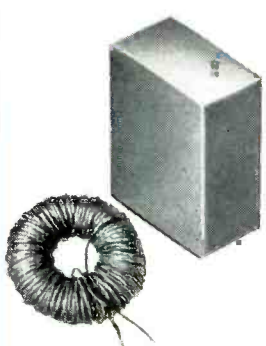
TO SPECIFICATION

HERMETICALLY SEALED OUNCERS

Weight 1⅓ ounce . . . 15/16 x 1⅜ x 1⅜ high . . . all standard ouncer designs plus specials such as 400 cycles 1 watt power . . . pulse transformers . . . saturable reactors . . . dual units (input & output in same case.)

HERMETICALLY SEALED SUB-OUNCERS

Weight .8 ounce . . . 15/16 x 1⅜ x 13/16 high . . . all standard sub-ouncer designs . . . plus special units up to 200 KC.



SUB-OUNCER PERMALLOY DUST TOROIDS

Weight ½ ounce uncased .8 ounce hermetically sealed. These miniatured HQE coils have characteristics similar to our standard HQA, C, and D coils with little reduction in Q considering minute size.

SUB-OUNCER TOROID FILTERS

Filters employing SUB-OUNCER toroids and special condensers represent the optimum in stable miniaturized filter performance. The unit shown . . . 1 x 1 x 2 . . . employs 5 coils and 6 condensers for a complete band pass filter . . . weight 6 ounces.

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FEBRUARY • 1949

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Model 4ST1A1

RESEARCH laboratories, educational institutions, and production test departments will welcome this new low-priced, small sized regulated power supply. Performance-engineered to meet practically every type of application within its field, and every budget requirement, it rounds out General Electric's very complete line of regulated power supplies. A striking number of features have been enclosed in this sturdy steel case—that will impress every engineer as noteworthy. Look them over—then order for immediate delivery.

- ★ 4½" built-in meter with clear, easily read scale.
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- ★ The unit may be operated grounded or ungrounded.
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- ★ Ripple is less than 10 millivolts RMS.

For complete information on General Electric Regulated Power Supplies write *General Electric Company, Electronics Park, Syracuse, New York*

You can put your confidence in—

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See the wide range of Regulated Power Supplies that are made by—

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Type PS-4. Dual Regulated Power Supply providing two separately regulated supplies. Individual d-c current output 0 to 200 milliamperes; in parallel 0 to 400 milliamperes maximum. Voltage output: 250 to 400 volts.

Type PS-4

Type YPD-2

Type YPD-2. A medium power unit of high quality for use wherever a closely regulated d-c voltage of low ripple content is required. D-C current output 0-300 milliamperes. D-C voltage output 250-450 volts.

Type YPD-4

Type YPD-4. This unit provides a wide range of output voltages which makes it extremely versatile for laboratory work. D-C current output 0 to 0.125 amperes maximum. D-C voltage output 160 to 1500 volts.

Send for a copy of our free catalog.

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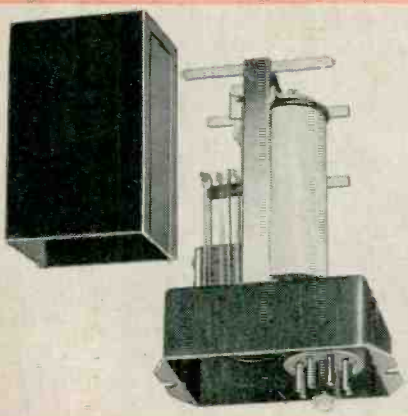
"Can you give us a relay that..."

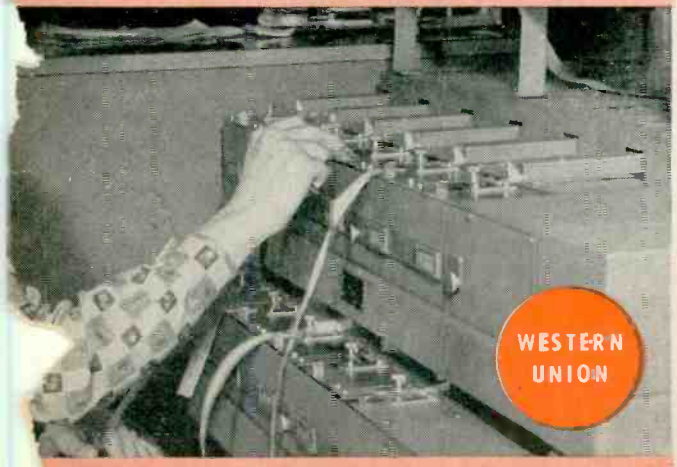
RCA turns to CLARE for a "relay we can install and forget" for Electron Microscope.

CLARE provides a precise operating relay, capable of long and reliable operating life, to meet the needs of this RCA precision instrument.



"Give Us a Dust-Tight Relay for Dusty Locations" — said LEEDS & NORTHRUP.

Radio plug mounted, with terminals brought through dust-tight Neoprene gasket and with dust-tight steel cover, this CLARE relay solved a LEEDS & NORTHRUP problem.



CLARE Relays in WESTERN UNION "Push-Button" High-Speed Switching System.

CLARE provides thousands of small relays of maximum reliability to meet exacting requirements of Western Union's high-speed communications program.

Tough relay problems are everyday routine with CLARE engineers

CLARE customers include some of the biggest names in the American industry . . . and many smaller concerns . . . whose engineers have sought and found in CLARE experiment and research the answer to unusual and difficult relay problems.

The decision to "put it up to CLARE" often saves untold hours of experiment, trial and error and sometimes costly delays. Many who get in touch with CLARE find our engineers have already solved their problem for somebody else.

CLARE leadership in the industrial relay field has been achieved by the ability of CLARE engineers to approach any and all relay problems with a completely open mind. No problem of relay size, shape or operating characteristics but finds them ready and anxious to cooperate in its solution.

There is a CLARE sales engineer located near you . . . as close as your telephone. If your problem involves relays, why not take advantage of CLARE experience with every type of relay requirement. To do so may easily save you time and expense. Look for CLARE in your classified telephone directory, or write: C. P. CLARE & Co., 4719 West Sunnyside Ave., Chicago 30, Illinois. In Canada: Canadian Line Materials, Ltd., Toronto 13. Cable address: CLARELAY.

CLARE RELAYS

First in the Industrial Field

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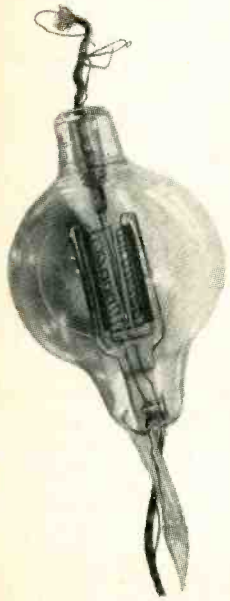
Why this team brings you better ELECTRON TUBES



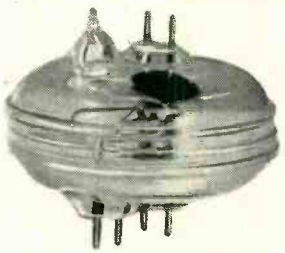
1912. The first effective high-vacuum tube, developed by the Laboratories for long distance telephony, was capable of operation at both audio and radio frequencies, and thus marked the beginning of modern electronics.

1918. This "peanut" tube, the Western Electric 215A, was developed for service in World War I. It was the first commercial tube whose filament was powered by a single dry cell . . . made possible compact, light weight radio equipment.

1919. The introduction of the copper-to-glass seal made water cooled tubes practical. The resulting high power tubes were used for broadcasting and for trans-oceanic radiotelephony.

1925. This was one of the earliest photoelectric cells. It was made by Western Electric for use in commercial picture transmission over telephone wires.

1940. The beating oscillator, used in the great majority of radar systems. This tube generated a wave in the receiver with which the received microwave was reduced in frequency for amplification.



1937. This microwave generator, the 368A, was the first commercial tube to generate frequencies higher than 1500 mc. This type of tube was used by Western Electric in the first absolute altimeter.

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—QUALITY COUNTS—

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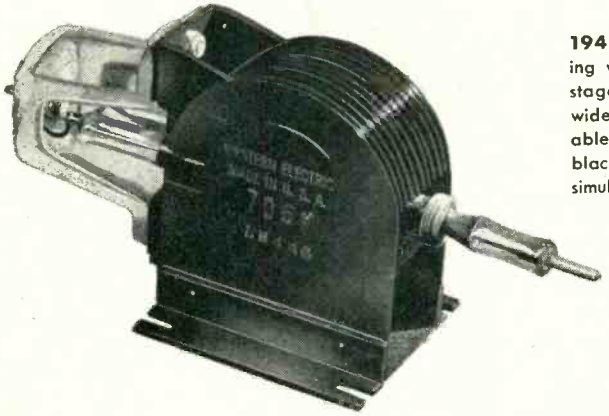
1942. This tiny 6AK5, operating in the vicinity of 400 mc, proved itself invaluable as an amplifier in radar receivers. Design specifications were supplied to other manufacturers by Western Electric to speed war production.

1940. Bell Laboratories produced the first American multicavity pulsed magnetron from a British model. The team of Western Electric and Bell Laboratories developed 75 new and improved magnetron designs by extending operation into the 10 cm, 3 cm and finally the 1 cm bands, and produced over 300,000 of these wonder tubes of World War II.



1945. The Bell Laboratories traveling wave tube, still in the research stage, amplifies over a band 40 times wider than present tubes—may be able to amplify dozens of color or black and white television programs simultaneously.

TODAY. These new forced air cooled FM transmitting triodes are among the latest in the line of Western Electric tubes designed by Bell Telephone Laboratories. Their thoriated tungsten filaments, rugged construction, flexible terminal arrangements and many other features make them tops in performance in the 88 to 108 mc band.

OVER 35 years ago in the laboratories of Western Electric, De Forest's Audion was improved and developed into the high vacuum tube and put to work for the first time amplifying telephone and radio frequency currents. And *for over 35 years* Western Electric and its research associate Bell Telephone Laboratories have been foremost in designing new and better electron tubes. Every tube shown here and many developments *basic* to the tube art are examples of that leadership.

Western Electric high power transmitting tubes for the broadcast field are now being manufactured for Western Electric by the Machlett Laboratories, Inc., another pioneer in electron tube development. Thus, in this field a new name has been added to the Bell Laboratories-Western Electric team — Machlett Laboratories.

BELL TELEPHONE LABORATORIES

World's largest organization devoted exclusively to research and development in all phases of electrical communications.

Western Electric

Manufacturing unit of the Bell System and the nation's largest producer of communications equipment.

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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

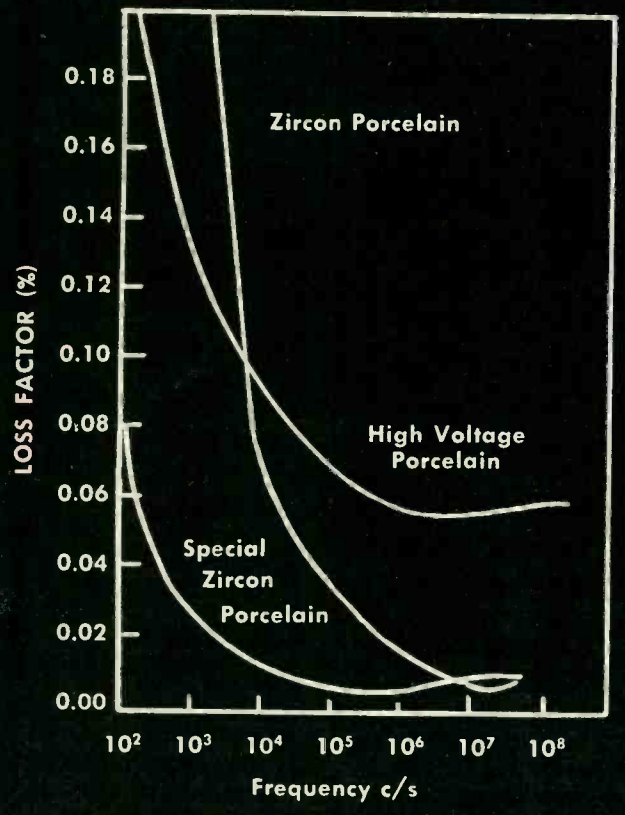
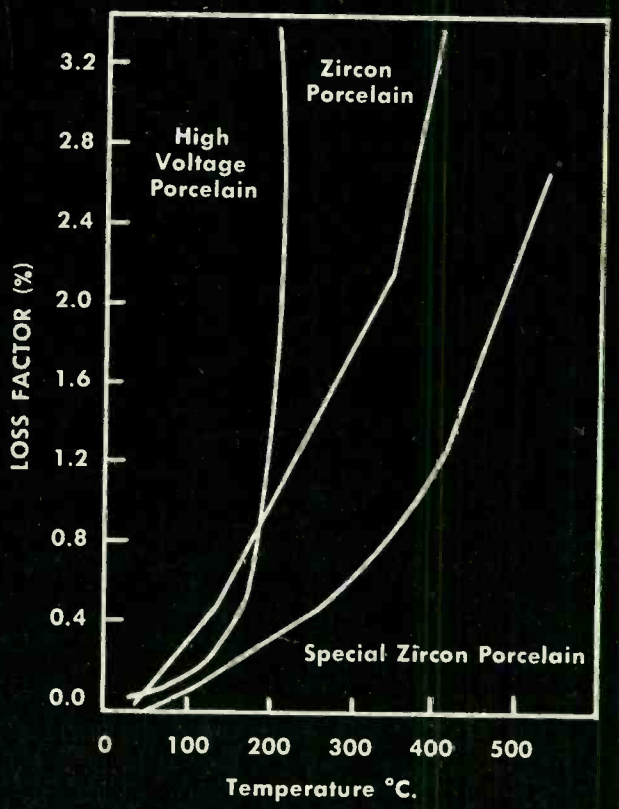


CHART 2



TAM

TITANIUM ALLOY MFG. DIVISION
NATIONAL LEAD COMPANY

Executive and Sales Offices: 111 BROADWAY, NEW YORK, N.Y. • General Offices and Works: NIAGARA FALLS, N. Y.

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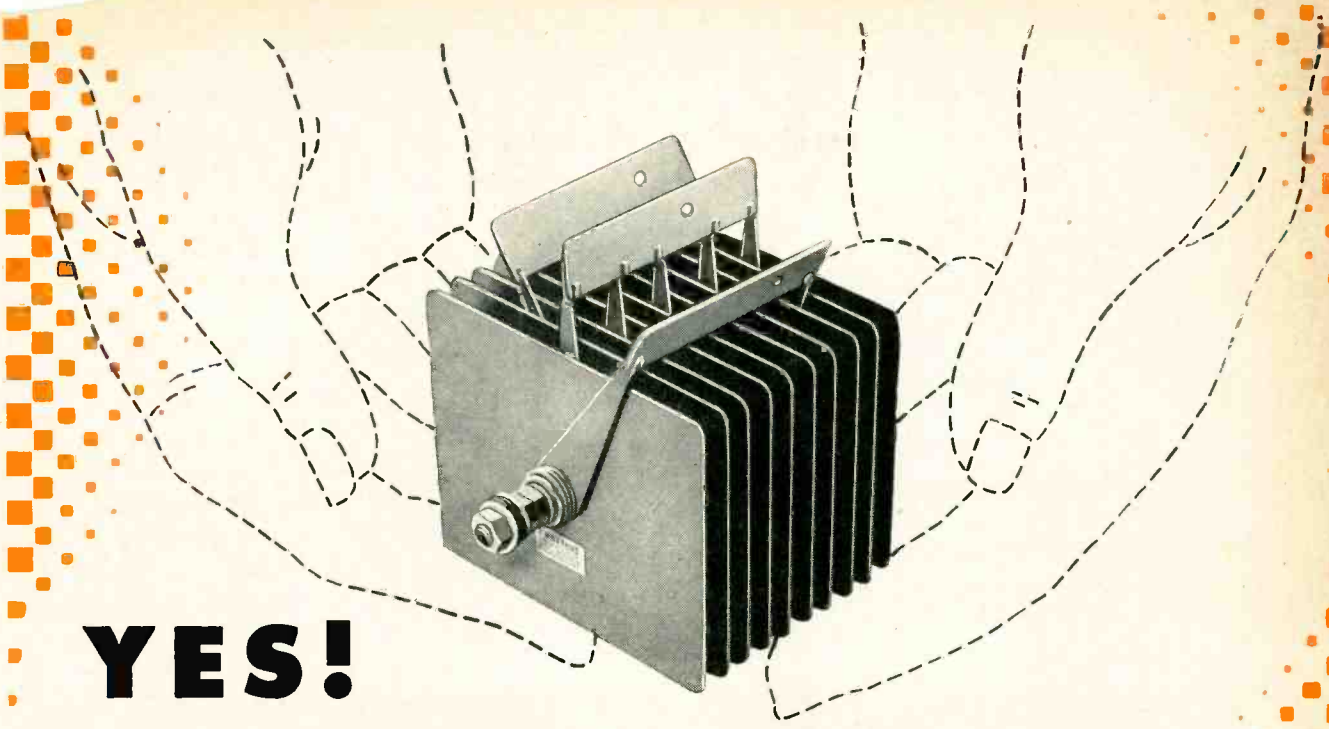

YES!

A Protective finish is added to Fansteel Selenium Rectifiers, too!

Expert mechanical and electrical engineering for their particular jobs by no means ends the processing of Fansteel Selenium Rectifiers. Protective finishes enable each rectifier to defy the most severe attacks in use. Fansteel pioneered rectifier finishes accepted as standard thruout industry. Choice is given of three:

M Finish—High gloss dust and moisture resistant, which withstands worse-than-average conditions.

K Finish—Multiple-layer, meeting the Standard Navy 200-hour salt spray test. K Finish withstands mercury vapor.

T Finish—For tropical conditions. Multiple layer, resistant to high humidity, fungus, salt spray and mercury vapor. Tests show no deterioration after one year at 135° F, at 95% to 100% humidity, when idle—worse than operating conditions.

To Select PROPERLY
To Buy PROPERLY
To Use PROPERLY

From Fansteel's code of aid to design and product engineers.

Added Economy! Fansteel Selenium Rectifiers assure longest, dependable trouble-free life. Our specialized rectifier engineers are always glad to counsel with you. Fansteel Metallurgical Corporation, North Chicago, Illinois.

1102

Fansteel

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RECTIFIERS
DEPENDABLE RECTIFIERS SINCE 1924

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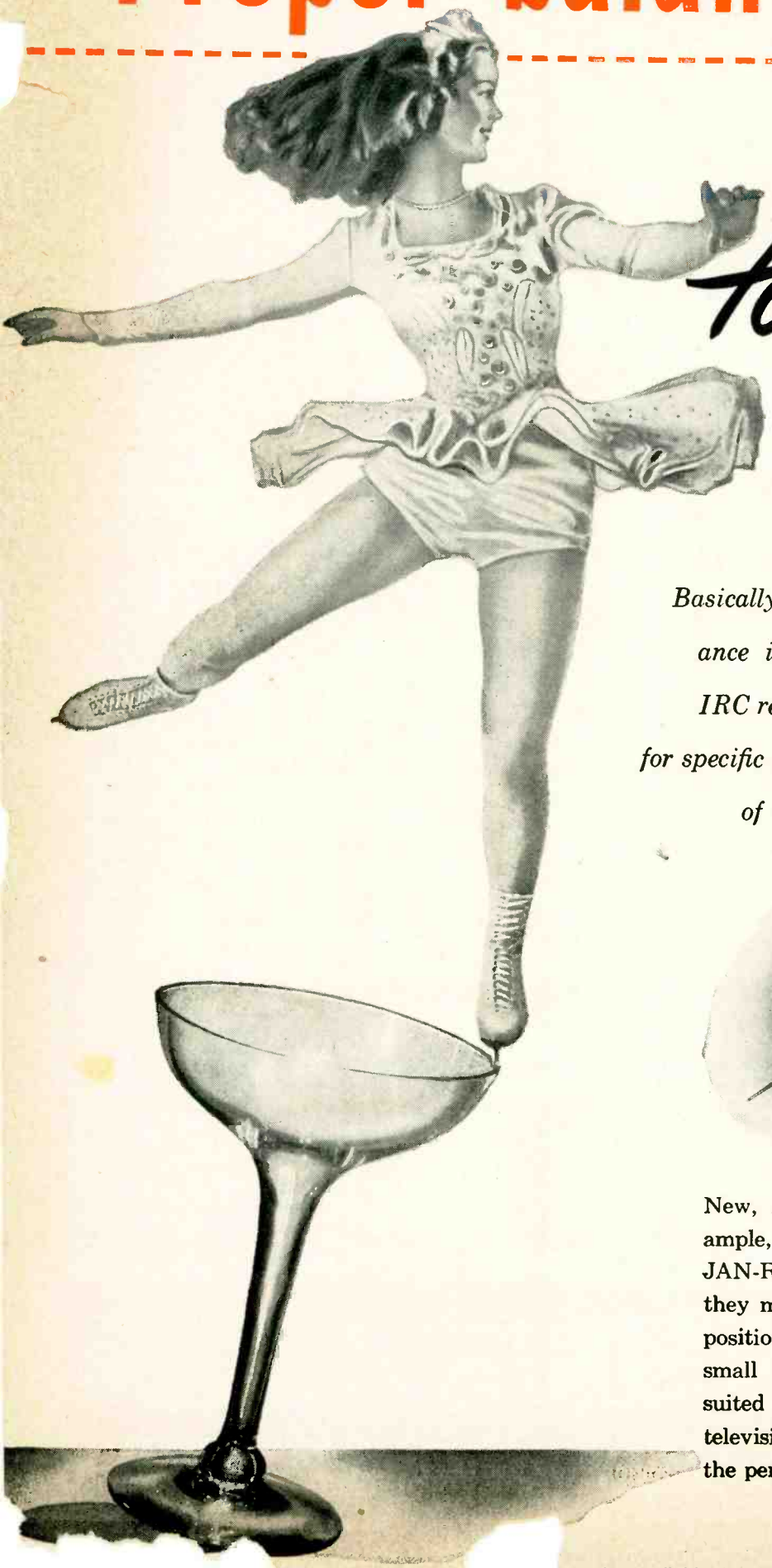
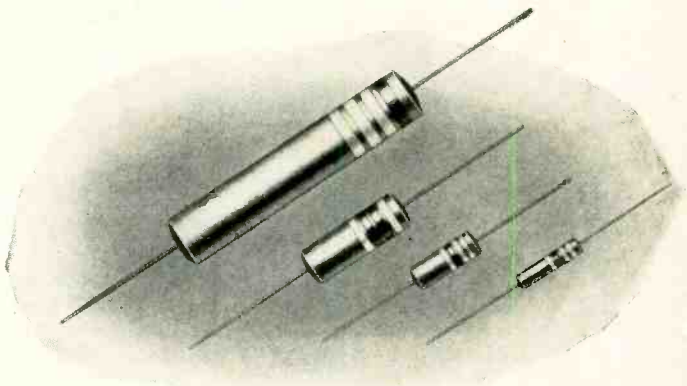
Proper balance can be



for resistors

Proper balance can be mighty difficult . . . but not for IRC resistors. Basically engineered for balanced *performance in every important characteristic, each IRC resistor type offers outstanding features for specific applications—without sacrifice of any significant factor.*



New, ADVANCED Type BT Resistors, for example, are uniformly superior in every important JAN-R-11 requirement. At ⅓, ½, 1 and 2 watts they meet JAN-R-11 specifications for fixed composition resistors. Balanced in every characteristic, small IRC ADVANCED BT's are particularly suited to high ambient temperatures and rigorous television circuits. 12-page Bulletin B-1 gives all the performance facts. Use the convenient coupon.

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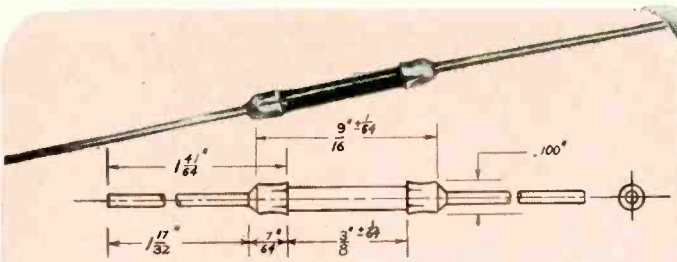
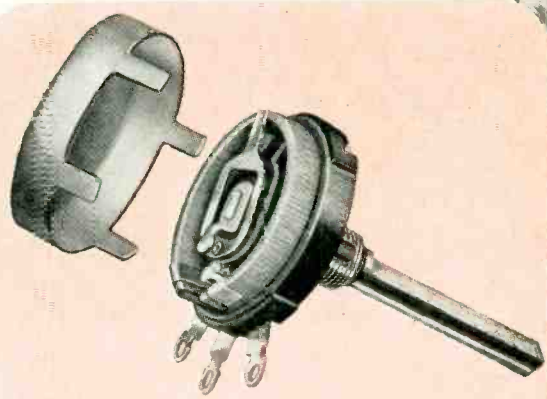
difficult

For close tolerance requirements, IRC Precisions offer a fine balance of accuracy and dependability. Extensively used by leading instrument makers, they excel in every important characteristic. 1% accuracy is standard. Noise level is inherently low, and windings are fully protected against high humidity. Available in a wide selection of ranges and types, as described in Bulletin D-1.

too!



Miniature MPM resistors are IRC engineered for high frequency applications. Their frequency characteristics are outstanding, but absolute balance has been maintained with all other significant electrical characteristics. Thin resistance film is permanently bonded to ceramic rods. Cupped ends of wire lead terminals are cemented to resistor bodies to form axial pigtails. Rated at ¼ watt, Type MPM's are available in resistance values from 10 ohms to 1.0 megohms. Write for Technical Data Bulletin F-1.



IRC Type W Wire Wound Controls are so carefully balanced, your customers can actually feel the difference. With center tap they are widely used as vertical and horizontal centering controls in television receivers. Design provides maximum adaptability to most rheostat and potentiometer applications within 2-watt power rating. Type W Controls have a 1¼" diameter, and 9/16" depth behind panel. Spiral Spring Connector provides positive electrical connection. Bulletin A-2 gives details. Write for your copy.

All standard IRC resistors are readily available in nominal quantities from your local distributor's well-stocked shelves. This is IRC's Industrial-Service Plan

at work, assuring you 'round-the-corner service on your small order requirements. We'll be glad to send you the name of your nearest IRC Distributor.

IRC

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I want to know more about the IRC Resistors checked below—

- ☐ Advanced Type BT's
- ☐ Precision Resistors
- ☐ MPM High Frequency Resistors
- ☐ Type W Controls
- ☐ Also send name and address of our IRC Distributor

Name .....

Title .....

Company .....

Address .....

.....

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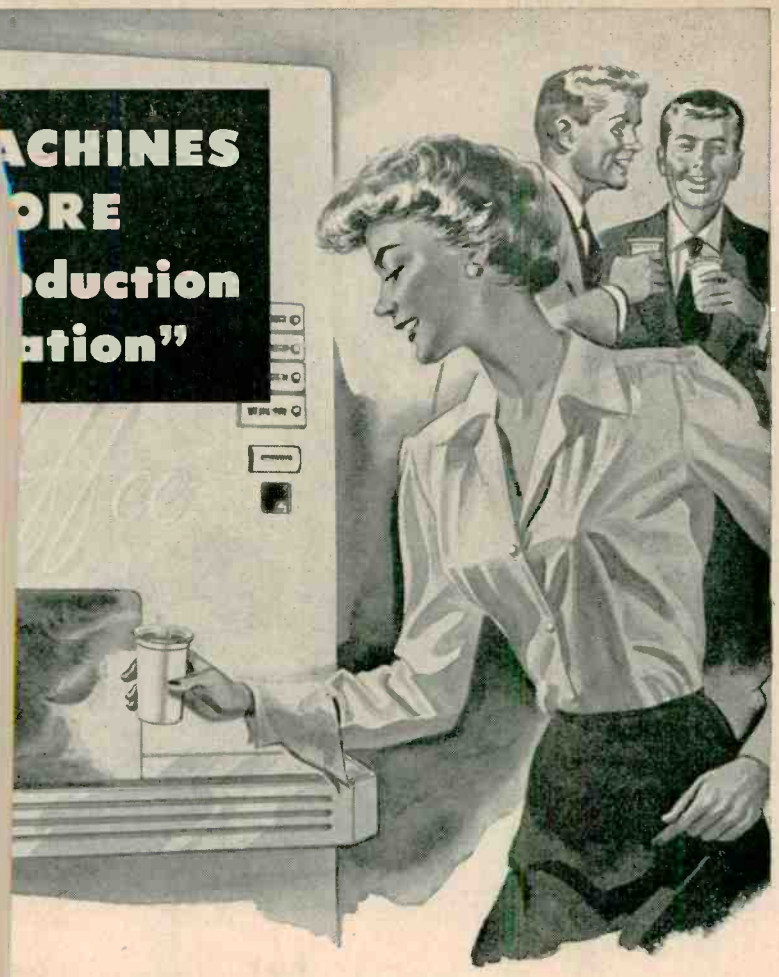
VENDING ACHINES EARN ORE ...both in oduction and "on ation"



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N "PAYOFFS" climb up toward jackpot levels, where American Phillips ...icing costs in all assembly departments. Workers work faster and better. ...are never gouged. For American Phillips Screws and drivers are fumble-...oof, slash-proof. And they can be handled *by anyone* with such ease and ...e-savings average *50% over slotted screws.*

STEA mode reces inces too, Screw

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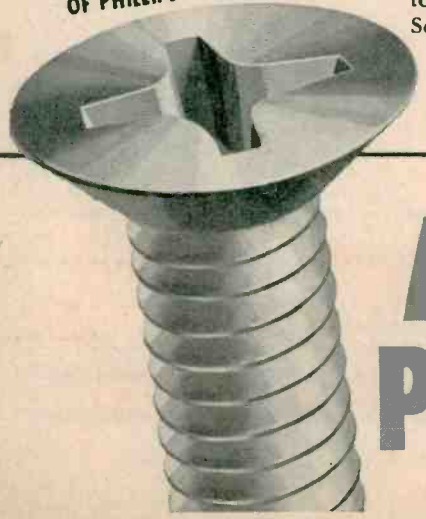
4-WINGED DRIVER CAN'T SLIP OUT OF PHILLIPS TAPERED RECESS



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...ago 11: 589 E. Illinois St. *Detroit 2:* 502 Stephenson Building

A ...ERICAN PH...LLIPS Screws

ALL TYPES

ALL METALS: Steel, Brass, Bronze, Stainless Steel, Aluminum, Monel, Everdur (silicon bronze)

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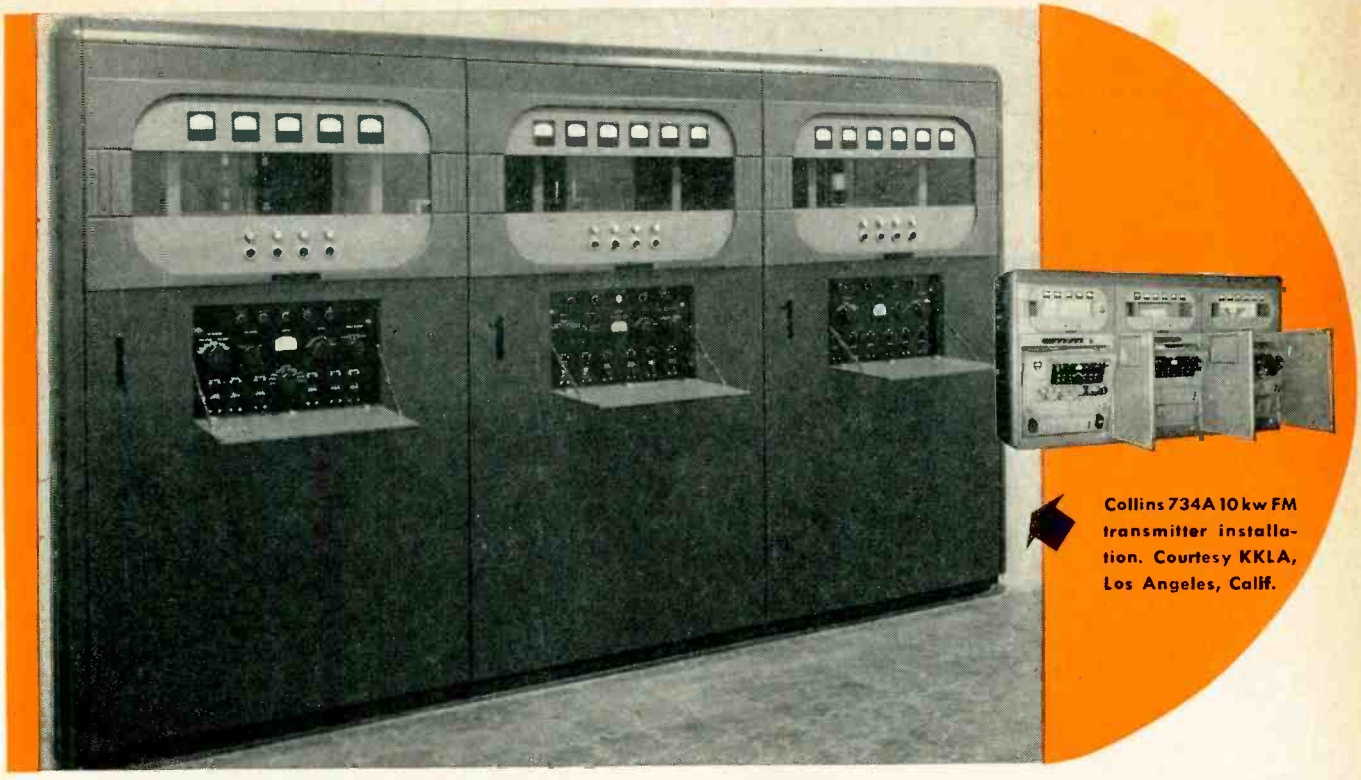

Collins 734A 10 kw FM transmitter installation. Courtesy KKLA, Los Angeles, Calif.

Designed for long-time stability

...not for quick post-war sale

Study the significance to you of the following features of the Collins 734A, 10 kw FM transmitter:

- Typically superior Collins engineering.
- Reliability proved by actual operation.
- Phasitron modulator circuit, eliminating more than ten tubes and related components compared with former circuits, and resulting in far greater simplicity and reliability.
- Low tube costs.
- Only 11 tube types in the total complement of but 33 tubes, thus minimizing spares.
- All tubes visible while equipment is in operation.
- Direct crystal control of carrier frequency, utilizing a frequency multiplication of only 486, provides carrier stability of ± 2 parts per million—better than ± 250 cycles per second.
- All controls accessible while the transmitter is in full operation.
- Motor driven variable tuning elements.
- Metering circuits for complete observation and recording of transmitter performance.
- Accessibility throughout. Maximum personnel and circuit protection. Easy maintenance.
- Excellent mechanical construction.
- Cabinets smartly styled, in three-tone gray.
- Competitively priced.

Write us about your plans, and ask us for an illustrated bulletin describing the Collins 734A transmitter in more detail.

FOR THE BEST IN FM, IT'S ...

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COLLINS RADIO COMPANY, Cedar Rapids, Iowa

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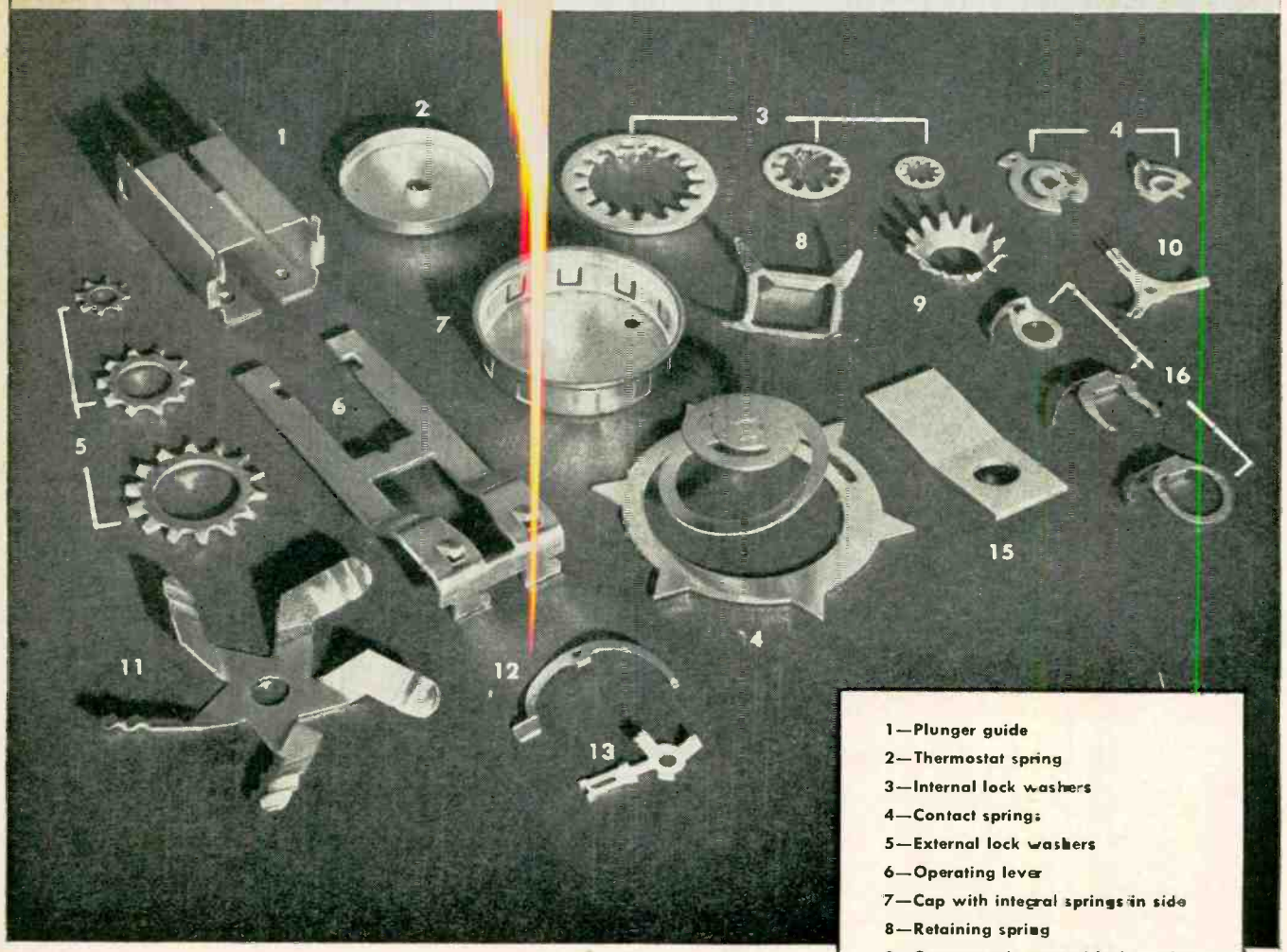
OFFER MANY ADVANTAGES



1—Plunger guide
2—Thermostat spring
3—Internal lock washers
4—Contact springs
5—External lock washers
6—Operating lever
7—Cap with integral springs in side
8—Retaining spring
9—Countersunk external lock washer
10—Pressure spring for capacitor
11—Five-contact spring
12—Contact spring for radio part
13—Pressure spring and terminal
14—Involute spring
15—Contact point for solenoid
16—Contact springs
—made of Phosphor Bronze strip supplied by Revere

STRENGTH — Resilience — Fatigue Resistance — Corrosion Resistance—Low Coefficient of Friction—Easy Workability—are outstanding advantages of Revere Phosphor Bronzes, now available in several different alloys.

In many cases it is the ability of Phosphor Bronze to resist repeated reversals of stress that is its most valuable property. Hence its wide employment for springs, diaphragms, bellows and similar parts. In addition, its corrosion resistance in combination with high tensile properties render it invaluable in chemical, sewage disposal, refrigeration, mining, electrical and similar applications. In the form of welding rod, Phosphor Bronze has many advantages in the welding of copper, brass, steel, iron and the repair of worn or broken machine parts. Revere suggests you investigate the advantages of Revere Phosphor Bronzes in your plant or product.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, New York

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

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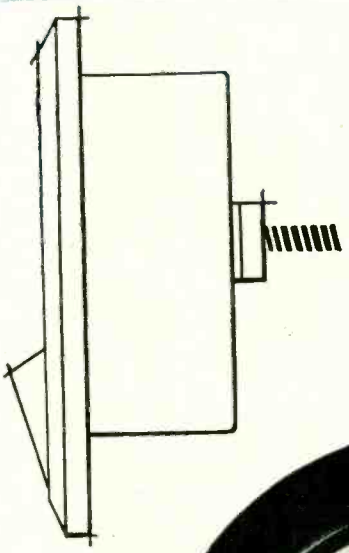
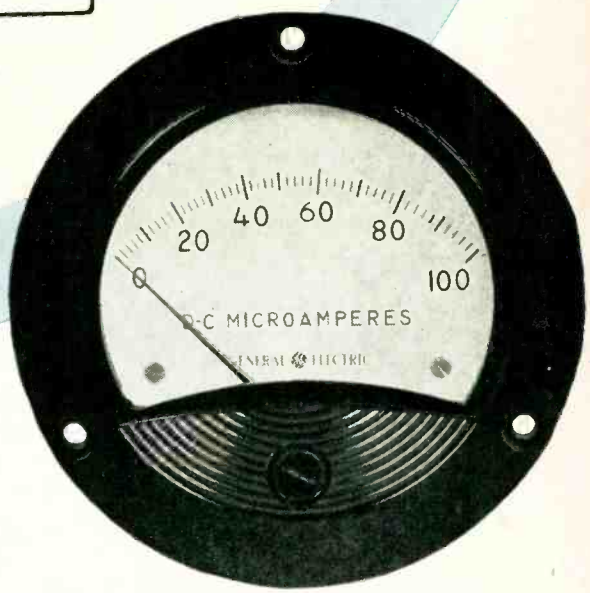
ENGINEERING GIVES YOU A NEW

Thin panel instrument



FOR COMPACTNESS
in your equipment



Where space is limited you'll appreciate these new thin panel instruments, Type DO-71. Through the use of internal pivots, depth behind the panel has been reduced to less than one inch. Yet, they are sturdy and accurate.

High-strength Alnico magnets give high torque, good damping, and quick response. This permits the use of large-radius pivots which add to the sturdiness and sustained accuracy of these new instruments.

Easier reading and improved appearance result from the other new features . . . Lance-type pointer, absence of arc lines, simplified scale layout, and legibility-tested numerals all contribute to ease and accuracy of reading.

The high accuracy and performance of the DO-71 instruments will add to the quality of your products. Plan to incorporate them in your design. Your nearest G.E. representative will be glad to discuss applications with you. See him today, or write for Bulletin GEA-5102. *Apparatus Dept., General Electric, Schenectady 5, N. Y.*

Available as d-c ammeters, milliammeters, microammeters, voltmeters, thermocouple ammeters, and rectifier ammeters, and voltmeters. A-c instruments of same appearance and frontal dimensions also available as ammeters and voltmeters.

GENERAL ELECTRIC

602-142

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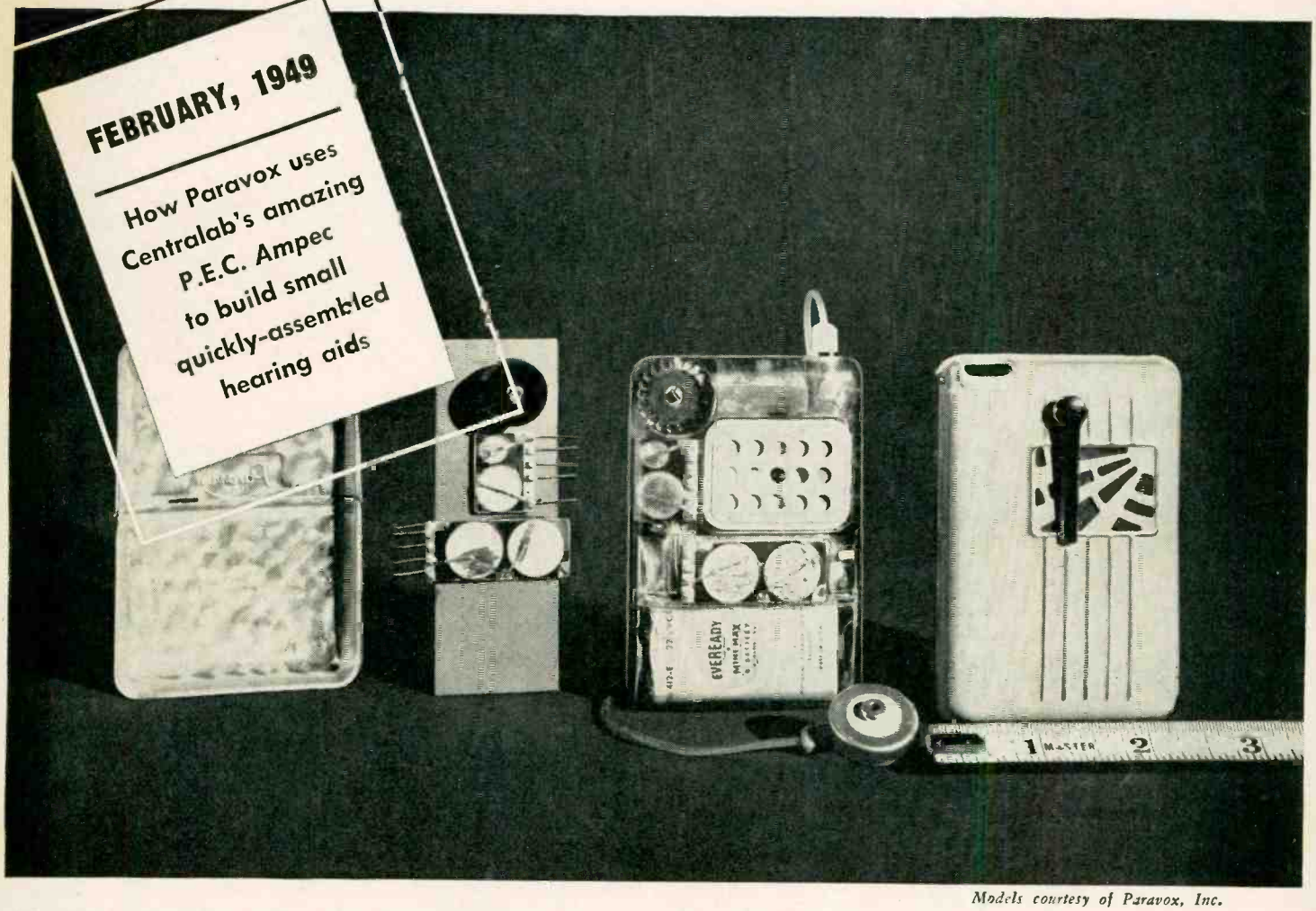
Centralab reports to

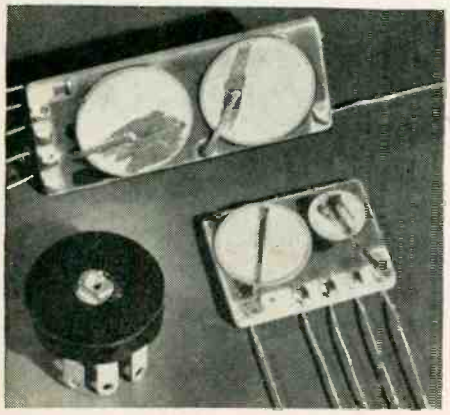
FEBRUARY, 1949

How Paravox uses Centralab's amazing P.E.C. Ampec to build small quickly-assembled hearing aids

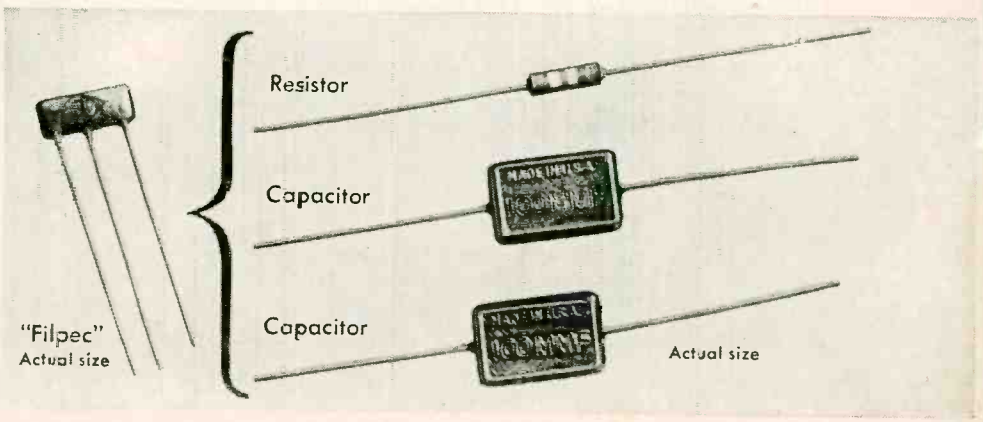


Models courtesy of Paravox, Inc.

1 Time, space and material savers! That's how Paravox, Inc., Cleveland hearing aid manufacturer, describes Centralab's revolutionary P.E.C. *Ampecs*. These tiny audio-amplifying units save time for Paravox by eliminating many assembling operations. They save space and material by reducing the number of components needed. What's more — like all CRL *Printed Electronic Circuits* — they are rugged, dependable, resistant to temperature and humidity. For Ampec facts, order Bulletin 973.



2 Two-piece *Ampec* and Model 1 *Radiohm* are the CRL units Paravox uses in its 4½-ounce hearing aid. *Ampec* is a complete 3-stage audio amplifier.



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 available from 50 to 200 mf. Resistor values from 5 ohms to 5 megohms. For complete information, write for Bulletin 42-9.

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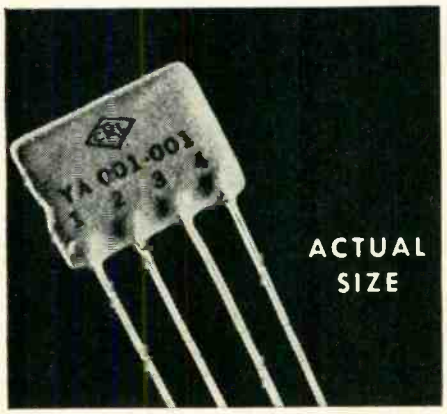
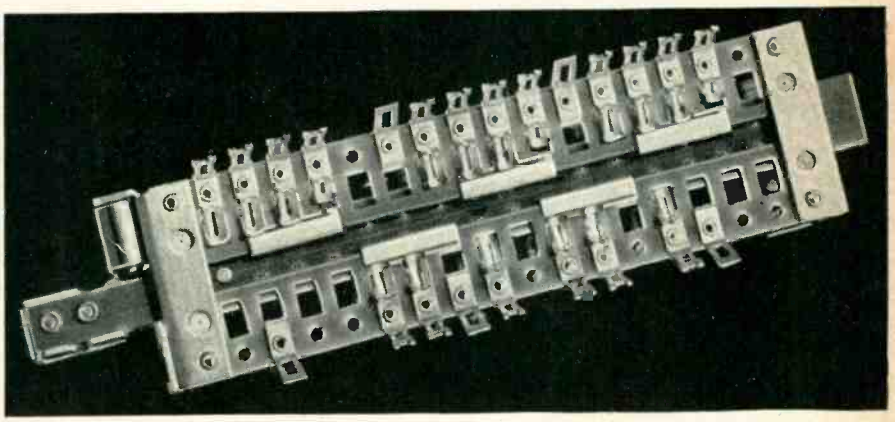
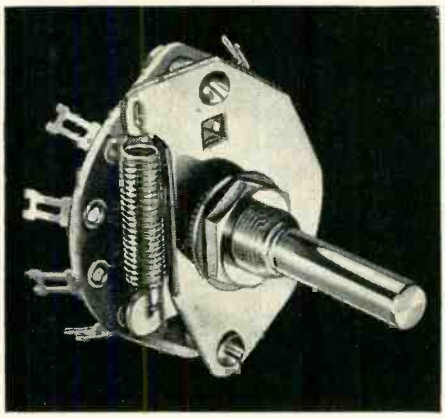
Electronic Industry

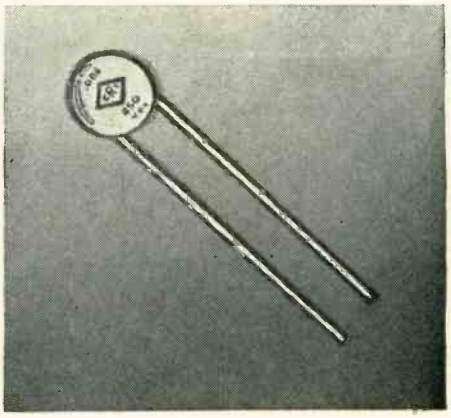


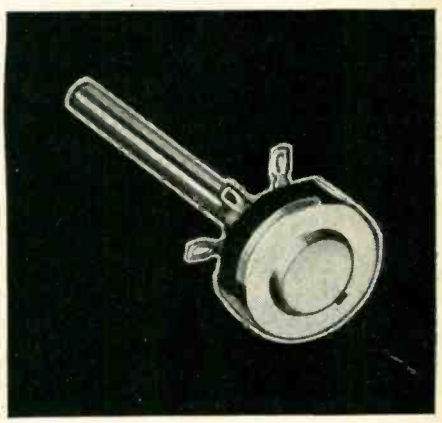


4 CRL's *Couplate* consists of a plate lead resistor, grid resistor, plate by pass capacitor and coupling capacitor. Write for Bulletin 42-6.

5 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.







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

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.

8 Wide range of variations in CRL's Model "M" Radiohm simplifies production and inventory. Bulletin 697-A illustrates convenience, versatility!

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.

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THE TRUSTY TRIO FOR *Tough Jobs*

TURNER 99

TURNER 999

TURNER U9S

Severe operating conditions are a "push-over" for Turner Dynamic mikes. Their accurate pickup and smooth natural response to voice and music is not affected by climate or temperature. Built-in ruggedness enables them to stand up and deliver under abuse that renders an ordinary microphone useless. Typical of Turner Quality are Models 99, 999, and U9S. Professionals both in appearance and performance they will give added efficiency to your operations. Find out more about these Turner Dynamics.

MODEL 99 DYNAMIC

Used by broadcast stations, large city police departments, and specified as standard equipment by internationally known manufacturers. Will not blast from close speaking. Case fits any standard microphone stand and adjustable saddle gives semi- or non-directional operation. Response is flat within ±5db from 40-9000 cycles. Level: 52db below 1 volt/dyne/sq. cm. at high impedance. Gun metal type finish. Complete with 20 ft. removable cable set in a choice of 30-50 ohms, 200 ohms, 500 ohms, or high impedance.

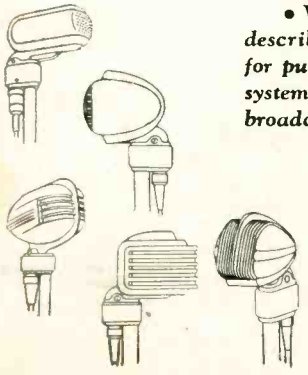
MODEL 999 BALANCED LINE DYNAMIC

Same style and finish as Model 99. Equipped with Balanced Line features for critical applications and professional results under all conditions. Has voice coil and transformer leads insulated from ground and microphone case. Line is balanced to the ground. Response is flat within ±5db from 40-9000 cycles. Level: 52db below 1 volt/dyne/sq. cm. at high impedance. Complete with 20 ft. balanced line low capacity removable cable set with 3-pin polarized locking connection in a choice of standard impedances.

MODEL U9S DYNAMIC

Four Impedances at Your Fingertips

Whatever impedance you need—50 ohms, 200 ohms, 500 ohms or high impedance—you can get it quickly and easily with the turn of the switch on Turner U9S. This flexible unit handles toughest jobs. Same precision engineering and rugged construction as Model 999 with built-in multi-impedance transformer. Response is flat within ±5db from 40-9000 cycles. Level: 52db below 1 volt/dyne/sq. cm. at high impedance. Complete with 20 ft. removable cable set.



• Write for complete literature describing all Turner Microphones for public address, recording, call system, amateur and commercial broadcast, and special applications.

THE TURNER COMPANY

905 17th Street N. E. • Cedar Rapids, Iowa

Microphones **BY TURNER**

Licensed under U.S. patents of the American Telephone and Telegraph Company, and Western Electric Company, Incorporated.

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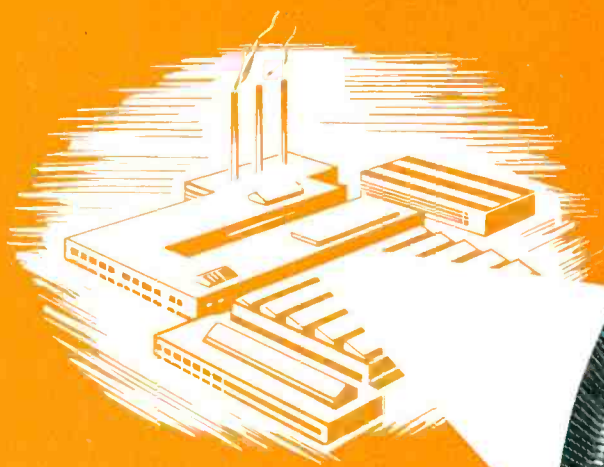
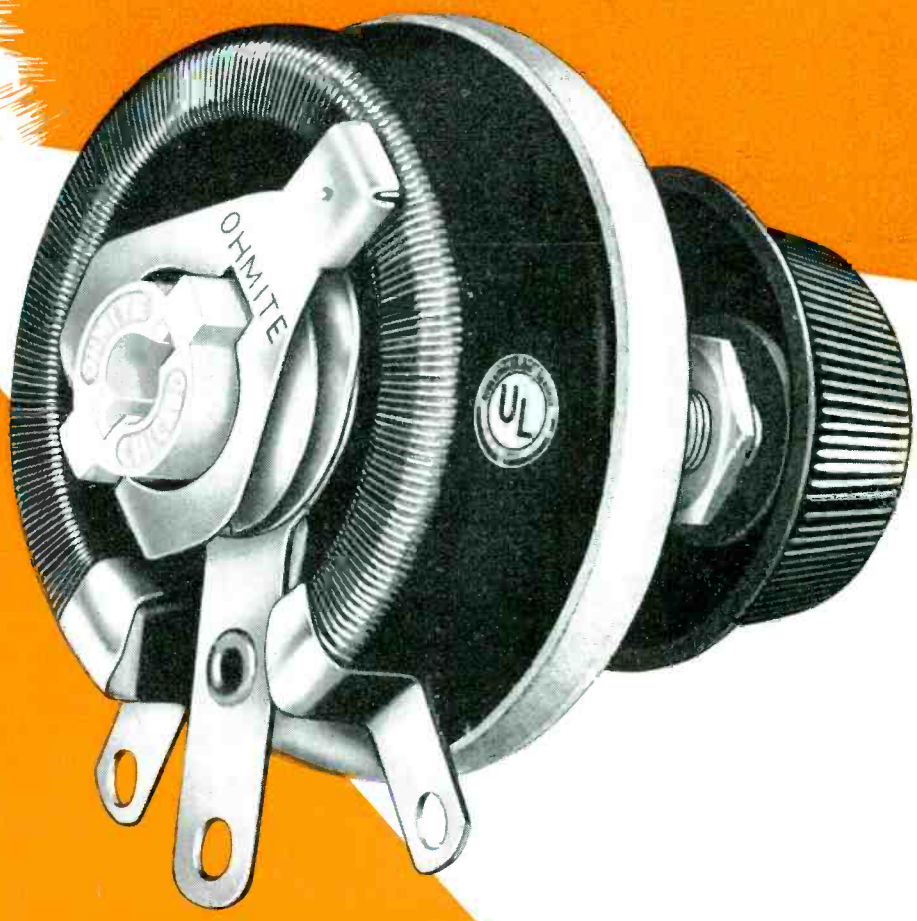
Month after Month—More OHMITE Power Rheostats are Purchased than all other Makes Combined





There's a reason for this overwhelming preference for Ohmite among men who specify rheostats.

These men—engineers, designers, technicians—know that Ohmite rheostats are smoother to operate. They know about the smoothly gliding metal-graphite brush, the all-ceramic construction, the windings permanently locked in place by vitreous enamel. They know that Ohmite rheostats can be depended upon for unfailing performance under the toughest operating conditions.

That's why Ohmite is first among industrial buyers . . . and why it will pay you to standardize on Ohmite rheostats for *your* product.

First Choice of Industry

Be Right with OHMITE

RHEOSTATS RESISTORS TAP SWITCHES

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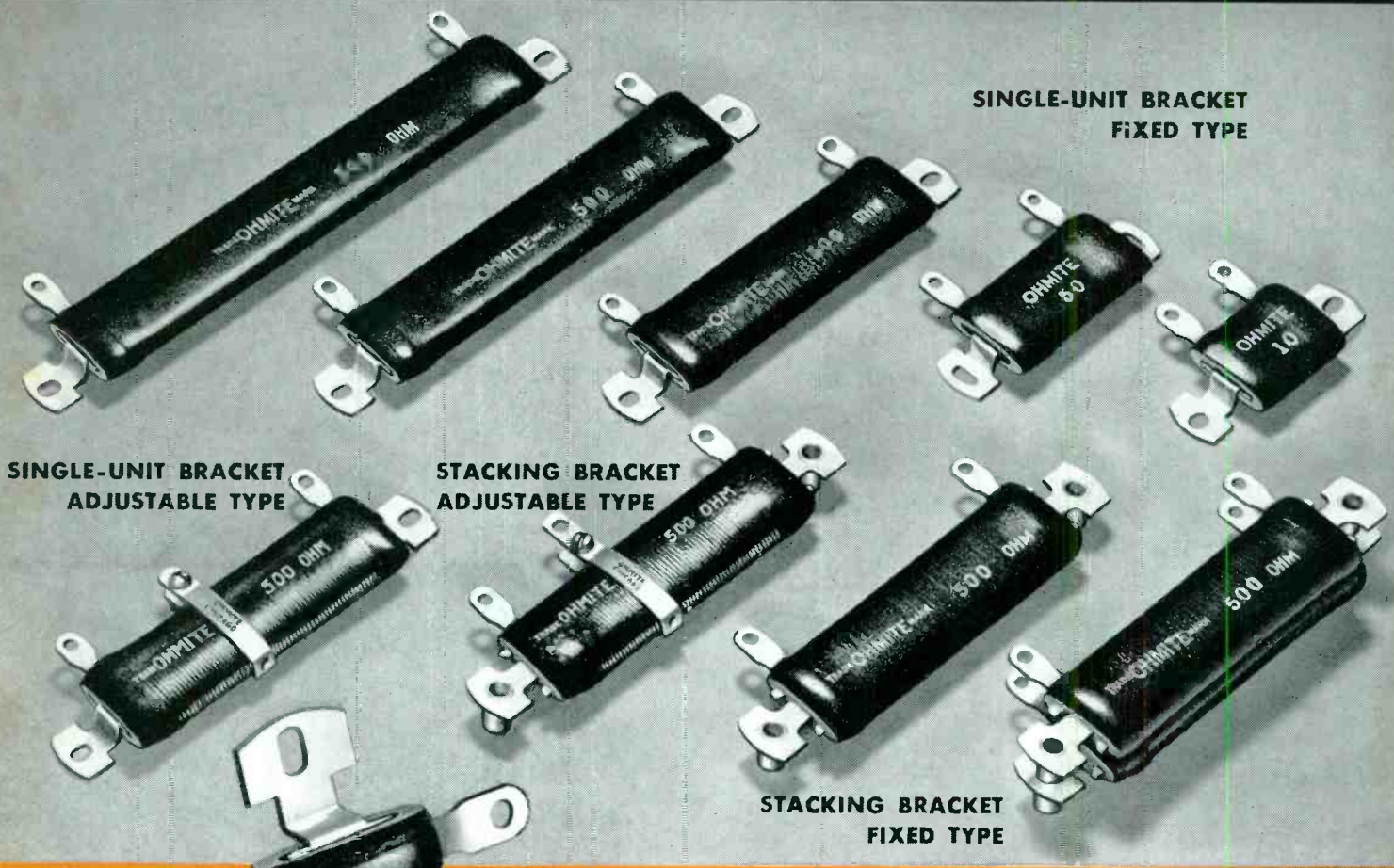
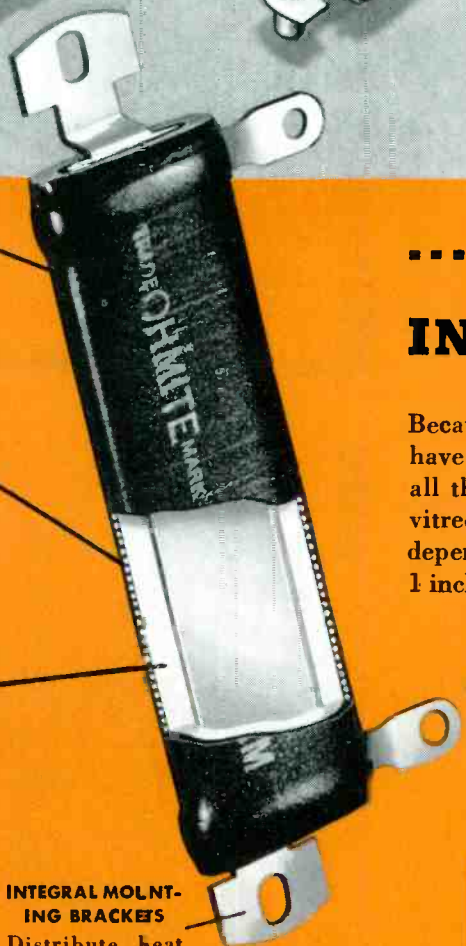
OHMITE THIN RESISTORS





VITREOUS-ENAMEL COVERING
Winding is rigidly held in place and protected from damage by Ohmite special vitreous enamel.

EVEN, UNIFORM WINDING
"Hot spots" and resultant failures are prevented by the resistance winding's unsurpassed uniformity.

STRONG, CERAMIC CORE
Unaffected by cold, heat, fumes, or high humidity, its core provides a strong base for winding.

FIVE WATTAGE SIZES
Lengths range from 1¼ inch to 6 inches, corresponding to ratings of 30 to 75 watts.

INTEGRAL MOUNTING BRACKETS
Distribute heat more evenly throughout resistor and conduct heat away quickly.

...PACK HIGHER WATTAGE INTO LESS SPACE

Because of their compact design, Ohmite Thin Type Resistors have a higher wattage rating per unit of space. They provide all the time-proven superiority of conventional Ohmite vitreous-enamel resistors—giving you a compact unit you can depend upon. Available in four types—all only ¼ inch thick by 1 inch wide—in five lengths and a wide range of resistance values.

Send for Bulletin No. 138

OHMITE MANUFACTURING CO.
4816 W. Flournoy St., Chicago 44, Ill.

Be Right with

OHMITE
RHEOSTATS • RESISTORS • TAP SWITCHES

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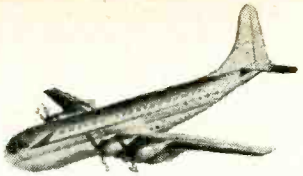
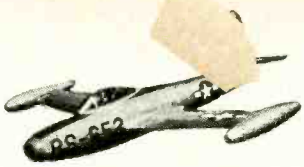
FILTERED
Y FILTRON
XB-47 Stratojet



FILTERED BY FILTRON
Boeing Stratocruiser



FILTERED BY FILTRON
Republic F-84 Thunderjet

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North American Aviation F-86 Jet

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North American Aviation FJ-1 Jet

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North American Aviation B-45 Jet

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Fairchild C-119A Packet

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Boeing B-50 Superfortress

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Boeing C-97 Stratofreighter

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McDonnell FH-1 Phantom Jet

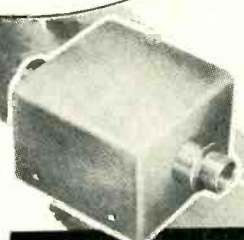
FILTERED BY FILTRON
McDonnell XF2H1 Banshee Jet

FILTERED BY FILTRON

MEANS DEPENDABILITY • LIGHTER WEIGHT • QUALITY • STRICT ADHERENCE TO SPECIFICATIONS AND

RADIO INTERFERENCE-FREE PERFORMANCE

FILTERED BY FILTRON . . . These planes, and others — that form "America's Mighty Armada," are equipped with electrical components which are FILTERED BY FILTRON . . . Some with as many as 27 FILTRONS per plane . . . These planes represent America's most advanced engineering and design — and FILTRONS represent the most advanced engineering and design of radio noise filters. FILTRONS are vital components not only in aircraft equipment, but wherever radio interference must be suppressed . . . FILTRON will design the RIGHT filter for your circuit conditions — and to meet your delivery requirements. All measurements are made in our new, modern, specially designed shielded Radio Noise Suppression Laboratory.



Shielded Spherical-Seat Terminal Filtron — designed for continuous high attenuation from 150 kc to well above 200 mc

RADIO NOISE FILTERS FOR:

Electric Motors
Electric Generators
Electronic Controls
Electronic Equipment
Fluorescent Lights
Oil Burners
Signal Systems
Business Machines
Electric Appliances
Electronic Signs
Electronic Heating Equipment

100 amp & 200 amp 50 Volt Aircraft Filtrons, size 3½" x 3½" x 2½"

2.5 amp Filtron for 50 V.D.C. operation size 1¾" x 1¾" x ⅞"

THE FILTRON CO., INCORPORATED
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SEND FOR CATALOG AND ENGINEERING MANUAL No. FC-20

LARGEST EXCLUSIVE MANUFACTURER OF RADIO NOISE FILTERS

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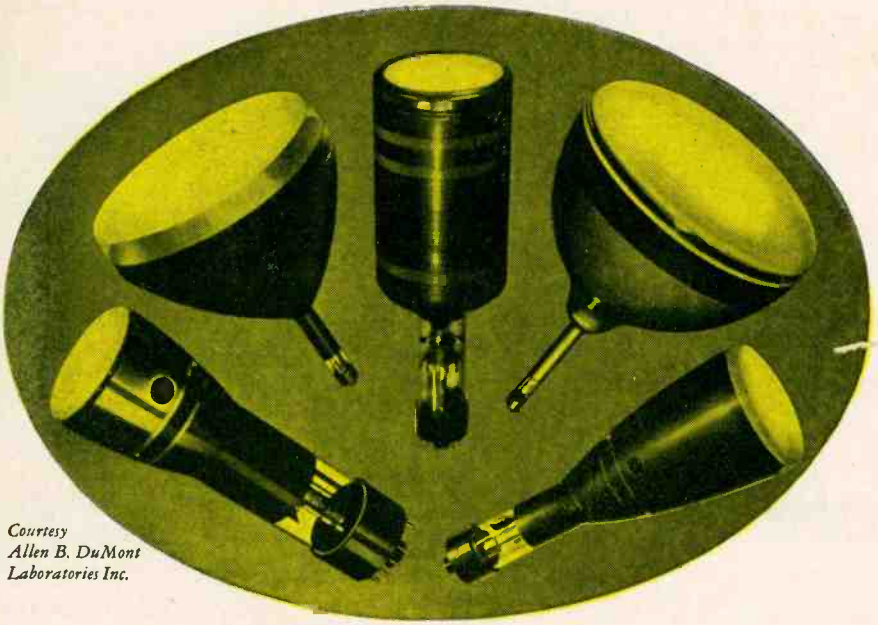
The *NEW* "dag" CRT Wall Coating ...

for *all* CRT glass envelopes



Courtesy Allen B. DuMont Laboratories Inc.

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 ☐
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- Copper oxide rectifier disc coating ☐
- Electrical resistances ☐
- Filament cement ☐

B-1

40th Anniversary Year

Acheson Colloids Corporation

Port Huron **Michigan**

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

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LOW CURRENT PAYS OFF...

with the GENERAL ELECTRIC PM-EM* FOCUS COIL!

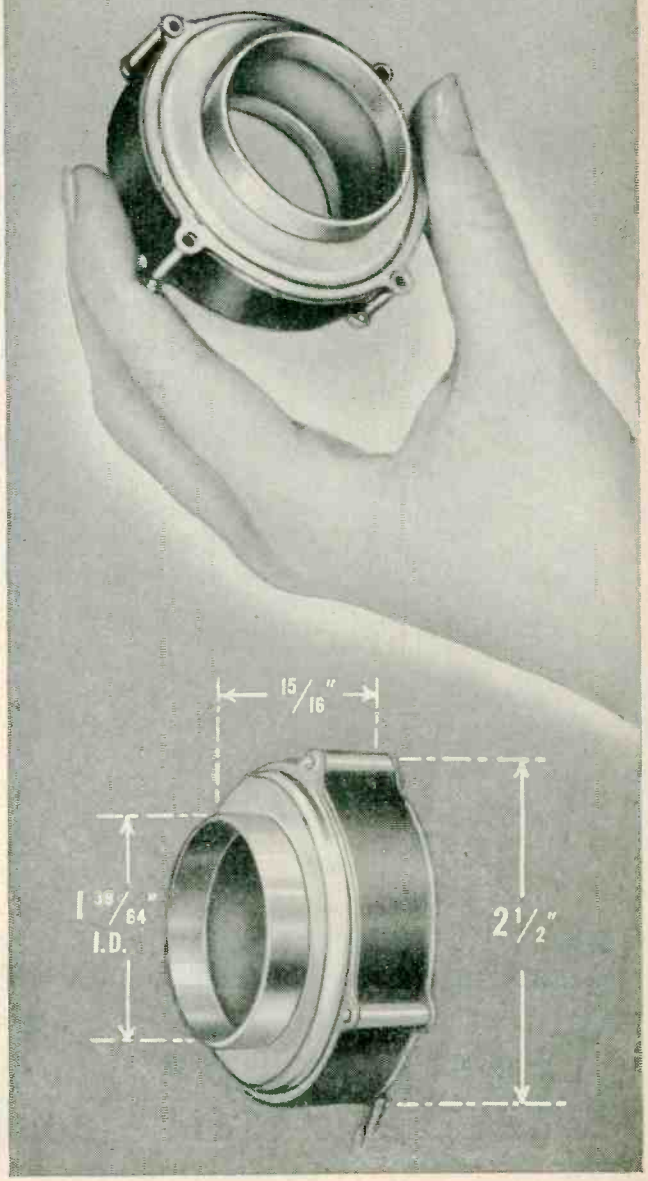
PERFORMANCE-ENGINEERED at Electronics Park, the General Electric Focus Coil is now being used by many leading television manufacturers. The reason for this widespread adoption of the G-E Focus Coil by design engineers is best explained by the following equation:

$$P_{EM} = I^2R = .109^2 \times 247 = 2.93 \text{ watts}$$
$$P_{EM-PM} = {}^2R = .029^2 \times 960 = 0.81 \text{ watts}$$
$$\text{Power Saving} = 2.12 \text{ watts}$$

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—

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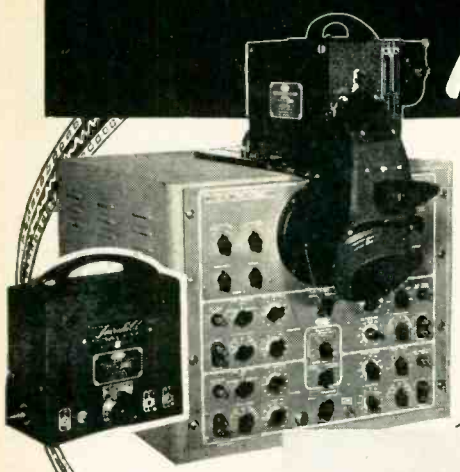
For permanent oscillograph records . . .

it's DU MONT all the way!

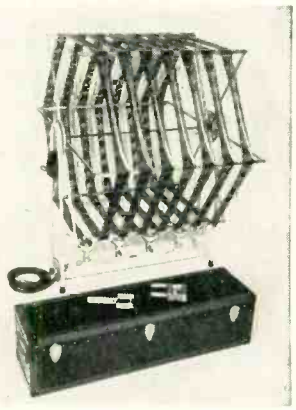


START with Type 314 Oscillograph-record Camera. Especially designed for cathode-ray oscillograph photography. Maximum convenience. Either single-image or continuous recording. Variable speed, electronically controlled. Cat. No. 1366-E, with f/1.5 lens, $1,155.00. Cat. No. 1217-E, with f/2.8 lens, $980.00.

Or with Type 271-A Oscillograph-record Camera (not illustrated). Single-image. Fixed-focus, f/3.5 lens. Cat. No. 1216-E, with mounting, $162.50.

DEVELOP your films with Type 2512 Motor-driven Processing Unit. Utterly simple. Accommodates up to 100 feet of 35mm. film. Cat. No. 1372-E, $231.00.

FINISH with Type 2514 Portable Drying Rack. Holds up to 200 feet of 35 mm. film. Motor-driven. Provided with heater. Easy rewinding. Unit may be folded up. Carrying case supplied. Cat. No. 1375-E, $232.00.



DU MONT CATALOG ITEMS . . .

HIGH AND LOW VOLTAGE OSCILLOGRAPHS: Amplifier frequency response selectable from d-c to 10 mc. Writing rates up to and exceeding 400 inches/microsecond. Deflection factors as low as 0.01 rms volt/inch. Prices from $127.20 to $6,073.75.

OSCILLOGRAPH POWER SUPPLIES: Up to 25,000 volts output for application as final accelerating potential to cathode-ray tubes.

PROJECTION LENS: Projects oscillograph traces on screen up to 30 feet distant. Excellent for demonstrations and lectures. Applicable to high-voltage oscillographs. Type 2542, Cat. No. 1431-E, $103.50.

VOLTAGE CALIBRATOR: For quantitative measurements. Operates with any oscillograph. Type 264-A, Cat. No. 1240-A, $39.50.

ELECTRONIC SWITCH: Provides a time-sharing system for oscillograph presentation of two separate traces. Type 185-A, Cat. No. 1072-A, $105.00.

LOW-FREQUENCY LINEAR TIME-BASE GENERATOR: Du Mont Type 215 accessory extends low-frequency range of the time-base of oscillographs. Cat. No. 1189-A, $215.00.

SPECIALIZED EQUIPMENT: Type 279 Dual-beam Cathode-ray Oscillograph presents two entirely separate traces. Cat. No. 1386-E, $1,294.50. • Type 275-A Cathode-ray Polar Coordinate Indicator employs a circular time-base. Cat. No. 1250-E, $390.00. • Calibrated scales; constant-voltage transformer; transducers; magnetic shields, etc.

DU MONT CATHODE-RAY TUBES: A full line of cathode-ray tubes. A choice of phosphors suited to your particular needs.

In oscillography, Du Mont can supply you with the *tube*, the *oscillograph*, the *accessory*. Note partial list of standard items.

And if your oscillograph needs are *extremely special*, even to the extent of exceeding the broad range of our standard equipment, Du Mont can now place at your disposal the services of our Instrument Model Shop which is equipped to design, develop and manufacture non-standard cathode-ray equipment, or to modify existing equipment and designs. Consult us.

Detailed literature on request. Equipment demonstrations arranged — no obligation.

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DU MONT for Oscillography

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Flexite HITEMP

flexible, extruded plastic tubing

takes the lead for RESISTANCE above 105° C

- HIGH TEMPERATURES
- HIGH DIELECTRIC
- STRETCHING
- ABRASION
- TEARING
- ACIDS, OILS, ALKALIES
- FLAMMABILITY
- ETC., ETC., ETC.

FLEXITE HITEMP is the electrical insulation tubing that sets new standards for resistance to extreme high temperatures. Compounded of a plasticized copolymer of vinyl chloride and vinyl acetate and manufactured with a true wall thickness, smooth inside and outside **FLEXITE HITEMP PLASTIC TUBINGS** offer the greatest resistance to high and low temperatures, are extremely flexible and have great tensile strength.

Other significant properties of **FLEXITE HITEMP** compare more than favorably with tubings of similar nature. Check the specifications of HITEMP, compare them with the requirements for [illegible] products and if you wish ag[illegible]er insulations for identical use . . . [illegible]TEMP sets a new high standard for protection against high temperatures, high dielectric, stretching, tearing, abrasion, exposure to acids, oils and alkalies, flammability, etc., etc., etc.— . . . samples and additional information will be sent upon request.

FLEXITE HITEMP PHYSICAL & ELECTRICAL PROPERTIES

a—tensile strength, minimum average.....2500 PSI

b—ultimate elongation, minimum average.....300%

c—dielectric strength, minimum.....800 v/mil

d—flammability.....non-inflammable

e—heat resistance—after 100 hours at 300° F. the tubing is not brittle and when flexed does not crack.

f—heat endurance—recommended for continuous operating temperatures up to 105° C., and when baked at 125° C. for 2,000 hours does not become brittle.

g—low temperature flexibility.....—30° C.

h—heat shrinkage.....ASTM Standards

#20 — #17 incl. — less than 8%
#16 — # 6 incl. — less than 5%
5 and larger — less than 3%

i—oil resistance—highly resistant to effects of transformer and lubricating oils, does not stiffen when continuously exposed to them.

Colors—black, white, red, green, yellow and blue are standard colors.

Dimensions and Tolerances—standard sizes to [illegible]B & S wires #20 to #0 inclusive, as specified by ASTM Spec. D[illegible]T.

Wall Thickness—in accordance with ASTM Spec. D922-[illegible] follows:

#20 — #10 incl. — .016" ± .003"
9 — # 0 incl. — .020" ± .003"

Standard Lengths—Standard 36" lengths or continuous lengths in coils. Sizes #20 — #10 incl., will be supplied on paperboard spools when so ordered.

Quality—uniform in quality and condition, smooth on both inside and outside, free of defects such as pin-holes, blisters, foreign inclusions and other imperfections.

Test Methods—properties enumerated in above specifications shall be determined according to Tentative Methods of Testing Nanrigid Polyvinyl Tubing, American Society for Testing Materials, Designation D876-46T.

And for a Plastic Tubing to Withstand Normal High Temperatures Mitchell-Rand Offers . . . Flexite-Norm . . . write for specifications.

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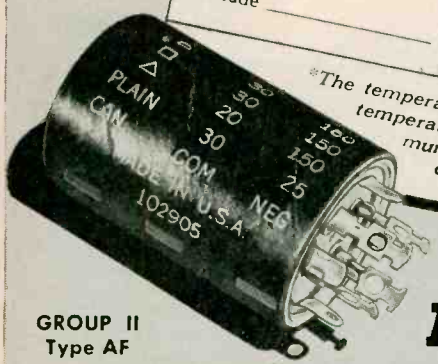
For dependable television...hour after hour...day in and day out... month after month...

GROUP I
Type E

GROUP I
Type AP

OPERATING CONDITIONS	Group I	Group I-A	Group II	Group III
	AEROVOX TYPES AP; BT; E; G; S; SC	AEROVOX TYPES BTN; SCN	AEROVOX TYPES AF; APG; MM; MSF; MSQ; MSR; MST; PRS	AEROVOX TYPES GL; PBS; PRSA; PRSB; PRSV; PRV; PT; SCL
*Temperature Range	−60° C. to +85° C. (−76° F. to +185° F.)	−60° C. to +85° C. (−76° F. to +185° F.)	−60° C. to +85° C. (−76° F. to +185° F.)	−40° C. to +60° C. (−40° F. to +140° F.)
Humidity	any, including immersion	any, including immersion	high	average
Altitude	any	any	any	

*The temperatures given are the minimum and maximum ambient operating temperatures. It is imperative, however, that the minimum and maximum ambient temperatures be stated for each application, as circuit design will affect the allowable temperature range.



GROUP II
Type AF

AEROVOX
extra-severe-service
ELECTROLYTIC CAPACITORS

GROUP II
Type PRS

● The above chart was compiled in 1946. It is based on Aerovox wartime experience in meeting the extra-severe-service requirements of military equipment. Likewise the needs of workaday electronic assemblies for industrial purposes.

Found in the Aerovox engineering literature, this chart classifies Aerovox electrolytic types into four groups based on severity of service and cost considerations. Groups I and I-A comprise hermetically-sealed electrolytics meeting the most rugged conditions of temperature, humidity, pressure and vibration. Group II types compromise between severe-service requirements and cost. Group III types meet cost considerations primarily.

Thus today's television requirements, as regards electrolytics quite as well as other capacitors, have been fully anticipated by Aerovox engineering and production developments of long standing.

1949 IS TV YEAR

● *Whether your electrolytic requirements be for extra-severe, severe or just normal service, let Aerovox engineers collaborate in working out the best answer. Visit with us at Booth 124, I.R.E. National Convention.*

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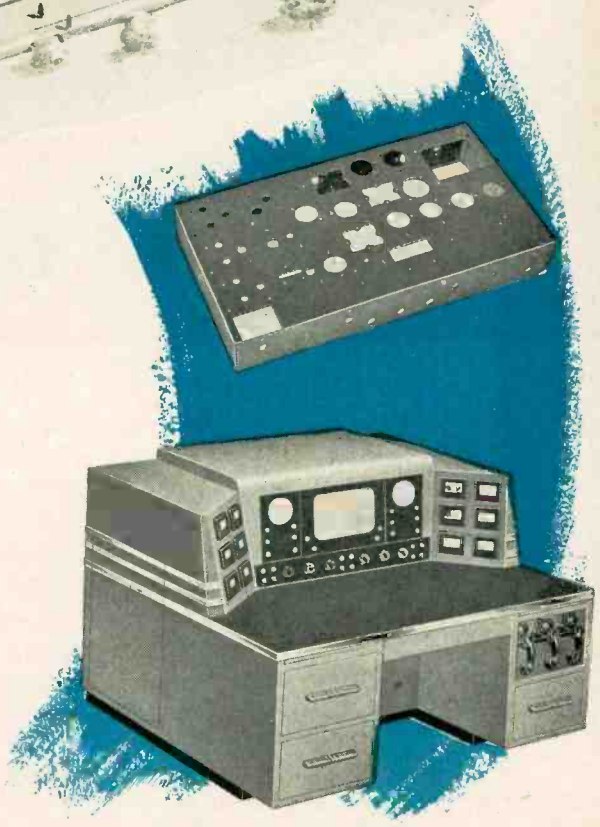
From the simplest to the most elaborate precision job, nothing is too big or too small. We invite your inquiries.



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THERE ARE AT LEAST TEN TIMES AS MANY OPPORTUNITIES FOR

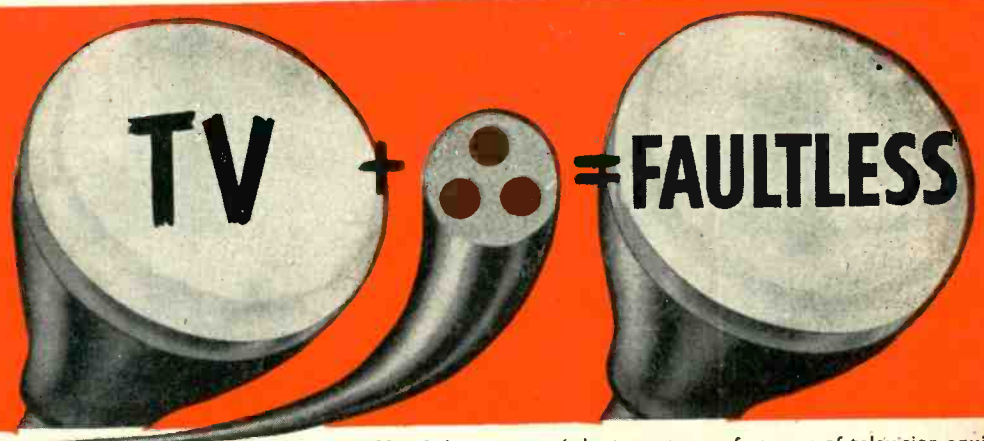
bad

JOINTS IN TELEVISION ASSEMBLIES AS THERE ARE IN RADIO SETS. AVOID H.R. TROUBLE AND GET CONSISTENTLY

good

SOLDERING JOINTS WITH

Television receivers contain from five to ten times as many resonant circuits as there are in ordinary radio sets and from ten to fifteen times as many connections. That means that there are at least ten times as many places where H.R. connections may occur through dry joints. It means, too, ten times as many chances of the set not passing the inspection at the end of the assembly line or proving unsatisfactory in service after it has reached the customer. H.R. joints are bad for your business and bad for your reputation as a manufacturer.



Here's how many of the largest manufacturers of television equipment safeguard themselves against H.R. joints—by using only Ersin Multicore Solder. Ersin Multicore Solder makes perfect soldered joints on difficult metals and alloys and even on heavily oxidised surfaces, speeding production and cutting manufacturing costs. If you are not already using Ersin Multicore Solder, it will pay you to investigate the advantages of using The Finest Cored Solder in the World; it complies with all requirements of United States Federal Specification, QQ—S—57 lb. Write *NOW* for helpful booklet, "SOLDERS & SOLDERING," with free samples and technical information.

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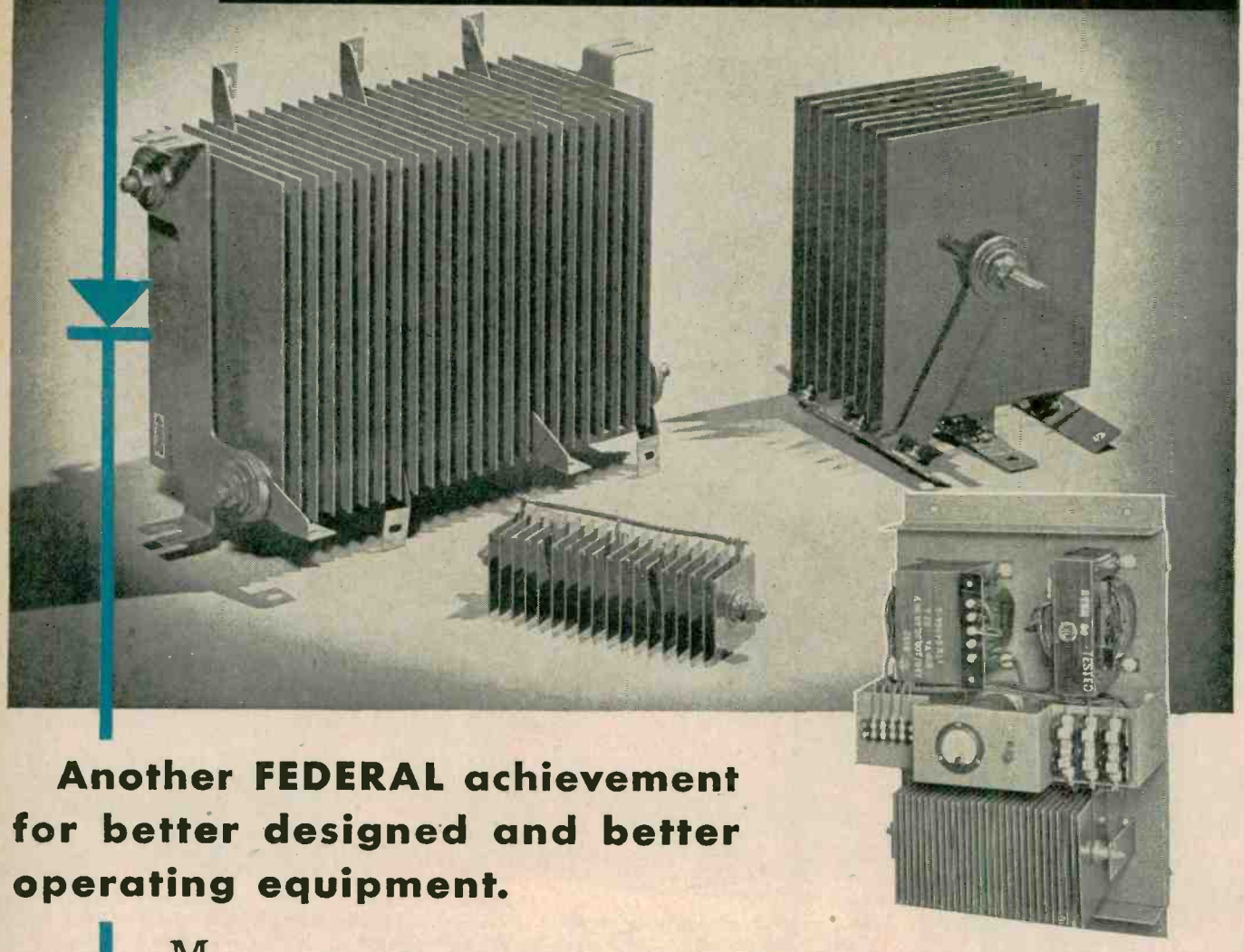

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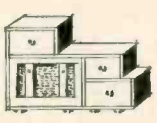



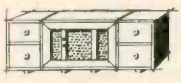


Jensen Customode

Your Chinese puzzle mystery is solved. Perfect for your ever-expanding requirements of audio-video equipment for your Home Entertainment Center or Amateur Shack. Four basic units: Reproducer Cabinet—designed especially for a Jensen 15-inch coaxial loudspeaker; Small Utility Cabinet—for tuner, amplifier, recorder, record-changer; Medium Utility Cabinet—for larger receiver, television set, or communications equipment; Record Cabinet—holding more than 200 records. With these units, thousands of combinations are possible. Beautiful cabinetry in cordovan or muted blonde mahogany.

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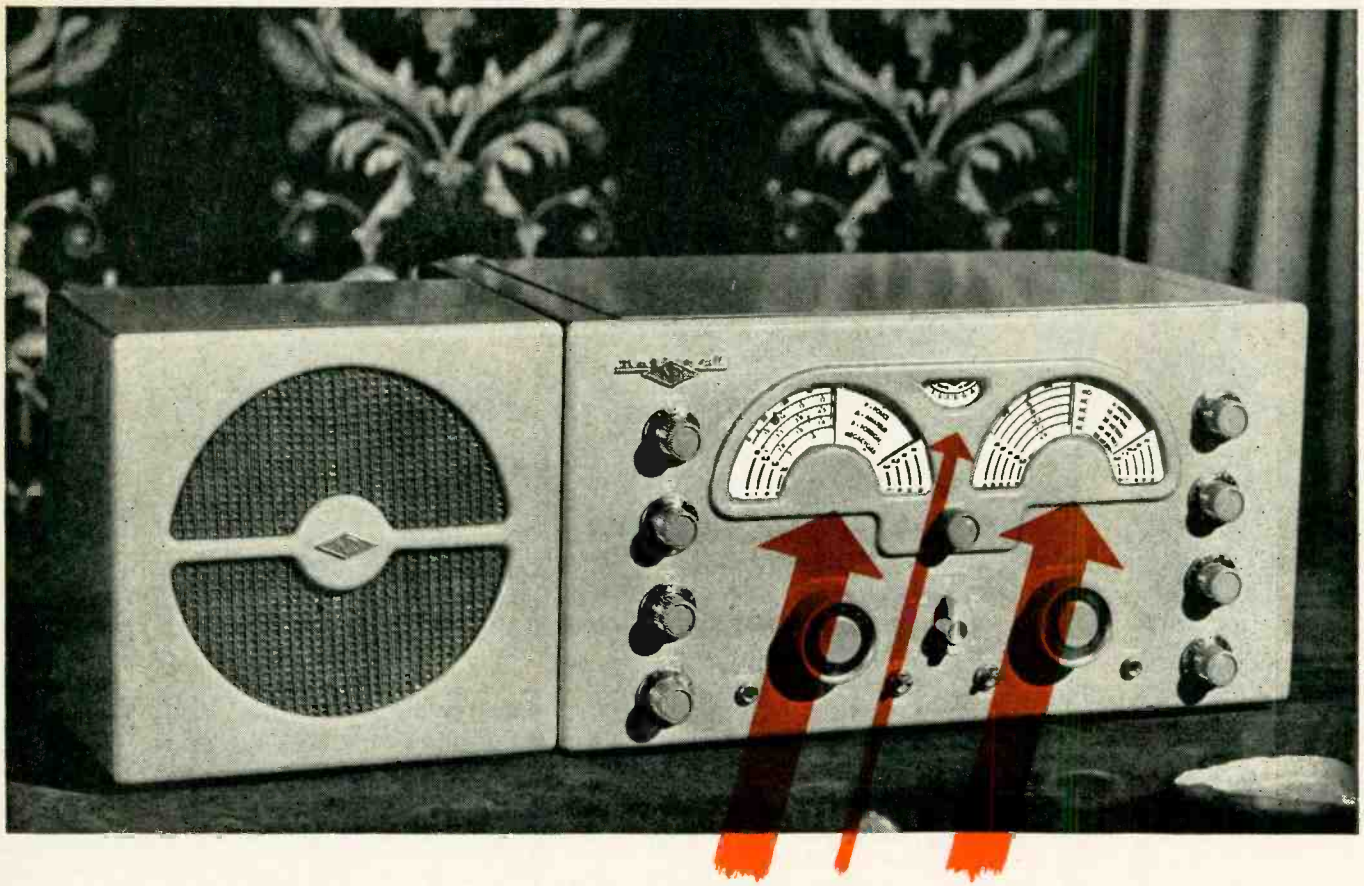
Translucent Graphic Lamicoid assures maximum clarity, legibility and accuracy in rear-illuminated dials for the Model NC-173 Radio Receiver manufactured by National Company, Inc., Malden, Mass.



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There's no eye-straining or neck-craning needed to see radio dials made of Translucent Graphic Lamicoid. Printed matter permanently laminated in the translucent thermosetting plastic stands out clearly with rear illumination. That's why National Company, Inc., uses Graphic Lamicoid for the rear-illuminated dials on the Model NC-173 Receiver.

Besides legibility and clarity, Graphic Lamicoid has many other advantages for instrument dials, control panels, maps, charts and diagrams. Printed markings and colors are sealed against wear, dirt and moisture. Lamicoid holds its size and shape for assured accuracy in precision instruments. It has high heat and wear resistance, excellent mechanical and dielectric strength.

Other types of Decorative Lamicoid—Engraving and Translucent, rigid and flexible—extend the range of application of this versatile material. Lamicoid is available in mechanical and electrical grades, too, that it will pay you to investigate through the nearest sales office or fabricator.

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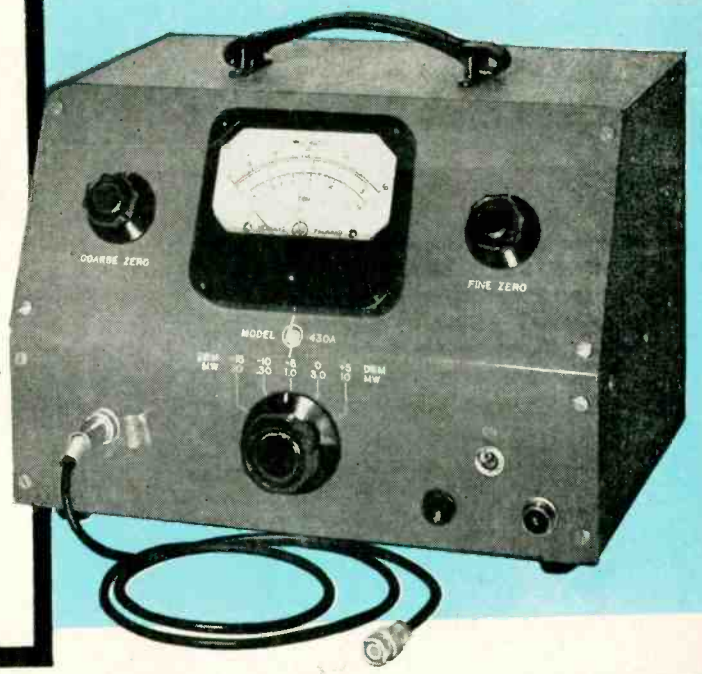

Automatic operation! Instantaneous power readings! No tedious calculations or adjustments! Read direct in mw. or dbm! Use at any microwave frequency!

To measure an unknown microwave rf, just connect the new *–hp–* 430A Microwave Power Meter to the 200-ohm barreter in your system. This one compact power meter does all the rest! No tedious calculating or knob-twisting. Except for initial range selection and zero set, operation is *entirely automatic!* You can make direct power readings *instantly* in milliwatts from 0.02 to 10 mw, or dbm from –20 to +10 dbm. Higher powers may be measured by adding attenuators or directional couplers to the microwave system. Any of 5 ranges are quickly selected by a front-panel switch. Power is read on an open-scale, 4" square-face meter mounted on a sloping panel.

The new *–hp–* 430A Power Meter is an ac bridge, one arm of which is a 200-ohm barreter. This bridge is in precise balance with zero rf power across the barreter. When rf power is applied, an equivalent in audio power is *automatically removed*. The bridge remains balanced, but the change in audio power level indicates on the vacuum tube voltmeter. This meter thus measures the unknown rf directly and instantaneously.

The *–hp–* 430A is designed for use with any 200-ohm barreter and mount, and may be used over any microwave frequency for which the mount is designed. The meter incorporates the famous *–hp–* resistance-tuned oscillator principle, and is ruggedly built for long, trouble-free service. There are no delicate components to get out of adjustment.

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BRIEF SPECIFICATIONS

Power Range: 0.02 mw to 10 mw, 5 ranges, 5 db intervals. Scale also reads dbm continuously from —20 dbm to +10 dbm. (0 dbm = .001 Watt).

External Barreter: Frequency range depends on barreter and mount. (Must be 200 ohms at power level of approximately 15.3 mw.) (Barreter and mount not supplied.)

Accuracy: ±5% of full scale reading.

Size: 12" wide, 9" deep, 9" high. 4" Square-Face meter.

Power: 115 v., 50/60 cps, 60 watts.

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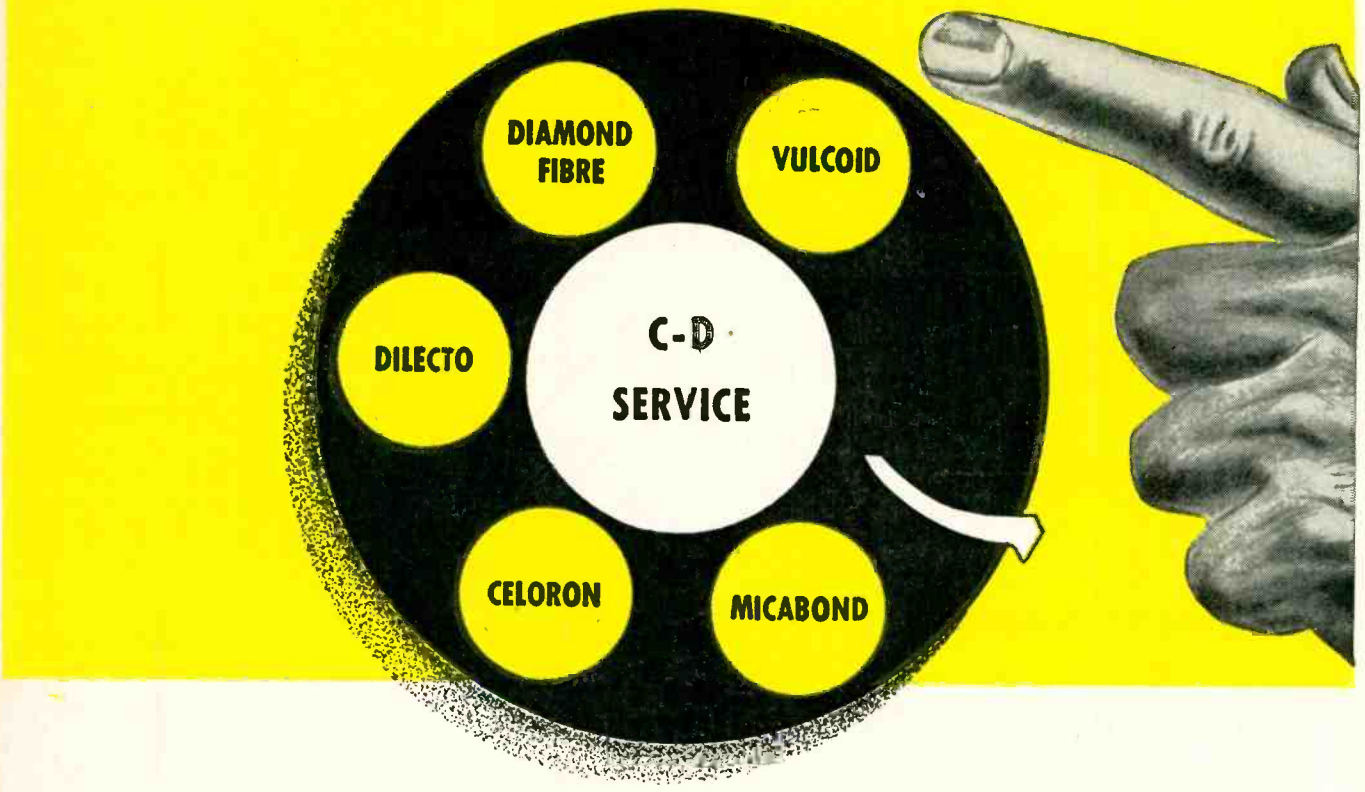

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One of the surest ways to reduce unit costs on any job is to be right the first time when selecting materials. Continental-Diamond's complete line of high strength electrical insulating materials makes proper product engineering easy.

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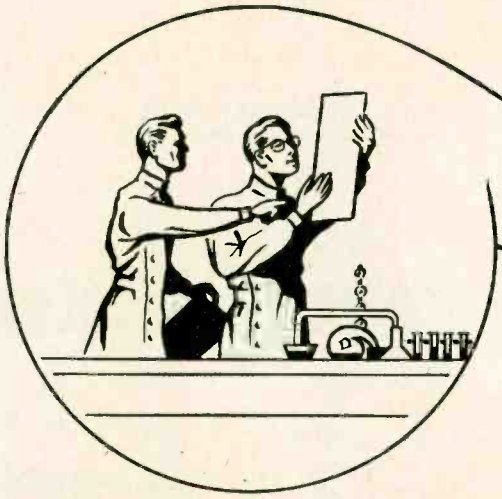
A REVOLUTIONARY NEW SPACE-SAVING CONDENSER PAPER WITH AMAZING SELF-HEALING QUALITIES.



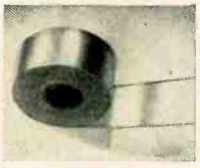
SMITH'S New-type Metallized Condenser Paper not only reduces space factor by eliminating the use of electrodes, but gives longer life, higher dielectric strength, and ends forever the disastrous effects of breakdowns.

NEW!!! NEW!!! Never before has anything like Smith Metallized Condenser Paper been offered the Electric and Electronic Industries.

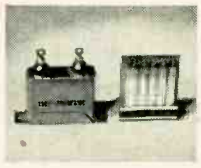
It's here! Today . . . now . . . Smith Paper, Inc. makes available its new Metallized Condenser Paper that bids fair to revolutionize the entire electric and electronic field. Smith Metallized Condenser Paper makes possible the first one-layer condenser with an .0003" dielectric material. It also makes possible a 75% saving in space factor over most conventional capacitors. And because of its self-healing characteristics it almost completely eliminates the factor of conducting particles and the usual serious effect of a breakdown.

Answers a long-unfilled need. Design engineers since earliest days of the capacitor industry have sought capacitors that would provide higher capacities, smaller space factors, higher dielectric strength, longer life characteristics, and the elimination of breakdown causes. Since such improvements in design have been limited by the dielectric materials available, the introduction of Smith's Metallized Paper will prove a great boon towards the attainment of these special characteristics. This industry-sought paper not only permits 75% savings in space factor, but also provides other extraordinary advantages.

Increased insulation resistance. It has been found in the manufacture of metallized paper that by covering the base Kraft Condenser sheet with an extremely thin, continuous and uniform film of lacquer, a marked increase in insulation resistance is obtained. This lacquering causes an increase in the thickness of .00030 condenser paper of .03 - .05 mils; while the succeeding zinc coating operation causes an increase in thickness of 3 - 5 millionths of an inch.



Metallized Paper



1 MFD—400 WVDC

4 MFD—150 WVDC

Capacitor samples courtesy Solar Manufacturing Corp., North Bergen, N. J.

Self-healing on breakdowns. Another of the outstanding properties of metallized paper is its capacity to self-heal on a breakdown. In other words, a capacitor wound with metallized paper may be brought to a breakdown voltage, but the effects of the breakdown are sufficient to cause a re-insulation around the breakdown area so that the capacitor is satisfactory for continued use. Numerous breakdowns do not appear to impair this self-healing characteristic. Smith Paper, by taking advantage of this property, is able to furnish a metallized paper devoid of particles which are conducting at the usual test voltages.

Automatically Controlled. Today equipment has been perfected for automatically controlling and continuously recording (where necessary) such properties as lacquer thickness and consistency, thickness of the metal layer, color and resistance of the metal layer, width of margin, etc. — all important characteristics of the product, the close control of which is essential for the best design and manufacture of metallized paper capacitors.

Complete facts available. All facts on Smith Metallized Condenser Paper as it applies to your industry may be had on request. Simply address Smith Paper, Inc., Lee, Massachusetts. There is no obligation.

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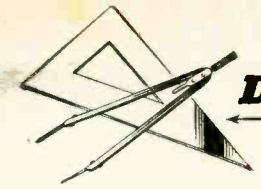

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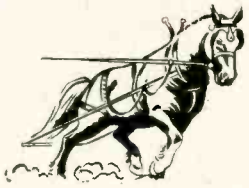

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Modern resistors designed for modern applications . . . I-T-E Oval Resistor Assemblies . . . specially suited for installations where space is limited, such as in aviation, sound, radio, and other electronics applications. I-T-E "Ovals" are distinguished by their high unit-area wattage ratios, which are due in part to the heat dissipation qualities of the mounting brackets. An I-T-E Oval Resistor—or an assembly of oval units—has a much higher wattage rating than that of a conventional round resistor of comparable size.

And I-T-E Resistors are better-built for a longer life of dependable performance. Bases are best non-hygroscopic ceramics . . . resistance wires are purest obtainable . . . resistances are uniformly wound, mechanically tied, and silver-soldered at high heat for permanent, solid connections.

No matter what your resistor problem calls for—compactness, long life, dependability, or exact tolerances—be sure to investigate I-T-E Oval Resistors, the *modern* wire-wound Power Resistors. Complete technical information, as well as valuable application data, is contained in the new I-T-E Resistor catalog. Send for it today.

There's an I-T-E Resistor for Every Purpose →

I-T-E OVAL RESISTORS				
Type	Watts	Length	Maximum Recommended Resistance	Mounting Centers
108 Oval	30	1¼"	10000	2"
200 Oval	40	2"	15000	2¾"
316 Oval	55	3½"	25000	4¼"
424 Oval	65	4¾"	35000	5½"
600 Oval	75	6"	50000	6¾"

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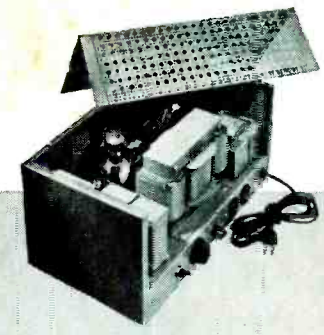
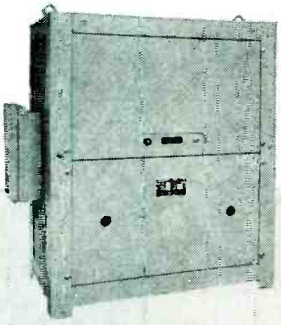


General Application

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: adiustable 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. C. Power Supplies, Saturable Core Reactors and Meter Calibrators made to order; please request information.

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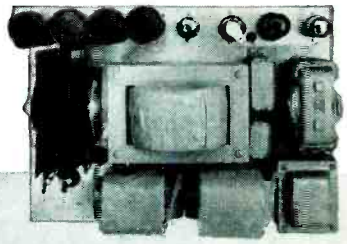
Stamford, Connecticut

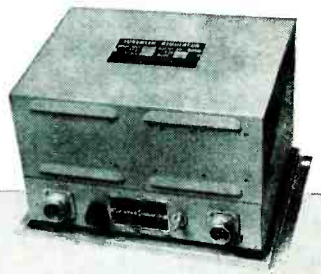
Represented in all principal cities.



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.

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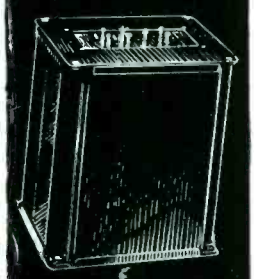
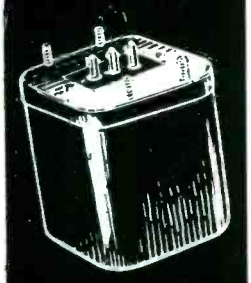
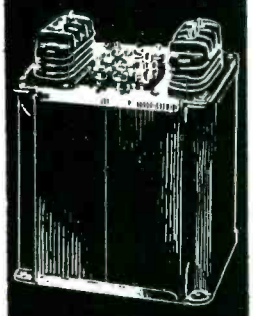
Now! Specify KENYON







KENYON one of the oldest names in transformers, offers high quality specification transformers custom-built to your requirements. For over 20 years the KENYON "K" has been a sign of skillful engineering, progressive design and sound construction.

KENYON now serves many leading companies including: **Times Facsimile Corporation, Western Electric Co., General Electric Co., Schulmerich Electronics, Sperry Gyroscope Co., Inc.**

Yes, *electronification* of modern industrial machinery and methods has been achieved by KENYON'S engineered, efficient and conservatively rated transformers.

For all high quality sound applications, for small transmitters, broadcast units, radar equipment, amplifiers and power supplies — Specify KENYON! *Inquire today for information about our JAN approved transformers.*

Check Your Requirements

"T" LINE TRANSFORMERS
HERMETICALLY SEALED TRANSFORMERS
"A" LINE TRANSFORMERS

- PLATE TRANSFORMERS
- FILAMENT TRANSFORMERS
- REACTORS
- CHOKES
- MODULATION TRANSFORMERS
- INTERSTAGE TRANSFORMERS
- INPUT & OUTPUT TRANSFORMERS
- SPECIAL FREQUENCY TRANSFORMERS
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Now — for the first time in any transformer catalog, KENYON'S new modified edition tells the full complete story about specific ratings on all transformers. Our standard line saves you time and expense. Send for the latest edition of our catalog *now!*

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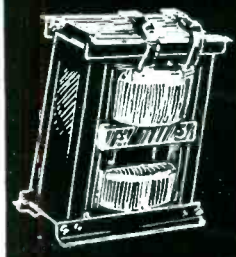
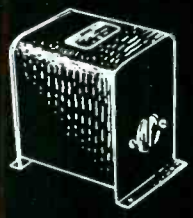
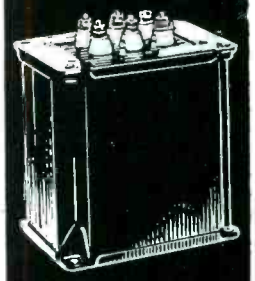
Name..... Address.....
Position..... City.....
Company..... State.....







KENYON TRANSFORMER CO., Inc. 840 BARRY STREET NEW YORK 59, N.Y.

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For driving stage
GL-5513

THE EYE IS EXACTING!

For output stage
GL-9C24

To assure high video-signal quality, specify G. E.'s pace-setting 220-mc triodes in your new TV transmitter design!

THE BEST, most up-to-date . . . these words must describe every unit of your television circuit IF you mean to get off on the right foot competitively. *So start by choosing General Electric ring-seal tubes.* Designed directly for grounded-grid circuits, they plug in quickly, firmly, with wide contact areas. Lead inductance is extremely low. The tubes need minimum neutralization.

All external parts are silver-plated to reduce r-f losses. Fernico metal-to-glass seals are used throughout. Sturdy, compact, built to true precision standards, Types GL-5513 and GL-9C24 are acknowledged performance leaders in the TV and FM fields.

Study the ratings of these modern yet service-proved v-h-f triodes; then phone your nearby G-E electronics office for further facts, plus (if desired) the application counsel of an experienced G-E tube engineer. Or, wire or write *Electronics Department, General Electric Company, Schenectady 5, New York.*

RATINGS AND ELECTRICAL CHARACTERISTICS

	GL-5513	GL-9C24
Filament voltage	6.3 v	6.3 v
Filament current	32 amp	240 amp
Interelectrode capacitances:		
Grid-filament	21.1 mmfd	24 mmfd
Grid-plate	8.7 mmfd	15.7 mmfd
Plate-filament	.11 mmfd	0.47 mmfd
Type of cooling	forced-air	water and forced-air
Plate ratings per tube, Class B r-f power amplifier (video service, synchronizing peak conditions):		
Max voltage	3,000 v	5,000 v
Max current	1.2 amp	2 amp
Max input	3,300 w	10 kw
Max dissipation	1,200 w	5 kw
*Power output, typical operation	1,160 w	3.4 kw
Plate ratings per tube, Class C r-f power amplifier (key-down conditions without modulation):		
Max voltage	4,000 v	6,500 v
Max current	1 amp	2 amp
Max input	3,600 w	12 kw
Max dissipation	1,200 w	5 kw
*Power output, typical operation	2.45 kw	9 kw

*Includes power transferred from driver to output of grounded-grid amplifier.

GENERAL ELECTRIC

160-H2-8650

FIRST AND GREATEST NAME IN ELECTRONICS

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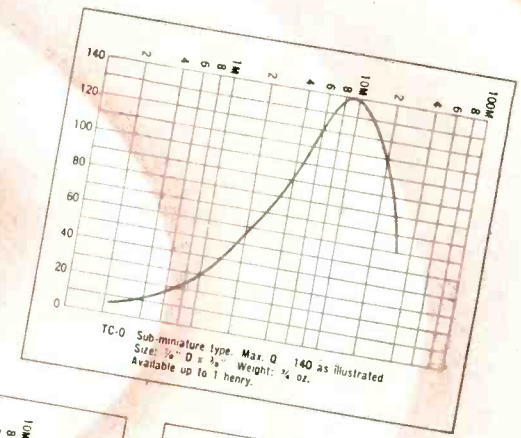
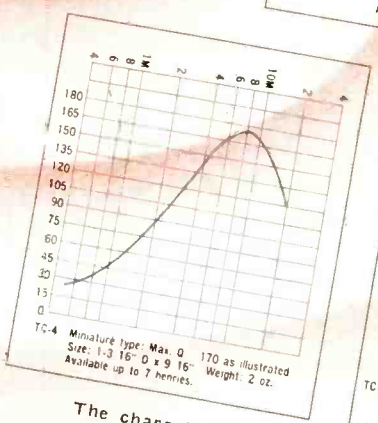
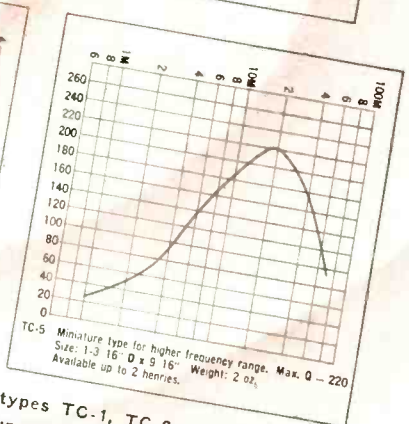
BURNELL & CO., A LEADER IN THE DEVELOPMENT OF MINIATURE AND SUB-MINIATURE COILS AND FILTERS.. INTRODUCES.. THE 'WEDDING RINGS', WORLD'S SMALLEST HIGH 'Q' TOROIDAL COILS

ACTUAL SIZE







Since discovering that toroidal coils are the solution to problems in compactness of communication and control equipment, design engineers have been confronted with the ever pressing problem of miniaturization.

A major step towards a solution has now been found and we take pleasure in presenting to the electronics field, the penultimate in the design of miniature high Q coils, the types TC-4 and TC-5 and the ultimate, sub-miniature TC-0 which is not much larger than a thumb nail.

For many applications, design engineers will benefit from our specialized experience in the manufacture of miniature components and filters by utilizing the performance capabilities, degressively, of their larger associates (Types TC-1, TC-2, TC-3) but compressed into midget proportions, permitting an elegant solution to the importunate problem of miniaturization.

All of the TC series are toroidally wound on molybdenum permalloy cores providing high Q with a stability unattainable by any other material.

The characteristics of the types TC-1, TC-2 and TC-3 are available upon request.

EXCLUSIVE MANUFACTURERS OF COMMUNICATIONS NETWORK COMPONENTS

ALL INQUIRIES WILL BE PROMPTLY HANDLED

Burnell & Company

YONKERS 2, NEW YORK

CABLE ADDRESS "BURNELL"

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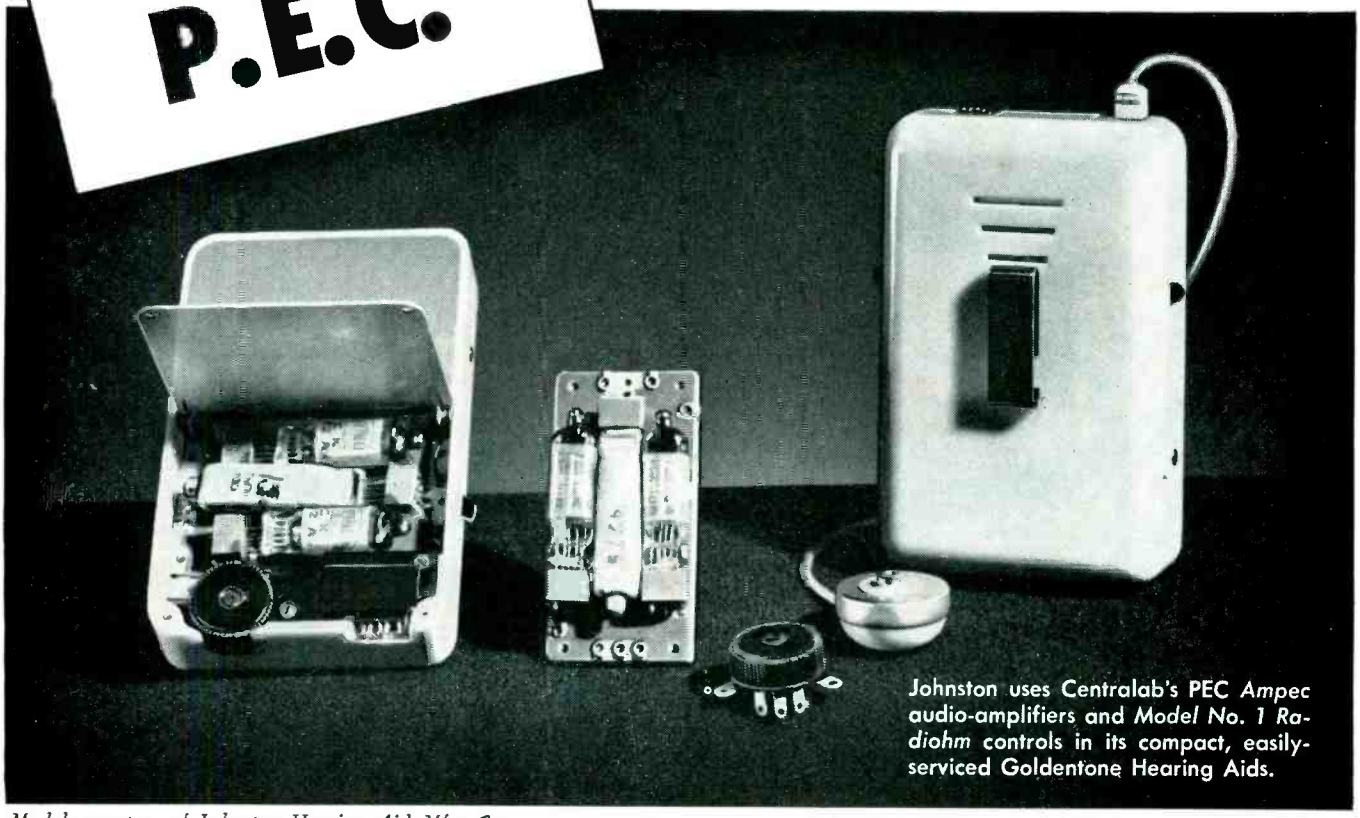
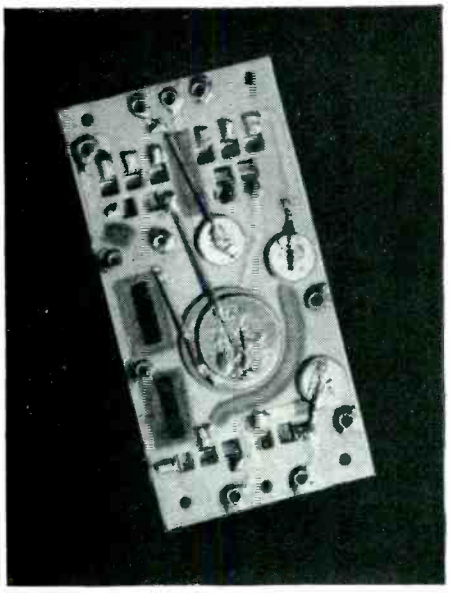
PROGRESS REPORT ON P.E.C.*

How Johnston uses CRL's "Printed Electronic Circuit" to build its light-weight, compact Goldentone Hearing Aid!



Johnston uses Centralab's PEC *Ampec* audio-amplifiers and *Model No. 1 Radiohm* controls in its compact, easily-serviced Goldentone Hearing Aids.

Models courtesy of Johnston Hearing Aid Mfg. Co.



TYPICAL "AMPEC"—(actual size, back view) shows how you can get complete electrical circuits—tube sockets, capacitors, resistors and wiring—in one miniature Centralab amplifier unit.

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

CUSTOMER comfort...greater output...dependable performance. That's what Johnston wanted for its new Goldentone. And that's what it got—with the help of Centralab's amazing P.E.C. Yes—*Ampec* made it possible to save space and material by reducing the number of components needed. It cut production time by eliminating many assembling operations. It improved performance by minimizing the chance of broken or loose connections and by resisting changes in temperature and humidity.

INTEGRAL CERAMIC CONSTRUCTION: Each *Printed Electronic Circuit* is an integral assembly of CRL *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.

This outstanding hearing aid development, illustrated above, was the result of close cooperation between Centralab and Johnston engineers. Working with your engineers, Centralab may be able to fit its *Printed Electronic Circuit* to your specific needs. Write for full information, or call your nearest Centralab Representative.

LOOK TO **Centralab** IN 1949!

Division of GLOBE-UNION INC., Milwaukee

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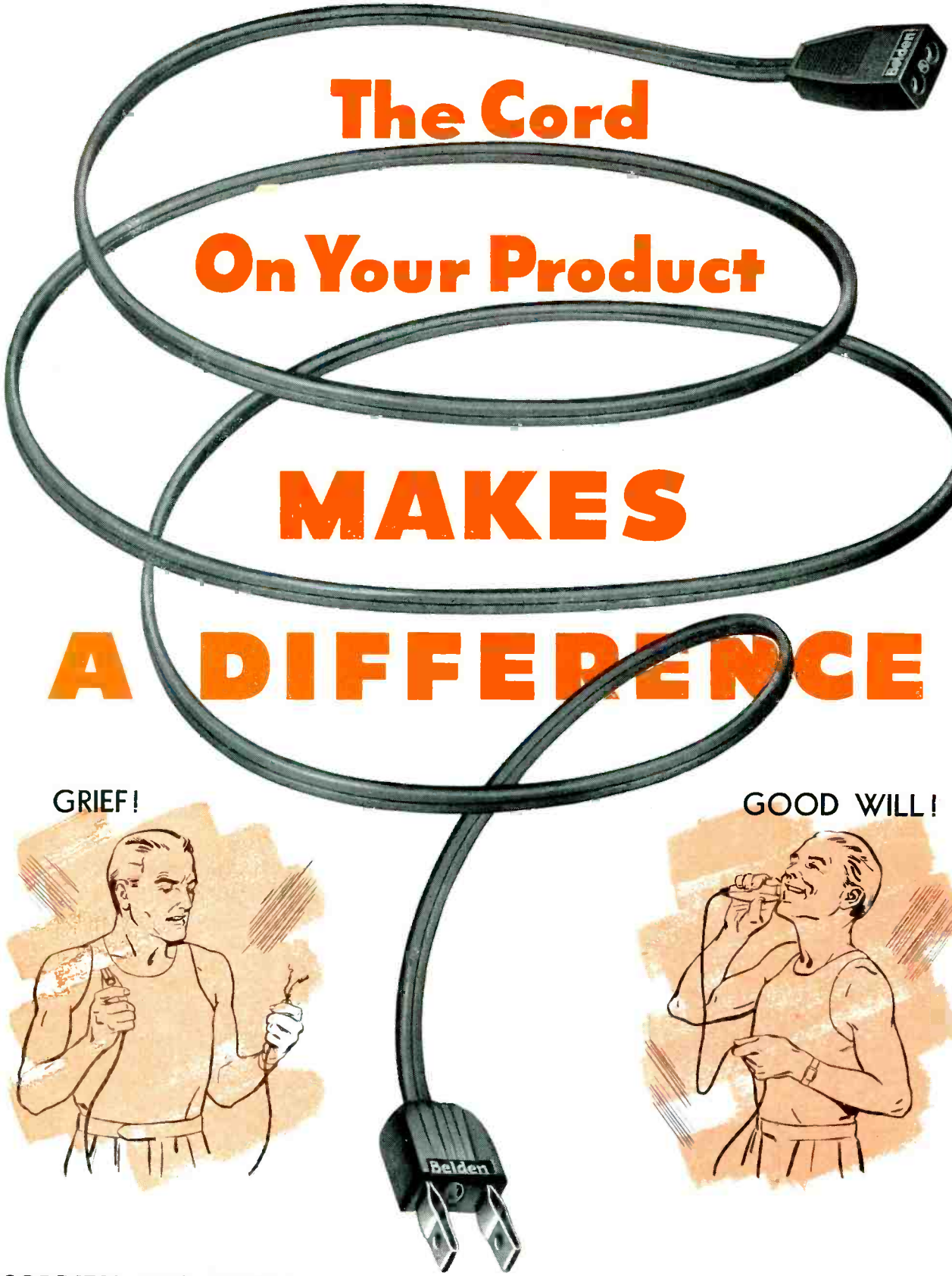
The Cord On Your Product MAKES A DIFFERENCE



GRIEF!

GOOD WILL!

CORDITIS-FREE CORDS

BY Belden WIREMAKER FOR INDUSTRY

© 1948, Belden Manufacturing Co., Chicago, Ill

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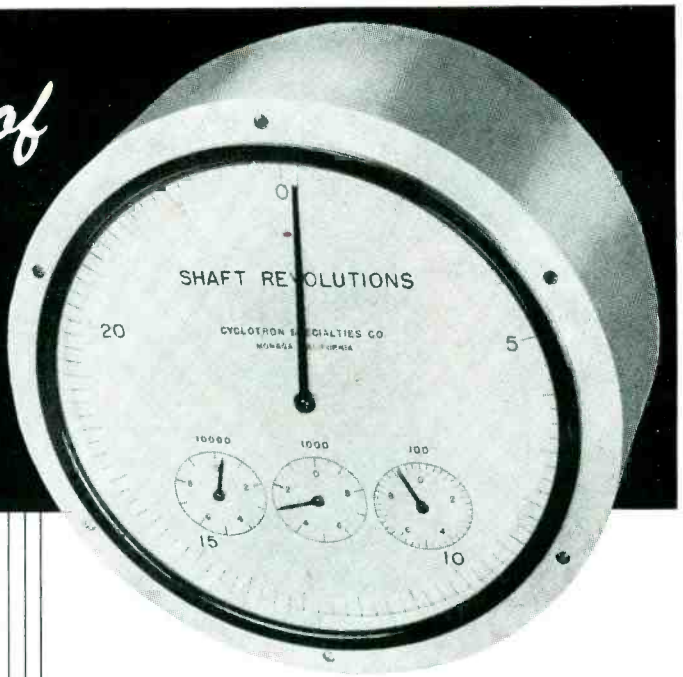
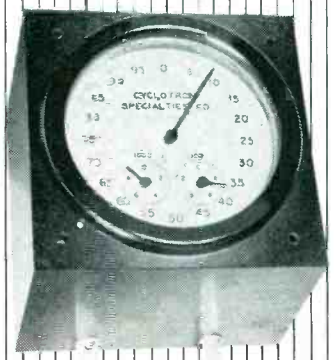
An Unusual Line of IMPULSE REGISTERS

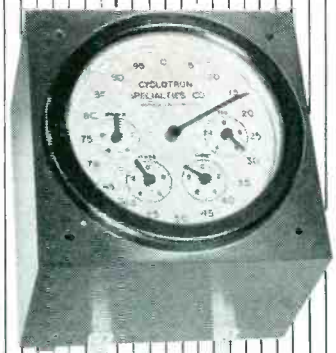


PRECISION REGISTER specially made for the United States Navy . . . used for precision propulsion measurements. Has 6-inch dial, and indicates up to 100 impulses per second.



FLUSH MOUNTED Type with single hole mounting and plastic case. Widely used for panel mounting.

TYPE 401-A with fully enclosed plastic desk case and non-removable-top binding posts. See the complete specifications below ➡



FLUSH MOUNTED Type with four auxiliary dials making possible direct readings to 999,999 impulses. Similar in construction to regular Flush Mounting.

Cyclotron Specialties Impulse Registers were originally designed to meet the exacting requirements of radio-activity research workers. Their outstanding performance has attained for them acceptance in nearly every scientific field and today, many special types are in use by scientific workers throughout the world.

Cyclotron Specialties Registers are unique in their ability to operate at exceptionally high speeds with complete accuracy and without adjustment or maintenance. They are unexcelled for high speed impulse recording and mechanical operations requiring counting in precise quantities.

SPECIFICATIONS OF IMPULSE REGISTER NO. 401-A

Accurately Registers Up to 60 Impulses Per Second

Main, easily-read sweep dial reads 0 to 100 directly
Sweep dial plus auxiliaries read 0 to 9,999 impulses without extra equipment
4000 ohm D.C. resistance
Operates on as low as 100 milliwatt
Small, compact, light weight
Durable, rugged construction to withstand unavoidable accidents
Dimensions: 3" x 4" Weight: 2 lbs.

In addition to the Cyclotron Specialties Registers illustrated, other types include higher speeds, electrical reset, add and subtract type and higher totalization. Inquiries for these special types will receive prompt attention.

Immediate Delivery of all Types in Reasonable Quantities

Cyclotron Specialties Company

MORAGA 6, CALIFORNIA

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A NEW SOLUTION TO OLD PROBLEMS

Aerocom's New Artificial Antenna,

Simulating Actual Operating Conditions,

Saves Time On Transmitter And Receiver Tuning

It is no longer necessary to final tune transmitters or receivers aboard aircraft. With the new Artificial Antenna (Model DA200) you can precisely simulate, electrically, any normal aircraft antenna. All this without leaving the test bench. This equipment will accept any transmitter power up to 200 watts -- coaxial fitting provides direct 52 ohm metered load. Sturdily constructed for hard usage, can be mounted in standard rack cabinet or used on bench top.

Keeping Your Radio Beacon Signal "On The Air" Is Simple With Aerocom's Automatic Transfer

The problem of transmitter failure in radio beacons is very serious. The safety of crew and passengers depends on the continuous operation of this navigational aid.

Aerocom's Automatic Transfer provides the means of placing your standby transmitter "On the Air" should the main transmitter fail for any reason except loss of powerline voltage. It can be set to function either on abnormally low carrier power or abnormally low level of keyed tone identification signals.

A letter or wire from you will bring descriptive literature

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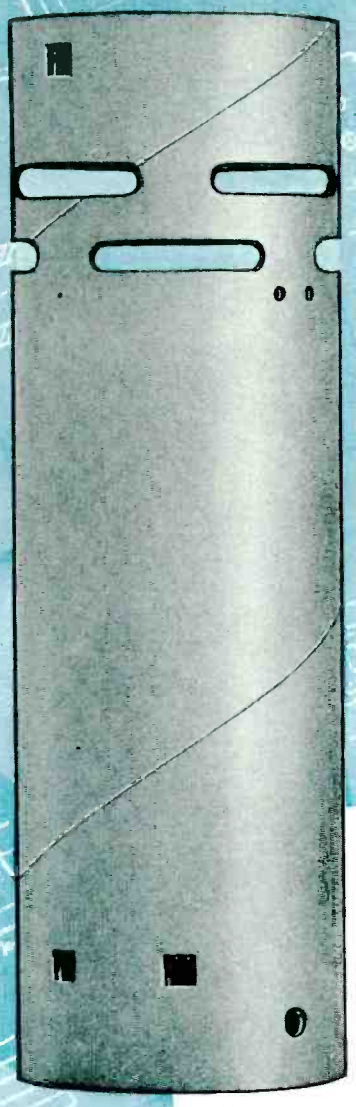

...punching dies available in endless *Variety* for COSMALITE* COIL FORMS

Manufacturers of radio and television receivers KNOW the outstanding advantages of COSMALITE in both performance and price.

There is a further saving in time and costs through the use of our extensive number of dies available to purchasers of Cosmalite Coil Forms.

*Reg. U. S. Pat. Off.

Your inquiry will receive personal and experienced attention.

See our Exhibit #220 at the I.R.E. Radio Engineering Show

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- All-Fibre Cans Combination Metal and Paper Cans
- Spirally Wound Tubes and Cores for all Purposes
- Plastic and Combination Paper and Plastic Items

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PRODUCTION PLANTS also at Plymouth Wisc., Ogdensburg, N.Y., Chicago, Ill., Detroit, Mich., Jamesburg, N.J.
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SALES OFFICES: Room 5632, Grand Central Term. Bldg., New York 7, N.Y., also 642 Main St., Hartford, Conn.
CANADIAN PLANT: The Cleveland Container Canada, Ltd., Prescott, Ontario

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Heat can't Mix up this Mixer--

The electric food mixer, now a permanent part of the modern kitchen, comes in for constant, hard use in the preparation of 1,095 meals in the home during one year's time. Frequently, the mixer is run for long periods of time, placing a heavy load on the small electric motor which powers the mixer unit. Insulation at vital points within the control unit must be able to withstand high heat and heavy current loads.

BH Extra Flexible Double Braided Fiberglas Sleeving is used to insulate the resistor lead wire in the motor and control unit of the Model 3-B *KitchenAid* Mixer made by the Hobart Manufacturing Company.

Here is what the makers of the *KitchenAid* food mixer say:

"High temperature and high voltage is the particular strain imposed on sleeving used to insulate the resistor lead wire in the motor and control unit. The heat resistance feature of BH Extra Flexible Double Braided Fiberglas Sleeving led us to choose this sleeving. Dielectric tests were made and BH Extra Flexible Double Braided Fiberglas Sleeving withstood 2000 volts. The results obtained have been quite satisfactory."

BH Extra Flexible Fiberglas Sleeving stays flexible as string because no hardening varnish or lacquer is used. Will not split or crack when bent. Resists abrasion and wear. Heat resistant to 1200°F. Write us today about your insulation problem.

BENTLEY, HARRIS MFG. CO., CONSHOHOCKEN, PA.

BH Fiberglas* SLEEVINGS

*BH Non-Fraying Fiberglas Sleevings are made by an exclusive Bentley, Harris process (U. S. Pat. No. 2393530). "Fiberglas" is Reg. TM of Owens-Corning Fiberglas Corp.

USE COUPON NOW

Bentley, Harris Mfg. Co., Dept. E-30, Conshohocken, Pa.

I am interested in BH Non-Fraying Fiberglas Sleeving for _____ (product)

operating at temperatures of ____°F. at ____ volts. Send samples so I can see for myself how BH Non-Fraying Fiberglas Sleeving stays flexible as string, will not crack or split when bent.

NAME _____ COMPANY _____

ADDRESS _____

Send samples, pamphlet and prices on other BH Products as follows:

- ☐ Cotton-base Sleeving and Tubing
- ☐ Ben-Har Special Treated Fiberglas Tubing

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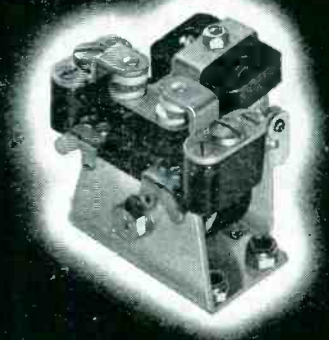
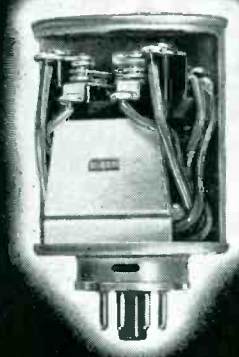
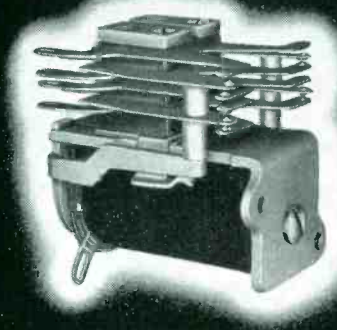
RELAYS OF ADAPTABILITY



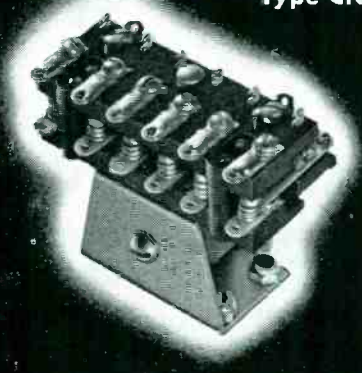
Type CN



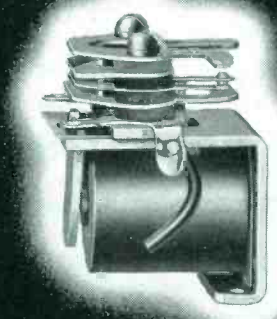
Type BOHO



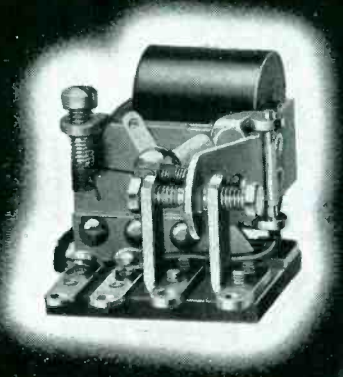
Type SK



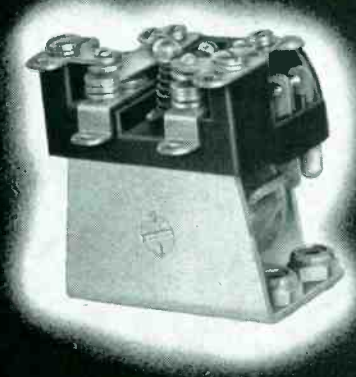
Type BN



Type F



Type BG



Type BO

Thousands of specifications are filled by the complete line of Allied Relays—seven of which are grouped around the Allied emblem of engineering leadership.

Allied Control engineers pioneered the design of relays from signal circuits to 75 ampere contacts, coils from 12 milliwatts to 3½ watts to give the smallest mounting area and accessible wiring facilities.

**Type "BOHO"* is D.P.D.T. relay sealed with standard octal plug. Contact rating of 5 to 10 amperes and coil capacity of 115 v. D.C. at 2.5 watts and 220 volts; 25 and 60 cycles at 4.5 volt-amperes.

**Type "CN"* is S.P.S.T. double break relay with 50 ampere contacts and coil capacity of 115 v. D.C. at 3.5 watts and 220 volts; 60 cycles at 10.5 volt-amperes.

**Type "BN"* is 6 P.D.T. relay with 15 ampere contacts and coil capacity of 115 v. D.C. at 3.5 watts (not available in A.C.).

**Type "BG"* is S.P.D.T. relay with 2 ampere contacts and coil capacity of 25 v. D.C. at 50 milliwatts (not available in A.C.)

**Type "BO"* is D.P.D.T. relay with 15 ampere contacts and coil capacity of 115 v. D.C. at 2.5 watts and 220 volts; 25 and 60 cycles at 4.5 volt-amperes.

**Type "F"* is S.P.D.T. with 2 ampere contacts and coil capacity of 85 v. D. C. at 1.5 watts (not available in A.C.).

**Type "SK"* from S.P.S.T. up to 4 P.D.T. with 1 ampere contacts and coil capacity of 60 v. D.C. at 750 milliwatts (for 4 P.D.T. relay) not available in A.C.

Allied Control representatives are located throughout the United States. A short note to our home office will give you the name of our nearest representative.

AL-119

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

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FAST TEMPO

at Templetone Radio

High speed and high accuracy producing coils for radios

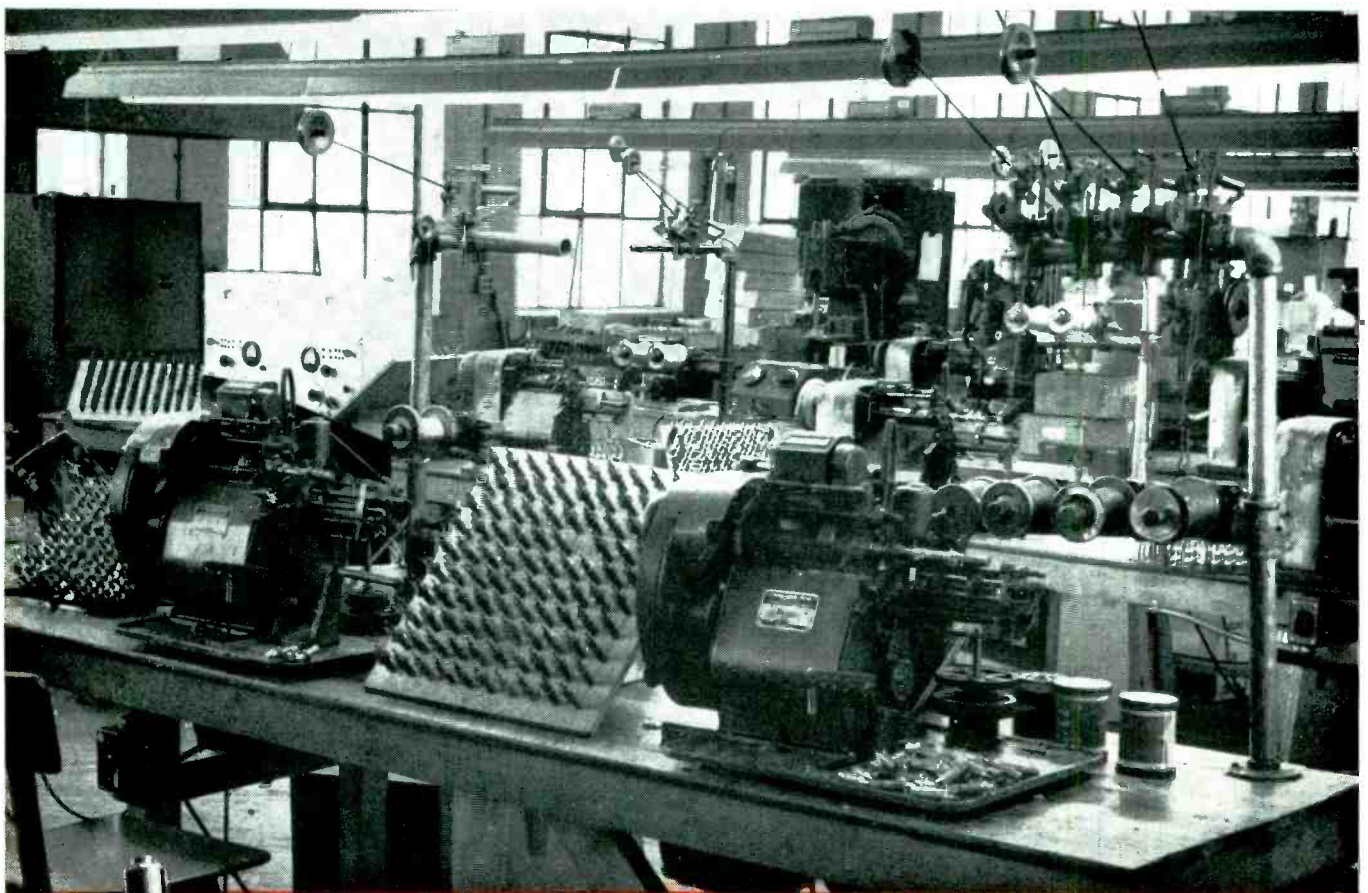
High-speed production of a great variety of lattice-type coils — with the accuracy that a fine radio receiver requires — is why No. 84 Universal Coil Winders were selected by Templetone Radio Mfg. Corp., New London.

Here, No. 84 machines wind antenna, primary antenna, I.F., R.F., self-tuning, blocking oscillator and other oscillating coils. Calibrated strap-type tensions facilitate handling of even the finest wires, and the "gainer" mechanism which accurately positions the wire turns is quickly adjusted.

The No. 84 Coil Winder is available to wind 1, 2, 3 or 4 coils at once, and one operator can handle two machines, depending on coil specifications. Speeds from 400 to 800 rpm. Counter-control provides instant automatic stop upon completion of coil.

Write for Bulletin 84-L.

UNIVERSAL WINDING COMPANY, P. O. Box 1605, Providence, R. I.



FOR WINDING COILS IN QUANTITY ACCURATELY . . . AUTOMATICALLY USE UNIVERSAL WINDING MACHINES

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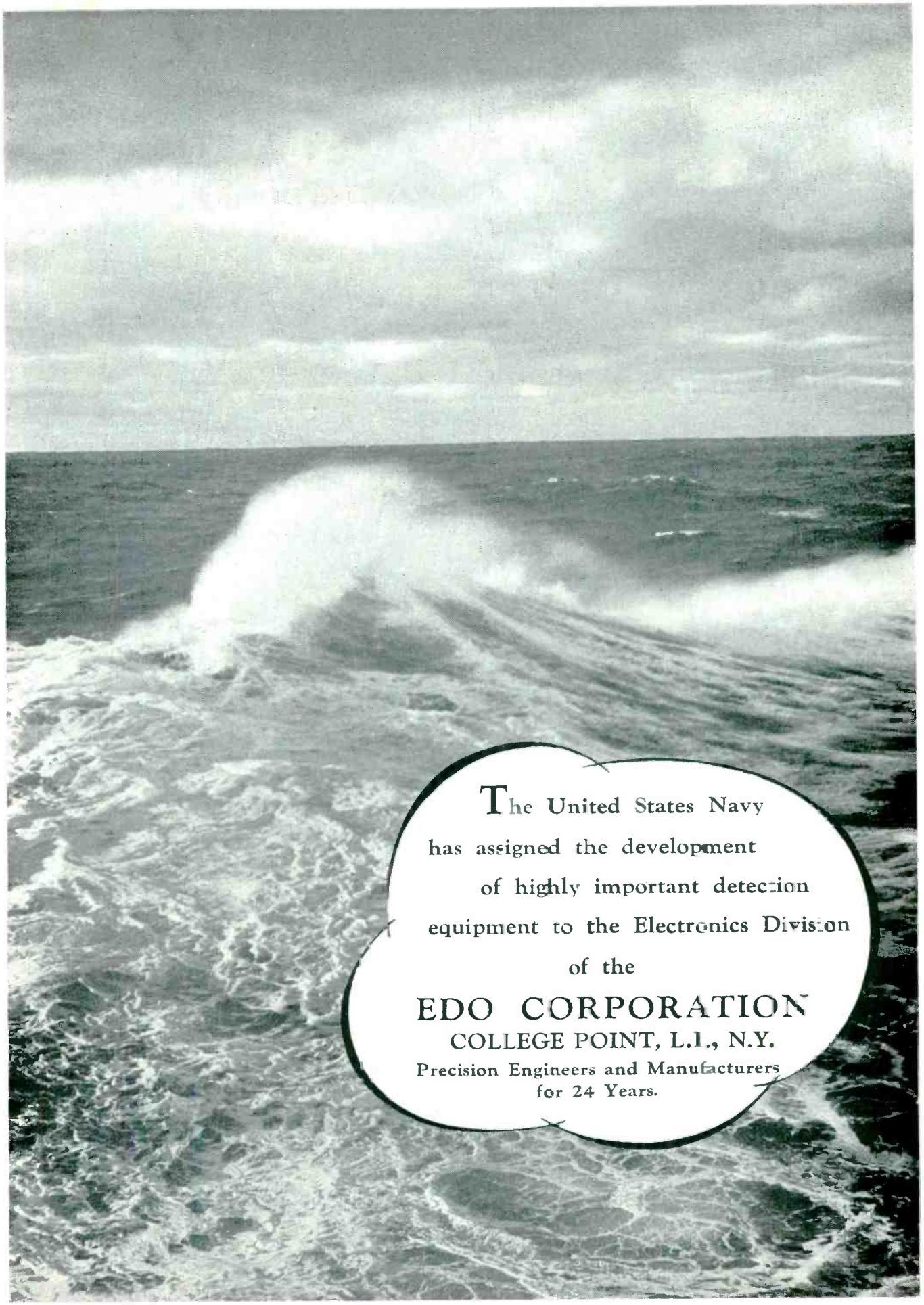

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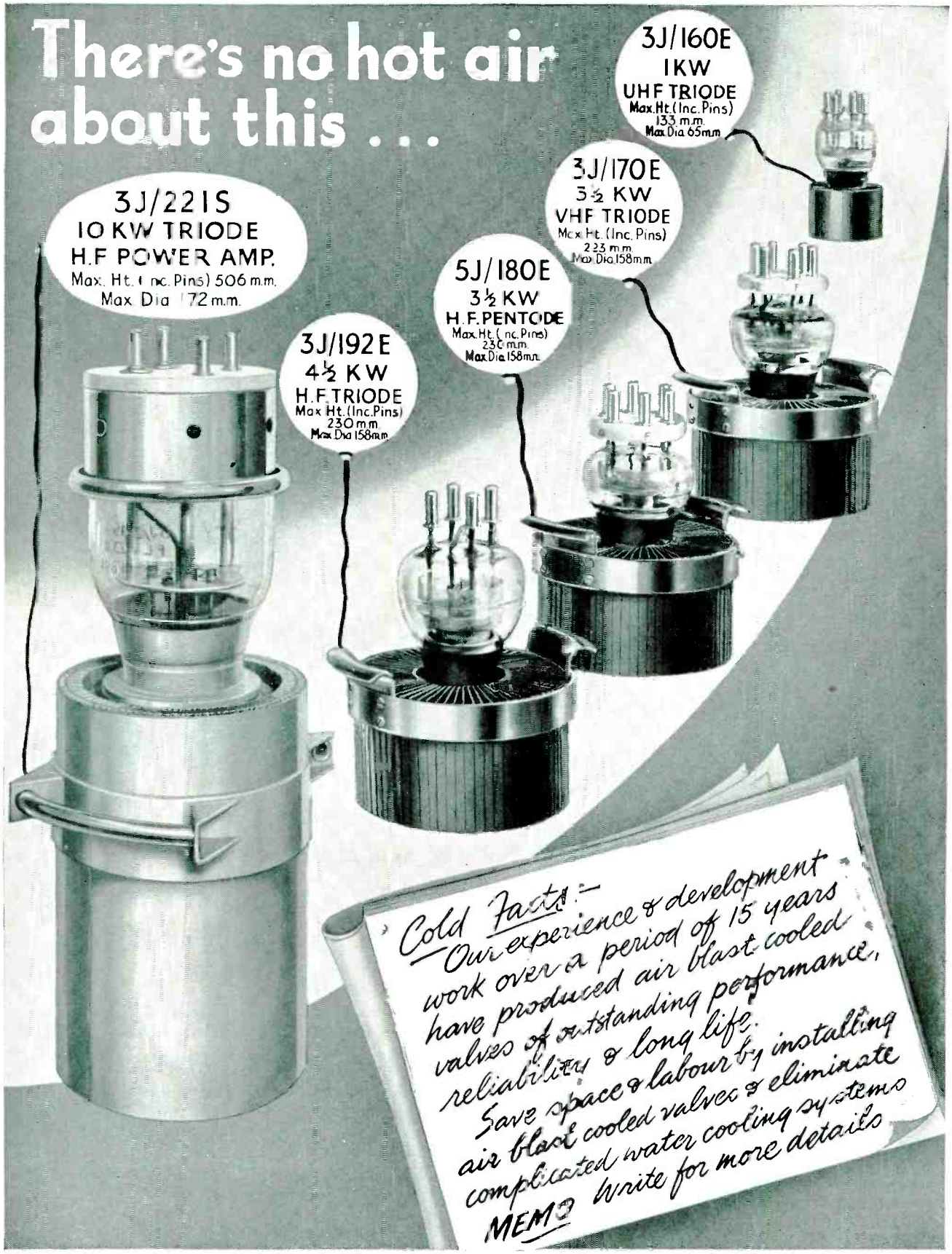
There's no hot air about this . . .



Standard Telephones and Cables Limited *Radio Division*

An I. T. & T. associate

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R.D.12

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for continuous use at

105° C

TEMFLEX 105 flexible plastic tubing

IDENTIFY IT BY THE NAME STRIP

High heat stops most plastic tubings, but not TEMFLEX 105 — TEMFLEX 105 defies heat . . . works continuously at extreme temperatures . . . as high as 105° C!

And TEMFLEX 105 retains the remarkable properties you have found in former Irvington plastic tubings—right up through those top temperatures.

TEMFLEX 105 passed Underwriters' Laboratories tests, yes — and more. In our own laboratories, we ran further gruelling tests—demanding unusual flexibility, high dielectric strength and strong oil resistance . . . after aging *longer*, at temperatures *higher*, than U.L. requirements.

Try TEMFLEX 105 for yourself where "hot spots" in your equipment have given you trouble. You will recognize it by the special name strip running the length of the tubing — this marking distinguishes TEMFLEX 105 from tubings limited to lower temperatures.

Generous samples and full data are yours for the asking. Send for them.

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Designers

NOW AVAILABLE FOR YOUR COMMERCIAL APPLICATIONS

CAPACITOR PULSE-FORMING NETWORKS

Developed by General Electric and proven by the thousands in the war, these compact units are now available for any commercial use. They find application in radar and industrial equipment where the normal capacitor discharge shape is not suitable and where an impulse having a definite energy content and duration is required. The network consists of one or more equal capacitor sections and the same number of inductance coil sections. Both capacitors and coils are hermetically sealed in the same metal container. Networks are treated with top quality mineral oil to provide stability of capacitance characteristics over a wide range of ambient temperatures. Sizes from which you can make your selection range from a 0.5-kw output rating to 4500-kw. Write for bulletin GEA-4996.

DESIGNED FOR BETTER READABILITY

General Electric's new line of 3 ½-inch thin panel instruments will save space and add to the appearance of your panels. They're dust-proof, moisture resistant, and vibrations normally encountered in aircraft and moving vehicles have no adverse effects. Especially designed for better readability, the scale divisions stand out by themselves. Lance-type pointers and new-style numbers mean faster reading. Available in square and round shapes, depth behind the panel is only 0.99 inches. Construction is of the internal-pivot type, with alnico magnets for high torque, good damping, and quick response. Check bulletin GEA-5102.

GENERAL ELECTRIC

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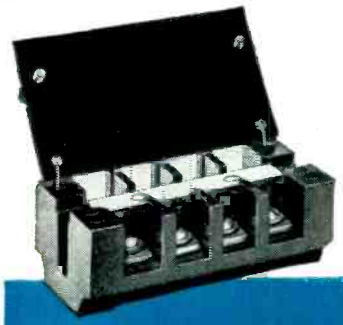
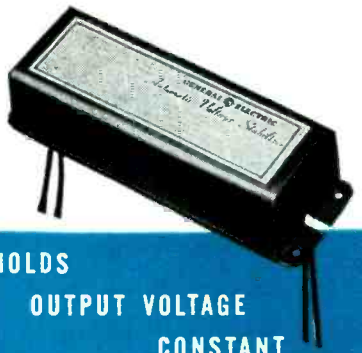
Digest

TIMELY HIGHLIGHTS ON G-E COMPONENTS



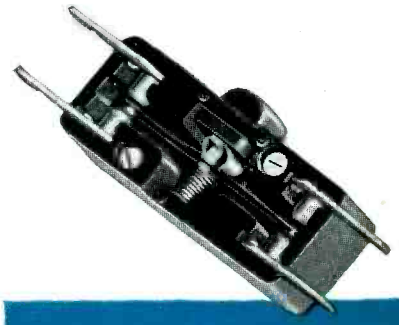
SIMPLIFY CONTROL WIRING WITH THESE TERMINAL BOARDS

Easy-action hinged covers protect control wiring, help give your product a neat appearance. Hook-ups are easy with the hard-gripping connectors. Simply strip the wire end, screw down the connector on the bare wire. Blocks are durable, too, constructed of strong Textolite with reinforced barriers between poles to insure against breakage. Marking strips are reversible—white on one side, black on the other. These terminal boards are available with 4 to 12 poles, 2 inches wide, 1¼ inches high. Send for bulletin GEA-1497C.



HOLDS OUTPUT VOLTAGE CONSTANT

This latest addition to G.E.'s line of automatic voltage stabilizers comes in 15-, 25-, and 50-va ratings. Output is 115 volts, 60 cycles. The small size of the unit makes it particularly applicable to shallow-depth installations in many types of equipment. You may have a job for this unit which will give you automatically stabilized output voltage at a low cost. There are no moving parts, no adjustments to make; long service is assured. Check bulletin GEA-3634B for more information about this and other G-E voltage stabilizers.



LOOKING FOR LIGHTWEIGHT SWITCHES?

Switchettes* are designed for applications which require a manually operated electric switch in a limited space. Though small, these switchettes are lightning fast in action and are built to withstand severe service. A wide variety of forms and terminal arrangements makes them particularly useful where special circuit arrangements are necessary. Switchette shown above has one normally open and one normally closed circuit, transferable when button is depressed. Check bulletin GEA-4888.

*Switchette is General Electric's trade name for these small snap switches.

FOR YOUR COOLING FANS

Here's a fractional-horsepower fan motor suitable for many uses because of its compact design, low servicing requirements, and extreme quietness. Long, dependable operation is assured by sturdy, totally enclosed construction. These Type KSP unit-bearing motors are of shaded pole type design with low starting torque characteristics especially applicable to fans. A continuous oil circulation system furnishes good lubrication. You can use simple, hubless, low-cost blades with the special mounting arrangement. Write for bulletin GEC-219.

General Electric Company, Section H642-19
Apparatus Department, Schenectady, N. Y.

Please send me the following bulletins:

- ☐ GEA-4996 Capacitor Pulse-forming Networks
- ☐ GEA-5102 Panel Instruments
- ☐ GEA-1497C Terminal Boards
- ☐ GEA-3634B Automatic Voltage Stabilizers
- ☐ GEA-4888 Switchettes
- ☐ GEC-219 Unit-bearing Fan Motor

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- ✓ High Insulation Resistance
- Easy Stripping
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- ✓ 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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Proven BEST by exhaustive tests! Leading producers of television, F-M, quality radio and all exacting electronic applications specify our Underwriter Approved "NOFLAME-COR" as a MUST. Immediate delivery. All sizes, solid and stranded. Over 200 color combinations.

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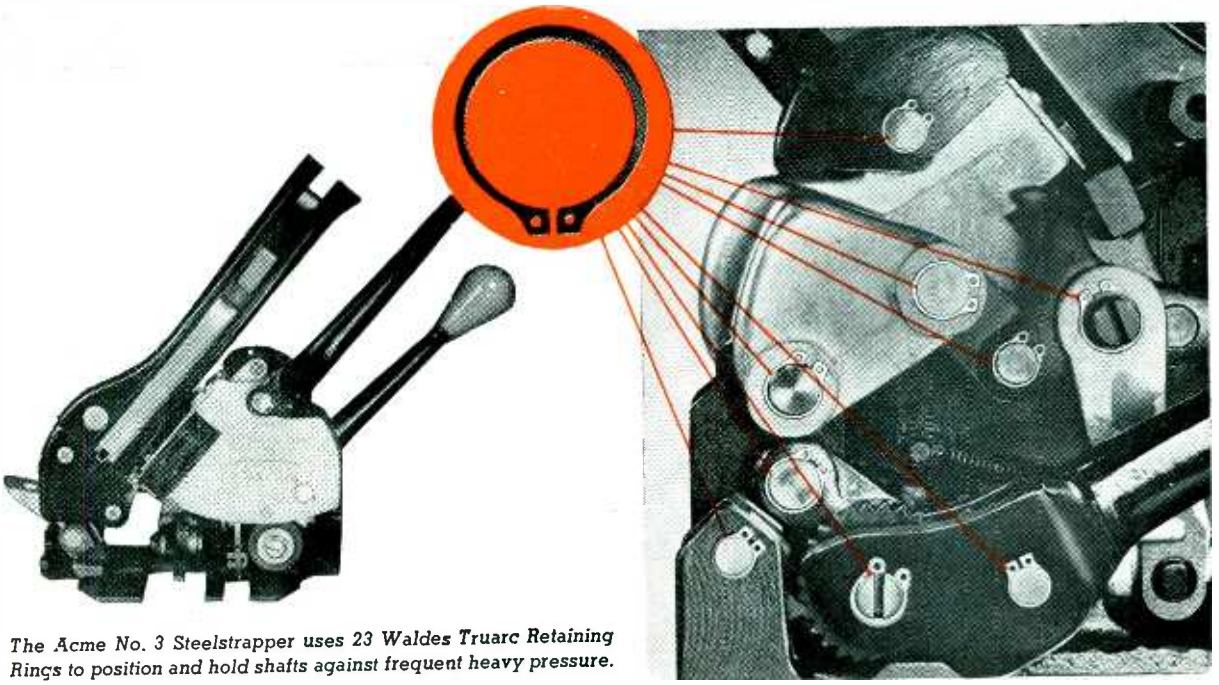
23 Truarc rings permit changeover to centerless grinding savings



The Acme No. 3 Steelstrapper uses 23 Waldes Truarc Retaining Rings to position and hold shafts against frequent heavy pressure.

"The use of Truarc Retaining Rings permits centerless grinding of pins instead of plunge-grinding. This eliminates the problem of taper and reduces the required tensional tolerances of these parts," reports Acme Steel Company of Chicago. "Furthermore, use of Truarc rings gives the Steelstrapper smoother lines by eliminating unsightly projections. This results in a more streamlined housing, a definite sales advantage."

Making repairs is much easier too, because Truarc simplifies assembly and disassembly. Truarc rings are precision engineered, may be used over and over again, remain always circular to give a never-failing grip. Wherever you use machined shoulders, nuts, bolts, snap rings, cotter pins—there's a Truarc ring that does a better job of holding parts together. Truarc cuts costs, adds sales advantages. Waldes Truarc engineers will be glad to show how Truarc can help you. Send us your problem.

WALDES

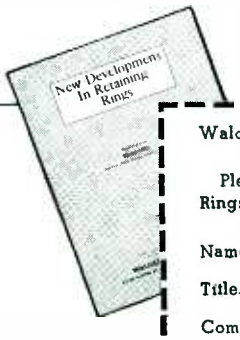
TRUARC

REG. U. S. PAT. OFF.

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.



● *Send for new Truarc booklet, "New Development In Retaining Rings"*

Waldes Kohinoor, Inc., 47-10 Austel Place E-2
Long Island City 1, N. Y.

Please send booklet, "New Development In Retaining Rings" to:

Name_____

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Company_____

Business Address_____

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Memo To ELECTRICAL MANUFACTURERS

INSUROK

is proving to be the RIGHT plastic material for a growing list of electrical manufacturers. Three grades of Laminated INSUROK you'll want to consider, for sheet stock or parts fabricated in our factory are

GRADES T-800 • T-640 • T-725

PROPERTIES OF T-800

Thickness	1/16"	1/8"	5/64"	5/64" Sanded
Volatile	0.30%	0.20%	0.31%	0.33%
Moisture Abs.	0.30%	0.18%	0.28%	0.28%
Expansion				
Center	.0001"	.0004"	.0001"	.0000"
Edge	.0000"	.0002"	.0001"	.0001"
Tests at Room Conditions				
Tensile				
Lengthwise		8,500		
Crosswise		7,300		
Modulus				
Lengthwise		1,195,000		
Crosswise		1,081,000		
Flexural				
Lengthwise		13,750		
Crosswise		12,300		
Compressive		35,000		
Specific Gravity	1.30	1.30		
Arc Test				
Maximum			26 sec.	22 sec.
Minimum			10 sec.	12 sec.
Dielectric Strength				
Short Time	658	540		
Step by Step	554	433		
Power Factor	.0197	.0199	.0206	.0190
Dielectric Constant	3.90	4.14	3.99	3.91
Loss Factor	.0767	.0823	.0821	.0742
Tests after 96 hrs. at 90% Relative Humidity 104° F.				
Power Factor	.0210	.0218	.0218	.0213
Dielectric Constant	3.99	4.31	4.11	3.98
Loss Factor	.0838	.0900	.0896	.0849
Insulation Resistance	167,000	166,000	225,000	330,000

COMPARISON OF INSUROK T-640 AND INSUROK T-725

Grade	T-640	T-640 Sanded	T-725	T-725 Sanded
Thickness	0.075"	0.078"	0.076"	0.077"
Volatile	0.45%	0.44%	0.31%	0.31%
Moisture Abs.	0.60%	0.67%	0.35%	0.40%
Expansion				
Center	0.0002"	0.0002"	0.0002"	0.0002"
Edge	0.0005"	0.0002"	0.0002"	0.0003"
Cold Flow				
122° F.	0.18%		0.21%	
212° F.	1.23%		2.25%	
Tests at Room Conditions				
Tensile				
Lengthwise	18,900	18,850	18,875	20,000
Crosswise	14,825	14,400	14,900	13,450
Modulus				
Lengthwise	1,385,000	1,340,000	1,395,000	1,550,000
Crosswise	1,125,000	1,250,000	1,265,000	1,145,000
Flexural				
Lengthwise	22,825	22,825	22,225	24,250
Crosswise	18,450	17,950	19,350	17,125
Dielectric Strength				
Short Time	680	664	715	692
Step by Step	604	598	653	641
Arc Test				
Maximum	78 sec.	138 sec.	86 sec.	135 sec.
Minimum	14 sec.	92 sec.	16 sec.	128 sec.
Power factor	0.0323	0.0307	0.0273	0.0278
Dielectric Constant	4.78	4.78	4.32	4.42
Loss Factor	0.154	0.147	0.118	0.123
Tests after 96 hrs. at 90% Relative Humidity 104° F.				
Power Factor	0.0394	0.0362	0.0301	0.0290
Dielectric Constant	5.08	4.88	4.49	4.66
Loss Factor	0.199	0.177	0.135	0.135
Insulation Resistance	17,500	25,500	117,800	95,400

Insulation resistance tested according to A.S.T.M. method D 257-46 using tapered pins.

The RICHARDSON COMPANY

GENERAL OFFICES: LOCKLAND, OHIO FOUNDED IN 1858

Sales Headquarters: MELROSE PARK, ILLINOIS

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ONE OF THESE 5 WILL BEST FILL YOUR V.O.M. REQUIREMENTS

MODEL 630. Outstanding Features: (1) The new Triplett Molded Selector Switch with contacts fully enclosed . . . (2) Has Unit Construction with Resistor Shunts, Rectifier Batteries in molded base . . . (3) Provides direct connections without cabling . . . no chance for shorts . . . (4) Big easily read 5½" Red • Dot Lifetime Guaranteed Meter.

TECH DATA

D.C. VOLTS: 0-3-12-60-300-1200-6000, at 20,000 Ohms/Volt
A.C. VOLTS: 0-3-12-60-300-1200-6000, at 5,000 Ohms/Volt
D.C. MICROAMPERES: 0-60, at 250 Millivolts
D.C. MILLIAMPERES: 0-12-120, at 250 Millivolts
D.C. AMPERES: 0-12, at 250 Millivolts
OHMS: 0-1000-10,000; 4.4 Ohms at center scale on 1000 scale; 44 Ohms center scale on 10,000 range.
MEGOHMS: 0-1-100 (4400-440,000 at center scale).
DECIBELS: −30 to −4, −16, −30, −44, −56, −70.
OUTPUT: Condenser in series with A.C. Volt ranges.

MODEL 630. . . . . . U.S.A. Dealer net price **$37.50**
Leather Carrying Case, $5.75. . . Adapter Probe for TV and High Voltage Extra.

MODEL 666-HH. This is a pocket-size tester that is a marvel of compactness and provides a complete miniature laboratory for D.C. and A.C. voltages, Direct Current and Resistance analyses. Equally at home in the laboratory, on the work bench or in the field . . . its versatility has labeled it the tester with a thousand uses . . . housed in molded case . . .

TECH DATA

D.C. VOLTS: 0-10-50-250-1000-5000, at 1,000 Ohms/Volt
A.C. VOLTS: 0-10-50-250-1000-5000, at 1,000 Ohms/Volt
D.C. MILLIAMPERES: 0-10-100-500, at 250 Millivolts
OHMS: 0-2,000-400,000, (12-2400 at center scale)

MODEL 666-HH. . . . U.S.A. Dealer Net Price **$22.00**
Leather Carrying Case, $4.75.

MODEL 625-NA. This is the widest range laboratory-type instrument with long 5.6" mirrored scale to reduce parallax. Special film resistors provide greater stability on all ranges. Completely insulated molded case. Built by Triplett over a long period of time, it has thoroughly proved itself in laboratories all over the world.

TECH DATA

SIX D.C. VOLTS: 0-1.25-5-25-125-500-2500, at 20,000 Ohms/Volt
SIX D.C. VOLTS: 0-2.5-10-50-250-1000-5000, at 10,000 Ohms/Volt
SIX A.C. VOLTS: 0-2.5-10-50-250-1000-5000, at 10,000 Ohms/Volt
D.C. MICROAMPERES: 0-50, at 250 Millivolts
D.C. MILLIAMPERES: 0-1-10-100-1000, at 250 Millivolts
D.C. AMPERES: 0-10: at 250 Millivolts
OHMS: 0-2000-200,000, (12-1200 at center scale)
MEGOHMS: 0-40, (240,000 at center scale)
SIX DECIBELS RANGES: −30 +3.0, +15, +29, +43, +55, +69. (Reference level "0" DB at 1.73 V. on 500-Ohm line.)
Six Output on A.C. Volts ranges.

MODEL 625-NA. . . . . U.S.A. Dealer Net Price **$45.00**
Carrying Case, $5.50. Accessories available on special order for extending ranges.

MODEL 2405-A. This instrument combines ultra sensitivity with a large 5¾" scale meter and is housed in a rugged metal case. . . It is furnished with hinged cover so that it can be used for service bench work or for portable field service. Gives A.C. Amperes readings to 10 Amps.

TECH DATA

D.C. VOLTS: 0-10-50-250-500-1000, at 20,000 Ohms/Volt
D.C. AMPERES: 0-10, at 250 Millivolts
D.C. MILLIAMPERES: 0-1-10-50-250, at 250 Millivolts
D.C. MICROAMPERES: 0-50, at 250 Millivolts
A.C. VOLTS: 0-10-50-250-500-1000 at 1000 Ohms/Volt
A.C. AMPERES: 0-0.5-1-5-10, at 1 Volt-Ampere
OHM-MEGOHMS: 0-4000-40,000 ohms—0-4-40 megohms (self-contained batteries)
OUTPUT: Condenser in series with A.C. Volts ranges
DECIBELS: −10 to +15, +29, +43, +49, +55. (Reference level "0" DB at 1.73 V. on 500-ohm line.)
CONDENSER TEST: Capacity check of paper condensers is possible by following data in instruction book.

MODEL 2405-A. . . . . U.S.A. Dealer Net Price **$59.75**

MODEL 2451. Electronic Volt-Ohm-Mil-Ammeter . . . is easy to use in complicated testing . . . A must in F.M. and TV work in any sensitive circuit where low current drain is a factor . . .

TECH DATA

D.C.-A.C.-A.F. VOLTS: 0-2.5-10-50-250-500-1000
R.F. VOLTS: 0-2.5-10-50
D.C. MILLIAMPERES: 0-2.5-10-50-250-500-1000
OHMS: 0-1K-10K-100K
MEGOHMS: 0-1-10-100
INPUT IMPEDANCE: 11 Megohms on D.C. Volts.
4.8 Megohms on A.C.-R.F. Volts

MODEL 2451. . . . . . U.S.A. Dealer Net Price **$76.50**
External high-voltage probe available on special order. See the Triplett V.O.M. line at your local Radio Parts Distributor or write

Precision first...to Last

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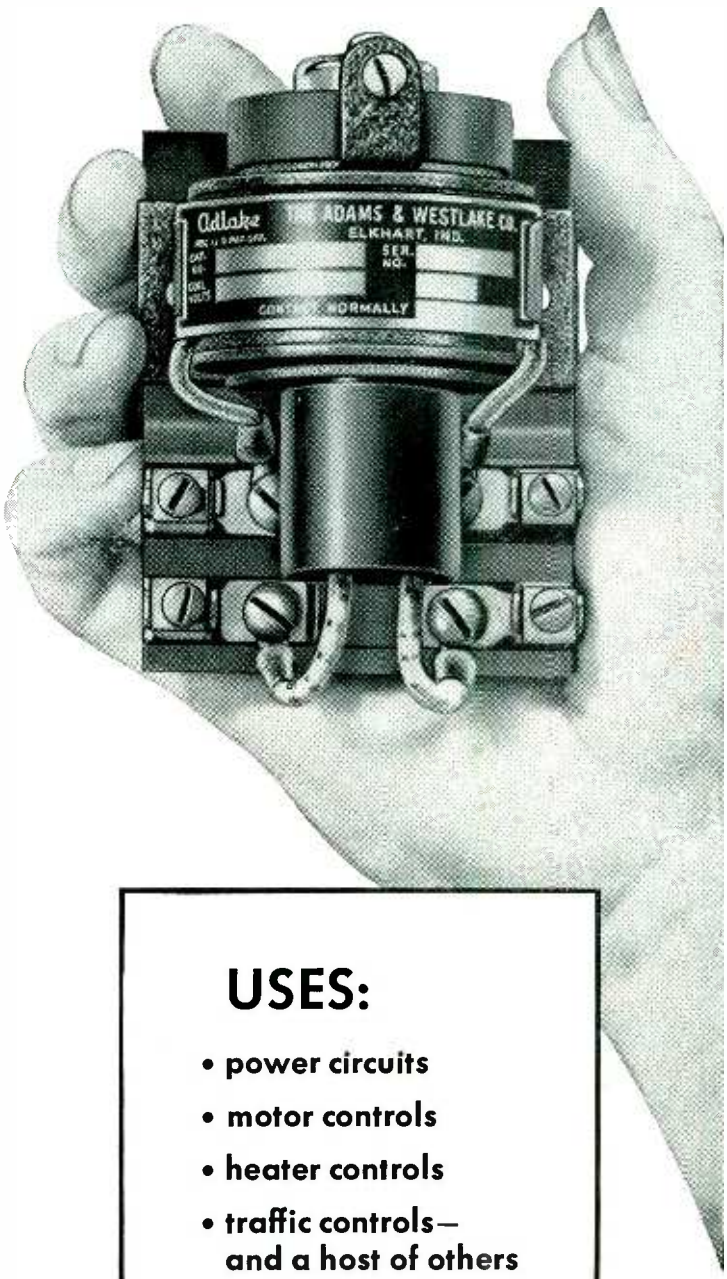
MIGHTY Midget!

Despite small size, handles **30** amps.!

It's the **new** ADLAKE No. 1110 **RELAY**



Thirty amps. is a big load, but the new Adlake No. 1110 Relay is rugged enough to handle it. It is small enough to fit in one hand, yet it makes and breaks 30 amps. easily, and with low operating current.

Like all Adlake Relays, No. 1110 is hermetically sealed against dust, dirt, moisture and oxidation; mercury-to-mercury contact prevents burning, pitting and sticking; it's silent and chatterless, absolutely safe and requires no maintenance. And it's cushioned against impact and vibration.

Both contact and coil leads are fastened to the terminal posts. Block is equipped with compression type terminals to simplify installation.

Write today for free, illustrated Adlake Relay folder, giving full details on No. 1107 and other new Adlake Relays. Address: The Adams & Westlake Company, 1107 N. Michigan, Elkhart, Indiana.

USES:

- power circuits
- motor controls
- heater controls
- traffic controls— and a host of others

Adlake TRADE MARK

THE Adams & Westlake COMPANY

Established 1857 • ELKHART, INDIANA • New York • Chicago

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

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The 5655 has three sections: (1) Image, (2) Scanning, (3) Multiplier. The image section contains a semi-transparent photocathode on the inside of the face plate, and on this the scene televised is focused by an optical lens system. This causes the photocathode to emit a stream of electrons from each illuminated area (proportional to the light striking the area), and these are focused on one side of the "target" where they produce a charge pattern. The opposite side of the target is scanned by a low-velocity electron beam from an electron gun in the scanning section. Electrons from the gun are turned back at the target forming a return beam which has been amplitude modulated by deposition of the electrons at the target, in accord with the charge pattern whose more positive areas correspond to highlights of the televised scene. In the multiplier section, the return beam is directed to a 5-stage amplifier (using secondary emission to amplify electron beam signals), and here the modulated beam is amplified at least 300 times—to drive the first stage of the video amplifier.

THE TUBE THAT

HAS DONE MOST FOR TELEVISION HAS 95%

NICHROME* V

METAL PARTS

This is the RCA Image Orthicon 5655—super-sensitive eye of the television camera. Developed primarily for studio use and applications employing artificial illumination, it is several times more sensitive to light at low levels than the fastest motion picture film.

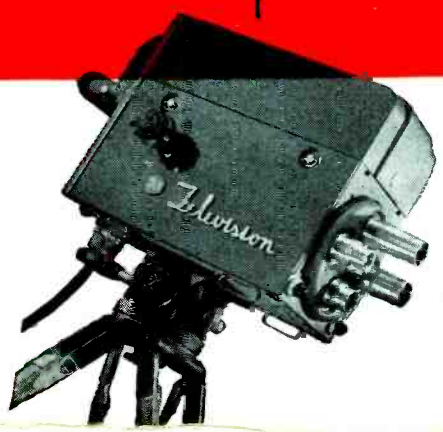
Only 15¼" long, it has over 150 precision-made parts, many assembled under microscopes.

These parts must remain unmagnetized by the strong magnetic fields of the focusing and deflection coils that surround the tube. Magnetized, they would produce fields of their own, and prevent proper operation.

When the parts are assembled, the glass housing of the tube is sealed. Temperature of the glass during sealing operations is raised to over 1600°F., temperature of the parts to as much as 900° F.

Under these conditions of manufacture, the alloy used must not only be entirely non-magnetic but possess high resistance to heat and oxidation. The only alloy that most satisfactorily meets these specifications is Nichrome V. *That is why 95% of the metal parts in the RCA Image Orthicon 5655 are made of Nichrome V.*

Driver-Harris manufactures over 85 alloys for the Electronic and Electrical fields. These are distinguished for giving exceptionally efficient, long and economical service—most particularly where requirements are unusually tough. So send us your specifications. As with the Image Orthicon, it is most probable a D-H alloy will best solve your manufacturing problems.



*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

SPECIAL PURPOSE ALLOYS SINCE 1879 D H TRADE MARK REG. U. S. PAT. OFF.

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

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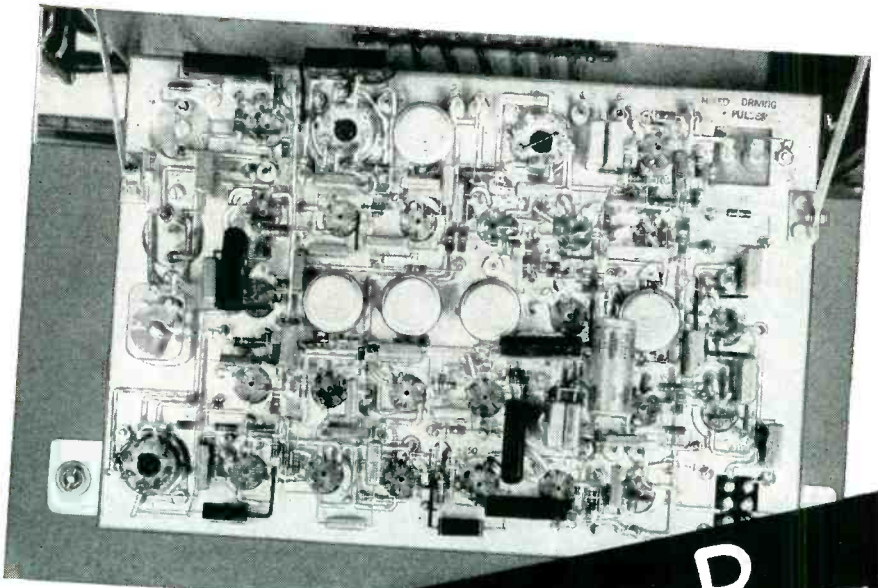
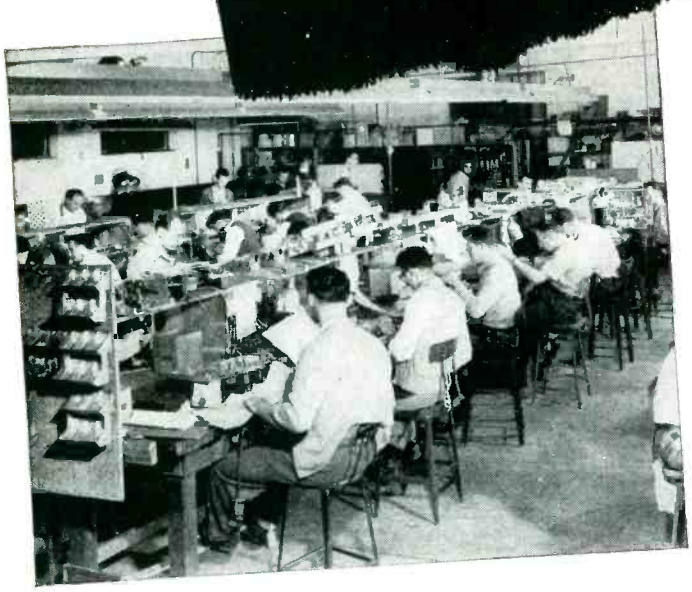


TIMING UNIT
PORTABLE SYNC GENERATOR
Type 5030-A

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



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SUPERIOR DESIGN plus QUALITY WORKMANSHIP equals DU MONT

First with the Finest in Television

You don't have to be an expert in higher mathematics to recognize the thorough dependability, accessibility and performance stability of all Du Mont Television Broadcast Equipment. It's there—you can see it in every component, bend of the wire, and soldered joint.

That is the reason why Television Broadcasters, guided by the experience of others, compare design *plus* workmanship, and then *buy* Du Mont, the "First With the Finest in Television."

Which simply adds up to this: Before you purchase your telecasting equipment, follow the lead of others—visit Du Mont—examine Du Mont—compare performance—and draw your own conclusions.

START AS SMALL AS YOU WISH, WITH THE DU MONT *Acorn Package*

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DUMONT *First with the Finest in Television*

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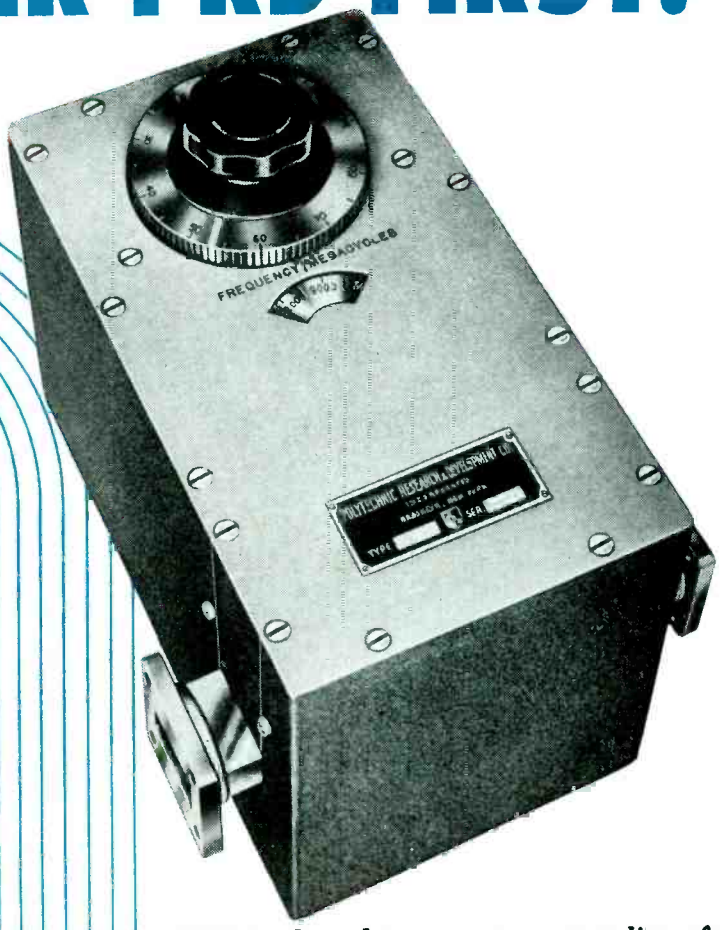
ANOTHER PRD FIRST!



PRD

PRECISION FREQUENCY METERS

Features:

- DIRECT READING DIAL
- HIGH Q, TE_{011} MODE CAVITY
- LINEAR DRIVE
- TEMPERATURE COMPENSATION
- HERMETIC SEALING
- REACTION OR TRANSMISSION COUPLING

PRD is pleased to announce a new line of precision cavity type frequency meters for the microwave spectrum. Units now available cover in standard waveguide sizes the important region from 5650 to 10,000 megacycles per second, and offer for the first time such features as linear dials which read directly in frequency, hermetic sealing to eliminate humidity effects, and the use of low temperature coefficient alloys to provide maximum accuracy over a wide range of temperature.

All units are calibrated by means of crystal controlled frequency standards. The use of precision miniature ball bearings and special temperature-stable greases assures retention of inherently high accuracy characteristics over long periods. Write to Dept. E-8 for an illustrated catalog of the complete PRD line of microwave test equipment.

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PRD *Polytechnic* RESEARCH & DEVELOPMENT COMPANY, Inc.

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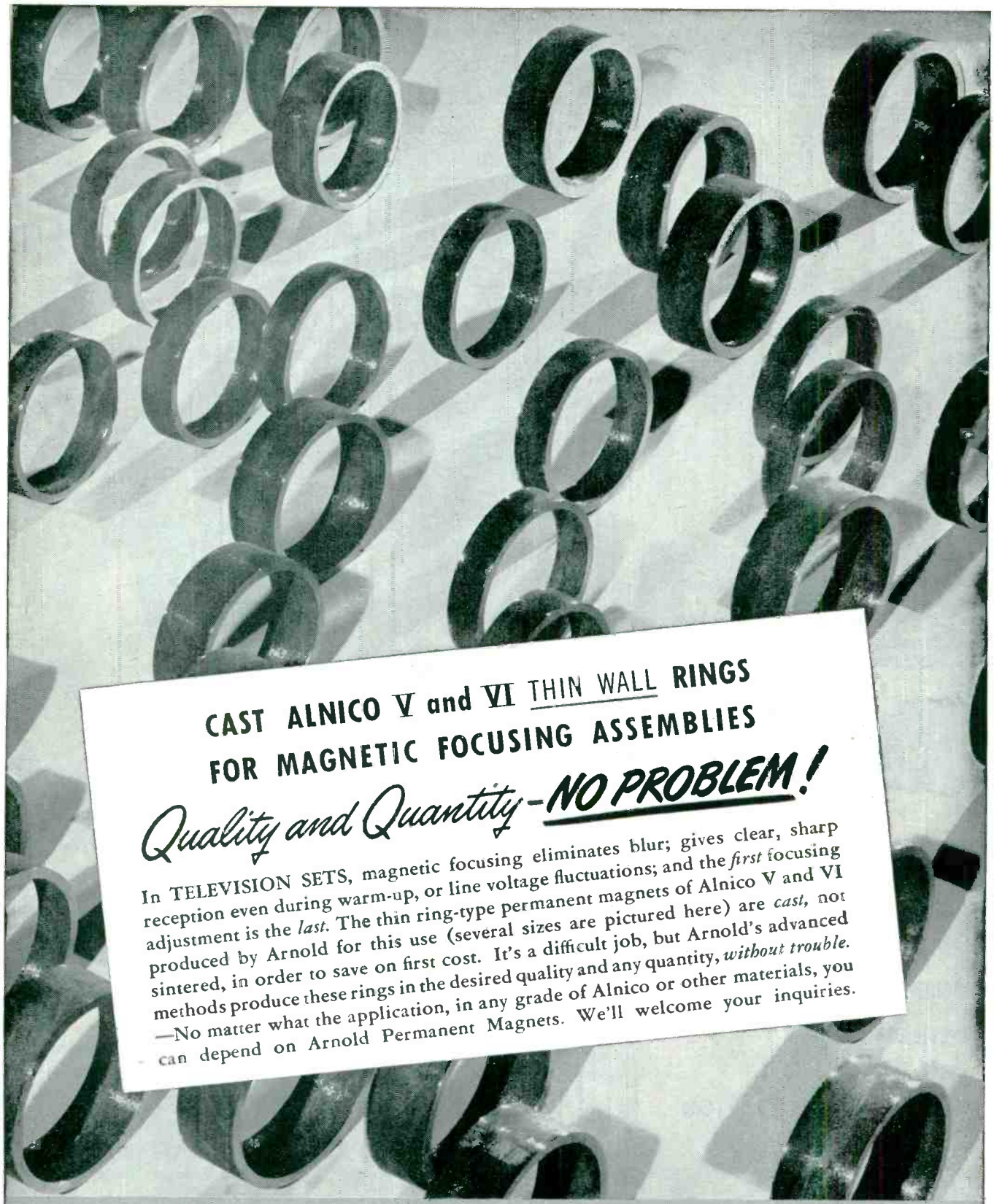

CAST ALNICO V and VI THIN WALL RINGS FOR MAGNETIC FOCUSING ASSEMBLIES

Quality and Quantity – **NO PROBLEM!**

In TELEVISION SETS, magnetic focusing eliminates blur; gives clear, sharp reception even during warm-up, or line voltage fluctuations; and the *first* focusing adjustment is the *last*. The thin ring-type permanent magnets of Alnico V and VI produced by Arnold for this use (several sizes are pictured here) are *cast*, not sintered, in order to save on first cost. It's a difficult job, but Arnold's advanced methods produce these rings in the desired quality and any quantity, *without trouble*. —No matter what the application, in any grade of Alnico or other materials, you can depend on Arnold Permanent Magnets. We'll welcome your inquiries.

THE ARNOLD ENGINEERING COMPANY

Subsidiary of

ALLEGHENY LUDLUM STEEL CORPORATION

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Specialists and Leaders in the Design, Engineering and Manufacture of PERMANENT MAGNETS

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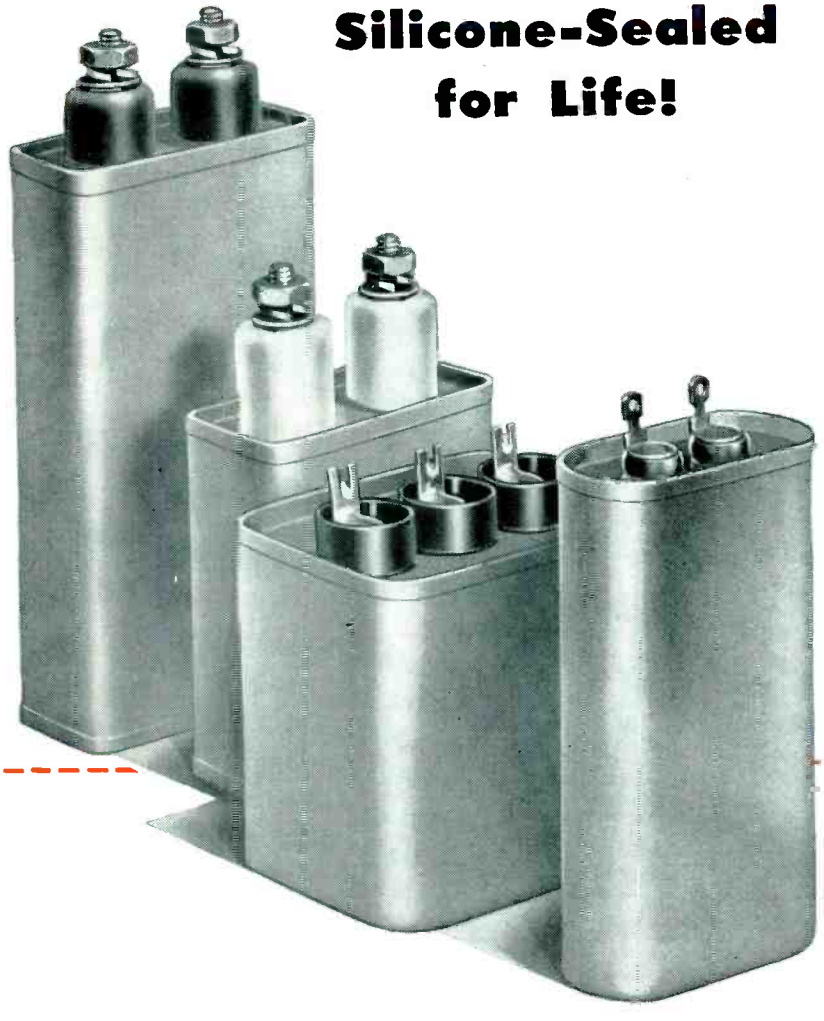
Now . . . G-E CAPACITORS are Silicone-Sealed for Life!



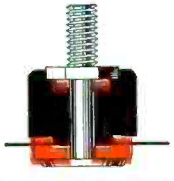
Silicone—the amazing new synthetic—made headlines when General Electric brought it out during the war. It's news again today—for G.E. has now made Silicone bushings and gaskets a *standard feature* of all its specialty capacitors up through 5000 volts.

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.

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Specialty Capacitors FOR

- Motors
- Luminous-tube transformers
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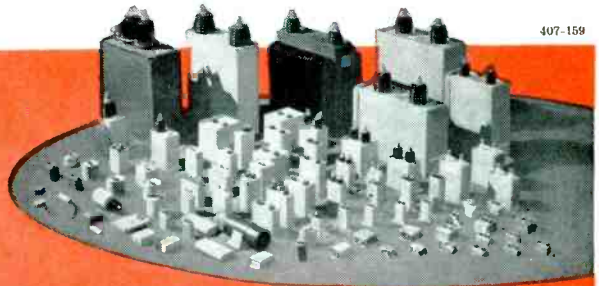
- Industrial control
- Radio filters
- Radar
- Electronic equipment
- Communication systems
- Capacitor discharge welding
- Flash photography
- Stroboscopic equipment
- Television
- Dust precipitators
- Radio interference suppression
- Impulse generators

AND MANY OTHER APPLICATIONS



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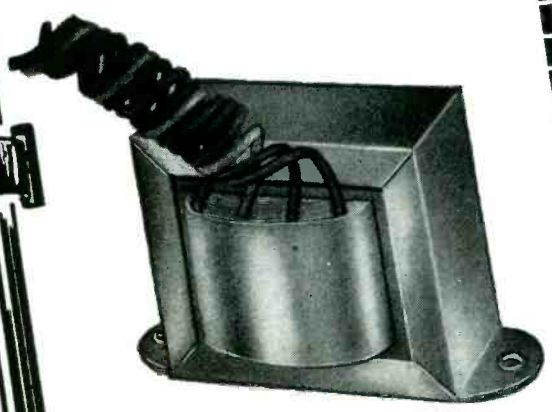
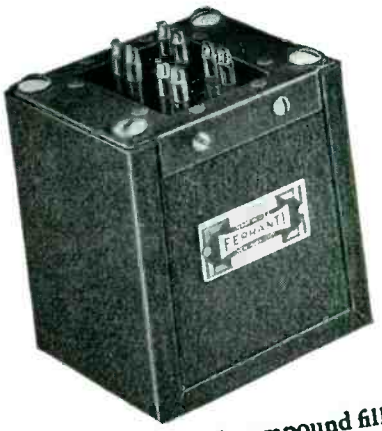
Wherever There's a CORE and COIL

Choose FERRANTI Power and Audio Transformers Chokes • Filters

3 EXAMPLES OF OUR WIDE RANGE:



OPEN FRAME TYPE for mass production, minimum cost and weight for enclosed equipment.



ENCLOSED CASE, compound filled, for high moisture resistance. Standard cases up to 500 VA. Wide range of standard audio transformer units.

HERMETICALLY SEALED and compound filled cases. Glass or ceramic sealed terminals. Designed to meet JAN salt water immersion tests.

We offer ample modern facilities and intensive experience in up-to-date practice, including the latest core material developments, and components for 400 cycle power supplies. Our large accumulation of patterns, tools and dies often makes it possible to supply your specific requirements from standard parts, thus cutting your costs without sacrifice of quality. Whatever the type of unit, our bid will meet your needs. Submit your inquiries.

POWER SUPPLY UNITS AND ELECTRONIC ASSEMBLIES TO SPECIFICATIONS

• *Ferranti Electric, Inc.* •

30-A Rockefeller Plaza • New York 20, N. Y.

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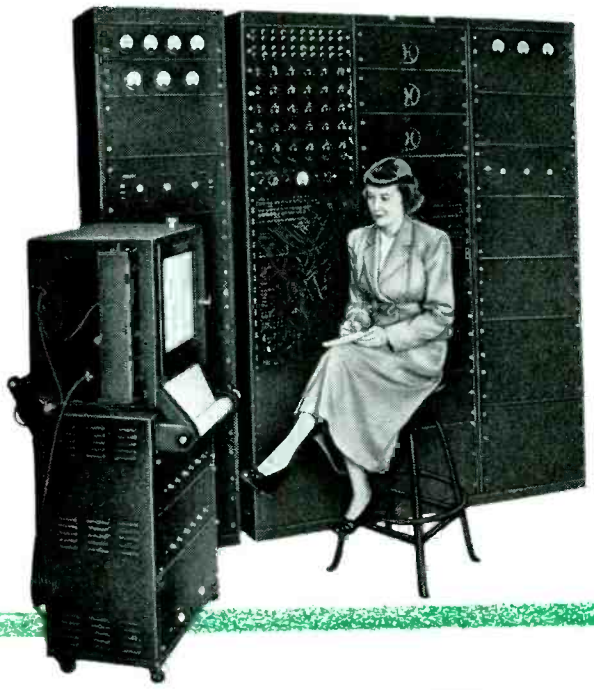
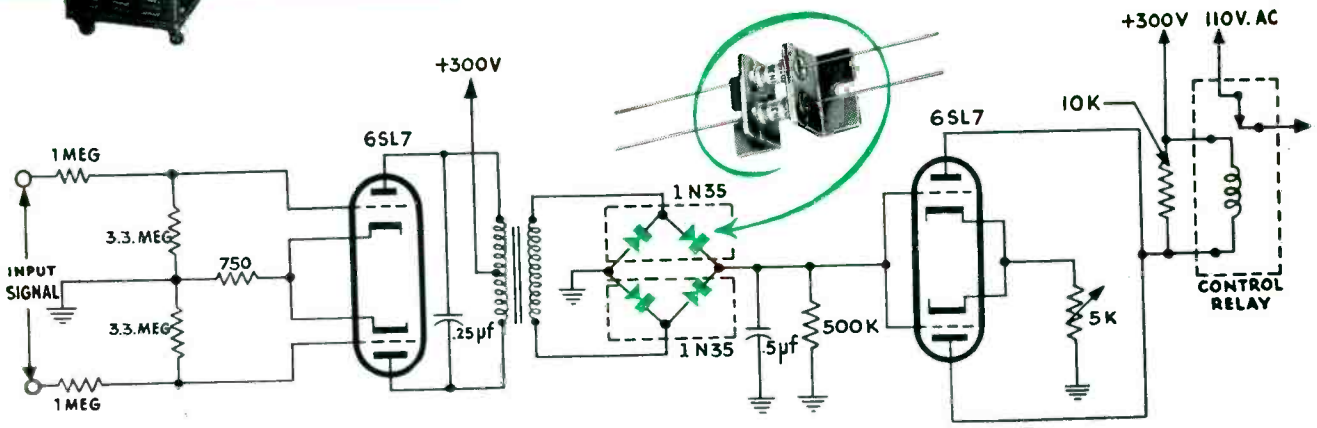
Reeves electronic "BRAIN" uses Sylvania Germanium Duo-Diodes in vital-to-accuracy circuit



THE Reeves Electronic Analog Computer (REAC), which compresses thousands of man-hours of calculations into a few hours' time, is one of the first office-size differential analyzers to be developed for industrial laboratory use. It incorporates an extremely sensitive system for automatic balancing of its 20 dc computing amplifiers, to offset any possible drift.

Unbalanced output from an amplifier operates a servo unit driving 20 magnetic clutches, which in turn drive nulling potentiometers till amplifier output is balanced within a few millivolts. Circuit shown in diagram then acts to index stepping relay to the next amplifier.

Two Sylvania 1N35 Germanium Duo-Diodes are used by Reeves Instrument Corporation, New York, in this accuracy-controlling circuit, because of their ability to handle very low voltages and pass an absolute minimum of ac signal.



Light, compact Sylvania Germanium Diodes and Duo-Diodes, which simplify wiring and need no heater supplies, are being used constantly by more manufacturers to improve performance, or to reduce cost, size and weight. Why not put them to work in *your* products?

GET THE FACTS ON TV USES TOO!

SYLVANIA ELECTRIC

Electronics Division, 500 Fifth Avenue, New York 18, N. Y.

ELECTRONIC DEVICES; RADIO TUBES; CATHODE RAY TUBES; PHOTOLAMPS; FLUORESCENT LAMPS, FIXTURES, WIRING DEVICES; ELECTRIC LIGHT BULBS

Sylvania Electric Products Inc.
Electronics Division, Dept. E-2902
500 Fifth Avenue, New York 18, N. Y.

Gentlemen:

Please send me your literature on Germanium Diodes and Duo-Diodes, including the series of Engineering News Letters showing their applications in television circuits.
I am also interested in receiving literature covering applications of your other products in the fields of:

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☐ *Radioactivity*
☐ *Radar and Microwaves*

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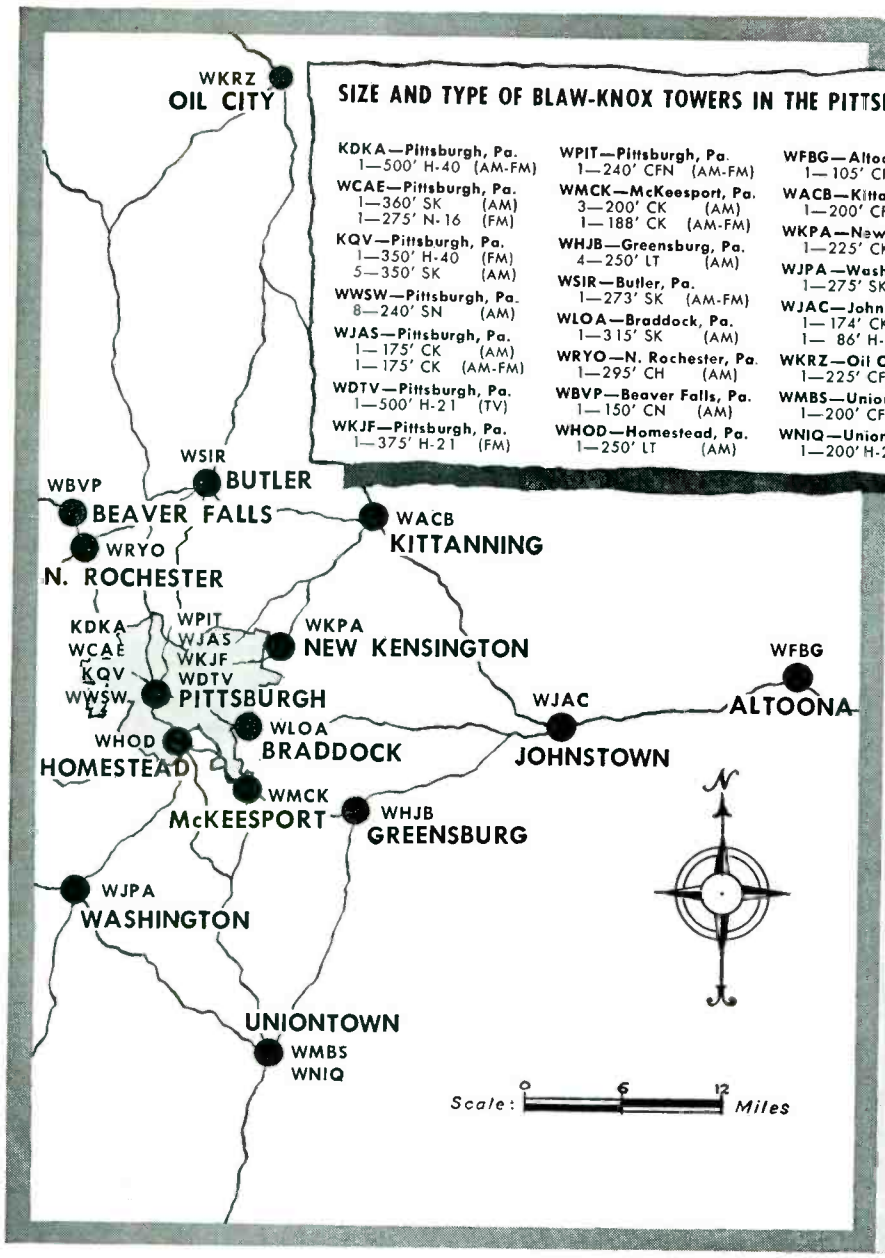

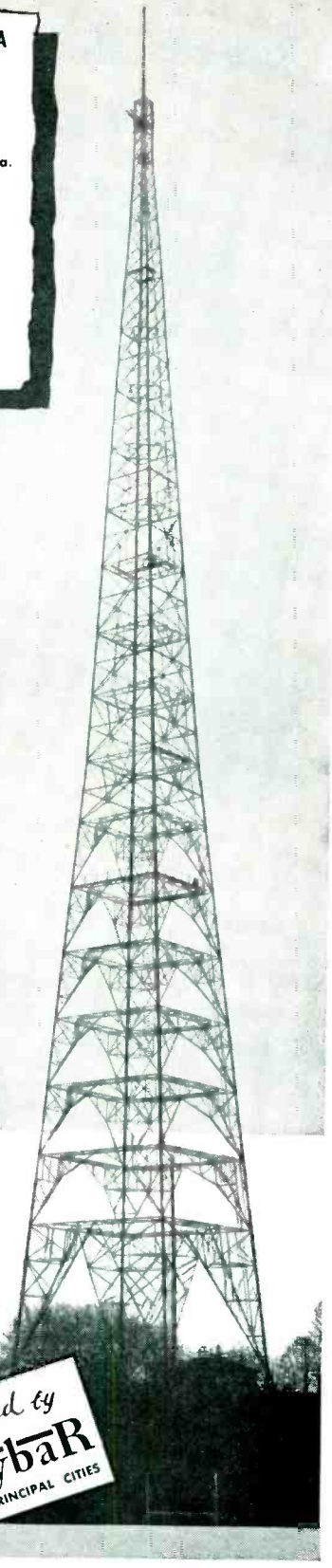

WHERE COMPETITION IS KEENEST...

BLAW-KNOX TOWERS DOMINATE THE AIRWAYS

That "still, small voice in the wilderness" hasn't a chance around Pittsburgh. To be heard above the electronic babble it must come out loud, strong and clear.

Receivers tuned to the stations shown here find clear, sharp signals broadcast via Blaw-Knox Antenna Towers . . . Radio engineers know you can "hear the difference."

BLAW-KNOX DIVISION OF BLAW-KNOX COMPANY
2077 Farmers Bank Bldg., Pittsburgh, Pa.

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OFFICES IN 100 PRINCIPAL CITIES

BLAW-KNOX ANTENNA TOWERS

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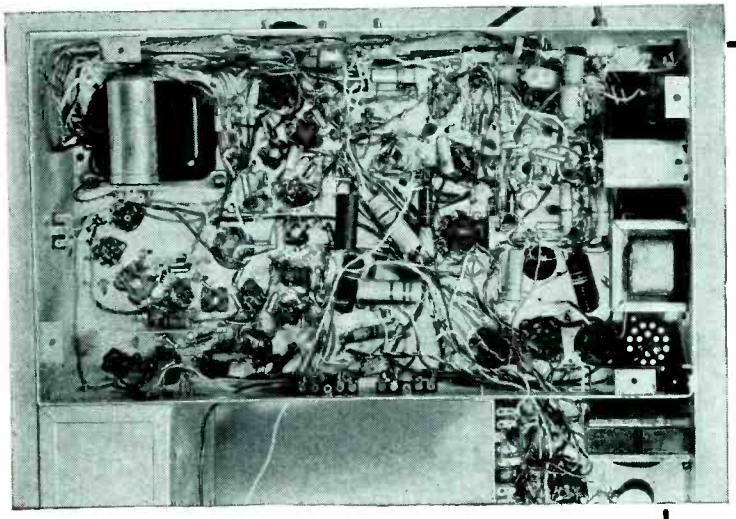
IT PAYS * TO SPECIFY Hi-Q COMPONENTS

for Hi-Quality T. V. Performance



RCA Victor television receiver Table Model 8T241 uses many **Hi-Q** *capacitors for Uniform, Dependable reception.*

● Not only RCA Victor, but practically every manufacturer of television sets looks to **Hi-Q** Electrical Reactance Corporation for components of *Dependable* quality ...*Precision* tested and *Uniform* capacity.

Today's tremendous demand for high quality **Hi-Q** components is being met at three (3) modern plants equipped with the most modern machines helping supply the needs of the fast growing electronics industry.

Our competent engineering staff is available for consultation with your engineers in the design of newly developed circuits.

Booth No. 54 at I. R. E.

A FEW OF THE COMPANIES USING Hi-Q ELECTRONIC COMPONENTS

STROMBERG-CARLSON
ZENITH RADIO
RCA VICTOR
Westinghouse RADIO TELEVISION
Sparton
CROSLEY
Bendix Radio
Motorola
Tele-tone
Packard-Bell
Admiral
DUMONT
GENERAL ELECTRIC

Hi-Q components are specified by over 200 leading manufacturers. Space does not permit listing all of our valued customers.

*

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.

MINIATURIZATION The smallest BIG VALUE components in the business make possible space saving factors which reduce your production costs . . . increase your profits.

Hi-Q *Electrical Reactance Corp.*
FRANKLINVILLE, N. Y.

Plants: FRANKLINVILLE, N. Y.—JESSUP, PA.—MYRTLE BEACH, S. C.
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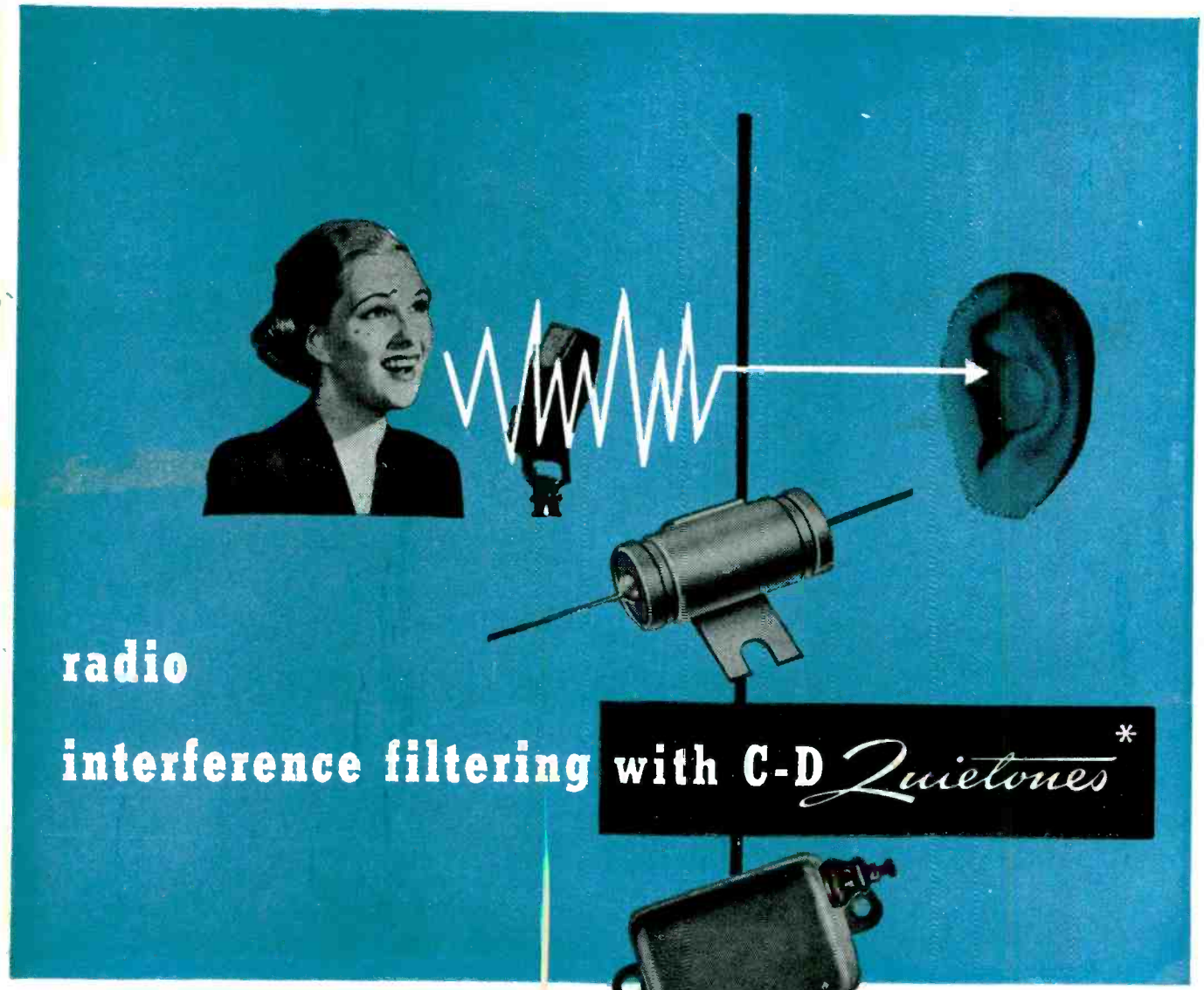

radio interference filtering with C-D *Quietones**

We have designed—and have available—many types of C-D Quietones which are equally effective on both Radio and video bands. They meet every requirement of manufacturers' cost and production schedules. One of these standard types may remove your product from the list of Radio interference generators. If not, we're ready and waiting—with a modern and complete laboratory and experienced engineers—to design and build a Quietone to meet your specific needs. Your inquiry is cordially invited. Cornell-Dubilier Electric Corporation, Dept. K-29 South Plainfield, New Jersey. Other large plants in New Bedford, Worcester and Brookline, Massachusetts, and Providence, Rhode Island.

CORNELL-DUBILIER

WORLD'S LARGEST MANUFACTURER OF

CAPACITORS

Make Your Product More Saleable with C-D Quietone Radio Interference Filters and Spark Suppressors.

* Reg. U.S. Pat. Off.

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"Give us the tools . . ."

What Are *YOUR* Chances If There Are No Profits?

Since the November 2 election there has been a dazzling variety of plans to have the government do more and more things and spend more and more money. But there is almost no variety in the plans which are suggested to raise the money.

"Pay for it by taxing profits," is the standard refrain. Slap on an "excess" profits tax. Boost the corporations' income tax rate.

Well — why not? Haven't the corporations been making so much money that a big chunk of it can be turned over to the government spenders without hurting anybody?

The answer is no!

How high profits should be can be debated endlessly. Some people claim that 1948 corporation profits, which will amount to about $20 billion, are too high. They emphasize the fact that profits are larger in relation to investment than they were a few years ago. Other people think profits are low. They stress the fact that profits are not much larger in relation to sales than they have been historically. Both sides agree that in some individual cases profits have been too high, as in others they have been too low or non-existent.

But if we cut the total volume of profits drastically, we shall do so at our national peril.

There is no room for debate about that. For we shall choke off the crucially important job of building new plants and equipment for our industries. Squeeze hard enough, and America will go the way of Britain — down the long and painful skids of industrial decline. Widespread unemployment, especially among our industrial workers who produce new plants and equipment, will mark the dreary way. Here is a fact which the President, the Congress, the C.I.O., and all of us have a real reason to remember:

Almost two-thirds of all profits today are going to rebuild and improve plants and equipment.

More than $13 billion of this year's profits are being plowed back. They are going — as a large proportion of profits have always gone — to buy for workers better tools to work with, better surroundings in which to work. They are making possible better products, and more of them, for all of us.

The figures below show how companies have put more and more profit-dollars and a larger share of their profits to work in the business:

YEAR	PROFITS REINVESTED	% OF TOTAL PROFITS
1929	$2.6 billion	31%
1939	1.2 "	24%
1943	5.9 "	57%
1944	5.2 "	53%
1945	4.2 "	47%
1946	6.9 "	55%
1947	11.2 "	62%
1948 est.	13.0 "	65%

continued on next page

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The record shows that each of us is the real beneficiary of this plowing back of profits.

Every American has benefited from these profits. Each dollar that business has put into its plants and equipment in the last thirty years has increased our yearly production by 35 cents.

This re-investment of profits has helped make possible a 75% increase in living standards since 1919.

It has helped increase wages from an average 48 cents an hour in 1919 to $1.36 today. Allowing for higher prices, that increase means that an hour's work today will buy twice as much as it did thirty years ago.

Why must business retain these billions of profits to improve its plants and equipment? Why must it plow back more and more? *The reason is that business already is caught in a tax squeeze.*

Federal taxes alone take at least thirty-eight of each one hundred dollars a company earns. Then, if the company pays out to its stockholders any part of what is left as dividends, the federal personal income taxes of the stockholders may take up to 77% of those dividends. Under these conditions, so few people are willing to invest in industry that the stock market is stagnant. Companies can not raise in that market the money they need for improvements.

The result: business must rely more and more on plowed-back profits to pay for new plants and equipment.

We know that everywhere in industry new and better ways of producing goods are standing ready for use. The previous editorial in this series mentioned some of them. We know, too, that depression and war put our industries far behind schedule — as much as $100 billion behind — in getting the new tools they should have had to keep themselves in first-class shape. McGraw-Hill is now completing a survey of industry that will measure these needs. The results will be published in this editorial series. We know already that in 1949 alone industry will need $18 billion or more for this purpose.

And all but a small fraction of that sum must come from profits.

Our prosperity, our strength as a nation, our hopes for better living depend on our continuing to generate and to plow back a large volume of profits.

For that reason we should not thoughtlessly follow these people who propose to pay for any and all new government activities by saying simply, "Soak the corporations." There is no need to follow them. There are other ways of obtaining necessary funds.

First and foremost should be economy within the government itself. If its citizens must pay still higher taxes, then surely government should exercise rigid self-restraint, cutting out all but the most essential activities and expenses.

After economy should come consideration of a broader federal tax base.

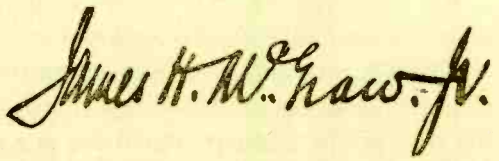
If these and other methods of raising money are inadequate and if taxes must take a bigger bite from business profits, two facts are clear. We should not adopt an "excess" profits tax with all of its complications and all of its corrupting effect on business. A moderate increase in the regular income tax on corporations is much less dangerous. *But even such an increase, if necessary, should be accompanied by special allowances for expansion and depreciation that will encourage companies to continue spending their earnings for new plant and equipment.* We all have a stake in that.

At this critical juncture in our history profits have a new and vastly more important role than they have ever had. In unprecedented degree they are the drive behind our present prosperity and the key to a better, stronger future.

Give profits the axe and the blow does not stop there.

It cuts into the employment, the prosperity and the strength of our nation.

Everyone of us has a stake in how the President and Congress handle taxes on profits — and now is the time to remind them of that stake.



President, McGraw-Hill Publishing Company, Inc.

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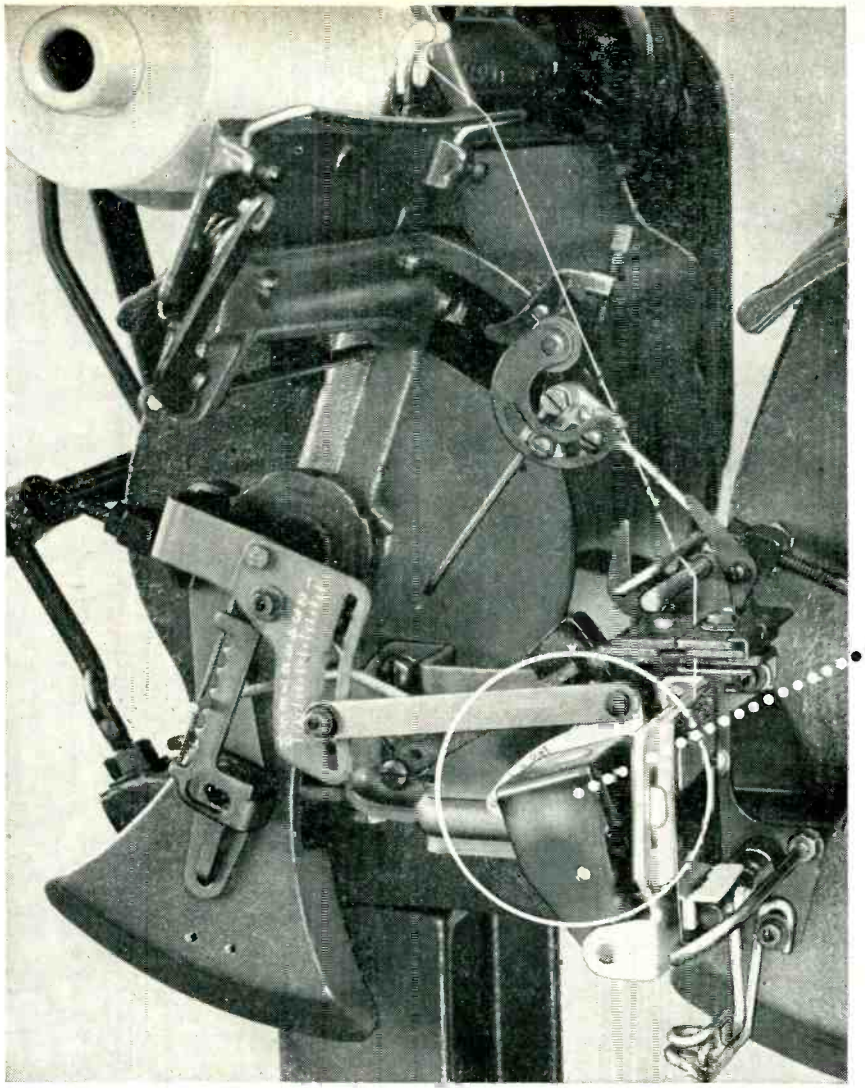

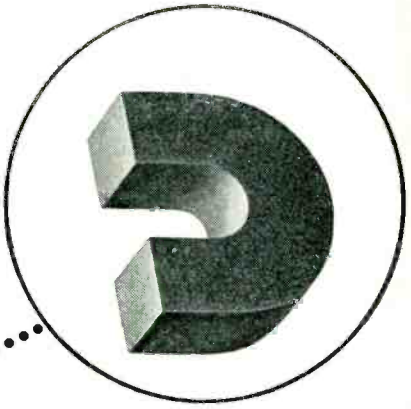

The "Magnetension," a new yarn-winding tension control developed by Universal Winding Company, Providence, R. I., uses this *Indiana* permanent magnet.

INDIANA PERMANENT MAGNETS TAKE THE "KINKS" OUT OF YARN-WINDING

● Here's another job made simple by *Indiana* permanent magnets—they hold tension leaves against wear plates to provide even winding tension on yarn-winding machines. And here are the direct benefits: non-multiplying tension; fewer broken filaments; less end breakage, cut ends, or loops at cones; less attention to machines; *and a better product at less cost.*

"PACKAGED ENERGY" MAY BE *YOUR* ANSWER, TOO . . .

Indiana permanent magnets provide constant, *predetermined* force for *many* needs. In magnetic chucks and separators for holding and lifting . . . in snap switches and pressure devices for replacing springs . . . in magnetic drives for transferring motion through seals without mechanical connections . . . the list is practically endless.

HOW AND WHERE TO USE PERMANENT MAGNETS . . .

Write for free Book No. 4E-2—the new reference manual by *Indiana.* It shows how permanent magnets save space, weight, and money; lists applications; gives materials and design data. If *you* have an application problem, let's get our engineers together. The experience of forty years and more than 30,000 successful designs is at your call. Write *today.*

INDIANA PERMANENT MAGNETS

THE INDIANA STEEL PRODUCTS COMPANY

6 NORTH MICHIGAN AVENUE • CHICAGO 2, ILLINOIS

SPECIALISTS IN "PACKAGED ENERGY" SINCE 1908

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Representatives and distributors in all territories.

WRITE FOR COMPLETE LITERATURE

PYRAMID
ELECTRIC COMPANY
156 Oxford Street
Paterson, N. J.

BUSINESS BRIEFS

By W. W. MacDONALD

TV Antennas offered to the public break down by types as follows:

27%	dipole(s) with reflector(s)
26	folded dipole(s) with reflector(s)
17	dipole
15	folded dipole
15	miscellaneous types

About 33 percent of the types listed use a plurality of dipoles and reflectors. Elements average 3, ranging from 1 to 12.

List prices average $23.82, with the low at $1.75 and the high $125.

Nominal impedance of types offered for sale is:

55%	300 ohms
37	72
8	other

And still they come!

Outdoor Tele Antennas, like other vhf types, are subject to null or "picket-fence" effects. Move them a foot or so to the left or right (and sometimes down rather than up) and signals often come through clearer or with more punch. Such skywires do *not* always work best lashed to a convenient chimney.

This leads us to believe that one or two new arrays that permit moderate lateral movement of elements should do well. Another design in the offing, by the way, appears to be aimed at maximum pickup from each of several local stations rather than compromise coverage of the whole 12 channels.

Indoor Tele Antennas have several makers of the outdoor variety worried. We doubt if any qualified technician really thinks that they will do as good a job, except in a very few unusual cases. The devil of it is that many dealers will take the easy way out if at all possible, as demonstrated in the radio business. So, while we fully underwrite any and all efforts to keep outside skywires in front, at least at this stage of receiver and transmitter development, it is not a crusade to which we would care to devote our declining years.

Speaking of Antennas, we hear that 10 percent of the tele antennas installed in connection with one particular set sold in the metropolitan New York City area are right in the room. Every week sees a new one, put out by another manufacturer, enter the market.

C-R Tube Mortality seems to be greatest during the first few days of use in television sets. One reason is the shipment of tubes in the neck-down position, which funnels internal gunk into the electron gun. Holding the bottles face down and shaking gently before use reduces the trouble to some extent.

Zenith, it seems, has found a way to put a square peg in a round hole.

Many Nuclear Physicists like to "roll their own" electronic apparatus because (1) they don't want outsiders to have any part of confidential information, (2) they believe their problems are too highly specialized for others to understand and (3) because they think they know how to build such gear as well as circuit specialists.

Regarding the first point: The government has cleared many consultants and industrial laboratories for such projects, and these people know how to keep their mouths closed for either military or commercial reasons. The second: If a physicist can explain it a good electronic engineer can understand it. The third: Some home-made apparatus we have heard about makes this presumption subject to question.

Purchase of electric motors, generators, adjustable-speed drives and controls by the nation's key industries in 1949 will match or exceed the previous year, according to 58 district managers and field sales engineers of Reliance Electric.

This sounds plausible to us because, although new plant con-

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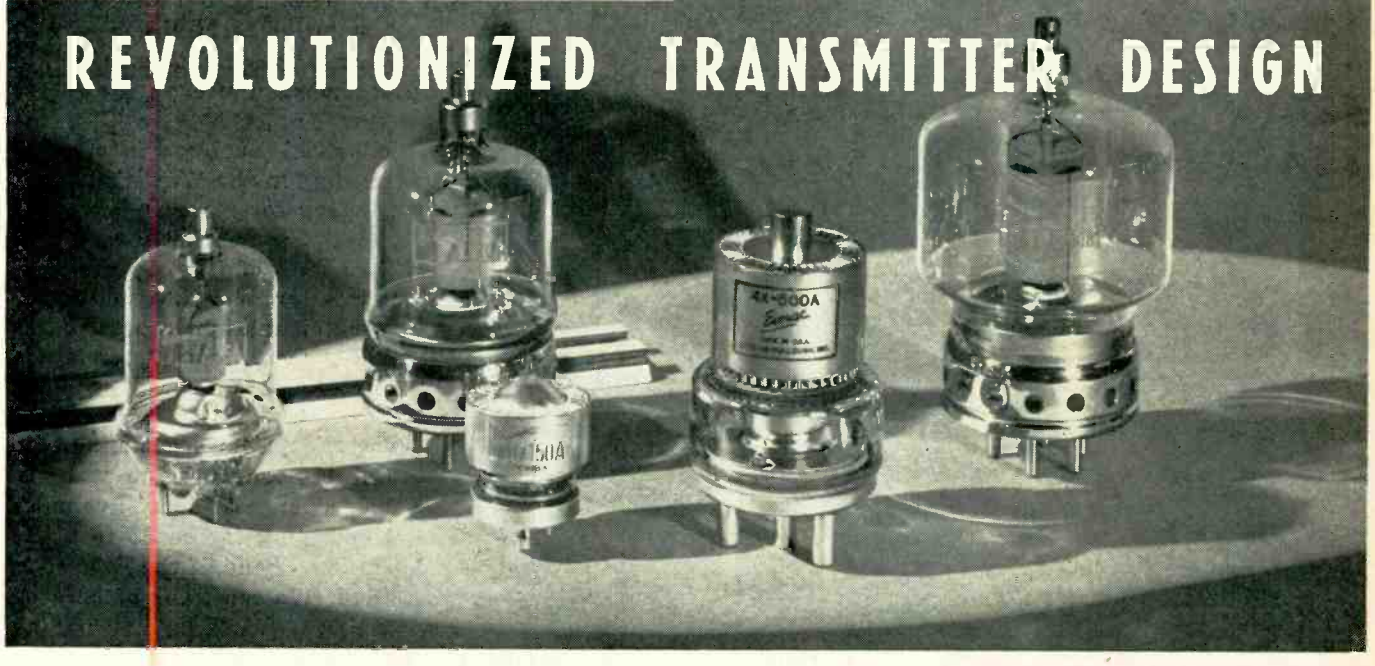
Follow the Leaders to

Eimac TUBES

The Power for R-F

THESE TUBES . . .

REVOLUTIONIZED TRANSMITTER DESIGN



THE 4-65A . . . is the smallest of the radiation cooled Eimac tetrodes. Its ability to produce relatively high-power at all frequencies up to 200-Mc. and over a wide voltage range offers considerable advantage to the end user. For instance the same tubes may be used in the final stage of an operator's mobile and fixed station. Two tubes, in the mobile unit operating on 600 plate volts will handle 150 watts input, while two other 4-65A's in the fixed station will provide a half kilowatt output on 3000 volts .

THE 4-125A . . . is the mainstay of present day communication. These highly dependable tetrodes have been proven in years of service and thousands of applications. Two tubes are capable of handling 1000 watts input (in class-C telegraphy or FM telephony) with less than 5 watts of grid driving power. In AM service two tubes high-level modulated will provide 600 watts output. For AM broadcast they carry an FCC rating of 125 watts per tube.

THE 4X150A . . . is highly versatile and extremely small (2½ inches high). It is an external anode tetrode capable of operating above 950-Mc. As much as 140 watts of useful output can be obtained at 500-Mc. Below 165-Mc. the output can be increased to 195 watts. It is ideally suited as a wide-band amplifier for television and for harmonic or conventional RF amplification.

THE 4X500A . . . is a top tube for high power at high frequencies and is especially suited to TV and FM. It is a small external anode tetrode, rated at 500 watts of plate dissipation. The low driving power requirement presents obvious advantages to the equipment designer Two tubes in a push-pull or parallel circuit provide over 1½ kw of useful output power with less than 25 watts of driving power at 108-Mc.

THE 4-250A . . . is a power tetrode with a plate dissipation rating of 250 watts and stability characteristics familiar to the 4-125A. Rugged compact construction together with low plate-grid capacitance, allows simplification of the associated circuits and the driver stage. As audio amplifiers, 2 tubes will provide 500 watts power output with zero drive.

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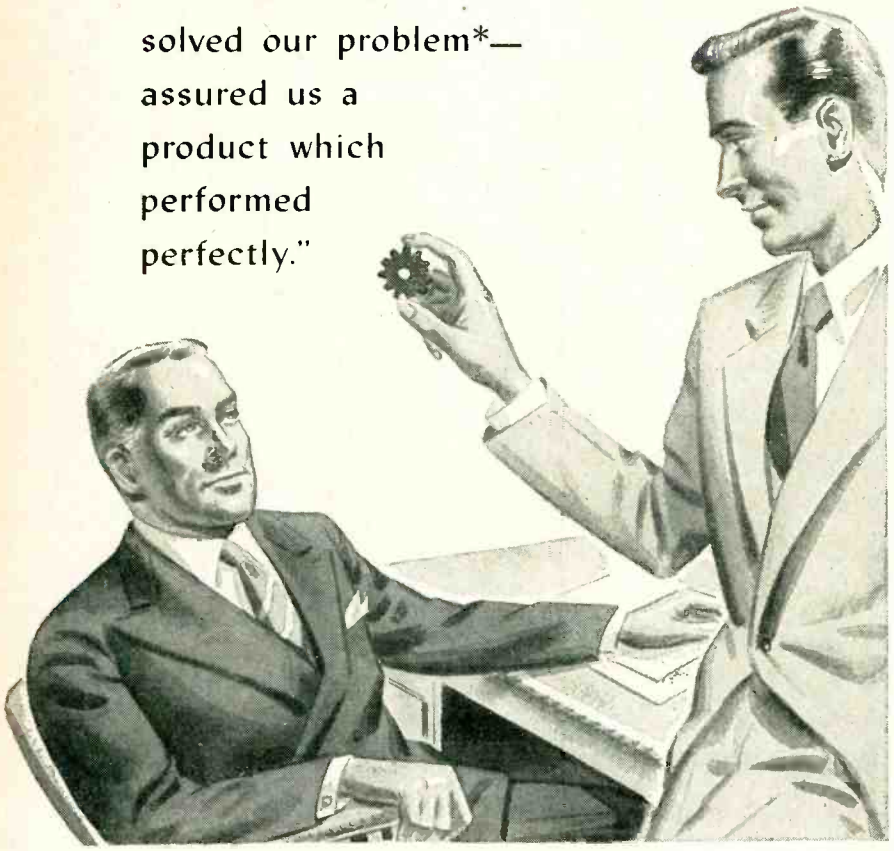

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struction will probably decline, the equipping of existing plants with more modern machinery seems essential if sales are to be maintained in the face of labor and material costs already pushing prices to a point near infinite customer resistance.

Industrial Business is steadily increasing on the West Coast and accounting for more and more of the electronics dollar. According to Sam Roth of United Catalog it accounts for about 30 percent of distributor sales in coastal cities at the moment, and 50 percent in the Los Angeles area.

Texas Baptists are planning to install 170 ten-watt f-m stations, having a range of about five miles and operating in the 88 to 92-mc educational band, if the FCC gives the nod. We can think of no good reason why Washington wouldn't come through with the necessary approvals, and at least one good reason why they will. So the use of this part of the spectrum by churches should increase sharply in the coming year.

Dog's Life is that of the Montana coyote. The government is now hunting him by plane and jeep, with the aid of uhf radio. The plane does the spotting and the jeep does the shooting.

Railroad Communication: 45 railroads now employ electronic communications equipment in yards and terminals, owning 879 portable and mobile stations (93 percent radio, 7 percent inductive) and 118 fixed stations (82 percent radio and 18 percent inductive). Some 22 railroads have installed equipment for routine communication with trains, 55 percent radio and 45 percent inductive.

Radiophones for passenger use, not included in the above figures, are being installed so fast that any tabulation we could make at this time would be obsolete before this issue of ELECTRONICS mailed.

Industry Mobilization Plans: Still stalemated. Looks like we might have peacetime procurement

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channeled to "leader" companies but with contingent contracts attached, a straddle embracing industry and military suggestions.

Conventional Methods of making electronic components better, smaller, lighter, cheaper or faster are of interest to the military, but what the current preparedness effort really needs is more blue-sky thinking along radical lines, according to Wright Field's Floyd Wenger.

Floyd, who spent many years as an engineer within the industry, says for example, that new core materials materially improve the performance of transformers but how about some one coming up with a magnetic liquid that can be poured into a coil to eliminate the fussy solid core entirely.

You pick it up from there.

More And More subminiature tubes are going into military gear, particularly the airborne stuff. In many instances the tubes are operated far over rating but do their job ok because the application does not require long life. In others forced-air cooling is employed, and in still others complete circuits are hermetically sealed and freon gas is substituted for air.

Electron-Wave Tubes in experimental use are capable of turning out appreciable radio-frequency power in the *millimeter*-wavelength range. This is down near the infrared spectrum, where point-to-point communications are achieved with a maximum of secrecy, so it should be of considerable interest to the military.

Rumor Has It that one of the big Universities thinks it may soon be able to predict whether or not seeds will germinate, using an electronic technique. More about this later if current experiments pan out.

Record Makers, Note: Keep this up, boys, and we'll have to design a phonograph turntable with stepless universal speed control, triplicate triggers and quadriplicate paddle wheels.

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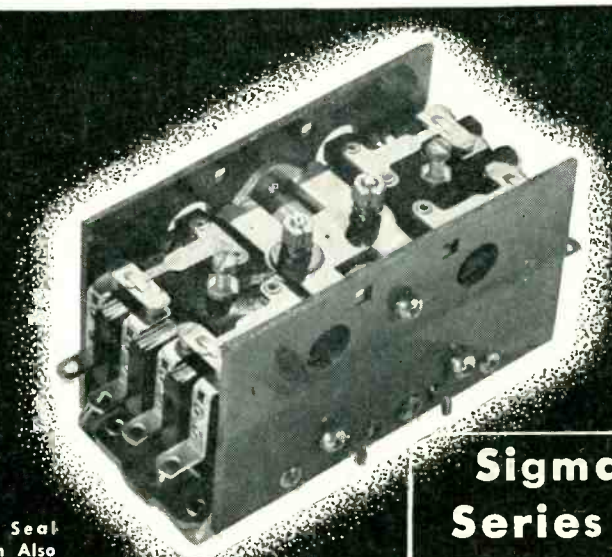

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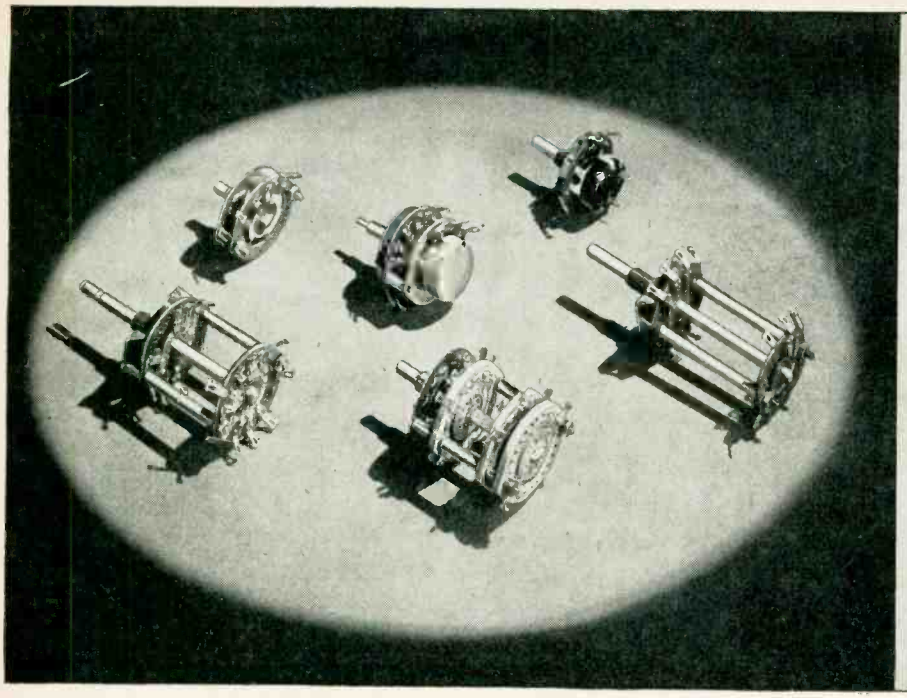

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CROSS TALK

► **10-INCH** . . . Several publications, including ELECTRONICS, have commented recently on the size of the television picture which can be accommodated on a 10-inch picture tube. Simple geometry proves that the largest image of 4-by-3 aspect ratio that can be placed within a 10-inch circle without cutting the corners covers 48 square inches. Further, such an image is the only one which takes full advantage of the screen size without wasting any of the transmitted information. Rounding the corners is routine practice in all but projection receivers. It permits a larger picture with little loss of the picture area. The most common practice produces a 52-square-inch image.

The trend in recent months has been to use more and more of the tube face, at the expense of cutting off more of the corners. One practice is to make the left and right edges of the scanning pattern just tangent to the edge of the tube; the most extreme is to make the top and bottom edges of the scanned rectangle touch the top and bottom edges of the tube face. The latter approach fills the entire face of the tube and achieves a picture area of something over 80 square inches on a 10-inch tube.

The choice between these pictures will, in the last analysis, be made by the public, and is perhaps not the concern of the engineer. But one result of corner cutting is of great importance to the economy of the television system. In receivers which use the full face of the tube, assuming no scanning distortion, about 40 percent of the image picked up by the television camera is not visible to the audience. If, as a result, the producers of programs take care not to occupy that invisible region with program material, the channel space occupied in scanning the unused area is then purely wasted. Since spectrum economy is one of the principal problems in television today, it would appear that coordination among receiver manufacturers is needed to decide the best balance between the purely rectangular and the purely circular form. Such coordination is forced on the broadcasters by the FCC; it is rightly voluntary on the part of the set makers. But it is equally essential to the public interest in either case.

► **JIM** . . . Our new assistant editor, James D. Fahnestock, whose name appears on the masthead for the first time this month, graduated from Purdue in electrical engineering last August. Like many a recent graduate, Jim's college career was interrupted by a tour of duty in the Army, from 1943 to 1946. His military career started with radar and radio maintenance. But the snafu got him and he was transferred to the infantry as a rifleman and fought in the Battle of the Bulge. Later he was personnel sergeant major of the Second Armored Division headquarters. Now, his degree in his pocket, he's back at radio and radar, with a dash of industrial electronics for flavor. Jim is an active ham, has just finished wiring a 30-tube television chassis. As for rifles, he's forgotten the whole thing.

► **F-M vs A-M** . . . On p 84 of this issue is published the first part of an experimental study of the relative merits of narrow-band f-m and a-m for naval communications. This is a "hot" subject, one on which we sought competent outside advice before publication. The advice was to publish the article and invite comment, which is hereby solicited. We feel everyone concerned with narrow-band f-m, or with any kind of f-m outside the field of broadcasting, will find this article high on his "must read" list. We realize that feelings may run high, and we stand ready to air both sides of the argument. Count ten and then write or telephone.

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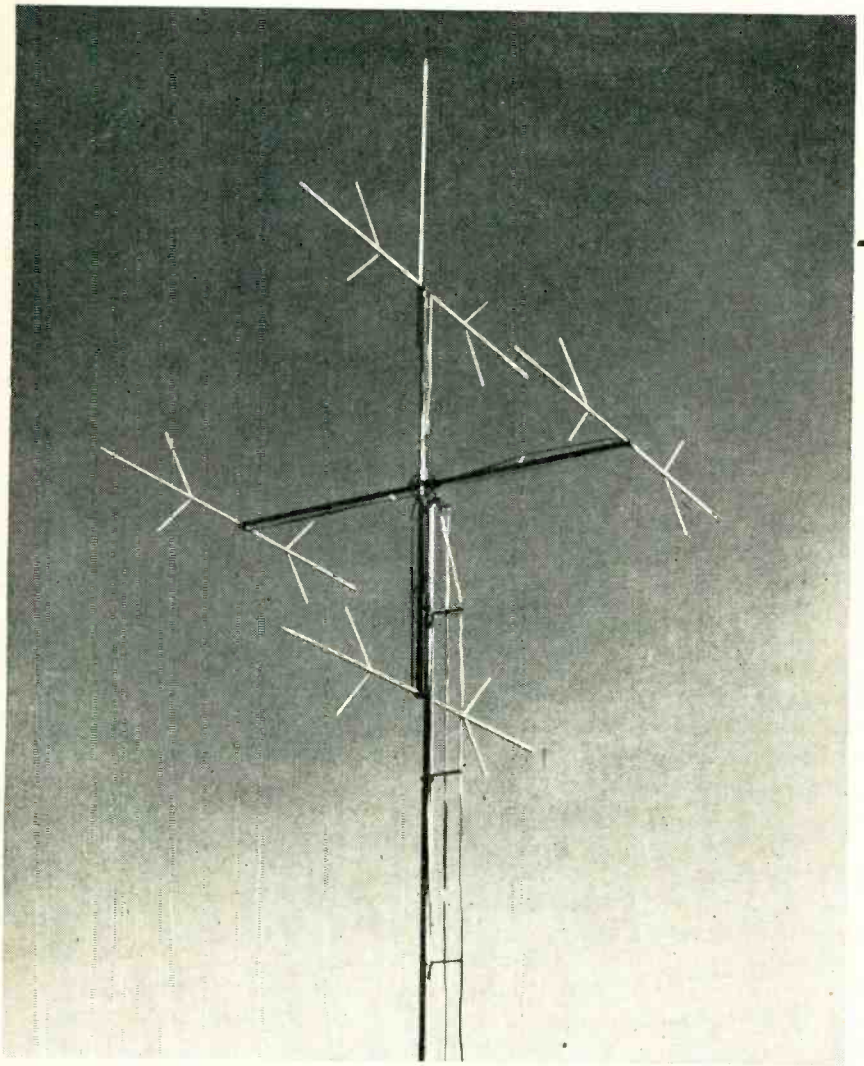
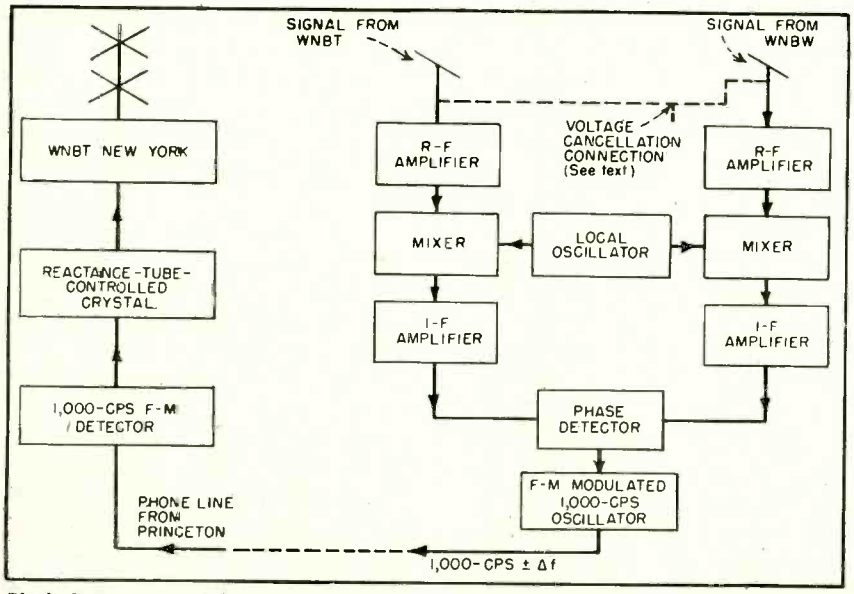
SYNCHRONIZATION of



Bridged dipole antenna, having 20-to-1 front-to-back ratio, used to pick up Washington station at Princeton, N. J. Obliquely attached rods broaden the antenna, make it suitable for use on all vhf channels



Block diagram of synchronization system as applied to NBC stations in New York and Washington

AT THE ENGINEERING CONFERENCE held before the FCC in December, R. D. Kell of the RCA Laboratories at Princeton, N. J. described for the first time his system of synchronizing television stations. This system promises to reduce materially severe inter-station interference which led to the current freeze on applications for television station permits.

The system controls the phase of the carrier of a television station so that it follows accurately any changes in the phase of another station operating on the same channel. The carrier beat between the two stations is thus reduced to zero frequency, and the troublesome horizontal black-and-white bars ("venetian blind" interference) noticed at the fringes of the service areas are removed. The picture scanning-rates of the stations need not be synchronized, since interference between the picture content of the two signals is some 15 to 20 db less noticeable than the carrier-beat interference.

Two syschronized stations operating on the same channel may give interference-free service when separated by approximately 150 miles, according to Mr. Kell's testimony, whereas a spacing of about 230 miles would be required for the same grade of service if synchronization were not used. The advantage of the system in permitting more stations to occupy the congested channels of the vhf band is obvious, so much so that the Joint Technical Advisory Committee (JTAC), commenting on the system at the conference, advised the FCC against proceeding with any allocation which precluded the use of synchronized carriers.

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TELEVISION STATIONS

System developed by R. D. Kell holds r-f carriers of interfering stations in rigid phase relationship to eliminate "venetian blind" interference, thus permitting closer geographical spacing of stations and easing congestion of video spectrum

Development work on the synchronization system was begun shortly after the FCC announced that no further action would be taken on the 310 applications for television station construction permits then pending until the problem of interference had been explored. The cause of this action was the fact that, as some new television station took the air, viewers in fringe areas which previously had had some degree of service on a particular channel found that the new station caused such interference that the channel became virtually useless.

Cause of Interference

The interference was caused by tropospheric propagation of the interfering signal. At times the interference became so severe that service radius of one station was reduced to 20 miles when the interfering station was 150 miles away (the minimum separation specified in the allocation at that time). One possible remedy was to put the stations further apart, say 250 miles, but the additional separation would require that many stations be eliminated from the allocation plan.

Synchronization Approach

When two carriers that are not synchronized come closer in frequency, the number of interference bars decreases until the carrier beat reaches 60 cps (the field-scanning frequency). At this frequency, one white and one black bar appear. As the beat frequency falls below 60 cps, the bars disappear, but the brightness of the picture varies as a whole at a rate equal to the beat frequency. The flicker becomes more evident and annoying as the beat frequency approaches zero. But when the two carriers are locked in a rigid phase relationship, the flicker disappears.

There is, of course, a residual amount of interference due to the presence of the interfering picture-content. The residual interference resides principally in the sync pulses and blanking pedestals of the interfering video waveform, since these are the parts of the video wave causing the heaviest degree of modulation. Since the distances from the receiver to the two stations are not in general the same, the interfering blanking bar generally is visible somewhere within the frame of the desired picture. Consequently, when the carriers are synchronized and the carrier-beat interference removed, the residual interference from the blanking bar becomes visible as the strength of the interfering signal is increased. The level of interfering signal at which the residual interference becomes visible depends on the depth of modulation of the interfering wave, that is, the residual interference is worse when the picture has a predominantly white background.

The extent to which residual interference is visible depends on the actual phase relationship of the two carriers at the receiving antenna. If the two waves are in quadrature (out of phase by 90 degrees) the residual interference is a minimum, but if the waves are in phase or 180 degrees out of phase, the residual effect is most noticeable. Mr. Kell reported to the FCC that, in the 90-degree case, carrier synchronization produces an improvement equal to approximately 30 times. That is, the interfering signal voltage can be increased 30 times before the residual effects become as annoying as the carrier-beat bars would be in the absence of synchronization. The average improvement incurred over all possible phase conditions was estimated at from 5 to 10 times in voltage.

Apparatus Used

The apparatus used in Princeton consists essentially of two narrow-band (100-kc bandwidth) receivers tuned to the picture carrier on channel 4. One receiver is connected to a dipole and single reflector oriented to receive signals from station WNBT, in New York, about 45 miles distant. The other receiver is connected to an elaborate bridged-dipole antenna, having a front-to-back ratio of 20 times in voltage, oriented to receive station WNBW in Washington, about 180 miles away. This second antenna also has some slight pickup of the New York signal, which is cancelled by feeding to it a portion of the voltage developed on the first antenna in proper amplitude and phase. This cancellation system would not be necessary if the receiver were located more nearly midway between the two stations.

The two receivers have a common local oscillator, so the relative phase relationship of the two signals is preserved throughout the two receivers to the outputs, which are combined in a phase detector. This detector develops a direct voltage proportional to the phase difference in the two carriers. The direct voltage is used to modulate a 1,000-cps f-m generator. The resulting f-m signal, varying over the range from 700 to 1,300 cps, is transmitted over an ordinary class-C

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telephone program-circuit to the New York station. Frequency modulation is used in the control signal so that variations in the gain of the telephone circuit do not affect the control.

At New York the f-m signal is applied to a 1,000-cps f-m detector which reconverts the f-m signal to a direct voltage proportional to the direct voltage produced by the phase detector in Princeton. This direct voltage is applied to a reactance tube which is connected across the crystal control of the WNBT picture transmitter. The phase of the WNBT signal is thus shifted until it arrives at a fixed 90-degree relationship with the WNBW signal, as measured at the phase detector in the receiver outputs. Any variation in phase occurring in the Washington signal thus acts to control the phase of the WNBT transmitter continuously and automatically.

Phase Relationships

The system maintains the relative phase of the two signals fixed at 90 degrees at the phase detector, in this case at Princeton. But elsewhere in the service area, the phase between the signals varies from point to point. There is, in effect, a standing-wave pattern created by the two signals traveling in opposite directions much like that caused by a reflected wave in a transmission line.

As in the transmission line, the standing-wave pattern changes from phase addition to phase opposition in a distance of a quarter wavelength, which varies from about 50 inches (channel 2) to 13 inches (channel 13). These distances apply at locations directly between the two stations; elsewhere the distances increase. In any event, as the location of the receiving antenna is moved, assuming the transmitter antenna positions are fixed, the extent of the residual interference varies from the minimum condition (90 degrees) to the maximum (0 or 180 degrees). Within the service area of the desired station this variation is not pronounced, but it becomes progressively more so at locations more nearly midway between the stations.

The effect is one which might become evident in the form of occasional appearance of residual interference if either the receiving antenna or transmitting radiator were in motion (due to tower sway, etc) or if rapid variations in the delay of transmission through the troposphere occurred in either transmission path. Neither effect has been noticed to any extent in the observations thus far made, and in any event such variations would change the level of the residual interference only slightly within the desired service area. Further experimentation is under way to evaluate the average degradation of service caused by such phase changes.

System Engineering

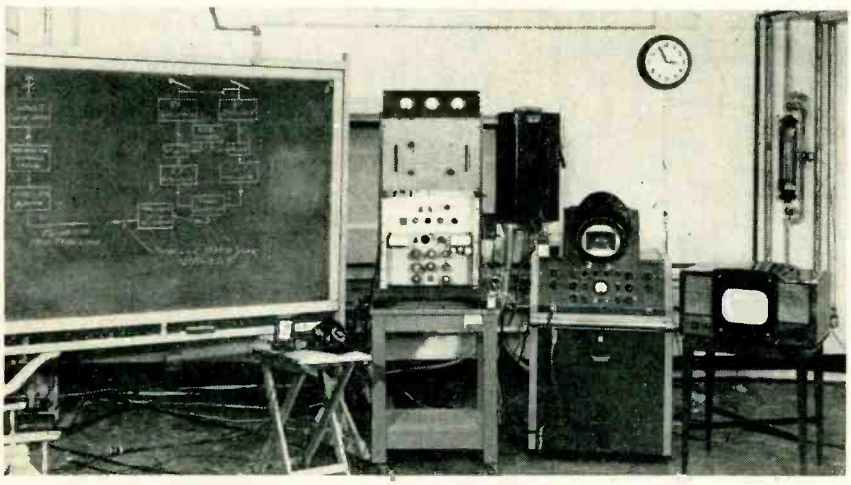
Thus far the synchronization system has been applied only to two stations. A full realization of its advantages is possible only if all stations operating on the same channel, and located in adjacent interference areas, are synchronized as a group.

One possible arrangement is to synchronize the stations in chain fashion, one station taking its comtrol from one direction and passing the control to the next station in the opposite direction. There appears to be no fundamental difficulty in setting up such an arrangement. The cumulative effects of errors in synchronization along the chain should not prove troublesome. In the event of complete failure of the synchronization equipment at one station the other stations in the chain would continue to operate as two separate groups and the loss of synchronization would affect only the area within 150 miles of the point of failure.

An additional system-engineering aspect not yet fully explored is the effect of three or more synchronized signals in the same area, as might occur within a triangle bounded by three stations on the same channel. Mr. Kell reported that a third interference signal has in fact been noted at Princeton from WBZ-TV in Boston when WNBT and WNBW are synchronized. The additional signal did not affect adversely the operation of the receivers and the synchronization circuits.

The theoretical aspects of the synchronization system had not been thoroughly worked out at the time of the presentation to the FCC. The effect of the ratio of the carrier amplitude to the amplitudes of the sideband components, and the effect of percentage modulation on that ratio, were discussed briefly in the JTAC report to the conference. But these and other important questions, such as the demodulation of a weak signal by a strong one in the presence of certain detector characteristics, and the effect of the phase difference on the residual interference as a function of the strength of the undersized signal, had not been studied in detail.

It was understood that Mr. Kell will present a full account of the development in March at the IRE Annual Convention.—D.G.F.



Demonstration setup at Princeton viewed by JTAC and FCC groups. The rack at center contains the two receivers and synchronization circuits

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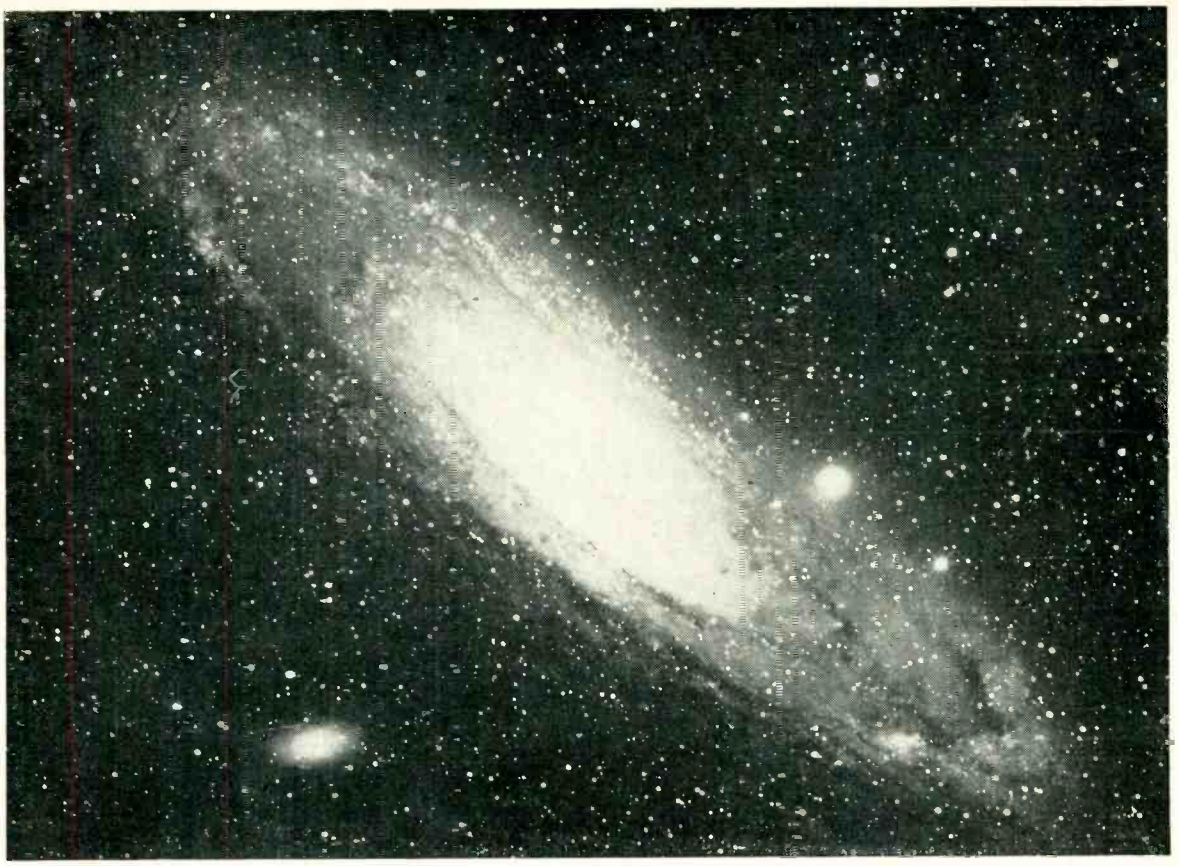

Andromeda Nebula, a source of galactic noise, as taken with the Jewett-Schmidt telescope at Harvard Observatory's Oak Ridge Station (courtesy Donald Menzel). Our own galaxy is thought to be similarly shaped

RADIO ASTRONOMY

Highly directional radio systems permit monitoring of uhf radiation from specific points on the sun and in interstellar space. Results show promising correlation between solar noise and radio communication, while galactic noise measurements provide a new tool for astronomers

By CHAS. R. BURROWS

Director, School of Electrical Engineering
Cornell University, Ithaca, New York

THE PHOTOGRAPH on the front cover of this issue of ELECTRONICS is that of a radio telescope being built by Cornell University, with the assistance of the Office of Naval Research, for research in radio astronomy.

This new branch of science was opened to investigation in 1931[1] when radio static of extra-terrestrial origin was observed coming from the center of our own galaxy in the constellation of Sagittarius in the Milky Way. Observations were made on a frequency of 20 mc during measurements of the direction of arrival of atmospheric static, one of the limiting factors in long-distance radio communication.

In spite of the obviously important practical application of the knowledge of intensity and distribution of galactic noise no further investigations were carried out on the interfering effect of this new type of noise until after World War II, when the Bureau of Standards undertook a systematic investigation of the time-frequency distribution of galactic noise and its limiting effect on communication by radio waves.

In the meantime another experimenter[2] built equipment with which he measured the relative intensity of galactic noise as a function of direction on a frequency of 160 mc. More recently[3] similar measurements have been made at 64 mc, with carefully calibrated equipment

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that made possible and worthwhile the laborious task of solving the integral equation for the absolute intensity of galactic noise as a function of direction. The equipment under construction at Cornell is designed to facilitate this reduction to absolute values.

Interpretation of Measurements

While galactic noise was observed first, it is the observation of enhanced solar noise that promises to be of greater help in improving long-distance radio communication. Since the determination of the absolute value of measurements of solar noise is somewhat simpler, let us consider it first.

The power (rate of flow of electromagnetic energy) incident upon the earth's surface from an outside source such as the sun is proportional to the projection of the receiving area on the plane normal to the direction of energy flow, the solid angle subtended by the source and the frequency interval. This proportionality factor, which in general is a function of the direction of arrival, position of the receiver, polarization, frequency and time, is called the specific intensity, and is measured in watts per square meter per steradian per cycle per second.

$$dP = I_{\sin\Theta\, d\Theta d\phi\, d\nu}^{\nu}(\Theta, \phi, x, y, z, p, \nu, t)\cos\Theta\, d\sigma \qquad (1)$$

where dP is incident power, I is specific intensity in watts per sq meter per steradian per cycle per sec, $\cos\Theta\, d\sigma$ is projected area, $\sin\Theta\, d\Theta\, d\phi$ is solid angle, and $d\nu$ is frequency interval. The radio telescope measures the integral of this

$$P = AB\int I_{\nu}(\Theta,\phi)F(\Theta,\phi)\sin\Theta d\Theta d\phi \qquad (2)$$

Here the projected area is replaced by the equivalent area A of the antenna multiplied by a directivity function, $F(\Theta, \phi)$, which in general is more complicated than the cosine of the angle which applies at optical frequencies.

Integrating over the frequency interval gives the bandwidth B which may be taken outside the integral sign. The specific intensity multiplied by the directivity characteristic of the antenna must still be integrated over the solid angle. For a uniform source that subtends an angle which is small compared with the acceptance cone of the antenna, this integration gives

$$W_{\nu} = \int I_{\nu}(\Theta,\phi)F(\Theta,\phi)\sin\Theta\, d\Theta\, d\phi = I_{\nu}\,\pi\, R^2/r^2 \qquad (3)$$

Here πR^2 is the area of the source at a distance r. For the sun this is numerically

$$W_{\nu} = 6.795 \times 10^{-5} I_{\nu} \qquad (4)$$

With this introduction let us consider the solar intensity received at the earth's surface throughout the frequency range in which measurements have been made.

Spectrum of the Sun

Figure 1 shows the frequency range at which measurements have been made at the earth's surface.

At the frequencies of the visible spectrum, the sun radiates energy as if it were a black body at a temperature of 6,000 degrees absolute. In the near infrared, the apparent temperature of the sun is about 7,000 degrees absolute, but the energy received at the earth's surface is very much reduced by absorption bands in the earth's atmosphere of methane, carbon dioxide and water vapor. Further toward the infrared the absorption due to water vapor is sufficient to almost completely absorb the sun's rays before they reach the earth's surface. On the ultraviolet side of the visible spectrum the apparent temperature of the sun is somewhat less than in the visible frequency range because of absorption in the solar atmosphere.

In all, there is a frequency range of approximately two decades in and on either side of the visible frequencies at which measurements can be made of electromagnetic radiation from the sun at the earth's surface. On the low-frequency side of this window in the earth's atmosphere there is a frequency interval of approximately two and one-half decades in which the absorption from atmospheric gases is practically complete.

There is another window in the earth's atmosphere beginning at a frequency of about 3×10^{10} cycles per second (wavelength of one centimeter) and extending toward the lower frequencies to the region where the earth is shielded from extra-terrestrial radiation by its own ionosphere. This window extends over a frequency range of about three and one-half decades. Accordingly, radio astronomy enjoys a wider window in the fre-

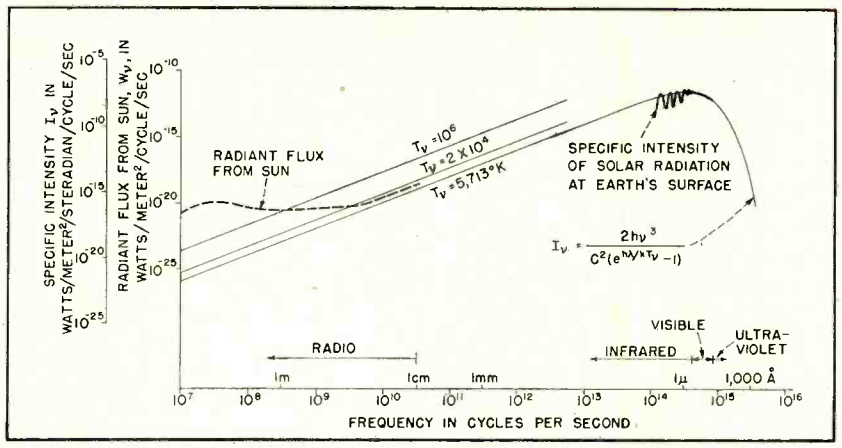

FIG. 1—Solar spectrum, with heavy solid curve showing optical window to sun through earth's atmosphere and heavy dashed line showing newly utilized radio window. Light lines show specific intensity that would be radiated by a black body of temperature T_ν

SIGNIFICANCE

For radio engineers: more accurate predictions of optimum operating frequencies, since activity on the sun affects the ionosphere.

For astronomers: a more accurate means of measuring the plane of our galaxy and making heretofore impossible measurements contributing to knowledge of the universe.

For meteorologists: a means of monitoring the complete thickness of the earth's atmosphere, in contrast to sounding measurements that go only to the height of maximum ion density.

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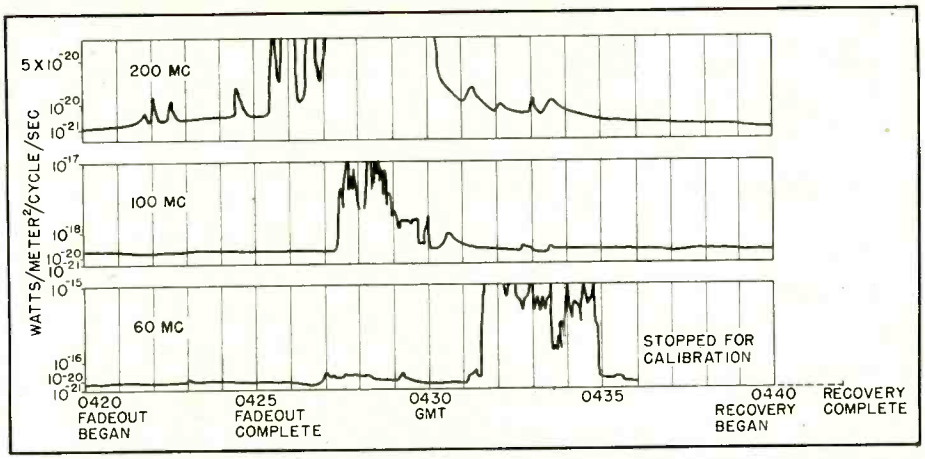

FIG. 2—Time sequence of a solar noise burst on three different frequencies, showing that such noise occurs first on the highest frequency. Time delay is that required for disturbance to propagate within solar atmosphere to height from which it may be radiated into space

quency spectrum than has been available to astronomers heretofore.

In the microwave region the apparent temperature of the sun is only slightly more than in the visible frequency range and is substantially independent of time, but in the meter wavelength range the radiation from the sun is variable and considerably greater than would be radiated by a black body at a temperature of 6,000 degrees absolute. This minimum radiation, called quiet sun, corresponds to an apparent temperature of approximately 1,000,000 degrees. This is not as startling as it appears, since spectrographic measurements in the visible and ultraviolet frequency range indicate that the temperature of the solar corona is of the order of 1,000,000 degrees.

In the microwave region the solar ionosphere appears transparent, so that the radiation from the lower regions of the sun is transmitted directly to the earth. At the longer wavelengths the radiation appears to come from a point in the solar ionosphere at which incoming radiation at this wavelength would be almost completely absorbed. As the wavelength is increased, this point goes to higher levels in the solar corona and accordingly to higher apparent temperatures. This theory has been worked out in some detail,[4] and numerical agreement with experimental data has been obtained.

In addition to this radiation from the quiet sun, which may be thought of as a temperature radiation from an equivalent black body, there are bursts of solar noise having from one thousand to ten thousand times the radiation from the quiet sun in the meter wavelength region. Sometimes these bursts of solar noise have been observed to occur at approximately the same time at different frequencies, in a time order that is suggestive of a disturbance that originates in the lower regions of the solar atmosphere and is propagated outwards with a velocity reasonable for material particles.

The records in Fig. 2 of the time of commencement of a solar burst on 200, 100, and 60 mc show the disturbance reaching the earth first on the higher frequencies and then on the lower frequencies in order.[5] This time sequence is in accordance with Martyn's theory for explaining the apparent temperature of the quiet sun in the radio-frequency region.

The solar record samples in Fig. 3 illustrate three characteristic types of signals that have been received from the sun at Cornell on 205 mc. Figure 3A shows enhanced solar noise, which is characterized by a general increase in level and rapid fluctuations. Figure 3B illustrates the quiet sun with an occasional large burst superimposed. Figure 3C illustrates the solar noise from a quiet sun.

Radio Communication Aspects

From solar noise measurements it is hoped that we will learn more about the sun and how it affects radio-wave propagation. Radiation from the sun provides the ionizing energy for the formation of the ionosphere which makes long-distance radio communication possible. It has been known for a long time that there is a good correlation be-

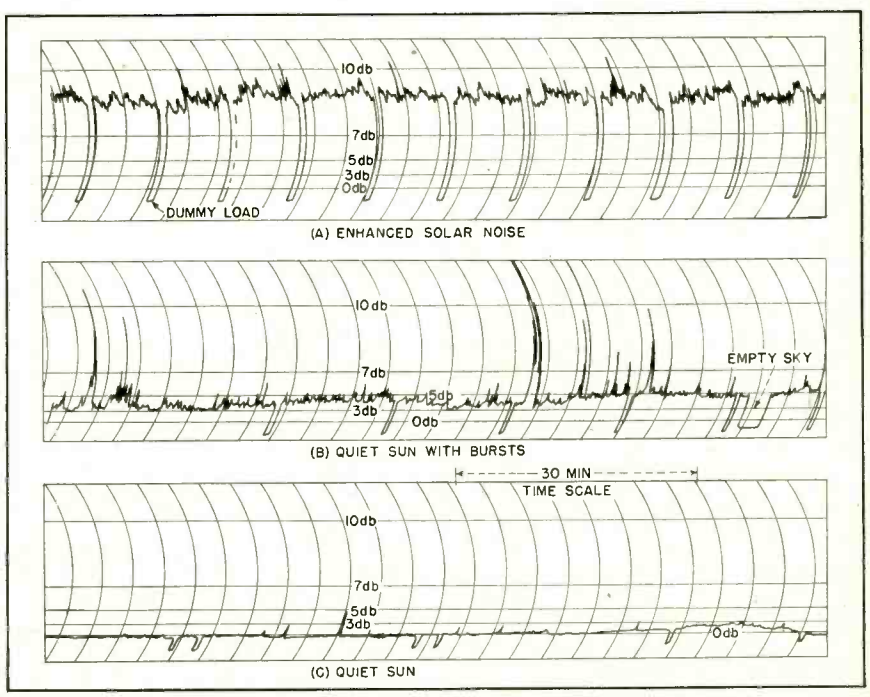

FIG. 3—Simple records of solar noise as obtained at Cornell Radio Observatory. Periodic minimums are reference levels produced by a dummy load. Ordinates are scaled in db above quiet sun

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tween solar activity and variations in radio-wave propagation conditions. Sunspots, faculae, flocculi, magnetic storms, auroras, earth currents, and radio-wave propagation are all related.

Measurements of enhanced solar noise have already shown that there is an intimate relation between it and sunspots. Interferometer measurements[6] made of enhanced solar noise at a time when there was a single large sunspot group showed that the enhanced solar noise came from the same part of the sun in which the sunspots were located. Other measurements[7] on this type of solar noise have shown it to have a component that is circularly polarized, just as would be expected if it were caused by electrons moving in the magnetic field of the sunspot.

Noise measurements during a solar eclipse[8] showed good correlation between the intensity of enhanced solar noise and the area of prominences and flocculi. During totality of the visual eclipse the solar noise was reduced to only 0.4 of its uneclipsed value, indicating radiation from the uneclipsed prominences. These prominences increased the effective diameter of the sun at 200 mc to 1.35 times its optical diameter.

Besides providing us with a new means of observing solar phenomena, the solar noise is in fact a measurement of radio-wave propagation through the earth's atmosphere.

This, then, gives us a means of measuring the propagation of a radio wave that has transversed the entire ionosphere instead of one that goes only to the height of maximum ion density and back, as with the usual ionospheric sounding measurements. Accordingly solar-noise experiments shed light on the earth's atmosphere.

Astronomy Aspects

The contribution of radio astronomy to the knowledge of our galaxy may be even greater than to knowledge of the sun. Our galaxy is thought to be a flat disc-shaped group of stars somewhat similar in shape to the Andromeda Nebula. Our sun is situated near the edge of this disc, roughly one-third of the distance to the center. Estimations of the mass of the galaxy require corrections for the absorption of light by interstellar matter. In fact there is some doubt that we can observe the center of the galaxy at optical frequencies because of this absorption.

The absorption that predominates at optical frequencies decreases rapidly with frequency and should be negligible at radio frequencies. This makes possible more accurate determination of the plane of the galaxy by measurements of the intensity of galactic noise as a function of direction.

Galactic Noise

Contours of equal galactic noise intensity can be plotted on galactic coordinates. The abscissa gives the angle around the plane of the Milky Way and the ordinate gives the angle above and below this plane.

Directional measurements indicate that the maximum radiation is received in approximately the plane of the Milky Way.[2,3,9] In this plane the maximum radiation comes from a galactic longitude of approximately 330 degrees. This is in the direction of the center of our own galaxy in the constellation Sagittarius. There is a secondary maximum at galactic longitude 45 degrees in the constellation Cygnus. This maximum is not as well developed at 160 mc as at 480 mc, presumably due to the decreased directivity of the antenna.

One phenomenon that has been observed in radio astronomy is the existence of intense apparent point sources. These have been plotted

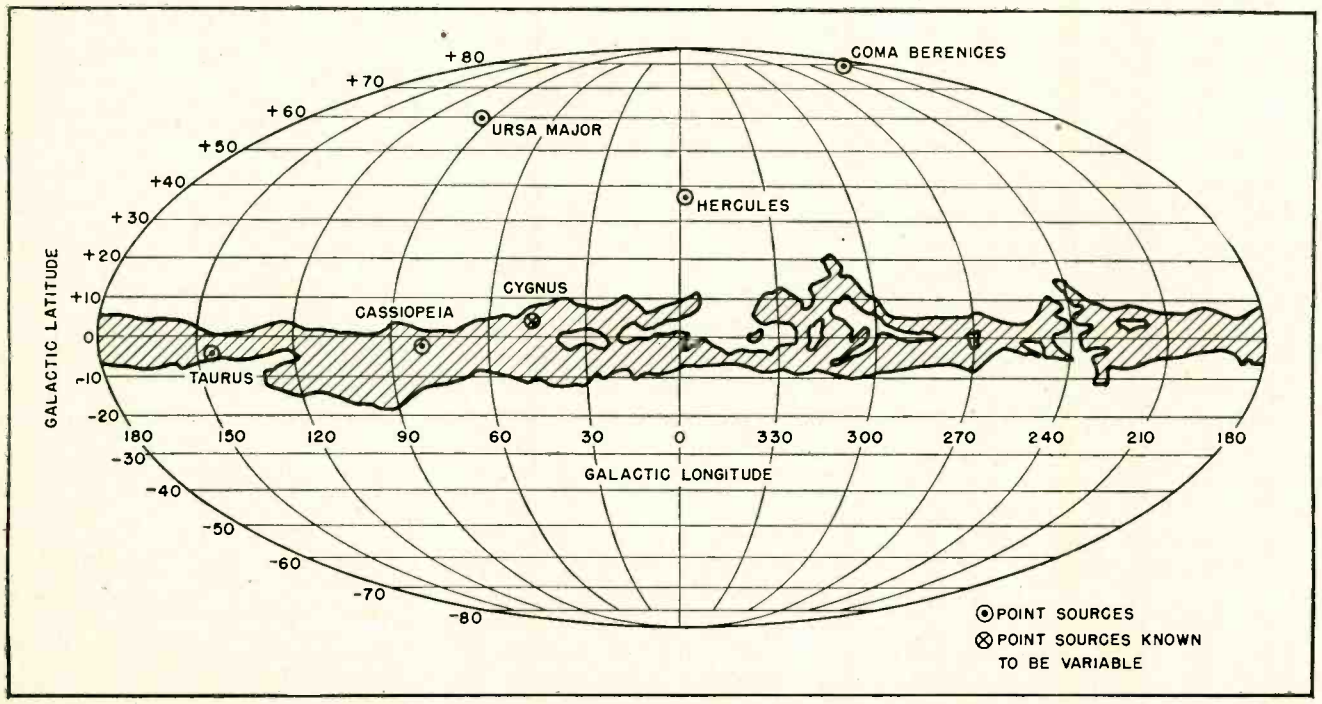

FIG. 4—Locations of observed point sources of intense galactic noise. So far nothing identifiable with the noise has been seen at these points with optical telescopes

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in Fig. 4. By using an interferometer technique, it has been determined that the diameter of these sources is certainly not more than eight minutes of the arc, but even for a source of this size the specific intensity is many times that received from our own sun. In spite of the large intensity of these apparent sources, nothing that can be identified with them has been observed with optical telescopes even though a search has been made in photographic plates taken both in the visible and in the infrared.

Point Sources of Noise

The first point source was observed in the constellation Cygnus.[10] The more exact location of this point source was determined by an interferometer method[11,12], in which it was also possible to determine an upper limit to the size of the source.

One interesting property of this point source is that its intensity varies with time. Measurements of signals from Cygnus have been made on 60, 85, 100, 150 and 200 mc by various experimenters. The amplitude of the variations decreases with increasing frequencies and generally becomes undetectable at 200 mc, though on three successive nights starting Oct. 18, 1948 appreciable variation was observed at 200 mc, as shown in Fig. 5. This point in the sky has been under observation at a frequency of 205 mc, with signals substantially constant.

The variability of the point source in Cygnus has been established beyond doubt[12] by making interferometer measurements at a frequency of 175 mc, using antennas directed at a high angle where the effects of the earth's atmosphere are at a minimum. Using the same equipment, it was found that signals from the source in Cassiopeia were steady while those from Cygnus were variable. Polarization from Cygnus is random rather than circular polarized, as would be expected if it were caused by the same phenomena that produce the enhanced solar noise.

Possible Explanations

Many hypotheses have been put forth to explain the origin of galactic noise, but none can explain the observed phenomena. It may be

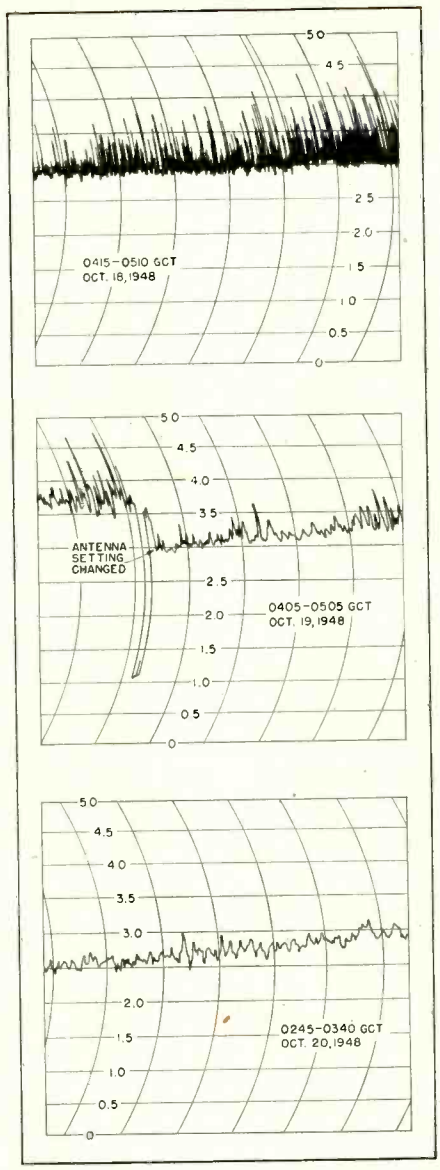

FIG. 5—Variations in noise radiation from general direction of Cygnus on 200 mc as observed by C. L. Seeger and W. E. Gordon on three consecutive days. Only portions of the records for the indicated time intervals are shown

that more than one of these mechanisms combine to produce these phenomena. It may be that galactic noise is caused by a process still unknown to astrophysicists.

One hypothesis is that free electrons in interstellar space may be radiating as classical oscillators. Another hypothesis is that radiation is caused by the free-free transitions of the electrons in the field of a proton. This is the radiation that takes place when an electron approaches a hydrogen nucleus in a parabolic orbit. A more accurate determination of the specific intensity of galactic noise as a function of frequency would help to determine which of these hypotheses, if either, is correct.

A third hypothesis is that galactic noise is caused by the scattering of radiation from type-B stars by electrons in interstellar space. Since this process would result in a preferred direction of polarization, measurements of the polarization of galactic noise will shed light on the correctness of this hypothesis.

Still another hypothesis is that noise is caused by enhanced radiation from stars, similar to enhanced solar noise. Here again measurements of the polarization of galactic noise will be valuable in the interpretation of the data. It has been suggested[13] that there may be enhanced radiation at a frequency of approximately 1,418 mc, which is one of the lines in the hyperfine structure of hydrogen.

There are many questions about both our sun and galaxy that can be answered by the new field of radio astronomy. This branch of science is now at about the point where astronomy was when Galileo invented the optical telescope. Scientists in this new field are just asking themselves the pertinent questions that will be answered in the years to come.

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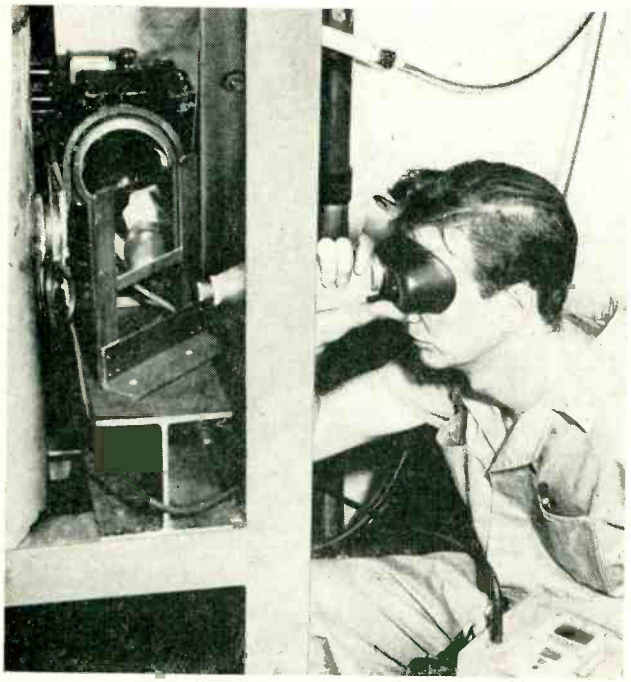
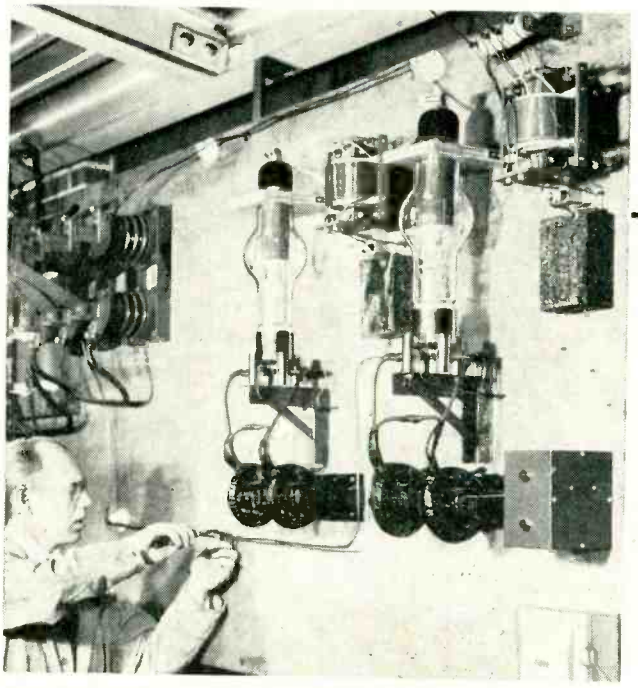
Photoelectric Control of



Photoelectric sensing unit on 15-kw electric furnace. Operator is checking temperature with optical pyrometer through peep-hole. Phototube views flame in 45-degree mirror



Installation of power thyratrons for control of 50 kilowatts of power to resistance-heated specimen whose temperature is being controlled by circuit like that in Fig. 5

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FOR MEASUREMENTS of the properties of materials, and for some production problems, it has been necessary to employ high temperatures which are held constant to within 1 or 2 percent. This can only be accomplished with automatic control of the electric furnace or of the power dissipated in a resistance-heated specimen. The temperature range of interest extends from 1,800 to 5,000 F, or from 1,200 to 3,100 Kelvin.

The function of a control for this application is to hold the temperature constant for a period of time at a value that has been selected with an optical pyrometer. The control performs three functions. It measures the temperature with an energy-sensitive element, converts and amplifies the indication into a variable potential or pulse, and employs the amplified signal to vary the primary heating current. Each of these functions will be considered separately here.

This paper was presented at the 1948 National Electronics Conference in Chicago.

Temperature-Sensitive Element

Representative temperature-sensitive elements are listed in Table I in the approximate order of decreasing time of response to a change in temperature.

The amplitude of the signal from each of these devices can be expressed, for a short range of temperatures, as a power n of the absolute temperature. It is important to investigate the value of n, for it determines the stability required in the amplifier for operation at that temperature. As an illustration, if the temperature changes by one percent, the signal will change by $(1.01)^n$, or approximately by n percent. If the control changes the temperature by an amount that is proportional to the signal, a drift of n percent in the amplified signal must not change the temperature by more than one percent. A drift of n percent in the amplifier may therefore be tolerated.

The second column in Table I indicates the approximate range of values of n for the average element at temperatures of 1,200 K and higher. The last column indicates the amplifier stability required to hold the temperature constant to one percent.

The response of a 919 vacuum phototube to a tungsten filament in a clear bulb is shown in Fig. 1. The value of n varies from 13.4 to 11.3 over the temperature range that was investigated. This is in fairly good agreement with the response reported for barrier-layer cells[1], in which the value of n is reported to be constant over this same temperature range and equal to 12.45.

For the proposed temperature range, vacuum phototubes offered the most promise as sensing elements. Resistance thermometers and attached thermocouples may distort the heat flow or interfere with tests on a specimen. There are no reliable thermocouples for the higher temperatures in this

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High-Temperature Furnaces

Temperatures up to 2,500 C can be held within 1 percent for days. Vacuum phototube serves as sensing element feeding cascaded d-c bridge amplifiers or a-c bridge, followed by amplifier that actuates on-off or continuous phase-shift thyratron control of furnace

range, and both of these indicators require a reference standard that will not be appreciably affected by large changes in ambient temperature which occur near a large furnace. The bolometer and radiation thermocouple have a speed of response that is of the order of a second, which is too slow for some specimens which are heated by passing a current through them.

Vacuum phototubes and their associated resistors are quite stable, and have calculable noise background for known ambient conditions.[2] They are rapid in their response and may be used with or without an optical filter. The greater response from the unfiltered phototube reduces the noise level with respect to the signal and requires less amplification so that this arrangement has always been employed.

One of the more serious objections to the phototube is the necessity for a clean optical system. For operators trained in the use of optical pyrometers, that is not a serious handicap. The phototube must always view a surface with the same optical characteristics. For specimens in inert atmospheres, this introduces no difficulty. With high temperatures in air, the phototube may view a thin target of stable oxides such as alumina or beryllia. This will be satisfactory unless vapors are present that react with the oxide surface or condense on it.

The intensity of radiated energy incident on a phototube observing a given area on a specimen or a furnace wall through a fixed optical system will vary as much as 1,000-fold for the required temperature range. Since the phototube and associated amplifier cannot respond with accuracy over such a large change in intensity, an iris diaphragm is placed in the optical path in the region that has the most uniform illumination, as in Fig. 2.

Table I—Comparison of Temperature-Sensitive Elements Above 1,200 K

Description	n	Amplifier Stability, Percent
Resistance thermometer	<1	1
Bolometer	>4	4
Radiation thermocouple	>4	4
Contact thermocouple	<1	1
Phototube, monochromatic (calculated for 0.8 mu and 1,200 to 2,500K)	13 to 7	7
(measured with green filter for 0.56 mu and 2,100K)	11	
Phototube, unfiltered	13 to 11	10
Voltmeter across load	0.5 to 0.8	0.5

Amplifier Considerations

The d-c amplifier for the phototube may be either the stable zero type or the constant signal amplification type. In the first type, a reference voltage is made approximately equal to the voltage output of the phototube and the difference voltage is amplified. This circuit is as accurate as the zero of the amplifier is stable.

In the second type of amplifier, the iris diaphragm is adjusted to admit approximately the same amount of light to the phototube at each control temperature, so that the output voltage of the amplifier is essentially the same for every temperature to be controlled. The stability here depends on having a constant amplification factor and no zero-drift of the amplifier.

With either circuit, the required amplification is of the same order, for the output must operate the same on-off or phase-shift control to vary the heating current.

With the difference-voltage amplifier, the permissible zero drift is measured in terms of the reference potential, which is balanced against the phototube signal. Quantitatively, the amplifier output voltage drift e_d, the reference voltage e_r

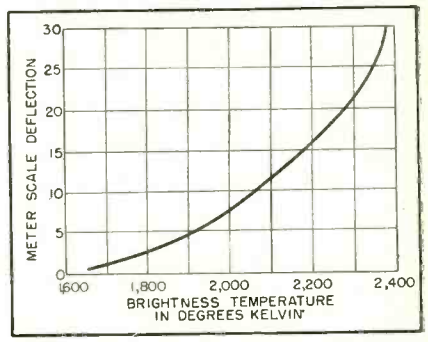

FIG. 1—Response of vacuum phototube with S-1 surface to brightness temperature of a tungsten filament

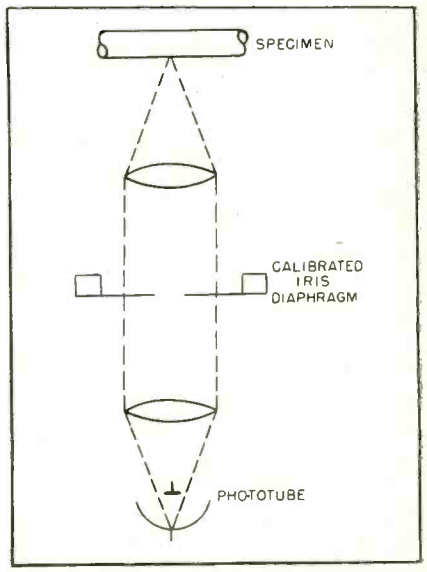

FIG. 2—Method of using iris diaphragm to control amount of radiation reaching phototube. Diaphragm opening may be calibrated roughly in terms of desired range of temperature to be controlled

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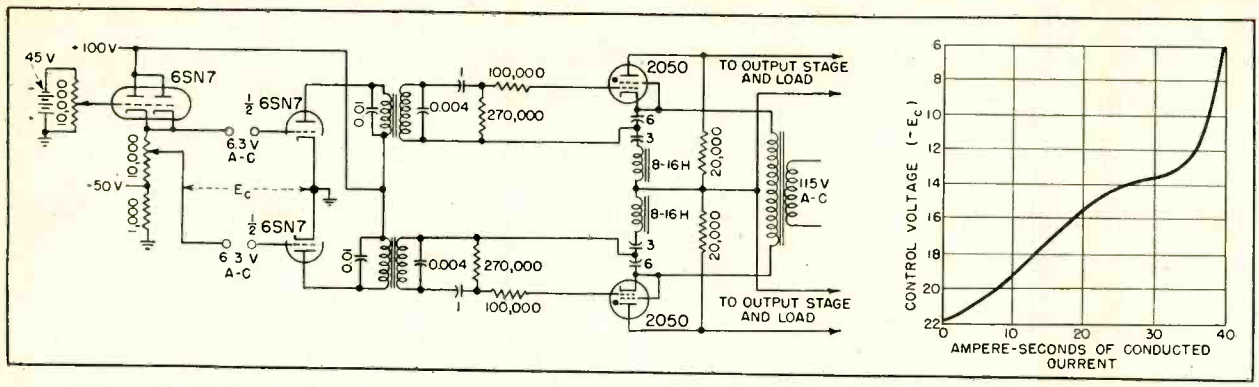

FIG. 3—Circuit for varying phase shift over 360-degree range for temperature control, and performance curve

and the amplification μ are related to the required amplifier stability S, which was shown in Table I, by the relation $S = 100\ e_d/\mu\ e$, percent.

With the constant-voltage type of amplifier, total drift e_D, output signal e, and stability S are related by $S = 100\ e_D/e$, percent.

The value of S in these equations must remain less than 5 percent for a temperature drift of about ½ percent when a phototube is employed as the temperature-sensitive element.

Unless a light chopper is used, the first stage of the amplifier must be a stable-zero d-c amplifier. Bridge amplifiers[3,4] are satisfactory, for the balance position of these amplifiers is very stable when a few simple precautions are employed. Oversize resistors must be installed, in positions where they are not affected by heat from the other components of the circuit. The unbalance signal from the bridge amplifier is, however, dependent on the voltage applied to the bridge.

The remainder of the amplifier may be of several types. Cascaded bridge amplifiers are stable in theory, but difficulties arise in the cascaded stages from the charging current to the filament through the filament transformers and from other sources. A more satisfactory solution is to employ a regulated a-c voltage on the bridge-type amplifier. The output of the bridge amplifier will then consist of pulses that can be amplified to any desired amount by the more stable a-c amplifiers. A feedback amplifier has proved quite satisfactory. The oscillating amplifier[5] with feedback at a different frequency appears to have promise.

For furnaces and massive devices without large heat capacities, an on-off control for 10 to 15 percent of the heating current is sufficient to control the temperature to 1 or 2 percent. For resistance-heated devices with very rapid response and for very accurate control of furnaces having large heat capacity, a phase-shift control for the heating current is desired.

The phase-shift control developed by General Electric[6] has given excellent regulation. This control varies the firing time of two thyratrons which are connected in opposite directions across a resistance in series with the load. The thyratrons are fired in the same phase position on the positive and negative half-cycles.

A modification of a recently described 360-degree phase-shift control[7], shown in Fig. 3 with its performance curve, appears to provide more efficient control. With the 360-degree control, the thyratron on the negative half-cycle conducts for the entire half-cycle before the thyratron on the positive half-cycle starts to conduct. A more uniform current control is obtained if the thyratron on the positive half-cycle starts to conduct when the negative thyratron is conducting for 120 degrees. As the phase shift is continued to increase the current, the thyratron on the negative half-cycle will conduct for 180 degrees when the thyratron on the positive half-cycle conducts for 60 degrees.

To get data for the curve the phase shift was measured and the ampere-seconds of conducted current were calculated. The phase shift is not linear with the d-c control voltage, particularly at the start and end of the phase shift, but there is a long usable range in which the heating current is almost proportional to the amplitude of the d-c signal. A control with this characteristic will have constant temperature sensitivity over a wider range of line-voltage fluctuations or for a wider range of power requirements.

Temperature Control for Furnace

A satisfactory control for a high-temperature furnace is shown in Fig. 4. The first stage of the amplifier is the bridge circuit, which is operated with regulated a-c plate voltage from a Sola transformer. The output of this stage is coupled into a four-stage feedback amplifier that can give much more than the required amplification, but this number of stages is employed to increase the stability. The output of the final stage is rectified, filtered, and operates a 2050 thyratron with a relay in the plate circuit. This relay controls a shunt contactor that varies the heating current to the furnace by about 10 percent. The furnace with which the control is used operates over the temperature range from 1,200 to 3,000 K and requires a maximum power of the order of 15 kilowatts. Zero drift and amplification are sufficiently stable to limit the drift in eight hours to 2 percent at all temperatures from 1,200 to 3,000 K, which is excellent for an on-off type of control.

Control for Rapid Response

The GE phase-shift circuit was successfully employed in the arrangement of Fig. 5 to control the temperature of a specimen that is heated directly by the passage of a current through it. The specimen

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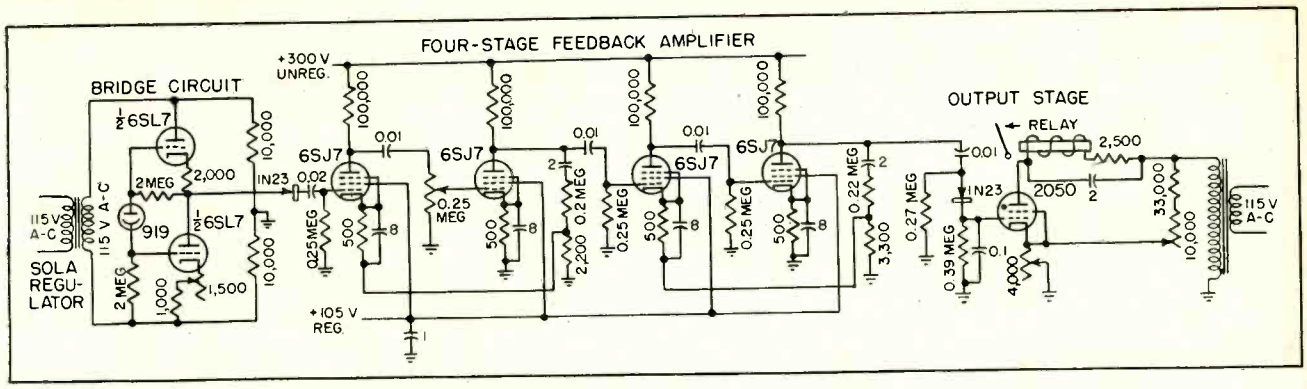

FIG. 4—Temperature control circuit for high-temperature electric furnace

has a thermal time constant estimated to be less than ½ second. For this control it was essential that the time constants in the circuit be minimized. Also, the control had to operate over a continuous range by phase shifting.

With the phase-shift circuit, it is not essential to maintain linearity of voltage amplification. It is more important to increase the amplification to the highest feasible amount. Cascaded bridge amplifiers are employed for the first two stages. The first bridge circuit, fed by a gas phototube having an S-1 surface, is operated on d-c for maximum gain. The circuit is a little sensitive to extraneous fields and care must be employed to balance out the stray capacitive coupling.

The circuit was required to shift the phase of thyratrons on a 4,100-volt Y-connected circuit with the center of the Y grounded. Each line was thus at a potential of 2,300 volts from ground. In order to operate the thyratrons at this potential above ground, an intermediate thyratron circuit was employed. The phase is shifted on 2050 thyratrons and their plate current is coupled to the grid resistors in the high-voltage line by transformers that have very small primary-to-secondary capacitance.

The control with this circuit was excellent. Over a period of three hours, the temperature of the specimen varied by 7 degrees F as read by an optical pyrometer. Since this measurement of temperature is more accurate than is usually accepted for an optical pyrometer, the specimen temperature could not have varied by more than a fraction of this.

The control shown in Fig. 5 has

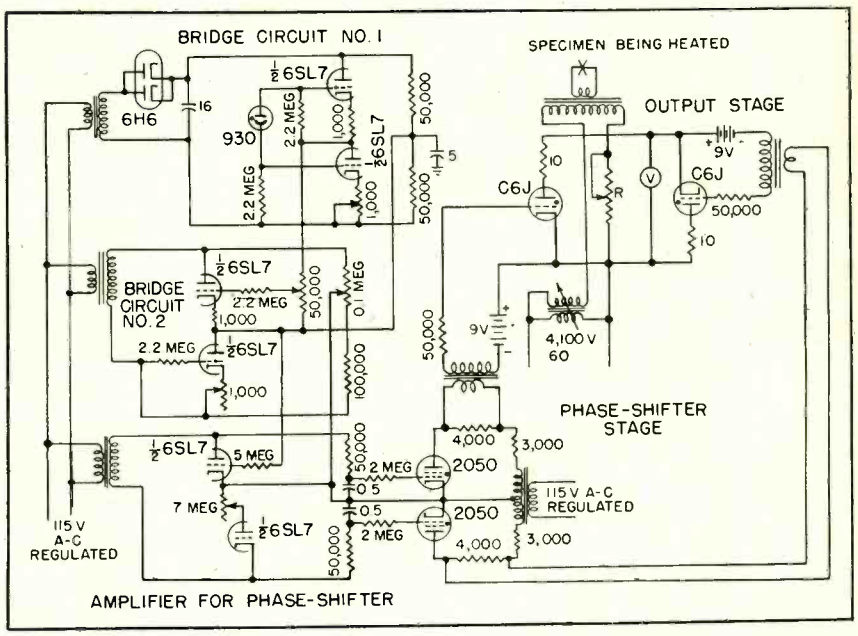

FIG. 5—Temperature control using vacuum phototube as rapid-response sensing element for monitoring temperature of specimen being heated directly by passage of current through specimen

been applied to furnaces and resistance-heated specimens for which the phototube may view a surface that does not change its optical properties with temperature. This includes furnaces with inert gases, and open furnaces in which a thin oxide surface may be viewed. It is particularly adapted to measurement of the physical and electrical properties of semiconductors. In one application, it was applied to resistance welding of steel. The surface was presumed to oxidize in a reproducible manner, and the control was able to interrupt the heating current at a reproducible temperature of the joint. This temperature was only a few degrees below the melting point of the metal. Tests indicated this weld was more reproducible than those made without as close a control of the temperature.

The work on this project was performed by the staff of the Electronics Group at Battelle Memorial Institute. The furnace control was constructed by E. N. Wyler and the specimen control was constructed by V. S. Buccicone and T. N. Hall.

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A-M and Narrow-Band F-M

Part I

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Washington, D. C.

THE investigation reported here was undertaken at the Naval Research Laboratory. It is the latest of several studies made in past years for guidance in choice of modulation type. Every effort was made during its course to insure as thorough and careful a comparison of two basic methods of modulating a radio wave as could be devised.

An ideal fundamental comparison of relative a-m and f-m performance might be made with equal spectrum occupancy and equal radiated power at maximum modulation as basic conditions. The investigation herein reported, however, was conducted with some departure from this ideal. Practical considerations dictated use of a frequency-deviation which resulted in greater spectrum occupancy by the f-m signal than by the a-m signal, and it was found more feasible in both the experimental and theoretical phases of the problem to make the unmodulated rather than the modulated power output of the two transmitters equal.

Any valid operational comparison must be based on identical equipment for both modulation systems, or on equipment with known, accountable differences. The comparison trials described in this paper were made with transmitters and receivers which were identical except for essential differences in the modulator and demodulator elements, and with identical antenna installations. In addition to laboratory and field operational trials, a mathematical study of comparative a-m/f-m performance was undertaken with the intent of determining the applicable theoretical limits, particularly in the weak-signal region into which then available theoretical treatments did not appear to extend.

Examination of all available records of other a-m/f-m comparison trials and investigations has indicated one common shortcoming. In general, the published data on equipment characteristics and operating conditions has been too meager to permit any sound judgment by the reader as to the validity of the tests and the conclusions derived therefrom. The following information concerning operational conditions, equipment characteristics, and data taken is therefore included as a guide to independent judgment and to anticipate some of the inevitable questions.

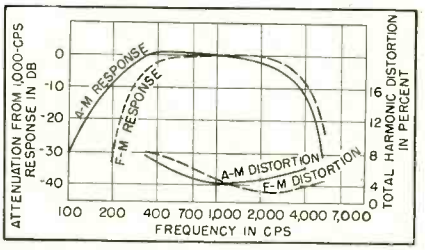

FIG. 1—Audio-frequency response and distortion of a-m and f-m circuits

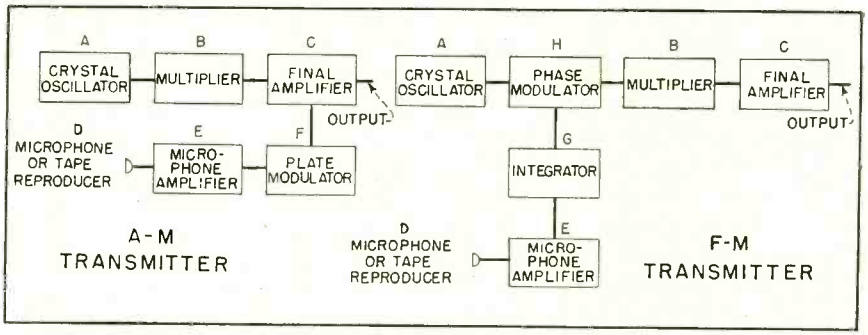

FIG. 2—Simplified block diagrams of transmitter equipment

Operational Conditions

The receiver bandwidth of a radio communication system prior to the final detector is usually determined by the spectrum occupancy of the radiated signal plus the combined frequency stability of transmitter and receiver. In the case of the equipment chosen for this investigation, this bandwidth was 125 kc at −6 db, a figure determined mainly by the frequency-stability consideration. The increased spectrum occupancy of an f-m signal with a modulation index (m_f) of more than 1 could therefore be tolerated, provided that it did not exceed a value of about ±10 kc. A figure for m_f of about 2.3 was adopted, based on a nominal top modulation frequency of 3,000 cps. This choice resulted in a maximum frequency-deviation value of ±7 kc, as compared to a maximum a-m spectrum of ±3 kc. Such a relatively small difference between a-m and f-m spectra (considering the important sidebands only) in an overall bandwidth of 125 kc made it practicable to keep the receiver

NOTE

The editors of ELECTRONICS consider themselves privileged to present, in two parts, this complete report of a long-term study.

The reader should note that the problems of naval mobile service, and the equipment specifications peculiar to its needs, may militate against the use of frequency modulation. Thus the thinking upon which this study is based does not necessarily carry over into land mobile communications nor, as the author himself points out, does it have any bearing whatsoever upon f-m broadcast practice

The opinions or assertions contained in this article are those of the author and are not to be construed as official or necessarily reflecting the views of the Navy Department.

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in UHF Communications

An evaluation of two types of voice modulation, under typical conditions of Navy communications experience and restricted to simple circuitry. Overall physical requirements of mobile equipment designed for this specific service are scrutinized

bandwidth the same for both types of modulation. A value of $m_f = 1$ would have resulted in a maximum deviation of ±3 kc, representing only ±0.0009 percent frequency variation at the carrier frequency used in the tests. Such small variations are difficult to monitor; the errors in measured results would consequently have been greater.

The reference or desired-signal frequency used throughout the trials was 328.2 mc. This frequency was chosen mainly on the basis of a minimum number and amplitude of spurious responses for the transmitter-receiver combination employed. The overall audio response range of the equipment was approximately 300 to 3,000 cps, corresponding to a maximum intelligibility or articulation factor for ideal conditions with male speech of about 90 percent (1 word in 10 misunderstood). Figure 1 shows the overall audio frequency characteristic of the transmitter-receiver combinations, together with a curve of overall harmonic distortion. The receiving equipment was used in narrow-audio condition; the receivers, as determined by signal-generator tests, had a measured harmonic distortion of well under 2 percent at 1,000 cps for 30 percent a-m operation and less than 0.5 percent with f-m up to ±20-kc deviation.

It was decided that, for ease of setting-up and measurement of operating conditions, all single-tone modulation tests would be made at 100 percent modulation with a-m and maximum or peak deviation (±7 kc) with f-m. The actual adjustment of modulation voltage in the f-m transmitters was accomplished by using the carrier drop-out at $m_f = 2.4$, as observed with spectrum-scanning equipment at a modulating frequency of 2,910 cps. Voice modulation was maintained at 30 percent average in the a-m system and at about ±2.1-kc average with f-m. No pre-emphasis or de-emphasis was utilized except in one of the final tests, since, with the i-f and a-f bandwidths employed, both modulation systems were assumed to be about equally capable of improvement by this means.

All output signal-to-noise ratio figures in the graphs and discussions that follow are rms values measured with 100 percent modulation for a-m and ±7-kc deviation for f-m, both with 1,000-cps tone modulation, unless otherwise stated. Thus, if a figure of +30-db output signal-to-noise (s/n) ratio is given, is would be about 10 db less, or +20 db, for 30 percent a-m or ±2.1-kc deviation with f-m.

Choice of F-M Detector

Much thought was given to choice of the f-m limiter and detector combination for the receiving equipment. It was considered essential that, in addition to suitable operating characteristics, this portion of the f-m system should not require any considerable design differences in the circuits preceding it, so that gain, selectivity, and all other characteristics up to the final demodulator stage itself would be identical in both the a-m and f-m receivers. Grid-bias plate-saturation type limiters were considered and rejected as unsatisfactory from the standpoint of their relatively poor impulse-noise limiting, inferior adjacent-channel performance, and relatively high limiting threshold; this latter would have required an additional stage of i-f amplification, which was inadmissible. After examination of the various other possible arrangements, such as the locked-oscillator types, the so-called ratio detector was chosen as the best compromise, with the intent that a subsequent

SUMMARY

A-M is preferable to f-m for certain highly mobile conditions of operation, owing to better weak-signal performance and relative freedom from cochannel and adjacent-channel capture effects, as well as generally lower susceptibility to multipath propagation difficulties.

A-M is preferable from the standpoint of spectrum occupancy, increasingly so as the carrier frequency is reduced.

A-M is preferable from the standpoint of ease of equipment alignment, freedom from detector symmetry and centering limitations, and for tolerance of severe detuning with negligible impairment of performance.

A-M is preferable from the standpoint of circuit simplicity, particularly in the receiving equipment.

F-M is advantageous for geographically fixed communication and broadcast systems with proper planning, particularly if the receiving equipment is carefully designed, operated, and maintained.

F-M is generally preferable for truly high-fidelity reproduction of speech or music, with the same limiting conditions as given in the paragraph immediately above.

F-M, in general, permits use of a smaller transmitter with less required primary power for a given carrier-output rating. By use of various devices in a-m transmitter design, the difference can be reduced if continuous-peak a-m output is not required.

F-M poses a difficult problem of transmitter modulation in crystal-controlled systems, increasingly so as required deviation increases, and may force high-order multiplication not otherwise required or desirable

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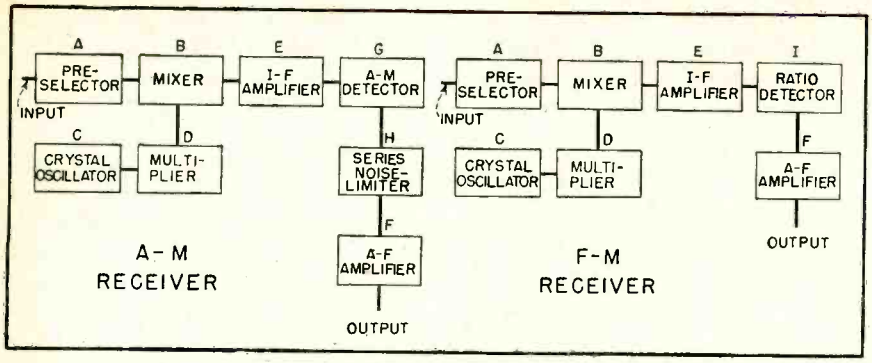

FIG. 3—Simplified block diagrams of receiver equipment

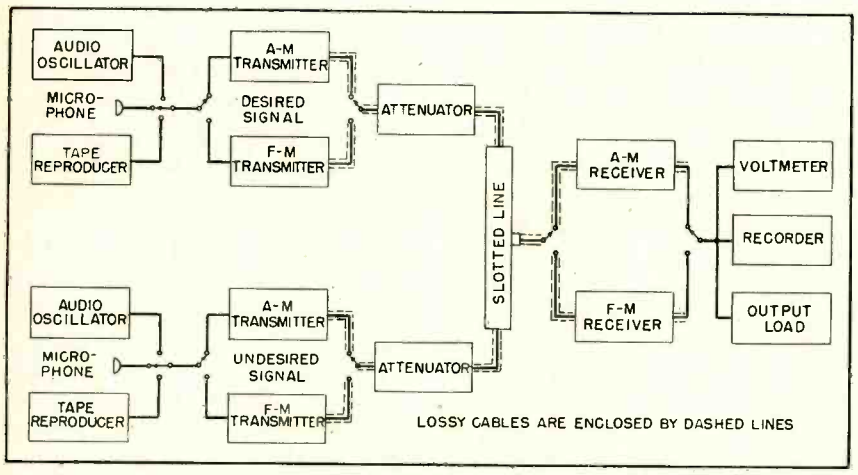

FIG. 4—Simplified block diagram of laboratory trial setup

theoretical analysis would be undertaken before final closing of the a-m/f-m comparison problem to determine how far the ratio detector as used caused departure from the theoretical optimum performance of an ideal f-m system.

The ratio detector, which is essentially a phase discriminator with current-balance rectifiers arranged to provide simultaneous detection and half-wave shunt-diode limiting in the discriminator-secondary circuit, was chosen for the following reasons:

Relatively good impulse-noise performance.
Good adjacent-channel interference suppression.
Small deterioration of signal-to-noise ratio with detuning.
Relatively low side responses.
Required no additional i-f amplification, due to its inherently low limiting threshold.
Provided high-level avc voltage, like that of an a-m diode detector.
Could be readily aligned with an a-m signal generator.

The circuit constants were so chosen as to provide optimum a-m rejection in the weak-signal region of operation, with the downward a-m characteristic as good as possible. This latter was not considered as a particularly serious factor for the purpose of most of the tests, since main reliance was to be placed on the results of laboratory trials, where fading or multipath propagation would not be encountered. It could, however, be a factor in the field tests, provided that the average signal energy reaching the f-m detector fluctuated to a considerable extent at a rate faster than about one-fifth of a second, a figure determined mainly by the detector time-constant. Distortion measurements taken overall showed that the detector linearity was good, the overall harmonic distortion of the receiver being less than 0.5 percent up to ±20-kc deviation with proper centering of the carrier on the discriminator characteristic.

Transmitters and Receivers

The transmitting equipments utilized are shown in block-diagram form in Fig. 2. Elements *A*, *B*, *C*, *D*, and *E* were identical in both the a-m and the f-m equipments; elements *G* and *H* were substituted in the f-m transmitter for element *F* of the a-m transmitter. The amplitude modulator controlled the plate current of the final r-f amplifier and was required to be capable of supplying as much a-f power as needed for 100 percent modulation of the carrier. The integrating network and phase modulator which provided f-m, however, operated at a low power level and demanded much less primary power input than the amplitude modulator.

The receiving equipments are shown in block-diagram form in Fig. 3. Elements *A*, *B*, *C*, *D*, *E*, and *F* were identical in both the a-m and the f-m equipments; element *I* was substituted in the f-m receiver for elements *G* and *H* of the a-m receiver. The duo-diode utilized for *G* and *H* was reconnected to provide the series-aiding diodes of a ratio detector, and a suitable phase-discriminator transformer was substituted for the final i-f transformer normally used in the a-m equipment. The space provided on terminal boards by removal of the a-m detector and limiter components was utilized for the f-m detector components. The result was a neat conversion, with essentially the same selectivity, reserve gain, freedom from regeneration, and fidelity as the original a-m form of the receiver.

As indicated above, separate equipments were used for the a-m and f-m systems. This step was decided on after consideration had shown the impracticality of switching the same equipment from one type of modulation to the other during the tests. The equipment as used essentially satisfied the requirement of an absolute minimum of difference in characteristics and circuits.

Standardization

The performance characteristics of the a-m transmitters and receivers had been thoroughly investigated prior to this problem. Similar thorough studies were made of the f-m transmitting and receiving equipment before starting the system trials. The measurements included determination of the noise factor (*nf*) of each receiver from the antenna circuit to the plate of the final i-f amplifier. The receiv-

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ers were then standardized in pairs, a pair consisting of one a-m and one f-m equipment, each with *nf* within 1 db of the other. It was subsequently found, as expected, that differences in standard sensitivity figures checked quite well with the differences observed in *nf* between receivers, and further checking of pairs for *nf* was done in terms of standard sensitivity. Standardized pairs were used throughout both the laboratory and field tests; these pairs were substantially identical in all characteristics, facilitating the segregation of differences in system performance due to modulation type by cancelling out, in effect, the equipment factor. It was found unnecessary to standardize the transmitters, since the unmodulated power output and degree of modulation, which were the factors of main importance, were easily adjusted and measured in each individual set-up.

Since close alignment of the desired signal to the center frequency of the f-m detector was considered essential for optimum and consistent results, a particular effort was made to select standardized or paired control crystals for each f-m transmitter and companion receiver. The crystals were selected so that the f-m system was within ±5 kc of centering in its receiver pass-band at the signal frequency chosen, giving an overall accuracy of about ±0.0015 percent provided the discriminator circuits were very accurately aligned. Similar standardized control-crystal pairs accurate within ±20 kc were used for the a-m equipments. Crystals were also selected for detuning, cross-modulation, and other off-channel tests.

Records and Maintenance

Careful records of technical data and meticulous maintenance of equipment in top operating condition are essential in an investigation involving as many observers and tests as did the subject study. All pertinent and useful data were recorded in written form; additionally, magnetic-tape records were made of all significant audio output, to permit subsequent comparison and evaluation. The audio records were considered of particular importance in the analysis of such items as difference in character of noise output from the two systems, presence or absence of transient effects such as swish, the auditory masking caused by heterodyne beats, and other conditions not apparent from meter readings alone. Paper-backed magnetic tape was used, recorded in modified Brush magnetic-recording equipment. This tape could be readily edited, permitting easy juxtaposition of significant sections for immediate comparison or the shortening of long runs of data to the essential material for analysis. The frequency-response, dynamic range, and other important characteristics of the recording system were satisfactory for the purpose intended.

All transmitting equipment was thoroughly checked before each run, including such modulating equipment as was involved in the particular test. Transmitter power output and modulation level were carefully maintained during the runs. Likewise each receiver was checked for alignment, sensitivity, and bandwidth before each test, using calibrated standard signal generators, with particular attention to centering and symmetry of the f-m detectors.

The laboratory trials utilized the receiving and transmitting equipments described above, with simulated propagation paths consisting of lossy cables and special attenuators of 50-ohm characteristic impedance. Figure 4 shows the setup in block-diagram form. One or more signals could be simultaneously provided in the system; such signals could be any desired combination of modulated carriers, unmodulated carriers, and impulse-type noise.

Intelligibility tests were made using standard word lists and also connected prose, and the relationship of intelligibility with both types of test material to the output signal-to-noise ratio with the approximately 300 to 3,000-cps audio band utilized was established.

Field Trials

Sea trials were conducted, in

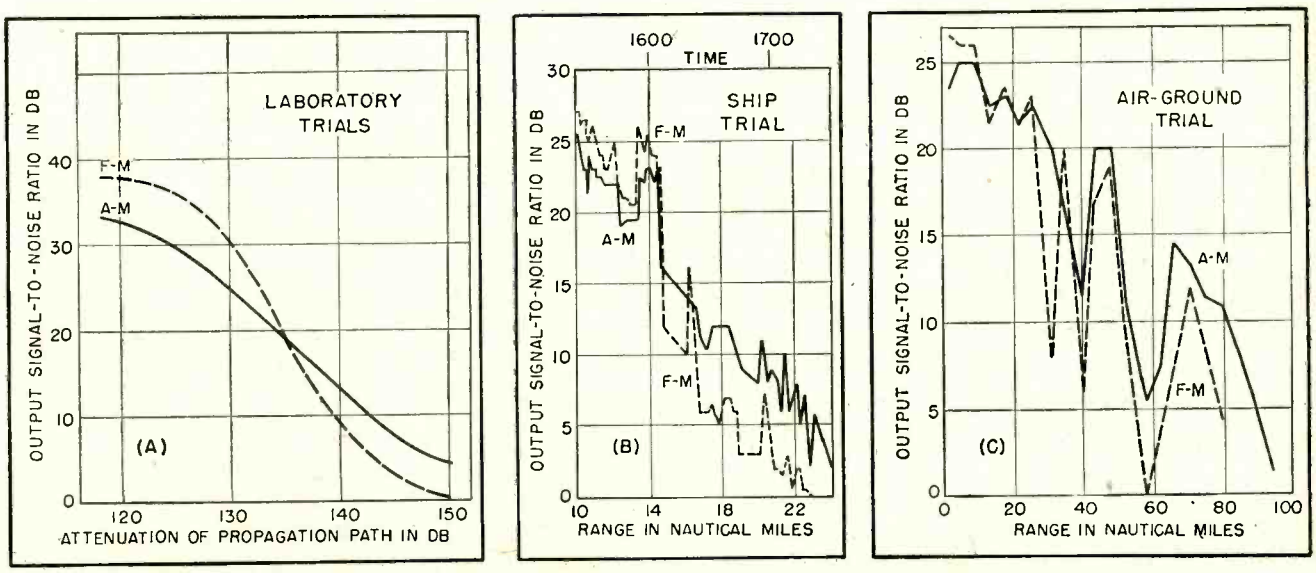

FIG. 5—Trial runs, (A) average of six laboratory tests, (B) ship trial, and (C) air-ground range

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which three ships were utilized to permit controlled measurements under both single-signal and two-signal conditions. The radiation patterns of all antennas used were carefully determined; these patterns were utilized in planning the ships' courses and allowable deviations therefrom. Similar tests were made of air-to-ground transmission, with the ground station located at one of the field activities of the Naval Research Laboratory, in cooperation with properly equipped aircraft. Radar noise-interference tests were also made.

Two factors were considered of major importance in this problem. The first was the relative operational performance obtained with the two types of modulation, and the second, the influence of the modulation type on the physical design and maintenance requirements of transmitting and receiving equipment.

Since the a-m and f-m systems under consideration were identical with respect to the gain and bandwidth of the audio, intermediate-frequency, and radio-frequency portions of the receivers, it was feasible to make comparisons on the basis of the output signal-to-noise ratios (s/n) obtained for given values of carrier level at the input to the receiver equipment. The performance comparisons which follow are based on this premise. Many factors combine to make it difficult to designate any given single output s/n ratio as an absolute minimum standard of communication. A series of investigations was made, however, to establish an approximate absolute low-limit of output s/n below which intelligible voice communication should not be considered as normally possible without repeats. This absolute low-limit rms s/n figure was found to be about +5 db (for peak or 100-percent modulation) for the audio band employed (approximately 300 to 3,000 cps), as determined by laboratory intelligibility and field communication tests using connected prose. The operational figure for minimum acceptable s/n ratio for safe communication employed by several military laboratories is between +16 and +20 db for peak modulation. It is understood that figures of +30 db or over are generally preferred for good land-line telephone practice. It should be emphasized that the +5 db s/n value is an absolute low-limit for the 300 to 3,000-cps audio band, which can be tolerated as a transient condition but not used as a design figure for safe-communication range.

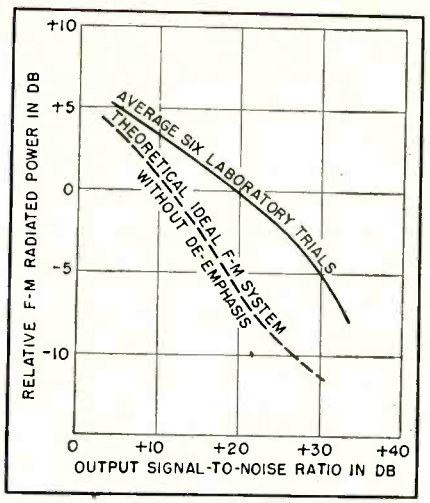

FIG. 6—The f-m/a-m power relation, no interference

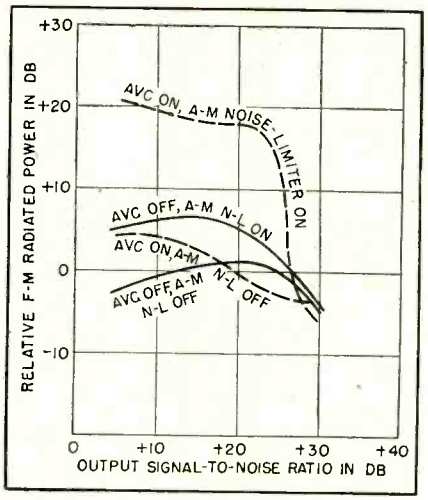

FIG. 7—The f-m/a-m power relation, impulse interference

In most tests, the receiver output voltages, both signal and noise, were measured with vacuum-tube voltmeters which gave rms indication. In some cases, the signal was separated from the noise by very sharp filters and corrected to give rms values.

In evaluating any communication system, two major operational conditions require examination: single-signal operation, that is, only one signal carrier present in the system; and multiple-signal operation, with two or more signal carriers simultaneously present in the system.

In the comparisons reported herein, both single-signal and multiple-signal operation were investigated. Although many single-signal characteristics of the equipments used were separately studied and compared, the single-signal operational factor considered of greatest importance in this report is that of relative range, which is indicative of relative radius of communication. In the multiple-signal case, three different conditions of operation were studied:

A desired signal in the presence of the undesired signal, where the undesired signal was in the form of spark or impulse noise (noise interference).

A desired signal in the presence of an undesired signal, where both had the same characteristics and the undesired signal was on the same carrier frequency as the desired signal (common-channel operation).

A desired signal in the presence of an undesired signal, where both had the same characteristics except that the undesired signal carrier was separated from the desired signal carrier by a frequency interval of one channel or more (adjacent-channel operation).

As indicated, multiple-signal operation studies were confined to two-signal conditions; time, unfortunately, did not permit three-signal investigations.

Range and Noise Trials

In the laboratory trials, the range data were obtained in terms of $(s + n)/n$ output ratio versus db attenuation in the transmission path. In the field trials, the output $(s + n)/n$ ratios were measured in the same manner as in the laboratory trials but the attenuation was determined in terms of distance. Data were taken in both cases which allowed conversion of the transmission-path attenuation and the distance into microvolts input to the receivers.

Two separate forms of noise interference were investigated, namely, radar interference and spark-noise interference. Radar effects were studied under the worst possible conditions of antenna spacings and equipment separation. No precautions were taken to filter the power lines of the equipments involved. The receivers used were

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energized from the same unfiltered power source as the radar equipments. Various pulse lengths, repetition rates and radar carrier frequencies were selected with the intent of producing maximum interference with a desired signal. In the case of the spark-noise tests, a value of 45 microvolts spark noise (quasi-peak) was selected as representative of the general noise level which previous measurements had indicated would prevail under average naval shipboard conditions. It is considered doubtful, however, that a noise level as high as 45 microvolts would be encountered in the regions where uhf receiving antennas are normally located. Operation with other levels of spark-noise interference (250 and 3,000 microvolts) was also investigated, with substantially the same results as obtained with 45 microvolts. The spark-noise generator employed was essentially a spark transmitter tuned to provide maximum energy in the range from 280 to 380 mc; its output spectrum resembled that produced by motor commutator noise.

Common-Channel Trials

Two separate effects are encountered in common-channel operation. One of these is the so-called capture effect, which manifests itself as a suppression or depression of the desired-signal output in the presence of an interfering signal on the same channel. This effect normally occurs in both a-m and f-m systems, although to a different degree. If the two carriers are of identical frequency so that there is no resultant beat, or if the carriers are sufficiently displaced in frequency so that no audible beat is produced, the capture or signal-depression effect will be more apparent, generally accompanied by variation in output noise level. If the carrier separations are such that the heterodyne products fall in the audible range, heterodyne-tone masking of the desired signal will occur, making it difficult to segregate the capture phenomena.

In these trials, as previously mentioned, a consistent effort was made to secure identical carrier frequencies for both the desired and interfering signals. Due to unavoidable variations between the control crystals, audible heterodyne-tone effects were encountered in most cases. Therefore, common channel operations were evaluated on two bases. In the laboratory trials, capture effects were segregated by the use of extremely sharp filters. The combined effects, in both the laboratory and field trials, were evaluated using speech intelligibility or articulation techniques. For the purpose of the capture-effect comparisons, a depression of the desired signal output to 30 db below its interference-free level was chosen as the standard of comparison. This value of 30 db represents the maximum depression of desired signal output level beyond which it was considered no longer practicable, under normal operating conditions, to obtain intelligence from the desired signal in the presence of the interfering signal.

Adjacent-Channel Trials

In the adjacent-channel interference studies, the cross-modulation measurements were made employing standard Navy techniques. Some of the 30-db-below-30-watts interference measurements with a-m were discontinued at separations of 2.4 mc, since closer frequency spacings appeared to result in direct breakthrough. Information obtained subsequent to these measurements, however, indicated that direct breakthrough actually occurred at frequency spacings of about 1.2 mc for both the a-m and f-m systems.

The standard interfering signal level of 30 db below 30 watts (1.23 volts rms) was adopted as representing the maximum likely interference to be encountered in uhf shipboard installations with present transmitters. The output s/n ratio depression effects are considered to be largely caused by carrier interference phenomena in the limiters and final detector, with possibly some mixer saturation effects. The onset of these effects was indicated by desired signal output decrease or noise output level increase, or, more usually, by the occurrence of both changes simultaneously in the presence of the interfering signal.

Range Trial Results

The average of six laboratory range runs is plotted in Fig. 5A. Increasing attenuation in the propagation path, shown as the abscissa, is equivalent to a decreasing level of signal input to the receivers, such as would result from opening the range in field tests. Figure 5B is part of the record of one of the field tests in the medium and weak-signal region, made with two ships drawing apart in an open-sea area about 200 miles from land. It shows the fluctuations in signal level which make field data more difficult to interpret than controlled laboratory test data. Figure 5C is a similar graph for air-to-ground transmission. These last tests were characterized by very rapid fluctuations of signal input level, which tended to obscure differences in performance by introducing meter lag effects and increasing the difficulty of averaging input and output meter readings. In general, however, the data for all tests indicated a crossover of the a-m and f-m

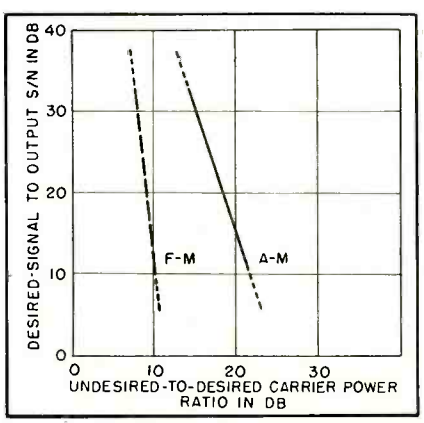

FIG. 8 — Cochannel operation, capture effect

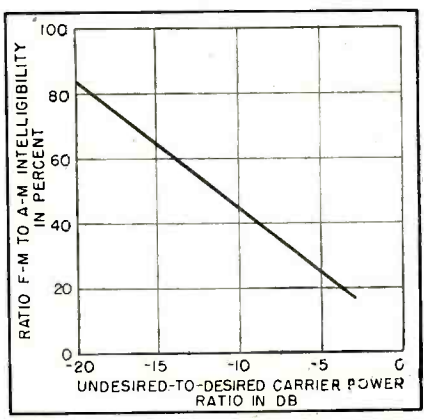

FIG. 9—Cochannel operation, intelligibility test

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range curves at output s/n ratios between +14 and +20 db.

Figure 6 shows the transmitter power increase (or decrease) required to provide the same output signal-to-noise ratio with f-m as obtained with a-m for the same range or distance from the transmitter. This comparison is based on the laboratory trials, which were essentially confirmed (within 5 db) by the associated field trials. The transmitter unmodulated carrier output power requirement is the same for both systems at an output s/n ratio of +19 db with the imperfect limiting of the ratio detector. For s/n ratios of less than +19 db, the f-m transmitter requires more unmodulated carrier power, while the converse is true for s/n ratios greater than +19 db. The dashed curve shows the theoretical comparison based on an ideal f-m receiver with perfect limiter. Under these conditions, the same a-m and f-m transmitter unmodulated power is required for +11-db output s/n ratio, with the f-m transmitter requiring about 0.7 db more power than the a-m transmitter for each db decrease of s/n ratio below +11 db and about 0.7 db less power for each db of s/n ratio increase above +11 db.

Radar Interference Test Results

In the two-signal investigations, in which the interfering signal was a pulse-modulated off-channel carrier, radar transmitters were used to produce the undesired signal.

With radar frequencies from well below to well above the desired signal (all outside the receiver signal band), peak-power outputs of very high level, pulse durations ranging from very short to long, and pulse repetition rates covering a wide range, no observable interference output was noted from the f-m receiver under any conditions. Some interference was observed in the a-m receiver output, but this was completely eliminated when the noise limiter was turned on. Spacings between the radar and receiver antennas were adjusted to produce maximum possible interference. Actual antenna separations ranged from one-quarter inch to ten feet. Various levels of desired signal were used, with the receiver on a channel frequency of 328.2 mc.

Impulse-Noise Test Results

In the two-signal studies in which the interfering signal was impulse-type noise, the spark generator previously mentioned was used to provide a broad spectrum of interference which centered close to the desired-signal frequency. The results of these studies are shown in Fig. 7, in the form of the f-m transmitter power increase (or decrease) required to provide the same s/n output ratio with f-m as obtained with a-m for the same distance from the transmitter.

The curves indicate that for s/n ratios of +25 db or less, the a-m system with noise limiter on requires less transmitter power than the f-m system and, conversely, for s/n ratios above 25 db, the f-m system requires less transmitter power than the a-m system. The avc conditions marked on the curves apply to both the a-m and the f-m receivers. The large difference between a-m and f-m performance with avc on is believed to be due mainly to the avc bias generated by the noise impulses, which reduced the receiver gain to a level not favorable to best f-m limiter action. Incorporation of an f-m limiter more nearly approaching the theoretical ideal should result in more nearly equal performance between the f-m system and the a-m with noise limiter on.

Common-Channel Test Results

Figure 8 is a plot of the capture effect encountered in two-signal operation, with both the desired and undesired carriers nominally of the same frequency and the undesired carrier exceeding the desired carrier level. It was measured by segregating the desired signal from other masking output, such as heterodyne beats by use of a sharp filter (wave-analyzer). The graph shows that for a desired-signal output s/n ratio on the order of +15 to 20 db, the a-m system can withstand an interfering carrier level about 10 db higher than the f-m system for a 30-db depression of the desired signal. Incorporation of limiting more nearly approaching the theoretical ideal would re-

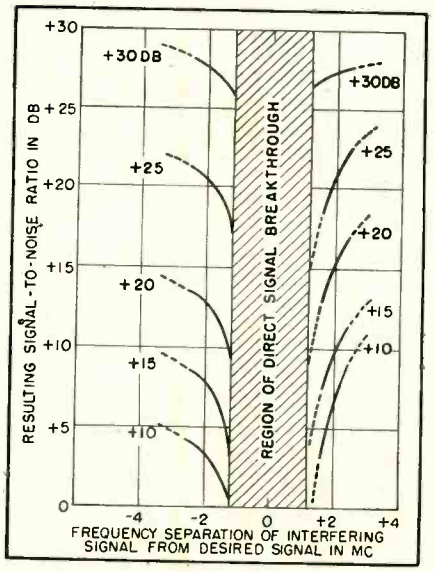

FIG. 12—Depression of s/n by adjacent f-m carrier

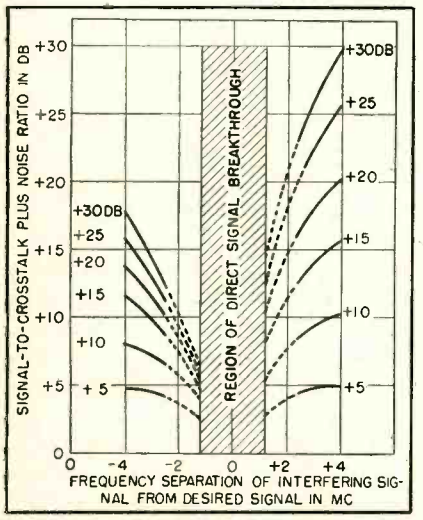

FIG. 10—The a-m crosstalk from adjacent channels

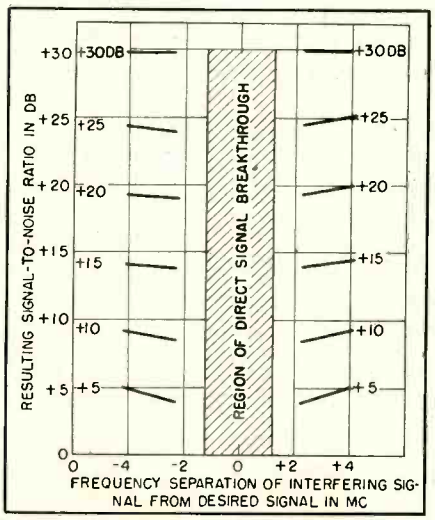

FIG. 11—Depression of s/n by adjacent a-m carrier

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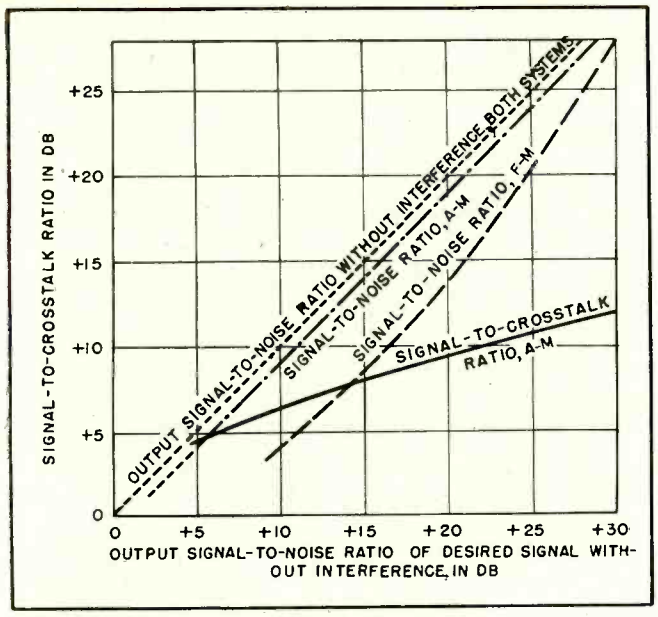

FIG. 13—Adjacent-channel operation, interference 2.4 mc below

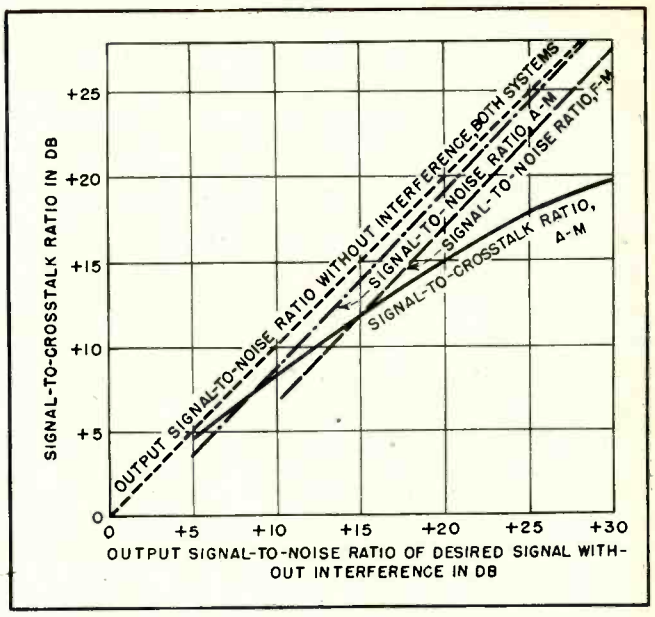

FIG. 14—Adjacent-channel operation, interference 2.4 mc above

sult in slight increase in slope of the f-m capture curve, resulting in greater capture effect, with the 30-db standard signal depression occurring at lower undesired-to-desired carrier ratios.

Figure 9 shows an intelligibility comparison with the undesired carrier below the desired carrier level. No output components were filtered out in this test. The graph shows the number of words correctly understood when listening to the f-m system for each one hundred words understood with the a-m system; it is comparative and does not show the absolute intelligibility of either system. The average a-m intelligibility was, however, in the order of 50 percent between −10 and −20 db undesired-to-desired carrier ratio. The a-m and f-m systems employed in the laboratory tests had a measured audio distortion overall of about 5 percent at 1,000 cps, as previously indicated.

Figures 8 and 9 together cover input ratios ranging from an undesired signal well below the desired signal level, under which condition masking by heterodyne tone is the main effect, to undesired signals well above the desired signal level, where capture effect is of more importance. Incorporation of more nearly perfect limiting could be expected to cause a greater downward tilt of the curve in Fig. 9, when the comparison is based on the same interference-free output s/n ratio of + 27 db.

Adjacent-Channel Results

Figures 10 and 11 show the cross-modulation and s/n ratio depression effects which occur in the a-m system with two-signal adjacent-channel operation. The cross-modulation curves of Fig. 10 are extrapolated to the region of direct signal breakthrough. The curves show less crosstalk from interfering signals above the desired signal frequency than from interfering signals below the desired frequency. This difference is due mainly to the alignment of the broad preselector circuits preceding and immediately following the first r-f amplifier tube in the receiver relative to the desired carrier frequency.

Figure 12 shows the depression of the s/n ratio of the desired signal in the presence of an interfering signal adjacent in frequency to the desired signal in the f-m system. (A similar difference between the two regions on either side of the desired signal appears as in Fig. 10, for the same reason.) During the course of these trials, no crosstalk due to cross-modulation effects was discernible in the f-m system.

Figure 13 summarizes the effects of adjacent-channel interference in both the a-m and f-m systems, with the interfering signal 2.4 mc below the desired signal frequency at a level of 30 db below 30 watts. From these curves, it is apparent that:

At input signal levels corresponding to an output s/n ratio of the desired signal without interference of +20 db or less, the interfering signal causes substantially constant depression of s/n. This depression is about 1 db with a-m and about 6.5 db with f-m.

Above this +20-db point, the a-m s/n depression remains constant at about 1 db, while the f-m s/n depression decreases.

The major interference effect in the case of the a-m system is the crosstalk resulting from cross-modulation, while in the f-m system it is the depression of the s/n ratio of the desired signal.

If it is assumed that the deteriorating effects of cross talk interference and fluctuation-noise interference are of equal significance, it can be concluded that at input signal levels corresponding to an output s/n ratio below about +14 db without interference, the resulting ratio of desired-signal to interference is higher with a-m than f-m. Above this 14-db point, the converse is true.

Figure 14 is a graph similar to Fig. 13, but with the interfering signal 2.4 mc above the desired signal frequency. The curves show less effect on the desired signal by the interfering signal. The relationships which exist are, however, similar to those shown in Fig. 13. Limiter performance closer to the theoretical ideal in the f-m case could be expected to result in greater output s/n depression effect, with, however, a lower desired-signal input level required to produce the indicated output s/n without interference.

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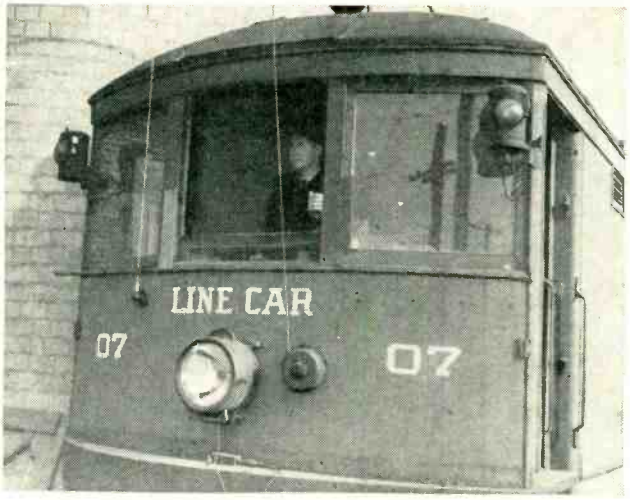
Interior of line car, showing operating position. Busy and call visual signals above and to right of conductor



Philadelphia Suburban line car is in constant contact with dispatcher. Vertical antenna at left of window

Pushbutton Selective

Control transmitter is turned on and a four-digit code is automatically keyed in less than a second after the touch of a button. Selective calling unit employs a unique combination of relays and tubes as time-delay elements, replacing conventional dial. A transit dispatching system is described

THE INCREASING USE of f-m radiotelephone equipment by the various services operating in their assigned frequency bands between 152 and 162 megacycles has created a problem of intraservice interference that has only been alleviated by cooperative sharing plans and operating practices to cut the amount of time that any one station uses its facilities.

One scheme for enhancing the usefulness of any one channel is selective calling together with a lockout system that prevents any but the called station from listening or talking while the selective function is employed. Such selective calling equipment has already been described[1,2] and used. However, selective equipment that encompasses the control of any appreciable number of stations is predicated upon the use of either a telephone type dial or the manipulation of a series of switches in certain sequence. While some services can perhaps afford the time necessary, others, such as taxi dispatching, find that any system taking more time than that required to depress a foot switch is inadmissible.

One of the most usual methods of obtaining a large number of selective combinations is the use of four-digit codes (such as 1126 or 2314) the sum of which is 10. It is the necessity for dialing four digits that takes the time.

Pushbutton Calling

With this problem in mind, The Hammarlund Manufacturing Co. has supplemented its line of dial-operated selective calling equipment with a pushbutton unit that automatically translates the dispatcher's or operator's information into the four-digit 10-total code required by the system. The equipment to be described employs banks of keys numbered from 1 to 84, but these numbers can just as well be replaced by serial numbers associated with the remote station, by colored tabs, letters of the alphabet, or even with pictures or symbols.

In operation, when the desired button is depressed the transmitter is turned on, the selective calling code is transmitted, and the transmitter is again turned off. All three operations are accomplished within about 0.8 second. Only the called station can reply, and visual supervisory signals are illuminated at both the control and remote stations to show the dispatching oper-

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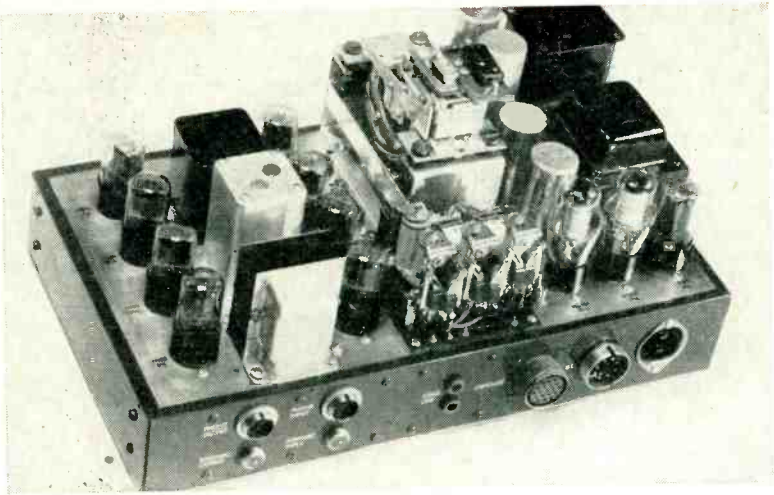

Complete central station coding unit actuated by pushbutton control sends out four-digit cipher

Calling

By J. K. KULANSKY
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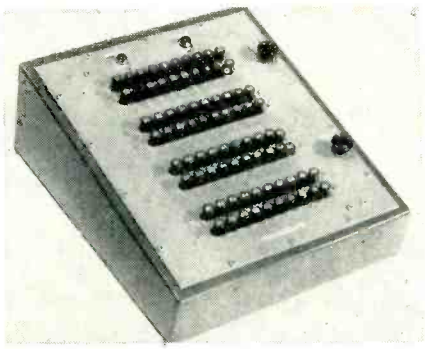

Central station selective control board. Numbers can be replaced by symbols or other designations

ator the condition of his equipment.

Simplex operation (customary practice) can be carried on with the dispatcher turning his carrier on and off by means of a foot pedal. When the call has been completed, the central operator presses his reset button. Within a 0.25-second period the carrier will be turned on, the coded clearing signal sent out to unlock the remaining remote stations, the carrier will go off and the dispatcher's board will indicate that the system has been restored for normal incoming calls, or for another coded outgoing call. If it is desired to call all stations, a single special button is depressed and 0.4 second later all remote stations can talk or be addressed. Multiple calling of certain predetermined groups can also be accomplished in 0.5 to 0.6 second, by depressing a single group button for the section desired.

A complete block diagram for the central station is shown in Fig. 1. The significant elements of the earlier dial-operated coder at the left are interconnected with the newer pushbutton device that can be used to replace the dial. The function of the electronic circuits in the three upper right-hand blocks (V_2, V_3, V_4 in Fig. 2) will be more fully discussed after the action of the system as a whole has been treated.

The stepping switch K_7 associated with the digit storage device is actuated by a solenoid and comprises three pairs of wiping contacts that traverse three 20-position rotary switch banks. Contacts 1 and 11, 2 and 12, and so on, are wired together so that the wipers are always ready to trace out a 1-to-10 sequence without restoring the switch to a neutral position.

Starting a Call

To initiate a call, the proper button is depressed, resulting in the actuation of the coding delay timer V_1 which immediately energizes the delay timer control relay, K_1. The pulse train initiator relay K_5 is then closed, energizing the transmitter control relay which puts the transmitter carrier on the air. At the same time, a green carrier indicator lamp is lighted at the control position. When the period of the coding delay timer V_1 has elapsed, relay K_1 falls back to its normal position to complete the ground path of the rotary magnet circuit associated with the digit storage device. When this ground path through the interrupter contacts K_{7A}, normally closed contacts K_{3}, K_{4A}, K_5 and K_1 is completed, the rotary magnet is energized.

When the rotary magnet armature is pulled closed the pawl on the rotary switch loads a spring that actuates the wiping contacts. When the spring completes the stroke, the interrupter contact K_{7A} opens. At the instant that the rotary magnet was energized, a positive impulse was passed through pulse transformer T_5 to the grid of the pulse train relay generator V_2 which, in turn, operates tone keyer V_6. The tone keyer sends a 3-kilocycle signal through mixer tube V_8 to the audio input of the transmitter.

As contacts K_{7A} open at the completion of the rotary switch initial stepping cycle, a positive pulse is transmitted to digit generator V_3 and relay K_3 is immediately energized. When contacts K_{3A} open, the circuit through the rotary magnet is broken. It remains broken until the time delay in V_3 has elapsed, whereupon the contacts K_{3A} close and the stepping cycle is repeated. The action is such that the rotary switch steps at about 20 pulses per second.

Digit Memory

The digit storage device is interconnected with the pushbutton keyboard so as to set up the proper circuits between contact 10 (and 20) and certain intermediate points

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for the code that is to be transmitted.

For example, the code for button 79 might be 5221 so that contacts 5, 7, and 9 would be connected via button 79 to contact 10. When wiper contact K_{7B} stops on an interdigit rest interval that is so connected, a positive impulse is passed through the digit storage device to interdigit interval timer V_4. Operation of V_4 triggers digit generator V_3 in a manner to be described later so that the digit generator control relay remains operated for a period of approximately 100 milliseconds. At the end of this interdigit space, K_{3A} will again be allowed to close and the rotary switch will complete the keying of the predetermined code group, stopping on the tenth contact. Again the interdigit space will be initiated, and in addition, with K_{3B} closed, the circuit will be closed through wiper contacts K_{7C} to short-circuit the turns of pulse train initiator relay K_5. When the contacts K_{5A} open, the rotary magnet circuit through K_7 opens. At the same time, the transmitter control relay also opens, turning off the carrier and extinguishing the supervisory indicator light. Concurrently, the red call complete or NOT RESET visual indicator lights to show that the selective call has been established (awaiting the answer of the called station) and that all other stations are in the locked-out condition with their busy lamps lighted. The sequence described provides for simplex operation in which a foot switch or other device is used to place the transmitter on the air for subsequent conversations. It is also possible to depress any other call button and establish communication with any other remote station or stations without releasing the first.

For semi-duplex operation, in which the central station transmitter carrier remains on the air for the full duration of the dispatcher's use, the equipment connections are slightly modified by a switch provided. The call is initiated as before except that the duplex relay K_6 is energized simultaneously with the pulse train initiator relay K_5 and maintains the carrier on even after K_5 opens to break the rotary magnet circuit and terminate the coded digit train.

When the ALL CALL button is depressed, the rotary magnet action will continue the stepping switch to the tenth contact without interruption, after which relay K_5 is shut off. Each of the called stations will then be activated to send or receive.

Reset Cycle

At the completion of a call, the reset button is depressed, resulting in the operation of the coding delay timer V_1 and the turning on of the transmitter. A mechanical time delay causes the reset switch to operate the reset translator relay K_4 just before it operates V_1. Contacts K_{1B} turn out the red call-complete lamp and contact K_{4A} opens the lead to the rotary stepping magnet, disabling the calling mechanism during the ensuing recycling operation.

When delay timer control relay K_1 falls back to its normal position, the reset initiator relay K_8 is closed through contacts K_{4C}. Dash gener-

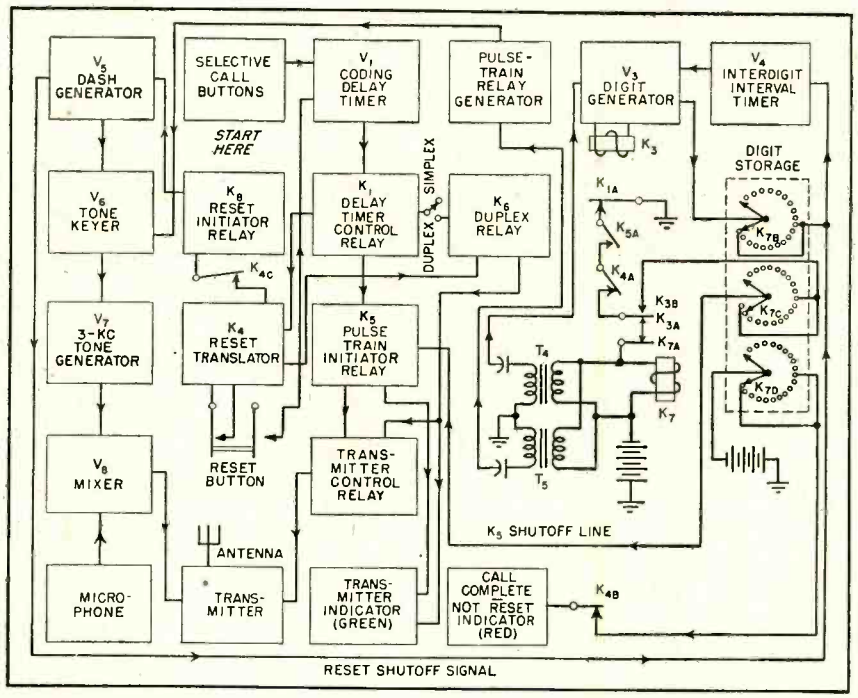

FIG. 1—Block diagram of the central station control and code-pulsing unit

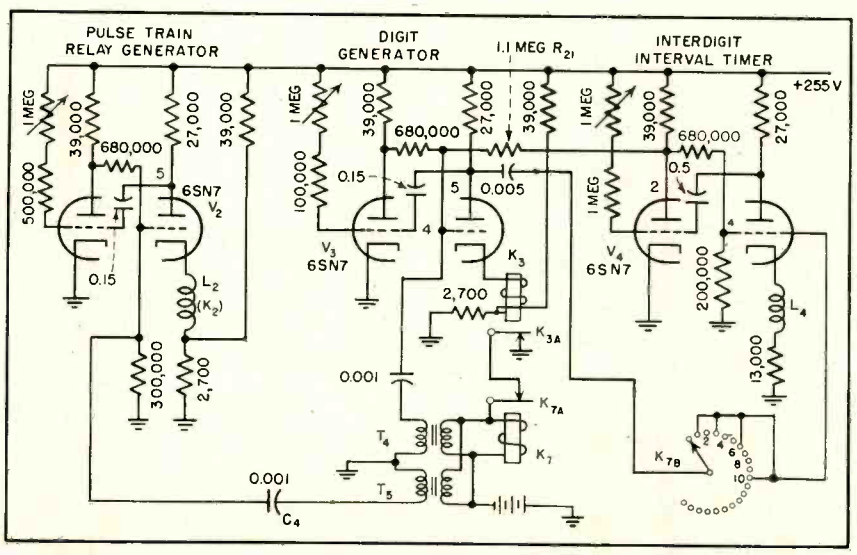

FIG. 2—Circuit diagram of tube and relay elements used to encipher the calling information

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ator V_5 operates tone keyer V_6 and the transmitter is modulated with a 3,000-cycle tone for about 250 milliseconds. At the end of this time interval, a positive reset shutoff signal is passed to the interdigit interval timer V_4. In the same manner as that described above, digit control relay K_3 is energized and shuts off K_5. All remote units are restored to normal and the transmitter is turned off. The control unit will now indicate the normal standby conditions with both lamps off.

Digit and Interval Controls

That the mechanism is a unique combination of relays used in the simplest possible manner together with electron tubes used as delay and pulsing elements is evident from the simplified circuit diagram of Fig. 2. The action of the digit and interdigit controls is explained with the help of the approximate waveforms given in Fig. 3.

When relay K_5 (Fig. 1) closes the d-c control circuit to the rotary magnet K_7 of the stepping switch, the magnet is energized. A positive impulse is transmitted through pulse transformer T_5, through capacitor C_4 to the grid of the pulse train relay generator V_2. The plate (pin 5) will go negative for approximately 0.035 second. The rotary magnet will allow the pawl of the stepping relay to engage the ratchet which in turn will load a spring attached to the wiper arm assembly. In approximately 0.017 second the loading cycle will have been completed and the interrupter contacts K_{7A} carrying d-c to the stepping magnet will be opened. At this time, a positive impulse will be transmitted from pulse transformer T_4 to the grid of the digit generator V_3 and the associated plate (pin 5) will go negative.

At this point, the pawl will return to its neutral position just as the spring recoils and steps the wiper assembly to the first contact. The interrupter contacts K_{7A} will again be closed, but the circuit through the rotary magnet is incomplete because of the open contacts K_{3A} of the operated digit generator relay K_3. When the time interval has elapsed and contacts K_{3A} again close, the cycle is repeated.

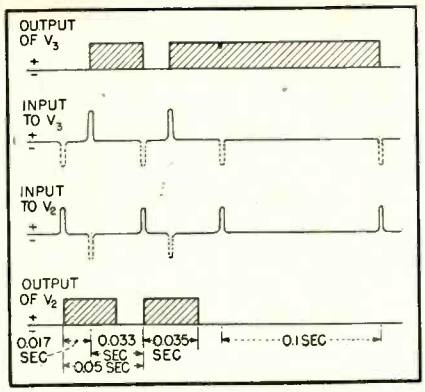

FIG. 3—Waveforms associated with generation of digits and spaces

However, the circuits are set up to restrict the maximum pulse rate to 20 pps. When the wiper contacts of the stepping switch rest on a coded digit interval at the end of a digit generator cycle, a positive impulse is passed from the plate (pin 5) of V_3 through the digit storage device to the grid of the interdigit interval timer V_4.

The impulse, received at the grid (pin 4) together with the accelerated action provided by inductance L_4 provides a rapid firing of V_4. This effect causes the other plate (pin 2) of V_4 to rise rapidly in potential and to accelerate further the rise in voltage of the grid (pin 4) of V_3 through 1.1 megohm d-c coupling resistor R_{21}. There arises a so-called double-cumulative action between V_4 and V_3 that also results in digit control relay K_3 remaining energized for a period of approximately 0.1 second. At the end of this period, K_3 again falls back to normal, closing the circuit to the rotary magnet K_7 through the contacts K_{3A}. The cycle is repeated four times to correspond with the four-digit code set up by the pushbutton control to which the digit storage device is connected. The starting and shutoff cycles are controlled by the relay contacts in the ground control lead of the rotary magnet d-c supply circuit (as shown in Fig. 1).

Mobile Decoder Unit

The decoder unit located in the remote or mobile receiving equipment comprises several miniature telephone-type relays and a stepping switch with ten contact positions. The switch is recycled by means of a return spring with a release magnet to disengage the ratchet detent.

The coded pulse train (Fig. 4) from the pushbutton unit is taken off in the receiver at the discriminator audio output point ahead of any manual volume control. The coded information passes through a bandpass filter tuned to 3-kc. The sharpness of the filters is such that frequency channels 100 kc apart might also be used without mutual interference. The information is then fed to limiter-amplifier V_2 which amplifies only the 3-kc bandpass information to the exclusion of voice frequencies or spurious noise that occurs when a carrier is not present. A second 3-kc filter with an effective Q in the order of 150 causes the pulse detector amplifier V_1 to amplify when a predetermined threshold level is established.

Under these circumstances, a voltage exists via the feedback loop to limiter-amplifier V_2. The effect is to increase the overall gain of the amplifier and cause the pulse detector to operate pulsing relay K_1. When the pulsing relay closes, the stepping switch K_7 advances to the first position. In addition, a signal is passed to the decoding relay K_2 as well as over the release line to the lockout relay K_6.

Initially, the last mentioned operations (decoding and lockout) are used for purposes to be described below. During the space time (no tone) separating the marking cycles (tone on) the lockout relay K_6 is operated through the lockout line and remains energized. When a digit pulse train (the impulses of a single digit) is ended, the pulsing relay K_1 will fall back to the normal position and cause voltage to be applied to the decoding relay K_2 through the coding plug if the first position for this group does not correspond with the code transmitted. In the coding plug all the undesired positions are wired together. The plug bears a code number that represents the unwired or desired positions. The signal response of the decoder can be quickly changed by substitution of a differently wired plug.

Under the call rejection conditions outlined, the decoding relay K_2 will operate the release magnet

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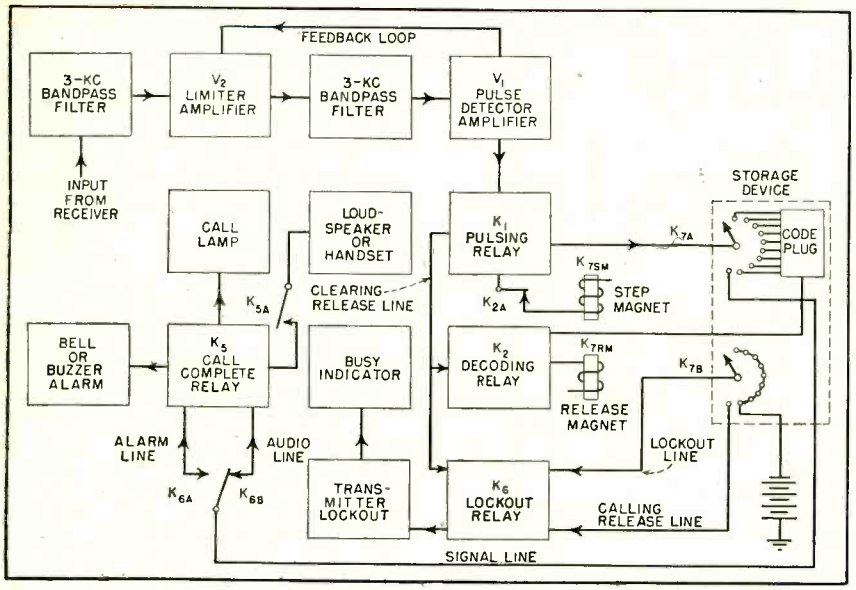

FIG. 4—Simplified block diagram of the mobile decoder attached to radio receiver

K_{7RM} of the stepping switch. When the next code group is transmitted after the 100-millisecond delay, the pulsing relay K_1 operates as before, but does not energize the stepping magnet K_{7SM} in the unit because the decoding relay K_2 remains operated through the marking (tone on) time of the digit pulse train and therefore maintains the decoding relay in its operated position until the entire four-digit code has been completed. Only the called station stepping switch will reach the tenth and final position. All stepping switches other than that at the called station will be resting in a neutral position with lockout relay K_6 operated. Each transmitter will be locked out, the receiver audio muted, and the busy indicator lighted when this condition of call rejection is achieved.

Called Station Operation

In the called station, lockout relay K_6 will be released via the calling release line from K_{7B}. The closed contacts K_{6A} will then operate call complete relay K_5 which locks up. As K_6 de-energizes, contacts K_{6B} close and the signal and audio lines are completed as far as contacts K_{5A}. The call bell or buzzer sounds, and the call lamp flashes. The busy indicator is extinguished and the transmitter lockout is relinquished.

When the operator lifts the handset, the call-complete relay K_5 is opened and the call bell and call lamp are disconnected. As contacts K_{5A} close, the audio line is completed to loudspeaker or handset, and the remote or mobile station is in readiness for two-way private communications. In some types of service, the alarm circuit can be dispensed with and the loudspeaker directly energized, so that the central dispatch operator can talk immediately without waiting for a reply.

If the called station is temporarily unattended and does not answer, a reset signal is transmitted by the central operator to pulse relay K_1 as described. In all mobile equipments it will operate coding relay K_2 which energizes release magnet K_{7RM}. All stepping switches restore to the neutral position and each lockout relay K_6 will be released. Although this operation restores the radio channel to normal standby condition and shuts off the bell at the called station, the lamp remains lighted as an indication that a call was put through in the operator's absence.

System Installations

Pilot models of the pushbutton selective calling unit were put into experimental service more than a year ago for taxi dispatching, greatly reducing the fatigue and occasional operator errors as compared with a dial-actuated system.

Other new users of the system include the Philadelphia Suburban Transportation Co. operating trolleys and buses from the 69th Street Terminal to Ardmore, West Chester, Media, Llanerch, and Sharon Hill. The Media line runs off in a direction essentially southwest. The West Chester line to the west is crossed at Llanerch by the north-south line from Ardmore to Sharon Hill. Total trackage is about 35 miles. Of the 50-odd trolleys, one new car is radio-equipped and also a line car. Although some installations are contemplated in the older cars, 14 new trolleys scheduled for delivery in January 1949 will come completely equipped with selective calling radio. In addition to trolley installations, there are three dump trucks, a panel truck, two line trucks, and two tow trucks now in full operation. Of the 100-odd buses some may be equipped as the need for communications arises.

Two aspects of rail transportation produce a need for selective calling radio. Because a trolley car cannot pass a stalled vehicle it may facilitate transportation to use the remaining single track of a dual-track system for temporary bi-directional traffic. Alternatively, shuttle service on both sides of an obstacle may be a better expedient. With full knowledge direct from the scene of the breakdown, the dispatcher at Llanerch can intelligently direct trolley operations and also call out a line car for towing, or mobile repair equipment over the highways. Because the importance of avoiding mass hysteria and undue anxiety to passengers is well recognized, the privacy of the system by means of selective switching, call buzzers, indicators, lights, and telephone handsets insures that only those who must be involved are aware that a difficulty has arisen.

Acknowledgment

The author acknowedges with thanks the cooperation of all those who have aided in bringing the project to a successful conclusion.

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(1) J. K. Kulansky, Selective Calling, Electronics, p 96, June 1946.
(2) E. H. B. Bartelink, Mobile Selective Calling, Electronics, p 103, Nov. 1948.

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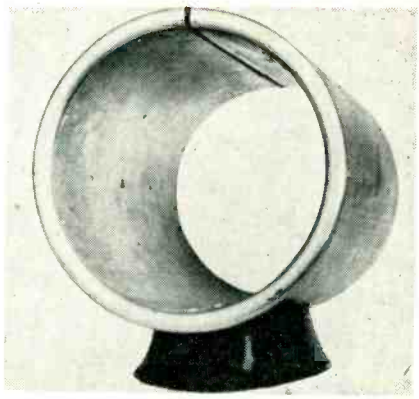
Automatic Direction-Finder



Externally-mounted loop is hermetically sealed for reliable all-weather operation, and does not move

Aircraft instrument employs unique switching circuits, and a novel loop structure which has no moving parts. The indicator will follow bearing changes of one quarter degree

By JOHN R. STEINHOFF
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New York, N. Y.

DIRECTION-FINDING INSTRUMENTS for aircraft must meet many stringent requirements. The one described in this article combines light weight and small volume with one-degree accuracy and instantaneous automatic operation. Radio transmitters are used as fix points; a dial on the instrument panel gives continuous bearing readings in degrees.

The externally-mounted loop assembly is stationary, eliminating the need for motors, bearings, and wiping contacts, and since it is hermetically sealed, weather extremes have no effect on the instrument's operation. The loop assembly consists of four coils wound on a cylindrical form. This type of construction permits wide spacing between turns, which results in greatly improved Q. The shield shell is streamlined for minimum air drag.

A drawing of the loop assembly showing the relative positions of the four coils is shown in Fig. 1A. Coils 1 and 2 are positioned 90 degrees from coils 3 and 4, and the coil pairs are wound so that when combined with signal voltage from the sense antenna the antenna field pattern consists of four right-angle cardioids, shown in Fig. 1B.

By a special switching system, the four coil voltages are sampled

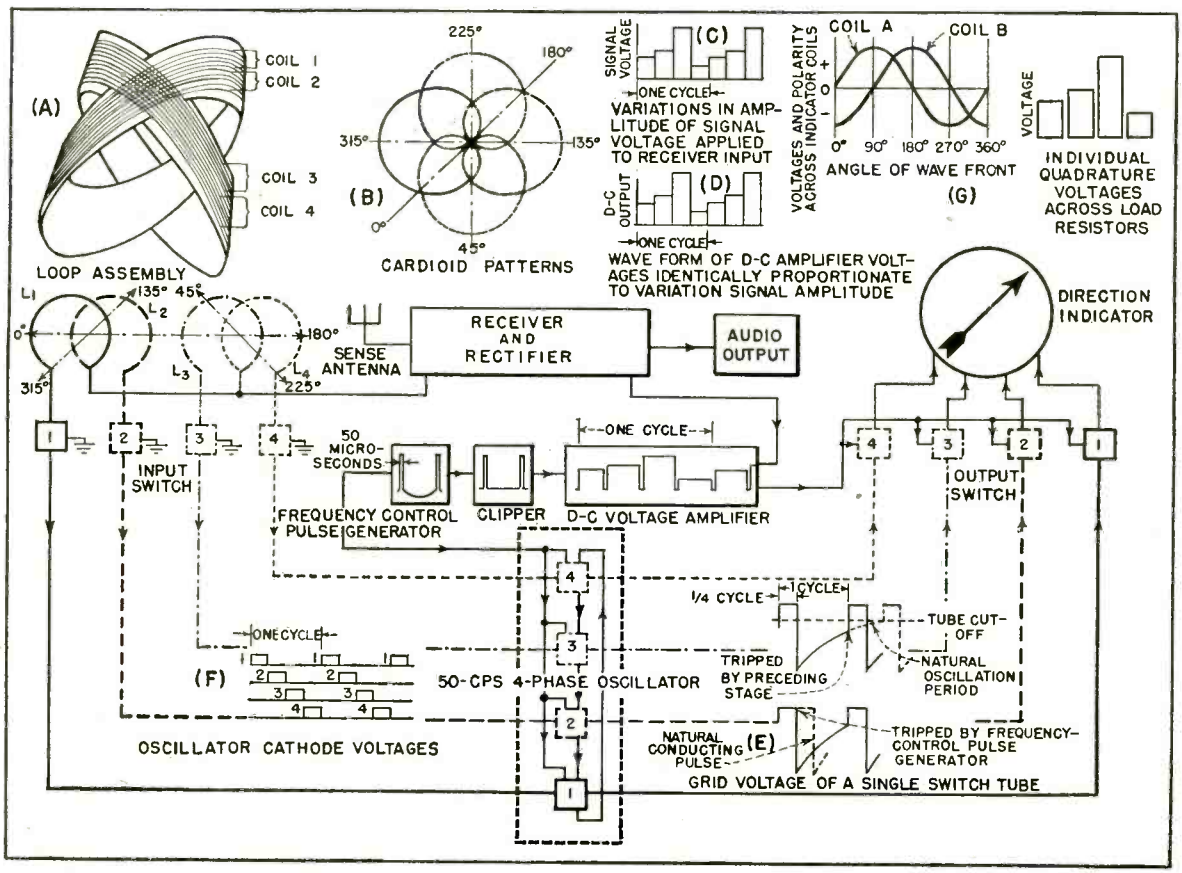

FIG. 1—Block diagram of the entire unit. (A) shows coils in the loop and their positions with respect to each other

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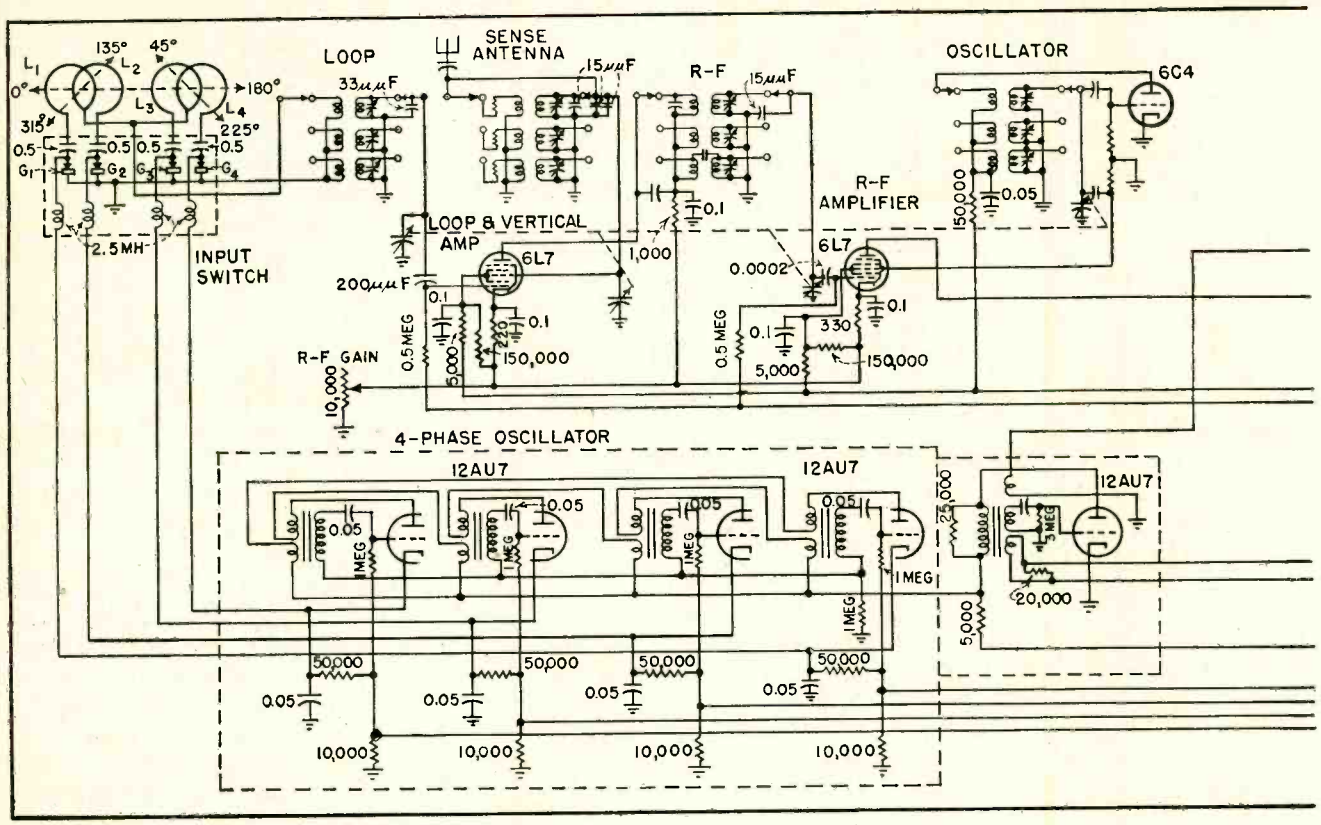

Circuit diagram of the automatic direction-finding equipment. All parts, except the loop and indicating meter, are mounted on the chassis shown below. The 250-μf capacitors across the indicator coils damp the instrument so that no hunting occurs. Frequency

separately and in sequence for 1/200th of a second, fifty times a second; and since the individual coil voltages depend on the angle of wave front with respect to the loop assembly, the output will be a fifty-cycle waveform, with each cycle divided into quarters, the amplitude of each quarter being proportional to the voltage picked up in the corresponding antenna coil. Typical variations of signal level applied to the grid of the 2nd 6L7 tube have a waveform as seen in Fig. 1C. This stepped voltage is a combination of loop coil and sense antenna signal voltages.

The quarter sections of the receiver output cycles, Fig. 1D, are switched (again, separately and in sequence) to the four coils of the indicating meter, which is constructed and calibrated to give readings in degrees.

Switching System

The heart of the switching system is the four-phase oscillator shown in the complete circuit diagram at the top of the page. It consists of four triodes (two 12-AU7's) connected as individual blocking oscillators with similar circuit values. Each stage is inductively coupled to the preceding stage, so that when one stage ceases to conduct, the following stage is tripped before recurrence of conduction by natural oscillation, as illustrated by the grid voltage curve shown in Fig. 1E.

Since the accuracy of the switching intervals depends on the action of the four-phase oscillator, its operation is controlled by a separate pulse generator which limits the conducting time of each four-phase oscillator triode to about fifty percent of its natural conducting time. Thus circuit variations, such as changes in tube mutual conductances, have no effect on the operation of the four-phase oscillator.

Figure 1F illustrates the cathode waveforms for the tubes in the four-phase oscillator. These current pulses are responsible for the switching of the antenna loop coils. The actual switching process is accomplished by the four germanium crystals, G_1, G_2, G_3 and G_4, which are connected in series with each individual loop coil and a common impedance-matching transformer. These diodes act as varistors and are individually activated by the cathode current of the corresponding triode in the four-phase oscillator. With a cathode current of 10 ma through the crystal the r-f resistance is very low. Thus one circuit is completed while the other three circuits are virtually open due to the slight back voltage across the diodes.

The input of the receiver (the grid of the second 6L7) sees the coil voltages combined with the sense antenna voltage, which is electronically coupled to the receiver through its own series of input transformers.

Receiver

The receiver is a three-band superheterodyne covering 200 to 1,700 kc with an average sensitivity of about 1.5 μv. The receiver sensitivity is a compromise which seems to give the best overall performance of the system.

Two i-f channels are used, one for direction finding and one for audio. A special winding on the frequency-control pulse-generator transformer is used in conjunction with a clipping circuit to form a negative pulse on the grid of the audio i-f tube, which causes the tube to cut

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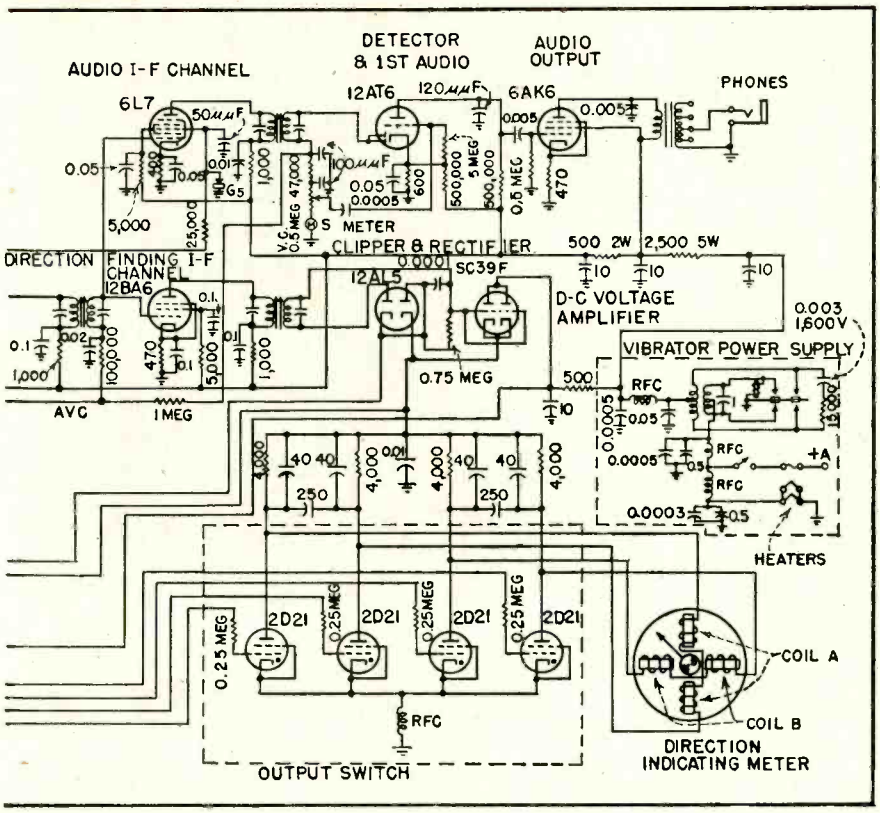


range of the receiver is 200 to 1,700 kc in three bands and the average sensitivity is 1.5 microvolts. Two i-f's are used, one for direction finding and one for audio

off momentarily during the transition period of switching, permitting audio reception simultaneously with direction-finding.

The direction-finder channel feeds into a rectifier, which in turn provides a d-c bias voltage to the SC39F voltage amplifier, varying in amplitude at the same ratio as the fluctuations in signal voltage applied to the receiver.

Output Switching

Four type 2D21 thyratrons with identical load resistors and common cathode connections through an inductance form the output switch. The voltage across the common cathode inductance caused by current flow through one of the thyratrons is sufficient to bias the other three thyratrons to cutoff.

Output switching is accomplished as follows: A winding on the frequency-control pulse generator transformer supplies a momentary negative pulse (positive pulses are clipped by the 12AL5) to the grid of the d-c voltage amplifier. This causes the SC39F to cut off, removing anode potential from the conducting thyratron, thereby deionizing it. Stimultaneously, the grid of the following thyratron is driven more positive, permitting ionization by virtue of the reduced grid bias resulting from the corresponding four-phase oscillator triode's conducting.

Indicator

The indicating meter is essentially a four-terminal differential-potential instrument similar to a ratiometer. It is angularly responsive to changes in polarity and current.

Four stationary coils are positioned around the periphery of an Alnico permanent-magnet rotor which is transversely magnetized. Rotor and pointer have jeweled pivots, minimizing hysteresis losses to a point where one quarter of a degree bearing changes will be followed by the indicator. Also a copper tube placed very close to the magnetic rotor induces eddy currents which create mechanical damping.

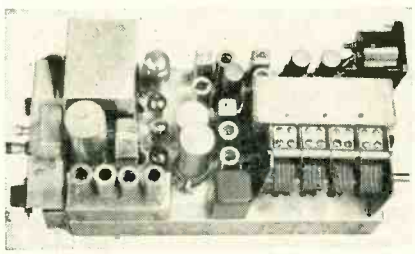
Opposite coils are connected in series, and potentials applied to the four terminals (Fig. 1G) cause an angular displacement of the indicator pointer.

The meter is connected to the four load resistors in the cathode circuit of the SC39F tube. Four 40-μf capacitors across the load resistors and 250-μf capacitors across the instrument coils adequately damp any pulsations of the meter pointer due to modulation or transients.

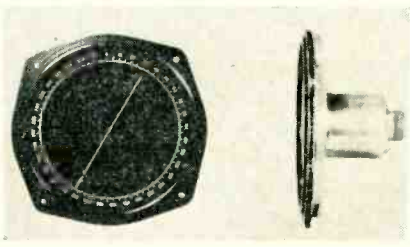
The equipment includes an S meter to facilitate tuning. All apparatus, other than the loop and the indicating meter, is encased in a unit 7½ inches wide, 6½ inches high, and 14½ inches deep. A view of the chassis is shown in the accompanying photograph. The components at the left of the chassis photograph form the vibrator power supply and the four-tube output switch. The r-f portion is at the right (the front of the chassis) and the blocking oscillator transformer unit is mounted underneath the chassis (not visible).

The equipment described is the result of extensive research and flight testing. If the signal is audible in the receiver earphones, the circuit will give a direction indication. A field strength of 5 μv per meter is sufficient for one-degree accuracy.

The system is, of course, subject to the usual skywave difficulties; and, as in most aircraft instruments, the plane itself introduces distortion of the field and a correction chart must be referred to for accurate bearing readings. The instrument is intended primarily for itinerant aircraft.



Top view of direction-finder chassis



Indicator is mounted on instrument panel

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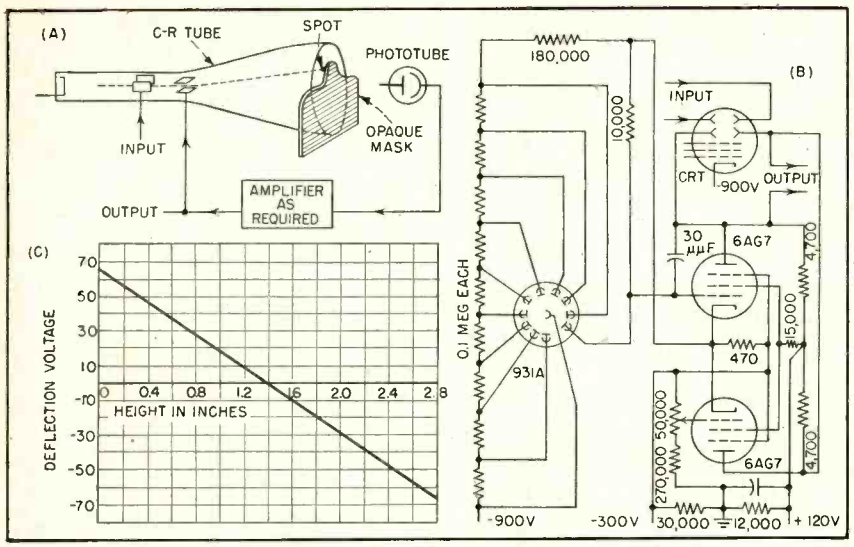

FIG. 1—Block and circuit diagrams for rectilinear waveformer. Figure 1C shows linearity of response to mask height

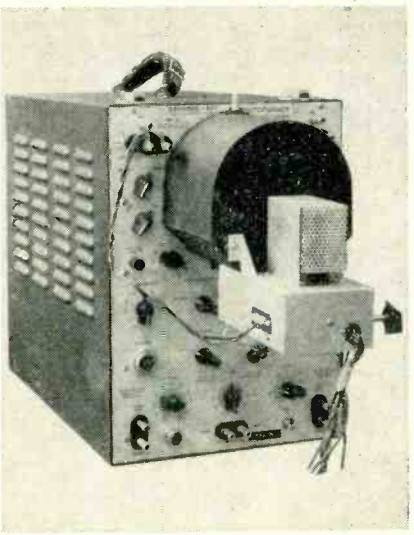

FIG. 2—Commercial oscilloscope converted to a waveform generator

Photoelectric

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INNUMERABLE APPLICATIONS may be found for an instrument capable of generating a diversity of waveforms. Likewise there is a universal need for a readily reproduceable nonlinear circuit element. It should have a high degree of accuracy and be capable of outputs over a wide range of frequencies. Such a device is the four-terminal instrument described here.

The Photoformer, as it is called since it generates waveshapes through the use of a cathode-ray tube and phototube, is fed with a sawtooth voltage of the desired frequency. This sawtooth voltage causes the cathode-ray tube spot to sweep horizontally, and a phototube viewing the screen, in conjunction with suitable amplifiers, causes the spot to vary vertically to conform to the contour of a paper mask which is fixed to the cathode-ray tube screen. The output voltage waveshape will be a replica of the shape of the paper mask used.

When used as an arbitrary nonlinear four-terminal network, the cathode-ray tube beam is deflected by the input, and the input-output relationship is governed by the edge of the mask used.

Essentially the device functions degeneratively so that variations of cathode-ray tube brilliance, phototube sensitivity, and the gain of any amplifiers employed have negligible effect on the transfer characteristic. The device is limited in response time by conventional bandwidth considerations and may readily be made to have rise times of 10 microseconds or less. Circuit refinement, with the best of present-day tubes, permits the achievement of rise times of less than 2 microseconds.

Principle of Operation

The basic elements of the instrument are shown in Fig. 1A. The cathode-ray tube is initially adjusted to provide a spot centered near the top of the cathode-ray tube face. The phototube views light emitted from anywhere on the cathode-ray tube face except those regions which lie behind the mask.

The output of the phototube is connected through suitable amplifiers to the vertical deflecting plates of the cathode-ray tube. Thus changes in light intensity at the phototube cause changes in the vertical height of the spot on the cathode-ray tube. Such changes in spot height may cause further change in light on the phototube.

The feedback loop formed in this manner is phased so that increasing light on the phototube causes the spot to move downward, and if the gain around the feedback loop is sufficiently great, this motion continues until a substantial fraction of the light from the spot is hidden behind the mask. At this vertical position equilibrium is maintained. If the mask is in close juxtaposition to the plane of the phosphor, or if the plane of the phosphor is imaged by a suitable lens into the plane of the mask, then small changes of spot height away from the equilibrium position tend to cause large changes of light on the phototube. Therefore the spot will always reach equilibrium very nearly at the height of the mask.

If the deflection sensitivity of the cathode-ray tube is independent of beam height, which is ordinarily the case, the output voltage is proportional to spot height. Furthermore, since the spot height is very nearly the height of the mask, the output voltage will likewise be substantially proportional to the mask height at any instant of time after equilibrium has been established.

The time to establish equilibrium

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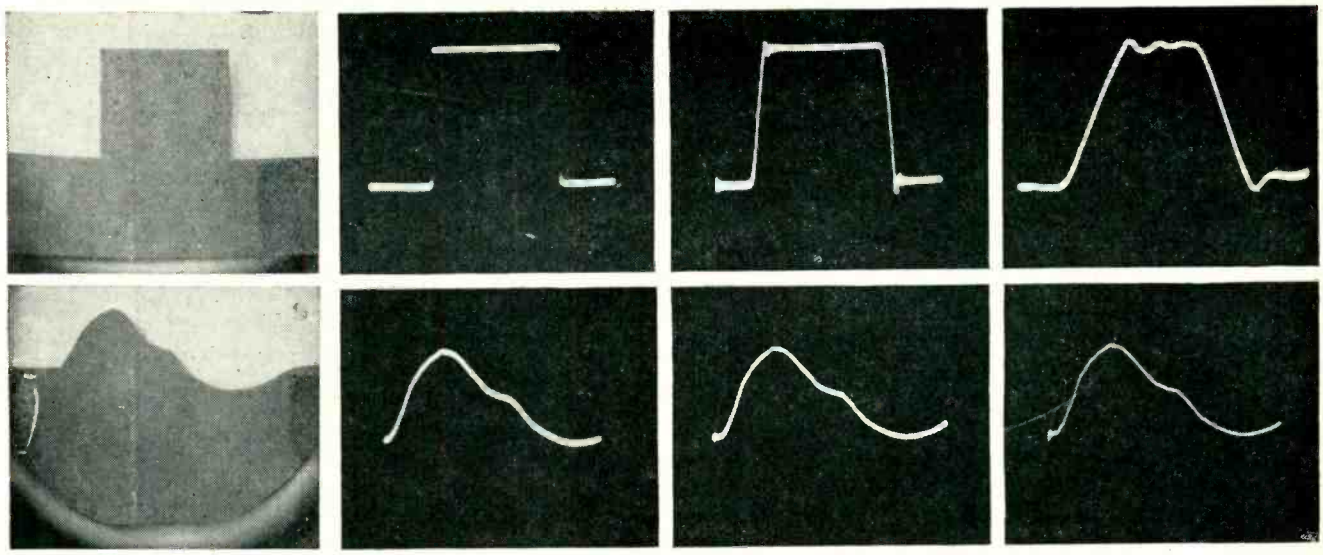

FIG. 3—Typical waveforms and the masks used. Top row shows square wave at recurrence frequencies of 75, 5,000 and 16,000 cps. Repetition rates of the more gradual shape shown on bottom row are 75, 1,200 and 4,300. Note small distortion

Waveform Generator

Through the use of simple paper masks fixed to the screen of a cathode-ray tube, this instrument is capable of producing practically any shape waveform with good accuracy over a wide range of frequencies. A few of the many possible applications for such a device, other than as a waveform generator, are discussed

and the exact height of the spot at which equilibrium is obtained will be determined from conventional feedback criteria. It is apparent that the duration of the transient prior to establishment of equilibrium is determined by the total delay time around the feedback loop. This delay time includes the decay time of the phosphor cascaded with the delay time through the amplifier and phototube. If short rise times are desired in the output, this total time delay must be short. Phosphors which exhibit short decay time, in order of decreasing persistence, are P1, P11, P5 and P15. By using P5, it is possible to provide rise time in the output circuit of less than 10 microseconds, which corresponds to a high frequency cut-off of approximately 150 kc.

Likewise, the degree of accuracy with which the center of the spot coincides with the mask height is determined in the static case by the gain around the feedback loop. For loop gains on the order of 40 db or greater, the position of a given portion of the spot (such as its center) will generally coincide with the mask displacement to an accuracy better than $\pm$ 1 percent.

The input signal is applied to deflect the spot horizontally. If the input signal varies slowly, the spot will come to equilibrium at the height of the mask corresponding to the horizontal position to which the spot is deflected.

Since horizontal spot displacement is nearly proportional to horizontal deflection voltage applied as input, and since output voltage is proportional to vertical height of the mask, the output voltage bears a relation to the input voltage substantially identical to the relationship between the vertical height of the mask and the horizontal distance measured along the mask. Thus, it is evident that any desired single-valued transfer characteristic is provided once a simple optical mask is made of the desired characteristic.

Typical Operating Circuit

These fundamental principles have been applied in the apparatus shown in Fig. 2. Here a commercial oscilloscope is provided with an auxiliary light-shielded phototube and an amplifier. The schematic of the waveform-generating portion of the circuit is shown in Fig. 1B.

The output voltage obtainable from this system may be expressed in terms of the vertical height of the mask. When the mask is in close juxtaposition to the phosphor, the output voltage is given directly by the vertical deflection sensitivity of the cathode-ray tube times the mask height corresponding to the horizontal distance at which the spot has been deflected by an input

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signal. Output voltages of approximately 50 volts per inch of mask height are typical.

A linearity characteristic was measured with the circuit of Fig. 1B, using the physical apparatus of Fig. 2 so arranged that the mask could be moved by a micrometer. The output voltage was found to vary with mask height as shown in Fig. 1C. In taking the data plotted in Fig. 1C a meter having an accuracy of 0.5 percent was used to read the output. Departures from linearity on the curve are of the order of magnitude of the possible meter calibration error, hence output is linearly related to mask height to within the commercial tolerance of highly precise meters.

In the dynamic case when the spot is deflected rapidly in the horizontal direction and caused to track a mask in the vertical direction, the output may depart from the proper value corresponding to the mask height.

Typical waveshapes generated are shown in Fig. 3. The top row shows the result when a square wave is traced from left to right. The square-wave mask is shown at the left. Because the vertical feedback amplifier passes the d-c component, there is no droop of the horizontal portions of the square wave at any recurrence frequency. The square-wave outputs shown are for recurrence frequencies of 75, 5,000, and 16,000 cycles per second. The rise and fall times are each approximately 10 microseconds, with an overshoot of about 3 percent initiating a decaying 170-kc shock-excited transient. The bottom row of Fig. 3 shows the generation of a more gentle wave.

Recurrent Wave Shapes

Using rectilinear coordinates, it is apparent that one cycle of a recurrent wave may be generated as the spot is deflected horizontally at constant writing speed, but to generate a second cycle it is necessary to restore the spot to its initial horizontal position. For this purpose a sawtooth voltage may be used as the horizontal signal. During the retrace time the system will try to generate a complete cycle of the wave in a very short time. This tends to cause a pip in the recurrent output waveshape, the pip occurring at the time of retrace.

If this pip is undesirable it can be eliminated by clamping means during the retrace cycle or more simply by use of a retrace time which is negligible compared to the response time of the Photoformer. The size of the pip is dependent upon the brilliance of the cathode-ray tube spot and any other factor which affects the gain around the feedback loop, since a change in the magnitude of the loop gain affects the response time. By adjustment of the loop gain and by proper choice in phasing of the cycle presented on the mask it is possible to render the pip negligible in most instances without resorting to clamping means.

For applications where a retrace pip is objectionable, an arrangement using polar coordinates has been developed. A block diagram appears in Fig. 4A. The spot is deflected circularly at a constant angular rate by applying sinusoidal waves in quadrature to the deflecting plates. The time axis in polar coordinates corresponds to the angular coordinate. A mask is employed in which the radial distance to the edge of the mask varies with the angular coordinate in accordance with the time variation of the amplitude of the desired wave shape. The spot is made to trace the edge of this mask by permitting light from the spot as it arrives at the phototube to deflect the spot radially towards the mask, For this purpose a cathode-ray tube with a radial deflecting electrode is used.

In this arrangement, after generation of one cycle of the wave the spot is ready to generate a second cycle without being suddenly brought to a new position, hence continuous recurrent functions may be generated without a recurrent pip at the start of each cycle.

In general it will be found that the radial deflection of the spot varies with the voltage applied to the radial deflecting electrode in a nonlinear manner. The polar coordinates to which the waveshape is drawn will therefore have a nonlinear radial axle. This nonlinearity is dependent on the geometry of the cathode-ray tube and can be expected to be quite stable so that once a mask is drawn taking into account this nonlinearity, the wave-

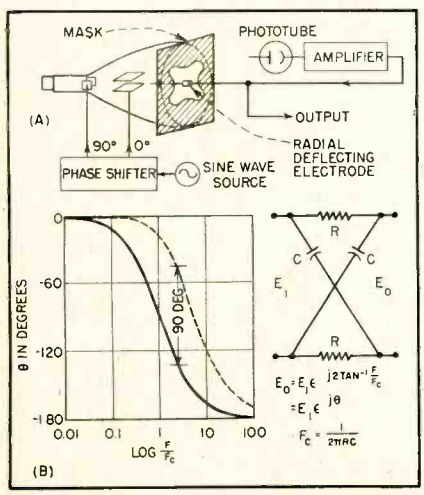

FIG. 4—Block diagram (A) of unit for polar coordinates. Phase shifter and its characteristics are shown in B

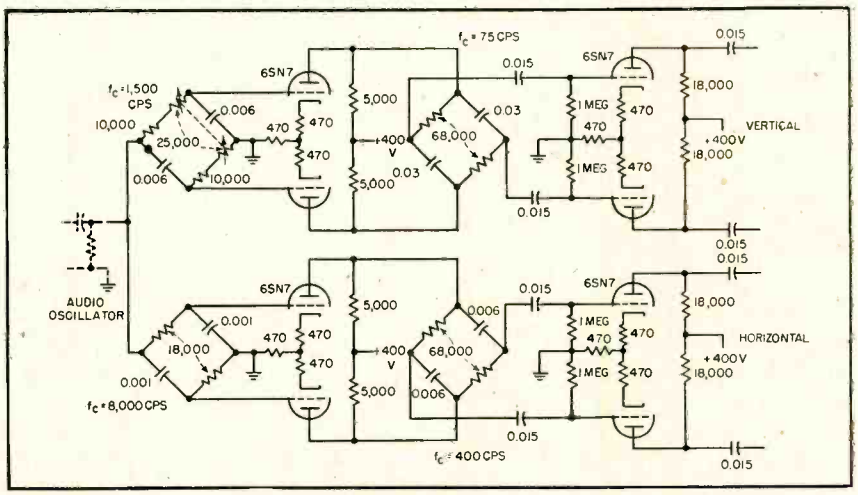

FIG. 5—This phase splitter provides quadrature sine waves for circular sweep used in polar coordinate unit. The phase shift imparted by the top channel differs from that of the bottom by about 90 degrees for frequencies between 100 and 5,000 cps

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shape generated is an accurate replica of the desired waveshape.

In order to provide a circular sweep over a wide range of input frequencies, a phase splitter has been employed as shown in Fig. 5. This phase splitter feeds the input signal into two channels each of which uses a simple phase distortion network of unity gain. Such a network is shown in Fig. 4B along with its phase response. Over a wide range of frequencies the phase shift varies linearly with the logarithm of frequency. By cascading two such networks having different time constants it is possible to increase the frequency range over which this linear relationship holds.

In one channel of the phase splitter of Fig. 5 two networks are employed, one with a quadrature point selected at 8,000 cps and the other at 400 cps. The second channel of Fig. 5 contains an additional pair of phase-shifting networks whose phase shift varies linearly with logarithm of frequency. The time constants of these networks provide quadrature shifts at 1,500 and 75 cps. With this set of time constants, the phase shift imparted by the second channel differs from that of the first channel by 90 ± 9 deg for any frequency from 100 to 5,000 cps.

Applications

Below are described a few of the innumerable applications of this instrument:

Volume Compressor-Expander Combination—By employing the compression transfer characteristic as in Fig. 6, the dynamic range in the output is reduced instantaneously over that of the input. Such a compressed signal may be fed over a network having limited amplitude capabilities into an instantaneous volume expander (expansion curve). The curves in Fig. 6 are so chosen that the overall transfer characteristic is linear.

Fourier Analyzer—If the instrument is employed to generate an arbitrary wave from a curve of that wave, and if the output is fed to a wave analyzer or spectrum analyzer, then the Fourier transform of any given curve may be instantly obtained.

Synthetic Speech Generator—By employing a plurality of masks with various speech waveforms it is possible to generate the various sounds required for intelligible audio communication. By manipulating these masks manually through a suitable keyboard and by controlling the rate of horizontal sweep, intonation and syllabification can be provided to closely approximate actual speech.

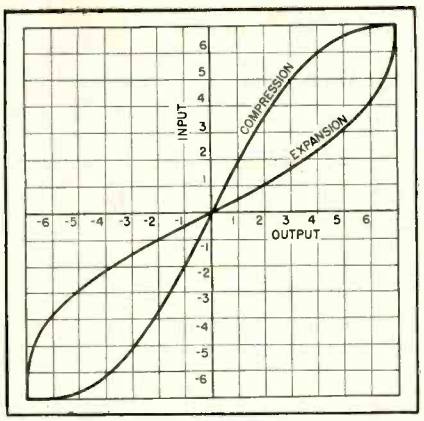

FIG. 6—A typical compression-expansion characteristic combination

Musical Sound Generator—For this purpose a plastic deformable mask can be employed which the musician shapes in accordance with the desired sound.

Frequency Modulator—By sending an input signal to be modulated in the form of a transverse vertical vibration along an opaque wire and by using the wire as a mask it is possible to provide an output which is a replica of the input but which is delayed in time in accordance with the horizontal displacement of the pickup spot by a modulating input signal. In this manner the signal to be modulated can be a complex wave.

Speech Scrambler—By providing an input signal to be scrambled in the form of a transverse vibrational wave along the wire as in the frequency modulator, and by employing a scrambling wave to displace the pickup point of signal along the wire according to a regular or arbitrary shape, the components of the speech output may have their various time coordinates thoroughly scrambled.

Bandwidth Compressor—By employing apparatus similar to that described above for a frequency modulator, the bandwidth required to transmit certain types of intelligence may be reduced below that normally required. For example, when the intelligence to be transmitted is in the form of a picture having many areas of relatively constant illumination, the time required to transmit data on these areas by scanning may be reduced by causing these areas to be scanned more rapidly. Similarly, areas of the picture in which sudden changes in intensity take place may be scanned more slowly, thereby increasing the time required for transmission of sudden discontinuities and decreasing the time required for transmission of uniformly illuminated areas. The effect of this is to reduce the maximum frequency required for transmission of the picture without affecting the total time of transmission of the picture.

General Nonlinear Device—Multiplication or division of two unidirectional voltages may be achieved by employing two Photoformers to take the logarithms of both voltages. A third may be employed to take the antilogarithm of the sum or difference of the two logarithm voltages, thereby providing an output which is the product or quotient of the two input signals.

Linearizer—It is possible to correct for any nonlinearity that might appear in a communications process. For example, in recording sound on film by variation of the density of the film in accordance with the sound amplitude, a critical part of the process is the obtaining of a linear relationship between the film density and the input sound intensity. If a Photoformer is employed at either the input to the recording apparatus or at the reproducing apparatus, any nonlinearity in the density-versus-exposure curve may be accurately and quickly corrected, to provide an overall distortion-free linear system. A flat frequency characteristic should be included between the distortion producing apparatus and the distortion-correcting unit.

The author expresses his appreciation to E. S. Brotzman, M. T. Bagley, R. D. Brown, W. E. Bradley, W. Miehle, E. Freyer and the many others who took part in the development of the unit and the preparation of this paper.

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Capacitor-Discharge Recorder Applications

Discussion of various recorder circuits incorporating capacitor-discharge networks. Noted are advantages and disadvantages of each type for various applications. Theory and operation of circuits and components are explained

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CAPACITOR-DISCHARGE instruments, both indicating and recording, have been found extremely valuable for measuring wind speeds, and for determining the short-term average rates of similar variable phenomena.

The basic instrument[1], shown in Fig. 1A, was originally intended for meteorological use, but recent experimentation with it has led to the development of a large number of derivative instruments, some of which have possible applications in many fields. Several of the more practical derivatives are discussed herein.

Relayless Instrument

Search for a very simple circuit, having no moving parts or contacts interposed between the instrument head and the meter, led to the development of the relayless circuit shown in Fig. 1B, which works satisfactorily through a very limited range of input frequencies, but indicates when it is "beyond its depth."

Constants are chosen so that C_1 just attains 99.9 + percent of full voltage during the *open* phase of the shortest contacting cycle to be measured. Also, the current during the longest *closed* phase likely to occur should not damage the meter. Capacitance of C_2 is normally several hundred times that of C_1.

When the anemometer contacts of this device are open, C_1 charges from the battery E, its rate of charge being determined by circuit constants. When the anemometer contacts close, C_1 discharges through R_2, initial discharge being directed into C_2 by L. As the circuit stabilizes, current flow follows the instrument circuit, L—R_3, until the anemometer contacts open. Charge remaining on C_2 drains off through the instrument circuit.

With a recording instrument in the circuit the trace, at very low frequencies, consists of widely-spaced asymmetrical sawteeth. As the frequency is increased, the sawteeth decrease in separation and amplitude, eventually becoming a smooth curve of low amplitude. Further increase in frequency produces a smooth curve of higher amplitude, which reaches a maximum value at some specific frequency, and then falls off again as the frequency is still further increased.

Useful range of the instrument is the central portion of the smooth curve, from the first minimum to the first maximum. Because average current through the instrument is a combined function of frequency, contacting cycle, and circuit constants, calibration by cut and try is preferable to calibration by the somewhat involved formula necessary.

In some instances, a subsidiary resistor between L and R_3 (Fig. 1B) will be found desirable in the instrument circuit.

In practice, this instrument circuit can be sealed against corrosive fumes, and has both small bulk and low cost. However, the lowest frequency indicated with substantial

PROVEN APPLICATIONS

Simple Instrument:
Measuring and recording of average wind speeds from contacting anemometer, rates of rainfall from tipping-bucket rain gauge, average stream flow from patent log

Simple Instrument with Auxiliary Infeed:
Measurement and recording of radioactivity disintegration rates, and average number of static bursts during thunderstorms

With Maximeter Attachments:
Indication of maximum or minimum value of any of the above

With Auxiliaries:
Operation of secondary devices when any of the above variables (or similar phenomena) exceeds a given rate

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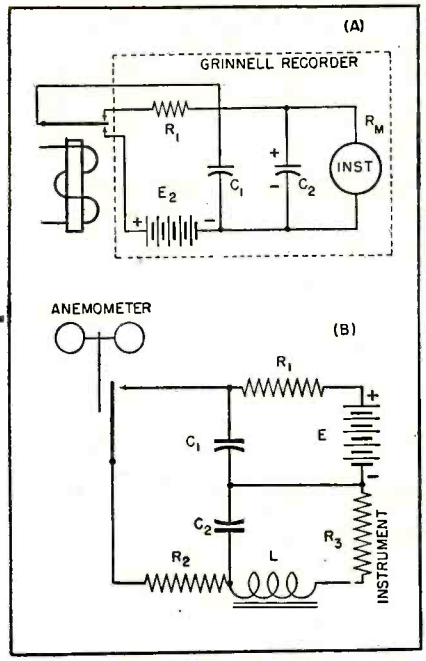

FIG. 1—In (A) the instrument current is nearly a linear function of relay rate. A relayless version is shown in (B)

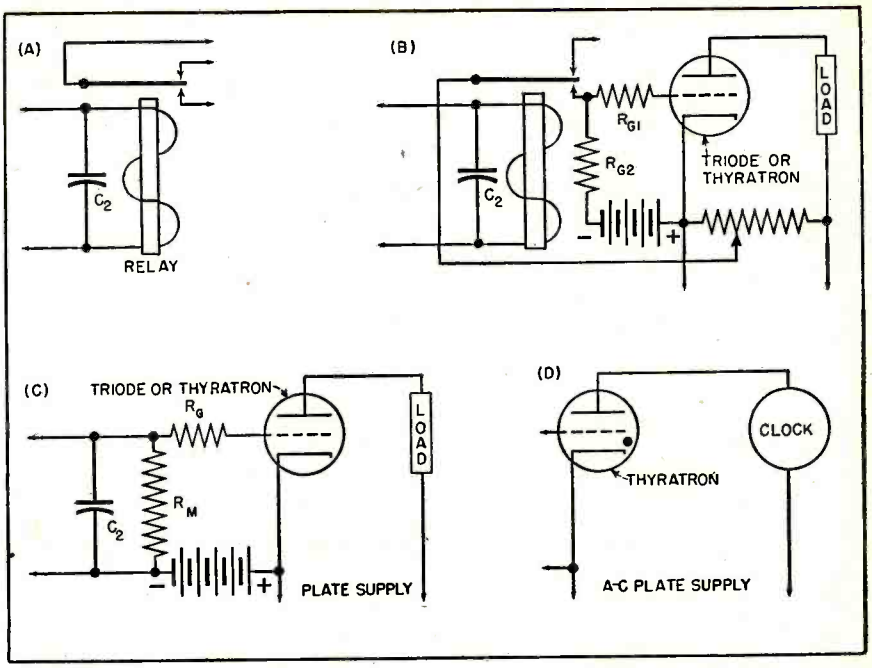

FIG. 2—Several limit-indicator circuits. Simple indicator in (A) is ideal for mobile installations, or where local power supply is limited or erratic. The other circuits are designed for use with triodes and thyratrons

correctness is about one fifth the highest frequency that can be shown, in the general range from five cycles per minute to ten cycles per second.

Limit Indicators

When a specific indication is needed as the impulse rate passes a given predetermined limit, whether high or low, a suitable rate-controlled indicator is produced by inserting an instrument-type relay such as a Weston in series with, or in place of, the instrument in Fig. 1A.

Suitable correction of the load resistance value (R_M or of other circuit constants, is necessary to retain calibration, which is determined from the formula:

$$I_M = \frac{1{,}000\, C_1\, F\, E_2}{1 + C_1\, F\, R_M}$$

in which I_M is instrument current in milliamperes, R_M the instrument resistance in ohms, C_1 the capacity of impulse capacitor in farads, E_2 the battery voltage, and F the number of impulses per second.

Simplest form of such a limit indicator is shown in Fig. 2A. This arrangement is suitable for portable or mobile installations, or where local power supply is limited or erratic. Coupled to a multipole relay, this indicator can be used to switch in and out a multiplier in the recorder circuit[2,3].

Because an instrument-type relay has little power-handling ability, the circuit of Fig. 2B was developed. Here, the instrument-type relay throws the grid bias of a vacuum tube from definitely negative to strongly positive, so that the plate current of a triode can be increased by a factor of as much as 50, and that of a thyratron by a factor many times greater.

Where very large loads are to be controlled (kilowatts), use of the first tube as a buffer, which operates a power thyratron through a simple cathode follower connection, is usually desirable.

The function of the resistors R_{G1} and R_{G2} in this circuit is to limit currents in the grid circuit to safe values. If these resistors are omitted, contacts of the relay may be damaged by circulating currents from bias supply and grid.

With a conventional instrument-type relay, it is possible to have three control ranges—below minimum, between limits, and above maximum (as in Fig. 2B). Because these three ranges can be electrically independent, or can be interlocked in many different ways, a wide variety of automatic control devices can be operated.

Elimination of the relay, by use of a direct connection to the grid circuit of a vacuum tube, is possible, as in Fig. 2C. Adjustment of the magnitude and polarity of the grid bias with respect to the potential across C_2 permits a very wide range of control possibilities. If a thyratron is used in this arrangement, with a-c on the plate, an electric clock can be operated in the plate circuit, giving a record or indication of the duration of values beyond the predetermined limits. This is shown in Fig. 2D. Many electric clocks function perfectly on half-wave-rectified 60-cycle current, but operation may be improved by use of a small inductor and capacitor to modify waveform.

Quite obviously, use of a vacuum tube alone in the output of a capacitor-discharge circuit requires fewer components than does the relay-vacuum tube arrangement. Very careful choice of the grid resistor, R_G, is necessary, however, or the voltage drop across R_G due to grid conduction will modify the charge on C_2 sufficiently to produce a spurious record or indication.

Since characteristics of a vacuum tube change with age, greatest consistency of operation is usually obtainable from a relay-vacuum tube arrangement. However, where

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Circuit operating conditions make a thermionic input essential, and high consistency of operation is required, a two-step control is usually satisfactory. This consists of a long-life tube, such as a telephone repeater, with the grid connected as in Fig. 2C. This tube controls a power tube, such as a thyratron, by means of a conventional cathode-follower connection.

When measurement of the time elapsed since a predetermined limiting value was passed is desired, a push-pull plate supply circuit for a single thyratron may be used, as in Fig. 3. Once the thyratron is started, the plate current flows continuously until the circuit is interrupted or *reset*. The electric clock in one leg of the full-wave rectifier circuit indicates time lapse. The other leg, in conjunction with a small filter (L_P—C_P) acts as a keep-alive. The filter need only be large enough to carry the thyratron for about 0.006 second immediately after the half cycle during which it is charged. Too large a filter will introduce undesired time-delay into the clock circuit.

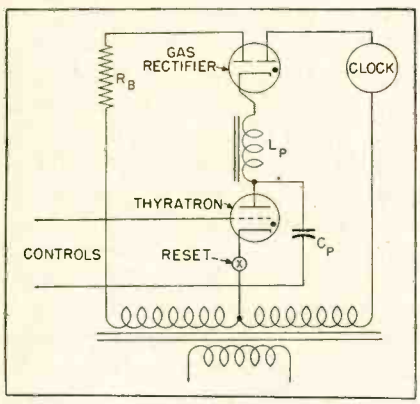

FIG. 3—Circuit for non-stop thyratron operation of electric clock for measuring time between occurrences of limiting values

Maximum Values

Many methods of determining the maximum value attained by a variable electrical phenomenon are known and in common use. Perhaps the simplest of these is the use of a dead hand on any standard indicating or recording instrument. This is pushed upward by the regular instrument pointer or pen, but cannot return to a lower position until it is reset.

Maximum value attained during any one of a number of sequent equally-spaced time intervals can be determined by use of a combination of stepping switches and time-interval units[4], although the installation becomes very large and involved when three significant figures are required[5].

Determination of the maximum value attained by a variable electrical phenomenon during a continuously shifting time interval is a more involved problem of which one phase, the continuous recording of the short-term mean value, is accomplished by use of the Grinnell recorder (Fig. 1A), or a similar capacitor-discharge instrument.

When two capacitors are linked by a diode, as in Fig. 4A, charges can be transferred in plate to cathode direction only whenever a sufficient potential difference exists. In consequence, voltage across C_3 will be the maximum voltage attained by C_2 less transfer drop (negligible for a high-vacuum diode, finite and not negligible for a gas diode.) If it is assumed that leakage in the second capacitor has been negligible during the time interval under consideration, maximum charge attained by C_2 during that same interval can be evaluated by measuring the charge on C_3.

This measurement is accomplished by recording the time necessary for the potential across C_3 to drop from its unknown value to a predetermined low value. This time can be found from:

$$T = 2.303\, RC_3 \log_{10} \frac{E_{C3}}{E_D}$$

$$\log_{10} E_{C3} = \log_{10} E_D + \frac{T}{2.303\, RC_3}$$

where E_{C3} = charge on $C_3 = I_M R_M$ less diode drop ($E_{C3} > E_D$) for highest value attained by I_M during interval under consideration, E_D is the drop-out voltage of relay, T the time in seconds, R the discharge resistance in ohms and C_3 the capacitance in farads.

A circuit arrangement similar to Fig. 4B, using an instrument-type relay, is suitable. In this instance, R of the formula is the resistance of the relay coil.

A somewhat more elaborate arrangement, using a thyratron, is shown in Fig. 4C. Here, R of the formula is the total effective resistance of the grid circuit, which must be high enough, in the grid-cathode leg, to reduce the effects of grid conduction to a negligible value. Where high precision, or great power-handling capacity, is required, the necessary grid resistance, $R_{GS} + R_{GX}$, is usually too high to permit adequate operation of the thyratron, so that use of a buffer tube will be desirable or necessary. Coupled to a printing clock (such as a Stromberg timer), this general arrangement is ideal for full automatic and unattended operation.

Operating theory is quite simple. When the switch is in the L position (Fig. 4), C_3 receives charge increments from C_2 through the diode whenever the charge on C_2

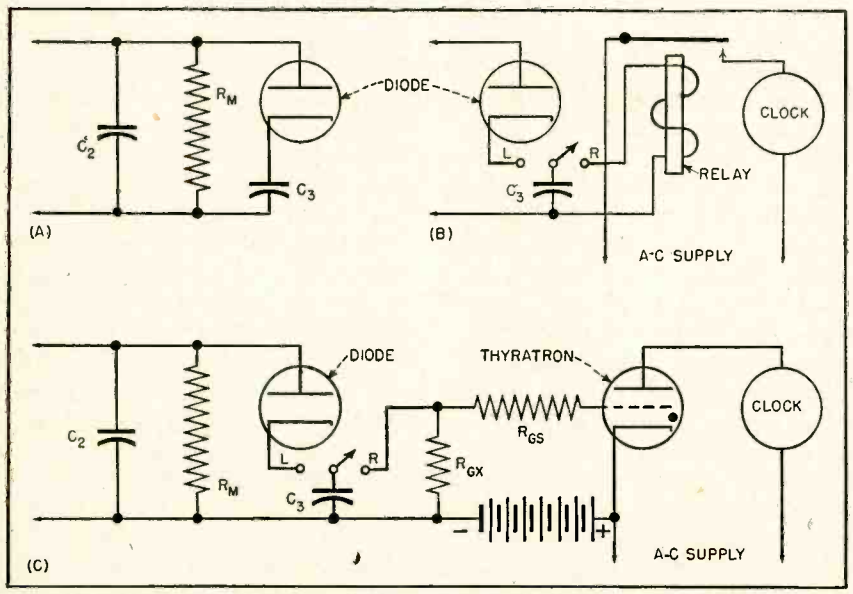

FIG. 4—Maximeter circuits for determining maximum charge attained by C_2 in terms of time units

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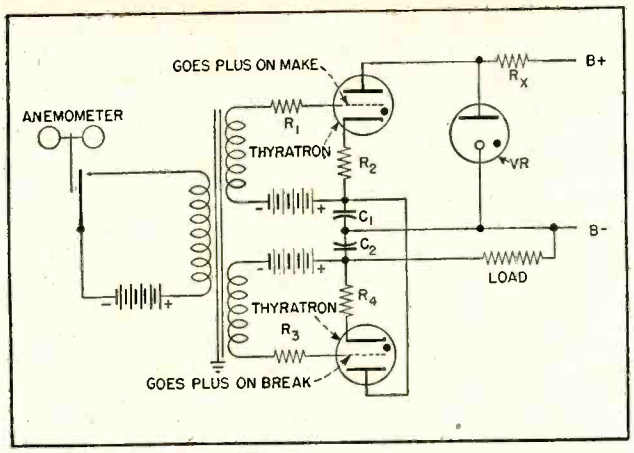

FIG. 5—Capacitor-discharge instrument adapted for kick-coil or flyback operation

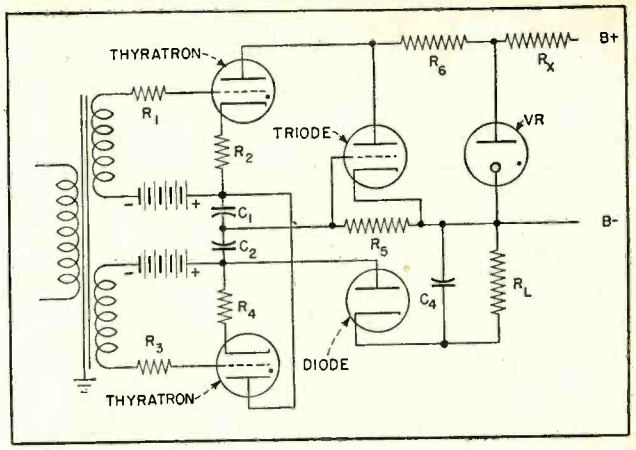

FIG. 6—Fundamental circuit for linear capacitor—discharge instrument in which charge increments are equal

exceeds its previous high value. When the switch is in the R position, C_3 discharges through a resistance of known value, to a known drop-out value, and operates a timer by means of a relay or vacuum-tube circuit. From the elapsed time of discharge, the initial voltage on C_3 may be found, and hence the maximum charge attained by C_2.

Attainable accuracy, which can be quite high, is limited by the leakage characteristics of C_3. In practice, the capacitance of C_3 is very small relative to that of C_2 (0.5 μf and 2,000 μf, for example), so that the charge transferred from C_2 to C_3 by the diode is smaller than the discriminatory threshold of the recording or indicating instrument (indicated by R_M is use. Although a dry electrolytic capacitor functions satisfactorily in C_2 position (after due aging), a high-grade impregnated paper capacitor is essential at C_3. With direct thyratron operation, the circuit may behave erratically in some ranges: if a buffer tube is used, calibration by formula is satisfactory in most instances.

Combined Values

Determination of the sum and difference of the rates of a number of compatible variables, and of some higher functions of their values, is theoretically possible by combining the outputs of two or more capacitor-discharge instruments. This principle has been applied successfully to determine the average of a number of simultaneously-measured wind speeds[3]. Because the fundamental capacitor-discharge circuit (Fig. 1A) is only approximately linear, only a narrow range of values can be combined with any hope of obtaining a usably accurate answer.

Modifications of the fundamental circuit to produce one of better characteristics were attempted, and several workable instruments resulted. The relay was eliminated, with no impairment of circuit functions, as in Fig. 1B, by adapting it for operation from the inductive kick, or flyback, of an isolating transformer, which also reduced troubles due to line noises and static. This circuit, operation of which has been described elsewhere, is shown in Fig. 5[9].

This arrangement is adjusted so that C_1 is charged from the regulated power supply when the anemometer circuit closes, and the charge is transferred to C_2 when the primary circuit opens. Except for transfer drops, which are constant, the formula is the same as that for the relay-operated device.

By inserting a triode in this circuit, so connected that its plate current is an inverse function of the voltage across C_2, as in Fig. 6, the input voltage of C_1 is made a constant plus that on C_2, so that the charge transferred from C_1 to C_2 is the same at all frequencies.

This is accomplished by passing the current from the averaging capacitor, C_2, through the instrument, R_L, and then through another resistor, R_5. Current through the instrument circuit is a function of the charge on C_2: hence drop across R_5 is also a function of this voltage. This potential is applied to the grid of a triode, operated in the linear portion of its characteristic, so that its plate current is inversely proportional to the current in the meter circuit. When a resistor of suitable value (R_6) is inserted in the plate circuit between the voltage regulator and the upper thyratron plate the drop across R_6, due to the plate current of the triode, equals a constant minus the potential across C_2. Because, in transferring its charge to C_2, C_1 discharges only until the potentials across the two capacitors are balanced, charge increments applied to C_2 are diminished in potential by that already across C_2, and the circuit is nonlinear if the charging voltage is constant.

In the modified circuit (Fig. 6), the charging voltage is no longer constant, but is increased in potential by the voltage already on C_2 (by means of the triode), so that the charge increments applied to C_2 are always equal, within the range of the instrument, regardless of the frequency. The circuit characteristic is thus linear, as may be substantiated by a mathematical analysis.

In this circuit, range of theoretical linearity is limited only by the length of the straight-line portion of the triode characteristic. Practical limitations, however, are considerably greater, particularly at the higher frequencies. The charging of C_1 through R_5 and R_6, takes an appreciable (but short) time. So that C_2 will not be charged backwards by the voltage drop across R_5 during this time, the diode is necessary. This introduces an error into the lower part of the in-

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strument curve, due to the toe at the base of the diode E_B—I_B curve; and also imposes a current ceiling at the top of the curve. An additional source of nonlinearity is introduced by the action of the diode because C_2 does not discharge continuously through the meter, but is partially out of circuit, so far as the instrument (R_L) is concerned, while C_1 charges. This effect is usually negligible, and can be compensated for, in any part of the instrument range, but not in the entire range, by modifying the constants of the triode circuit. A better compensatory procedure is to increase the charging voltage and decrease the capacitance of C_1. This is theoretically and practically sound because the charging time increases as the *log* of the applied voltage, but varies directly as the first power of the capacity.

A number of variations and parallels, mostly designed for higher frequencies but applicable with modification to lower frequencies, have recently been outlined by Easton and Odessey[7], with a mathematical description of their behavior. It is interesting to note that the same formulas apply in the range of kilocycles per second and that of cycles per minute.

Practical tests show that a circuit of this type (Fig. 6), constructed with over-the-counter components, is linear within about 0.5 percent through a frequency range of about 30 to 1; that the linearity falls off considerably if the range is extended; and that the entire circuit is subject to drift as the triode ages. Frequency range may be extended considerably, in some instances, by use of a suitably-connected tetrode in place of a triode, but drift and other changes in the tube characteristic offset much of the apparent gain. The function of C_4 in this circuit is as a damping device to prevent a kick in the instrument trace during the time that C_1 is charging. Its value is usually quite small, a 0.5-μf capacitor across a 1,000-ohm, 0-1 ma Esterline-Angus milliammeter being more than adequate.

Sum and Difference

Outputs of a number of linear circuits may be fed into one indicating or recording instrument to produce a sum or average, using a circuit such as Fig. 7A. Any number of inputs, within reason, may be used. The sum is read directly on the instrument, after suitable calibration. Average value is found by dividing the recorded or indicated sum by the number of inputs actually in operation; by use of a new calibration; or by suitable shunting of the instrument.

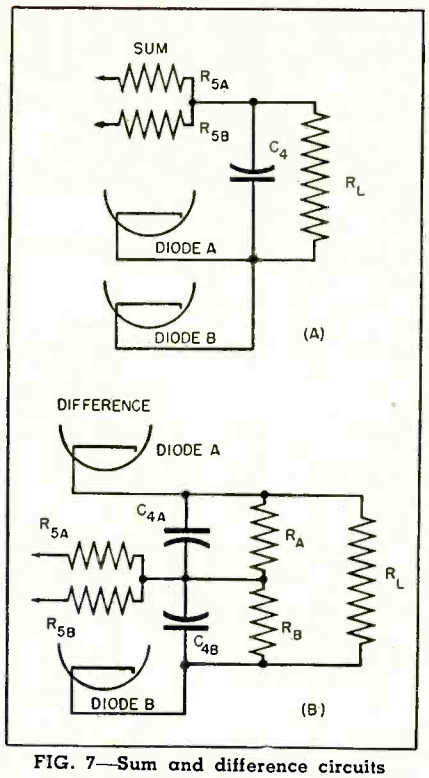

FIG. 7—Sum and difference circuits

If two linear capacitor-discharge instruments are connected *back to back*, the voltage between the two diode cathodes is the difference between the drops across their load resistors. From this voltage, and its polarity, the difference between the two input frequencies may be determined. Theoretically, the load resistors can be omitted, but in practice this is undesirable, for the constant voltage (the lower value) will accumulate, eventually raising the voltage across both capacitors to the supply value, if the capacitors do not puncture first. For this reason, R_A and R_B are essential. These, in many applications, may consist of the moving coils of a differential instrument; or even the paired coils of a ratiometer (such as the Sensitive Research Model RA). When the meter is connected from cathode to cathode, as in Fig. 7B, it is in a bridge circuit, and can be calibrated by standard formulas.

When only a same or different indication is needed, or the two values to be compared are nearly alike, use of a linear circuit is unnecessary, and entirely satisfactory frequency matches can be obtained with the simpler nonlinear instrument.

Conclusions

Practical tests with various capacitor-discharge instruments, most of them arranged as recorders, indicate the following:

For overall simplicity, and for field use where power supply is limited, the relay-operated nonlinear instrument (Fig. 1A) is ideal.

For maximum dependability, and for field use where there is a reasonably good source of power, the kick-coil or flyback design (Fig. 5) is very satisfactory.

For maximum linearity, use of the linear capacitor-discharge circuit is indicated.

For most purposes, auxiliary devices employing an instrument-type relay are preferable to those controlling a grid directly.

Tests of various forms of capacitor-discharge equipment, indicate that the instrument and its derivative devices have a definite place in the field of instrumentation, particularly in the low-frequency range, and for the measurement of functions that are not uniformly spaced in time. Because of its general flexibility, the instrument can be adapted readily for many uses.

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Feedback Improves Response of D-C Amplifier

Frequency response of a modulation type direct-current amplifier having high gain is made more linear by negative feedback. Gain and feedback controls are ganged to make response independent of amplification. The instrument amplifies low currents sufficiently to drive recording meters

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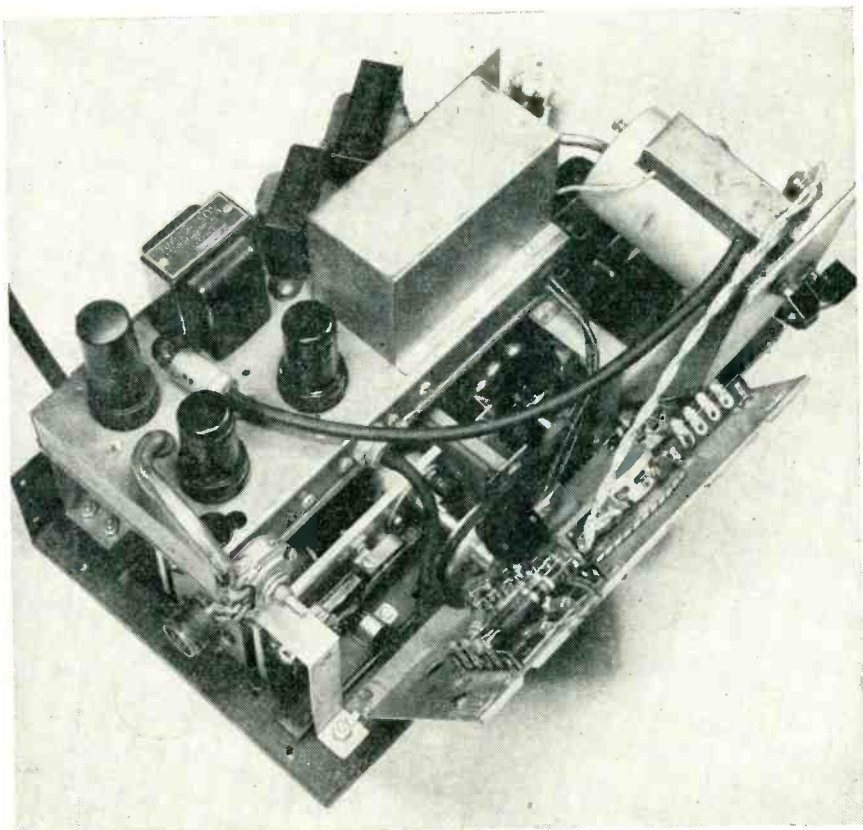
NEGATIVE FEEDBACK, as usually applied to amplifiers, improves their frequency response, linearity and stability. These benefits can be obtained in direct-current amplifiers as well as in the more common a-c types. Because d-c amplifiers are used as essential parts of precision equipment, the improvements obtained by using negative feedback with them are especially desirable.

Carrier Type Amplifier

The d-c amplifier to which negative feedback has been applied is a modification of one developed several years ago.[1] The first model was built to meet the need for a compact, portable instrument, that would detect minute currents from low-energy sources.

The operating principle of the amplifier is the conversion of the d-c input signal into a-c by a mechanical breaker, stepping this a-c up by a transformer, amplifying it with several vacuum-tube stages, and finally rectifying it with a second breaker driven synchronously with the input breaker. Designed to operate with a 5 to 20-ohm input source, the amplifier is capable of measuring direct potentials between 0.01 microvolt and 300 microvolts. Applications of this amplifier to infrared spectroscopy[2], and medical research[3] have been described.

The modifications incorporated in the latest model to make it a more useful laboratory tool consist of (1) an input signal attenuator to permit using the amplifier with larger signals, (2) a fourth stage of amplification to increase gain and output power, (3) a filter to smooth the



To avoid thermal disturbances, low-impedance input is completely connected with the same type of copper wire. Rigidity and compactness add to instrument's utility

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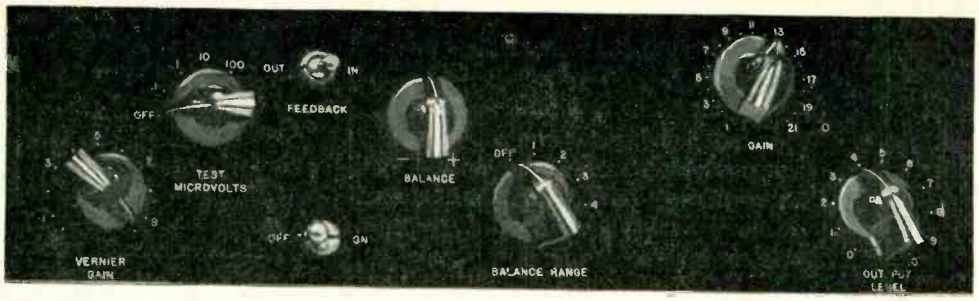

Flexibility of the d-c amplifier is enhanced by incorporating several controls. Because the gain control operates within the feedback loop, it is ganged with the feedback control to give the same response at all settings

pulsating d-c from the output breaker, thus permitting direct connection to modulation-type recorders, (4) a negative-feedback circuit to improve performance and (5) a means of limiting the output to protect meters and recorders.

Arrangements of Inputs

Figure 1 shows a wiring diagram of the amplifier. Low-level signals, introduced at P_1, are applied alternately 75 times per second across the two halves of the input transformer, which presents a 5-ohm input impedance and has a voltage step-up ratio of about 1 to 300. This is an extremely sensitive input. Therefore, electrostatic shielding, noninductive wiring, and low thermal emf copper-to-copper junctions must be used with the external circuit connected to P_1 to reduce objectionable noise and drift.

The first vacuum-tube stage is overdriven by relatively small input signals in the order of 300 microvolts, so that when attempting to use the amplifier with larger input signals some type of divider had to be employed. It was found that in most instances considerable noise and drift were introduced by inductive loops and high thermal emf junctions in the divider. Therefore, another input P_2 was added by means of which signals could be applied across a 0.05-ohm section of the internal input circuit. This, in effect, is a built-in divider which reduces the signal by a factor depending upon the external input resistance used. A copper shorting plug is applied to P_1 to complete the input circuit when using P_2. The sensitive part of the circuit is all compactly inside the same multiple shielding, and is all made of the same copper wire with a minimum number of junctions. Because much larger currents must be introduced at P_2 than at P_1 to produce the same input voltage, the external circuit can be less carefully constructed. In a similar manner, zero-bias and test signals are applied across the two 0.01-ohm sections of the input by means of relatively large currents from the control panel.

Output and Feedback Circuits

A 6Y7 twin triode, operating as a class-B amplifier, was added to increase gain and output power. It feeds push-pull through a step-down transformer matching into the load on the d-c side of the output breaker. This additional stage was needed to compensate for the

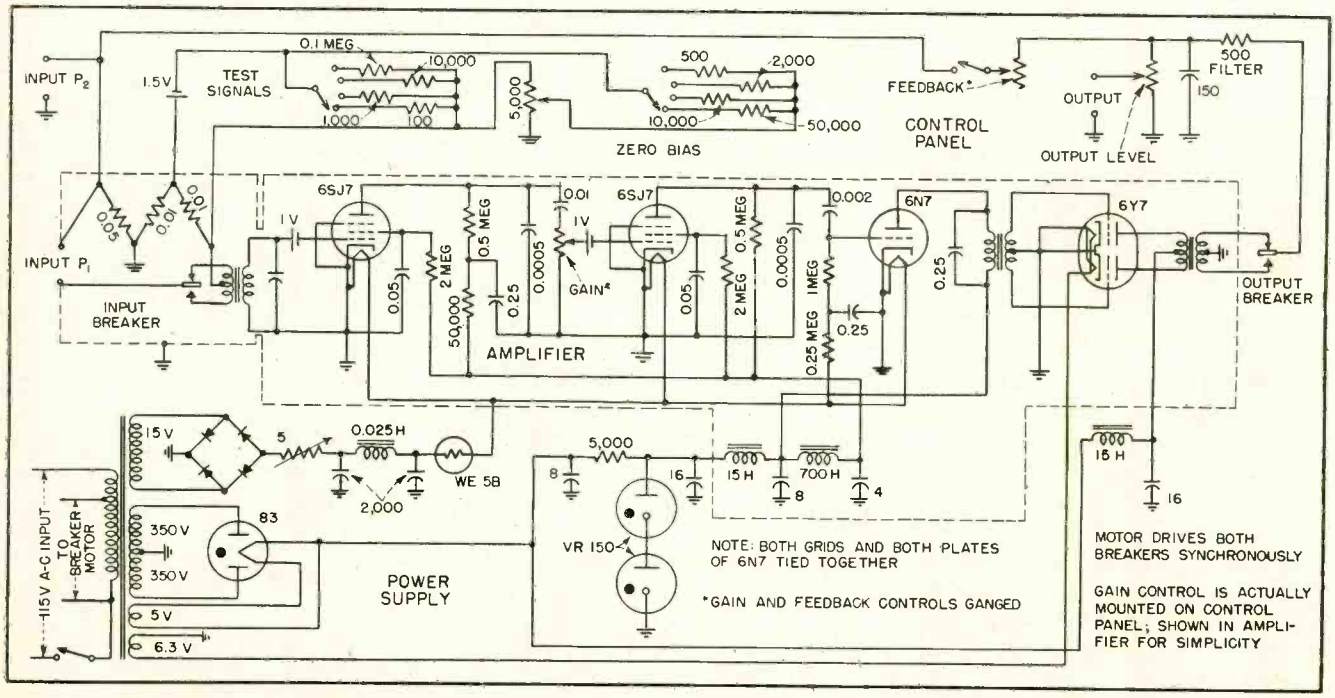

FIG. 1—Heaters of voltage amplification stages are supplied with direct current to minimize interference from power frequencies. Dashed box shows components in shielded amplifier proper; above are parts on panel; below are those in separate power supply

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gain lost by the action of negative feedback. and the power lost in output filtering. It also increases the net output to 25 volts positive or negative across a 1,500-ohm load, which is sufficient to drive recording instruments.

The output filter is a resistance-capacitance type with a time constant of about 0.05 second. It reduces the ripple voltage to about 5 percent, which has been found satisfactory for operating into such recorders as the Brown Electronik, Leeds and Northrup Speedomax, and Brush oscillograph.

A small portion of the filtered output is fed back negatively to the 0.05-ohm section in the input circuit. This feedback improves output linearity and speed of response at the expense of gain. It was found that satisfactory output linearity and speed of response were obtained when the negative feedback voltage was such as to reduce gain by a factor of 4 to 1 at all levels of amplification. To maintain this ratio required a different setting of the feedback rheostat, between output and input, for every setting of the 20-step gain attenuator between the first and second amplifier stages. Therefore, the two controls were ganged as shown in Fig. 1 so that one adjustment changes gain and maintains the same output linearity and response characteristics.

Operating Characteristics

Often the amplifier is used with sensitive meters, which could be damaged by the full 25-volt output. To prevent this, an output level control was added which reduces the maximum output in 10 equal steps.

The regulated power supply requires 100 watts of 110-volt, 60-cycle power. To reduce 60-cycle interference, the filaments of the first three amplifier stages are supplied with filtered d-c; the fourth stage uses a-c filament supply.

The minimum detectable signal depends, of course, upon noise level, which in turn is affected by input resistance and response characteristics of the overall system including the indicating meter. Expressing noise in terms of equivalent input voltage with a 5-ohm input resistance and using a five-milli-ampere Esterline-Angus recorder, the maximum departure from the mean does not exceed 2×10^{-9} volt.[1]

Sinusoidal signals up to 20 cps are passed without serious attenuation. This frequency-response characteristic makes the amplifier satisfactory for use with modulation type infrared receivers. Figure 2A shows relative output of a constant amplitude sinusoidal input signal plotted against frequency, with and without feedback. The rapid attenuation observed without feedback is due primarily to the output filter. Figure 2B shows the response to a one-microvolt 2.5-cps square-wave with and without feedback.

In Fig. 2C output voltage is plotted against input microvolts at full gain for several settings of the output level control. At level 10 it can be seen that linearity is good up to 20 volts output and satisfactory up to 25 volts for most applications. At minimum gain, about one millivolt input at P_1 is required for full output. In this case the first vacuum-tube stage is not over driven, and linearity is maintained with this amplifier because the voltage applied to the input transformer is considerably less than the actual input signal due to the action of negative feedback. The maximum signal that can be applied at P_2 will depend, as previously mentioned, upon the external input resistance used; it will be approached when a current of 20 milliamperes is flowing in the input circuit.

A variety of applications has been found for this amplifier. It has the sensitivity and stability necessary for precise measurement of minute currents in the laboratory as well as ruggedness and a wide range of signal coverage for photocell, strain gage, and thermocouple measurements under adverse conditions of vibration and acceleration. It is essentially a current-sensitive device having a low input impedance.

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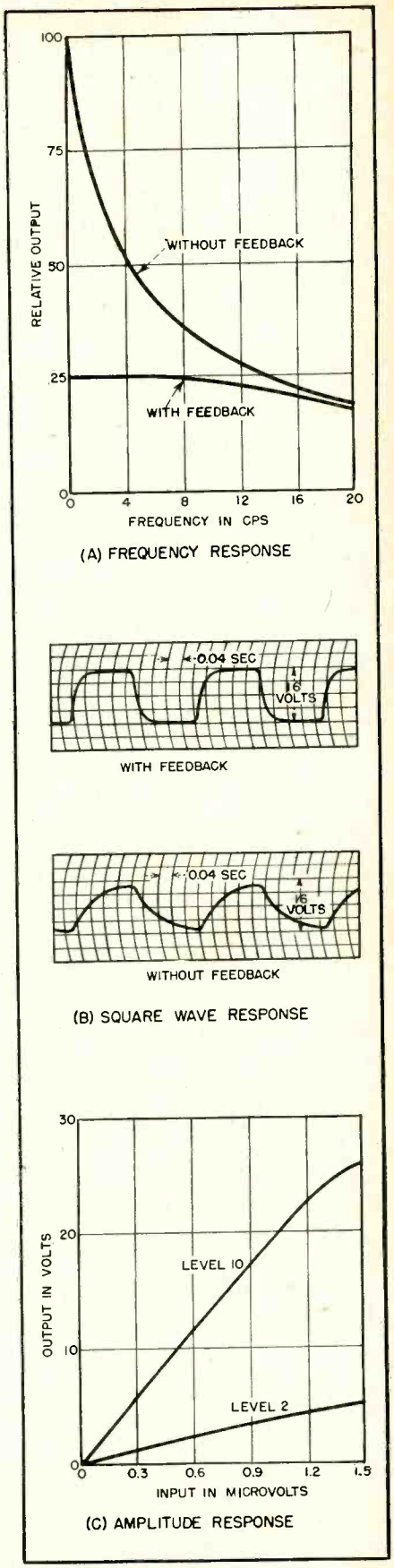

FIG. 2—(A) Feedback flattens frequency response to sinewaves and improves squarewave response (B). At low output levels, amplifier is linear, but at high levels (C), it tends to saturate

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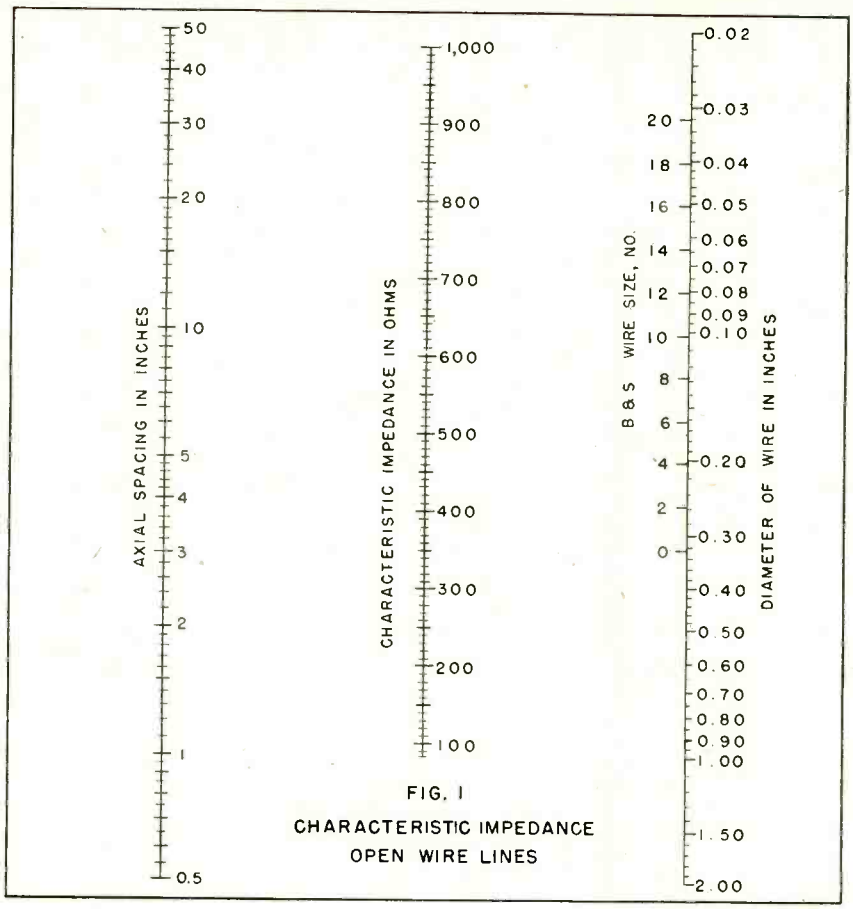

FIG. 1
CHARACTERISTIC IMPEDANCE
OPEN WIRE LINES

R-F Transmission

IN radio engineering, nomographs permit the saving of considerable time, particularly where the repeated solution of mathematical equations is required. They are especially well suited to portraying the relationships between the many electrical and mechanical properties of radio frequency transmission lines since these relationships may generally be expressed by relatively simple mathematical equations. Ten of the most useful of these equations have been plotted as nomographs as a convenience to the radio engineer. Each of these is discussed briefly and the formulas are given to permit an evaluation beyond the accuracy of the nomograph should this be desired in any particular case. The derivation of the formulas is based upon certain simplifying assumptions which are generally considered justifiable for radio-frequency transmission lines.

1. Characteristic Impedance of Transmission Lines

For radio-frequency transmission lines where the losses per wavelength are relatively small, the charactertistic impedance is essentially a pure resistance. The characteristic impedance is numerically equal to the square root of the ratio of the distributed inductance to the distributed capacitance per unit length. Since both of these parameters are uniquely related to the physical size and spacing of the conductors, it is possible to express the characteristic impedance in terms of the physical dimensions of the line.

Thus, the characteristic impedance (Z_o) of an open 2-wire line is

$$Z_0 = 276 \log_{10} (2D/d) \text{ ohms} \quad (1)$$

where D is the wire separation on centers and d is the wire diameter, both in the same units. Figure 1 shows the characteristic impedance of an open 2-wire line as a function of the conductor dimensions and their center-line spacing.

2. Characteristic Impedance of a Coaxial Line

The characteristic impedance (Z_o) of a coaxial transmission line is

$$Z_0 = 138 \log_{10} (D/d) \text{ ohms} \quad (2)$$

where D is the inner diameter of the outer conductor and d is the outer diameter of the inner conductor. This applies only to a line where the medium between conductors is predominantly a gas, such as air, at low pressures.

If the coaxial line is filled with a uniform dielectric material other than a low pressure gas, the characteristic impedance is reduced by a factor equal to $1/k^{\frac{1}{2}}$, where k is the relative dielectric constant of the material. For a line with bead insulators at small uniform intervals, the effective dielectric constant (k_e) may be computed from the following

$$k_e = (k\,t + s)/(t + s) \quad (2a)$$

where t is the thickness of one bead, s is the spacing between two beads, both t and s in the same units; and

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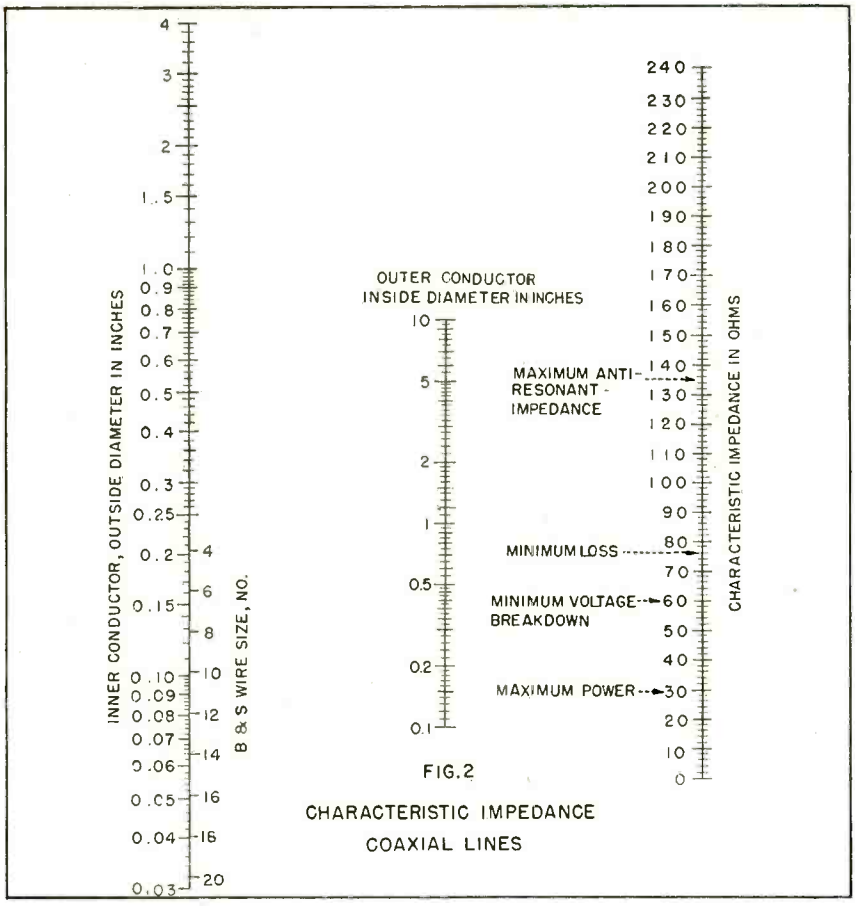

FIG. 2

CHARACTERISTIC IMPEDANCE
COAXIAL LINES

Line Nomographs

Ten equations commonly used to compute relationships between electrical and mechanical properties of radio-frequency transmission lines have been plotted as convenient nomographs

k is the relative dielectric constant of the bead. A number of optimum values for the characteristic impedance of coaxial lines exist which are based upon different considerations such as the maximum power handling capability and the minimum loss. Several of these optimum values are indicated along the characteristic impedance scale on the right hand side of the nomograph. Fortunately, all of these optimums are relatively broad in their characteristics and a considerable departure can generally be tolerated for any particular application.

Figure 2 shows the characteristic impedance of a gas dielectric coaxial transmission line as a function of the two conductor diameters.

3. High-Frequency Resistance of a Coaxial Line

The high frequency resistance of a coaxial transmission line is one of the principal factors which determine the attenuation along the line. It is also one of the factors which determine the maximum anti-resonant impedance and the minimum resonant impedance of a line section when used as a circuit element. The high frequency resistance of a coaxial line is a function of both conductor dimensions and of the frequency (due to skin effect). It is also a function of the resistivity of the material of which the conductors are made.

For copper coaxial lines the high frequency loop resistance *(R)* is

$$R = 0.0315 f^{1/2} \left[\frac{1}{d} + \frac{1}{D} \right] \underset{\text{per 1,000 feet}}{\text{ohms}} \qquad (3)$$

where f is the frequency in kilocycles, D is the inner diameter of the outer conductor in inches, and d is the outer diameter of the inner conductor in inches.

For conductors other than copper, the high frequency resistance is proportional to the square root of the ratio of the resistivity of the conductor to that of copper.

Figure 3 shows the resistance of a copper coaxial line as a function of the conductor dimensions and the frequency. Dielectric losses, which are negligible in a gas dielectric line, are not included.

The nomograph on Fig. 3 is used as follows: draw a straight line connecting points on the first and fourth scales from the left, which show, respectively, the line conductor diameters. Obtain the intersection of this line with the second scale marked Size Factor. Now project this intersection to a corresponding point on the third scale marked Pivot Line, as shown in the example on the nomograph. Finally, connect this new pivot point with a straight line intersecting the desired value on the sixth or frequency scale. The intersection of this latter straight line with the scale marked Resistance in ohms per 1,000 feet gives the desired loop resistance value.

4. Conversion of Loss Resistance to Decibels Attenuation per Unit Length

It is sometimes convenient to convert loop resistance of a transmis-

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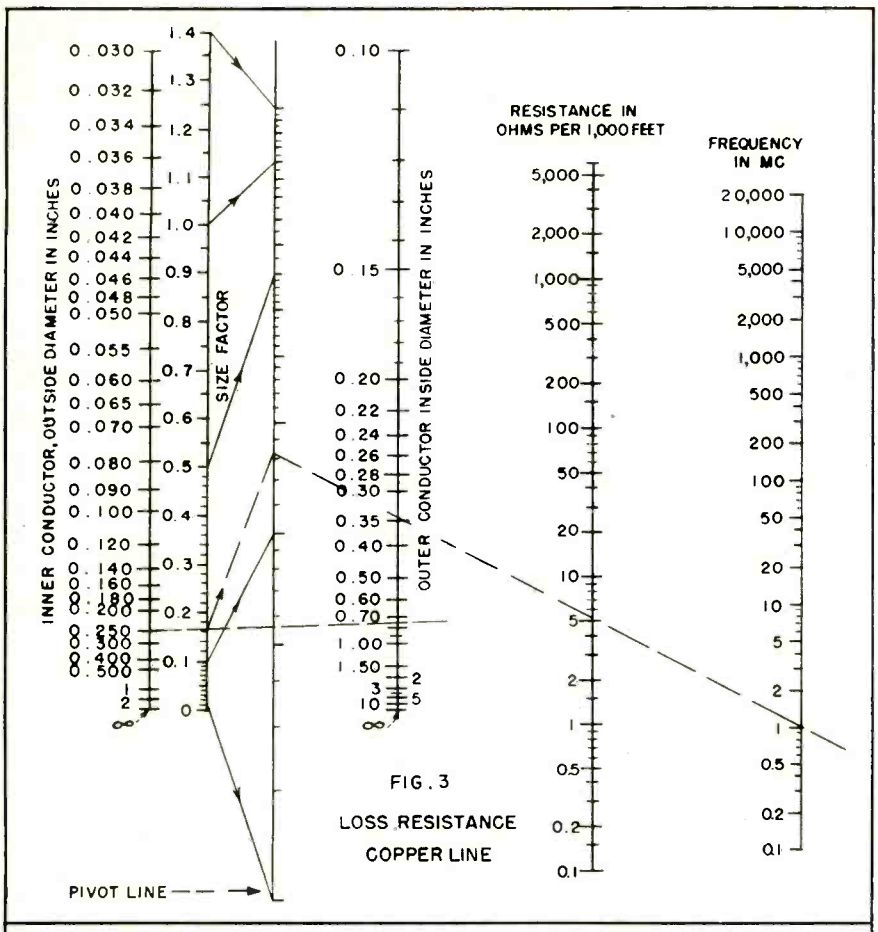

FIG. 3

LOSS RESISTANCE COPPER LINE

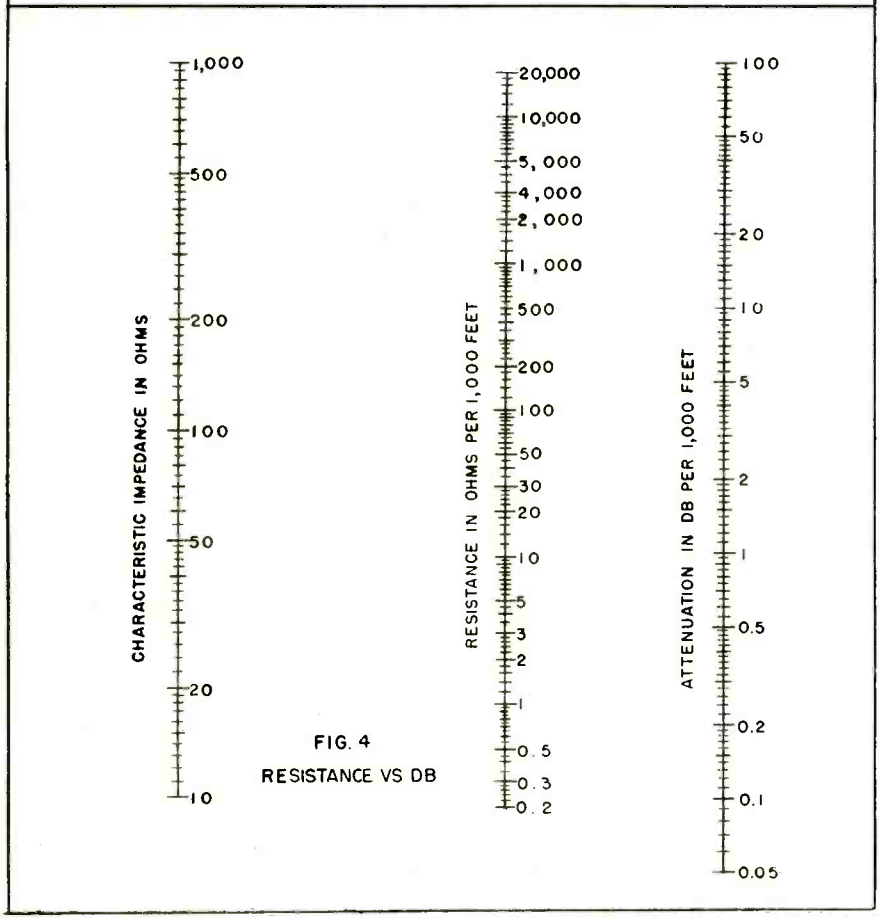

FIG. 4

RESISTANCE VS DB

sion line (as obtained from Fig. 3) to decibels (db) per unit length. This may be done if the characteristic impedance of the line is known. The conversion equation is simply

$$db = R/0.23025\,Z_0 \qquad (4)$$

where R is the loop resistance and Z_0 is the characteristic impedance. This relationship is plotted on the nomograph of Fig. 4. The nomograph applies to either open-wire or coaxial lines and does not require the line conductors to be of copper.

5. Antiresonant Impedance of a Transmission Line Section

The antiresonant impedance Z_{AR} of a transmission line section either open or short-circuited at its far end is a function of the total conductor resistance and the characteristic impedance of the section. The relationship is

$$Z_{AR} = 2\,Z_0^2/R \text{ ohms} \qquad (5)$$

where Z_0 is the characteristic impedance and R is the resistance of the antiresonant line section.

The shortest antiresonant line section is one-quarter wavelength long (short-circuited at its far end) and accordingly this will have the highest antiresonant impedance. A line section one-half wavelength long (open-circuited at the far end) will have only half as high an antiresonant impedance because its resistance R is twice as great.

Figure 5 shows the antiresonant impedance of a transmission line as a function of the total resistance and the characteristic impedance of the section. The nomograph applies equally to either coaxial or open wire lines.

The resonant impedance of a transmission line section is simply one-half of its total resistance (obtained from Fig. 3); accordingly, no nomograph has been plotted for this.

6. Input Reactance of a Transmission Line Section

A short length of transmission line is sometimes used as a reactance element in high-frequency circuits. The input reactance is a function of the electrical length of the line section and its characteristic impedance. The reactance varies between values essentially equiva-

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lent to plus and minus one half of the antiresonant impedance (obtained from Fig. 5). In air or gas dielectric coaxial lines, the electrical length is very nearly the same as the physical length measured in terms of free space wavelengths. A dielectric other than a gas results in a reduction in the length of the wave in the line which is proportional to the square root of the average dielectric constant. Thus a polyethylene coaxial cable with a dielectric constant of 2.5 will be electrically $(2.5)^{\frac{1}{2}}$ or 1.6 times as long as if the dielectric were a gas.

The electrical length and the characteristic impedance of a line section as well as its termination (either open circuit or short circuit) determine the magnitude and sign of the input reactance. For an open-wire or coaxial line section, open-circuited at its far end, the input reactance X_s is

$$X_s = -Z_0 \cot (360\, l/\lambda) \text{ ohms} \qquad (6)$$

where l/λ is the electrical length in wavelengths and Z_0 is the characteristic impedance.

For an open-wire or coaxial line section, short-circuited at its far end, the input reactance X_s is

$$X_s = Z_0 \tan (360\, l/\lambda) \text{ ohms} \qquad (6a)$$

Figure 6 shows the input reactance of an open or short-circuited transmission line section as a function of the electrical length, the characteristic impedance, and the termination.

7. Quarter - Wave Transmission Line Impedance Transformers

Impedance transformations are often made along radio-frequency transmission lines by employing a quarter-wave section of transmission line of selected characteristic impedance as an impedance transformer. When such a line section is terminated in a pure resistance its input impedance will be a pure resistance which depends upon the load resistance value and the value of the characteristic impedance of the quarter-wave line section.

Figure 7 shows the input resistance R_s of a quarter-wave open wire or coaxial line section terminated in a pure resistance load. The relationship is

$$R_s = Z_0^2/R_t \text{ ohms} \qquad (7)$$

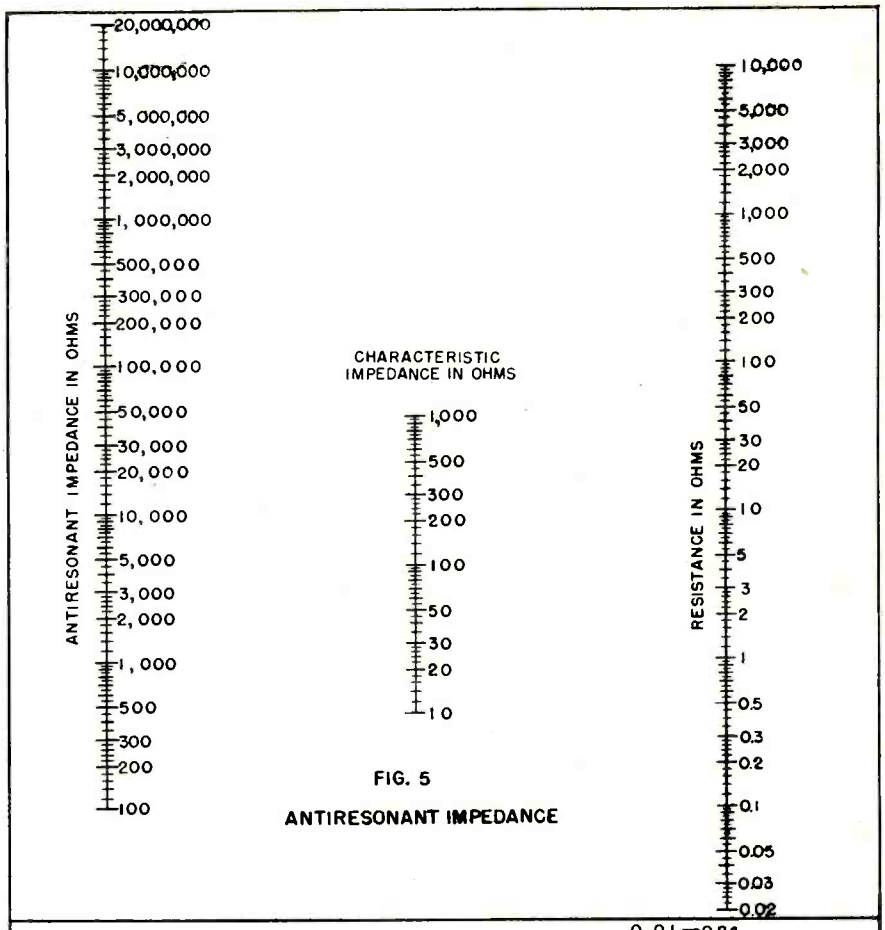

FIG. 5

ANTIRESONANT IMPEDANCE

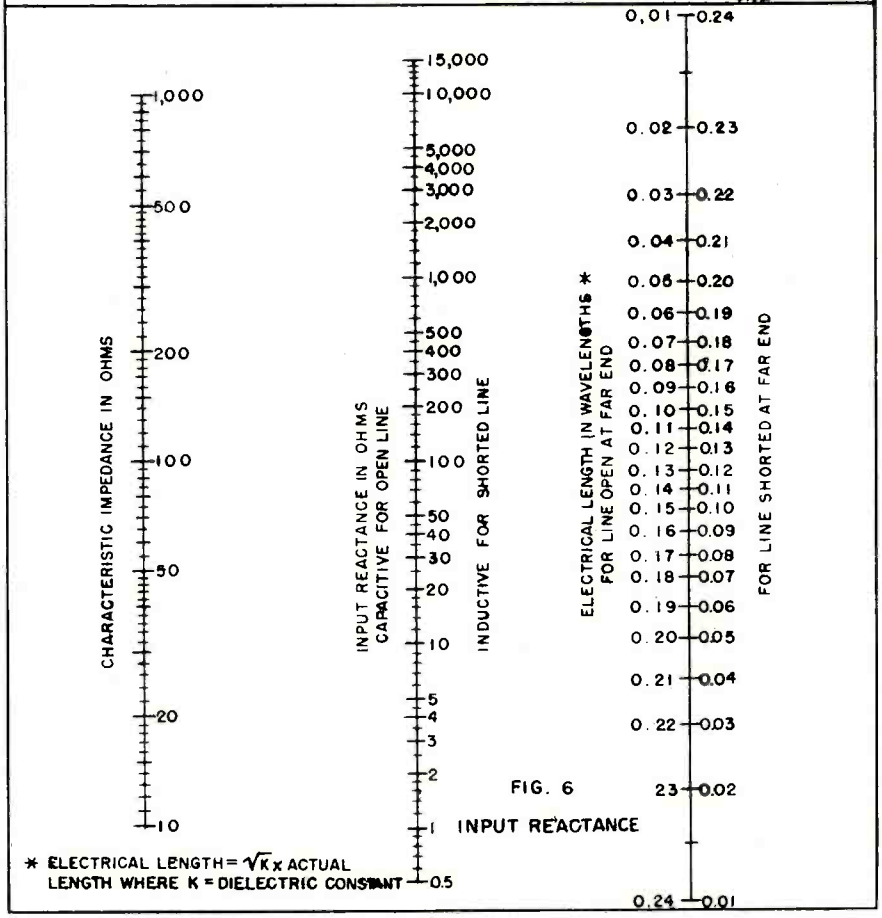

FIG. 6

INPUT REACTANCE

* ELECTRICAL LENGTH = $\sqrt{K}$ x ACTUAL LENGTH WHERE K = DIELECTRIC CONSTANT

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where R_l is the terminating resistance and Z_o is the characteristic impedance.

8. Current-Phase Relationship Along a Transmission Line

The phase relationship of the current from point to point along a radio-frequency transmission line will be uniform with length only when the line is terminated in an impedance equivalent to its characteristic impedance; otherwise the phase will vary nonuniformly along the line.

Figure 8 shows the phase relationship of the current at the sending end of a line, with respect to the current in a resistance load, as a function of the ratio of the load resistance to the characteristic impedance of the line, and of the effective length of line. The relationship is

$$\phi = \underset{\text{degrees}}{\arctan}\left[\frac{R_l}{Z_0}\tan\left(360\,\frac{l}{\lambda}\right)\right] \qquad (8)$$

where R_l is the load resistance, Z_o is the characteristic impedance and l/λ is the electrical length in wavelengths.

The current in the load will always lag the current at the sending end of a transmission line. It will undergo exactly 180 degrees of phase shift in each electrical half-wave length regardless of the ratio of the load resistance to the characteristic impedance.

9. Voltage Gradient along a Coaxial Line

In a coaxial transmission line the maximum voltage gradient occurs at the surface of the inner conductor. When this gradient exceeds the critical value of approximately 20,000 volts (rms) per cm, breakdown will occur in the form of either corona or arcover. If the characteristic impedance of the line is less than the optimum breakdown value of 60 ohms, arcover will occur without corona—if it is more than 60 ohms, corona will precede arcover.

Figure 9 shows the maximum voltage gradient G_{max} on a coaxial line as a function of the characteristic impedance of the line, the physical size of the inner conductor

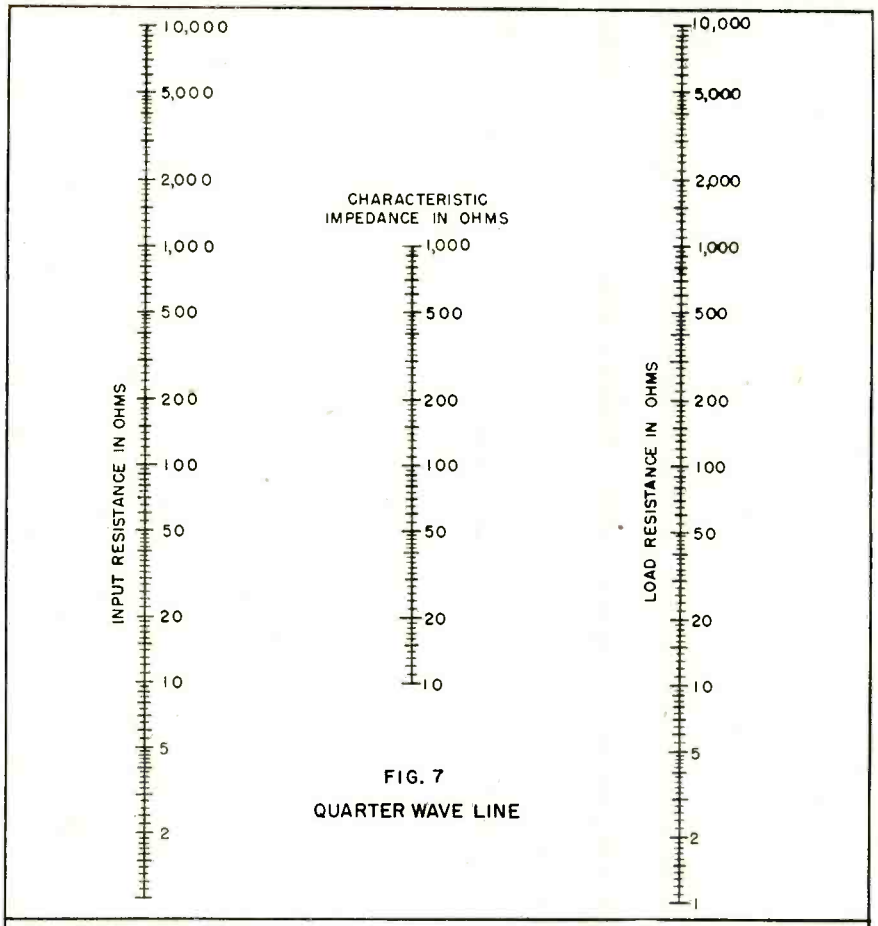

FIG. 7
QUARTER WAVE LINE

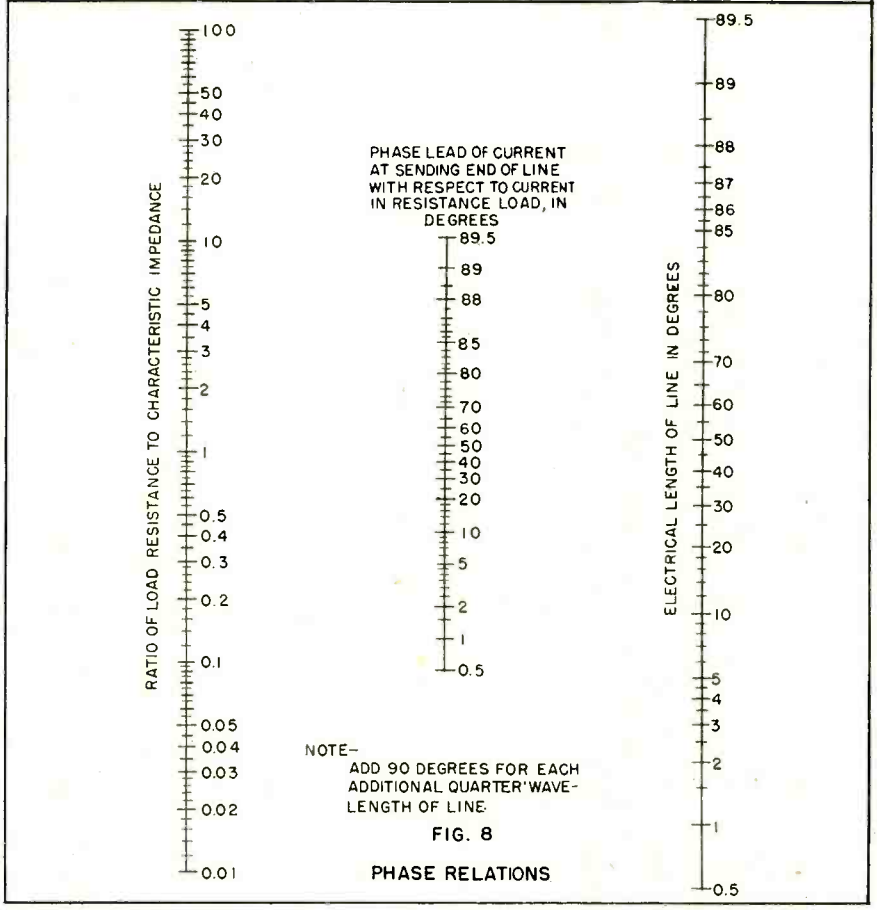

FIG. 8
PHASE RELATIONS

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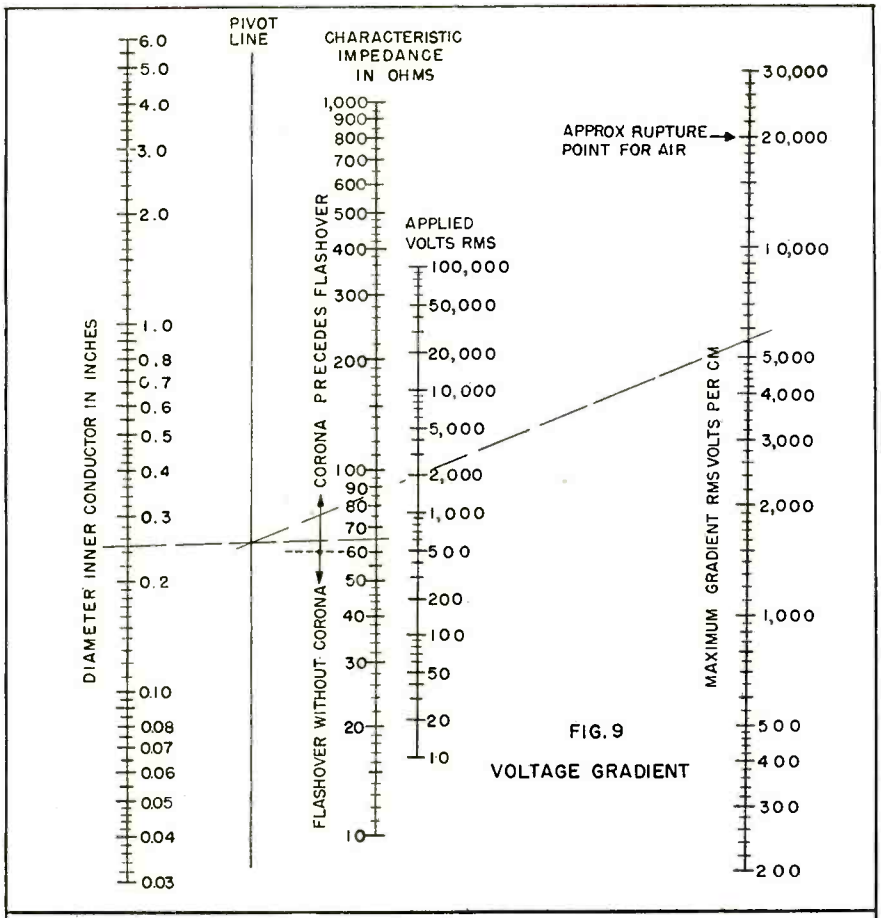

FIG. 9
VOLTAGE GRADIENT

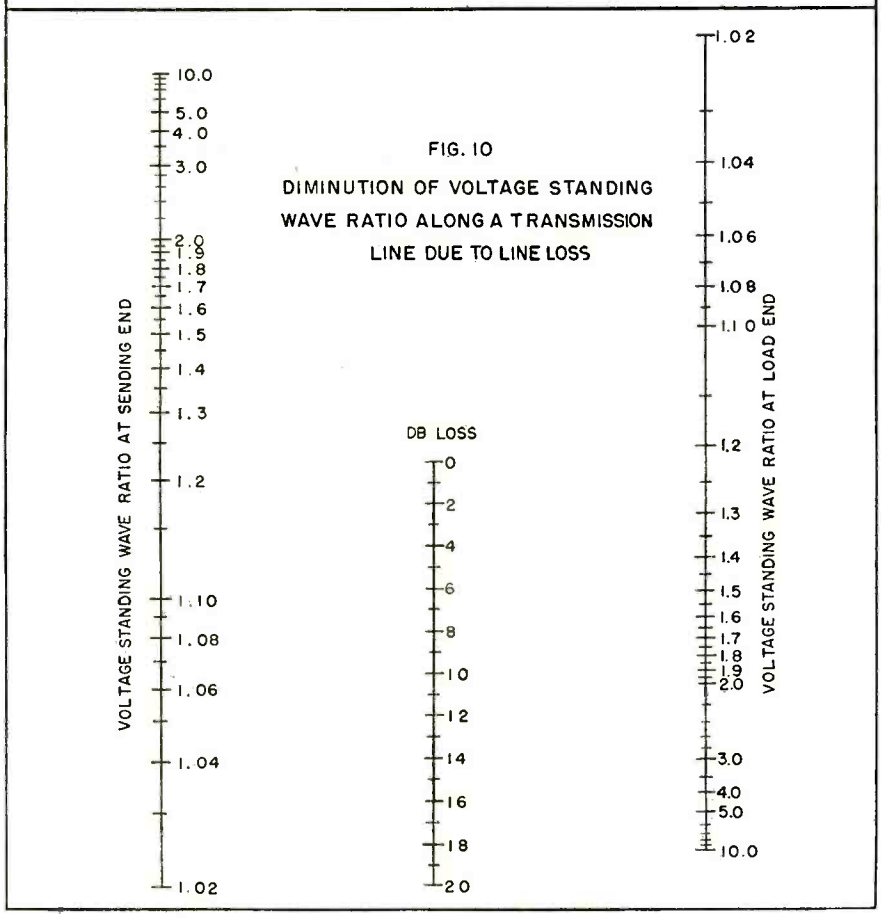

FIG. 10
DIMINUTION OF VOLTAGE STANDING WAVE RATIO ALONG A TRANSMISSION LINE DUE TO LINE LOSS

and the applied voltage. The relationship is

$$G_{max} = 47.2E/dZ_0 \text{ rms volts per cm} \quad (9)$$

where E is the applied rms voltage, d is the diameter of the inner conductor in inches, and Z_0 is the characteristic impedance.

This nomograph is used as follows: first, connect with a straight line points on the first and third scales from the left which represent the inner conductor diameter and the characteristic impedance (see example on nomograph). The intersection of this line with the second scale labeled Pivot Line is next connected with a second straight line passing through the desired point on the fourth scale labeled Applied Volts, RMS. The intersection of this second straight line with the fifth scale gives the desired value for the gradient on the surface of the inner conductor in rms volts per cm.

Bead insulators may cause higher gradients in their vicinity resulting in premature voltage breakdown particularly if they fit loosely on the inner conductor.

10. Diminution of Standing Wave Ratio Due to Line Loss

A high-frequency transmission line whose characteristic impedance is not matched by the load impedance will have standing waves along its length. The standing wave ratio in the vicinity of the load will be numerically equal to the ratio of the load resistance to the characteristic impedance (or its reciprocal if this is less than unity). If the line has attenuation, there will be a gradual diminution of the standing wave ratio in the direction of the generator.

Figure 10 shows the relationship between the standing wave ratio in a region near the generator (assuming that the wavelength is small compared to the line length), the standing wave ratio near the load, and the line loss in decibels (as obtained from Fig. 3 and 4). The relationship is

$$\text{db} = \left[10 \log_{10} \frac{(S_L + 1)(S_G - 1)}{(S_L - 1)(S_G + 1)}\right]^{1/2} \quad (10)$$

where S_L is the voltage standing wave ratio near the load and S_G is the voltage standing wave ratio near the generator.

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Stagger-Peaked

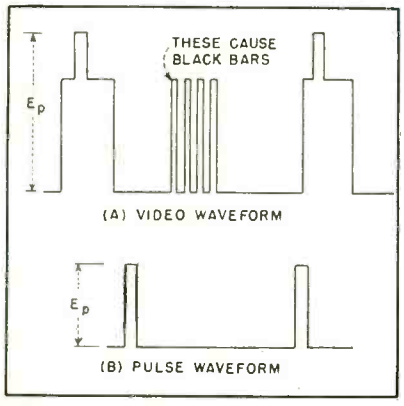

FIG. 1—Types of signals which can be handled by the staggered technique

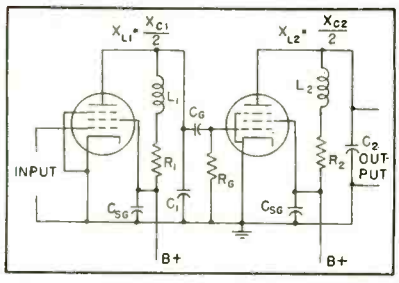

FIG. 2—Capacitances C_1 and C_2 are the result of tube and circuit

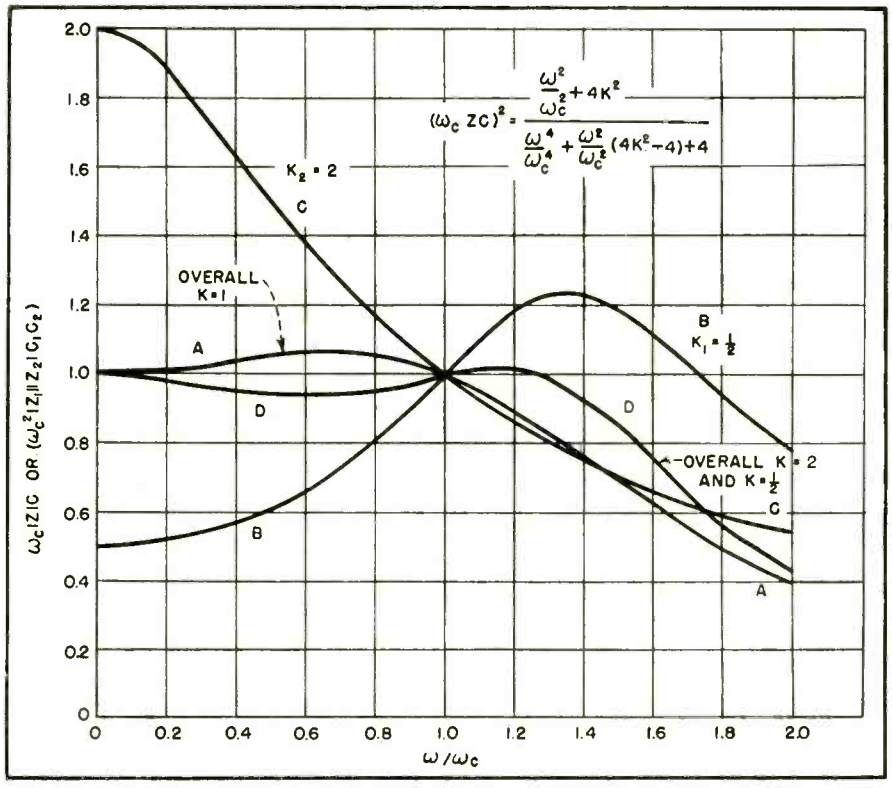

FIG. 3—Amplitude plotted against frequency for several combinations of stages using various values of K

IT HAS BEEN customary to design a video amplifier so that its power output in response to a sinusoidal input voltage is substantially constant between a high and low cutoff frequency. If the wide-band amplifier is to be used primarily for sine-wave work, or is intended as part of a general-purpose oscilloscope, the conventional design procedure[1] is satisfactory and economical. In the case of video amplifiers which are intended solely for the amplification of pulses or television signals, economies in design can be achieved by the use of staggered high-frequency compensation.

The realization of a desired amplitude-versus-frequency characteristic by means of stagger-tuning a group of individual cascade amplifier stages is well known when applied to tuned amplifiers[2]. In this paper, a similar general principle is applied to video amplifiers.

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Characteristics of Video Signal

Figure 1 shows two types of signals for which staggered high-frequency compensation is suitable. The series of narrow pulses in Fig. 1A is similar to those which result in the narrow wedges in monoscope test patterns. A Fourier analysis of the waveforms of Fig. 1 indicates that while the wave of voltage may have a peak magnitude of E_p volts, no one of the spectral components may be that large; in fact, the higher-frequency components become progressively smaller.

In the case of video signal amplifiers for television receivers, it is customary to specify high-frequency cutoff at about 4 megacycles. However, the signal-frequency components near 4 mc have amplitudes which are only a tiny percentage of E_p. Therefore, it is not necessary for the amplifier which drives the picture tube grid to deliver equal power throughout the entire frequency spectrum.

Most of the signal energy is concentrated at the low and middle portions of the spectrum and very little is ordinarily found near the upper end of the band. The small components require equal amplification with the lower-frequency components, but do not require as large plate-current swings.

Characteristics of Output Stage

The foregoing qualitative considerations indicate that an amplifier which has constant small signal gain, but a falling power-handling capacity with frequency, will produce a satisfactory picture on the

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Video Amplifiers

Staggered high-frequency compensation of a video amplifier provides twice the signal from a given amplifier tube in the conventional shunt-peaking circuit, or permits use of a tube having only half the plate-current consumption

cathode-ray tube. This principle when applied to the output stage of a video amplifier intended for television or pulse signals enables the use of an output-tube plate load resistor of at least twice the size of that dictated by the conventional design procedure.

The proposed approach makes it possible to obtain at least twice as much signal from a given amplifier tube, or, for a given video signal output, to use a tube having at least half the plate-current consumption. The resultant cost of a pulse oscilloscope or of a television receiver might therefore be reduced by a significant amount with no sacrifice in performance.

Design of Video Circuits

An analysis has been made of a pair of video amplifiers employing shunt-peaking compensation and embodying the proposed design principles. Consider the circuit shown in Fig. 2. The gain of this amplifier at low frequencies (neglecting the effects of coupling and screen bypass capacitors) is

$$A = R_1 G_{m1} \cdot R_2 G_{m2} \qquad (1)$$

where R_1 and R_2 are plate load resistances and G_{m1} and G_{m2} are tube transconductances.

At any frequency

$$A = Z_1 G_{m1} \cdot Z_2 G_{m2} \qquad (2)$$

At a particular frequency, f_c, designated as the cutoff frequency, the magnitude of the plate load impedance ($|Z|$) may be made equal to R, the load resistor, when

$$\begin{aligned} R &= X_c \\ X_L &= X_c/2 \end{aligned} \qquad (3)$$

Now suppose

$$\begin{aligned} R' &= KR = KX_c \\ \text{and } X_L &= X_c/2 \end{aligned} \qquad (4)$$

Since

$$Z = \frac{X_L X_c - jR X_c}{R + j(X_L - X_c)} \qquad (5)$$

Substituting into Eq. 5 gives

$$Z' = \frac{\left(\frac{R'}{2K} \cdot \frac{R'}{K}\right) - j\left(\frac{R'}{K} \cdot R'\right)}{R' + j\left(\frac{R'}{2K} - \frac{R'}{K}\right)} = \frac{\frac{R'}{K}\left[\frac{1}{2K} - j\,1\right]}{\left[1 - j\frac{1}{2K}\right]} \qquad (6)$$

from which

$$|Z'| = \frac{R'}{K} = R \qquad (7)$$

Equation 7 shows that the gain of the stage at the cutoff frequency is independent of the value chosen for K, subject to the limitations set forth in Eq. 3 and 4.

If we now set

$$R_1' = K_1 R_1;\ R_2' = K_2 R_2;\ K_1 = 1/K_2 \qquad (8)$$

the overall gain at low frequencies of the two stages is

$$A_T = \frac{R_1}{K_2} G_{m1} \cdot R_2 K_2 G_{m2} = R_1 G_{m1} \cdot R_2 G_{m2} \qquad (9)$$

and the high-frequency (f_c) gain is the same.

The analysis to this point has shown that if the size of the output load resistor is multiplied by a factor K_2 and the size of the input stage load resistance is multiplied by $K_1 = 1/K_2$, the amplifier will have the same gain at low frequencies and at cutoff frequency as an amplifier designed in the conventional manner ($K_1 = K_2 = 1$). The values of compensating inductance and circuit capacitance are identical in both types of designs.

There is no change in the overall gain, but it is possible to drive the amplifier to twice the signal power output without overload when $K_1 = 1/2$, $K_2 = 2$. The first stage pre-emphasizes the higher-frequency components to compensate for the tendency of the second stage to drop off with frequency.

Overall Response

The general frequency response and time-delay characteristic for the above circuits are of interest. The impedance in the plate circuit of either video amplifier is

$$|Z|^2 = \frac{R^2 + \omega_2 L_2}{1 - 2\omega^2 LC + \omega^4 L^2 C^2 + \omega^2 C^2 R^2} \qquad (10)$$

The stated conditions for compensation are:

$$\begin{aligned} \omega_c &= 2\pi f_c \\ \omega_{cL} &= \frac{1}{2\omega_c C} \\ R &= \frac{K}{\omega_c C} \end{aligned} \qquad (11)$$

from which

$$LC = \omega_c^2/2 \qquad (12)$$

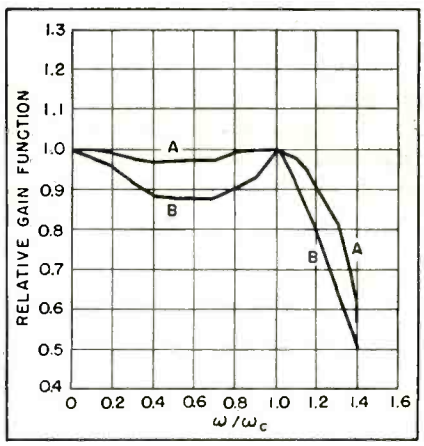

FIG. 4—Curve A shows the overall response of four stages, each having different values of K. Curve B applies to four stages, each having K—1

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$$L = \frac{1}{2\omega_c^2 C}$$

$$\omega_c L = \frac{1}{2\omega_c C}$$

The generalized dimensionless impedance function is

$$(|Z| \omega_c C)^2 = \frac{(\omega/\omega_c)^2 + 4K^2}{(\omega/\omega_c)^4 + (\omega/\omega_c)^2 (4K^2 - 4) + 4} \quad (13)$$

The phase angle may be determined from

$$\theta = \arctan \omega/R [L(1 - \omega^2 LC - CR^2] \quad (14)$$

Substituting the design criteria for L, C, and R gives

$$\theta = \arctan (\omega/\omega_c) \left[\frac{2 - (\omega/\omega_c)^2 - 4K^2}{4K}\right] \quad (15)$$

and $$\omega_c t = (2\pi/360°) (\theta/\omega/\omega_c) \quad (15a)$$

The normalized impedance function of a two-stage video amplifier designed in the conventional fashion ($K_1 = K_2 = 1$) is plotted in Fig. 3, curve A. The corresponding impedance functions for stages having $K_1 = 1/2$ and $K_2 = 2$ are shown in curves B and C, the composite of the two stages results in curve D.

Note that in comparing the amplifiers whose responses are shown in curves A and D, the response in the specified pass band is nearly the same for both, while the amplifier for which $K_1 = 1/2$, $K_2 = 2$ displays a greater bandwidth. The 3-db point in this case occurs when ω/ω_c equals 1.64 compared with 1.46. This increase in bandwidth indicates that for equal bandwidths the amplifier with staggered compensation may be expected to give approximately 20 percent more gain than the conventional shunt-peaked circuit.

If a four-stage amplifier is set up, with $K_1 = 1$, $K_2 = 1$, $K_3 = 1/2$, $K_4 = 2$, the composite characteristic would be as in Fig. 4. Response of a conventional four-stage amplifier in which $K = 1$ is shown by curve B of Fig. 4.

The time-delay characteristic for each type of amplifier may be deduced from Fig. 5.

The circuit chosen for the above analysis was selected not for its excellence as a video amplifier but rather for the ease and simplicity of analysis and demonstration. The method may also be applied to most other types of high-frequency compensation networks, perhaps with a bit more mathematical difficulty.

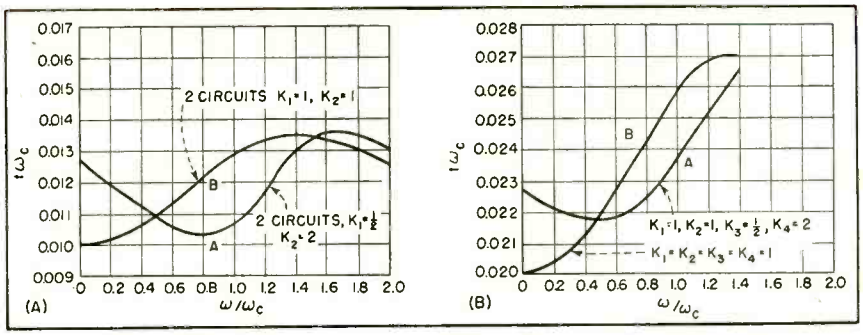

FIG. 5—Time delay of the video amplifiers plotted against frequency

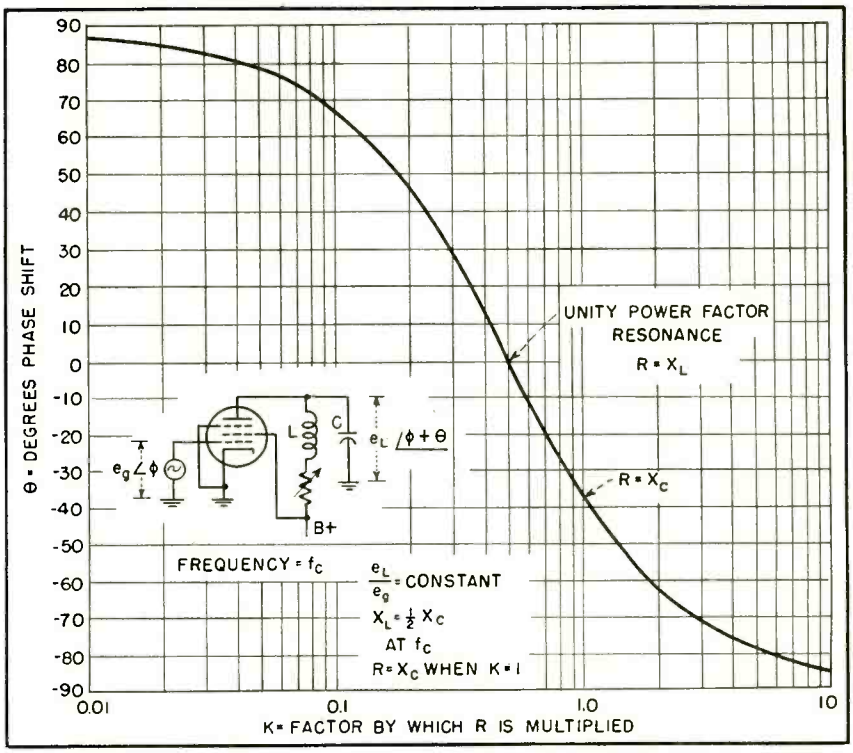

FIG. 6—Effect of load resistance upon phase shift of amplifier at cutoff frequency f_c

It has been shown in a qualitative manner than factors of $K_1 = 1/2$ and $K_2 = 2$ should produce no discernible deterioration of amplifier performance principally because the high-frequency components have relatively small amplitudes. Experiment indicates that values of K larger than 2 may be used, but the author has made no extensive mathematical study of this.

Further Applications

An interesting consequence of Eq. 7, which shows that the gain of an amplifier stage at a frequency f_c may be independent of the value of load resistance, is in the use of the circuit as a phase shifter.

While the gain of the circuit at f_c does not change as R is varied, the phase shift certainly does. This can be seen from study of Eq. 15. Let K be equal to zero ($R = 0$) and $\omega/\omega c = 1$, then Θ becomes plus 90 degrees. If K becomes very large (R approaches infinity) Θ approaches minus 90 degrees. Thus a variation in R can produce a phase shift which lies between plus or minus 90 degrees. The phase shift is equal to zero when K is 1/2.

Figure 6 is a plot of Θ versus K and illustrates the use of this circuit as a constant-amplitude phase-shift network. To obtain a variable phase shift of $n\pi$ radians, it is only necessary to cascade n identical stages.

References

(1) Terman, "Radio Engineers Handbook," McGraw-Hill Book Co., N. Y., 1943, p 413.

(2) H. Wallman, Stagger-Tuned Amplifier Design, Electronics, May 1948.

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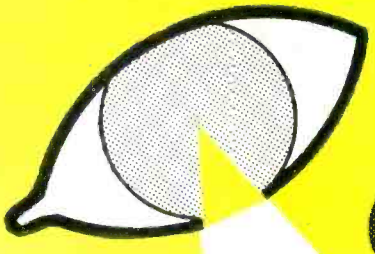

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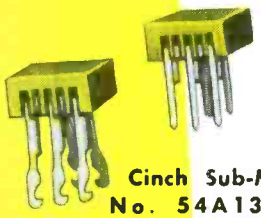

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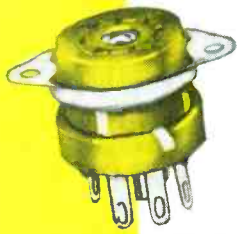

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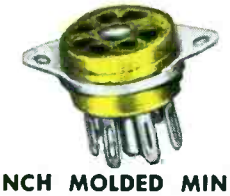

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Stabilizing Gain

Chart simplifies calculations involving fluctuations in gain with and without negative feedback, amount of feedback and sacrifice in gain to obtain required stability

By T. E. KORN
Research Associate
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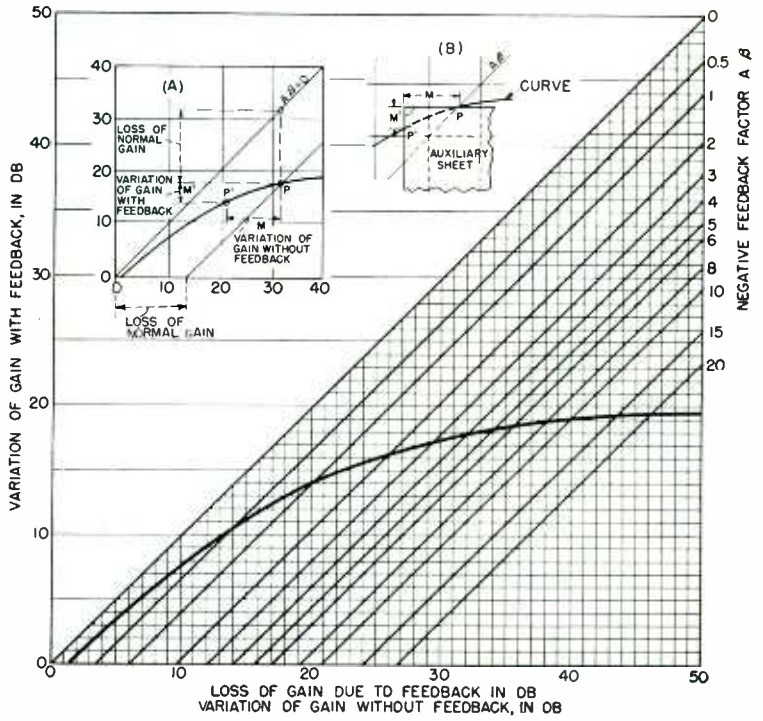
Brussels, Belgium



ONE ADVANTAGE of applying negative feedback to low-frequency amplifiers is the stabilization of gain that is obtained. Usually the effects of feedback are calculated from the equation $A' = A/(1 - A\beta)$ where A' is the voltage gain with feedback, A is the voltage gain without feedback, and $A\beta$ is the feedback factor. By converting this equation into logarithmic form and generalizing the reference level, the accompanying chart can be plotted. As used in the chart, A and A' are in db.

Usually the VARIATION OF GAIN WITHOUT FEEDBACK is given in the form of two measured values of A or ΔA corresponding to the extremes of power supply fluctuation, change in tube parameters and other effects. The VARIATION OF GAIN WITH FEEDBACK will generally be given in the amplifier specifications. There will be a REDUCTION IN OVERALL GAIN produced by the feedback, which has to be computed so that the initial gain A can be made large enough to give the required A' after feedback has been applied. The necessary FEEDBACK FACTOR to produce the specified effect may have to be computed, or it may have been obtained already by using the feedback to reduce distortion or output impedance. Although the factors that are given and the ones that are to be found may differ from problem to problem, any two are sufficient to obtain the others from the chart.

Example

An existing amplifier having 5 db more gain than necessary and a measured variation of gain from the normal of −6 db to +4 db is to be stabilized. How much feedback can be used and what will be the resulting stabilization? A loss of 5 db can be tolerated, therefore at this value along the base locate the diagonal line corresponding to the feedback factor; this is 0.8. To find the stabilization, locate the intersection of this feedback factor line with the heavy curve; call it point P. Drop from P to the abscissa and move along the number of db corresponding to the variation of gain without feedback. Return upward to a new intersection with the heavy curve, point P'. The difference measured along the side (ordinate) of the chart between P and P' gives the variation in gain with feedback. For this example the gain will vary with feedback from −3.8 to +2 db. Insert (A) shows construction.

An interesting and usual problem arises when the actual variation of gain and the acceptable variation are given, and the amount of feedback required to produce this stabilization is to be found. Without the chart such a problem entails considerable calculation; with the chart it is simple. As shown in insert (B), the actual and acceptable variations are marked in from the corner of a sheet of paper, forming points P and P'. The edges of this sheet are then kept parallel to the coordinates of the chart and the sheet moved until both P and P' lie on the heavy curve, which they will at one point if the required stabilization is obtainable. Point P is then at the intersection with the required feedback factor. As before, the loss in gain is given at the intersection of this diagonal with abscissa, as in (A).

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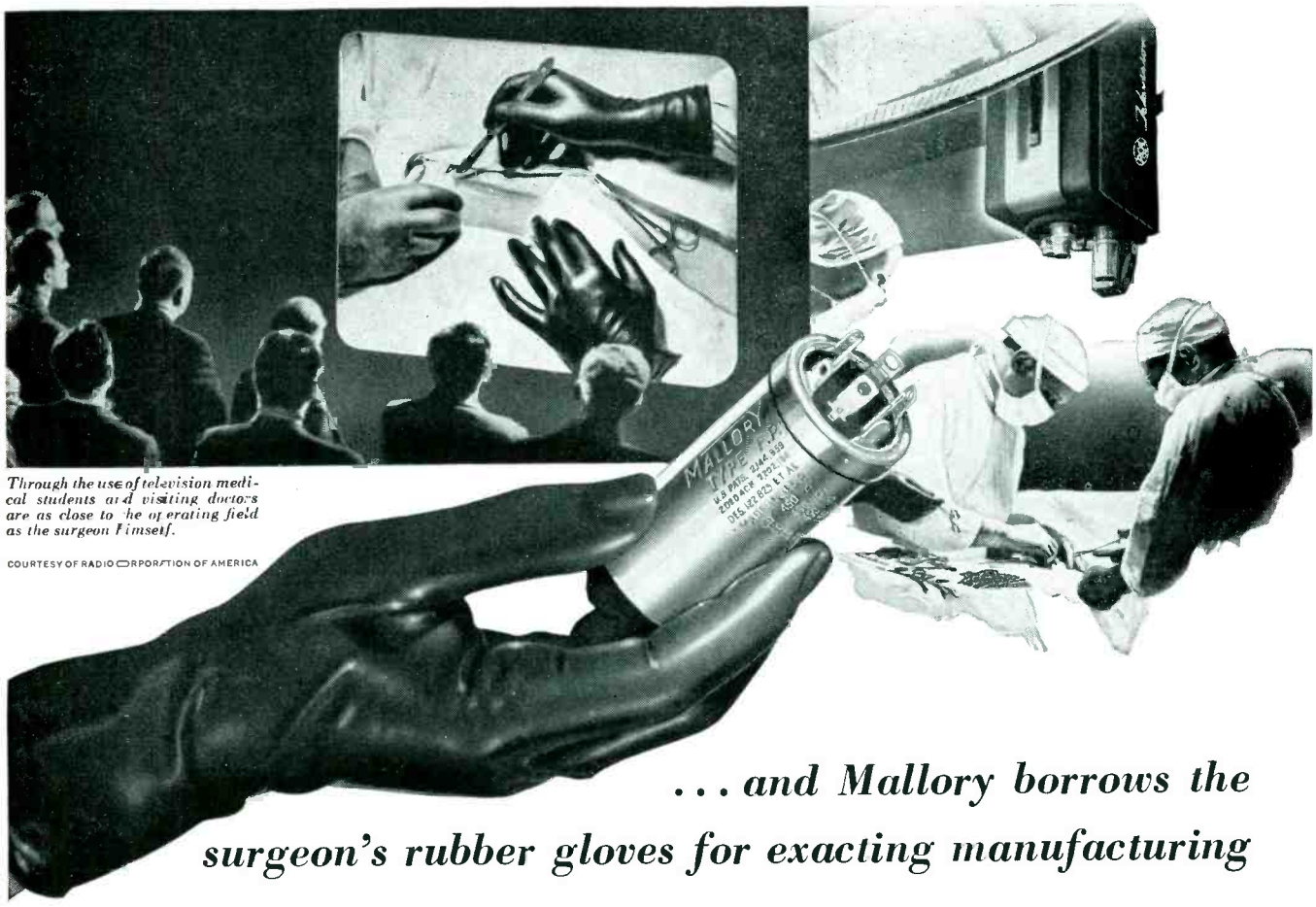

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There are more rubber gloves in this picture than you can see. They are worn by Mallory craftsmen in assembling the Mallory FP Capacitor. Thus no human hand* touches any vital part during processing and assembly.

Mallory knows there can be no compromise with quality—in television. New standards are essential for long life, dependability and trouble-free operation. The "rubber glove" technique is typical of Mallory's exacting standards.

Mallory FP Capacitors are accustomed to severe service—have been operating at 85° C. for years. Even though this extreme temperature may not be apparent in your particular model, it's good to know that Mallory gives you an extra margin of safety. So make it Mallory and be safe.

FP is the type designation of the Mallory developed electrolytic capacitor having the characteristic design pictured. Adopted as standard by RMA, it is famous for dependable performance.

**The chlorides present in perspiration cause destructive corrosion which shortens the capacitor's life in the field.*

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TUBES AT WORK

Including INDUSTRIAL CONTROL

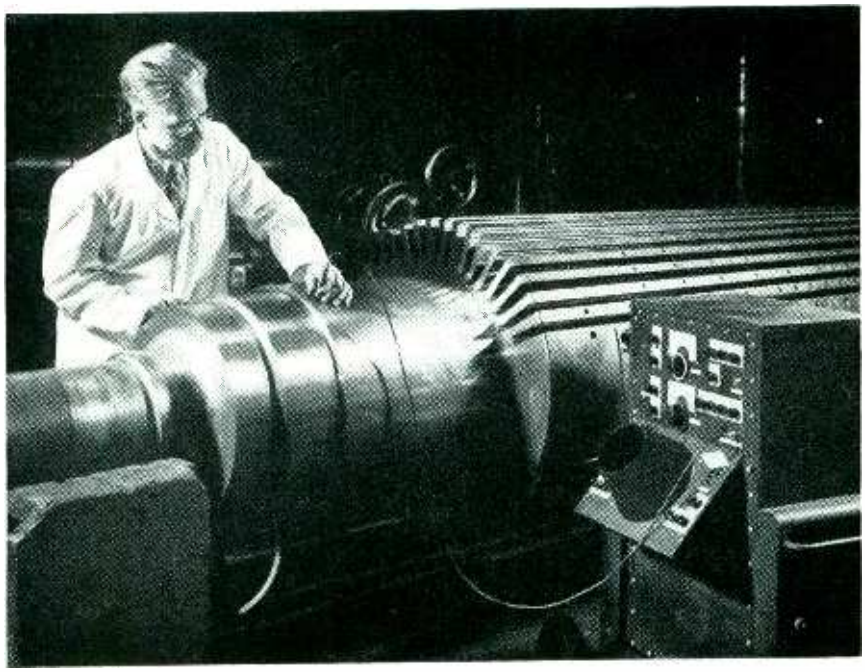
Edited by VIN ZELUFF

Ultrasonic Flaw Detector

LATEST improvement on x-ray for revealing imperfections in metals is the ultrasonic stethoscope devised by engineers of the Westinghouse Electric Corp. to test massive electric generators. Whereas x-ray is practical only for metal thicknesses up to about six inches, the ultrasonic technique tests solid metal ranging in size from 0.25 inch to 30 feet thick.

By using a crystal similar to that in phonograph pickup arms as a transducer, electrical impulses are changed into high-frequency sound waves. When projected through metal these waves reveal flaws such as cracks, cavities and foreign particles and reflect sound back to the crystal. Changed back into electrical impulses the reflections appear as bright vertical lines on the viewing screen of a cathode-ray tube.

Exact location of an imperfection in the metal is found by measuring the time it takes the sound waves to penetrate and bounce back to the crystal. When the metal is flawless throughout, the sound waves reflect from the opposite side of the object.



Ultrasonic stethoscope at Westinghouse East Pittsburgh plant is used to examine a new rotor before assembly in a generator

Electronic Load Resistor

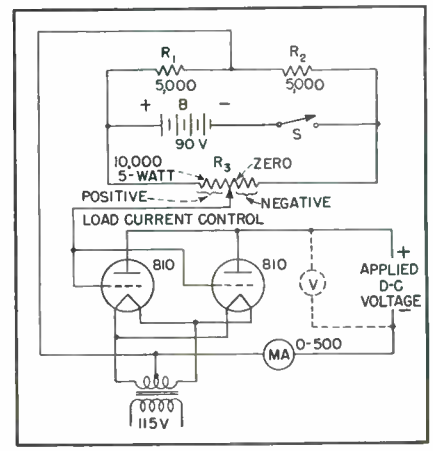
By RUFUS P. TURNER

Los Angeles, Calif.

THE plate-cathode path of a high-voltage triode tube makes an efficient load resistor for checking the output characteristics of power supply units. The effective resistance can be varied at will over wide limits simply by varying the d-c grid bias of the tube—hence, an electronic rheostat.

At cutoff bias, the resistance is infinite. The lowest resistance (highest current drain) corresponds to that current level, for a given applied voltage, at which the d-c power input equals the plate dissipation of the tube. The electronic load resistor has none of the vagaries evidenced by wirewound rheostats and slider-type resistors usually employed in power-supply testing.

The diagram shows a typical, practical circuit employing two 810's in parallel. The total safe



Continuous loading of a power supply under test is provided by this circuit

plate dissipation is 300 watts for the pair of tubes. When higher currents must be drawn from the power supply under test, additional tubes should be added in parallel. The adjustable bias circuit (comprised by B, R_1, R_2, R_3, and S) is bridge-connected to allow smooth, continuous variation of the grid voltage from a high negative value, through zero, to a high positive value. When R_3 is at its center-resistance position, the grids have zero bias. At all settings to the right of center the bias is negative, and at all settings to the left of center the bias is positive. In the first instance, plate current is decreased; in the second instance, increased.

When placing the unit into operation, the operator must make certain that potentiometer R_3 is at its

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Lee Electric & Mfg. Co. *says* "all parts were selected to meet the customers' stringent specification."

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MAXIMUM PROTECTION AND LONG LIFE

Culco Constant Current Battery Charger, Type CE 180 with HEINEMANN Circuit Breakers installed.

Lee Electric & Mfg. Co., of Los Angeles, realizing the necessity for the most flexible yet unfailing protection of electronic components and equipment, chose HEINEMANN *Magnetic* CIRCUIT BREAKERS for this battery charger. In case of short circuit or dangerous overload, the breakers trip INSTANTLY, but do not trip on initial surge or temporary excess current. In this application the breakers in the input and output are interlocked, so that operation of either one will remove the unit from the A.C. line.

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HEINEMANN ELECTRIC COMPANY

97 PLUM STREET TRENTON, NEW JERSEY

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highest negative-voltage setting. This will prevent excessive current flow accidentally through the tubes. When tests are completed, switch S must be thrown off to prevent battery drain.

Use of the electronic load is simple: Connect the output terminals of the power supply under test to the applied d-c voltage terminals of the load circuit and adjust R_a until the circuit draws the desired number of milliamperes. At this point, measure the power-supply voltage. Repeat the operation at a sufficient number of points to show the voltage-current characteristic of the power supply.

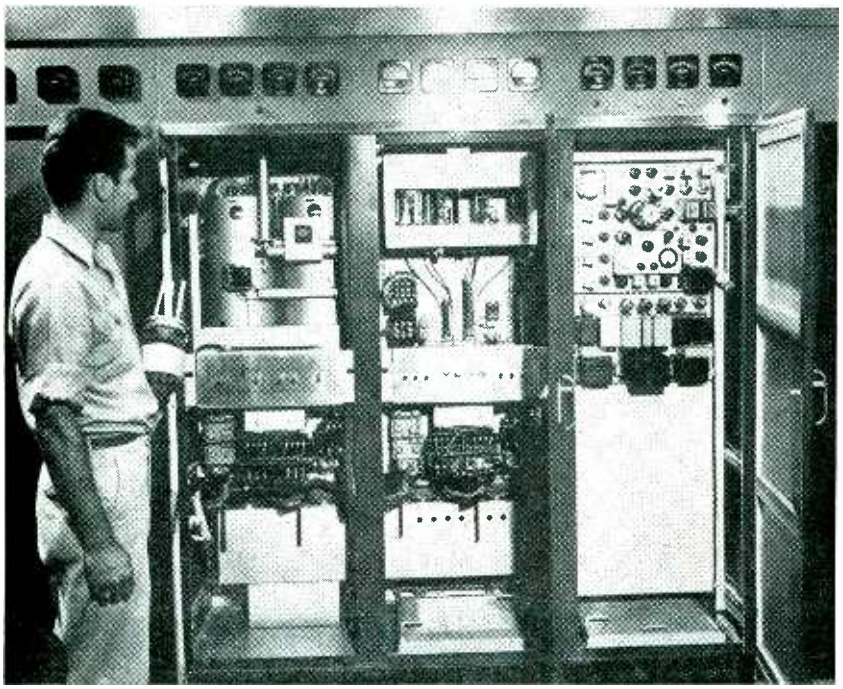
This 120-kva rectifier unit supplies plate voltage to all power amplifier tubes from the final down to the 250-watt stage

High-Power F-M Transmitter

WTMJ-FM, MILWAUKEE, located about 21 miles from the downtown metropolitan district of the city, is providing signal strength at 93.3 mc on the order of 30,000 microvolts over the city area. Primary coverage within the one-thousand microvolt contour is given to an area of approximately 18,000 square miles, including Wisconsin's four largest cities, Milwaukee, Madison, Racine and Kenosha.

The a-m noise level is better than 52 db and the f-m noise level is better than 65 db, which includes studio and the 26-mile circuit of a telephone program line. The transmitter, an RCA BTF-50A, is designed for a nominal output power of 50,000 watts at any frequency between 88 and 109 mc. The second harmonic content was found to correspond to 120 microvolts at a distance of one-half mile from the transmitter. This value is not considered objectionable to other services.

Single-ended amplifiers, operating class C and comprising a minimum of variable elements, are used throughout the transmitter. The output of the f-m exciter using a reactance tube circuit is coupled through a coaxial transmission cable to the doubler stage which consists of a single 4-125A/4D21 tube. A small trimming capacitor provides proper matching between the exciter transmission line and the grid circuit of the doubler. The output of the single-tube doubler is tuned to the carrier frequency. The doubler is used to drive the first r-f (250 watt) amplifier consisting of two 4-125A/4D21 tubes which operate in a parallel connection of tube elements.



At WTMJ-FM, engineer Raymond Herndday holds a 7C24 tube which is used in the 10-kw stage at left and in the 1 and 3-kw stages of the center rack. The rack at right contains the modulator

The first r-f amplifier contains gold-plated variable inductors which are used in conjunction with three-element pi networks (which incorporate the tube plate and grid capacitance) to tune the doubler and first r-f amplifier. This circuit arrangement presents a high L-C ratio, provides a maximum bandpass and reduces distortion and losses to a minimum.

Adjustments of the variable inductors are made from a front-panel control strip where all tuning controls and switches of the r-f unit are located. The vernier controls are operated by a hand crank and incorporate a calibration dial which provides preset tuning information for future reference. The tuning handle is inserted only during actual tuning, to avoid inadvertent detuning during operation.

Grounded-Grid Amplifiers

Advantages of single-ended circuits, high stability, good shielding and ease of tuning are realized in the design of the 1, 3 and 10-kw amplifiers. All employ 7C24 tubes in grounded-grid circuits and are identical in construction with the exception of coupling circuits. The 1 and 3-kw amplifiers consist of two grounded-grid 7C24's in cascade. These tubes provide driving power for the 10-kw amplifier which employs two 7C24's operat-

(continued on p 140)

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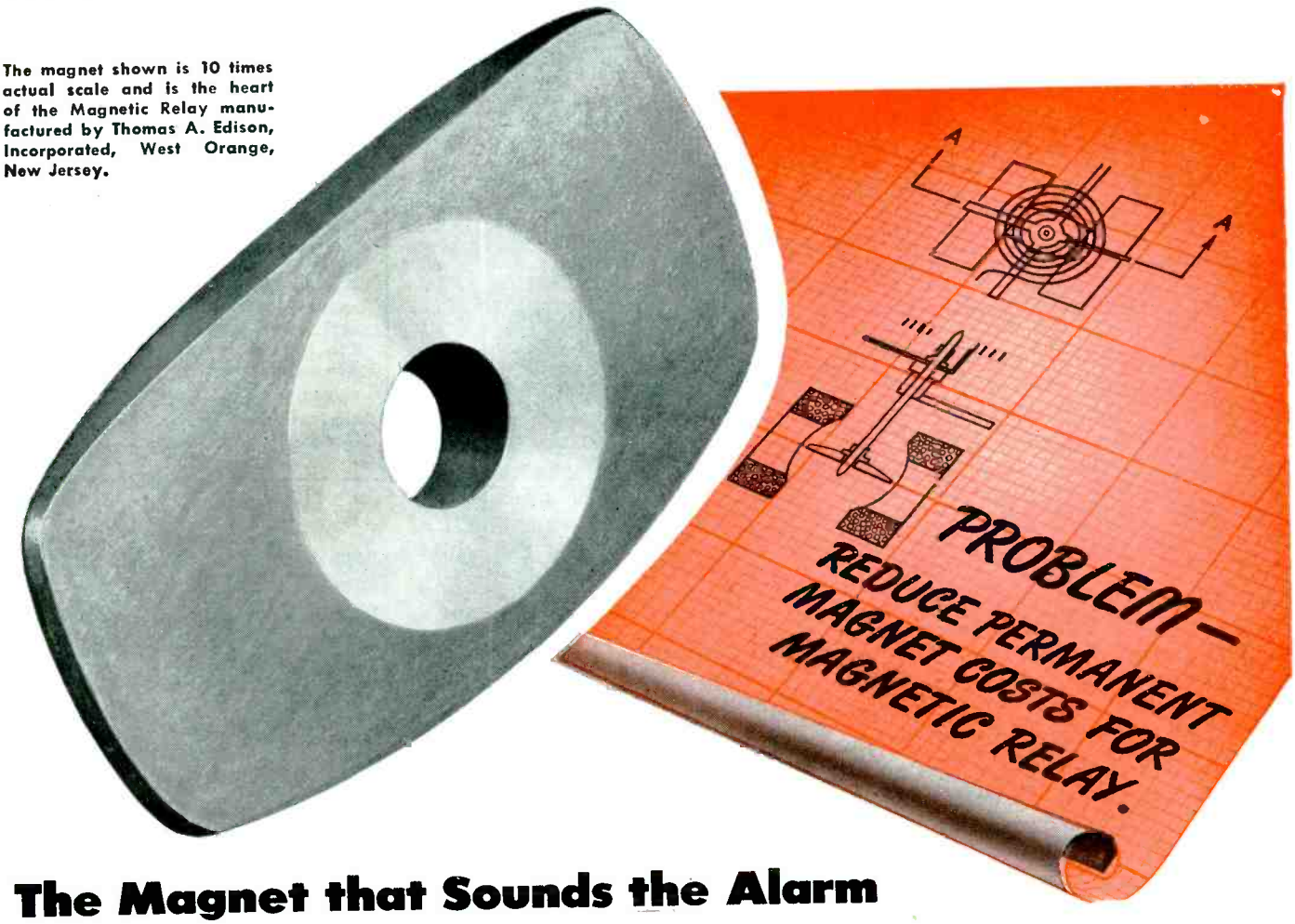
YOU GET QUALITY PLUS ENGINEERING SERVICE WITH G-E PERMANENT MAGNETS

The magnet shown is 10 times actual scale and is the heart of the Magnetic Relay manufactured by Thomas A. Edison, Incorporated, West Orange, New Jersey.



The Magnet that Sounds the Alarm

Here's a unique application for G-E permanent magnets. As the moving element in the Edison Sensitive Relay, a tiny G-E Sintered Alnico 5 permanent magnet completes an electrical circuit . . . instantly sounding the alarm for fire.

Design specifications for this magnet application were severe. Extremely high pole tip density was required. Yet mass had to be low. Cost conscious G-E engineers worked closely with Thomas A. Edison, Incorporated. Costs were cut by redesign and by the use of Sintered Alnico 5 . . . a new magnetic alloy recently developed by General Electric.

Perhaps your permanent magnet costs can be reduced. Our design engineers will be glad to work with you to improve your product. Remember, too, that General Electric produces all grades of CAST and SINTERED ALNICO as well as special magnetic alloys for your product.

Edison Aircraft Fire Detection System—Fast, Safe, Dependable

Here's how the Sensitive Magnetic Relay fits into the Edison Fire Alarm system. An Edison thermocouple detector mounted in the area to be protected generates its own emf when a dangerously rapid rise in temperature occurs. This emf (measured in *millivolts*) actuates the Sensitive Magnetic Relay and sets off a fire alarm. When the fire is out and conditions return to normal, the detectors signal "Fire Out" and are again ready to signal "Fire" rapidly and truthfully.

PERMANENT MAGNETS

CHEMICAL DEPARTMENT, SECTION 14-2
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THE ELECTRON ART

Edited by FRANK H. ROCKETT

Summaries of Papers at Conference on Instrumentation in Nucleonics and Medicine

INSTRUMENTATION REVIEW

This report of the recent conference on nucleonic and medical instrumentation constitutes a concise survey of an exacting and expanding field. From the wealth of material that the speakers presented, the information in which ELECTRONICS readers are most directly interested has been summarized here to form a broad review of the present and potential applications of electronic instrumentation in these two important sciences. The review covers:

TECHNIQUES USED IN INSTRUMENTS and in making measurements were surveyed at a Conference on Electronic Instrumentation in Nucleonics and Medicine sponsored by the AIEE and the IRE and held in the Engineering Societies Building, New York City, from Nov. 29 to Dec. 1; about 500 representatives of industrial, governmental and university laboratories attended the six technical sessions. During the first day, means for measuring biological phenomena were reviewed. On the second day, biological uses of radioactive tracers were discussed. Papers presented the third day described progress being made in detectors for nuclear particles. The speakers, leaders in their various fields, presented, for the most part, papers reviewing the present state of their sciences.

In the following columns, the highlights of interest to ELECTRONICS readers from the 26 papers are summarized individually. What was presented in the papers, discussions and in conversations before and after the sessions showed that (1) the instrument designer needs to be fairly well acquainted with the phenomena that his equipment is to detect and indicate (the foremost purpose of the conference was to provide an opportunity for research and instrumentation groups to exchange this basic information), (2) electronic methods are the only ones providing the sensitivity and rapidity necessary for refined nuclear and medical measurements, but that instabilities such as noise and drift and limited resolution (frequency response) mask the measurements, and (3) these highly specialized but limited fields of application, by requiring the utmost of electronics, are providing the impetus for improving techniques. The work described at the conference shows a great intensity of activity in the field and rapid progress.

Biological Applications

Requirements in Amplifiers

By HARRY GRUNDFEST

College of Physicians and Surgeons
Columbia University
New York, N. Y.

A REVIEW of the action in nervous systems shows that the interval between stimulation and response is in the order of milliseconds. Therefore, in electrophysiology (in which the basic problem is: How do electrical nerve impulses originate and propagate?) electronic techniques are used because the phenomena under study (1) are electrical and (2) act rapidly. In studying nerve potentials, direct-current amplifiers having sensitivities in the millivolt range are used.

The equivalent circuit of the fiber can be deduced from wave measurements along it. The fiber resembles a lossy transmission line. To make measurements on such a line (nerve fiber) without loading, an amplifier with an input resistance of megohms and a shunt capacitance of micromicrofarads is required. To obtain sufficient resolution for studying the waveshape of the transmitted pulses, the frequency response should extend to megacycles; sensitivities of ten to several hundred microvolts with low noise levels are required where oscilloscopic observations of waveshapes are made. The amplifier should not be blocked by large spikes because one frequently wishes to study fluctuations of a few microvolts that follow a millivolt spike.

A general purpose amplifier would have a minimum sensitivity of 200 millivolts across a 10-megohm input, 130-db voltage gain that is continuously variable, giving enough output to drive a cathode-ray tube, nonintegrating and nonblocking coupling networks and a frequency response that is flat within ten percent to 20 kc, although some measurements, as indicated earlier, require greater sensitivity and frequency response. The input circuit should not produce polarizing voltages across the specimen and should have high rejection of undesired signals. Wirewound resistors, heavy-duty components and battery operation are usually needed to obtain stability.

Present Practice in Biological Amplifier Design

By JOHN P. HERVEY

Johnson Foundation
University of Pennsylvania
Philadelphia, Pa.

SO LITTLE has been published about differential amplifiers that engineers are not generally acquainted with the problem. Amplifiers for action potentials, which have repetition rates of 10^{-2} to 5×10^{2} per second and rates of rise in the order of microseconds (although this is not an upper limit), may have to

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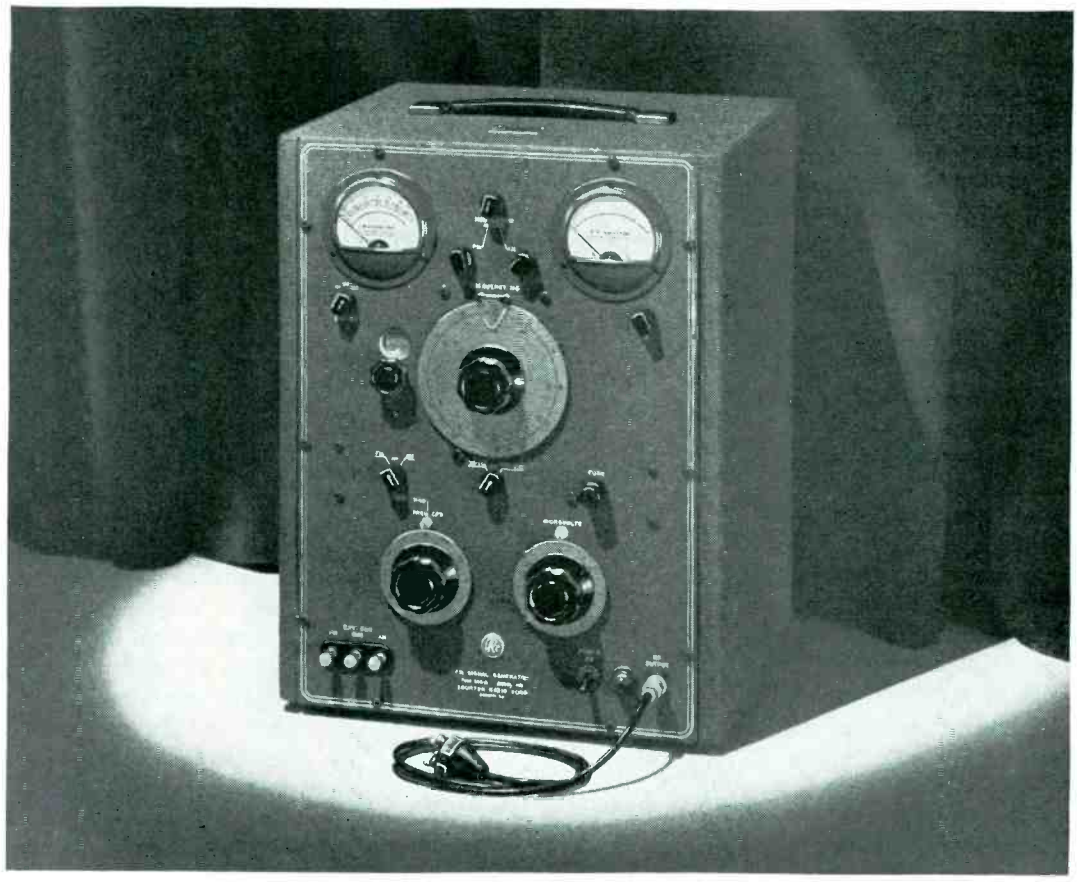

FM-AM SIGNAL GENERATOR

Type 202-B · 54-216 megacycles

The Accepted Standard of Performance!

In January, 1946, at the I. R. E. National Convention in New York City, a preliminary engineering model of the type 202-A FM-AM Signal Generator was displayed for the first time. Many well known FM and television engineers, invited to comment frankly on performance specifications, suggested refinements and features which they believed would be most desirable in the finished design.

Utilizing this valuable information, Boonton Radio Corporation's engineers worked another full year before they were ready to place their approval on the final design—the type 202-B FM-AM Signal Generator.

The advantages of this essential instrument were recognized immediately. Since its enthusiastic reception, the 202-B has increased in popularity and today it is generally accepted as the acknowledged standard of FM-AM signal generator performance. Practically every well known radio manufacturing concern is now placing increasing numbers of this versatile instrument in full time use, assisting their engineers and research staffs to design and produce better, lower cost radio and television receiving equipment.

If you have an FM or television instrument requirement, let us acquaint you with full particulars and technical data concerning the Type 202-B FM-AM Signal Generator. Write for Catalog F.

BOONTON RADIO Corporation

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FREQUENCY MODULATED SIGNAL GENERATOR • BEAT FREQUENCY GENERATOR AND OTHER DIRECT READING INSTRUMENTS

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be measured in the presence of other biological potentials such as a muscle potential between the probes and ground that is larger than the potential being studied. Such a condition requires a differential amplifier (J. F. Toennies, *Rev. of Sci. Inst.*, p 95, 1938).

Several symmetrical amplifiers can be cascaded to produce higher rejection than is obtainable from a single stage, but *identical* tubes are not available for each stage so that results are short of ideal. Balancing circuits can be used to compensate for inequalities in tubes, but at a sacrifice in high-frequency response. Differential action is obtainable to the order of 100 kc.

To select closely similar triodes for such circuits, the tubes are first aged for 100 hours under their expected d-c operating conditions. Those aged tubes with anode-cathode potential drops within five percent and negligible grid current in the actual circuit are selected for use. Tube noise is intermittent and varies randomly; if it is of appreciable magnitude, the tube is rejected. It is easier to get two matched triodes in separate envelopes than in a single envelope. Type 1620 is preferred for low noise and the good chance of getting matched pairs; it has low grid current.

With pentodes, the inequality in screen characteristics, even after selection by anode current equality, requires a battery or separate power supply so that screen currents in the common cathode resistor are avoided. Medium-mu triodes (6J5 or triode-connected 6SJ7) give better differential action than either high-mu triodes or pentodes. Tube selection provides an order of magnitude improvement. However, there is no differential action to suppress transients and hum in heater circuits, which are electrostatically picked up inside the tubes. Cathode-follower inputs tend to introduce noise.

Flicker is the most persistent noise source at low frequencies. Little is known about it, but it becomes noticeable below about 100 cps and troublesome below 20 cps; its most probable period is 0.1 to 1.0 second and masks short period drift, hence both it and drift are difficult to measure. Amplifiers are mounted in shielded boxes lined with an acoustic insulation to isolate the chassis from vibration.

Audiology Requirements

By ARAM GLORIG
Walter Reed Hospital
Washington, D. C.

AUDIOMETERS are used to provide stimuli for studying normal and defective hearing. Quiet (—60-db noise level), stable operation is necessary to obtain precision. For speech testing, high fidelity (80 to 15,000 cps), avc to maintain voice level and low distortion in records when canned voice is used are required. Tape or wire recordings might provide the required low noise. A portable sound-treated room providing at least 40-db attenuation to outside noises would facilitate measurements, as would a smaller, stabler receiver and an automatic group tester.

Diagnosis of the cause (organic, psychogenic or pretended) of defective hearing necessitates development of objective hearing tests. One method is to make use of the differential between apparent loudness increments for each type of hearing impairment, but test equipment for such measurements is limited. Also, test equipment should incorporate means for calibration to check its condition.

Cathode-Ray Photography

By CHARLES M. BERRY
Cornell University Medical College
New York, N. Y.

TRACING VELOCITIES, on which the brightness of the image depend, are affected by the vertical motion of the cathode-ray tube spot in tracing the wave. A study of biological data shows that tracing velocities range up to 50 cm per millisecond, but that most actions lie below 25 cm per millisecond. Thus conventional and inexpensive equipment (f2.8 lens, 1,400-volt medium-persistence screen cathode-ray tube) can be used. One can use the motion of the film to give the time base thus decreasing the writing rate; film velocities of about 20 cm per second should be used. It might be easier to move the film horizontally so that the same connections could be used with either the sweep or the film motion for time base. Added conveniences would be provision for numbering each frame and photographing two tubes simultaneously.

Electrocardiograph

By JOHN L. NICKERSON
College of Physicians and Surgeons
Columbia University
New York, N. Y.

AN EMPIRICAL CORRELATION has been established between the pattern of electrical potentials across the body and cardiac ailments. Significant features of potentials are magnitudes and durations of distinguishable waveshapes in the pattern. These patterns are recorded for study and diagnosis. If records are to be used by students the ink or wax oscillographs should be durable; the recorder should be portable, have a one-centimeter per millivolt sensitivity that is both adjustable and stable over a 30-minute interval within five percent and have low, but not necessarily direct-current, response. Cardiographers are interested in resolving hundredths of a second.

Electroencephalograph

By CHARLES H. RICHARDS
Cornell University Medical College
New York, N. Y.

BRAIN WAVES arising in nerve elements can be detected from the surface of the scalp where the 50 to 1,000 microvolts on the brain are attenuated to a tenth of this value. The diagnostic technique is to localize the area of abnormal voltages. Direct-inking recording is used to obtain records running up to an hour and to observe the record as it is made.

The patient is examined in an electrically shielded room to minimize interference. Four independent channels are used for clinical work and eight for research, corresponding to the eight lobes of the brain. The alpha rhythm occurring from about 8.5 to 12 cps

(Continued on p 172)

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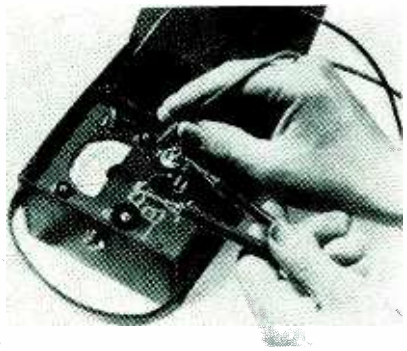
NEW PRODUCTS

Edited by A. A. McKENZIE

Miniature Multitester

INTERNATIONAL INSTRUMENTS, INC., 311 East St., New Haven, Conn. The miniature multitester is a combination ohmmeter and voltmeter for resistance, a-c, and d-c



measurements. The d-c voltage range is 300 v with accuracy of plus or minus 2 percent at 10,000 ohms per volt. The a-c range is within 5 percent. Resistance up to 2 megohms can be measured.

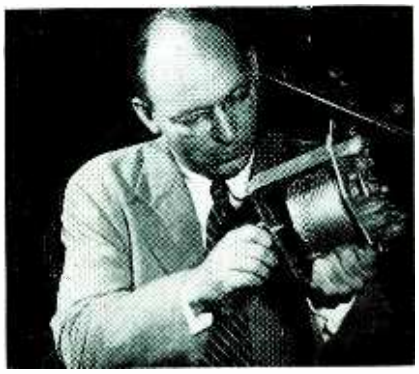
Removable Stylus Pickup

THE PICKERING CO., Oceanside, L. I., N. Y. Model R-150 cartridge reproducer for playing home phonograph records has a removable

stylus that can be replaced by hand. Either sapphire or diamond stylus can be furnished.

Television Transmitter

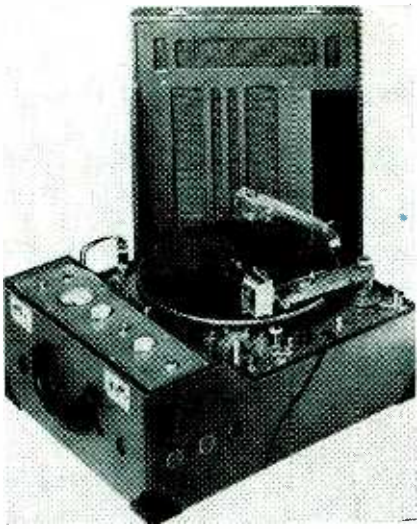
RADIO CORP. OF AMERICA, Camden, N. J., has in production a new 500-watt television transmitter for operation in the higher frequency channels (174 to 216 mc). Under favorable conditions the type TT-



500B, using a coaxial tank circuit, coupled with a six-section super turnstile, can cover a 20-mile radius.

Microgroove Recorder

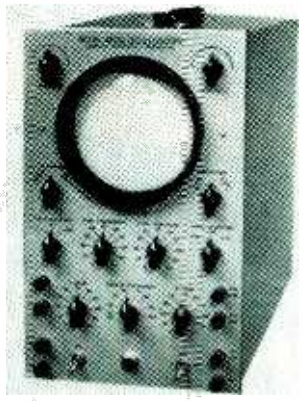
PRESTO RECORDING CORP., Box 500, Hackensack, N. J. Two new recorders, types K-10 and Y-3 are modifications of types K-8 and Y-2 respectively. They can be used for



both standard and microgroove recording. The series 15 phono turntables are a companion line for reproducing either microgroove or those and standard recordings.

Broadband Oscilloscope

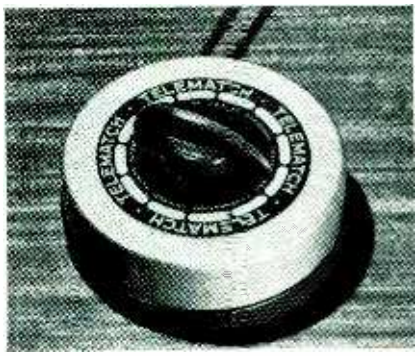
TELEMARK ELECTRONICS CORP., 325 Troy Ave., Brooklyn 13, N. Y. Model 450A 5-in. oscilloscope em-



ploys amplifiers with bandwith from 2 cycles to 450 kc, extending to 850 kc at 6 db down. Deflection sensitivity is 0.15 rms volt per inch.

Television Matcher

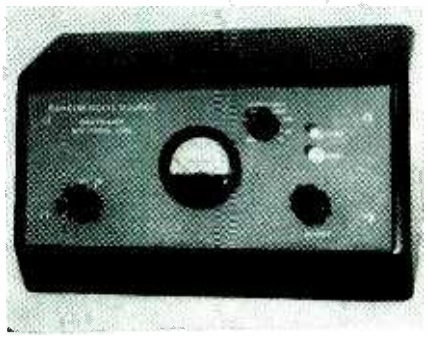
STANDARD TRANSFORMER CORP., Elston, Kedzie and Addison, Chicago 18, Ill. The Telematch unit helps eliminate ghosts and also pro-



vides a better television signal by matching the antenna leadin to the receiver. Price is $9.50.

Random Noise Source

DALE POLLACK, 352 Pequot Ave., New London, Conn., announces a line of random noise signal generators, using saturated diodes as sources, for facilitating measurement of receiver characteristics. Model 101, for the 1 to 110-mc



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QK-174A

F-M communications magnetron

- ★ Tunable 1990-2110 megacycles.
- ★ Frequency modulation 15 megacycles.
- ★ Power 100 watts.
- ★ Efficiency 35%.

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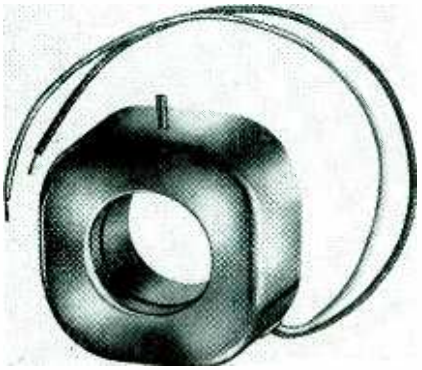
range, has an output impedance adjustable from 50 to 500 ohms and a noise figure of 0 to 27 db at 500 ohms. Model 102, for the 100 to 3,000-mc range, has an output impedance of 50 ohms and a noise figure of 0 to 20 db.

Focus Coil

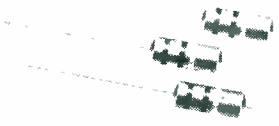
ARTHUR SLEPIAN & Co., Bridgeport 7, Conn. A new focus coil for television tubes uses a paper-section coil winding. The entire assembly



is wax-impregnated and heat treated to relieve stresses and improve its magnetic qualities.

High-Voltage Resistor

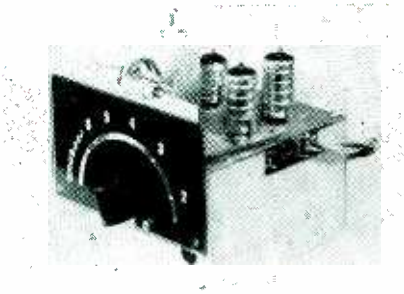
INTERNATIONAL RESISTANCE CO., Philadelphia, Pa. Type BTAV resistor is designed to operate continuously at much higher voltages than the maximum rated voltage of the standard BT resistor, and to



withstand surges up to 6,000 volts. A variation of the RMA color code, consisting of a wider separation between the first and second significant bands, distinguishes it from the advanced BTA resistor.

Television Front End

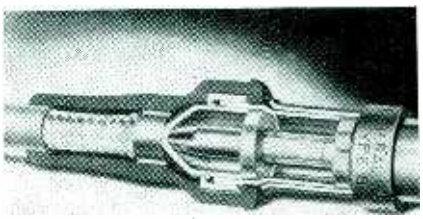
VISION RESEARCH LABS., INC., 87-50 Lefferts Blvd., Richmond Hill, N. Y. Model TF701 television front end contains r-f amplifier, oscillator and mixer circuits for a television



tuner that covers all 12 channels. The tuning control equipped with a planetary drive covers the bands in a 180-degree rotation in a manner similar to conventional receivers.

Lab Connector

GENERAL RADIO CO., 275 Massachusetts Ave., Cambridge 39, Mass. The type 874 coaxial connector series can be used at frequencies exceeding 4.5 kilomegacycles whenever a shielded connection is needed.



Chief feature of the new connectors is their ability to be joined without adapters. Each unit is, in effect, a combined male and female connector.

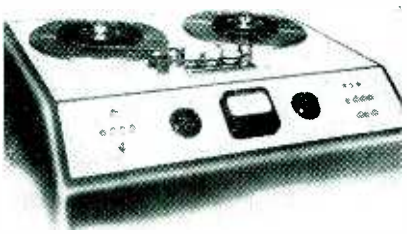
Twin Receivers

TELEX, INC., 1370 Northwestern Bank Bldg., Minneapolis, Minn. The Twinset is a twin receiver headset weighing 1.6 ounces and can be adjusted to fit any head

shape or size. Single cord connection replaces the more conventional Y cord.

Tape Recorder

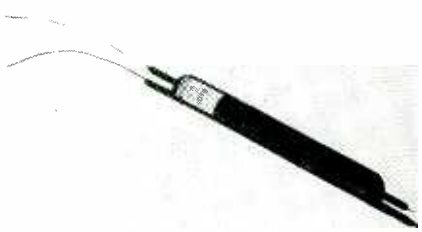
FAIRCHILD RECORDING EQUIPMENT CORP., 88-06 Van Wyck Blvd., Jamaica 1, N. Y. A new magnetic tape recorder meets NAB specifications set for 30 inches per second



tape travel using a speed of only 15 inches per second. Signal-to-noise ratio is better than 60 db and maximum total harmonic distortion is 2 percent.

Thin-Glass Geigers

RAYTHEON MFG. CO., Newton 58, Mass. Three new Geiger tubes, types 1B90, CK1018, CK1019 have thin glass side walls. They vary in recommended operating voltage



from 950 to 1150 volts. The CK types have been designed for use in portable battery-operated counters. Life of the tubes is in excess of 10^8 counts.

Mobile F-M Equipment

GENERAL ELECTRIC CO., Syracuse, N. Y. Designed for police departments, public utilities, taxis and the like, the new mobile f-m transmitter-receiver for communication in the 152 to 162-mc band operates on 6.3 volts d-c and has a 20-watt output. Carrier frequency stability is better than ±0.002 percent from − 30 to + 60 degrees C and

(continued on p. 197)

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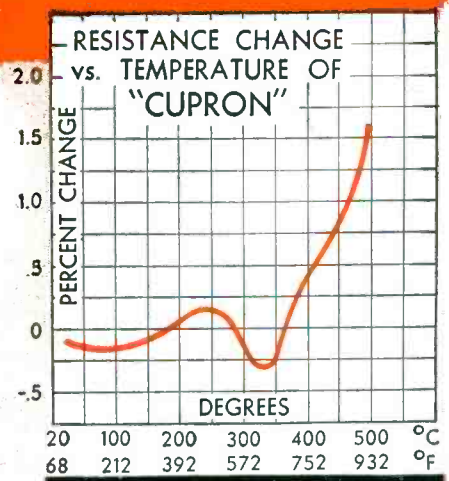
Photomicrographics are only part of the story...

EVERY KNOWN TEST QUALIFIES WILBUR B. DRIVER ALLOYS FOR SUPERIOR INSTRUMENTATION!

Photomicrographic checking of grain size and quality of metals is only one of the exhaustive tests which Wilbur B. Driver resistance alloys are subjected to throughout production. There are many others including ASTM life, tensile strength, yield point, hardness, micrometer and thorough testing for resistance. These constant checks plus industry-old experience, are the reasons you can depend on all Wilbur B. Driver alloys to perform as specified. The alloys listed are so produced, and are especially recommended for instrumentation.



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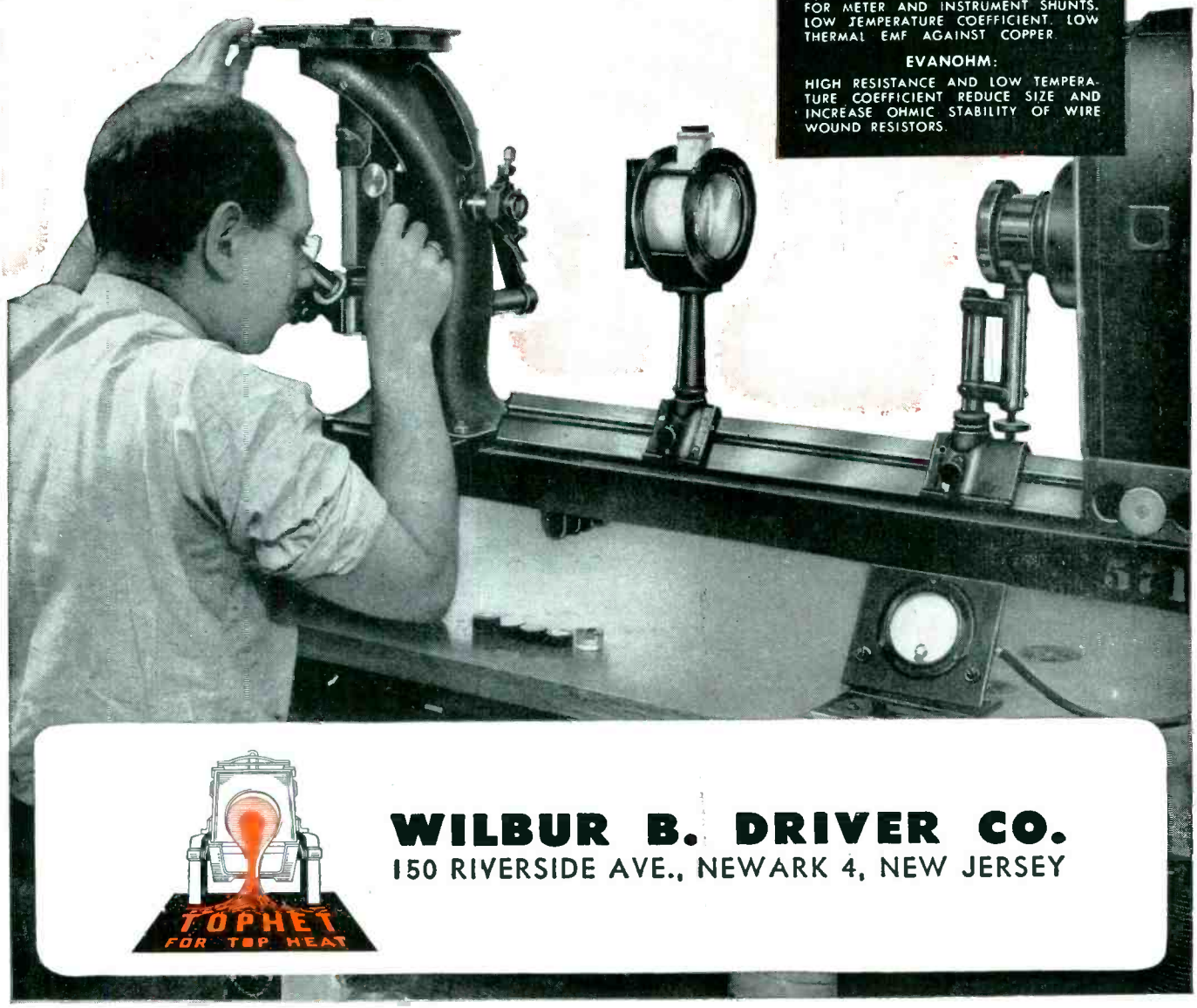
MANGANIN:
FOR METER AND INSTRUMENT SHUNTS. LOW TEMPERATURE COEFFICIENT. LOW THERMAL EMF AGAINST COPPER.

EVANOHM:
HIGH RESISTANCE AND LOW TEMPERATURE COEFFICIENT REDUCE SIZE AND INCREASE OHMIC STABILITY OF WIRE WOUND RESISTORS.



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FOR TOP HEAT

WILBUR B. DRIVER CO.
150 RIVERSIDE AVE., NEWARK 4, NEW JERSEY

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NEWS OF THE INDUSTRY

Edited by WILLIAM P. O'BRIEN

Research Accrediting Program

GRADUATE students who wish to undertake basic research in the physical sciences may now do so under the fundamental research program of the Naval Research Laboratory, Washington, D. C. Here it is possible for students to conduct their research leading to advanced degrees at cooperating institutions while employed at the Laboratory, using its facilities for their work.

The scientific program of the NRL is divided into the nine fields of chemistry, electricity, mechanics, metallurgy, nucleonics, optics, physics, radio and sound. A large portion of the Laboratory's effort is devoted to radio and electronic research which is divided into three major programs.

Primary purpose of the first program is to provide a fundamental basis for new and improved radio and electronics systems and components for the Navy. Studies are made of the electric and magnetic properties of matter at radio frequencies, the basic theory underlying antenna operation, microwave components, wave propagation and radio interference caused by radiation of solar origin.

In the second radio research program investigations are conducted for the purpose of achieving maximum effectiveness in the use of radio principles as embodied in ship, shore, airborne, submarine, portable and mobile equipment. Herein are included communication studies and work on countermeasures.

The third program in this field comprises investigations relating to gunfire control, missile guidance and control, and all-weather flying.

Application for admission to the research accrediting program is made by filling out and sending in to the Training Section at the Laboratory a Standard Form 57 of the U. S. Civil Service Commission, obtainable from the Commission, the NRL or from any first or second class post office. Participants in the program will usually qualify for P-1 or P-2 positions, with an annual salary of $2,974 or $3,727, respectively as civil service employees.

Tele Network Reorganization

FINAL step in the complete reorganization of the DuMont television network engineering department was the appointment of Robert Bigwood as facilities engineer. Other engineering department subdivision heads are:

Operations engineer Henry Fraser is in charge of coordinating the entire network engineering operation.

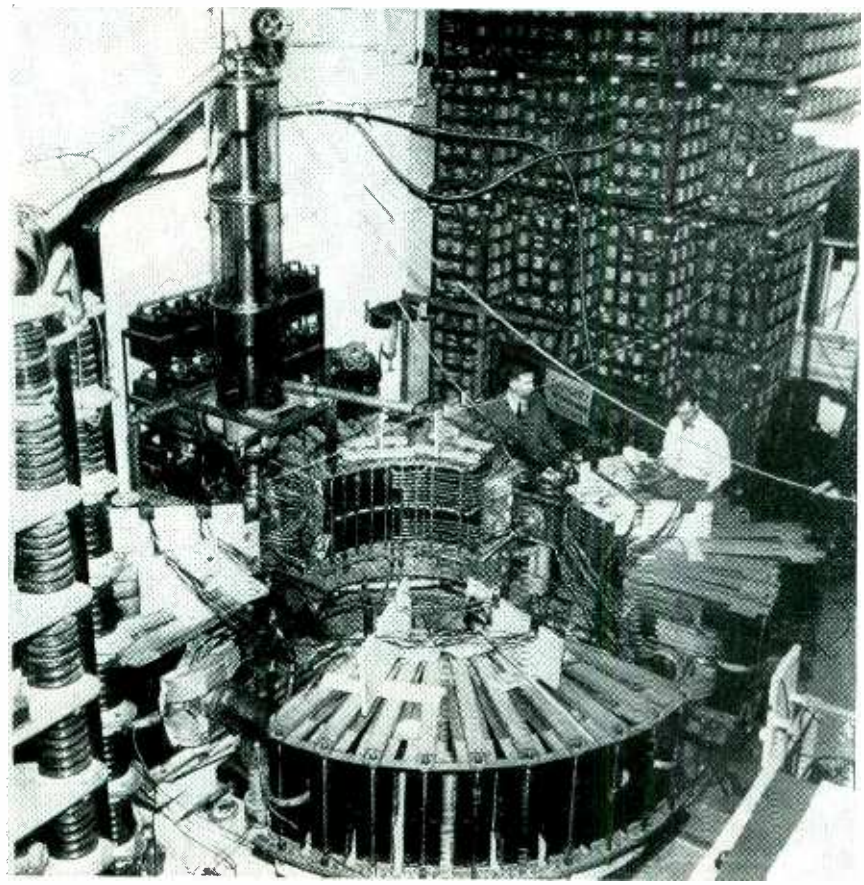
The chief engineers of DuMont's three owned and operated stations, Sal Patremio at WABD in New York, Malcolm Burleson at WTTG in Washington, and Raymond Rogers at WDTV in Pittsburgh are responsible for the operation and maintenance of equipment at their respective stations.

Teletranscriptions engineer Harry Millholland is in charge of the engineering aspects of teletranscriptions, DuMont's system of transcribing television programs from the face of cathode-ray tubes.

Radio Engineering Show

EXHIBITS in the 1949 Radio Engineering Show to be held at Grand Central Palace, New York City, March 7–10, will exceed all past

NEW SYNCHROTRON SUCCESSFULLY TESTED



Shown checking the University of Michigan's huge new synchrotron for splitting the nuclei of atoms are Dr. H. R. Crane (left), co-designer of the instrument, and George Grover, a research associate. Initial test of the 15-ton, 300,000,000-electron volt apparatus was termed a success

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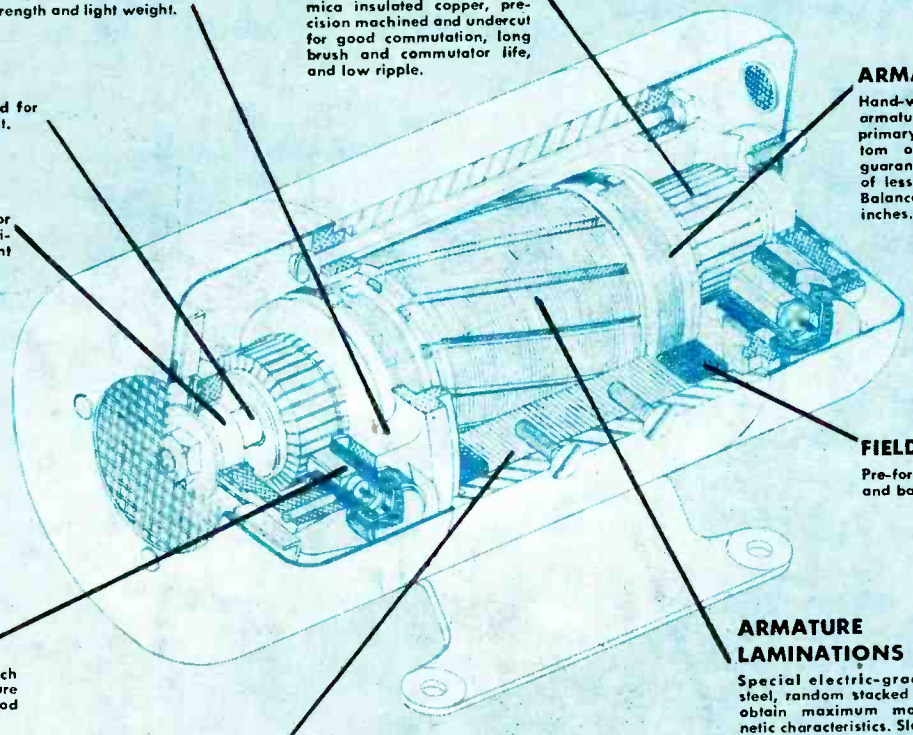
What makes BENDIX* dynamotors SO MUCH BETTER?
For the answers look inside!



END BRACKETS
Die-cast aluminum for strength and light weight.

COMMUTATORS
Finest grade, hard-drawn, mica insulated copper, precision machined and undercut for good commutation, long brush and commutator life, and low ripple.

SHAFT
Precision machined for accurate bearing fit.

ARMATURE
Hand-wound by skilled armature winders with primary winding in bottom of slot to insure guaranteed ripple value of less than 1 per cent. Balanced to .0002 ounce inches.

BEARINGS
New Departure, SKF, or Fafnir ball bearings, lubricated with gavernment appraved lubricants.

FIELD COILS
Pre-formed, impregnated, and baked for long life.

BRUSHES
Specially selected for each type of dynamotor to insure greatest brush life and good commutation.

ARMATURE LAMINATIONS
Special electric-grade steel, random stacked to obtain maximum magnetic characteristics. Slots are skewed to smooth abrupt flux changes.

POLE SHOES
Special electric-grade steel with flared tips to smooth out flux changes. Pole assemblies are easily removable.

RED BANK DIVISION	FINISH— BLACK WRINKLE	
BENDIX AVIATION CORPORATION	MATERIAL	SCALE
1. Grinding symbol "G" denotes smooth grind. 2. All threads must be national form class 2 fit. 3. All relationships on drwg. must be held as shown. 4. Tolerances on dim. of parallel faces are for size only.	CA-68A	DR. J FITZ
TOOL REP. / MET.		TR.
		CKD.
		APP.

*TRADEMARK

It Pays to buy Quality . . .
and no finer Quality Dynamotor
is available than a
BENDIX DYNAMOTOR

Dynamotors • Inverters • Convertors • D.C. Motors • Carbon Pile Voltage Regulators

RED BANK DIVISION of
RED BANK, N. J.
Bendix AVIATION CORPORATION

Export Sales: Bendix International Division,
72 Fifth Avenue, New York 11, New York

TEMPERATURE RISE—40° C.

STARTING TIME—.3 seconds (or less if specified).

VIBRATION RESISTANCE—Will withstand .03 inches (.06 total excursion) between 10 and 60 c.p.s., without special mounts.

TEMPERATURE RANGE—Will operate through ambient range of —55°C to +85°C.

ALTITUDE—Will operate normally to 20,000 feet and higher if special altitude brushes are specified.

CAA APPROVAL—All Bendix dynamotors are capable of meeting Civil Aeronautics Authority type Certification tests and are in use by major, scheduled airlines and government services.

INSPECTION AND TEST—All Bendix Dynamotors are carefully inspected in every step of production. Every unit receives a six to twelve hour run-in, depending on type, to insure praper brush seating.

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records. Firms and organizations numbering 192 had already taken space by Dec. 15, as compared with the total of 185 exhibitors in 1948.

Emphasis is being placed on "spotlighting the new" in equipment and materials. The exhibits will range from raw materials used in radio and electronic manufacture to complete transmitters and studio equipment. Advances in test equipment will also be a major attraction for the 12,000 engineers expected.

A new feature is a nuclear center for exhibiting the test, control and laboratory equipment of nucleonics, in which 14 firms are taking part. There will also be special sound theaters in which six firms will demonstrate their audio equipment.

Fourteen half-day technical sessions will be held in lecture halls in Grand Central Palace, and additional sessions will be at the Hotel Commodore.

MEETINGS

MARCH 7–10: IRE annual convention, Hotel Commodore and Grand Central Palace, New York City.

APRIL 6–12: 27th annual convention of the National Association of Broadcasters, Stevens Hotel, Chicago, Ill.

APRIL 11–15: Sixth Western Metal Congress and Exposition, Shrine Auditorium, Los Angeles, Calif.

APRIL 18–20: Eleventh annual Midwest Power Conference, Sherman Hotel, Chicago, Ill.

APRIL 25–27: Fourth Annual Spring Meeting of the RMA and IRE, Benjamin Franklin Hotel, Philadelphia, Pa.

MAY 16–20: Radio Parts Industry Trade Show and RMA Silver Anniversary Convention, Hotel Stevens, Chicago, Ill.

Broadcasters Must Use FCC-Approved Monitors

ALL STANDARD broadcast stations are required to maintain a constant check on modulation percentage and frequency deviation by means of monitors which have received formal FCC approval. The Commission had on occasion authorized the issuance of waivers of the rules (on condition that alternate means were provided) due to the shortage of this equipment after the war. Such waivers are no longer necessary because of the supply now available.

Stations at present operating without frequency and modulation monitors must have them installed after March 1, 1949; stations beginning operations after that time will not receive authorization without the approved monitors.

Hotel Installs Telefax

TELEGRAPH service around the clock was recently established in the Wardman Park Hotel, Washington, D. C., by installation of Western Union Telefax. This practical application of Ultrafax principles involves equipment which scans telegrams with an electric eye, eliminating keyboard transmission.

The operation involves pressing a button and depositing a telegram in the slot of a Telefax (facsimile) machine located adjacent to the hotel registration desk. Telegrams are then automatically wrapped around a revolving cylinder and scanned by phototube, with resultant signals going out over wires. Incoming telegrams drop out of the Telefax machine ready for delivery.

Radio for Trolley Cars

FOURTEEN new interurban trolley cars now on order for the Philadelphia Suburban Transportation Co. will be equipped with GE two-way radios. The installation will use selective calling to eliminate loud speakers and insure privacy, with conversations carried on through handsets.

A pilot installation made last September on one trolley car and on 12 supervisory and emergency vehicles has proved the advantage of radio in eliminating traffic jams and expediting service.

First trolley car in the U. S. to be equipped with GE two-way radio and selective calling. The car is operated by the Philadelphia Suburban Transportation Co.

Radio Consultants Form Association

TO MEET the need for an association of consulting radio engineers to handle mutual problems, a group of consulting engineers practicing before the FCC have banded into the Association of Federal Communications Consulting Engineers. The object of the organization is to aid and promote the proper federal administration and regulation of the engineering and technical phases of radio communication.

Following the formalities of organization, officers were elected for the year expiring in April 1949, as follows:

C. M. Jansky, Jr., president; Glenn D. Gillett, vice-president; A. D. Ring, secretary; and George C. Davis, treasurer. Other members of the executive committee are Frank G. Kear, James C. McNary, Joseph A. Chambers and John Creutz.

Other members are: Stuart L. Bailey, John H. Barron, Clyde H. Bond, Lester H. Carr, Ronald H. Culver, Everett L. Dillard, Millard M. Garrison, Paul F. Godley, Robert L. Kennedy, Worthington C. Lent, George M. Lohnes, Frank H. McIntosh, Russell P. May, E. C. Page, William E. Plummer, James O. Weldon, Herbert L. Wilson and Grant R. Wrathall.

The association hopes that mem-

(continued on p 226)

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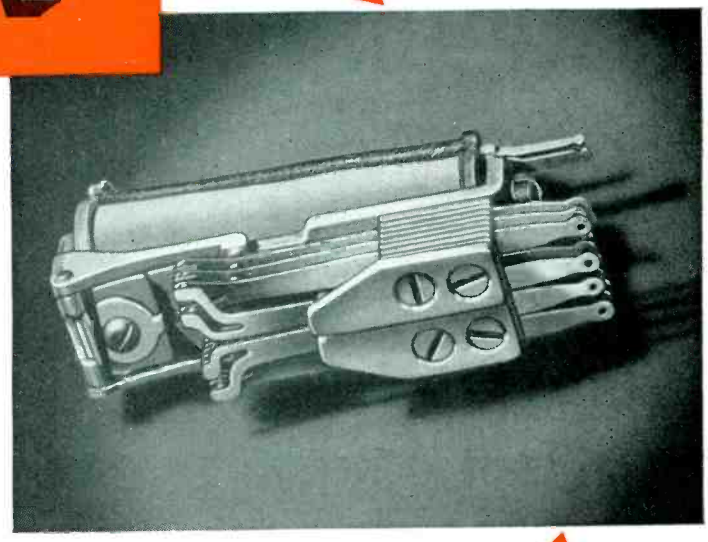
NOW all these features in ONE GREAT RELAY!



Independent twin contacts for perfect contact operation.

A highly efficient magnet circuit for sensitivity and high contact pressure.

Coil operating range: up to 300 volts, D.C., and 230 volts, A.C.

Any controlled circuit arrangement requiring up to 26 terminals.

Compact design for important savings in space and weight.

Unique armature bearing for long wear under severe conditions.

It's the Class "B" Relay
by AUTOMATIC ELECTRIC

Here's a relay that steps out from the crowd—a relay even better than Automatic's widely used, *widely copied*, Class "A" relay. Use the Class "B" for your most exacting application—and discover for yourself its wide margin of superiority in sensitivity . . . dependability . . . compactness . . . versatility . . . and long wearing qualities!

The Class "B" Relay and many others are described in catalog 4071—write for your copy.

TYPE 45 ROTARY SWITCH

A rotary switch that's new and better! 70 steps a second speed . . . up to 10 (or more) bank levels . . . only one field adjustment. Ask for literature.

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Distributors in U. S. and Possessions:
Automatic Electric Sales Corporation
1033 W. Van Buren St., Chicago 7, Ill.
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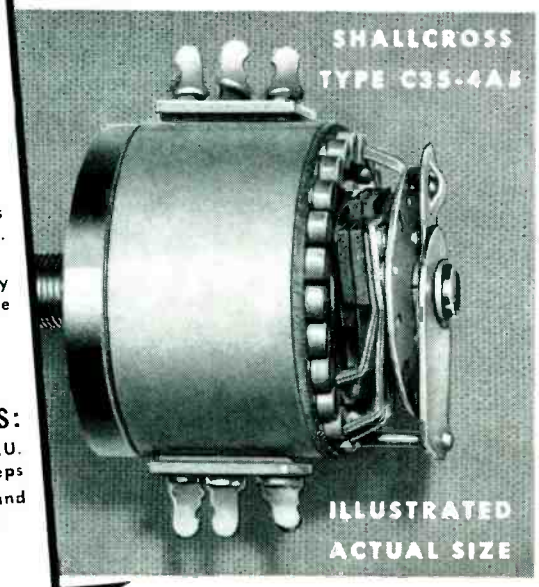
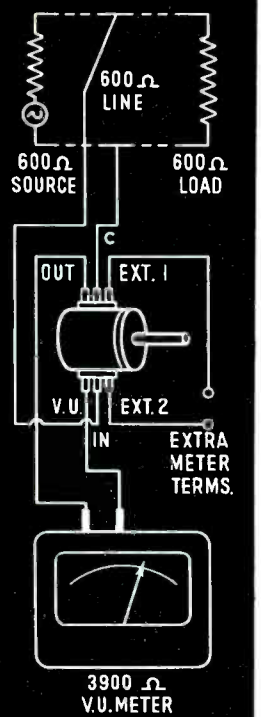
FEATURES NEVER BEFORE AVAILABLE IN A V.U. METER MULTIPLIER

- FIVE STEP STRAIGHT "T" CIRCUIT
- ONLY 1¾" DIAMETER
- IN ATTENUATOR "OFF" POSITION:
  1. Extra pair of Terminals for separate use of V.U. Meter.
  2. "T" Network completely disconnected from line and meter.
- TWO STANDARD ATTENUATION RANGES:
  1. 0 (1mw) to +16 V.U. and OFF in 4 V.U. steps
  2. +4 to +20 V.U. and OFF in 4 V.U. steps
- CONTACT SPACING: 30° between adjacent steps





The ingenious electrical-mechanical design of these new type C35 V.U. Meter Multiplier Attenuators provides five step Straight T performance in a control size normally limited to ladder and potentiometer circuits.

A pair of extra terminals greatly increases the utility of this unit, since in the OFF position the V.U. Meter Multiplier network is automatically disconnected from the line which it normally bridges, and the V.U. Meter—completely isolating both.

As illustrated in the circuit at the left, the V.U. Meter is connected to the auxiliary pair of terminals on the Multiplier when in the OFF position, thus enabling the meter to be used for volume indication on another line, for tube checking and other purposes. Use of additional V.U. Meter Multipliers permits a single meter to be used for any number of lines with each line isolated from all others. The size and technical features of this new unit suit it ideally for use in consolettes.

•

Prices and delivery of this unit as described or as modified to meet your requirements available on request. Address: Dept. E-29, Shallcross Manufacturing Company, Collingdale, Pa.

Shallcross

TUBES AT WORK
(continued from p. 126)

Hoist and sling hold the 5592 tube ready for lowering into the tube well in the background. Two of these tubes form the 50-kw final amplifier

ing in parallel into two concentric-line tank circuits.

Each plate tank is a tuned transmission-line type and is concentric with the anode of its 7C24 tube and forms an integral part of the grounded-grid circuit. This design provides a low inductance path from grid to ground, effectively isolates plate circuits from cathode circuits and eliminates the need for neutralization.

The two tubes in the 10-kw amplifier have a common input circuit with motor-driven tuning and coupling adjustments. Just as in the 1 and 3-kw stages, the plate circuits are tuned by adjusting the position of capacitor-type shorting bars and output coupling is effected by small loops between the inner and outer conductors of the plate lines. In all three stages, input, plate, and output, the circuits are motor-tuned.

Cooling air for the 1, 3 and 10-kw stages is supplied by an external blower. Filtered air is also supplied to each 7C24 tube through the center conductor of the plate lines.

Driver and Final

A concentric-line tank assembly provides good shielding of the driver and power amplifier grounded-grid circuits. The driver amplifier feeds two parallel-connected final sections and each one of these concentric-line tanks forms

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This new automatic voltage stabilizer supplies a constant 115 volts

We want to get in touch with any manufacturer whose product will operate better if supplied from a stabilized voltage source.

General Electric has recently announced three new automatic voltage stabilizers that provide steady, dependable output voltages, despite varying input voltages. Rated 15, 25, and 50 volt-amperes, these stabilizers are instantaneous (recovery time: 3 cycles), entirely automatic, and have no moving parts. They deliver 115 volts output (± one per cent for fixed, unity power factor loads) with the input voltage varying from 95 to 130 volts.

These units will operate continuously at no load or short circuit without damage to themselves. They will limit the short circuit current to approximately twice normal full load current. Dimensions are $9^{1}/_{2} \times 3^{1}/_{8} \times 2^{11}/_{32}$" high—making possible shallow depth installations. Other standard G-E stabilizers are available in ratings from 100 to 5000 va.

Drop us a line if you see a possibility for these new automatic voltage stabilizers in your product. Please give us all the information you can—and if possible, a circuit diagram or description of the load, so that we can help you in evaluating the application. Simply address your nearest G-E Apparatus Sales Office or *Apparatus Department, General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

411-34

www.americanradiohistory.com

an integral part of the grounded-grid circuit. The one compact unit eliminates neutralization, radiation and r-f pickup in adjacent r-f circuits. Each section is similar in design and uses a 5592 forced-air-cooled triode in a grounded-grid circuit. Tubes and components are interchangeable. The base of the concentric-line units forms a chamber for cooling air and contains the control wiring and high-voltage bus. Tuning of the plate line is provided by shorting bars with contact fingers that are moved vertically along the center conductor by motor-driven lead screws. Input tuning is accomplished by two flat-plate air capacitors, one motor driven and the other manually operated.

Motor-driven rotatable loops which are reactance tuned by series capacitors provide output coupling. The amplifiers feed equal load impedances, are individually motor controlled, and provide easy load balancing as well as smooth adjustment of power output. The transmitter front panel contains one set of controls for the driver tuning motors and another set to operate the tuning motors of both final amplifier units. For emergency operation at reduced power, the antenna is switched to the 10-kw stage, thus assuring uninterrupted service.

For maximum suppression of harmonic radiation, a harmonic attenuator is included in the transmitter. It consists of a pretuned low-pass filter capable of 38-db attenuation.

The transmission line and antenna are monitored by a circuit that is actuated by any unwarranted change in signal intensity. It then shuts down the transmitter. A reclosing mechanism returns the transmitter to the air, if the fault is cleared.

Tube Derrick

For changing tubes, a mechanically operated tube hoist is solidly mounted in a swivel supporting structure. Two swivel supports are provided and the hoist may be lifted from one support to the next, thus accommodating the tube to be removed.

In the main rectifier, six 857-B mercury-vapor tubes are connected

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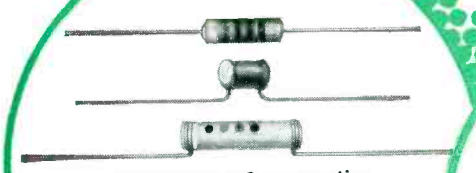
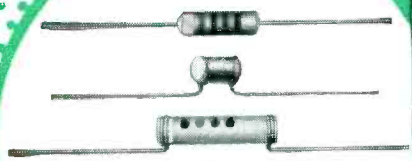


Temperature Compensating Molded Insulated Ceramicons
0.5 MMF—550 MMF
Temperature Compensating Dipped Insulated Ceramicons
0.5 MMF—15,000 MMF
Temperature Compensating Non-Insulated Ceramicons
0.5 MMF—1,770 MMF

Types 504B, ½ Watt—518B, 1 Watt Resistors
10 ohms—22 megohms

Types L-4, L-7, S-5 Suppressors for Spark Plugs and Distributors

Cinch-Erie Plexicon Tube Sockets with 1,000 MMF built in by-pass condensers



Erie "GP" Molded Insulated Ceramicons
10 MMF—5,000 MMF
Erie "GP" Dipped Insulated Ceramicons
0.5 MMF—15,000 MMF
Erie "GP" Non-Insulated Ceramicons
10 MMF—10,000 MMF

come to

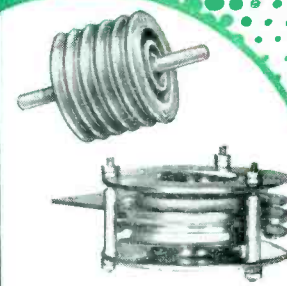
ERIE RESISTOR

for quality and economy in

ELECTRICAL COMPONENTS

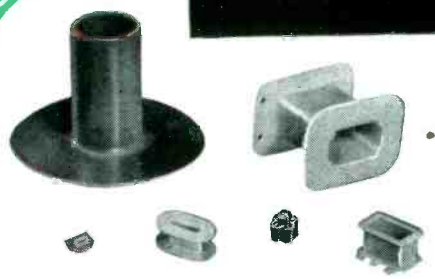
High quality is joined with simplicity in design to assure long-life economy and ease of installation in ERIE RESISTOR products. A complete line of Ceramic Condensers for receiver and transmitter applications; Button Mica Condensers for high frequency applications; Carbon Resistors and Suppressors; Custom Injection Molded Plastic Knobs, Dials, Bezels, Nameplates and Coil Forms. Complete technical information on request.

Electronics Division
ERIE RESISTOR CORP., ERIE, PA.
LONDON, ENGLAND . . . TORONTO, CANADA



High Voltage Double Cup and plate Condensers
Up to 15,000 VOLTS WORKING

Button Mica Condensers
15 MMF—6,000 MMF



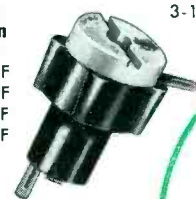
Custom Injection Molded Plastic Knobs, Dials, Bezels, Name Plates, Coilforms, etc.

Type 557 Ceramicon Trimmer

Type 531 and 532 Tubular Trimmers
0.5-5 MMF
1-8 MMF

Type TS2A Ceramicon Trimmer
1.5-7 MMF 3-13 MMF 4-30 MMF
3-12 MMF 5-20 MMF 7-45 MMF

Type 554 Ceramicon Trimmer
3-12 MMF
5-25 MMF
5-30 MMF
8-50 MMF



Type 720A

Types 323 and 324 Insulated

Type 2322

Type 2336

Erie Stand-Off Ceramicons
5 MMF—5,000 MMF

Feed-Thru Ceramicons
3 MMF—1,000 MMF
3 MMF—1,500 MMF

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in a three-phase, full-wave circuit with a half-voltage tap to supply the lower power stages. A pre-heated spare tube can be manually switched in place of any of the six operating tubes, at the same time removing the defective tube from the circuit.

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Circuit indicator lamps permit analyzing and localizing transmitter, tube or line faults. A reclosing system returns full power automatically if the plate voltage is removed due to operation of overload devices on rectifier backfires, vacuum-tube gas arcs, antenna flashovers or other causes. This operation is repeated three times on the high-power rectifier. If the fault persists on the third re-application of plate voltage, the recloser locks out until reset manually.

Automatic Temperature Stabilizer

By Robert Rudin
Columbia University
New York, N. Y.

THE BASIC PRINCIPLES of the unit described in this article may be applied to any application where smooth and accurate temperature control is important. It was developed at Bell Laboratories to fill the need for such a temperature-controlling device for use in connection

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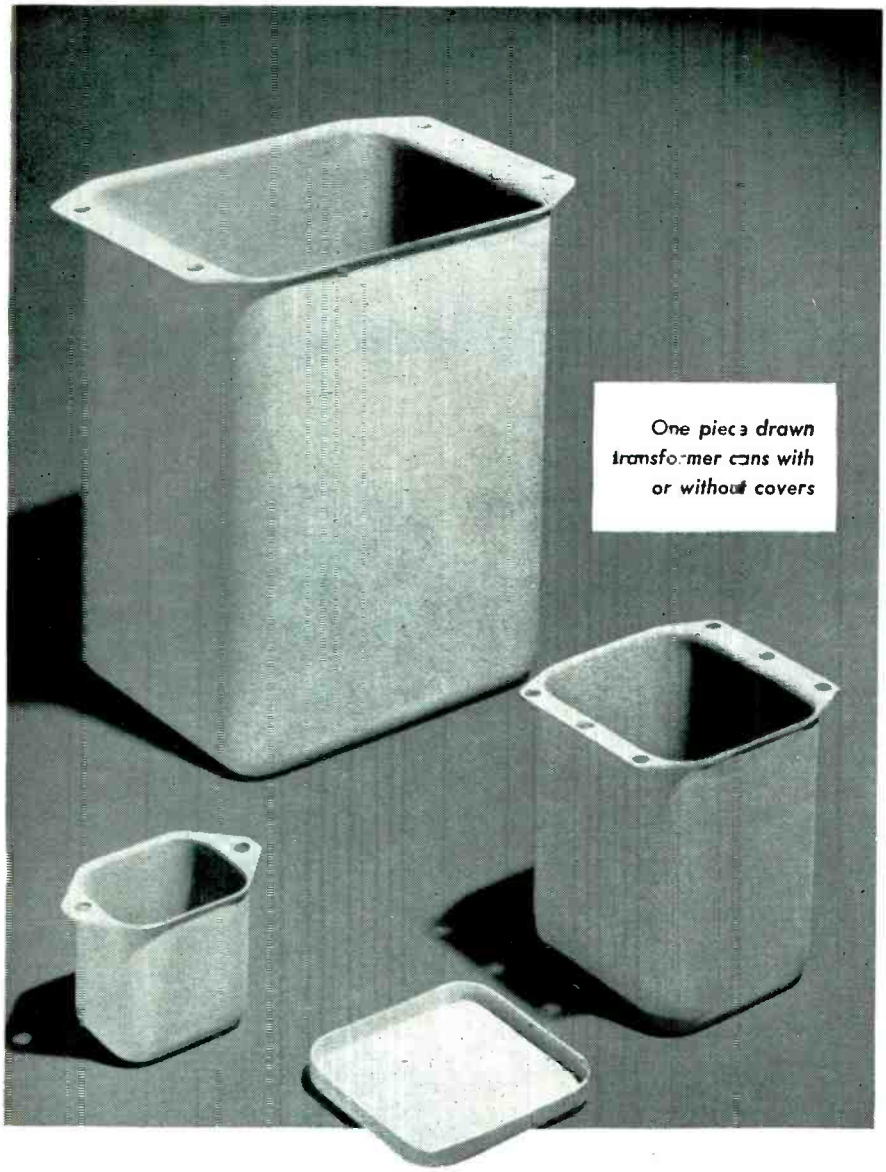

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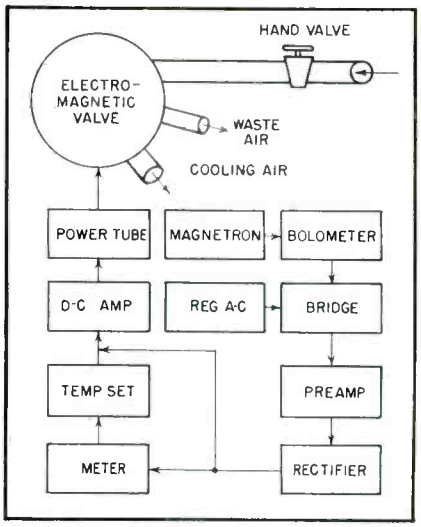

FIG. 1—Block diagram of temperature control for range from 30 to 100 C

with magnetron oscillators.

The block diagram in Fig. 1 and the circuit diagrams of Fig. 2 and 3 show schematically how the device works. A bolometer is brought into thermal contact with the component whose temperature is to be controlled, and connected into a bridge circuit. With a constant voltage supplied by a regulated a-c supply, the output of the bridge will vary with the resistance of the bolometer, which is determined by the temperature of the unit to which the bolometer is connected.

This output voltage is amplified and rectified, and the resulting d-c voltage is superimposed on a variable bias obtained from a potentiometer. The difference between these two voltages is applied to the grid of a d-c amplifier which in turn controls the grid of a power tube. The varying plate current of the power tube moves a shutter in an air valve which allows more or less cooling air to circulate. For safety, the valve is built to open fully in the event of circuit failure.

The device described is intended to control magnetron temperatures in the range of 30 to 100 C. The bridge is balanced at 120 C, the a-c output being nearly proportional to the difference between that temperature and the actual temperature. An extended range of −60 to +100 C may be obtained by use of an attenuator in the final a-c stage.

The regulated voltage of 6.3 volts rms is stabilized by the WE 4B ballast lamp and by the WE 7A ballast lamp in conjunction with the

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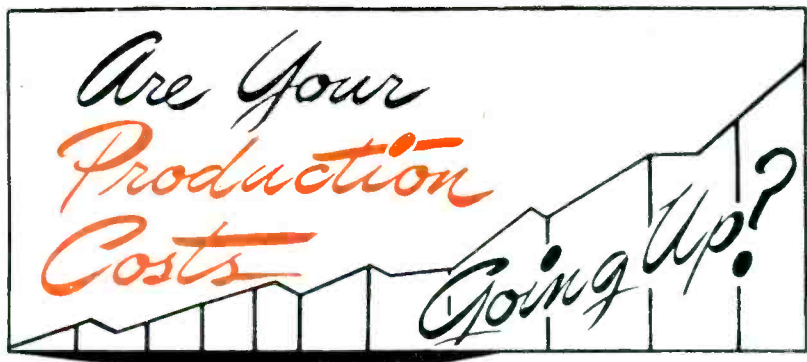

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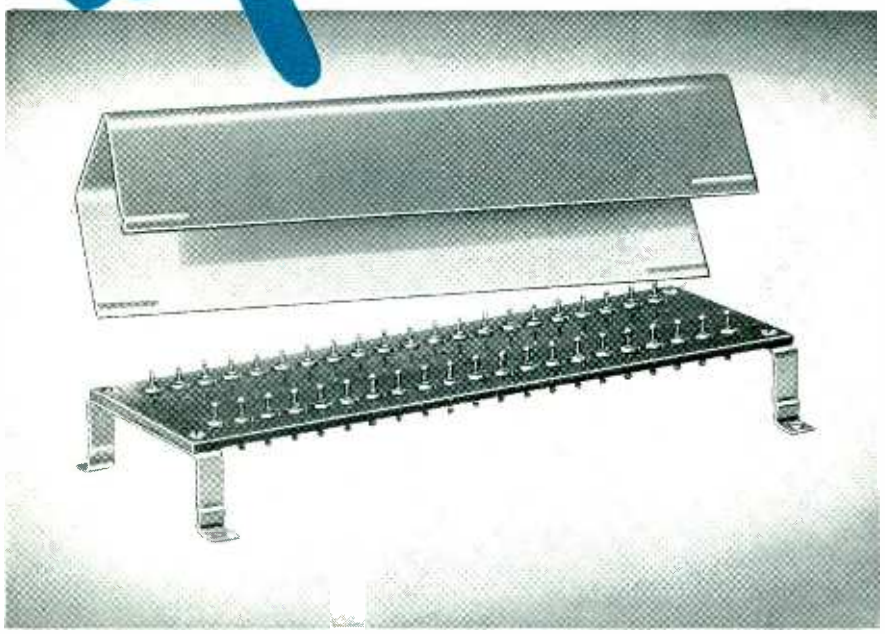

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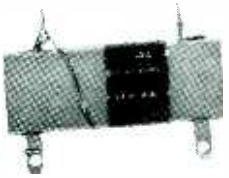

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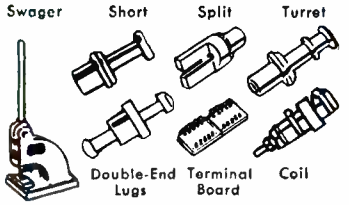

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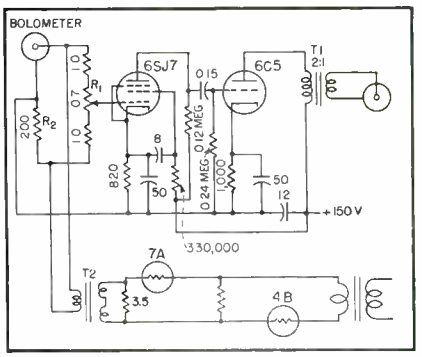

FIG. 2—Bridge and preamplifier circuits are mounted in a shielded box

3.5-ohm resistor across the primary of T_2. The voltage drop across this resistor is about 1.8 volts and the voltage delivered to the bridge after transformation is about 1 volt.

Short impulses caused by sudden line voltage changes and the inherent thermal inertia of the ballast lamps are practically eliminated by a filter in the power tube circuit.

The bolometer consists of a flat coil of platinum wire 0.004 inch in diameter. This coil is covered with a 0.005-inch thick sheet of mica and the whole assembly is enclosed in a copper sheet box which is shaped to match the contour of the magnetron. A shielded cable connects the bolometer to a shielded box which contains the bridge and the 6SJ7-6C5 preamplifier. The power amplifier and output parts are mounted on a separate chassis. A 6C5 amplifies the a-c output from the preamplifier and feeds the rectifier through a step-up transformer T_3. The 6H6 diode serves as a voltage doubler delivering up to 75 volts for 20 C. The meter reading this voltage is calibrated in temperature units and mounted in an inverted position so temperature rises will read from left to right.

The biasing potentiometer is fed by a d-c voltage which is stabilized

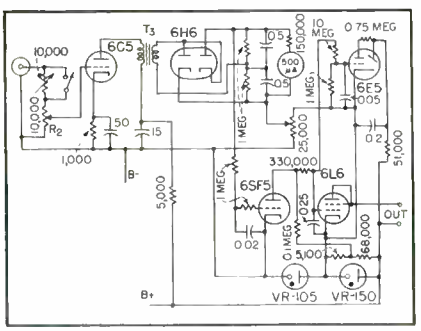

FIG. 3—Output of the power amplifier feeds a coil in a magnetic field

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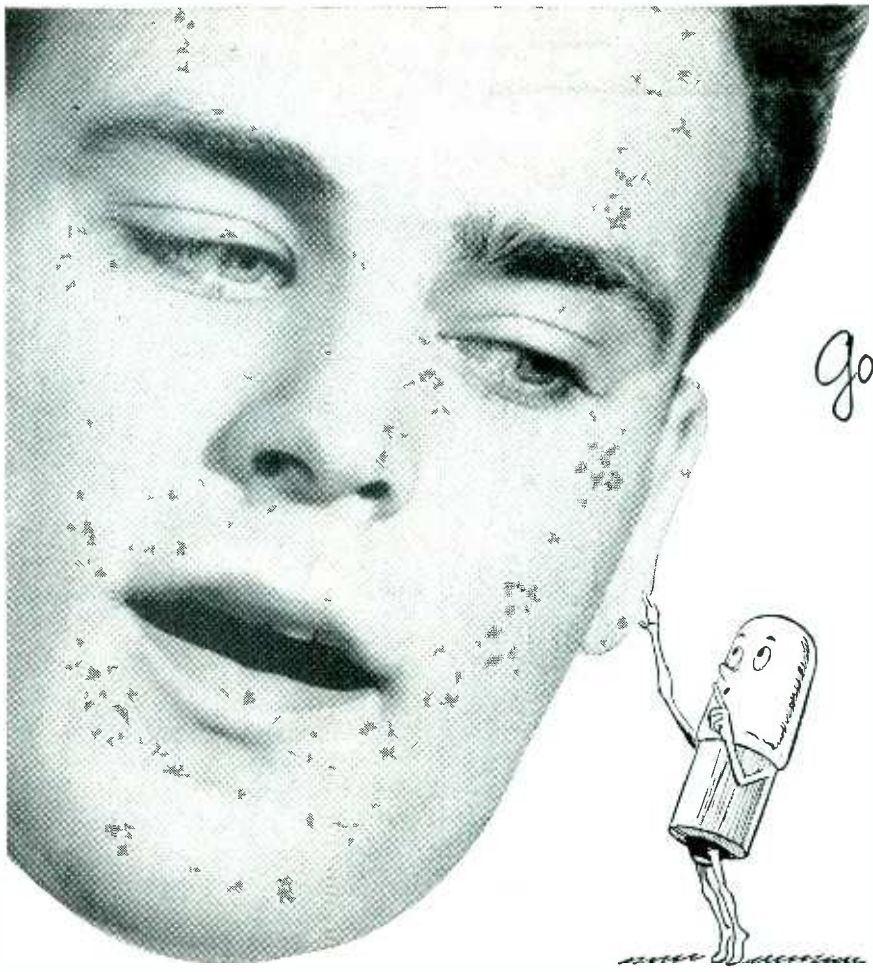

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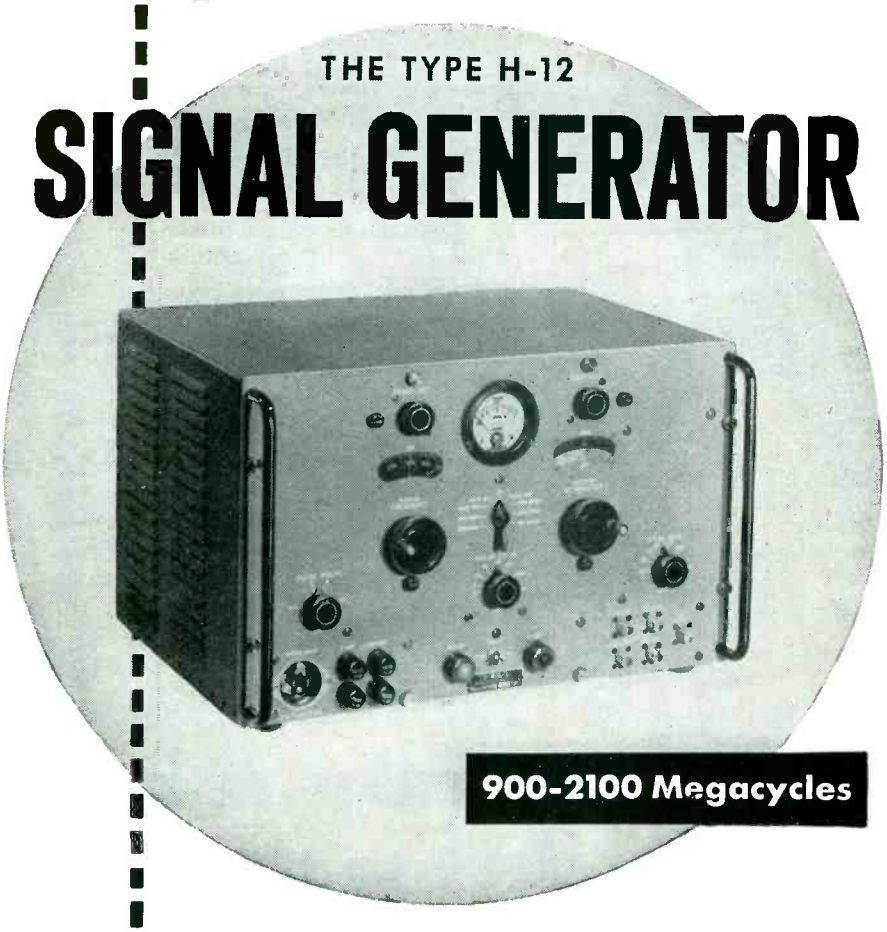

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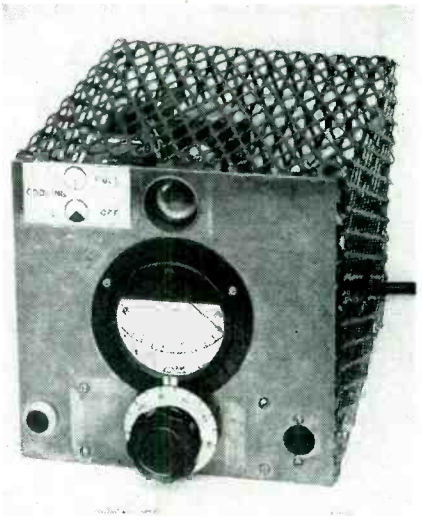

To indicate higher temperature to the right, the panel meter is inverted

by a VR-105 gas tube. Its dial is calibrated in temperature so that operating temperatures may be set.

The air control consists of a balanced shutter which rotates through an angle of approximately 60 degrees. The plate current of the 6L6 varies linearly with the grid voltage of the 6SF5 and controls the air circulation by passing through a coil in the field of a powerful permanent magnet.

A voltage variation of 0.5 volt at the grid of the 6SF5 is sufficient to move the air valve from extreme open to closed, and that voltage will be generated by a change of approximately 0.5 C. The 6E5 cathode-ray tube indicates the amount of cooling, a closed eye meaning air valve is fully open and the hand valve should be opened to allow the unit to operate at the regulating point.

The bolometer cannot assume the exact temperature of the magnetron, but the relationship between their temperatures is practically constant. For calibration the bolometer is attached to a heating device which duplicates the geometric and thermal conditions of the magnetron. This calibrating unit is brought up to 120 C and the meter is adjusted to read that temperature at full scale by means of R_1 (this corresponds to the zero reading on the inverted meter). The minimum reading is adjusted by R_2 with the bolometer at a temperature of 20 C. The temperature-setting potentiometer is calibrated by setting it to approximately mid-

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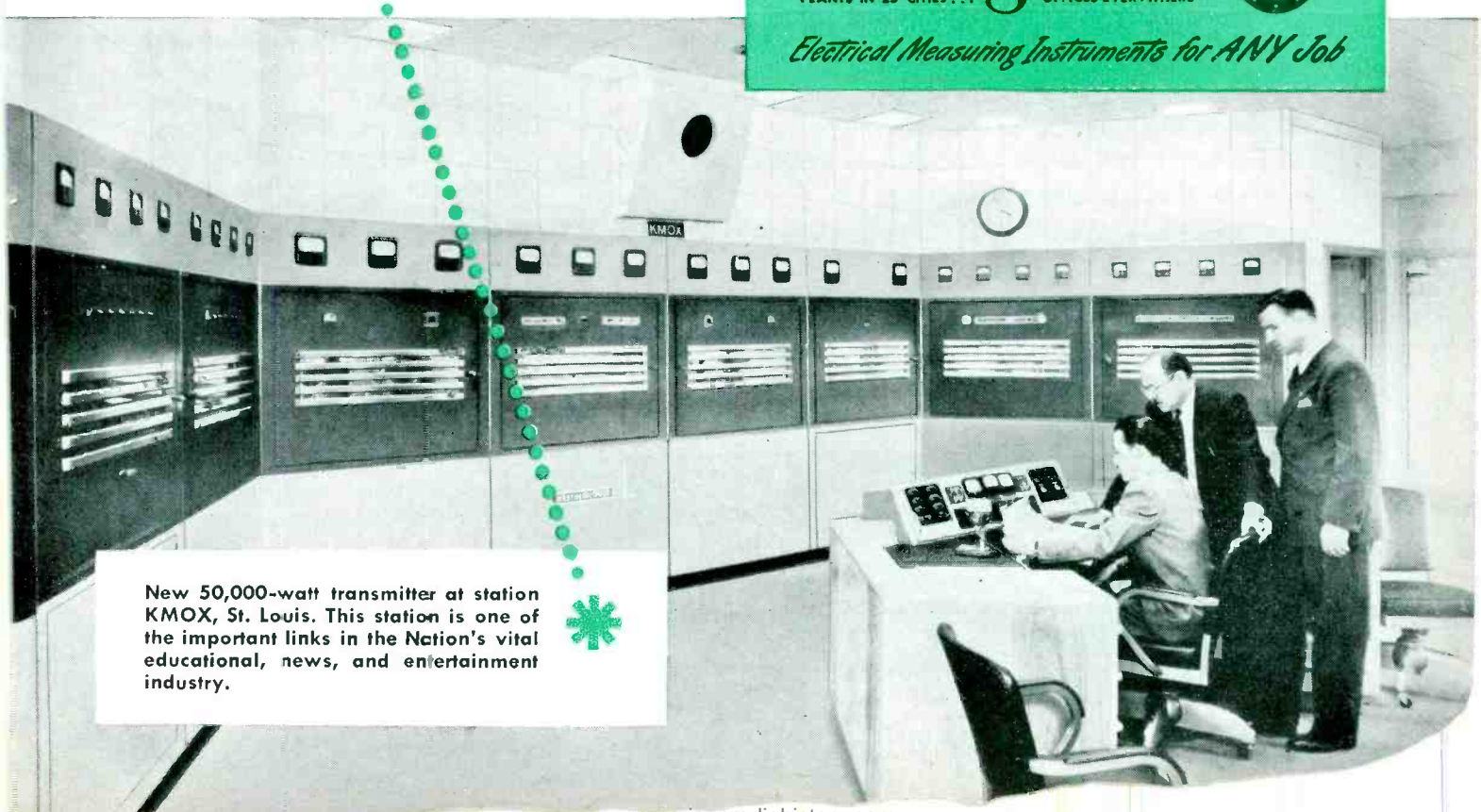

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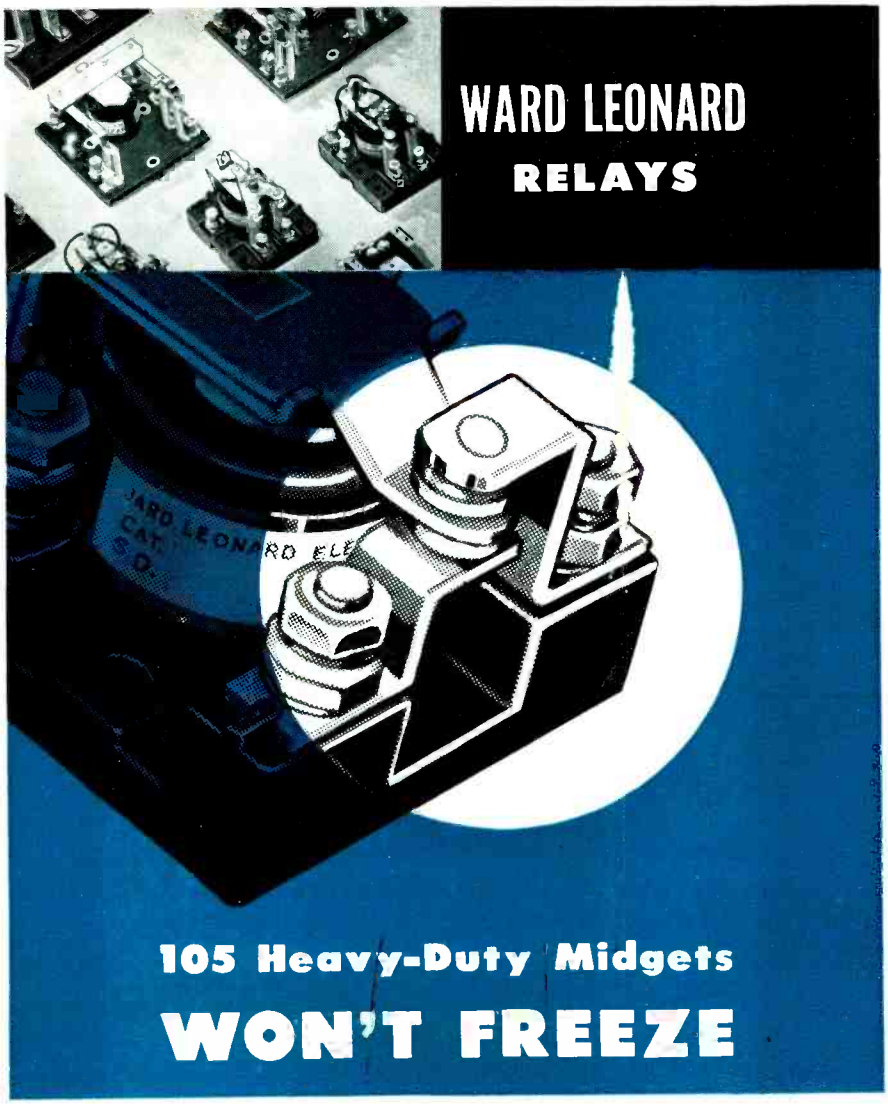

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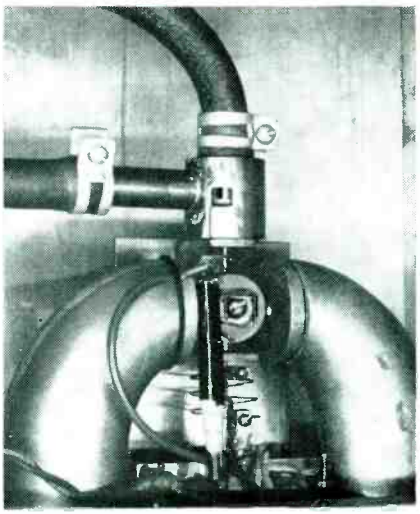

Details of air valve construction

scale and adjusting magnetron temperature to the middle of the range by controlling the hand valve.

The capacity of the source of cooling air should be around twice that needed at any particular time to minimize hunting. With this device temperature controls in the order of ±0.1 C are possible. When applied to water-cooled devices, the control is somewhat less accurate and the tendency for hunting is much greater due to the slower circulation of cooling medium.

The author wishes to thank C. J. Calbick of BTL for his cooperation in testing and checking the equipment described.

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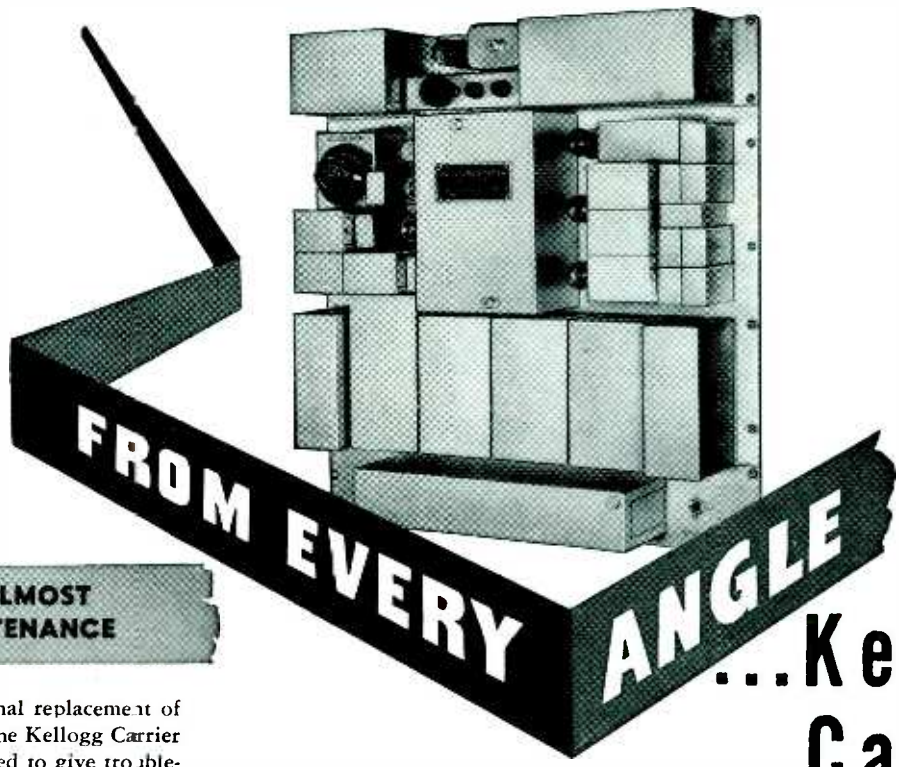

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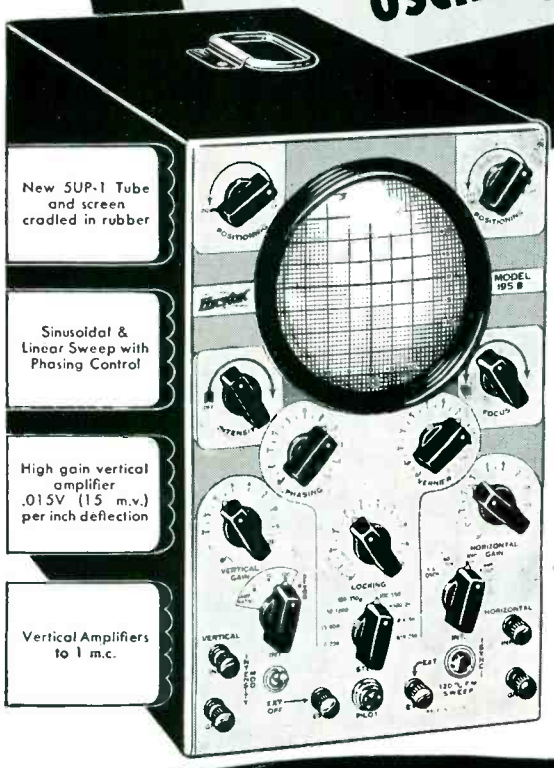

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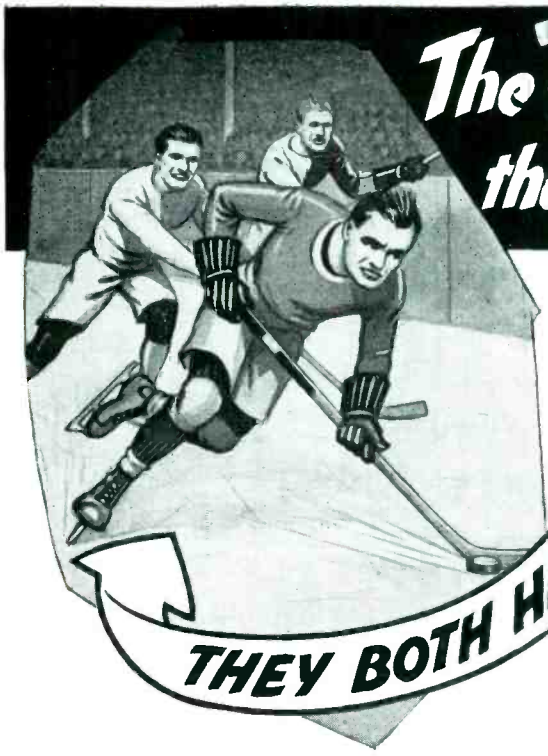

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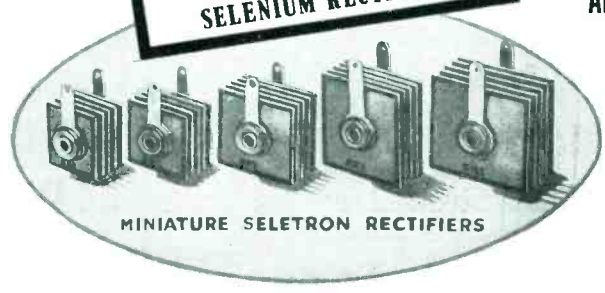

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Seletron Selenium Rectifiers are available in a wide range of sizes, from high voltage power stacks to the low ma. types of the "Miniature Family."

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Current Rating	75 ma.	100 ma.	150 ma.	200 ma.	250 ma.
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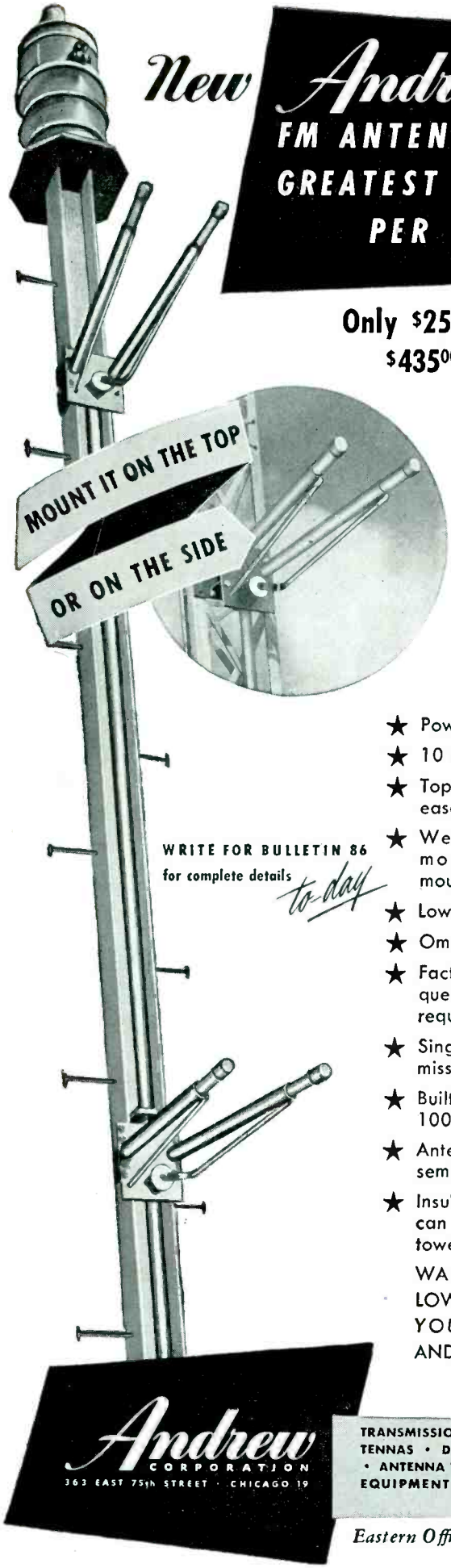

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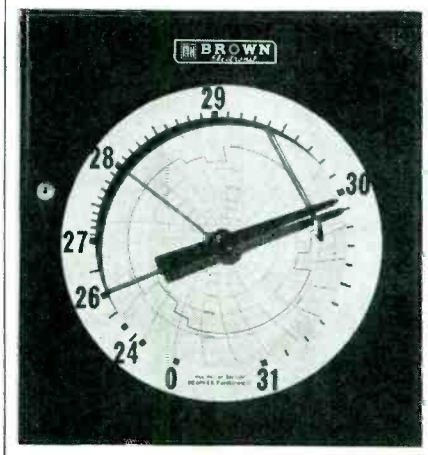

Indicator gage for molten steel refining bath temperatures. Recorder stylus moves only when operator takes reading

tube is then depressed for several seconds until the indicator pointer comes to a rest. The recorder is usually located on the instrument panel for each furnace or on a separate panel which is clearly visible to the operator when using the tube.

A correction factor must be taken into consideration since the air blast used to form the viewing cavity oxidizes the steel around the cavity surface, thereby giving a slightly higher reading than true bath temperature. Where this effect is objectionable, inert gases may be used for purging.

European Receiving Tubes

By H. A. S. GIBAS
Amsterdam, Holland

AMERICAN TUBES used in some European countries are manufactured in Europe or imported from the United States. Most of the European continental tubes are produced by one of three manufacturers: Philips, Telefunken and Tungsram. In several countries there are firms, which are owned by one of these three, but which manufacture tubes under a different name.

Most modern European types of receiving tubes are designated according to a standard system, which is explained in Table I. The type number consists of letters and figures. The first letter indicates the heater voltage or current, and the following letters explain the general tube type. The first number gives the base of the tube, and

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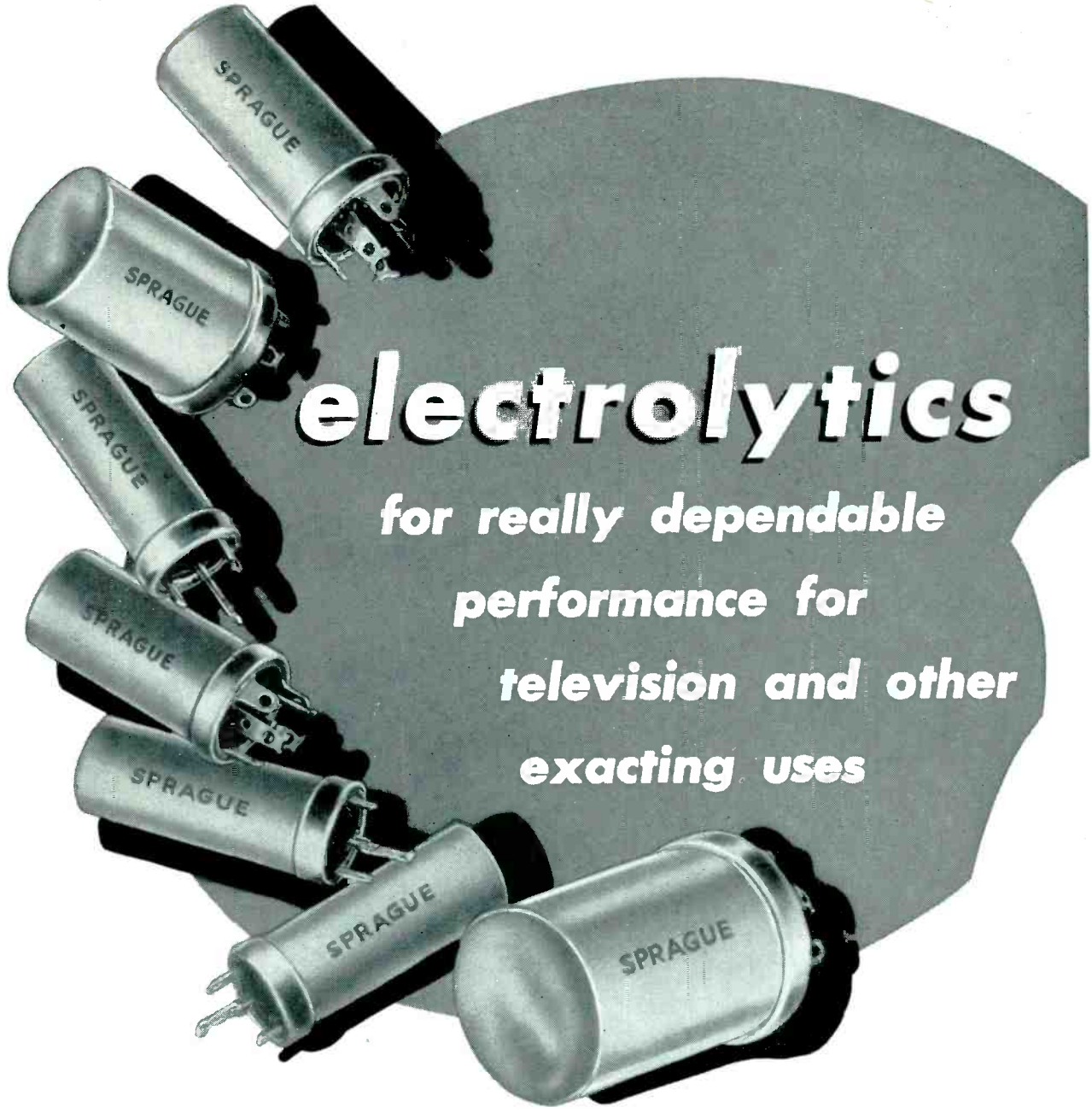

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These sturdy little dry electrolytics have what it takes to match the toughest capacitor assignments in television and other exacting equipment where the use of ordinary components may only be inviting trouble. They're compact, easy to mount. They'll withstand plenty of heat. Thanks to a recently developed processing technique, they are outstandingly stable, even after extended shelf life. In every respect, they are designed for better-than-average service on tougher-than-average jobs.

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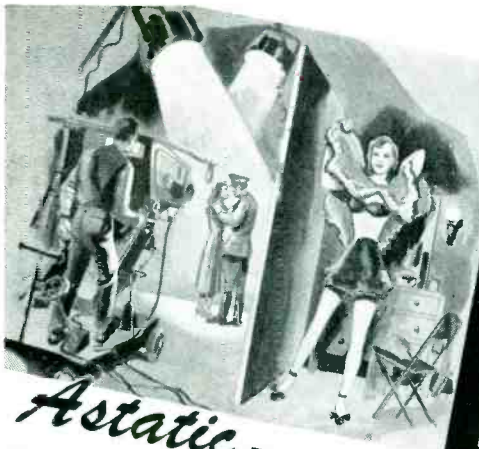
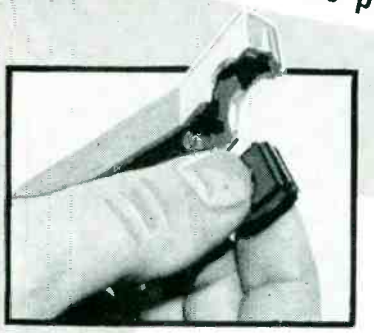


THE QUICKEST CHANGE ON RECORD(S)

Astatic FL SERIES PICKUPS switch from LP Micro-groove to Standard 78 RPM records in seconds . . . with no changing of needle pressure or similar adjustments



LIKE THE DEMANDS on Television entertainers for speed in changing costumes — there is need for greatest possible ease and speed when phonograph owners change back and forth from 33-1/3 to 78 RPM Records. Public satisfaction and convenience demand it. That's why the two-in-one feature of Astatic's new FL Series Long-Playing Pickups is considered of first importance. Each of these amazing units plays both types of recordings . . . and makes the change-over in seconds. There is no changing of needle pressure, no similar adjustments to make. All that the user need do is change cartridges. Takes only seconds, because the FL Pickups' tiny LP Cartridges fix themselves into playing position on the same slip-in principle which firmly joins barrel and cap of many modern fountain pens.

The reproduction qualities of FL Series Pickups at only five-gram needle pressure are nothing short of spectacular, thanks to complete new engineering, mechanically and electrically. For comparable performance at lower cost, you may want to consider other new Astatic Long-Playing Models. Write for new brochure, giving full details, illustrations.

Astatic Crystal Devices manufactured under Brush Development Co. patents.

FL-33 Crystal Pickup

FLC-33 Crystal Pickup

FLT-33 Crystal Transcription Pickup

The "400" Arm with either QT-33 Crystal Cartridge or MI-2M-33 Magneto Induction Cartridge

THE Astatic CORPORATION
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Table I—Explanation of European Tube Types

First Letter—Heater Voltage or Current

A–4v a–c	E–6.3v a–c	K–2v d–c
B–0.18A d–c	F–12.6v a–c	P–0.3A a–c
C–0.2A a–c	G–5v a–c	U–0.1A a–c
D–1.4v d–c	H–4v d–c	V–0.05A a–c

Following Letters—Tube Systems

A–Single Diode	N–Gas Triode
B–Double Diode	P–Secondary emission tube
C–Triode	W–Half-Wave Gas Rectifier
D–Output Triode	X–Full-Wave Gas Rectifier
E–Tetrode	Y–Half-Wave Vacuum Rectifier
F–Pentode	Z–Full-Wave Vacuum Rectifier
H–Hexode	
K–Heptode or Octode	
L–Output Pentode	
M–Magic Eye	

First Figure—Tube Base

1–Y8A (Europ. metal)	5–All-glass (B8G or B9G) or special
2–Octal or Loctal (B8G)	7–Subminiature
3–Octal (K8A)	9–All-glass (B7G)
4–B8A Bimlock	

Figures above 100 similar to types below 100 but with different base
EF 112 = EF 12 EL 151 = EL 51
Second figure indicates serial number

the second number the type of the series.

The first tubes with this designation had only one number between 1 and 9. They have European bases or P-bases, the so-called pot-base in which the tube-holder seems to be a pot. The U-types UBL1, UCH4, UF9 and UM4 have American octal bases.

Types with numbers above one hundred are identical with those below one hundred but have different bases. Thus the EF112 is identical with the EF12; but the EF112 has the cathode separated from the shield and third grid, with separate base contacts.

Philips has developed the Rimlock tubes, standard D, E and U types with small dimensions. The base diameter is 22 mm (0.87 in.). Characteristics are similar to the American miniature series.

A normal 4-tube superheterodyne contains one ECH41 as oscillator and frequency changer, two EAF4's, the first as i-f amplifier and rectifier for automatic gain control, the second as demodulator and i-f amplifier, and one EL41. as the power tube.

The tubes for an a-c/d-c superheterodyne are one UCH41, two UAF41's, one UL41, and one UY41. The heater voltage of all these is 115.2 volts, the heater current 0.1 ampere.

Other new tubes comprise the D70-series miniature battery tubes,

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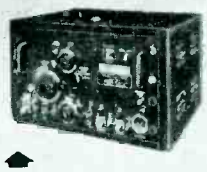
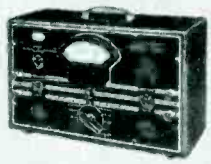


FREQUENCY SHIFT EXCITER
—Provides RF drive and frequency shift keying to transmitter

B&W DISTORTION METER MODEL 400



B&W AUDIO OSCILLATOR MODEL 200

B&W AUDIO FREQUENCY METER MODEL 300

2 KW AMPLIFIER—Class C R-F amplifier. Range: 1-25 Mc's

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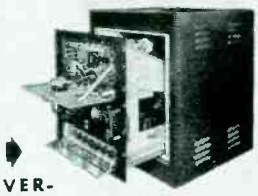

DUAL DIVERSITY CONVERTER—Provides diversity mixing on frequency shift circuits.

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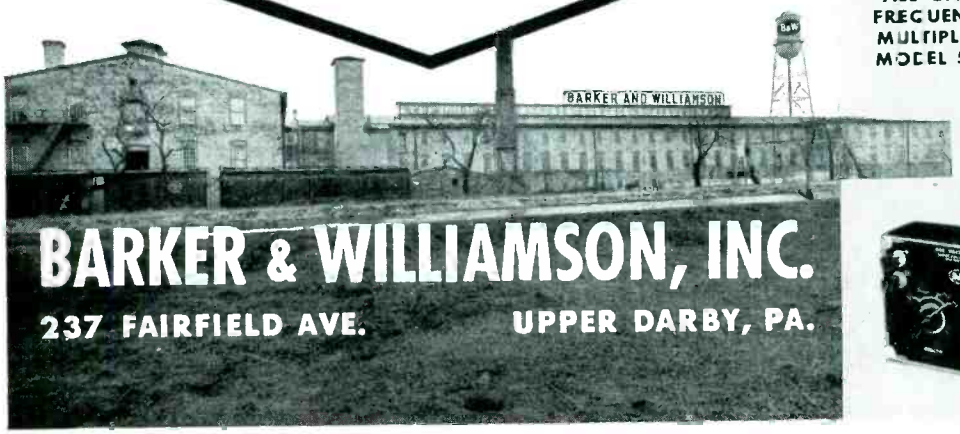
E&W ALL BAND FREQUENCY MULTIPLIER MODEL 504



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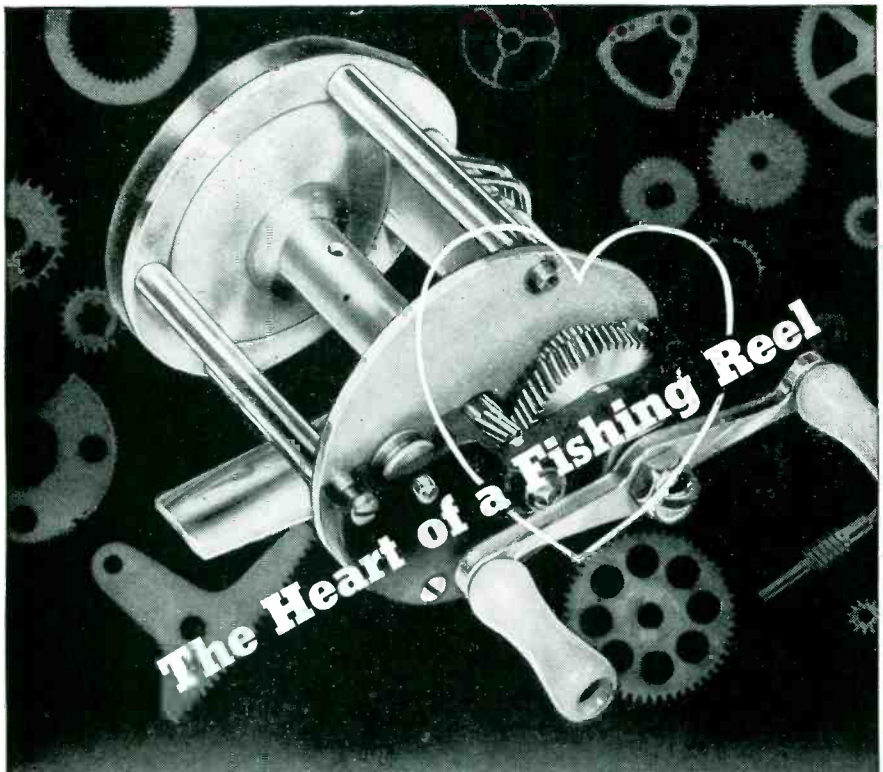

Fishing reel gears must operate smoothly at a speed of 3000 revolutions per minute or more, when a cast is executed. These gears must also withstand the strain of hauling in a fighting fish of unpredictable size and strength, thus rendering a dual purpose: speed and velvety smoothness in one direction—strength and durability in the other.

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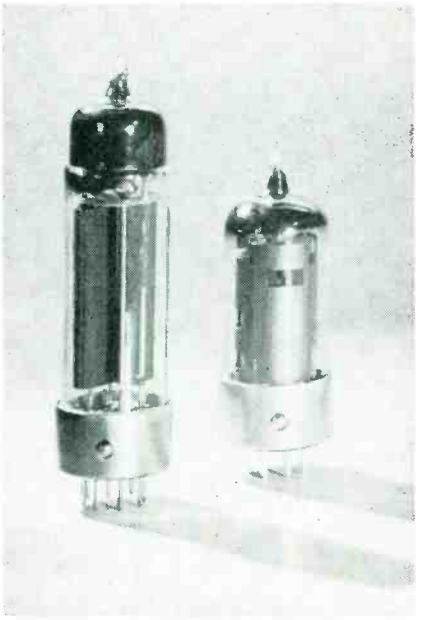
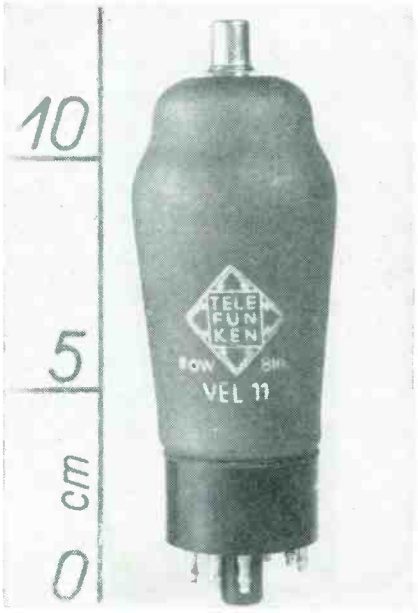


Philips Rimlock tubes with 22-mm diameter bases. Heater current is 0.1 amp for 6.3-volt version

and the 90-series. The latter type has an outer diameter of 19 mm (0.75 inch) and an F-pin base.

The principal British tube manufacturers are G.E.C. (Marconi-Osram), Mazda, Mullard (Philips)



The VEL11 encloses two pentodes, one for grid detection and one for power amplification, in one envelope. Dark sprayed shield improves tube's heat radiation

and Standard Telephones. All these make similar tubes as the continental standard types, some with different designations.

Very interesting is the new VEL11 of Telefunken. It contains two tetrodes; the first for grid detection, the second for power ampli-

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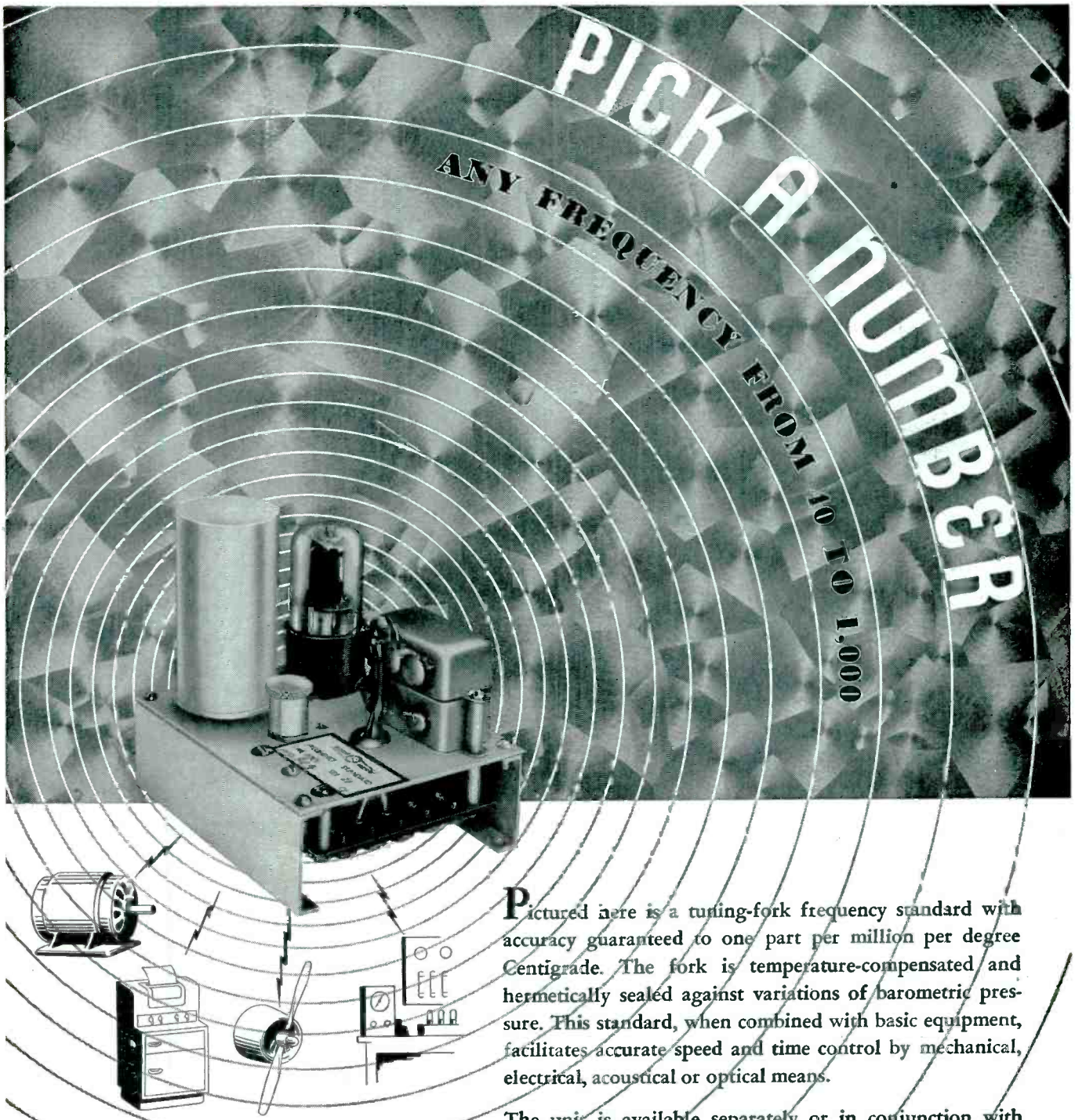
PICK A NUMBER

ANY FREQUENCY FROM 10 TO 1,000



Pictured here is a tuning-fork frequency standard with accuracy guaranteed to one part per million per degree Centigrade. The fork is temperature-compensated and hermetically sealed against variations of barometric pressure. This standard, when combined with basic equipment, facilitates accurate speed and time control by mechanical, electrical, acoustical or optical means.

The unit is available separately or in conjunction with complete timing instruments. Our engineers are ready to cooperate on any problem.

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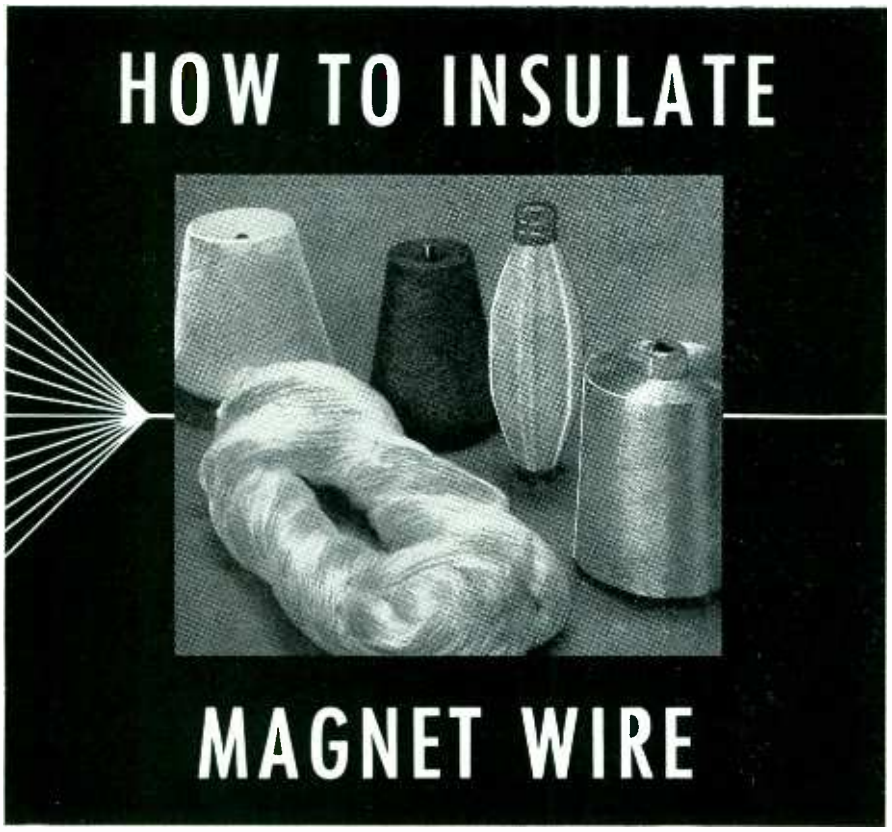

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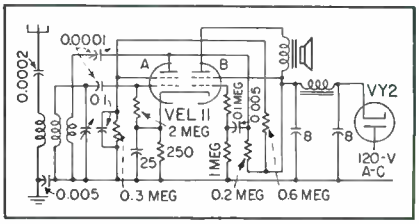
Table II—Characteristics and Typical Operation of dual tetrode VEL11

	A	B
Fil. 90v, 0.05 amp		
Plate Voltage	40	200 volt
Screen Voltage	30	200 volt
Grid Voltage	0	−6 volt
Plate Current	0.8	22 ma
Screen Current	0.2	3 ma
Power Output		2 watts
Plate Resistance	0.2	0.009 Meg
Input Resistance	0.28	0.03 Meg
Transconductance	1,500	5,200 μmho

fication. Table II gives the data. With this one tube it is possible to make a sensitive receiver with one tuned circuit. A second advantage is the small heater current. The V-series has a small rectifying tube, the VY2, with a heater voltage of 30 v. Thus a receiver (see accompanying circuit diagram) with one VEL11 and one VY2 has at 120 volts a total heater consumption of



Sensitive 2-tube single-tuned-circuit receiver using the new type VEL11 tube and VY2 rectifier. Heaters connected in series across 120 volts

6 watts. Furthermore in the V-series there is a triode-hexode frequency changer VCH11 and a high gain pentode, the VF14.

Most modern European tubes are all-glass types. The characteristics are nearly the same as those of the older types. The smaller sizes, the shorter connections to the pins and glass as the only insulating material make them more suitable for ultra-short-wave work, such as television and frequency modulation.

Egg Records on Wire

CHICKEN BREEDERS, in developing better strains of laying hens, keep exact records of the number of eggs laid by each fowl. When the breeder has some 12,000 subjects, as is the case on the Heisdorf and Nelson farm near Kirkland, Washington, record keeping becomes quite involved.

This particular farm has saved itself considerable time by wiring its hen houses to permit operation of a wire recorder. Plugs are arranged along the wall at intervals,

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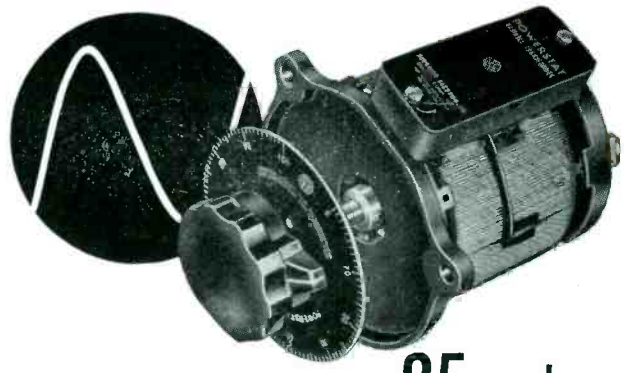
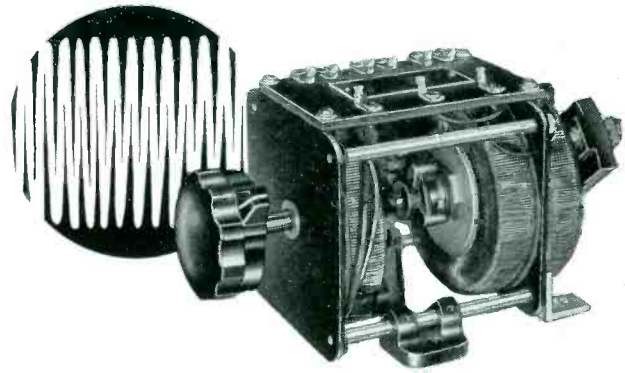


25 cycles

50-60 cycles



400 cycles

Whether your application involves 25, 50, 60 or 400 cycles, there's a POWERSTAT variable transformer to meet the need for precise, dependable, continuously-adjustable a-c voltage. Every POWERSTAT features the characteristics of excellent regulation, high efficiency, conservative rating, zero waveform distortion, rugged mechanical construction and smooth control. All are readily adapted to your circuit design.

For 25 cycles operation, a complete line of POWERSTATS are offered for 115 and 230 volt, single and three phase duty. For 50-60 cycles systems, standard POWERSTAT variable transformers are available in numerous models and ratings. Both manually-operated and motor-driven units for push-button remote control are designed for 115, 230 or 440 volt, single and three phase applications.

For 400-800 cycles, the requirement for variable a-c voltage control usually dictates service specifications. For this reason it is not feasible to offer a standard line. However, many POWERSTATS have been designed and built for these higher frequencies and the experience of the Superior Electric engineers is at your disposal. Consult with these specialists in voltage control at The Superior Electric Company.

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Low as $5.07 was, remember Air Express rate *included* door-to-door service, receipt for shipment and more protection. It's the world's fastest shipping service that *every* business uses with profit.

World's finest Scheduled Airline fleet carries Air Express. 24-hour service — speeds up to 5 miles a minute. Direct to over 1000 airport cities; air-rail for 22,000 off-airline offices.

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17-lb. carton of hearing aids goes 900 miles for $4.70.
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(Same day delivery in both cases if you *ship early.*)

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Productivity records for 12,000 hens are compiled easily and accurately with a special wire recorder installation

and the wiring extends to an adjacent building where the recorder is kept.

The accompanying photograph shows one of the hands with the microphone strapped to his chest. He plugs his microphone into a convenient outlet, and as he takes each chicken from her nest, reads the number on her leg band and makes appropriate comments on her productivity for that particular day. At the end of the day, the recorder is carried into the office where permanent production records are compiled and transcribed.

The wire recorder installation has cut the record-keeping time to a small fraction of what it was when each hen's record was kept by hand. The cost of wiring the hen houses ($75 for each house of 1,200 birds) and the cost of the wire recorder ($450) are expected to be defrayed in a short time by use of the system.

A Method Of Feeding Turnstile Antennas

By Ralph E. Taylor
Electronics Laboratory
National Bureau of Standards
Washington, D. C.

THE TURNSTILE ANTENNA, as introduced by G. H. Brown,[1] consists primarily of two coplanar half-wavelength dipoles mounted in space quadrature as shown in Fig. 1. The dipoles are fed with r-f currents that are equal in magnitude but phased 90 degrees apart in time. Such an arrangement gives a

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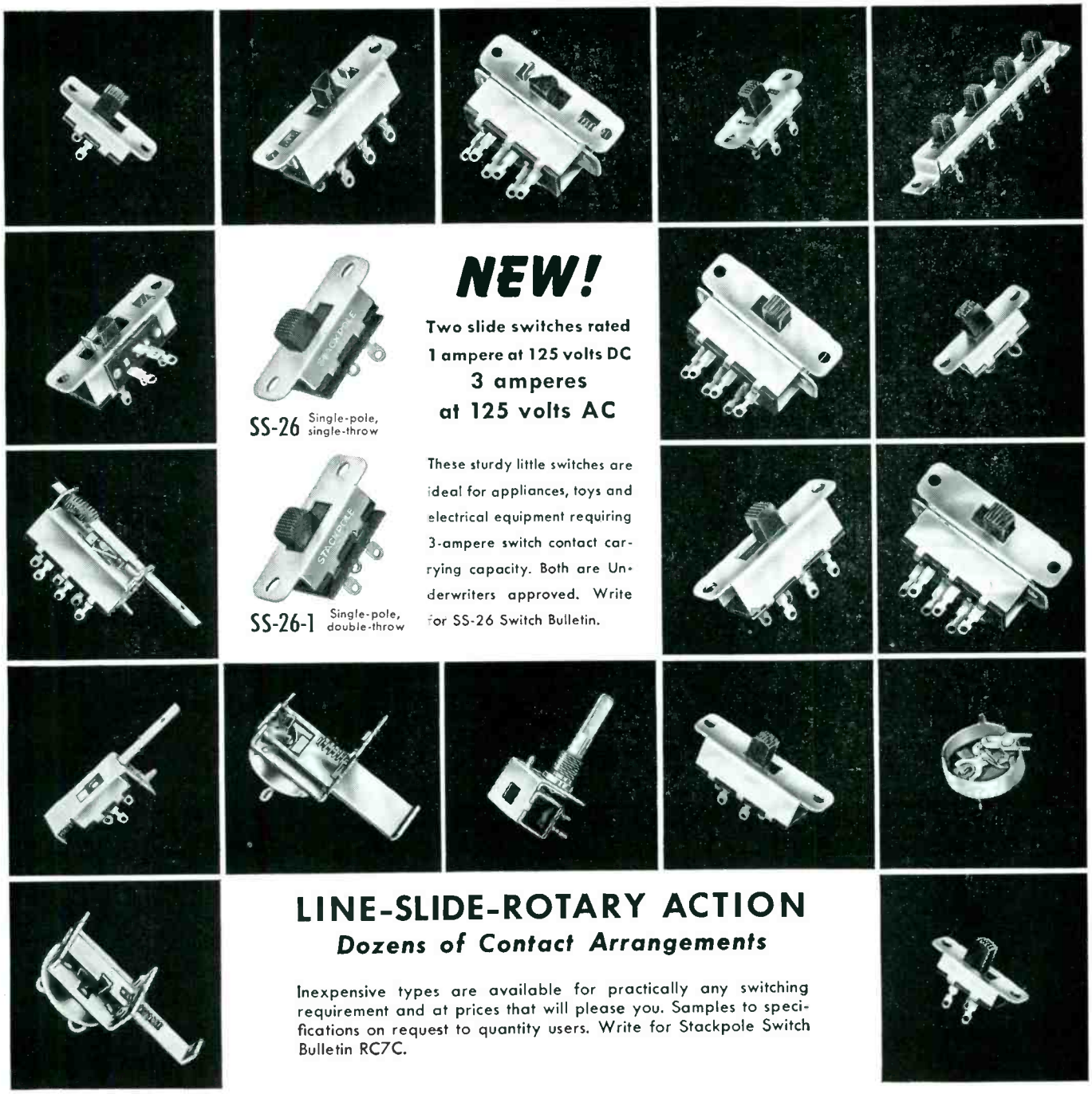
to modernize your product and to enhance its "saleability"



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Two slide switches rated
1 ampere at 125 volts DC
3 amperes
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SS-26 Single-pole, single-throw

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These sturdy little switches are ideal for appliances, toys and electrical equipment requiring 3-ampere switch contact carrying capacity. Both are Underwriters approved. Write for SS-26 Switch Bulletin.

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Dozens of Contact Arrangements

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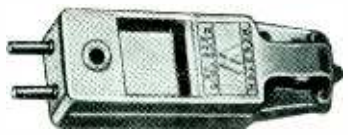

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Model F 14

This model cartridge is for both LP and standard records. A "twist of the wrist" converts it from one to the other, at the listener's pleasure. Complete with needles and guard assembly.

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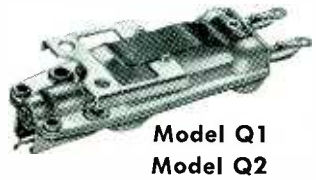

Model Q1
Model Q2

This cartridge protects record, needle and crystal from accidental injury due to rough handling of the tone arm. Exceptionally quiet playing. Available in 1 volt or 2 volt models.

MAGNETIC CARTRIDGES

Model M1

This new magnetic cartridge incorporates the latest refinements for superior playing performance. Provides .1 volt output at 1000 cps . . . comes complete with osmium-tipped replaceable needle.

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A new die-cast zinc alloy tone arm for use with F series cartridge, tracking at very low pressure.

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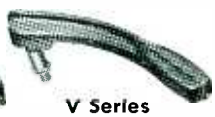

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P Series for LP Records

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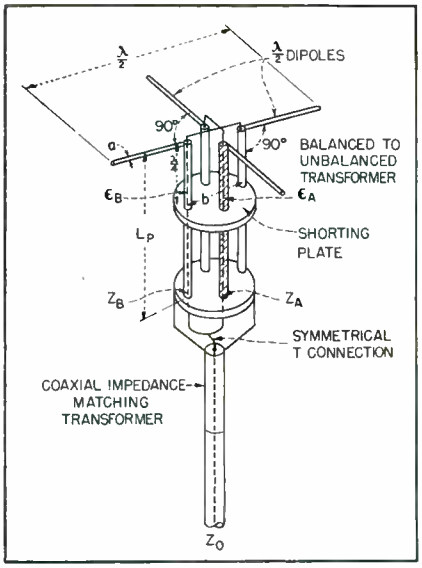

Fig. 1—Schematic drawing showing method of feeding turnstile antenna

nearly circular radiation pattern in the plane of the dipoles. A circularly polarized r-f field vector is radiated in directions normal to the plane of the dipoles.

The turnstile antenna may be considered as essentially comprising four identical, symmetrically-spaced elements, with terminals at the points labeled *A*, *B*, *C* and *D* in Fig. 2A. The relative magnitudes and phases of the various currents can then be represented by means of the vector diagram shown in Fig 2B. The current I_A leads the current I_D by 90 degrees. Similarly I_C lags I_D, I_B lags I_C, and I_A lags I_B, in each case by 90 degrees. If the dipoles are resonant, the current I and voltage E into a given element are in phase. Coupling between adjacent elements is reduced to a minimum by virtue of the fact that they are at right angles to each other.

A method of feeding turnstile antennas is illustrated in Fig. 1. Phasing is accomplished by feeding the dipoles with separated coaxial feeders having physical lengths which are equal, and electrical lengths which differ by a quarter-wavelength. This is achieved by employing different dielectric materials in the feeders. The physical length is given by the relation

$$L_P = \frac{\lambda}{4(\sqrt{\epsilon_A} - \sqrt{\epsilon_B})}$$

where $\epsilon_A > \epsilon_B$ and λ is the wavelength in free space. ϵ_A and ϵ_B are the respective dielectric constants of the insulating materials in the

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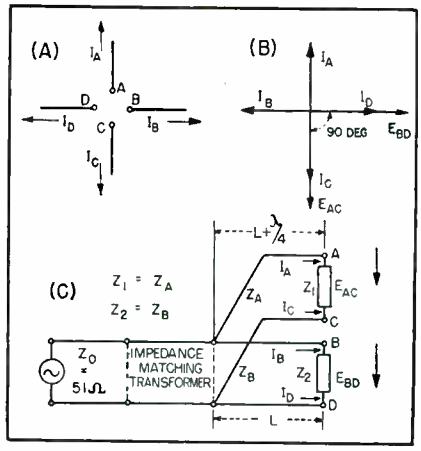

Fig. 2—Radiating antenna (A), vector diagram (B), and equivalent circuit (C) for turnstile antenna

dipole feeders. The sense of rotation of the r-f field vector radiated from the dipoles can be reversed by interchanging ε_A and ε_B in Fig. 1. The center conductors of the dipole feeders are shown attached to the center conductor of a series, coaxial, impedance matching transformer. A symmetrical T connection is formed.

An equivalent circuit diagram is shown in Fig. 2C. The characteristic impedances of the dipole feeders, Z_A and Z_B, are matched with the respective dipole resistances, R_1 and R_2. Since the dipoles are resonant, no appreciable standing waves exist in the dipole feeders. Length L represents the electrical length of the ε_B insulator and $L + \lambda/4$ the electrical length of the ε_A insulator. The matching transformer matches the impedance of the parallel combination of Z_1 and Z_B to the characteristic impedance Z_0 of the main feeder line. Antenna currents are prevented from flowing on the outside of the main feeder line by means of a balanced-to-unbalanced transformer shown in Fig. 1. This transformer consists of a high impedance, quarter-wavelength, shorted section of balanced transmission line. It also serves as a rigid mechanical support for the dipoles.

Antennas of the type shown in Fig. 1 are used for telemetering from the V-2 at 1,000 mc. (ELECTRONICS, March, April, 1947). The following parameters were chosen: $\varepsilon_A = 4.6$ (Grade 1137 Lava from the American Lava Corporation), $\varepsilon_B = 2.1$ (Poly F-1114, or Telfon, a du Pont de Nemours product), $Z_A = 51$ ohms, $Z_B = 61$ ohms, $a =$

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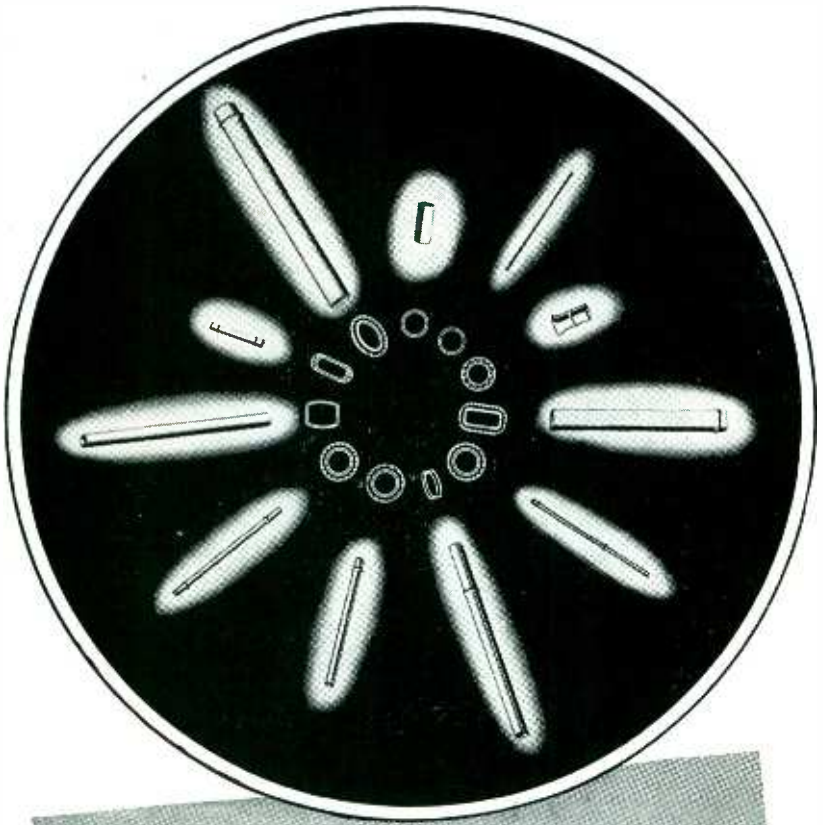

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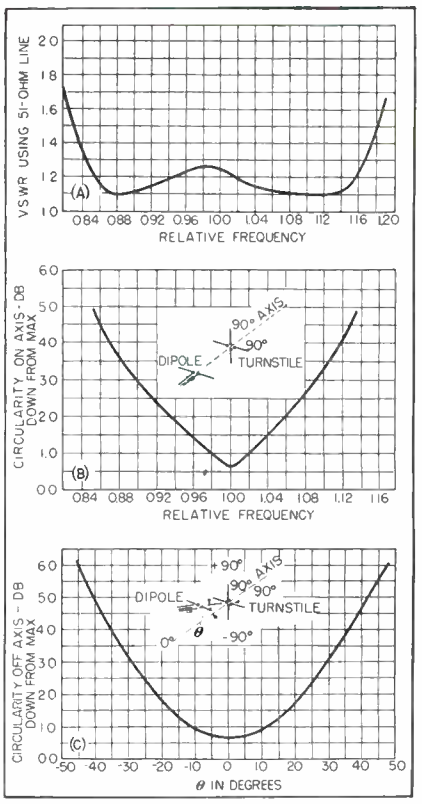

Fig. 3—Typical curves showing operation of antenna using feed system described

0.30λ at 1,000 mc, $b = 0.07\lambda$ at 1,000 mc, and $Z_o = 51$ ohms.

Figure 3A is a plot of voltage standing-wave ratio versus relative frequency. The measurements were made on a 51-ohm coaxial line. The bandpass is 35 percent using a limiting value of vswr (E_{max}/E_{min}) equal to 1.5 to 1.

Figure 3B is a plot of the circularity on axis (eccentricity of the rotating r-f field vector) versus relative frequency. The bandpass is 19 percent for a limiting value of 3 db. These measurements were made with a half-wavelength receiving dipole located in a plane parallel to the plane of the turnstile dipoles. The receiving dipole was spaced approximately ten wavelengths away from the turnstile antenna. It was rotated through 360 degrees about the axis perpendicular to the turnstile dipoles. A comparison was made of the maximum and minimum signals received when the pickup dipole was rotated. This comparison is known as the circularity. Figure 3C is a plot of the circularity versus angle θ in degrees at the center frequency.

REFERENCE

(1) George H. Brown, The Turnstile Antenna, ELECTRONICS, p 14, Apr. 1936.

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(continued from p 130)

(normal variation between individuals) is the dominant component, with a secondary peak at about 30 cps in a spectrum extending from about 0.5 to 50 cps. Abnormal amplitudes rise to 1,000 microvolts with fast spikes.

Present apparatus needs improved differential features above the presently available 1:100; a discrimination of 1:1,000 would help. There should be an overload indication. For research the frequency response should extend to zero and have direct writing with response to 150 cps. Improved methods of analyzing the frequency content of the wave are needed, especially an instrument that gives not only the amplitude of a given frequency component as do present analyzers but also its phase.

Miscellaneous Recorders

By KENDRICK HARE

Cornell University Medical College, New York, N. Y.

BECAUSE BIOLOGISTS are interested in a wide range of phenomena, no one recorder serves all uses. The frequency range to be recorded extends from a cycle a month to several hundred cycles a second. In certain instances it is simpler to use impulse counters and count the cycles.

Among the phenomena that are measured is resistance in which case the effects of electrode resistance are troublesome. For pressure measurements the strain gage and bridge recorder are used because of their adaptability (the gage can be modified for insertion inside a body). Volumetric measurements of changes of an internal organ can similarly be measured. Temperature changes are monitored. Although water and CO_2 losses and consumptions change slowly and so can be measured by sampling techniques, the methods now used are cumbersome and time consuming. An ideal recorder would have multiple independent channels with amplifiers adaptable for wide ranges of source impedances and sensitivities and direct-inking recorders combining both high speed of response and wide excursion;

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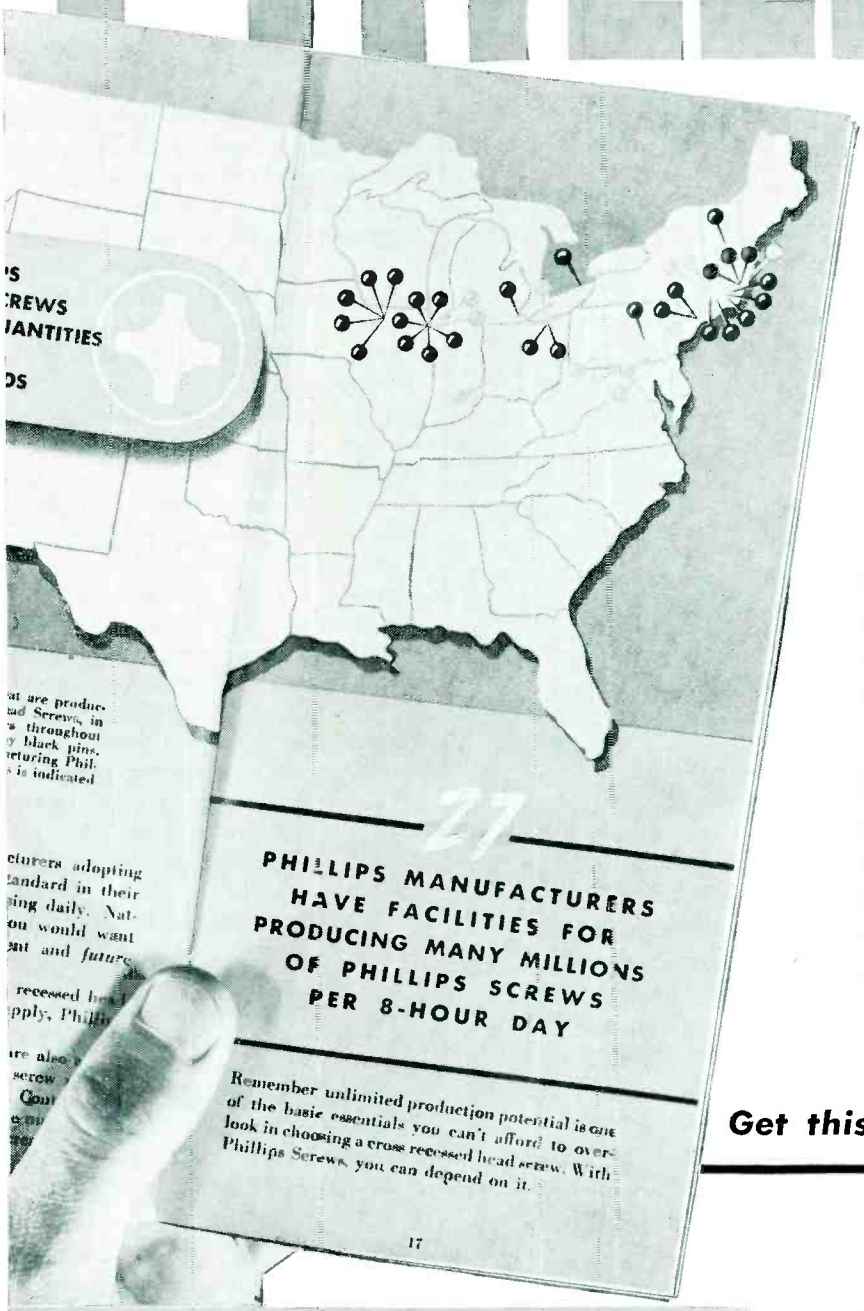

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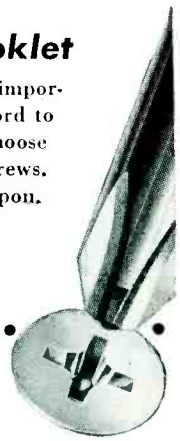

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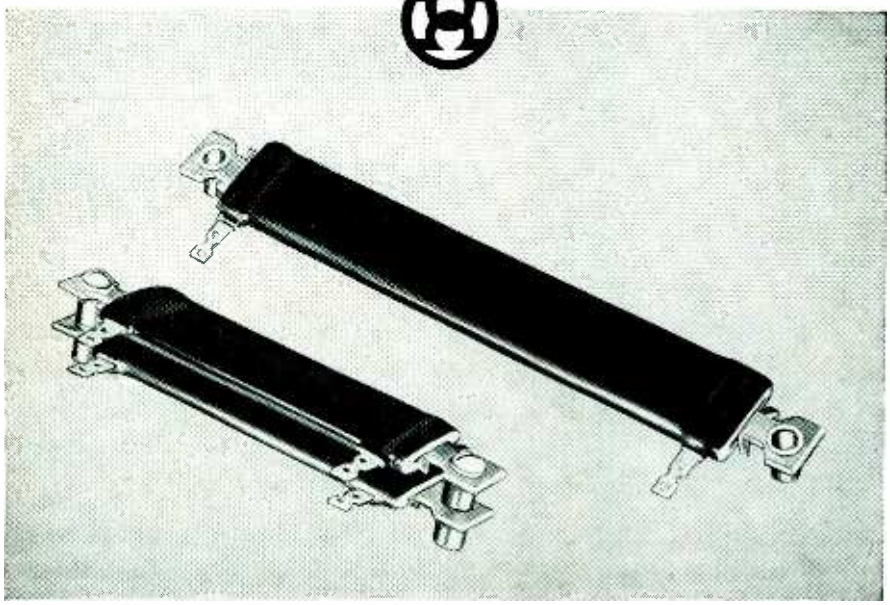

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the equipment should not be able to apply high voltage to the patient.

Biological Recorder Design

By S. R. GILFORD

National Bureau of Standards
Washington, D. C.

TO SPECIFY REQUIREMENTS for a recorder, one needs to know the (1) magnitude of the input signal, (2) input impedance and (3) frequency range. A survey of the literature suggests that flat response to 200 cps is desirable, but the physiological requirements have not been rigidly determined. String galvanometers have half-power response at about 300 cps; amplifier and pen types cut off (half-power) at about 75 cps.

One of the more important characteristics of these recorders is their phase lag. To measure this property a phototube has been set up to observe the record and to generate a blanking pulse passed to the Z axis of an oscilloscope. A circular trace is generated by the X and Y axes at the frequency being measured. The blanking pulse is moved to zero phase by a phase-shifting bridge in the circuit to the recorder input; the bridge angle indicates the phase lag.

These phase measurements show string galvanometers to be linear to about 60 cps and pen motors to about 40 cps. Present instruments are suitable for clinical use but wider ranges of flat frequency-amplitude and linear frequency-phase response are needed. Safety requires that the patient be grounded and that power-line isolation transformers be used.

Nucleonics and Biology

Nucleonic Instrumentation

By A. DAHL

Instrument Branch
Atomic Energy Commission
Oak Ridge, Tenn.

IN SURVEYING THE FIELD, we can divide it into (1) detectors and (2) indicators. The primary problems in detectors arise from the leakage produced by humidity and the design and construction of the pulse circuits. To obtain uniform calibration the spectral sensitivity of the

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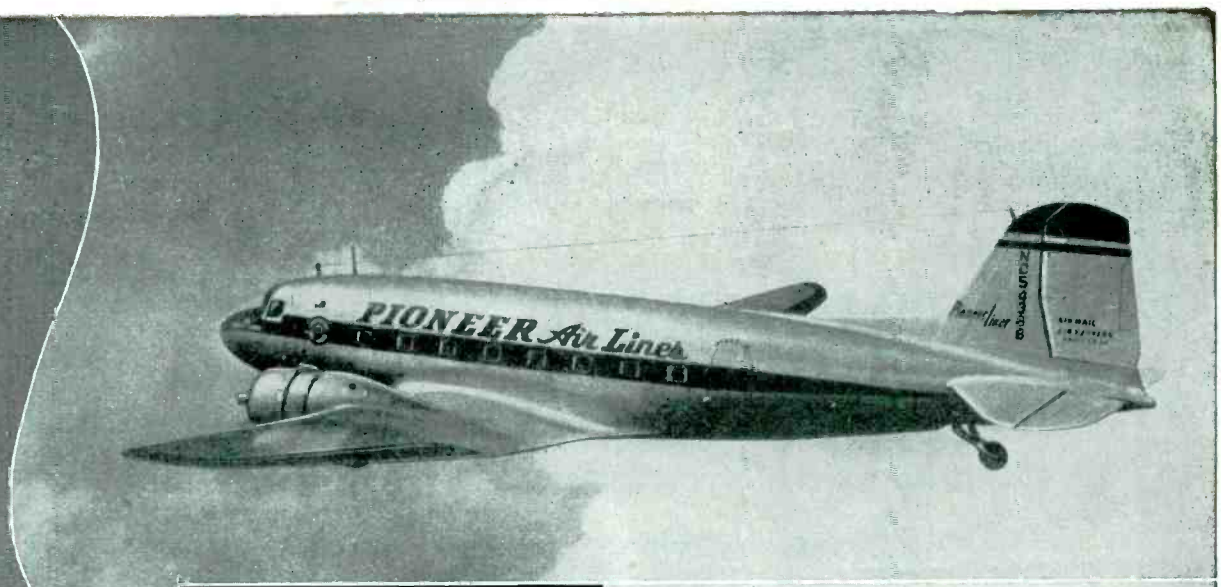

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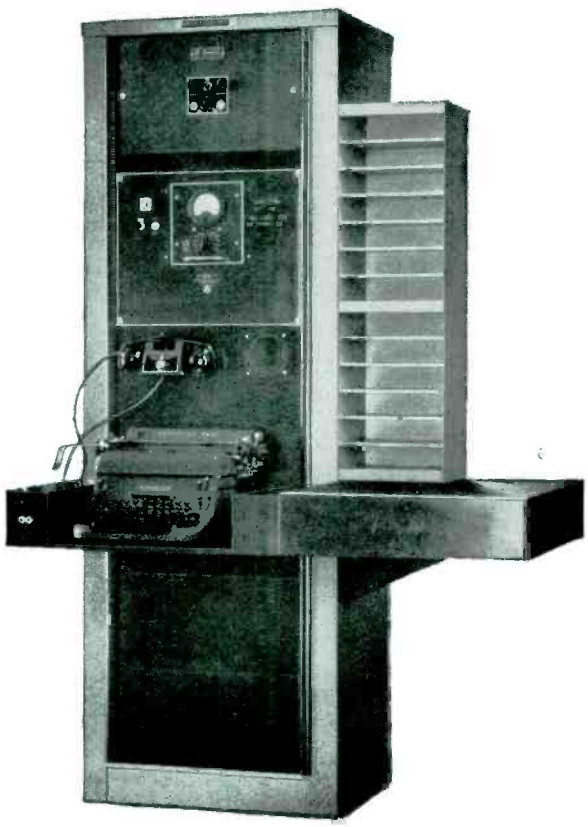

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detectors should closely approximate that of air by being made of material having a comparable atomic number (carbon or graphite is frequently used).

The major electronic problem arises from the high resistance required for the input from the detector, which may be hundreds of megohms. The insulation resistance must be larger than this. Usually radio insulators are from 10^8 to 10^{10} ohms. Of the special high-resistance insulators, Teflon has the highest resistance, Fluorethene comes next, then Polystyrene. Resistances from 10^{16} to 10^{18} ohms are required, which means that the insulators must be carefully cleaned and not handled. Grid current of electrometers must be low (5×10^{-14} amp is obtained in some subminiature tubes).

Radiosotopes in Biology

By C. A. Tobias, Jr.

Donner Laboratory of Medical Physics
University of California
Berkeley, Calif.

Although reliable commercial instruments are generally available, the field of radioactive tracer techniques is in its infancy and many detection and recording problems remain unsolved. Measurement of absolute disintegration rate is difficult; simple, easily calibrated instruments are needed, and means for measuring many samples so as to save the experimentalist's time should be developed (capacity for recording about 1,000 samples). Efficiency of gamma detectors has been greatly improved by the development of fluorescent (calcium tungstate) detectors used with photomultiplier tubes (1P21) so that 20 percent of the gamma rays penetrating the crystal are counted, which is about 150 times the efficiency of G-M detectors.

Prepared Discussion By L. Marinelle, *Argonne National Lab., Chicago, Ill.:* Radiation detectors are less highly developed than their associated electronic equipment. A very wide range of radiations need to be counted at high rates, high resolutions and low wall absorption. Several investigators have developed methods for separating background from source. For example,

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9. Simple optical adjustment system.
10. *Quality built* after more than 10 years of development.

NORELCO PROTELGRAM consists of a projection tube, an optical box with focus and deflection coils, and a 25 kv regulated high-voltage supply unit, making possible large-size home projection. More than ten years of exhaustive research resulted in this ideal system for reproducing a projected picture. The optical components are designed to produce perfected projection for a 16" x 12" image, the optimum picture size for steady, distant observation and also for *proper viewing at less than 5 feet.*

Other NORELCO products include standard 10" direct-viewing tubes and special-purpose cathode-ray tubes for many applications.

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PROTELGRAM IS PICTURE PERFECTION IN PROJECTION

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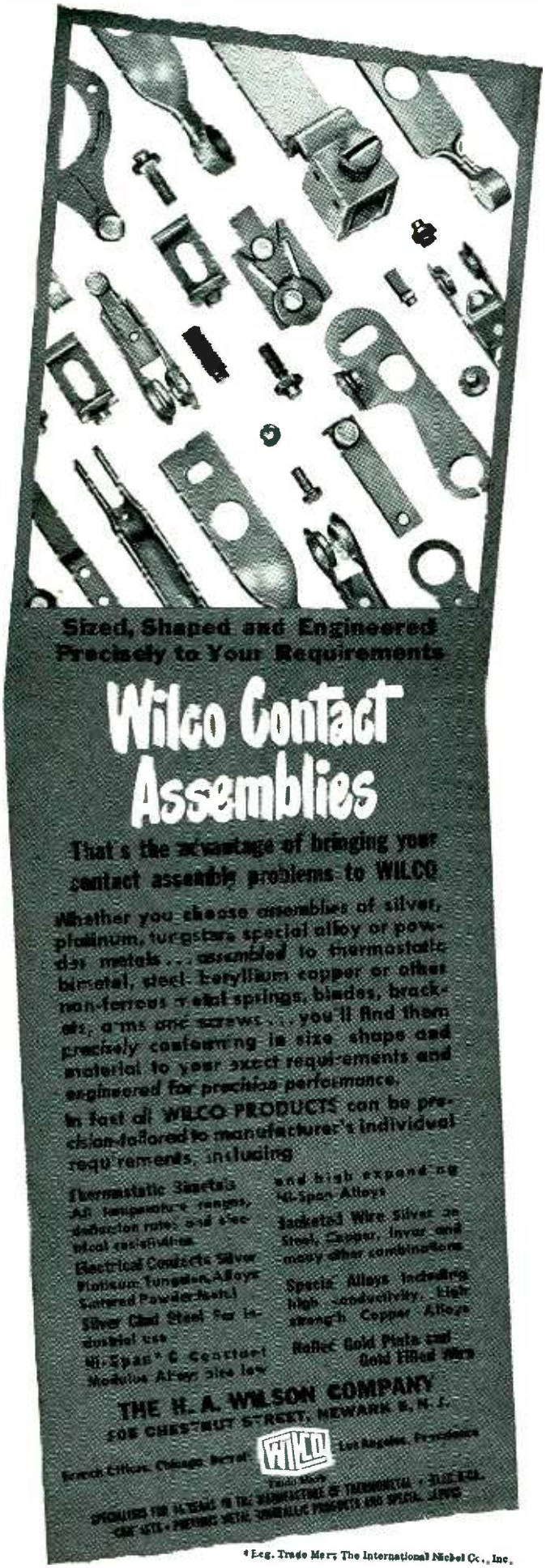

a detector in a shield with a small entrance channel can be operated with a plug in the channel and then removed to separate background and source counts. The detector can be constructed in such a manner that the area between the sample and detector is a maximum, for example with the sample inside the counter, to increase sensitivity. But detectors and holders need to be arranged to minimize contamination to the counter walls.

Geiger Counters

By H. FRIEDMAN
Naval Research Laboratory
Washington, D. C.

A REVIEW of G-M counters shows that self-quenching types are used almost exclusively. The rate of rise of the pulse depends on tube geometry and is faster for smaller tubes. Hydrogen, for example, quenches the metastable states of such inert gases as krypton, zenon and so on. The addition of small concentrations of impurities lowers the breakdown threshold voltage. Temperature independence can be achieved by adding a halogen as quenching agent giving a high-speed low-voltage counter. The smallness of G-M tubes is limited by mechanics, not by anything inherent in their operation; the largeness is limited by the dead time requirements.

Because electrons achieve ionizing velocities only near the cathode wire, increasing the number of cathodes per unit volume of gas increases the efficiency of the tube. Although it is difficult to construct a tube that has an inherent directional property, several tubes can be grouped to achieve special directivity and coincidence properties.

Thin-Window Beta Counters

By F. C. HENRIQUES, JR.
Tracer Laboratories, Inc.
Boston, Mass.

THE RANGE of a beta ray for all elements is proportional to the weight per unit area (within 15 percent) where the thickness of the material determines its weight. For monitoring low-energy emitters, the thinnest possible window is preferable. Optical mica can be sliced thinly and sealed to the tube

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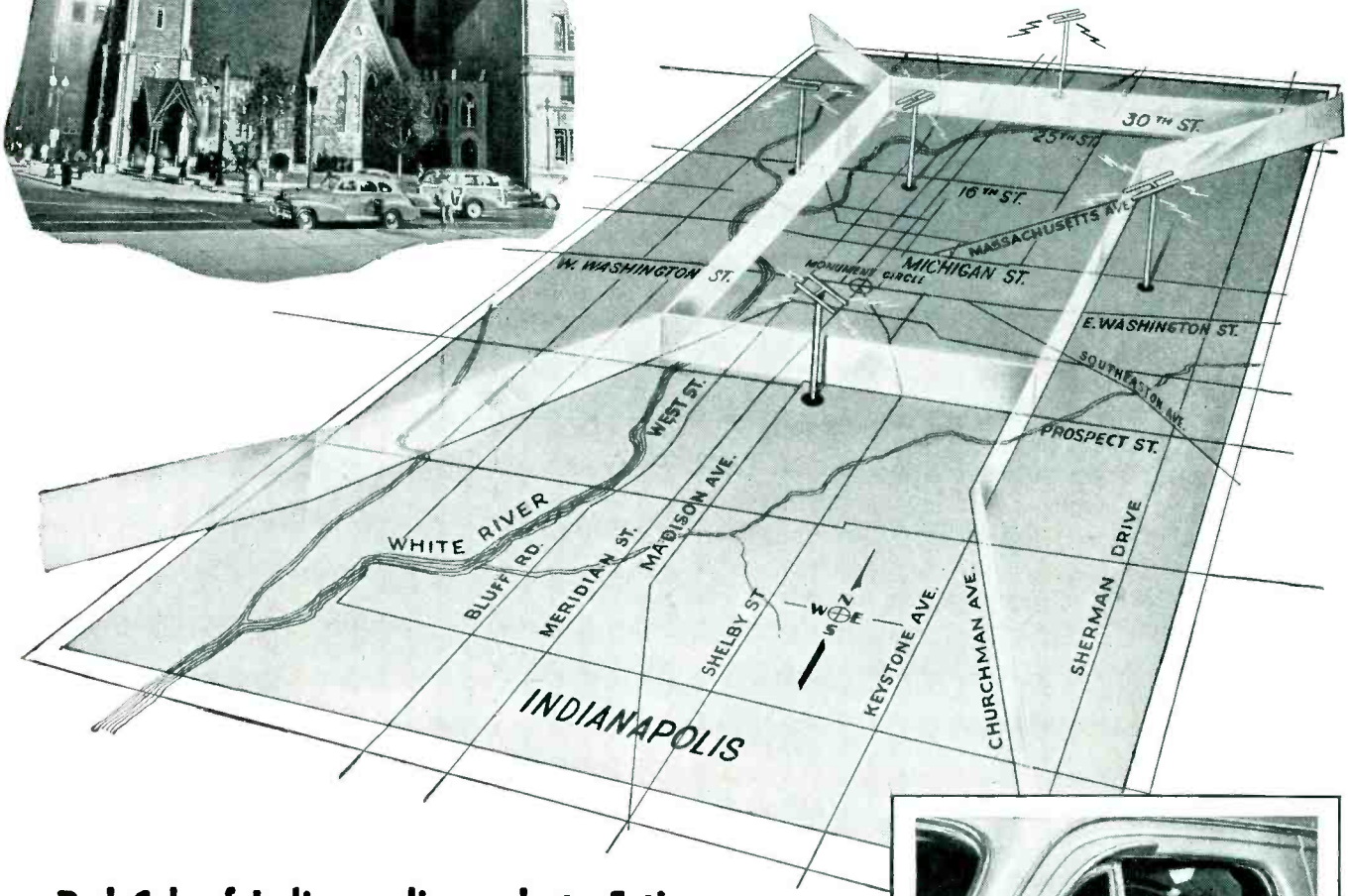
SYLVANIA RADIO TUBES IN Motorola RADIOS SPEED THE CAB-DIRECTING MESSAGES!

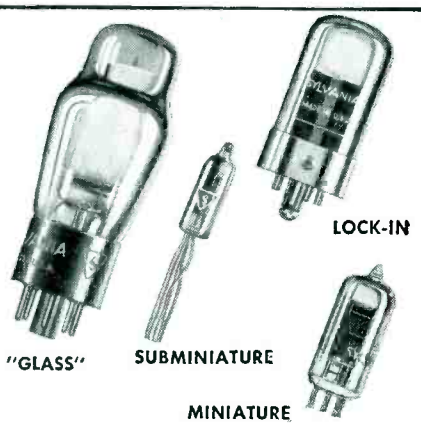


Red Cab of Indianapolis conducts 5 times more business with "Satellite" 2-way FM system!

THIS advanced system of taxicab dispatching used by Red Cab, Inc., of Indianapolis, Indiana, was especially developed by Red Cab, Inc., with the assistance and technical advice of Motorola Radio Engineers to answer the problem of congestion of the single radio frequency allowed to taxicab operators. Replacing the single central station and its single dispatcher with five independent stations, the system makes it possible for a large cab company to conduct many more times the business and radio dispatching without jamming the air. The five stations are controlled by a set of toggle switches under the various dispatchers' fingertips so that any number of dispatchers from one to five may be used and so that each dispatcher may select one station at a time or any combination.

And in every set in the 111 radio-equipped cabs, Sylvania's rugged Lock-In Tubes are firmly seated in their sockets, performing admirably day in and day out, under all kinds of jarring road conditions! For information on Sylvania Tubes see Sylvania Distributors, or write Radio Division, Emporium, Pennsylvania.

Red Cab driver receiving radioed instructions for picking up a fare in his district, in city of Indianapolis.



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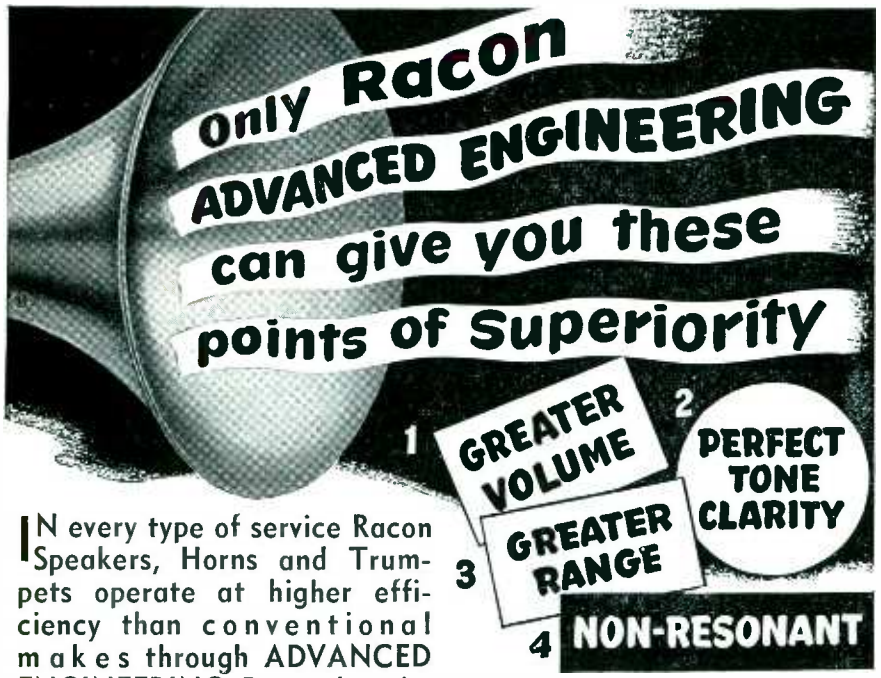

IN every type of service Racon Speakers, Horns and Trumpets operate at higher efficiency than conventional makes through ADVANCED ENGINEERING. Do not be misled by similarity in outward appearance. Only Racon, embodying special features of internal construction, can give you the outstanding superior performance of a Racon unit.

RE15 — Re-Entrant Trumpet, 18 inch acoustic length. List Price $34.00 (as illustrated).

Racon Double Re-Entrant Trumpet

Designed to deliver highly concentrated sound over long distances with highest efficiency. Free from resonant effects. Seven models in bell diameters from 10¼" to 25½". Also four radial models in widths from 9" to 36".

RASOB — Midget Marine. List Price $40.00 (as illustrated).

Racon Double Re-Entrant Marine Speakers

Made from a heavy aluminum spinning with heavy aluminum casting for base. Waterproof; not affected by extreme temperature changes. Four models in bell diameters from 6¼" (Miniature marine) to 14" (regular marine). Designed for long range reproduction and pick-up in all types of service. Regular, Midget and Miniature Models approved by Bureau of Marine Inspection and Navigation and Dept. of Commerce, for shipboard use.

RETOT — Junior Giant With Alnico V Magnets. List Price $50.00 (as illustrated)

Permanent Magnet Horn Units

These units, highly popular in all types of service, embody many improvements. Two groups, one with Alnico V Magnets and one with Alnico Blue Dot Magnets. All steel parts plated to prevent corrosion. Also fitted with corrosion proof metal or plastic diaphragms. Voice coil impedance on all units: 15 ohms. Special ohmages on request.

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by plastic or soft glass bond to form such a window.

So that the thin window will not pop, the outside of the tube is pumped equally with the inside during manufacture and the outside pressure returned as the tube is filled (approximately to atmospheric pressure) with its gas mixture. Windowless tubes can be used. A flanged assembly carries the tube and the sample holder so arranged that the sample can be rotated through a seal into the tube. This windowless construction increases the sensitivity over the background by a factor of two, but requires some time to come to equilibrium after rotation and is easily contaminated.

Autoradiographic Technique

By GEORGE A. BOYD

School of Medicine and Dentistry
The University of Rochester
Rochester, N. Y.

AUTORADIOGRAPHY, applicable in all branches of basic science, is restricted in this summary paper to histological and cytological techniques. Where higher resolution of the location of radioactive materials is needed than is possible with detector tubes, photographic records are made by autoradiography.

Stable Isotope Measurement

By DAVID RITTENBERG

College of Physicians and Surgeons
Columbia University
New York, N. Y.

THERE ARE TWO TYPES of mass spectrometers: (1) those used to determine with high precision the mass of positive ions and (2) those used to determine with moderate precision the relative concentration of various masses. The resolution of the instrument depends on its radius of curvature and, in practice, on the width of its slits.

There are two types of constructions: the 60 or 90-degree sector types and the 180-degree sector types. In the 60-degree type, positive ions are formed by electron bombardment and are accelerated through holes in electrodes. A focusing magnet is used to confine the bombarding electron beam, but it must be positioned so as not to interfere with the main magnet, creating difficulty in aligning the instrument. In the 180-degree

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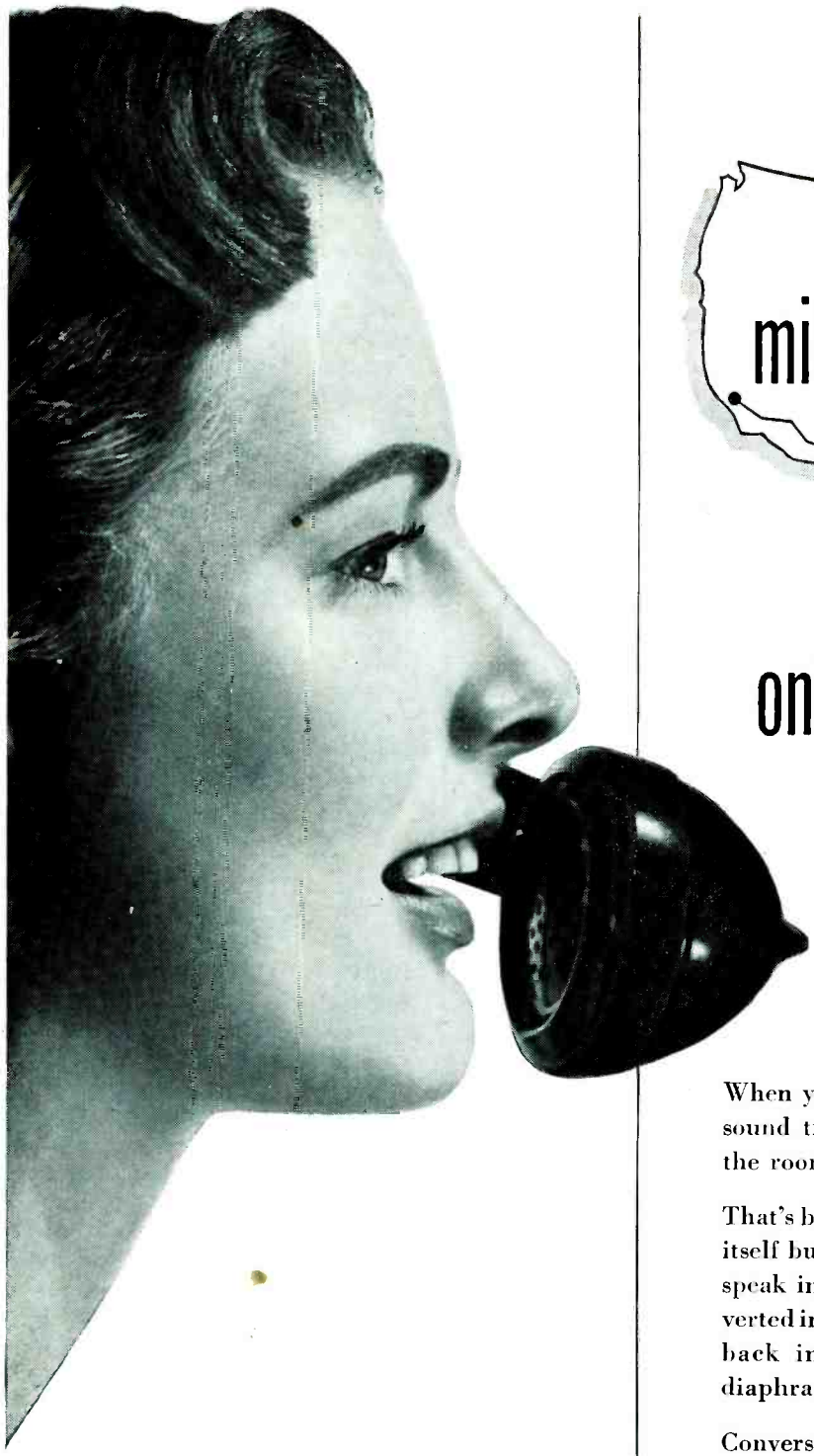

only inches of sound!

When you talk by telephone, far or near, the actual sound travels much less than when you talk across the room!

That's because the telephone system carries not sound itself but an electrical facsimile of sound. When you speak into a telephone transmitter your voice is converted into electrical vibrations which are not changed back into sound until they reach the receiver diaphragm.

Conversion of sound into its electrical equivalent, through the invention of the telephone, opened the way to the measurement of sound by accurate electrical methods. In developing means to make the telephone talk farther and sound clearer, the scientists of Bell Telephone Laboratories had to develop the tools for sound-wave analysis and measurement.

The condenser microphone, the wave filter, the amplifier — each the product of telephone research — have helped to reveal the structure of sound as never before. Each has helped to build the world's finest telephone system.

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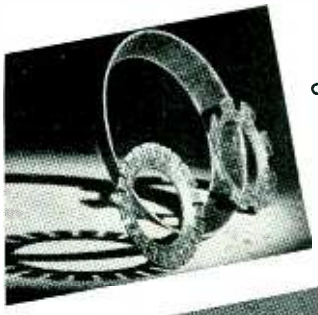

That is, all for the moment, but next week or next month we may receive blueprints and specifications calling for still another form — different in shape, thickness, flexibility, dielectric or other characteristics — to be added to the hundreds of processing operations which always start with Mica and end up with MACALLEN Mica — precisely made for customers' specifications, but to our own high quality standards. We have done so much with Mica, processed it in so many ways, and brought that processing to such standard forms and uniformity, that anything new seems almost inconceivable — nevertheless, our business is not static.

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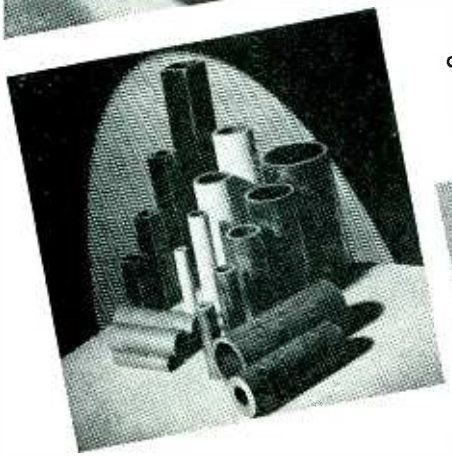

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types, the magnet is large to achieve a large radius of curvature but it is relatively easily aligned because the main field also focuses the electron beam. The ions are always in the magnetic field and so are not lost, and the gun potential does not affect the ion current.

Associated with the spectrometer proper is the electron gun to produce the ionizing beam, a high-voltage supply and an amplifier employing direct-current feedback, which is troublesome. A simpler amplifier and an ion source of higher yield and stability, in which changing voltages do not change the results, and an arrangement to stabilize voltages to keep the instrument on the peak collector current are needed. To increase the rate of taking data in industrial applications, an automatic voltage sweep should be incorporated to show the mass spectrum.

Protection from Radiation

By G. FAILLA

College of Physicians and Surgeons
Columbia University
New York, N. Y.

BIOLOGICAL CELLS show different degrees of tolerance to ionizing radiations. There is actually no such thing as a minimum dose that is ineffective, but in practice there seems to be a threshold. Cells show more recovery from small intermittent doses than from the same total continuous dose, but continuous small exposure can lead to permanent cellular damage. The present safe dose of a tenth a Roentgen a day (300 to 400 times that produced by cosmic rays at the surface of the earth) needs to be modified to provide a larger safety factor; three tenths a Roentgen per week is suggested. Additional specifications are being developed such as total body exposure, permissible emergency exposure that can be tolerated once in a lifetime by an individual and age limits for types of exposures.

Protection Instrumentation

By F. R. SHONKA

Argonne National Laboratory
Chicago, Ill.

THE ENERGY OF RADIATION is less interesting biologically than its ionizing effectiveness. Alpha part-

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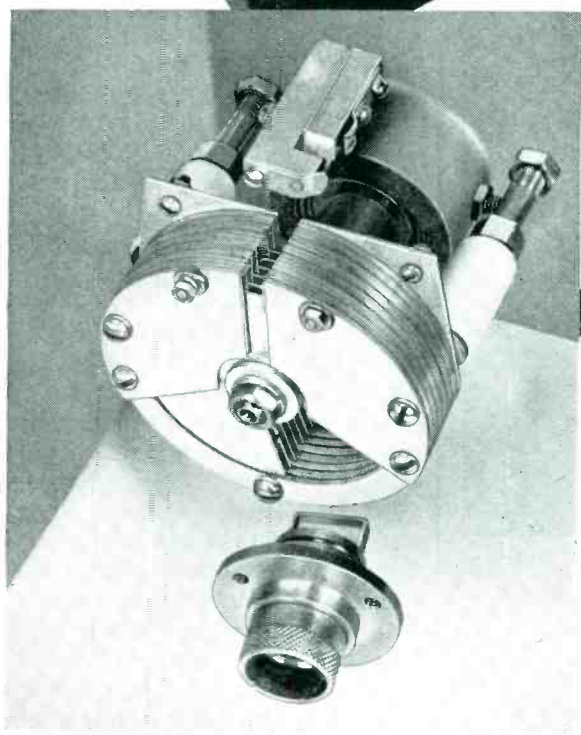
100 to 500 Mc OSCILLATOR

THIS oscillator, designed for use as a power source for general laboratory measurements and testing, covers the frequency range of 100 Mc to 500 Mc. With its associated power supply it is small, lightweight and compact. The entire range is covered with a single-dial frequency control with a slow-motion drive equipped with an auxiliary scale.



The tuned circuit of the Type 857-A Oscillator is our well-known Butterfly type. The difficulty of sliding contacts in any part of the oscillator circuit is avoided in this unique construction. The photograph above shows the output coupling loop and output jack. Coupling can be changed from maximum to almost zero by rotating the output jack.

FEATURES

- Dial calibrated directly in megacycles to an accuracy of ± 1%
- Vernier dial with 100 divisions, covering the oscillator range in ten turns
- Output through a coaxial jack with provision for varying coupling
- Output of ½-watt at 500 Mc
- Electron-ray tube in power supply to indicate grid current and furnish indication of oscillation
- Filament and plate power furnished by the Type 857-P1 Power Supply which is furnished with the oscillator

TYPE 857-A U-H-F OSCILLATOR (with power supply) . . **$285**

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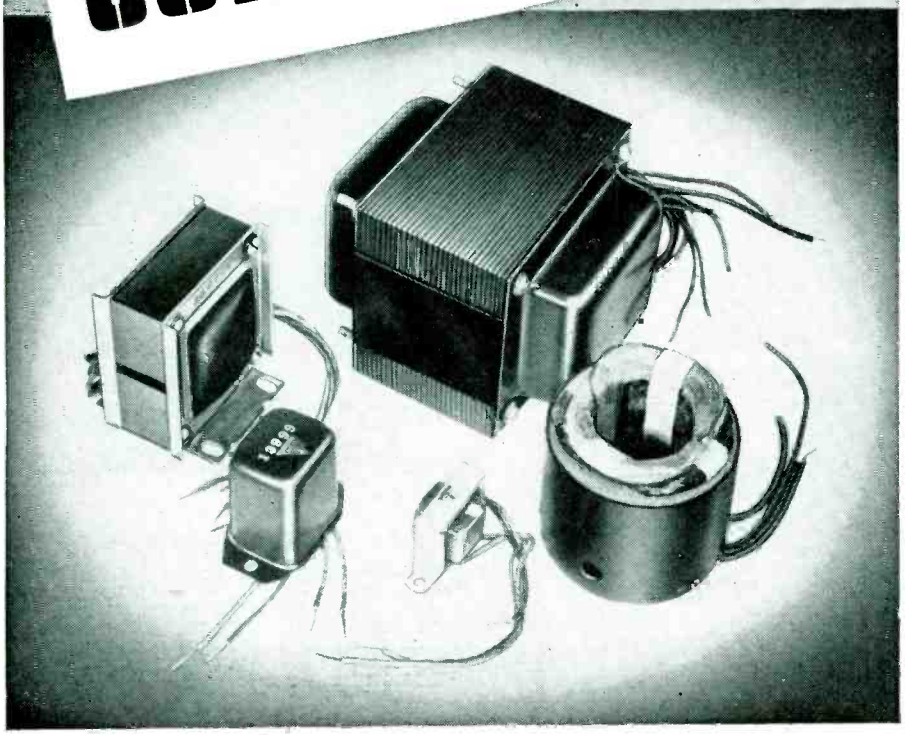

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icles produce about the same ionization at all energy levels; beta particles produce more ions at low velocities than at high; gamma rays, acting in various ways at different energy levels, have variable specific ionization densities; slow and fast neutrons act differently with different materials.

To measure slow beta particles in the presence of high-energy cosmic rays, use an ionization chamber; use G-M tubes to measure high-energy radiation with two differentially connected chambers to distinguish absorbed alpha particles from penetrating beta particles. Portable G-M detectors, although their output pulses are independent of the radiant energy, make sensitive survey instruments for monitoring laundry, hands and airborne dust. Gamma rays can be measured with ionization chambers or G-M tubes.

Nuclear Particle Detectors

Proportional Counters

By S. A. KORFF
New York University
New York, N. Y.

PROPORTIONAL COUNTERS are gas-filled diodes operated at a potential just below the point of positive corona. Ionizing radiation particles produce a local corona, which then extinguishes itself. The tubes are constructed with cylindrical symmetry for mechanical simplicity. Unfortunately however, this shape affords a wide difference in internal path lengths for the ionizing particles and hence produces a directional factor in the counter's sensitivity that needs to be taken into consideration or modified by external diaphragms.

The size of the voltage pulses produced by the counter in the presence of radiation is determined by (1) counter geometry, especially the diameter of the central wire (2 to 4 mils gives a tube of reasonable operating voltage) and (2) the gases in the counter, which can be anything, but those that form positive ions are preferred. Methane or borontrifluoride are used for neutron detection. The circuits associated with these counters are adapted to respond to pulses in the order of a tenth of a volt. The minimum energy particle to which a

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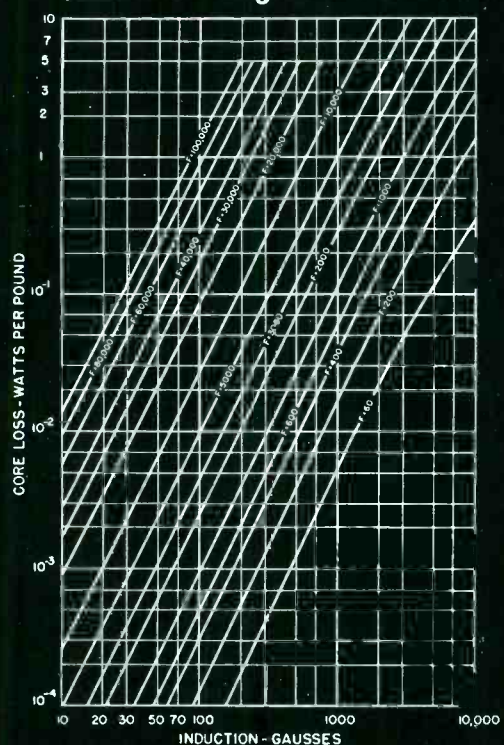
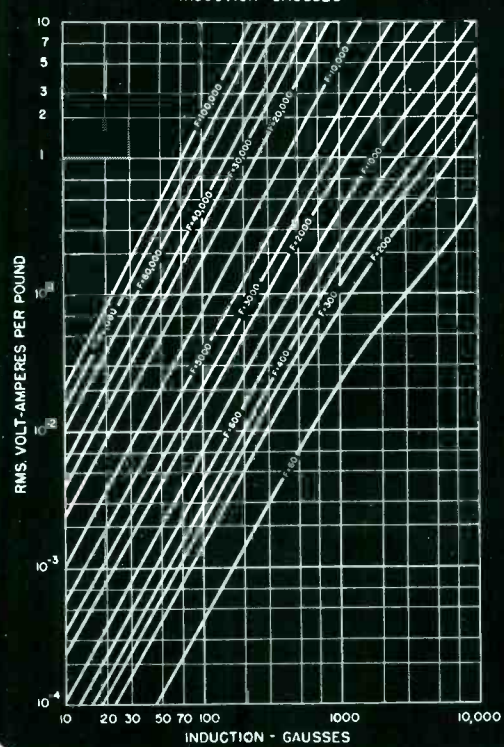
Tests at 100,000 cycles a second

Core loss and excitation characteristics of .002" high quality ARMCO Thin-Gage Electrical Steel.





show top magnetic properties of this .002" steel

Operating advantages of the newest grades of ARMCO Thin-Gage Electrical Steel for high frequency equipment are demonstrated by a series of tests made in Armco's Research Laboratories.

Magnetic characteristics of .002" steel have been accurately determined up to 100,000 cycles a second.

These tests reveal superior permeability from lowest to highest inductions; low core loss over a wide range of frequencies; and adequate insulation for even the highest volt-per-turn designs.

ARMCO Thin-Gage Electrical Steel is given a full-annealed treatment and insulated at the mill. No additional annealing is necessary except for relieving coiling strains after cores have been wound.

Whenever your applications involve changes in magnetic flux equivalent to frequencies from 400 to as high as 1,000,000 cycles a second, this steel has five definite advantages.

1. Supplied in coils 12⅜ inches wide for high-speed manufacturing operations.
2. Skin-effect is not appreciable at high frequencies.
3. Stacking factor is high (400 sheets of ARMCO .002-inch insulated steel make a stack only 1-inch high).
4. CARLITE Insulation on both sides assures minimum inter-lamination loss.
5. Hysteresis is exceptionally low.

Whether you are manufacturing high-frequency devices or your equipment is in the "idea stage," be sure to look into the advantages of ARMCO Thin-Gage Silicon Steel. Write for more information. Armco Steel Corporation, 30 Curtis Street, Middletown, Ohio.

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ARMCO THIN-GAGE ELECTRICAL STEELS

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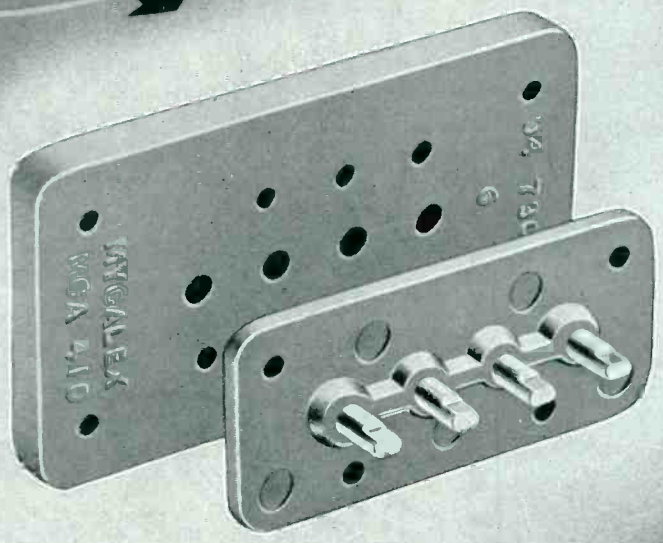
See why Leaders in TELEVISION choose MYCALEX 410 insulation



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Stability in a television circuit is an absolute essential. In the station selector switch used in receivers of a leading manufacturer, the MYCALEX 410 molded parts (shown here) are used instead of inferior insulation in order to avoid drift in the natural frequency of the tuned circuits. The extremely low losses of MYCALEX at television frequencies and the stability of its properties over extremes in temperature and humidity result in dependability of performance which would otherwise be unattainable.

Whether in television, FM or other high frequency circuits, the most difficult insulating problems are being solved by MYCALEX 410 molded insulation... exclusive formulation and product of MYCALEX CORPORATION OF AMERICA. Our engineering staff is at your service.

Specify MYCALEX 410 for:

1. *Low dielectric loss*
2. *High dielectric strength*
3. *High arc resistance*
4. *Stability over wide humidity and temperature changes*
5. *Resistance to high temperatures*
6. *Mechanical precision*
7. *Mechanical strength*
8. *Metal inserts molded in place*
9. *Minimum service expense*
10. *Cooperation of MYCALEX engineering staff*

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counter responds depends on the thinness of the entrance window.

The unique property of proportional counters is that they distinguish, by the amplitude of the output pulse, the nature of the ionizing particle. Alpha, beta and gamma rays produce progressively smaller pulses. One electron would produce a pulse of about 10^{-8} volt; there is sufficient gas amplification to raise this to 0.01 to 1.0 volt and, of course, each particle produces many ionizations within the tube. Proportional counters are faster than Geiger - Muller counters; pulses can actually overlap, but counters paralyze at high rates.

Neutron Detection

By B. T. FELD

Massachusetts Institute of Tech. Cambridge, Mass.

NEUTRON DETECTION depends on the kind (energy) of neutron that is to be detected. Neutrons are uncharged and hence cannot be observed directly by ionization techniques, but the ionizing secondary particles that they produce on penetrating atoms can be detected. There are two general categories of detectors using these secondary emissions: (1) instantaneous, in which the neutron produces a reaction the results of which are instantaneously observable, and (2) delayed, in which the reaction or its results are apparent only after an appreciable interval.

In the instantaneous methods, boron absorbs a neutron emitting an alpha particle within 10^{-18} to 10^{-20} second. This alpha particle can be detected by a proportional counter or an ionization chamber. A modification is to use an ionization chamber containing fissionable material to produce an ionizing particle within the chamber that will pulse it.

Delayed detection makes use of cloud chambers, photographic emulsions, or (n,γ) reactions. In cloud chambers, neutrons produce charged particles which in turn form condensation paths that can be observed or photographed. Similar events take place in photographic films. Some time after a neutron is absorbed by an atom, a disintegration may take place that can be detected. (Cont. on page 188)

Speaking of Percentages

THE MYCALEX CORPORATION OF AMERICA

sincerely believes that every user of insulation will be interested in the following progress report on Mycalex 410, molded — exclusive formulation of the Mycalex Corp. of America — for the four year period, 1945-1948:

- Average selling price of Mycalex 410 *reduced* by more than 50% over the past four year period.
- Raw material costs *increased* approximately 150%.
- Labor costs to make Mycalex 410 *increased* approximately 50%.
- Demand and production of Mycalex 410 *increased* approximately 500%.

The constantly increasing number of users of Mycalex 410 have benefited — with a better product — better service and deliveries — at a *lower cost*.

Research, plant expansion, improved engineering, additional new efficient manufacturing equipment — have permitted us to make available in increased quantities — — Mycalex 410 — molded — at prices comparable to other less efficient molded insulations.

MYCALEX 410 is now priced to meet rigid economy requirements

Send us your blue prints. We can handle the tough jobs as well as the less complicated ones. Any interest evidenced on your part in Mycalex products and services — will receive the prompt, courteous and intelligent attention of a competent Mycalex factory sales engineer. He will receive the fullest backing and cooperation from other factory executives — to serve you promptly — with a quality product and at an economical and fair price.

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Neutrons can be classified by their energy ranges.

TYPE NEUTRON	ENERGY RANGE
Thermal	Average energy, 0.025 ev (2,200 meters per second)
Resonance	From thermal to 1,000 ev
Intermediate	From 1 kev to 1 mev
Fast	From 1 mev to 20 mev
Ultrafast	From 20 mev on up

Thermal neutrons are detected using ionization chambers with uranium or boron. Foils are frequently used in (n,γ) reactions with G-M counters or electrometers. The cross section of thermal neutrons is quite large. Another method is to take advantage of the difference of absorption in cadmium of particles of different energies to separate thermal neutrons from the total neutron effect.

Intermediate neutrons can be detected by converting them into thermal neutrons in a paraffin sheath about a boron proportional counter. Fast neutrons produce fission in U-238, the threshold property of which can be used to distinguish energy levels. Although the probability of collision decreases with increasing energy, ultrafast neutrons can be detected by proton recoil or by induced fission in some elements, such as bismuth, that are lighter than uranium.

Ionization Chambers

By J. A. VICTOREEN

Victoreen Instrument Company
Cleveland, Ohio

THE GOLD-LEAF ELECTROSCOPE has evolved into the ionization chamber, in which an applied charge escapes due to ionization of the surrounding gas by the radiation to be measured. The unit of radiation, the Roentgen, is defined in terms of the charge produced by ionization in air, air having about the same mass and atomic number as the human body, in which early x-ray operators were interested. In constructing small chambers for wide energy ranges, care must be taken to avoid excessive effects due to the chamber walls. In any event, chambers should be calibrated against standard ionization chambers. The chamber must be large

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enough to absorb all the energy from short wavelengths and the walls thin enough to admit the long wavelengths.

Ionization Measurements

By E. W. MOLLOY

National Technical Laboratories
South Pasadena, Calif.

IN USING ionization chambers for measurement, the problem is to develop circuits, especially for health surveys, that respond to currents from 10^{-14} to 10^{-8} ampere, are light and sturdy, have long battery life and are easily operated and serviced. Basically what is needed is a direct-current amplifier with an input resistance of 10^{11} ohms, low grid current, 0.1-volt input, high insulation and sufficient gain so that a sturdy indicating instrument can be used.

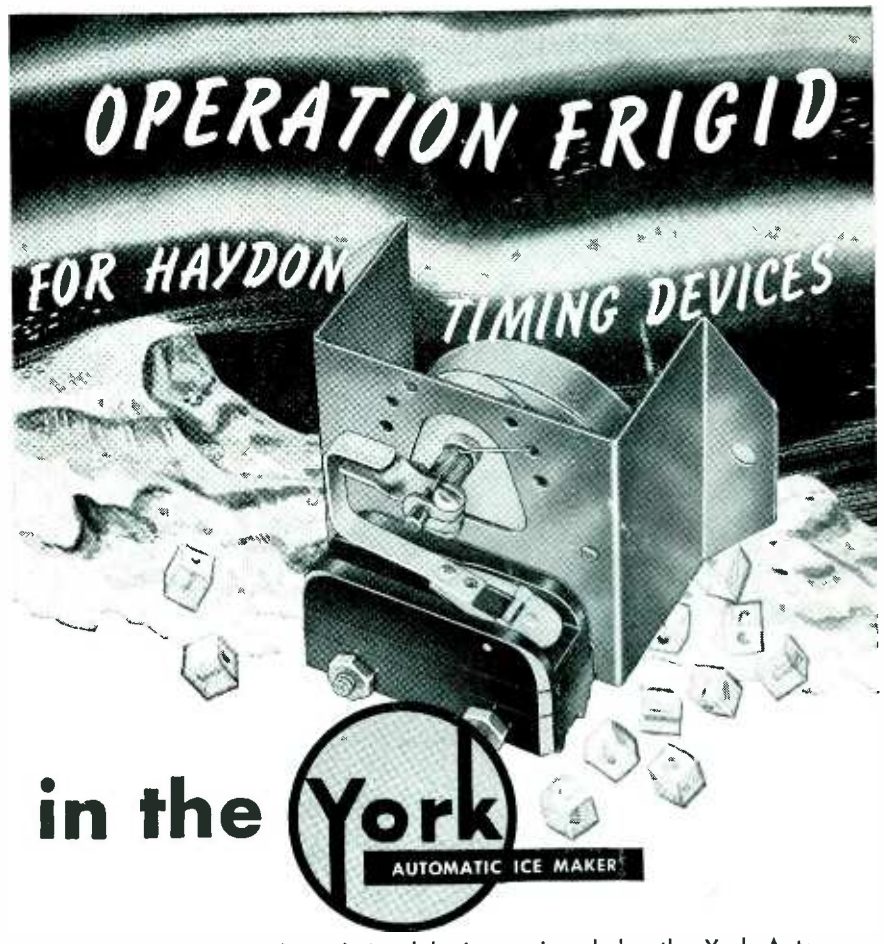
Modern circuit methods, using negative feedback, permit making the circuit response nearly independent of tube parameters. Two, or at most three, electrometer tubes can be built into portable equipment; the output tube is operated as a cathode follower making calibration practically independent of battery voltage over a wide range. One arrangement is to operate the first tube as a high-gain electrometer and to arrange the second tube to maintain the input grid at a constant voltage by feedback to decrease its time constant, reduce drift and increase linearity. Gain can be controlled by adjusting the amount of feedback. With a fully-pumped tetrode the required performance can be obtained by operating the coated cathode at 60 percent of its rated current, the grid just enough negative to avoid electron collection, the screen and plate at low voltages with currents in the microamperes and a plate resistor of 100 megohms; grid current is then 10^{-14} ampere and the gain is from 100 to 200. Silicon oils have made the necessarily high vacuum pumping for such tubes possible.

Stabilized Voltage Supplies

By W. A. HIGINBOTHAM

Brookhaven National Laboratory
Upton, Long Island, N. Y.

THE AVERAGE CURRENT required by counters and chambers is at most a



A Haydon timer, through its delaying action, helps the York Automatic Ice Maker turn out fresh, sparkling, crystal-clear cubes — even after periods of inoperation. This specially-designed timing device interrupts normal thermostatic action when the machine is turned on, after a period of inoperation — activates machinery which "harvests" old ice before a cycle is started to make perfect cubes. This delaying action not only produces better cubes — it insures against excessive freezing of partially completed ice — prevents consequent damage to the equipment. York ingenuity, plus Haydon timing development, has resulted in the production of this machine — a time and money saver wherever ice is used in large quantities, wherever business depends upon the constant production of ice to maintain customer satisfaction. This is but one instance in which Haydon timers are serving today. There are thousands of applications in which Haydon-engineered timers can help solve timing problems . . . in commerce, in industry, in science and in the home.

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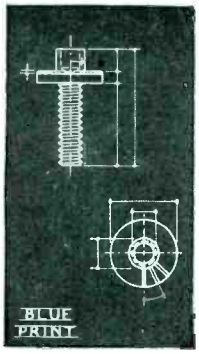

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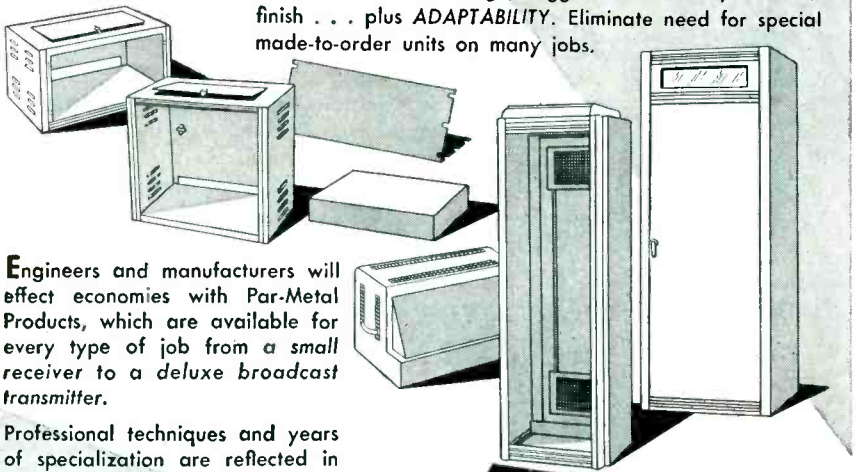

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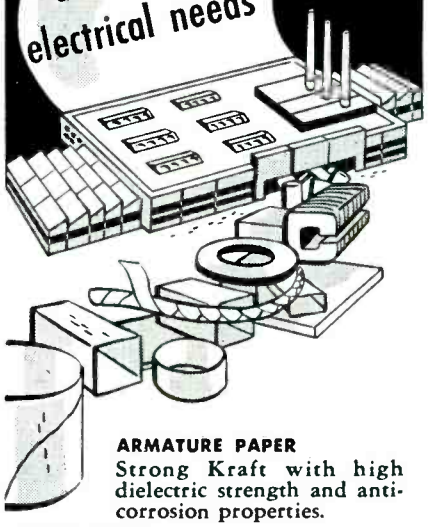

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milliampere including the bleeder current. Ionization chambers do not require stabilized supplies. Proportional counters need low noise supplies and voltage stability to 0.1 percent per hour. Geiger-Muller tubes are not critical as to voltage stability or noise. Photomultipliers, on the other hand, require highly regulated supplies. For laboratory and portable equipment, batteries are used, but they become noisy with age. A regulated supply costs about 5 cents per volt.

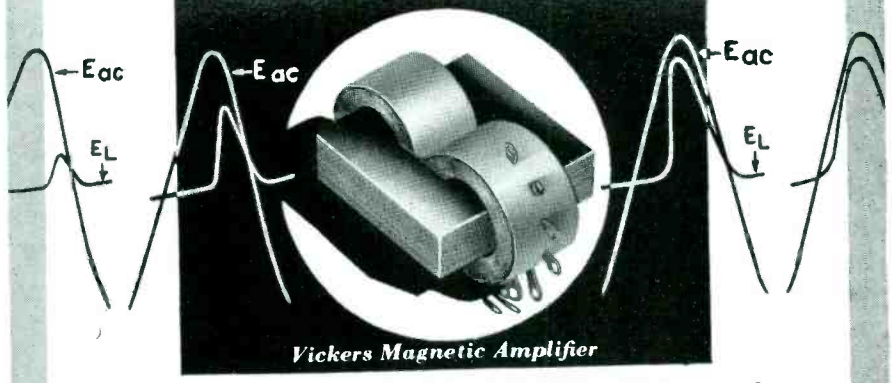
In supplies for power-line operation, the transformer is the weakest link, especially its insulation. Power lines give from 90 to 135 volts and have small static voltages. For rectification a tube or disc stack can be used; an R-C filter is sufficient for initial smoothing.

The most popular regulator is the degenerative type. The high-voltage resistors necessary in this circuit, if of the composition type, are not satisfactory at high power; use several radio resistors in series. Voltage regulator tubes are not accurate to the several tenths of a percent necessary in some applications. In addition, changes in contact potentials of the grids of the amplifier tubes in the regulator with changes in their heater currents limit the accuracy of regulation.

Chains of gas regulator tubes are used. The shunt regulator can be used. The mu-balance regulator requires rebalancing for new tubes; the mutual-conductance regulator has limited range. Radio-frequency supplies are light in weight and avoid noise from transformer and rectifier, but they have high internal impedance and so need protection from humidity—use a regulator in the d-c supply to the r-f oscillator. The pulse type supply has no particular advantage over the r-f type and is critical with regard to waveshape.

Usually the regulator is followed by additional filtering, but caution must be observed because some capacitors are noisy. In designing the supply, attention must be given (1) to the surge when the power is turned on (a slow-heating rectifier filament would be useful) and (2) to safety; 2 μf at 5,000 volts

NOTICE
OF IMPORTANCE TO THE ELECTRICAL INDUSTRY



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BO-2	P.P. Plates to Line	*Pri.—20,000 ohms CT *Sec.—600/150 ohms CT	+30 dbm	19.00
BO-3	P.P. Plates to Line	Pri.—5,000 ohms CT *Sec.—600/150 ohms CT	+40 dbm	17.00
‡BO-4	P.P. Plates to Line	Pri.—7,500 ohms CT *Sec.—600/150 ohms CT	+43 dbm	18.00
BO-5	P.P. Plates to Line	Pri.—10,000 ohms CT *Sec.—600/150 ohms CT; 16/8/4 ohms.	+37 dbm	24.00

‡Tertiary winding provides 15% inverse feedback. *Split and balanced windings.

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Cloud Chambers

By G. C. BALDWIN

General Electric Co.
Schenectady, N. Y.

BECAUSE CLOUD CHAMBERS give the spatial distribution of ions formed by a nuclear particle, they give more fundamental information than do other detectors. The ions formed in the chamber are, in effect, amplified by preferential moisture condensation on them. The density of the track indicates the nature and state of the particle.

The tracks formed in the gas of the chamber, which may be air, water vapor or alcohol, are photographed using zenon-filled flash lamps, an f2 lens and Super-X film through a mirror arrangement that gives a stereoscopic view. The negatives are then reprojected through a duplicate optical system to produce an image in space that can be located by properly tilting a ground glass to obtain the exact direction of the track. In this way precise determinations of momentums associated with a collision can be made. In evaluating the evidence from the chamber, (1) the intensity of the track indicates the number of ions produced, (2) its curvature in a magnetic field shows the ratio of charge to mass of the passing particle, and (3) the length of the track shows the total particle energy.

Electron Multipliers

By P. S. JOHNSON

Bureau of Ships, Navy Dept.
Washington, D. C.

BY PLACING A PHOSPHOR over the window of an electron multiplier phototube, a sensitive nuclear detector is obtained that holds interesting possibilities as a portable survey type instrument. Nuclear particles excite scintilations of light in the phosphor that are received and amplified by the phototube. The first consideration in making such counters is the phosphor. Many workers have contributed to this problem: naphthalene, due to Kallmann, and anthracene are the most important of the organic phosphors, the latter being the more sensitive (Bell at Oak Ridge has grown large crystals of

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it, which he polishes and coats with a reflecting backing to direct as much light as possible into the phototube, thus getting an additional improvement of two). Transtilbene is fast, phenanthrene is also used. Although inorganic phosphors such as calcium tungstate ($CaWO_4$), sodium iodide with thilium activation (NaI-Tl) and potassium iodide (KI-Tl) are slower than the organic ones, they are more durable. Silver activated zinc sulfide (ZnS-Ag), if thin, is useful for alpha detection; the problem with it is to incase phosphor and phototube in a light shield that does not absorb alpha rays.

The second consideration is the multiplier tube. The 1P21, which is the selected ten percent having low noise and stable sensitivity of the 931A production, is the most popular, but 931A and 1P28 types are also used. The amplifier into which the tube works is simple; it brings the level up to that required to operate a meter and discriminates against background. Using a coincidence technique with two tubes observing one phosphor, Morton at RCA gets 20 to 50 times the sensitivity of a G-M counter for alpha particles.

Crystal Counters

By ROBERT HOFSTADTER

Palmer Physical Laboratory
Princeton University
Princeton, N. J.

THERE ARE TWO TYPES of crystal counters, the scintilation type just described and which has developed in the last two years, and the conduction crystal counter that was invented in 1945 by Von Heerden. In the scintilation counter, an ionizing particle moves an electron into a conduction band in which it drifts about the crystal until it falls back giving forth a fluorescent quantum. Fortunately, sodium and potassium iodide are quite transparent to their own fluorescence. Various materials can be used; the problem now under investigation is to find sensitive and stable crystals.

The conduction-type crystal counter, in which diamond has been widely used, depends on the motion through the crystal of an electron released by an ionizing particle. Electrodes are placed on the crystal

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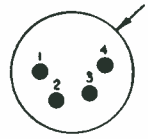
NEW 4-CONTACT INSERT NOW AVAILABLE IN THE TYPE "XL" SERIES



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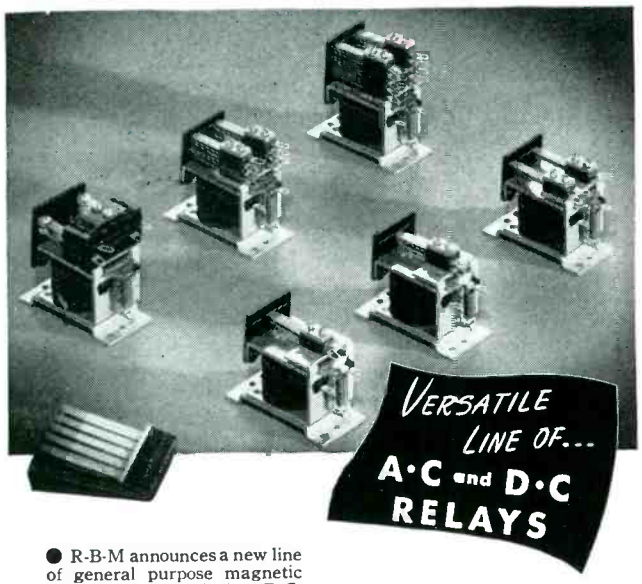

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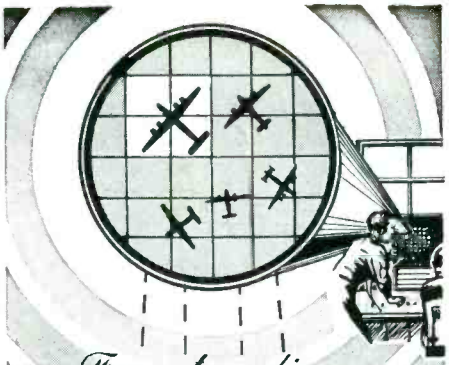

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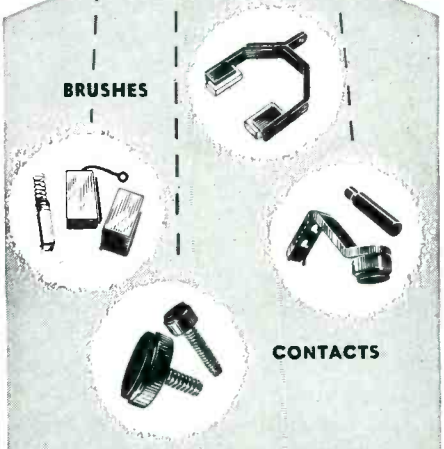

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by evaporation, sputtering or developing, and a high voltage applied across it. Released electrons then migrate across the crystal, producing pulses of current that can be amplified by electronic circuits. The pulse rise time from these crystal counters is in the order of microseconds, increasing with applied voltage and agreeing with the theoretically computed mobility in the case of pure crystals. In time the trapped immobile holes in the crystal produce a counteracting field that inhibits the action. The crystal can be rejuvenated by heating or, in the case of counting gamma particles, the applied field can be reversed. Growing the crystals is still difficult; test tubes of the molten material are slowly lowered through the freezing point in an oven, the tube broken and crystals cut from the rod.

Counting Techniques

By MATTHEW SANDS

Massachusetts Institute of Tech.
Cambridge, Mass.

A NUCLEAR ELECTRONIC DETECTOR feeds a pulse amplifier that drives electronic counters to form the basis of the counting technique. The fundamental problems in designing equipment for this technique are (1) to obtain the maximum information from each test and (2) to use inherently stable circuits. The data of interest to nuclear physicists include both the number of incident particles and their energies, thus the pulses should not only be counted but discriminated as to amplitude. Pulses between two amplitude limits can be selected by differential discriminators ahead of a counter. By arranging the equipment to catalog the pulses by amplitudes, much data can be obtained from each run.

Photographic Emulsions

By J. SPENCE

Research Laboratories
Eastman Kodak Co.
Rochester, N. Y.

ALL NUCLEAR DETECTORS use amplification of some form; in photographic phenomena the amplification is obtained by the catalytic development process. If absolute results are to be obtained, a control film should be used with each lot of test film. The requirements for

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For every requirement

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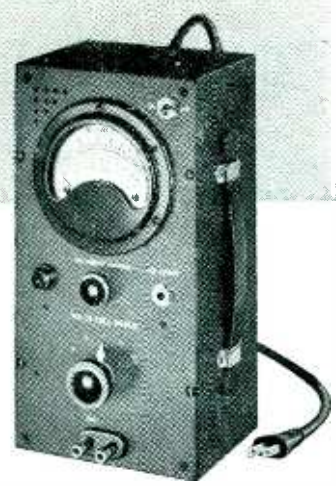

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FREQUENCY—30 c.p.s. to 5.5 megacycles
ACCURACY—0.5 DB.
AC OPERATION—110-120 volts.

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RANGE—.001 to 100 volts
FREQUENCY—5 to 150,000 cycles.
ACCURACY—2% at any point on scale.
DC OPERATION—self-contained batteries.

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Model 302
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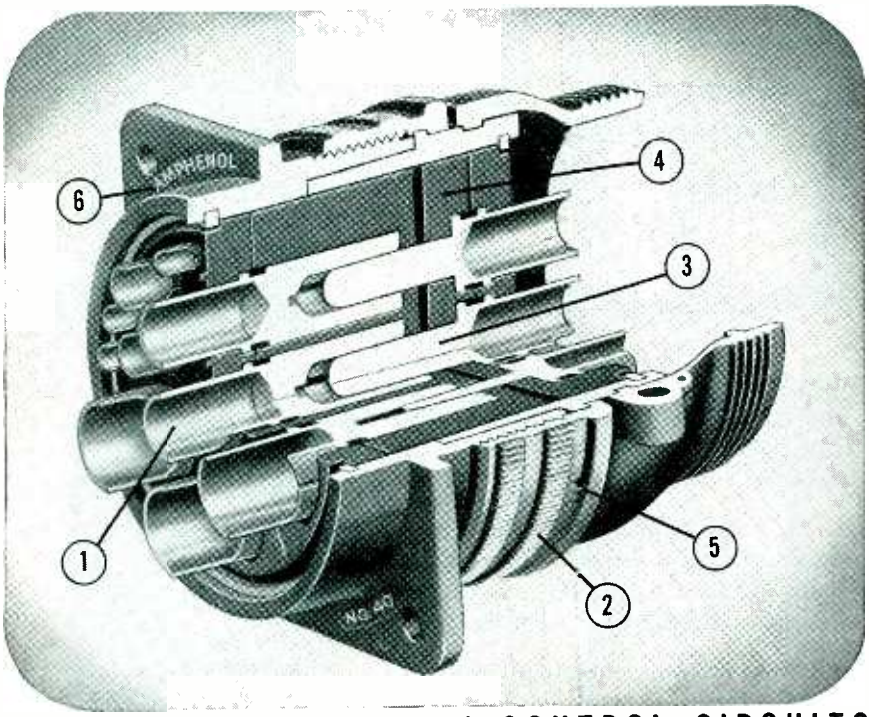

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72 PAGES OF "AN" CONNECTORS

This is a new catalog, just off the presses a few months; long enough, however, to receive the acclaims of top engineers as the most complete and informative on the subject of "AN" Connectors. We are glad to provide a copy for your reference, kindly make request on company letterhead to our Department 13E.

AMERICAN PHENOLIC CORPORATION
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nuclear emulsions are uniform grains and high sensitivity; silver halide concentration is made higher to obtain recognizable tracks. Heretofore, films for use in x-ray technology were the only large application. To provide films for the extended nuclear studies, further development is being carried on. A film so sensitive that the background cosmic rays would fog it in a week (before it could be shipped to the customer) has been made experimentally.

SURVEY OF NEW TECHNIQUES

VACUUM BRAZING is being applied to large components in a furnace used by the research division of Collins Radio Co. The furnace, constructed by National Research Corp., permits brazing on Resnatrons to be performed at less than a micron pressure so that there is virtually no oxidation.

UNATTENDED weather stations are being developed by the Signal Corps Engineering Labs at Fort Monmouth. Wind-driven generators will charge storage batteries, which may be buried 20 ft below the earth's surface to prevent freezing. The batteries will operate automatic radio stations which will transmit signals indicative of temperature, pressure, relative humidity, wind speed and direction, precipitation and sunshine intensity, thus providing year-round weather reports from nearly inaccessible parts of the world.

POSSIBILITY of finding a visible counterpart for audible music was discussed by R. K. Potter of Bell Labs at the Washington convention of the SMPE. He pointed out that loudness might be represented by apparent distance from the observer and frequency by position left or right. Such visible music should give the viewer the impression that he actually hears, not just sees an abstraction. For example, the pattern can be a series of equally spaced spikes each representing a particular frequency the whole giving the appearance somewhat of a wall of fire. (Might be an interesting adjunct to musical programs on television.)

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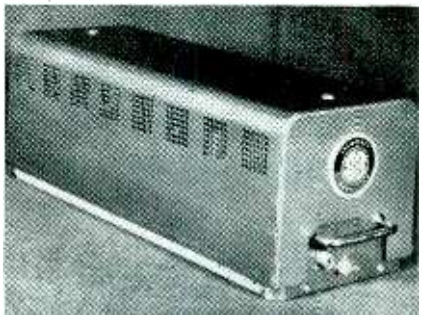


selectivity is 60 kc, 50 db down for an adjacent channel, and 120 kc, better than 85 db down for an alternate channel.

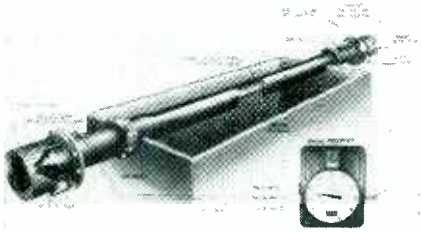
Voltage Multiplier

SYLVANIA ELECTRIC PRODUCTS INC., 500 Fifth Ave., New York 18, N. Y., has announced the Polymeter d-c voltage multiplier, which

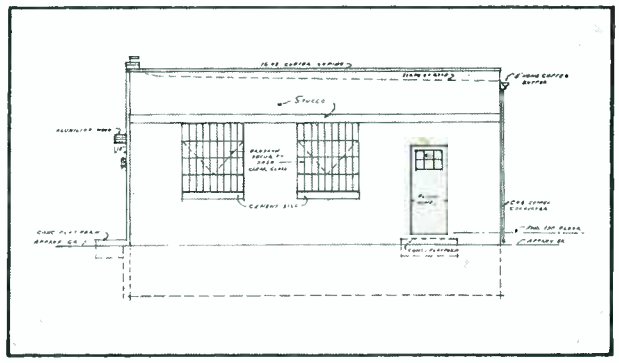
extends d-c voltage measurements to 10,000 volts. The unit consists of a 48-in. plug-in flexible lead tested for 22,000-volt breakdown, nickel-plated brass contact pin, removable bakelite safety flange and a varnished bakelite handle 4¼ inches long.

Smoke Density Recorder

BAILEY METER CO., 1050 Ivanhoe Road, Cleveland 10, Ohio. A new smoke density recorder comprises a sealed-beam light source, bolometer smoke detector, and electronic recorder. Voltage across the bolo-



with CONCRETE
— the small extra first cost of test samples pays off in assurance of efficiency and durability of the finished structure.



with TRACING CLOTH . . .

The small extra first cost of Arkwright Tracing Cloth, over that of tracing paper, repays many times over in the efficiency and durability of valuable drawings.

Arkwright gives both immediate *and* future advantages. The expert work of the draftsman is made permanent. Your investment in time and money is backed by sharp, clean reproductive quality. Under repeated use — or on file for subsequent need — Arkwright assures perfect drawing performance year after year.

For every drawing worth keeping for future use — use permanent Arkwright instead of perishable tracing paper. Send now for generous samples and prove this superiority. Sold by leading drawing material dealers everywhere. Arkwright Finishing Company, Providence, R. I.

The Big Six Reasons Why Arkwright Tracing Cloths Excel

1. Erasures re-ink without feathering.
2. Prints are always sharp and clean.
3. Tracings never discolor or go brittle.
4. No surface oils, soaps or waxes to dry out.
5. No pinholes or thick threads.
6. Mechanical processing creates permanent transparency.

ARKWRIGHT
TRACING CLOTHS
AMERICA'S STANDARD FOR OVER 25 YEARS

www.americanradiohistory.com

PRECISION POTENTIOMETERS

Toroidal and Sinusoïdal

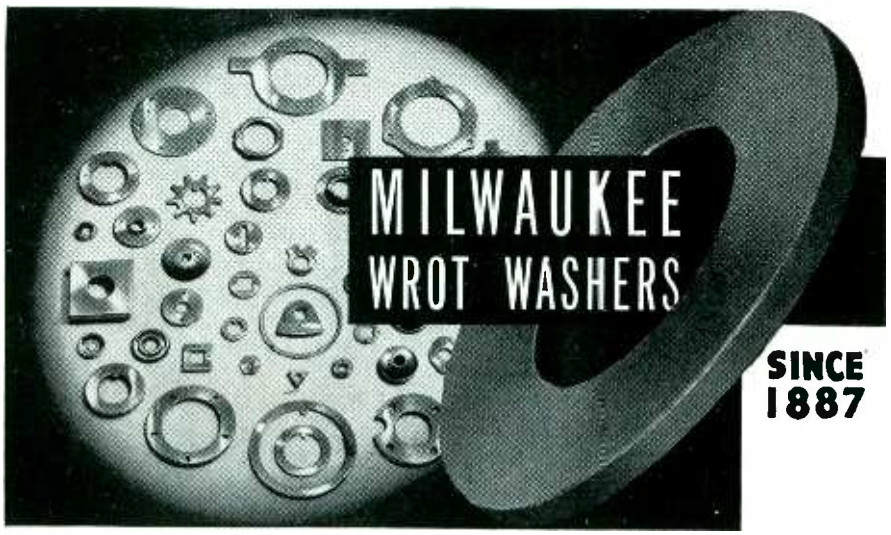
For use in computing and analyzing devices; generation of low frequency saw tooth and sine waves; controls for radio and radar equipment; position indicators; servomechanisms; electro medical instruments, measuring devices—telemetering; gun fire control where 360° rotation, high precision and low noise levels are essential.

The type RL14MS sinusoidal potentiometer is illustrated. It is wound to a total resistance of 35,400 ohms and provides two voltages proportional to the sine and cosine of the shaft angle. It will generate a sine wave true within ±.6%. Overall dimensions are 4⅜" diameter x 4 11/32 long plus shaft extension ¼" diameter x 1¼" long.

Write for Bulletin F-68

THE GAMEWELL COMPANY

Newton Upper Falls 64, Massachusetts



The SYMBOL of QUALITY for 62 YEARS

WASHERS . . . Standard and Special, Every Type, Material, Purpose, Finish . . . STAMPINGS of every Description . . . Blanking, Forming, Drawing, Extruding.

Your most dependable source of supply — the world's largest manufacturer of Washers, serving Industry since 1887. Over 22,000 sets of Dies.

Submit your blueprints and quantity requirements for estimates.

WROUGHT WASHER MANUFACTURING CO.

The World's Largest Producer of Washers

2118 S. BAY ST., MILWAUKEE 7, WIS.

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 samplec 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.

www.americanradiohistory.com

meter filament is balanced against the voltage drop across a motor-driven slidewire unit in the recorder. Changes in filament temperature cause potentiometer unbalance. The recording pen is positioned by the unbalance.

Small Battery Tester

SIMPSON ELECTRIC CO., Chicago, Ill. Model 379 pocket-size dry-battery tester has a single rotary switch

which selects the voltage of the battery under test and brings into line the correct loading resistor. A percentage scale shows the exact condition of the battery in percentage of full voltage. All types of batteries can be tested with the unit.

Burglar Alarms

RIPLEY CO., INC., Middletown, Conn. A new low-cost photoelectric burglar alarm uses a modulated light

NEW LOW PRICES

TRANSCRIPTION TURNTABLE. By unbiased tests—delivers the highest signal-to-noise, lowest rumble and flutter content, and also offers a *synchronous direct gear drive!* Unexcelled for dubbing from disk to disk or film; where seconds count for FM and AM recorded broadcasts; or for laboratory uses where extraneous noise and distortion cannot be tolerated. The Fairchild positive direct-from-the-center turntable drive provides quick start, high torque, instant speed change to 78 or 33.3 rpm. NEWS! Fairchild Transcription Turntables are available for immediate delivery—**at the new low price of $485.**

UNIVERSAL 6-POSITION EQUALIZER makes it unnecessary to use a separate equalizer for each pickup. You can now experiment with various pickup cartridges while using this one equalizer. Both lateral and vertical transcription arms can be connected and selected without switching—by simply using the proper setting of the 6-position control knob. The Fairchild Preamplifier-Equalizer mounts in place of your present equalizer; prevents obsolescence; saves the cost of additional equalizers; frees one preamplifier; provides for cuing and monitoring; eliminates low level hum problems; and is an investment in economy. Write for complete details.

***MICRO-GROOVE* FOR RECORDING STUDIOS**

STUDIO RECORDER is receiving high praise from recording engineers since they discovered its excellent Micro-Groove recording performance. Its pitch being continuously variable from 80 to over 500 lines-per-inch, it not only records readily at Micro-Groove pitch but provides for momentary decrease of pitch for indicating the end of one selection and the start of another.

Radio stations, using the new Fairchild Transcription Arm for Micro-Groove reproduction, are experiencing the full advantages of the improved quality, especially at inner disk diameters, as well as the long playing time of these new LP records. Write for complete details.

IT'S A FACT: Fairchild Recording Equipment Corporation has been newly formed to specialize—*as its name implies*—in sound recording equipment. All Fairchild Camera and Instrument Corporation sound equipment—*including Portable Disk Recorders and Unitized Amplifier Systems*—are available for immediate delivery at new low prices. Write for complete details: 88-06 Van Wyck Boulevard, Jamaica 1, N. Y.

Fairchild RECORDING EQUIPMENT CORPORATION

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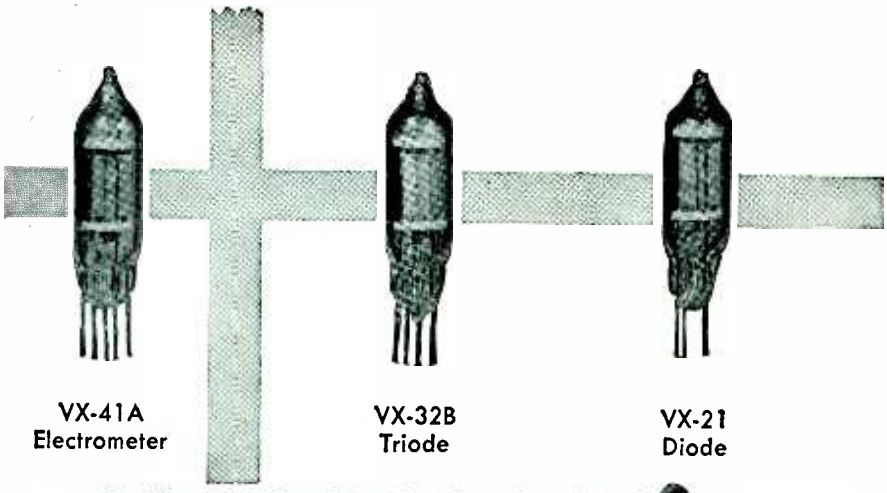
Components which are contributing an essential service in the progress of radiation instrumentation.

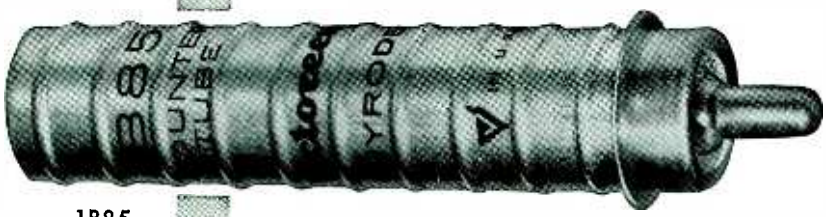
10 mil-filament subminiature tubes



VX-41A Electrometer

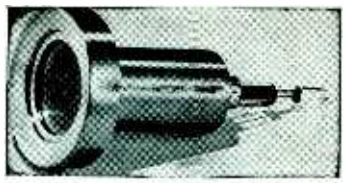
VX-32B Triode

VX-21 Diode



1B85

The new 1B85 Thyrode is a thin rib re-enforced aluminum self-quenched, beta-gamma counter tube operating at 900 volts. Wall thickness 30 mg/sq. cm.



1B67/VG-10A

RMA TYPE 1B67 has been assigned to the standard laboratory mica window self-quenched, beta thyrode which operates at 1200 volts. Window thickness 2.0 to 2.6 mg/sq. cm. Other thicknesses on request.

1B87

The new 1B87 sub-miniature Thyrode is designed to operate at 900 volts with a plateau greater than 100 volts and a nominal background counting rate of 12 counts per minute.

Hi-Meg

Hi-Meg resistors

Hi-meg resistors vacuum sealed, from 10^8 ohms to 10^{13} ohms measured to within 1% accuracy are a symbol of reliability in all ion chamber radiation measuring instrument and electrometer circuits.

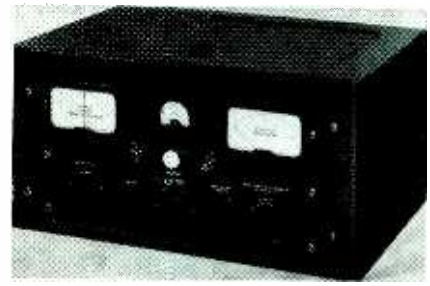
Victoreen

5806 HOUGH AVENUE CLEVELAND 3, OHIO

beam so that it is independent of ambient light. Range of the unit is 250 feet so that the illumination can be reflected from several points to form a crisscrossed protective area.

F-M Monitor

WEST COAST ELECTRONICS CO., 1601 South Burlington Ave., Los Angeles 6, Calif. An f-m modulation monitor designed for use in the



emergency service field has a sensitivity of 200 microvolts or better and can be used for any one of four channels in the band from 30 to 200 mc. Peak deviations of 20 kc can be monitored.

Writing Oscillograph

ELECTROFAX CORP., 30 Burtis Ave., New Canaan, Conn. The direct writing oscillograph illustrated has a frequency response linear to 50 cycles at 30 mm amplitude. Tape

speeds from 1 to 100 mm per second can be attained. A standard amplifier and a larger galvanometer can be supplied.

Pickups

ASTATIC CORP., Conneaut, Ohio. Type FLT-33 crystal transcription pickup illustrated is one of a complete new line of seventeen different models. Crystal and magnetic types, cartridges with diamond,

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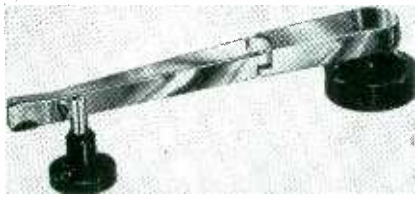
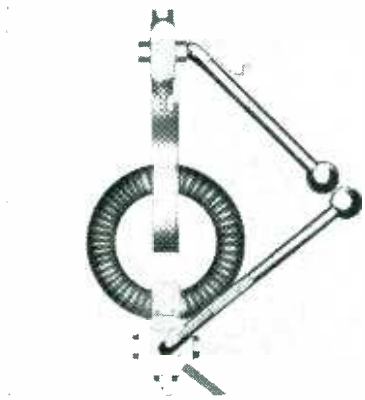


sapphire or precious metal needles are available. Standard or long-playing recordings can be used with the broadcast type shown which has a needle pressure of 5 grams.

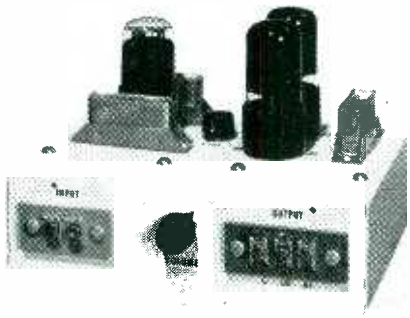
Isolation Transformer

ANDREW CORP., 363 E. 75th St., Chicago 19, Ill. The Isoformer is an air insulated transformer for supplying 60-cycle lighting voltages to tower lighting circuits without providing an r-f path to ground. It is available in two models: type 2015 for maximum lighting loads of 1.5 kw, and type 2030 for maximum loads of 3 kw.



Cueing Amplifier

FAIRCHILD RECORDING EQUIPMENT CORP., 88-06 Van Wyck Blvd., Jamaica 1, N. Y., has made available a cueing amplifier for transcription turntables. Using push-pull stages and inverse feedback,



RCA 715-B OSCILLOSCOPE

In a class by itself...

Featuring—

- ✓ *Extended frequency range*
- ✓ *Time-interval marker*
- ✓ *Triggered sweep*

● Designed for those who need the best . . . the RCA 715-B Oscilloscope permits precise examination of extremely short, sharp-fronted pulses and other unusual waveforms . . . as well as the observation and measurement of either recurrent or transient phenomena such as occur in television transmitters and receivers, radar apparatus, computing equipment, and other pulse-producing devices. The 715-B produces steady, clear traces even with random recurrence of signal.

This oscilloscope features extended frequency range, high vertical deflection sensitivity, triggered sweep, internal time-interval marker, and input calibration meter. It's mounted on easy-rolling castors for convenient movement from one location to another.

Ask your local RCA Test and Measuring Equipment Distributor for descriptive bulletin, or write RCA, Commercial Engineering, Section 42BY, Harrison, N. J.

SPECIFICATIONS OF 715-B

Frequency Range:
Vert. Amplifier . . . . Flat ± 1 db; 5 cycles to 11 Mc.
Horiz. Amplifier . . Flat ± 2 db; 3 cycles to 500 kc.
Deflection Sensitivity: (For 1600 volts at second anode)
Vert. Amplifier . . . . . 0.17 peak-to-peak volts/in.
Ext. Horizontal Input . . 0.85 peak-to-peak volts/in.
Sawtooth Time Base . . . . . 5 cycles to 100 kc.
Triggered Time Base . . . . . Repetition rate up to 10 kc.
Blanking . . Return trace blanked on triggered time base
Power Supply . . . . . 110/220 volts, 50/60 cycles
Power Consumption . . . . . 500 watts
Dimensions . . . . . w. 21"; h. 49½"; d. 26½"
Weight . . . . . 350 lbs.
Price—$2,400.00 F.O.B. Camden, N. J.

Available from your RCA Test and Measuring Equipment Distributor

RCA **RADIO CORPORATION of AMERICA**
TEST AND MEASURING EQUIPMENT *HARRISON, N. J.*

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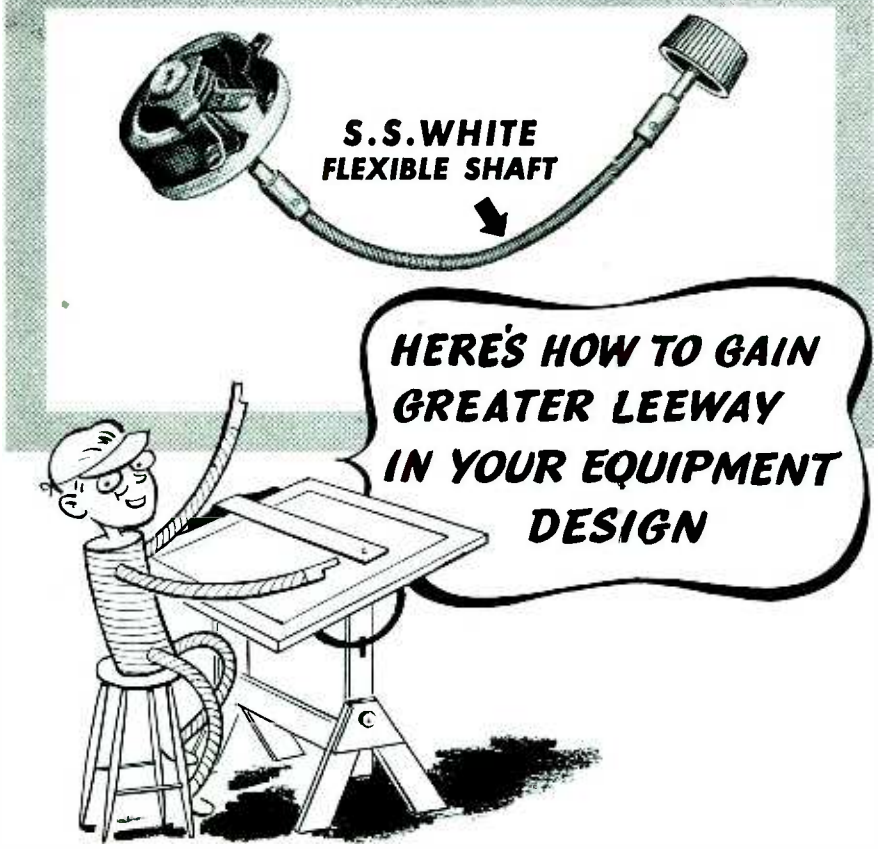
DESIGN TIPS FROM CHIEF ENGINEER FLEXY



"Study that illustration a minute. It won't take you long to see the many design possibilities you gain by using S.S.White remote control flexible shafts to connect variable elements to their controls.

"For instance, the *flexible* shaft coupling gives you a free hand in locating the elements independently of their controls. This is mighty important when it comes to meeting space, wiring and servicing requirements or when you're working for top circuit efficiency.

"As for the control knobs . . . you get the same freedom in positioning *them*. This means that you remove many limitations on your cabinet designs and can provide more convenient tuning.

"So, when your circuit design includes variable elements, think of S.S.White flexible shafts. This is a tip many designers of electronic equipment have used to good advantage."

WRITE FOR THIS FLEXIBLE SHAFT HANDBOOK

It contains 260 pages of facts and technical data on flexible shafts and how to select and apply them. Write for a copy.

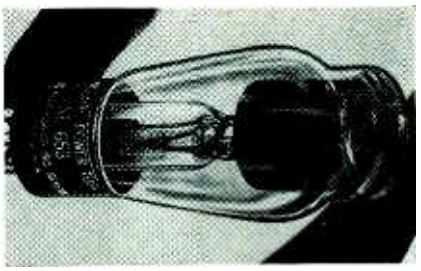
S.S.White MAKES IT RIGHT

S.S.WHITE INDUSTRIAL DIVISION
THE S. S. WHITE DENTAL MFG. CO. DEPT. E 10 EAST 40th ST., NEW YORK 16, N. Y.
FLEXIBLE SHAFTS AND ACCESSORIES
MOLDED PLASTICS PRODUCTS—MOLDED RESISTORS
One of America's AAAA Industrial Enterprises

the 635-A2 amplifier has a frequency response of 70 to 15,000 cps ± 1½ db. It provides 3 watts of audio output, and transformer input is 10,000 ohms.

Industrial Rectifier

NATIONAL ELECTRONICS, INC., Batavia Ave., Geneva, Ill. Type NL-653 mercury vapor tube has a



900-volt peak inverse voltage rating. Peak current is limited to 12 amp d-c with average 3 amp maximum.

Meter and Tube Tester

TRIPLETT ELECTRICAL INSTRUMENT Co., Bluffton, Ohio. Model 3480 combination tester for tubes as well as voltage, current, and resistance

tests measures voltage up to 1,200 volts; current up to 120 ma or 12 amps and resistance up to 50 megohms. The equipment operates from 115 volts.

H-V Measurements

RICHARD MATTISON Co., 114 East Sixteenth St., New York 3, N. Y. A high-voltage tester for television work operates with all vtvm's having input impedances of 10 megohms and is a multiplier that will

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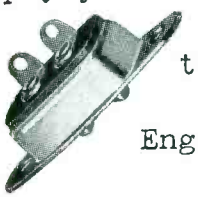
If you need Radio Parts...

in quantities suitable to Volume Production...it may pay you to call upon



the Design Engineers of United-Carr and its subsidiaries. They have helped many manufacturers

★ CUT COSTS

★ SPEED PRODUCTION

★ TURN OUT FINER FINISHED PRODUCTS

UNITED-CARR FASTENER Corp.

CAMBRIDGE 42, MASSACHUSETTS

MAKERS OF DOT FASTENERS

DESIGNED FOR DISCRIMINATING MANUFACTURERS

QUALITY

UNIFORMITY

SERVICE

Also manufacturers of high grade cotton and silk covered wires, cotton and silk coverings over enamel coated wires, and all constructions of Litz wires. A variety of coverings made to customers' specifications, or to requirements determined by our engineers. Complete design and engineering facilities are at your disposal; details and quotations on request.

Leakproof

ENAMELED MAGNET WIRE

A product, resulting from many years of research in the field of fine wire manufacture, that meets the most rigid requirements of radio and ignition coils.

A new coating method gives a smooth, permanently - adherent enameling, and mercury-process tests guarantee perfect uniformity. Great flexibility and tensile strength assure perfect laying, even at high winding speeds. If you want reduction in coil dimensions without sacrificing electrical values, or seek a uniform, leakproof wire that will deliver extra years of service, this Hudson Wire product is the answer.

Winsted

HUDSON WIRE CO.

Division

WINSTED • CONNECTICUT

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 PEL-X.

HOLLISTON **PEL-X** TRACING CLOTH

You will never appreciate the superior qualities of PEL-X Tracing Cloth until you try it. Suppose six draftsmen at lunch told you why they preferred PEL-X. There might be six different reasons — all good.

What is your next step? Chances are you will first test PEL-X — give it a stiff workout using your pet testing technique. That suits us. We make it easy for you — just write for a generous sample.

Test PEL-X for speed with pencil, minute perfection of weave, uniform transparency, durability under repeated erasures, high resistance to moisture and perspiration — and other special qualities. Write for generous sample.

THE HOLLISTON MILLS, INC.

CHICAGO NORWOOD, MASS. NEW YORK

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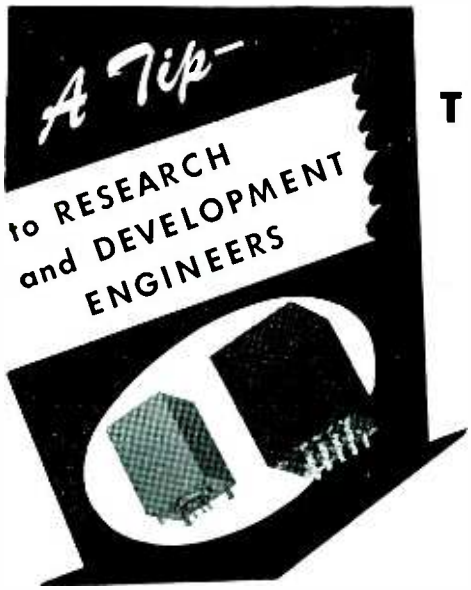
For Unusual and Difficult Requirements



USE **ADC** TRANSFORMERS

- Research
- Models
- Testing

STEEL When a steel company engineer was presented with a problem of testing steel with an application of variable frequency, an oscillator output impedance as low as 0.01 ohms was required over a wide Frequency range.

Through the aid of **ADC** engineers and the use of special **ADC** designed transformers a regular oscillator was equipped to perform the test satisfactorily with great savings in time and money to the steel company. Remember **ADC** as a transformer source for unusual and difficult assignments as well as for high quality and dependable production transformers.

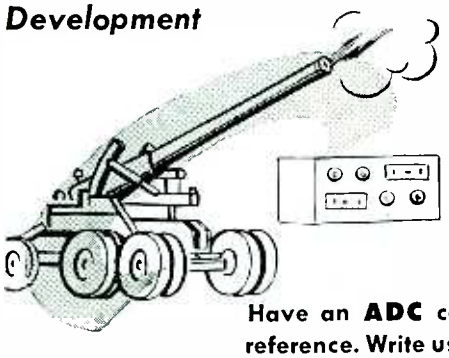
Research

COMMUNICATIONS Today a large utility company has a satisfactory communication system between its central location and its mobile units because **ADC** engineers worked out technical transformer applications for the maker of a power line carrier telephone. From model stage to production this company depended upon the skill of **ADC** transformer design and production. You, too, will find **ADC** helpful in all unusual model work as well as production.

Models

ENGINEERING The development of a computer to check the muzzle velocity of a cannon with greater accuracy required many special transformer applications. This job is typical of scores of development tasks presented to **ADC** engineers from university laboratories, communication developments, guided missile programs and developmental engineers everywhere. **ADC** supplies transformer "know how" with excellent transformer production to assure you a reliable source of dependable transformers.

Development



Have an **ADC** catalog in your file for ready reference. Write us about your special problems.

Foreign Inquiries Solicited. Cable address: **AUDEVCO MINNEAPOLIS**

ADC *Audio* **DEVELOPMENT CO.**
"Audio Develops the Finest"
2833 13th AVE. SOUTH · MINNEAPOLIS 7, MINN.

extend the range of existing instruments by 10. It can also be used with a microammeter by calibrating the scale in kilovolts.

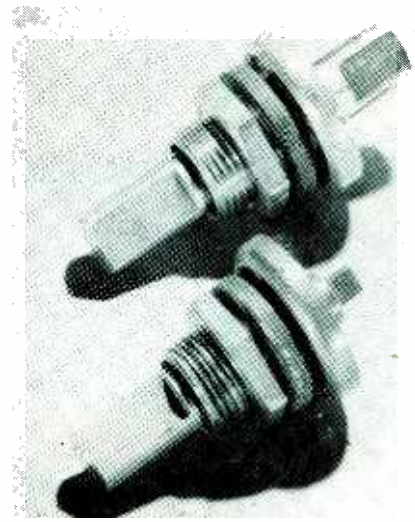
Sealer

SPECTRUM MFG. CO., 540 North 63rd St., Philadelphia 31, Pa. A new electronic sealing machine is

designed to seal documents, cards, or photographs into cellulose acetate envelopes. The edge weld is about 1/16 inch wide.

Rotary-Shaft Seals

H. & H. BUGGIE AND CO., Madison Ave. and Twenty-second Streets, Toledo, Ohio. Series 1100 rotary shaft seals have been designed for



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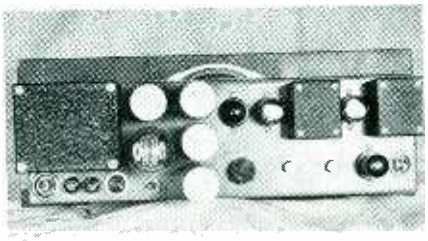
electrical and radio equipment with variable controls and from which moisture must be excluded. Four sizes are obtainable. Engineering data are available.

Special Amplifier

SCHUTTIG AND CO., Ninth and Kearny Sts., N. E., Washington 17, D. C. Type S174A adjustable threshold power amplifier can be used for straight amplification or



as a noise-suppressing type. A gain of 30 db is provided with power output of 3 watts. Threshold can be adjusted to any level within the range of minus 20 to plus 10 db.

Improved Marker

KAY ELECTRIC CO., Pine Brook, N. J. A new model of the Mega Marker has a wider frequency range, from 29 to 39 mc, but is

otherwise identical with the standard model which includes a marker at 4.5 mc for adjustment of television sound discriminators.

Radioactivity Demonstrator

TRACERLAB INC., 55 Oliver St., Boston 10, Mass., has developed the SU-4 radioactivity demonstrator for teaching basic principles in schools and colleges. Radiation is indicated by loudspeaker, by a flashing neon light and quantita-

New Headset from TELEX . . .

NO PRESSURE ON THE EARS

Here's a really new headset: TELEX TWINSET! Sweaty, tiresome "ear-cups" are gone forever! Signal may be piped directly *into* the ear so that *nothing touches the ear* at all! Matched in-phase magnetic receivers banish listening fatigue—listen for hours in complete comfort with this high-fidelity, 1.6 ounce headset.

An all purpose headset, the unique TELEX TWINSET, is designed for your hearing comfort and exacting headset demands. Obtainable from your favorite parts jobber, or, write Dept. 10, Telex Inc., Telex Park, Minneapolis, Minnesota.

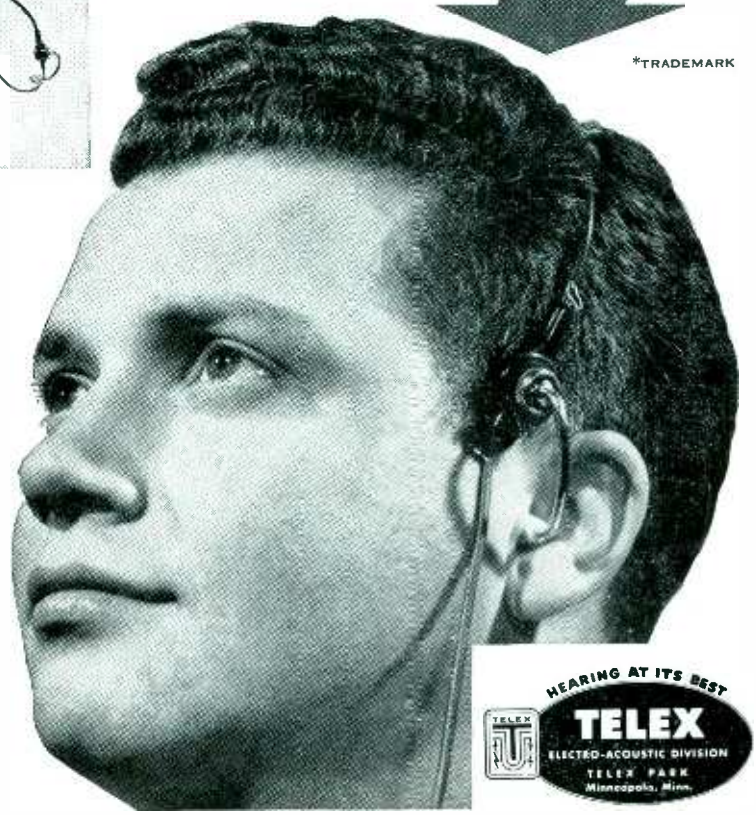
SPECIFICATIONS:

Sensitivity—101 decibels above .000204 dynes per sq. cm. for 10 microwatts input
Impedances—1000 ohms and 64 ohms
Construction—Weight: 1.6 oz. Tenite plastic and bright nickel construction, with headband of Z-Nickel steel wire encased in plastic. Single 5-foot cord plugs into either receiver. Sealed, rustproof diaphragms.

Special Cord with built in miniature Volume Contr l also available

NEW TELEX TWINSET*

*TRADEMARK



HEARING AT ITS BEST
TELEX
ELECTRO-ACOUSTIC DIVISION
TELEX PARK
Minneapolis, Minn.

TELEX, Telex Park, Minneapolis, Minnesota
Manufacturers of Telex Monoset* • Telex Pillow Speaker • Telex Precision Hearing Aids

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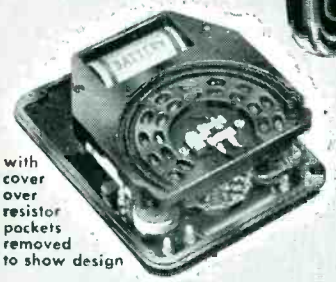
No value equal to it...

Model 260 Volt-Ohm-Milliammeter

There's good reason why this is the world's most popular high sensitivity volt-ohm-milliammeter. In every part, from smallest component to overall design, no competing instrument can show superiority. It outsells because it outranks every similar instrument. And in the Simpson patented Roll Top safety case, shown here, it brings you important and exclusive protection and convenience.

. . . in staying accuracy
. . . in functional design
. . . in useful ranges
. . . in sensitivity
. . . in ruggedness
. . . in precision

Sub-Panel Assembly —Strong, Simple, Accessible



with cover over resistor pockets removed to show design

The ruggedness, the simplicity of design, and the consequent accessibility of components are shown here. Molded of sturdiest bakelite, the sub-panel provides separate pockets for resistors. This separation makes for orderly assembly, highest possible accessibility, and added insulation for preventing shorts. All connections are short and direct. Cable wiring is eliminated. Each battery has its own compartment, again increasing accessibility.

High voltage probe (25,000 volts) for TV, radar, x-ray and other high voltage tests, also available.

The New Simpson Switch Mechanism. You will find no other switch mechanism on the market like this Simpson switch. It is built of molded bakelite discs. Unusually sturdy contacts, of heavy stamped brass, silver-plated for superior conductivity are molded permanently into each disc. They can never come loose, never get out of position. When the discs are assembled into the complete switch, these contacts are self-enclosed against dust. Danger of shorts is automatically eliminated. As the switch is rotated from range to range, the contact is always positive and unvarying.

A ball-and-spring mechanism positions the switch at the selected range by a 3-point pressure. Switch is thus held securely in place, yet smoothly re-positions to each new range. This mechanism is also self-enclosed against dust in a bakelite housing.

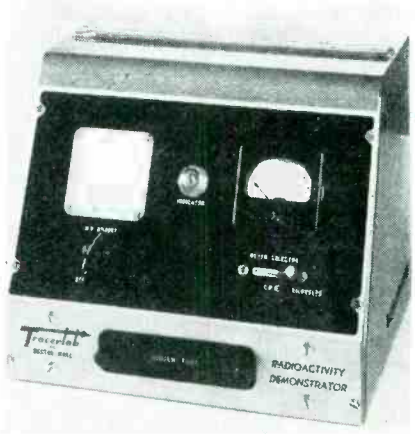
RANGES

20,000 Ohms per Volt D.C., 1,000 Ohms per Volt A.C.
Volts: A.C. and D.C.: 2.5, 10, 50, 250, 1000, 5000
Output: 2.5, 10, 50, 250, 1000
Milliamperes, D.C.: 10, 100, 500
Microamperes, D.C.: 100
Amperes, D.C.: 10
Decibels (5 ranges): —10 to +52 D.B.
Ohms: 0-2000 (12 ohms center), 0-200,000 (1200 ohms center), 0-20 megohms (120,000 ohms center).
Model 260, Size: 5¼" x 7" x 3⅛" $38.95
Model 260 in Roll Top Safety Case, as shown.
Size: 5⅜" x 7" x 4¾" $45.95
Both complete with test leads and 32-page Operator's Manual

Ask your jobber or write for complete descriptive literature.

Simpson
INSTRUMENTS THAT STAY ACCURATE

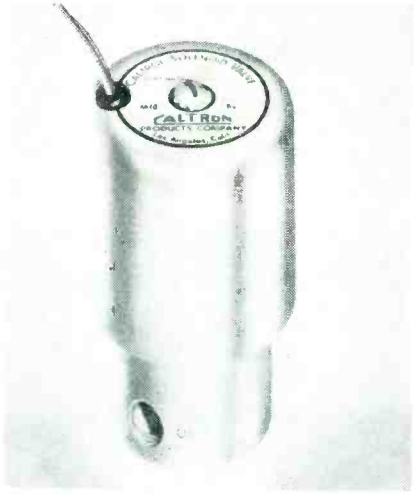
SIMPSON ELECTRIC COMPANY
5200-5218 W. Kinzie St., Chicago 44, Ill.
In Canada: Bach-Simpson, Ltd., London, Ont.



tively with a counting rate meter. The meter will indicate up to 2,500 counts per minute, and by means of a switch will also indicate voltage across the Geiger tube. The instrument operates on 110 volts a-c.

Small Solenoid Valve

CALTRON PRODUCTS CO., 1406 So. Hobart Blvd., Los Angeles 6, Calif. Available in three valve body materials, aluminum, brass, and stainless steel, a new small solenoid valve



can be furnished in a variety of sizes and actuating voltages. Operation from zero to 600 pounds per square inch is possible.

Resistor

WILKOR PRODUCTS, INC., 3835 West 150th St., Cleveland 11, Ohio. A complete line of Carbofilm resistors is available in sizes from ‡ to 1

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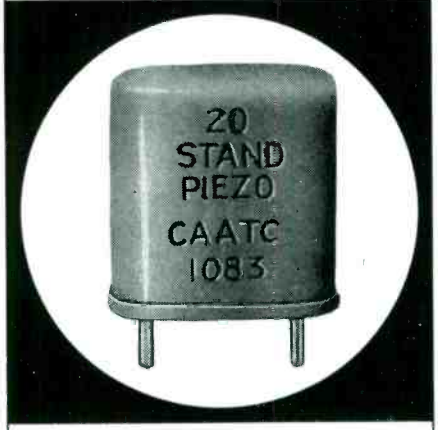
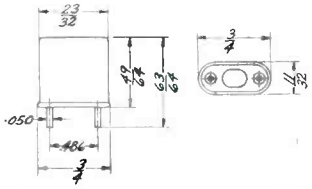
STAR performers

IN THE BULL RING
IT'S THE MATADOR



IN COMMUNICATIONS
IT'S STANDARD'S
CRYSTAL TYPE 20



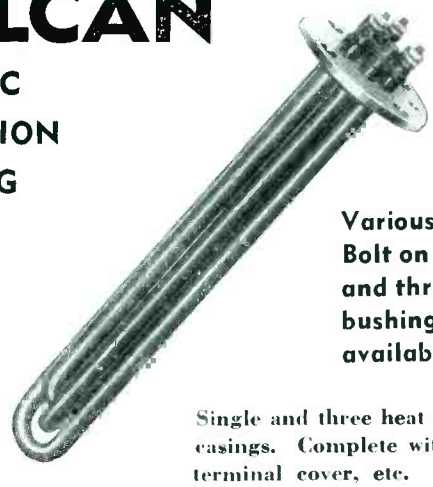
Superior engineering is responsible for this versatile, stable, quality crystal unit—hermetically sealed and filled with dry nitrogen. Frequency range from 1 mc to 75 mc. Meets ±.005% stability in temperature range −55°C. to +90° C.
Let us send you a FREE CATALOG with complete information.

STANDARD PIEZO COMPANY
Office & Development Laboratories
CARLISLE, PENNSYLVANIA

For heating water, oils, paraffin, chemicals, etc.

VULCAN

ELECTRIC
IMMERSION
HEATING
UNITS



Various types of Bolt on flanges and threaded bushings available.

Single and three heat with metal casings. Complete with gaskets, terminal cover, etc.

A new VULCAN Electric Immersion Heater is especially designed for melting fats, greases and similar compounds.

VULCAN ELECTRIC COMPANY
DANVERS 10, MASS.

Makers of a wide variety of Heating Elements for assembly into manufacturers' own products and of Heating Specialties that use electricity.

REDUCE ASSEMBLY REJECTS WITH...

TINNED STEATITE TERMINALS

HERMETICALLY SEALED

GENERAL CERAMICS AND STEATITE CORPORATION — STEATITE INSULATORS

...THAT WITHSTAND HIGH SOLDERING TEMPERATURES
...ARE IMMUNE TO ROUGH SHOP HANDLING
...HAVE TINNED SHOULDER FOR RAPID ASSEMBLY
...FOR 200°C SERVICE ON SPECIAL ORDER

A tinned surface, permanently bonded to the glazed body of these terminals permits rapid soldering to any metal enclosure. Exceptional strength of the steatite body practically eliminates assembly rejects that frequently result when other types of terminals are subjected to soldering temperatures or rough handling. Leads are brought out through an axial hole in the center of the bushing and terminated on the tinned lug. A drop of solder on the hole effects a complete hermetic seal. For complete information concerning tinned steatite terminals, call or write today.

General CERAMICS and STEATITE CORP.
OFFICES and PLANT: CROW'S MILL ROAD, KEASBEY, N. J.

MAKERS OF STEATITE, TITANATES, ZIRCON PORCELAIN, ALUMINA, LIGHT-DUTY REFRACTORIES, CHEMICAL STONEWARE

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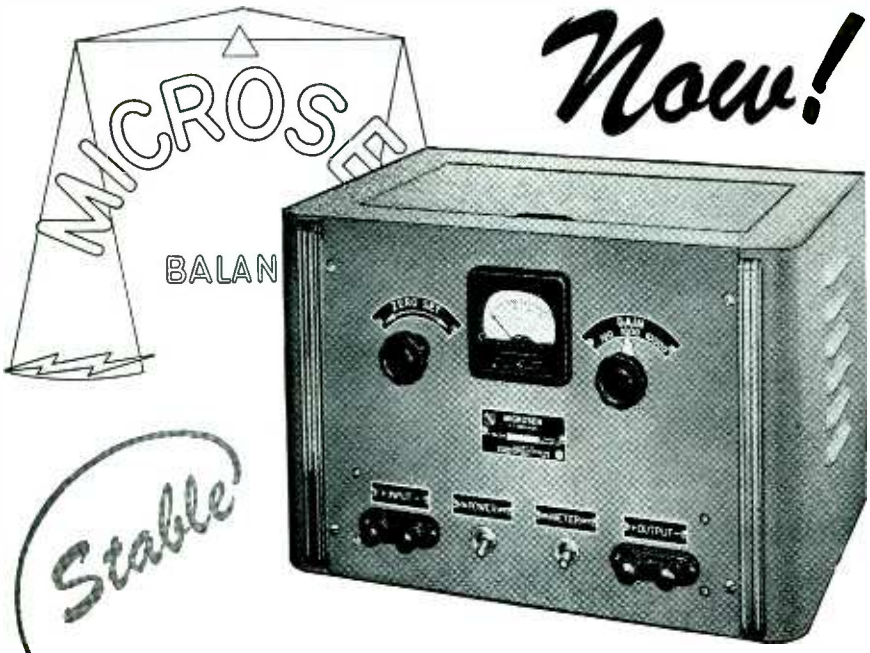


D. C. AMPLIFICATION
at moderate cost

The Microsen Balance principle, developed in our electrical instrument laboratory, makes possible for the first time at moderate cost, a D. C. Amplifier incorporating High Stability, Fast Response, Isolated Input, and Versatility.

Models available include Voltage, Current and Potentiometer Type Amplifiers, Direct Current Converters, Direct Current Transformers, and Engineered Designs to meet special requirements.

Line voltage variations of 15% cause output changes of less than .5%. No mechanical rectifiers or choppers. Standard tubes. Time constant from .001 to .2 seconds. Drift less than 5 Microvolts per day. Not affected by temperature variations.

May we send you our bulletin 143-E.

MAXWELL M&M MANNING & MOORE INC. TRADE MARK

MICROSEN
D. C. AMPLIFIER

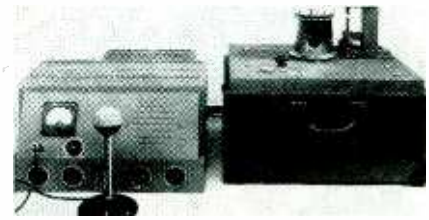
A Product of
MANNING, MAXWELL & MOORE, INC.
BRIDGEPORT 2, CONNECTICUT

Makers of 'American' Industrial Instruments, Hancock Valves, Ashcroft Gauges, Consolidated Safety and Relief Valves. Builders of 'Shaw-Box' Cranes, 'Budgit' and 'Load-Lifter' Hoists and other lifting specialties.

watt, in values from 20 ohms to 5 megohms with tolerances from 0.5 to 1 percent. Smallest resistor in the line measures ⅜-inch overall length.

Sound Spectrograph

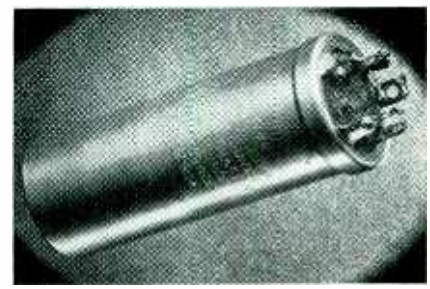
KAY ELECTRIC Co., Pine Brook, New Jersey. The Bell Labs sound spectrograph is used for the study of complex sound waveforms as in



speech education for the deaf and foreign language speech training. Recordings are made on current sensitive paper.

Multiple Capacitor

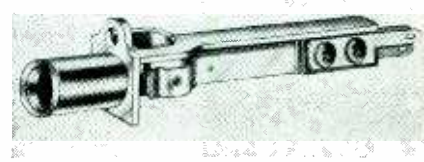
PYRAMID ELECTRIC Co., 156 Oxford St., Paterson, N. J. Type 85TM capacitor shown operates at tem-



peratures as high as 85 C. The unit contains four sections, three of them totalling 75 microfarads at 450 d-c volts operating, and the fourth is 100 microfarads at 50 volts.

Improved Jack

AUDIO DEVELOPMENT Co., 2833 Thirteenth Ave., So. Minneapolis 7, Minn. A new jack designed for audio connections in radio and tele-



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vision broadcasting is physically interchangeable with any standard telephone type with a quarter-inch shaft.

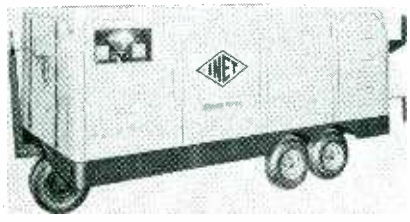
Triple Analyzer

FISHER SCIENTIFIC CO., Pittsburgh 19, Pa. The Nefluoro-Photometer is a line-operated electronic instrument designed for nephelometric, fluorometric and colorimetric analy-

ses. Three light sources are available for various analyses: incandescent, mercury and sodium. The unit employs a built-in galvanometer.

Mobile Rectifier

INDUSTRIAL ELECTRONICS AND TRANSFORMER CO., Los Angeles, Calif. The mobile regulated rectifier illustrated includes operation from 208 volts, 60 cycles, 400 volts



at 50 cycles and 208 volts at 400 cycles and a remote sense circuit to give voltage regulation at the aircraft end of the d-c cables. The mobile unit is rated 2,000 amperes continuous at 28.5 volts.

Specialty Nut

PRESTOLE CORP., 3119 Bellevue Road, Toledo 6, Ohio. A new spring steel Snap Nut is suitable for

Kester Cored Solder—1st in the Television Field

Use Kester Solder for fast, efficient soldering on all TV receivers

In the television and radio fields, where good work is important and economy in present high labor costs is essential, Kester Solders of the Rosin-Core type *fit right into the picture.* Made to the highest standards possible, Kester Flux-Core Solders have always been and still are the standard in the industry.

Write for new 28-page manual, "SOLDER and Soldering Technique"

Free technical manual featuring a complete analysis of the application and properties of soft solder alloys and soldering fluxes.

1899 50th Anniversary 1949

KESTER SOLDER COMPANY
4204 Wrightwood Avenue, Chicago 39, Illinois
Factories Also At
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NEW . . .

MECHANICAL CONSTRUCTION FOR DAVEN DECADES

SPECIAL FEATURES

SWITCH: Patented knee-action switch for high contact pressure and low, uniform, contact resistance.

VIBRATION-PROOF CONSTRUCTION: Will withstand the Signal Corps Vibration tests.

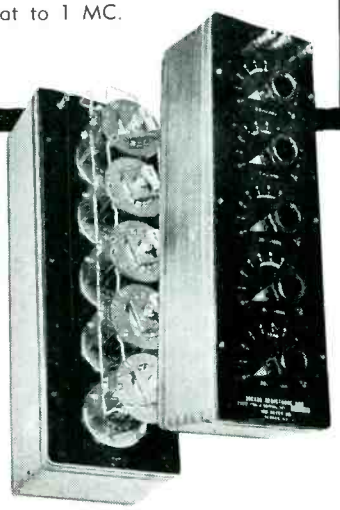
CONTACT RESISTANCE: .002 ohm. Will remain within .0003 ohm throughout the life of the unit.

TYPE OF WINDING:
1, 10, 100 ohm steps—Ayrton-Perry wound.
0.1 ohm steps—bifilar wound.
1,000 and 10,000 ohm steps—unifilar wound.

TYPE OF WIRE: All units up to 10,000 ohms are wound with manganin. Values over 10,000 ohms are wound with nichrome alloy.

TEMPERATURE COEFFICIENT: All resistors have a temperature coefficient of less than ±.002% per degree C, at room temperature.

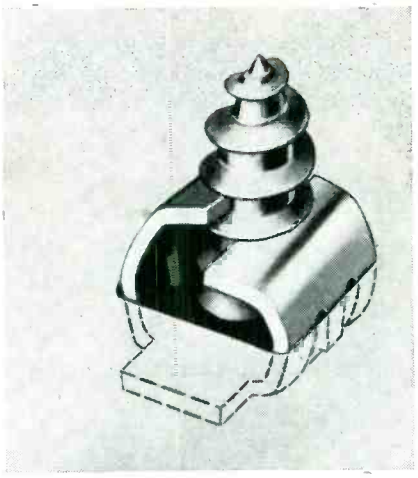
FREQUENCY CHARACTERISTICS:
0.1, 1, 10, and 100 ohm steps—flat to 1 MC.
1,000 ohm steps—flat to 50 KC.
10,000 and 100,000 ohm steps—flat over the audio range.



This new construction is supplied on individual decade units and in decade resistance boxes.

Visit Daven exhibit at the I.R.E. Convention Booth 94-B and 95.

Write for descriptive literature Dept. E—2



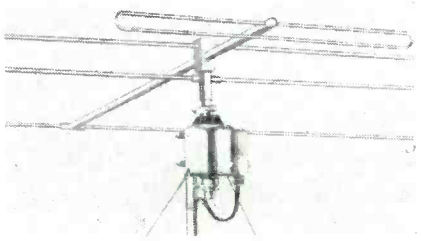
anchoring nut-to-panel for blind attachments. As the screw is driven in, the arched spring arms of the nut expand just enough to permit entry of the screw.

Plastic Preheater

GENERAL ELECTRIC Co., Schenectady 5, N. Y., has available a new 3-kw, 40-mc preheater for plastic preforms. It operates on 220 volts, single phase, 60 cycles, and is designed to heat 40 oz of wood-flour phenolic compound from 70 to 250 F in one minute. Further information is given in bulletin GEA-5091.

Antenna Rotator

ALLIANCE MFG. Co., Alliance, Ohio. An electric antenna rotator is now



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SEE The latest equipment and components of 192 organizations, in the engineering exhibits

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Wm. C. Copp, Exhibits Manager
303 West 42nd St., New York 18, N Y.

ULTRA SENSITIVE D. C. AMPLIFIER

An Electronic Replacement For Sensitive Galvanometer Systems

The Model 53 Breaker-type D.C. Amplifier was developed for the measurement of d. c. and low frequency a. c. voltage in the microvolt and fractional microvolt region. It is compact, portable, and makes an excellent replacement for the suspension galvanometer. The output of the amplifier is sufficient to operate standard meters and recording devices directly.

It has been employed for the amplification of infra-red detectors, thermocouples, voltaic photocells, and the like, both in research and industrial applications.

Among the advantages of this amplifier are the following:

1. Noise level that approaches the theoretical limit imposed by Johnson noise.
2. Extremely low zero drift (less than .005 μ V after warmup).
3. Freedom from the effects of vibration such as found in moving vehicles.
4. Response characteristics permitting overall amplification flat from 0 to 10 cycles per second.
5. Reliability, as demonstrated by units which have been in continuous operation for several years.

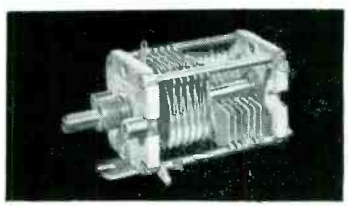
THE PERKIN-ELMER CORPORATION

Dept. 52, GLENBROOK • CONNECTICUT

New! **JOHNSON**

TYPE L VARIABLES

CERAMIC SOLDERED
FOR STABILITY-STRENGTH



DUAL TYPE

Available in Three Models:

3.5 to 27 mmf, 4.6 to 51 mmf, 6.8 to 99 mmf.
Spacing .030" and .080"

These new JOHNSON Variables are ideal for use where peak efficiency is required under the most adverse conditions, such as portable-mobile operation.

JOHNSON also makes Type L Variables in Single, Differential and butterfly types in many different models.

All are ceramic soldered. There is nothing to work loose causing stator wobble and fluctuations in capacities.

Write For New JOHNSON Type L Variable Catalog Today!

JOHNSON
a famous name in Radio
E. F. JOHNSON CO., WASECA, MINN.

SELF-LOCKERS...

UNBRAKO

Reg. U. S. Pat. Off.

PAT'D. AND PATS. PEND.

SOCKET SET SCREWS
WITH THE
KNURLED CUP POINT

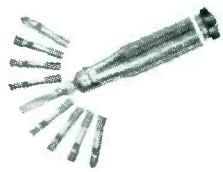
The KNURLED cup point of this popular "Unbrako" Socket Set Screw makes it a *Self-Locker* . . . because the keen edges of the counter-clock-wise KNURLS positively prevent creep, *regardless* of the most chattering vibration. A real fastener, if ever there was one . . . it positively *won't shake loose!* Sizes from #4 to 1½" diameter, in a full range of lengths.

Knurling of Socket Screws originated with "Unbrako" in 1934.

Write us for the name and address of your nearest "Unbrako" Industrial Distributor and for your copy of the "Unbrako" Catalog.

OVER 46 YEARS IN BUSINESS

"HALLOWELL" KEY KIT



KITS: PATS. PEND.

You can't tighten or loosen socket screws without a hex socket wrench, so why not get our No. 25 or No. 50 "Hallowell" Hollow Handle Key Kit which contains most all hex-socket bits.

STANDARD PRESSED STEEL CO.

JENKINTOWN, PENNSYLVANA, BOX 596
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In the field of electronics and the electrical goods industry, MOSINEE stands for paper-base processing materials with scientifically controlled chemical and physical properties, high quality standards and dependable uniformity . . . with good dielectric strength, high tensile or tear strength; proper softness or stiffness; creped with controlled stretch or flexibility; specified pH for maximum-minimum acidity or alkalinity; accurate caliper, density, liquid repellency or absorbency . . . or other technical characteristics vital to your quality standards and production requirements.

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"Essential Paper Manufacturers"

available for f-m and television beams. A remote-control unit contains a three-position switch and warning signal to show that the unit has reached one end or the other of its 365-degree rotation. The motor drives the antenna at approximately 1 rpm. List price is $39.95.

Tuner and Amplifier

ALTEC LANSING CORP., 161 Sixth Ave., New York 13, N. Y. Type ALC-101 f-m and a-m tuner is designed to work in conjunction with

type A-323C amplifier, which can be separated from the tuner unit by a 6-foot cable. The amplifier is essentially flat from 20 to 20,000 cycles. The a-m section uses a tuned radio-frequency circuit for local reception. The f-m receiver uses a ratio detector.

Ion Charger-Reader

NUCLEAR INSTRUMENT AND CHEMICAL CORP., 223 West Erie St., Chicago 10, Ill. Model 2050 ion chamber charger-reader is designed to read pocket ion chambers used by

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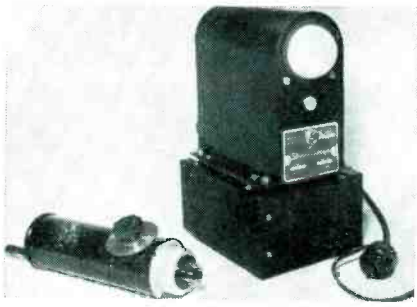
personnel exposed to gamma or x-radiation. The unit will charge the ion chamber to a known voltage and will measure the residual charge after exposure to radiation.

Vacuum Monitors

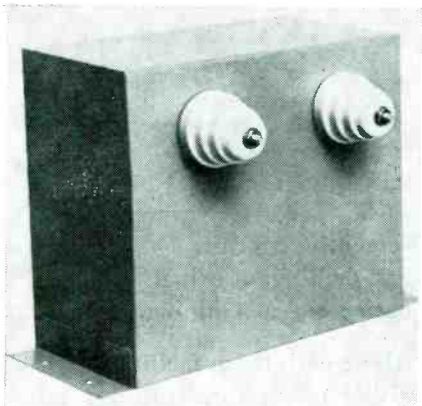
SKANEATELES MFG. CO., INC., 122 Dickerson St., Syracuse 2, N. Y. The Skanascope vacuum monitors use controlled gas-discharge tubes



as the basic sensing element. They feature precision signal and relay output control. Range is from 100 millimeters of mercury to 5 microns absolute. Power required is 115 volts a-c, 60 cycle, at 0.5 ampere, plus the load on the relay base through a 115-volt a-c outlet.

Pulse Networks

CONDENSER PRODUCTS CO., 1375 North Branch, Chicago, Ill. Plasticon TS pulse networks operate at

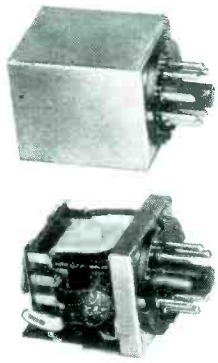


temperatures up to 150 C with lower losses than those composed of paper or mica capacitors. The dielectric does not fatigue under pulse duty.

Navigational Equipment

SPERRY GYROSCOPE CO., Great Neck, N. Y. The Mark 2 loran receiver indicator using miniature tubes

3 IMPORTANT NEW Relay Developments



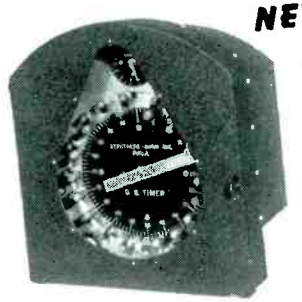
NEW!...TINY OCTAL BASE RELAYS for AC, DC or half-wave rectified AC

TYPE 118XBX: Available in either open or metal-enclosed types as illustrated, also hermetically sealed. Highly sensitive on DC. DP-DT contacts rated 2 amps. at 115 V. AC. DC operating power is .15 watts with maximum coil resistance of 2,200 ohms. Write for Bulletin 2400.

NEW!...HERMETICALLY SEALED DC RELAYS FOR HIGH-ALTITUDE AVIATION

These little CX3554 Relays are insensitive to humidity changes and capable of operation at 70,000 feet. Features include shock resistance to 50 G's; vibration resistance better than 10 G's; high-speed operation without contact bounce, and reliability over an ambient range of −75° C. to +200° C. SP-DT contacts nominally rated 2 amps. withstand inrushes of 12 amps. at 26.5 V. DC. Coil is rated 26.5 V. DC with operating range of 18/32 V. DC. Write for Bulletin 2410.

NEW!...MONEY-SAVER FOR TIMING CONTINUOUS PROCESS WORK



Stepless, wide-speed range. Complete timing reliability

Besides eliminating the need for numerous cascaded timers, the new Struthers-Dunn DB Timer usually requires much less auxiliary control equipment. An entire process combining many operations can quickly be set up on a single dial. Total time cycle adjustments as well as the timing of individual periods are easily made. Write for DB Timer Bulletin 7110.

STRUTHERS-DUNN

5,348 RELAY TYPES

STRUTHERS-DUNN, INC., 150 N. 13TH ST., PHILADELPHIA 7, PA.

ATLANTA • BALTIMORE • BOSTON • BUFFALO • CHARLOTTE • CHICAGO
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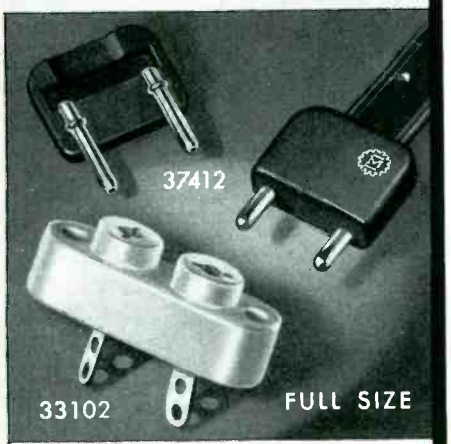
Designed for

Application



PLUGS *and* SOCKETS *for* 300 OHM LINE

The new Millen No. 37412 ***Designed for Application*** plug is an inexpensive, compact, and efficient polyethylene unit for use with the 300 ohm ribbon type polyethylene transmission lines. Fits into standard Millen No. 33102 (crystal) socket. Pin spacing ½", diameter .095". Ideal for many amateur, laboratory, commercial communication and television applications.

JAMES MILLEN MFG. CO., INC.

MAIN OFFICE AND FACTORY

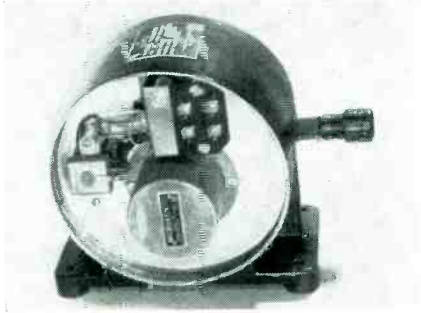
MALDEN

MASSACHUSETTS

features small size, trunnion-mount, large numbered meter, motor driven phase-shifting circuit, automatic frequency control and ultraviolet illuminated time-difference meter and station selectors.

Pressure Transmitter

MANNING, MAXWELL & MOORE, INC., 11 Elias St., Bridgeport 2, Conn. The Microsen electromechanical relay is combined with a Bourdon tube to produce a stable

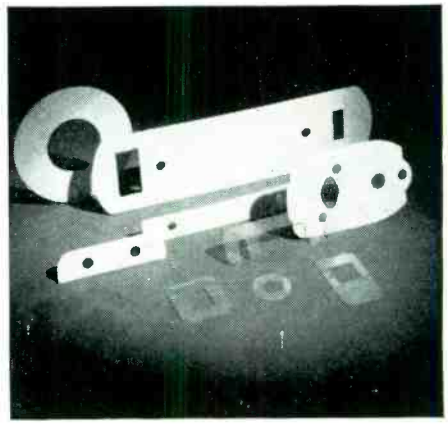


d-c signal that can be recorded or read at a distance. Standard pressure ranges up to 50,000 pounds are available. Write for Bulletin 145.

F-M and Tele Sweeps

COASTWISE ELECTRONICS CO., INC., 130 North Beaudry Ave., Los Angeles 12, Calif. Model 720 Ferret f-m and television sweep generator has a range from 0 to 260 mc and

COMPLETE FACILITIES for PRECISION-FABRICATED PLASTICS



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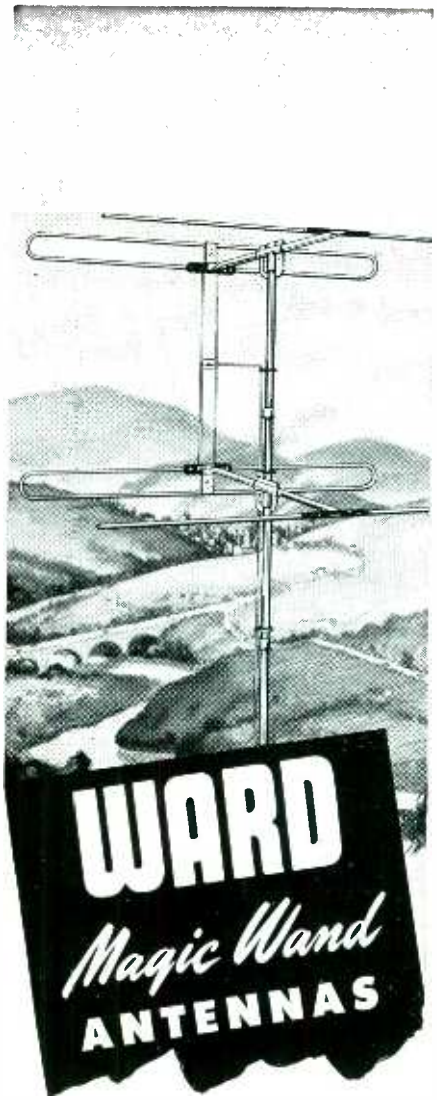

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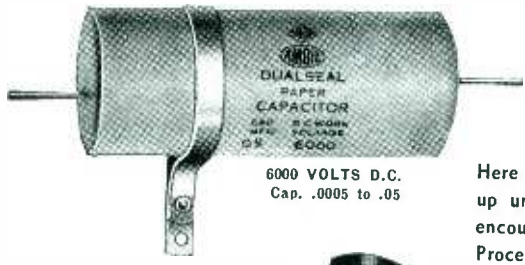

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sweep width from 50 kc to 20 mc. Internal crystal marker is controlled by a plug-in crystal in the range 19 to 40 mc. Write for catalog sheet.

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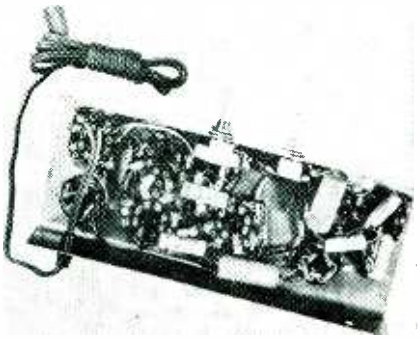
SPECIAL PRODUCTS Co., Silver Spring, Md. Model 309 phono-amplifier and preamplifier combination may be used with low-level



pickups and with regular crystal cartridges for either standard or microgroove records. Response is essentially flat from 1,000 to 14,000 cps (± 1 db) with rising characteristic of 12 db down to 50 cycles. Hum level is 40 db below maximum signal output.

Process Control

G. C. WILSON & Co., 2 N. Passaic Ave., Chatham, N. J. The Flexitrol is a new electronic load control for use with all motor-operated pro-

cesses, such as pulverizers, pumps, and extruders. One model is suitable for motors of all ratings.

Persistent CRT

RADIO CORP. OF AMERICA, Harrison, N. J. Model 10KP7 cathode-ray tube is a 10-in. type employing magnetic deflection and focusing. A long-persistence, two-layer screen exhibits greenish-yellow phosphorescence that lasts several minutes. Overall characteristics of the tube

Silicone News

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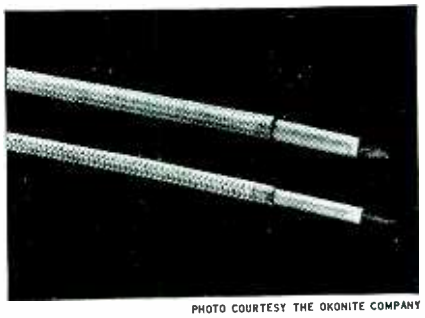

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Silastic is extruded over wire and cable ranging from No. 18 to 500,000 circular mils in size to provide insulation having maximum resistance to heat, ozone and weathering.*

Silastic* has been chosen to insulate the new line of heat-stable "Okotherm" wire and cable made by the Okonite Company of Passaic, N. J. Silastic* insulation maintains its high dielectric strength even after continuous long time exposure to temperatures as high as 200° C. (400° F.). Its dielectric loss factor is low compared with that of organic rubbers.

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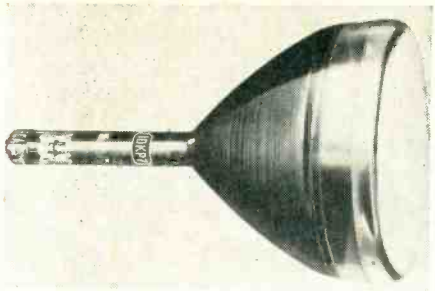
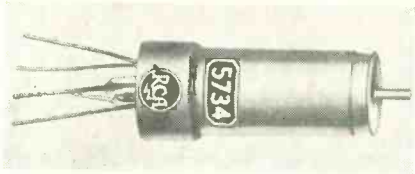


facilitate its use as a radar indicator.

Mechano-Electronic Transducer

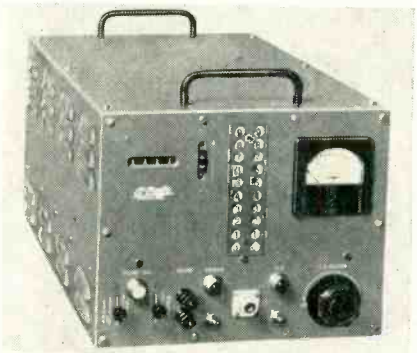
RADIO CORP. OF AMERICA, Harrison, N. J. A mechano-electronic triode transducer model 5734 consists of a metal shell (plate connection),



internal shield, plate, grid, heater and cathode elements. The moving element is the plate shaft which extends through a thin metal diaphragm at one end of the tube. The shaft has a deflection sensitivity of 40 volts per degree deflection. The tube is primarily useful for vibration measurements.

Scaler

EL-TRONICS, INC., Philadelphia, Pa. Model LS-100 Geiger laboratory set employs a direct-reading decade



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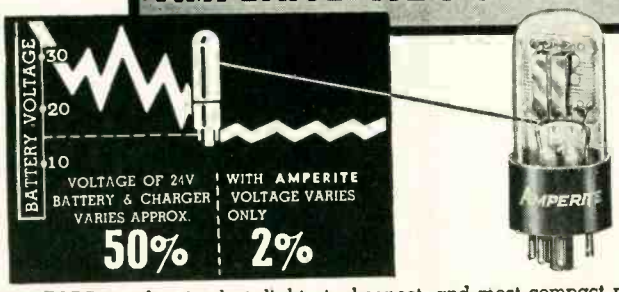

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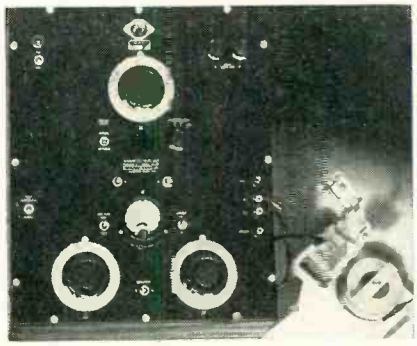
Magnetic Test Set

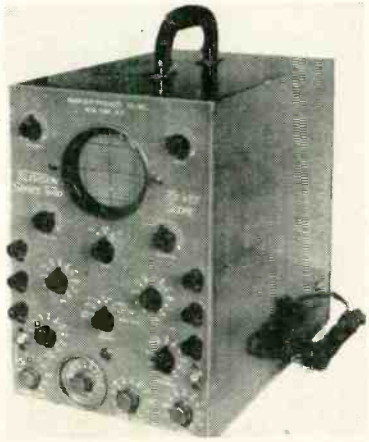
GENERAL RADIO CO., 275 Massachusetts Ave., Cambridge 39, Mass. Type 1670-A magnetic test set for materials in laminar form provides measurements of permeability and core loss at 60 cycles. The measure-



ments are made on a Maxwell bridge of the inductance and loss of a solenoid surrounding the sample.

Television Testing

RADIO CITY PRODUCTS CO., INC., 152 W. 25 St., New York City, N. Y. Two television test instru-



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Brought out of the research laboratory and into industry, ultrasonics has tremendously-broad, practical applications. This guide points the way to greater use of ultrasonics in, for example, MATERIALS TESTING: to detect flaws in metals, plastics and glass, etc.; CHEMICAL INDUSTRIES: to make better mixtures and emulsions, etc.; METALLURGY: for extremely uniform mixtures free of air bubbles, etc. It likewise discusses experimental applications to systems of television, underwater signaling, depth sounding, communication, destruction of bacteria, etc.

CONTENTS

1. Ultrasonic Waves
2. Ultrasonic Waves: Further Theory
3. Crystals for Ultrasonic Use
4. Crystal Holders for Ultrasonic Use
5. Resonance and Reflection
6. Continuous-wave Ultrasonic Systems
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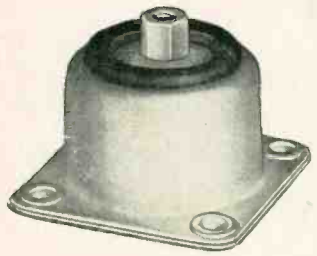

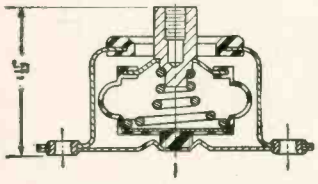

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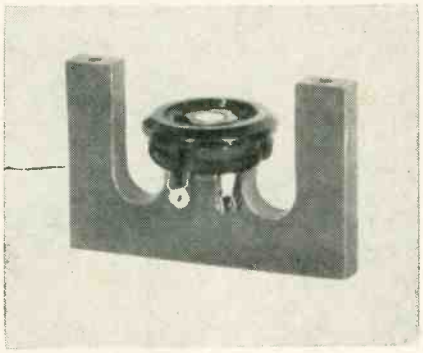

exact replacement for ceramic sockets in television receivers.

Tensile Tester

INSTRON ENGINEERING CORP., 2 Hancock St., Quincy 71, Mass. Model TT-B is a high-precision tensile testing instrument with a load

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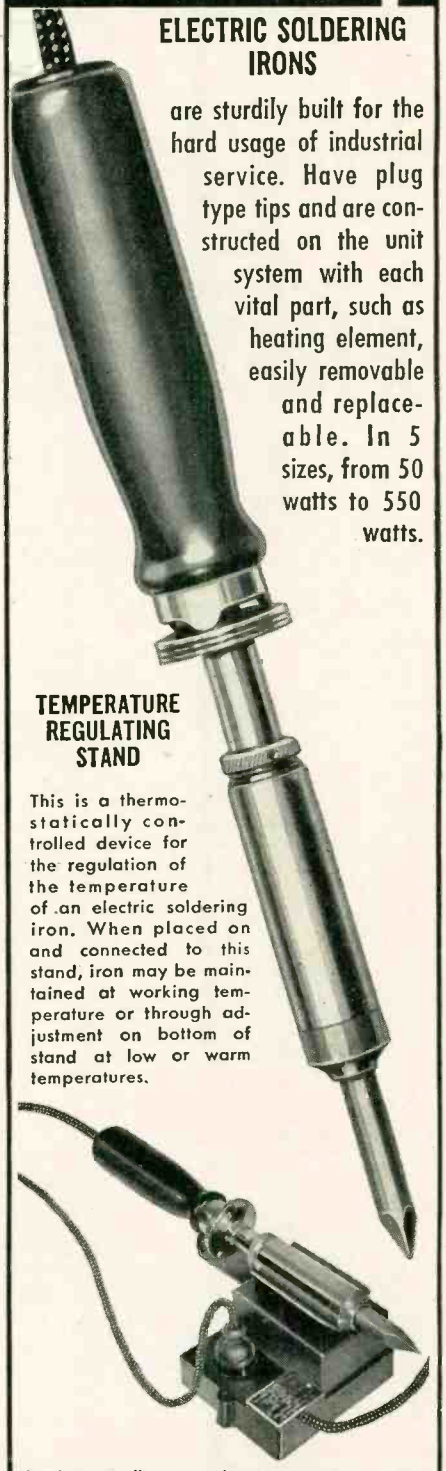

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This is a thermostatically controlled device for the regulation of the temperature of an electric soldering iron. When placed on and connected to this stand, iron may be maintained at working temperature or through adjustment on bottom of stand at low or warm temperatures.

For descriptive literature write 110-1

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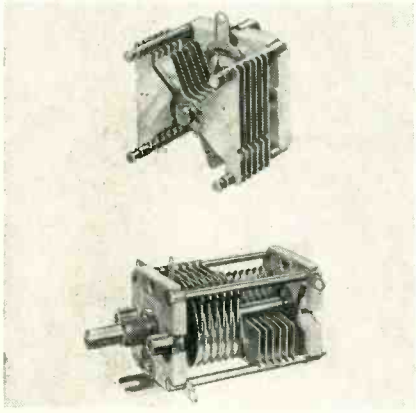

soldering obviates the use of eyelets, nuts or screws. A split-sleeve tension bearing insures positive contact and prevents fluctuation in capacitance.

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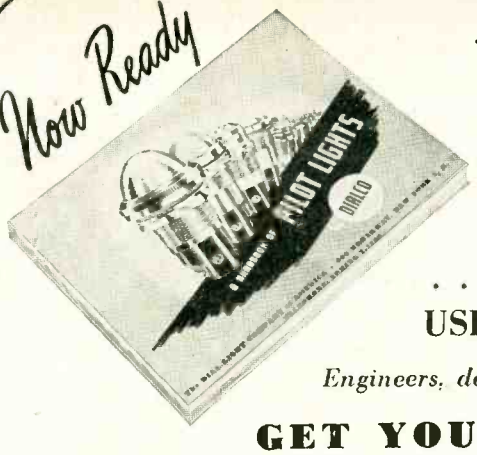

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Low A.C. Voltage: 6.3 Volts A.C. at 6 amps. center-tapped, unregulated

REGULATION
Within 1% for voltage between 30-500 volts, from no load to full load.
Within 1% for line voltage variations from 105 to 125 volts at full load current for any voltage between 30-500 volts and within 2% at 10 volts.

HUM VOLTAGE
Within 10 Millivolts at any voltage or load within ratings.

LINE INPUT
105-125 Volts A.C. 50-60 cycles.

OUTPUT TERMINATIONS
High and low voltage outputs available from front and rear of unit. Positive or negative terminal of high voltage output may be grounded as desired.

Detailed specifications will be forwarded upon request without obligation.

E/M

ELECTRONIC MEASUREMENTS COMPANY
RED BANK • NEW JERSEY

trolyte is pure caustic potash in distilled water. Catalog 127 describes the battery in detail.

Oscilloscope Camera

FREDERICK P. WARRICK, 8666 Grandville, Detroit 10, Michigan. The camera illustrated can be used in conjunction with any oscilloscope with a short-persistence screen. It

has a capacity of 100 feet of 35-mm film and a speed range from 25 to 850 inches per second. Remote starting and stopping is provided.

Literature

Control Instruments. The Brown Instrument Co., Wayne & Roberts Aves., Philadelphia 44, Pa. Catalog 15–13 gives 31 pages of schematic diagrams, photographs and dimensional drawings illustrating construction and operation of a line of continuous balance potentiometers, indicators, controllers and pyrometric switches.

R-F Cables. The Telegraph Construction & Maintenance Co., Ltd., Telcon Works, Greenwich, London S. E. 10, England. Publication No. 10 describes the characteristics of various types of coaxial cables, delay cables, fittings and characteristics.

F-M Antenna. Andrew Corp., 363 East 75th St., Chicago 19, Ill. Bulletin 86 describes the Multi-V antenna for f-m broadcasting. The unit can be either side or top mounted on existing structures and has a power gain of 1.6.

Impedance Matcher. Radex Corp., 2076 Elston Ave., Chicago 14, Ill. A catalog sheet outlines the advantages of the new impedance-matching bridge.

Sonic Analyzer. Panoramic Radio Corp., 92 Gold St., New York 7,

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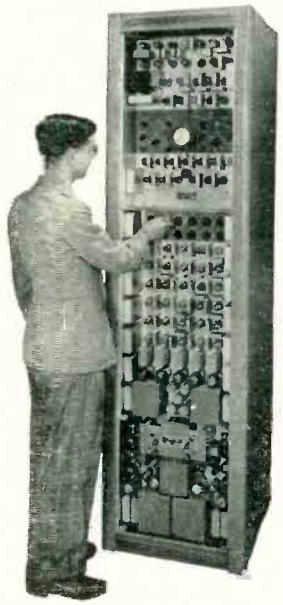
POLARAD
TELEVISION *Equipment*

for studio • laboratory • manufacturer

SYNCHRONIZING GENERATOR

Model PT 101—Television



FEATURES

- Built-in 3" oscilloscope with synchronized sweeps for viewing Timing and Video Output pulse wave forms.
- Synchronized marker system for checking pulse width and rise time.
- Extreme stability, insured by deriving all pulses from leading edge of master oscillator pulse.
- Means for checking synchronizing pulses in odd and even fields.

SPECIFICATIONS

525 line, interlocad, 60 fields, 30 frames, RMA Synchronizing pulses held to tolerance specified in the NRTPB report of 1945. Output Pulses; Synchronizing, Video Blanking, Camera Blanking, Horizontal Driving, Vertical Driving Pulses. 4 volts across 100 ohm termination. Dual output jacks. 115 volts 50/60 cps. Complete with tubes.

TELEVISION MONOSCOPE SIGNAL SOURCE

Model PT 102

- Composite Video Signal
- Wide Band Video Amplifier, 6 DB down at 10MC
- Dual outputs for feeding two 75 or 100 lines
- Black positive or Black negative output.
- Resolution greater than 600 lines

INPUT: Vertical and Horizontal Driving pulses. Camera and Kinescope Blanking Pulses.

OUTPUT: Composite Video Signal, 3 volts, 100 ohm line 115 volts 50/60 cps. Complete with tubes and including high and low voltage power units.

●

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NEW YORK 7, N. Y.

Polarad Electronics Company

Television engineers and consultants to the nation's great television stations.

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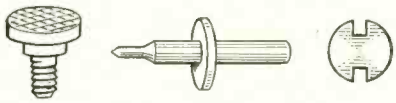
for safety later

DO IT BETTER NOW!

SPRINGS are the "life" of a design. On their own power, they pull, push, open, close—actuate vital parts of mechanism. When they fail, so does the product!

For safety, springs should be ***designed into*** the product, after the right type, size and metal have been determined. Generally, this is an engineering job, and if you are not set up to do it, you are welcome to this assistance as a "plus" with your order. Just send us a description of the device, preferably with sketch or blue print.



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SPRINGS & SCREW MACHINE PRODUCTS

THE PECK SPRING COMPANY **9 King St., Plainville, Conn.**

AVIOMETER Roanwell

ANOTHER DEVELOPMENT
for
COMMUNICATIONS EFFICIENCY

CHARACTERISTICS

Receiver and microphone in this headgear provide higher output than standard telephones when used on non-amplified circuit.

Sensitive receiver for inter-communications – 135 ohms, damped response.

Sensitive lip microphone, noise excluding, 50 ohm carbon, all position, extended frequency response.

Lucite temple pad and junction box with connecting cords enclosed in vinylite cushion headband on one side to balance weight of headphone.

Whatever your need or problem in communications terminal equipment, Roanwell is qualified to serve you. A skilled laboratory staff will tackle your special development problems. Write today – telling us your requirements. And send for our new catalog.

BALANCED SINGLE HEADGEAR

Receiver and microphone in a single, compact, lightweight assembly leave wearer's hands free at all times. Another Roanwell precision instrument specially adapted to provide greater efficiency in communications.

THE AVIOMETER DIV. Roanwell CORPORATION
662 PACIFIC ST. • BROOKLYN 17, N. Y.

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The LOGICAL CHOICE in Custom Installations

Brilliant, realistic reproduction of broadcast and recorded music is assured with the H. H. Scott Model 210-A amplifier. Built to laboratory standards of electrical, mechanical, and musical excellence, this 20-watt amplifier is essential to satisfactory custom performance in both FM and AM radio reproduction as well as in record playing.

FEATURES INCLUDE:

- *Dynamic noise suppressor for both scratch and rumble.
- Equalization for standard and long-playing records.
- Extended listening range.
- Twenty-watt output — negligible distortion.
- Minimum controls — maximum flexibility.
- Compact design — oversize components.
- Full year's guarantee.

For full details, request bulletin 902E2.

Now *DYNAMIC NOISE SUPPRESSION

with your present Radio-Phonograph or Amplifier on both Standard and Long-Playing Records.

Reduces *scratch* and *rumble* without fixed loss of "highs" or "lows".

Add realism to your music reproduction by these 2 simple steps.

1. Plug in the "Little Wonder" *Dynamic Noise Suppressor between your pick-up and amplifier.
2. Plug in the socket adapter to the power-tube socket.

The "Little Wonder" (Type 110-A) realizes the full capabilities of your present equipment; remote control mounts anywhere; high-and-low-frequency noise suppression; two inductor type high-frequency gate circuit; two separate control rectifiers; compact — 7 x 3¾ x 4¾ inches. For full specifications write for bulletin 902E1.

*Licensed under U. S. and foreign patents pending and issued.

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"PACKAGED ENGINEERING"
385 PUTNAM AVE. • CAMBRIDGE 39, MASS.

N. Y. The Sonic Analyzer model AP-1 separates frequency components of a complex audio wave and measures frequency and magnitude according to a six-page brochure.

Midget Relays. Struthers-Dunn, Inc., 150 N. 13th St., Philadelphia 7, Pa. Bulletin 2100 has been compiled to simplify selection and use of midget relays.

Microwave Equipment. The Waveguide Mfg. & Equipment Co., Inc., 190A Duane St., New York, N. Y. has just issued a new bulletin on its line of microwave and waveguide equipment.

New Resistors. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa., has issued a 12-page brochure on advanced types of fixed composition resistors including 30 detailed charts and graphs.

STL Antennas. Andrew Corp., 363 East 75th St., Chicago 19, Ill. Bulletin 902 describes stl antennas utilizing parabolic dishes for the 920-to-960 mc f-m relay band.

F-M STL. Radio Engineering Labs., Inc., 35-54 36th St., Long Island City, N. Y. has just put out preliminary information on the new model 707 relay equipment for use between 920 and 960 mc utilizing the Serrasoid modulator.

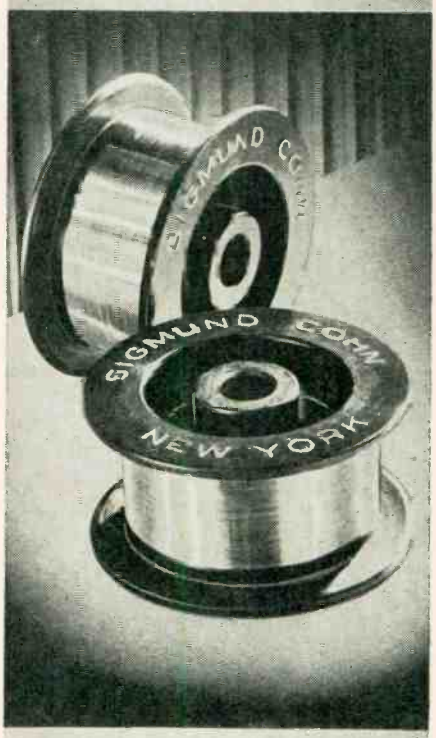
Rocket Tubes. Sylvania Electric Products Inc., 500 Fifth Ave., New York 18, N. Y. has put out an interesting 16-page booklet on a line of planar triodes designed for use at the ultrahigh frequencies.

Marking Tape. Topflight Tape Co., York, Pa. has an illustrated brochure showing some of the many uses to which its printed, adhesive tape can be put.

Geiger Survey Meter. Precision Radiation Instruments Inc., 1101 North Paulina St., Chicago 22, Ill. A sheet describing the model 101 portable Geiger survey meter indicates the elements of the plug-in circuit.

Magnetic Amplifiers. Vickers, Inc., 1815 Locust St., St. Louis 3, Missouri, has recently published a 28-page brochure on the circuits, characteristics, applications, and illustrations of magnetic amplifiers.

MICRODIMENSIONAL WIRE & RIBBON



- Wires drawn bare to .0004" diameter
- Wollaston Process Wire .0005" to .000010"
- Ribbon rolled to .0001" thickness
- Made in almost all ductile metals and alloys; or we will draw wire from your own metals.

Your inquiry, with engineering specifications is invited.

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SINCE 1901

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F—13A

Manufacturers use the advertising pages in this magazine to get *news* about their products or services to *you*... quickly and effectively. Their advertisements contain information designed to help you do your job better, quicker, and cheaper, which is just as newsworthy as the editorial columns.

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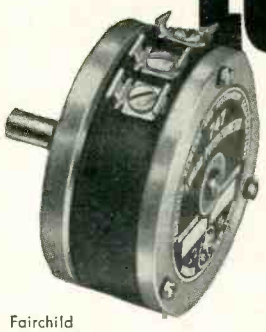
LONG LIFE



Fairchild
Precision Linear Potentiometer

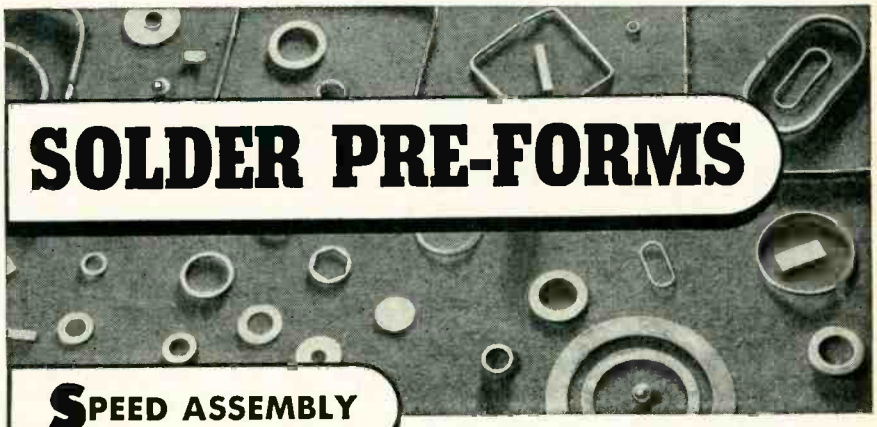
POTENTIOMETER PERFORMANCE THAT EXCEEDS SPECIFICATIONS

Specifications covering Fairchild Type 748 Linear Potentiometers guarantee a service life of more than 1,000,000 cycles at 30 rpm and linearity of .1%—yet laboratory tests have revealed a service life of several million cycles at 100 rpm with the original linearity tolerance increasing to only .15%!

This amazing performance stems from Fairchild's exclusive design and precisionized skills that provide just the right contact materials, the right resistance wire—and the exact adjustment of wiper arm pressure.

For further information on the only precision potentiometers that offer a service life of over 1,000,000 cycles with *sustained* accuracy address: Dept. J, 88-06 Van Wyck Boulevard, Jamaica 1, New York.

Fairchild CAMERA AND INSTRUMENT CORPORATION



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SAVE MONEY

Step up production—bring costs in your shop down—with solder pre-forms. Pre-formed rings, washers, pellets, discs, etc., made to your order, insure better bonds, lower costs, and faster assembly. We can supply you with custom-made pre-forms of any shape required, in a wide variety of solders, copper and brazing alloys.

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ATR

"A" BATTERY ELIMINATORS

for DEMONSTRATING AND TESTING AUTO RADIOS

New Models . . . Designed for testing D. C. Electrical Apparatus on Regular A. C. Lines. Equipped with Full-Wave Dry Disc Type Rectifier, Assuring Noiseless, Interference-Free Operation and Extreme Long Life and Reliability.

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bership will eventually include substantially all professional radio engineers who devote the major portion of their time to the practice of consulting engineering before the FCC and who meet certain minimum requirements set forth in the constitution and by-laws of the organization. Applications for membership or associate membership may be made through A. D. Ring, secretary.

RMA Issues Recommended Standards

TO KEEP PACE with wartime and postwar technical developments, the RMA Engineering Department has released thirteen new and revised recommended standards. Most of the recently issued group apply to radio and television components rather than to complete equipment, while two have to do with television and result from the industry's rapid expansion. One of the latter covers requirements for television relay facilities, and the other brings up to date the designation system for c-r tubes.

New and revised standards are as follows: Audio Facilities for Radio Broadcasting Systems (TR-105-A); Numerical Values, Decimal Multipliers, and Tolerances (GEN-101); Preferred Values (GEN-102); Moulded Mica Capacitors (REC-115); Fixed Composition Resistors (REC-116); Fixed Wire Wound Resistors (REC-117); Electrical Performance Standards for Television Relay Facilities (TR-106); Fixed Paper Dielectric Capacitors in Tubular Non-Metallic Cases (REC-118); Vibrator Power Transformers (REC-119); Power Transformers for Radio Broadcast Receivers (REC-120); Variable Control Resistors (REC-121); High Frequency Circuit Switches (REC-122); Designation System for Cathode Ray Tubes (ET-111).

BUSINESS NEWS

SYLVANIA ELECTRIC PRODUCTS INC. has purchased the plant formerly occupied by the Rumsey Pump Co. at Seneca Falls, N. Y., for ex-

YOU NEED THIS BOOK!

IF YOU BUY...USE...
OR SPECIFY SMALL PARTS

Here's one of the most up-to-date and complete booklets on practically all types of small metal parts. Gives you engineering specifications and vital data on application of:

Lock Washers	Snap Rings
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You'll find this booklet a valuable addition to your technical library. It is crammed with sizes, facts and figures . . . data on latest AN specifications . . . information on how you can save your company time and money in the production of small parts.

This is just another part of Diamond G Service offered to industry by Garrett's, manufacturers of small parts. Whatever your needs—even though they may seem impossible to meet—call the Diamond G man. We think you'll be amazed. When a promise of quality, price or delivery is given by Garrett's—YOU ARE SURE OF SATISFACTION. Diamond G Service is based on turning the seemingly impossible into a regular reality.

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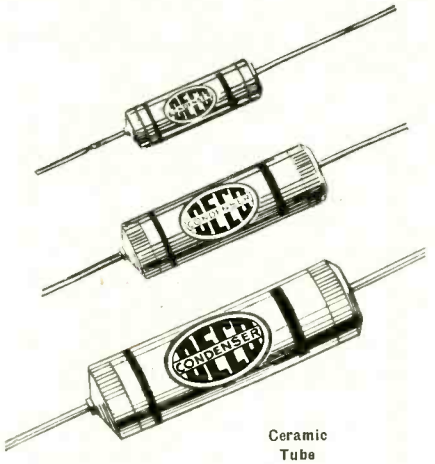
THE WORLD'S FINEST TUBULAR

CAPACITORS



At last! . . . after years of painstaking research the Dumont Engineers now offer the finest tubular condenser ever designed. Moulded right into a Ceramic Tube . . . oil sections . . . 100% moistureproof and heatproof. Sizes from .0001 to .5 and from 100 Volts to 20000 Volts. From ¼" x ⅝" long to 1½" x 4" long.

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Also available in Silicone Oil for 125°C operation.

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HASN'T "SQUARED THE CIRCLE" BUT HAS "SQUARED THE BOW"

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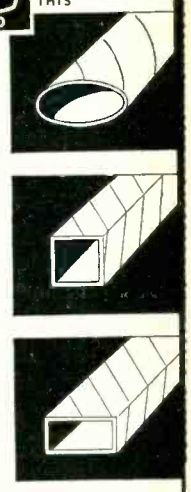
DI-FORMED PAPER TUBES

at no extra cost!



Precision DI-FORMED Paper Tubes have made a most important improvement throughout coil industry. Now ALL coil manufacturers and users can take advantage of the opportunity to obtain Precision DI-FORMED square and rectangular paper tubes for coil bases, *at no extra cost!*

Results: greater strength—automatic stacking—elimination of coil forming after winding—closer engineering of coils, saving wire. Precision characteristics, spiral winding, better insulation, space and weight saving are improved. Tubes also made round, oval, any shape.

Write for samples—also new Mandrel List. Many new sizes.

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Specially developed for recording in flight, the TYPE S12-A OSCILLOGRAPH is ideal for operation under acceleration or vibration. The S12-A is a complete instrument with internal governor motor, gear-driven record, timing device, record numbering, automatic record-length control, and record footage indicator. Case is rigid cast aluminum only ten inches wide by 18 inches long. Complete instrument weighs only 35 pounds.

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Type S12-A twelve-element
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WRITE FOR
BULLETIN SP-167A

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TECHNICRAFT 3 BASIC FLEXIBLE WAVEGUIDE TYPES

DIFFERENT CHARACTERISTICS

Advantageous as it would be to manufacturers and users to standardize, experience has shown that more than one set of characteristics is needed to meet the requirements of varied applications. To select the correct flexible waveguide for an application, consider all characteristics involved and judge one type of construction against other types.

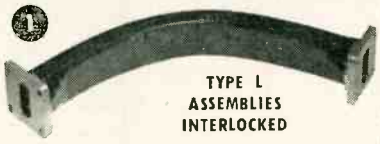
If a flexible assembly is desired to provide a 90° E-plane bend AND a 90° twist, Technicraft Type L, Interlocked Construction is the logical choice. For a short, very flexible, detachable coupling to a frogile X-band magnetron, or for flexible elbows or bends, Technicraft Type S, Seamless-Corrugated Assemblies are ideal. These units can be internally pressurized without a jacket. For installations involving a difficult shock mount problem where long life is required with repeated flexibility in ALL planes simultaneously, Technicraft Type V, Vertebra Assemblies will provide unequalled performance.

Great care is taken in the manufacture and testing of Technicraft flexible woveguide assemblies to assure low attenuation and low standing wave ratio. Technicraft assemblies have electrical characteristics which remain stable with flexing.

Our engineers will gladly supply information on different assemblies and recommend the correct type for your particular application. Send us complete details of your problems on flexible and rigid waveguide assemblies, or combinations of both.

It's New!

Technicraft Laboratories Bulletin F-2 entitled "How to Select Flexible Waveguide Assemblies" now available upon request.



1

TYPE L ASSEMBLIES INTERLOCKED

Electrical Characteristics Stable with bending AND TWISTING

2

TYPE S ASSEMBLIES SEAMLESS-CORRUGATED

Preformed flexible couplings maintain desired shape

3

TYPE V ASSEMBLIES VERTEBRA

Unequaled for shock mounts

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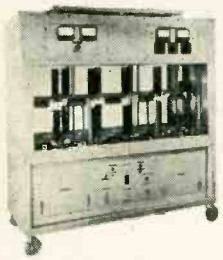
Specialized Industrial Electronic Equipment



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AGING RACK

- for simultaneous testing of 25 power supplies for projection television system.
- Permits checking of B+ drain and output KV of each 27KV power supply from a central switchboard.
- Contains regulated power supply of the following specifications:
- Less than ½% output voltage change with load variations from 0—1.5 amperes.
- Voltage adjustable from 250 to 450.
- Automatic interlocks for starting at low voltage.
- Overvoltage trip interlocks.
- Many other safety and convenience features.

BETA *Can build it*

BETA is equipped to engineer and build specialized electronic equipment of all types. Whether you need a single unit for production purposes or several hundred as part of a finished product—

BETA CAN BUILD IT!

BETA also manufactures a standard line of Kilovoltmeters, Electronic Microammeters, Portable 0-30 KV Power Supplies and custombuilt High Voltage Power Supplies up to 200 KV.

Field Engineers throughout the country are at your service to discuss our products more thoroughly with you.

SEND FOR DESCRIPTIVE LITERATURE—Dept. E

BETA ELECTRONICS CO.
1762 Third Ave., New York 29, N. Y.

panded television tube production. The new plant contains approximately 98,000 square feet of space. Acquisition of the plant is consistent with Sylvania's policy of industrial decentralization now operating in twenty-five plants located in five states.

FM ASSOCIATION has moved its offices from the Munsey Building to 526 Dupont Circle Building, Washington, D. C.

SPRAGUE ELECTRIC CO., North Adams, Mass., recently acquired the Herlec Corp., Milwaukee, Wisc., to expand production and development of ceramic capacitors and printed circuits.

THE AMERICAN STANDARDS ASSOCIATION sectional committee on radio has been reactivated to coordinate Joint Army-Navy specifications with civilian standards.

COSSOR (CANADA) LTD. now occupies its new plant and temporary offices in Halifax, Nova Scotia, and will produce its own twin-beam oscillographs and other electronic devices as well as distribute instruments imported from the parent company in England.

AIRBORNE INSTRUMENTS LABORATORY, INC. has leased 10,000 sq ft of space in a building at 61 Second St., Mineola, N. Y., to house its engineering and production division.

ALLEN B. DUMONT LABORATORIES, INC., recently acquired title to the former Wright Aeronautical plant, East Paterson, N. J., to house its television receiver assembly lines, general offices and engineering laboratories.

ELECTRICAL REACTANCE CORP., Franklinville, N. Y., has acquired a new plant at Myrtle Beach, S. C., to increase facilities for radio and television component manufacture.

CRAVEN, LOHNES AND CULVER, consulting radio engineers, is a new partnership continuing the practice of Lohnes & Culver in the Munsey Bldg., Washington, D. C.

FARNSWORTH TELEVISION & RADIO CORP. has consolidated and ex-

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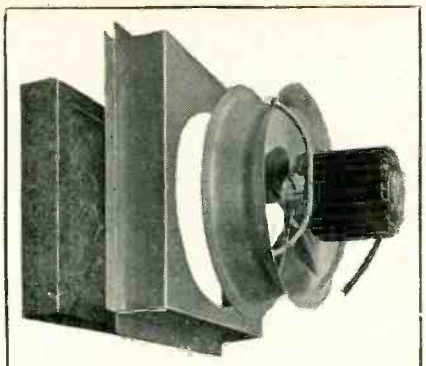


CABINET FLUSHING FAN

300 to 450 CFM actual displacement • For both push and pull operation • Choice from 6 propellers to match backpressure 115 or 220 Volt 50 to 60 Cycles • Totally enclosed ballbearing motor to operate in ambients of 55°C to 60°C. Resilient mounting incorporated • Low noise level • High quality finish

NOW A STANDARD COMPONENT IN THE COUNTRY'S LEADING BROADCAST & TV TRANSM'S SPECIFIED IN CAA & NAVY TRANSMITTERS

Write for copy of:

RP-22	Technical description & dimensions
RM-24	Airflow & motor temp. rise curves
AN-1	Application Note on dustfilters
AN-4	Fan installation suggestions
RM-27	Prices & discount schedule

Send for complete catalogue on ROTRON cooling components. Designers & manufacturers of components to Gov't spec's.

ROTRON DIVISION
(A Division of Jenckes Knitting Machine Co. of Pawtucket, Rhode Island—Est'd 1898)
Engineering Sales Office
WOODSTOCK, N. Y., P.O. BOX 272

RAWSON Thermocouple Meters

No Wave Form Errors
R.M.S. Readings
½ of 1% Accuracy

SINGLE RANGES from 1 ma full scale to 10 amperes full scale. Good from DC to 2 megacycles and higher.

MULTIPLE RANGE INSTRUMENTS with selector switches. Any practical combination of voltage or current ranges furnished to order.

Example 1.5-5-15-50-150-1500 volts at 1000 ohms per volt, DC to 10 KC.

RAWSON THERMAL MULTIMETERS

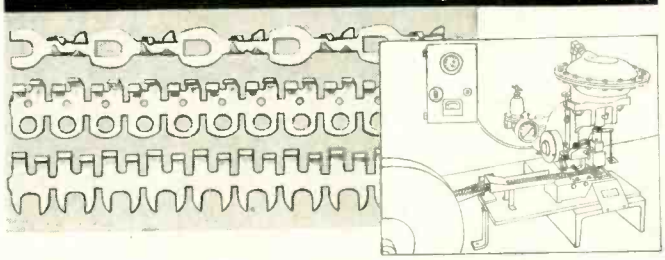
Ranges on one meter—10 ma to 3 amps, 300 mv to 1000 volts.

Write for Bulletin 502

RAWSON ELECTRICAL INSTRUMENT COMPANY
111 Potter Street Cambridge, Mass.

Representatives
Chicago Los Angeles New York City

Now Terminals Can Be ATTACHED & SOLDERED in ONE Automatic Operation!



New Terminal Attaching Machine—

attaches and solders various sizes and types of pre-soldered tandem terminals (supplied on reels) at rates up to 1200 per hour. Machine cuts off, clinches and solders terminals in one instantaneous operation. Eliminates handling of loose terminals, solder and flux to increase production and lower costs on long runs. Standard types available. Strong, perfectly soldered joints are assured, as absolute control of heat is maintained. Send for detailed information, enclose sample of wire and terminal now used. Address Dept. E.

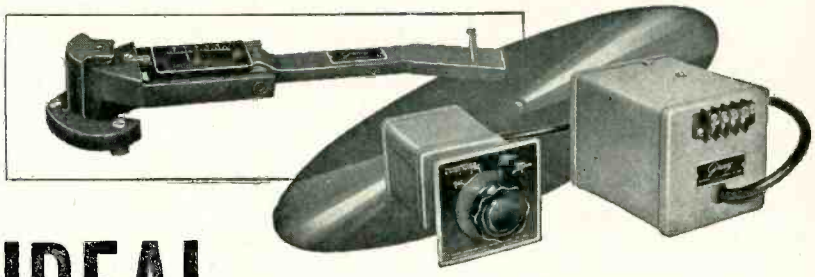
For ordinary runs in moderate quantity we continue to produce

SEPARATE TERMINALS for ELECTRIC WIRES

We also make SMALL METAL STAMPINGS, exact to Customer's Prints. Modern Plant, Equipment and Methods. Precision Work. Moderate Die Charges. Prompt, Dependable Service.

PATTON-MacGUYER COMPANY
17 Virginia Avenue, Providence, R.I.

GRAY TRANSCRIPTION ARMS and EQUALIZERS



IDEAL *for the* New LP Records

The GRAY TRANSCRIPTION ARM 103-LP, with Selected GE Variable Reductance Cartridge with 1 mil Diamond Stylus, has been especially designed for use with the new LP Micro-Groove Records. Due to such features as **adjustable stylus pressure, frictionless motion, self-leveling base** and **the accommodation of any standard cartridge,** arm obsolescence is precluded. Arm, with 1 mil Diamond Stylus Cartridge, $77.95.

The GRAY #602 4-position EQUALIZER for GE Cartridge, adjustable for conventional records, transcriptions, and LP recordings—by the turn of a switch. Complete at $53.50.

Inquiries invited for development and manufacturing.

GRAY RESEARCH & DEVELOPMENT COMPANY, Inc.
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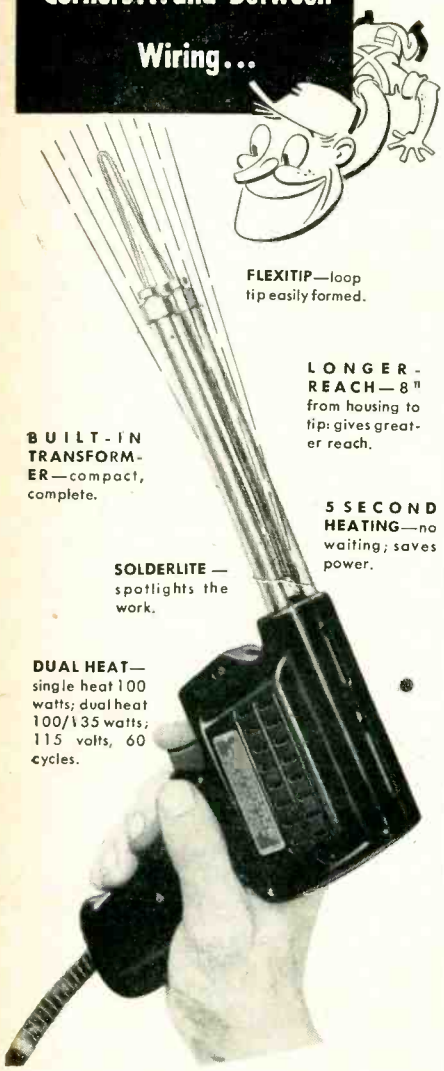
How to Solder Around Corners... and Between Wiring...



Form the FLEXITIP on your 8" Weller Gun into any shape you want and see how it slides around corners, between wiring, into the tightest spots even when the job's buried deep.

Solderlite and 5-second heating mean hours and dollars saved—your Weller Gun will pay for itself in a few months. And because the transformer is built in—not separate—the Weller Gun is a complete, compact unit, easy to use. There's no need to unplug the gun when not in use; heat comes "on" only when the trigger is pulled.

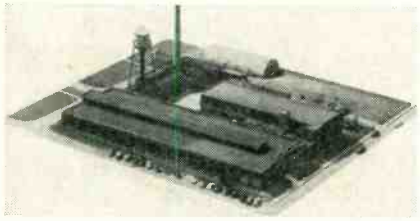
For laboratory and maintenance work, we recommend the efficient 8" model—DX-8 with dual heat; or 4" types S-107 single heat and D-207 dual heat. Order from your distributor or write for bulletin direct.

Be sure to get your copy—SOLDERING TIPS, the new Weller Handy Guide to easier, faster soldering—20 pages fully illustrated. Price 10c at your distributor's or write direct.

WELLER
MANUFACTURING COMPANY
806 PACKER STREET • EASTON, PA.

panded its Fort Wayne, Indiana, plant to include engineering, research, procurement, manufacturing and sales activities.

NATIONAL UNION RADIO CORP., Orange, N. J., has purchased a 70,000-sq ft plant in Hatboro, Pa.,



National Union's new Hatboro plant

for the production of all types of c-r tubes.

WILLIAM BRAND & Co., New York, N. Y., has acquired the tubular braiding plant of the International Braid Co., Fall River, Mass., to provide extra capacity for untreated braided sleeving.

INDUSTRIAL ELECTRONICS CO., INC., Hanover, Mass., was recently formed to manufacture industrial electronic controls.

THE WAVEGUIDE MFG. & EQUIPMENT CO., INC., manufacturers of microwave and waveguide equipment, have moved into larger quarters at 190A Duane St., New York City.

REFCO CORP., New York City, was recently formed to manufacture radio, electrical and electronic products to specification.

PERSONNEL

WILLIAM A. WILDHACK, member of the NBS staff since 1935 and also associate editor of the *Review of Scientific Instruments*, has been named chief of the Missile Instrumentation Section of the Electronics Division, National Bureau of Standards.

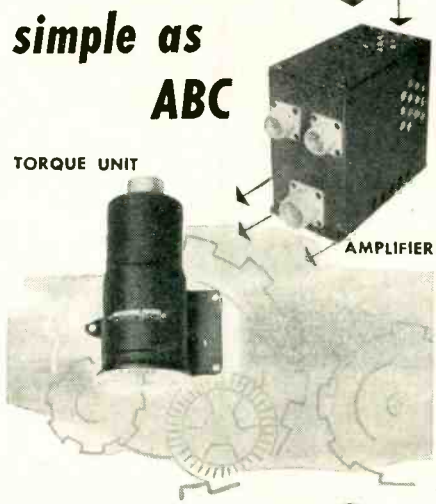
MARVIN W. SMITH, formerly vice-president in charge of engineering and research at Westinghouse Electric Corp., was recently elected executive vice-president of Bald-

Let Eclipse-Pioneer Remote Torque Amplifier Systems Do the Work...

Eclipse-Pioneer, foremost producers of Remote Indicating and Control Systems for aviation, have now developed similar systems for industrial applications. Basically, they are a means of translating a minute motivating force such as: motions of pressure, temperature, or moisture-sensitive elements into a predetermined type of work such as remote indication, or remote control of a function. Our engineers are available to help you save time, save space and save money with Eclipse-Pioneer Remote Torque Amplification Systems

*REG. U.S. PAT. OFF.

...They're as simple as ABC



ECLIPSE-PIONEER DIVISION of TETERBORO, NEW JERSEY
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Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, N. Y.

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New! JOHNSON

TYPE L VARIABLES

CERAMIC SOLDERED
FOR STABILITY-STRENGTH

BUTTERFLY TYPE

Available in Three Models:

2.8 to 10.5 mmf, 4.3 to 26 mmf, 6.5 to 51 mmf. Spacing .030" and .080"

Two sets of stator contacts are provided for connecting components to either side of the variable without appreciably increasing lead inductance of the circuit.

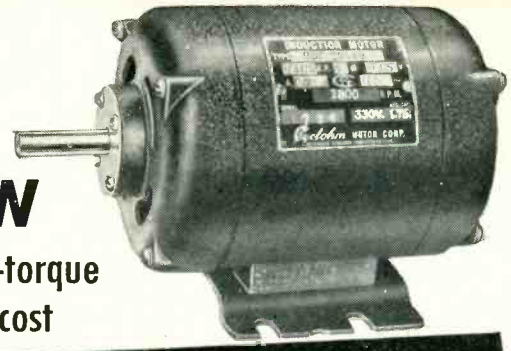
JOHNSON also makes Type L Variables in Single, Dual and Differential types in many different models.

All are ceramic soldered. There is nothing to work loose causing stator wobble and fluctuations in capacities.

Available in .030" and .080" spacings for all types of communications equipment having tuned circuits operating as high as several hundred megacycles.

Write For New JOHNSON Type L Variable Catalog Today!

JOHNSON
a famous name in Radio
E. F. JOHNSON CO., WASECA, MINN.



new
higher-torque
lower cost

Cyclohm SPLIT-PHASE

standard
and
synchronous
motors

● Now typical Cyclohm compactness and dependable performance are available in a new *Split-Phase* Motor—both Standard and Synchronous types. This new Cyclohm unit is ideal for vending machines, garage doors, appliances, blowers, control mechanisms, and many applications where its *high starting torque* is an advantage. Since no capacitor is required the cost is lower. Ball bearings or sleeve bearings. Horsepowers up to 1/15 in the Standard, 1/25 in the Synchronous. Various speeds, voltages and frequencies. Write today for details—also for information on Cyclohm Capacitor Type and Speed Reducer Motors.

CYCLOHM MOTOR CORP.
Division Howard Industries, Inc.
5-17 46th Road, Long Island City 1, N. Y.

For HEAVY DUTY WORK! Severest Electrical Services!

P-506-CE
Plug with Cap

S-506-DB
Socket with
deep Bracket

JONES PLUGS & SOCKETS
500 SERIES
Proven Quality

For 5,000 Volts, 25 Amperes per Contact Alterable by circuit Characteristics.

Socket contacts phosphor bronze, knife-switch type, cadmium plated. Plug contacts hard brass, cadmium plated. 2, 4, 6, 8, 10, and 12 contacts. Plugs and sockets polarized. Long leakage path from terminal, and terminal to ground. Caps and brackets, steel parkerized (*rust-proofed*). Plug and socket blocks interchangeable in caps and brackets. Terminal connections most accessible. Cap insulated with canvas bakelite.

Write for Jones BULLETIN 500 for full details on line.

HOWARD B. JONES DIVISION
Cinch Mfg. Corp.
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An Engineer's DREAM COME TRUE!

When you hear the Newcomb "Red Knob" record condition compensator for the first time, we are sure you'll agree it's really a "*Dream Come True.*" These two great Newcomb Amplifiers with the "Magic Red Knob" do wonders in eliminating needle scratch and record distortion while retaining the maximum natural brilliance.

Of course, it's not only this remarkably effective scratch control that gives you the extreme quality achieved by these two amplifiers. Their measured performance is superb. In every respect, they represent the ultimate in technical perfection, ***and in addition***, there's a listening quality that even performance curves do not tell. That's why we ask you to be sure and hear these two Red Knob Amplifiers before you buy. Both have built in Pre-Amplification for G.E. or similar variable reluctance type pickups, plus inputs for AM-FM radio and crystal pickups, and the finest of tone controls.

Both are individually, and completely, custom tested to insure each unit will be "Laboratory Perfect." A "Certificate of Performance" accompanies each amplifier. Look for it. It is your assurance of individual perfection.

See your Newcomb Distributor or write for detailed specifications.

KXLP-30
30 WATTS
LIST PRICE **$225.00**

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DEPT. H, 6824 LEXINGTON AVE., HOLLYWOOD 38, CALIFORNIA

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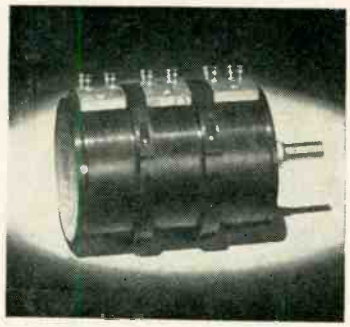
ACCURATE PHASING WITH T.I.C. METHOD OF GANGING PRECISION POTENTIOMETERS

MECHANICAL SPECIFICATIONS

- Precision machined aluminum base and cover 2" diameter, 1" depth.
- Precision phosphor bronze bushing.
- Centerless ground stainless steel shaft.
- No set screws.
- Mechanical rotation—360°.
- Clamping method of gauging permits individual adjustment of angular position.
- Temperature range—850°F to +165°F.
- Rotational Life—At least 1 million complete cycles of revolution.

ELECTRICAL SPECIFICATIONS

- Winding—both linear to 0.2% and non-linear to 1% accuracies.
- Paliney contact to winding; two-brush rotor take-off assembly with precious metal contacts.
- High, uniform resolution provided by our method of winding non-linear resistances.
- Electrical rotation maximum 320°.
- All soldered connections (except sliding contacts).



(3 gang RV-2)

Write today for bulletins on other T.I.C. products; Z-Angle Meter . . . R.F. Z-Angle Meter . . . R-F Power Oscillator . . . Translatory Variable Resistors . . . Slide Wire Resistance Boxes . . . Phase Angle Meter.

This general line of precision potentiometers was developed in collaboration with the Fire Control Section of the Glenn L. Martin Company.

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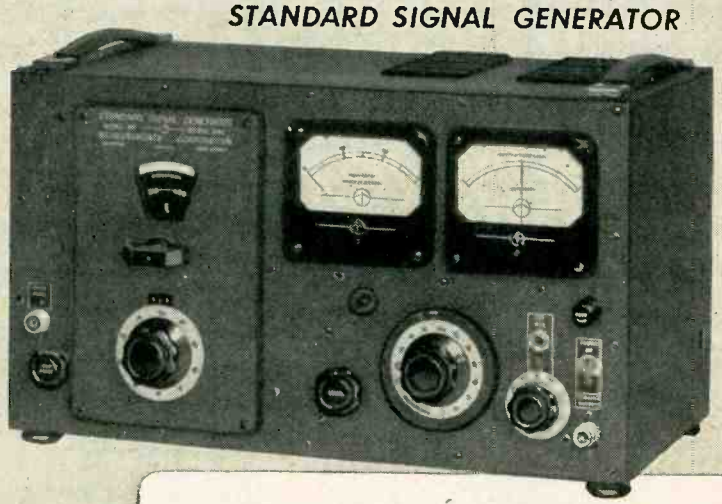
MEASUREMENTS CORPORATION *MODEL 80*

STANDARD SIGNAL GENERATOR



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Standard Signal Generators
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Television and FM Test Equipment

2 to 400 MEGACYCLES

MODULATION: Amplitude modulation is continuously variable from 0 to 30%, indicated by a meter on the panel. An internal 400 or 1000 cycle audio oscillator is provided. Modulation may also be applied from an external source. Pulse modulation may be applied to the oscillator from an external source through a special connector. Pulses of 1 microsecond can be obtained at higher carrier frequencies.

FREQUENCY ACCURACY ±.5%

OUTPUT VOLTAGE 0.1 to 100,000 microvolts

OUTPUT IMPEDANCE 50 ohms

MEASUREMENTS CORPORATION
BOONTON NEW JERSEY

win Locomotive Works, Eddystone, Pa.

BENJAMIN P. SHIRO, formerly with Noblitt-Sparks engineering department, has been appointed plant manager of Stromberg-Carlson's Erie, Pa., plant which manufactures table radios and radio-phonographs.

DANIEL E. HARNETT, formerly president of the Harnett Electric Corp., Port Washington, N. Y., was recently appointed director of engineering at Emerson Radio and Phonograph Corp., New York, N. Y.

CLEDO BRUNETTI, former chief of the engineering electronics section of the Bureau of Standards, is now associate director of the Stanford Research Institute.

C. Brunetti

E. Maxwell

EMANUEL MAXWELL, having worked in the microwave field at MIT since 1941, has joined the National Bureau of Standards' Cryogenics Section, where he will work on superconductivity and low-temperature physics.

GEORGE F. MAEDEL has been promoted from superintendent to vice-president and general superintendent of RCA Institutes, Inc., New York City.

JOHN E. WHITE has been appointed chief of the Electron Tube Section of the Electronics Standards Laboratory of the National Bureau of Standards. He was previously assistant chief of the Bureau's Electron Tube Laboratory.

COURTNEY SNELL, video control engineer for NBC, has been appointed field supervisor for WNBQ operations in the Chicago area.

RAYMOND W. RODGERS, formerly with WFIL-TV, has been appointed

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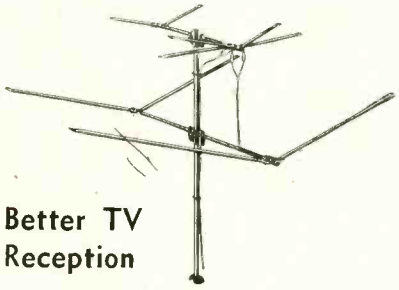
PREMAX

Proved . . .



Better TV Reception

On All 12 Channels

Eliminates interference! Insures stronger signal! Covers ALL television channels! Easiest antenna to erect! Low cost to dealer or service man! Hundreds of satisfied dealers attest to the satisfactory reception being secured with the Premax T-448 all-channel antenna.

Send for specifications, test charts and prices.

PREMAX PRODUCTS
DIVISION CHISHOLM-RYDER CO., INC.
4902 Highland Ave., Niagara Falls, N. Y.

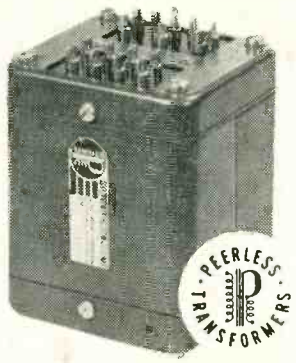
Littelfuse Makes Headline News with "In-Line" Fuse Retainer

Littelfuse's latest development: the "in-line" fuse retainer for fingertip ease in fusing. Precisely molded of high impact bakelite and designed primarily for low voltage applications: car radios, heaters, spot lights and other automotive trouble spots where a fool-proof easy-to-handle fuse installation is desired. The strongly spring-locked retainer opens with a "push-and-twist" of the finger tips. Inside, the fuse rests against knife-edged, cup contacts that assure greatest degree of contact with lowest voltage drop. Doubled wall thickness at juncture of shoulder and lower body.

Available for all standard automotive fuse sizes. Retainer may be had with or without wire leads and terminals, with or without fuses.

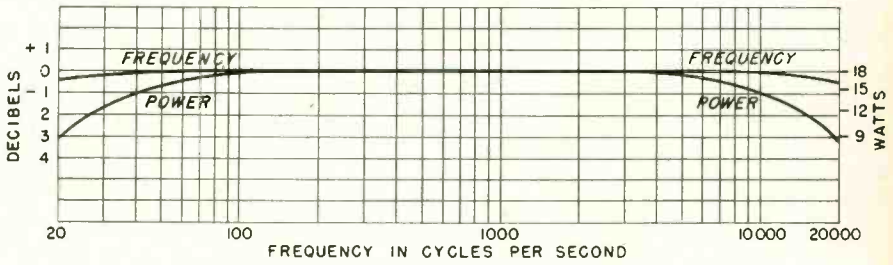
LITTELFUSE *Incorporated*
4769 N. RAVENSWOOD AVE., CHICAGO 40, U. S. A.
NITE-T-LITE • SWITCH-LITE • IGNITION FRITZ • NEON INDICATORS
SWITCHES • CIRCUIT BREAKERS • FUSES, MOUNTINGS AND ACCESSORIES

AUDIO DESIGN ENGINEERS!



In amplifier design, the weakest link in the chain may now be your strongest! Often the difference between a good amplifier and a mediocre amplifier lies with the output transformer. Peerless 20-20 Line output transformers handle full rated power from 40 to 10,000 cycles within 1 db. Examine this typical curve for an 18-watt rated transformer which shows power output and frequency response. Because of careful design, feedback up to 25 db can be used with these transformers without experiencing appreciable difficulty from phase shift.

PEERLESS 20-20 LINE OUTPUT TRANSFORMERS



Peerless guarantees that published characteristic curves are true, accurate, unretouched, made on production line items.

PEERLESS ELECTRICAL PRODUCTS DIVISION
6920 McKinley Ave., Los Angeles 1, Calif.
161 Sixth Avenue, New York 13, N. Y.

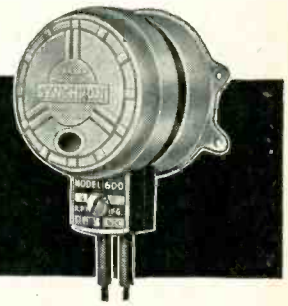
ALTEC LANSING CORPORATION

Frazar & Hansen Ltd., 301 Clay Street, San Francisco 11, Calif., *exclusive export agent*

SYNCHRON
TRADE MARK

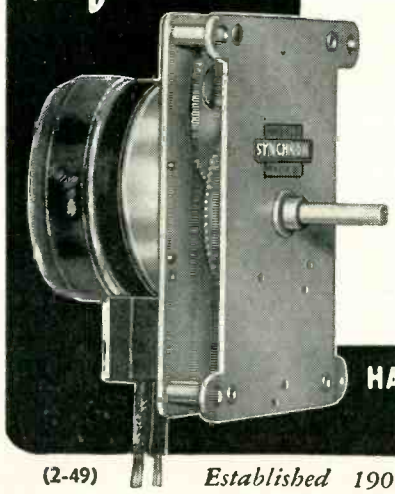
TIMING MOTORS AND TIME MACHINES

Synchronous Self-starting Self-oiling



Never Need Oiling . . . Operate Efficiently In Any Position . . .

Motor is equipped with oil storage reservoir and patented oil feed to bearings. Rotor shaft, reduction train, and output shaft, all have double bearings to reduce vibration and assure quiet, efficient operation when mounted in any position.



Brass Gears Operate Against Steel Pinions—Steel Shafts Operate In Babbitt Bearings

There is no compromise for quality in the design and construction of SYNCHRON Timing Motors and Time Machines! If you have any timing design problems, SYNCHRON offers the benefit of long experience and capable design assistance. Write for catalog and engineering data.

HANSEN MANUFACTURING CO., INC.
Princeton 10, INDIANA

(2-49) *Established 1907 - a Pioneer in Synchronous Motors*

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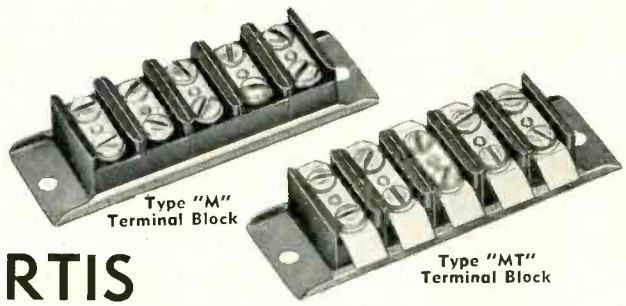
A Pair of Space Savers for Your Control Wiring



CURTIS

Type 'M' and 'MT'

TERMINAL BLOCKS

Write for your copy of Bulletin DS-119.

Sturdy and compact, these Curtis Terminal Blocks are specially designed for installations where space is limited. Type "M" is plain; Type "MT" is furnished with white fibre marking tags, providing both circuit identification and increased insulation. Both are factory-assembled in 1 to 24 terminals. Maximum insulation from the mounting channel is afforded by the solid terminal base. Ample clearance and creepage distances for use in circuits carrying up to 300 volts, 15 amps.

CURTIS DEVELOPMENT & MFG. CO.

Terminal Block Sales —
5 North Crawford Avenue, Chicago 24, Illinois
Factory — Milwaukee 10, Wisconsin

COUNT TEN TIMES FASTER ...and accurately!

MODEL 310
ILLUSTRATED
PRICE $185.00

The new Photo-electronic Counter was designed for industrial applications in which mechanical counters do not count accurately or wear rapidly because of counting speed. One of the well-known Potter electronic counter decades is used to scale down the operating speed of a reliable electromechanical register. In the Model 310, the photo-electric "eye" is located inside the cabinet and the light enters through a small window at the rear. In the Model 312, the photo-electric "eye" is housed separately for remote counting. Small objects as well as closely spaced parts can be accurately counted since the width of the photo-electric beam is only ¼ inch, and does not require complete interruption for actuation. Another version, the Model 311, uses an electromagnetic pick-up coil for counting shaft rotation without contact.

For complete literature or consultation on high speed counting, timing and control problems call or write Dept. 6-U.

NEW POTTER PHOTO-ELECTRONIC COUNTER

- ★ High speed—counts at rates up to 6000 per minute
- ★ Long life—mechanical register operates at only 1/10 normal rate
- ★ Direct reading—units digit is read from electronic counter, other digits from mechanical counter
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- ★ Compact — completely self-contained, no wiring required, easy to install
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INSTRUMENT Potter COMPANY

acting chief engineer of WDTV, DuMont tele network station in Pittsburgh.

JOHN R. NILES, until recently group supervisor at the Engineering Research Institute, University of Michigan, is now chief engineer at Radioactive Products, Inc., Detroit.

DAVID F. TUTTLE, former Bell Labs apparatus development staff member, has been named acting associate professor of electrical engineering at Stanford University, Calif.

WILLIS W. HARMAN, previously with an Office of Naval Research project on vacuum tubes, is a newly appointed acting assistant professor of electrical engineering at Stanford University, Calif.

CHESTER H. PAGE, formerly chief of the Electronic Computer Section, has been named electronics consultant for the National Bureau of Standards. His services will be available to all Bureau divisions concerned with electronic research.

FRANK M. FOLSOM has advanced from the position of executive vice-president in charge of RCA Victor to president of Radio Corp. of America.

WALTER C. REED, after 20 years with GE at Pittsfield, Mass., as development engineer, has established a consulting engineering office in Dalton, Mass.

ROBERT BIGWOOD, formerly affiliated with the American Broadcasting Co., was recently appointed facilities engineer for the DuMont television network.

RALPH HACKBUSCH, vice-president and general manager of Stromberg-Carlson Ltd., Toronto, has been elected president of the Canadian Radio Technical Planning Board.

OLIVER E. BUCKLEY, president of Bell Telephone Laboratories, has been appointed by President Truman to a six-year term as member of the general advisory committee of the Atomic Energy Commission.

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Vital Aids TO

MANUFACTURERS OF MINIATURE TUBE RADIOS AND EQUIPMENT

★ Star Miniature Socket Wiring Plugs for accurate alignment of miniature socket contacts during wiring. Precision cast of zinc base alloy—pins of stainless steel. #JE-9 (9 pin); #JE-10 (7 pin).

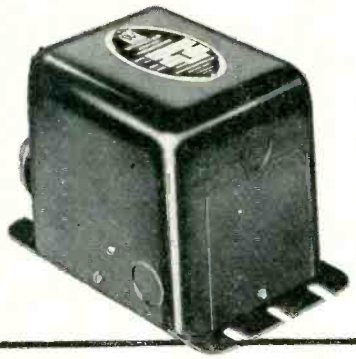
★ Star Miniature Tube Pin Straighteners (with stainless steel insert) to obtain a perfect fit when the tube is placed in the equipment. #JE-15 (9 pin); #JE-13 (7 pin).

Scientifically designed — Precision made
Immediate Delivery in Any Quantities

★STAR EXPANSION PRODUCTS CO., INC.
147 CEDAR STREET, NEW YORK 6, N. Y.

Visit Our Display Booth, I.R.E. Show, March 7-10, 1949

WEBSTER RACINE ELECTRIC WISCONSIN



uses

PARAMOUNT PAPER TUBES

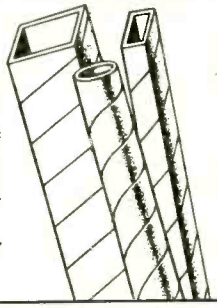
in Oil Burner Ignition Transformer

Used as a core for primary and secondary coils . . . because of its moisture resistant qualities and greater mechanical strength.

SEND FOR ARBOR LIST OF OVER 1000 SIZES

Lists great variety of stock arbors. Includes many odd sizes. Write for Arbor List today.

Inside Perimeters from .592" to 19.0"



● This is typical of the wide use of PARAMOUNT paper tubes by leading manufacturers of electrical, radio and electronic products. With over 15 years of specialized experience, PARAMOUNT can produce exactly the shape and size tubes you need for coil forms or other uses. Square, rectangular, or round. *Hi-Dielectric, Hi-Strength.* Kraft, Fish Paper, Red Rope, or any combination, wound on automatic machines. Tolerances plus or minus .002". Made to your specifications or engineered for *you.*

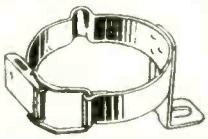
PARAMOUNT PAPER TUBE CORP.
616 LAFAYETTE ST., FORT WAYNE 2, IND.
Manufacturers of Paper Tubing for the Electrical Industry

BIRTCHER

STAINLESS STEEL - LOCKING TYPE

TUBE CLAMPS

Stainless Steel



Corrosion Proof

83 VARIATIONS

Where vibration is a problem, Birtcher Locking TUBE CLAMPS offer a foolproof, practical solution. Recommended for all types of tubes and similar plug-in components.

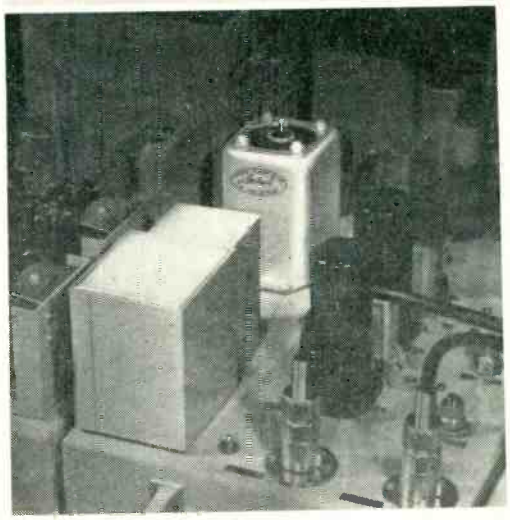
More than three million of these clamps in use.

FREE CATALOG

Send for samples of Birtcher stainless steel tube clamps and our standard catalog listing tube base types, recommended clamp designs, and price list.

THE BIRTCHER CORPORATION
5087 HUNTINGTON DR. LOS ANGELES 32

INDUCTANCE CONTINUOUSLY VARIABLE



Lenkurt knows how

Ampex Electric Corp., manufacturer of the new Ampex broadcast-type tape recorder, uses a Lenkurt Adjustable-Core Molded Pot Assembly for peaking the erasing oscillator to required frequency. Inductance is adjustable, stepless, in a 20 per cent range up to 3 henries.

Other advantages are improved Q, simplified shielding, economy of space and weight, and the possibility of mounting parts closer together. Write for data.

Lenkurt

LENKURT ELECTRIC CO.
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A WORKSHOP HIGH-GAIN ANTENNA

will . . .

More than triple the effective power of the transmitter.

Increase the effective power of the mobile transmitter.

Increase the operating area.

Permit the use of low power, low cost equipment.

Workshop High-Gain Beacon Antennas are designed specifically for the 152-162 megacycle band —taxicab, fire, police, and private fleet communications.

Design Features

- Low angle of radiation concentrates energy on the horizon.
- Symmetrical design makes azimuth pattern circular.
- Can be fed with various types of transmission lines. Special fittings are available for special applications.
- Enclosed in non-metallic housing for maximum weather protection.

Available for immediate delivery through authorized distributors or your equipment manufacturer.

—THE— WORKSHOP ASSOCIATES
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Specialists in High-Frequency Antennas

64 NEEDHAM STREET
Newton Highlands 61, Mass.

NEW BOOKS

Principles of Microwave Circuits

EDITED BY C. G. MONTGOMERY, R. H. DICKE AND E. M. PURCELL. *Volume 8 in MIT Radiation Laboratory Series, published by McGraw-Hill Book Company, New York*, 1948, 486 *pages*, $6.00.

THIS work is a broad study of the properties of passive space-charge-free microwave elements. Its technique is to proceed from the basic laws which govern such devices, wherein much is said about the behavior of virtually any geometrical configuration of conducting walls and dielectric spaces, to an examination of the special characteristics of those elements which, because of their relative simplicity, are in widespread use.

The authors proceed along two fundamental lines. The first they call the Maxwellian approach, wherein the ambitious program of complete field description throughout the element is provided, in theory at least, by Maxwell's equations and the requirements of boundary conditions. The second they call the electrical engineering approach, wherein interest is confined basically to impedance measurements at the various element terminals, and the erection of equivalent circuits in terms of them.

As an apt illustration, it is pointed out that the electrical engineer is seldom concerned with the solution of magnetic distribution around an inductor. For low-frequency work he wants to know only two quantities, inductance and resistance, to ascertain performance in the circuit in question. And these quantities, while admittedly available from a Maxwellian solution (along with a great deal of unwanted information) are more simply obtained via terminal measurements.

Of course, ultimate justification for the impedance technique is itself provided by Maxwellian theory, and this justification is fully and concisely presented.

The book is written on an advanced level. Having established the impedance concept and prepared for description in terms of equivalent circuits, the authors use whatever mathematical weapon is most

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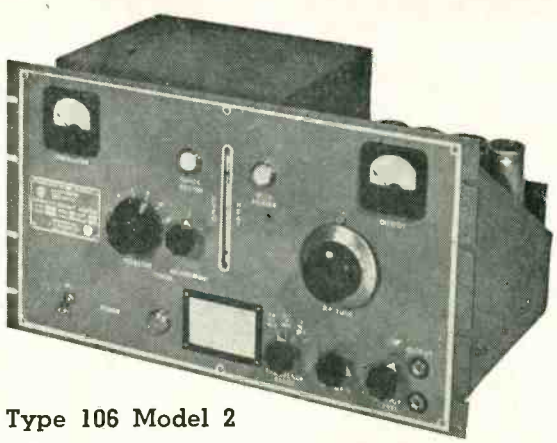

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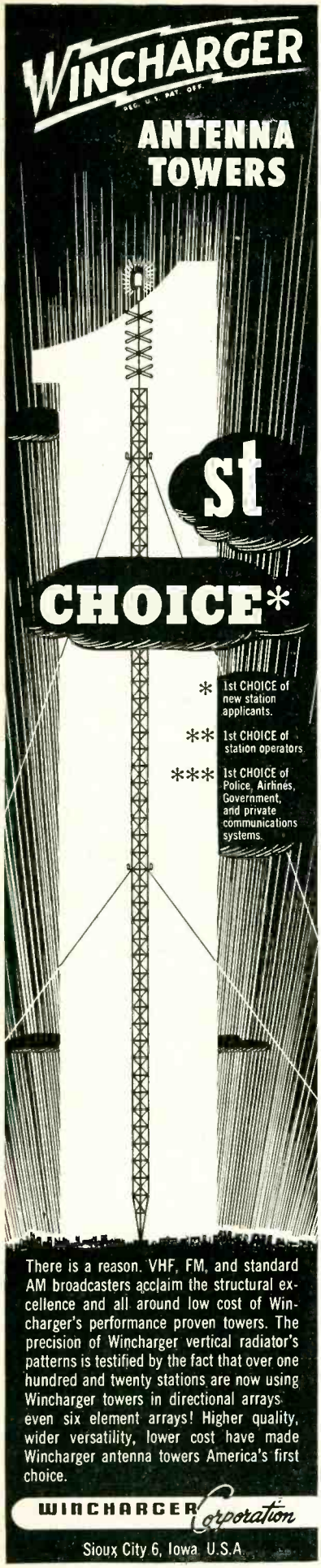

effective in the running attack. There is much manipulation of matrices, as is to be expected in equivalent circuit studies of multiterminal systems, with repeated reference to Maxwell when the situation requires it. For readers who are practiced in these techniques no difficulty will arise, for the developments, while extensive, are complete. Others may be hard-pressed to draw off the physical concept that is sometimes left as an implicit by-product of the development at hand.

With regard to scope, the finite length of the book has imposed no regrettable limitation. Specific studies are made of irises, shorting wires and changes in dimensions; tunable screws, holes and slots; bends, branches, T's, ring circuits and turnstiles; systems involving lossy dielectrics, imperfect conductors, ferromagnetic materials and ionized gases.

The treatment of these specialized problems alone will guarantee the book's welcome by microwave engineers, and the broad generalizations from inquiries into the properties of symmetry, resonance, mode transformation and scattering, will be of high interest to theoretical workers.—J. F. MCALLISTER, General Electric Co., Syracuse, N. Y.

Microwave Transmission Circuits

EDITED BY GEORGE L. RAGAN. *Vol. 9 of the M.I.T. Radiation Laboratory Series. McGraw-Hill Book Co., New York*, 1948, 725 *pages*, $8.50.

THIS VOLUME, one of the ten in the MIT Radiation Laboratory Series devoted to the microwave art, provides the radio design engineer with a wealth of valuable information on microwave transmission circuits and their components. Far from functioning solely as a designers handbook, this book provides the reader with an understanding of the underlying principles involved in each type of component described. As a consequence, it will be of considerable value even as newer and more advanced designs evolve. The subject matter is efficiently arranged, starting with a chapter on elementary line theory

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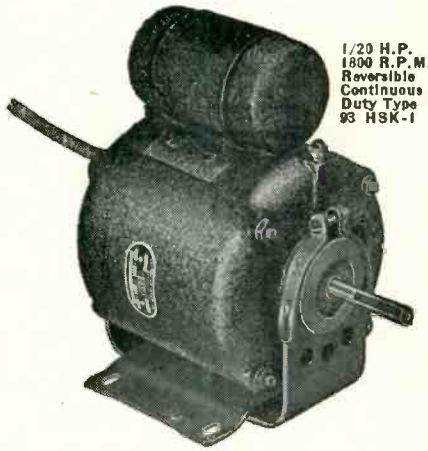

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Electronic Instruments

Volume 21 of the MIT Radiation Laboratory Series, EDITED BY IVAN A. GREENWOOD, JR., J. VANCE HOLDAM, JR., AND DUNCAN MACRAE, JR. *McGraw-Hill Book Co., New York*, 1948, 721 *pages*, $9.00.

THIS VOLUME is divided into five parts: Electronic Analogue Computers, Instrument Servomechanisms, Voltage and Current Regulators, Pulse Test Equipment, and Design and Construction of Electronic Apparatus. Of these, the part on servos occupies nearly half the volume, and the part on computers about a third; the other three parts are short. These subjects are grouped into this volume because they are the central elements of modern measuring and controlling instruments.

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carried from the broad requirements through functional block diagrams to detailed circuits. Other chapters describe and compare specific methods of performing mathematical manipulations. This first part of the volume is more important to the growing field of computers than the whole of Volume 27, "Computing Mechanisms and Linkages".

The second part, on servomechanisms, approaches the subject from the specialized viewpoint of high-performance instrument servos, but duplicates in some respects the fuller treatment given in Volume 25, "Theory of Servomechanisms". However, the clear and concise treatment of this part is more of a length suited to the instrument engineer than the longer treatment, and forms an essential addition to the part on computers. The part on servos is about equally divided into chapters on theory, specific methods, and components.

The content of the remaining three sections is sufficiently obvious from their titles not to need further comment here, other than to observe that many techniques and components are described in these coordinated sections for information on which readers would otherwise have to consult recent scattered magazine articles. A table, based on limited data, presents an interesting comparison of the characteristics of various voltage regulator tubes.

There is duplication of a sort throughout this volume with other volumes of the series. On the other hand, many of the computer circuits depend on high-gain wideband amplifiers the design of which is covered in Volume 18, "Vacuum Tube Amplifiers", and to which the reader is referred. Volume 22, "Cathode Ray Tube Displays", treats at greater length some of the material presented in the part of this volume on pulse testing. However, it would be misleading to make these comments about duplication appear as adverse criticisms. The approach of this volume in the series is that of the instrument engineer, who must design more reliable equipment than that required in other branches of the art.

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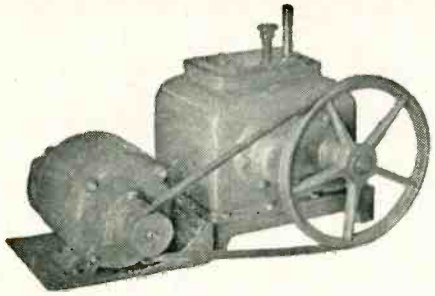

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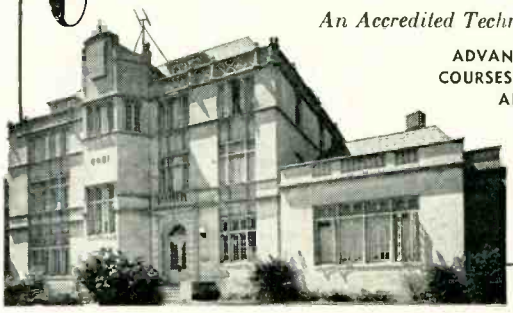

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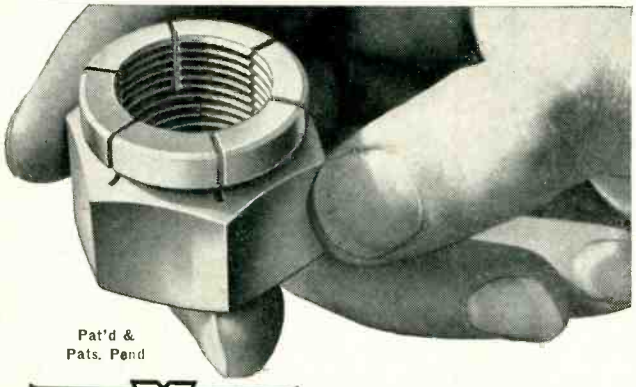

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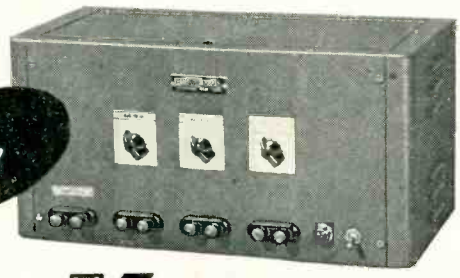

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this volume is its approach. Judged on this basis, the volume is an important contribution to the art, showing how accuracy and dependability can be built into electronic instruments. By precept, the authors also encourage the use of modern methods in solving problems of instrumentation.—F.H.R.

Handbook of Industrial Electronic Circuits

BY JOHN MARKUS AND VIN ZELUFF, *Associate Editors,* ELECTRONICS. *McGraw-Hill Book Co., New York,* 1948, 272 *pages,* $6.50.

THIS BOOK includes diagrams and descriptive material on some 440 electron-tube circuits. Although as the title indicates, they can all be considered as in the field of industrial electronics, many are radio communication circuits that have been adapted to the industrial field.

The contents pages list some 22 main groups. These include not only the familiar classifications, such as counting circuits, limiter circuits and motor control circuits, but cover a much wider field as indicated by the inclusion of metal-locating circuits and ultrasonic circuits.

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Not only will this book interest all engineers in the field of industrial electronics, but it will certainly prove to be of great help to group and section leaders in laboratories and engineering departments to aid them in getting new or inexperienced engineers familiar with the many circuits available today. The values of the circuit com-

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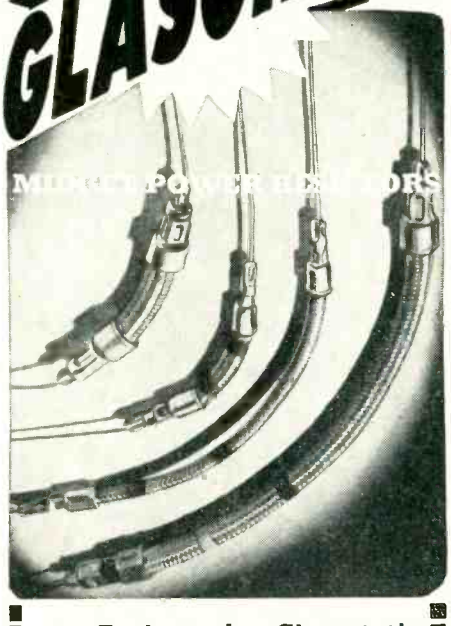

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It is up to date in that it includes a number of circuits used in nucleonic instrumentation. Its completeness is indicated by the inclusion of no less than 18 circuits under the grouping of multivibrator circuits.

It is provided with an excellent index in which the various circuits, in addition to their titles, are associated with familiar designations, such as flip-flop, loran testing and other frequently used terms, as well as commonplace applications as, for example, dish-washer control.

This book is primarily a tool-box for the industrial electronics engineer. Just as a toolmaker has a much finer set of tools than a machinist, so this publication lists circuits for workers and specialists in the field. It is not intended for elementary study of principles or theories.—W. C. WHITE, Electronics Engineer, Research Laboratory, General Electric Co., Schenectady, N. Y.

Principles of Servomechanisms

BY GORDON S. BROWN AND DONALD P. CAMPBELL, *Massachusetts Institute of Technology. John Wiley & Sons, New York*, 1948, 400 *pages*, $5.00.

PROFESSOR BROWN and his associate are well known to those who worked with servomechanisms during the recent war and to many others in the control and communication fields. Their efforts to bring together the concepts of these two fields, especially in the classroom, make this book a significant contribution to the literature of servomechanisms.

The subtitle "Dynamics and Synthesis of Closed-Loop Control Systems" defines the approach of the book, which is divided into chapters on dynamics of elementary systems, transient response using Laplace transforms, sinusoidal response, reduction of detailed system diagrams to functional elements (the material presented in this chapter can well be used in all fields of electronics to lighten the burden of the design engineer), methods of synthesis of the gain and frequency

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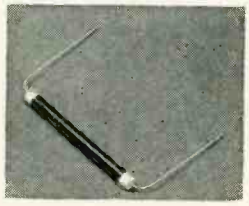

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functions, multiple disturbances, experimental procedures and a method for approximating the transient response from the frequency response, this last chapter being based directly on the thesis of G. F. Floyd prepared under the authors' supervision. An appendix contains problems for each chapter.

Compared with other books on control and servomechanisms, this text deals with logical methods rather than with the properties of specific components and assemblies. The authors present a comparison of Laplace and Fourier transforms, both of which are much used by electronic engineers, concluding (p 149) that ". . . the whole structure of algebraic synthesis . . . should be looked on as an implicit assistant rather than an explicit method of attack in synthesis. . . . The procedure . . . expressed in terms of the variable ($j\omega$) . . . contains all the information required."

Although the authors recognize (p 147) that "Synthesis involves essentially creativeness or invention somewhat beyond the scope of this book" their systemization of the method of attack frees designers from much of the uncertainties of approach. Throughout the book, the available methods of attack are reviewed and evaluated and specific tools presented in developing the means whereby engineers can anticipate the relative stability and other factors of performance of closed-loop controls operating under dynamic conditions.—F.H.R.

Radar Scanners and Radomes

EDITED BY W. M. CADY, M. B. KARELITZ AND LOUIS A. TURNER. *Volume 26 of the MIT Radiation Laboratory Series. McGraw-Hill Book Co., New York*, 1948, 491 *pages*, $7.00.

TECHNICALLY the radar scanner, or antenna mount, is the assembly of the antenna and the mechanism that causes the radiated beam to scan. A radome is a plastic enclosure for the antenna. The design and construction of both scanners and radomes involve much mechanical engineering as well as the electrical or electronic aspects which come naturally to mind.

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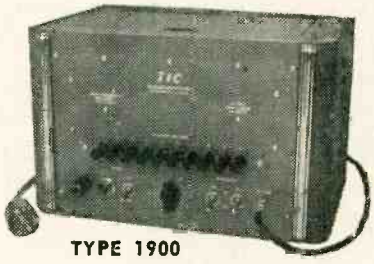

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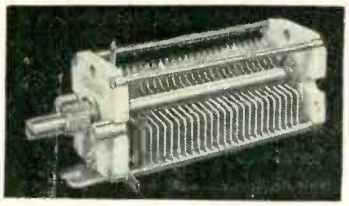

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Write for the LINDE Synthetic Sapphire Technical Data Sheet No. A-1.

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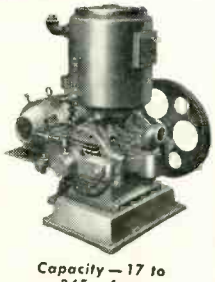

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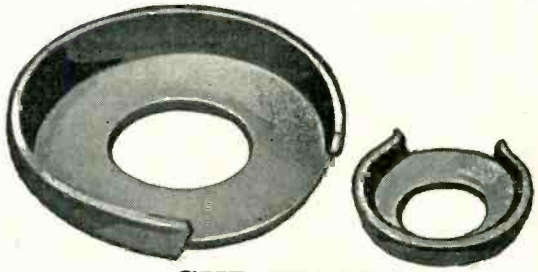

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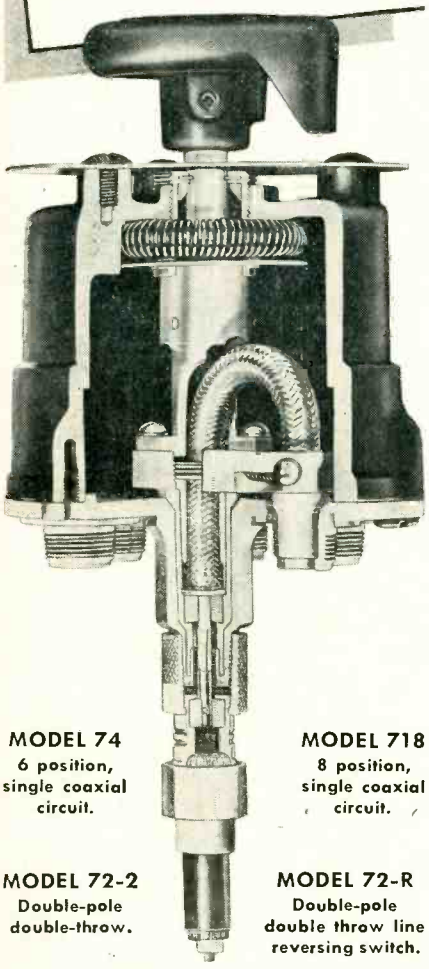

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subject could not be included in this volume, notably material on antennas operating at wavelengths longer than 10 cm, scanners not developed at the Radiation Laboratory and certain material the nature of which cannot be disclosed or learned because it was deleted for reasons of security.

In spite of these omissions the volume is useful for the simple reason that the material will be found nowhere else. Part I is largely concerned with the mechanical engineering of radar scanners; Part II deals with radomes and is the first comprehensive discussion of this subject. Both parts are properly broken down into smaller divisions, Part I dealing with such matters as ground and ship antennas, including material on reflectors and scanning feeds, ground antenna mounts, stabilization of ship and airborne antennas, and scanner control mechanisms.

Although Part II deals mostly with the electrical design of normal-incidence and streamlined radomes, there are chapters on the theory of transmission and reflection of electromagnetic waves by dielectric materials (hitherto untreated in texts), on radome materials and methods of fabrication, and on the installation and testing of radomes. Quite a bit of material on servomechanisms is included.

Although this reviewer is not passionately interested in radar systems or, especially, in mechanical engineering problems, he found this book not only instructive but interesting to read—and to prove it, he read it!—K.H.

Radio Fundamentals

By Arthur L. Albert, *Prof. of Communication Engineering, Oregon State College. McGraw-Hill Book Co., New York, First Edition,* 1948, 595 *pages,* $4.50.

Written primarily to serve as a radio course textbook for "beginning students, for radio technicians, and for radio amateurs," this newest contender for classroom adoptions assumes only that the readers have some training in elementary electrical theory. Chapters II, III and IV provide a con-

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densed review of the basic electrical theories applicable to radio, making the book essentially independent of the author's earlier "Electrical Fundamentals of Communication".

Willing or not, the reader of this book gets a full dose of radio, along with problem questions that would test the mettle of many a radio design engineer. Whether such a vast scope of material can be assimilated in the time generally made available for radio in the college curriculum or in trade schools is a moot question. Starting with acoustics and ending with radio receivers, the text goes through components, basic circuits, modulation, demodulation, transmitters and antennas, conscientiously covering even such specialized topics as six-phase rectifiers, single-sideband radio telephony and wave analyzers. Verily, anyone who masters this book should acquire conversational knowledge about a lot of radio topics.

In his endeavor to cover this vast field, the author has been forced to make many statements without having space to give the reasoning back of them; the reader must accept these flat statements on faith, or have them explained by someone who knows the background. We fear that the uninitiated would have a tough time learning the real fundamentals from this text unless he had a good teacher back of it. There is a lot in the book, however, for the man who has had a good practical or theoretical beginning in radio fundamentals.—J.M.

• • •

Books Received for Review

RADIO STATION MANAGEMENT. By J. Leonard Reinsch. Harper & Bros., New York, 1948, 177 pages, $3.50. Acquisition of a station, organizational setup, handling of programs, sales, personnel, accounting, advertising, promotion, engineering, and samples of business forms.

EXPLORING ELECTRICITY. By Hugh Hildreth Skilling, Prof. of Elec. Eng., Stanford University. The Ronald Press Co., New York, 1948, 277 pages, $3.50. Personal anecdotes and stories about the people who discovered how electricity behaves—Thales, Priestley, Franklin, Galvani, Volta, Oersted, Ampere, Ohm, Cavendish and on up to the little group who watched an explosion at Los Alamos.

A CONCISE HISTORY OF MATHEMATICS. By Dirk J. Struik, Prof. of Math., MIT. Dover Publ., New York, 1948, 2 vol., 299 pages, total, $3.00 per set. The major personages and main concepts of mathematics, in its pure sense, are concisely reviewed to provide a coordinated background for those familiar with world history and mathematical techniques.

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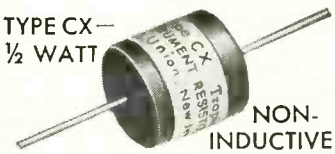

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DEAR SIRS:

WE NOTICE in K. H. McPhee's Melting Point Chart on page 118 of the December 1948 issue of ELECTRONICS a rather obvious error.

Graphite, according to our experience and that of authorities, does not have a melting point, but sublimes (Ed. Note: passes from solid to gas, without going through liquid state). Mantell, ("Industrial Carbon", 1946, pages 429-430) is a bit vague, hedging to the extent of talking about the melting point, and putting down >3,500 C under Melting Point in the table, but mentioning "there is some evidence that it sublimes."

Chaney, Hamister and Glass, in a paper for the Electrochemical Society published in March 1935 as Preprint 67–18, entitled The Properties of Carbon at the Arc Temperature, state that their "results indicate that carbon sublimes without melting at ordinary atmospheric pressure". The sublimation temperature was determined as 3,810 K± 10 K (3,537 C).

The particular point we want to make is not for the exactness of the temperature, but that carbon does not melt!

H. W. ABBOTT
Director of Research
Speer Carbon Company
St. Marys, Pa.

DEAR SIRS:

I WAS PLEASED to receive H. W. Abbott's comment on the controversial subject of the melting of graphite.

The Melting Point Chart was compiled with the knowledge that the melting of carbon is a phenomenon which has not been completely explained. The chart's purpose is to present melting point data in as simple and direct a form as possible.

Other elements listed on the chart show sublimation tendencies and indeed all of the melting points of the more refractory elements are subject to revision as research is continued.

Many of the more popular handbooks omit mention of the sublimation characteristics and assign a

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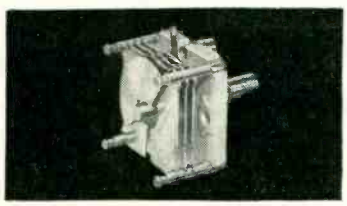

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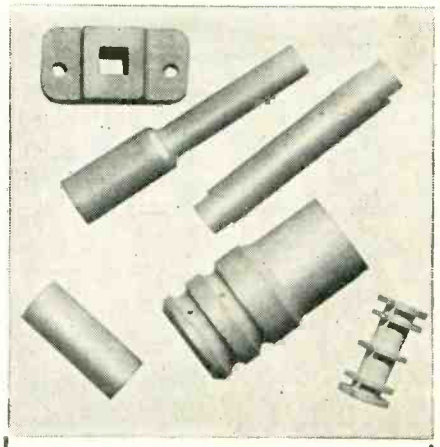

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definite melting point to carbon. The "Handbook of Chemistry and Physics," 30th Edition, 1947, lists carbon as follows:

Carbon	*Melting Point, deg C*
Amorphous	Subl. 3,537
Graphite	3,527
Diamond	>3,500

Mellor's "Modern Inorganic Chemistry", 1939 Edition, p 329, under the subject of carbon, says: "It is only recently that carbon has been melted and it has been found to solidify to pure graphite. It volatilizes at ordinary pressures at about 3,600 C without melting, and the vapor condenses to amorphous carbon."

The following quotation from a catalog of the Stackpole Carbon Co. summarizes nicely my present feelings on the subject: "While the values of the melting and boiling points of carbon are subject to criticism as to their exactness and implications, the order of magnitude is correct and the comparison between carbon and some of the other elements is interesting. There is evidence that carbon does not melt but that it sublimes."

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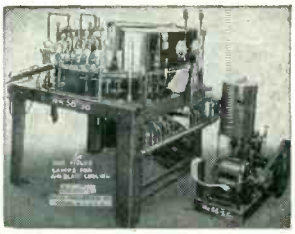

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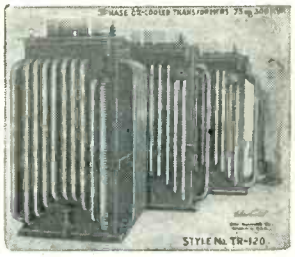

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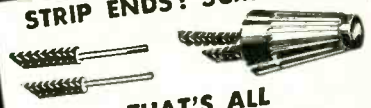

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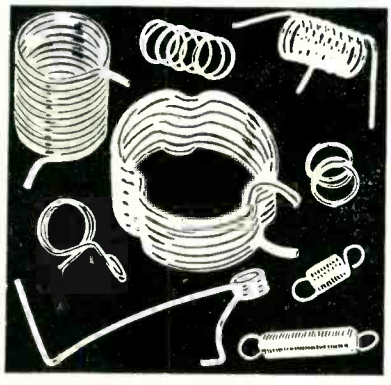

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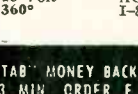
KIT B—2400 VOLTS HIV comprising TWO 1200VCT/300ma Xfmrs—Famous Make Herm Sld HIV insul 5¼x5½x4¾" PLUS 2x866A rectifiers & sockets & 2-2mfd 2000VDC oil cndsrs & 12 Hy 300ma Csd HiV ins CHOKE. "TAB" Special—Inc. Both Xfmrs... **$21.95**

Single Xfmr 1200VCT, Only..... 6.95
Medium Power Kits for Your Rig—110V/60cyc Input KIT C—700 VOLTS CT/125Ma, Filaments 2x6.3V/2A, 5V/2A and 115V/100Ma. Isolation Winding FEDERAL Tel for USN HiV ins Herm Sld 5x5x3¾" PLUS 5Y3GT rect. & socket, 2-10mfd electrolytics & 10 Hy Csd CHOKE. "TAB" Special..... **$4.49**

KIT D—500 VOLTS CT/60Ma & 6.3V/4A, Cylind USN HI V ins Herm Sld 3¾Hx3" dia PLUS rect. 2—10mfd electlytics, & 30 Hy Csd H.V. ins CHOKE. "TAB" Spec. Only.. **$2.98**



POPULAR METER BUYS!

200 Microamp DC GE 4" Sq. 5 Scales AC&DCV&ohms Red & Black K.E. for RCA Volt Ohmyst..... 120 Ma RF to 65 Mc Weston 3½" B'Csd..... $7.95 $12.95

300 Ma RF to 65Mc Weston 3½" B'Csd.....$12.95

Range	Description	Each
5 Ma	Tuning 2½" Bklt Csd GE	$1.49
25& 2.5 Ma	GE Galvnmtr zero ctr	3.95
1 Amp	RF 2½" GE Bklt Csd	3.95
5 for 9A	RF 2½" GE/Wstg B'Csd	3.49
750 Ma	RF 2½" CSD & Couple Wstn	3.49
15 Amp	DC 2½" Csd Hoyt	2.95
240 Amp	DC 50 MV mvt 2½" B'C	2.49
30 Volt	DC AN 2½" B'Csd Wst	2.49
10000 V	DC 1000 ohms/v 3½" B'Csd	12.95
150 Volt	AC 25-125 cyc 2½" Wstg/GE	3.95
7.5 Volt	AC 3½" Bklt Sq. RA 35 Wstg	4.49
15 Volt	AC 3½" Bklt Sq. Weston 476	4.95
360°	I-82 Bendix Autosyn	4.95

PRECISION RESISTORS

"NO MFGRS CHOICE, We ship types in stock"

.116	182	689	2700	14440
.42	199	697	2850	14460
.425	200	700	2860	14500
.607	209.4	733	2900	15000
.7	216	750	3000	15500
1.3	220	800	3100	16500
1.75	220.4	806	3290	17000
2.5	225	854	3384	17500
3.	230	900	3500	18000
3.33	235	910	3509	18380
4	240	917	3700	18500
4.35	245.4	946	3730	18800
5	250	978	3760	19000
5.025	260	1000	4000	19500
6	271	1030	4200	20000
6.25	275	1056	4280	20520
7	280	1060	4300	21000
7.5	286	1100	4314	21500
7.8	289	1110	4440	22000
7.9	299	1150	4444	22500
8	300	1155	4500	22990
10	310	1162	4720	23000
10.38	311.5	1175	4750	23150
10.48	320	1200	4850	23325
11.25	325	1225	4885	23400
12	340	1250	4900	24000
13.52	350	1260	5000	24600
14.2	366.6	1322	5100	25000
14.5	370	1350	5210	25200
15	375	1355	5235	25400
16	380	1400	5200	26660
16.37	390	1495	5500	27500
17	400	1500	5600	29000
20	410	1510	5730	29500
21	414.3	1518	5910	29900
25	418.8	1600	6000	30000
26	425	1640	6140	31000
30	426.9	1646	6200	33000
37	427	1650	6300	35000
48	440	1670	6495	37000
50	450	1680	6500	38140
51.78	452	1710	6840	38500
55	470	1740	6990	39500
60	475	1770	7000	40000
63	478	1800	7500	43000
68	480	1818	7700	47000
71.4	487	1830	7930	47500
74	500	1865	8000	48000
75	520	1900	8250	48660
80	525	1910	8500	49000
81.4	540	1960	8700	50000
89.8	550	1980	8800	52000
90	575	2000	8992	54000
95	580	2045	9000	56000
100	600	2080	9445	60000
101	607	2095	9500	61430
105	612	2145	9710	62000
105.7	625	2160	10000	64000
107	633	2195	10430	65000
113.1	640	2200	10500	68000
120	641	2250	10600	70000
121.2	649	2300	11000	72000
125	650	2400	11400	75000
147.5	657	2450	11500	77000
150	665	2463	11690	80000
160	669	2485	12000	84000
165	670	2490	12600	90000
170	675	2500	13220	91000
			13500	95000

ABOVE SIZES EACH 30¢.....TEN FOR $2.50

100000	166750	240000	380000	620000
110000	169360	245000	400000	621000
115000	180600	250000	402000	654000
120000	185000	265000	422000	750000
125000	198000	268000	458000	761300
130000	200000	275000	478000	800000
135000	201000	294000	500000	900000
140000	220000	307500	520000	930000
145000	225000	314000	521000	950000
147000	229000	330000	570000	
150000	235500	333500	575000	
155000	238000	353500	600000	

ABOVE SIZES EACH 40¢.....TEN FOR $3.50

1 Meg	2 Meg	3.673 Meg	4.5 Meg	11.5 Meg
1.2	2.5	3.9	5	12.83
1.5	2.855	4	9.05	19.5
1.8	3	4.23	10	20

ABOVE SIZES EACH 75¢.....TEN FOR $6.50

Vacuum Precision Hivolt Resistors

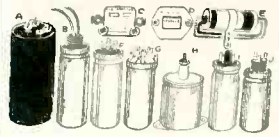
.12, .25, .6, .75, .83, .99 megohms
1, 1.5, 2, 3, 4.75 megohms 0.5% accuracy
SPECIAL $1.00@.....TEN FOR $7.50
SEALED 12Meg/10KV/9W.....$1.35 @ 10for 10.00
MVZ8/20 Watt/30 Megohms/25KV.$1.98@6for 10.00
MFB105/1Meg/.5% accy/Jan,R-29.$1.98@6for 10.00
Type 2/20megJAN R29/20KV/0.5%accy..... 29.95

Attenuators—100K & 250K Ohms

IRC 100000 ohms 20 position $2.98
IRC 250000 ohms 20 position 4.98
Write for Qty Prices on ½, 1&2W Insulated Resistors.
Resistor Kit, asstd ½&1W, 100 for..... 98¢

Xtal Diodes—Thermistor—Varistor

IN34 .....$1.08; 2/$2.10; 10/$9.85
IN21, 21A, 22, 23, 23A ea.....$1; 12/$10
IN21B, IN26.....$2; 10 for $17.50
IN35 Dual Diode.....$2.29
D16839½, Therm Compensator.....$2; 3/$5
D170396 HF pwr meas.....90¢; 3 for $2.50
IC Bulb Time Delay.....90¢; 3 for $2.50
USN CW20259 Varistor 38C.....$2.95



ELEC'LYTIC CONDENSER SPECIALS! !

A) Tubular, metal case, paper cov., lug term.

Mfd.	WVDC	Each
40	450	.55
300	25	.30
500	200	1.49
6000	15	1.98
30-30	350-300	.65
30-15-10	250	.45
40-40-20	2x150-25	.50
40-20-20	150	.40
80-12-10	150	.50
100-40-20	2x150-50	.50

B) Tubular, metal, scr mtg. wire leads

12	450	.47
40	200	.50
500	10	.40

E) Tubular, pigtail mtg. and term.

8	150	.18
8	450	.27
10	25	.15
10	50	.23
24	150	.35
8-8	450	.49
10-20	350-25	.39

I) Tubular, plug-in term.

100	25	45
20	20	.35
30	30	.40
20-20	2x350	.50

G) Tubular, prong mtd. lug terminals.

Mfd	WVDC	Each
10-10-20	350-300-25	.50
10-10-20	200-150-25	.50
10-10-5	350	.50
20-20-20	2x400-25	.50
20-10-20	350-300-25	.50
20-10-20	400-400-25	.50
40-20-20	300-25-50	.50
40-30-25	2x150-25	.45
40-40-10	2x150-25	.50
3x40	150	.65
10-10-5-20	2x250-300-25	.50
8-8-2-4	2x350-2x250	.45
10-10-10-20	350-300-250-50	.50
12-12-30-30	2x450-2x25	.50
15-15-40-20	2x200-25-25	.45
15-15-40-40	2x400-2x25	.55
20-10-5-10	2x350-300-25	50
20-20-10-40	400-2x250-25	.65
4x40	25	.35
40-15-15-15	475-350-150-25	.75

F) Tubular, metal lug term.

Mfd.	WVDC	Each
10	250	.30
20	25	.15
20	200	.35
25	250	.40
25	300	.45
25	400	.50
25	475	.54
40	450	.65
50	25	.20
50	400	.85
200	200	1.39
250	25	.39
250	150	1.29
10-20	350-25	.39
15-15	350	.49
8-8-20	2x350-150	.60
4x10	400	.70

J) Tubular, screw mtd, lug term.

8	450	.35
16	450	.45
50	350	.50
125	250	.65
1000	30	1.25
2000	5	.75
8-8	400	.45
15-15	450	.50
18-18	250	.40
20-1000	150-5	.95
25-25	300	.45
25-40	450	.65
60-20	400	.80
20-40	350	.98
2x1000	15	1.20
10-40	300-25	.45
25-10	450	.55
40-20	250-25	.45
50-10	450-250	.85
10-10-10	2x350-25	.50

MICA CONDENSERS

Fig.	Mfd	WVDC	Each	Fig.	Mfd	WVDC	Each
C	.0002	500	$0.20	C	.006	600	$0.25
C	.0003	600	.20	D	.006	2500	.98
D	.0004	2500	.35	D	.0062	1200	.40
D	.00047	2500	.35	C	.008	600	.25
D	.00055	600	.30	C	.0082	2500	1.00
C	.00089	1200	.25	D	.01	500	.25
C	.001	500	.20	C	.01	600	.30
C	.001	750	.20	C	.01	1200	.60
D	.0012	600	.20	D	.01	1200	.60
C	.002	1200	.30	C	.01	2500	1.25
D	.002	2500	.75	D	.01	2500	1.25
C	.003	600	.25	D	.015	1200	.65
D	.003	600	.25	D	.015	2500	1.30
D	.0035	2500	.75	D	.02	600	.45
C	.0039	2500	.85	C	.026	500	.65
D	.0043	2500	.95	C	.03	600	.98
C	.005	600	.30	D	.03	600	.98
D	.005	600	.30	D	.03	1200	1.45
C	.005	1200	.40	D	.033	600	1.10
D	.005	2500	.95	D	.033	1200	1.90
D	.005	3000	1.25	C	.043	600	1.65
D	.0051	1200	.35	D	.05	600	1.90

CAPACITORS OIL RATED WVDC

TAPPED 2.8mfd/200VDC oil .....15 for $1.50
2mfd/330VAC/1000WVDC oil .....5 for 1.98
5mfd600WVDC/220VAC & Brkts oil.....2 for 1.80
7mfd/600V 99¢; 10mfd/600V 1.39
3.3mfd/225VAC $1.25; 4mfd/600V ..... .89
20mfd/600V $2.75; 4mfd/330VAC/1000VDC.... 1.39
3mfd/2000VDC $4; 4mfd/3000VDC 5.95
2mfd/2000VDC $2.49; 2mfd/5000VDC 10.00
4mfd/5000VDC $16; 2mfd/2500VDC..... 28.00
1mfd/2500VDC $95; 1mfd/4000VCD 3.75
.00025mfd/25KV 4.95
2x1mfd/400V 12 for $1; 3x1mfd/400 V 10 for 1.00
1mfd/400V 12 for $1; 2mfd/400V.....5 for 1.00
.5mfd/500V 10 for $1; 1mfd/500V.....8 for 1.00
.05mfd/600V 30 for $1; 2x.05mfd/600V...25 for 1.00
3x.05mfd/600V 15 for $1; 3x.22mfd/600V....12/1.00
3x.1mfd/600V 8 for $1; 2x.25mfd/600V....6 for 1.00
3x.25mfd/600V 5 for $1; .5mfd/600V.....8 for 1.00
.1mfd/1000V 4 for $1; .25mfd/1000V.....4 for 1.20
.2mfd/5000V $2.25; 1mfd/3600V 3.25

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2C22	.39
2C26A	.28
2C34	.59
2C40	1.98
2C43	7.50
2C44	1.75
2C46	3.69
2D21	1.18
2E22	1.50
2E24	4.95
2E25	4.25
2E26	3.95
2E30	2.49
2J21A	12.39
2J26	8.95
2J31	10.95
2J32	13.95
2J33	24.95
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3C21	5.95
3C22	18.95
3C23	4.95
3C24	.69
3C30	1.50
3CP1	3.00
3D2A	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	4.98
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
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5FP7	3.95
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801A	.98
802	2.95
803	8.95
804	12.95
805	5.95
807	1.25
808	1.89
809	2.95
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
829B/3E29	4.95
830	2.95
830B	5.25
832/A	4.95
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834	5.55
836	1.15
837	2.50
838	3.95
841	.69
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860	3.00
861	49.95
864	.69
865	2.98
866A	.99
868	1.95
869B	75.00
872A	2.95
874	2.49
876	.39
878	2.49
884	1.49
885	.98

Type	Price
891	110.00
902P1	7.95
904	9.95
905	11.95
913	7.95
920	2.95
923	.98
925	1.40
929	1.25
930	1.10
931A	4.95
954	.75
955	.75
956	.75
957	.75
958A	.75
1608	4.95
1611	.98
1613	.75
1614	1.75
1616	1.39
1619	.75
1621	1.98
1622	1.75
1624	1.75
1625	.49
1626	.49
1628	4.95
1629	.69
1631	1.50
1633	1.65
1634	.79
1635	1.10
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0B2	2.05
0B3/VR90	.75
0C3/VR105	.75
0D3/VR150	.75
0Y4	.88
0Z4	.88
0Z4G	.88
01A	.50
1A3	.72
1A4	1.28
1A4P	1.56
1A5GT	.72
1A6	1.28
1A7GT	.80
1B3GT	1.49
1B4	1.56
1B5/25S	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	1.06
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
2F5	.88
2V3G	1.98
2X2A	1.25
3A4	.39
3A8GT	1.98
3B7	.36
3D6	.36
3O4	.88
3Q5GT	.96
3S4	.80
3V4	.80
5AZ4	.50
5R4GY	1.15
5T4	1.28
5U4G	.60
5V4G	.96
5W4	1.06
5W4GT	.66

Type	Price
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
6AR5	.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
6C6	.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/6T7G	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
6SF5GT	.72
6SF7	.80
6SG7	.80
6SH7	.39
6SJ7	.66
6SJ7GT	.66

Type	Price
6SK7	.66
6SK7GT	.66
6SL7GT	.96
6SN7GT	.88
6SQ7	.60
6SQ7GT	.60
6SR7	.72
6SR7GT	.72
6SS7	.66
6ST7	.88
6SV7	.88
6T7G	1.24
6U5/6G5	.72
6U6GT	.72
6U7G	.72
6V6	1.28
6V6GT	.80
6W7G	.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	1.06
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
7Q7	.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	.39
12A7	1.28
12A8GT	.80
12AH7GT	.88
12AL5	.80
12AT6	.60
12AT7	1.06
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
12S17GT	.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	1.06
14X4	.88
19	1.28
19T8	1.06
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	.39
31	.39
32	1.28
32L7GT	1.28
33	.39
34	.39
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
70L7GT	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
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9001	.89
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The NEW 900A VTVMVOMAX

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- Current ranges—6 ranges from 1.2 ma. to 12 amps. Plus or minus 2% absolutely stable.

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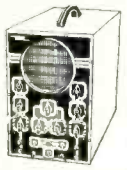

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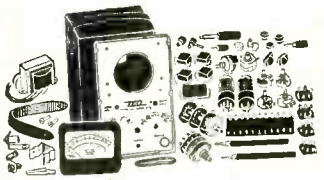

MODEL 221K VACUUM TUBE VOLTMETER KIT

Comes complete, nothing else to buy.

- DC and AC ranges 0-5, 10, 100, 1000 Volts.
- Ohmmeter ranges, ranges .2 to 100 megohms. 5 ranges R x 1 - R x 100, R x 1000, R x 10,000, R x 1 megohm.
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VOLT-OHM MILLIMETER KIT

Easy to assemble—Easy to use.

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5069611, Delco, 12 V., 10,000 R. P. M.
Price $3.50 each net.

5067043 Delco, 12V., 10,000 R. P. M.
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5067125, Delco, 27 V., 10,000 R. P. M. With Governor.
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S. S. FD6-18 Diehl 27 V., 10,000 R. P. M.
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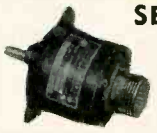

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FP-25-3, Diehl, Low-Inertia, 20 volts, 60 cycle, 2 phase.
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Pioneer Magnetic Amplifier Assembly Saturable Reactor type output transformer. Designed to supply one phase of 400 cycle servo motor.
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Price $3.25 each net.

5G Generator, 115 volts, 60 cycle.
Price $25.00 each net.

W. E. KS-5950-L2, Size 5 Generator, 115 volts, 400 cycle.
Price $3.50 each net.

Size 5 Generator, Army Ordnance Drawing No. C-78414, 115 volts, 60 cycle.
Price $14.00 each net.

2J5S1 Selsyn Differential Generator, 105-105 volts, 60 cycle.
Price $15.50 ea. net.

2J1F1 Selsyn Generator, 115 volts, 400 cycle. **Price $3.50 ea. net.**

INSTRUMENT ASSOCIATES

Write for complete listings

147-57 41st AVENUE FLUSHING, N. Y.
Telephone INdependence 3-1919

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RELIANCE SPECIALS

PRECISION RESISTORS

WIRE WOUND 1% Tol. or Better

Any Order For

100 pieces.....10% Off
1000 pieces.....20% Off

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	55.1	400	7,000	25,000
.76	75	723.1	7,500	30,000
1.01	97.8	2,500	8,000	100,000
1.53	125	2,850	8,500	150,000
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			70,000
5.05	270	7,000	50,000	75,000

1 WATT—40c

100,000Ω	128,000Ω	180,000Ω	470,000Ω	525,000Ω
120,000	130,000	250,000	500,000	600,000
125,000	160,000	320,000	522,000	700,000

1 Megohm, 1 Watt, 1%—65c; 5%—40c

JUST ARRIVED

115V **RELAYS** 60 cycle

Mfg.	No.	Contacts	Price
SD	1XBX103	DPDT, 6A	$2.45
SD	TD 435 (time delay)	SPST, N.O.	2.75
Leach	1355	DPST, N.C.	1.90
Leach	1127	DPDT	2.45
Leach	2124 SMX (Micalux)	4PST, N.O.	3.50
Advance	965 B	DPST, N.O., 10A	2.10
Advance	SA 1000X (Isolantite)	DPDT, 10A	2.95
Paragon	CPX-24166	60 sec. delay, 10 A.	6.50

FILAMENT TRANSFORMERS

WESTINGHOUSE #6D4298

Tested at 34,000 volts
Pri. 115 V. A. C., 60 Cyc. Sec. 5V
@ 6.5 Amp.

ONLY $8.50

CHOKE

400 MA. 12 Henry 90 Ohms, 6,000 V.D.C. Test. Herm. Sealed. 4½" x 5⅝" x 4½", 12 lb..$3.85

200 MA. 10 Henry, 115 Ohms, 3¾" dia. x 4½", 6¾ lb. $1.95

FUSES

3 AG			3 AG
1/8 Amp.	$4.00 per C	2 Amp.	$2.50 per C
1/4	4.00	3	2.50
3/4	4.00	4	2.75
1	2.50	10	3.00
1 1/2	2.50	15	3.00

115V TRANSFORMERS 60 cyc.

24 Volt, 10 A, cased.....$4.75, 10 for $45.00
2.5 Volt, 6.5ACT each of two windings cased. $2.45
5 Volt, 60 ACT, 5 K.V. ins.....$6.75
300 Volt, 4 A each of two windings, open, tapped primary, net weight: 70 lb. $17.50

STEEL JUNCTION BOX

Water-tight, 14 ga. steel. 17"x25"x6½". Screw type brass hinge on lid. 50 lb. Reduced to $2.50

CAPACITORS

OIL FILLED

MFD	V.D.C.	Price	MFD	V.D.C.	Price
.012	25,000	$6.20	.2	750 V.A.C.	
.03	16,000	5.75	(2,200	V.D.C.)	.49
(.375@	16,000 and		1	2,000	.95
(.75@	8,000(dual)	14.95	10	1,000	1.75
1	7,500	12.50	8	1,000	1.50
.1	7,500	1.95	4	1,000	1.00
.1-.1	7,000	2.45	3	1,000	.80
.1	7,000	1.85	2	1,000	.65
.02-.02	7,000	1.65	.05	1,000	.29
.1	6,000	1.75	1	800	.40
.03-.03	6,000	1.65	10	600	1.35
1	6,000	8.50	4	600	.69
.01	5,000	1.35	2	600	.39
2	4,000	5.50	1	500	.29
.25	3,000	1.75	.5	500	.24

RG 8/U NEW-UNUSED 52 OHM COAXIAL CABLE

500-2,500 feet .....$40.00 per M
3,000-5,000 feet ..... 35.00 per M
5,500-10,000 feet ..... 30.00 per M
10,500-20,000 feet ..... 27.50 per M
over 20,000 feet ..... 25.00 per M

No charge for reels.

COAXIAL FITTINGS

Hood 10c | Socket 40c SO-239 83-1R | Plug 40c PL-259 83-1SP | Angle Adapter 40c M-359 83-1AP

PL259A, 83-1SPN, 83-1J. UG21U. UG22U UG13U, UG27U, UG28U assembled with short piece of RG 58U.....40c each
UG85U Baby "N" Plugs.....40c each
UG87U Baby "N" Socket.....40c each

NEW ARRIVALS

PRECISION POTENTIOMETERS

Guaranteed Perfect—Mostly Original Boxes

20,000	Muter	314A	$1.70
20,000	GR	314A	2.50
10,000	Muter	471T	2.35
10,000	DJ	292	.95
10,000	GR	371T	2.50
10,000	GR	471A	3.50
6,000	Muter	314A	1.70
6,000	DJ	260	1.70
6,000	GR	314A	2.50
5,000	Muter	314A	1.70
5,000	DJ	271T	2.00
5,000	GR	314	2.50
2,000	Muter	314A	1.70
2,000	DJ	260	1.70
1,000	GR	314A	2.50
50	DJ	292	.75
20	GR	301	1.10
12	DJ	292	.75

Westinghouse Motor Generator Set

D.C. Gen.: Volts 45, Amps .15, Exc Volts 24
A.C. Motor Volts 110, Cycle 240, Phase 3, RPM 13,000

Style 1278129, 2½" x 2½" x 5½"
Price $6.75

SHIELDED WIRE—#18

50 ft.—$1.00
1000 ft.—Only $12.50

PULSE TRANSFORMERS

X 143T 2, UTAH, core—⅝" x ⅜" x ¼", 3 windings, open frame, capable of shortest pulses $1.50

X 124 T2, UTAH, marked 9262 or 9280, small gray case 1⅞" high x 1⅛" x ⅝" with two 6-32 mtg. studs. Ratio 1:1:1, hypersil core $1.50

Spec.—10, 111, Chicago Transformer equivalent of 9262 .....$1.50

7472407, GE, core ⅝" x 1⅜" x 3/16", 2 windings (0.6 ohm and 0.08 ohm DC).....$1.25

80G16, GE $1.25

D161310. Western Electric, cased 1⅜" dia. x 1⅞" high, impedance ratio 120 to 2350 ohms, molybdenum Permalloy tape core. Frequency response 50 Kc to 4 Mc.....$2.00

D166638, W. E., cased 1¾" x 1¾" x 2¼", 2 semitorridal windings, 150 turns ea. of two windings, used in portable oscilloscope..$1.25

352-7250-2A, cased 15/16" dia. x 1⅝" high, DC 10 ohm, 3½ ohm sine wave response 140 cy. to 175 Kc.....$1.25

352-7251-2A, similar to above but for shorter pulses $1.25

300 KVA GE 7557296, 50 ohm pulse cable connection; 3,850 V. in 17,300 V. out. (250 KVA @ ¼ micro second).....$15.00

800 KVA K2731, 28,000 Volt pk. output, Biflar, pulse width: one microsecond $19.50

MULTIMETER

Superior Mod. 770: 6 AC, 6 DC, 4 current, 2 resistance ranges. Guaranteed for 1 year $13.90

JUST ARRIVED JONES BARRIER STRIPS

Type	Price	Type	Price
2-140Y	$.05 ea.	10-141Y	$.51 ea.
3-140 3/4W	.12	12-141	.39
4-140	.12	17-141Y	.78
5-140Y	.19	20-141Y	.93
5-140	.14	2-142	.10
7-140Y	.26	3-142Y MSX	.23
10-140Y	.36	4-142Y MSX	.30
18-240	.35	4-142	.18
2-141	.15	5-142	.21
2-141Y	.11	6-142	.25
3-141	.11	7-142	.29
5-141Y	.25	8-142	.33
6-141	.21	9-142Y	.52
8-141	.27	9-142	.37
8-141 3/4W	.42	10-142 3/4W	.58
8-141	.38	10-142	.40
9-141Y	.42	10-142Y	.58
9-141	.30	11-142Y MSX	.76
10-141 3/4W	.47	12-142	.48
10-141Y	.47	17-142	.67
10-141	.33	17-142X	.97
11-141	.36	4-150	.46

Any order for 100 pieces—10% off; for 1,000 pieces—20% off

Vernier dials, 2⅝" dia. 0-100 in 360°, black with silver marks, thumblock. For BC221....$.85

UNIVERSAL JOINT

ALUMINUM

1⅛" long x ½" O.D. ¼" ID

35c

ALLEN SET SCREWS

4-40x1/8	6-32x1/8	8-32x3/16
4-40x3/16	8-32x1/8	8-32x5/16

All sizes.....$1.50 per C

WRAPPED BALL BEARINGS—New

Mfg.	ID	OD	Width	Price
Fafnir 33K5E	3/16"	1/2"	5/32"	25¢
Fafnir 38K	5/16"	7/8"	9/32"	25¢
Timken	1/2"	1 3/8"	7/16"	85¢
ND5202C13M	1/2"	1 3/8"	1 3/8" (dual)	1.25
ND 88503	43/64"	1 37/64"	21/32"	1.00
MRC 206SF	1 5/32"	2 7/16"	5/8"	1.25
Farnir 545	2 1/6"	2 5/8"	15/32"	1.00

NEEDLE BEARINGS

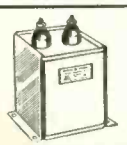
B88 1/2" wide	1/2"	11/16"	25¢
B108 1/2" wide	5/8"	13/16"	30¢
GB34X 1/4" wide	3/16"	11/32"	25¢

Glyptal Cement { 1 qt. cans, GE #1286 75¢; 1 gallon cans.....$2.50; 5 gallon cans.....$11.00

HARDWARE ASSORTMENT — (mostly brass) —screws, nuts, washers, solder lugs. 3 lbs. $1.00

MINIMUM ORDER $3

All Orders f.o.b. PHILA., Pa.



$42.50 Regular Price
2mfd 4,000 V DC
#23F47
Your Cost Only $5.50

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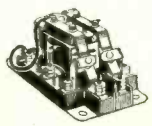

110V, 60 cyc. RELAY
6 A. DPDT Contact
#CS1729 Only $2.45

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A. BR18/BB52/5oz/36VS'By ..... $1.39; 10/$10
B. Burgess3V/F2BP/June '47 ..... 6 for $1.00
D. BB54/2V/27A Willard S'B 1.89
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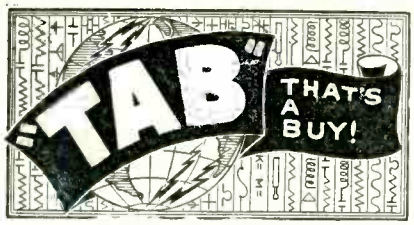
WILLARD 6V/25AH 7½ L 2½W 6½ D 3.39
EVERYREADY Hevi-Duty Minimax BA43p/o SCR284



CRYSTALS—Mtd FT243 exacting S. C. Specs

3525Kc	4190Kc	5235Kc
3735Kc	4780Kc	5485Kc
3980Kc	5030Kc	ea. 98¢, 2/$3

Write for other frequencies

Hi Accy Xtal Frequency Standards

100Kc	$5.98	5000Kc	$3.98
200Kc	$3.98	4700Kc	.98
500Kc	12.98	81.95Kc	1.98
1000Kc	4.49	Useable in BC221.	

CRYSTALS—Mtd htr Ovens HiAccy Stability 501C, 5025, 5055Kc, ea. $14.98

TELEVISION

COMPLETE TRANSFORMER TV POWER SUPPLY KITS

High, Low & Fil voltages. FEATURING Herm Sld WE. USN oil-filled XFMR inputs 105, 115, 125 VAC, 50-425 cps Out 600VCT or 300VDC/175Ma and 6.3V/10A, 5V/8A, 2.5V/3A, 5V/3A. H.V. insulated. 10000V & 300VDC & ALL Filaments for 10" to 15" TV Set—Above Xfmr & 2-3B24 Doubler—Rect & 5U4G rect. & All cndsrs, sockets, choke & data "TAB" Special **$29.95**

5000V, 300VDC & ALL FILAMENTS KIT. Same Xfmr plug 5U4G & 3B24 rect. cndsrs, chokes & sockets, diagram **$21.95**

Transformers ONLY $16.95

BASIC TV & CRT PWR SUPPLY—2.5KV Xformer out of BC-412 Scope with 2.5V/1.75A for 2x2 fil and 6.3V/.6A windings. KENYON SI3336 or equivalent **$8.95**

Safe socket 9.95

Television Components

V'OutputXfmrsimRCA204T2 $2.98
Utah9318 H'BlkgOsc Xfmr 1.40
UTC88662 V'BlckgO cXmfr 1.29
Erie HiV Cndsr 500mmf 10KV ..40
Jeffers HiV Cndsr500mmf/20KV .75
Yoke Mag Defl simRCA20iDI 4.59
FocusCoil for MagnKinescps 3.95
HiV Flybak H'OutXFMRSsim RCA21ITI 5.49

Rectifiers' Bridge

In	Out	Amps	Price
18	14	1.35	$2.49
18	14	3.5	3.49
18	14	5.	4.85
18	15	11	9.95
18	15	18	14.95
18	15	27	22.95
36	28	32	1.49
36	28	3.5	6.75
36	28	5.	7.50
36	30	11	17.95
36	30	18	26.95
36	30	27	36.95
90	75	0.15	1.49
210	100	0.04	.49

Selen FEDERAL 100ma, 72¢; 200ma ..... 98¢
Selen CT 18Vin/12out 1.5A 1.49

RELAYS—Famous Makes

CLARE A-12280/115V-60cy/3SP DT&3SPNC $2.98
CLARE Octal based 115VAC/DPNC&SPNO 3.98
S'DUNN 32AXX10 Reset&o'load 10ma&115VAC 4.98
S'DUNN 17AXX109/115VAC/SP NO/6to30A cts 1.98
LEACH 115VAC/DPDT/10Amp Contacts 1.98
Write for Complete Relay List.

TUBES . . . JAN & STANDARD TYPES

OA4G	$1.04	3GP1	4.95	6SJ7	.72	39/44	.39
OZ4	.85	3JP1	2.95	6SJ7GT	.48	41	.48
1A4	1.26	3Q5G	.94	6SK7	.65	50	1.56
1A5GT	.48	4AP10	6.95	6SL7	.75	50L6	.66
1A6	1.26	4C35	19.90	6SL7GT	.58	50L6	.58
1A7GT	.58	5AP1	2.75	6SN7	.86	81	1.54
1B21/471	2.95	5BP1/ 5GP1	1.55	6SN7GT	.59	83	.88
1B23	49.00	5BP4	3.95	6SQ7	.54	83V	.88
1B24	4.89	5CP1	3.95	6SR7	.70	84/6Z4	.72
1B27	4.89	5CP7	13.49	6SS7	.71	114B	1.23
1C6	1.26	5D21	19.00	6T7G	1.53	117N7	1.54
1C7G	1.26	5FP7	1.49	6U5/6G5	.81	205B/VT2	1.98
1D5GP	1.25	5HP1	4.95	6U6	1.49	211	.89
1E4G	.89	5LP7	9.95	6U7	.70	215A	.89
1F4	1.04	5R4	1.25	6U7G	.58	227	3.90
1F7GV	1.54	5T4	1.15	6V6	.69	231	.98
1G4GT/G	1.04	5U4G	.59	6X5	.81	250TH	19.49
1H4G	.88	5V4G	.53	6X5GT	.58	250TL	18.98
1H6G	1.28	5W4	.87	6Y6GT	.87	304TH	5.95
1JG	.96	5X4	.70	6Z7G	1.23	304TL	1.98
1J6G	1.35	5Y3G	.38	7A4	.70	307A/RK75	4.25
1L4	.70	5Z3	.81	7A6	.69	327A	4.90
1LA4	.94	5Z4	.88	7A8	.69	376 GL276	5.98
1LB4	.94	6-11Ballast	.59	7B5	.70	388A	.40
1LC6	.94	6A3	1.26	7C4/1203A	.49	393A	5.95
1LE3	.94	6A4	1.53	7E6	.70	446B	1.98
1LH4	.78	6AB7/1853	.89	7E7	.85	527CIM	4.85
1LN5	.69	6AC7	.69	7G7	1.04	559	.73
1N5GT	.58	6AF6	.86	7L7	.86	575A/975	14.25
1P5GT	.69	6AG5	1.00	7N7	.69	701A	3.95
1P24	2.95	6AG7	.98	7Q7	.86	702A/702B	3.49
1Q5GT	1.04	6AJ5	.98	7V7	1.04	703A	2.90
1S5	.70	6AK5	.89	9-3Ballast	.59	704A	1.75
1T4	.69	6AL5	.98	9JP1	3.95	705A/8021	1.59
1T5GT	1.04	6AS6	.98	9LP7	2.69	707B/ 2K28	10.98
1V	.86	6B4G	.93	10	.67	710A/8011	2.75
2A3	1.04	6B5	1.54	10-B4Ballast	.59	713A	1.63
2A5	.86	6B8	1.26	10Y	.60	715B	8.90
2A6	1.04	6B8G	1.05	12A6	.23	717A	1.49
2A7	1.04	6C4	.27	12AH7GT	.87	722A/287A	9.95
2B7	1.26	6C5	.54	12C8	.39	723	4.95
2C21/1642	.81	6C6	.48	12DP7	12.95	723A	5.50
2C26	.59	6C8G	1.05	12GP7	14.75	723AB	5.90
2C34/RK34	.55	6C21/ 450TH	24.90	12H6GT	.39	725A	7.25
2C40/446A	.75	6D4	1.25	12J5	.39	802	2.95
2C43/464A	4.49	6E5	.71	12K8	.85	803	4.95
2C44	1.69	6F6/1613	.69	12Q7GT	.70	804	9.75
2D21	1.20	6F8	1.04	12SA7GT	.45	805	3.95
2E22	1.45	6G6G	1.04	12SC7	.70	807	1.15
2E25/HY65	3.49	6H6G	.38	12SH7	.71	808	1.75
2J21/725	12.95	6J4	.95	12SJ7	.64	809	2.90
2J26	12.95	6J5	.55	12SJ7GT	.48	810	6.95
2J31	16.95	6J6	.95	12SK7	.58	811	2.20
2J33	14.50	6J7	.70	12SL7GT	.86	813	6.95
2J34	18.95	6K5G	.86	12SQ7	.58	814	2.70
2J42/700A	29.85	6K6GT	.69	12SR7	.39	815	2.49
2K25	24.49	6K7	.70	14B6	.69	816	1.09
2K28	10.98	6K7G	.54	14R7	.86	826	.49
2K29	6.98	6K8	.86	15E	.85	828	10.00
2V3	1.96	6L5	1.04	24G/3C24	.69	829	3.95
2V3G	1.05	6L6	1.04	25B6	1.98	832	3.75
2X2	.49	6L6M/1622	.90	25Z5	.53	836	1.12
3A4	.70	6L7	.75	25Z6GT	.59	837	2.25
3B7/1291	.95	6N7/1635	.85	28D7	.39	838	2.90
3B24	1.29	6P5G	.94	30	.39	842	2.98
3BP1	1.49	6S7	.87	31	.39	843	.39
3BP1A	2.95	6SA7	.54	32L7GT	1.19	845	4.50
3C23	4.95	6SA7GT	.49	35A5	.70	845W	4.75
3CP1/ 1808P1	4.95	6SC7	.71	35L6GT	.58	860	2.49
3D22	.34	6SF5	.58	35W4	.44	861	10.95
3D6/1299	.85	6SG7	.71	35Z5GT	.45	865	.78
3E29/829B	3.85	6SH7	.48	37	.78	866	1.59
				38	.39		

866A	1.15
868/PJ23	1.49
872A	2.45
876	.39
878	1.29
884	.89
885	.96
902	5.49
918/CE1C	1.49
922	1.49
923	.95
931A	3.95
954	.21
955	.40
956	.33
957	.21
958A	.63
991	.67
1294/1R4	1.04
1603	6.75
1609	.98
1612	2.70
1613/6F6X	.57
1614/6L6X	1.50
1616	1.39
1619	.39
1622	1.58
1625	.39
1626	.39
1629	.58
1641/RK60	.75
1851	1.23
2050	.69
2051	.44
7193	.38
8013A	3.95
8016	1.47
8020	1.98
9001	.40
9002	.59
9003	.49
9004	.49
9006	.28
C6J	4.95
CK1005	.35
CRC/814	2.70
CRD72	1.85
F127A	18.00
FG27A	9.90
FG104	14.95
FG105	7.95
FG166	49.00
GL434	7.95
GL534/ IS21	1.95
M55B	.39
REL36/ 6J4	.98
RX215	7.95
UX6653	.69
VR90 OD3	.74
VR92	.23
VR105/ OC3	.74
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WE215A	1.80
WL468	9.95
WL531	9.95
WL619	20.00

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KITS

Amplifier Kits

HIGH FIDELITY — A Hi-Fi circuit with perfect linear response, phase inverter & full tube complement featuring 2-2A3 PP output, 6SJ7 and 6SN7. All parts, tubes, controls, diagram & remarkable RCA Audio Amplif Chassis described below, less Output Xfmr. A GREAT BUY **$14.95**

17.5 WATT AMPLIFIER KIT—Similar above with all components exc. 2-1619/6L6 delivering 17.5 Watts.

14 WATT AMPLIFIER KIT—Similar above exc. 2-6V6GT delivering 14 Watts. 17.5 or 14 Watt Kit less output Xfmr. ONLY **$12.95**

RCA AUDIO AMPLIFIER CHASSIS for AMPLIFIER KITS above. Heavy duty porcelainized chassis. Gray rustpf 7¼x12¼x 2¼". 9Amphenol sockets incl 6 octal, 3 inputs, cutout for pwr transfr & choke. Chassis marked for 2 mic. Vol. Tone. Fuse.

BASIC ALL-ELECTRONIC VT-VM KIT — An ultra-sensitive tester; similar to RCA Volt-Ohmyst Jr. Includes PRECISION resistors. 4" Sq GE 200 microamp meter (reads 2-10-30-100-1000V DC; 10-30-100-300-1000VDC; 1000/10000/100000/1meg/10 megohms). 11 megohm input resistance. Full data. Less case **$19.95**

BASIC 3" SCOPE KIT—Sensational visual testor foundation. 3BPI CRT plus 5Y3GT & 2x2 tubes, 115V60cyXfmr—1320V. 375 VCT/110ma, 5V/3A, 2.5V/3.25A. All cndsrs & choke for Lo & Hi Volts supply & sockets. Less chassis, amplifier & sweep circuits **$16.95**

Antenna AN-30 Telescopic Whip collapses 12" to 9 ft New o'Seas pkg ea. 1.49; 2/2.49

ANT AT5/ARRI, ATI/APN2 30 cm/12"lg 2/coax conn w'prf gask & mtgFlange .98¢; w/PL259, 1.24

ANT AN130B Spring Swiveled WhipEND Lu'd 33" lgl.25:2/1.98

ANT P108/LU3 12cm lg w/coax fitting ea. 1.98

ANT AS23/APw/coaxFtg. 2.98

ANT MS49-54, 18ft Whip 3.98

Blowers—Cool that Tube!

100 CFM/12V $5.95
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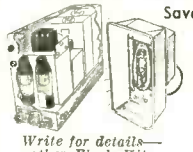
Xfmr 12 or 28V to 115 VAC 1.69
250 CFM/28VACDC 8.95
250 CFM 28/115VAC Xfmr. 10.95
40 CFM/28VACDC "LR" 3.49



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Replaces $2000 WORTH OF FLASH BULBS. Write for complete data! BASIC FOTOFLASH KIT—Complete Pwr Supply inc. cndsrs, tubes, xfmrs, circ diag, all instructns & FOTOFLASH lamp & reflector for 115VAC. Only **$29.95**

Write for details— other Flash Kits

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16mf/660AC/3000DC intermitnt 7.95
15mf/330AC/2000DC $4.50; 25mf/330AC2000DC 7.95
16mmPAN50film GSAP camera 54 rolls 5.49
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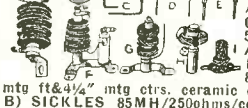

RF CHOKES

A) HAMMARLUND CH500/2.5 MH8ohms 500 ma ..... 98¢
A) 20 MH/500ma/14.75 ohms DCR 8mmf dist Cap w/ mtg ft&4¼" mtg ctrs. ceramic core ..... 98¢
B) SICKLES 85MH/250ohms/ceramic form ..... 70¢
C) NATIONALR300/1mh/300ma/10ohms@28c..4/98¢
C) Two 2.5MH/125ma&.01&.002cdsr&Resist ..... 45¢
D) 5MH/300ma, pi wound ..... 29¢
E) MILLER2½&5mtr/2.5MH/.27ohms/1A@25c.5/98¢
F) Nat'IR152/80&160mtrs/4MH/600ma/10ohms ..98¢
G) SICKLES HF 20MH/200ma75ohms ..... 49¢
H) Hash Chokes for MercuryVaporRec@25¢; 5/98¢
I) SICKLES 1.5MH/200ma, ea. 25¢; 5 for ..... 98¢

LAMPS, PILOT LIGHTS, SOCKETS

Sockets for		Tungar Bulbs		Aviation Lgts	
2X2HV	$0.30	20X672*	$2.95	C1249/12VGR	
705/715	.69	199698*	2.95	25	$1
803/304TL	.90	289881*	2.50	Sealed Beam	
807	.27	Mazda P1**		4522/250W	1.49
829/832	.25	47** Box 10	.50	4560/600W	3.50
866	.24	49** Box 10	.60	Neon Bulbs	
872/211	.49	64** @	.07	NE2 100 Qty	4.50
Diheptal	.69	S6/T4**15¢;		NE16/991	.25
Magnal	.54		1.39	NE51/NE20	.08
Locktal 49SSL	.24	100W/20V**	.25	NE20 Qty 100	6.00
Octal 78S8	.08	313/28V**	.10	Acorn Sockets	
Octal 49SS8	.15	323/3V**	.10	5 for	1.00
Min 59500	.12	TEL. Slide Lamps—6,24,30V 18¢			
Min & SH	.25	100 for	$15.00		

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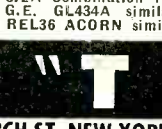

SNOOPERSCOPE INFRARED Image-Converter Tube. HiSensivity simplified design 2" dia., Willemite screen—Resolution up to 350 lines/in. Complete data & Tube. "TAB" SPECIAL **$10.98**

12DP7GE Magn. Defl. TeleVCR & Data SPECIAL 12.95
2 for $25.00; 10 for 115.00
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G.E. GL434A similar 7C29/1KW, HF RF. 7.95;
REL36 ACORN similar 6J4-GndGrid. SPECIAL. 98¢

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CONSTANT V'REG NEW RAYTHEON in 95-130V/60cy; Out 115V/60cy Cased $10.95
RAYTHEON—in 198 to 242V inpt/50-60cys; Output 220V/500Watts/0.5% Rgltn Rackmtg $36.00
SOLA CONSTANT V'REG USN Csd in 95to190V/50-60 cys; Output 115or220V 2KW/17.4Amps Cnstnt Duty, 1% Regltn LN*..$130. Same Cased NEW, USN Cost $369, Only $162
Variac, 200B/75Watt0-135V GR. $10.95
Variac, 200C/860Watt/0-135V GR $15.98
Variac, 100R/0-230or270V/2KW/115or220Vin. .$39.95
POWERSTAT in 115V out0-130V/1KW $18.00
BANDPASS FILTER XFORMERS SHARP CUTOFF HiQ CSD & SHIELDED, 60, 90, 150 cys. $2.25
UTC 854 cys, 1250 cys. ea. .....$1.95....3 for 4.50

Last Minute Specials!

Vibroplex Type SC J36 Keys $5.95
A'Bradley Type 702 Contactor 3P25A 4.49
Relay G'Dian 500 4PSTNO 12to28VAC ..... .98

HEINEMAN MAGNETIC BKRS.

10 ma, 220 ma 3, 5, 10, 15, 20, 30, 40, 80 & 180 amps New, each 1.95...10 for $18.00
SQ'D, KLIXON & GH 5, 10, 20, 25, 33, 35 & 60 70 Amps, 98¢ each...10 for $8.00
THERMOSTAT 85°F/20A adjustable...49¢

NAVY LINE FILTERS

Cased Filters 0.1 to 1000 Mc's/USN $1.29
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$3 MIN. ORDER F.O.B. N.Y.C.
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Another of the famous Weston fan shaped line. Very large scale 5.8" long. These meters were made by Weston to General Radio specifications, with special mirrored scale and knife edge pointer. Accuracy 1%.

0-600 Microamps
170 M.V.
Coil Res: 250 Ohms

Your Price **$22.50**

GE TYPE DO 50 DC AMMETER

50 MV FULL SCALE RECTANGULAR 3¼" x 3", Barrel 2¾" DIAM, x 1½" DEEP, MOUNTING HOLES 2⅝" x 2⅜" c. to c. Special Scale, can be used with Ext. Shunt for any range, bakelite case

A BUY! Price ..... 10 for $27.50

GE TYPE DO 50 DC VOLTMETER

3 volts full scale, 100 ohms 1V, special scale, same dimensions as above, bakelite case.

A BUY! Price ..... 10 for $27.50

A SCOOP on a 'SCOPE DUMONT

Used! Guaranteed

Model 164-E

3" CRT operates at accelerating potential of 1100 V—brilliant well - defined trace, Vert amp voltage gain approx 43, horiz amp voltage gain approx 55, Freq. range vert. & hor. amp both uniform ±3 DB from 5-100,000 CPS Input impedance 1 megohm vert, .8 megohm hor. Operates 115 V, 40-60 cycle.

Price New $115.00
Your Cost $77.50

MICROVOLTER—FERRIS Model 20B

.2 to 100,000 microvolts output, continuously variable . . . operates on 115 V. 60 cycle AC . . . push button selector for 18 frequencies from 455 K.C. to 22 M.C. . . . with or without 400 cycle 30% modulation . . . frequency may be varied ±2% by screwdriver adjustment.

Your Price $100.00

BC 403E OSCILLOSCOPE

Made for Signal Corps by RCA for use in SCR-270D Radar—Can be converted to other uses — A Gold Mine for Parts — Shipping Weight: 400 lbs—Without Cathode Ray Tube 5BP4 ..... **NEW! $57.50**

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-5½"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

WHSE PORTABLE GALVANOMETER

Type PX-12, Movement 7 MA, special scale, solid connecting terminals, contains a 1 Volt internal cell which can be easily removed for conversion to DC AMMETERS & VOLTMETERS, with leather case and canvas carrying strap.

A buy at $4.95

STRUTHERS-DUNN RELAYS

D.P.S.T., Normally open, 115 V, 60 Cycle, AC coil, 30 Amp. contacts, fibre base with 4 holes for mounting. Dimensions, 4½" L x 3" W x 3¾" H.

A Real Buy At **$2.50**

PANEL METERS

Code—R-Round, S-Square, B-Bakelite, M-Metal, F-Flush, SF-Surface, FS-Full Scale

A. C. VOLTS

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**
Simpson	125	0-150	2" R-M	2.95
Weston	476	0-1.5	3" R-B	4.50
Whse	RA35	0-7.5	3" R-B	**3.95**
Weston	476	0-8	3" R-B	**3.95**
Weston	476	0-10	3" R-M	4.75
Trpltt	331JP	0-150	3" R-B	**4.50**
GE	AO22	0-150	3" R-B	5.50
Brlngton	32XA	0-150	3" R-B	4.50
Whse	NA35	0-15/150	3" R-B 3 Studs	5.95
Whse	DY-2	0-15	4" R-M Ext. Mult	9.75
Weston	642	0-75	4" R-M SF or F	7.50
Whse	RA37	0-300/600	4" S-B	
w/ 2 to 1 Potential Transformers				**9.75**

AC AMPS

Whse	NA35	0-3A FS, 0-120 Scale	3" R-B	4.95
Trpltt	431AC	0-5A FS, 0-150/300 Scale	3" S-B	4.95
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	**9.75**
w/external Current Transformers				

DC MICROAMPS

Weston	301	0-100	3" R-B	12.50

DC MILLIAMPS

McClntk	2001	0-1	2" R-B	**3.95**
Weston	506	0-1	2" R-B Spec. Scale	4.50
Sun	525	0-2	2" R-B	2.50
Weston	506	0-3	2" R-B	3.95
Weston	506	0-15	2" R-B	3.50
GE	DW41	0-25	2" R-B Wide Flange	**3.50**
GE	DW41	0-30	2" R-B	3.50
Weston	506	0-50	2" R-M	3.95
McClntk	2001	0-100	2" R-B	3.50
Simpson	25	0-1	3" R-B Spec Scale	**4.50**
GE	DO41	0-1	3" R-B	4.95
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	0-2	3" R-B	7.50
Simpson	25	0-5	3" R-B	4.75
GE	DO41	0-10	3" R-B	4.75
Whse	NY35	0-15	3" R-B	4.50
Simpson	25	0-15	3" R-B	3.95
GE	DO53	0-20	3" R-B	3.95
Weston	301	0-25	3" R-M	**5.95**
Weston	301	0-30	3" R-M	5.95
Weston	301	0-100	3" R-B	6.50
Whse	NX35	0-200	3" R-B	4.50
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**
Weston	301	5-0-5	3" R-B Spec Scale	5.50
GE	DO58	0-8	4" S-B Blk Scale	7.50
GE	DO58	0-30	4" S-B	7.50

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
GE	DO41	0-1.5	3" R-B	4.75
Simpson	25	0-10	3" R-B SF	4.50
Weston	301	0-10	3" R-B	7.50
Trplett	421	0-1.5	4" S-B	3.50
Whse	KX24	Concentric 50-0-50MV	4" S-B BlkSpecScale	**14.95**
Whse	KX24	Concentric 50MV	4" S-B Spec Scale	**14.95**

DC VOLTS

Sun	378	0-3	2" R-B	2.50
GE	DW40	0-15	2" R-B Short Flange	3.50
Weston	506	0-20	2" R-B	3.50
Simpson	125	0-35	2" R-M	**2.50**
Weston	506	0-40	2" S-B	3.95
Weston	506	0-250	2" R-M	5.50
Weston	301	0-30	3" R-M	5.95
Weston	301	0-150	3" R-M Blk Scale	**5.95**

All Scales White, All Cases Flush Unless otherwise specified.

HIGH VOLTAGE TRANSFORMER

GE Cat No. 7470609 can-enclosed with insulators
PRI—115/230 V. 50/60 Cycles
SEC—14000 V., Rating 1.4 Kva
Dimensions: 16"H x 12"W x 10"D.
Shipping Weight: 178 lbs.

A buy at $45.00

R. C. A. POWER TRANSFORMER

PRI—440/220 V. 60 CYCLES
SEC—125/115/105 V. at .8KVA
Bracket mounted, pri & sec terminal board. Dimensions: 5¾" H x 7½" W x 8" D, Shipping weight: approx 40 lbs.

Your price $12.50

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 **$3.75**
SEC—15 V at 12 Amps **$3.75**
Also available: SEC—10V at 18 Amps

POWER TRANSFORMER

PRI—440/220 V. 60 Cycles
SEC—125/115/105 V., RATING .8KVA
RCA Open construction. Bracket mounted, pri & sec terminal board. Overall dimensions: 5¾" H x 7½" W x 8" D. Mounting dimensions: 6⅞" x 5⅞".

Price $12.50

GE Step Down Power Transformer

GE Type M Cat #61021, Enclosed, Size: 4-9/16" H x 4⅞" W x 12½" L.
PRI—460 V 60 Cycles: SEC—115 V
RATING—750 Watts **$9.00**

GE STEPDOWN TRANSFORMER

Cat No. 61G5, Fully Enclosed, Wall or Bench Mounting, Isolation Type
PRI—230 Volts, SEC—115 Volts
RATING—250 Watts, 60 Cycles
Dimensions—8Hx4¾Wx4½D, Shipping Weight approx. 21 lbs. $6.75

GE #K2731 PULSE TRANSFORMER

Pri. Imp. 50 Ohms
Sec. Imp. 450 Ohms

1 Micro-second, 635 PPS, Pri. Input 9.5 KV PK, Sec. Input 28 KV PK, BWR Out 800 KW, Bifiliar 2.75A.

A buy at $17.50

TRANSTATS

Type RH Input: 115 V. ±10%. Output: 115 V. Made as a line voltage corrector ±10% of input voltage, or can be connected to give ±20% of input. **Rating .25 KVA.**

Your price $6.50

RATING 3KVA, MAX AMPS 26

same as above, can also be reconnected to be used as an isolation type step down with variable secondary, Input: 115V, Output: 0-30V, at 30 Amps.

Your price $18.00

RATING 1.85 KVA, MAX AMPS 16

same as above, can also be reconnected as isolation type transformer above Input 115 V, Output: 0-30 V, at 16 Amps.

Your price $17.00

DYNAMOTOR MADE BY G. E.

INPUT 28 V D.C. OUTPUT 1000 V D.C. CAPACITY 350 MA. With voltage regulator box on top. Approx. dimensions: 12" L x 6" Diam. Weight: 30 lbs.

A buy at $5.75

3PDT #1XCX114, Coil 115V. AC Contacts, 115 V. AC, 6 Amps, Micalex Base, Dimensions 3½" x 2½" x 2" H $3.95

4 Pole St, Coil 115V. AC, Contacts 115V. AC, 30 Amps, Fibre Base, Dimensions, 5" x 5" x 3" H. $4.95

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0-150 DC MICRO GE 2½" rd bl sc 610 ohms 70 MV.....$4.50
0-200 DC MICRO WH 3½" rd 230 ohms 43 MV MR 35 W 200 DCUA.....$8.50
0-200 DC MICRO SUPER 4" Rect 500 ohms Special sc.....$7.50
0-400 DC MICRO TRIUMPH 4" Rect 500 ohms, special sc.....$5.50
0-500 DC MICRO De Jur Amsco 2½" rd.....$3.00
0-500 DC MICRO GRUEN 2½" rd.....$3.95
0-500 DC MICRO SIMP 2½ rd.....$3.50
0-500 DC MICRO TRIP 2½" rd.....$3.50
0-500 DC MICRO WH 3" sq SPEC SC.....$4.95
0-550 DC MICRO GE 3" sq Spec sc.....$4.50

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0-1 DC MA De Jur Amsco 2½" rd Spec Sc..$2.50
0-1 DC MA GE 2½" rd sc cal 140/500.....$3.00
0-1 DC MA GE 2½" rd met cs Spec Sc.....$3.00
0-1 DC MA GE 2½" rd Spec Sc.....$3.50
0-1 DC MA WH 2½" rd bl sc Spec Sc.....$3.00
0-1 DC MA McClintock 3" sq 65 ohms Spec Sc.....$3.50
0-1 DC MA McClintock 3½" rd.....$3.50
0-1 DC MA Sun 3½" rd.....$3.00
0-1 DC MA WH 3½" rd 53.7 ohms resist MR 35 W 001 DCMA.....$7.50
0-1.4 DC MA Hick 3½" rd 70 ohms, w. Micrombos sc.....$3.50
0-1.5 DC MA Hick 2½" rd met cs.....$2.00
0-2 DC MA RS 20 MV mvt Spec Sc.....$2.50
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
0-10 DC MA Hick 2½" rd met cs Spec Sc..$2.50
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 GE 2½" rd bl sc.....$3.00
0-20 DC MA GE 3" sq.....$3.75
0-25 DC MA Weston 3½" rd.....$4.95
0-30 DC MA GE 3½" rd.....$3.50
0-30 DC MA GE 3" sq.....$3.25
30/300 DC MA WH 3½" rd.....$3.50
30/300 DC MA WH 3" sq.....$3.95
0-50 DC MA GE 3½" rd.....$3.95
0-50 DC MA GE 3" sq.....$3.95
0-80 DC MA GE 3½" rd.....$3.75
0-100 DC MA Weston 2½" rd.....$3.95
0-100 DC MA Weston 3½" rd. surf. mtd. bake. or met. cs.....$4.50
0-150 DC MA Gruen 2½" rd.....$3.00
0-200 DC MA Gruen 2½" rd.....$3.00
0-200 DC MA Weston 2½" rd bl sc.....$3.50
0-200 DC MA Marion 3½" rd.....$4.00
0-200 DC MA Simp 3½" rd.....$4.50
0-200 DC MA Weston 3½" rd.....$4.95
0-200 DC MA WH 3½" rd.....$4.50
0-300 DC MA GE 3½" rd.....$4.95
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SPECIAL METERS

FREQUENCY METER JBT 30-F Dual Range covers frequency ranges from 48-52 cycles & 58-62 cycles: Dual element, vibrating reed type, 115 volt, 3½" rd flush metal case.....$5.95
FREQUENCY METER Range 350 to 450 cycles, 115 volt A.C. Iron core dynamometer type movement, 50 cycles per scale division, black scale luminous markings Weston model 637, 3½" Aircraft style.....$4.95
FREQUENCY METER 50 to 70 cycles, Westinghouse HY 5½" square Proj. mtd case: Accuracy within 1% electric dynamometer type movement: Comp with ext. reactor.....$45.00
FREQUENCY METER 58 to 62 cycles, Westinghouse HY 5½" square Proj. mtd. case. Accuracy within 1% Electric Dynamometer type movement; Comp with ext. reactor.....$39.50
HOUR METER, Totals to 99,999.9 hours and repeats. WH NH-35, 3½" rd. fl bake case. Operates on 230 volt 60 cycle.....$8.50
D.C. MILLIAMMETER, Weston 271 fan type, 1-0-1 MA (60-0-60 M.V.) movement Sc. cal 600-0-600 R.P.M.....$12.50
DECIBEL METER, Weston 506 minus 10 to plus 6, 6 MW in 600 ohms 2½" rd fl bake case..$5.50
DECIBEL METER. Weston 301 type 61, —10 to plus 6 3½" rd. fl bake case, 6 MW 600 ohms, Zero DB = 1.9 volt. High speed type .29-.35 Seconds to final reading. Only 2-6% overthrow, 5000 ohms at Zero DB. 16-50 Damping factor. Complete with external wire wound precision resistors to extend the range to any or all of the following ranges.
— 20 to plus 16 DB
— 30 to plus 26 DB
— 40 to plus 36 DB
Ideal for sound and broadcasting applications (Quantity Available) Total List Price $37.50
Your cost only.....$11.50
DECIBEL METER GE DO-46 —10 to plus 6 DB, 3½" rd fl bake case, Zero DB = 1.9 volts. Your Cost Only.....$8.95
RECTIFIER TYPE MILLIAMMETER, Weston Model 545, type 81, 4" Aircraft type, full scale. equals 1.1 MA AC, 940 UA DC mvt., 70 ohms resistance of moving coil, bl sc. calib 0-270°, $6.50

A. C. AMMETERS

0-30 AC A Trip 3½" rd.....$4.00
0-30 AC A Trip 3½" rd met cs.....$3.50
0-50 AC A GE 3½" rd.....$4.50
0-50 AC A WH 3½" rd.....$4.95
0-60 AC A WH 4½" rd surf mtd cs.....$8.00
0-60/120 AC A Burl 3½" w ext current transformer.....$7.50
0-60/120 AC A Burl 3½" less current transformer.....$4.50

A. C. VOLTMETERS

0-15 AC V GE 2½" rd bl sc 800 cy.....$2.50
0-15 AC V GE 2½" rd bl blank scale IS-122..$2.50
0-15 AC V GE 3½" rd bl sc.....$3.00
0-15 AC V Weston 476 3½" rd.....$4.50
0-15 AC V WH 3½" rd.....$3.95
0-40 AC V WH 2½" rd bl sc, lum mkgs, 400 cy.....$2.95
0-75 AC V Weston 2" rd met cs ring mtd....$2.95
0-130 AC V WH 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 Weston 2½" rd met cs.....$2.95
0-150 AC V GE 3½" rd ring mtd cs, 400 cy..$4.00
0-150 AC V GE 3½" rd bl sc.....$4.50
0-150 AC V GE 3½" rd 400 cy.....$4.00
0-150 AC V GE 3½" rd bl sc 400 cy.....$4.00
0-150 AC V GE 3½" rd.....$5.50
0-150 AC V Trip 3½" rd.....$4.50
0-150 AC V Trip 3½" rd met cs.....$4.00
0-150/300 AC V Trip 3½" rd w res for 300 V.$5.50
0-150 AC V WH 3½" rd 400 cy.....$4.50
0-150 AC V WH 3½" rd.....$5.50
0-150 AC V WH 3½" rd surf mtd met cs....$3.00

R. F. AMMETERS

0-250 MA RF GE 2½" rd bl sc cal 0-5.....$3.50
0-250 MA RF WH 2½" rd bl spec sc.....$3.50
0-500 MA RF Weston 3½" rd with ext thermocouple.....$9.50
0-1 RF A GE 2½" rd bl sc.....$2.95
0-1 Amps RF GE 3½" rd.....$7.50
0-1 RF A GE 2½" rd met cs.....$3.00
0-1.5 RF A GE 2½" rd met cs bl sc.....$2.95
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 Amps RF Weston 3½" rd.....$8.50
0-2 RF A Simp 2½" rd.....$3.50
0-2.5 Amps RF Weston 3½" rd.....$8.50
0-2.5 RF A Weston 2½" rd.....$3.95
0-2.5 RF A Simp 3½" rd.....$4.95
0-2.5 RF A Westinghouse 3½" rd.....$5.50
0-2.5 RF A McClintock 3½" rd.....$4.50
0-3 Amps RF Weston 3½" rd w ext thermocouple.....$11.50
0-3 RF A Simp 2½" rd.....$3.50
0-3 RF A WH 3½" rd.....$5.50
0-4 RF A GE 2½" rd bl sc.....$2.95
0-5 Amps RF Weston 3½" rd.....$8.50
0-5 Amps RF GE 3½" rd.....$7.50
0-6 RF A GE 2½" rd bl sc.....$2.50
0-10 RF A Weston 3½".....$6.50
0-8 RF A GE 2½" rd bl sc.....$2.95
0-20 RF A Weston 2½" rd.....$3.50
0-20 RF A GE 3½" rd.....$4.95
0-30 RF A Trip 3" sq W e/t leads & couple..$8.00

D. C. AMMETERS

0-1 DC A GE 3½" rd.....$4.95
0-1.5 DC A GE 3½" rd.....$4.95
0-5 DC A Gruen 2½" rd.....$3.50
0-10 DC A Weston 3" rd surf mtd, bake or met cs.....$4.50
0-15 DC A Sun 3½" rd.....$4.00
0-15 DC A Trip 3½" rd.....$4.00
0-15 DC A WH 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 GE 2½" rd met cs.....$3.50
30-0-30 DC A U.S. Guage 2" met cs bl sc...$1.50
0-200 DC A Weston 506 2½" rd W 50 MV shunt.....$7.50
0-300 DC A GE 2½" rd W 50 MV shunt.....$7.50

D. C. VOLTMETERS

0-3 DC V Simp 2" rd met cs ring mtd.....$2.00
0-3 DC V Trip 2½" rd bl sc met cs.....$2.00
3-0-3 DC V WH 2½" rd surf mtd 200 r/v....$1.25
0-5 DC V WH 2½" rd 200 r/v.....$3.50
0-10 DC V Sun 2½" rd 100 r/v.....$2.50
0-15 DC V GE 2½" rd bl sc.....$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 GE 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
0-50 DC V WH 3½" rd 200 r/v.....$3.95
0-150 DC V Weston 3½" rd surf mtd, bake or met cs, 200 r/v.....$6.50
0-600 DC V Simp 2½" rd w ext res.....$4.00
0-750 DC V Weston 3½" rd met cs 1000 r/v, $11.00
0-1.5 KV DC WH 3½" rd 1000 r/v.....$7.25
0-15 KV DC GE 3" sq 500 ua mvt, less mult.$4.95
0-15 KV DC WH 3½" rd 1 MA mvt, less mult, $4.50

Gasoline Heater—Motorola Model GN-3-24

An internal combustion type heater which will give 15,000 B.T.U. of heat per hour. Ideally suited for use with equipment, farms, boats, bungalows, cabins, trailers, work sheds, darkrooms, mobile equipment, transmitter stations, etc., and any place where a quick heat is required in volume. Very economical in operation—tank holds one gallon of gasoline which is sufficient for 6 hours operation. Uses any grade gasoline.
This unit is designed primarily for aircraft installation, 24-28 volts d.c., but it can be readily adapted for a 115 or 230 volt 60 cycle power supply by use of a transformer and rectifier. Simple circuit diagram for adaption to 115 or 230 volt 60 cycle use supplied with each unit. Can be used on 32 volt farm or boat systems as is without the installation of additional transformers, etc. Power consumption approximately 75 to 100 watts.
Takes very little space—can be readily stored when not in use—measures appróximately 12 long x 9½" high x 9½" wide, weighs only 30 lbs complete with all accessories.
These units are complete with exhaust pipe, 3" air duct elbow, control switch and cord, as illustrated, and are supplied with Technical Manual and Parts Catalog.

SIMPLE TO INSTALL—SAFE TO USE—
NO ODORS
BRAND NEW—IN ORIGINAL CARTONS—
READY TO USE
Made by Gavlin (Motorola) Mfg. Company.

NET PRICE..... **$22.50**

DUAL RANGE VOLTMETER 0-15, 0-150 Volt A.C., Weston 528 w. case & leads.....@ $9.50
DUAL RANGE AMMETER, 0-3, 0-15 Amp. A.C. Weston 528 w. case & leads.....@ $12.50
SPEC. COMBINATION above voltmeter & ammeter, both for.....@ $21.00
COMBINATION OFFER 0-150 Volt A.C. & 0-30 Amp. A.C. Triplett 3½" Rd. meters. Both for..$7.95
A.C. VOLTMETER, portable, 0-300 V., R.S. Steel 6.....@ $27.50
A.C. AMMETER, port 0-200 A. Weston 155, self cont.....@ $32.00
D.C. VOLTMETER, port, 0-3, 0-150 V., Dual range. W.H. PX-4.....@ $17.50
D.C. VOLTMETER, port. 0-15, 0-150 V, dual range. R.S. steel 6.....$21.00

PORTABLE CHRONOMETRIC TACHOMETER

To measure speeds from 0 to 20,000 R.P.M. with scale calibrations in 10 R.P.M. divisions. Divide scale reading by 2 when using the peripheral wheel and you can read surface speeds up to 10,000 F.P.M.
3 2" open face dial provides unequaled readability. Each division on large dial indicates 10 R.P.M. & each division on small dial indicates 1000 R.P.M. Readings are similar to those made on kilowatt hour meters. Results of tests remain on dial until next test taken.
Complete with 2 tips, peripheral wheel & operating instructions—No stop-watch or other timing mechanisms required. Made by Jaeger Watch Co. model 43 A-6. Complete in velvet lined case 5" x 3½" x 1½". List price $75.00.....@ $24.50

MULTIPLE RANGE, CONTINUOUS INDICATING PORTABLE TACHOMETER

Three ranges in R.P.M. & three ranges in F.P.M. 300-1200, 1000-4000, 3000-12,000 R.P.M.
Large 4" dial shows INSTANTANEOUSLY & CONTINUOUSLY the speed or change in speed of any revolving shaft or surface.
Complete with 4 tips, peripheral wheel, extension rod and operating instructions. No stop watch or other timing mechanism required.
Made by Jones Motorola, Stamford, Conn. Comes complete in velvet lined case 7⅛" x 4" x 5". List price $75.00.....@ $24.50

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. C.O.D.'s not sent unless accompanied by 25% Deposit.
Orders accepted from rated concerns, public Institutions, etc., on open account.
The above is only a partial listing of the many items we have in stock. Send for free circular.
MANUFACTURERS, EXPORTERS, DEALERS—we invite your inquiries.
NOTICE—We Repeat—all items are Surplus—New—Guaranteed. All prices FOB, N. Y.

We carry a complete line of surplus new meters suitable for every requirement, such as portable, panel, switchboard, laboratory standards, etc.

OVER 50,000 METERS IN STOCK

We also have in stock various surplus components, tubes, code keying and recording units, code-training sets, tachometers, analyzers, tube testers, converters, precision resistors, current transformers, transmitters, receivers, condensers, and other electronic units, parts and accessories.

MARITIME SWITCHBOARD

336 Canal Street Worth 4-8217 New York 13, N. Y.

www.americanradiohistory.com

MICROWAVE PLUMBING

10 CENTIMETER

WAVEGUIDE directional coupler, 27 db. Navy type CABV-47AAN, with 4 in slotted section $42.50

SQ. FLANGE to rd choke adapter, 18 in. long OA 1½ in x 3 in guide, type "N" output and sampling probe —as shown.....$32.00

"S" BAND CRYSTAL MOUNT, gold plated, with 2 type "N" connectors.....$12.50

POWER SLITTER, 726 Klystron input, dual "N" output $5.00

MAGNETRON TO WAVEGUIDE coupler with 721-A duplexer cavity, gold plated.....$27.50

10 CM WAVEGUIDE SWITCHING UNIT, switches 1 input to any of 3 outputs. Standard 1½" x 3" guide with square flanges. Complete with 115 vac or d.c. arranged switching motor. Mfg. Raytheon. CRP 24AAS. New and complete.....$150.00

10 CM. END-FIRE ARRAY POLYRODS....$1.75 ea.

"S" BAND Mixer Assembly, with crystal mount, pick-up loop, tunable output.....$3.00

721-A TR CAVITY WITH TUBE, Complete with tuning plungers $12.50

10 CM. McNALLY CAVITY Type SG.....$3.50

WAVEGUIDE SECTION, MC 445A, rt. angle bend. 5½ ft. OA 8" slotted section.....$21.00

10 CM. OSC. PICKUP LOOP, with male Homedell output $2.00

10 CM. DIPOLE WITH REFLECTOR in lucite ball, with type "N" or Sperry fitting.....$4.50

10 CM. FEEDBACK DIPOLE antenna, in lucite ball, for use with parabola.....$8.00

⅞" RIGID COAX—⅜" I.C.

RIGHT ANGLE BEND, with flexible coax output pickup loop $8.00

SHORT RIGHT ANGLE bend, with pressurizing nipple $3.00

RIGID COAX to flex coax connector.....$3.50

STUB-SUPPORTED RIGID COAX, gold plated 5' lengths. Per length.....$5.00

RT. ANGLES FOR ABOVE $2.50

⅞" COAX, ROTARY JOINT $8.00

RT. ANGLE BEND 15" L. OA.....$3.50

FLEXIBLE SECTION, 15" L. Male to female..$4.25

MAGNETRON COUPLING to ⅞" rigid coax with TR pickup loop, gold plated.....$7.50

⅞" RIGID COAX—¼" I.C.

⅞" RIGID COAX. BEAD SUPPORTED per ft..$1.20

SHORT RIGHT ANGLE BEND $2.50

ROTATING JOINT, with deck mounting.....$6.00

RIGID COAX slotted section CU-60/AP.....$5.00

1.25 CENTIMETER

"K" BAND FEEDBACK-TO-PARABOLA HORN with pressurized window $30.00

MITRED ELBOW cover to cover.....$4.00

TR/ATR SECTION choke to cover.....$4.00

FLEXIBLE SECTION 1" choke to choke.....$5.00

KBAND Rotary joint.....$45.00

ADAPTER, rd. cover to sq. cover.....$5.00

MITRED ELBOW and S sections choke to cover..$4.50

3 CENTIMETER PLUMBING

(STD. 1" x ½" GUIDE, UNLESS OTHERWISE SPECIFIED)

"X" BAND PREAMPLIFIER, consisting of 2-723A/B local oscillator-beacon feeding waveguide and TR/ATR Duplexer section, including 60 mc. IF amp. $47.50

RANDOM LENGTHS of waveguide, 6 in. to 18 in. long .....$1.10/ft.

WAVEGUIDE RUN, 1⅜" x ½" guide, consisting of 4 ft. section with rt. angle bend on one end and 2" 45 deg. bend other end.....$8.00

WAVEGUIDE SECTION, 1⅜" x ½" choke to choke, 4 ft. long $6.75

DUMMY LOAD, TS 332/UP.....$22.50

"X" Band pressurizing gauge section, with 15-lbs. gauge and pressurizing nipple.....$18.50

45 DEG. TWIST, 6" Long.....$10.00

12" SECTION, 45 deg. twist, 90 deg. bend.....$6.00

11" STRAIGHT WAVEGUIDE section choke to cover. Special heavy construction, silver plated.....$4.50

15 DEG. BEND 10" choke to cover.....$4.50

5 FT. SECTIONS, choke to cover.....$14.50

18" FLEXIBLE SECTION $17.50

"E" and "H" PLANE BENDS.....$12.50

BULKHEAD FEED THRU.....$15.00

"X" BAND WAVEGUIDE, 1¼" x ⅝" OD. 1/16" wall, aluminum .....per ft. $ .75

WAVEGUIDE. 1" x ½" I.D. 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 $8.50

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.....$6.00

ROTARY JOINT, choke to choke, with deck mounting $6.00

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

CU 105/APS 31 Directional coupler, 25 db....$15.00

CU 106/APS 33 Directional coupler, 25 db....$15.00

CG 176/AP Directional coupler, 20 db.....$18.00

FLEX. WAVEGUIDE .....$4.00/Ft.

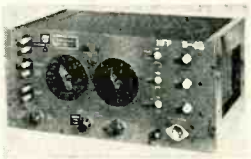
"X" BAND calibrated attenuator.....$85.00

SHIELDED KLYSTRON tube mounts with rough attenuator outputs $90.00

2½" FLEXIBLE SECTION, cover to cover.....$5.00

PULSE EQUIPMENT

MODULATION UNIT BC 1203-B



Provides 200 - 4,000 PPS. Sweep time: 100 to 2,500 microsec. in 4 steps, fixed mod. pulse, suppression pulse, sliding modulating pulse, blanking voltage, marker pulse, sweep voltages, calibration voltages, fil. voltage. Operates 115 vac. 50-60 cy. Provides various types of voltage pulse outputs for the modulation of a signal generator such as General Radio #804B or #804C used in depot bench testing of SCR 695, SCR 595, and SCR 535. New as shown...$125.00

MIT. MOD. 3 HARD TUBE PULSER: Output Pulse Power: 114 KW (12 KV at 12 amp). Duty Ratio: .001 max. Pulse duration: .5, 1.0, 2.0 microsec. Input voltage: 115 v. 400 to 2400 cps. Uses 1-715B, 1-829-B, 3-'72's, 1-'73. New.....$110.00

APQ-13 PULSE MODULATION. Pulse Width .5 to 1.1 Micro Sec. Rep. rate 624 to 1348 Pps. Pk. Pwr. out 35 KW. Energy 0.018 Joules.....$49.00

TPS-3 PULSE MODULATOR. Pk. power 50 amp. 24 KV (1200 KW pk): pulse rate 200 PPS, 1.5 microsec; pulse line impedance 50 ohms. Circuit—series charging version of DC Resonance type. Uses two 705-A's as rectifiers. 115 v. 400 cycle input. New with all tubes $49.50

APS-10 MODULATOR DECK, Comp less tubes $75.00

APS-10 Low voltage power supply, less tubes...$18.50

PULSE TRANSFORMERS

W.E. #D166173 Hi-Volt input transformer, W.E. Impedance ratio 50 ohms to 900 ohms. Freq. range: 10 kc to 2 mc. 2 sections parallel connected, potted in oil $12.00

W.E. KS 9800 input transformer. Winding ratio between terminals 3-5 and 1-2 is 1.1:1, and between terminals 6-7 and 1-2 is 2:1. Frequency range: 380-520 c.p.s. Permalloy core.....$2.00

G.E. K2731 Repetition Rate: 635 PPS, Pri. Imp: 50 Ohms. Sec. Imp: 450 Ohms. Pulse Width: 1 Microsec. Pri. Input: 9.5 KV PK. Sec. Output: 28 KV PK. Peak Output: 800 KW. Biflar 2.75 Amp.....$19.50

W. E. #D166927! Hi Volt input pulse Transformer.$9.95

G.E. K2150A Will receive 13KV. 4 micro-second pulse on pri., secondary delivers 14KV. Peak power out 100KW. GE $15.00

G.E. K2748A Pulse Input, line to magnetron....$12.00

#9280 Utah Pulse or Blocking Oscillator XFMR Freq. limits 790-810 cy-3 windings turns ratio 1:1:1 Dimensions 1 13/16 x 1⅛" 19/32.....$1.50

PULSE NETWORKS

G.E. #25E5-1-350-50P2T. 25 KV, 5 sections, "E" circuit, 1 microsecond pulse length, 350 PPS. 50 ohms impedance $45.00

G.E. #6E3-5-2000-50P2T, 6KV, "E" circuit, 3 sections, .5 microsecond, 2000 PPS, 50 ohms impedance..$6.50

7.5E3-1-200-67P. 7.5 KV, "E" Circuit, 1 microsec, 200 PPS. 67 ohms impedance, 3 sections.....$7.50

7.5E4-16-60-67P. 7.5 KV, "E" circuit, 4 sections, 16 microsec. 60 PPS, 67 ohms impedance.....$15.00

DELAY LINES

D-168184: .5 microsec. up to 2000 PPS, 1800 ohm term $4.00

D-170499: .25/.50/.75/microsec, 8 KV, 50 ohm imp $16.50

#13830 5 microsec twelve taps, 500 imp.....$4.00

MICROWAVE TEST EQUIPMENT

TS-238 GP. 10 cm. Echo box with resonance indicator and micrometer adjust cavity, 2700 to 2900 Mcs calibrated. New as shown $85.00

THERMISTOR BRIDGE

Power Meter 1-203-A. 10 cm. mfg. W.E. Complete with meter, interpolation chart, portable carrying case $72.50

Bell Labs Dual Mount mixer-beacon assemblies. 2 complete mixer-beacon mounts on gold-plated waveguide section..$50.00

Slotted Line, Bell Labs, 1-⅛" x 5/16" guide, gold plated.....$150.00

TS-108-AP dummy load.....$65.00

"X" Band calibrated attenuator.....$85.00

Shielded klystron tube mounts with rough attenuator outputs $90.00

W. E. I 138. Signal generator, 2700 to 2900 Mc range. Lighthouse tube oscillator with attenuator & output meter. 115 VAC input, reg. Pwr. supply. With circuit diagram $50.00

3 cm. wavemeter: 9200 to 11,000 mc transmission type with square flanges.....$15.00

3 cm. stabilizer cavity, transmission type.....$20.00

3 cm. wavemeter, micrometer head mounted on X-Band guide. Freq. range approx. 7900 to 10,000 Mc..$75.00

MAGNETRONS

TUBE	FRQ. RANGE	PK. PWR. OUT.	PRICE
2J31	2820–2860 mc.	265 KW.	$25.00
2J21-A	9345–9405 mc.	50 KW.	25.00
2J22	3267–3333 mc.	265 KW.	25.00
2J26	2992–3019 mc.	275 KW.	25.00
2J27	2965–2992 mc.	275 KW.	25.00
2J32	2780–2820 mc.	285 KW.	25.00
2J38 Pkg.	3249–3263 mc.	5 KW.	35.00
2J39 Pkg.	3267–3323 mc.	87 KW.	35.00
2J55 Pkg.	9345–9405 mc.	50 KW.	35.00
2J61	3000–3100 mc.	35 KW.	65.00
2J62	2914–3010 mc.	35 KW.	65.00
3J31	24,000 mc.	50 KW.	55.00
5J30			39.50
714AY			25.00
720BY	2800 mc.	1000 KW.	50.00
72CY			50.00
725-A	9345–9405 mc.	50 KW.	25.00
730-A	9345–9405 mc.	50 KW.	25.00

Klystrons: 723A/B $12.50: 707B W/Cavity 20.00

MAGNETRON MAGNETS

GAUSS	POLE DIAM.	SPACING	PRICE
4850	¾ in.	⅝ in.	$12.50
2500	1⅝ in.	1—11/16 in.	12.50
1500	1⅝ in.	1½ in.	12.50

TUNABLE PKG'D "CW" MAGNETRONS

QK61 ..2975-3200 Mcs QK61 ..3150-3375 Mcs
QK60 ..2800-3026 Mcs QK59 ..2675-2900 Mcs
Now .....$65 each

INVERTERS

PE 218: Input: 26-28vdc. 92 Amp. Output: 115 v, 380-500 cy, 1500 v.a. New $49.95

PE 206: Input: 28 vdc: Output: 80 v, 800 cy, 500 v.a. New.....$12.50

G.E. #5D21NJ3: Input: 27 vdc, 35 Amp. Output 485 v.a., 400 cy. New $49.95

VARISTORS

D-171631	$.95	D-168549	$.95
D-167176	$.95	D-162482	$3.00
D-168687	$.95	D-166271	$2.50
D-171812	$.95	D-162356	$1.50
D-171528	$.95	D-161871A	$2.85
D-163298	$.95		

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

MICROWAVE ANTENNAS

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) $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: 4½' 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 1,000-4500 mc. No drive mechanism $65.00

DYNAMOTORS

Type	Input Volts	Input Amps	Output Volts	Output Amps	Radio Set	Price*
BD 77KM	14	40	1000	.350	BC 191	20.00N
						14.00LN
PE 73CM	28	19	1000	.350	BC 375	24.50N
DM 21	14	3.3	235	.090	BC 312	3.45N
DM 21CX	28	1.6	235	.090	BC 312	3.45N†
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 86	28	1.25	250	.060	BC 36	3.95
PE 101C	13/26	12.6/ 6.3	400	.135 .020	SCR 515	5.25N
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
B-19 pack	12	9.4	275	.110	Mark H	9.95N
			500	.050		
D-104	12		225	.100		14.95N
			400	.200		
DA-3A*	28	10	300	.260	SCR 522	8.95N
			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		17.50
	26	6.3	800	.020		
			9	1.12		

N—New. LN—Like New. *For PE 94, Less Filter Box & Relays.

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

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R·H·S
SPECIALS OF THE MONTH

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The Opening of Our New Larger Quarters at 189 Greenwich St., N. Y. 7 (formerly at 63 Dey St.)

1 K.W. POWER SUPPLY KIT

2500-0-2500 Volts @ 500 MA
or
2000-0-2000 Volts @ 500 MA
(oil-filled Xformer from BC610) $39.95

1—Swinging choke	14.95
1—Smoothing choke	7.95
1—Filament Xformer	9.95
2—2 Mfd., 3000 v. Condensers, ea	3.45
2—872A Tubes ..... each	1.95
2—Plate Caps for 872A.. each	.20
2—Sockets for 872A..... each	1.19
2—Hash Filter Chokes pr. .79	

All parts New! Reduced to **$79.50**

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Full Wave Bridge Type

INPUT	OUTPUT		
up to 18v AC	up to 12v DC	½ Amp.	$0.98
up to 18v AC	up to 12v DC	1 Amp.	1.95
up to 18v AC	up to 12v DC	5 Amp.	4.45
up to 18v AC	up to 12v DC	10 Amp.	7.45
up to 18v AC	up to 12v DC	15 Amp.	9.95
up to 18v AC	up to 12v DC	30 Amp.	14.95
up to 36v AC	up to 28v DC	1 Amp.	3.45
up to 36v AC	up to 28v DC	5 Amp.	7.45
up to 36v AC	up to 28v DC	10 Amp.	12.45
up to 36v AC	up to 28v DC	15 Amp.	18.95
up to 115v AC	up to 100v DC	.25 Amp.	2.95
up to 115v AC	up to 100v DC	.6 Amp.	6.95
up to 115v AC	up to 100v DC	5 Amp.	19.95
up to 115v AC	up to 100v DC	3 Amp.	12.95

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NATIONALLY ADVERTISED BRANDS
All Ratings D. C.

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.5mfd.	600v	.35	4mfd.	2000v	3.75
1mfd.	600v	.35	15mfd.	2000v	4.95
2mfd.	600v	.35	4mfd.	2500v	3.98
4mfd.	600v	.60	2mfd.	2500v	2.49
8mfd.	600v	1.10	.1mfd.	2500v	1.25
10mfd.	600v	1.15	25mfd.	2500v	1.45
3x.1mfd.	1000v	.45	.5mfd.	2500v	1.75
.25mfd.	1000v	.45	05mfd.	3000v	1.95
1mfd.	1000v	.60	.1mfd.	3000v	2.25
2mfd.	1000v	.70	.25mfd.	3000v	2.65
4mfd.	1000v	.90	1mfd.	3000v	3.50
8mfd.	1000v	1.95	12mfd.	3000v	6.95
10mfd.	1000v	2.10	2mfd.	4000v	5.95
15mfd.	1000v	2.25	1mfd.	5000v	4.95
20mfd.	1000v	2.95	.1mfd.	7000v	2.95
24mfd.	1500v	6.95	3mfd.	4000v	6.95
.1mfd.	1750v	.89	2mfd.	3000v	3.45
.1mfd.	2000v	.95	2x.1mfd.	7000v	3.25
.25mfd.	2000v	1.05	.02mfd.	12000v	9.95
.5mfd.	2000v	1.15	.02mfd.	20000v	11.95

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200 mfd.—35 VDC	.59
100 mfd.—50 WVDC	.49
4x10 mfd.—400 VDC	.89
4000 mfd.—18 WVDC	1.95
4000 mfd.—25 WVDC	2.95
4000 mfd.—30 WVDC	3.25

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8 hy @ 300 ma	3.95	1 hy @ 800 ma	14.99
25 hy @ 160 ma	3.49	10 hy @ 250 ma	2.45
12 hy @ 150 ma	2.25	10 hy @ 200 ma	1.98
30 hy @ 70 ma	1.39	10/20 @ 85 ma	1.59
.05 hy @ 15 amps	7.95	15 hy @ 125 ma	1.49
.1 hy @ 5 amps	6.95	15 hy @ 100 ma	1.39
4 hy @ 600 ma	5.95	3 hy @ 50 ma	.29
200 hy @ 10 ma	3.49	30 hy Dual @ 20 ma.	1.49
600 hy @ 3 ma	3.49	8/30 hy @ 250 ma.	3.50
.065 hy @ 2.5A	2.49	10 hy @ 100 ma.	1.29

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1N21	.59	802	2.95	1R5	.79
1N23	.59	803	3.75	1S4	.69
1N34	1.59	805	3.95	1S5	.59
1P24	.89	807	1.19	1T4	.59
2AP1	2.39	808	1.95	3Q4	.59
2C22	.19	809	1.98	3Q5	.69
2C26	.29	810	4.89	3S4	.59
2C40	.74	811	1.49	5Y4GT	.49
2C44	.69	812	1.39	6A7	.59
2C46	3.75	813	5.25	6A8GT	.59
2D21	1.19	814	2.75	6AG5	.79
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2J26	9.95	826	.49	6BG6G	1.49
2J31	11.49	829B	2.89	6C6	.49
2J32	14.75	832A	2.49	6D6	.49
2J36	24.55	833A	29.50	6F5GT	.49
2J37	18.95	836	.79	6F6GT	.49
2J38	14.75	837	1.19	6F6	.59
2J39	18.95	838	2.95	6H6GT	.39
2J40	18.95	841	.50	6J5GT	.42
2J46	18.95	843	.39	6J5	.55
2J49	26.95	845	3.29	6J7GT	.55
2J51	69.50	851	17.95	6K6GT	.49
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2V3G	.79	866JR	1.10	6Q7GT	.55
2X2	.27	869B	18.75	6SA7GT	.49
3AP1	2.39	874	.69	6SC7	.55
3BP1	1.39	876	.39	6SF5GT	.59
3B22	.59	878	1.29	6SH7	.49
3B24	.69	884	.79	6SJ7GT	.49
3B26	.89	885	.78	6SK7GT	.49
3CP1	2.95	902P1	5.95	6SL7GT	.59
3C22	19.95	905	4.95	6SN7GT	.59
3C23	2.49	923	.69	6SQ7GT	.49
3C24	.29	954	.24	6V6GT	.59
3C30	.59	955	.35	6X5GT	.59
3C31	1.49	956	.45	7A8	.69
3DP1	2.25	957	.24	7B7	.69
3D21A	1.50	958	.35	7C5	.59
3E29	3.39	1611	.98	7C6	.59
4B24	2.25	1613	.59	7F7	.49
4E27	12.95	1616	.75	7Y4	.49
5AP4	4.75	1619	.21	12A8GT	.63
5BP1	1.10	1622	1.59	12AT6	.49
5BP4	2.45	1624	.85	12AU6	.75
5CP1	1.98	1625	.29	12BA6	.59
5D21	18.95	1626	.25	12BE6	.59
5FP7	.85	1629	.29	12J5GT	.49
5JP1	11.95	1630	1.98	12J7GT	.49
5J29	18.95	1638	.49	12Q7GT	.59
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5LP1	11.95	1851	.69	12SF5GT	.49
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5U4G	.45	8005	1.98	12SK7GT	.49
5V4	.72	8011	.65	12SQ7GT	.49
5X4	.59	8012	1.39	12SR7GT	.49
5Y3	.35	8013	.89	14A7	.69
5Z3	.55	8014	3.98	14B6	.69
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6AB7	.85	8020	.89	24A	.49
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6AL5	.59	9002	.35	2526GT	.45
6C4	.19	9003	.35	26	.45
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6Q5G	1.25	CK1005	.29	35/51	.59
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211	.35	FG238B	29.50	43	.52
227A	3.75	GL146	7.95	45	.52
231D	1.49	GL605	39.50	47	.74
249C	.75	GL697	29.50	50A5	.89
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304TL	.72	HY615	.39	50L6GT	.49
304TH	3.39	ML100	19.95	50Y6GT	.59
316A	.35	ML101	39.50	56	.54
327A	4.95	ML502	39.50	59	.95
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531	2.50	VU111	.49	78	.49
559	.75	0Z1	.59	80	.35
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706CY	18.95	1H5GT	.54	83	.89
714AY	6.95	1N5GT	.59	83V	.89
715B	7.89	1LA4	.95	84	.59
715C	18.95	1LA6	.95	89	.69
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721A	1.59	1LC6	.95	117P7GT	1.15
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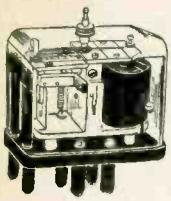

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F2L .002 3 KV DC	.90
F2L .003 3 KV DC	.90
F2L .005 3 KV DC	1.20
XR .0001 MMF 5 KV DC	.75
F2L .0005 MMF 5 KV DC	.85
F2L .001 MMF 5 KV DC	1.30
F2L .0015 MMF 5 KV DC	1.60
F2L .003 MMF 5 KV DC	1.90
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F3L .002 MMF 6 KV DC	3.50
F3L .0025 MMF 6 KV DC	3.60
F3L .003 MMF 6 KV DC	3.75
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F3L .0005 MMF 8 KV DC	2.90
F3L .0006 MMF 8 KV DC	3.00
*PL .001 MMF 8 KV DC	4.95
F3L .0015 MMF 8 KV DC	3.50
F3L .002 MMF 8 KV DC	4.00
F3L .0025 MMF 8 KV DC	4.50
F3L .003 MMF 8 KV DC	5.00
F3L .01 MMF 8 KV DC	6.50
F3L .004 MMF 8 KV DC	5.50
F3L .005 MMF 8 KV DC	6.00
*G2 .005 MMF 10 KV DC	5.95
*G2 .002 MMF 10 KV DC	6.95
*G2 .001 10 KV DC	5.95
XA .0005 MMF 12 KV DC	4.90
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* Ceramic Case. Tol ± 5%.

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0-99,999.9 hours. 3½" Square Bakelite Case. 110V 60 Cycle. Brand New. . 7.95

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11 mfd 250 vac— .85	.1/.1 mfd 7000 vdc—2.25
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10 mfd 600 vdc— .95	.65 mfd 12,500 vdc—12.95
2 mfd 1000 vdc— .79	.02 mfd 20 kv dc—7.95
4 mfd 1000 vdc— .95	2 mfd 18 kv dc—59.50
15 mfd 1000 vdc—2.95	Dual .75 mfd 8 kv,— .35
2 mfd 1500 vdc—1.25	16 kv 7.95
6 mfd 1500 vdc—2.95	
1—mfd 2000 vdc—1.45	
2 mfd 2000 vdc—2.25	
4 mfd 2000 vdc—3.65	
2 mfd 4000 vdc—5.50	
1 mfd 5000 vdc—4.50	

CHOKE BARGAINS

5 Henry 50 ma 300 ohms	3 for $ .99
5 Henry 75 ma 230 ohms	2 for .99
8 Henry 160 ma 140 ohms	.99
1.5 Henry 250 ma 72 ohms	.59
5 Henry 300 ma 65 ohms	3.75
6 Henry 550 ma 30 ohms	4.95
4.3 Henry 620 ma 42 ohms	6.95
10 Henry 750 ma 95 ohms	11.50
Swing. Choke 1.6/12 Henry 1 amp/100 ma 15 ohms	24.50
.07 Henry 7 amps .5 ohm	4.50

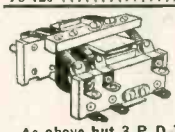
H.V.-H. CURRENT PLATE TRANS.

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.

Now only $39.95

MEDIUM CURRENT PLATE

As illustrated above. 1500-0-1500 volts at 600 ma. Pri. 110/220 v. 50/60 cycles. 8 x 8½ x 7 s.w.t. 78 lbs ..... now $27.50



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
As above but 4500 ohm DC Coil 1.75

RECTIFIER TRANSFORMER

2 separate 110 v primaries. Sec. 70-75 v at 3 amps. 35-37 v (pri in series). Fully cased. Now only $1.89 ea.

GENERAL PURPOSE TRANSFORMER

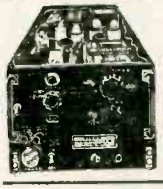
Ideal for Bias, Filament, Isolation Stepdown, etc., 2 isolated 110v pr. sec. 110v at 900 ma plus 6.3 @ 2 amp. Fully cased ..... Now $1.49 ea.

HIGH CURRENT PLATE TRANSFORMER

820 volts ct at 775 ma. Primary 110/220 v 25 to 60 cycles. Fully cased 6½ x 6½ x 7" ..... $6.95 ea.

Thordarson Plate Transf. 2370 volts ct at 250 ma. Tapped at 300-0-300 volts. Separate 215 volt 55 ma bias winding. Pri 110v 60 cy. Fully shielded. $11.95 ea.

UTC type PA 5000 ohm plate to 500 ohm line and 6 ohm voice coil. 60 to 10,000 cps ± 1 DB. 10 watts $2.75



RADAR JAMMER

425-750 MCS AN-APT 2. Contains 10 tubes:

(1)—307 . (2)—703A (2)—6AC7 (1) —6AG7 — (2) —5R4GY (1)—2x2 (1) 931A. Unit has blower motor and 400 cycle own supply complete with all tubes, etc. BRAND NEW. Now $12.95 ea.

STEPDOWN TRANSFORMER

220/110 volts, 100 watts. Fully encased, 5⅛ x 4¼ x 5⅛. 110V. 60 cycle ..... $2.49 each

U. H. F. COAX. CONNECTORS

831AP-UG12U-UG21U-UG-14U-UG146U-UG-206U.
831R-831SP ..... 35¢ ea.

FILAMENT TRANSFORMERS

110 Volt 60 cy. Pri.—H.V. Ins.—Fully Cased

6.3 V 10 Amps	$1.89
5 Volts 15 Amps	2.95
2.5 Volts 10 Amps	3.75
5 Volts Ct 3 Amps	1.50
10 Volts Ct 3.25 Amps	1.75
2.5 Volts Ct 21 Amps	4.95

MULTI-SECONDARIES

5v CT 13.5A, 5v CT 7A, 5v CT 7A	5.95
5¼v CT 21 Amp, 7.5v 6 Amp, 7.5v 6A	5.95
10 volts CT 13 Amps, 7.5v 2.5 Amp	5.50
6.3v 21 Amp, 6.3v 2A, 2.5v 2A	4.75
5 volts 4A, 6.3 volts 3 amp	2.50
2.5v CT 20 Amps, 2.5v CT 20A	7.95
2.5v CT 10A, 6.3v 1A, 5v 3A, 5v 3A	4.50

PHASE SHIFT CAPACITOR

4 Stator Single Rotor. 0-360 Degrees Rotation ..... Only $2.95 each

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 type DI, 100-150-2500-3000-4500-5300-7500-18000-40000 ohms	.24 ea.

Precision 15 Meg. 1% Accuracy Resistor. Non-inductive, 1 watt, hermetically sealed in glass. .29 ea. 10 for $2.50.

50 Megohm 80 watt IRC type MVE Resistor with mounting ..... .99 ea. 10 for $6.90

1% PRECISION RESISTORS

Wire Wound—Standard Make

2000-2500-5000-8500-10,000 ohms	$.39 ea.
50000-95000 ohms	.49 ea.
100000-750000-1 meg	.89 ea.

W. W. POWER RHEOSTATS

25 Ohms 25 Watt	.49
300 Ohms 50 Watt	.69
50 Ohms 50 Watt	.69
150 Ohms 50 Watt	.89
Dual 200 Ohms 50 Watt	.89

VARIABLE CERAMICONS

1.5 to 7 MMF	.24	4 to 30 MMF	.24
3 to 13 MMF	.24	7 to 45 MMF	.24

FIXED CERAMICONS

Capacity in MMF: 1-2-3-4-5-8-10-12-15-17-18-20-25-30-33-40-50-60-85-120-200-500. Your cost any capacity ..... .09 each

Voltage Regulated Power Supply—input 110 v. 60 cy. Delivers 150 v. DC—Well filtered (3 chokes) uses VR 150 and 6x5. Has extra 6.3 v winding. Swell for eco's, freq. meters, etc., 16x3⅝x5 with tubes. Only $6.85

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.

WE BC 1091A-Radar RF unit—with magnetron, etc., in pressurized tank 59.50

CWI 60 AAG range calibrator and power supply, book, cables, etc. 29.50

VARIABLE CONDENSERS—CERAMIC INS.

MIDGET		XMITTING	
35 mmf	.39	75 mmf .3 spacing	$5.95
250 mmf	.49	150 mmf .07 spacing	.95
325 mmf	.59	Dual 250 mmf .051 Spc.	2.75
APC 100	.29	Dual 250 mmf .1 Spec.	3.95
APC 140	.35	125 mmf .07 Spc.	.89

ODDS 'N' ENDS BARGAINS

Federal DPDT Anti-Cap Switch	.75
Heineman 5 Amp Circuit Brkr 110 VAC	.95
Butterfly Cond. 2-11 MMF Ball Bearings	.59
CD .002 3500 W V DC Type 9 Mica	.49
CD 16 Mfd 450 WV Elect. In Can w/leads	.39
JAN 6C4 Tubes New, Boxed	4 for .99
.1 x .1 2 KVDC Oil Cond	.89
Midget Closed CKT Jacks	2 for .29
1000 and 25 WVDC Elect in Can	.79
Trimm Commercial Phones Hi Imp	3.99
BZRS Microswitch S.P.D.T. 10 Amp	.29
.0015 5% Silver Micas	9 for .99
10 ohm 20 watt Resistors	12 for .99
2 Mfd 250 VAC Oil Cond	5 for .98
25 Mfd 25 VDC Elect. Tubular	6 for .99
500 ohm 50 watt Adjustable Slider	.29
50 ohm 25 watt Adjustable Slider	5 for .99
Silver Var. Cond. .5 to 2.5 Mmf	6 for .99
½ Meg. Pots with Switch	.79
1/40 Amp (25 Ma) Littlefuses	15 for .99
100 ohm 100 watt Adjustable Slider	.49
C-H Battoggle DPST 20 Amps 250 VAC	.95
100K, 1.5K Pots	.39
.5 Meg. Pots S.D.S.	.39
H-H SPST Push Button Switch N.O.	.29
MU Switch with Roller SPST 15A/110	.39
705A Ceramic Sockets	5 for .99
3 Section Ceramic Wafer Switch, 2 Pole 5 Position Per Section, Non Shorting	.69 ea.
100 ohm 100 watt Resistors	4 for .99
20K ohm 50 watt FER Resistor	4 for .99
H.S. 30 Earphones	2 for .99
IRC 220 ohm 100 watt	5 for .99
1000 ohm 200 watt	2 for .99
Corning Glass Slug Form and Var. Cap.	5 for .99
Shielded Littlefuse Holders 3 AG	10 for .99
CTC 3:1 PP Input, Hermetic Seal	2 for .99

PEAK ELECTRONICS CO. *DEPARTMENT EA*

Phone Cortland 7-6443 **188 Washington St., New York 7, N. Y.** *SEND FOR BULLETIN*

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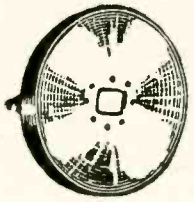
PARABOLOIDS



Ideal for microwave experimental work.
Spun Magnesium dishes
Reinforced Perimeter
17½" Diameter x 4" Deep
Two sets mounting brackets on rear
Open center hole 1½" x 1⅝"

Per Pair, Brand New . . . $8.75

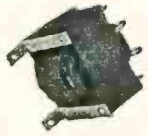
MERCURY CONTACT RELAY

Western Electric D-168479

For applications in all types of high speed switching devices. Long service life, high operating speeds. Large current and voltage handling capacity, uniform and constant operating characteristics under adverse atmospheric conditions. Hermetically-sealed mercury-wetted contacts in gas-filled glass envelope. Free from moisture, dirt, corrosion and atmospheric pressure. Single pole double throw contacts.
7000 hours life at 60 operations per second. Two coils of 700 ohms, and 3300 ohms. Operating current, coils series aiding—6.6 mils. Release current, coils series aiding—5.2 mils. Four page Technical Data on request.

Brand New in Original Cartons, $4.75

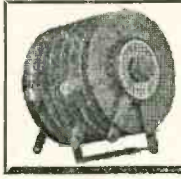
STEPDOWN TRANSFORMERS



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

SELENIUM RECTIFIER



Bridge Type

Input: 36 V. AC.
Output: 28 V. DC., 1.1 Amps.

Brand New $2.75

SHOCK MOUNTS

	A	B	C	D	E
A. Lord #20, 3" x 3" x 1¾"					.40
B. U. S. Rubber #5150 C, 2⅜" x 2⅜" x 1⅛"					.30
C. Lord 15, 2⅜" x 2⅜" x 1⅛"					.25
D. Lord #10, 1¼" x 1¼" x ⅝"					.10
E. Lord #3, 1¼" x 1¼" x ⅜"					.10

BRAND NEW

RADAR ANTENNAS

SO-1 (10 cm.) $149.50
SO-13 (10 cm.) $129.00
TDY (10 cm.) $95.00

Radar Repeater Adapters, Antenna Control units with P P I units, Transmitter-Receiver units, etc. for SO Radar.
All Brand New Equipment.

8,000-VOLT TRANSFORMERS

Primary: 115 V., 60 cycles.
Secondary: 8000 V., C.T., 800 V.A.

Brand new in sealed cans $27.50

SOUND POWERED TELEPHONE HANDSETS

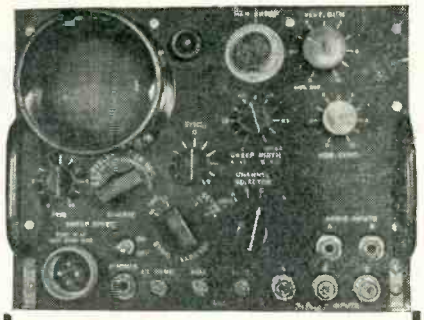
W. E. Type TS-10M.
Complete with 7 ft. cord.

Brand New . . . $16.95

DYNAMOTORS—500 Watts
Navy Type CAJO-211444

Input: 105-130 Volts D.C., 6 amps. Output 13 or 26 Volts D.C. (26 V. at 20 amps. in series or 13 V. at 40 amps. in parallel). Designed for radio use, fully R.F. filtered, complete with separate Square D line switch box.

BRAND NEW $59.50



MODEL AN/APA 10 PANORAMIC ADAPTER

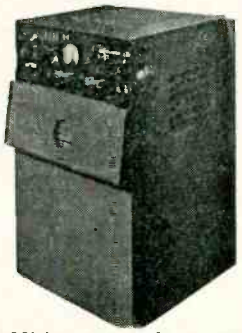
Provides 4 Types of Presentation:

(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. For operation from 75 to 125 V. 400 to 2600 cycle A.C. power source . . $124.50
Converted for operation on 115 V. 60 cycle source $149.50
80 Page Technical Manual $3.50

Raytheon RECTICHARGERS



Input: 115 volts AC, 60 cy., 1 Ph. . . . Output: 48 v. DC at 3 amperes regulated and adjustable. Charges 23 to 24 cell battery or may be used direct as battery eliminator.

The Raytheon Recticharger is designed to supply current at constant voltage to any load within its rating, and in addition to supply current to a storage battery connected across its load, of sufficient amount to maintain full charge. The function of the battery is to supply surge current due to sudden changes in load and to supply current above the rating of the Recticharger for temporary overload, and to act as a "stand-by" source of power in event of commercial power failure.

BRAND NEW $69.50

SOUND POWERED CHEST SETS

No Batteries Required

Ideal for television installers, or any antenna measurement work. Leaves hands free to make adjustments. Set consists of microphone and headset as illustrated.

Brand New **Per Set $19.50**

G. E. 400 CYCLE SERVO AMPLIFIERS

Type 2CV1C1

Brand New $29.50
Metal Dust Cover Included

LINEAR SAWTOOTH POTENTIOMETER

W.E. No. KS 15138

The d-c potentiometer consists of a closed type die-cast aluminum alloy frame consisting of a continuous resistance winding to which electric power is supplied through two fixed taps 180 degrees apart. Two rotating brushes (180 degrees apart and bearing on the resistance winding) and two take-off brushes are provided for the output voltage. Varying the position of the brushes varies the output voltage in accordance with a linear sawtooth wave. The potentiometer is excited with 24-volt direct current, is arranged for panel or bracket mounting, is approximately 3-11/16 inches in diameter, 3 inches deep, 4¾ inches long, and has an approximate weight of one pound. External connections are made through a standard AN type connector.

Brand New $5.75

SOUND POWERED TELEPHONES

Type TP-3

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 $39.50

SYNCHROS
(Selsyns, Antosyns, etc.)

G.E. types 2J5FB1, 2J5S1. Ford Inst. types 5SDG Bendix types 1-1, 11-2, X, CAL 18300 Electrolux type XXI Diehl type 1V, 78414. Navy ordnance types 5G, 5CT, 5DG, 1F, and many other types in stock.

All prices indicated are F O B Tuckahoe, New York. Shipments will be made via Railway Express unless other instructions issued.

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INC.
5 WAVERLY PLACE TUCKAHOE 7, N. Y.
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— THE BEST IN ELECTRONIC SURPLUS —

AMAZING "SNOOPERSCOPE" TUBE

An Infra-Red Image Converter Tube that enabled our combat men to see in the dark and through camouflage. No scanning or amplifiers necessary! Uses only infra-red light source and simple high-voltage supply which can be easily built from toy ignition transformer and rectifier tube. An optical system, necessary only for long-range work or where magnification of image is desired, can be made from toy telescope. Shows image with good detail in greenish-white color on 1⅜" screen. Has wonderful possibilities for darkroom work, fog penetration devices, night photography, etc. With technical data and diagrams. All NEW, individually boxed tubes.

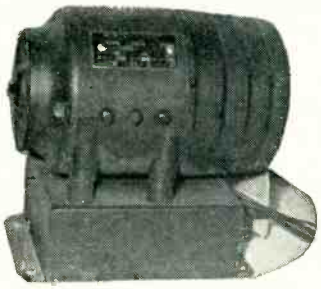
PRICE, EACH $10.00

20-40 MC RADIO BEACON EQUIPMENT

MODEL RC-163 is designed for ready connection to RADIO SET SCR-508, 528, etc, and 608, 628, etc.—or similar transmitting and receiving equipment. It permits directive transmission and reception, and can also be used for navigation by using two beacons on a base line. The beacon eqpt. consists essentially of a rotating directional antenna (Adcock type) synchronized to an automatic code keyer (which can be removed). Four sets of plug-in inductors are supplied to cover the 20 to 40 mc range. Designed to operate from a 12-volt storage battery, power consumed approximately 54 watts (4.5 amps.). Supplied with antenna array, antenna mount with rotating motor, code discs, audio oscillator, phase-load box, mast sight, tuning indicator-receiver which checks field strength as well as frequency, valuable compass and tripod, control panel, all necessary cables and complete technical manuals for installation, theory and service. Equipment is NEW and export packed, two cases per complete set.

PRICE, EACH $169.50

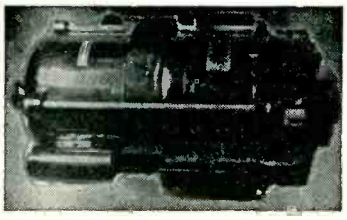
32 VDC 110V AC CONVERTER



Mfd. by Kato Engineering, for marine or farm installation. Rotary type, compact and ruggedly built for continuous duty. Rubber shock mounting on filter case, with complete input and output filtering. Output 110 volts, 60 cycles AC, .225 KVA, but will operate efficiently on loads up to 300 watts. New units only.

PRICE, EACH $39.95
Quantities, 10 or more, Each $32.00

AMPLIDYNE MG SET
Motor 110/220, 60 C. A. C.



For Automatic or Remote Control of heavy equipment, Mfd. by General Electric. Generator is Type V-5875677, motor 73AB58; Navy type CG-21ABU. Generator delivers 250 volts, DC, 375 watts. Motor, 115 or 230 volts 1-phase, 60 cycles AC, rated at ¾ HP RPM-1725. Includes capacitor for starting, and instructions for 115 or 230 volt connections. Generator section can be removed, and entire assembly shortened to make valuable ¾ H. P. AC motor. Quantity sufficient to warrant this conversion.

PRICE, EACH $60.00

SPECIAL BARGAINS!!

TYPE-MAB 135 Volt "B" and 1.5 Volt "A" Battery Block, for personal and battery portable radios. This battery will give added RF gain and power output to battery sets because of the additional plate voltage over conventional battery blocks which are usually only 90 volts. Uses standard 5-prong plug connector for connection. Dim.: 3½"x1¾"x6⅜". All Export packed for long shelf-life, and guaranteed perfect. Five (5) for..... $5.00

HANDY-TALKIE BATTERIES, for SCR536 or BC611. Type BA-38, 103.5 volt "B" battery, and type BA-37 1.5 volt "A" battery. All export packed and guaranteed perfect. **PRICE, Per Set (both batteries)..... $2.50**

VT-127A Platinum Grid VHF Tube.	PRICE, EACH	$ 2.25
450 TH, GE or Machlett	EACH	24.90
807	EACH	1.20
813	EACH	7.50
861	EACH	32.50
872A	EACH	2.45
450TL	EACH	29.95
527	EACH	11.95
750TL	EACH	40.50

FOR OSCILLOSCOPE USERS

VOLTAGE DIVIDER PROBE. Permits viewing and measuring voltage waves of larger magnitudes than normally possible. Consists of 3-piece molded body containing resistors and capacity which make up divider circuit, plus coax cable and alligator clips for connections. Permits measuring and analyzing voltage peak values of 1400 volts, with less loading on source and less wave shape distortion. NEW, with technical bulletin.

PRICE, EACH $4.95

RADAR
TREMENDOUS ASSORTMENT

Hundreds of major radar components, mostly for navy types, includes power transformers, wave-guides, plumbing of all sorts, magnetrons, cavity chambers, echo boxes, connectors, antennas. Inspection invited, or write us your requirements.

SF RADAR, NEW and Complete, in original cases with operating spares. **PRICE, Complete $2500.00**

SF-1 RADAR SPARES. All NEW major units, with tubes, transformers, capacitors, etc. **PRICE COMPLETE SET SPARES $775.00**

SF RADAR SPARES, NEW PRICE, COMPLETE SET $500.00

RADIO TRANSMITTERS MODULATORS, AND POWER SUPPLIES

Immediate Delivery from Stock

BC-325 Transmitter, 400 W.-A1, 100 W.-A2 and A3. 1.5 to 18.0 mc. M.O. or X'tal control on 6 frequencies. Operates from 110/220/1/60c. AC. With tubes in excellent condition. **PRICE, EACH.....$400.00**

TCR—Radiomarine Transmitter, 125 watts (conservative) A1, A2, & A3. For ship or shore station radio telephony, 6 channels in 2 to 3 mc band controlled by remote control box supplied. Complete RF, modulator and power supply (for 110 or 220 V. 50/60 cycles AC) in one cabinet. Excellent condition, with tubes and remote control box. **EACH $500.00**

BC-319-A Transmitter, CW only 300 watts output. Freq. range 4.0 to 13.4 mc. Operates from 110/220 volts, 60 cycles AC. Excellent condition. Less tubes. **PRICE, EACH $300.00**

Wilcox, 96-200A 2-KW RF section. Large cabinet with complete RF end containing the VFO, intermediate sections and PA stage. Almost new, but lacks PA inductance only. Power supply separate unit not available, but can be built. Less tubes. **PRICE $500.00**

RCA 8023/HF Ship Transmitter. 200 watts output, A1 and A2. Freq. range 4.0 to 20 mc. Operates from mg set (not supplied) in IF main transmitter (RMCA type 8024). With tubes, but no receiver. Excellent cond. **PRICE, EACH.....$350.00**

MACKAY SHIP TRANSMITTERS. The following Mackay ship-radio types are available: 150-AY, 151-A1, 149-A, 136-A, '04-M, 147-M. Some new, most in excellent condition. Write for prices.

LINK FM Transmitter Receiver, 70-100 MC. Model 1498 DC. 50 watts output, wall style cabinet containing transmitter, receiver and 14 V. D.C. power supply, handset. Dim: 34"x21"x11". NEW CONDITION. Complete with tubes, crystals, special telescopic antenna, instruction book. **PRICE, EACH $600.00**

RADIO TRANSMITTER BC-339, CW only, 1-KW output. Freq. range 4.0 to 26.5 mcs. Six crystal positions also M.O., four intermediate stages and two 833s final. Operates on 220 volts 50/60 cycles. Reconditioned new. Complete with power supply and one set operating tubes. **PRICE $2400.00**

MODEL AT-14A TRANSMITTER. Mfd. by Phillips. Output A1 275 watts; A2, A3 225W. Freq. range 2 to 20 mcs. Four xtal positions & separate M.O. Operates on 110/200/220/240/260 volts 50/60 cycles. **PRICE,** complete with power supply & set of operating tubes $900.00

Extra power supply & modulator only for above model AT-14A, complete in cabinet with tubes. Has 1600 Volt D.C. output at 450 mils for R.F. stage. **PRICE.....$475.00**

MODEL SVC100L/110 TRANSMITTER. Output A1 150 watts, A2-A3 50W. Mfd. by Philips. Freq. 2 to 20 mcs., with 6 pretuned channels. Operates from 90-260 volts 50/60c. A.C. **COMPLETE,** with tubes.....$450.00

RCA 2-CHANNEL A.F. AMPLIFIER. 250W. per channel, total 500W. Complete with power supply, voltage gain stages for low level input, metering circuits, in one cabinet approx. 6 ft. high. Operates from 110 volts 50/60c A.C. Almost new cond. with tubes. **PRICE $1,000.00**

BC-1100 (RC-263), 75W, A1, 50W, A2, 4 channel, dial selection of channel. 1.5-10 mcs. 110-260V 25-60c. A.C., with remote control New EACH $575.00

Collins TCB-1, 1.5-12 mcs., 75W, A1/A2/A3, 10 channel, 2 boxes spares, 110V AC, less autotune motor. New EACH.....$600.00

TDE Transmitters, 125W A1/A2, 35W. A3, 300Kc-18.1 Mcs., operation 115V. DC. Excellent Condition. EACH.....$600.00

Supreme ship-to-shore transmitter-receiver, 100W output, 9 channel, 2-3 mcs., crystal controlled, for 110V. 60c. A.C. Condition N-2. Complete with tubes and microphone. EACH $600.00

110V. DC to 110V. AC M.G. for above, when used on DC source.....$85.00

Northern Radio ship to shore transmitter-receivers, 5 channels crystal controlled, 65W. output, 110V. DC. 1.5 to 5.6 mcs. With tubes. EACH $250.00

Halstead model 10LFA transmitters, A3, 25W. output, 200-400Kc. 110V 60c. operation. Condition N2. EACH.....$100.00

All Prices F.O.B. N.Y.C. **All Material Offered Subject to Prior Sale**

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AUTOSYNS

Pioneer Types

AY-1, AY-14, AY-20, AY-30, AY-54D, 2320, and **AY-101D.**

Prices on request

DYNAMOTOR

D-101. 27 v. DC in @ 1.5 amps. DC output 285 v. @ .060 amps. Stock #SA-187. **Price $1.50 ea.**

SWEEP GENERATOR CAPACITOR

Hi-speed bearings. Split stator. Silver plated coaxial type. 5-10 mmf.

Stock #SA-167. **Price $2.75 each.**

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6-12 v. 60 cycles 5 inch indicator with 0 to 360° dial. Heavy duty transmitter. Stock #SA-115. **Price $9.95 per system**

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New — **Original Cartons**

Stock #SA-99.

Price $9.50 each

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Pioneer 12800-1-D. 115v. 400 cy. Low inertia motor and follow-up Autosyn. Stock #SA-160. **Price $9.50 each**

Sperry A-5 Amplifier Rack—644890 Contains Weston 350-450 cy. freq. meter and 0-130 volt voltmeter. Mounting for associated amplifiers.
Stock #SA-183 **Price $8.95 each**

Phase Shift Capacitor — 4 stators single rotor 0-360° phase shift, (Use in compiex wave synthesis.) Stock #SA-114. **Price $4.75 ea.**

INVERTER

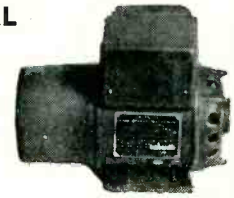
SPECIAL

400 Cycles

Three Phase

Holtzer Cabot

MG-153



Input 28 volts DC at 52 amps. Output three phase 115 volts 400 cycles at 750 V.A. 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.**

DC SERVO MOTORS

G.E. 10 RPM DC Motor 5BA 10FJ12

Output 40 lb./in at 10 rpm. 24 v. @ 1.1 amps. Series - wound 2 wire reversible.

(Housing is Common Lead)

Ideal for relay servo-systems. Stock #SA-17. **Price $8.75 each.**

C-1 Autopilot Servo Unit—28 v. DC shunt motor, 2250 rpm. 2 magnetic clutches, reduction gear, differential and 2 magnetic brakes. Output shaft 15 rpm. Torque 225 in/lbs.
Stock #SA-180 **Price $19.50 each**

Elinco B-64 DC Servo Unit—80 v. DC max. armature voltage, 27.5 v. field. 1/165 hp. 3100 rpm. Field current 200 ma. Armature current 200 ma. at normal torque.
Stock #SA-211 **Price $12.50 each**

⅛ HP DC Motor—G.E. 5BA25MJ409, 24 v. 7.5 amps. 7500 rpm. Cont. duty. 5" lg. x 2½" diam. ¾" shaft ext.
Stock #SA-235. **Price $4.75 each.**

Bendix A-14795 DC Motor—28 v. 1 amp. 1/100 hp. Series wound. Use on AC or DC.
Stock #SA-234. **Price $1.45 each**

Universal Electric DC Motor—28 v. 0.6 amps. 1/100 hp. 4 lead shunt wound.
Stock #SA-233. **Price $1.95 each**

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MECHANICAL DIFFERENTIALS
SINUSOIDAL POTENTIOMETERS
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DC SERVO MOTORS

SYNCHROS

Navy Types

1G, 1F, 1CT, 5G, 5F, 5CT, 5DG, 5HCT, 5SF, 5HSF, 6DG, 7G, etc.

Prices on Request

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 $3.75 each**

MICROWAVE ANTENNA

AS-217A/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.

MAGNESYNS

Pioneer CL-3

Use as transmitter or indicator on 26 v. 400 cy. or 52 v. 800 cy. May be used as indicator with 360° potentiometer on DC.
Stock #SA-6 **Price $1.95 each**

Compass System

Kollsman remote transmitter and indicator for operation on 26 v. 400 cycles power source.
Stock #SA-22 **Price $6.95 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

G.E. Servo Amplifier—2CV1C1 Aircraft amplidyne control amplifier, 115 volt 400 cycles. Two channel. Uses 2 6SN7GT and 4 6V6GT tubes. Supplied less tubes. Stock #SA-168 **Price $9.50 each**

Edison Time Delay Relay—Vacuum sealed in glass, s.p.s.t. contacts normally closed. 30 v. 7 second delay to open. Many experimental applications.
Special Price Three for $1.95

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11.5 KVA 50/60 cy. Commutor, range 0-115 V. Max. Amps 100. Reconnection diagram available for 230 V 50A operation, Brand New. Factory Cases.....$75.00
.25 KVA. Fixed winding 115/1/60. Commutator range 103-126 V. Max AMPS. 2.17.....$9.45
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Raytheon Fil Type U 8964, Pri 115 V 60 Cy Sec: 2.9 Volts @ .19 Amps.....$.95
Raytheon Fil Type U-8370 Pri—220/440 60 CY. SEC #1, #2, #3—2.5 Volts @ 5 Amps. Sec: #4 2.5 Volts @ 15 Amps 3KV Test.....$6.50
Raytheon Dist Type CRP-30382. Pri: 220/440 V 1.71 A. Sec: 115 V @ 6.53 A. Test V 4000 W Power.....$14.50
Raytheon Fil U-5083 Pri: 220/440 V 60 Cy Sec. 5 Volt @ 30 Amps. 1780 test Volts.....$10.95
Raytheon Plate and Fil U3508A. PRI: 115 V. 60 Cy Sec: 640V 80 Ma; 6.3 V 3.2A; 5 Volts 3A..$3.00 @ 3A.....$3.00
Raytheon Plate and Fil Type U8824. Pri: 115 V 60 Cy Sec: 770 V @ .07 Amps.; 5 V @ 3 Amps.; 5 V @ 6 Amps.; 2.5 V @ 10 Amps.....$3.95

MOTOR GENERATORS

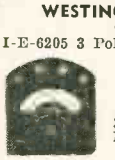
Built by Allis-Chalmers to U. S. Navy Spec. Input: 115 VDC at 14 A 3600 RPM. Output: 1.25 KVA 120 V 60 Cy. 1 ph., 10.4 Amperes 80% P. F. Ball bearings. With resistive control of voltage output and frequency built-in. Centrifical automatic controller built-in permitting line-start operation. Fully enclosed. Splash-proof. Brand New! Factory Cases. $100.00 Same machine for 230 Volts. D. C. Operation $120.00. Spare parts, kit of brushes, brushholders ball bearings, field coil, etc. in steel case....$10.00

STANDARD BRAND OIL CAPACITORS

Cat # D22514 Dual Rated .375 MFD @ 16,000 Volts and .75 MFD @ 8,000 Volts.....$9.50

WESTINGHOUSE NOFUZE "DE-ION" CIRCUIT BREAKERS

I-E-6205 3 Pole, 5 Amp 600 Vac. Type.....$6.75



WESTON PORTABLE VOLTAMMETER

Model 280. Ranges 3-15-150 VDC and 3-15-30 ADC Accuracy 1%. Black leather carrying case. Brand New. $21.00

RCA REPRODUCERS

MI-2917J. 10" Dia Speaker. 5 Watts. Freq resp. 250-5000 cycles. VC Imp. 15 Ohms. Weather proofed.....$14.95

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Mfd. by "Price". Type CGR-63-D. 10" Dia. 8" depth. Built in output transformer for 4000 Ohm Imp. Pri.....$10.95

Deck Entrance Insulators (Bowl and Flange Type) Mfd. by Ohio Brass Co. Heavy galvanized metal flange 10½" Dia., porcelain bowl set in rubber gaskets, top bell 7¾" Dia. Brass feed thru rod 10½" long. Insulation distance between top bell and flange is 6½".....$3.50

SCR 511 **Walkie-Talkie**—Low Power Portable Trans-Receiver for phone operation on dry or storage batteries. Consists of BC745 RCVR and Transmitter, and PE157, power supply. Operating Range 5 miles, freq. 2-6 Mc. Complete with Crystals and batteries. New.....$85.00

STANDARD BRAND RHEOSTATS

High shock rheostats, four 13" plates with circular contacts, 100 ohms 8-2A, 175-345 V connected in series. Assembled for back of board mounting or by reversing the supporting brackets for floor or table operation. Brand new.....$19.75

MARATHON MOTOR GENERATORS

Two separate units coupled together on a common bed plate. MARINE TYPE with voltage regulator and frequency controller. Input at 110 V. DC Output 110 VAC. 1 phase, 60 cy, 500 VA. Rebuilt like new. Special.....$65.00
Same unit as above with 32 VDC Input and 300 VA Output.....$54.00

AN80 Antenna. Half Wave length 470 MC. Ant. Blade 5" long mounted in isolantite form with amphenol connector.....75¢ ea.

RAYTHEON PULSE TRANSFORMER WX5137. Pri. 4 KV. 1 MU. Sec. Sec. 16 KV 16 Amps. Fil. Trans. Pri. 115 V 60 Cy.....$2.00

COMMAND TRANSMITTERS. 2—3 MC, LN $4.95, 3—4 MC LN $12.95, 4—5.3 MC. LN $5.95, 5.3—7 MC LN.....$5.95
Salvage Command Transmitters @ $2.95. No choice of frequencies.

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Type 306A. Direct reading 0-50,000 Cy in ten ranges. Input voltage 1 to 200 V RMS. Input imped. 25,000 OHMS. Recorder output 5.0 Ma 1000 OHMS max. Acc. 2%. Regulated power supply 105-125V 50-60 cy. 70 W. 6" meter scale, 8⅝" H. x 19" W. x 13⅝" D. Wgt. 41 lbs LN.....$75.00

RA-50A WESTERN ELECTRIC RADAR HIGH VOLTAGE SUPPLY. Consists of trans. 20,000 VCT @ 750 VA Filtering by .05 MFD @ 12,500 V with two 705 "A" S Tubes. Fil. trans. supplies 5 Volts, 10 Amps. @ 15,000 Volt Test. 21½ x 17 x 11½.....$49.95

WILLARD STORAGE BATTERIES. Used in GE Portables Model LB530—2 V @ 20 AH. 4" x 3½" x 5½" $2.50 each. 10 $20.00 case lots of 36, $53.50

KATO ROTARY CONVERTERS

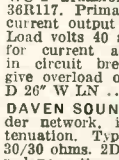
Type 1206A Model 26/A54 Maing. Input 2.8A 1800 RPM. Output 24VDC 115 VAC, 1 ph, 60 cy. 9A put 115 VAC. 1 ph. 60 cy. 9A 1 KVA. Compact and ruggedly built for continuous duty operation. Rubber shock mounting on filter case. Input and output filtered. Brand new original cases.....$90.00

BECKMAN HELIPOTS

Model A, 10 turns, 3600° rotation, 20,000 ohms resistance, 5 watt 0.5 guaranteed linearty, 5% resistance tolerance. With aluminum stop as pictured $5.00. Without stop $4.50

WESTINGHOUSE FLEXARC WELDERS. Type WC-2 Transformer type for single operation, Style 36R117. Primary 550/440 V 60 cy. 1 ph. Welding current output 300 Amps. Continuous for one hour. Load volts 40 at rated load. Rotating handle on top for current adjustment. Self cooking with built in circuit breaker to deenergize the welder and give overload or short circuit protection. 37" H 18" D 26" W LN.....$125.00

DAVEN SOUND ATTENUATORS. Type 350E. Ladder network, impedance 250/250 ohms. 2 DB attenuation. Type 350A Ladder network, impedance 30/30 ohms. 2DB attenuation. Compact constant impedance attenuators that will dissipate 10 watts in any position. Linear attenuation. Your choice..$2.50



WESTINGHOUSE AUXILIARY RELAYS

Type MC, Style Ph 8082-1, 115 VAC 60 cy. cont rating. Electromagnet Coil 10 Amp. Contacts 4PST, 70 ohm. Coil used to operate a number of circuits from one control circuit. Used frequently for tripping circuit breakers, Glass top. Dimensions 6½" x 4½ x 4½". Brand new orig. cartons....$7.95

GENERAL ELECTRIC DIATHERMY MACHINE

Sloping marble control panel on which is mounted a quenched spark gap, an oscillation transformer and a dual scale milliammeter with full scale deflection of 1000, and 4000 Ma. 18" x 18" x 10". 115 V 60 Cy Operation LN.....$27.00

WESTINGHOUSE WATTHOUR METERS

Type CS, 240V/60cy/1ph 15 Amp. 3 Wire, new $12.50

G. E. TYPE IRT INDUCTION VOLTAGE REGULATOR

3 Ph. 1.64 KVA Oil Filled Outdoor service pri Volts 208 Load Amps 10.5 Brand New.....$65.00

GENERAL ELECTRIC AMPLIDYNE

Model 5 AM 49 AB 7 Input 440 V. 60 Cy. 3 ph. 1A Output 250 VDC 1.5A 375 W 3450 RPM New.....$75.00
Amplidyne Control Amlifier W5999179 List 7. 115 V 60 cy. Designed to Supply DC to Amplidyne Control Windings in seisyn operated amplidyne Servo Systems.....$15.00
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Model 5AM 78AB50A Input: 440 V. 60 Cy. 3 Ph. Output 250 V. DC 6A 1.5 KW.....New $225.00

COOPER HEWITT LAMPS

#160-A9T2S1. Mercury Vapor Light gives high blue white luminosity almost pure ultra violet. 110 V. 60 Cy. Used for lighting photographic, newspaper photo-engraving shops and for industrials. 55" Long 1½" Diameter. New.....$4.00

RAYTHEON CHOKES

S. M. Choke UX7776. 1.28 Henries 130 MA 57 ohms.....$1.00
S. M. Choke UX8678. 15 Henries 28MA 1050 Ohms.....$.50
S. M. Choke UX9116. .03 Henries @ 2A (Rectifier Choke).....$2.25
Choke Assembly, CRP30509. 1.8 Henries 0.384A.....$1.50
Dual Choke, WX5146 1.5 Henries 400 MA 1.5 Henries @ 400 MA.....$1.75
S. M. Choke (Rectifier). UX9114. 0.100 Henries 1.4 Amps.....$2.00
G. E. #7385576, 87.9 Henries @ .0672 Amps. 7.5 KV DC Test.....$10.00
Amertran, 20 Henries @ 45 MA.....$.75

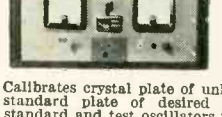
SELECTOR SWITCHES

Heavy duty. Built for U. S. N. to control multi-circuit devices. Removable contacts enabling any combination of closed and open circuit. Your choice 5 section 5 pole; 10 section—20 pole; 15 section—15 pole; 15 section—30 pole. $1.50 ea. Case lot of (5) $5.00 or (5) cases special price...$17.50

Motor Driven "Benjamin" Horn Navy Type—H-8. Heavy Duty, 115 VDC @ .42 Amps.....$5.50
High Pressure Axial Flow Fan Mfd. by Dynamic Air Eng. co. Model 586-SC8, 24-28 VDC. ⅛ HP. 225 Capacity C.F.M. 8000 RPM. Motor is mounted inside a cylindrical tube 11" x 6" and has 2—6" blades one on each end and two cut off valves.....$5.99
Portable D C Ammeter, Hoyt #515 0-15 ADC. Mirrored scale 3½" L. Molded Bakelite Base 4½" x 5½" x 2¼". In Black wrinkle finished steel case 5¼" x 6" x 2⅝". Furnished with 3 ft. color coded rubber insulated clip leads. Basic movement 12.5 MA.....$5.50
S Cord. 2 Conductor #18 Cut in 9 ft. lgths. Ideal for appliance, fan, or blower mfgs., etc. Large quantity available, quotation on request.

DELCO CONSTANT SPEED MOTOR

Type A-7155, 27 Volts @ 2.4 amps. 1/30 HP. 3600 RPM 2½ Diam. x 5¼ Long x ⅞, shaft extension 5/32" Diam. Cont. duty, 4 hole base Mtg.....$4.25
POWER CABLE SINGLE CONDUCTOR # 1/0 Neoprene covered. mfg. by U. S. Rubber spec #CMPW-43Q45. Available in 600 ft. reels only $190.00 per M.
NAVY BATTLE LANTERNS mfg. by Delta type JR-1S uses 2 #6 Dry Cells Complete w/bulb but w/o Batteries. Brand New.....$3.50



FITCH RADIO CRYSTAL DUPLICATOR MODEL QZ-1000

Calibrates crystal plate of unknown frequency against standard plate of desired frequency. Consists of standard and test oscillators whose outputs are mixed to produce an amplified beat note the frequency of which is shown on meter with ranges of 500, 5000, 50,000 cycles. Metal cabinet W/hinged cover. 9" H x 13" W x 19" L. 4" square activity and frequency meters on front panel. L. N.....$22.50

WESTINGHOUSE INDUCTION HEATER

An outstanding Value, Westinghouse Induction Heaters, 450KC 10KW. Radio Frequency Generators 450 MC. 140 Amps. Input 220/440 V 3PH 60 Cy. 48" W x 48" H x 30" D uses the following tubes: 1 WL5604, 3 WL872, 3 WL678, 1 5W4, Water Cooled, like New.....$475.00

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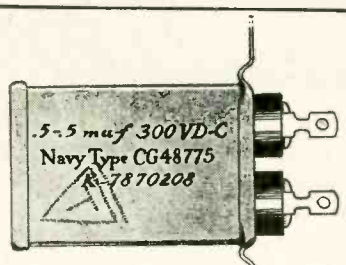
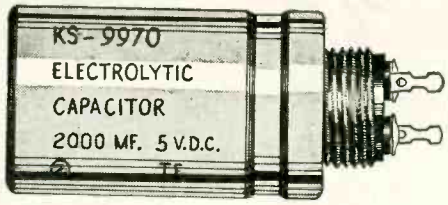
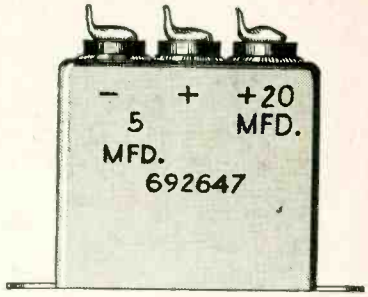
INTEREST IN COMPONENTS FOR THE LABORATORY



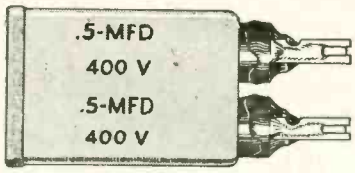
Dual .5/300 Mfd. volt Standard Brand Condensers, for mounting through chasis. Price 15¢ each



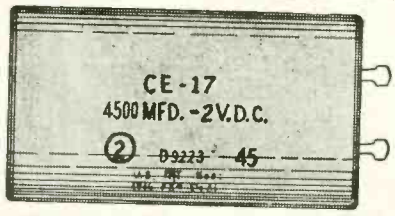
2000 Mfd. 5 volt (without mounting nut) electrolytic. Price 49¢ each



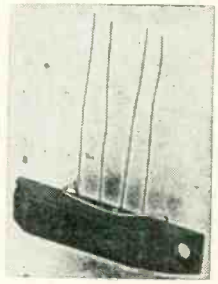
Very Special. The two left hand terminals are five mfd. at 35 volt. The right hand terminal and the can are 20 Mfd. at 35 volt. Electrolytic. Only 15¢ each.



Dual .5/400 Mfd. volt Standard Brand Condensers, no brackets: very good multiple use. Price 14¢ each



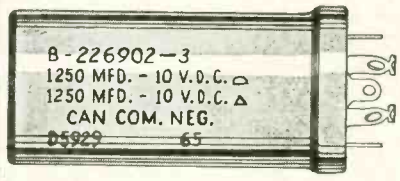
4500 Mfd. 2 volt electrolytic. Price, special, 39¢ each



#1 — This is a full wave bridged selenium rectifier. Input 115 to 130 A.C. Continuous duty. Output 15 milliamperes at 25 volts drop. Less than 25 volt drop if less current is drawn. For instruments, relays, etc. 39¢ each.

TERMINAL STRIP, 6 TERMINAL

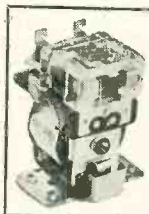
5" x 1" by 1" high overall, hard black bakelite moulded, 8 x 32 brass studs, 12 heavy brass hex nuts, 6 lockwashers. Heavy or light wiring. Mounts flat, insulated for 5000 v. 14 bakelite fingers separate wires to each terminal allowing wires to enter either side without danger of shorting. Suitable for transmitters, indus. equip.; may be cut shorter cheaply.—Price 11¢ each.



Dual 1250 Mfd. 10 volt electrolytic, Price 49¢ each

1.5 Mfd. 220 volt, AC, oil filled, Standard Brand (without mounting brackets). Good value at 25¢ each.

1600 Mfd. 12 volt electrolytic, Price 49¢ each

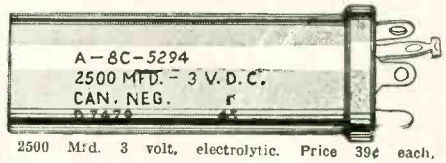


#37—G.E. CR. 2791-B109P36

10000 ohms S.P.D.T. Makes at 90 volts 9 M.A. Breaks at 70 volts 7 M.A. Sensitive relay for high voltage. Operates very satisfactorily up to 220 volts D.C. Contacts rated at 3 amperes. Priced at only .....79¢. Bargain

#34—G. E. CR2791-B106C44

S.P.D.T. Double Break. Makes at 11 volts 60 M.A. Breaks at 6 volts 36 M.A. 180 ohm coil. Contacts rated at 10 amperes. Priced at only .....39¢

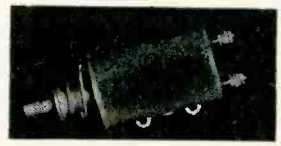


2500 Mfd. 3 volt, electrolytic. Price 39¢ each.

Bank of 10 Midget telephone relays. These are attached to rack with knurled thumb screws, thus easily removed from rack.

Prices:

Rack of 10-300 ohm coil make one—break none....$3.25
Rack of 10-300 ohm coil make two—break one....$3.75
All operate at much lower than rated 24V.



#89—CANNON SOLENOID

This item just must be seen and tested to be appreciated. At 6 volts, draws 1 1/3 ampere, has ½ pound pull at ¾ in. stroke; 2 pound pull at ⅜ in. stroke. At 12 volts, draws 2-2/3 amperes, has 1 1 pound pull at ¾ in. stroke; 4 pound pull at ⅜ in. stroke. At 24 volts (rated voltage), draws 5 amperes, has 2 pound pull at ¾ inch stroke; 8 pound pull at ⅜ in. stroke. Very compact, easily mounted Tapered shaft that goes clear through the back of the case when energized protruding ⅛ of an inch which would be sufficient to close a micro switch in addition to the mechanical functions above described. 69¢ ea.

#85—G. E. THYRITE K-522332 (M)

Diameter 3 in. Thickness ⅛ in. Hole ½ in.
Good voltage regulator, 3rd harmonic generator.
Current:
5 ma. at 18 volts; 10 ma. at 23 volts.
20 ma. at 29 volts; 40 ma. at 36 volts.
Rating: 3 watts maximum in air.
Priced at 25c each.
We have sold these at $1, right along.

#82—G. E. THYRITE K-8396832-1

Diameter 1⅞". Thickness ⅛". Hole ½". Good voltage regulator, 3rd harmonic generator.
Current: 5 ma. at 21 volts
10 ma. at 24 volts
20 ma. at 28 volts
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Rating 1½ watt maximum in air..15¢ ea.

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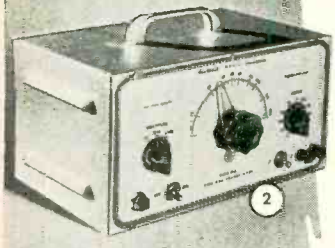
Heathkits are beautiful factory engineered test equipment kits supplied complete but unassembled with all parts — tubes, grey aluminum cabinets, punched, formed and plated chassis, calibrated panels, ready wound coils and complete detailed instruction manuals for assembly and use. With costs zooming up, Heathkits save the labor cost of assembly enabling thousands to have equipment which they otherwise could not afford.

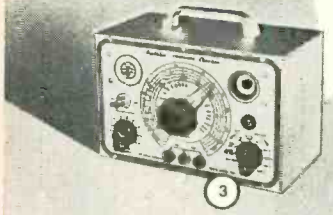
1 *Heathkit* VACUUM TUBE
VOLTMETER KIT

Everything you want in a VTVM. Shatterproof solid plastic meter face, automatic meter protection in burn-out proof circuit, push pull electronic voltmeter circuit assuring maximum stability. Linear DC and AC scales. AC and DC full scale ranges of 3V-10V-30V-100V-300V-1000V. A total of 24 ranges. Isolated DC test prod for signal tracing and measurements of voltage while instrument is in operation. An ohmmeter section accurately measuring resistance of 1/10 ohm to one billion ohms with internal battery. Extremely high input resistance 11 megohms on all ranges DC and 6.5 megohms on AC. All these features and many more are the reasons hundreds of radio and television schools are using Heathkit VTVM's and recommending them to all students. Like all Heathkits, the VTVM kit is complete, 110V. 60 cycle power transformer, 200 microamp meter, tubes, grey crackle cabinet, panel, test leads, 1% ceramic precision divider resistors and all other parts. Complete instruction manual. Better start your laboratory now.
Shipping weight 8 lbs. **$24.50**



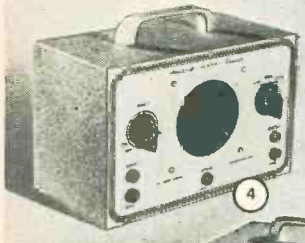
2 *Heathkit* SINE AND SQUARE WAVE
AUDIO GENERATOR KIT

The ideal instrument for checking audio amplifiers, television response, distortion, etc. Supplies excellent sine wave 20 cycles to 20,000 cycles and in addition supplies square wave over same range. Extremely low distortion, less than 1%, large calibrated dial, beautiful 2 color panel, 1% precision calibrating resistors, 110V. 60 cycle power transformer, 5 tubes, detailed blueprints and instructions. R.C. type circuit with excellent stability.
Shipping weight 15 lbs. **$34.50**



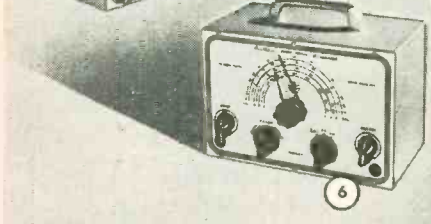
3 *Heathkit*
CONDENSER CHECKER KIT

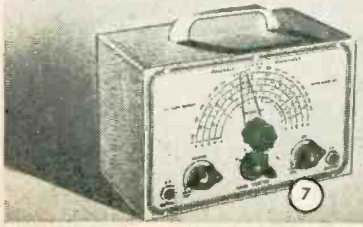
Checks all types of condensers, paper mica — electrolytic — ceramic over a range of .00001 MFD. to 1000 MFD. All on readable scales that are read direct from the panel. NO CHARTS OR MULTIPLIERS NECESSARY. A condenser checker anyone can read without a college education. A leakage test and polarizing voltage of 20 to 500 volts provided. Measures power factor of electrolytics between 0% and 50%. 110V. 60 cycle transformer operated complete with rectifier and magic eye tubes, cabinet, calibrated panel, test leads and all other parts. Clear detailed instructions for assembly and use. Why guess at the quality and capacity of a condenser when you can know for less than a twenty dollar bill.
Shipping weight 7 lbs. **$19.50**



4 *Heathkit*
SIGNAL TRACER KIT

Reduces service time and greatly increases profits of any service shop. Uses crystal diode to follow signal from antenna to speaker. Locates faults immediately. Internal amplifier available for speaker testing and internal speaker available for amplifier testing. Connection for VTVM on panel allows visual tracing and gain measurements. Also tests phonograph pickups, microphones, PA systems, etc. Frequency range to 200 Mc. Complete ready to assemble. 110V. 60 cycle transformer operated. Supplied with 3 tubes, diode probe, 2 color panel, all other parts. Easy to assemble, detailed blueprints and instructions. Small portable 9" x 6" x 4¾".
Shipping Wt. 10 lbs. **$19.50**





5 *The* NEW 1949 HEATHKIT 5-INCH
OSCILLOSCOPE KIT

New improved model of the famous Heathkit Oscilloscope. Building an oscilloscope is the finest training for television and newer servicing technique and you save two-thirds the cost. All the features and quality of instruments selling for $100.00 or more. Supplied complete with cabinet, two color panel, 5BP1 tube, 2 5Y3 tubes, 2 6SJ7 tubes and 884 generator tube. Power transformer supplies 1000 volt negative and 350 volt positive. Sweep generator 15 cycles to 30 M. cycles. Has vertical and horizontal amplifiers. Oil filled filter condensers for long life. Complete blueprints and instructions included.
Shipping weight 25 pounds.
Express only **$39.50**

6 *Heathkit* FM AND TELEVISION
SWEEP GENERATOR KIT

A necessity for television and FM. This Heathkit completely covers the entire FM and TV bands 2 megacycles ot 230 megacycles. The unit is 110V. 60 cycle transformer operated. Uses two 6J6 tubes, two 6C4 tubes and a 6X5 rectifier. An electronic sweep circuit is incorporated allowing a range of 0 to 10 MC. A sawtooth horizontal sweeping voltage and phase control are provided for the oscilloscope.

The coils are ready assembled and precision adjusted to exact frequency. As in all Heathkits, the best of parts are supplied, Mallory filter condenser, zero coef. ceramic condensers, all punched and formed parts, grey cackle cabinet, 5 tubes, test leads, etc. Better get it built now and be ready for the FM and TV business. Shipping Wt. 6 lbs. **$24.50**

7 *Heathkit*
SIGNAL GENERATOR KIT

Every shop needs a good signal generator. The Heathkit fulfills every servicing need, fundamentals from 150 Kc. to 30 megacycles with strong harmonics over 100 megacycles covering the new television and FM bands. 110V. 60 cycle transformer operated power supply.

400 cycle audio available for 30% modulation or audio testing. Uses 6SN7 as RF oscillator and audio amplifier. Complete kit has every part necessary and detailed blueprints and instructions enable the builder to assemble it in a few hours. Large easy to read calibration. Convenient size 9" x 6" x 4¾". Ship. Wt. 7 lbs. **$19.50**

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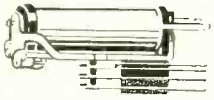
The following list represents only a tiny portion of our relay stock. Write or wire us for information on types not shown.

STANDARD DC TELEPHONE RELAYS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-101	24V	1500.	DPST (NO)	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

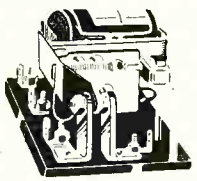
Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-164	24-32V	1000.	SPST (NO)	W. E.	$1.20
R-512	24-48V	3500	DPDT	W. E.	1.30
R-513	12-24V	300	DPDT-DPST (NC)	W. E.	1.20
R-514	4-6V	60	SPDT	W. E.	1.05
R-526	6V	35	DPDT-SPST (INC-1ND)	W. E.	1.05

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 (1NO) (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 (NO)	R.B.M.	.65
R-523	90-125V	6500	DPDT	Clare	1.90
R-222	12V	100	DPST (ND)	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	6-12V	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 (NO)	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

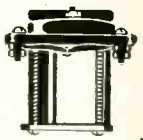
Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-248	28V DC	150.	SPST (NO) 10A.	Guard. 36471	$1.05
R-244	75V AC	265	SPST (NO) 20A.	Leach 1327	1.75
R-206	24V DC	150	5PDT-3 AMP.	P&B-KL	1.20
R-207	24V DC	210	4PDT-3 AMP.	P&B-KL	1.10
R-219	50V DC	1500	DPST (NO) 15A.	P&B-SP	1.25
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	3POT-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) SPOT	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 (ND) 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	OPDT 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 SPST (NO)	Leach 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.	6041H8B	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	3.50
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.

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APR-1 RADAR SEARCH RECEIVER, range 300-4000 mc, similar to APR-4 Receiver, 110 volts, 60 cps.

TUNING UNITS for APR-1 or APR-4 Receivers
TN-17 range 80-300 mc
TN-18 range 300-1000 mc
TN-19 range 1000-2000 mc
TN-54 range 2000-4000 mc

10 Cm TEST LOAD TPS-55 PB/T..$5.00

X BAND VSWR TEST SET TS-12/AP, complete with linear amplifier, direct reading VSWR meter, slotted wave guide with gear driven traveling probe, matched termination and various adapters, with carrying case, new.

X BAND PICK-UP HORN AT-48/UP, with coaxial fitting $5.00

X BAND POWER LOAD TS-108/AP, new $25.00

SIGNAL GENERATOR MEASUREMENTS 78E, 45-85 MC, 1-100,000 microvolts, calibrated output. $100.00

TS 155A/UP SIGNAL GENERATOR, 2700-3300 mc pulsed, calibrated output, 110 v. 60 cy. New.

TS 9/APQ5 CALIBRATER.

S BAND MIXER, type N signal input, oscillator input, and I.F. output connectors, variable oscillator injection.....$17.50

MICROWAVE TEST CABLE, 15' RG-9U cable with UG-24U connectors. 15 feet long .....$4.00 8 feet long....$3.50

LOSSY CABLE, 10 db at 3300 megacycles, type N connectors.....$3.50

TYPE N CONNECTORS AND ADAPTERS, UG-10, 12, 21, 22, 24, 25, 27, 29, 30, 58, 59, 83, 86, 167, 190, 201, 245 and UHF Connectors SO-239, PL-259, 83, 1AP, UG-266, complete with center contacts, immediate delivery.

RADAR JAMMER, T-26/APT-2, 435-715 megacycles, 110 volts, 400 cps, new, complete with antenna.....$40.00

COMPLETE SQ RADAR, 10 cm, 300 yards minimum, max. 3, 15, 45 miles, A, B, or P.P. I. presentation, 90-130 volts, 60 cps.

SD-3 SHIPBOARD RADAR EQUIPMENT, complete with all accessories, operates on 115 volts, 60 cps, new.

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ATTENUATOR PADS, 50 ohms, unbalanced pi, 20 decibels ± 2db
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RADAR RECEIVER BC 1068-A, 150-200 megacycles, individual tuning for the r.f. stages, band widths 4 megacycles, 115 volts, 60 cps, 14 tubes.....$45.00

GENERAL RADIO PRECISION WAVEMETER, type 724A, range 16 kc to 50 megacycles, 0.25% accuracy, V.T.V.M. resonance indicator, complete with accessories and carrying case, new..$175.00

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TS 10/AP for APN-1.....$40.00

TS 203/AP CALIBRATED SELSYN.$13.00

W.E. NETWORKS, D-162630, D-162629, D-161637, D-162634.....$1.00 each.

G.E. DELAY LINE, 4 microseconds 1000 ohms, 0-2 mc $4.00

TRANSFORMERS, 115 volts, 60 cps primaries:
1. 6250, 3250 and 2000 volts, tapped primary $14.00
2. 6250 volts 80 ma, ungrounded, G.E. $12.00
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PULSE TRANSFORMER, Utah 9280.$1.50

PULSE TRANSFORMER
GE 68G 828G-1.....$5.00

HYPERSIL CORE CHOKE 1 Henry, Westinghouse L-422031 or L-422032..$3.00

VARISTORS WE D171528, D171628, D161871-A.....75c each.

0-350 volts, 1000 ohms per volt meter, Westinghouse NX-35.....$4.50

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Red Bank 6-4247

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ET-8023D1—200 watt **ship transmitter** Mfr: RMCA. New, **$550 ea.**

TAJ—500 watts cw, 150-550kcs.

TBK—500 watts cw, 2.2-20.0 mcs.

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1, 2, 5 and 100 hp., dc and ac.

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Thousands of strains and feed thru's too

METER MULTIPLIERS — PRECISION RESISTORS. 20,000 volts, 20 megohms. Accuracy ± 0.5%. New, in original packing. Standard Brands. Manufacturer's current list is more than $240.00! Our price: $22.00

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APG—amplifier cans.

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DC input volts 27.0 amps 1.50 — DC output volts 285 amps .060 **.75**

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A "hot" receiver covering the 174 to 210 MC Television band. Has individually slug tuned antenna R.F., Detector and oscillator circuits resulting in maximum sensitivity; contains 2 F.F. and 5 I.F., stages detector and video amplifier. Complete with 110 volt AC power supply and 14 tubes..... **29.95**

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8 MFD 330 VAC $1.25
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.05 400 VDC, 8 for ..... .50
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7C4/1203A	.35		
12A6	.45		
12SH7	.69		
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211	1.15		
371B	2.95		

864/5T24	.80
872A	2.45
826	1.00
954	.65
957	.65
991	.50
958A	.65
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Miniature Tube Sockets 7 prong

Socket and shield complete .....25¢

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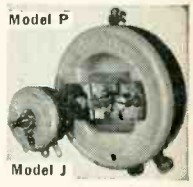
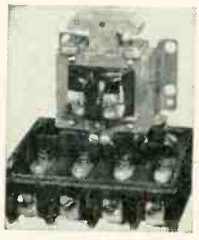
22 ohms 1.5 amps model J 1.25

200 ohms, 1.06 amps insulated for 600 volts. model P 3.50





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4 MFD 600 volts	1.25
6 MFD 600 volts	1.50
7 MFD 600 volts	1.50
10 MFD 600 volts	1.00
15 MFD 600 volts	2.75
2 MFD 1000 volts	1.25
8 MFD 1500 volts	2.50
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.30 MFD 2000 volts	1.00
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No.	TYPE	MAX. CAP.	MIN. CAP.	No. PLATES	AIR GAP	LENGTH	LIST PRICE	OUR PRICE
PL-6043	EV-140-AD	140	5	27	.020	3 11/16	$7.60	$1.50
PL-7105	NT-50-GD	50	7	11	.070	4 3/32	7.60	1.95
PL-8005	XR500-PS	475	18	21	.030	2 7/8	6.50	2.95
PL-7101	NP-75-DS	75	11	19	.084	4 3/32	5.20	1.95

METER Model MD 3001, MA 0-1 range. Two scales—0-5 DC KV. 0-10 DC Milliamperes.....2.95
SYNCHROS Navy types. 5G, 5CT, 5HCT, 6G, 6SG, 6DG. Kayline has complete SD-3 Navy Radar sets in stock. Write for information.
1" MIDGET METER in all aluminum case. 0-1 Ma 3.95
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No.	An. No.	Description	Each	Price per 100
83-1SP	(PL259)	Plug	28¢	22¢
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83-168	(UG176U)	Reducing adapter. Use with 83-1SP or 83-1SPN	15¢	12¢
83-1H	(UG106U)	Hood	12¢	10¢
83-1R	(SO239)	Receptacle	35¢	28¢
83-1AP	(M359)	Angle Adapter	28¢	22¢
83-1T	(M358)	Connector	$1.25	$1.12
83-1J	(PL-258)	Junction	85¢	70¢
83-22R	(UG103U)	Receptacle	45¢	35¢
83-22SP	(UG102U)	Plug	45¢	35¢

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RG5U	per 1000 ft.	$70.00
RG6U	per 1000 ft.	120.00
RG7U	per 1000 ft.	70.00
RG8U	per 1000 ft.	40.00
RG9U	per 1000 ft.	135.00
RG10U	pef 1000 ft.	90.00
RG11U	per 1000 ft.	100.00
RG12U	per 1000 ft.	175.00
RG13U	per 1000 ft.	125.00
RG18U	per 1000 ft.	320.00
RG22U	per 1000 ft.	120.00
RG29U	per 1000 ft.	37.50
RG34U	per 1000 ft.	175.00
RG39U	per 1000 ft.	55.00
RG54A/U	per 1000 ft.	60.00
RG54U	per 1000 ft.	65.00
RG57U	per 1000 ft.	75.00
RG58U	per 1000 ft.	59.00
RG59U	per 1000 ft.	45.00
RG62U	per 1000 ft.	50.00
RG71U	per 1000 ft.	120.00

Prices based on a minimum quantity of 500 ft. For cut lengths add 50%

UG TYPE CONNECTORS

Deduct 10% from prices shown on total order of 100 or more.

AN #	Price ea.	AN #	Price ea.
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UG-10/U	1.56	UG- 98/U	1.55
UG-11/U	1.45	UG-100/U	2.34
UG-12/U	1.14	UG-101/U	2.95
UG-13/U	1.56	UG-107/U	2.25
UG-14/U	1.45	UG-108/U	1.75
UG-15/U	1.14	UG-109/U	1.75
UG-16/U	1.56	UG-114/U	1.50
UG-17/U	1.45	UG-115/U	1.35
UG-18/U	1.25	CW-123/U	.45
UG-18A/U	1.05	UG-155/U	.40
UG-18B/U	.99	UG-154/U	3.75
UG-19/U	1.28	UG-155/U	3.75
UG-19A/U	1.38	UG-156/U	4.25
UG-19B/U	1.45	UG-160/U	1.90
UG-20/U	1.17	UG-160A/U	1.55
UG-20A/U	1.26	UG-167/U	2.25
UG-20B/U	1.41	UG-173/U	.30
UG-21/U	.99	UG-175/U	.15
UG-21A/U	1.05	UG-176/U	.15
UG-21/U	.99	UG-188/U	1.30
UG-22/U	1.08	UG-201/U	1.22
UG-22A/U	1.38	UG-202/U	2.75
UG-22B/U	1.34	UG-206/U	1.02
UG-23/U	.99	UG-208/U	28.50
UG-23A/U	1.26	UG-212/U	4.50
UG-23B/U	1.29	UG-213/U	4.50
UG-27A/U	2.25	UG-215/U	3.35
UG-28/U	2.34	UG-216/U	8.70
UG-29/U	1.22	UG-213/U	3.10
UG-30/U	1.75	UG-218/U	6.50
UG-33/U	30.00	UG-222/U	35.00
UG-34/U	35.00	UG-231/U	2.00
UG-35A/U	28.00	UG-236/U	11.75
UG-36/U	35.00	UG-241/U	2.20
UG-37/U	28.00	UG-242/U	2.50
UG-37A/U	30.00	UG-243/U	2.75
UG-57/U	.99	UG-244/U	2.50
UG-58/U	.63	UG-245/U	1.25
UG-59/U	2.75	UG-246/U	1.45
UG-59A/U	1.70	UG-252/U	4.50
UG-60/U	1.90	UG-254/U	1.82
UG-60A/U	1.30	UG-255/U	1.85
UG-61/U	2.05	UG-260/U	1.12
UG-61A/U	1.80	UG-261/U	.95
UG-62/U	28.00	UG-262/U	1.05
UG-83/U	1.50	UG-269/U	2.60
UG-85/U	1.65	UG-273/U	1.50
UG-86/U	1.69	UG-274/U	1.98
UG-87/U	1.40	PL-274	1.12
UG-88/U	1.17	UG-290/U	.85
UG-89/U	.95	UG-291/U	1.05
UG-90/U	1.05	UG-306/U	2.03
UG-91/U	1.25	UG-333/U	4.70
UG-91A/U	1.05	UG-334/U	5.75
UG-92/U	1.10	UG-352/U	6.00
UG-92A/U	1.35	UG-287/U	5.25
UG-93/U	1.25	UG-270/U	6.50
UG-93A/U	1.45	UG-259/U	4.10
UG-94/U	1.25	UG-279/U	2.40
UG-94A/U	1.05	UG-157/U	4.25
UG-95/U	1.10	MX-195/U	.55
UG-95A/U	1.35	UG-197/U	5.25
UG-96/U	1.25	UG-235/U	28.50
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714AY	9.80
725A	12.50

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417A	9.80
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723A	4.00
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VR-150	.69
724B	1.95
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3D6/1299	.39
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7C4/1203A	.39
12A6	.39
12A6GT	.39
VT-52 (SPEC 45)	.39
446A (2C40)	.74
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954	.49
957	.49

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VT-25A (10Y)	.39
VT-158A	4.90
211	.98
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801	.95
804	6.95
807	1.19
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841	.69
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1629	.29
7193 (2C22)	.29

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250R	4.95
WL-531	19.95
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WL869B	29.95

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3BP1	2.95
5AP1	2.49
5BP1	1.95

SPECIAL: 3CP1/S1 Cathode Ray Tube with Altimeter Markings . . . . . 98¢

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Standard Brands

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5 MFD 5000 VDC PFD 502 oil paper	12.00
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2X3500 MFD 25 VDC Metal can spec	1.98
1000 MFD 15 VDC type SC mount	.98
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1 MFD 5000 VDC oil filled	4.95
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8-6-4-1-MFD 600 VDC TJ choice	.79
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2X.15 MFD 8000 VDC Vitamin Q	3.75
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.1 MFD 3500 VDC oil filled	1.75
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100 asso. of the following for $3.00 .1-.05-25.5-.003-.005-.007 etc. paper and Mica 600 VDC—other pop. makes stock up 100	3.00
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Mica .01 type 86 3500 VDC 2500 VAC each	2.95
Mica type MX6I .002 10000 VDC each	6.50
Mica .0039 6000 VDC type G1 each	4.95
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WESTERN ELECTRIC TRANSMITTER

TYPE T-112-B (14-C)

- Freq range 2 to 18 MC.
- Power Output: 800 w. A1, 400 w. A2 A3.
- Telephone dial 10-channel selector.
- Input: 220/3/60.

This equipment is packed in 8 cases and includes 2 cases of spares. Export crated, F.O.B. N.Y.C. subject to prior sale.

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ALL NEW—ORIGINAL CARTONS

AUTOMATIC ELECTRIC—25 steps, 4 levels, 12V. DC. coil—Special price—$12.50

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Made By Well Known Manufacturer

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500 CYCLE GENERATOR

4KVA 110 Volt single phase p/f 1 3400RPM. 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 & separator DC output of 14V@40Amps. OD25½x12"dia. Wt. Approx 200 lbs. Brand New. FOB EVERETT or MIDWEST..... **ea. $79.95**

AMPLIDYNE

GE#5AM31NJ9A 28VDC 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**

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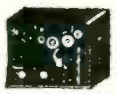
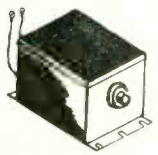


Type# 2CH1. Designed to add ballistics corrections to B29 fire control systems. Contains 4 servo amplifiers, 2 time delay amplifiers, hundreds of gears, differential selsyns, geared head motors, etc. Wt. 100 lbs. Brand New..... **$29.95**

50 RPM GEARED HEAD AC MOTOR

115 Volts 60 cycle single phase 3 wire reversible (uses external 3 mfd. cond.). Mfd. by Holtzer-Cabot #RBC-3712 Torque 100 oz/in. ⅜" dia. shaft. Wt. 9 lbs. Brand New..... **ea. $8.95**

10,000 VOLT 23 MA TRANSFORMER

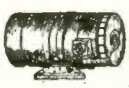


Pri. 115 Volt 60 cycle GE#56G9. UL approved. OD 7½x5x5". Wt. 14 lbs. Brand New .... **ea. $6.95**

1/3 HP VACUUM PUMP

The pump is a MOTAIR #588 Size CAC MC#68313. It has an air filter, a forced feed oil lubricating & sealing system & can be used to compress air on output side. The motor is a CENTURY 1/HP 220 volt 50-60 cycle 1725RPM 3 phase. OD 13x11x7". Wt. 40 lbs. Brand New..... **ea. $39.95**

400 CYCLE INVERTER



GE#5D21NJ3A 28VDC input 110 Volt 400 cycle output 485VA 4.2 Amps. Single phase p/f 1. OD9x6¼x5¼". Wt. 12 lbs. Brand New..... **ea. $7.95**

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for worthwhile savings to you

CAPACITORS
Standard Brands

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A-1

500 mfd @ 200 d-cwv; 2 insulated terminals; 2" dia. x 4⅛" can; mounting bracket; new, factory packed. (A-1) ... $ .95

JF-1

.25/.25 mfd @ 6,000 v d-c or .125 mfd @ 12,000 v d-c; oil filled w/ mounting bracket; new, factory packed; 5" x 3½" x 9½" o.a. height. (JF-1) .. $3.75

MICA:

CD-1

.001 mfd @ 25,000 v d-c; 25 amp @ 3,000 kc, 18 amp @ 1,000 kc, 11 amp @ 300 kc; 10½" x 4" x 9" o.a. height; new, factory packed (CD-1) .. $25.00

2 mfd ¾ 600 v d-c; tubular oil ..... $ .39

3.5/.5 mfd 1,000 v d-c, oil ..... $ .90

1.0/1.0/1.0 mfd 3,000 v d-c test 1,200 v d-c working, isolated sections $1.20

9.12 mfd @ 1265 v a-c, 60 c single phase. 5 kvar..... $17.50

1.25/1.25 mfd @ 7,500 v d-c $12.50

1.0 mfd 25,000 v d-c; net wt. 65 lbs. (C-107)..... $36.00

VACUUM CAPACITOR: 50 mmfd @ 32,000 v d-c; tubular: 2¼" dia. x 6½", clip mounting; new, factory packed $4.95

POWER SUPPLY KITS

#1 YOU GET: Full wave high voltage transformer, rectifier, capacitor combination.
2 KENYON TRANSFORMERS Type S-13483: 115 v 60 c pri.: 3,200 v ½ wave sec. @ 250 ma. Coupled together they give 3,200 v full wave @ 500 ma.
1 KENYON FILAMENT TRANSFORMER type T-389: 115 v 60 c pri.; 2.5v ct sec. @ 10 amps; 9,000 v test.
2 866A tubes. 2 JOHNSON SOCKETS.
4 CAPACITORS, Cat. #23F47: 2 mfd 4,000 v d-c.
COMPLETE..... $35.00

#2 Do you need a low voltage supply? Then don't pass this up! There's
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1 THORDARSON CHOKE type T-74029; 15 h @ 150 ma.
2 CAPACITORS type PT-SC-2: 8/8 mfd @ 600 v d-c; oil filled; 4 prong plug-in type:
1 5T4 RECTIFIER TUBE; 1 SOCKET;
FOR..... $9.50

DRY DISC RECTIFIERS
Continuous Duty Ratings

3.5 v a-c, FWB, 1.8 v d-c @ 1.0 amp. ..... $ .90
6.5 v a-c, FWCT, 2.2 v d-c @ 3.0 amps. 1.20
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0-154 v a-c, FWB, 600 ma d-c..... 6.85
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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 250T, 371, 872 and 5563, etc. rectifier tubes..... **$12.50**
Net Wt. 15¾ lbs. Dim 6½" W x 6" D x 12" H.O.A.

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WESTON MODEL 301: 20 kv @ 1,000 ohms per v; 3" face calibrated to read 0 to 20 kv; 1 ma full scale deflection; flush type, calibrated for steel panel mounting; used with Weston precision 20 meg resistor (orig. cost over $125.00), which is included, plus standoff insulators and mounting clips.....$18.00

A-C AMMETER

WESTON MODEL 476: 3" face, calibraed to read 0 to 120 amps, has 3 amps full scale deflection; used with 40 to 1 current transformer, which is included $8.50

Voltage Regulators

TRANSTAT:
115 v 50/60 c input; 103 to 126 v output @ 2.17 amps.....$9.50
TRANSTAT:
115/230 v 50/60 c input; 0 to 260 v output @ 2.5 amps.....$21.50
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115 v 50/60 c input; 0 to 130 v output @ 10 amps.....$24.50
VARIAC:
115 v 50/60 c input; 0 to 135 v output ¾ 5 amps; cased...$14.50

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95 to 125 v 50 c input; 115 v output:

30 va...	$ 6.00	250 va..	$18.00
60 va...	8.40	500 va..	34.00
120 va..	13.20	1000 va.	66.00

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TUBE WL 386/ML-3W: 125 kv X-ray rectifier; oil immersion type; filament: 10 v @ 11.6 amps..... $32.00

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750TL	47.50	3C23	4.75	531	18.00
WL533 750W U.H.F. Triode	17.50	FG81A	4.75	872	1.75
714AY Magnetron	9.50	C6A	8.50	3B22	2.95
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AC RELAYS!

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Struthers Dunn #CS2366 Coil 110 Volts, 60 Cycles 3PST Contacts 110 Volts AC 30 Amps. Price only $2.95

Struthers Dunn #CS2368A Coil 110 Volts, 60 Cycle DPST Contacts 110 V.A.C., 30 Amps. Price only $1.95

Cased AC Relay Allied #BJH 6A115 Coil 115 Volts 50/60 Cycles DPDT Contacts Housed in hermetically sealed can with feed-thru glass-wire terminals. .....Price $1.95

Relays—while they last—any of following types only $.39 each or 3 for $1.00

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Telephone type RBM #556-883. Double contact D.P.D.T. plus 2 S.P.S.T., one normally open, other normally closed. Dual winding coil, each winding 170 ohms.

Telephone type RBM #556-884. Double contacts, 2-S.P.S.T., one normally open, other normally closed. Dual winding coil, ea. winding 170 ohms.

Telephone Type Relay #D4544 D.P.S.T. Coil 1000 ohms 12 Volts D.C.....Price $ .95

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Struthers Dunn S.P.D.T. Relay 36 Volt coil—20 ma. Contacts 2 amps. at 115 V. A.C.

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Type RH
Fixed Winding 115 Volts—400 cycles
Commutator ranges 75-120 Volts
Load—.72 KVA
Housed in Shielded case 5½" x 6" x 6½" Price $1.65

4000-6000 VOLT LOW CURRENT DC SUPPLY

Brand new completely wired and tested. Ready to operate from 115 volt power line. D.C. output is filtered. ....Price Complete $12.50

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Model NFRD

Designed for radios, appliances, and electrical equipment consuming up to 1300 watts (12 amperes) at 120 volts AC or DC.
Housed in a metal case 1⅞" x 3" x 7½" complete with male and female line connectors.
Price only $1.95

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Types WW3, WW4, and WW5

Following sizes are in 1% and 2% tolerance — Price $.35

1 meg		1500
.8 "	46,000	1400
.75 "	40,000	1200
.7 "	33,000	1000
.6 "	17,000	750
.268 "	17,300	235
.22 "	13,300	130
125,000	12,000	125
120,000	10,000	110
109,000	7,500	55
	4,500	22
95,000	4,300	20
92,000	4,000	14
84,000	2,500	12
82,000	2,230	10
80,000	2,200	6
54,500	1,700	

Following sizes are 5% or better tolerance, — Price $.15

22,000	70	50
40	35	30

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	105.8	4.4
4.285	63.96	4.35
	53.32	4.3
	33.22	3.94
	23.29	3.5
	13.52	1.563
220.4	13.333	.29
147.5	10.2	.268
	5.1	.25

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British type adaptor for converting PL-173 to 83-1R socket
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9 - button automatic switch. Depressing one button automatically releases another; has 8 ind. SPST circuits, normally open & 1 SPST circ. normally closed with locking catch. **OAK Type "80"** $1.25

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ALL BRANDS GUARANTEED
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1.0 Mfd— 600 vdcw	.35
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2.0 Mfd— 600 vdcw	.39
4.0 Mfd— 500 vdcw	.59
4.0 Mfd— 600 vdcw	.69
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6.0 Mfd— 600 vdcw	.79
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1000 mfd 15 vdcw 1 section.....	.79
1000 mfd 25 vdcw 1 section.....	.88
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1¾" wide x 1 15/16" hi
5 terminal—4⅛" long..... 49¢
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250 VAC or DC 3 Amp. 4 heavy duty cond. in oil & 2 chokes in one can 4x3¾x1¾ for 101 noise Fil. jobs in line ETC. reg. $15.00 special....1.95

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Pots ½-1 & 2 meg. with switch .55 ea. 6 for 3.00

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Type 820-Z 5-20 Mmfd Zero Temp.....24¢ each.
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From "AM" Dials 5 to 1.....80¢ each.

COLLINS FILAMENT TRANSFORMER
PRI: 210/220/230/240/250 VAC. 50/60 CPS.
SEC: 7.5 VAC C.T. @ 24 Amps. Herm. Sealed.
Insulation 2500 Volts.....Price $11.95

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.125 MFD. 27 KV.DC.
With mounting brackets

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Normally open or closed. Adjustable from —40 to +400° F. each $1.25

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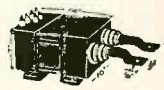
HIGH CURRENT
AMERTRAN
5.1 Volts at 190 Amps.
Primary 105/125 Volts



Can easily deliver 250 Amps. Insulation 35 Kv. Test. Approx. Shipping weight 96 lbs.

Plus $2 crating charge $17.50

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
B1–7X5	7.5 AMP.	7.95
B1–10	10 AMP.	9.95
B1–15	15 AMP.	13.95
B1–20	20 AMP.	15.95
B1–25	25 AMP.	20.95
B1–30	30 AMP.	24.95
B1–40	40 AMP.	27.95
B1–50	50 AMP.	32.95
B1–60	60 AMP.	36.95

Full Wave Bridge Types

Input 0–54VAC	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

Input 0–72VAC	Output 0–54*VDC	
Type#	Current	Price
B4–1X2	1.2 AMP.	$7.95
B4–3X5	3.5 AMP.	15.95
B4–5	5 AMP.	17.95

Input 0–115VAC	Output 0–110*VDC	
Type#	Current	Price
B6–150	150 MA.	$1.95
B6–250	250 MA.	2.95
B6–600	600 MA	5.95
B6–2	2 AMP.	12.95
B6–3X5	3.5 AMP.	21.95
B6–5	5 AMP.	24.95
B6–7X5	7.5 AMP.	32.95
B6–10	10 AMP.	36.95

Input 0–234VAC	Output 0–180*VDC	
Type#	Current	Price
B13–4	4 AMP.	$54.95
B13–7X5	7.5 AMP.	63.95
B13–10	10 AMP.	69.95

Full Wave Bridge Types

Input 0–36VAC	Output 0–25*VDC	
Type#	Current	Price
B2–150	150 MA.	$.98
B2–220	220 MA.	1.25
B2–300	300 MA.	1.50
B2–450	450 MA.	2.25
B2–600	600 MA.	2.95
B2–1	1 AMP.	3.95
B2–2	2 AMP.	4.95
B2–3	3 AMP.	6.95
B2–5	5 AMP.	9.95
B2–6	6 AMP.	10.95
B2–7X5	7.5 AMP.	13.95
B2–10	10 AMP.	15.95
B2–15	15 AMP.	24.95
B2–20	20 AMP.	27.95
B2–30	30 AMP.	36.95

Three Phase Bridge Types

Input 0–12*VAC	Output 0–130*VDC	
Type#	Current	Price
3B7–4	4 AMP.	$32.95
3B7–6	6 AMP.	48.90
3B7–11	11 AMP.	65.00

Input 0–234VAC	Output 0–250*VDC	
Type#	Current	Price
3B13–4	4 AMP.	$56.00
3B13–6	6 AMP.	81.50
3B13–11	11 AMP.	110.00

CENTER TAPPED TYPES

Input 12–0–12VAC	Output 0–8*VDC	
Type#	Current	Price
C1–10	10 AMP.	$7.95
C1–20	20 AMP.	12.95
C1–30	30 AMP.	17.95
C1–40	40 AMP.	21.95
C1–50	50 AMP.	25.95
C1–80	80 AMP.	34.95
C1–120	120 AMP.	46.95

* 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	.80 per set
For Types 3B	1.20 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

All TXF Types are Tapped to Deliver 32, 34, 36 Volts.

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-3	1000 MFD	25VDC	1.69
CF-4	2X3500 MFD	25VDC	3.45
CF-18	10000 MFD	25VDC	4.95
CF-5	1500 MFD	30VDC	2.49
CF-6	4000 MFD	30VDC	3.25
CF-7	3000 MFD	35VDC	3.25
CF-8	100 MFD	50VDC	.98
CF19	500 MFD	50VDC	1.95
CF-16	2000 MFD	50VDC	3.25
CF-17	50 MFD	150VDC	.59
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

ELECTROLYTIC CAPACITORS

		Lots of 10	Lots of 100
100 MFD	50 VDC	$2.20	$19.00
40 MFD	150 VDC	1.80	17.50
50 MFD	150 VDC	2.00	18.50
8–8–20 MFD	350,150 VDC	4.70	43.00
*20–20 MFD	400,250 VDC	4.50	38.00
10 MFD	450 VDC	2.50	20.00
15 MFD	450 VDC	2.50	20.00
15–15 MFD	450 VDC	3.00	22.00
40 MFD	450 VDC	4.20	36.00

* 4 prong plug-in type.

METERS

O-15 MA.D.C. Weston #506 2" Rd.	$2.95
O-30 A.D.C. Weston W/shunt 2½" Rd., aircraft type	2.95
O-50 A.D.C. Weston #301 3½" Rd., Enclosed shunt	5.50
O-60 A.D.C. West., w. shunt, 2½" Rd., aircraft type	3.25
O-120 A.D.C. West. w. shunt, 2½" Rd., aircraft type	4.95
O-8 V.A.C. G.E. 3½" Round	2.95
O-30 V.D.C. West. 2½" Rd., aircraft type	2.95

To avoid shipping errors, kindly order by type #. All prices subject to change without notice.

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G. E.

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(.001 ohm To 10 Megohms ± 0.1%)
MB-8 MEGOHM BRIDGE ..... $ 60.00
(1-100,000 Megohms ± 5%)

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Transformers, Reactors, Filters, complete line of QBD supersonic components	
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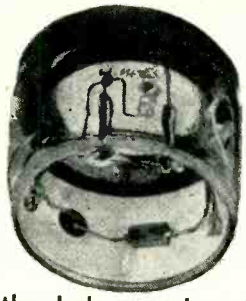

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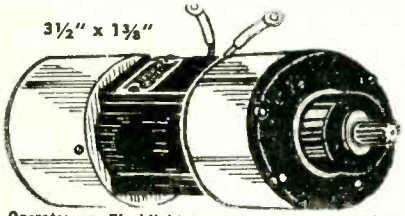
3½" x 1⅜"



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Fixed taps at each 10% of full resistance value. Dimensions 1⅛" dia. x 9½" long.

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50 ohms	300 ohms	1500 ohms	5000 ohms

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Transformer, 115V.A.C. 60 cycle, output 5 volts at 190 amps., ideal for welding etc. Good condition $12.95

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PE237—Heavy duty vibrator power supply, 6, 12, or 24 volt input, 525v, 95 ma; 105v, 42ma.; 6.5v, 2 amp.; 6v, 500ma.; 1.3v, 450 ma.; small supply—100v, 17ma.; 1.35v, 450ma. with tubes, shock mounted, Brand New.....$29.50

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(Additional Wanted Ads on page 279)

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Also APR-1 and APR-4 Receivers

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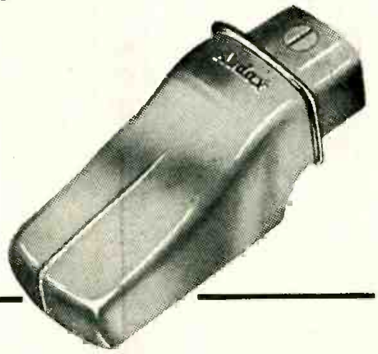

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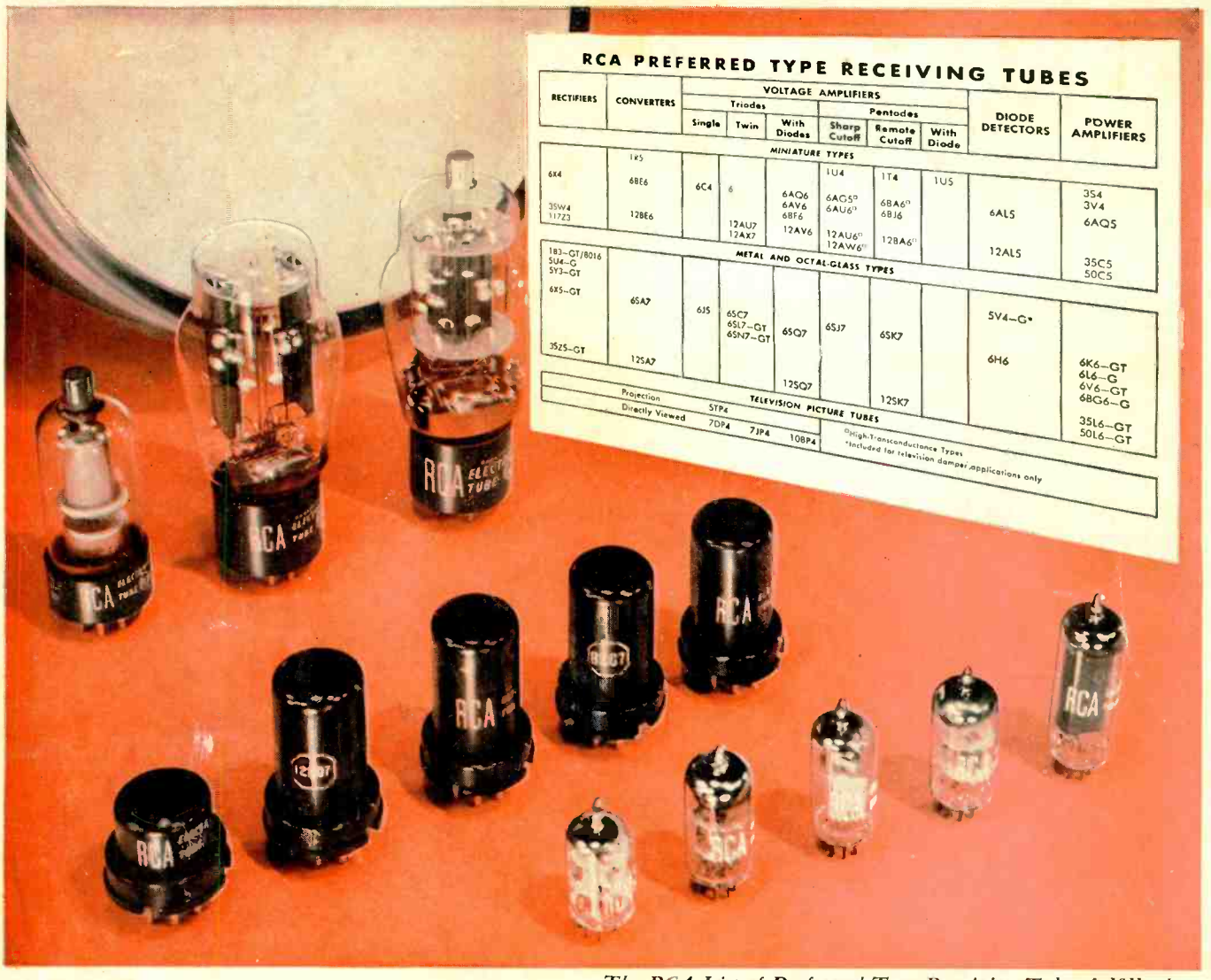

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