electronics

A McGRAW-HILL PUBLICATION

OCTOBER • 1947

TUBES FOR INDUSTRY ..... **Cover**
Production-testing gas-filled C16J's at Electrons, Inc.

KSBR'S 50-KW F-M TRANSMITTER, by R. L. Norton, Byron O. Ballou, and R. H. Chamberlin **80**
Details of the r-f section of equipment using maximum permissible power on high band are given

UHF HEATING OF FROZEN FOODS, by Philip W. Morse and H. Earl Revercomb **85**
A c-w magnetron heats a meal in a cavity in 70 seconds

STATUS OF VHF FACILITIES FOR AVIATION, by Peter Caporale **90**
Operating principles of vhf omnidirectional radio range, glide-path portion of ILS, and other new CAA equipment

TELEMETERING FATHOMETER, by E. F. Kiernan **96**
Relayed pulses on 8 and 70-megacycle channels link ship and shore equipment for robot depth sounding

MAGNETIC TAPE RECORDER FOR MOVIES AND RADIO, by R. H. Ranger **99**
Broadcast program and sound film editing can be facilitated by use of new machine and tape with high overall fidelity

COLOR FACSIMILE **104**
Colored pictures are scanned, analyzed with filters, and reproduced on plain paper by colored pencils

BETA-RAY THICKNESS GAGE FOR SHEET STEEL, by Otto J. M. Smith **106**
G-M counters measure absorption of beta rays by steel strip moving over a radiostrontium source

PEACETIME RADAR, by B. B. Talley **113**
River towboats no longer stalled by fog on inland waters

TUBE FAILURES IN ENIAC, by F. Robert Michael **116**
Open heaters and damaged cathode coatings were chief troubles in 18,800-tube computer during year of operation

SPIRAL SWEEP OSCILLOSCOPE TIMER, by R. B. Moran, Jr. **120**
Pulses occurring between 0.05 and 90 microseconds apart can be photographed and their spacing accurately measured

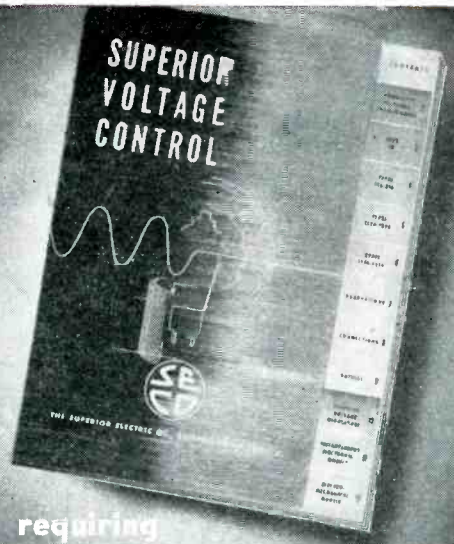
D-C AMPLIFIER FOR LOW-LEVEL SIGNALS, by Charles B. Aiken and W. C. Welz **124**
A 0.001-microvolt signal can be distinguished from noise

BUSINESS BRIEFS	74	ELECTRON ART	136	NEW BOOKS	260
CROSSTALK	79	NEW PRODUCTS	140	BACKTALK	264
TUBES AT WORK	132	NEWS OF THE INDUSTRY	144	INDEX TO ADVERTISERS	283

James H. McGraw, Jr., President; Curtis W. McGraw, Senior Vice-President and Treasurer; Nelson Bond, Director of Advertising; Eugene Duffield, Editorial Assistant to the President; Joseph A. Gerardi, Secretary; and J. E. Blackburn, Jr., Vice-President for circulation operations.
ELECTRONICS, October, 1947, Vol. 20; No. 10. Published monthly, with additional issue in June, price 75c a copy. Directory issue $2.00. Allow at least ten days for change of address. All communications about subscriptions should be addressed to the Director of Circulation.
Subscription rates—United States and possessions, $6.00 a year, $9.00 for two years, $12.00 for three years. Canada (Canadian funds accepted) $7.00 a year, $11.00 for two years, $14.00 for three years. Pan American countries $10.00 for one year, $16.00 for two years, $20.00 for three years. All other countries $15.00 for one year, $30.00 for three years. Please indicate position and company connection on all subscription orders. Entered as Second Class matter August 29, 1936, at Post Office, Albany, New York, under the Act of March 3, 1879. BRANCH OFFICES: 520 North Michigan Avenue, Chicago 11, Ill.; 68 Post Street, San Francisco 4; Aldwych House, Aldwych, London, W.C. 2; Washington, D. C. 4; Philadelphia 3; Cleveland 15; Detroit 26; St. Louis 8; Boston 16; Atlanta 3, Ga.; 621 So. Hope St., Los Angeles 14; 738-9 Oliver Building, Pittsburgh 22.

New Bulletin 547

Features VOLTAGE CONTROL by SUPERIOR ELECTRIC



All the information required for selection of the correct voltage control apparatus is included—

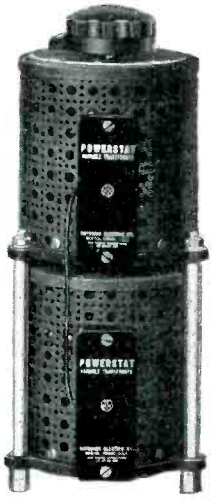
FOR INSTANCE: If you have an application requiring variable voltage to a load of about 1 KVA turn to page 4.

POWERSTAT TYPES 116 - 216

POWERSTATS types 116 and 216 are alike in appearance and physical size . . type 116 operates on 115 volts to deliver 0 - 135 volts, 7.5 amperes — type 216 operates on 230 volts to deliver 0 - 270 volts, 3.0 amperes. Incorporated into each type is protective screening, output receptacle, "on-off" switch, input cord-plug, and fuse protection.

When back-of-panel mounted as part of other equipment, these POWERSTATS are furnished uncased as shown in the illustration of type 116U. Ganged assemblies are supplied for open-delta or wye connected three phase duty. All single and multiple types 116 and 216 can be adapted to motor-operation. Type MT116 is a typical motor-driven unit.

116-2D



116

116 U

MT 116

To get your copy of Bulletin 547 . . . and for more information on POWERSTATS types 116 and 216, write

SUPERIOR ELECTRIC, 1104 Laurel Street, BRISTOL, CONNECTICUT.

THE SUPERIOR ELECTRIC CO.

BRISTOL, CONNECTICUT

POWERSTAT VARIABLE TRANSFORMERS • VOLTBOX A-C POWER SUPPLY • STABILINE VOLTAGE REGULATORS

partners in creating

"Impossible" is a word that is not recognized by engineers. To dam a mighty river, tunnel under it or suspend a bridge across it—things such as these that once seemed pure imagination were made possible by instruments devised to refine and extend human faculties, to translate the precision of engineering thought into action.

Keuffel & Esser Co. is proud to have played so large a part in making such instruments widely available. In this way K & E equipment and materials have been partners of the engineer and draftsman for 78 years in shaping the modern world. So universally is this equipment used, it is self-evident that K & E have played a part in the completion of nearly every engineering project of any magnitude. Could you wish any surer guidance than this in the selection of your own "partners in creating"?

Not only for construction and building, but for setting up precision machine tools and long production lines, in the fabrication of large ships and aircraft, experienced engineers know that they can rely utterly on K & E transits and levels. Coated lenses for increased light transmission, precision-ground adjusting screws, chromium-coated inner center and draw tubes, completely enclosed leveling screws, improved achromatic telescopes—all these typify the advanced design of these instruments.

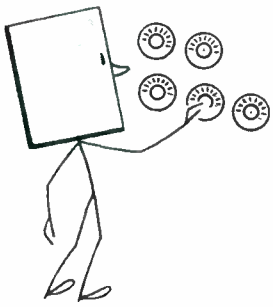
Why this team brings

Early in the history of radio telephony, it became evident that further growth and expansion depended on accurate means of controlling frequency. The first step toward solving this problem was taken in 1915, when a Laboratories engineer developed the first master oscillator circuit for radio transmission. In 1917 came the first crystal controlled oscillator using Rochelle salt crystal, and in 1921 the application of quartz crystals.

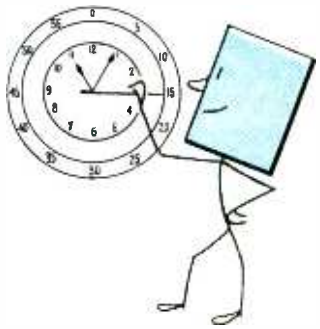
From that day on, the Bell Laboratories-Western Electric team has pioneered in piezoelectric crystals. New cuts, new circuit applications, new methods of growing synthetic crystals . . . all have been developed by the Laboratories, and all mass-produced by Western Electric.

Today it is only natural to look first to this team for the finest quartz and synthetic crystals for every service.

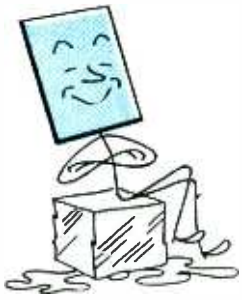
1917 A Rochelle salt crystal used by a Laboratories researcher to control an oscillator circuit was the granddaddy of all frequency control crystals.



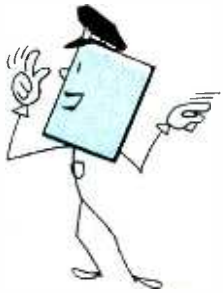
1924 Quartz crystal applied to frequency control of station WEAF by Bell Laboratories-Western Electric team greatly improved the quality of distant broadcast reception and laid foundation for more economical use of radio spectrum.



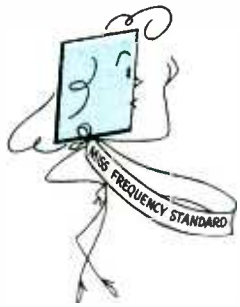
1927 Oscillating 100,000 times a second, a crystal served as the heartbeat of a clock far more accurate than any other timing device ever before made by man.



1933 Low - temperature - coefficient crystal cuts, utilizing for the first time specially selected shape, dimensions, and orientation characteristics, increased frequency stability, made temperature controls needless for certain applications.

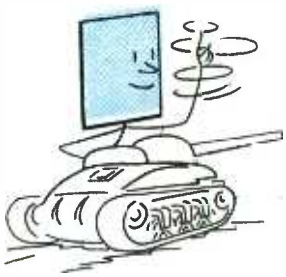


1934 "Traffic Cop" crystal filter designed by Bell Laboratories to act as separation unit for carrier systems. Led to today's 480 channel coaxial systems and single sideband radio transmitters.



1939 GT crystal serves as a "frequency model." Used for Loran, extremely accurate time signals (stable to 1 part in 10^9), and other applications requiring utmost frequency stability.

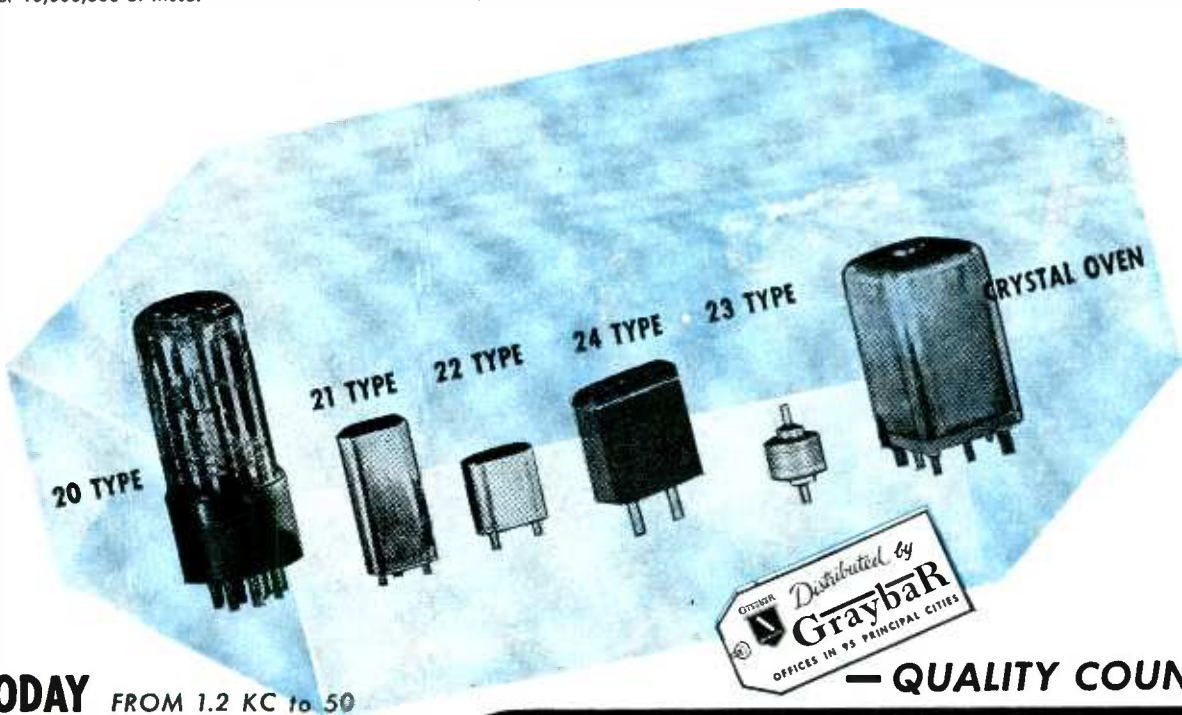
you more accurate frequency control



1942 Wire mounted crystal unit designed to withstand shocks and rough usage went into battle in tanks and with artillery. Western Electric produced over 10,000,000 of these.

1943 Synthetic ADP crystals, first mass-produced by this team, were also first applied by the team to underwater sound in Sonar. Change acoustic energy into electric and vice versa.

1947 EDT crystals — the first low-coefficient synthetics — are being grown on Western Electric's crystal farms to replace hard-to-get natural quartz.



TODAY *FROM 1.2 KC to 50* MC.—that's the extraordinary range covered by Western Electric's new line of crystal units for oscillator control. All are engineered to assure maximum frequency for a given design, with increased accuracy and stability.

— QUALITY COUNTS —

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.

A MESSAGE from the President

IN response to hundreds of inquiries, we wish to announce that there will be no new HAMMARLUND receiver in the price range of the HQ-129-X until the summer of 1948 at the very earliest.

Extra engineering effort, extra precision and extra care in manufacturing have made the HQ-129-X famous as the Ham's receiver that is built to professional standards.

You can buy the HQ-129-X with confidence. It has every up-to-the-minute improvement that radio science has so far developed for amateur radio receivers.

L. A. HAMMARLUND, *President*

HQ·129·X

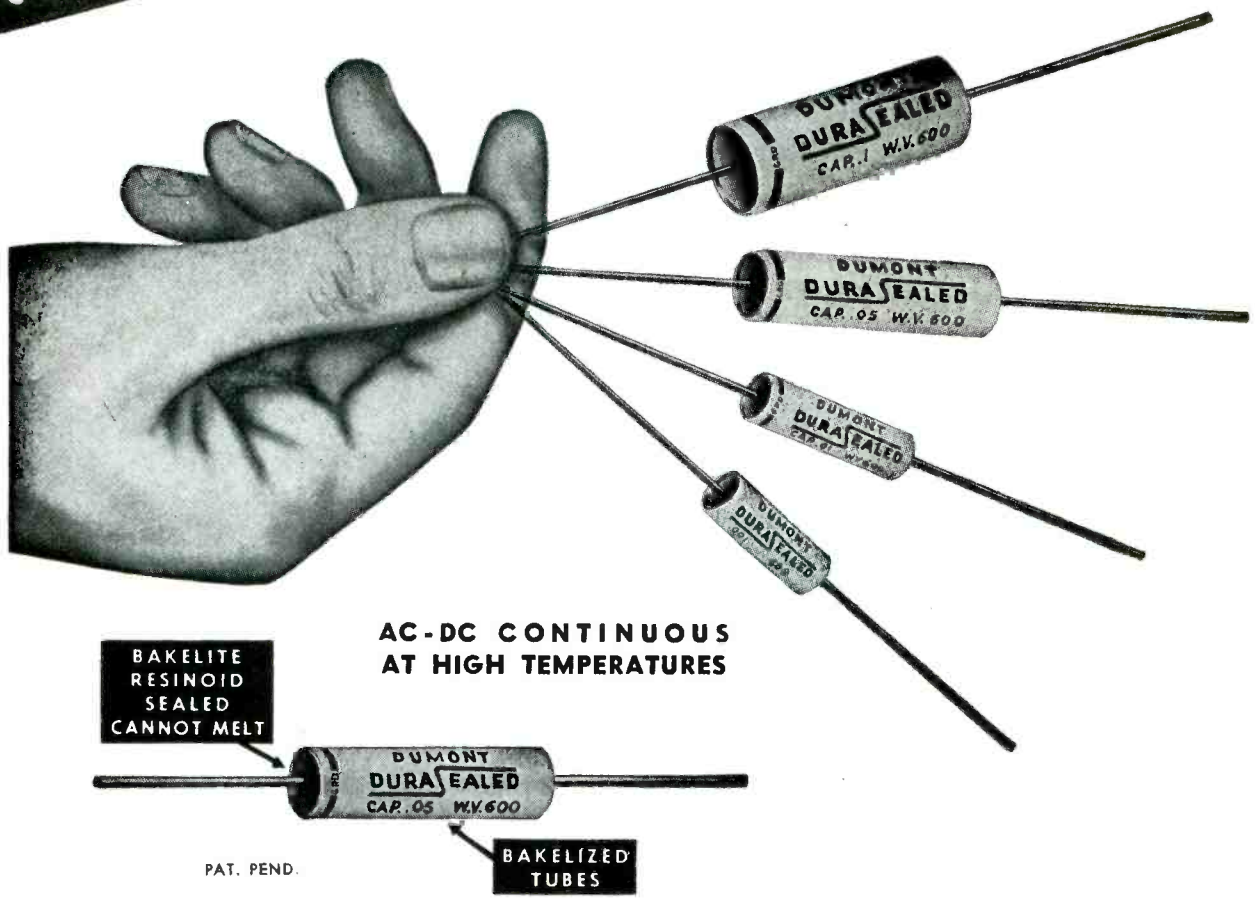
THE SIGN OF QUALITY
ESTABLISHED 1910

HAMMARLUND

THE HAMMARLUND MFG. CO., INC., 460 W. 34TH ST., NEW YORK 1, N.Y.
MANUFACTURERS OF PRECISION COMMUNICATIONS EQUIPMENT

AT LAST!

SPECIAL WARTIME DEVELOPMENT NOW AVAILABLE FOR PUBLIC USE . . . TYPE P6 DUMONT *PAPER* CAPACITORS



AC-DC CONTINUOUS AT HIGH TEMPERATURES

PAT. PEND.

★ Dumont engineers scored in the greatest single achievement in paper tubular capacitors . . . meeting the most exacting requirements. This type P6 has the ends sealed in BAKELITE RESINOID. Leads cannot PULL OUT or MELT OUT. Bakelite treated tubes sealed in vacuum.

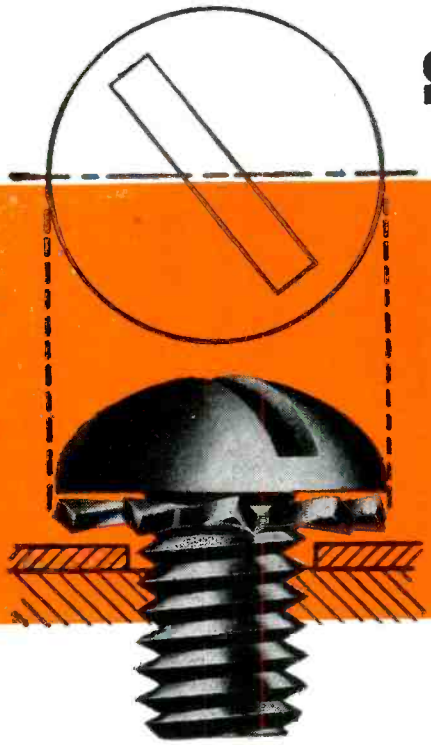
★ **HEAT PROOF**
★ **MOISTURE PROOF**
★ **LONGER LIFE**
★ **VACUUM SEALED**
★ **SOLVES SPACE PROBLEMS**

DUMONT ELECTRIC CORP.
MFR'S OF CAPACITORS FOR EVERY REQUIREMENT

34 HUBERT STREET NEW YORK, N. Y.

CONSIDER THE ASSEMBLY ADVANTAGES OF

SEMS *by* SHAKEPROOF



A BETTER FASTENING BECAUSE THE TOOTHED LOCK WASHER IS AUTOMATICALLY POSITIONED FOR POSITIVE CONCENTRIC SEATING!

In sems by Shakeproof you not only have all the time and labor saving benefits of the pre-assembled principle and the extra locking power of Shakeproof's tapered-twisted teeth but also certain other special advantages which are exclusive to this combination unit.

To appreciate this fact consider these mechanical features:

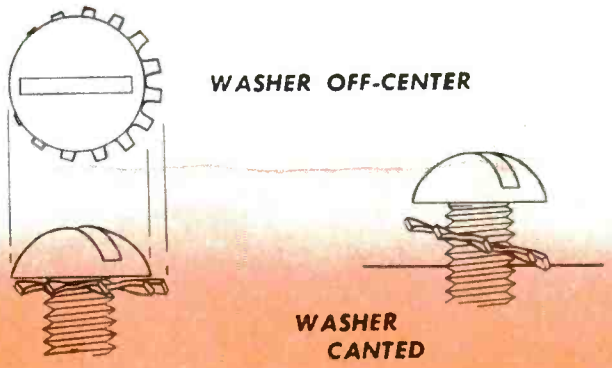
1. The toothed lock washer is held on the screw by the rolled thread and is free to rotate. *The internal diameter of the washer is smaller than the diameter of the screw thread.* The small internal diameter produces a close fit of the washer to the unthreaded portion of the screw shank which positions the lock washer teeth concentric with the screw and reduces the overall washer diameter to closely match the diameter of the screw head.
2. The thread which holds the lock washer on the screw keeps it approximately parallel to the clamping surface of the screw head and eliminates any possibility of canting which might cause buckling of the parts being fastened. Thus, when the sems is driven home, the locking teeth are automatically positioned so that they can function to their full power.
3. Concentric tooth seating assures easy installation in narrow channels or where screws must be placed close together because the washer does not protrude far enough to interfere. This also assures neat appearance and protection against catching edges for each fastening.

Specify sems by Shakeproof — it's your assurance of faster, better and lower-cost assembly!

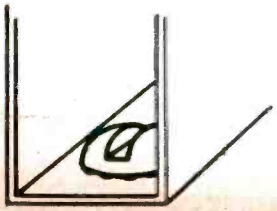
SHAKEPROOF inc.
"fastening Headquarters"

Division of ILLINOIS TOOL WORKS
2501 North Keeler Avenue, Chicago 39, Illinois
Offices in Principal Cities
Plants at Chicago and Elgin, Illinois • In Canada:
Canada Illinois Tools, Ltd., Toronto, Ontario

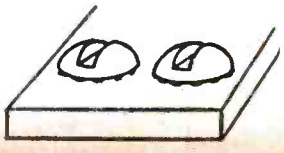
THIS CAN'T HAPPEN!



THIS DOES HAPPEN!



Narrow channel application showing why the washer must be kept concentric with the screw and no larger in overall diameter than the screw head.



With concentric seating plus correct overall diameter of the lock washer, screws can be placed close together. Note the neat appearance of each fastening.

MOTOROLA

"FM HANDIE-TALKIE"

Utilizes Sixteen RAYTHEON Subminiature Tubes

HERE is a personal communications unit that will greatly facilitate the work of surveyors, construction men, police officers, fire fighters, forest rangers, and others . . . the new Motorola "*FM* Handie-Talkie."

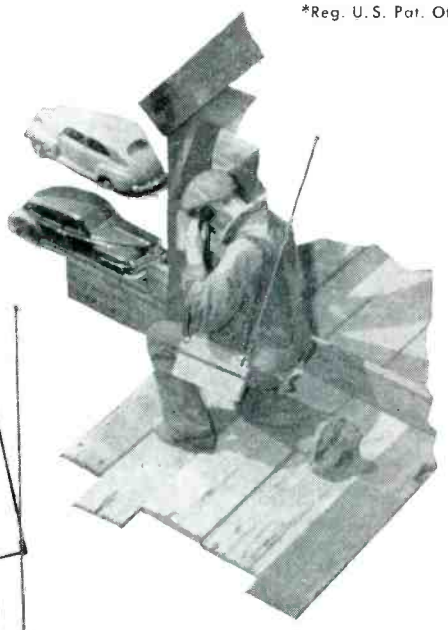
Smaller than an 8½ x 11 loose-leaf notebook, and weighing only 8½ lbs., this new complete FM transmitter-receiver, strapped to the back or carried by hand, permits two-way conversations *in excess of 2 miles between units, depending on terrain. The range is greatly increased when working with mobile units, or fixed stations of an existing 25-44 mc. system.*

The new Motorola "*FM* Handie-Talkie" is crystal-controlled to operate at any fixed frequency in the 25-44 mc. band and utilizes a full-fledged superhetrodyne circuit. Its small size, weight, and high sensitivity have been attained, in part, by the use of 16 Raytheon* Subminiature Tubes.

*Reg. U.S. Pat. Off.

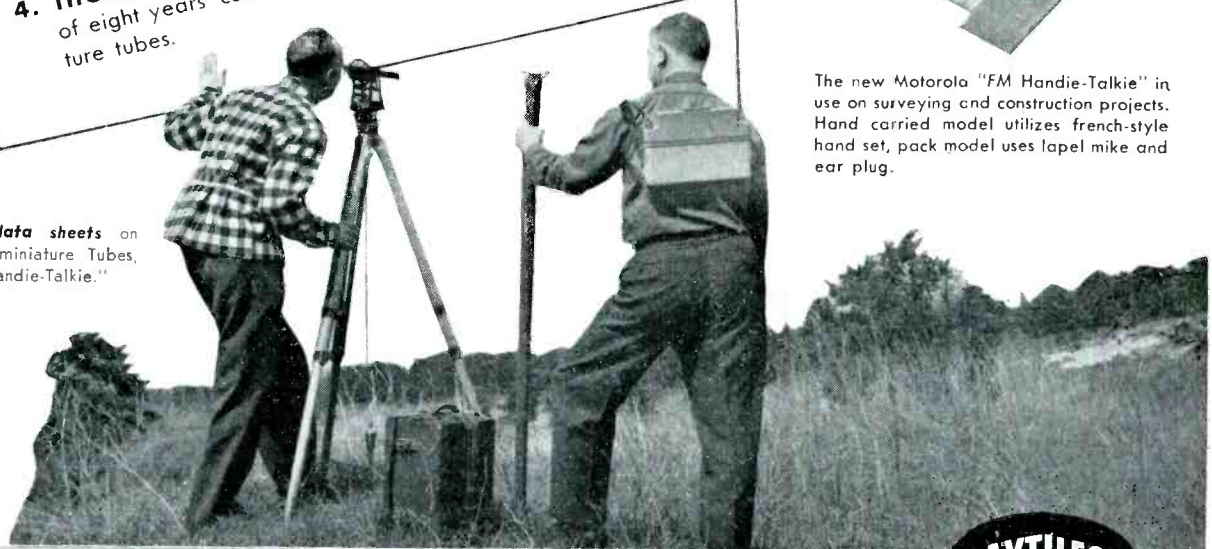
Why Motorola and other manufacturers use RAYTHEON Subminiature Tubes . . .

1. **MORE COMPACT AND SALEABLE PRODUCT** can be produced, due to flat shape of tubes and reduced size of battery which results from low filament drain.
2. **RAYTHEON SUBMINIATURE TUBES PLUG INTO STANDARD SOCKETS** — several commercially available makes to choose from.
3. **READILY AVAILABLE** — OVER 30 TYPES — standard throughout the world.
4. **THOROUGHLY RELIABLE IN OPERATION** as a result of eight years' continuous production of long-life subminiature tubes.



The new Motorola "FM Handie-Talkie" in use on surveying and construction projects. Hand carried model utilizes french-style hand set, pack model uses lapel mike and ear plug.

Write for data sheets on Raytheon Subminiature Tubes, Motorola "Handie-Talkie."



RAYTHEON MANUFACTURING COMPANY
SPECIAL TUBE SECTION
Newton 58, Massachusetts

RAYTHEON

Excellence in Electronics

RADIO RECEIVING TUBES • SUBMINIATURE TUBES • SPECIAL PURPOSE TUBES • MICROWAVE TUBES

Take a tip from a PWC Cord Set

A new, different and vastly better cord set. Flex it, twist it, use it, abuse it. It won't crack, fray or rot... isn't harmed by oils, greases, acids or most other chemicals . . . doesn't deteriorate with age.

We make them by the thousands for the country's top appliance manufacturers and leading electrical distributors—all types of flexible cords—parallel, light, medium and heavy-duty jacketed types—with standard or special plugs, receptacles or grommets molded on. Chances are there's one in your own office or home. Look for the letters PWC on the plug like that in the illustration. Note the cord's high luster, smooth, abrasion-resistant, easily cleaned finish . . . its attractive, permanent color and relatively small diameter, its flexibility.

Tailor-made, for every application, special electrical, chemical and physical characteristics are engineered into all PWC products . . . flexible cords, multiple conductors, telephone wires, radio wires, power cable, building wire, apparatus and machine tool wire, coaxial cable, shielded cables, special purpose wire and cable.

Send us your requirements and let us show you the gains from using PWC-engineered products. Our production facilities are geared to meet your needs.

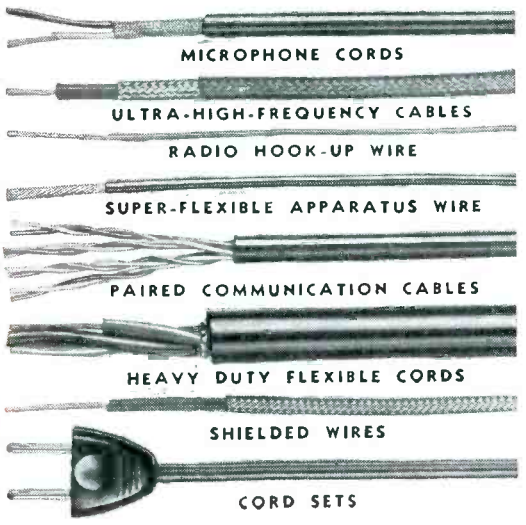
PLASTIC WIRE & CABLE CORP.

World's leading exclusive manufacturer of plastic insulated wire and cable

408 East Main Street, Jewett City, Conn.

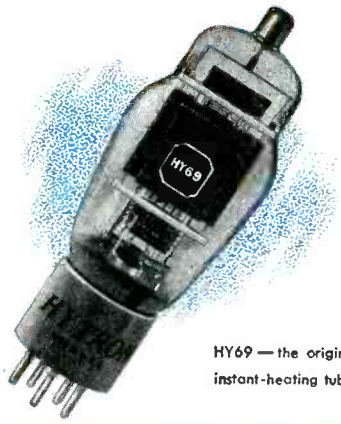
PWC MEANS 10 WAYS BETTER

1. Superior dielectric strength.
2. Can't fray, crack or rot.
3. Low moisture absorption.
4. Greater mechanical strength.
5. Higher abrasion resistance.
6. Flexible over wide temperature range.
7. High chemical resistance.
8. Wide range of permanent, gem-like colors.
9. Non-combustible.
10. Lasting appearance.



Over 90% OF NEW MOBILE TRANSMITTER DESIGNS USE HYTRON

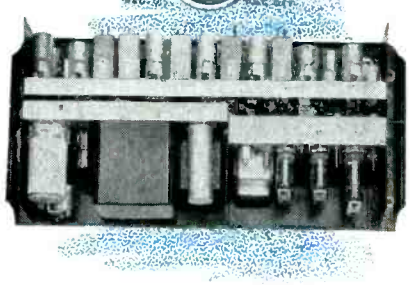
THE ORIGINAL INSTANT-HEATING TUBE



HY69 — the original instant-heating tube.

Because they fill a real need for conserving filament power, Hytron instant-heating tubes are in. Yes, the 2E25, 2E30, HY69, HY1269, and 5516 are in the new mobile transmitter designs of many famous friends—too many to thank in this small space. The 2E25 and 2E30 also appear on the Army-Navy Preferred List. Why so popular? With no standby current, battery drain can be cut to 4% of that with cathode types—attainable power output and range increase. Potentials of rugged filaments are centered for battery operation. Beam pentode versatility simplifies the spares problem—one type can power all stages. Join the leaders. If you build mobile equipment—for land, sea, air—put Hytron original instant-heating, easy-on-the-battery tubes on *your* preferred list.

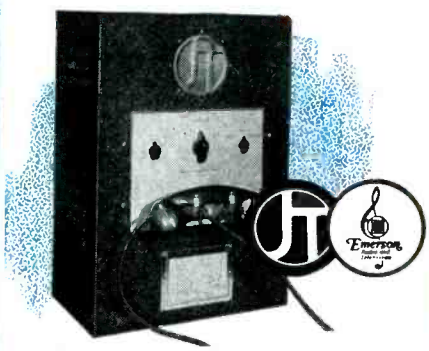
BENDIX RADIO



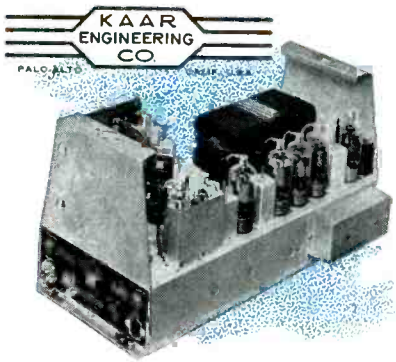
Bendix MRT-3A, 152-162 mc f-m taxicab transmitter uses 2E30's generously.

Federal's 25-watt, vhf Model FMTR-25-VC. Note emphasis on 2E30 and 5516.

Harvey Laboratories chose 2E30's, 5516's for its Model 542 f-m transmitter.



Jefferson-Travis Model 351, 35-watt marine radio-telephone employs HY69's.



Kaar FM-50X features 2E25, HY69 throughout. Hytron instant-heating tubes since 1939.

5516's power both driver-doubler and final of Motorola's Model FMTRU-30D.

WRITE FOR FREE NEW DATA SHEETS: 2E25, 2E30, HY69, HY1269, 5516.

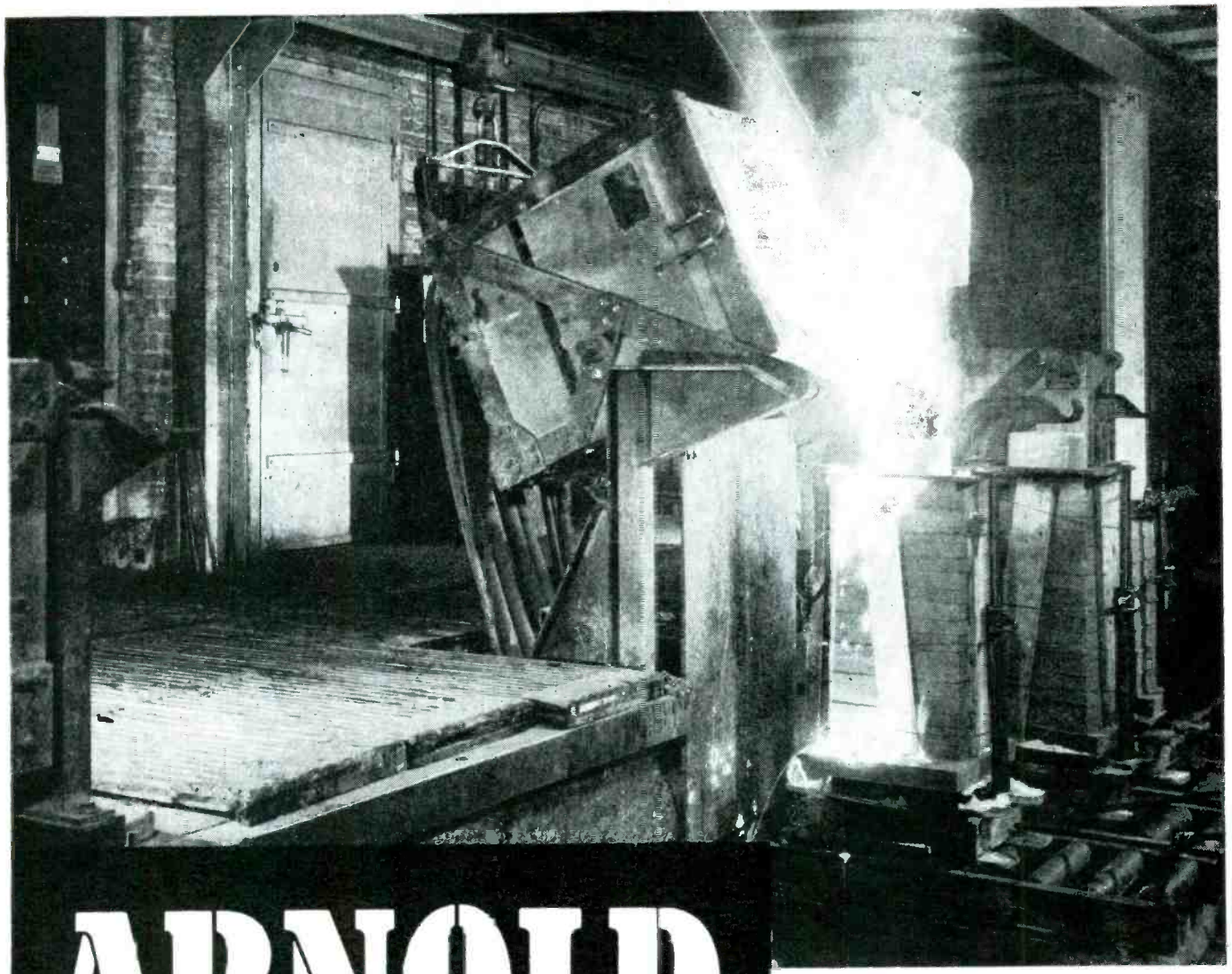
SPECIALISTS IN RADIO RECEIVING TUBES SINCE 1921

HYTRON

RADIO AND ELECTRONICS CORP.

MAIN OFFICE: SALEM, MASSACHUSETTS

HYTRON RADIO TUBES



ARNOLD PERMANENT MAGNETS

100% quality-controlled at every step from the design board to final assembly

The increased efficiency and economy you'll realize in the use of Arnold Permanent Magnets are *constant* factors. The thousandth unit is exactly like the first—because they're produced under controlled conditions at every step of manufacture, to bring you complete uniformity in every magnetic and physical characteristic. Count on Arnold Products to do your magnet job *best*—and they're available in any grade of material, size, shape, or degree of finish you require. Write us direct, or check with any Allegheny Ludlum field representative.

W&D 1297

THE ARNOLD ENGINEERING CO.

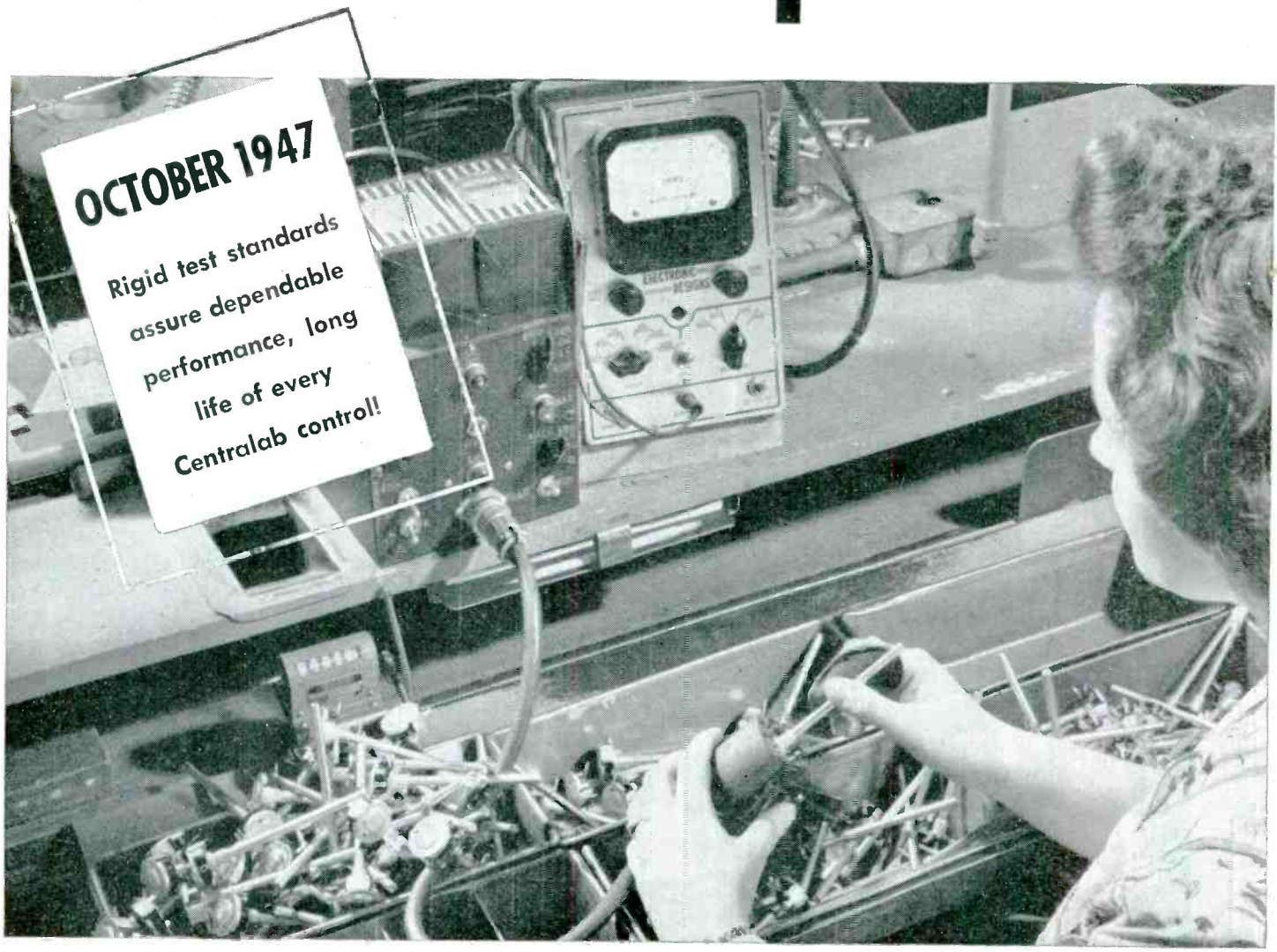
Subsidiary of

ALLEGHENY LUDLUM STEEL CORPORATION

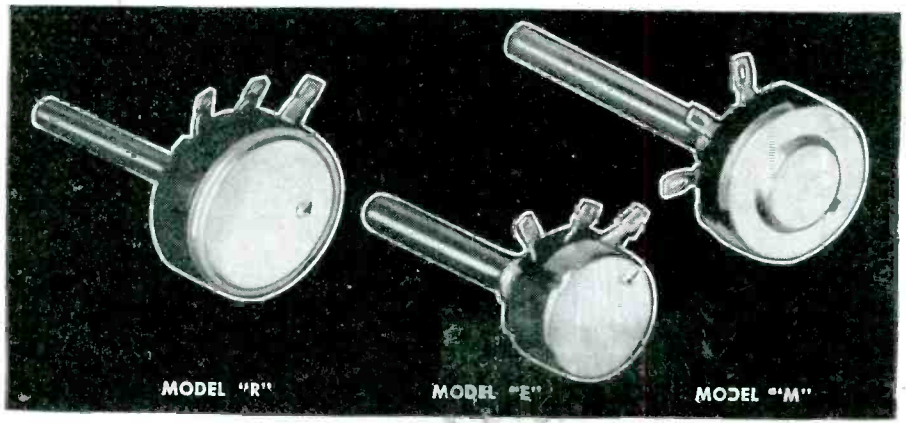
147 East Ontario Street, Chicago 11, Illinois

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

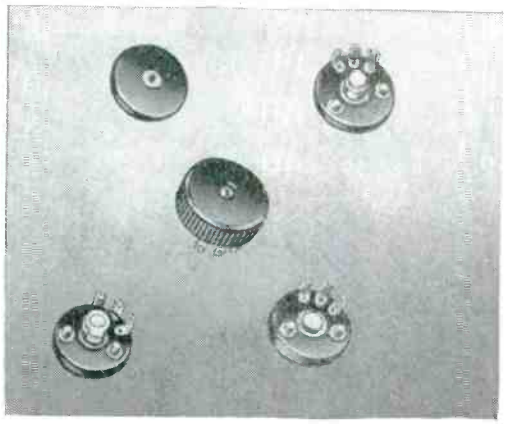
Centralab reports to



1 100% electrical test for continuity and "shorts" completes Centralab's program of tests for each control before it is shipped. This includes testing for resistance at various degrees of rotation, taper, noise, mechanical dimensions, etc. It's the reason why Centralab controls assure you accurate ratings, precision workmanship, trouble-free installation, long field service life — above and beyond your specification requirements. But that's not all . . .



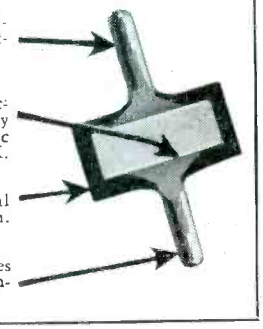
2 CRL's complete Radiohm line offers wide range of variations for special needs: *Model "R"* — wire wound, 3 watts; or composition type, 1 watt. *Model "E"* — composition type, ¼ watt. Direct contact, 6 resistance tapers. *Model "M"* — composition type, ½ watt. Write for Bulletin 697.



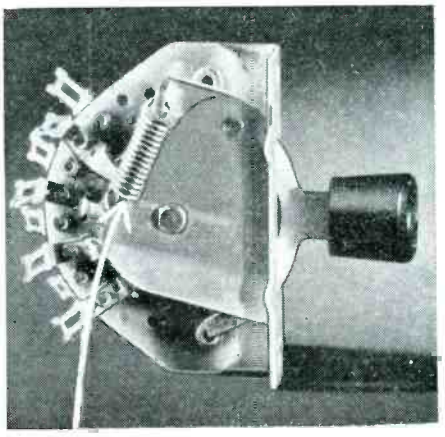
3 Here's Centralab's newest control for miniature receivers, amplifiers. No bigger than a dime, high quality performance is assured.

Electronic Industry

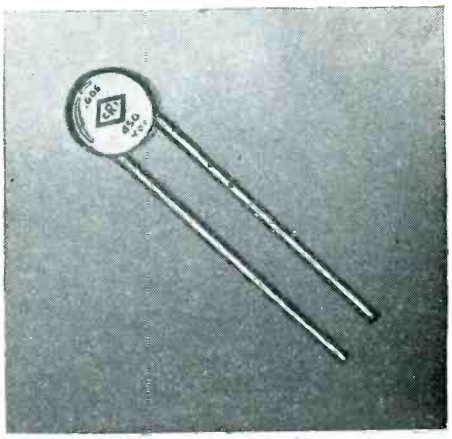
Cutaway view shows integral ceramic construction



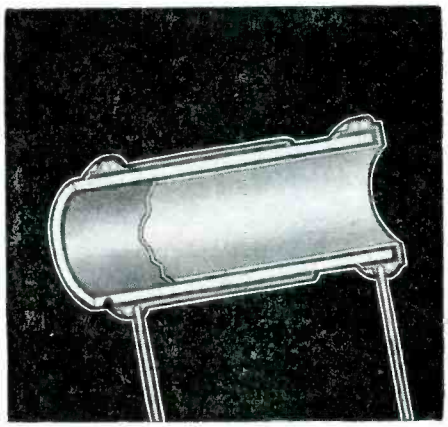
4 CRL *Hi-Vo-Kaps* combine high voltage and small size for television applications. For use as filter and by-pass capacitors in video amplifiers.



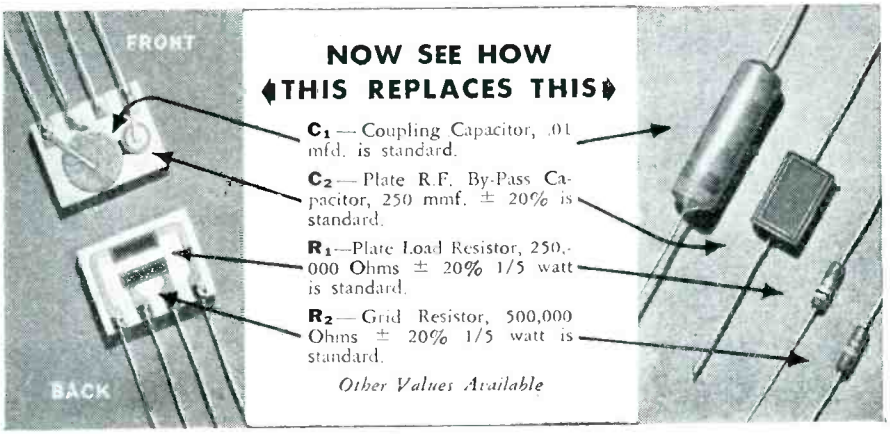
5 Revolutionary, CRL *Lever Switch* features exclusive coil spring design. Guaranteed minimum life of 50,000 cycles. Write for Bulletin 970.



6 For utmost reliability in small physical size, low mass weight, use CRL *Hi-Kaps* — miniature ceramic disc capacitors. Write for Bulletin 933.



7 The recognized dependability and high quality of Centralab's ceramic capacitor line is now available in quantities for quick delivery.



8 First commercial application of the "printed circuit", CRL's new *Couplate* offers a complete interstage coupling circuit consisting of an integral assembly of *Hi-Kap* capacitors and resistors closely bonded to a steatite ceramic plate and mutually connected by metallic silver paths "printed" on the base plate.

Look to Centralab in 1947! ***First in component research that means lower costs for 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.

New! UNITIZED amplifier systems for recording

with plug in flexibility

Flexibility is the outstanding advantage of the *new* Fairchild Unitized Amplifier System. It includes 13 basic components which can be assembled in an endless number of combinations to meet the standard, special and changing recording requirements of schools, broadcasting and the professional recording industry. Related units are simply plugged in or cabled together. It's that easy . . . that quick!

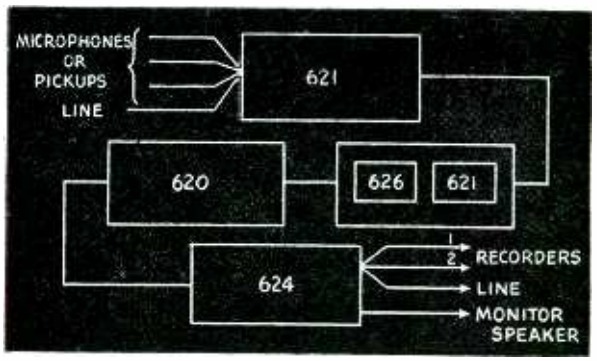
Fairchild's Unitized Amplifier System now makes it practical and economical to build highly individualized audio systems to satisfy all of the varied and changing requirements of the individual recording engineer. Further, the flexibility of the Fairchild system permits the units to be rearranged or the system to be expanded at will without obsoleting a single component.

Fairchild's 13 basic components have been especially designed by *recording* engineers to meet the specific requirements of the various types of *recording* systems.

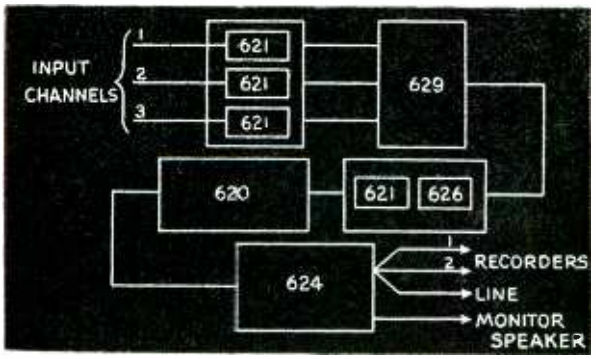
Unit 620 — Power Amplifier	Unit 626 — NAB Equalizer
Unit 621 — Microphone Preamplifier	Unit 627 — Variable Equalizer
Unit 622 — Pickup Preamplifier Equalizer	Unit 628 — Diameter Equalizer
	Unit 629 — Mixer
Unit 623 — Line Amplifier	Unit 630 — VI Panel
Unit 624 — Output Switch Panel	Unit 631 — Bridging Device
Unit 625 — Input Switch Panel	Unit 632 — Auxiliary Power Supply

Study the typical setups shown on this page. Then set down your own requirements . . . select the basic units you'll need . . . assemble them for convenient panel board operation . . . or let us do it for you. How will your specific amplifier system perform? Professionally! Like all Fairchild Sound Equipment—it keeps the original sound alive. Precisionized mechanical and electronic skill is the precise reason.

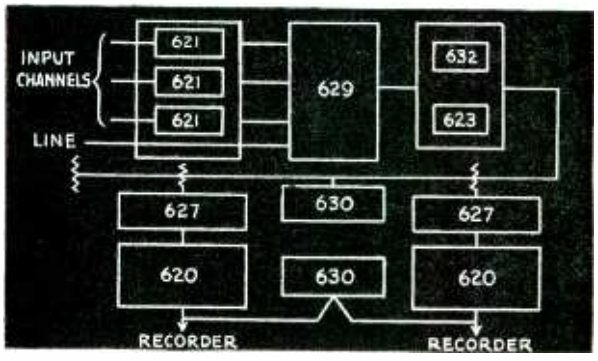
Want more details? Address: 88-06 Van Wyck Boulevard, Jamaica 1, New York.



Single Channel Systems: for recording from a microphone or record or playing back from a pickup.



Multiple Channel Systems: for recording simultaneously through multiple input channels in conjunction with a mixer.



Dual Recording Channels: for recording simultaneously on two machines through dual channels with separate variable equalizers.

Fairchild CAMERA AND INSTRUMENT CORPORATION

SOUND EQUIPMENT

MAKERS OF: TRANSCRIPTION TURNTABLES, STUDIO RECORDERS, MAGNETIC CUTTERHEADS, PORTABLE RECORDERS AND LATERAL DYNAMIC PICKUPS

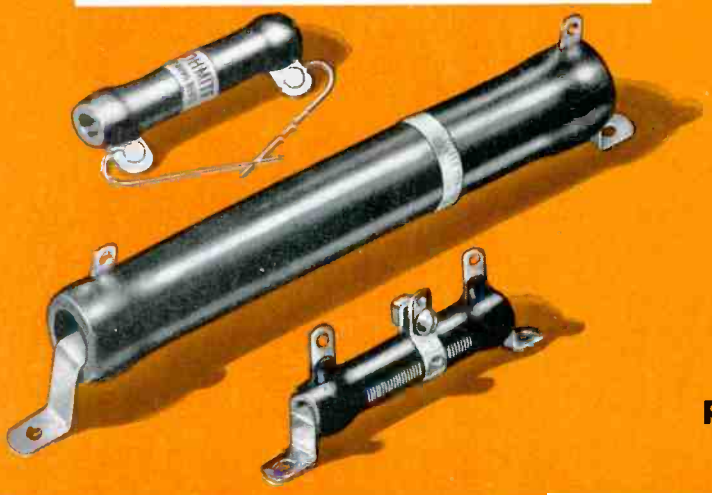
COULOMB ...FIRST to establish major laws in electrostatics

Charles Augustin Coulomb (1736-1806)

Coulomb, a French military engineer engaged in research, invented the torsion balance with which he measured the forces of attraction and repulsion of electrically charged balls and of steel magnets, from which he established laws of electrostatics and magnetism. Today, the unit of electrical quantity bears his name.

From an Original Drawing made for OHMITE

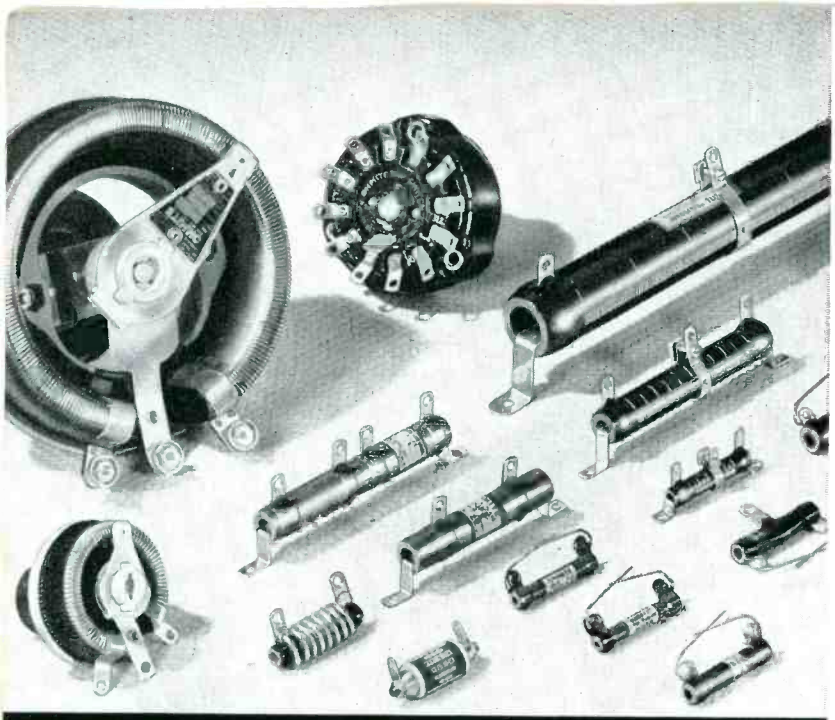
OHMITE ...FIRST in Wire-Wound Resistors...today



Ohmite offers the most complete line of wire-wound resistors on the market today. These Ohmite resistors have become known for their dependability...their unfailing performance under adverse operating conditions. For *extra* dependability...specify Ohmite resistors—industry's first choice.

Be Right with **OHMITE**

RHEOSTATS • RESISTORS • TAP SWITCHES



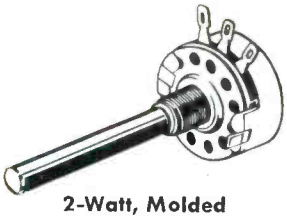
Ohmite Rheostats

Resistors, Tap Switches

Available From Stock

at your Ohmite Distributor

FIVE NEW OHMITE ITEMS



2-Watt, Molded CompositionPotentiometer

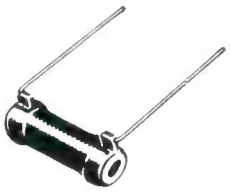
Now—a 2-watt unit with a good margin of safety for industrial use. Withstands heat, cold, moisture, and severe service. *Sold only through Ohmite distributors.*

± 5% Tolerance Composition Resistors

Now, "Little Devil" resistors in ½ and 1-watt sizes in ±5% tolerance. Also ½, 1, and 2-watt sizes in ±10%. *Available only through Ohmite distributors.*

RB-2 Direction Indicator Potentiometer

A compact, low-cost unit used with a 6-volt battery and ordinary 0-1 milliammeter to indicate, remotely, the position of a rotary-beam antenna or other device.



5-Watt Wire-Wound Resistors

Rugged, vitreous-enameled "Brown Devil" resistors in a compact, 5-watt size. Values from 1 to 10,000 ohms. Tolerance ±10%.

High-Frequency Plate Chokes

Single-layer wound on low-power factor bakelite cores. Moisture-proof coating. Four stock sizes, 50 mc. to 460 mc. Rated 1000 ma.

You can get immediate delivery on reasonable quantities of Ohmite products . . . rheostats, resistors, tap switches, and other items . . . from your local Ohmite distributor. He carries a complete stock of standard Ohmite items. Call on him when you need moderate quantities for experimental work or small production runs. He is organized to give the industrial user prompt delivery on all items listed in the Ohmite Stock Catalog No. 19.

Write for the name and address of the Ohmite distributor that serves your territory. It will pay you to become acquainted with him.

Write For Stock Unit Catalog No. 19

Be Right with . . .

OHMITE

RHEOSTATS • RESISTORS

TAP SWITCHES

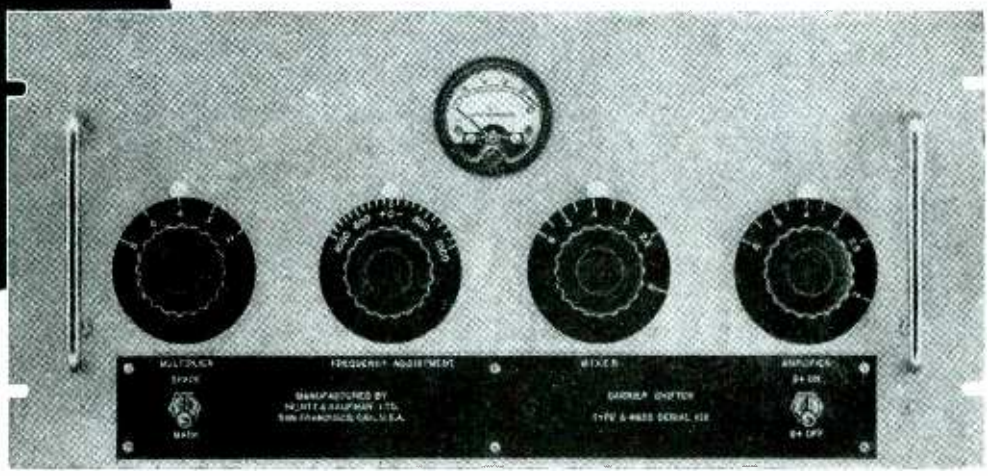
Industry's First Choice

OHMITE MANUFACTURING CO.

4817 Flournoy Street, Chicago 44, Illinois

Announcing HEINTZ AND KAUFMAN FREQUENCY SHIFT EXCITER

Another unit in the Heintz and Kaufman line of FS equipment which assures improved communications



Frequency shift communication systems require use of a transmitter exciter which will shift the carrier around a center frequency. Shifts normally used vary from 600 to 850 cycles between mark and space frequencies. The frequency shift keyer replaces the usual crystal oscillator stage in the transmitter.

The H&K Type A-4625 is a frequency shift exciter designed for this purpose. The output of a 200 k. c. stabilized oscillator is mixed with the output of a crystal oscillator which operates in the 2 to 6 megacycle band. The highest frequency derived from this mixing operation is selected, amplified.

A reactance tube and keyer tube are provided for obtainance of frequency shift. The reactance tube shunts the 200 k. c. oscillator circuit and is so arranged that keying voltages applied to the grid of the keyer tube cause changes in oscillator frequency in accordance with the telegraphic impulses transmitted.

TUNING CONTROLS

The unit is designed for maximum ease of operator adjustment. A control is provided for small variations in output carrier (center) frequency. Adjustments of 1000 cycles at the shifter output frequency can be made with this control. A calibrated shift spread control is also furnished which establishes the amount of shift required at the fundamental frequency. The relationship between extremes of shift is not changed by adjustment of the carrier center output frequency. Mixer plate and amplifier plate circuits are tuned by calibrated panel dials. A test switch for the purpose of establishing mark and space frequencies is provided to permit placing the unit on assigned frequency and then adjusting the desired amount of frequency shift.

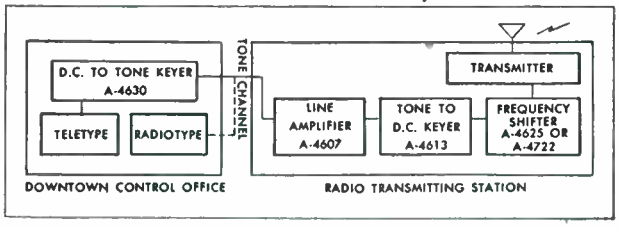
POWER SUPPLY

A separate power supply of heavy duty construction is included with the shifter exciter. It is capable of providing 200 ma. at 300 volts together with required filament voltage of 6.3 volts.

PHYSICAL DESIGN

The shifter and power supply are constructed on separate 2″x 8″x 17″ chassis with 8¾″x 19″ panels. The units may be installed in a standard 19″ relay rack or cabinet. Chassis are chrome plated steel or anodized aluminum. Panels are finished in platinum grey crackle.

Frequency Shift Exciter in Transmitting System



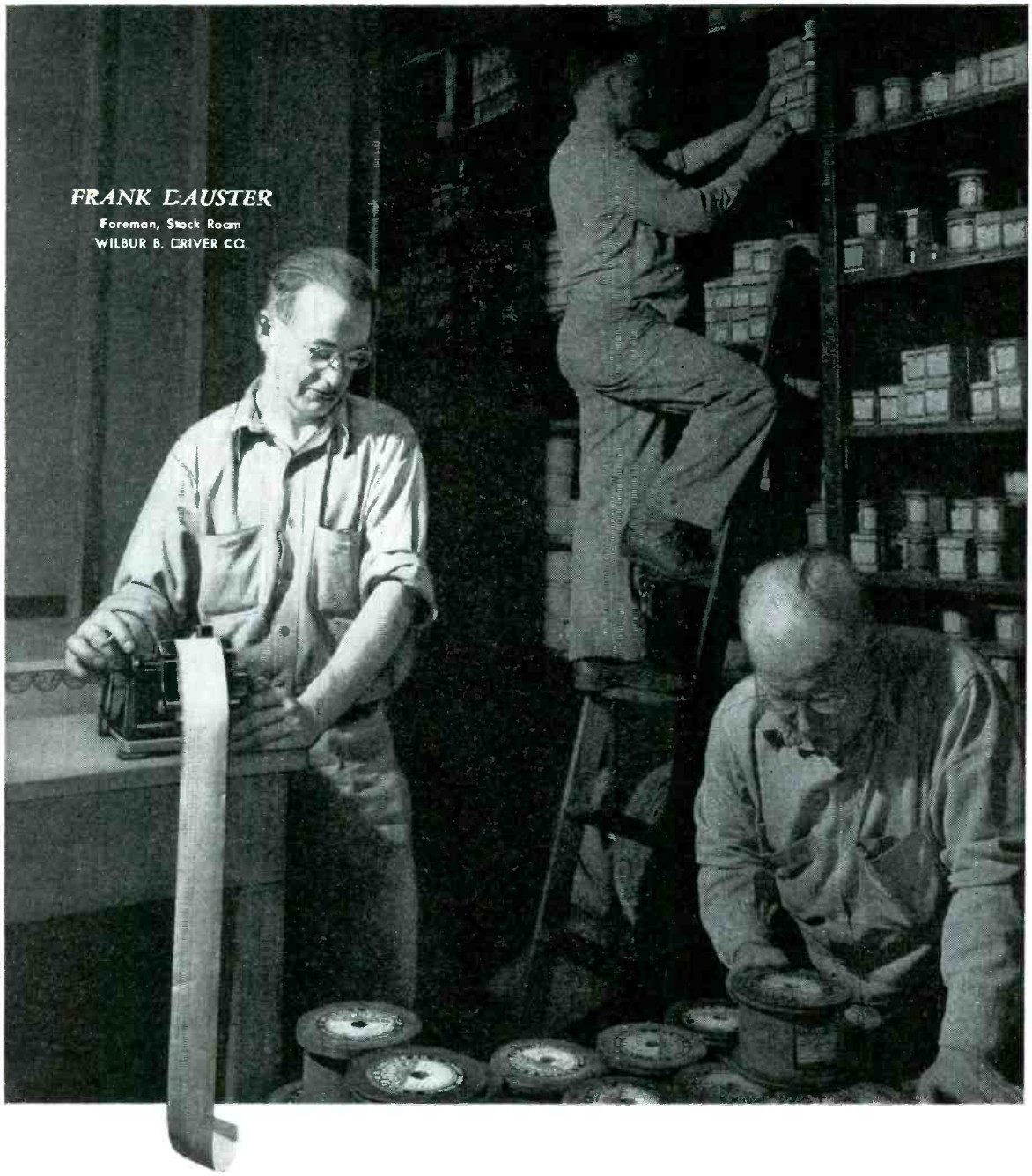
Write for detailed information. We make a complete line of FS equipment. Our Engineering Department will be glad to correspond with you about your requirements.

HEINTZ AND KAUFMAN, LTD.

COMMUNICATIONS EQUIPMENT DIVISION · 50 DRUMM ST. · SAN FRANCISCO 11 · CALIF.

Gammatron Tube Division · Lynden Avenue · South San Francisco

EXPORT AGENTS: M. Simons & Sons Co., 25 Warren Street, New York City · Cable Simontrice, Newyork



A "yes man" by his own choosing!

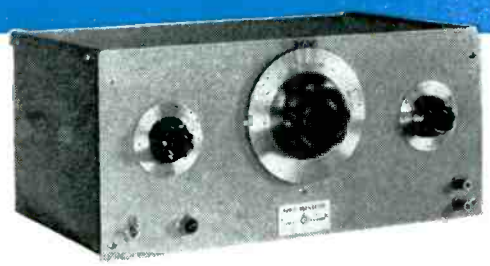
Twenty-eight years of experience in drawing, annealing and inspecting resistance wire for Wilbur B. Driver Co., have taught Frank Dauster many things. He knows what constitutes quality, and he knows how to inject it into customers' specifications.

Frank considers himself a "yes man" because "yes" has been his answer even when customers' specifications have appeared impossible to meet.

A tribute to this kind of resourcefulness is the fact that, even with today's shortages, Frank stamps "Materials in Stock" on a majority of incoming orders—proof indeed that research and production have kept the pace.

WILBUR B. DRIVER CO.

150 RIVERSIDE AVE., NEWARK 4, NEW JERSEY



200 SERIES AUDIO OSCILLATORS

Available in six standard models. *-hp-* 200A and *-hp-* 200B have transformer-coupled output delivering 1 watt into matched load. Primarily designed for audio testing. *-hp-* 200C and *-hp-* 200D have resistance-coupled output and supply constant voltage over wide frequency range. The *-hp-* 202D is a modification of the 200D, extending frequency downward to 2 cps. *-hp-* 200I is a spread-scale oscillator designed for interpolation work and for applications where oscillation frequency must be known with utmost accuracy.

202B LOW FREQUENCY OSCILLATOR

Specially designed for work between ½ cps and 1000 cps. Provides excellent wave form, good stability, split-hair measuring accuracy in the very low frequencies. Ideal for vibration or stability checks on mechanical systems, for testing geophysical, electro-cardiograph or electro-encephalograph equipment, checking response of seismographs, or electrical simulation of mechanical phenomena.

Resistance-Tuned Oscillators ...For Every Measuring Job 1/2 cps to 10 mc!

From A to Z in measuring, there's an *-hp-* resistance-tuned oscillator engineered to fit your exact need. Nine precision oscillators in all...and each bears the famed *-hp-* family characteristics of no zero set, constant output, low distortion, great stability, and decade tuning. Brief data on these *-hp-* oscillators are given here. For complete details, write or wire today!

HEWLETT-PACKARD COMPANY
1508A PAGE MILL ROAD • PALO ALTO, CALIFORNIA

201B AUDIO OSCILLATOR

Meets every requirement for speed, accuracy, wave form purity and ease of operation in FM and other fields where high fidelity is most important. Provides 3 watts output into a 600 ohm resistive load. Distortion held to 1% or less, at 3 watts, ½% at 1 watt output. Excels in testing high fidelity amplifiers, speakers, and in comparing frequencies.

650A WIDE-BAND OSCILLATOR

Continuous frequency coverage, 10 cps to 10 mc. Highly stable, versatile. Output flat within 1 db throughout frequency range. Available voltages range from .00003 to 3 v. Other advantages include 94" scale length, 6 to 1 micro-controlled tuning drive, 50 db output attenuator variable in 10 db steps, output voltage divider providing 6 ohm internal impedance (reducing output voltage 100 to 1).

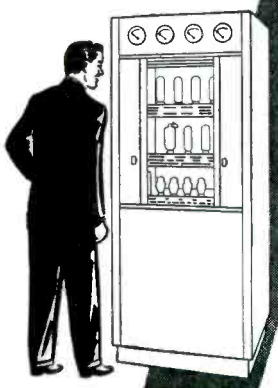
BRIEF SPECIFICATIONS

Instrument	Freq. Range	Output	Distortion	Freq. Response
-hp- 200A	35 cps to 35 kc	1 watt/22.5v	Less than 1%	±1 db to 15 kc
-hp- 200B	20 cps to 20 kc	1 watt/22.5v	Less than 1%	±1 db to 15 kc
-hp- 200C	20 cps to 200 kc	100 mw/10v	Less than 1% to 20 kc	±1 db to 150 kc
-hp- 200D	7 cps to 70 kc	100 mw/10v	Less than 1% 10 cps to 20 kc	±1 db throughout range
-hp- 202D	2 cps to 70 kc	100 mw/10v	Less than 2% 10 cps to 70 kc	±1 db, 7 cps to 70 kc
-hp- 200I	6 cps to 6 kc	100 mw/10v	Less than 1% above 10 cps	±1 db, 6 to 6000 cps
-hp- 202B	½ cps to 1000 cps	100 mw/10v	Less than 1% 1 to 1000 cps	±1 db, 10 to 1000 cps
-hp- 201B	20 to 20,000 cps	3 w/42.5v	Less than 1%	±1 db throughout range
-hp- 650A	10 cps to 10 mc	15 mw/3v	Less than 1% 100 cps to 100 kc	±1 db throughout range

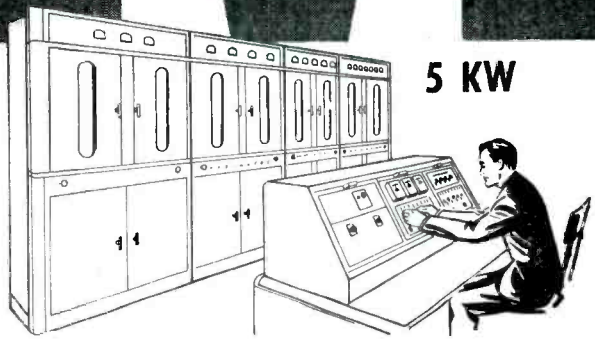
hp laboratory instruments
FOR SPEED AND ACCURACY

AM

250 WATTS



1 KW



5 KW

Your money's worth and MORE!

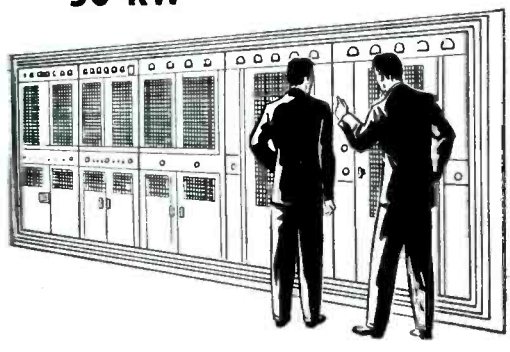
. . . in every power range

Through the years, the experience of hundreds of stations from coast to coast has proved that you get the most for your money in Western Electric transmitters.

You get outstanding design by Bell Laboratories — top quality performance — dependability — and rock bottom operating cost.

You will want these things in *your* new AM transmitter. Get full details from your local Graybar Broadcast Representative or write to Graybar Electric Co., 420 Lexington Ave., New York 17, N. Y.

50 KW



Western Electric

—QUALITY COUNTS—

Distributed by GRAYBAR — OFFICES IN 91 PRINCIPAL CITIES

● No. 3 of a series on Theory and Application of Electrical Insulation

Familiarity with Breakdown Theories Is

The prevention of dielectric breakdown offers a real challenge to product designers and manufacturers of electrical equipment. Three major theories have been advanced to establish causes responsible for dielectric breakdown. These are the thermal theory, ionic theory and disruptive theory.

THERMAL THEORY

Fig. 1-a

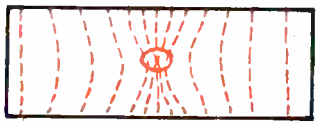


Fig. 1-b

Fig. 1-c

The most generally accepted thermal theory, introduced by Wagner[1], is based on the premise that all solid dielectrics are somewhat heterogeneous. The author points out that some spots, layers, or filaments of dielectrics are lower in resistance than others.

It is his contention, therefore, that the current distribution over a given specimen is not uniform when potential is applied. The weak portion carries more current, energy is released and the spot heated up as indicated in Fig. 1-a. If the insulation or the electrodes are capable of conducting the heat away fast enough, the condition is stable and no failure occurs. But if, on the other hand, the heat is removed too slowly, the weak spots grow hotter and, consequently, lower in resistance, Fig. 1-b, since most materials have a negative temperature coefficient of resistance. This continues until thermal instability results, followed by insulation breakdown (Fig. 1-c).

[1] *"Physical Nature of Breakdown of Solid Dielectrics," A.I.E.E., Vol. 41, 1922.*

IONIC THEORY

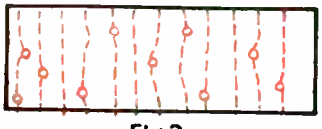


Fig. 2-a

Fig. 2-b

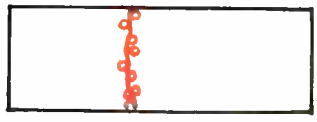


Fig. 2-c

To visualize the ionic theory of insulation breakdown, one can imagine a solid dielectric as an electrolyte in which ions move about to produce a current. This ionization is believed to result from collision or chemical action caused by the field voltage. In either case, as the potential is increased, the fast-moving ions will (1) dissipate energy, and (2) produce other ions. The small circles shown in Fig. 2-a represent regions of local breakdown formed by the dissociation of dielectric molecules. Figure 2-b illustrates that with still higher fields, ions are formed at an increasing rate until instability and eventual insulation failure occur (Fig. 2-c).

DISRUPTIVE THEORY

Fig. 3-a

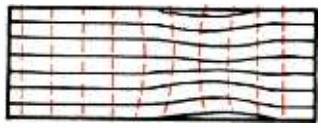


Fig. 3-b

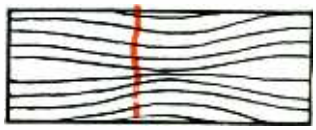


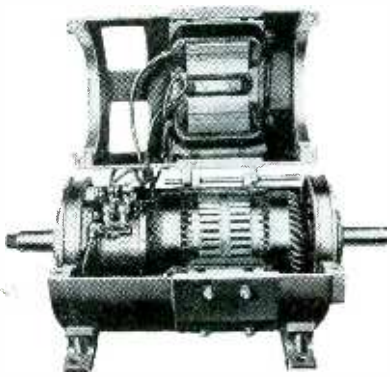
Fig. 3-c

The appeal of the disruptive theory lies in its analogy to mechanical phenomena. We imagine electric breakdown to be a sort of rupture and destruction of molecular and other bonds in the material. Considerable evidence is available to support the disruptive explanation; for example, we know the breakdown of thin specimens and dielectrics at low temperatures cannot be explained by the thermal or ionic theories. The effect of mechanical stress on electrical breakdown gives further support to this theory; investigations have shown that mechanical stresses approaching the elastic limit may reduce the electrical breakdown strength to as little as 10 percent of its normal value. Figures 3-a, 3-b and 3-c show that the lines of electrical force become progressively concentrated on the portion of the dielectric which is under the greatest mechanical stress, thus leading to breakdown.

Helpful in Selecting the Right Dielectric

APPLICATIONS OF DIELECTRIC BREAKDOWN THEORIES

According to the foregoing theories of dielectric breakdown, an insulating material that is to give best service should be, generally speaking, homogeneous in structure, have high physical and dielectric strengths, and be able to withstand high operating temperatures. The insulation used in many household utensil devices and similar electrical heating appliances serves as a fine example of the importance of understanding the theoretical factors affecting insulation behavior.

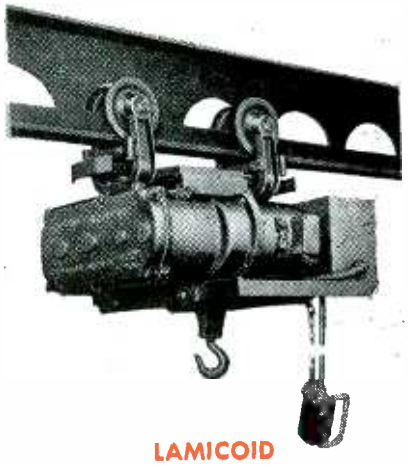


EMPIRE

varnished cloths and tapes, carefully selected to facilitate uniform impregnation, are made from highest quality canvas, duck, silk, rayon and fine cambrics. Special yellow and black varnishes are chosen for their ability to impregnate these materials and to provide a smooth surface. Used widely in armature, stator, field, transformer and regulator coils, terminal leads, high tension cable splices, and busbar insulation.

MICANITE AND SUPER MICANITE

(built-up mica) are made from several different grades of thin mica splittings bonded with various resins. When made with organic bond, which is volatilized during heating, it is popular in electric furnaces and flatirons, where the heating element is never disturbed. Micanite with inorganic binder, which will not burn away, is suitable for unsupported heating elements in toasters, surface heaters and similar products.



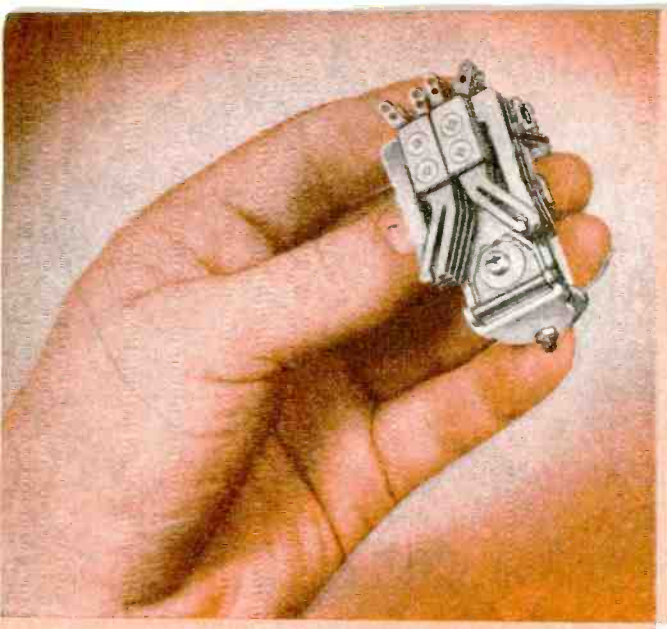
LAMICOID

a dense, uniform, thermosetting laminated plastic—is produced with a wide variety of fillers, depending upon the properties desired in the end product. Popular hoist motors, which need added protection from burn-out since they are frequently operated beyond normal capacity, rely on Lamicoid slot sticks in the armature and Lamicoid brush rigging for adequate overload protection and long, trouble-free operation.

Mica Insulator Company offers the electrical industry a single source of supply for a complete line of electrical insulation. The company is also a headquarters for insulation information, based on over 50 years' experience in this field. If you have an insulation problem, consult our technical service department—they will gladly help you select the material best suited to your particular application.

Insulator COMPANY
SCHENECTADY 1, NEW YORK
Atlanta • Birmingham • Boston • Chicago • Cincinnati • Cleveland • Detroit • Houston
Los Angeles • Milwaukee • New York • Philadelphia • Rochester • St. Louis • San Francisco

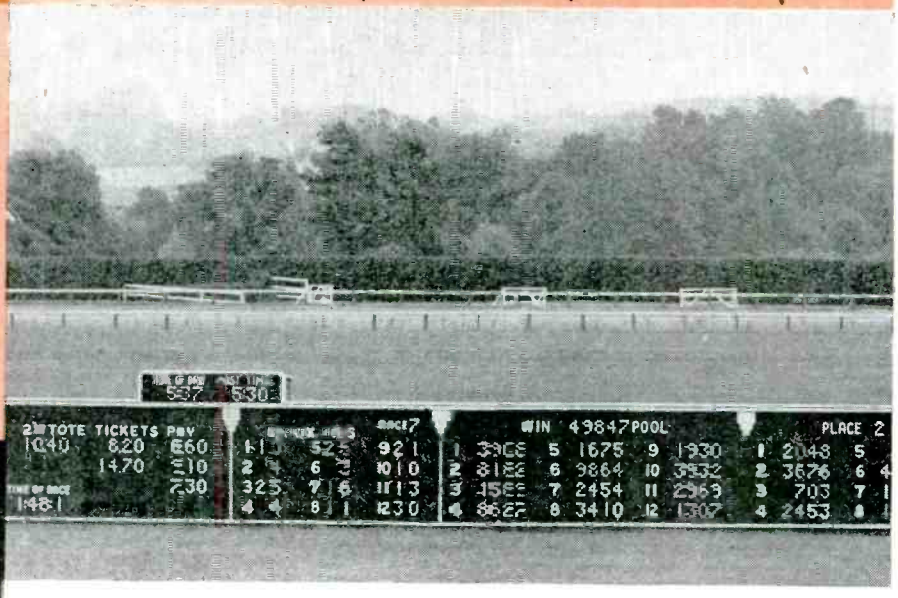
MICO
ELECTRICAL
INSULATION
Trade mark



Why the American *Can't Afford* and How it

Clare Relays and Stepping Operation of Race-

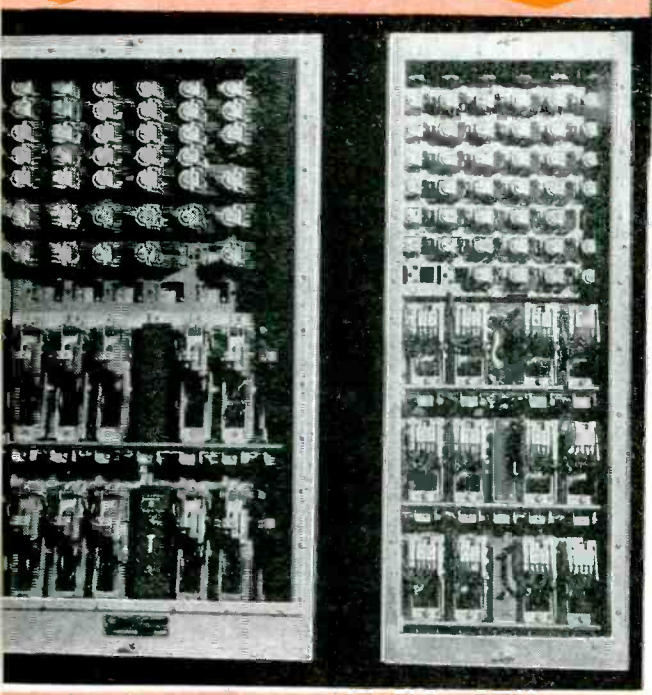
Clare Type "J" d-c Relays are distinctive for small size and twin flexible contact fingers which reduce chance of circuit failures as one contact is sure to close even when the other may be blocked by presence of dirt or grit.



Grandstand view of infield indicator board. Each figure on the board is produced automatically by a nest of 24 lamps. Each nest is controlled by five Clare Relays, which enable any digit

OLD

NEW



This highly intricate and accurate electrical machine, owned and operated by American Totalisator Company, Inc., of Baltimore, acts as a gigantic cash register to facilitate, simplify, and audit pari-mutuel wagering at some 57 racing plants, from coast to coast.

Because the American Totalisator registers and totalizes unlimited sums of money every day, and its owners *guarantee its accuracy* and assume all risks, operational errors would be so costly, that they simply can't be tolerated.

American Totalisator Company's choice of Clare relays and stepping switches for this, the most exacting day-in-day-out service to which relays have ever been subjected, is highest evidence of their unfailing accuracy and their staying power.

In the latest model of the American Totalisator, inaugurated at Delaware Park in May—there are 45 Clare Type "J" Relays and 12 Clare Stepping Switches in each

Reduces Size and Weight

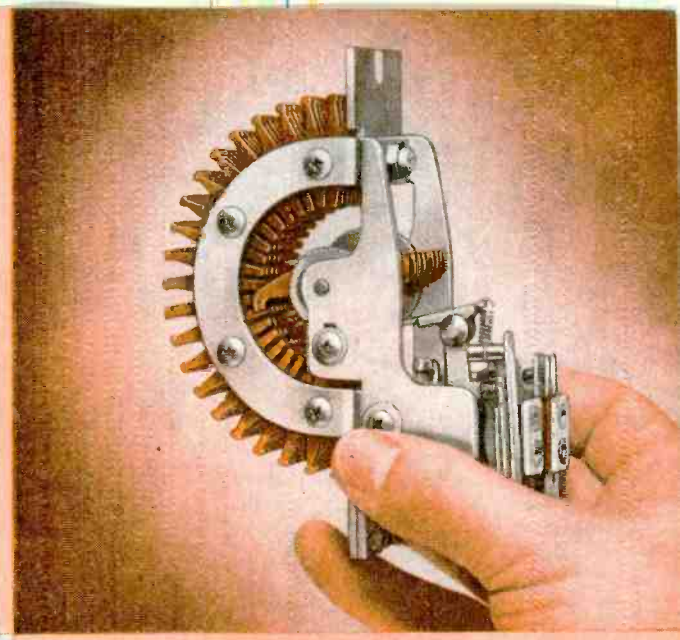
Photograph shows how use of small Clare Type "J" Relays permits size and weight of Totalisator adding machine unit to be reduced. (New unit weighs only half as much.) Each of these thirty-nine such units uses 45 Clare Relays and 12 Clare Stepping Switches to register Win, Place, or Show wagers for one of 12 runners in a race.

CLARE

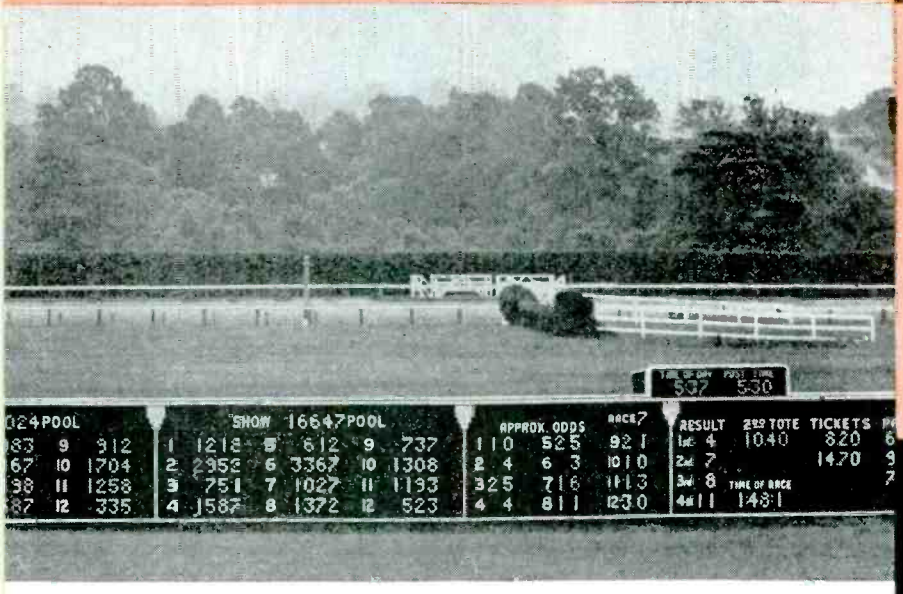
"Custom-Built" Multiple Contact Relays

Totalisator Company *Mistakes* Avoids Them

Switches Insure Faultless track Totalisator



Clare Spring-Driven Stepping Switches will select any channel or circuit path out of 20 . . . or 40. In the Totalisator, they provide an accurate counter, with the initiation of impulses coming from the ticket-issuer keys.

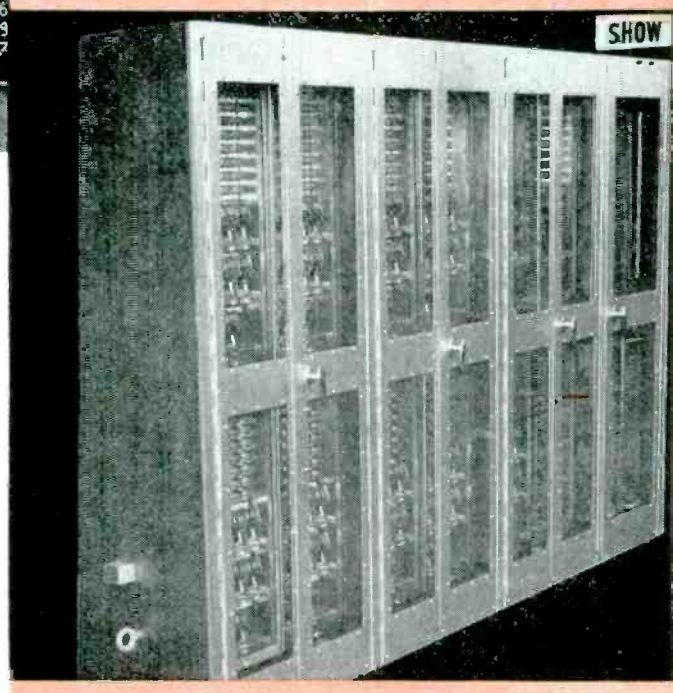


from 0 to 9 to be formed. Progressive totals and odds are flashed every 90 seconds. Payoff prices are displayed within five seconds after a race is declared official.

of the 39 runner and pool-total adding machines which constitute the heart and brain of this superlative example of inventive genius and engineering skill.

American Totalisator Company chose Clare Type "J" Relays for this new "Tote" for these excellent reasons: its extreme compactness makes possible great savings in size and weight; its fast action effects a striking increase in the operating speed and money-handling capacity of the "Tote Room" equipment; its distinctive twin flexible contact fingers remove all cause for worry about circuit failures resulting from dirty contacts.

Clare sales engineers are located near you to show you how Clare "custom-building" can give you just the relay you need for your most exacting requirements. Look in the classified directory of your telephone book or write: C. P. Clare & Co., 4719 West Sunnyside Avenue, Chicago 30, Ill. Cable Address: CLARELAY. *In Canada: Canadian Line Materials, Ltd., Toronto 13, Ontario.*



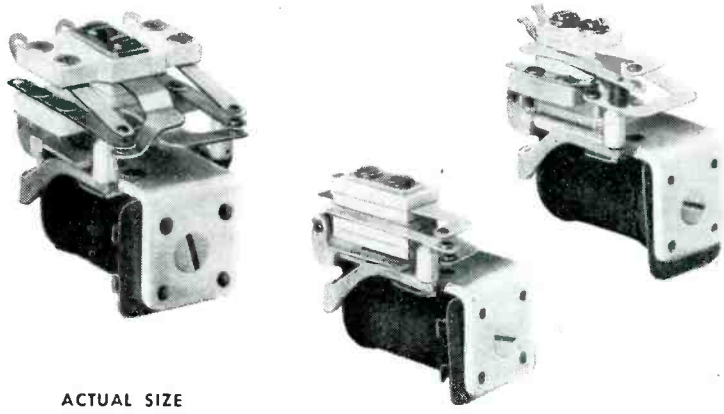
Use CLARE RELAYS for Tests

View of an adding machine bay for the Show pool (front). This bay contains the 12 runner adding machines, one pool-total adding machine, and various auxiliary equipment units. At the back (right) is the control panel and routine tester. Clare Relays in the routine tester automatically test every phase of operation.

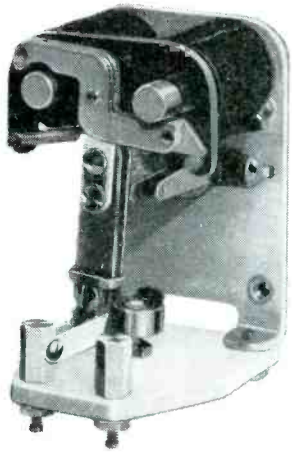
RELAYS

for Electrical, Electronic and Industrial Use

ARC miniature D.C. RELAYS with Steatite Insulation



ACTUAL SIZE



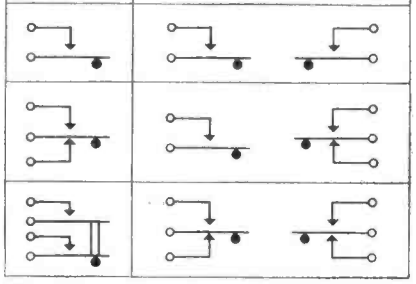
ANTENNA THROW-OVER

Originally designed for use in aircraft equipment, these MINIATURE relays give completely dependable operation under extreme conditions of vibration, humidity and temperature.

The Steatite insulation and general construction of these relays makes them inherently suitable for switching circuits requiring permanently low leakage, for switching certain high frequency circuits, and for any application where a compact, light weight, yet sturdy relay is required. Particular attention has been paid to design of relays that will not "chatter" under vibration even in the un-energized position.

The antenna throw-over relay shown is of unique design and provides the wide contact spacing and positive action necessary for this special purpose, for a weight of only 0.2 lb.

The other small relays are provided in the contact combinations illustrated at right, with maximum overall dimensions of 1¼" x ⅞" x 1⅜" and a maximum weight of 0.09 lb.

FOR EITHER 14 VOLT OR 28 VOLT D.C. OPERATION	
SINGLE ARM	DOUBLE ARM
	

Write on your letterhead for our Catalog describing these and our other Component Parts.

Aircraft Radio Corporation

DEPENDABLE ELECTRONIC EQUIPMENT SINCE 1928

Boonton, N. J.

When the makers of the Air-Way Sanitizor designed "the vacuum cleaner of tomorrow" they demanded extra insulation. The field core assembly in the pedestal-type base had to be protected against heat, vibration, and rough handling. To do this job, they selected Bentley, Harris Extra Flexible Fiberglas Sleeving. After more than a year's experience with this insulation here is what they reported:

"We use BH Extra Flexible Fiberglas Sleeving as extra insulation on the lead wire of the field core assembly. We consider this Sleeving very desirable from the standpoint of durability, insulating properties, and resistance to cracking and breakdown due to heat and other deteriorating factors."

If you are designing a new appliance or improving your present product, try BH Extra Flexible Fiberglas Sleeving. See its many production advantages in your plant, in your own product—under actual service conditions.

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-15 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:

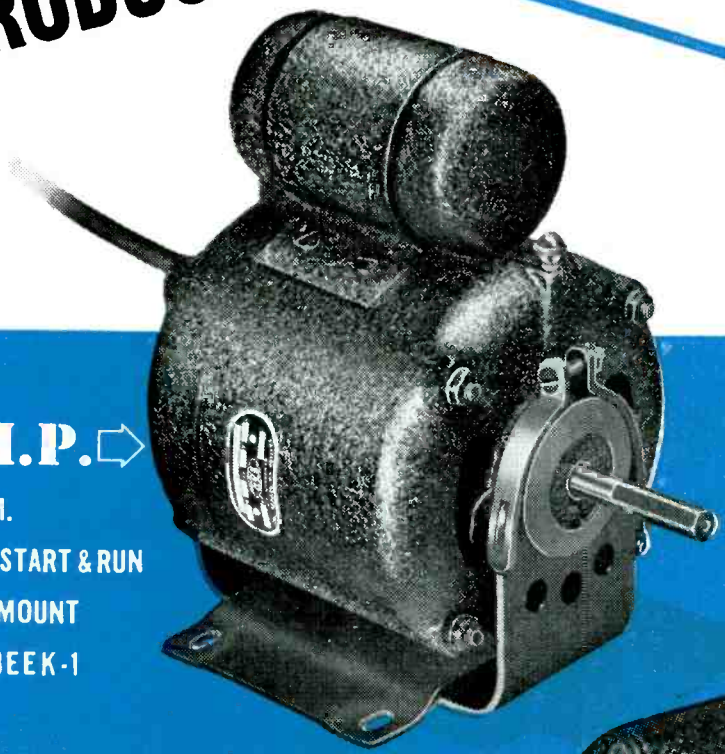
- ☐ Cotton-base Sleeving and Tubing
- ☐ Ben-Har Special Treated Fiberglas Tubing

IN PRODUCTION... PROMPT DELIVERY

93 FRAME

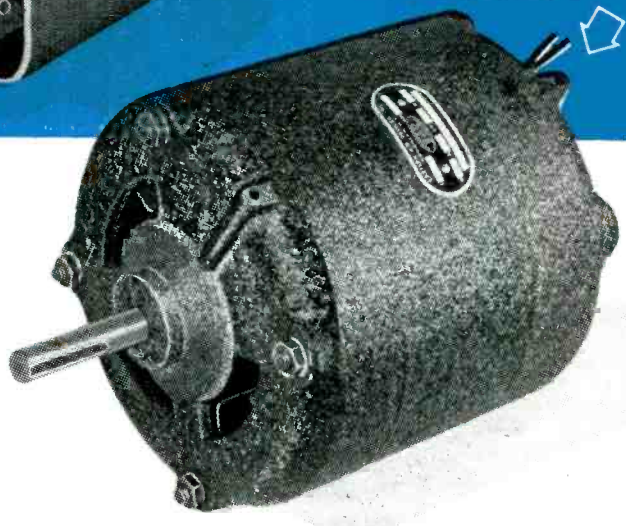
1/10 H.P.

1625 R. P. M.
CAPACITOR START & RUN
RESILIENT MOUNT
TYPE #B93EEK-1



1/15 H.P.

1550 R. P. M.
SHADED POLE
ROUND FRAME
TYPE #A93GLK-1



- AMPLE RESERVE POWER
- EXCEPTIONALLY COOL RUNNING
- EXTRA RUGGED CONSTRUCTION

Economically Priced • Designed to Give Top Performance

RIGID BASE • ROUND FRAME • RESILIENT MOUNT
Motors can be supplied with OVERLOAD PROTECTION, CONDUIT BOX, and other Optional Equipment.

Write for . . .
Technical Data
Outline Drawings
Performance Curves

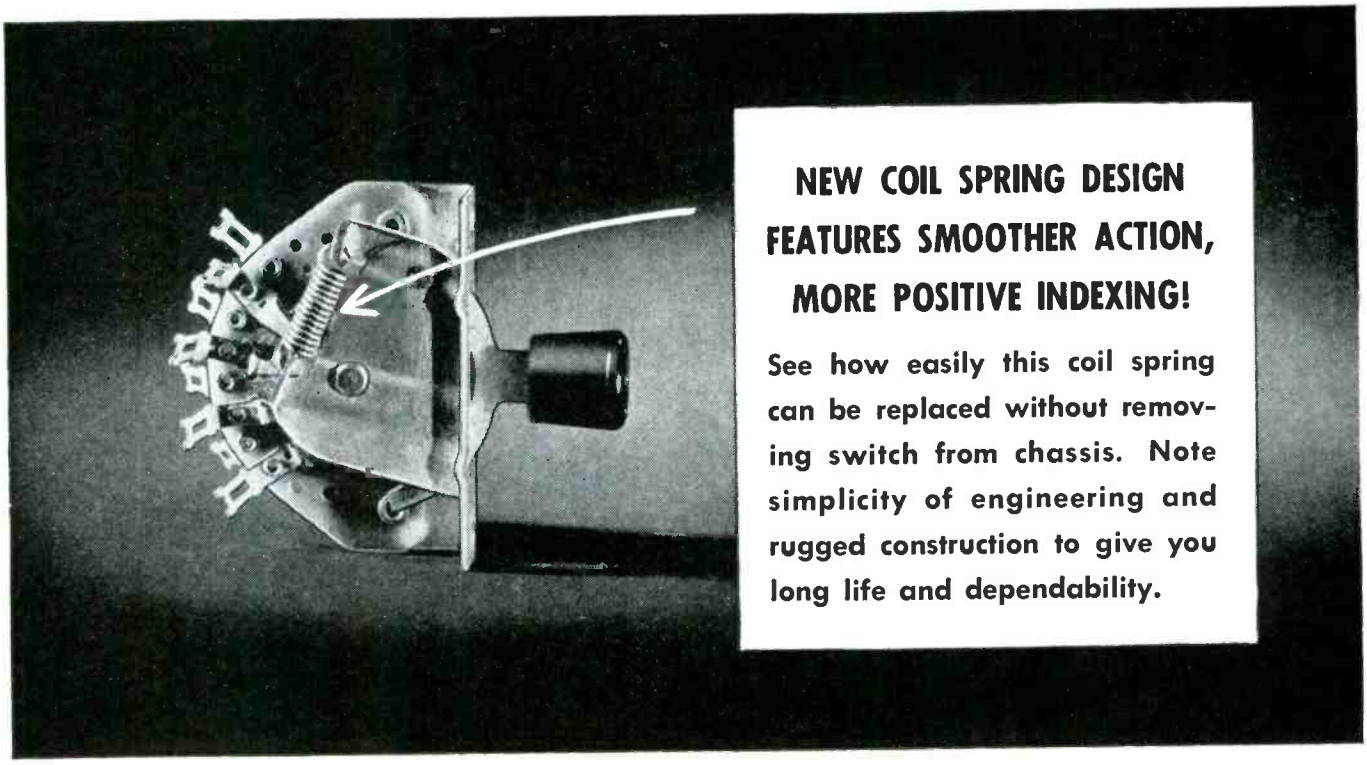
EASTERN AIR DEVICES INC.

130 FLATBUSH AVENUE • BROOKLYN 17, N. Y.

Centralab Announces a New and Revolutionary

LEVER SWITCH

With a Minimum Life Test of 25,000 Cycles!



NEW COIL SPRING DESIGN FEATURES SMOOTHER ACTION, MORE POSITIVE INDEXING!

See how easily this coil spring can be replaced without removing switch from chassis. Note simplicity of engineering and rugged construction to give you long life and dependability.

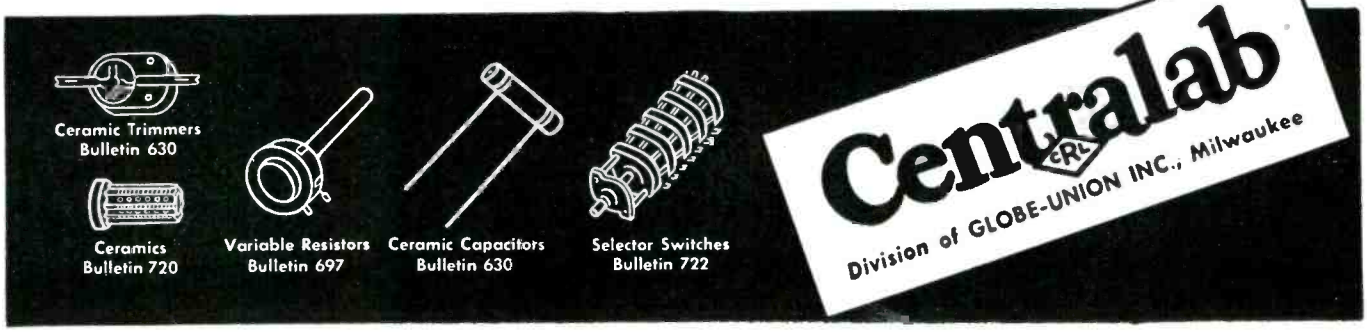
8 Basic Combinations of Indexing Available!

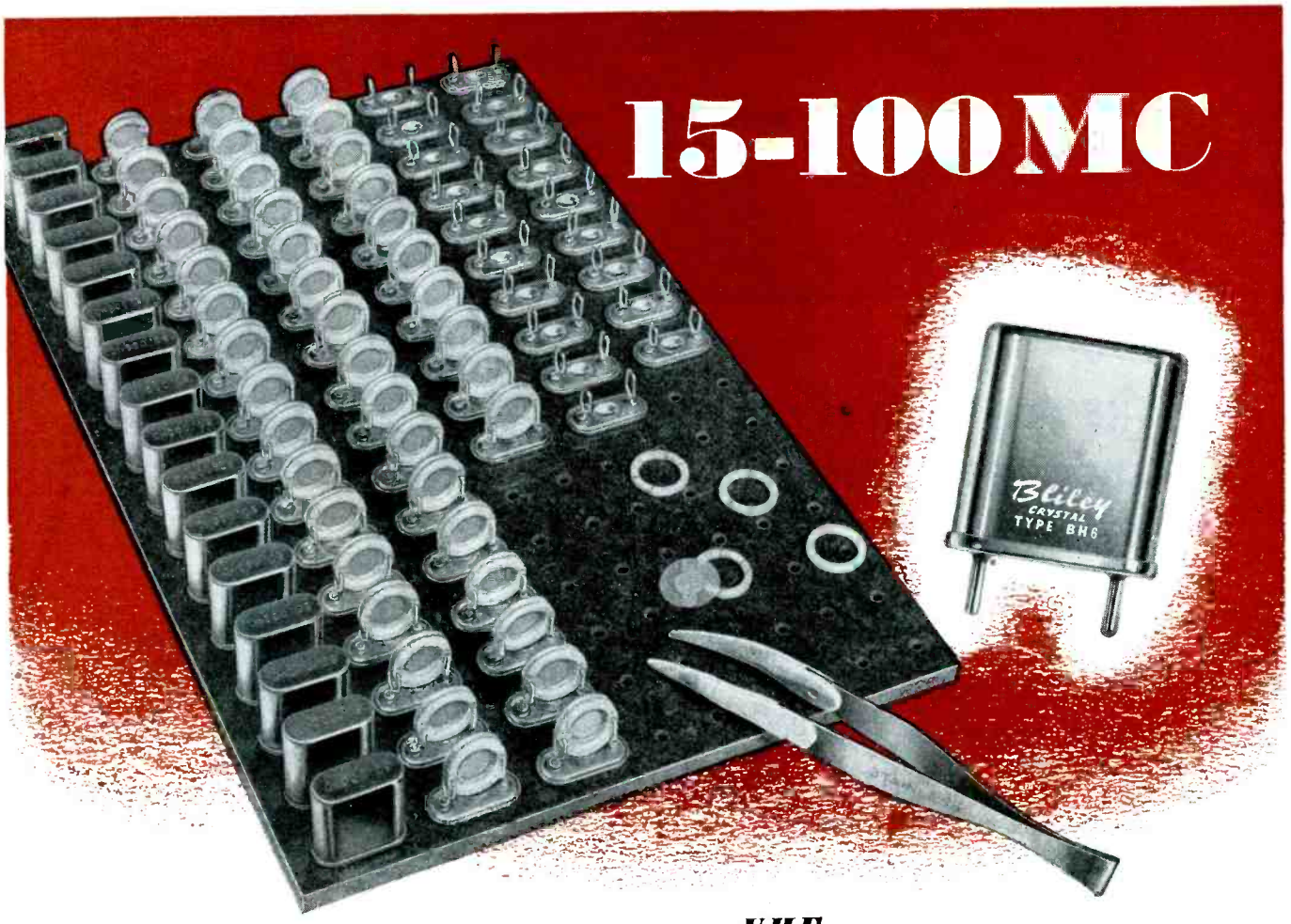
COMPARE the outstanding features of Centralab's new lever switch, and you'll see why it's the finest product of its kind available today!

New, exclusive coil spring design with cam and roller offers you new dependability, long life and resistance to hard service for inter-com and test equipment use. Guaranteed minimum life of 25,000 cycles.

Combinations of spring return and positive indexing provide a flexibility which makes it adaptable to almost any circuit requirements. Available with shorting or non-shorting contacts, or combination of both. Low capacity. 30 degree indexing. Rated at 6 watts. Brass silver-plated clips and contacts. All other metal parts cadmium-plated steel.

Send today for complete information and bulletin number 970.



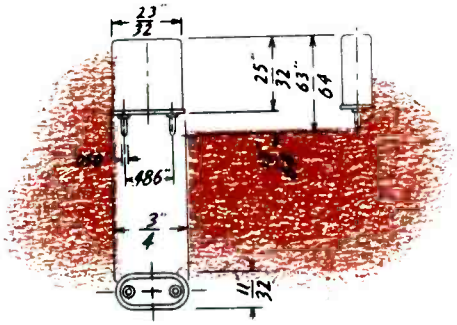


A Significant Advance in VHF Design with BLILEY BH6 CRYSTAL UNITS

Crystal performance in the range 15-100 mc is an accomplished fact with the new BH6 unit. New processing techniques produce paper thin quartz plates operating on third, fifth, and seventh overtones. Stability, precision, and reliability have all been proven in this outstanding design—another triumph of Bliley engineering and craftsmanship.

Crystal holders look pretty much alike externally but the internal assembly is the vital spot. In the BH6 unit a pair of ceramic rings rigidly clamp the delicate quartz crystal in position. The crystal, lapped as thin as .004″, is processed to micro-tolerances and silver plated to insure long term precision. Every step is carefully controlled and inspected before the complete assembly is hermetically sealed in its metal case.

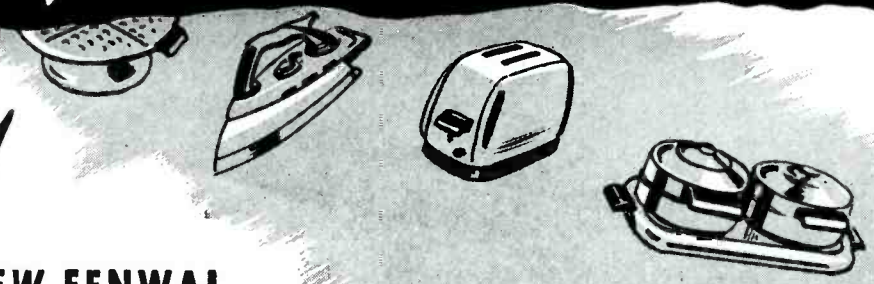
The finished BH6 crystal unit is not a prima donna —it will meet the most rigid service requirements in your VHF equipment. Design engineers are invited to write for recommendations covering oscillator circuits best suited for optimum performance; stating qualifications such as drive requirements to the following stage, frequency tolerance, and temperature range over which tolerance must be maintained.



Bliley CRYSTALS

BLILEY ELECTRIC COMPANY • UNION STATION BUILDING, ERIE, PENNSYLVANIA

If your product uses HEAT

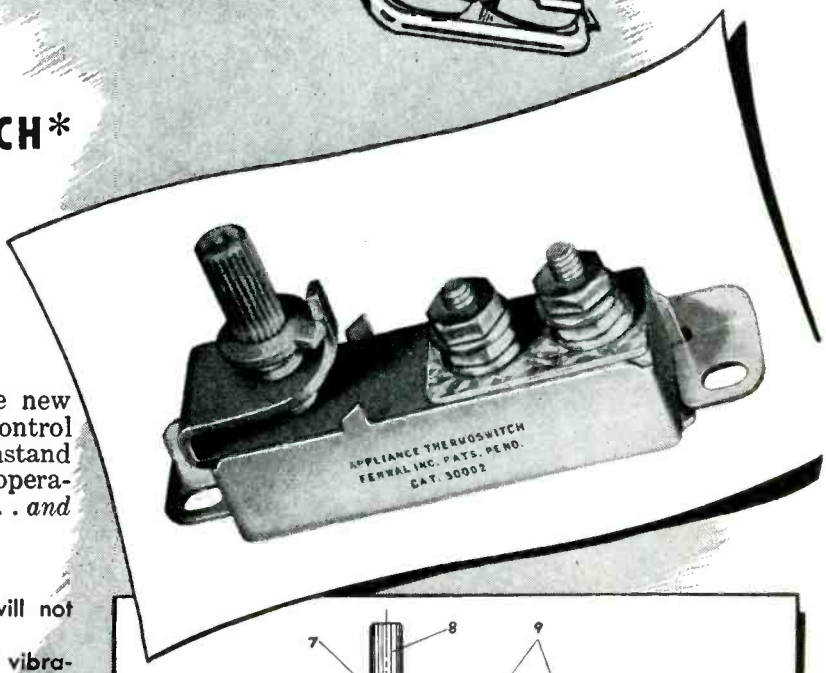


Specify

THE *NEW* FENWAL APPLIANCE THERMOSWITCH* CONTROL

Safe • Accurate • Long-Lasting Temperature Control For All Types of Electrical Appliances

The unique and rugged design of the new Fenwal Appliance THERMOSWITCH Control provides a heat control unit that will withstand shock, vibration, tampering and other operational hazards that lower product life . . . *and influence buying attitudes.*



Note these outstanding features:

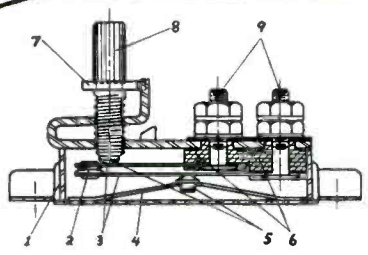
- Torque applied to terminal binding posts will not shift contact support members.
- Adjusting screw will not drift under normal vibration.
- The mounting bracket provides for side or bottom mounting, or a cross-mounting bracket is available for special applications.
- One-piece, welded case and cover assures rugged, tamper-proof unit . . . stable temperature settings.

TWO DISTINCTLY DIFFERENT MODELS FOR HIGH AND LOW TEMPERATURE RANGES

The Appliance THERMOSWITCH Control is available in models especially designed for both high and low temperature ranges. The high temperature model provides control over the wide range of 175°F.–600°F. The low temperature model provides extremely critical control for low temperature applications throughout its range of 50°F.–250°F. Each model assures the highest degree of efficiency and dependability; both incorporate the outstanding Fenwal characteristics.

SPECIFICATIONS

Overall case dimension: ½" high x ⅝" wide 2⅛" long.
Maximum Load Rating: 1200 watts on 110 volt 60 cycles.
TEMPERATURE RANGE:
50° F. to 250° F. (Series 30003)
175° F. to 600° F. (Series 30002)



1. Expanding stainless steel case.
2. Fine silver contacts.
3. Contact Supporting Members.
4. Low expansion metal bridge.
5. Ceramic Insulating Buttons.
6. Precision Ceramic Locator.
7. Stop Collar.
8. Adjusting Screw.
9. Terminal Binding Posts.

RUGGED • COMPACT • LIGHTWEIGHT

Precision built

FOR FOOL-PROOF PERFORMANCE

There is a Fenwal THERMOSWITCH Control to meet the requirements of most temperature control applications. Write for complete information.

Fenwal

FENWAL INCORPORATED

43 PLEASANT STREET, ASHLAND, MASSACHUSETTS

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

Section of the Belden enameling department, where Beldenamel Magnet Wire is produced.

Know-How MAKES MAGNET WIRE

Here is but one of many banks of machines that produce Belden Magnet Wire. It represents the most advanced design in accurate high-speed equipment for handling the enameling process. Every possible mechanical factor contributes to the uniform, high quality of the finished product.

But the machinery is little more than symbolical of the more important *ingredients* of Belden Magnet Wires. The know-how to produce it and the know-how to collaborate in its application.

Since 1902, through experience, through never-ending research—through constant performance studies under actual working conditions—Belden know-how has produced the first satisfactory enameled wire—superior textile and synthetic coverings—and the newly announced "Celenamel"—a great new development.

Belden's Business is more than making wire—it is a service where your needs command machines and men—and "know-how."

Belden

WIREMAKER
FOR INDUSTRY

Know-How MAKES RUBBER-COVERED ELECTRICAL CORDS

Whether you manufacture automobiles or television sets, kitchen appliances, or heavy electrical machines—you will use some rubber-covered wire. And the variety of wires available for the services is just as broad as your requirements.

Broad, too, is the variety of quality—from which to choose. Will the cable on your welder stand up ten hours—or a thousand? Will the cord on the lamp you manufacture be a dangerous nuisance—or a long, safe, faithful servant?

In its rubber-covered wire department Belden has the latest type machines. Belden procures the finest raw components. But again, it requires more than materials and machines to make wire: *Men with know-how.*

Almost fifty years of experience—means you can get the right wire to meet your needs at Belden.

Twisting fine copper wires together to make a flexible conductor for rubber-covered cable.

Belden WIREMAKER FOR INDUSTRY

In newer AM broadcast equipment Type GL-893A-R plays an important part, since forced-air cooling adapts the tube for transmitters using that increasingly popular method. (With water-cooled anode, as Type GL-893-A, the same proved power tube is obtainable for services such as industrial h-f heating and international 50- and 100-kw broadcasting.)

A better tube than any predecessor, with improved filament construction and more highly developed grid design — easier to "break in" when placed in service — Type GL-893A-R is one of an extensive group of up-to-the-minute General Electric transmitting tubes that cover the full range of broadcast requirements.

If a station operator, whether AM, FM, or Television, your replacement needs on all types are ideally served by the G-E tube distributor or dealer right in your area. Because of tubes on hand, backed up by branch stocks strategically located, your local G-E source of supply can give you prompt service that will help you stay on the air a profitable 100 per cent of scheduled time.

If a builder or designer of transmitters, General Electric offers you the widest range of tubes in respect to power-output ratings, frequencies, and circuit applications. *Your needs,* moreover, come first with experienced G-E tube engineers who will be glad to assist you in selecting the right tube types for equipment on your drawing-boards. Consult your nearest G-E electronics office, or *Electronics Department, General Electric Company, Schenectady 5, N. Y.*

GL-893A-R

50-kw power output, Class C telegraphy

RATINGS

Filament voltage	10 v	(Voltage given is *per strand* of special filament which permits operation from d-c or from 1-, 3-, or 6-phase a-c power supply. Current is *per terminal.*)	
current	61 amp		
Max plate ratings:	CLASS B A-F (2 tubes)	CLASS C R-F (telephony)	CLASS C R-F (telegraphy)
voltage	20,000 v	12,000 v	20,000 v
current	4 amp, per tube (signal)	2 amp	4 amp
input	60 kw, per tube (signal)	24 kw	70 kw
dissipation	20 kw, per tube	12 kw	20 kw
Typical power output	70 kw (signal, 18,000-v operation)	18 kw (12,000-v operation)	50 kw (18,000-v operation)
Maximum frequency	5 mc at full ratings; 25 mc at reduced rotings.		

GENERAL ELECTRIC

161-F7-8850

FIRST AND GREATEST NAME IN ELECTRONICS

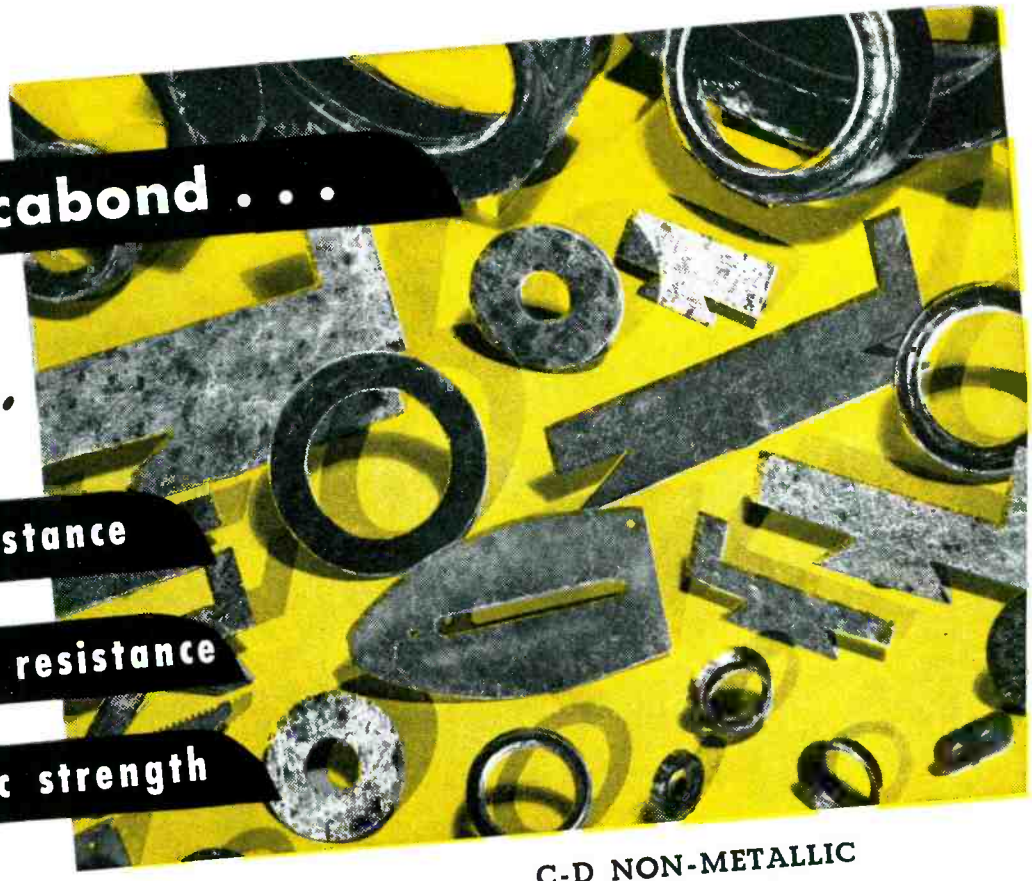
C-D Micabond . . .

gives you . . .

high heat resistance

high moisture resistance

high dielectric strength



If you want electrical insulation that will withstand heat—that is little affected by moisture—and that will provide excellent dielectric properties—specify C-D Micabond.

Micabond combines the heat resistance, moisture resistance and electrical insulating properties of raw mica into easy-to-use sheet, tube and tape form. Micabond sheet is easily punched and formed for commutator segments and rings, heating element insulators, terminal washers and similar applications. Micabond tube is ideal for many applications such as resistance coils and insulating bushings. Micabond tape is used extensively as a highly efficient insulating wrapping for coils.

C-D Micabond is made in 23 standard types and grades —one or more of which is sure to give you the specific insulating properties required to improve the overall performance of your product. For complete information on C-D Micabond, write for our latest Micabond bulletin or ask us to have an engineer help you with your problem.

C-D NON-METALLIC PRODUCTS

DIAMOND VULCANIZED FIBRE

VULCOID—Resin Impregnated Vulcanized Fibre.

DILECTO—Thermosetting Laminated Plastics.

CELORON—A Molded Phenolic Plastic.

MICABOND—Built-up Mica Electrical Insulation.

HAVEG—Plastic Chemical Equipment, Pipe, Valves and Fittings.

STANDARD & SPECIAL FORMS

Available in Standard Sheets, Rods and Tubes; and Parts Fabricated, Formed or Molded to Specifications.

DESCRIPTIVE LITERATURE

Bulletin GF gives Comprehensive Data on all C-D Products. Catalogs are also available.

Continental-Diamond C-D Engineered Non-Metallics

D-5

BRANCH OFFICES: NEW YORK 17 • CLEVELAND 14 • CHICAGO 11 • SPARTANBURG, S. C. • SALES OFFICES IN PRINCIPAL CITIES
WEST COAST REPRESENTATIVES: MARWOOD LTD., SAN FRANCISCO 3 • IN CANADA: DIAMOND STATE FIBRE CO., OF CANADA, LTD., TORONTO 8

Continental-Diamond FIBRE COMPANY

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

NEW! A complete portable recording console THE PRESTO 90-A

Here in one easily portable unit is complete amplifier equipment to produce recordings on remote assignments that equal the best recordings in permanent installations.

Presto 90-A has 3 low-level input channels with mixers, master gain control and variable high and low frequency equalizers.

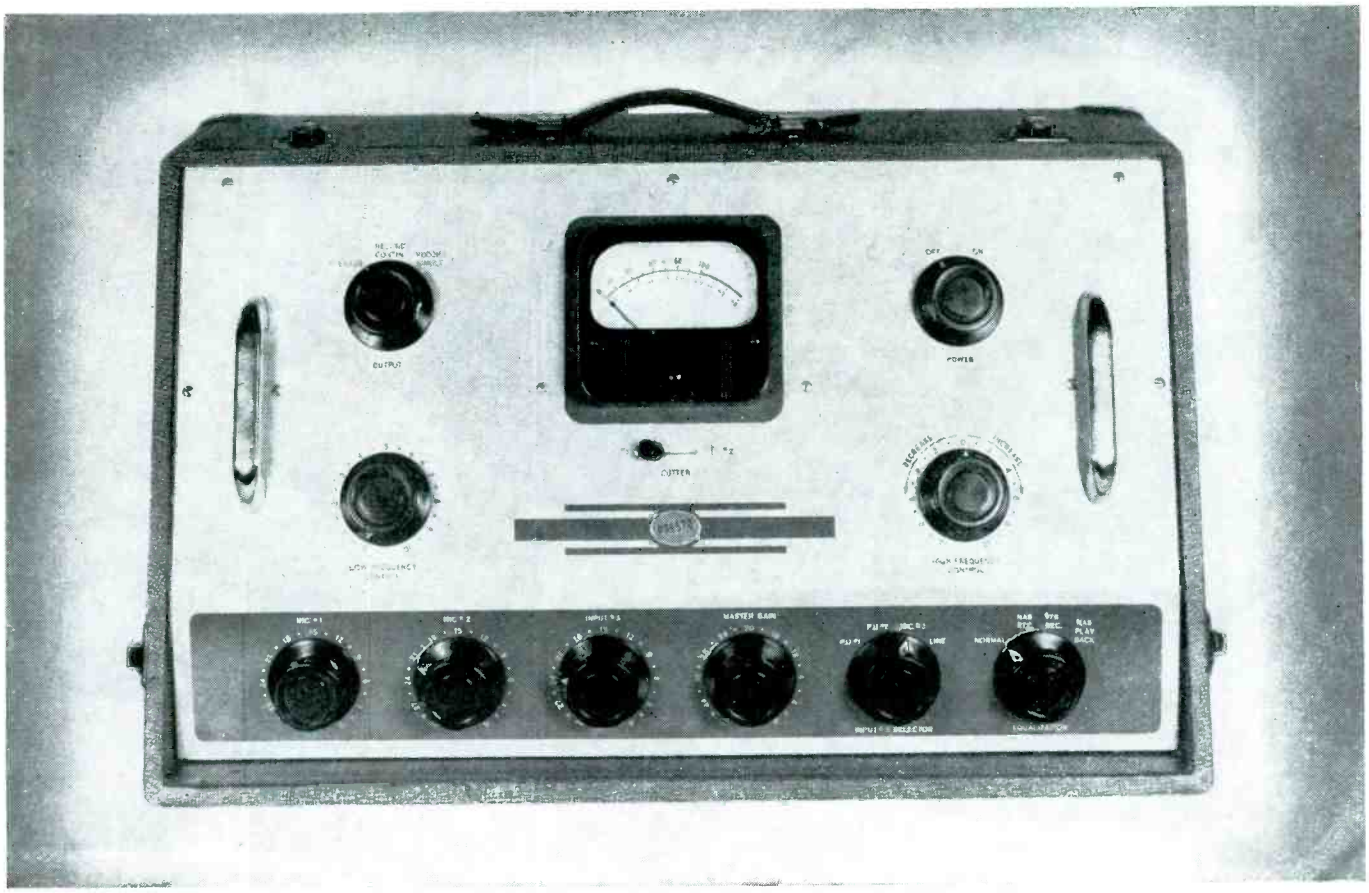
It has four fixed characteristics: flat between 30 and 15,000 CPS...NAB recording...78 r. p. m. recording...playback complimenting NAB recording.

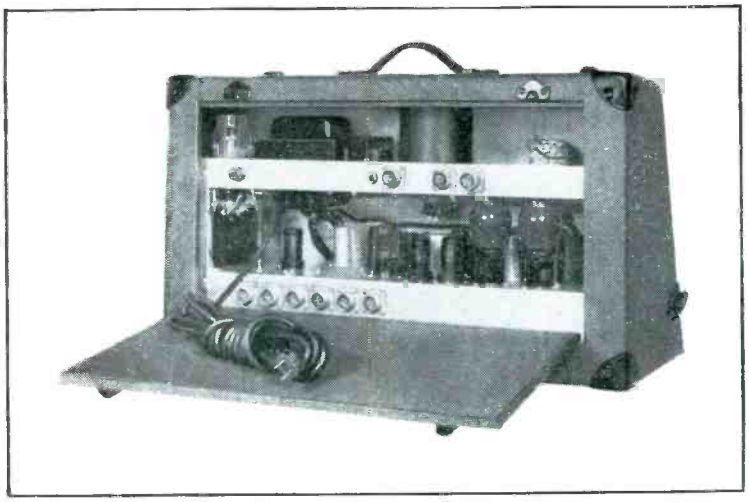
Other features include: line input and output, V.U. meter, switching for one or two recorders, over-all gain—115 db, power —10 watts undistorted.

In quality of parts and workmanship and in flexibility of operation, the Presto 90-A is the equal of the finest studio equipment.

Presto engineers are proud to present this new recording console as a forward step in recording equipment.

Immediate delivery can be made from stock.





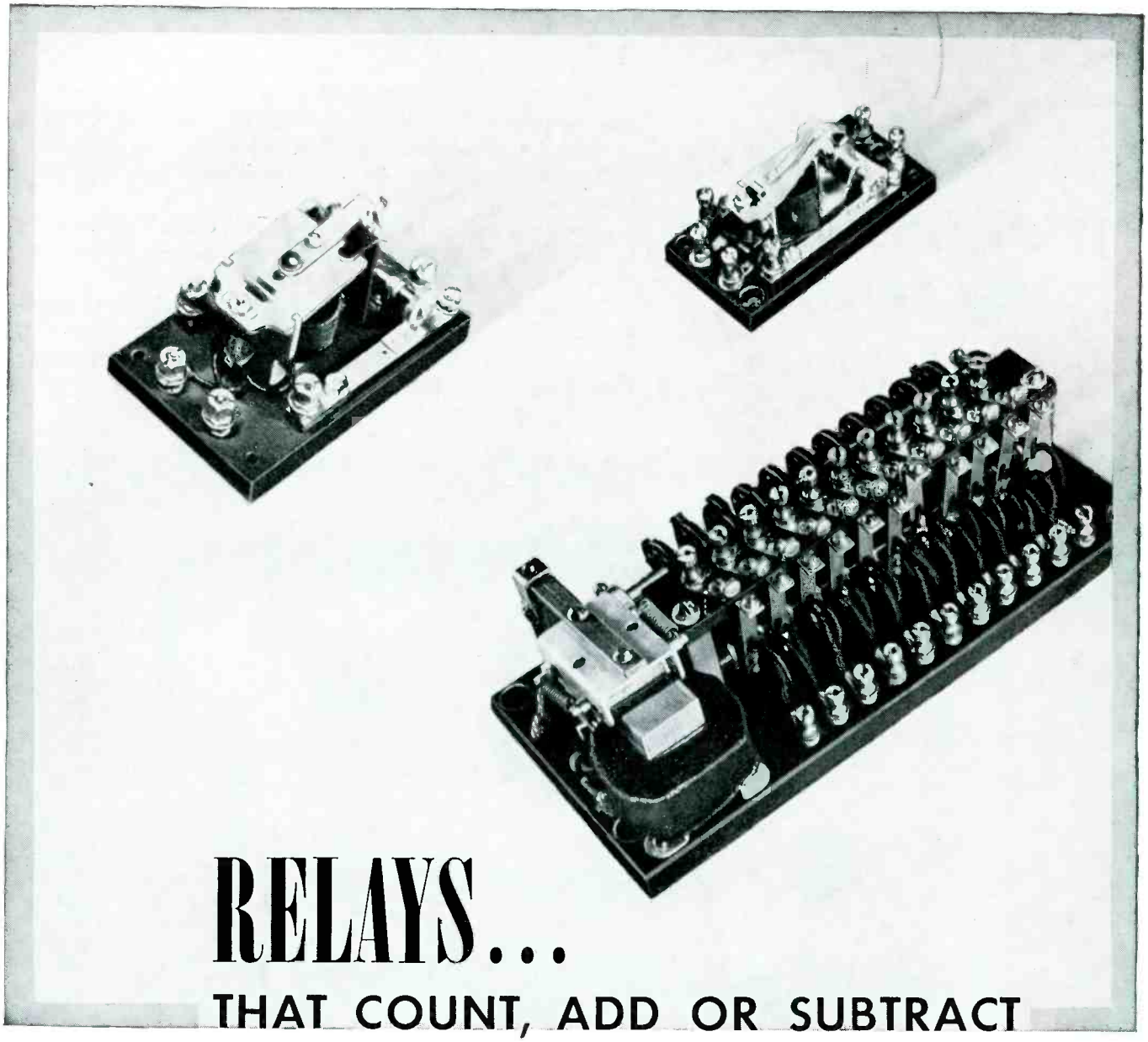
PRESTO

RECORDING CORPORATION

248 WEST 55TH STREET, NEW YORK 19, N. Y.

Walter P. Downs, Ltd., in Canada

FREE! Presto will send you free of charge a complete bibliography and digest of all technical and engineering articles on disc recording published since 1921. Send us a post card today.



RELAYS...

THAT COUNT, ADD OR SUBTRACT

. . . and have unfailing memories

Ratchet-type relays, another version of the popular Struthers-Dunn "Memory" Relay Series, are designed to supervise a control pattern for two or more circuits by successive impulses to a single operating coil. They are widely used for street railway safety signals, capacitor bank switching, single button control of reversing mechanisms, interlocking, and other operations requiring "memory" or "counting" supervision.

Also available with two operating coils for electrical re-set or "forward-and-reverse" stepping.

S-D STRUTHERS-DUNN, INC.

5,327 RELAY TYPES

STRUTHERS-DUNN

STRUTHERS-DUNN, INC., Philadelphia 7, Pennsylvania

ATLANTA • BALTIMORE • BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND • DALLAS
DENVER • DETROIT • HARTFORD • INDIANAPOLIS • LOS ANGELES • MINNEAPOLIS • MONTREAL
NEW YORK • PITTSBURGH • ST. LOUIS • SAN FRANCISCO • SEATTLE • SYRACUSE • TORONTO

Unusual Sensitivity—.001 volt
Million-to-one Range—.001 to 1000 volts
High Input Impedance for Truer Reading

The RCA WV-73A Audio Voltmeter

. . . a sound investment in test equipment

The RCA WV-73A Audio Voltmeter will accurately measure a-c voltages over wide ranges of frequency and amplitude far beyond the limits of ordinary a-c voltmeters. Response is excellent over the entire range of 20 cycles to 20 kc.

Applications range from measuring the electrical conductivity of switches to determining slight variations in light intensity for photo-tube work. It is sensitive and accurate enough to be used for calibrating service instruments.

This instrument has a linear decibel scale and an overlapping logarithmic voltage scale. Accuracy is the same at all points on the scale.

You can use the WV-73A to determine the response of audio systems and to locate sources of frequency distortion. It also serves as a high-gain a-f amplifier with near-perfect fidelity.

Available from your RCA Laboratory and Measuring Equipment Distributor.

TEST AND MEASURING EQUIPMENT

RADIO CORPORATION of AMERICA

ENGINEERING PRODUCTS DEPARTMENT, CAMDEN, N.J.

In Canada: RCA VICTOR Company Limited, Montreal

Distinctive beauty

SUPERB PERFORMANCE

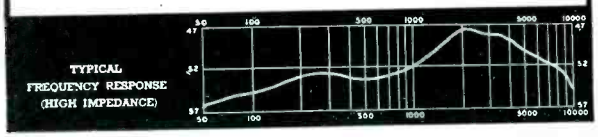
TURNER COLORTONE DYNAMIC—MODEL 5D

• The post-war microphone sensation. Beauty that sings to the eye and ear. Turner Colortones bring sparkling color to stage and orchestra settings, home recorders, television studios, night spots, etc. Their high quality reproduction accents the performance of finest recording and sound system equipment. Cases are styled in a choice of gleaming ivory, rich orange, bright yellow, and soft pastel green finishes. Improved dynamic circuit with Turner precision diaphragm and Alnico V magnets provides extremely accurate pickup and smooth wide-range response to voice and music. Shielded output transformer excludes all annoying hum pickup. Available in four standard impedances with or without built-in slide switch. See them today at your dealer.

SPECIFICATIONS

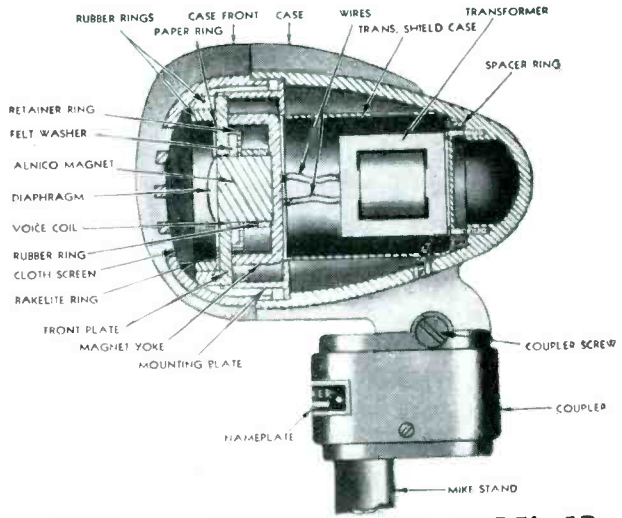
MODEL 5D COLORTONE DYNAMIC

EFFECTIVE OUTPUT LEVEL: 52 db below 1 volt/dyne/sq. c. m. at high impedance.
FREQUENCY RESPONSE: Flat within ±5 db from 50-9000 c. p. s.
OUTPUT IMPEDANCE: 50, 200. 500, ohms, high.
DIRECTIONAL CHARACTERISTICS: Semi-directional. Non-directional when tilted back 90°.
DIAPHRAGM: Highest quality, corrosive resistant aluminum.
MAGNETIC CIRCUIT: Employs highest quality Alnico V magnet. Highly shielded output transformer excludes all hum pickup.
CASE: Tenite. With 90° tilting head. Rubber tilt brake holds in any position.
FINISH: Choice of yellow, green, ivory, orange.
MOUNTING: 5/8"—27 standard coupler.
CABLE: 20 ft. removable, shielded, single conductor, with connector.
DIMENSIONS: 4¼" long x 2⅞" wide x 4⅝" high.
WEIGHT: 17 ounces.



ALSO AVAILABLE WITH HIGH QUALITY CRYSTAL CIRCUIT AS MODEL 5X

MICROPHONES IN COLOR



INTERIOR CONSTRUCTION MODEL 5D

Turner Colortone Dynamics will stop you with their beauty—you'll choose one for its superior quality.

THE TURNER COMPANY

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

Microphones licensed under U.S. patents of the American Telephone and Telegraph Company, and Western Electric Company, Incorporated. Crystals licensed under patents of the Brush Development Company

REVERE SHEET AND STRIP FOR DRAWN PARTS

FOR all products to be made by drawing, stamping and similar sheet metal operations, Revere sheet and strip of copper or brass offer maximum ease of fabrication. Not only are these metals naturally ductile, but they benefit further from the metallurgical skill which Revere has gained in 146 years of experience.

In composition, mechanical properties, grain size, dimensions and finish, you will find Revere metals highly uniform. They enable you to set up economical production methods and adhere to them. They can help you produce better products at faster production rates, with less scrap and fewer rejects.

Revere copper, brass and bronze lend themselves readily to the widest variety of finishing operations—polishing, lacquering, electro-plating. With these superior materials it is easy to make radio shields and similar products beautiful as well as serviceable.

That is why wise buyers place their orders with Revere for such mill products as—*Copper and Copper Alloys:* Sheet and Plate, Roll and Strip, Rod and Bar, Tube and Pipe, Extruded Shapes, Forgings—*Aluminum Alloys:* Tubing, Extruded Shapes, Forgings—*Magnesium Alloys:* Sheet and Plate, Rod and Bar, Tubing, Extruded Shapes, Forgings—*Steel:* Electric Welded Steel Tube. We solicit your orders for these materials.

REVERE

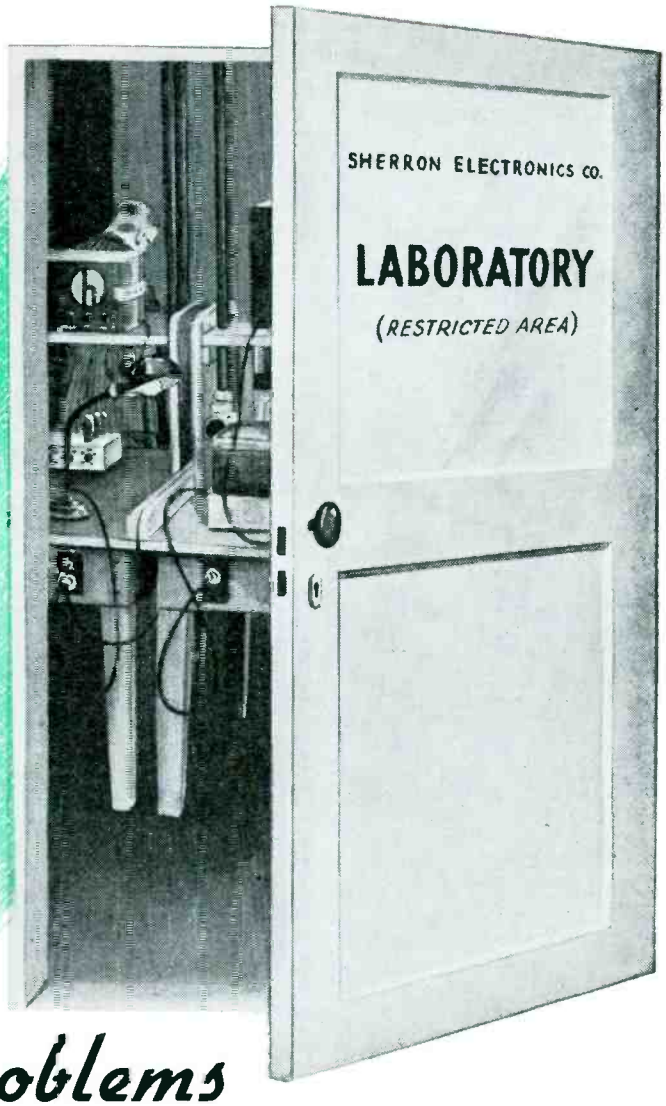
COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, N. Y.

Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; New Bedford, Mass.; Rome, N. Y.

Sales Offices in Principal Cities, Distributors Everywhere.



DOORWAY TO SOLUTIONS FOR *Electronics Problems*

America's destiny may well be determined by the vision, resourcefulness and researches of electronics scientists. The implications of the development of electronic applications are clear, even without definition. Speed, therefore, is a crucial factor in the evolution of electronics, whether as a tool or weapon... Keenly alert to this urgency, Sherron's scientists, physicists and mathematicians are massed in an ever-pressing assault on electronics problems. At their command is the most advanced equipment. Theirs is the experience of a host of different electronics enigmas clarified, of specialized electronics applications worked out to meet difficult and unusual operating conditions.

SHERRON LABORATORY PROJECTS COVER:

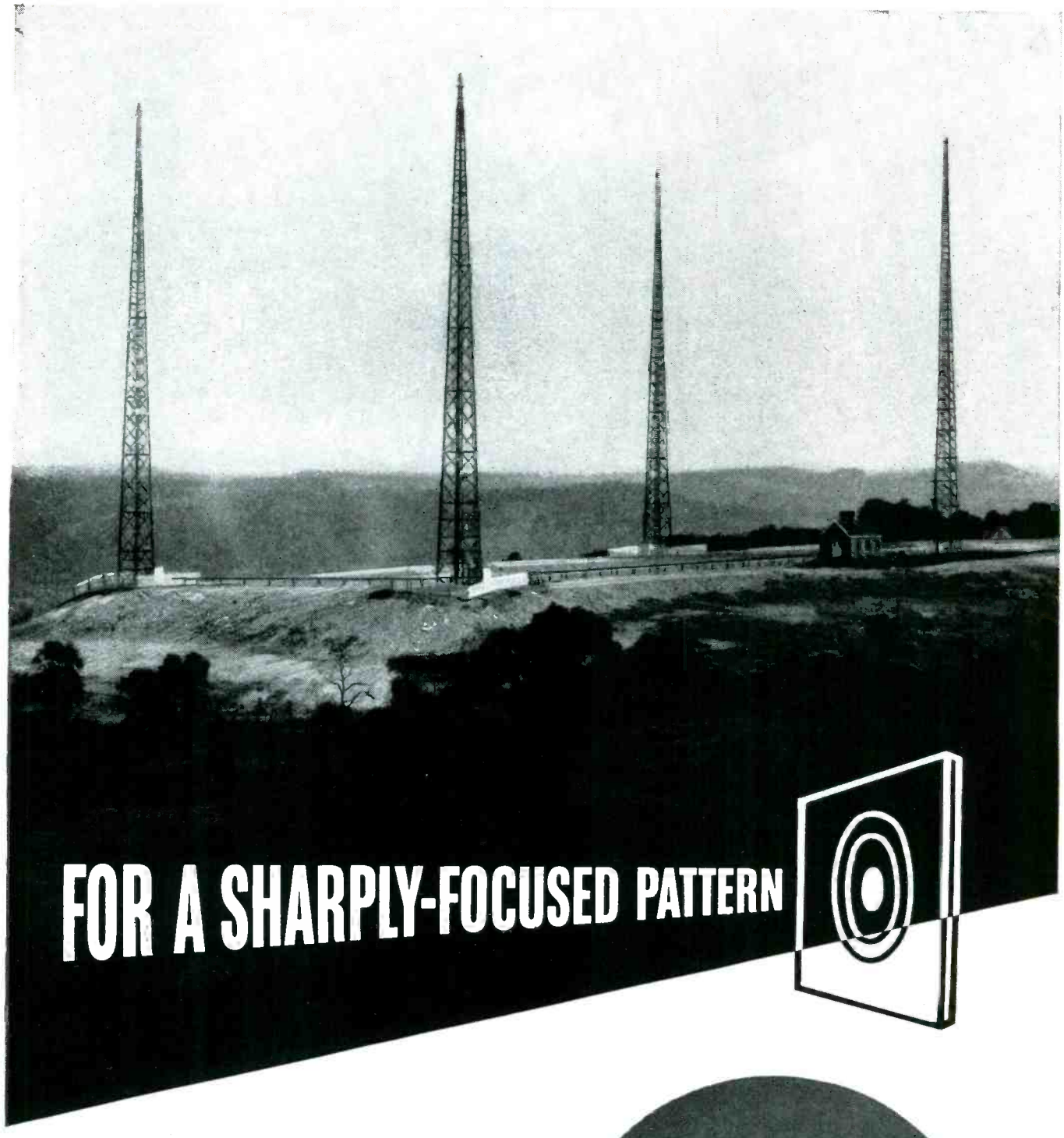
1. ULTRA AND HYPER HIGH FREQUENCY TECHNIQUES
2. ELECTRON BALLISTICS
3. THERMIONIC EMISSION
4. HIGH VACUUM ELECTRONIC TUBES TECHNIQUES
5. RADAR: — (DETECTION — NAVIGATION)
6. ELECTRONIC CONTROL FOR DRONE AND GUIDED MISSILES

Sherron Electronics W2XDK

SHERRON ELECTRONICS CO.

Division of Sherron Metallic Corporation

1201 FLUSHING AVENUE • BROOKLYN 6, NEW YORK



FOR A SHARPLY-FOCUSED PATTERN

Typical of Blaw-Knox cooperation with radio engineers is this new directional array of four 200-ft. self-supporting, base-insulated towers, which permits the station to "throw its voice" in specified directions. In addition to acting as an AM radiator, one tower also supports an FM clover-leaf antenna.

If your plans call for a new station or increasing the efficiency of your present equipment, Blaw-Knox engineers stand ready to apply a wealth of experience in tower design to your advantage.

BLAW-KNOX DIVISION
OF BLAW-KNOX COMPANY
2077 Farmers Bank Bldg., Pittsburgh 22, Pa.

BLAW-KNOX
Antenna
TOWERS

MORE THAN 50 GRADES OF G-E TEXTOLITE LAMINATED PLASTICS ARE AVAILABLE

PROBLEM—DEVELOP A GRADE OF LAMINATED PLASTICS WITH HIGH ELECTRICAL PROPERTIES-HIGH MECHANICAL PROPERTIES

G-E Textolite grade No. 2008 is an excellent general-purpose laminate because it has both high electrical and high mechanical properties. This factor enables it to fill a number of jobs well. Grade 2008 can be punched hot and is readily machined. In the electrical industry it is frequently used for relays, vibrators, switches and in applications where low dielectric losses are important.

THERE ARE OTHER GRADES

In fact there are more than fifty grades of G-E Textolite laminated plastics for you to select from. And like grade 2008 described above, each of these many grades has an *individual combination* of properties. None are exactly alike. With such a selection, you can be certain of getting the grade with the right properties for your job.

And this wide range of grades is supplied in numerous forms—sheets, tubes, rods; fabricated parts; molded-laminated parts; low-pressure laminated parts; post-formed laminates. Investigate fully the many grades and forms of G-E Textolite for greater economy . . . for product improvement. Plastics Division, Chemical Department, General Electric Co., One Plastics Ave., Pittsfield, Mass.

TEXTOLITE LAMINATED IS SUPPLIED IN FIVE FORMS

SHEETS, TUBES, AND RODS—These standard shapes are available in thousands of sizes. Up-to-date manufacturing methods facilitate quick deliveries.

FABRICATED PARTS—G.E. has modern fabricating equipment to machine Textolite laminated plastics parts to your own specifications.

MOLDED-LAMINATED PARTS—Textolite is custom molded directly to shape. Molded laminated products are among the strongest plastics parts produced.

LOW-PRESSURE MOLDED PARTS — Extremely large and irregular Textolite shapes are custom molded by the low-pressure laminating process.

POST-FORMED LAMINATES—Sheets of Textolite laminated plastics are custom formed into simple shapes by this very inexpensive method.

GET THE COMPLETE STORY! Send for the new bulletin G-E TEXTOLITE LAMINATED PLASTICS. Mail the coupon below for your free copy.

PLASTICS DIVISION (AC-10), CHEMICAL DEPARTMENT
GENERAL ELECTRIC COMPANY
ONE PLASTICS AVE., PITTSFIELD, MASS.

Please send me the new G-E Textolite laminated plastics bulletin.

Name .....

Firm .....

Address .....

City ..... State .....

GENERAL ELECTRIC

CD47-E4

More and More Users of Extruded Vinyl Tubing are STANDARDIZING on NATVAR #400

Here's Why:-

Most users, to make sure that they get the right tubing for a particular job, run tests on the various extruded tubings available to find out whether they are suitable. For some applications, heat resistance is of primary importance. For others, it may be tensile strength, high dielectric, oil resistance, low moisture absorption, or a combination.

Before Natvar #400 was available, it was often the practice to stock several different types of special purpose tubings. This is no longer necessary. Test reports show that Natvar #400 is able to hold its own on practically every count for which a special purpose tubing might be considered.

One of the largest electrical manufacturers reports:

> This tubing has been used in radio transformer construction here at ——— for some time, and it has been found satisfactory ... A comparison of our results with those of the supplier is very favorable ... One peculiar characteristic of this material is the manner in which it behaves after immersion in hot transformer oil. A sample before immersion gave a tensile strength of 4140 psi, and after immersion a tensile strength of 6890 psi. ... The sag test which was conducted in this investigation was more severe than is usually conducted on materials of this type. Nevertheless, this tubing performed remarkably well under these conditions ... A copy of this report is being sent to the various division engineers for review.

Another large electrical manufacturer reports:

> MATERIAL TESTED: #400 Natvar Tubing, Flexible Extruded Vinyl.
>
> Effect of Heat: Like any other plastic, this material softens upon heating, but at 125° C. it does not flow or sag. It remains unaltered, except for darkening, after a week in the drying oven.
>
> Effect of Oil: In oil at 100° C., the tubing does not swell, soften, dissolve or harden. It remains unchanged except for a change in color.
>
> Effect of Compound Treatment: The tubing flatted out due to heat, but was still pliable when removed. It is satisfactory for this application.
>
> Dielectric Strength: Dielectric Puncture Tests, using a metal rod as inner electrode, and copper ribbon as outer electrode, gave the following results (tested in oil at room temperature):

	Short Time	Step-by-Step
As received	19,000 v=725 v/mil	17,600 v=691 v/mil
Dried 2 days @ 125°C	19,000 v=744 v/mil	16,800 v=667 v/mil
Dried 3 days @ 125°C plus 24 d. in oil : 100°C	26,000 v=1023 v/mil	19,400 v=723 v/mil

Underwriters' Laboratories limitations permit wide use. Natvar #400 is now available for immediate shipment in most sizes, either from your wholesaler's stock or from our own. Write, wire or phone us your requirements.

Excerpts from the E.T.L. report covering tests made on Natvar No. 400 in accordance with A.S.T.M. Standards.

DIELECTRIC STRENGTH—A.S.T.M. D350-43
Average volts per mil: At 28°C—1090
At 85°C— 700
Wall thickness: .0235"

DIELECTRIC CONSTANT AND POWER FACTOR
Dielectric constant at 29°C and relative humidity 60%
At 60 cycles: 8.15
At 1 megacycle: 4.35
Power Factor: At 60 cycles: .056
At 1 megacycle: .064

ARC RESISTANCE—A.S.T.M. D495-42
Average—135 seconds

OIL RESISTANCE—A.S.T.M. D295-43T
"Turbol 10" at 105°C was used. After 15 minutes immersion there was no apparent change in the tubing. After 24 and 48 hours there was no sign of change in the tubing. Three separate tests were made.

HEAT ENDURANCE—A.S.T.M. D350-43
After 7 days at 125°C the tubing did not crack or otherwise fail when bent 180° around a 5/16" mandrel.

TENSILE STRENGTH AND ELONGATION
At 200% elongation: Average 1980 lbs. per sq. in.
At Maximum: Average 2870 lbs. per sq. in.
Total elongation: 350%

LOW TEMPERATURE FLEXIBILITY

FLAME RESISTANCE—D350-43
Burned about ¼ in. in 10 to 15 seconds and then went out. Three tests were made.

EFFECT OF CHEMICALS
Effect of 7 days immersion in solvents at room temperature; average of 3 tests in each solvent:

Solvent	Change in weight Per cent of weight of specimen as received	Change in dimensions Per cent of dimensions of specimen as received Length	Outside diameter	Thickness
5 per cent sulfuric acid	+ 0.41	none	none	none
1 per cent potassium hydroxide	+ 0.83	none	none	none
Petroleum	+ 6.62	+2.6	none	none
Ethyl Alcohol	+ 1.66	none	none	none
Benzol	+21.9	+6.6	+10.9	—24.0

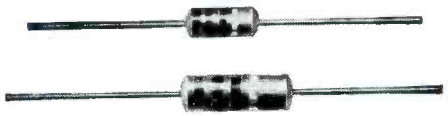
WATER ABSORPTION
Average of 5 tests

Water absorption, per cent by weight of dry specimen	0.63
Soluble matter, per cent by weight of dry specimen	0.01
Total water absorption, per cent by weight of dry specimen	0.64
Change in dimensions: in length	none
in outside diameter	none
in thickness	none

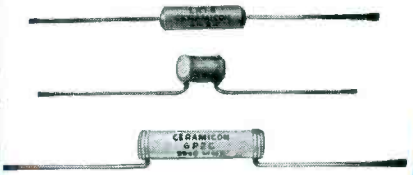
ERIE RESISTOR

SYMBOL OF QUALITY

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

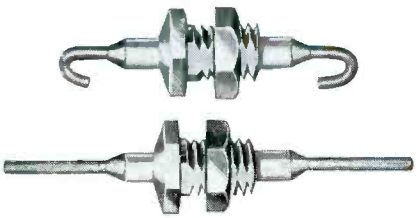


Types 504B, ½ Watt—518B, 1 Watt Resistors
10 ohms—22 megohms



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

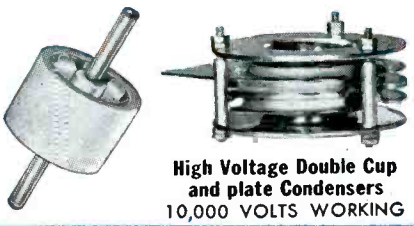
Custom Injection Molded Plastic Knobs, Dials, Bezels, Name Plates, Coilforms, etc.



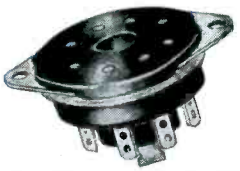
Feed-Thru Ceramicons
3 MMF—1,000 MMF
3 MMF—1,500 MMF

Types L-4, L-7, S-5 Suppressors for Spark Plugs and Distributors

Button Mica Condensers
15 MMF—6,000 MMF



High Voltage Double Cup and plate Condensers
10,000 VOLTS WORKING



Cinch-Erie Plexicon Tube Sockets with 1,000 MMF built in by-pass condensers

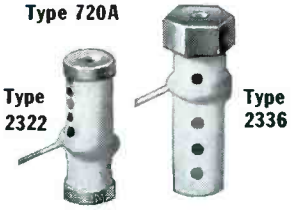
Type 554 Ceramicon Trimmer
3-12 MMF
5-25 MMF
5-30 MMF
8-50 MMF

Type 557 Ceramicon Trimmer

Type TS2A Ceramicon Trimmer
1.5-7 MMF 3-13 MMF 4-30 MMF
3-12 MMF 5-20 MMF 7-45 MMF

Types 323 and 324 Insulated

Type 720A



Type 2322

Type 2336

Erie Stand-Off Ceramicons

MAKERS OF QUALITY *Electronic Components*

ERIE RESISTOR has developed and manufactured a complete line of Ceramic Condensers for receiver and transmitter applications; Silver-Mica and Foil-Mica Button Condensers; Carbon Resistors and Suppressors; Custom Injection Molded Plastic Knobs, Dials, Bezels, Nameplates and Coil Forms. Complete technical information will be sent on request.

Electronics Division

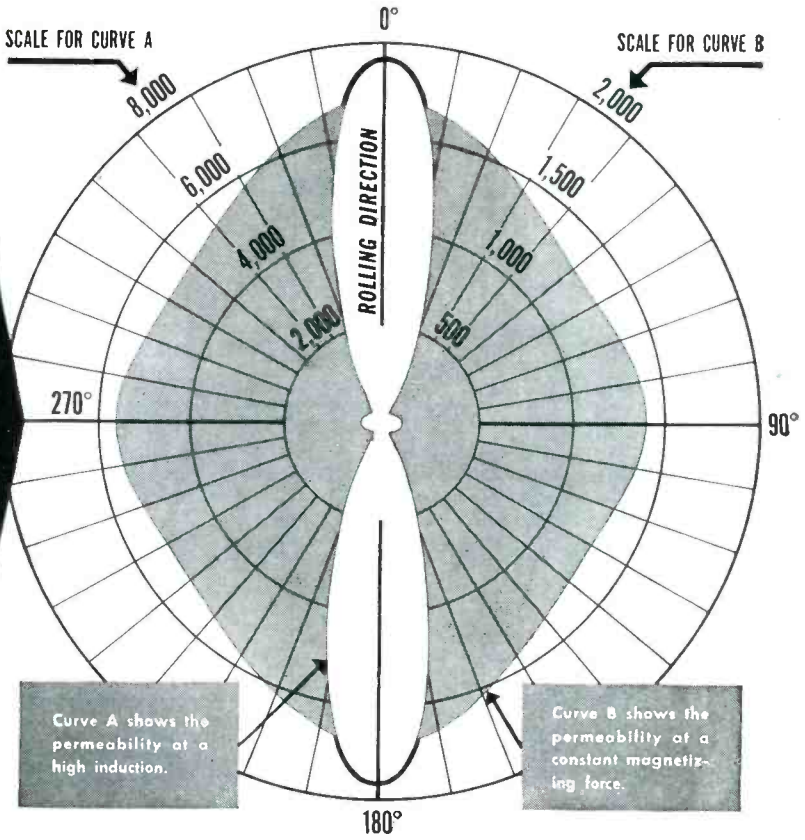
ERIE RESISTOR CORP., ERIE, PA.

LONDON, ENGLAND TORONTO, CANADA

NEW!

Oriented Steels with LOWER Core Loss and HIGHER Permeability

POLYDIRECTIONAL PERMEABILITY CHART



Newest development of Armco Research is a group of oriented electrical steel grades known as ARMCO TRAN-COR X, XX and XXX.

They make possible the design of lighter cores with higher operating inductions. And they give the transformer designer three cold-reduced grades with these unusual advantages: *lower* core loss concurrent with *higher* permeability in the rolling direction, and a higher space factor. Heretofore, lower core loss has been obtained only at the expense of permeability.

All Armco oriented electrical steels are CARLITE Insulated. CARLITE Insulation assures minimum inter-lamination loss. This special surface treatment also increases rust-resistance and improves shear and die life. Its extreme thinness has practically no effect on space factor.

The new grades are rolled .014" thick only. They are supplied in 30-inch wide coils, or in slit coils down to 1", and in sheets 30¾" x 120".

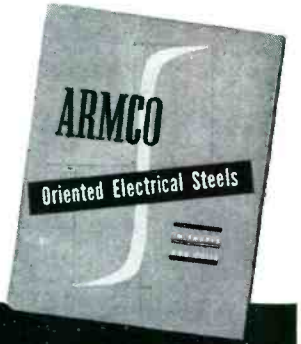
MAXIMUM CORE LOSSES

ARMCO TRAN-COR X	1.00 watt per pound
ARMCO TRAN-COR XX	0.90 watt per pound
ARMCO TRAN-COR XXX	0.80 watt per pound

Core loss tests on Armco oriented electrical steels are made at an induction of 96,750 lines psi. (15 kilogausses). Test limits are based on the general testing procedure approved by the American Society for Testing Materials, except that parallel-grain specimens are given a stress-relieving anneal after shearing.

GET THIS BOOKLET

If you can profit from the advantages of these new steels in your electrical products, write for additional information. We shall be glad to send you a copy of the booklet "Armco Oriented Electrical Steels." Just address The American Rolling Mill Co., 368 Curtis Street, Middletown, Ohio.

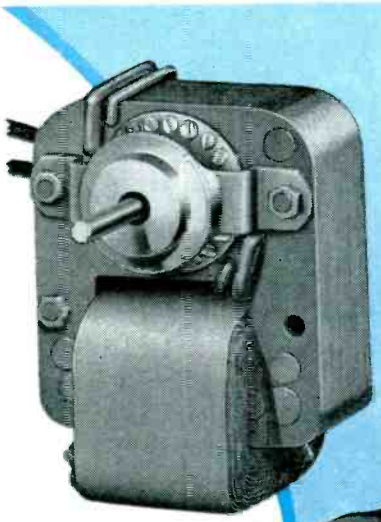


ARMCO ORIENTED STEELS

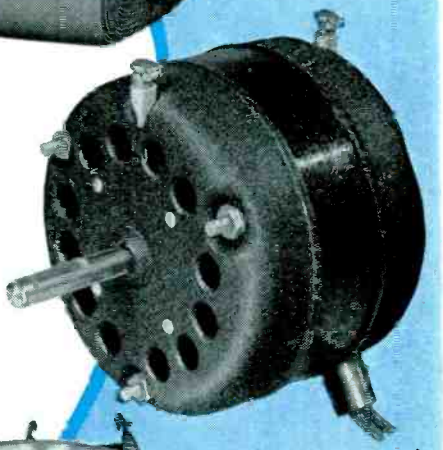
MAKE IT MOVE with alliance MOTORS

Alliance Motors operate automatic controls, valves, switches, fans and blowers, air circulators, motion displays, phonograph turntables, record changers, air conditioning units, room heaters, automobile heaters, electric fans, magnetic disc tape and wire recorders, toys, business machines and numerous other devices.

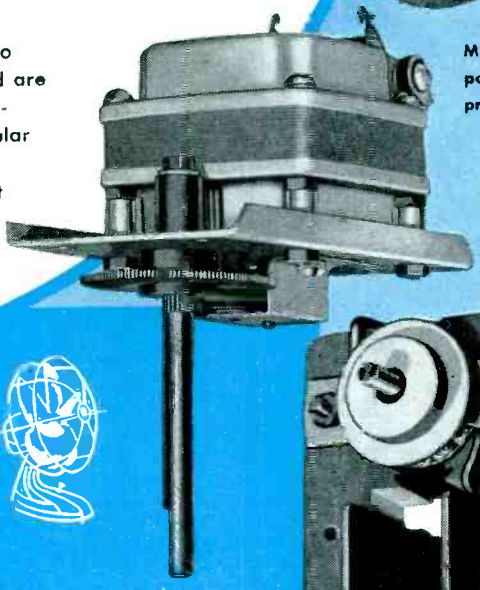
Horse power ratings range all the way from 1/400th up to 1/30th h.p. Alliance Motors are light-weight, compact, and are mass-produced at low cost—made in both shaded pole induction and split-phase resistor type. Designed for particular jobs, some are uni-directional, others are reversible. Alliance makes motors for both continuous and intermittent duty. Wherever designs call for *more motion*—automatic action—remember, there is an Alliance Motor for the job!



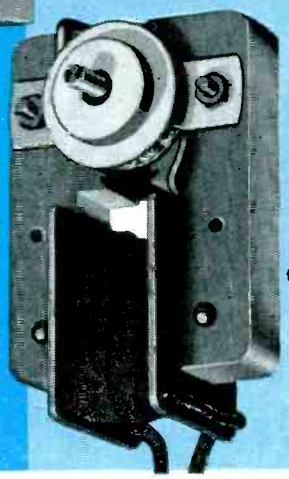
Model K shaded pole induction type will develop up to 1/100th h.p.



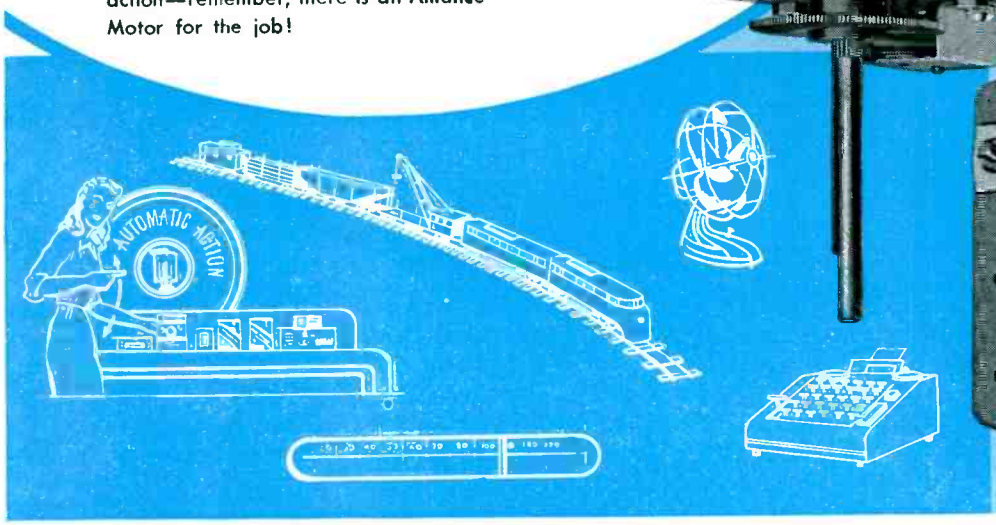
Model A fan motor, 6-pole shaded design. Approximately 1/30th h.p.



Model ER—fully enclosed, split-phase resistor type with or without gears.



Model MS shaded pole induction type motor, full load h.p. .0021

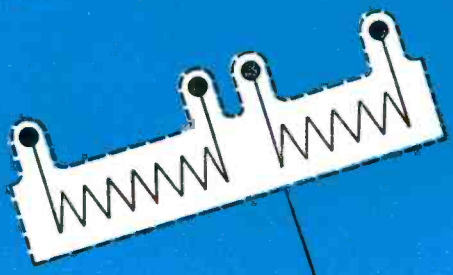


WHEN YOU DESIGN—KEEP alliance MOTORS IN MIND

ALLIANCE MANUFACTURING COMPANY • ALLIANCE, OHIO

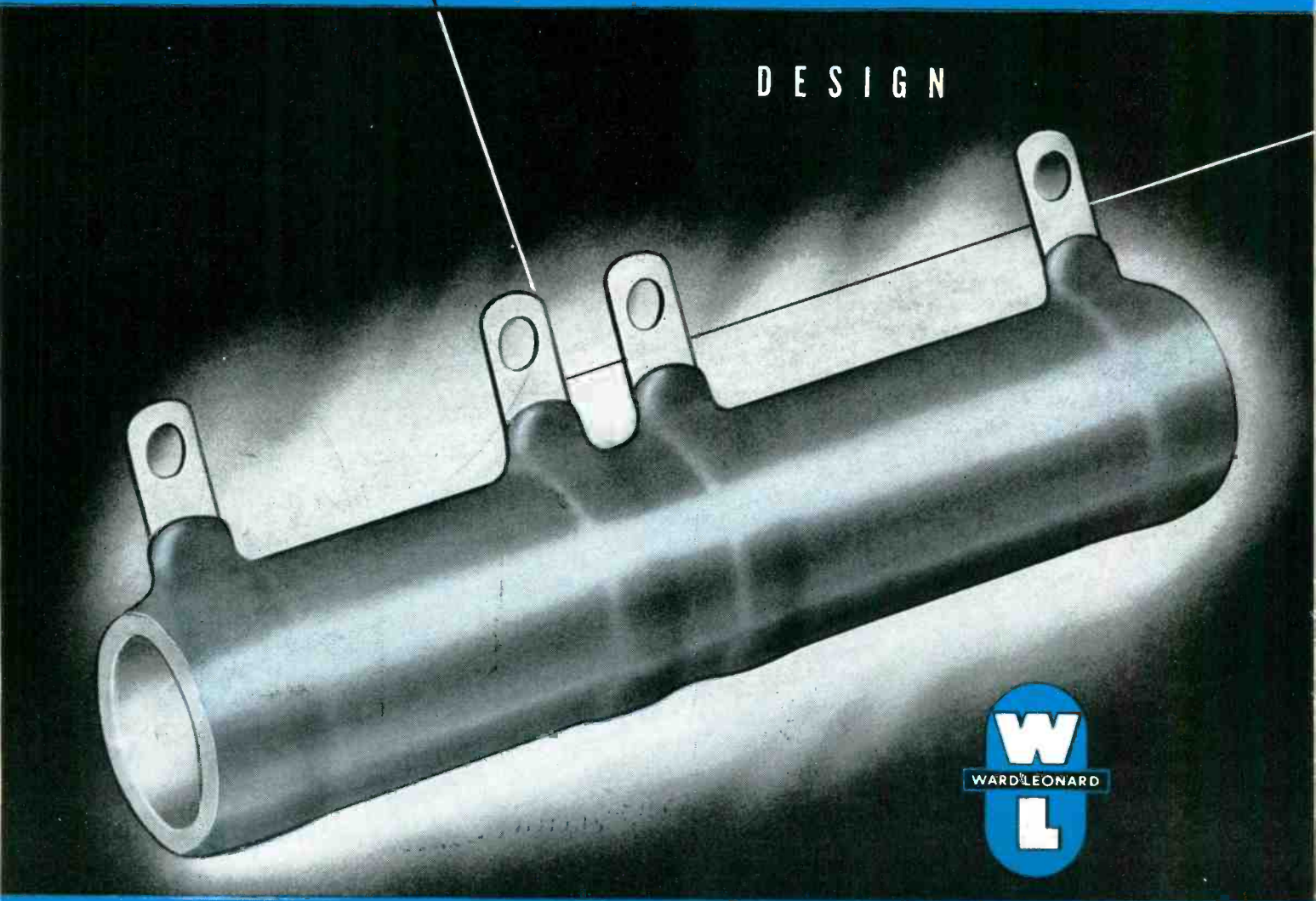
Export Department: 401 Broadway, New York 13, N. Y., U. S. A.

Siamese Twin Resistor



SAVES 40%

IN TELEVISION SET ASSEMBLY COST



WARD LEONARD ELECTRIC CO.

Where Basic Designs in Electric Controls

In a television receiver circuit, two power wound resistors were needed, but the space for mounting them was hard to find.

So Ward Leonard suggested: instead of two separate resistors, each requiring individual mounting and installation, let's make a single Vitrohm unit with two *electrically independent* resistance windings.

This unit is mounted just like any single resistor.

RESULT: less space needed . . . assembly cost cut 40%!

FOR YOUR PRODUCT'S FASTER ASSEMBLY... OR BETTER PERFORMANCE— PUT THE PROBLEM THROUGH

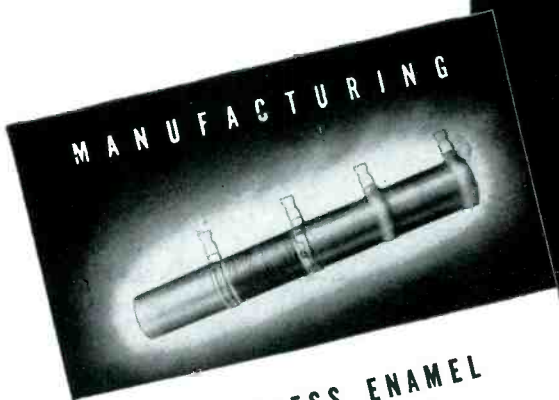
Result – Engineering

As this case shows, it often happens that by a slight modification of a basic design or by use of a certain manufacturing method, Ward Leonard can give you the *exact* result you need—without the extra cost of a *special* design.

Before you decide to "make the best" of a "standard" component, or pay a premium for a "special", submit the problem to Ward Leonard. At no obligation, see if "Result-Engineering" can't work out the solution for you.

Blue means "Result - Engineering" in resistors, rheostats, relays and other electric controls. The distinctive blue identifies Ward Leonard "Result - Engineering"

FREE BULLETINS on "Result-Engineered" Resistors. (*Please request on business letterhead, mentioning your title.*) WARD LEONARD ELECTRIC CO., Mount Vernon, New York. *Offices in principal cities of U. S. and Canada.*



CRAZELESS ENAMEL CHASES HEAT

VITROHM Resistors are processed with a special vitreous enamel of Ward Leonard's own manufacture. VITROHM—tough, hard, moisture and acid resisting—fuses tightly to base (a) terminal connection (b) and wire (c) providing a medium (d) for quickly dissipating heat and protecting the resistance element.

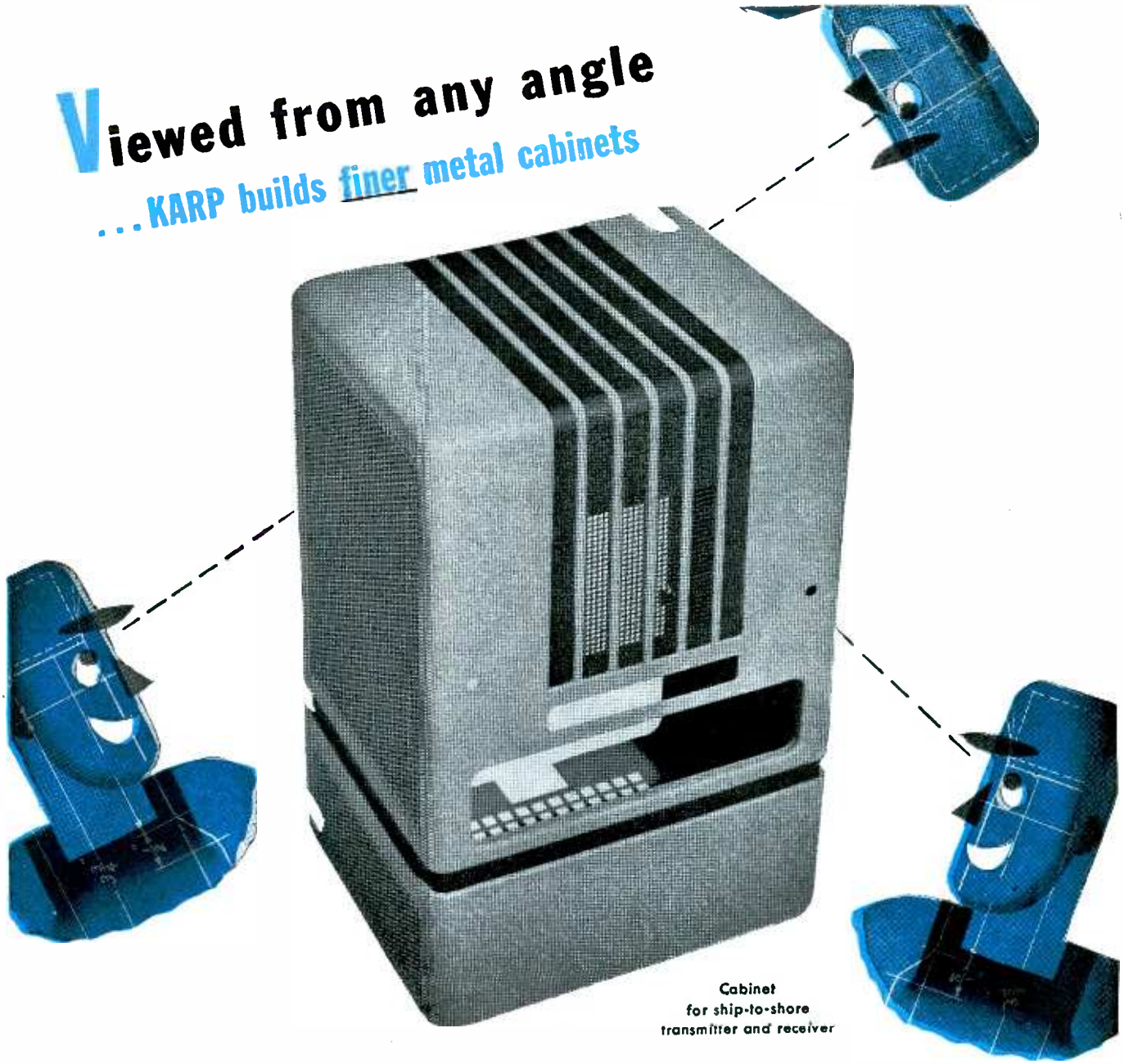
Result: wire and surface temperatures maintained within close range.

RESISTORS • RHEOSTATS
RELAYS • CONTROL DEVICES

are "Result-Engineered" for You

Viewed from any angle

...KARP builds finer metal cabinets



Cabinet
for ship-to-shore
transmitter and receiver

No matter how you look at it, you'll find many reasons why Karp-built cabinets, housings and enclosures will add value to completed equipment assemblies.

We will follow your designs with fidelity, or our design specialists can suggest design ideas which will enhance appearance, achieve ruggedness, save space or weight. Our work insures uniformity and accuracy—which mean production economy both in the fabrication and in your own assembling operations.

At your service is our staff's combined "know-how" gained in 22 years of specialization. Our tool and die department is so complete that we often save customers special die costs. We make our own dies and do all our own finishing. We do all kinds of welding—including spot-welding of aluminum with electronic timing controls.

It's the hard-to-do type of craftsmanship that brings out the best in our trained minds and skilled hands. We invite your inquiries on any sheet metal fabrication.

Any Metal • Any Gauge • Any Size
Any Quantity • Any Finish

KARP METAL PRODUCTS CO., INC.

124 - 30th STREET, BROOKLYN 32, NEW YORK

Custom Craftsmen in Sheet Metal

Steatite SEALEX BUSHINGS

the GUARANTEED hermetic seal!

Pressure tested, shockproof Sealed Leads and Multiple Headers

Whether your terminal problem involves vibration, temperature, hermetic sealing or ordinary lead termination, GENERAL CERAMICS Steatite Sealex Bushings and Multiple Headers offer important advantages that reduce assembly costs and improve product quality. Mounting as a single unit, they can be quickly soldered, welded or sweated to the equipment enclosure and provide perfect termination for one or as many leads as required.

GENERAL CERAMICS Sealex Bushings and Multiple Headers are available in many standard sizes and types suitable for most applications. Special types can be supplied on short notice. Hermetic sealing is absolute and each unit is individually pressure tested at 50 psi; all metal parts are hot-tinned for fast soldering. Sealex Bushings are available in sizes from 0.5 to 20 amps with flashover ratings to 40 Kilovolts. Steatite — the insulation used in these products — has a low loss factor of only 0.7% at 1000 K.C., which recommends the use of these terminals at practically any frequency.

WRITE TODAY FOR CATALOG!

GENERAL CERAMICS engineers will gladly assist in applying Steatite Sealex terminals to your equipment, or will collaborate in developing special types for unusual conditions. An informative, fully illustrated catalog covering all General Ceramic insulators, is available free upon request on company letterhead. Write for your copy today!

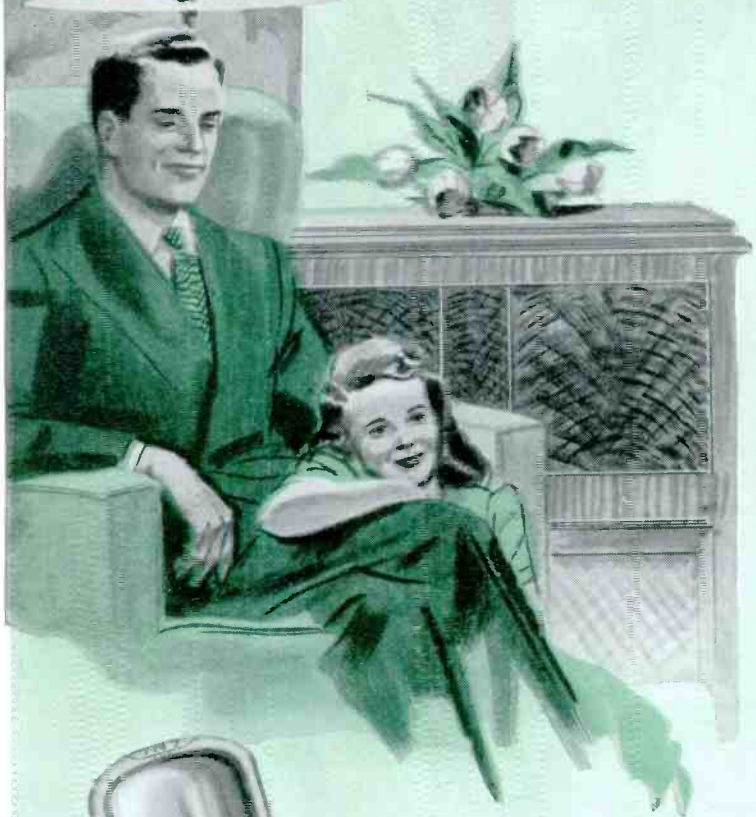
GENERAL CERAMICS · STEATITE CORPORATION · STEATITE INSULATORS

General CERAMICS and STEATITE CORP.

GENERAL OFFICES and PLANT: KEASBEY, NEW JERSEY

MAKERS OF STEATITE, TITANATES, ZIRCON PORCELAIN, ALUMINA, LIGHT-DUTY REFRACTORIES, CHEMICAL STONEWARE

Why the *Lock-In* Tube is at home in FM



ULTRA-HIGH FREQUENCIES . . . HANDLED WITH EASE
The Sylvania Lock-In is *the* tube specifically engineered to more than satisfy the requirements of Frequency Modulation — handles ultra-high frequencies with ease! Some reasons for this electrical superiority are: short, direct connections . . . fewer welded joints — less loss; getter located on top . . . shorts eliminated by separation of getter material from elements.

STAYS PUT IN SOCKET . . . MECHANICALLY RUGGED
Specially designed "lock-in" locating lug on each tube keeps it in place—assuring firm socket contact. Improved tube mount keeps elements ruggedly supported on all sides. There are few welded joints and *no* soldered joints—the elements can't warp or weave.

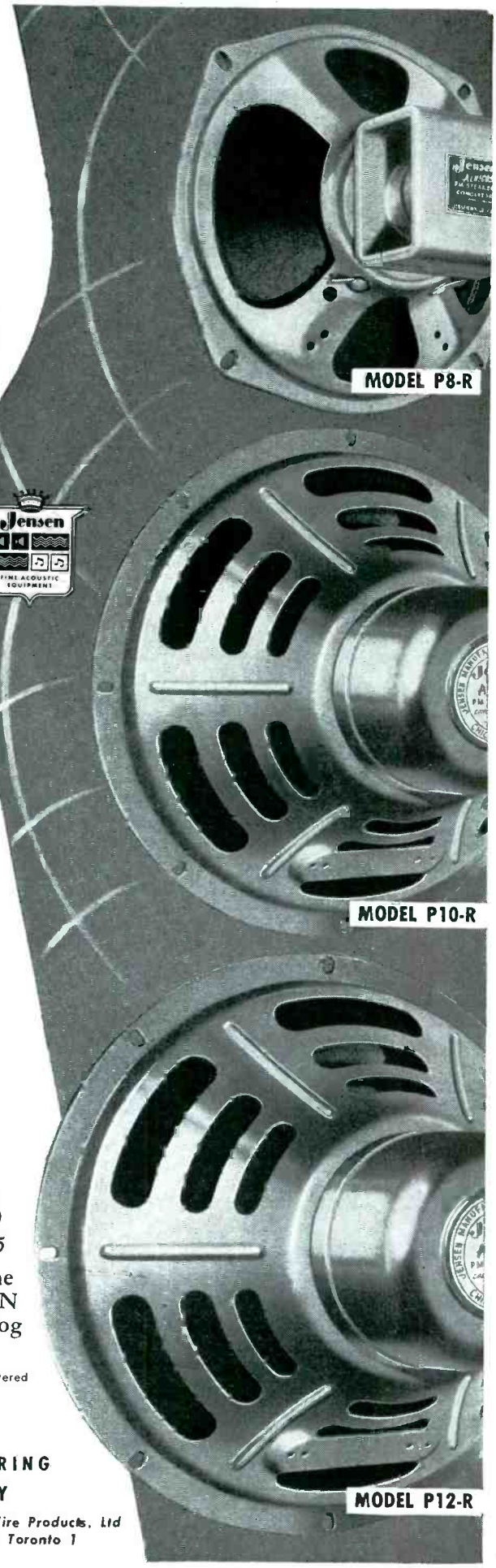
COMPACT . . . MADE TO FIT SMALL SPACES
This famous Sylvania product is ideal for use in modern sets, where the tendency has been toward more compact units—has reduced overall height and weight. Has no top cap connection . . . overhead wires are eliminated! *See Sylvania Distributors or write Radio Tube Division, Emporium, Pa.*

SYLVANIA'S LOCK-IN TUBE . . .
. . . the radio tube whose electrical and mechanical superiority makes it the ideal choice for FM and television, equipment in the air, on the road, marine radar.

SYLVANIA ELECTRIC

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

Listen it's a Jensen SPEAKER



3 New CONCERT* SERIES PM SPEAKERS

with Alnico 5 "R" Motors

The new JENSEN Concert Series speakers illustrated are now available at price levels only slightly higher than the well-known Standard Series models P12-S, P10-S and P8-S. These new "R" speakers offer unequaled values in power handling capacity, in efficiency, and in response-frequency. Overall performance is just a notch below that of the famous JENSEN PM12-H (now P12-Q), PM10-H (now P10-Q) and PAH-8 (now P8-Q), at substantial price savings.

Model P12-R, ST-103 — 12 watts $19.50
Model P10-R, ST-121 — 10 watts 18.50
Model P8-R, ST-169 — 9 watts 15.25

For complete information on *all* models in the Concert series, as well as on other JENSEN equipment, send today for JENSEN Catalog No. 1010. Use the handy coupon below.

*Trade Mark Registered

JENSEN MANUFACTURING CO.
6607 South Laramie, Chicago 38, Illinois
Please send me a copy of the 1947 Jensen catalog.

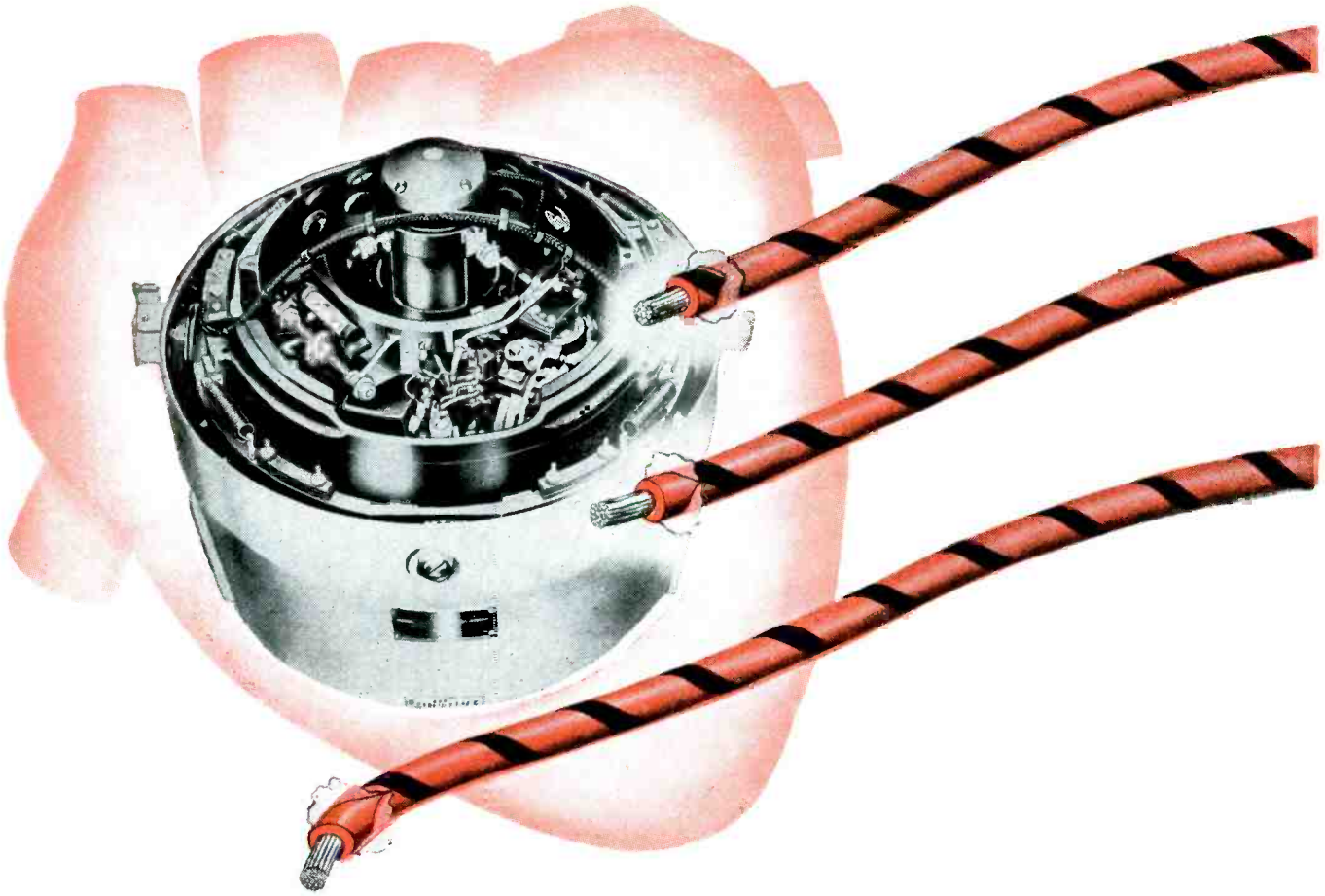
Name_____

Address_____

City_____ Zone___ State_____

JENSEN MANUFACTURING COMPANY

In Canada: Copper Wire Products, Ltd 11 King St. W., Toronto 1



ARTERIES FOR A SHIP'S HEART GET PROTECTION WITH DU PONT NYLON

In wiring for the Arma gyro compass, tough, long-lasting nylon jacketing resists heat, oils, abrasion, and flexing

The heart of a modern ship is the gyro compass—which tells the navigators what course they're on.

Arma Corporation of Brooklyn, N. Y., makes gyro compasses for the Navy. Naturally, they make them with the best materials obtainable. And that's why they're using connective wiring jacketed with Du Pont nylon.

Arma says that before adopting this wire jacketed with nylon they tested wire with many and various jacketing materials. None before nylon met the rigid specifications. None sufficiently withstood lubricating oils, heat and hard mechanical abuse.

Nylon-jacketed wire not only meets every one of the specifications, but a much thinner jacket is required than with previous jacketing materials, and thus space is saved.

Surprenant Manufacturing Company of Boston, manufacturer of the wire, has this to say: "As an extrusion jacket of protective covering on wire, nylon is unsurpassed in present-day thin-wall extrusion. The abrasion resistance of nylon is greater than that of any existing material used in a like manner. Nylon has a 'slick' surface that allows easy movement through narrow apertures. In addition it has the desirable properties of very high tensile strength and great extensibility. Compression strength, necessary especially in a protective covering, is more than adequate. To these properties can be added the more apparent features of ease of extrusion with proper controls and ability to color in delicate shades when required."

When you think of jacketing for wire and cable, think of Du Pont nylon. It is tough and abrasion-resistant, able to stand flexing and rubbing over extended periods. It can resist heat, oils, many chemicals, salt water and fresh water, and aging. Write us *today* for more information. E. I. du Pont de Nemours & Co. (Inc.), Plastics Department, Room 1410, Arlington, New Jersey.

DU PONT
REG. U. S. PAT. OFF.
Plastics
BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY

● Today when production costs are moving up and raw materials are still scarce in many industries engineers are improving measurement and control of all processes.

For surface finish measurement many engineers have turned to the Surface Analyzer*. Perhaps in your industry, too, the exact microinch analysis of surface finish is important.

The Surface Analyzer checks surface finish from less than 1 to 5000 microinches. Permanent, instantaneous direct-inking oscillograph chart record is obtained by exploring the surface with a diamond point—the motion of which is magnified and recorded on a moving paper chart. In cases where "peak and valley" chart profiles are not needed, the Brush "RMS" meter provides a constant visual check of average surface roughness. For a profile chart of an actual surface or an instant "average" reading, the Surface Analyzer is unequalled.

Why not look into the Surface Analyzer today?

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

THE Brush DEVELOPMENT COMPANY

Canadian Representatives:
A. C. Wickman, (Canada) Ltd., P. O. Box 9, Station N, Toronto 14

3405 Perkins Avenue • Cleveland 14, Ohio, U.S.A.

MAGNETIC RECORDING DIV. • ACOUSTIC PRODUCTS DIV.

INDUSTRIAL INSTRUMENTS DIV. • CRYSTAL DIVISION

Now in a New and Up-to-Date Catalog Line

CHICAGO TRANSFORMERS and REACTORS

Sealed in Steel

For years, Chicago Transformer has met with outstanding success the varying requirements of the electronics industry for top-quality, custom-built transformers and reactors. Today, C.T. is augmenting this service to the industry with a new catalog line of units, to be manufactured on a standard design basis.

Now, small-quantity purchasers of transformers in the various fields of electronics—broadcast, communications, experimental, amateur, public address, and industrial control—can acquire for their equipment the advantages of progressive, practical C.T. engineering.

Now, large-scale manufacturers of electronic equipment who are in a position to utilize standard components can find in C.T.'s new catalog the transformer ratings and constructions that will fit their latest designs.

Characteristics of this new line are as up-to-date as tomorrow's laboratory project. Ratings have been skillfully selected, by men who know the trends in circuit design, to achieve maximum flexibility of application, close matching with today's preferred types of tubes, and conformance with RMA and FCC standards.

Modern, too, is the type of mounting used. Drawn steel cases and three variations of Chicago Transformer's famous Sealed in Steel construction will offer the combined advantages of "steel wall" protection against moisture and corrosion, efficient magnetic shielding, vibration-proof mechanical strength, compactness, and a streamlined appearance that spells "eye appeal" in finished equipment.

For further details, write for catalog

THE POWER LINE

Plate and Filament Supply Transformers with high voltage secondaries for both capacitor-input and reactor-input systems, and with corresponding filament supplies.

Plate Transformers for use in low to medium high power transmitters.

Filter Reactors accurately matched with the Plate and Filament Supply and Plate Transformers above.

Filament Transformers for supplying the filaments of today's most widely used tubes.

Bias Transformers—combination plate and filament supply.

Step-Down Transformers for operating radios and appliances on 220 volts, 50/60 cycles, in the export trade.

THE AUDIO LINE

Full-Frequency Range, 30 to 15,000 Cycles, provides uniform response over this entire band with ± ½ db up to 10 watts of audio power, within ± 1 db over 10 watts. Standard RMA impedances. Included are Input, Output, Driver, and Modulation Transformers; Modulation Reactors.

Public Address Range, 50 to 10,000 Cycles, frequency response within ± ½ db up to 10 watts of power, within ± 1 db over 10 watts, throughout this range. Secondary impedances match 600 and 150-ohm lines, 16, 8, and 4-ohm reproducing systems. Listed are Driver and Output Transformers.

Commercial Range, 200 to 3,500 Cycles, affords response with variations not exceeding ± 1 db over the range of voice frequencies. For use with 600 or 150-ohm lines. Input, Output, Driver, and Modulation Transformers offered.

CHICAGO TRANSFORMER

DIVISION OF ESSEX WIRE CORPORATION

3501 ADDISON STREET • CHICAGO 18, ILLINOIS

HOW TO BE SURE YOU GET THE BEST

D-C capacitors

You can

test the paper for density . . . thickness . . . porosity . . . power factor . . . chloride content . . . dielectric constant . . . dielectric strength.

And then test the foil for thickness . . . purity . . . softness of the anneal . . . freedom from oil . . . cleanliness of surface . . . absolute smoothness.

And then test the liquid dielectric for specific gravity . . . viscosity . . . power factor . . . color . . . acidity . . . flash point . . . dielectric strength . . . dielectric constant . . . insulation resistance . . . water content.

And after that, test every single finished capacitor for shorts, grounds, and opens at overvoltage between terminals and between terminals and case . . . and measure the capacitance of every single unit . . . and then check every single capacitor to see that it has an air-tight, leak-proof hermetic seal.

Or you can

buy General Electric capacitors . . . which have already passed every one of these tests

. . . on the materials when they were made.

. . . and again before they were used. . . . and on the capacitors during manufacture.

. . . and then, finally, on every single capacitor before shipment.

SPECIALTY CAPACITORS

General Electric makes a wide variety of specialty capacitors, all of which must pass similar comprehensive tests. For full information on types, ratings, dimensions, types of mounting, and prices, address the nearest General Electric Apparatus Office or *Apparatus Department, General Electric Company, Schenectady 5, N. Y.*

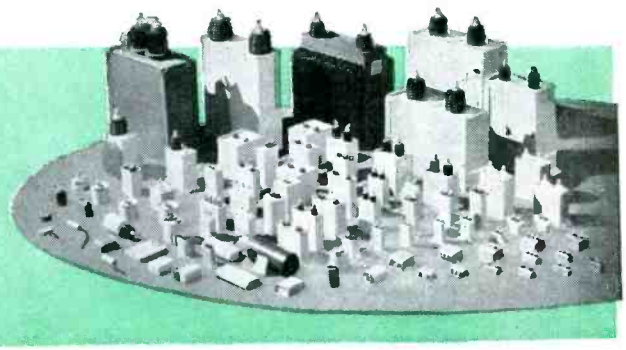
GENERAL ELECTRIC

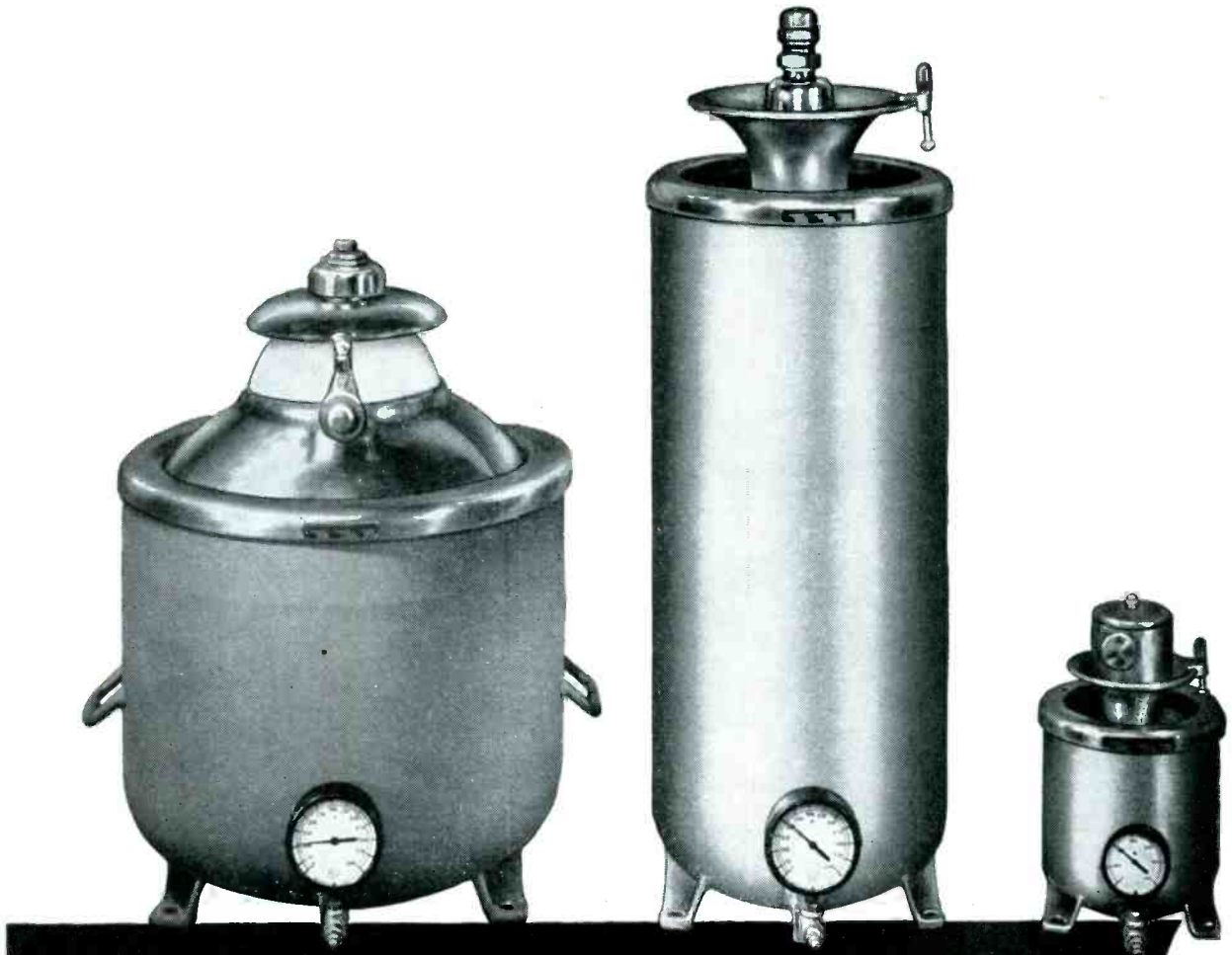
407-145

Specialty Capacitors FOR

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

AND MANY OTHER APPLICATIONS





NO INCREASE IN PRICE

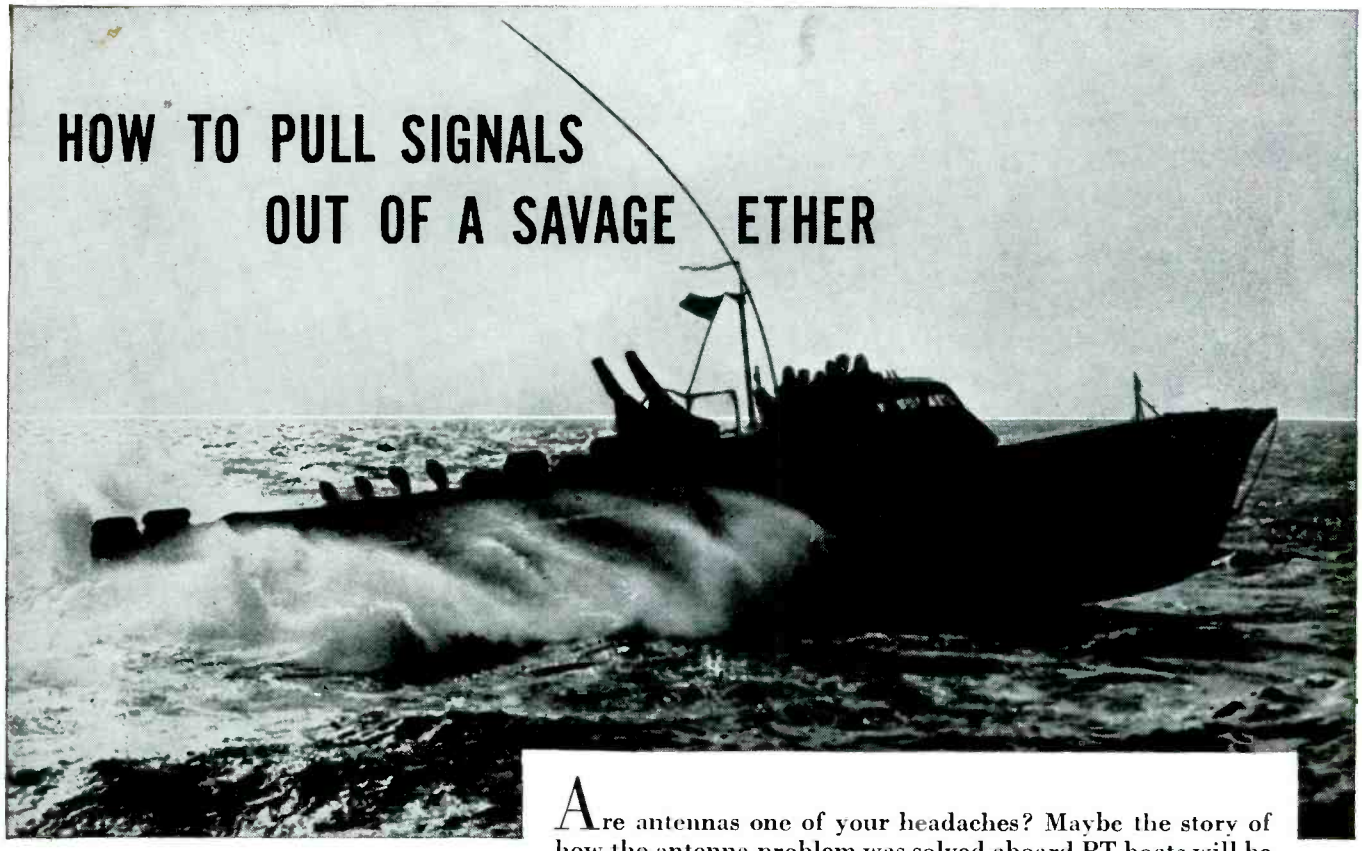
LAPP GAS-FILLED CONDENSERS AT PREWAR PRICES . . .

There's good news for designers and builders of high voltage electronic circuits who find themselves caught in an inflationary spiral of costs. No advance in prices has been announced —none is contemplated—for Lapp Gas-filled Condensers. Known as the most satisfactory source of high current and high voltage capacitance, these units offer non-deteriorating, dependable performance; impossibility of puncture; lowest loss with consequent economy of power; constant capacitance under temperature variation; and compact, space-saving design. Variable, adjustable, and fixed units are available with current ratings up to 500 amperes R.M.S., power ratings up to 60 Kv peak. Units now in service range up to 60,000 mmf. (fixed units), 16,000 mmf. (variable and adjustable units).

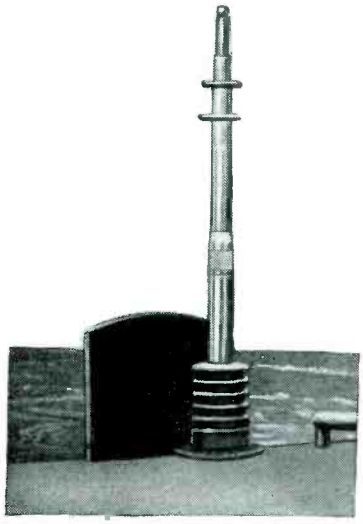
Lapp

LAPP INSULATOR COMPANY, INC., LE ROY, NEW YORK

HOW TO PULL SIGNALS OUT OF A SAVAGE ETHER



Roaring into action on fighting PT boats, Premax Monel antennas defied salt spray, weather, and whipping wind.



Premax Monel Antennas are built in multiple sections of tough, cold-drawn Monel tubing, telescoped one inside the other. Above illustration shows antenna in fully telescoped position.

Are antennas one of your headaches? Maybe the story of how the antenna problem was solved aboard PT boats will be of some help to you.

PT antennas had to fight corrosive salt air and water. They needed strength and stiffness to withstand whipping winds and plunging boats. They had to function in arctic cold and tropic heat.

An answer was worked out for the Navy by Premax Products Division of Chisholm Ryder Co., Inc., Niagara Falls, N.Y. It consisted of telescoping tubular antennas, made of sections of seamless tubing furnished by the Superior Tube Co., Norristown, Pa.

The metal that met the combination of conditions?—Monel.* To quote Premax engineers:

> *"Monel has been found to be the most practical material for radio antennas. Sudden shocks do not affect its toughness . . . its fatigue strength exceeds the limits of mild steel or all brasses and bronzes.*
>
> *"Rigid tests by both Government and private agencies have shown Monel antennas to be dependable and satisfactory under all conditions."*

Do you have an electrical problem that can be solved by the combination of properties obtainable in Monel . . . or the other Inco Nickel Alloys?

All are strong, tough, and corrosion resistant. In addition, each has special properties needed for special jobs. Write us describing your problem. Our technical assistance is yours whenever you ask for it.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N.Y.

Monel*

EMBLEM OF SERVICE
NICKEL INCO ALLOYS

MONEL* • "K"* MONEL • "S"* MONEL • "R"* MONEL • "KR"* MONEL
INCONEL* • NICKEL • "L"* NICKEL • "Z"* NICKEL *Reg. U.S. Pat. Off.

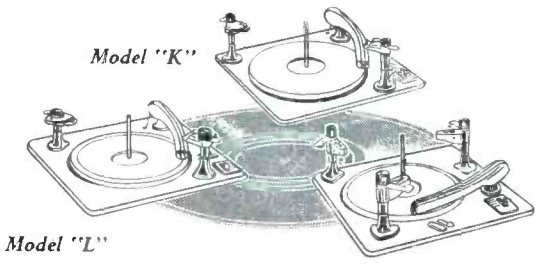
More sales appeal

. . . thanks to a better changer

From symphony to swing . . . from classics to conga—records have never been more in demand. It's logical then that the record changer frequently influences the sale of a radio-phonograph combination. That's why so many leading radio manufacturers have made Seeburg Record Changers standard equipment on their fine combination instruments.

Seeburg makes three fine changers. While each is for sets of varying price range, all are engineered to provide simple, reliable, trouble-free performance . . . the last word in listening pleasure.

Plan now to build more sales appeal into your instruments by equipping them with Seeburg Changers. Seeburg's broad experience in the design and manufacture of all kinds of changing mechanisms is your guarantee of satisfaction.



Seeburg

RECORD CHANGERS ★ MUSIC SYSTEMS

J. P. SEEBURG CORPORATION
1500 N. Dayton St., Chicago 22

Dispose of problems like these . . .

Often there are problems in your own backyard which have been around so long that you are used to them . . . even forget they are problems! A review of your manufacturing process may disclose problems that **"dag"** colloidal graphite can dispose of for you.

"dag" colloidal graphite is unctuous, electrically conductive, resistant to extremes of temperature, chemically inert, opaque, heat conductive, photoelectrically insensitive, gas absorbent, diamagnetic, microscopic in size.

Among these properties, or in a combination of them, may be the correction for a profit-eater in your operation. Let Acheson engineers share the problem with you. Meanwhile, send for informative literature and get an idea of the surprising problems that **"dag"** colloidal graphite has solved for many manufacturers.

ACHESON COLLOIDS CORPORATION, Port Huron, Michigan

This new literature on **"dag"** colloidal graphite is yours for the asking:

460 A data and reference booklet regarding **"dag"** colloidal graphite dispersions and their applications. 16 pages profusely illustrated.

421 Facts about **"dag"** colloidal graphite for ASSEMBLING AND RUNNING-IN ENGINES AND MACHINERY.

422 Facts about **"dag"** colloidal graphite as a PARTING COMPOUND.

423 Facts about **"dag"** colloidal graphite as a HIGH TEMPERATURE LUBRICANT.

431 Facts about **"dag"** colloidal graphite for IMPREGNATION AND SURFACE COATINGS.

432 Facts about **"dag"** colloidal graphite in the FIELD OF ELECTRONICS.

ACHESON COLLOIDS CORPORATION
PORT HURON, MICHIGAN, DEPT. K-5

Please send me, without obligation, a copy of each of the bulletins checked:

460 ☐ NAME_____

421 ☐ POSITION_____

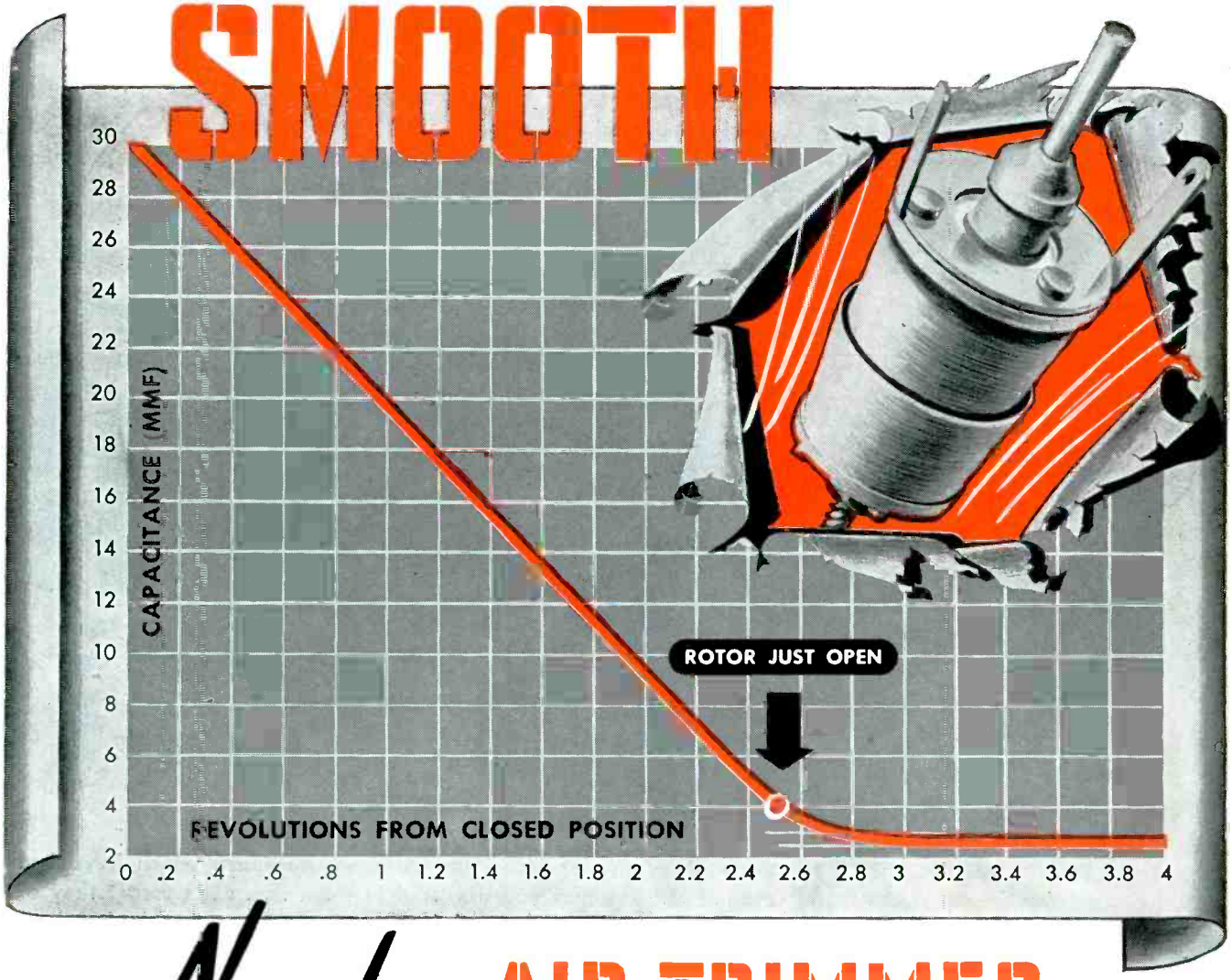
422 ☐ FIRM_____

423 ☐ STREET_____

431 ☐ CITY_____ ZONE_____

432 ☐ STATE_____

SMOOTH



Norelco AIR TRIMMER

The smooth linear characteristics illustrated result from the mechanical design of the NORELCO Air Trimmer. This concentric design makes adjustment alignment and testing procedures extremely simple.

Permanence of adjustment and resistance to mechanical shock assures complete freedom from microphonism.

Low minimum capacitance, high "Q", light weight and small mounting area result in general acceptance of NORELCO Air Trimmer for applications in F. M. discriminators, Television I.F. transformers and other high frequency circuits.

Exact Size

A booklet describing the NORELCO Air Trimmer and a working sample will be supplied to interested manufacturers upon request. Contact our representative in your area, or write directly to Philips.

✓ CHECK THESE FEATURES:

- "Q" over 850 at 1500 kc.
- D.C. insulation resistance greater than 50,000 megohms for relative humidities up to 50%.
- Minimum capacity—2.5 mmf.
- Parallel Damping—greater than 3 megohms at max. cap.—when measured at 1500 kc.
- Maximum capacity—over 30 mmf.

Special variable air condensers ranging from 5 mmf. minimum are now available. Write us regarding specific applications.

Norelco
Reg. U. S. Pat. Off

ELECTRONIC PRODUCTS

NORTH AMERICAN PHILIPS COMPANY, INC. DEPT. E-10, 100 EAST 42ND STREET NEW YORK 17, N. Y.

IN CANADA: PHILIPS INDUSTRIES, LTD., 1203 PHILIPS SQUARE, MONTREAL

Now...

YOU can improve the quality of your sound systems

New Western Electric loudspeakers feature clear, *natural* reproduction

Now everyone can enjoy truly lifelike sound reproduction, unmatched tonal brilliance—with these small, wide range Western Electric loudspeakers.

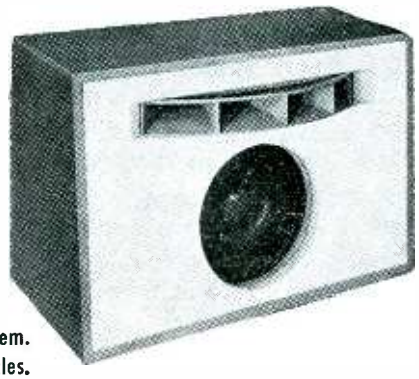
Designed by Bell Telephone Laboratories, they meet today's demand for truly *high quality* sound reproduction. They're part of a complete line that now makes such reproduction available for *every* type of application—from home radios and record players to giant public address systems.

For full details, get in touch with the nearest office of Graybar Electric Company (offices in 95 principal cities) or send the coupon to Graybar.

728B—12" direct radiator.
30 watts. 60—10,000 cycles.

756A—10" direct radiator.
20 watts 65—.0,000 cycles.

755A—8" direct radiator.
8 watts. 70—13,000 cycles.



757A — dual unit system.
30 watts. 60—15,000 cycles.

Distributed by GraybaR
OFFICES IN 95 PRINCIPAL CITIES

Western Electric

— QUALITY COUNTS —

Graybar Electric Company E-2
420 Lexington Ave., New York 17, N. Y.

Gentlemen: Please send me literature describing the new line of Western Electric loudspeakers.

*Name*_____

*Company*_____

*Address*_____

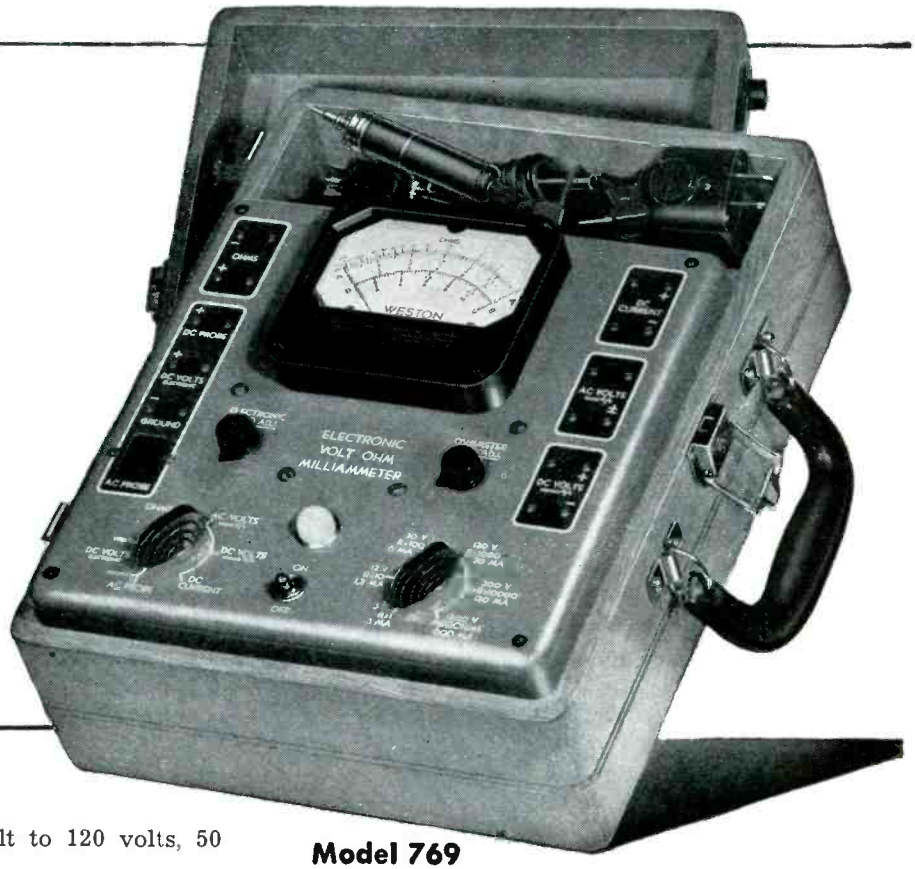
*City*_____ *State*_____

NOW One INSTRUMENT FOR ELECTRONIC MEASUREMENTS

WESTON ELECTRONIC ANALYZER

Incorporating:

1. ***A conventional Volt-Ohm-Milliammeter with self-contained power source.***
2. ***A high-impedance electronic Volt-Ohmmeter using 115 volt, 60 cycle power.***
3. ***A stable, probe-type, Vacuum Tube Voltmeter, for use to 300 megacycles.***



Model 769

Accurate a-c measurements .25 volt to 120 volts, 50 cycles to 300 megacycles.

Extremely small R.F. Probe (3½" x ¾" dia.). Probe constants, 5 megohms paralleled by 5 mmfd., approx.

New unity gain d-c amplifier provides absolute stability with line voltage variations from 105 to 130 volts.

D-C Electronic amplifier ranges 3 to 1200 volts at 15 megohms, resistance ranges 3000 ohms to 3000 megohms.

Conventional 10,000 ohm per volt d-c ranges 3 to 1200 volts, 1000 ohm per volt a-c rectifier ranges 3 to 1200 volts.

Resistance ranges 3000 to 300,000 ohms where a-c power is not available.

Entire Model 769 protected from external RF influences.

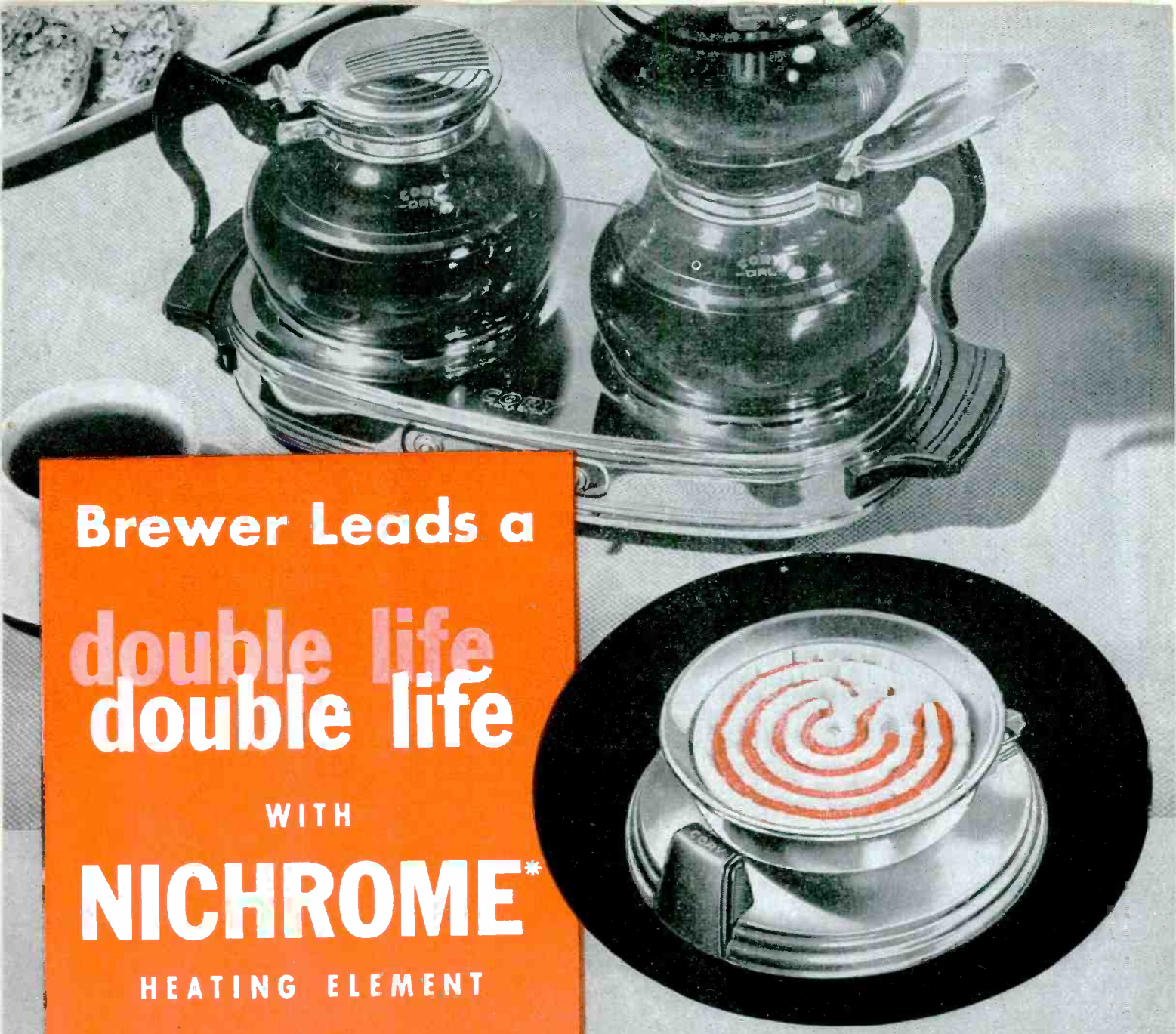
Uses standard commercial types of tubes replaceable without recalibration.

Size only 10" x 13" x 6⅛".

Full details from your jobber or local WESTON representative. Literature available . . . Weston Electrical Instrument Corporation, 618 Frelinghuysen Avenue, Newark 5, New Jersey.

WESTON Instruments

ALBANY · ATLANTA · BOSTON · BUFFALO · CHARLOTTE · CHICAGO · CINCINNATI · CLEVELAND
DALLAS · DENVER · DETROIT · JACKSONVILLE · KNOXVILLE · LITTLE ROCK · LOS ANGELES
MERIDEN · MINNEAPOLIS · NEWARK · NEW ORLEANS · NEW YORK · PHILADELPHIA
PHOENIX · PITTSBURGH · ROCHESTER · SAN FRANCISCO · SEATTLE · ST. LOUIS
SYRACUSE · IN CANADA, NORTHERN ELECTRIC CO., LTD., POWERLITE DEVICES, LTD.



Brewer Leads a double life double life WITH NICHROME* HEATING ELEMENT

A single heating element which provides a choice of two heats — one high for quick coffee brewing — one low for keeping it piping hot — is the heart of a new coffee brewer manufactured by the Cory Corporation of Chicago.

Like hundreds of other *quality* electrical appliances, the Cory coffee brewer is equipped with a *Nichrome* heating element — for *Nichrome* can be depended upon to deliver the desired heat throughout a life-time of trouble-free, economical operation.

Because of its excellent electrical properties, strength and thermal durability, *Nichrome* has been the standard of quality in electrical heat and corrosion-resistant alloys for more than 38 years — *and Nichrome is made only by . . .*

Nichrome IS THE HEART OF GOOD ELECTRICAL APPLIANCES

Driver-Harris COMPANY

HARRISON • NEW JERSEY

BRANCHES: Chicago • Detroit • Cleveland • Los Angeles • San Francisco • Seattle
The B. GREENING WIRE COMPANY, LTD., Hamilton, Ontario, Canada

SPECIAL PURPOSE ALLOYS SINCE 1889 — D/H — TRADE MARK REG. U. S. PAT. OFF.

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

PRODUCTIVE LIGHTING IS *Controlled* BY EACH USER ...FOR EACH OCCASION

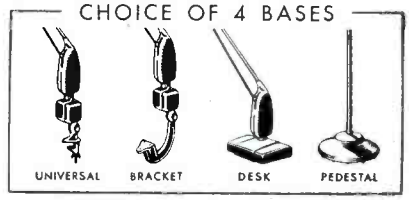
Trained eyes and hands have an ally in the Dazor *Floating* Lamp, whether they're teamed in the first-aid room, at a high-speed machine or across an executive desk. By *floating* the light to the best position for seeing, the user completely controls intensity and position. And a finger-tip touch *changes* either, each time the job requirements change.

If you are accustomed to stationary lighting, or a lamp of restricted motion, the free movement of light in *all planes* will intrigue you. Dazor alone has the patented *Floating* Arm and its device for holding the reflector firmly, without locking or manual tightening.

But more important than the *how* is the *why* of Dazor illumination. Employees who enjoy this comfortable, glareless lighting see fine details more clearly on machining, assembly, inspection, drafting and other exacting operations. As errors and hazards decline, there is a rise in morale. Special skills come to the front and productivity shows a gain.

Phone Your Dazor Distributor for typical applications by other users or an on-the-spot demonstration. For the name of this nearby lighting authority, if unknown to you, write to Dazor Manufacturing Corp., 4481-87 Duncan Ave., St. Louis 10, Mo. *In Canada* address inquiries to Amalgamated Electric Corporation Limited, Toronto 6, Ontario.

MOVES FREELY INTO ANY POSITION AND STAYS PUT — *WITHOUT LOCKING*



DAZOR FLOATING LAMPS

FLUORESCENT and INCANDESCENT

Now Available---

A Line of PLASTICON* GLASSMIKE RF Transmitting Capacitors

(actual size)

Superior to mica capacitors because:

- **Greater safety factor**
  (3500 VDC Operating; 7500 VDC Test)
- **Lower RF losses**
  (See current rating below)
- **More conveniently mounted**
- **Less chassis space**
- **Smaller overall volume**
- **Impervious to moisture**
  (The GLASSMIKE construction is 100% sealed)
- **Silicone-fluid filled**

The above advantages are possible by the use of the Type L film dielectric which has lower losses than mica.

● ● ●

TYPE LSG — PLASTICON* GLASSMIKES

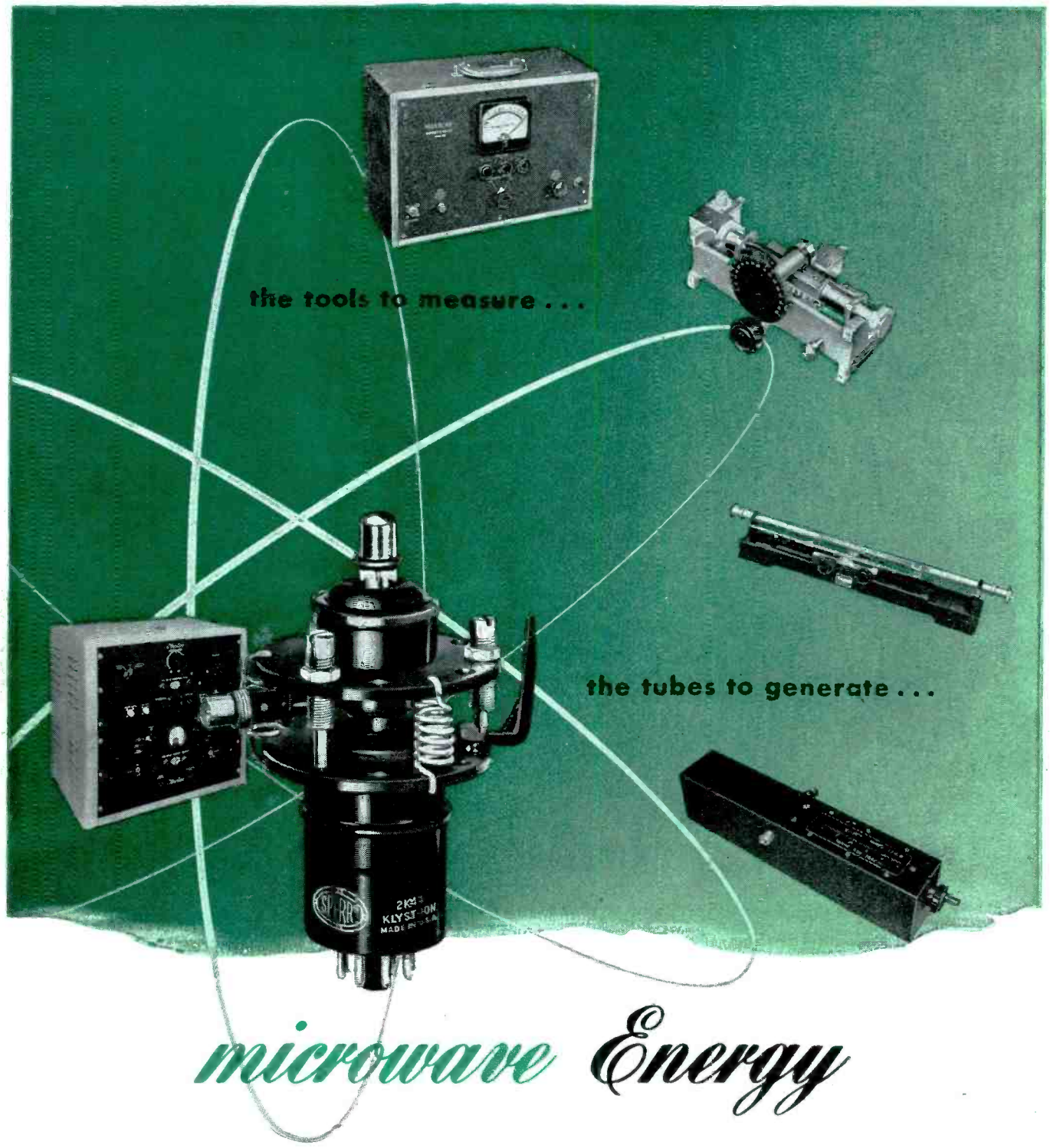
3500 VDC Operating — 7500 VDC Test

Cat. No.	Cap. Mfd.	Dimensions OD Length	Current Rating in RF Amperes 100 Kc	300 Kc	1 Mc	3 Mc	List Price
LSG500	.00005	19/32″x1–3/16″	.02	.05	.16	.47	$1.50
LSG101	.0001	19/32″x1–3/16″	.03	.09	.31	.94	1.50
LSG251	.00025	19/32″x1–3/16″	.05	.25	.5	2.2	1.50
LSG501	.0005	19/32″x1–3/16″	.15	.5	1.6	3.0	1.50
LSG102	.001	19/32″x1–9/16″	.31	.94	2.5	4.5	1.70
LSG202	.002	3/4″ x1–9/16″	.62	1.9	4.5	7.0	2.45
LSG502	.005	3/4″ x1–3/4″	1.6	3.1	6.0	7.0	3.50
LSG602	.006	29/32″x1–9/16	1.9	3.5	6.2	7.0	3.75
LSG103	.01	29/32″x1–3/4″	3.1	5.0	7.0	7.0	4.25

*PLASTICONS—Plastic Film Dielectric Capacitors

Condenser Products Company

1375 NORTH BRANCH STREET • CHICAGO 22, ILLINOIS



microwave Energy

The Sperry Klystron Tube to generate ultra-high-frequency microwaves . . .

The Sperry Klystron Signal Source to "power" them . . .

The Sperry Microline to test and measure them . . .

These Sperry products equip the research or development engineer with every essential for development or design in the microwave field.

The Sperry Klystron Tube has already opened up new vistas in navigation, aviation, medicine, radio, telephone, telegraph and other major applications. It is ready for many new local oscillator or high power uses.

The Sperry Microline includes practically every type of instrument for quick precision measurements in the microwave frequency bands.

This Sperry service — beginning with a source of microwave energy, the Klystron, and following through with every facility for measuring microwaves — opens up almost unlimited possibilities for industry.

We will be glad to supply complete information.

Sperry Gyroscope Company, Inc.

EXECUTIVE OFFICES: GREAT NECK, NEW YORK • DIVISION OF THE SPERRY CORPORATION

NEW YORK · CLEVELAND · NEW ORLEANS · LOS ANGELES · SAN FRANCISCO · SEATTLE

SUPERIOR ELECTRIC COMPANY PROTECTS THEIR AUTOMATIC VOLTAGE REGULATORS WITH

HEINEMANN
MAGNETIC CIRCUIT BREAKERS

In a Bulletin advertising the high quality equipment shown at the left, the manufacturer states that since the first STABILINE Voltage Regulator, Type EM was built, many improvements have been added, among them "a fast-trip magnetic type circuit breaker to perform two functions. It eliminates the task of replacing fuses when the current is overloaded, and also acts as an ON-OFF switch." This emphasizes the convenience of the HEINEMANN CIRCUIT BREAKER.

POSITIVE Yet FLEXIBLE *Protection*

In the above equipment the Circuit Breaker is installed in the brush lead of the Powerstat variable voltage transformer. When the load exceeds the current rating of each individual transformer, the Circuit Breaker opens thus eliminating any chance of injury to any part of the equipment.

These breakers are *instantaneous* on short circuit, but a magnetic-hydraulic time delay mechanism allows passage of slight, temporary overload. If this overload continues beyond the time-delay limit, the breaker trips. Magnetic blowout provides high and fast interrupting capacity.

***Your* equipment can be equally well protected by the installation of**

HEINEMANN MAGNETIC CIRCUIT BREAKERS

Write for further information

EST. 1888

HEINEMANN ELECTRIC COMPANY

97 PLUM STREET TRENTON, NEW JERSEY

THE RUHR—
VALLEY OF DECISION

FOR AMERICANS and for American business the most important single spot on earth today is the Ruhr Valley of Germany—a valley no bigger in area than the State of Rhode Island. Upon recovery in the Ruhr hinges recovery in Europe. Upon recovery in Europe hinges the peace of the world.

No machine can run with its most important part missing. Western Europe without the Ruhr is a dead machine. Before the war, over half the coal and steel produced in the Western part of Continental Europe came from this one little valley. Today, the fact is that no other region in Europe has the technical skills and enterprise to produce the industrial supplies which Europe must have if it is to help itself back to a self-supporting economy. And, after observing Europe for many weeks, I am convinced that no one but the United States can successfully supervise the rebuilding of the Ruhr.

If you will keep four considerations in mind, as the international politicians gamble, you can easily tell whether the United States is playing its proper role in the rehabilitation of the Ruhr. Here are the four considerations:

I. We are paying for the Ruhr rehabilitation (or the lack of it).

II. We alone have the skill and enterprise to supervise its rebuilding.

III. It will be a tough organizing job requiring money, hard work, and outright sacrifice on the part of management men and technicians.

IV. We had better do it well if we love our children.

I

We are paying for rebuilding the Ruhr—or we soon shall be. The British now control the Ruhr, its government and its industry. They have been paying out about four hundred million dollars—American dollars—a year to buy the food, raw materials and equipment needed to rebuild the Ruhr. The British must spend American dollars for these supplies because the supplies can not be bought anywhere but in America. Thus far the British have, in effect, obtained the dollars which they spend for the Ruhr by drawing them out of the $3,750,000,000 loan which we granted Britain last year.

Now the loan is fast running out. The British lack dollars and other assets. We must take over, directly or indirectly, the dollar expenditures for rebuilding the Ruhr. We shall pay for it. Therefore—

II

We should supervise it. The British have been running the Ruhr's industry. They might conceivably suggest to Washington that they continue to run it while we pay the bill. *That we should never agree to.* There is a sound old rule that he who pays the piper shall call the tune.

Perhaps we would not need to invoke that rule if the British had done a good job reviving the industries of the Ruhr. *They have done a poor job—physically and ideologically.*

The physical output of the coal mines and steel mills of the Ruhr in recent months was actually smaller than at the first of the year. Production of coal amounts to little more than half of the pre-war 127 million tons per year. Steel productions limps along at one-sixth of the pre-war rate—far below the volume permitted even under the present low level-of-industry plan for Germany.

Ideologically, the British Labor Government has tried to export to Germany the brand of socialism which is making such a dubious record at home. Foreign Minister Bevin—although he may now have misgivings about it—committed himself to nationalization of the Ruhr's coal and steel industries. British representatives have pushed hard to get General Lucius Clay, our able military governor in Berlin, to agree to socialization of the Ruhr. So far, he has resisted this pressure, but our State and War Departments and we as individuals must back him up to the limit if he is to continue to combat this pressure successfully.

Even if the British government were not socialist, there would be good reason for questioning the ability of Britain to rehabilitate the industries of the Ruhr. In recent generations, the British management class has shown itself more

interested in cartels, restricting output, and allocating markets, than in full-steam, ingenious enterprising production.

Certainly the British must remain full partners in the *political* administration of Germany. No one suggests anything else. However, their recent production record demands turning the job of revitalizing the Ruhr industries over to the nation which is paying the bill and which leads the world in production.

If we have any faith in the business philosophy by which we have lived and prospered for 170 years, we should demonstrate that that philosophy still is dynamic by taking up the burden of the Ruhr.

III

It will be a tough job. It will require men and supplies and money from the United States. It can not possibly be done in less than five years. A list of some of the necessary steps shows how hard it will be.

A. Plans for socializing the Ruhr should be shelved quickly. The industries there should remain in trusteeship for five years. Then the Germans themselves should decide their ownership; let us hope that by that time we can demonstrate to them that private ownership and private initiative mean high production, good distribution and high wages.

B. The top supervising management jobs—both the top policy and the top technical jobs—required outstanding business ability. That is why American business men must be willing to go to Germany, sacrificing comfort and leisure, and even income, if necessary.

C. Germans should take over the management job at the operating level. The Germans are good technicians. They have a greater incentive than anyone else for getting the Ruhr back in working order. That incentive should be harnessed.

D. Special effort should earn special rewards. There is nothing wrong with the Ruhr (or the rest of Europe) that hard work will not cure. Before a man will work hard, he must feel that his work will advance him and his family. That simple motive, which powers our whole economy, must be revived in the Ruhr. To revive it requires enormous ingenuity and work... a new currency... a logical customs union... a sensible ration system... enough food, clothing, housing and consumer goods so that the worker can buy something with his currency and his ration points.

E. America will have to furnish a good share of these foodstuffs and supplies. Certain key items of equipment also will be needed. Only as we succeed in our job can this flow be diminished.

F. A sensible priorities system must channel Ruhr coal and steel into those uses which, in turn, will further increase output. Repair parts for railroad cars should stand high on the list. Housing, coal equipment and machine tool parts should come ahead of the automobiles and permanent steel bridges which at times have been accorded preference.

German technical management of industry in the Ruhr—point C above—need not mean *political* control of the Ruhr by some future sovereign German state. As the French know, the Ruhr, next to the atomic bomb, is the most dangerous weapon in the world. It is the arsenal without which no European power, even Russia, would dare start a war. There is no sense in turning that arsenal back to the *political* control of a nation which twice in 25 years used it for aggression. (And three times since 1870.) Surely we have enough resourcefulness to let the Germans who live in the Ruhr run the industries there without turning political control over to a central Prussian state.

This partial list shows how much hard work and statesmanship the United States must put into the Ruhr. But—

IV

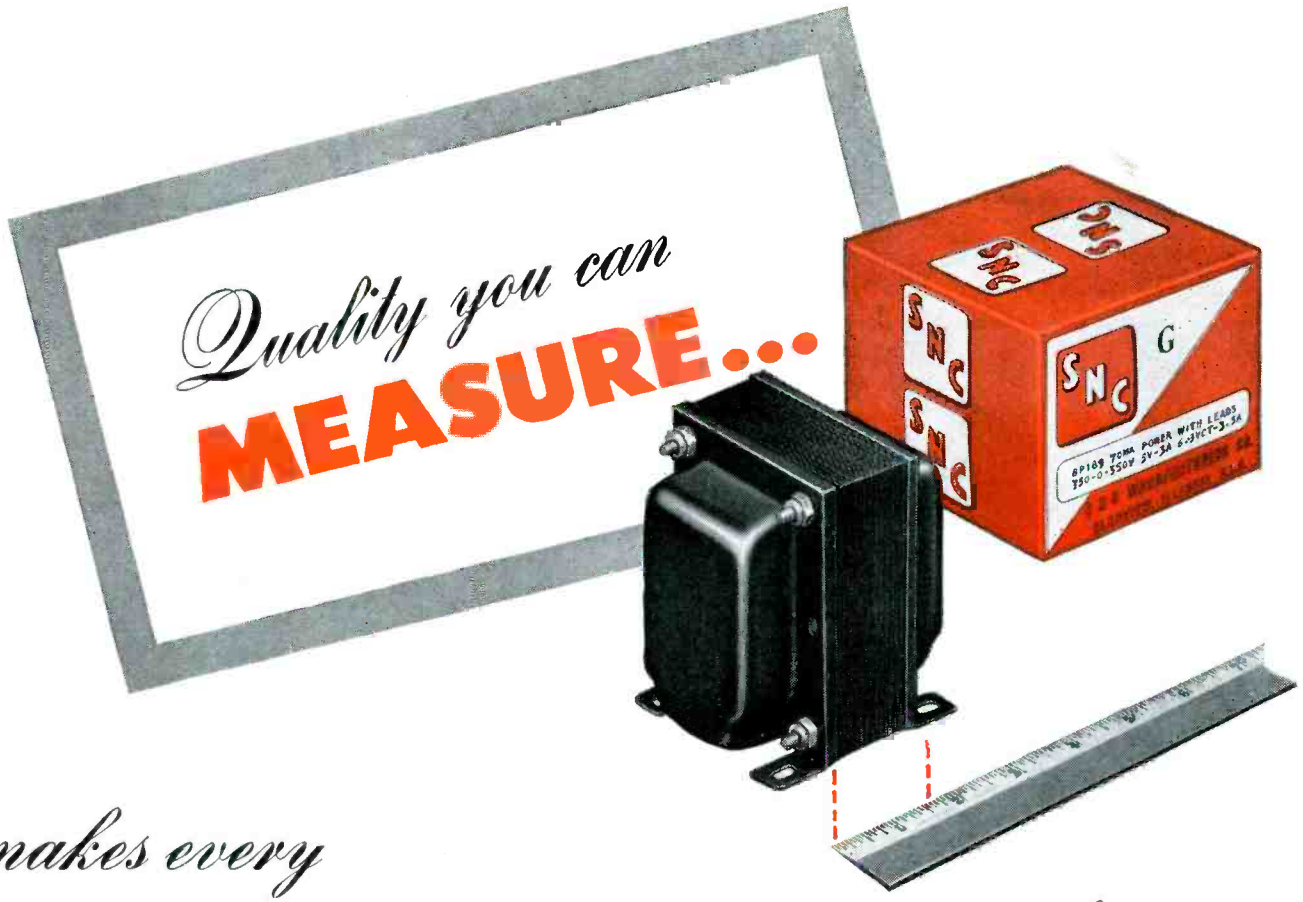
We had better do it if we love our children. If we do not do this job—if we should pull out of Germany or fail there—we leave behind us a vacuum which neither Britain or France has the strength or ability to fill. Russia has the will and, if left unopposed, the power to fill that vacuum. Therefore, the day we fail or the day we pull out of Germany, the third world war takes a long step closer to us and certainly to our children. What greater incentive does any American need to work for than our success in this field?

If we succeed, the western zones of Germany in conjunction with Belgium and Holland can become self-supporting in three to five years. That way lies recovery for all Europe. That way lies peace for the world. That way lies vindication for the American business system in which we believe—the system of competitive private enterprise, with freedom for the individual and his initiative.

James H. McGraw, Jr.

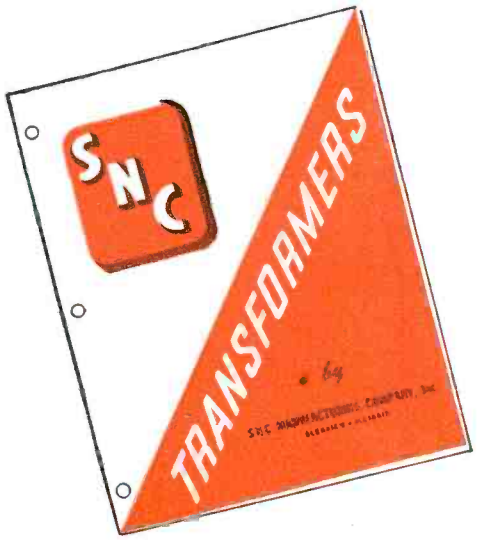
President McGraw-Hill Publishing Company, Inc.

THIS IS THE 60TH OF A SERIES



makes every

SNC TRANSFORMER *give outstanding performance*



Join the increasingly large number of manufacturers, retailers, hams and other component part buyers who rely on SNC for quality, trouble-free equipment. Write for catalog today.

Place a rule against the stack of an SNC No. **8P189** transformer and the *extra* width clearly indicates the added quality built into every item in the complete SNC line.

Skillful engineering, latest production techniques and highest quality materials . . . backed by careful workmanship, exacting step-by-step inspection and rigorous final testing . . . are just a few of the reasons why SNC transformers keep rejects at a minimum and give outstanding performance.

Remember! SNC gives MORE applications with SMALLER inventories for GREATER profits!

SNC MANUFACTURING CO., INC.

Quality Transformers

WEST LAKE AVE. NEAR LEHIGH • GLENVIEW, ILLINOIS

BUSINESS BRIEFS

By W. W. MacDONALD

A Number Of Readers have asked us, some with thinly-veiled implications that are distressing to entertain, just what the formula for this column is. We don't always achieve it but here, at least, is our idea of an ideal item: It deals with the field of electronics, interests the writer (obviously the slick little gimmick used to keep stuff out), and indicates how somebody can make more money or at least avoid losing it.

More Jobs For Engineers result from the FCC's current liberality with respect to new broadcast station applications. If licenses are issued the need for engineers is obvious. Not so obvious is the fact that in order to protect their interests existing stations must do a lot of paper work to prove that they adequately serve the public in their primary coverage area, and that only an engineer can properly do such work.

Business Briefs readers should by now be quite aware of the fact that a lot of people (ourselves included) find it stimulating to keep in close personal touch with the progress of television in the nation's bars. United States Television, latest convert to this new sport for statisticians, says that the average number of lookers is 81, with a daily turnover of 353 and a weekly turnover of 984.

Seeing double is, of course, an occupational hazard.

All Is Not Beer And Skittles for bar television. Some pub owners have had to ban draught-brew sales during show periods to discourage the practice of coasting for hours on one thin dime. A few relying heavily upon rapid turnover of transient drinkers who buy a quick one and leave have actually taken sets out. Bars still represent the most effective promotion medium television has at the moment, nevertheless.

Incidentally, several shrewd New York and New Jersey operators are making themselves a nice piece of change by buying $400 table-type television sets, equipping them with larger c-r tubes and cabinets, and selling them for $1,000 or more to bars.

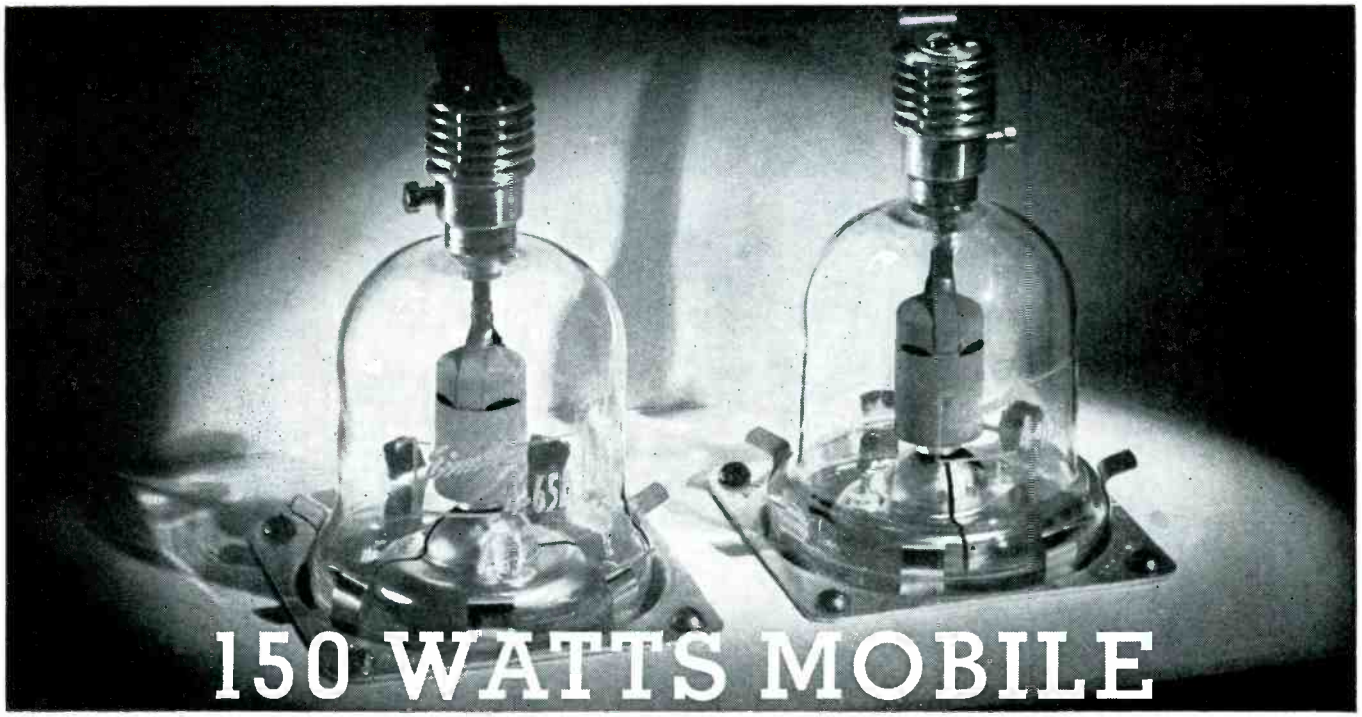
Not Yet A Law, but quite likely to be one soon because CAB is urging it, is use of electronic terrain-clearance indicators that light a light or ring a bell whenever commercial airliners get below a critical altitude. Most operators see the handwriting on the wall and are already placing orders for such devices.

Wired Wireless Schemes envisioning transmission of r-f over power lines for entertainment purposes are in for a bump if their proponents hope to avoid licensing under FCC rules permitting unlicensed operation of certain remote-control devices. A number of such schemes have been reported and the Commission is cracking down on most of them.

Surplus Electronic Equipment to be sold by the Government is just about washed up. Most of the equipment still on hand is being shifted from WAA to FWA for distribution among educational institutions. Hallelujah!

Shot In The Arm for f-m is the introduction of many new inexpensive tuners and converters now hitting the market. Stations have been screaming for them for a long time, and in many instances contracted for private-brand designs to build their market. It took nationally-known manufacturers a long time to get in production but they are rolling merchandise out now.

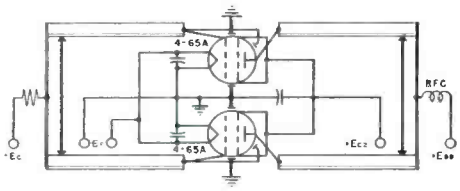
Common Carrier Service on 152 mc, for doctors, salesmen and others who must keep in close touch with their offices while driving, was predicted in these columns two months ago. Now it is an accomplished fact, with one station operating experimentally just across the



150 WATTS MOBILE

PUSH TO TALK

With the announcement of the new Eimac Tetrode type 4-65A, satisfactory high-power mobile transmission became a reality. Designed as a transmitting tube, with the transmitter man's problems in mind, the 4-65A provides stable operation over a voltage range of from 400 to 3000 volts. This characteristic alone enables continuity of system design, using the same vacuum tubes in the final stage of both the mobile and fixed station (two 4-65As will handle 150 watts input with 600 plate volts in the mobile unit, and operating at 3000 plate volts, in the fixed station, two 4-65As provide ½ kilowatt output).



SIMPLIFIED CIRCUIT FOR USE ABOVE 100-MC.

The tube is a "natural" for the 152-162 Mc. band. Its low interelectrode capacitances, compact structure, short electron transit time, high transconductance, together with being a tetrode allows simplification of circuit. Operation of the 4-65A can be continued up thru the 225-Mc. amateur band in either FM or AM service.

The 4-65A incorporates an instant heating thoriated tungsten filament, processed grids—controlling primary and secondary emission, and a processed metal plate—enabling momentary overloads without affecting tube life. All of the internal elements are self supporting without the inclusion of insulating hardware. Neutralization is normally unnecessary since practical isolation of the input and output circuits is achieved by the screen grid and its supporting cone. No special gear is required for installation, as the five pin base fits available commercial sockets.

In typical operation, class-C-telegraphy or FM-telephony, one 4-65A with a plate voltage of 600 volts, 125 milliamperes of plate current, and a plate power input of 75 watts will provide 50 watts of output with less than 2 watts of grid drive. In 1500 volt operation with an input of 190 watts, the output is 140 watts. With the plate voltage increased to 3000 volts and an input of 325 watts, an output of 265 watts per tube is obtained.

The 4-65A is amazingly versatile, being ideally suited for audio, television, r-f heating, and communication applications, stationary or mobile. It is priced at $14.50 each. Additional data may be had by writing to:

EITEL-McCULLOUGH, Inc.
181 San Mateo Ave., San Bruno, California

Follow the Leaders to

Eimac TUBES *The Power for R-F*

Export Agents: Frazar & Hansen, 301 Clay Street, San Francisco, 11, California

To insure performance of the 4-65A . . . severe mechanical tests are conducted—from withstanding a bump test to holding up under excessive vibration. Tests are carried even further . . . satisfactory shipment of the tube is insured by package drop tests.

river from our New York offices, in Brooklyn, and another about to open up in Manhattan close enough to pump plenty of r-f into our typewriter.

Receiver Production by RMA members for the first six months of 1947 totalled 8,883,734 units. Here's the way the total broke down:

TYPE	PRIVATE BRAND	FACTORY
Electric		
Table (under $12.50 billing price)	97,313	484,643
Table (over $12.50 billing price)		
A-M	653,130	3,027,446
A-M/F-M	30	59,842
F-M (including converters)	.....	1,005
Consoles		
A-M	20,146	28,465
A-M/F-M	10,648	4,967
Table-Radio-Phonos		
A-M	137,206	641,105
A-M/F-M	7,311	71
Console Radio-Phonos		
A-M	74,648	431,573
A-M/F-M	33,005	328,684
Battery		
Portable A-C/D-C.	119,132	921,064
Table	116,197	158,181
Consoles	284	.....
Auto	1,208,159	.....
Television		
Converters	850	24
Radio Table Models	1,015	31,754
Radio Consoles		
Direct viewing.	.....	8,611
Projection	.....	618
Radio Phonos		
Direct viewing.	.....	3,192
Projection	.....	325
Phonographs		
Phono only	38,650	99,493
With radio attachment	1,689	133,258
TOTAL	2,519,413	6,364,321

Receiving Tube Production for the first half of 1947 totalled 103,362,432, according to RMA. Of this total, 66,371,204 tubes went to set manufacturers, 23,920,166 were for replacement, 12,804,197 went overseas, and 266,865 were used by government agencies.

Good Management is by no means universal in the field of electronics; this we knew. But we did hope the industry would stack up better in a survey of opinion among bankers, business men, newspaper and magazine editors. Some 200 firms were nominated for a list of "best managed companies in America." Just two are in our business.

Protective Services that guard industrial plants, stores, and lush private homes against burglary and fire, and in some cases also record or control manufacturing conditions remotely, use a great deal of elec-

tronic as well as electrical equipment. Few realize that such services represent truly "big business."

One protective service company has subscribers in over 1,000 municipalities; did $14,000,000 worth of business in 1946.

Back In July we reported that a manufacturer of hotel radios had had an unhappy experience with a poorly designed quarter-in-the-slot timer. A *Business Briefs* reader (May his tribe increase!) promptly wrote in and asked if we knew of someone who might be interested in a *good* timer design he had tucked away in a closet and, if so, could we bring about a meeting of minds. We did, and we could. Which reminds us that if anyone else out there in the audience is hiding a light under a bushel we stand ready and willing to serve.

Poor Man's Pleasure is playing records, according to Admiral's Dick Graver, who says 57 percent of all phonograph owners make less than $3,000 a year.

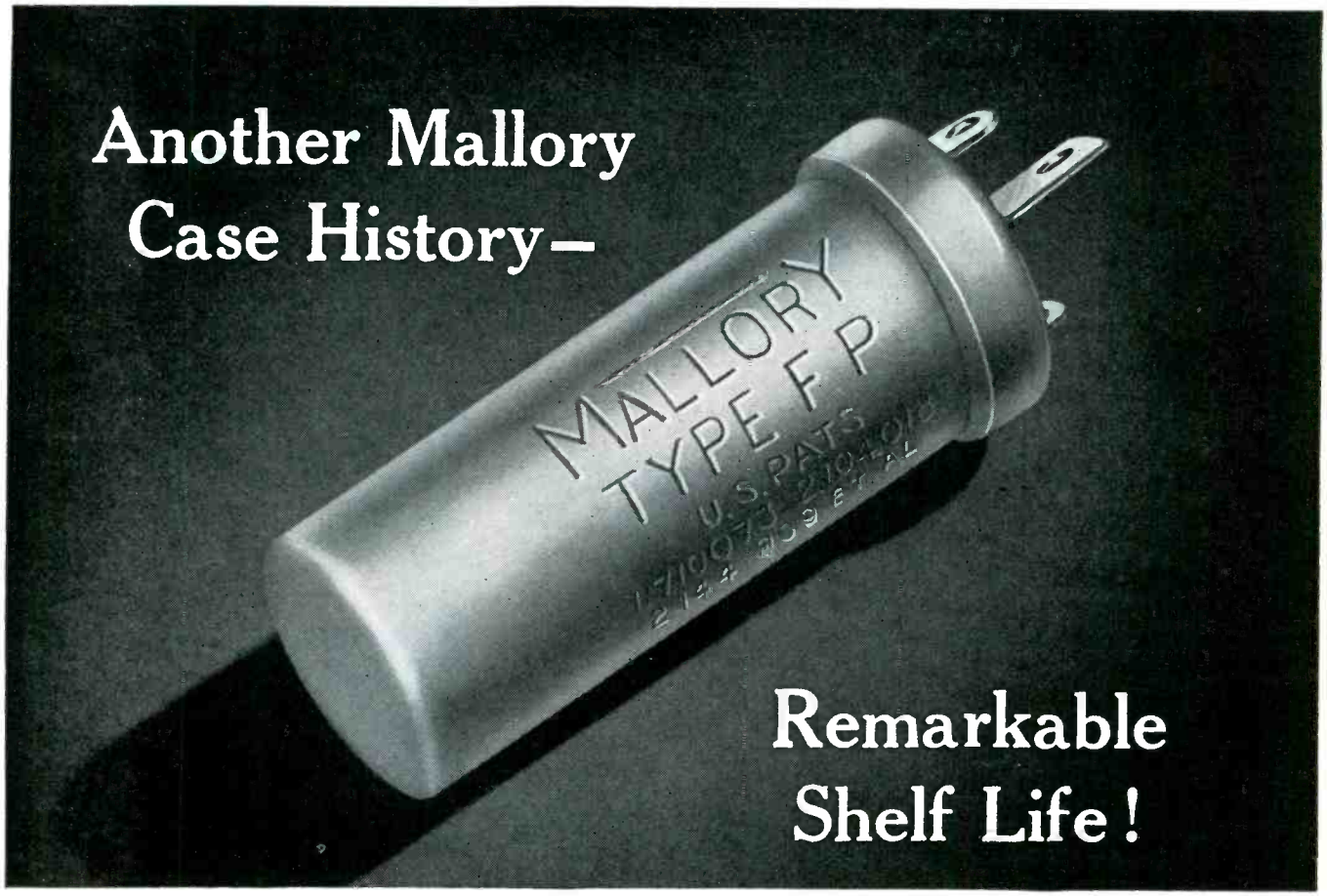
Net Income of the Philco Corporation in the second quarter of 1947 totaled $1,626,974 after deduction of all taxes and charges including an inventory reserve of $1,200,000 for future research expenditures.

Hytron (exclusive of its Air King division) reports $43,854 net earnings after federal taxes for the first five months of the year.

Citizen's Band Radio is too good an idea to die a-borning. It needs a good push, and is going to get it. Watch coming issues of ELECTRONICS.

Story Of The Month is the one about the engineer who had designed a new gadget and asked a market-wise friend what he thought of it. Said the friend:

"A drunk once bet a bartender he could taste any mixed drink and identify it. The barkeep rattled some bottles to confuse the issue and then served a glass of plain water. The drunk sipped and thought, tasted again and admitted defeat. 'I don't know what it is,' he said, 'but I can tell you one thing . . . *it won't sell*!'"



MANY YEARS AGO the Mallory FP capacitor became standard as a high quality, low cost space saver, with self contained mounting features. Now two of the first of these famous capacitors have come to light, with convincing proof of their remarkable shelf life characteristics.

Early in 1938, one of our engineers stored two of these first capacitors, without voltage, near his home, where they would be subjected to the extremes of outside weather. At the beginning of the war our engineer enlisted in the Signal Corps and forgot about his experiment. Recently he discovered the capacitors, which for *nine years* had been subjected to the heat and cold of outdoor weather conditions. They had withstood the elements with remarkable success.

The following tests were performed on the two capacitors with the results noted:

After full voltage was applied the capacitor dropped in leakage to within our specification in 8 minutes—at 30 minutes, the leakage current had dropped to .23 mills—far less than our guaranteed limit of .8 mills.

The capacitors were rated 10 mfd., 450 volts—encased in our standard ¾ x 2" FP containers. The *actual* capacity of one was found to be 10.3 mfd., the other 10.5 mfd.—series resistance of the first was 5.83 ohms, the other 4.28 ohms—the series resistance limit is 24 ohms. All of the characteristics are well within our limits.

CORROSION-FREE

One of the two units was opened for internal inspection and was found to be completely corrosion-free—the electrolyte was moist and in perfect condition. As this is written, the other is still on life test, giving excellent results.

This dramatic evidence of Mallory top quality proves again—

YOU EXPECT MORE AND GET MORE FROM MALLORY

P. R. MALLORY & CO. Inc.

MALLORY CAPACITORS

(ELECTROLYTIC, OIL and WAX)

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

CROSS TALK

►**ATHLETE** . . . A correspondent informs us that a trespasser was apprehended some months ago at WOR's Carteret, N. J. broadcasting plant. When found he was dangling his bare feet in one of the ponds, through which cooling water is circulated, claiming it was a cure for a bad case of athlete's foot. Turns out that copper sulphate, dumped into the pond to clear it of algae and other vegetable matter, is a recognized treatment for the ailment. This story has the ring of authenticity.

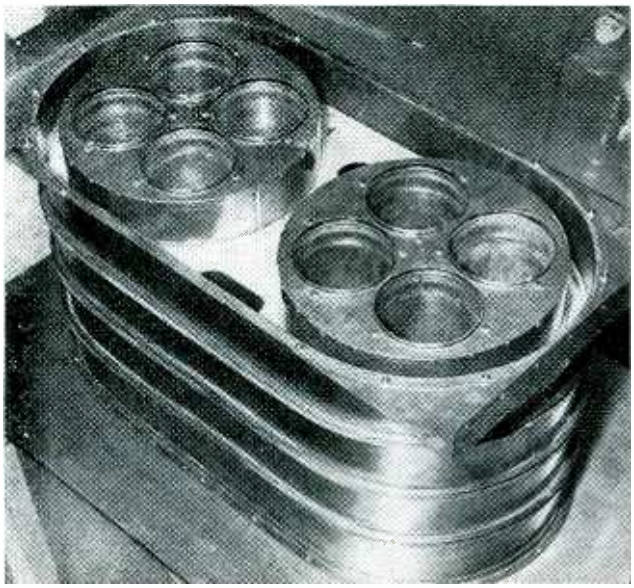
Local farmers are at it again in other departments of the story-telling art. It appears: (1) Casey's creek, a small body of water near the station, gives out with the programs; (2) so do the water faucets in nearby farmhouses; (3) lights in hen coops cannot be turned off while the station is on the air, resulting in greatly increased egg production and weary hens; (4) cows grazing on grass growing on the station plot produce twice as rich milk as cows restricted to less vital pasture. Our favorite is the athlete, dangling his feet and munching idly on a spear of tall (vital) grass.

►**LIGHT** . . . The radio business, we remind ourselves, is based on a simple technique, accelerating electrons back and forth along a wire at a sufficiently rapid rate to cause the radiation of energy. By dint of much struggle, the rate of the alternating accelerations has been pushed up to 100 billion per second, producing waves a fraction of a centimeter long.

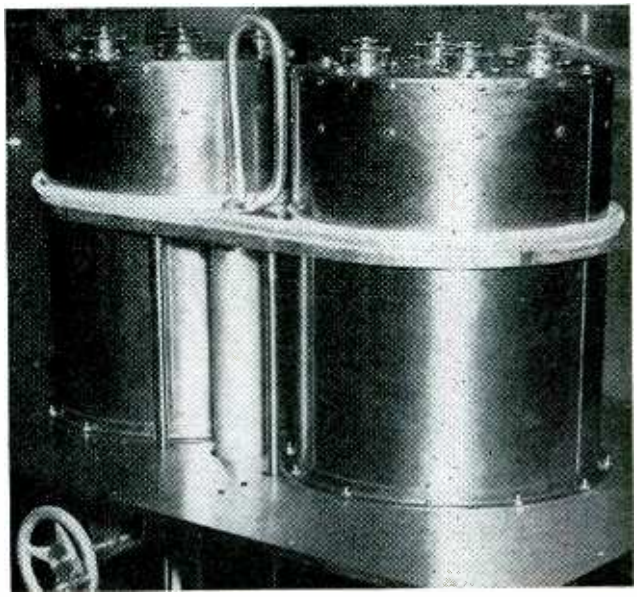
Now comes word that this technique has been applied, by members of the G. E. Research Laboratory at Schenectady, to accelerate electrons so fast that they produce not microwaves but visible light, at frequencies in the range of 10^{14} cycles per second, or a hundred million megacycles. The technique, described recently in Electron Art (p 136, September), involves the rapid whirling of an electron beam in the 70-million volt synchrotron, accompanied by radial deceleration or acceleration in a magnetic field.

There are, of course, simpler ways of producing light, by bouncing electrons against atoms in an incandescent lamp filament, for example. But this is the first direct observation of acceleration of an electron, analagous to feeding current to an antenna, to make it produce its own light. The achievement bespeaks a new extension of our control over electrons, of no commercial value for the present, but of great scientific interest.

►**COMPUTERS** . . . J. R. Newman, writing in a recent issue of the *New Republic* (p 14, June 23, 1947), has produced a brilliant essay on electronic computers, one of the finest examples of technical writing for the layman we have seen. Among the many acute observations made are three we think should particularly interest the engineer: First, the awful complexity of the big computers (18,000 tubes in the ENIAC) is giving way to simpler organisms of even greater power. The MANIAC, (the rumored name of von Neumann's Princeton machine, for "mechanical and numerical integrator and calculator") will do everything that ENIAC will do, but has less than 1,000 tubes. Second, the introduction of memory devices and alternate-sequence programming circuits (which automatically select a future course of computation based on a numerical result achieved during the course of solving the problem, without human intervention) has endowed the machines with rudimentary "personalities" and subjected them to psychic disturbances. They may even develop dual personalities and attempt, like any schizophrenic, to go off in two directions at once. Third, the vast saving of time afforded by electronic computation, is particularly vivid in Newman's words. The ENIAC, taking into account wind direction and velocity, air temperature, rotation of the earth and spin of a projectile, will compute the trajectory of the shell in less time than it takes the shell to reach its destination. D. R. Hartree the English physicist (who, incidentally, helped us to understand how a multicavity magnetron works), spent fifteen years of his life computing atomic structures. The job could have been done by electronic computers in hours, or days at the most.



Anode tank



Cathode tank

KSBR's 50-kw High-Band F-M Transmitter

Operating experimentally on 100.5 mc since April 23 at the maximum power permitted by the FCC, the equipment described is nearing commercial perfection. Details of the r-f section, employing unique tank circuits and a new multi-unit tube, are given

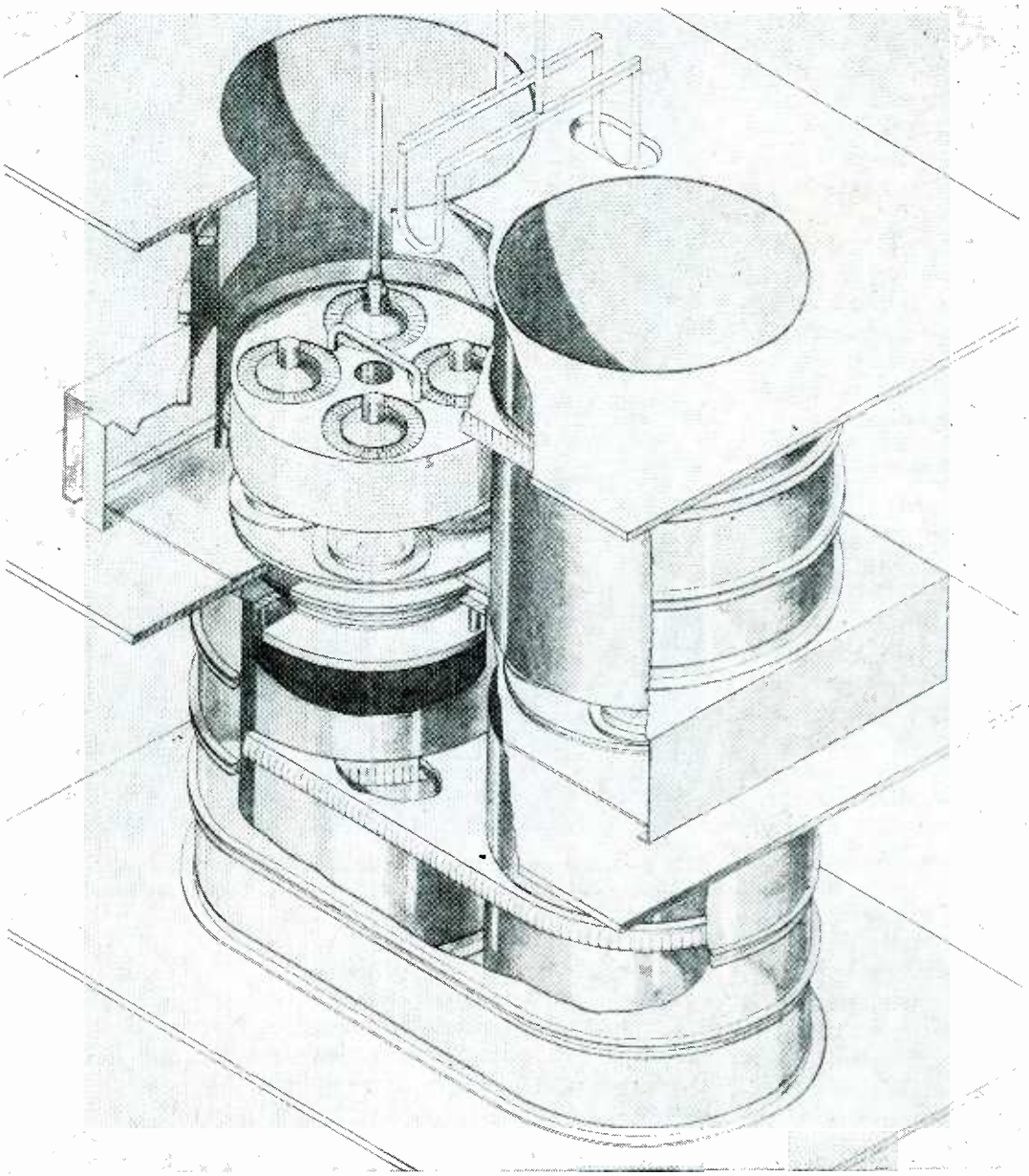
By R. L. NORTON
Application Engineering Dept.

BYRON O. BALLOU and **R. H. CHAMBERLIN**
Laboratory — *Engineering Dept.*

Eitel-McCullough, Inc., San Bruno, California

TO DEVELOP 50 kilowatts for the so-called f-m high band new tubes and new circuit techniques are necessary. This is a description of the 100.5-mc transmitter of KSBR, designed and built for Radio Diablo, Inc. by Eitel-McCullough. The transmitter has been operating experimentally since April 23 from a temporary location in the latter's laboratory at San Bruno. It will soon be installed on 3,800-ft. Mt. Diablo, overlooking the San Francisco Bay area.

Starting from a Radio Engineering Laboratories, Inc. dual-channel phase-shift modulator and frequency multiplier chain, the transmitter requires only three air-cooled stages to reach the 50-kw output level, as shown in Fig. 1. Following the modulator and frequency-multiplier unit is a 3.5-kw push-pull-parallel tetrode stage. This stage drives a push-pull, gounded-grid triode amplifier which raises the power level to 13 kw. A 50-kw grounded-grid stage follows, with either two four-unit triodes in push-pull or eight single triodes in push-pull-parallel. All stages following the modulator operate from a common power supply, at an effi-



Cutaway drawing of 50-kw final r-f amplifier stage, employing a grounded-grid circuit. Adjacent photos show anode (top) and cathode (bottom) tank arrangements

ciency (total d-c plate input to useful output to the transmission line) of 68 per cent.

3.5-kw Amplifier

The 3.5-kw stage, shown in Fig. 2, at present consists of four 4X500F's in a push-pull-parallel arrangement driven directly from the 829B output stage of the exciter unit. These tubes operate at an overall efficiency of approximately 72 percent. Neutralization is accomplished by tuning the screen grids to ground. This stage will be replaced by four 4X500A's, which do not require neutralizing at f-m broadcast frequencies.

The cooling system used in the 3.5-kw amplifier is unusual, and is similar to that used in all air-cooled stages in the transmitter. Conventional practice in air cooling tubes is to have the cooling air enter the open end of the anode cooler and leave through the base end. In a vhf transmitter using linear tank circuits this requires that air enter through the anode tank lines and exhaust into the amplifier itself. In the KSBR transmitter air enters the cooler of each air-cooled tube from the base end and exhausts

through the anode lines. The greatest advantage of this system is that incoming cool air is passed over the glass between the adjacent electrode seals as well as over the seals themselves. The principal disadvantage is that the chamber containing the anode tank must be sealed so that air leakage direct to atmosphere does not occur. In vhf apparatus this is a minor disadvantage, however, as the amplifier anode circuit is normally completely enclosed by nearly air-tight shielding to prevent r-f leakage.

13-kw Amplifier

A pair of 3X2500A3 air-cooled triodes is employed in a grounded-grid circuit as a second amplifier, shown in Fig. 3. This amplifier was originally designed to use four tubes as a so-called ring amplifier, with four-conductor cathode and anode tank circuits. These tank circuits, which are the resonant-line equivalent of a four-wire transmission line in which diagonal wires are connected in parallel, have the advantage of reducing the surge impedance to less than half the value of a two-wire line of equivalent spacing-to-diameter ratio.

Initial tests indicated that it would be feasible to develop well over the required 10 kw with two tubes, and the amplifier was therefore converted to push-pull operation, using two conductors of the original four in each tank circuit. To preserve symmetry in the cabinet, two of the conductors which had been at diagonal corners of the four-conductor tank circuit were used. The resulting tank circuits have high surge impedance and the cathode tank circuit, which has the highest shunting capacitance, is quite short at the high-frequency end of the f-m band. For operation at frequencies above 105 mc, coupling to the amplifier from the preceding stage would be simplified by the use of closer tank-conductor spacing and the resulting increase in physical line length.

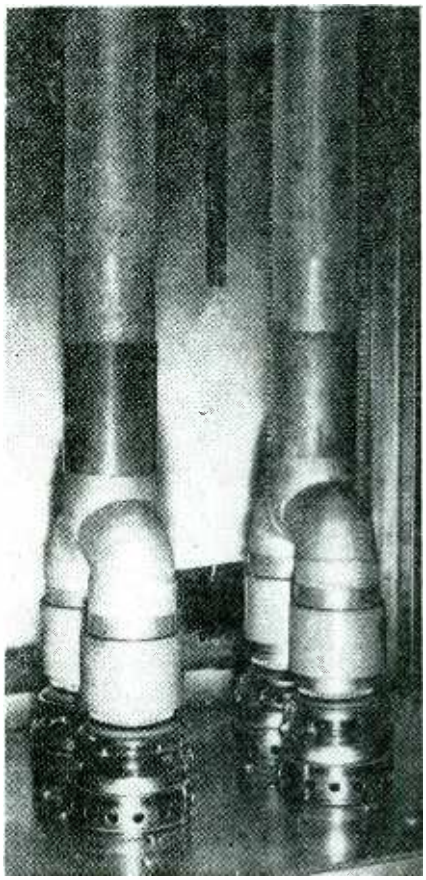


FIG. 2—3.5-kw push-pull-parallel stage of 50-kw f-m transmitter

FIG. 3—13-kw push-pull stage, anode tank at top and cathode tank at bottom

50-kw Amplifier

The 50-kw final amplifier tank circuits are illustrated in the drawing and adjacent photos appearing on the first pages of this article and the complete amplifier is pictured in Fig. 4. It uses a pair of 3X12500A3 triodes in a grounded-grid circuit. The 3X12500A3 is a new multi-unit thoriated-filament triode designed specifically for the purpose of efficiently producing an output of 25 kw per tube at f-m frequencies, but is obviously suited to a number of other applications. Figure 5 shows the tube, which consists basically of four units of the 3X2500A3 type assembled on a common mounting. Low-inductance discs interconnect the filament and grid terminals of the four units. Grid and filament contact fingers are provided on the tube, so that the socket consists simply of concentric rings against which the tube is held by suitable clamping means. The four units are assembled in their mounting in such a way that individual units may be replaced at the factory.

In any amplifier using air-cooled

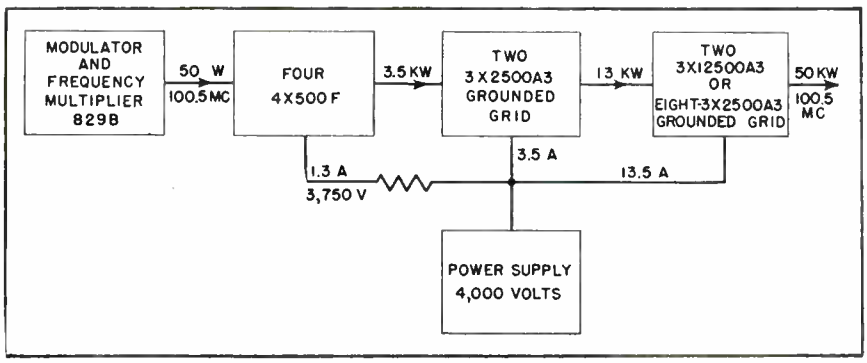


FIG. 1—Block diagram of the 50-kw f-m transmitter

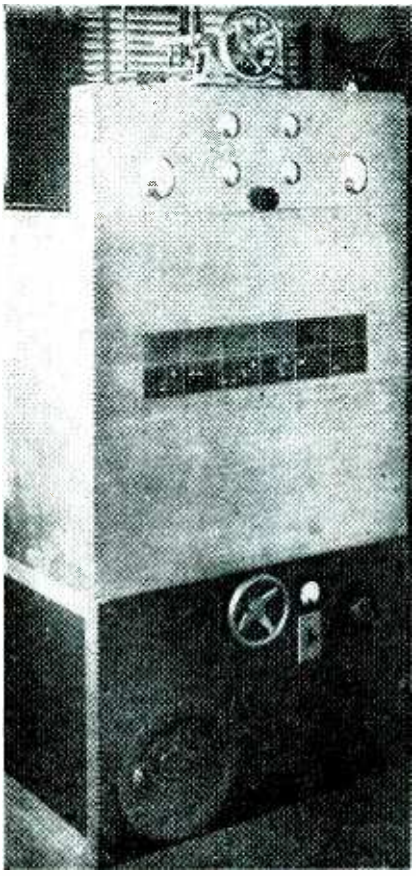


FIG. 4—The complete power amplifier designed and built for KSBR

tubes and capable of delivering 50 kw at 100.5 mc the transverse dimensions of the tank-circuit conductors themselves tend to become an appreciable portion of a quarter wavelength, and it is possible for voltage differences to exist between points on the end of a conductor which should be at the same potential. For this reason, it was deemed advisable for the initial tests on the 50-kw stage to employ separate 3X2500A3 tubes rather than grouping them together on common mounting surfaces. Separate tubes combined with separate anode blocking and grid by-pass capacitors allow individual metering of the grid and anode currents, so that the degree of loading and excitation to each tube can easily be observed. The amplifier is arranged so that it will, with minor modifications, accommodate eight type 3X2500A3's in push-pull-parallel or two 3X12500A3's in push-pull.

The cathode-to-cathode input capacitance of the amplifier is approximately 150 $\mu\mu$f, which makes it necessary to employ as a cathode tank a balanced line having a surge impedance in the neighborhood of ten ohms if the circuit is to be used on its fundamental mode. An unshielded two-conductor line of this impedance would have a spacing-to-conductor-diameter ratio of about 1.005, and would therefore require impossibly large conductors if the conductor-to-conductor spacing were any reasonable value. Most of the r-f current would flow in a small section of the conductors where they faced each other, with the result that unequal excitation voltages would be supplied to the four cathodes on the end of each conductor.

The cathode tank circuit used is shown in the drawing and an adjacent photo and consists of two 12-inch diameter conductors on 14-inch centers. These two conductors are completely enclosed by an oval shield spaced one-half inch from the conductors. The conductors and the shield are fabricated from sheet copper stock. Tuning of the cathode tank circuit is accomplished by changing the position of a shorting plate, shown in Fig. 6, which contacts the two tank conductors and the shield. The shorting plate is moved by means of four lead screws which are linked together by chain and operated from a panel control through bevel gears. At resonance the cathode tank circuit is approximately one-eighth wavelength long.

Tank Circuit Details

Dividing the amplifier into two separate sections is a §-inch thick 24-inch-by-36-inch duraluminum plate, which serves as an isolating shield between cathode and anode circuits. The cathode-tank shield is fastened firmly to the lower face of the shield.

The anode tank circuit is similar to the cathode tank circuit. In the anode circuit, however, the spacing between the conductors and the shield is one inch, as the anode tank does not need to be as low in surge impedance as the cathode circuit. When shunted by the output capacitance of the amplifier tubes, the anode tank circuit is slightly over one-eighth wavelength long at resonance. The shorting plate is similar to the one used in the cathode circuit, except for a larger outer dimension to accommodate the larger shield.

Power is taken from the anode circuit by means of two loops which enter from above and project through slots in the shorting plate into the field around the conductors. The two loops are connected in parallel at their upper ends, and feed an open-wire transmission line leading to the antenna. The coupling loops are supported at their upper ends by a piece of sheet Teflon, which can be driven up or down by lead screws to allow adjustment of the amount of coupling to the anode circuit. A single stub, adjustable as to length and place-

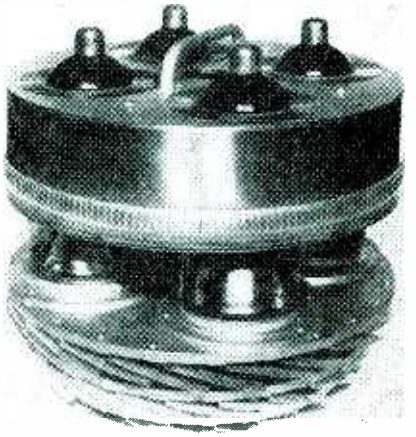


FIG. 5—Eimac 3X12500A3 multi-unit triode, two of which are used in the KSBR 50-kw f-m transmitter final r-f amplifier

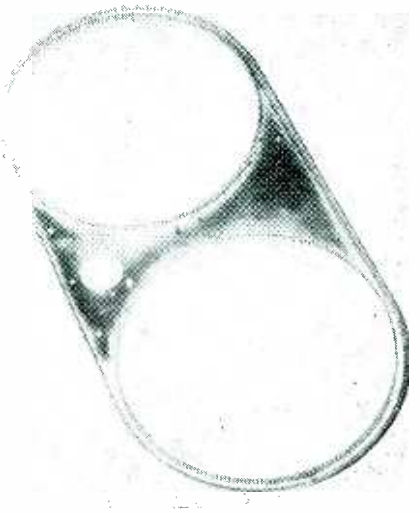


FIG. 6—Movable shorting plate used to tune final r-f amplifier cathode circuit

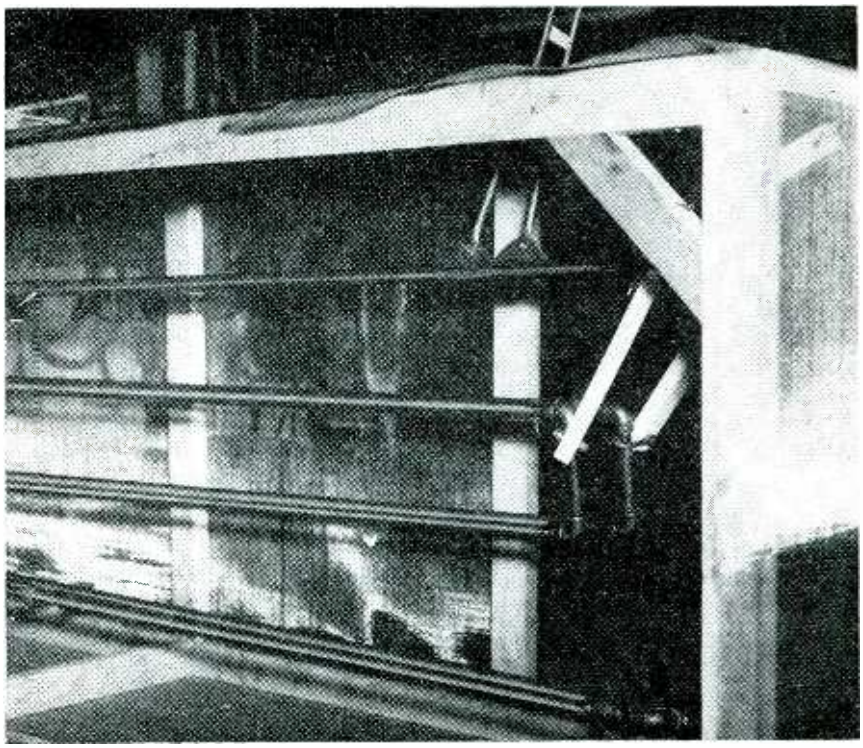


FIG. 7—Dummy load used in testing the KSBR 50-kw transmitter

ment, is located on the transmission line near the point where it connects to the coupling loops, to allow tuning out the reactance of the loops.

Operation

Typical operating conditions for the three amplifier stages are given in Table I. The amplifier delivers 50 kw at 100.5 mc with relative ease. A power output of 58 kw has been obtained without exceeding tube ratings.

The most difficult problem encountered in the design of the 50-kw stage was the coupling circuit used between the amplifier and its preceding driver stage. The rms cathode-to-cathode voltage on the amplifier is only about 1,500 volts. The power delivered to the amplifier cathode circuit is approximately 13 kw, resulting in a cathode-to-cathode impedance of approximately 180 ohms.

Originally the coupling system between the amplifier and its driver consisted of a length of three-inch 50-ohm coaxial line coupled by relatively small loops to the plate circuit of the driver and the cathode circuit of the amplifier. Two coaxial stubs spaced one-eighth wavelength apart were located on this line near the amplifier end. In order to pass sufficient current through the coupling loop at the amplifier end to couple to the low-impedance cathode circuit, it was necessary to have a high standing-wave ratio in the section between the stubs and the amplifier. This resulted in a very high voltage point one-fourth wave back from the coupling loop with consequent frequent flashovers. The present coupling system consists of a pair of $\frac{3}{8}$-inch copper tubes spaced $1\frac{1}{2}$ inches and connected to the cathode tank near the cathode end. By means of a single movable stub on this line it is possible to reduce the standing-wave ratio to a point where the losses are tolerable, and at the same time obtain sufficient coupling to the cathode tank circuit.

Output Measurements

Output measurements on the transmitter have been made by use of a calorimeter load shown in Fig. 7. This load consists of a two-wire transmission line of $\frac{1}{2}$-inch black iron pipe with 6-inch spacing. The line is 40-feet long, and is folded back on itself to make an overall length of 8 feet. Both ends of the line are shorted, and an additional adjustable shorting strap is provided at the end opposite that at which the power is applied. Cooling water enters at a tee in the lower fixed short and travels through both pipes in parallel, leaving by way of a tee at the upper short. Power is applied through a two-wire transmission line from the transmitter which is tapped onto the load near the upper short. Standing waves in the transmission line from the transmitter are eliminated by adjusting the tap point and the position of the lower movable shorting strap. Complete shielding of the load is necessary to prevent loss of power by radiation. With a water flow of approximately 5 gallons a minute, a temperature rise of 140 F is obtained in the water passing through the load. Power is calculated from the rate of flow, temperature rise and the specific heat of water.

There is some radiation of power from the transmission line between the transmitter and the load, and also some resistance loss in the transmission line. These losses have been neglected in Table I. Allowance for the losses might increase the transmitter power output figure by one or two kilowatts.

Table I—Operating Conditions in Last Three Stages

	First Amplifier (Four 4X500F)	Second Amplifier (Two 3X2500A3)	Power Amplifier (Two 3X12500A3)
D-C plate voltage	3,750	4,000	4,000
D-C plate current (amp)	1.3	3.5	13.5
D-C grid voltage	−200	−500	−500
D-C grid current (amp)	0.075	0.5	1.8
D-C screen voltage	500	.....	.....
D-C screen current (ma)	0.055	.....	.....
Driving power (approx, kw)	0.050	3.2*	12.5*
Useful power output (kw)	3.5(2)	13*	50

*Discrepancies between driving power and power output of preceding stages are due to losses in coupling circuits.

UHF HEATING of Frozen Foods

Problems encountered in developing 1,050-mc continuous-wave magnetron oscillator equipment for thawing and heating precooked frozen food. Operating at a frequency comparable to the newly allocated 915-mc band for electronic heating, the unit makes a vegetable, potato, and meat too hot to eat in 70 seconds

By PHILIP W. MORSE and H. EARL REVERCOMB

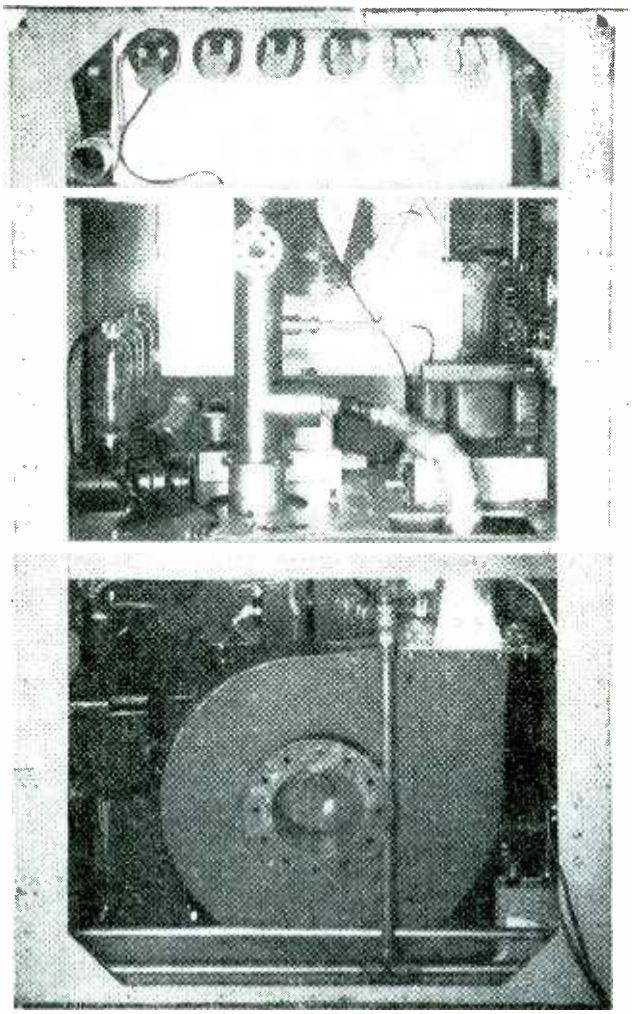
Electronics Department, General Electric Company, Syracuse, New York

THAWING and heating precooked frozen meals electronically offers several advantages. When these meals are heated by conventional methods such as a hot-air oven, the thawing and heating time is never better than 15 minutes. This factor alone limits use, particularly in restaurants. When the heating is done in a minute the restaurant can prepare food in off-peak hours, keep its menu in deep freeze and thaw and heat dinners when they are ordered. Obviously such a food dispensing system eliminates much of the waste inherent in present-day restaurant methods of food preparation and saves the restaurant owner from the daily losses which he now suffers because he has to guess what his volume of business will be.

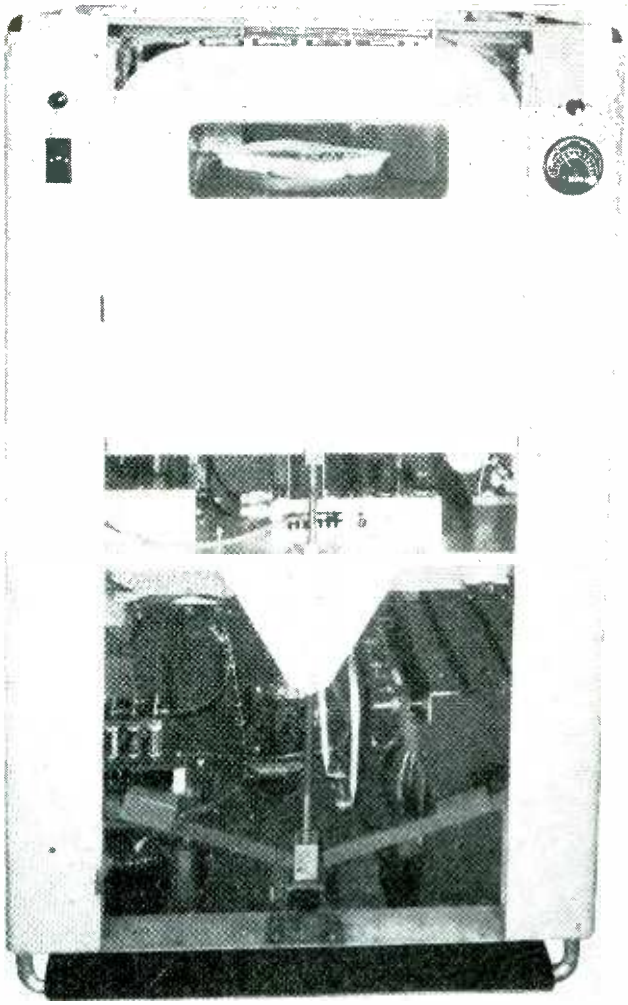
Electronic heating of food produces the heat from within. Therefore, the only thing that heats in the electronic oven is the food. Since at the frequency involved a heating unit is about 50-percent efficient, food thawing and heating by electronic means can be made capable of operation at higher efficiencies than by the conventional conduction methods.

Investigation of food thawing and heating using the ultra-high-frequency band was conducted primarily because arcing between food

Only 70 seconds are required to heat a frozen meal from zero Fahrenheit to a temperature too hot to eat



Rear view of electronic heater. Heating cavity on top shelf. Rectifier tubes at left, transmission line in center, and control circuits to right of second shelf. Air blower and power transformer occupy the bottom portion in the cabinet



Front view of heater. A slotted door provides access to the heating cavity and is operated by the foot treadle at bottom of the unit. Electronic control chassis are just visible on the second shelf. A water line is used for cooling

masses occurred at frequencies of 40 megacycles and below. This arcing started before sufficient power could be coupled into the food for useful purposes. Peas, for example, are especially vulnerable to this kind of arcing. The high voltage gradient necessary for the heating of foods at lower frequencies rendered them impractical.

It was, therefore, decided to use a frequency approximately twenty-five times that of the highest frequency used before the war to heat foods. Since heating is directly proportional to frequency times the voltage gradient squared, increasing the frequency to 1,050 megacycles lowered the voltage gradient for the same amount of heating by a factor of five. Arcing was eliminated when this procedure was followed.

From this experience it might be supposed that there is no limit to how high one can go in frequency for the heating of food. But this is not the case. Penetration difficulties are apparent as soon as a frequency of much over 1,000 megacycles is exceeded.

Equipment Used

Figure 1 shows the basic elements of the developmental setup. The three and one-eighth inch transmission line from the magnetron was equipped with a directional coupler as well as a slotted line for indicators in matching the impedance of the load to that of the line. Provisions were also made for inserting a triple stub or movable sleeve transformer for impedance matching. Various load cavities were tested under this arrangement to determine their characteristics and suitability for food heating.

Early heating of precooked frozen dinners by ultrahigh frequency was carried out in a waveguide-shaped cavity using the $H_{0,1,n}$ mode, where n was any whole number between 3 and 6. See Fig. 2. Input coupling was made with a variable probe length. The frozen

dinner plate was placed at an experimentally determined position in the cavity. It was learned that by varying the input probe length and the position of the dinner plate along the cavity, settings could be found which gave a very good impedance match (small reflections of power, see Fig. 3) in the melted or partially melted state. However, impedance match in the frozen state was not as good.

Food Data at UHF

These findings indicate that electrical characteristics of food in the frozen and unfrozen state are quite different. Table I gives the changes encountered in the electrical characteristics of various common foods at 1,000 megacycles. Note the considerable variation in a given food between the frozen and unfrozen state. Peas at 23C have a dielectric constant of 9 and loss tangent of 0.5; the same peas have a dielectric constant of 2.5 and a loss tangent of 0.2 when frozen.

When it is considered that every food in a precooked frozen dinner undergoes an electrical change comparable to the change in peas, the overall impedance change is a major problem; naturally this impedance variation is accompanied by a variable amount of power reflected back to the generator during the heating cycle.

The energy required to bring food from 0F through the melting point at 32F is about the same as the energy needed to raise the melted food from 32F to 170F. As a result, any system which heats food evenly must be able to heat both in the frozen and unfrozen state. No system which couples energy to only one state of the food will work. This poses still another problem: to devise a heating cavity insensitive enough to impedance changes during the heating cycle of the food to give a satisfactory impedance match and, at the same time, heat the food evenly at 1,050 megacycles.

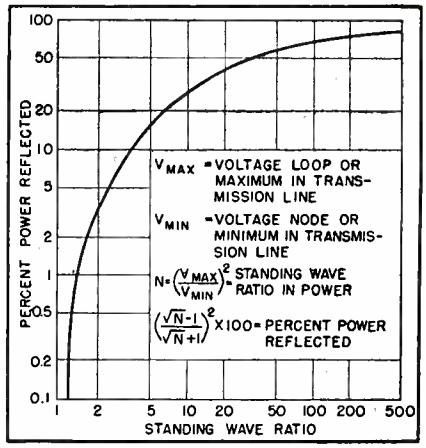


FIG. 3—Standing-wave ratio in power, plotted against percent power reflected

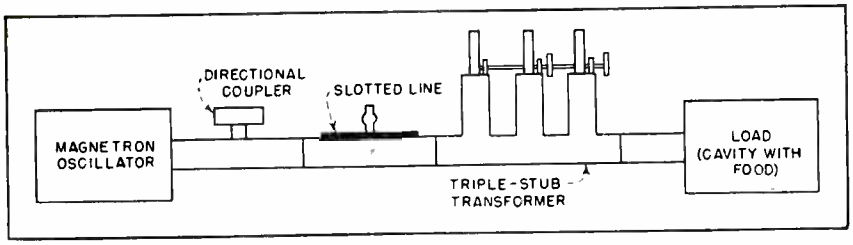


FIG. 1—Waveguide arrangement used for feeding uhf energy from the oscillator into the food

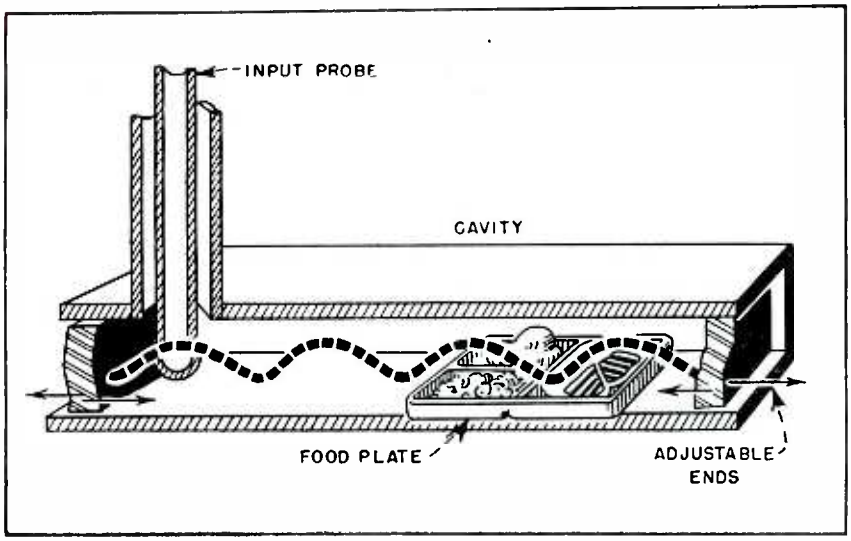


FIG. 2—Impedance matching is done by varying the probe length, the position of the food, and the length of the cavity

Since the plate is approximately eight inches in diameter, it covers the maximum and minimum heating area in the modes set up in the cavity. Consequently, at no time is uniform heating attained in cavities of this type. Different load configurations, such as tapering the load and the cavity as shown in Fig. 4, to counteract for heating differentials were tried. Various types of cavities producing relative motion between the food and field were studied. None of the methods was entirely successful in overcoming differences in heating. When the load was moved, or the field within the cavity was shifted, difficulty was experienced in coupling power due to overall impedance changes.

From the experiments in the waveguide-shaped cavity, a number of facts were learned which tended to clarify the problem. Contrary to what was generally believed before the developmental work was undertaken, heating is uneven in both horizontal and vertical planes. Further analysis of this problem, plus the fact that it was much easier to couple energy into the unfrozen food, indicated that the heating effect of frozen food is a runaway proposition. Once the food thawed at one point, that specific spot had a tendency to absorb more than its proportionate share of the energy. The configuration of the electromagnetic waves within the cavity was, in a large measure, de-

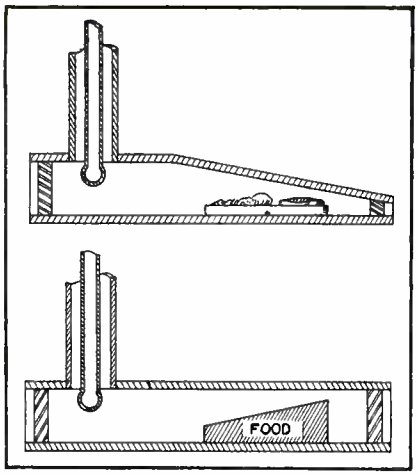


FIG. 4—Tapering the cavity and the food load, as shown above, provides more uniform heating but does not entirely solve the problem

termined by the partially melted food. This configuration was so set up in the cavity as to continue the heating in the areas already melted, because the high loss points establish the field configuration rather than vice-versa.

Inconclusive results were obtained in efforts to counteract this tendency for food to overheat at the original points of melting. In every case, considerable impedance changes were experienced, indicating that the partially melted foods were distorting the field within the cavity to the extent that external controls had little or no effect upon the overall picture.

From a frequency point of view, tests have shown that the runaway tendency in the ultrahigh frequency heating of precooked frozen meals is more troublesome when the frequency is higher. At approximately 3,000 megacycles this effect is three or four times greater.

Effect of Standing Waves

Early tests also indicated another condition of heating which was not wholly apparent when the tests were first undertaken. By measuring the standing wave in a waveguide-shaped cavity in which a very thin layer of mashed potatoes was placed, it was found that the greatest heating effect took place at the point of voltage minimum. Since this problem was originally approached from the dielectric heating standpoint, the previous notions of the type of cavity to be used were changed to some extent. Instead of dealing with high voltages, it was necessary to look at the problem from the point of view of relatively high circulating currents which were induced in the food due to its good conductivity. In other words, the impedance match of the electromagnetic energy into the potato was best at the low-voltage point in this particular cavity.

Because the ratio of the electric vector to the magnetic vector in an electromagnetic field is dimensionally an impedance, it suggests that this ratio must be the right value for correct impedance matching into the food. This also hints the interesting theory that the heating of foods at this frequency may be considered to be more analogous to ultrahigh frequency induction heating rather than dielectric.

A number of cavities were built embodying the idea of heating taking place at the voltage minimum. As a general rule, it was no problem to couple energy into food when it was placed at the voltage minimum. Under these conditions heating was very localized — any effort to broaden the heating area by moving the food through the heating zone, or shifting the field by external means, changed the impedance so much that this type of heating was considered undesirable. Since these cavities were designed to heat intensively at localized points, it was noted that some distortion of the food occurred when too much energy was pumped into it in too short a time.

One suggestion, evolved by the size of the heating areas, was to separate the food plate into its three component parts and place the plate so that each part occupied a distinct heating area in the cavity. A waveguide-shaped cavity was used and the three units of the food plate were placed at three separate voltage minima. Heating was uneven between the three separate units because the food unit which melted first continued to absorb energy at a rate greater than its proportionate share of the available power.

No Aid from Steam

Existence of steam in a food unit would tend to equalize the temperature differential during the heating cycle, it was believed. No conclusive results were obtained. By way of explanation, the heating cycle is obviously too fast for steam conduction to exert any noticeable effect. Further experiments along this line have tended to confirm that it makes little or no difference whether the food is covered during the process of heating.

Since the Q of a cavity is proportional to the ratio of energy stored to energy dissipated, it was believed that a very small cavity (minimum

Table I—Characteristics of Foods at 1,000 Megacycles

Specimen	Temp. of Test (C)	Dielectric Constant	Loss Tangent*	Penetration (inches)**
Beef, raw	−15	5.0	0.15	2.28
Beef, roasted	23	28.0	0.2	0.97
Peas, whole, boiled	−15	2.5	0.2	3.12
Peas, whole, boiled	23	9.0	0.5	0.59
Pork, raw, ground	−15	6.8	1.2	0.26
Pork, ground, 50% fried	35	23.0	2.4	0.07
Potato, boiled	−15	4.5	0.2	2.39
Potato, boiled	23	38.0	0.3	0.57
Spinach, boiled	−15	13.0	0.5	0.56
Spinach, boiled	23	34.0	0.8	0.22
Squash, baked	−15	5.0	0.3	1.46
Squash, baked	23	47.0	0.8	0.16

* Dielectric constant in complex form is: $\epsilon = \epsilon' - j\epsilon''$

Loss tangent: $\tan \phi = \frac{\epsilon''}{\epsilon'}$

** Depth at which power density falls to $\frac{1}{\sqrt{e}}$ or 0.6 of the surface value. $e = 2.7183$

size for the frequency used) would have a low Q and therefore good characteristics. Many of these cavities presented excellent loading qualities, both in the frozen and unfrozen state, and could be considered satisfactory from this standpoint alone. Unfortunately, the cavities were small and the food had to be located very close to the coupling loop. Invariably, the food nearest the loop was badly burned and distorted by the high energy level at this portion of the cavity.

Changes made in the interior cavity structure, either by shielding or by spacing the loop from the food, did not entirely overcome this difficulty. It should be pointed out that a low-Q cavity similar to the type described was used with considerable success at one kilowatt of power. Provided the power level is low enough (heating cycle long) cavities operate with fair results.

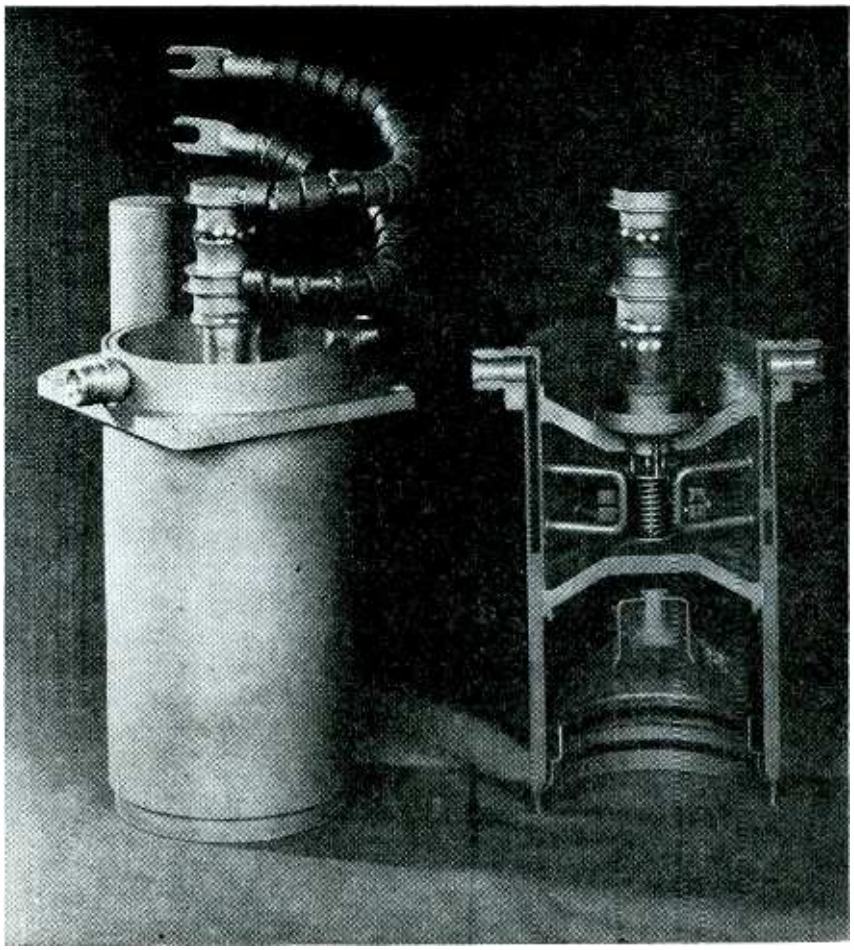
Foolproof Design Needed

Cavity designs which will operate satisfactorily for heating precooked frozen meals were only part of the overall problem. There were certain requirements to contribute to the unit's ease of operation in limited floor space. Since it must be presumed that the electronic oven will be operated by aspiring short-order cooks, the operation of such an oven must be as nearly automatic as possible. No delicate external tuning adjustments for use during the heating cycle can be tolerated and the oven must be able to handle a wide variety of meals. Undoubtedly most operators will be inclined to experiment and treat the unit as a toy, so provisions must be made so that the equipment will not be damaged with any kind of load. Finally, such an oven is limited in the floor space it must occupy because it will be used where floor area is very much at a premium.

Equipment has been developed which substantially meets the general requirements. For all intents and purposes, it is automatic in its operation. A power switch, a load timer (0-120 sec), and a foot treadle are the only controls necessary for operation. When the unit is turned on, a 40-second time delay prevents the use of the equipment until the tubes are heated. As soon as the green indicator light above the power switch lights, the oven is ready for operation. This is done by merely placing the frozen meal in the oven and stepping on the foot treadle; from then on, the operation is automatic. The cavity door slides into place, power is applied, and the meal heats as long as the load timer dictates.

When the heating cycle is over, power is cut off and the cavity door drops down. All the operator need do is remove the heated meal from the electronic oven and the machine is ready to begin a new heating cycle. While power is being applied to the food, a red indicator light above the timer shows. By pressing this indicator light any time during the heating cycle, heating can be terminated and the cavity door will drop down. The equipment is so designed that the operator is protected by the usual door interlocks and other means.

Due to the great number of vegetables and meats that comprise a meal, precooked frozen dinners present an almost infinite number of combinations. Our experience has indicated, nevertheless, that with one or two exceptions, the electronic oven will handle this wide variety of dinner combinations with satisfactory uniformity. Tests have shown that 12-ounce precooked frozen dinners, consisting of a vegetable, potato, and meat, can be heated from 0F to a temperature too hot to eat in 70 seconds. The meals were not specially prepared for use in this equipment, but were a standard commercially produced product. They were refrigerated months earlier, then reconstituted to the peak of cooking freshness in 70 seconds.



Complete magnetron and cutaway view showing internal construction. A continuous-wave type, it is capable of providing five kilowatts of output power at 1,050 megacycles

Typical installation of antenna array for vhf omnidirectional radio range. The five loop elements are in the small structure atop the 30-foot-diameter circular counterpoise, and are connected to the transmitter in the building below by means of solid-dielectric cable

Status of VHF Facilities for Aviation

THE VHF RADIO PROGRAM of the Civil Aeronautics Administration has three main parts: (A) vhf radio ranges for air navigation; (B) vhf localizers and markers for instrument landing systems at airports; (C) vhf communication between ground stations and airplanes.

The vhf ranges will ultimately replace the present network of low-frequency four-course aural ranges. The changeover from the latter type of facility is dictated by two basic factors: (1) the need to avoid or minimize the problem of natural interference such as atmospherics, which is very severe in the 200-400 kc band; (2) the need to move into a portion of the spectrum less congested than the lower band. The present network of low-frequency aids more than saturates the band, and yet is not adequate for the needs of air navigation. The importance of these two factors to the safety and dependability of air navigation is absolutely paramount.

Since the vhf facilities operate at frequencies which can be received only within line-of-sight distances, approximately, it follows that for aircraft at an altitude of 1,000 feet above the terrain the service area has a radius of the order of 35 to 40 miles. This type of facility is therefore classified as a short-distance navigation aid. The frequency channels can therefore be repeated at certain geographical intervals—in this case, 500 miles based on a maximum altitude of 18,000 feet. The frequency band available for this use (112-118 mc) permits 30 channels 200 kc wide and the geographical distribution is on this basis. When and if receiver manufacturers develop a more practical and reasonably priced receiver capable of handling 100-kc spacing and channels, the available frequencies will be, of course, effectively doubled. (Present equipment capable of 100-kc spacing is too expensive for all but large types of commercial aircraft.)

The vhf ranges provide all of the services now available with the low-frequency aids and at the same time furnish additional information and greater flexibility of use.

The instrument landing system runway localizer is also in the vhf band for the above reasons as well as for added convenience. Its function requires a radiation space pattern of such sharpness as to result in an impracticable antenna array at frequencies much below those now in use (about 110 mc). These circumstances, combined with judicious system design in such mat-

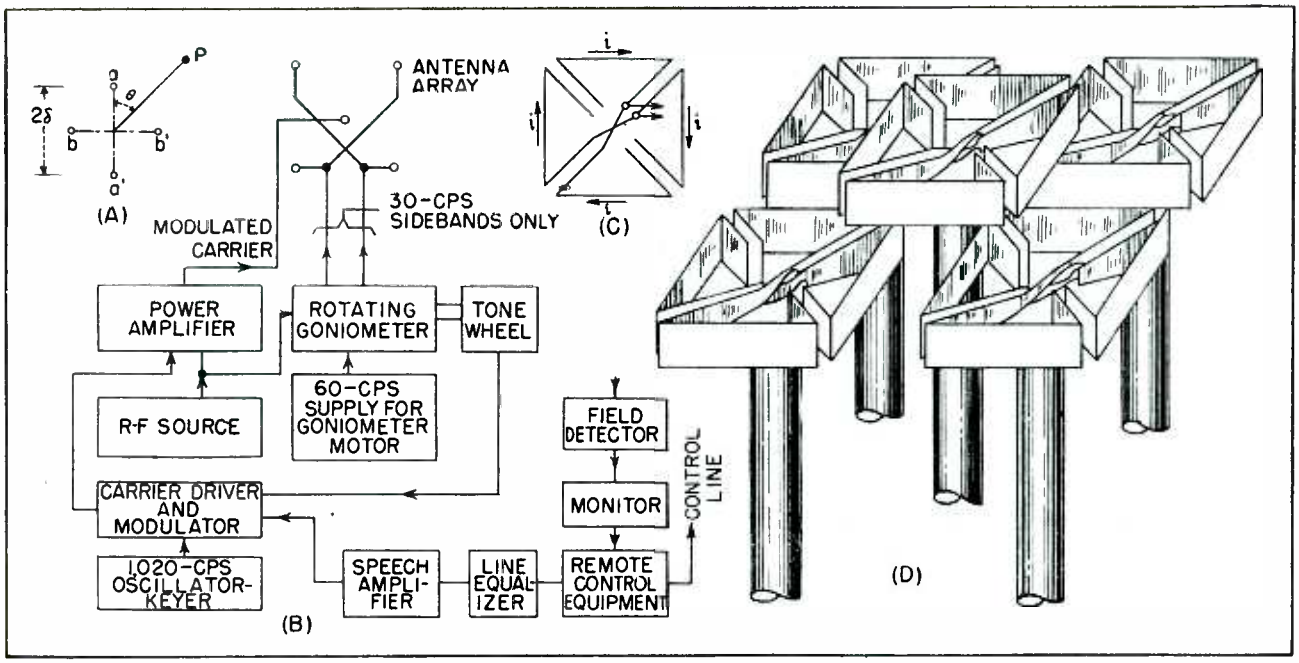


FIG. 1—Antenna array and transmitter equipment used at ground station of vhf omnidirectional range, which operates in the band from 112 to 118 mc. With distance-measuring equipment in aircraft, one station like this is sufficient for an absolute fix

Technical details of the vhf omnidirectional radio range now being installed throughout the country by CAA for short-range air navigation, along with operating principles of glide-path portion of CAA instrument landing system and new phase-comparison localizer

By PETER CAPORALE

Chief, Radio Engineering Section, Civil Aeronautics Administration, Washington, D. C.

ters as modulation, have resulted in a single airborne unit for the use of both ranges and runway localizers. The desirability of this situation is obvious.

The markers of the instrument landing system (ILS) are in the vhf band, but the glide path is not (it operates at about 335 mc). The system will be discussed below in its entirety since the particular glide path frequency is not inherent in the functional aspects of the ILS as a whole.

In the problem of ground-air-ground communication, the basic considerations are again freedom from natural interference and adequate frequency channels to provide for the expanding load created by air navigation. Therefore, the vhf communication program will also ultimately replace the m-f and h-f circuits now being used.

This program, including the specific types of facilities involved, is in accord with the conclusions reached internationally by ICAO (previously PICAO) in Montreal in November 1946.

The VHF Range

The basic radio aid for air navigation is the vhf omnidirectional range operating in the 112-118 mc band. This is a facility which provides two reciprocal tracks from the station. The azimuths of these tracks, however, are selected by the pilot so that he may use a track at any desired azimuth around the station, without any discontinuities over the entire 360 degrees. It is this fact which gave rise to the term omnidirectional. Once the pilot has selected a track, any deviation of his path from the track will result in a right or left deflection of a zero-center instrument in the aircraft. This instrument will read zero when the plane is on the track and is, in fact, the localizer portion of the cross-pointer instrument used with the vhf ILS localizer developed by CAA.[1]

The idea of this type of aid is not new,[2] but the means of accomplishing the desired results are considered novel and of interest technically.[3] Basically the system radiates two space patterns; one is circular and contains the carrier, while the other is a rotating sinusoid and contains only the sidebands corresponding to modulation of the above carrier by a monochromatic tone of low frequency. This latter pattern has a relative phase varying with azimuth (relative to the station). The receiver in the aircraft is designed to observe this phase and compare it to a fixed reference

phase, thereby providing an indication of azimuth.

The reference phase signal is obtained by modulating the carrier with a subcarrier which is in turn frequency-modulated by the monotone referred to above. By this means the reference and variable-phase signals can be conveniently separated in the receiver. The carrier pattern is nondirectional and its phase does not vary with azimuth, hence the modulation on the subcarrier can be used as a reference.

The radiation pattern for the sidebands is obtained by the use of two pairs of so-called point sources at right angles to each other and in the form of a square as shown in Fig. 1A. The two radiators of each pair are fed in phase opposition and the two pairs are fed in phase quadrature. At a distant point P in space, therefore, the field due to the pair aa' will be $kI\sin(\delta\cos\theta)\sin pt$ and that due to the pair bb' will be $kI\sin(\delta\sin\theta)\cos pt$ assuming the same current amplitude in both pairs. The total sideband field will therefore be $E_s = A \sin(pt + \beta)$, where $A \equiv kI\,[\sin^2(\delta\cos\theta) + \sin^2(\delta\sin\theta)]^{\frac{1}{2}}$ and $\beta \equiv \tan^{-1}[\sin(\delta\sin\theta)/\sin(\delta\cos\theta)]$. If δ is very small so that $\sin(\delta\sin\theta) \rightarrow \delta\sin\theta$, then $E_s = kI\,\delta\sin(pt + \theta)$.

The relative phase of E_s is the same as the azimuth θ and the latter can be observed by measuring the former. For any practicable value of δ, the phase β will vary somewhat from θ, and $|\beta - \theta|$ is known as the octantal error due to the fact that

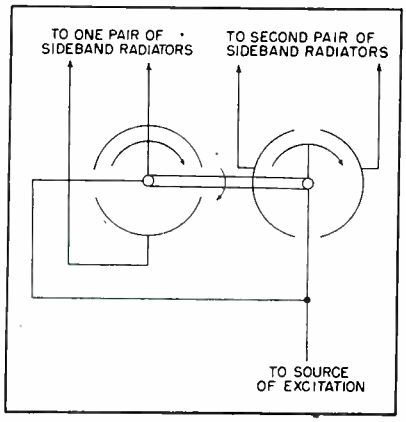


FIG. 2—Arrangement of rotating capacitance goniometer used to obtain sideband energy for vhf range

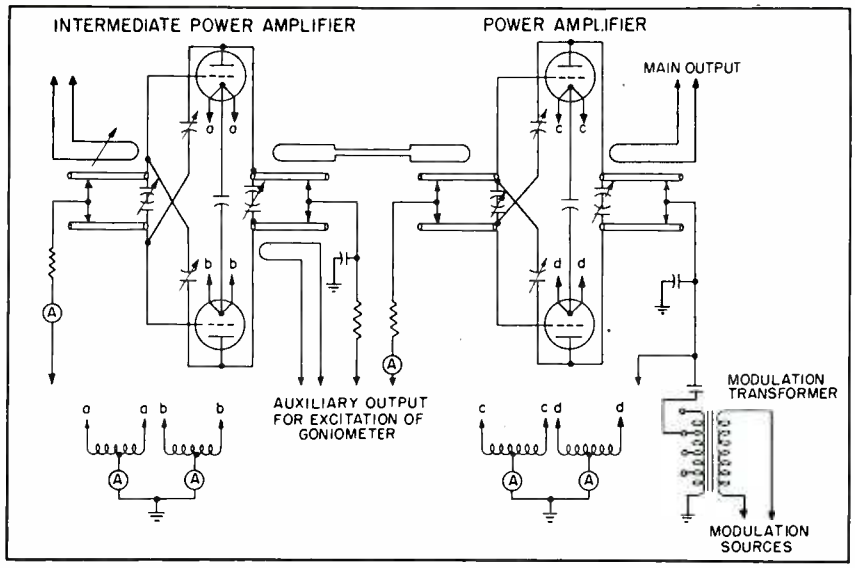


FIG. 3—Schematic circuit diagram of transmitter used in vhf range station

it varies from zero to its maximum within one octant of azimuth. It is evidently zero for all values of θ for which $\sin\theta = \cos\theta$, or for which $\sin\theta$ or $\cos\theta$ vanishes. Hence there is no error at $\theta = 0, \frac{\pi}{4}, \frac{\pi}{2}, \ldots$, and the maximum error lies between these points. This maximum error is, as pointed out, a function of δ. It is approximately 2 degrees for the spacing actually used (somewhat over 50 degrees), based on an array of four independent point sources.

In practice each radiator consists of a magnetic dipole of considerable dimensions and the close spacing results in a very appreciable coupling between antennas. This affects the radiated patterns and hence the octantal error. It has been found that by judicious arrangement of the radiators the octantal error is reduced to a practically unobservable magnitude. This is desirable, even though octantal error would be a fixed characteristic of the station and could be easily taken into account in the published charts.

The carrier with its several modulations, including reference signal and voice, is radiated by a separate antenna, also a magnetic dipole, located at the center of the sideband array but at a higher or lower horizontal plane for mechanical reasons.

In the receiver, the signals from the sideband and carrier antennas combine to produce a modulated signal which is then normally processed, through rectification, back to the original audio monotone, but it will now have a relative phase depending on the azimuth of the receiving antenna relative to transmitter. The frequency-modulated signal on the carrier is, after first detection, handled separately and ultimately converted also to its original audio frequency. The receiver thus reproduces the original monotone but in two parts, one of constant phase and the other of variable relative phase.

These two components are then fed into a circuit for comparing phases. Equality of amplitude and phase results in zero deflection in a d-c differential meter. A calibrated phase shifter is further used with the reference signal so that its phase may always be adjusted relative to that of the variable phase component. In this manner the latter, and hence the azimuth, can be measured.

Use of Range Signals

The vhf range facility may thus be used in two ways. The observer may determine his azimuth from the station by adjusting his phase shifter until the indicator shows zero deflection (so the two signals are in proper phase, and he is on course), or he may set the phase shifter for a predetermined value of azimuth and then navigate so as to keep on course as shown by the differential meter. In this manner,

he can fly along a radial to or from the station at the desired bearing of azimuth.

The combination of differential meter (cross-pointer instrument) and the phase shifter (known as azimuth selector) is not capable of distinguishing between a course and its reciprocal. An additional circuit is therefore provided to resolve this ambiguity by means of indicator lights.

It is of interest to note that an observer within range of two or more of these facilities can obtain not only his bearing with respect to any one of them, but also an absolute fix. Further, he can follow a course other than a radial one by obtaining absolute fixes at successive stages of the journey and navigating accordingly. An automatic means for doing just this is in process of final design and is expected to be available within the next year or two. The equipment required is DME (distance measuring equipment) and a computer for transforming the available observations into visual navigational indications. This is such that the cross-pointer instrument will show on-course as long as aircraft is flying the predetermined course. Deviations from this course will result in corresponding deflections of the meter.

Antenna Site Requirements

The siting requirements to insure satisfactory performance are definite, of course, but can usually be met adequately. There must be no obstructions between the transmitting and receiving antennas. This is basic to these and all higher frequencies. The ground contours and characteristics within a radius of 500 to 1,000 feet of the transmitting antenna are the most vital factors.

Ideally, therefore, a site should be flat to within 20 or 30 feet for a radius of 500 to 1,000 feet, and no obstructions within line of sight should rise more than 2 degrees above the horizon of the antenna. In practice these requirements are rarely fully met but they constitute a guide for survey parties. Actually these facilities have been installed and have been operating satisfactorily between Las Vegas, Nevada and Denver, and between Chicago and New York. The terrain encountered on these two routes is quite typical of bad siting conditions.

Ground Station Equipment

A block diagram for the ground station is shown in Fig. 1B. The antenna elements are horizontal loops of relatively wide metallic strips, so designed[1] that the current around the loop is approximately constant in amplitude and phase and takes the directions indicated in Fig. 1C. The diameter of the loop is in the order of magnitude of $\lambda/4$. Under these conditions, the polarization of the electric field is almost wholly horizontal and the horizontal space pattern is circular. The latter, however, is distorted by the proximity of the four radiators required to minimize octantal error. By proper orientation of the loops relative to each other, the octantal error practically vanishes. Figure 1D shows the actual array, with the carrier loop in the center of and above the sideband array.

The r-f lines to the antenna system, which is located on a 30-foot counterpoise about thirty feet above the ground, are of the solid dielectric type such as RG-8/U. They are all precut to provide the proper phasing and matching.

The sideband energy is obtained by means of a rotating capacitance goniometer (Fig. 2), essentially a capacitor in which the distance between the plates is constant, but the effective area A varies sinusoidally with time so that capacitance $C = kA = K\sin pt$. Thus the current through the capacitor at a frequency $\omega/2\pi$ is $I = k\omega E \sin pt \sin \omega t$, which represents the sidebands resulting from modulating a signal of frequency $\omega/2\pi$ by one of $p/2\pi$ or vice versa.

It has been found desirable to maintain $p/2\pi$ at a low value, in this case 30 cps. This is obtained by driving the goniometer rotor at 1,800 rpm. Inasmuch as the phase of this modulation will ultimately (in the receiver) be compared to a reference phase, it is essential that the reference signal be strictly constant in phase and of the same frequency as the variable phase signal.

To insure constancy of phase, the reference signal is generated by a magnetic tone wheel mounted on the same shaft as the goniometer rotor. This wheel has teeth cut in its periphery, of a shape to represent (at 1,800 rpm) a 10-kc wave frequency-modulated at 30 cps. The wheel is driven in a magnetic circuit, varying its reluctance in the above manner and generating a corresponding emf. This latter then is used through appropriate amplifiers to amplitude-modulate the carrier signal fed to the center loop of the array. In this way, the reference and variable-phase signals are maintained in proper synchronism despite minor variations in primary power frequency or goniometer speed.

In one type of goniometer assembly, a phase adjustment permits setting the desired angle between the tone wheel and the goniometer rotor. The rest of the structure serves to provide the desired

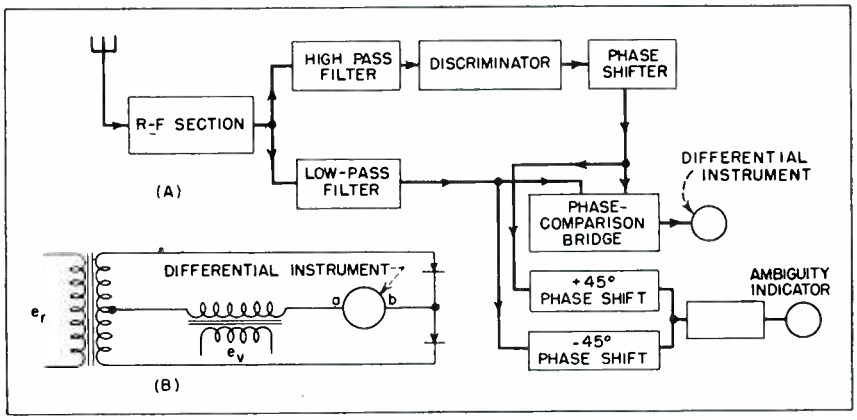


FIG. 4—Block diagram of a-f section of vhf range receiver, and circuit detail of differential zero-center meter that provides on-course information for the pilot

impedance relationships between various parts of the circuit.

The transmitter proper is essentially the same as described previously.[1] It is capable of providing a carrier output of at least 200 watts. Its final stage can be modulated up to 100 percent, though it is not so used here. The intermediate power amplifier has sufficient output at carrier frequency to provide energy to the goniometer as well as for excitation of the power amplifier stage.

Figure 3 is a schematic circuit diagram of the transmitter. The sideband power input to the goniometer is of the order of 20 watts. Of this about 11 watts is lost due to the fact that the goniometer is only 80 percent efficient and the antenna array only 60 percent efficient as a result of the close spacing of the elements. The remainder modulates the carrier (in the receiver) to a depth of 30 percent. (The reference phase signal modulation on the carrier is also 30 percent.) The rest of the transmitting equipment is of standard design adapted to the requirements peculiar to this service.

VHF Range Receiver

The receiver is, in the r-f portion, more or less standard. The a-f portion, however, separates the 10-kc subcarrier and the 30 cps derived from the sideband antenna. The two are carried along separately, the former going through the necessary demodulation circuits to recover the 30-cps reference signal, (shown in Fig. 4A) which is then passed through a special phase shifter. This consists of two transformer windings at right angles to each other and fed by two components of the reference signal which are in quadrature. A third winding rotates inside the first two and has a voltage induced in it with a phase dependent on its position relative to the two primaries.

In this manner, the reference signal may have its phase varied from zero to 360 degrees. From this instrument (the azimuth selector) the reference signal as well as the variable phase signal are fed into a bridge circuit (Fig. 4B) containing the differential zero-center meter (actually part of the cross-pointer instrument used in the instrument landing system.) The deflection of the meter will depend on the relative amplitude and phase of the variable phase signal e_v with respect to the reference e_r, zero deflection occurring only for quadrature phase relationship or one of the two components vanishing, or both. Hence if e_r and e_v are adjusted to be in quadrature at some azimuth, say θ_0, then the vector sum of e_r and e_v differs from the vector difference, the currents in the differential instrument do not balance, and a deflection occurs.

Since the two signals can be in quadrature twice in 360 degrees, an ambiguity results which is resolved by additional phase-shifting circuits together with a suitable indicator. With this one can tell whether the azimuth selector shows true bearing or its reciprocal.

Instrument Landing System

The standard CAA instrument landing system has been described elsewhere[1], and only those features not previously mentioned will be given here.

The markers are unchanged. It is anticipated, however, that they will be generally replaced by suitable distance-measuring equipment as soon as the latter is available. Installation of DME is expected to start in the fiscal year 1948.

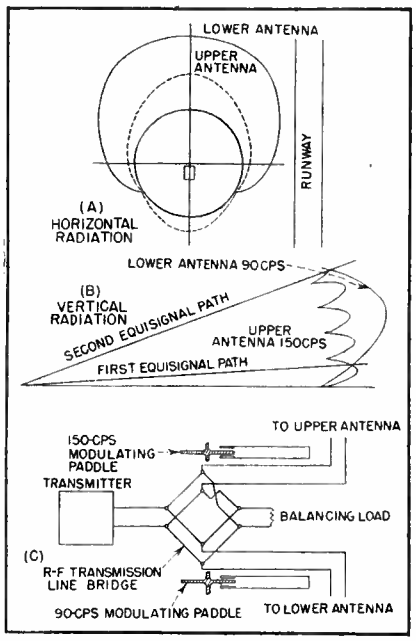


FIG. 5—Radiation patterns and modulating arrangement of 335-mc equisignal glide path transmitter used in standard CAA instrument landing system

The glide path operates at about 335 mc and is of the equisignal type using 90-cps and 150-cps modulations. The unmodulated carrier output is of the order of 25 watts. These two modulations are impressed on separate portions of the carrier, which are then fed to two vertically separated antennas. Each of the antennas produces a space pattern which is more or less circular in the horizontal plane, but multilobed in the vertical plane. The intersection of two of these lobes forms the equisignal surface used for a glide path. Figures 5A and 5B show these patterns. In the vertical plane there is a multiplicity of equisignal zones, the lowest being the one that is used. The antenna is designed so that the next lowest path is of the order of 15 or 20 degrees above the horizontal so that no possibility of confusion can exist. Instead of being perfectly circular, the horizontal patterns are compressed to the rear of the facility so as to minimize the effects of reflecting objects in that area, thus easing site requirements.

The actual glide path is the intersection of the equisignal surface and the vertical plane containing the localizer course, this intersection being hyperbolic. In practice the upper antenna is composed of two elements, one above the other and spaced one-half wavelength, so that actually three vertically stacked radiators comprise the antenna system. By adjusting the spacing between the upper and lower portions and by varying the relative powers fed to the two portions, the patterns can be controlled sufficiently to permit a variation of two or three degrees in the inclination of the glide path.

Splitting of the carrier into two portions and modulating of each portion with its proper tone is accomplished in the present equipment by means of transmission-line bridges together with mechanical variation of line impedances, as shown in Fig. 5C.

The receiving equipment is very similar to the localizer receiver[1] except for differences dictated by the different radio frequency.

The equisignal localizer has already been described. A more desirable form has now been evolved, however, which is scheduled to supersede the previous method completely. This is the so-called phase-comparison localizer (Fig. 6A). As its name implies, its use depends on the comparison of the relative phase between two signals.

Phase-Comparison Localizer

The antenna system is the same as that of the equisignal type, that is, a nondirectional radiator for the carrier, and one or more pairs of radiators for the sidebands—all in a symmetrical linear array. The sideband radiators on one side of the carrier antenna are, as before, in opposite phase to those on the other side. The only real difference between this and the equisignal type is in the fact that the carrier is modulated by a subcarrier which is itself frequency-modulated by a low-frequency tone. (The arrangement is, in fact, identical to that used in the vhf omnidirectional range.) Sidebands corresponding to this same low-frequency tone are impressed on the other radiators.

As a result of the phasing of the sideband radiators, each pair will produce a horizontal space pattern having a null and consequently a phase reversal along the perpendicular bisector of the array. Referring to Fig. 6B, for each pair the expression for the field is of the form $e = kI\sin(\delta\sin\theta)$. Obviously the field for $\theta = \theta$ is exactly equal but opposite in phase to that for $\theta = -\theta$, and vanishes for $\theta = 0$.

In the receiver, the signal corresponding to the sidebands just mentioned is combined with the reference signal in the bridge circuit described in connection with the omnirange receiver. Thus if e_v is in phase with e_r, the voltage applied to the differential instrument (Fig. 4B) is from b to a and the pointer deflects to one side. If the relative phases are reversed, the voltage will be from a to b and the pointer deflects to the other side. If $e_v = 0$, the current through the instrument is zero and there is no deflection. The circuitry and operation, and hence the equipment (in the aircraft) is the same as for the omnirange. From a practical viewpoint this is a powerful recommendation for the phase-comparison localizer.

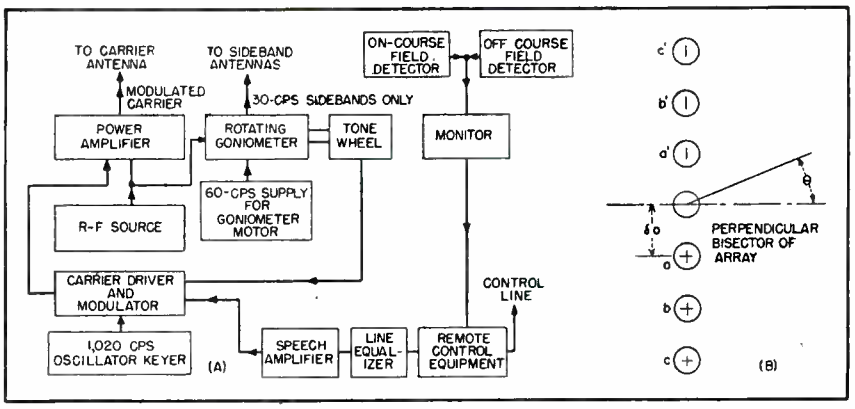


FIG. 6—Block diagram of phase-comparison localizer that is scheduled to replace equisignal localizers now being used in ILS, and detail of antenna array used

In the ground equipment this type of localizer represents a considerable simplification over the equisignal type and a further standardization of apparatus. The goniometer is in fact used, but in this case the inactive set of plates is connected to a dummy load to maintain balance. As in the equisignal type, the carrier can be modulated with voice and identification.

In practice, the phase-comparison type of localizer provides the same performance as the equisignal, but with appreciably greater ease of maintenance and hence greater reliability and efficiency of operation. These considerations have led to the adoption of this form as the CAA standard. It will replace the equisignal type as soon as the flying public is more generally equipped with proper receivers. It is also scheduled by ICAO to be the international system, waiting only for more widespread availability of receiving equipment.

VHF Communication

With respect to air-ground-air communication there is no special technique involved, the equipment being of standard design. All of this communication as well as the vhf navigation aids are within the band from 108 to 132 mc and the airborne receiver used for the navigation aids is designed to cover the entire band for communication as well.

There are also voice channels on both the runway localizer and the omnirange, which are used generally for traffic control and weather information. At the present time, consideration is being given to utilizing a very narrow portion of the above spectrum for continuous weather broadcasting. The operator would record weather information on a continuous tape which then would be run through the transmitter. This has not yet been worked out operationally.

Conclusion

This paper is confined to the matter described by the title. But it is not to be inferred that no work is being done on newer, promising techniques to accomplish the above results a little better or more economically. Both laboratory and field tests have been in progress for some time on new ideas and devices, particularly those depending on pulse techniques.

The CAA has the statutory obligation of providing certain services continuously and reliably with the best means available. It, therefore, cannot adopt various new devices before they are suitable for use in civil operations of airways, nor can it discontinue its program of constantly improving service.

The CAA is working to provide always a better airway aids service to a constantly expanding civil aviation, which in turn means better service to a large and vital segment of military aviation in time of emergency.

REFERENCES

(1) P. Caporale, The CAA Instrument Landing System, ELECTRONICS, p 116, Feb. 1945 and p 128, March 1945.

(2) David G. C. Luck, An Omnidirectional Radio Range System, *RCA Review*, July 1941 and Jan. 1942.

(3) This facility has also been described, recently, by D. M. Stuart of CAA.

TELEMETERING FATHOMETER

Modified radio equipment serves to link sections of a standard Navy fathometer to secure continuous depth indications beneath a remote-controlled pilotless ship. Radio frequencies near 8 and 70 megacycles are employed

By E. F. KIERNAN
U. S. Navy Electronics Laboratory
San Diego, Calif.

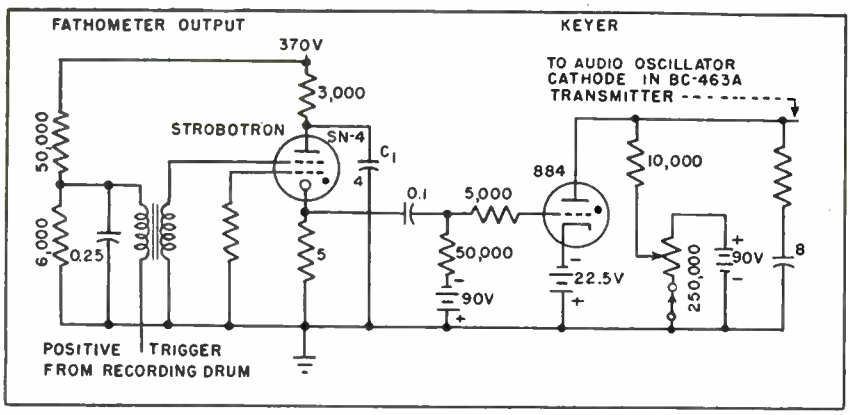


FIG. 1—Modified fathometer output circuit and keyer circuit used to modulate the control station transmitter

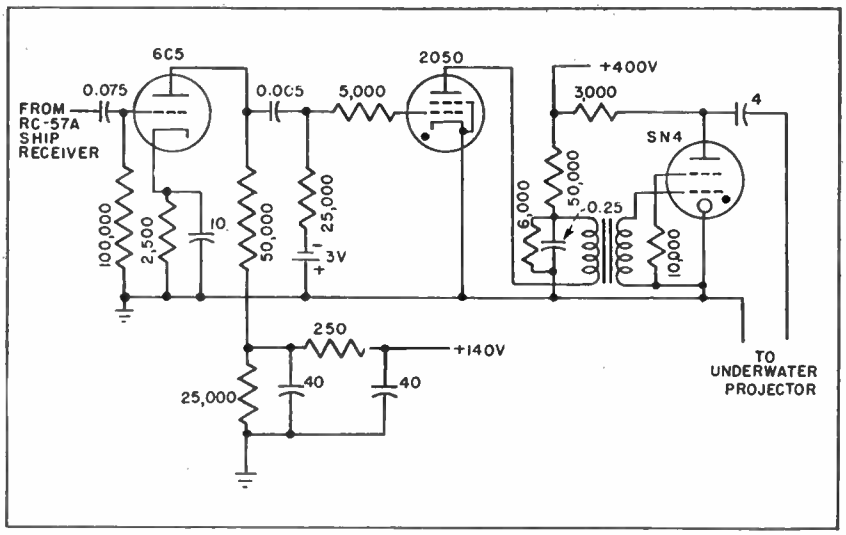


FIG. 2—Modified ship receiver output circuit used to translate received pulses from the control station into projector pulses for echo sounding

In the remote control of ships, it is often desirable to observe continuously and record, on shore, numerous phenomena encountered by the controlled craft. As part of such a specific problem, it has been necessary to record the depth of water beneath a ship while it is being maneuvered. Existing electronic equipment was modified for the purpose, and its disposition is illustrated. The equipment used is divided into two groups, a transmitter, receiver, and recorder located at the control position on shore; and a transmitter, receiver, and depth-sounding equipment on the mobile ship.

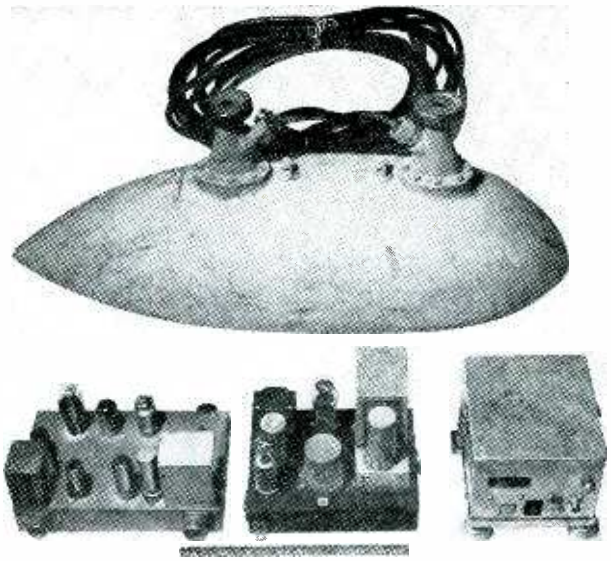
The control station may be considered as a closed radio and wire circuit in which impulses initiated by a portable fathometer-recorder equipment are received after a variable time delay (due to the time required for the sound to travel through the water); this delay is plotted by the recorder in terms of ocean depth.

The ship equipment consists of an ultrasonic projector triggered from the shore, and an ultrasonic hydrophone that sends back the desired time-delay information. A radio receiver and transmitter are also necessary to tie this underwater transducer equipment into the closed radio circuit of the control station.

For a telemetering system in which the measurement of small time intervals gives the desired information, the radio links and trigger mechanism must contain only small, fixed, known time delays, and as a corollary, the bandwidths of the system must be sufficient to pass the required sharp pulses without unduly modifying their steepness.

The standard Navy type NK-2

Control equipment includes the RBF-1 converted f-m receiver and loop at left, modified NK-2 recorder and the keyer. The BC-463A transmitter is at the rear

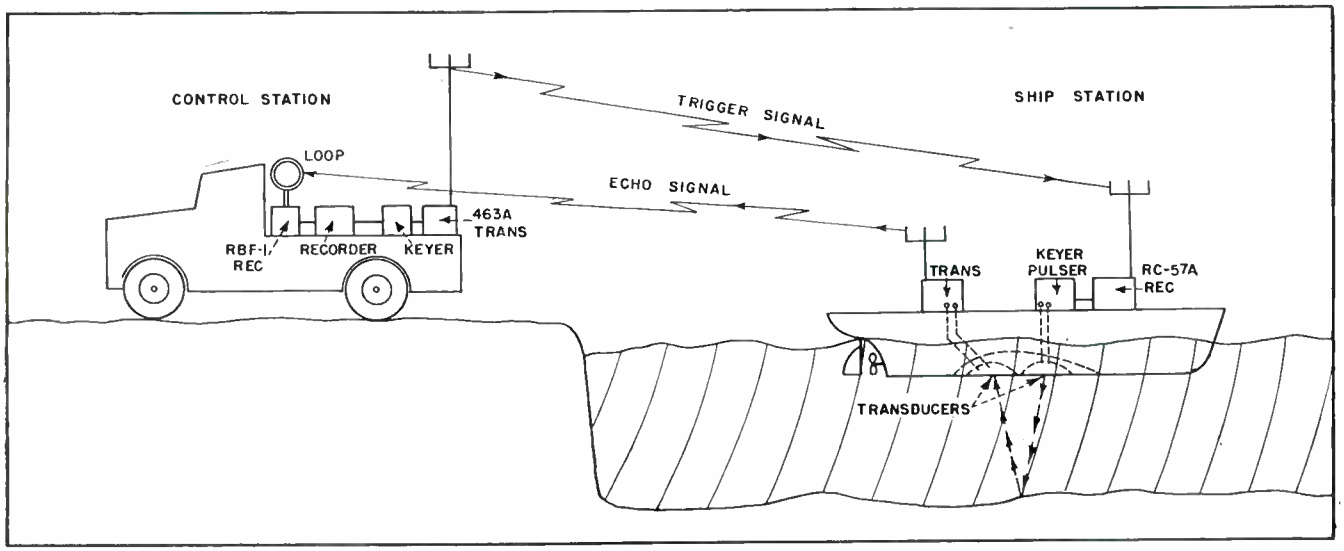


Ship station equipment. The housing at top contains projector and hydrophone. Amplifier and transmitter, the keyer pulser, and the RC-57A superregenerative receiver are in the front

fathometer that was modified for telemetering normally functions as follows: A 12-v storage battery supplies power to a centrifugal governor-controlled motor. Through suitable gearing, this motor drives a drum which has a single turn of wire mounted in a spiral groove along its face. The wire projects approximately half its diameter (0.026 in.) above the surface of the drum face. A similar mechanism is used in facsimile receivers. Friction rolls drive the arc-discharge type recording paper across the face of the drum. Above the paper, and lightly contacting it, a printer strip is mounted parallel to the longitudinal axis of the drum. As the drum revolves, the point of contact between the printer strip, the paper, and the spiral wire moves at uniform speed across the paper. At the instant the point of contact passes a reference line near one edge of the paper, a pulse is transmitted into the water by discharging a capacitor into the projector unit of the transducer.

The pulse in the water travels to the bottom, where it is reflected, and the echo is intercepted by the hydrophone unit of the transducer. The signal from the hydrophone is passed through a high-gain amplifier and is then fed to the printer strip. The signal causes an arc discharge to take place from the strip through the paper to the spiral on the drum. The point of contact between strip and spiral depends upon the elapsed time taken by the pulse during its travel through the water.

The paper is graduated in feet, and the depth of water may be read



Complete block diagram of the fathometer telemetering system employing a robot ship

directly from the recording. The range of scale is directly proportional to the rotational speed of the spiral drum. A suitable gear-shifting mechanism provides a selection of ranges.

The triggering contacts consists of a stationary brush and a rotary segment mounted on the end of the spiral drum shaft. The stationary brush position is adjustable to provide alignment between pulse and index line on the recording paper.

The modified output of the fathometer recorder is shown in Fig. 1. As originally wired, the cathode of the type SN-4 strobotron was tied directly to ground and the tube normally functioned to discharge capacitor C_1 through the projector to generate the underwater pulse. Because the length of the impulse was insufficient to key the audio oscillator of the modified BC-463A transmitter, the 884 gas-tube circuit was added. By inserting a 5-ohm resistor in the cathode circuit of the strobotron, sufficient voltage is developed across it when the tube fires to trigger the 884 tube.

The RC networks have been chosen to give proper time constants for the desired keying interval. It was found necessary to insert the battery in the cathode circuit of the 884 tube to balance out the drop through the thyratron that was sufficient to bias the transmitter audio oscillator to cutoff. It was found necessary to prevent strong sunlight from falling directly on the strobotron since sunlight caused the tube to remain continuously ionized.

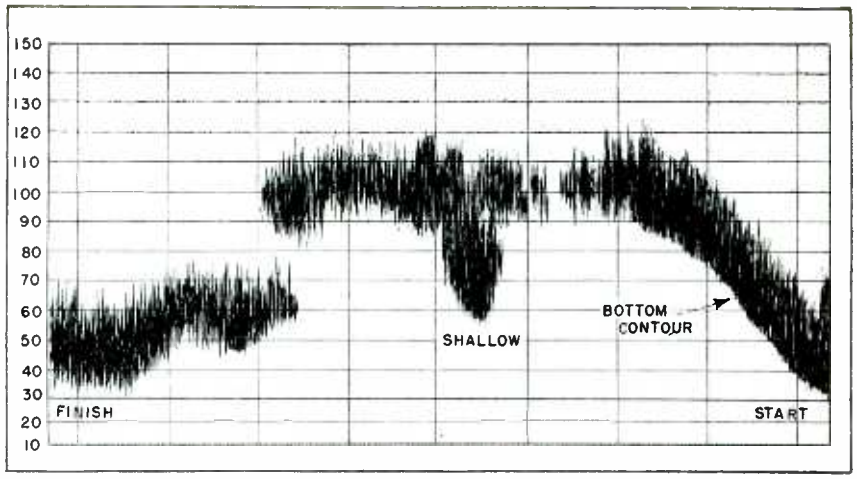


FIG. 4—Drawing showing the salient features of a record obtained from trial run of the robot ship. From right to left, the contours revealed by echo soundings indicate the cruise from shore to deep water and back

The RBF-1 f-m receiver was chosen for use at the control station to receive the incoming signal from the low-power ship transmitter and operate the recorder. The circuit was modified for a-m reception by converting the limiters to additional i-f amplifiers and the discriminator was changed to a diode-type detector. The necessary bandwidth required for pulse reception was inherent in the original f-m design. For use in proximity to the control transmitter it was found advisable to construct an electrostatically shielded loop, suitably placed and oriented. The antenna was made by fastening a length of RG-11/U concentric cable, in the shape of a closed, one-turn loop, to a piece of plywood. The inner conductor was soldered to the outer sheath at the closure point.

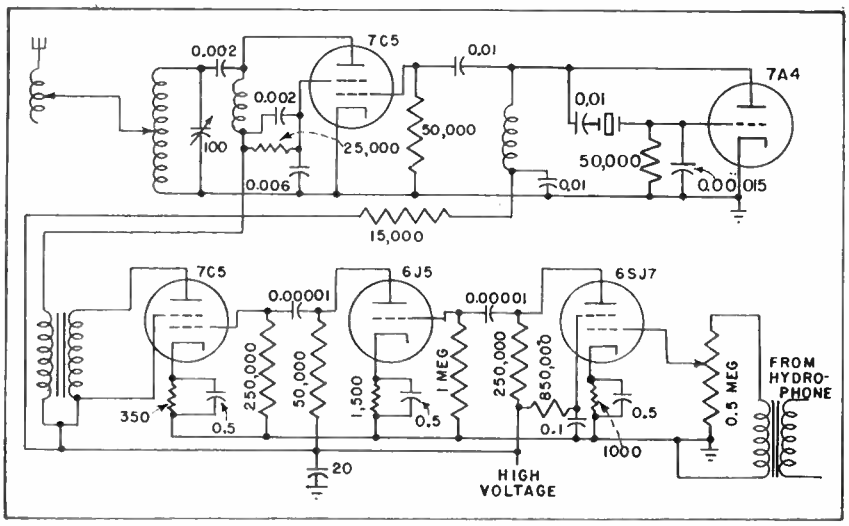


FIG. 3—Hydrophone audio amplifier and ship transmitter that sends back received echoes from ocean bottom to the control station recording equipment

Ship Station Equipment

The receiver employed at the mobile station to operate the transducer projector is the RC-57A superregenerative type, the circuit for which appears on page 89 of the December 1946 issue of ELECTRONICS. It tunes in the frequency band 67 to 72 megacycles.

Figure 2 shows a keyer-pulser that was built to convert the negative output pulse from the receiver to a capacitor discharge into the transducer projector. The circuit uses a type 6C5 phase-reversing amplifier to trigger the type-2050 thyratron. It was found that although the gas tube would fire from a negative pulse, a delay of several milliseconds occurred. It apparently requires considerably more time to transfer an arc between control grid and cathode to the anode when the cathode is negative than it does when the cathode is positive since the cathode must reverse polarity in the former case.

The echo picked up by the hydrophone is fed to the amplifier and transmitter shown schematically in Fig. 3. The unit is essentially an audio amplifier modulating a 5-watt a-m transmitter with a carrier frequency of 8 megacycles. A band of audio frequencies from 600 to 16,000 cycles can be successfully transmitted.

A sample record of a trial run is shown in Fig. 4.

Initial production model of the magnetic tape recorder. Tape runs from left to right. The recording, erasing, and playback head is front and center

Magnetic Tape Recorder for Movies and Radio

New equipment using improved tape driven by three motors at a speed of thirty inches a second has an overall response flat within 4 db from 32 to 9,600 cycles. Overall design considerations and circuits for the recorder-reproducer are shown and a word spotter for editing is described

By RICHARD H. RANGER

President, Rangertone, Inc., Newark, N. J.

THE BASIC FACTORS underlying the magnetizing of ferrous wires as a means of recording, storing, and later reproducing intelligence have been known since the turn of the century, and more recently the expansion of the technique to include ferrous oxides on paper or plastic tapes has been well developed[1].

In Germany, magnetic tape recordings were used by broadcast stations and the military during the war. The technique was probably developed to its highest point in the so-called K-7 Magnetophone manufactured by Allgemeine Elektrische Gesellschaft. The recordings consist essentially of iron rust supported on a synthetic tape of great inherent physical strength. The tapes pass rapidly and uniformly by erase, record, and pick-up heads.

A method of using a frequency in the order of 100 kilocycles as a means of erasing and preparing tape for recording audio currents has been worked out to give a quality of reproduction not heretofore approached. Using an early model Magnetophone and what information has become available in the United States through reports of Army Intelligence missions[2], to-

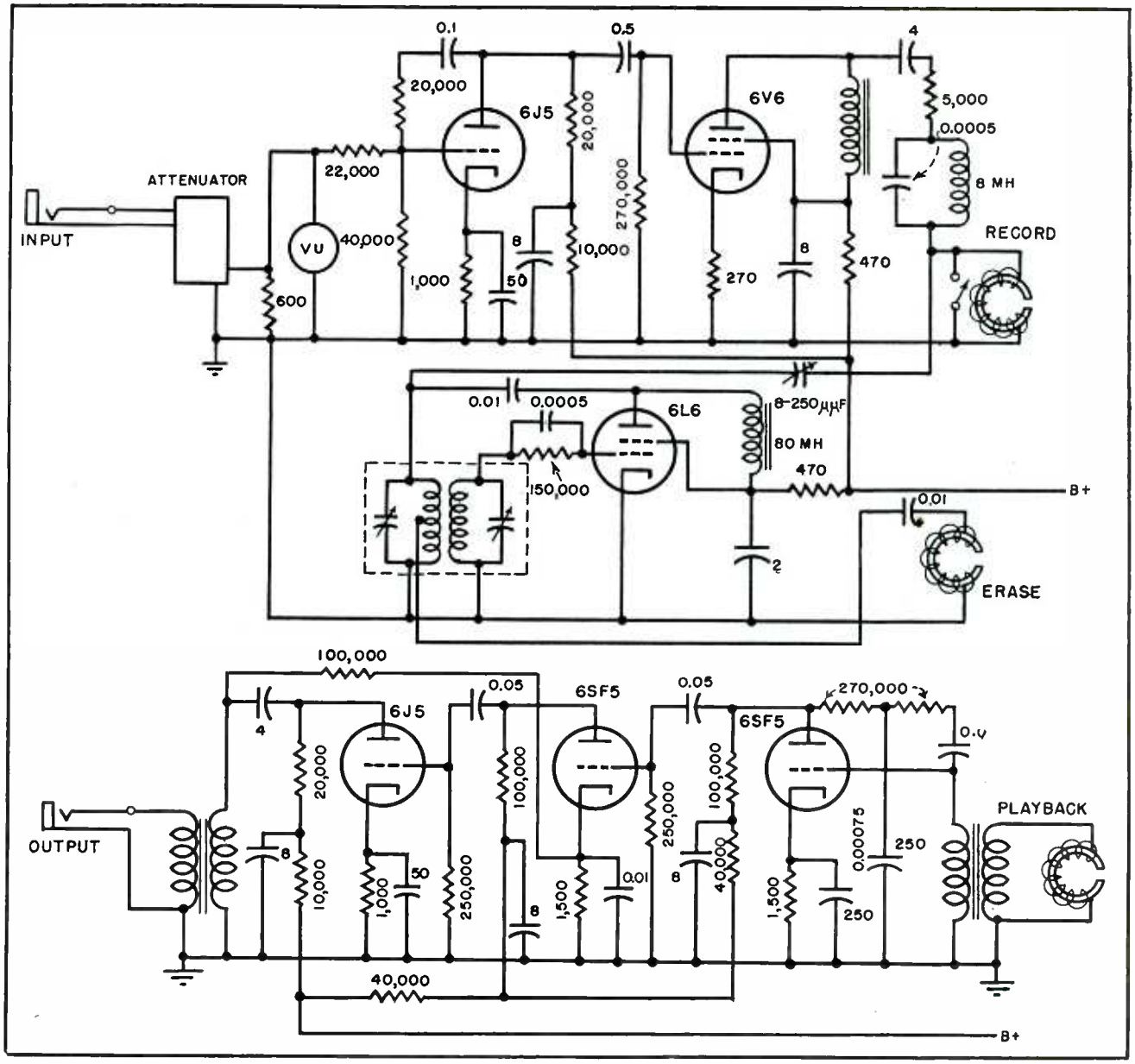


FIG. 1—Circuit diagram of the recorder-reproducer, showing method of energizing record and erase heads

gether with American laboratory and production methods, a new recorder-reproducer has been built that matches or surpasses its predecessors in every detail.

With a view to manufacturing a professional machine, the first production model has been constructed along the lines illustrated, using the circuits shown in Fig. 1. The main elements in the equipment are the erase, record, and play-back heads; the tape; the amplifiers; and the drive mechanism. The play-back head is the most critical of the three because signals recorded on the tape are of low intensity. It requires 70 db of amplification to bring the peak recorded signals up to 0 db. Since the dynamic range possible with tape recording approaches 60 db, the very weakest signals are down some 130 db in the levels only a little above the thermal noise of tubes.

Construction of the Heads

In Germany and America, the development of high permeability materials has been carried farther than anywhere else, and therefore, the materials for making the heads have been available. The head in Fig. 2 is made in two halves from laminated high permeability material 6 mils thick. The width of the pole pieces is greater than the quarter-inch width of the tape to allow for slight sidewise excursions of the tape in passing. The actual gap in the head is small, being in the order of 0.4 mil across. The gap itself is filled with a nonmagnetic shim of beryllium copper. The windings and impedances of these heads are as shown in Table I.

For the erase operation, the current required is determined largely by the magnetic properties of the tape used. With one of the ferric oxide tapes some 80 milliamperes of 70-kc energy is necessary to do a thorough demagnetizing job.

FIG. 2—Typical recording head removed from the assembly

The ferrous oxide tapes, current in the States, and especially the nickel-irons require much stronger erase current fields. Although the remanence and coercive force of these latter materials is far greater (this would appear to be an advantage for greater permanency) it has been found that the lower values of red oxide were better from the point of view of quality linear response. It is interesting to note that only red oxide made by oxidizing the ferrous black oxide is magnetically effective. The reasons are not known, but it is presumed that by slowly oxidizing the ferrous its lattice structure is maintained, which is presumed to hold the magnetic structure just enough to give a flexible medium.

Recording Bias

For the record head, an audio signal of 4 ma is combined with a high frequency bias of 1.5 to 2 ma for best results. The action of the bias current in improving the linearity of the magnetic remanence of the tape is shown in Fig. 3. Fig. 4A shows the remanence with varying recording current without the use of bias. This curve shows high irreversible areas, all of which indicate lack of linearity. Figure 4B shows the remanence with half the optimum bias, and Fig. 4C shows the remanence with full corrective action of the bias applied. Greater values of high frequency bias only have the effect of reducing the overall remanence,—in other words, erasing is beginning; so a definite optimum value exists. A little trick that seems to identify the correct bias, is that below the proper strength, the third harmonic is evident, and above the proper value, the fourth harmonic increases.

It must be realized that the tape is magnetized longitudinally by the variations of the magnetic force at the gap in the recording head. It is necessary for the tape to be in direct contact with the heads to obtain best results. The pressure of the tape on the heads must not, of course, be overdone, as the tape itself might be considered as a form of fine crocus cloth, and its action is always to give a beautiful finish to the heads.

The design of the core at the gap in the heads is such that the gap increases gradually in size as the head wears down. This means that the equipment will gradually show less response on the highs as playing time increases. The effect, however, is not noticeable for over 500 hours playing time, depending upon the degree of care exercised in the operation of the machine. A disengager is provided on the head assembly by means of which the tape is made to stand off from the heads in the rewind operation, or from the erase and record heads in the playback operation. The entire head assembly is plugged in with one operation, and each machine is furnished with two complete assemblies in order to take care of operational failure, besides providing a spare while a worn head is serviced. In servicing, the heads are taken apart, and re-assembled with new cores. This process is simple, but the lapping of the gap is a precision jeweler's job and involves the use of special jigs.

The function of the high permeability material is to concentrate a maximum of flux at the extreme edges of the gap. It is readily appreciated however, that the effective width of the gap, even with these materials, is determined by this concentration. Actually the magnetic gap is about 0.2 mil wider than the physical gap owing to the slight spreading of the crowded magnetic lines of force as they leave the iron core edges and pass through the tape.

Mechanical Tolerances

The actual alignment of the gap perpendicular to the motion of the tape is most critical. A slight er-

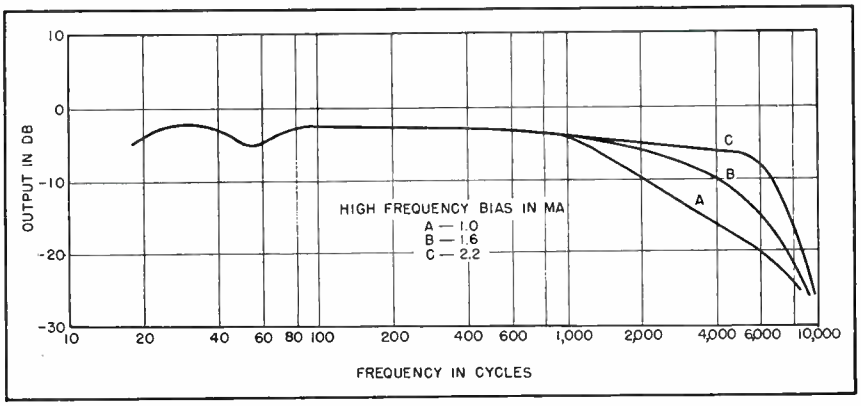


FIG. 3—Effect of bias current in improving linearity of magnetic remanence of tape

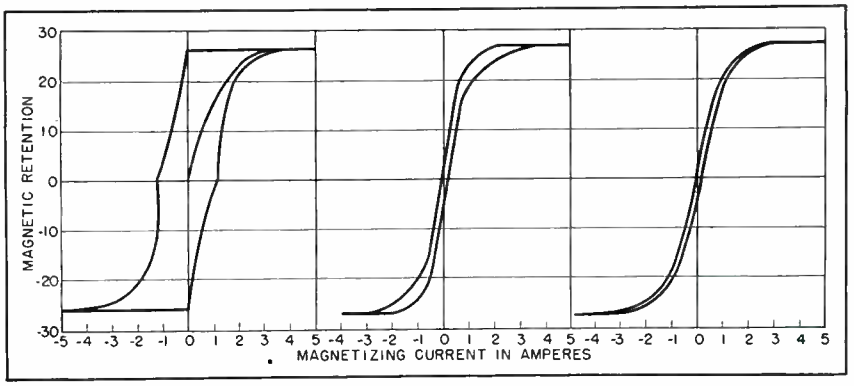
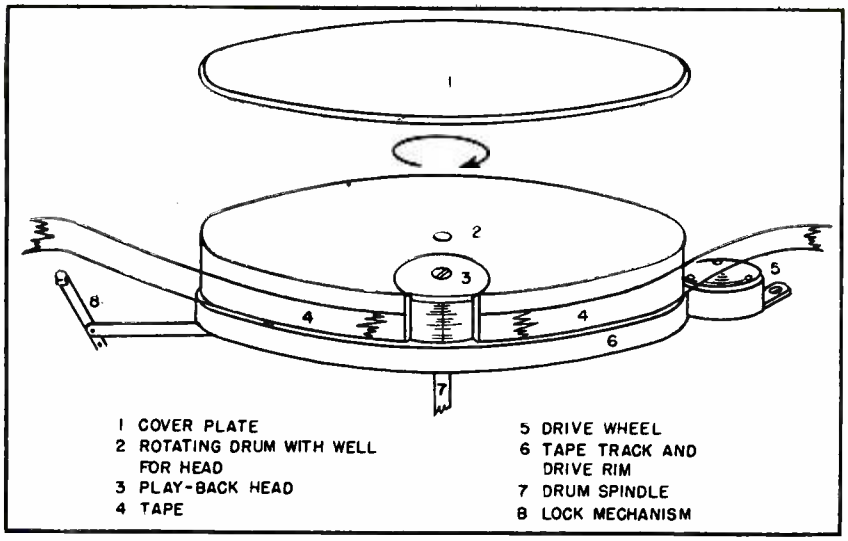


FIG. 4—(A) magnetic remanence with varying record current and no bias; (B) remanence with half optimum bias current; (C) remanence with full corrective bias



Artist's sketch of the word-spotter that can be plugged in replacing the triple head. A still newer device will operate in two different ways: with the play-back head stationary and the tape moving normally by, or with the head revolving past the stationary tape

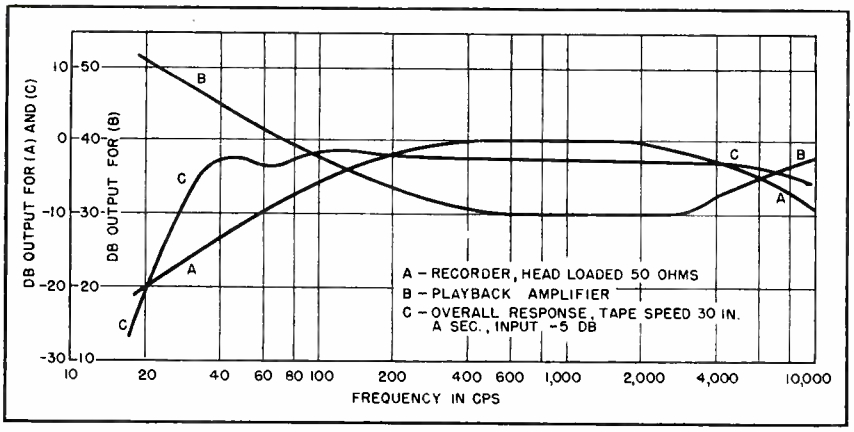


FIG. 5—Component and overall response curves for the magnetic tape unit. Curve A shows the recorder alone with no input equalization. The amplifier response is superimposed in curve B (note the different vertical coordinates); while the combined response is given in C

ror in this alignment will easily result in a variation equivalent to the width of the gap across the quarter-inch tape. This alignment can be achieved through the use of a microscope set up with sturdy longitudinal and vertical movement controls. Actual alignment adjustment is made by screw adjustments on the top of the head assembly, and can be accomplished in the field with the tape in motion. For this purpose, a standard tape recorded at 6,000 cycles with 50 percent modulation is furnished. Adjustment can then be made by observing maximum response, and setting the adjustment screws to this position. With the pickup head adjusted it is then possible to align the record head. For this second check purpose, a blank tape is used, and recorded with a 6,000-cycle signal put on the recording head. The pickup head is not readjusted during this operation, but its maximum response is noted as the record head screw is adjusted.

Gap Spacings

The recording head has a normally wider gap than that of the pickup head. There seems to be an improvement in using a slightly larger gap than that in the playback. In recording, the signal laid down on the tape seems to be primarily a function of what is happening at the pole piece edge where the tape leaves the recording gap. This edge should be as straight as possible. The magnetism that will remain in the tape may be considered as a statistical average of the effects the tape has undergone, caused by both the audio recording and the high frequency bias as it passes through the gap fields. This statistical average is finally influenced more by the flux immediately on the edge of the gap where the tape last passes than it is at any other point.

This phenomenon has two beneficial results; it increases the free magnetomotive force ready to go up into the tape at the trailing edge, and it makes the resultant lines of force appear to pass up more vertically into the tape and thus increase the definition.

The alignment of the erasing head is not at all critical; it is 20 mils wide. In much the same manner as demagnetizing a watch, the purpose of the erase head is to create a rapidly alternating magnetic field that increases and decreases as the tape passes through it. In consequence the tape is left neutral magnetically. Noise on the tape is entirely a function of the statistical averaging of the so-called domains of magnetization, and where there is as thoroughly a random condition as possible, noise will be at a minimum. It is obvious that the high frequency bias accomplishes this same improvement in quality on recording, by leveling this statistical average to that value required to represent the desired audio response.

Equalization of Amplifiers

The amplifiers for this recording system have gone through considerable progressive evolution. Generally speaking, it appears that for the recording head virtually constant response with respect to frequency change is the optimum. However, there are some who believe that a slight increase for the low and high frequency may be desirable. For the play-back, however, post emphasis may be used to completely realize a straight line frequency response from whatever signal has been put on the tape. The actual response on a tape with no post emphasis, and recorded with a constant current input to

the recording head is shown in Fig. 5A. The response rises to a maximum around 1,000 cycles in a head loaded for 50 ohms. For an unloaded recording head, maximum response will occur at about 4,000 cycles. The play-back amplifier is therefore compensated for these conditions so that its response follows curve B. The final result of the overall recording and reproducing amplifiers is shown in curve C.

THE VALUE OF MAGNETIC TAPE RECORDING

Interest in magnetic tape recorders is particularly high among three groups.

Film makers are eager to explore the possibility of using magnetic tape as a simpler, cheaper means of recording, editing, and dubbing in the eventual sound track of sound movies.

The success in recording one prominent radio show has led to strong pressure by other artists for similar handling of their productions.

F-M broadcasters, dependent in many cases upon recorded music for the bulk of their present programming, have also taken a keen interest in magnetic tape

Tape Drive

It is essential that constant tape speed be maintained. Three motors are employed to insure constant tension at all points in the tape path. One of these motors is to the left and on normal playing it controls the release of the tape reel. It must oppose this release with a torque fairly constant from start to finish. The second motor is synchronous and holds the tape rigorously to the rotational speed of this motor by means of a sleeve on its shaft which presses against a rubber idler. The third motor is on the right and drives the take-up reel. As the reel builds up in diameter with the successive layers of tape the moment arm increases with the radius; the larger the reel the slower the rotation. These two facts show the necessary relation between rotational torque of the motor and speed. It is necessary for the motor drive on both the tape take-up and release spools to have a curve of torque inversely proportional to the speed of the reel. Although it has not been possible as yet to obtain a straight-line function for this curve, modification of the rotors of normal capacitor start and run motors has resulted in the characteristic indicated in Fig. 6. Whatever the rotational torque of the motor, the pull on the tape will decrease with increasing radius.

Table I—Head Characteristics

Head	Turns	Resistance (ohms)	Impedance (ohms)
Erase	100	1	2,000
Record	600	10	11,000 at 70 kc 560 at 1 kc 58 at 100 cycles
Play-back	600	10	560 at 1 kc 58 at 100 cycles

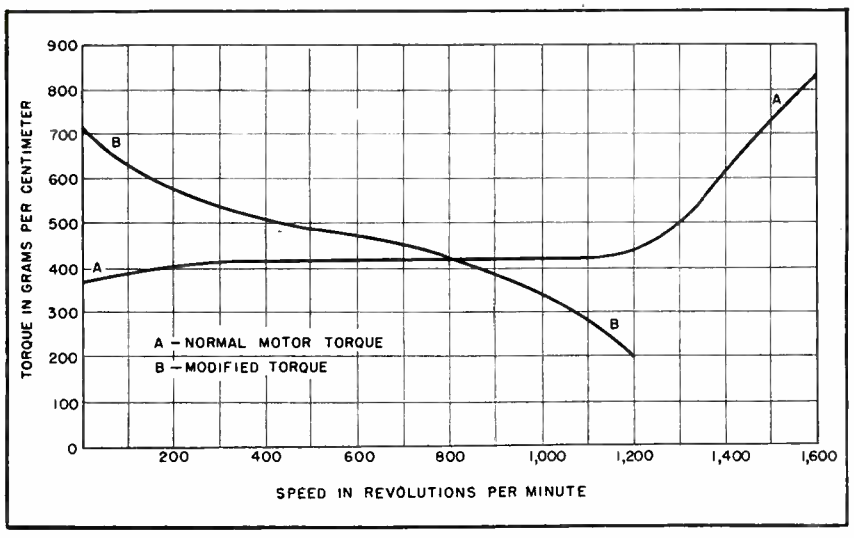


FIG. 6—Modifications in the torque characteristics of motors for recorders

Editing Aid

Use of the equipment for broadcast or sound-track dubbing has been greatly enhanced by the recent development of a "word-spotter". Still in the experimental stage, the device has been arranged to plug in, replacing the conventional head assembly, and is driven by the sync motor spindle and rubber idler that customarily pulls the tape. The large driven drum of the spotter has a circumferential groove slightly wider than the tape. A playback head is mounted flush on the edge of the drum, so that if a short length of the tape is held stationary in the groove, musical chords, syllables or short words are repeated over and over. By this means it is easily possible to spot desired portions of a recording with uncanny accuracy.

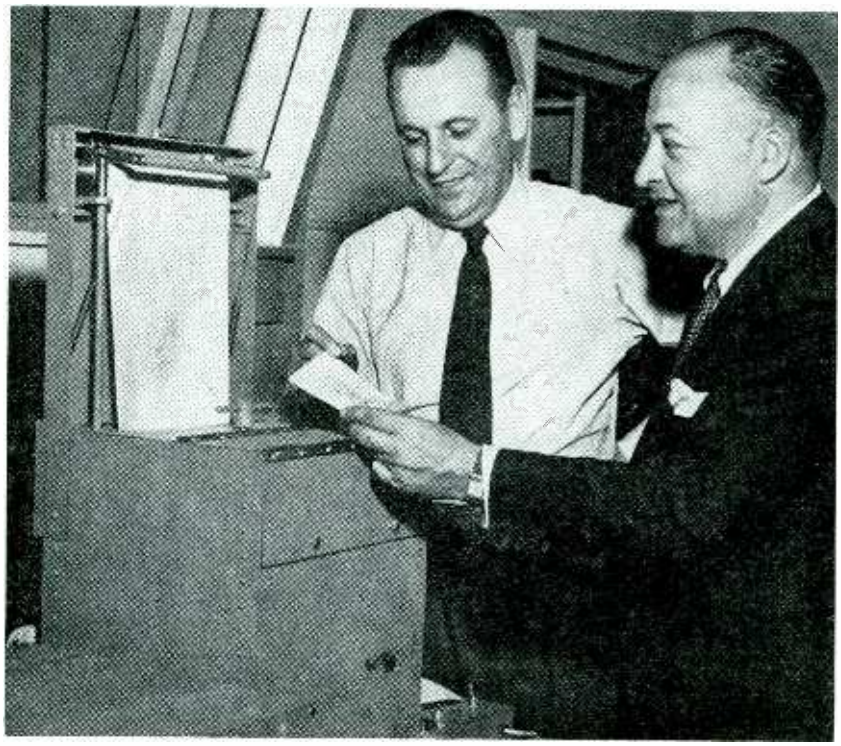
Experiments now in progress indicate that the machine may prove useful as a memory device for computer systems, since the shelf life of magnetic wires and tapes has so far proved to be indefinitely long. In order to eliminate errors resulting from possible cold flow of the plastic tape used as the base for the magnetic powder, investigations are being made of Fiberglas tape as a support for the recording medium.

References

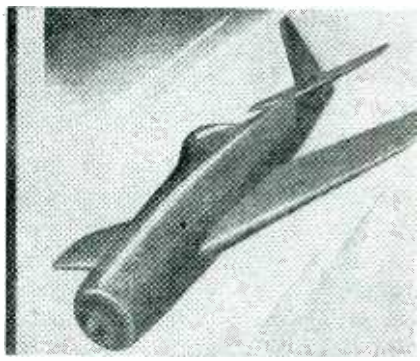
(1) M. C. Selby, Investigation of Magnetic Tape Recorders (including bibliography) Electronics, p 133, May 1944.
(2) A Bibliography of OTS Reports on Magnetic Tape Recorders (a free publication) Reference Service Section, Office of Technical Services, Department of Commerce, Washington 25, D. C.

Bibliography

(1) Magnetic Sound for Amateur Movies, Electronics, p 140, March 1947.
(2) R. H. Ranger, Design of Magnetic Tape Recorders, Tele-Tech, p 56, August 1947.



Colorfax experimental recorder disseminating color comics



Black and white reproduction of colored-drawing facsimile

COLOR FACSIMILE

Experimental system reproduces a colored picture by means of cyan, magenta, yellow, and black pencil leads on ordinary untreated paper. New recorder employed will achieve cheaper monochrome

A NEW, simplified facsimile receiver, invented by L. R. Philpott and W. G. H. Finch, has been developed as a color printer for use in a radio or wire reproducing system called Colorfax. Still in the development stage, the f-m receiver and printer combination may become available for home use in 1948 at a cost of about $100. It will be quickly adaptable to either monochrome or color broadcasts on f-m. For comparable transmission bandwidths the speed of reception for color will be a quarter that of black and white.

The experimental equipment built for demonstration on telephone lines prints colors at a rate of one-half inch a minute for a bandwidth not exceeding 1,800 cycles per second. Pictures are reproduced at the equivalent of 100 lines to the inch, as compared with newspaper color screens that are usually 65-line screen. The most important economic feature of the process is the fact that any paper fit to write upon can be used; special chemically treated stock is not needed.

The present limitation to the color process is the unavailability of entirely suitable colored leads for use in the recorder. This problem has not yet been vigorously attacked. Pictures transmitted by the experimental system are therefore lacking in strength and fidelity.

The color technique involves three main steps; analysis of the original by means of red, green, and blue color filters between a light source and phototube; electronic amplification and coding of the resultant currents; synthesis of color at the printer by means of cyan, magenta, and yellow pencil leads. The original is also scanned by plain light to operate a black pencil. Because each line of the original is scanned four times, any or all the pencil leads can be caused to operate, overprinting in most cases, to produce color combinations.

Supplementary equipment is nec-

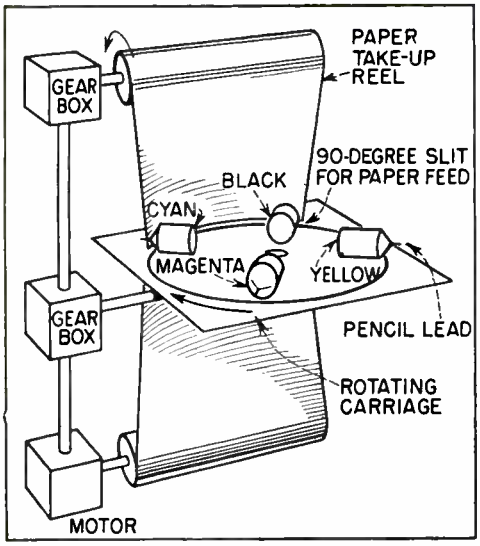


FIG. 2—Elements of the color printer

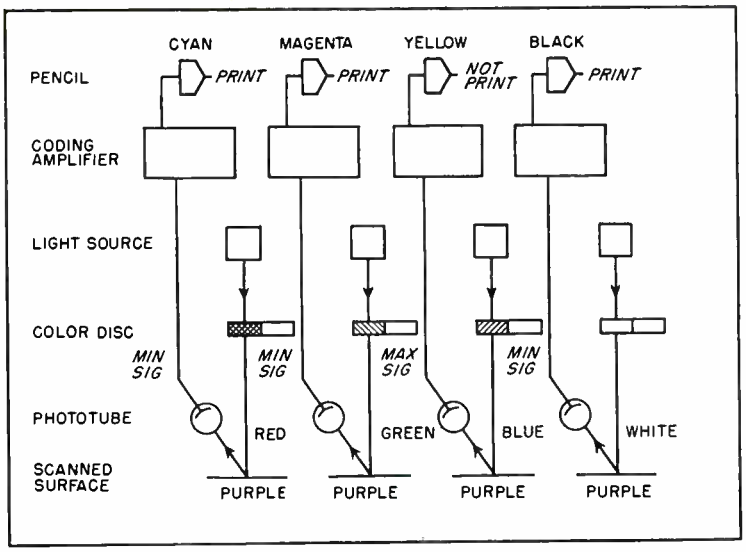


FIG. 3—Scanning sequence for a purple area.

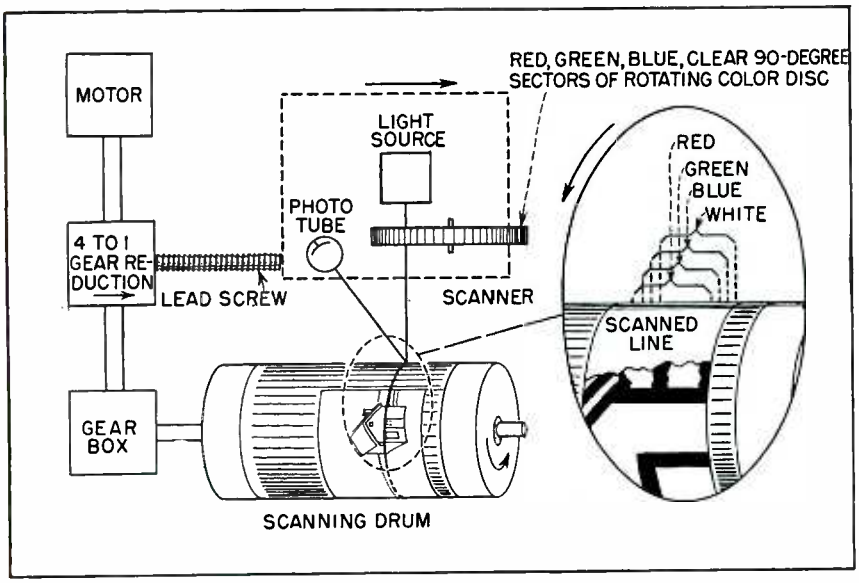


FIG. 1—Elements of the color facsimile transmitter. Each line area is scanned four times, once for each color. Expanded detail is approximate

essary, as in any system of facsimile, to maintain synchronism between transmitter and receiver and to feed paper past the rotating printer with its four actuating heads. Simply inserting black leads in each holder and increasing speed of paper feed by a factor of four converts the printer for normal black and white reception.

System Components

The elements of the color facsimile transmitter are shown in Fig. 1. The motor drives the scanning drum at a rate such that the same line element is covered four times by the light beam. However, as the drum revolves, red, green, blue and clear sectors of a color disc are interposed between the light source and the drum, one for each of the four periods of complete rotation. The magnified detail indicates approximately how a single line strip would be illuminated by different colored beams of light in succession. Light, or lack of it, is observed by the phototube, output from which is sent through an electronic conversion circuit and then to the receiver.

The receiver motor in Fig. 2 can be synchronized with the driving motor at the transmitter by any of the standard means. Further synchronization must be obtained between the color disc at the transmitter and the pencil drives on the rotating carriage at the receiver. Each of the recording pencil leads maintains a gentle pressure against the paper as the latter moves upwards at right angles to the plane of the arc described by the rotating carriage. When driving impulses are received, the pencil leads are pushed against the paper by an electromagnet for the duration of the impulse or series of impulses. Any or all the pencils can be energized. They are oriented so as to overprint each line, beginning with cyan (actuated, or not, by the red-light beam) and ending with black (connected through the clear-light circuit). Then the cycle begins again for the next line as the paper on the recording drum moves upward.

The simplified representation of Fig. 3 indicates system action when a purple area is viewed by the scanner. In this illustration probably all the recording pencils except yellow would be caused to operate, the colors combining to make a reasonable facsimile of the original colored area. —A. A. McK.

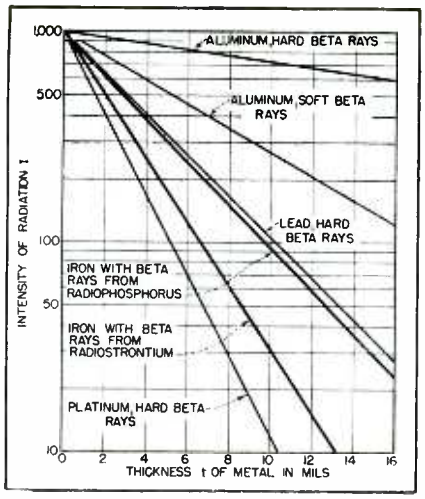


FIG. 1—Absorption of beta rays by various thicknesses of iron

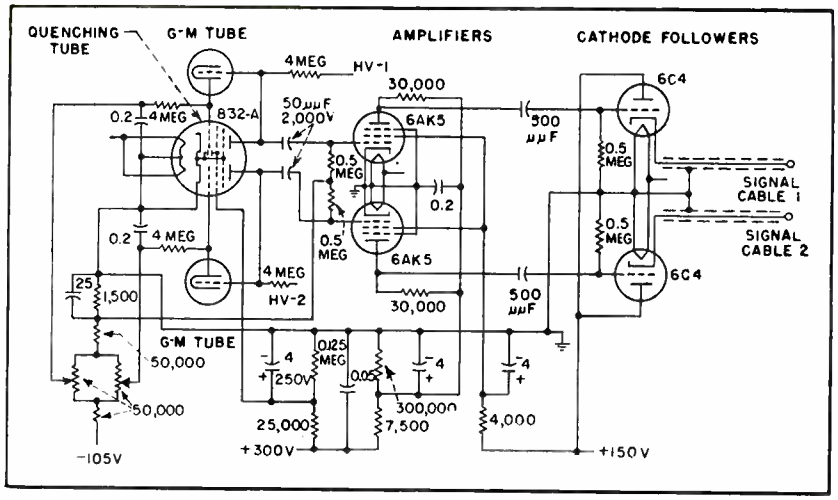


FIG. 2—Quenching circuit used for the two G-M tubes, with amplifiers and cathode followers for feeding into rate meter circuit that indicates thickness directly

Beta-Ray Thickness Gage

G-M counters and integrating circuits, responding to absorption of beta rays by steel strip moving over a radiostrontium source, measure thickness over range of 7 to 24 mils. Sheets can be sorted automatically by a mechanical gate after cutting. Accuracy is analyzed

A CONTINUOUS-READING beta-ray intensity meter was built for an application in which the thickness of a material was being measured by the absorption of beta rays. The problem arose in connection with the measurement of the thickness of steel in tinplate mills. A thickness gage which did not actually contact the material could be based upon the absorption of either x-rays or beta rays.

Beta rays are absorbed by a material in such a way that the transmitted intensity of the beam is a function of the initial intensity and energy and the composition and thickness of the material. The ratio of the transmitted to the incident intensity can be a measure of the thickness of homogeneous material, independent of the permeability or the conductivity.

Beta-Ray Sources

The available sources of high-energy beta rays are given in Table I. Radioactive strontium, which decreases to half its strength in 55 days, is ideal because of the lack of obscuring gamma-radiation. Measurements of absorption of beta rays in iron were made, using a Geiger-counter tube as a detector. The results are plotted in Fig. 1, along with data on other metals for comparison. The equations for each of these curves are $dI/I = a\ dt$, and $2.303 \log (I_0/I) = a\ t$. The absorption coefficient a is 0.346 per mil of iron for strontium $_{88}Sr^{89}$ (1.32 million electron volts or mev).

Table I also shows the rate at which the strength of radiostrontium decreases logarithmically with age. One might buy twice the strength needed for a specified job and replenish it every 55 days. This is particularly economical if a range of thicknesses is to be measured.

Detection of a high-strength source can be accomplished with a fluorescent screen, a photomultiplier tube, and an amplifier. For low intensities, however, the conventional detector is a thin-walled Geiger-counter tube, and such tubes were used in this work.

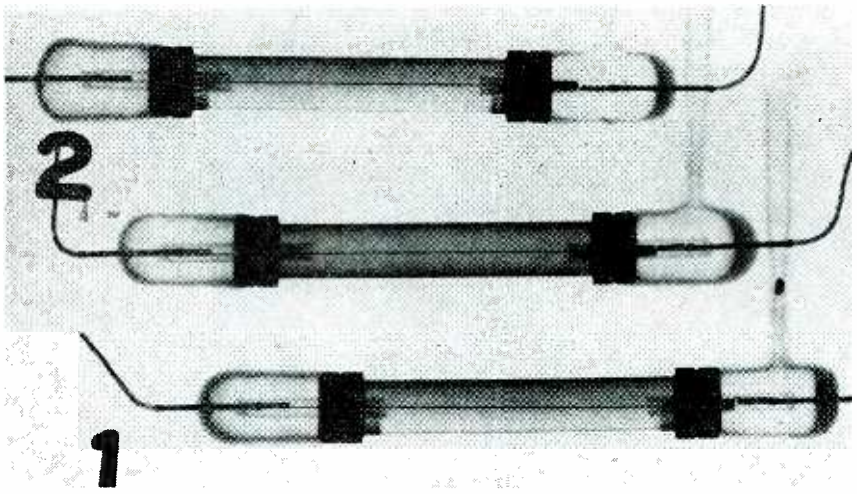
Thickness Gage

An intensity meter and thickness gage was built using two Geiger-counter tubes as beta-ray detectors, a conventional quenching circuit, pulse-shaping amplifiers, a pulse counter consisting of an averaging frequency meter, and a balancing circuit to indicate the change in average rate, with a meter to read directly the thickness change in thousandths of an inch (mils). The power supplies were regulated to minimize line fluctuation effects.

PUTTING NUCLEONICS TO WORK

Here is one of the first articles to give details for industrial utilization of products of the atomic pile, including specific circuits permitting application to a host of process control problems.

Radiostrontium and radiophosphorus for use as beta-ray sources can now be obtained from United States Atomic Energy Commission, Isotopes Branch, Box E, Oak Ridge, Tennessee.



X-ray picture of Geiger-counter beta-ray detectors using nickel envelopes. The thin wall on the lower side of each tube is three mils thick

for Sheet Steel

By OTTO J. M. SMITH

Research and Development Laboratory, Summit Corporation, Scranton, Pa.

The circuit of the quenching head is given in Fig. 2. The G-M tubes and amplifier tubes in the measuring head were mounted on rubber bushings to reduce microphonics and other vibration difficulties. In order to get the high counting rate required to minimize statistical fluctuations, the time constant of the G-M tube recharging circuit was made as low as possible. Four megohms was the lowest series resistance that could be used between the high voltage and the G-M anode and still have a satisfactory plateau on the curve of counting rate versus anode voltage.

The quenching and first amplifier tube was chosen to have low capacitances in parallel with the G-M tubes. An 832-A double pentode was used for this reason, and also because of its higher voltage rating than conventional receiving-type tubes. The amplifier tubes were miniatures in order to conserve space, and 6C4 cathode followers were used to drive the long signal cables.

The rate meter circuit is shown in Fig. 3. The positive pulses from the two cathode followers are added at the grid of the 6AK5, clipped, amplified further, inverted by the 6C4, and sharpened and clipped as positive pulses at the grid of the 6AG7 frequency-meter tube. This tube is driven from cutoff to saturation by each pulse. A series grid resistor is used so that saturation current is approximately the same regardless of the amplitude of the input pulses. Each pulse changes the voltage across a precision capacitor in the plate circuit by a known amount.

The capacitor discharge current flows through the 6H6 and is stored by the 4-μf capacitor. Since this capacitor has a fixed impedance drain, the current through the impedance and the voltage across the capacitor are both proportional to the average frequency of the pulses. This is measured by a rate meter calibrated in counts per second. A gang switch provides full-scale readings of 1, 2, 5, 10, 20, and 50 kc.

A second circuit contains a meter with a linear scale covering +60 to −50 percent error and a logarithmic scale from +2 to −2 mils thickness deviation. This carries current not only from the rate meter, but also from a balancing circuit which supplies constant current of such a magnitude that the resultant through the meter is normally zero with a sheet of the correct thickness.

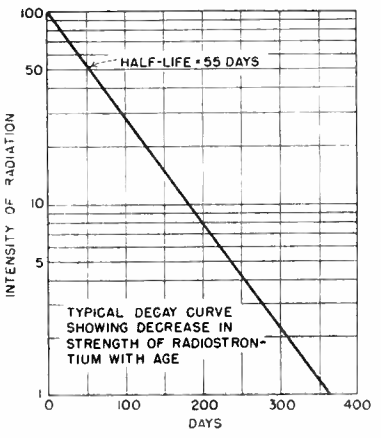
Both the balancing current and the rate meter are supplied from the same regulated source, so that changes in this 290-volt supply have no effect on the deviation meter.

Diode current in the 6H6 in the absence of a signal is prevented by a 1.1-volt bias developed across the

Table I—Beta-Ray Sources Having Long Half-Life and High Energy

Element	Mev*	Half Life
$_{6}C^{14}$	0.09	10^{4} years
$_{15}P^{32}$	1.69	14.3 day gamma-free
$_{16}S^{35}$	0.12	88 days
$_{37}Rb^{86}$	1.60	19.5 days
$_{37}Rb^{87}$	0.13	6×10^{10} years
$_{38}Sr^{89}$	1.32	55 days gamma-free
$_{40}Zr^{93}$	about 0.25	63 days
$_{41}Cb^{92}$	1.38	11 days
$_{71}Lu^{176}$	0.22	7×10^{10} years
$_{72}Hf^{181}$	....	55 days
$_{73}Ta^{182}$	....	97 days
$_{77}Ir^{192,194}$	....	60 days
$_{82}RaD^{210}$	0.025	22.2 years

*Million electron volts.



190-ohm voltage-divider resistor. The calibration of the frequency meter is independent of the characteristics of the 6AG7 tube, and is a function only of the magnitude of the plate voltage supply.

Voltage Supplies

Power supply circuits used for the beta-ray thickness gage are shown in Fig. 4. Conventional full-wave and half-wave circuits with VR tubes across the outputs provide +300, +150 and −105 volts. The G-M tubes require well-regulated voltage sources, however, as shown at the lower left in Fig. 4. A neon glow tube reference has better regulation than a VR tube, hence four type 991 neon tubes are used; these must be selected and pre-aged carefully. All of the first amplifier tubes in the voltage regulator circuits are operated at very low currents so that the total change in current through the 991 tubes is about one ma, which is the maximum permissible current change for satisfactory operation. The neon tubes also regulate the +290-volt supply for the frequency-meter tube and the balancing circuit.

The screen grid of the 6SJ7 is supplied from an unregulated source in order to compensate partially for changes in the a-c line voltage. The fine calibration of the frequency meter was adjusted by varying the 290-volt regulated supply with the grid potentiometer for the 6SJ7 tube.

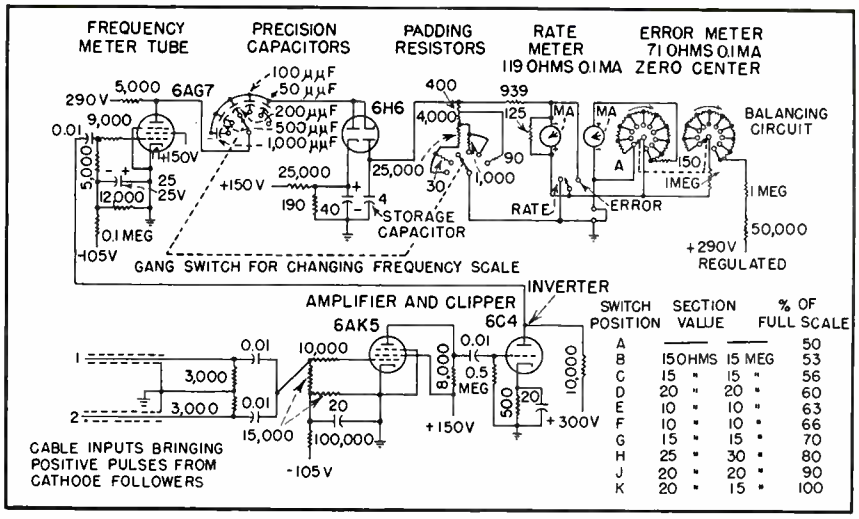


FIG. 3—Measuring circuits of the beta-ray thickness gage

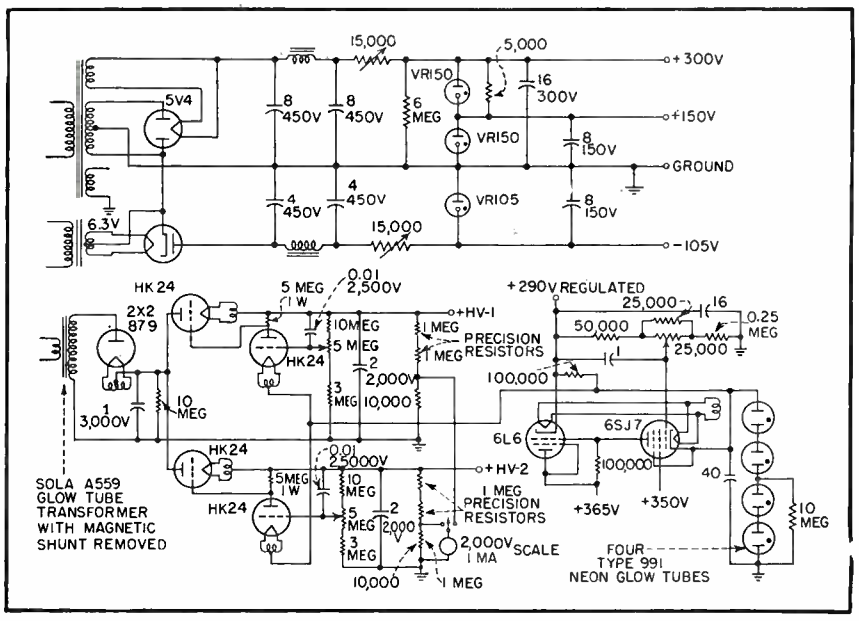


FIG. 4—Low-voltage supply and regulated power supply for thickness gage

Rate Meter

Since this pulse counter is designed to measure the average frequency of randomly distributed pulses, the resolving time of the 6AG7 counting tube must be very short with reference to the average time between pulses. This was accomplished by making the time constants low for the charging and discharging circuits of the precision capacitors.

Figure 5 shows the calibration of the frequency meter for pulses with uniform spacing. It can be seen that the response dropped to 92.6 percent of what it should be at ten times full-scale frequency, on each scale except 50 kc.

The response drop of Fig. 5 may be approximately analyzed by using a universal pulse response curve for an RC circuit, one form of which is plotted in Fig. 6A. This shows the decrease in output as the pulse length becomes shorter, the time between pulses being very long. The condition holds for all cases where the response is limited by the time constant of the circuit carrying current during the pulse.

Figure 6B is a universal pulse response curve of an RC circuit when pulse length is fixed. It shows the decrease in output for increasing frequency with a fixed pulse length. This is valid only when the time constant is much less than the pulse length and the period is slightly more than the pulse length. It holds for all cases where the response is limited by the time constant of the circuit carrying current between the pulses, such as two pulses occurring close together in a random distribution. The generalized time scale is the ratio of the difference between the pulse length and the period to the time constant.

Figure 6C shows the form of the resolution curve for the equipment for uniform input frequencies. The lower universal curve is the same as in Fig. 6A, and f_m/f is the ratio of the frequency meter response to the actual frequency as given in Fig. 5. An increase in the average frequency increases the bias due to grid rectification in the pulse-shaping amplifiers and results in a de-

crease in the pulse length. This data was taken with the gang switch set at 10 kc.

The intervals in a Poisson distribution of pulses can be obtained from Fig. 7. For an average rate of F counts per second and a resolving interval of t seconds (no pulse being recorded after an interval shorter than t seconds), the per-unit error scale $(1-f/F)$ used with curve A shows the fraction of all intervals which are shorter than t seconds. This curve and scale also represent the fraction of intervals shorter than an arbitrary t in any Poisson distribution, irrespective of whether there exists an actual measuring device. The f/F scale with curve A gives the fraction of the intervals that are longer than t seconds.

The response f_m/f from Fig. 5 is entered in Fig. 6A, and the value of t/T determined. Then f is plotted versus t/T in Fig. 6C, to show the decrease in the pulse length. At low frequencies t/T becomes a maximum of about 14, and the pulse length t is a maximum of 2.2 microseconds. The pulse length does not vary in a random distribution, for it is a function only of the average rate. As long as the rate meter reads less than 10 kc, the pulse length, is greater than 1.4μ sec.

With the meter switch set at 10 kc and with an input of random pulses whose average is 10 kc, the meter will read slightly in error due to some of the pulses coming at very close intervals. Those pulses separated by a spacing less than the pulse length of 1.4 microseconds will not count at all; $Ft=0.014$ and per-unit lost pulses$=0.014$. Figure 6B holds in this case, because the pulse length is constant as long as the average frequency is constant. Each pulse will count for only half a pulse if it follows an interval that makes $(1/f-t)/T=0.7$. Since $T=0.16$ microsecond and $t=1.4$ microseconds, this makes $1/f=1.5$ microseconds, $Ft=0.015$, and only $0.015-0.014=0.001$ per-unit pulses count between zero and one-half.

Again referring to Fig. 6B, each pulse will count for 0.99 of a pulse that follows an interval for which $1/f=2.14$ microseconds, $Ft=0.0214$, and only $0.0214-0.015=0.0064$ per-unit pulses count for less than 0.99 pulse and more than 0.5 pulse.

Summing these effects, effectively only 0.0146 per-unit pulses are lost due to the finite resolving time of the meter, with a random input. This 1.5-percent error corresponds to a rate of 10 kc and is considerably less for lower frequencies.

In addition to the uniform frequency meter scale, one could use a second meter scale on which the spacing of the divisions compensated for this error, or a calibration curve could be plotted. (This error in the rate meter must not be confused with that due to the resolving time of the Geiger-counter tube itself, which is of a different kind.)

Calibration of Thickness Meter

The time constants of the electrical circuits for the rate meter and the thickness meter are long with respect to 0.1 second. It was desirable for the thickness meter to average over an interval of about ½ second. The electromechanical system of a 100-microampere, 71-ohm, 3-inch panel meter had an apparent time constant of ½ second when a total equivalent shunting resistance of 400 ohms was presented to the meter.

The circuit actually used for the thickness meter consists of a 300-ohm tapped shunt in parallel with this style of meter. The rate meter is a 119-ohm type, shunted with 125 ohms. The 939-ohm resistance in series with this meter performs two functions. It makes the padding resistors large, so that small resistance changes in the meter and relaying circuits do not affect the calibration. Conversely, changes in the padding resistors with changing scale settings do not alter the time constants of the meters.

The zero reading on the thickness meter can be adjusted, regardless of the rate meter reading, by varying the compensating current with the one-megohm variable resistance shown in Fig. 3.

A given angular deflection of the thickness meter represents a fixed percentage change in the rate. Therefore, the calibration of the thickness meter must be a function of the rate meter reading, and inversely proportional to it. This change in calibration is effected by a tap on the error meter shunt, which varies the distribution of current between the meter and the shunt without varying the impedance presented to the meter by the shunt.

The taps were computed so that a change in the rate-meter current of 50 percent corresponds to a change of 50 microamperes in the error meter, or half scale. The error meter is provided with a zero-center linear percentage scale from +60 percent for a negative current of 60 microamperes to −50 percent for a positive current of 50 microamperes through the meter. There is also a logarithmic thickness scale for mils of iron.

It is possible to correct for apparent thickness errors due to either the resolving time of the G-M tubes or the use of a strontium instead of a phosphorus source. The correction is made by changing the setting on the tapped switch. If the thickness meter reads only 0.8 of the actual thickness change, then the tapped switch is set to 0.8 of the actual rate, and the thickness gage re-zeroed with the continuously variable potentiometer.

Resolving Time and Dead Time

There are two common types of equipment to which a resolving

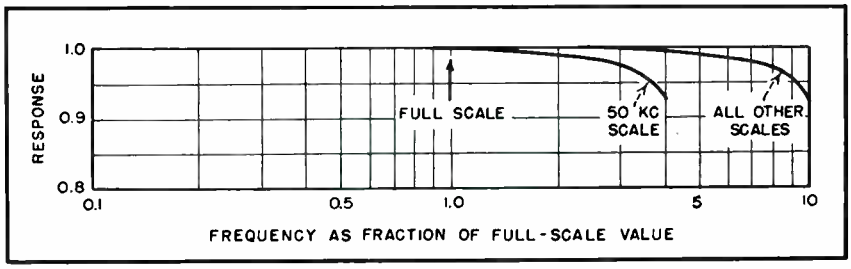


FIG. 5—Frequency-meter calibration for uniformly spaced pulses. Ordinate is response as fraction of what it should be

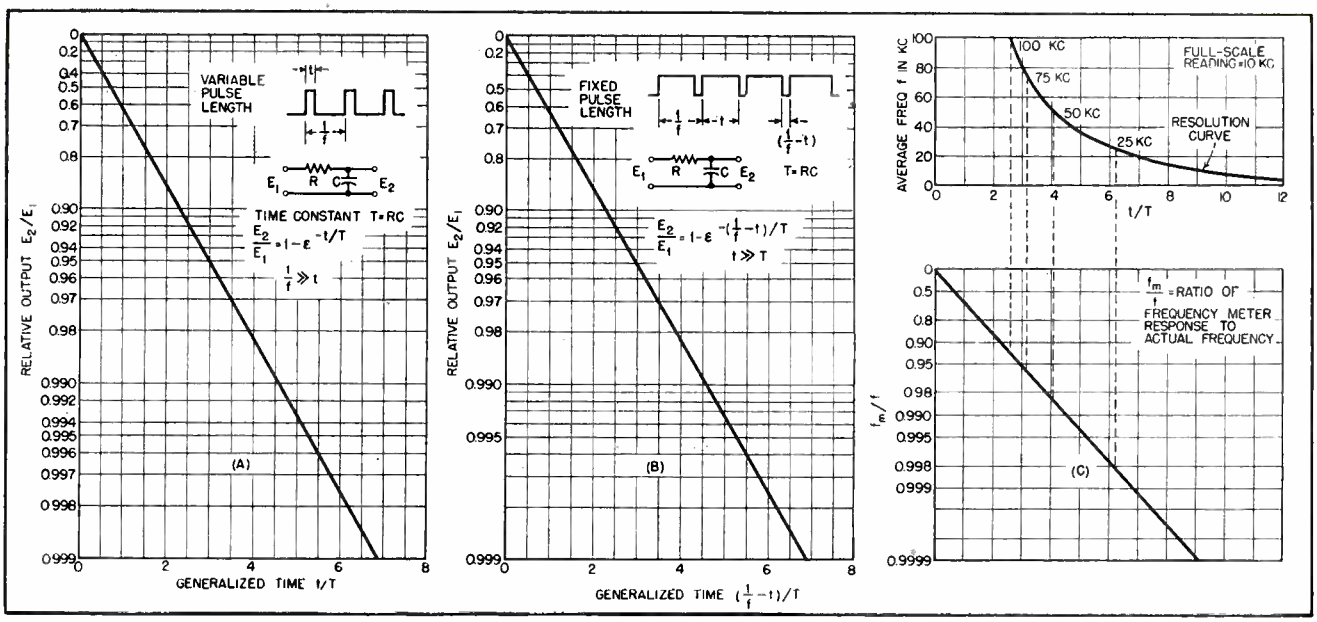


FIG. 6—Universal response curves for RC circuits with variable-length and fixed-length pulses, and resolution curve for the equipment

time has been ascribed. The first is called a type I recorder. In mechanical form, it is a pulse counter with a rachet mechanism. To be recorded, a count must be preceded by an interval t (resolving time) during which no count has arrived. This is the time required for the rachet mechanism to slide over a new tooth and engage its corner. If a number of counts arrive during this time, the corner will never be engaged, and no count will be recorded.

If a uniform input frequency to this counter is slowly increased, using uniformly spaced input pulses, the counter will reach a maximum and then jam, as shown by curve C in Fig. 7.

If the input to the counter is a Poisson distribution of average rate F, the counting rate will equal $f=Fe^{-Ft}$. The measured frequency f will reach a maximum rate of F/e when $Ft=1$, and then decrease. This is shown by curve B in Fig. 7, where the generalized reading ft of the frequency meter is plotted against the generalized actual input frequency Ft of random pulses. The value f is the frequency reading of a type I meter with a resolving time of t seconds.

For computing an actual Poisson distribution it is often convenient to have a correction factor, as a function of the measured rate instead of the actual rate, to apply to the measured rate. This has been plotted in Fig. 8A. It can be seen that $K=e$ for the above-mentioned maximum condition of $ft=1/e$ and $Ft=1$.

The resolving time of a type I device can be measured by supplying a uniform input frequency to it. The resolving time is equal to the reciprocal of the maximum frequency at which the device will operate. If a pure random distribution is supplied, the resolving time will be equal to the reciprocal of the input frequency F when the measured frequency f is a maximum: $t=1/F_t=1/ef_m$.

Sometimes it is desired to compute the resolving time from measurements made at much lower rates. The output frequencies of the device should be measured for two inputs whose ratio is exactly two. This can be done by accurately changing the position of a radioactive source from which the random pulses are derived. Then

$$f_1 = F_1 e^{-F_1 t}$$
$$f_2 = F_2 e^{-F_2 t}$$
$$F_2 = 2F_1$$
$$t = f_2/2f_1^2 \log_e (2f_1/f_2).$$

The second kind of device which has a resolving time is called a type II recorder. The recorder has a mechanism such that the recovery time is completely unaffected by additional counts coming in during the recovery period. This can be represented physically by a biased flip-flop pulse generator operated from negative signals. During the pulse which follows a signal, successive signals have no effect. The length of the pulse, t, is called the dead time, to distinguish it from the resolving time of a type I unit.

If the average frequency of a random distribution of input pulses to this device is slowly increased, the output frequency will reach a maximum asymptotically, and will not decrease at very high input rates. The output frequency measured on the device will be $f=F/(1+Ft)$. This reaches a maximum value of $1/t$, as shown in Fig. 8B. The correction factor to apply to the measured frequency is $K=(1+Ft)=1/(1-ft)$. This is plotted in Fig. 8C, for high counting rates. For low counting rates, the correction factor is approximately $(1+ft)$, or the error in the measured rate is f^2t.

If the input to this device is a uniform frequency, the output will equal the input until the maximum rate of response is reached, then the output will drop to one-half. As the input frequency rises from $1/t$ to $2/t$, the output again increases to its maximum value, and then drops to two-thirds. This is dotted curve B in Fig. 8B. The response will vary between the maximum

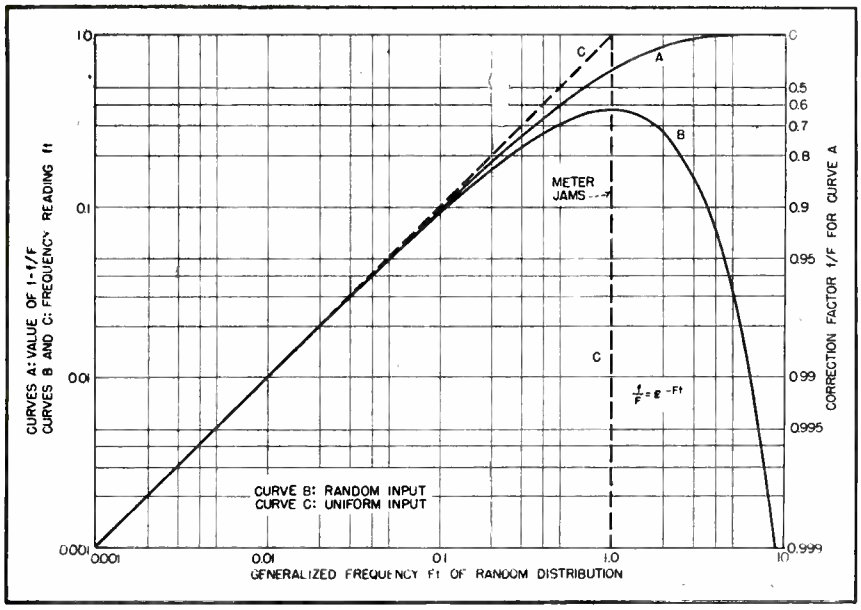


FIG. 7—Poisson distribution of pulses

value and points on the random response curve. A knowledge of this allows one to measure the response of a type II device to a random input, using only uniform test frequencies. The minimums lie on the random curve, and the maximums are the asymptote. Note that the meter reads correctly for frequencies less than the reciprocal of the dead time t.

The dead time can also be computed from two random frequency measurements at much lower rates.

$$f_1 = F_1/(1 + F_1 t)$$
$$f_2 = F_2/(1 + F_2 t)$$
$$F_2 = 2F_1$$
$$t = 2/f_2 - 1/f_1$$

Geiger-Counter Tubes

The Geiger-counter tubes used in the thickness gage operate as type II devices at high counting rates. An ionizing event in the tube caused a small discharge, and a definite dead time had to elapse before the central electrode voltage had risen enough so that another ionizing event would cause a second cumulative discharge. Beta rays that entered the tube while the voltage was low operated as ionizing events but the rise of ionization was not cumulative, and therefore these beta rays represented lost counts. These counters had a maximum asymptotic rate of 16,000 cps as used in the thickness gage circuit. This represented a dead time of 60 microseconds.

There was another serious disadvantage of this dead time. The change of counting rate with change of beta-ray intensity was less at the higher counting rates, and became zero at 16,000 cps. A low counting rate gave the best resolution for thickness changes, but a high counting rate was needed to minimize the statistical fluctuations for rapid readings. The effectiveness of a G-M tube can be taken as the product of its ability to resolve thickness changes and its accuracy.

The per-unit fluctuation in a single reading of N counts is $N^{-0.5}$ for a true Poisson distribution. The per-unit (fractional) probable error of a rate meter reading of time constant T with n G-M tubes each receiving F random counts per second is $(2nFt)^{-0.5}$.

Curve A in Fig. 8B is $ft = Ft/(1 + Ft)$. Thickness change resolution is proportional to its slope: $df/dF = 1/(1 + Ft)^2$. The effectiveness product would be $P = (2nFt)^{0.5}/(1 + Ft)^2$. This product is a maximum when $dp/dF = 0$. Then $Ft = 1/3$. From Fig. 8B, $ft = 1/4$ and $f = 1/4t = 16{,}000/4 = 4{,}000$ cps reading, per tube. Nothing is gained in exceeding this rate, for the G-M tubes are more stable at lower counting rates.

Gaging Sheet Steel

One application of a thickness gage of this sort is in a tin plate mill, where steel sheets range in thickness from 7 mils to 24 mils. These sheets can be measured by the beta-ray thickness gage as they move on the shearing line. After being cut into lengths, the sheets can be sorted by a mechanical gate (controlled by the measuring device) into on-gage and off-gage sheets. The switches on the thickness meter control a memory device on the mechanical gate, which takes care of the time lag necessary due

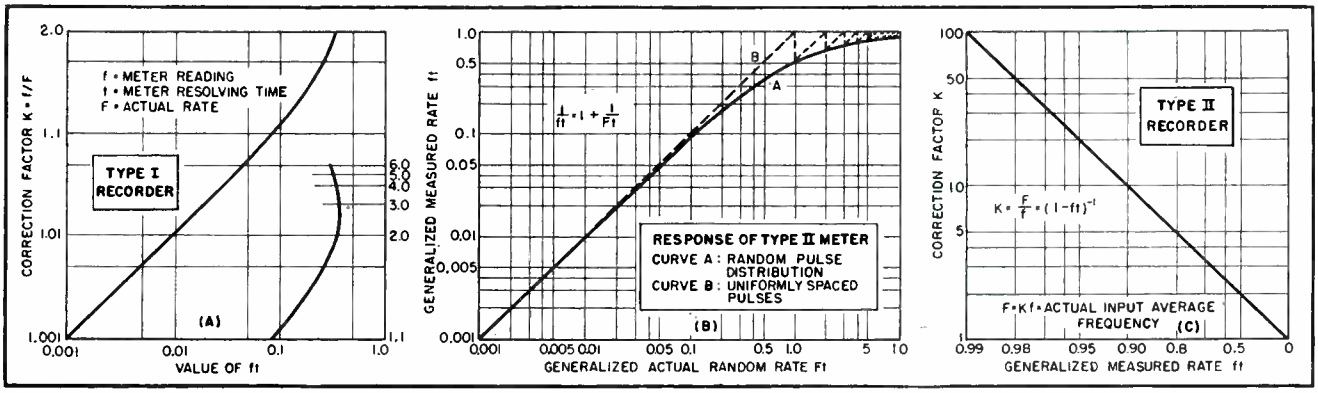


FIG. 8—Correction-factor curves for type I and type II recorders, and response of type II meter to Poisson distribution of pulses

to the physical displacement between the flying micrometer and the gate.

Continuous-Reading Meter

The maximum error in any continuous measurement of this sort can be estimated. Figure 9 shows the electrical equivalent circuit of the indicating meter, where input voltage X and output voltage Y correspond to the actual thickness and the measured thickness respectively. The response of this circuit is

$$\begin{aligned} X &= iR + Y \\ X &= iR + (1/Cp)i \\ Cp\,X &= RCpi + i = Tpi + i \\ i &= Cp\,X/(1 + Tp) \end{aligned}$$

Here $T = RC$ is the time constant of the measuring circuit or meter.

When X has been changing steadily in the same direction for a long time, and there is no second derivative of either X or Y with respect to time, $dX/dt = dY/dt$, $i = C\,dY/dt = C\,dX/dt$, and $X = Y + iR = Y + T\,dX/dt$. The maximum error in the measurement of X is $(T\,dx/dt)$.

If we assume that a constant thickness of sheet is coming through the micrometer, and that at time $t = 0$ the thickness began to increase at a constant rate of $dx/dt = R_1$, the solution would be

$$i = Ke^{-t/T} + C\,dX/dt$$

When $t = 0$, $i = 0$, error $= 0$, and

$$\begin{aligned} K &= -CR_1 \\ i &= CR_1(1 - e^{-t/T}) \\ Y &= X - RCR_1(1 - e^{-t/T}) \\ \text{Error} &= X - Y = TR_1(1 - e^{-t/T}) \end{aligned}$$

After a long time, the steady-state value of Y is $Y = X - R_1T$, and maximum error $= R_1T$.

The curve of thickness X in Fig. 9 also shows a sharp bump on the sheet. Considering zero time at the peak of the bump, there is a steady rate of change of thickness $dX/dt = R_1$ before zero time, and a different rate of change R_2 (negative) afterwards.

$$i = Ke^{-t/T} + C\,dX/dt_{t>0}$$

When t is 0, $i = (X-Y)/R = R_1T/R = K + CR_2$, $K = C(R_1-R_2)$, and

$$i = CR_2(1 - e^{-t/T}) + CR_1e^{-t/T}$$

Y is a maximum at time t_m when $dY/dt = 0$.

$$\begin{aligned} Y &= X - iR = X_0 + R_2t - TR_2(1 - e^{-t/T}) - TR_1e^{-t/T} \\ dY/dt &= R_2(1 - e^{-t/T}) + R_1e^{-t/T} \\ t_m/T &= \ln(R_2 - R_1)/R_2. \end{aligned}$$

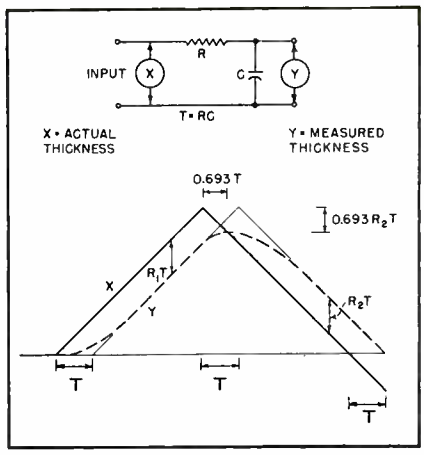


FIG. 9—Time response and equivalent electrical circuit of indicating meter

This is also the time at which the error is zero and the dotted Y curve crosses the solid X curve, for when $i = 0$,

$$\begin{aligned} R_2(1 - e^{-t/T}) &= -R_1e^{-t/T} \\ t/T &= \ln(R_2 - R_1)/R_2 \end{aligned}$$

If $R_2 = -R_1$, $t_m = 0.693\,T$. At this instant, the meter has its maximum deflection, and is in error from the maximum height of the bump by $0.693\,R_2T$. The error reaches its maximum practical value when the rate of thickness change has been constant in the same direction for considerably longer than the meter time constant. This is again the value R_2T. The maximum error in the time position of a sharp bump is thus $0.693\,T$ where T is the time constant of the measuring system, and the maximum error in the height of a sharp bump is $0.693\,R_mT$ where $R_m = dX/dt$.

Proposed Systems

An optimum in operation is obtained if the setting of a sorting or reject gate considers the fact that the meter reading most closely approximates the thickness of the sheet passing through a short time before. A sheet that registers on-gage, following one that registered off-gage, is always a good sheet. Therefore, for conservative operation, the reject gate may be set to discard the sheet preceding as well as an indicated bad sheet.

In an acceptable thickness gage, the meter reading should be assumed to correspond to the thickness at a time $0.7\,T$ preceding. This gives the error in height for sharp bumps as $0.7\,R_mT$, and the error for a steady rate of change of thickness R_m would be only $0.3\,R_mT$.

The speed of operation of a thickness gage is an important factor. The beta-ray gage is limited by the time constant of the integrating rate meter. If this time constant is short to make the speed of operation fast, then the statistical errors will be large. As the time constant is increased, both the statistical errors and the speed of operation will decrease.

In designing a gage, the maximum statistical error (three times the probable error) should be made equal to the maximum speed error, and each equal to half of the total permissible error E in mils.

$$\begin{aligned} E/2 &= 3 \times 2.94/\sqrt{2nFT} = 0.7\,R_mT \\ T &= E/1.4\,R_m \\ (nF)_{\min} &= 25.2\,(2.94)^2\,R_m/E^3 \end{aligned}$$

Design values of total error E and maximum rate of thickness change R_m can be entered in this equation, and minimum values of total random counts per second, $(nF)_{\min}$, can be computed.

The total thickness change which it is desired to measure determines the maximum counting rate, and influences the number of tubes required. The value of $(nF)_{\min}$ given above occurs at maximum thickness. If the minimum thickness is d mils less than the maximum,

$$(nF)_{\max} = (nF)_{\min}e^{0.346\,d}$$

For a G-M dead time t, the maximum-effectiveness product occurs at a rate $F = 1/3t$. It is not good practice to operate the G-M tubes at a rate much higher than this, and therefore $F_{\max} = 1/3t$. The number of tubes required is

$$n = 654\,R_mt\,e^{0.346\,d}/E^3$$

If R_m is 0.2 mil per second, t is 60 microseconds, d is 0.2 mil, and the maximum permissible error is 0.2 mil, $T = 0.7$ second, and $n = 1$. One tube is thus required. If the measurable thickness change d is increased by a factor of ten to 2.0 mils, the time constant will be unchanged, but two tubes will be required. If, further, the maximum error is decreased to 0.1 mil, the meter time constant must be halved to 0.35 second, and the number of tubes required increased by a factor of 8, to 16 total. It can be seen that the permissible error is a very critical design factor.

Radar-equipped, the Standard Oil towboat SOHIO SOUTHERN, pushes 12 barges containing 15,750 tons crude oil and four empty barges up the Ohio River

Peacetime RADAR

Towboat traffic on narrow inland waterways is expedited by radar equipment. Saving as much as $100 an hour when ships are stalled in fog, use of electronic units permits continuous movement of boats and barges in conditions of zero visibility

By B. B. TALLEY

Colonel, Corps of Engineers
District Engineer, Louisville District
Corps of Engineers, USA

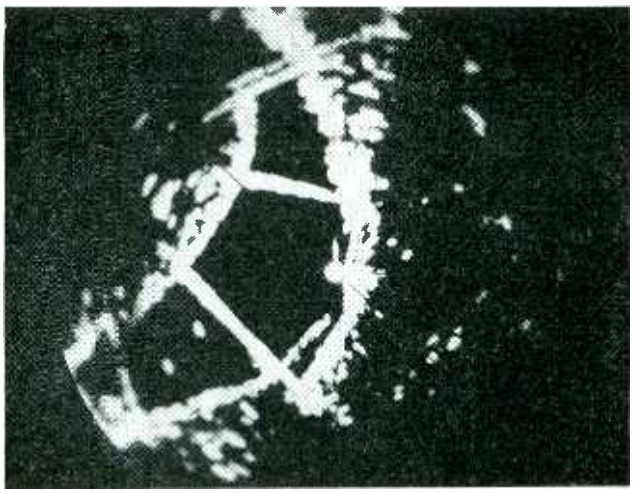
FOG has always been the enemy of commerce on the Ohio River and many other inland streams of the country. At some seasons of the year it persists during the early hours of almost every day. Mixed with smoke from the factories of cities it is doubly prevalent in the vicinity of the numerous highly industrialized areas.

Large towboats often push tows of 20,000 deadweight tons and some of these and other boats on the Ohio and Mississippi cost as much as $100 per hour to operate. Until the advent of radar they were forced to tie to the riverbank in time of fog, with a resultant slowdown of movement, increased cost of operation, and obviously, at an increased cost to the consumer of the goods being transported.

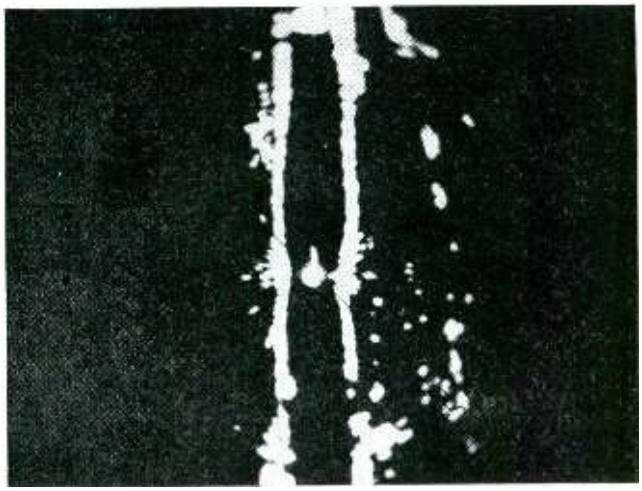
As a means of permitting continuous movement of traffic on inland waterways regardless of weather, the Louisville District, Corps of Engineers, in May, 1946, undertook the development of radar and radar navigation charts for the Ohio River. Private navigation interests, notably the Ashland Oil & Refining Company, have equipped some of their boats with radar for experimental purposes with noteworthy results and the U. S. Coast Guard has installed a three-centimeter radar aboard its cutter SUMAC.

Survey Equipment

In March 1947, the Louisville District installed a Radiomarine Corporation model CR 101 radar on the survey boat CHEROKEE, a converted sea-air rescue boat. The equipment incorporates many of the latest advances in the radar field, providing optimum performance at ranges of 1½ and 5 miles, with appropriate range-rings for all ranges to 50 miles. It radiates a 1.6-degree horizontal beam on a 17-degree vertical pattern, using a super high frequency of 9,320-9,500 megacycles, and magnetron center



Pilot's radar view of bridges and locks as the SOHIO SOUTHERN leaves the canal at Louisville. The white circle at center is the boat and the projection upward is the line of barges

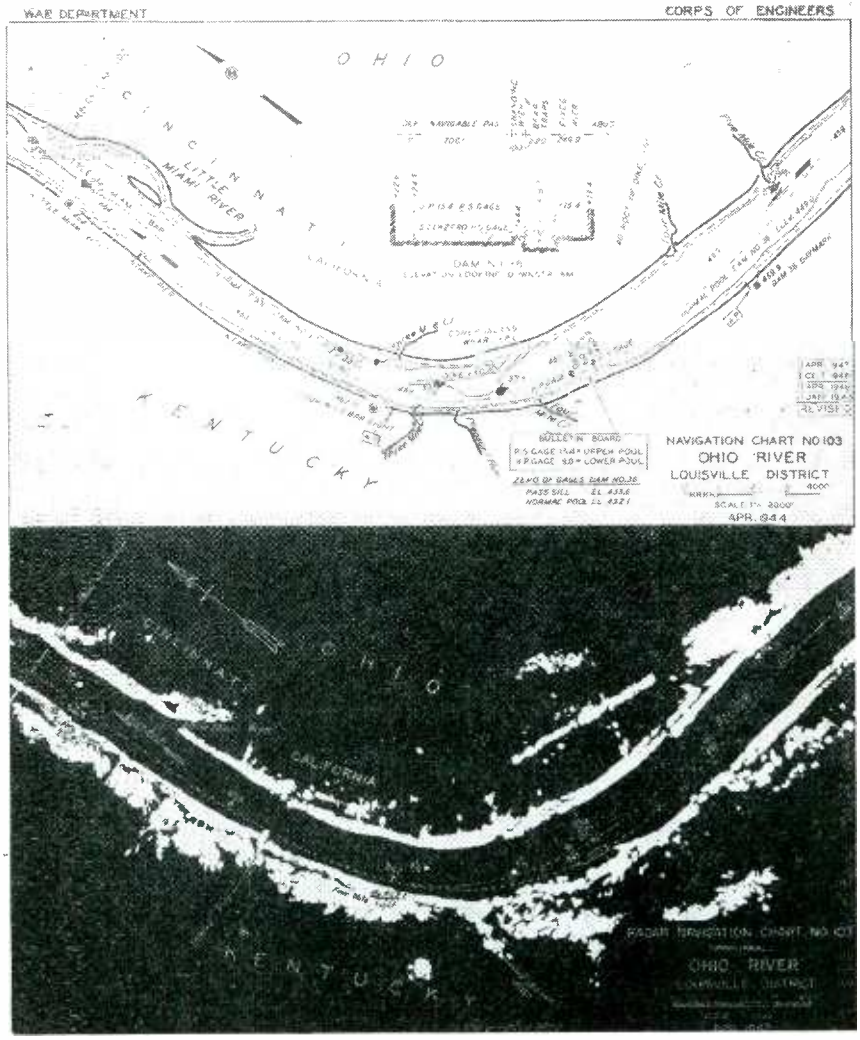


Now in midstream, the ship and its tow passes the intake works of the Louisville municipal water system. The white spot in the channel at the top of the photo is an oncoming boat

frequency of 9,375 megacycles, 3.2-centimeter wavelength.

The unit gives good range-resolution with a minimum range of 80 yards. It is presently powered from a 5-kw, 4-cylinder, 60-cycle a-c auxiliary generator set, and draws approximately 12 amperes at an input voltage of 117.

Objects as close as 80 yards are reproduced on a ppi scope and materially assist in navigating narrow river-channels and approaches to locks and dams. The antenna revolves at 12 rpm through a 360-degree path, thus scanning the horizon once each five seconds. Inasmuch as the cathode-ray tube has a persistence of image of about 30 seconds, a continuous image remains on the screen.



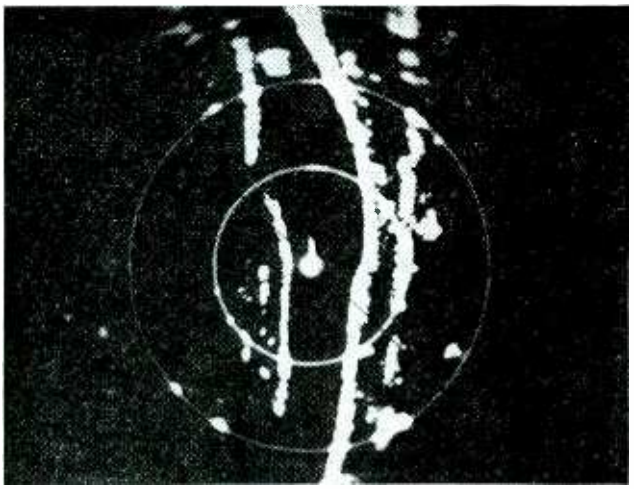
A conventional navigation chart of the Ohio River at Cincinnati is shown at top. Below it is a controlled mosaic formed by matching several photographs of radar images taken at several points, and rephotographing. With the new chart, pilot of radar-equipped boat can follow the channel or sailing line in fog or darkness

Continuous Chart

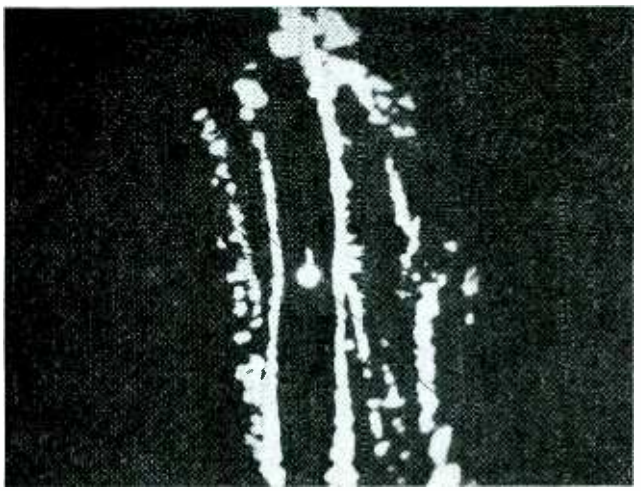
A series of overlapping or contiguous photographs of the screen made as the boat progresses along a given line (the sailing line of a channel) can be combined into a controlled mosaic to form a continuous strip map or chart. A 4 x 5 Graflex camera is fitted to the radar, mounted in a metal hood and at a fixed focal length from and parallel to the plane of the screen.

This arrangement was satisfactory for experimental purposes and with certain refinements, including the introduction of an automatic shutter-operation, might prove an acceptable method of conducting an ultimate program of chart making. Concurrent experiments are underway, with an automatic radar recording camera built for strictly military purposes during the war by the Fairchild Camera and Instrument Corporation.

To obtain photographs with the



Distance rings one-half mile apart show an approaching boat as a little more than a mile away. The ship is now following the sailing line off Six Mile Island above Louisville



Clear sailing ahead after passing bridges and other obstructions at Louisville. Unhampered by fog or night, the pilot can match the scope screen against the radar navigation chart

Fairchild camera, it is necessary only to mount it on the radar, set the intervalometer at the desired interval, and turn on the switch. The camera is interconnected with the electrical circuit of the radar and operates with manual attention only to the intervalometer.

Because of persistence of image on the ppi scope, the image obtained by one sweep of the antenna cannot be erased before the next one commences to be formed. Thus, there are 2 to 3 overlapping images of different degrees of brilliance on the scope at all times. This causes a blurred picture when photographed. To eliminate this overlapping and to increase definition of image, the cathode-ray tube is energized only during periods of photography. This is done automatically by a relay in the electrical circuit of the radar and camera.

The camera magazine has a capacity of 1,600 exposures, and one loading of the camera is sufficient to photograph more than 100 miles of river.

Beacons Needed

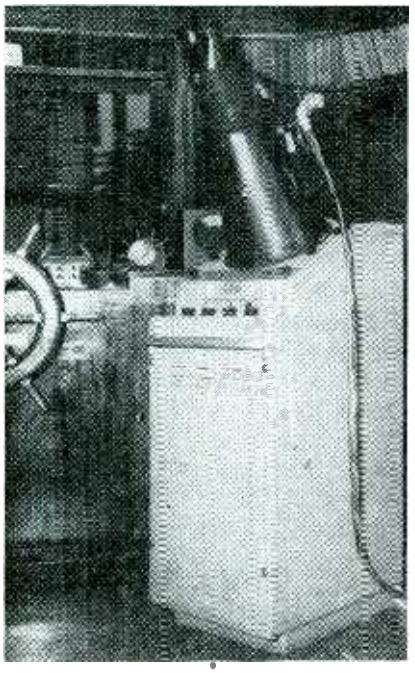
One shortcoming of radar has been its failure to resolve into easily identifiable form the individual piers and spans of a bridge. As they appear on provisional radar navigation charts the images of bridges are solid white (blank) walls across the stream. Although the sailing line has been transcribed from conventional navigation charts in its correct position on the radar charts, a pilot would be running some risk should he attempt to navigate within a narrow channel under a bridge with only the location of his sailing line shown on his chart.

It is necessary for him to judge his distance from shore and estimate the location of the bridge piers. This situation can be corrected by placing buoys or channel markers above and below the bridge to mark the navigable span to be picked up by radar when they are one half to one mile distant. There are objections to placing these buoys in the river, however, as they would become possible obstructions to navigation, or at least tend to confuse the pilots of craft not equipped with radar.

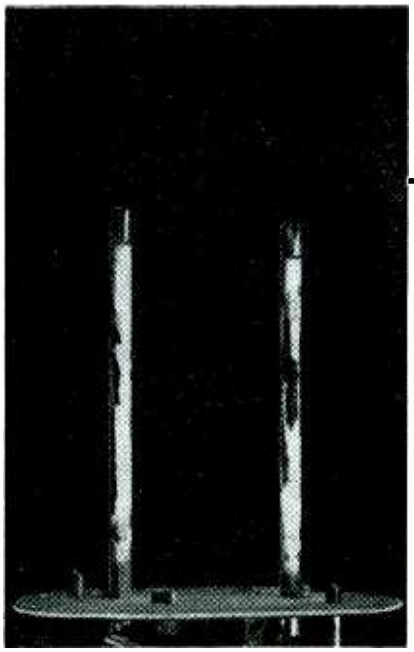
The solution may lie in the field of small, economically-built low-power automatic transponder radars, or the perfection of a suitable metal target easily and cheaply installed and requiring a minimum of maintenance attention. The coded transponder is a form of automatic radar transmitter that sends out interrupted signals in a predetermined code. This positive signal is stronger than the echo signals to the master radar and it shows with greater brightness on the cathode-ray tube screen than those reflected from surrounding objects.

The best known of these coded instruments is the Army Air Force's iff system (Identification Friend or Foe). The Air Material Technical Command at Wright Field is cooperating in the studies. A conception of the result desired is shown in the accompanying illustrations.

The present radar navigation chart requires use of illumination at night. This is objectionable to pilots, accustomed to working in the dark. The objection may be overcome, either by means of transparent radar charts to be viewed on a light table, or by printing the charts with fluorescent ink which will glow under ultraviolet light—the latter has been done simply and effectively.



Radar console in the survey boat CHEROKEE. Attached to the light shield is the automatic recording camera



Blistered cathodes of 6SN7 tube after blisters have broken away

Tube Failures

Analysis of causes of tube failures in 18,800-tube electronic computing machine during one year of operation shows that open heaters and damaged cathode coatings are chief troubles. An average of two tubes failed each time the a-c supply to the heaters was shut down

By F. ROBERT MICHAEL

Research Engineer
Moore School of Electrical Engineering
University of Pennsylvania
Philadelphia, Pa.

The Electronic Numerical Integrator and Computor (ENIAC) provides, after a year of operation, unique life test information in the failures among its 18,800 vacuum tubes and their chronological occurrence during that year. All tubes which failed were opened and examined with a binocular microscope, and all noticeable defects were classified and recorded. The various faults which caused tube failure are illustrated and discussed here, and in several cases their rate of occurrence is plotted against time.

In the ENIAC, numbers are represented by combinations of electrical pulses, and the pulse system is used for the transmission of orders as well. Pulse repetition rate is 100 kc, with rise times of approximately 0.2 and 0.5 μ sec for pulse durations of 2 and greater than 10 μ sec respectively. Pulse amplitudes range from 15 to 50 volts in most cases. The numbers of vacuum tubes used and their general functions are shown in Table I, along with the numbers of failures for each type.

Operating Practices

The vacuum-tube heaters were in operation approximately 80 percent of the time from November 1945 to November 1946, amounting to 7,000 hours. Heater circuits were turned off at night for the first few months, and during this period a comparatively large number of tube failures resulted from heater-to-cathode shorts. It was felt that these failures might be due to initial current surges in the a-c circuit. Investigation showed the transient current to be approximately four times steady state, which agrees well with the hot-to-cold resistance ratio of tungsten heaters at 1,000 to 1,200 degrees K.

It was necessary at that time to allow any corrective circuit change to wait until the scheduled moving of the ENIAC to Aberdeen, Maryland, and to leave the heater circuits on 24 hours a day with the exception of accidental power failures. The rate of failure for a-c shut downs averaged about two tube failures out of 18,800 per heater shut down, which was a small rate but undesirable because of the time required to locate and replace failures.

Meanwhile a series of experiments was started, using 100 tube samples, to determine whether a graduated application of voltage would materially reduce the rate of failure caused when heaters were turned off and on. Such experiments showed no difference between the group of tubes to which full voltage was applied at once and those receiving a gradual application of voltage.

It was the practice to shut off the d-c supply each night and at any time the ENIAC was left unattended except when it was actually working on a problem. No correlation between d-c supply voltage shut downs and tube failure rate was noticed.

Design Center Values

Tube life and probability for failure are important considerations when a large number of vacuum tubes is involved; especially when, because of ENIAC's high speed, so much possible work is lost in breakdown time. Design center values were therefore chosen conservatively.

Heater voltages were designed for 95 percent of rated voltage or 6.0 volts $\pm$ 0.1, although they aver-

INDUSTRIAL SIGNIFICANCE

Reduction of tube failures is even more important in industrial electronic equipment than in ENIAC because trained troubleshooters are not always on hand in factories. Therefore, many of the conclusions presented here on selection and operation of standard tubes in the ENIAC can profitably be utilized to improve the odds against failure of tubes in industrial service

in ENIAC

aged about 5.9 volts. Grid current was limited to 1 ma, with 0.5 ma average current. Grids were swung negative three times the cutoff voltage, but not exceeding 150 volts negative to the cathode.

Plate voltage was set at 50 percent of maximum ccs (continuous commercial service) rating, plate current at 25 percent maximum ccs rating, screen voltage at 50 percent maximum ccs rating, and screen current at 25 percent maximum ccs rating.

Maximum heater-to-cathode potential was limited to ± 50 volts, with one side of all heaters tied to a d-c potential. Power supply voltages were bypassed to cut signal hash and a-c hum to 2 percent (peak to peak) of the d-c magnitude.

Standard commercial receiving tubes with octal bases were purchased throughout 1943 to 1945 from a number of manufacturers and were tested individually for acceptance before use in the ENIAC. Allowance was made for a ± 50 percent cutoff voltage variation and a ± 40 percent variation in r_p for all tubes with the exception of cutoff in 6AC7. This latter was held to a ± 0.5 volt tolerance. Approximately 5 percent of all tubes were rejected except 6AC7, in which case about 40 percent were rejected.

Tube Failure Records

It was evident that keeping a record of tube failures would allow anticipation of more troublesome periods in operation. Investigation of causes of failures gave information for possible circuit changes and tube specifications which would permit further reduction of breakdowns, increasing the reliability of operation. An attempt was made to open each tube that failed in a way that would not change the internal conditions at the time of failure.

Table I—Summary of Tube Failures in ENIAC

Type	Approx. Number of Tubes	Percent of 18,800	Number of Tubes Removed	Percent of 644 Tubes Removed	General Use
6SN7 Twin Triode	6,550	35.0	200	31.0	Trigger and pulse counting circuits; also normally-on amplifier
6L6 Beam Power	1,200	22.0	175	27.2	Pulse amplifier; transmission normally off, pulsed on
6SA7 Pentagrid Converter	2,600	14.1	50	7.8	Coincidence tube, normally off; turned on by pulsing both grids; called gate
6SJ7 Triple Grid Amplifier	1,500	8.0	20	3.1	Input pulse amplifier; normally off
6V6 Beam Power	1,300	7.0	25	3.9	Pulse-forming circuits; normally on, pulsed off
6L7 Pentagrid Mixer	1,200	6.5	35	5.4	Use similar to 6SA7
6AC7 Television Pentode	500	2.5	110	17.1	Normally on; input amplifier with critical cutoff
807 (Enlarged 6L6)	350	1.8	20	3.1	Power amplifier, high voltage swings; normally off
6J5 Detector Triode	300	1.6	2	0.3	Amplifier; normally on
6Y6 Beam Power	300	1.6	7	1.1	Amplifier; normally on
	18,800	100.0	644	100.0	

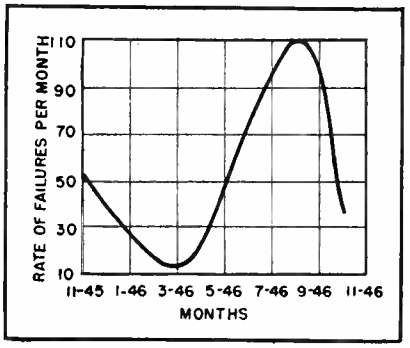


FIG. 1—Rate of failure of all tubes in one year of ENIAC operation

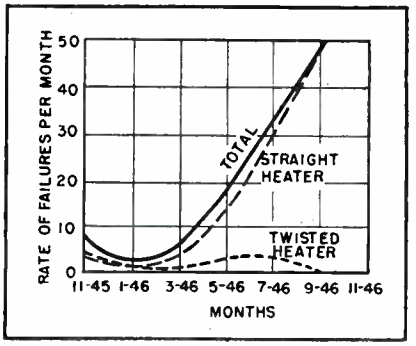


FIG. 2—Comparison of failures of straight and twisted heaters

Figure 1 provides a graphic record of tube failure per month for the 644 tubes removed from the ENIAC. The downward trend from November 1945 to March 1946 is probably marking the decreasing number of tubes at the borderline of acceptability when placed in operation in the ENIAC. This downward trend in rate of failure for the first 1,000 hours or so is normal experience when using large numbers of tubes. The peak in August 1946 is due largely to a complete overhaul given the machine in preparation for a problem which used its facilities to the utmost.

The five major causes of these 644 tube failures were: (1) open heater wire; (2) damaged oxide cathode coating; (3) internal leads and supports dangerously close; (4) open electrode spotwelds; (5) burned-open shorts. Open or damaged heaters accounted for 270 failures and damaged cathodes caused 150 failures, while the remaining three types of faults accounted for between 50 and 100 failures each.

Open Heater Wire

The 6SA7 tubes (14 percent of all tubes used in ENIAC) were con-

structed with the twisted type heater, and had no open-heater faults. The 6L6 tubes (22 percent) were constructed with straight or looped heaters and gave 15 percent of all open-heater failures. The 6SN7 tubes (35 percent) were constructed with both types of heaters, and contributed 75 percent of all open-heater failures, of which 15 percent were in twisted heaters and the remainder in straight heaters. The remaining 10 percent of open-heater failures came from tubes having straight heaters.

The fact that 57 percent of all tubes in the ENIAC produced 90 percent of the heater failures indicated possibilities of faults peculiar to these two types (6L6 and 6SN7). It was found that the straight folded-type heaters in these types, combined with certain manufacturing features, were mainly responsible for the failures.

In most of the open-heater faults of the twisted type, the heater wire had pulled away from the support wire. Such faults in both straight and twisted heaters seem to occur only when the spot weld between the heater and support wire has not imbedded the tungsten heater wire sufficiently in the softer metal (Ni alloy) support.

Examination of straight heaters showed approximately 90 percent of all faulty tubes with straight heaters either had the insulating coating chipped off their bends, baring the tungsten wire with additional circumferential cracks over its length, or appeared to have had their insulating coatings shifted away from the bend while in a semi-liquid state. The latter were probably coated by dipping, and tilted before they were dry. The first condition was the more prevalent. It is common practice in manufacturing to coat the tungsten wire by processing it while being wound from one spool onto another. The coated, spooled wire is then bent into the straight heater folds. In so bending, the coating cracks, baring some bends. A more elastic insulating coating is being sought by tube manufacturers.

Few twisted heaters showed chipped insulating coating and exposed bends. The 6L6 straight heaters gave most of their trouble in cathode-to-heater leaks. Figure 2 shows, for all tubes inspected, the rate of failures per month traceable to chipped or otherwise bared heater faults. Separate curves for twisted and straight-type heaters are included for comparison.

In an attempt to correlate a-c shutdowns with tube failures, a rack of 100 6L6 and 100 6SN7 tubes was tested by applying full heater voltage long enough for tubes to heat, and turning tubes off till cool, with this cycle being repeated continually. In the same rack another 100 6L6 and 100 6SN7 tubes were similarly cycled, but with heater voltage applied in steps to approximate a constant linear expansion in the heaters. This test showed little difference in tube failures between samples over a period of eight months.

One other fault noticed with heaters had to do with their mountings. Figure 3 shows the various types of heater mountings encountered in this investigation. In the case of single-heater tubes, the support wires are cut to the same length and bent into position. The heater wires should be run parallel far enough apart so that the supports do not touch, and close enough to slip easily into the cathode sleeve. Heaters were observed with the insulating coating worn away by rubbing of the cathode sleeve edge during vibration, expansion, and contraction. For this consideration the construction of Fig. 3A proves better than that of Fig. 3B.

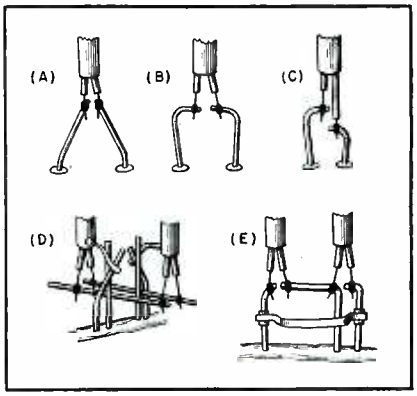


FIG. 3—Types of heater mountings encountered in ENIAC tubes

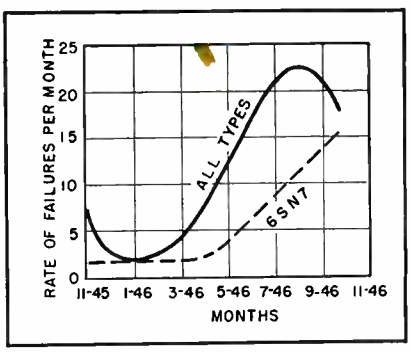


FIG. 4—Failures traceable to blistered oxide cathode coatings, causing low emission

If one support were cut shorter before bending, as in Fig. 3C, the supports could be closer without shorting, providing the heater wire is insulated down beyond the upper support. The heater would not then be spread, and chances of rubbing its insulating coating against the edge of the cathode sleeve would be minimized.

Of the two 6SN7 double mountings, that of Fig. 3E seemed to be the neater and less troublesome in this investigation. The upright posts in Fig. 3D provided more obstruction to the pliable cathode bands, causing the bands to short and burn open; actually, however, this mounting allows closer, more parallel heater wires to enter the cathode sleeve.

Damaged Cathode Coating

With little exception, the main damage to cathode coatings was blistering—an uneven, bubble-like puff of oxide coating which when broken away exposes the bare cathode sleeve. Other damages, noted rarely, were burns or holes adjacent to shorted electrodes.

Rates of failures per month due to damaged oxide coatings are shown in Fig. 4 for all tubes and for 6SN7 tubes individually. The same tendency was noted for each other tube type. The curves turn upward in the vicinity of March, when the ENIAC was being used to capacity. The percentage increase in failures is many times greater than the approximate percentage of additional tubes used in March, which would indicate that blistering involves an aging effect.

As would be expected, most of the tubes with blistered cathodes were removed because of low emission. The most acceptable answer to blistering seems to be that of gas formation between sleeve and coating. This effect would increase with age if the following is assumed. Many

cylindrical cathode sleeves, such as 6SN7, are made with seams down their length. During processing, these sleeves are exposed to oil (or some other liquid) baths. If not thoroughly cleaned before the oxide coating is applied, the liquid, if thin enough, will infiltrate the seam and be covered with the oxide coating. In use, the heated liquid would diffuse through the coating along the surface of the cathode sleeve and liberate gas, causing blisters.

Internal Leads and Supports Dangerously Close

Support wires are considered to be those wires which leave the tube base pins to pass through the glass stem and press into the evacuated envelope. In some cases these support wires are bent and spot-welded directly onto the electrode structure. In other cases a thin, pliable copper or nickel band, here called a lead, is used to connect the support to the electrode structure.

The compromise necessary between the spread of the heater wires entering the cathode sleeve and the closeness of their supports can be responsible for shorted heaters.

The most dangerous of all near-shorts seemed to be those involving the pliable lead bands connecting support wire to electrode post or another support wire. These bands are usually used long enough to provide necessary slack for running them around other supports. In some cases the cathode bands are curved to avoid the control grid supports, only to be curved too close to each other. If the cathodes are at an appreciable voltage difference with respect to each other, their bands may touch from expansion or the electrostatic pull between them. In pentagrid tubes, with numerous electrode posts, the cathode band is very often quite close to a support wire.

Approximately 100 of the tubes removed from the ENIAC had near shorts. Percentages of these failures for each type of tube indicate that near shorts are of general occurrence in all types.

Failures discussed here are those in which tubes investigated showed an internally open connection between support wires and electrode

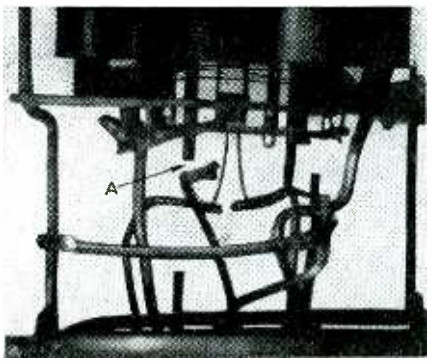


FIG. 5—Arrow points to control grid support of 6L6 pulled away from its post and providing near-short to adjacent heater

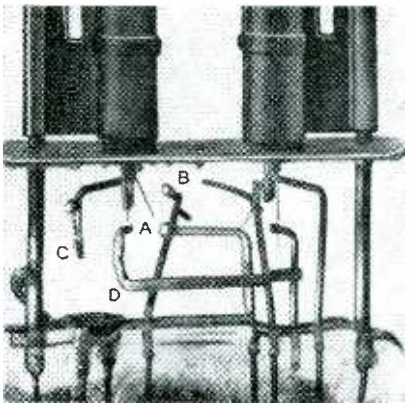


FIG. 6—Burned-open shorts in 6SN7 at heater (A), cathode band (B), control grid support (C), and heater band (D)

posts. No cases were found in which a lead band had pulled away from another wire.

Open Electrode Spotwelds

With open spotwelds (other than open heater-to-support spotwelds, already covered) it was not possible to identify definite characteristics of the opened spotwelds that might indicate faulty welds, though discoloration from the heat of the weld was seen.

Records of the rate of these approximately 50 failures with time show no significant tendencies, and the distribution among the various tube types is in rough proportion to the relative number of the tubes of each type employed in the ENIAC.

A few cases were found in which the screen support had pulled away from the screen grid post, and consequently touched or nearly touched the plate support. In most cases the size of the bend in the screen support decided whether it shorted or not.

Figure 5 shows a control grid support, having pulled away from the control grid post, in a position near shorting the adjacent heater wire. A little drop of metal fastened to the underside of the support presumably was part of the joint and under intense heat melted, allowing the support to snap away from the grid post.

Burned-Open Shorts

Initial reasons for these shorts were usually burned away, hence a separate classification was made even though causes may have been one or more of the faults previously taken up. Tabulation gave a random distribution of failures with time, in rough proportion to the numbers of tubes of each type in the ENIAC.

An interesting example of what a short can do is shown in Fig. 6. The left-hand side of the structure is completely burned open; the heater (A), the cathode band (B), and the control grid support (C) are burned open, leaving only the plate support intact. Molten droplets can be seen on the remaining wires, forced upward by the pressure of the burning. This burn continued down into the glass press, melting the surface around the supports.

This short might have been caused by an overhanging end of the heater band (D) touching the control grid support during vibration or expansion. The difference of potential across this band segment could have been as much as 150 volts.

Most burned-open wires encountered were of the lead band type which had probably expanded and touched another support or band. The kind of burned-open short pictured in Fig. 6 was the second most frequently occuring.

The author wishes to acknowledge the helpful criticism given by Thomas Kite Sharpless of the Moore School of Electrical Engineering Research Division, University of Pennsylvania, who is chief engineer of the EDVAC project (Electronic Discrete Variable Computor—a faster, more compact, and more versatile successor to the ENIAC). Appreciation is also expressed for the untiring efforts of Viola Andreoni, project worker.

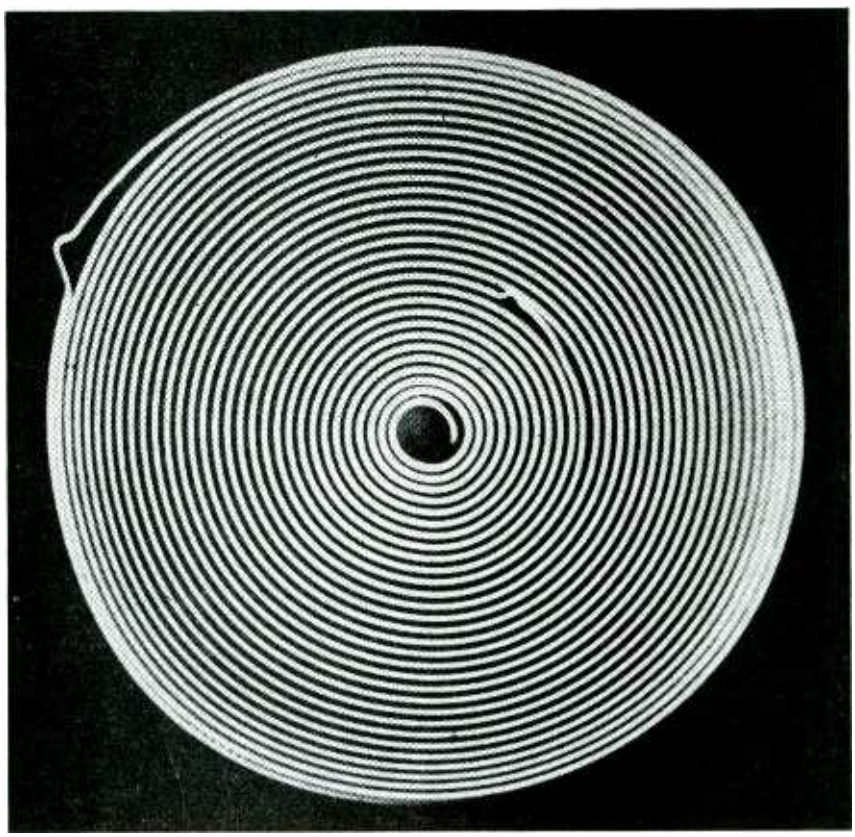
Spiral Sweep

The time difference between the initiation of two or more positive pulses can be determined to within 0.05 microsecond by photographing their display on a single spiral trace revolving once every 2 microseconds and having a total length from 25 to 100 microseconds

By R. B. MORAN, Jr.
California Institute of Technology
Pasadena, Calif.

THE fields of electronics and nuclear physics both require extremely accurate measurement of time intervals between pulses that are in themselves only a matter of microseconds in length. The timing equipment to be described has been designed particularly for cyclic or aperiodic phenomena requiring a photographic record that can be scaled and interpreted at leisure.

A spiral sweep was chosen for the display of the intelligence because of the great effective length that can be recorded at one exposure and for the ease with which the record can be measured without the introduction of separate time markers. This latter advantage results from the fact that the angular velocity of the spot is constant and can be accurately standardized by suitable control of the sweep oscillator frequency. In practice, an enlarged photograph (shown) is made of the cathode-ray tube face and the time difference between successive pulses is read by simply counting off the number of complete revolutions and adding the time represented by the residual angle. A transparent protractor calibrated directly in hundredths of a microsecond is placed on the photograph for this purpose.



Representative photograph of the cathode ray tube display. The spacing between the pulses represents a time interval of 38.55 microseconds

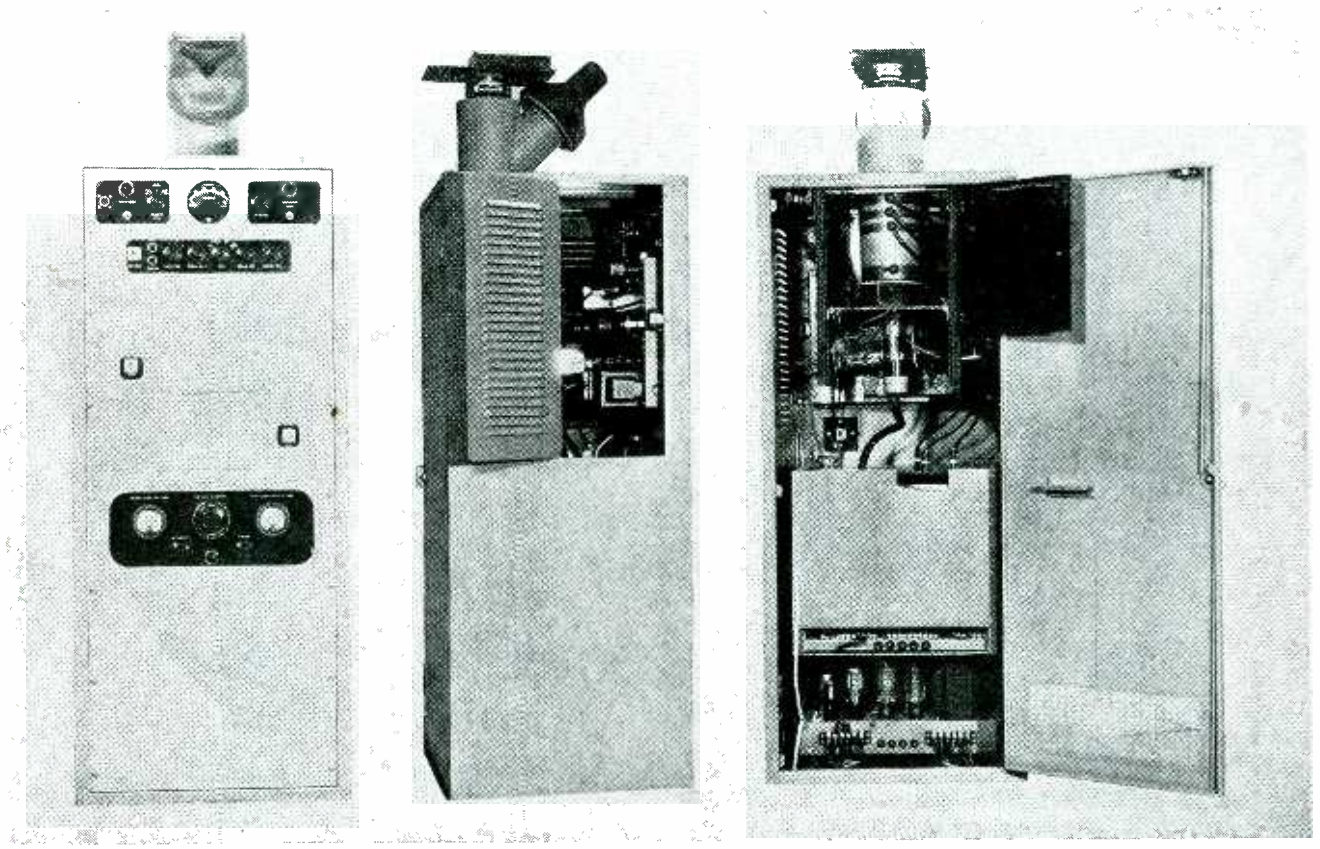
A DuMont type 5RP11 multiband cathode-ray tube is employed because it has the highest writing speed suitable for photography. Writing speeds as high as 100 inches a microsecond have been obtained, although the equipment described was constructed for phenomena whose total life encompasses 25 to 100 microseconds. With the sweep driven by a 500 kilocycle crystal oscillator, an accuracy of better than 0.05 microsecond has been obtained, provided that the pulses themselves have a comparable rise time.

Block Diagram

Operation of the spiral sweep oscilloscope is best understood by dividing the circuit functions into the units indicated on the block diagram, Fig. 1. The trip selector determines the method by which the oscilloscope is to be triggered. The trip pulse generator supplies a suitable negative pulse with a very steep front to operate the single-shot gate multivibrator that supplies a square positive pulse to the grid of the cathode-ray tube. This impulse turns on the beam that is normally cut off. At the same time, the gate multivibrator supplies the sweep generator with a negative square-wave pulse of the same length. The sweep generator supplies a single linear trapezoidal pulse of the same length as the gate pulse, and of variable amplitude.

The crystal controlled timing oscillator runs continuously at 500 kilocycles, and supplies the modula-

Oscilloscope Timer



Front, side and rear views of the equipment showing the viewing hood and camera above the top of the enclosing cabinet

ting amplifier with an accurately timed signal of constant amplitude. This amplifier modulates the 500-kc sine wave with the negative sawtooth wave from the sweep generator in such a way as to produce a 500-kc sine wave that decreases linearly in amplitude with time during the recording interval. The modulated signal is fed into a phase shifting network that splits it into two balanced outputs 90 degrees out of phase. These two outputs are then fed into the radial pulse injection amplifier which superimposes the signal pulses to be measured on the 500-kc sweep voltages in such a way that the pulse will record radially and have a fixed amplitude at any time it appears in the sweep cycle. The output of the pulse injection amplifier is fed directly to the deflection plates of the oscilloscope tube. A damping circuit tends to pass only positive pulses and therefore damps oscillatory wave trains that may be shock excited in the field circuits. The negative pulse input jack is provided for direct control of the cathode-ray tube grid in order that times may be indicated by producing blank spaces in the record.

A schematic circuit diagram of the tripping, gate and sweep generators is shown in Fig. 2. A sharp negative trip pulse is generated by discharging C_1 through R_1 and the thyratron V_1. The trip selector S_1

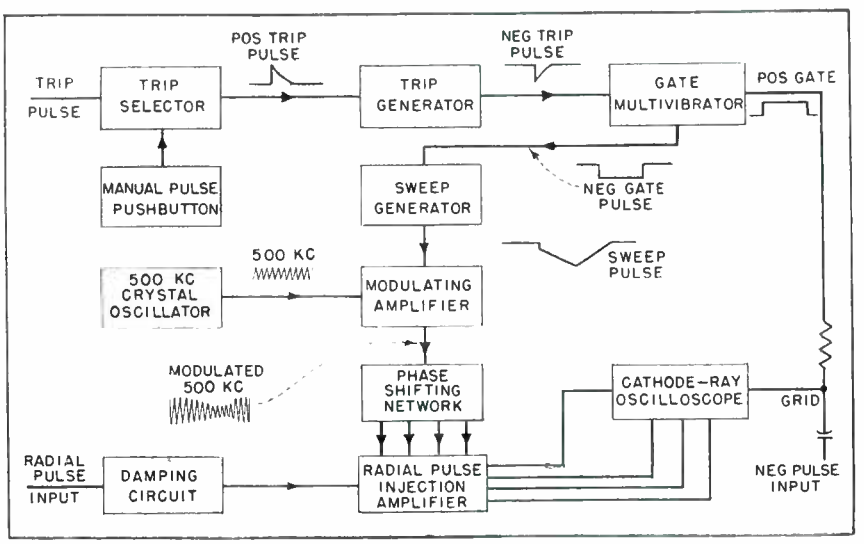


FIG. 1—Block diagram showing interconnection of the principal circuit elements in the spiral sweep timer

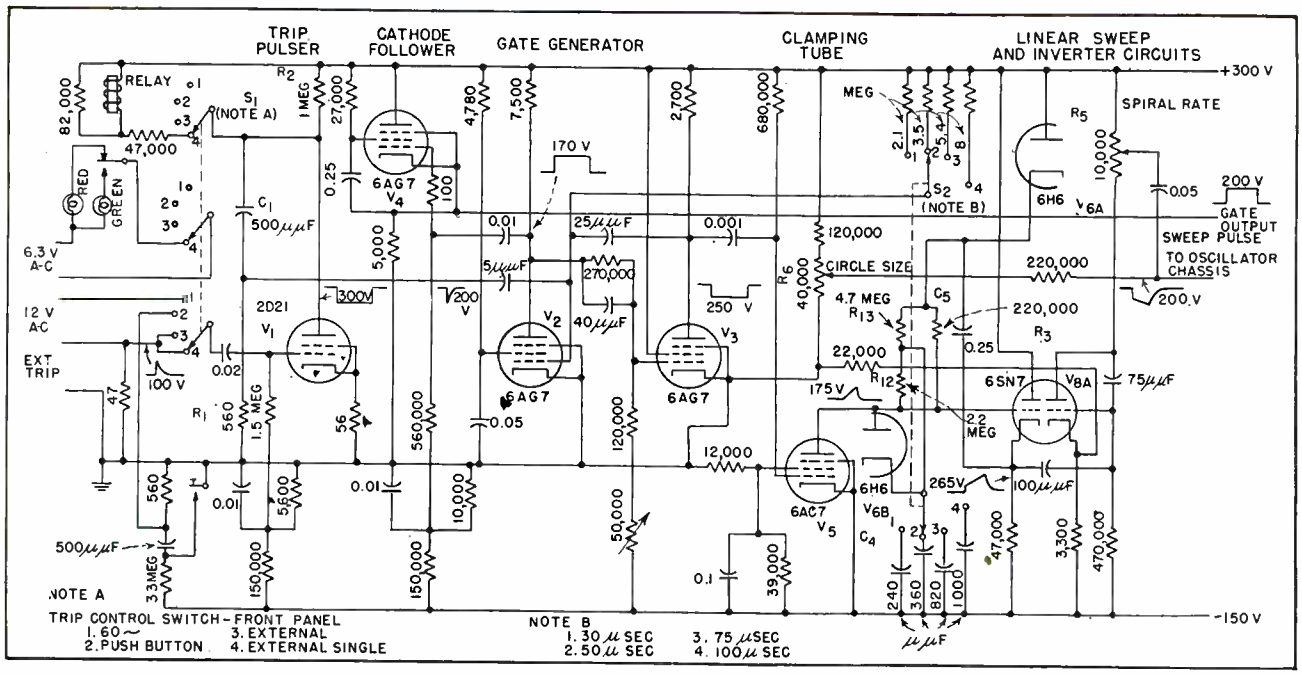


FIG. 2—Sweep generator that is triggered by any one of four different types of impulse. Sweep length is variable depending on position of S_2

allows the thyratron, normally cut off, to be tripped from the 60-cycle line, by the manual trip button, from any positive trip pulse train fed in through the external trip jack, or by a single external positive trip pulse. In any of the first three positions of the trip selector the thyratron V_1 goes out after C_1 has discharged because charging resistor R_2 is so large that the current is too small to sustain ionization. In the single trip position of S_1, C_1 is charged through a relay and a comparatively low resistance. The total plate load resistance of the thyratron is now low enough so that an arc is sustained. Capacitor C_1 can not recharge until S_1 has been operated to break the plate circuit and reset the circuit. The tripped or ready condition of V_1 for single pulses is indicated by the red or green pilot light. This circuit serves as a lockout to prevent more than one sweep from occurring when the equipment is tripped from the field circuit which may generate some extraneous pulse after the desired signals have been generated.

Pentodes V_2 (normally conducting) and V_3 (nonconducting) are connected in the circuit of a square-wave generator to transform the negative trip pulse into a gate pulse of length determined by capacitor C_3 and the timing resistor R_4 which is chosen by S_2. Cathode follower V_4 effectively isolates the generator from the cathode-ray tube.

Sweep Generator

Clamping tube V_5 is normally conducting, its plate being at a potential about 20 volts above its cathode. When it is cut off by a negative gate from V_3, its plate suddenly rises to the potential to which C_4 is charged. The height of this initial rise is determined by the voltage divider R_{12} and R_{13}. When the plate of V_{6B} goes positive with respect to its cathode it conducts and C_4 is charged through R_3. Tube V_{8A} is coupled to the cathode of V_{6A} by a "boot-strap" coupling capacitor. Therefore, as C_4 is charged, the cathode of V_{6A} is raised above the B+bus and V_{6A} then ceases to conduct. The boot-strap action of V_{8A} keeps a constant voltage across R_3 tending to maintain the charging current of C_4 constant in order to generate the desired linear topped sweep pulse. When the sweep length selector switch S_2 adjusts the value of C_4 it also selects a value of R_4 which will make the gate pulse just long enough to allow C_4 to charge to full voltage. A negative sweep pulse is

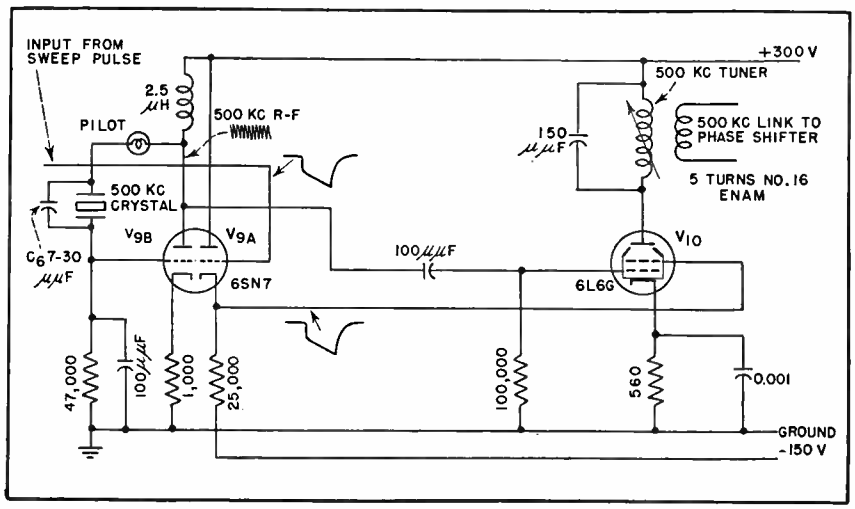


FIG. 3—Crystal oscillator and modulator for combining the 500-kc component with the sweep pulse from equipment in Fig. 2

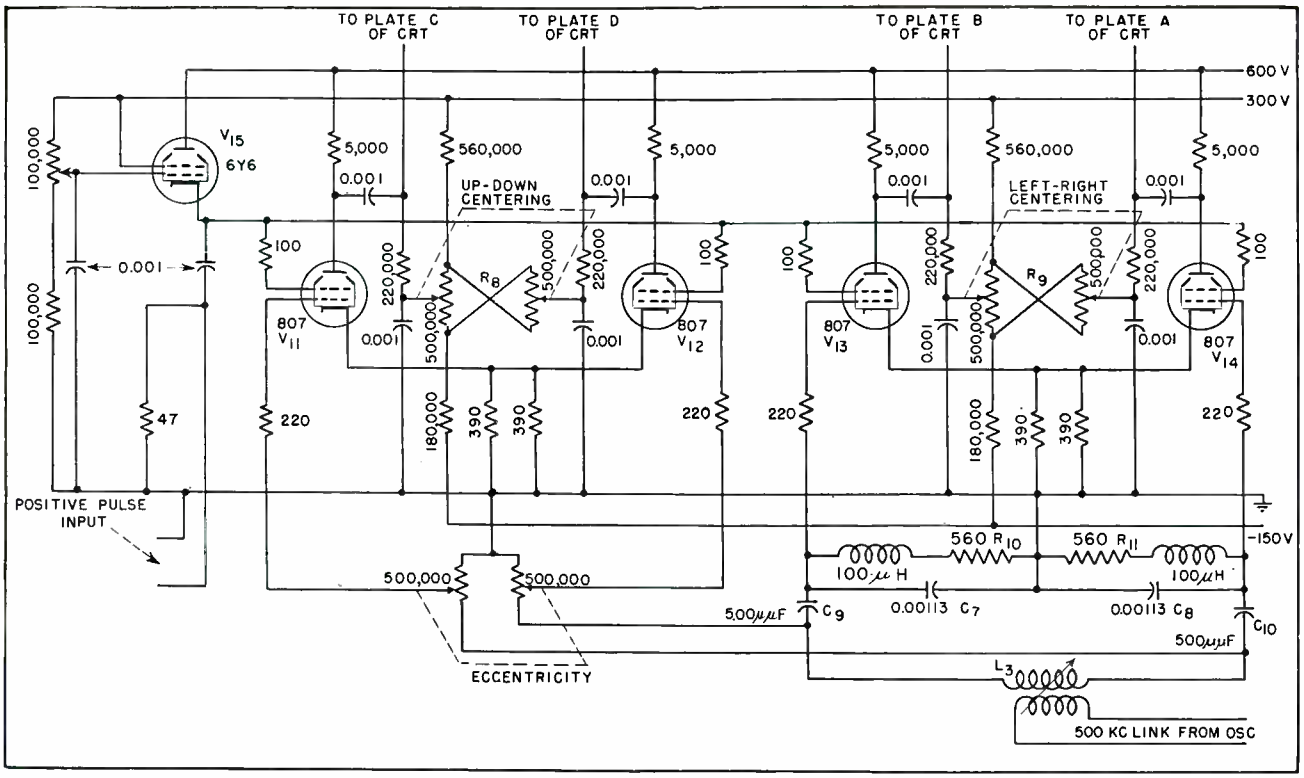


FIG. 4—Radial pulse injection amplifier that is connected to the cathode-ray tube. Positive input pulses to be timed are injected on the screens of the amplifiers, causing an aberration in the normal spiral traced by the electron beam

furnished the modulating amplifier by V_{9B} and its amplitude is controlled by the spiral rate control R_5. The initial bias of this negative pulse lead is controlled by the circle size control R_6.

Output from a conventional Pierce oscillator (Fig. 3) operating at 500 kc and stable to one part in 10,000, is fed through a cathode follower V_{9B} to the screen of V_{10}, the grid of which is connected to the sawtooth sweep circuit. The resulting modulated wave, of a form indicated in Fig. 1, is fed through a low impedance line to the injection amplifier unit.

Radial Pulse Injection Amplifier

The sweep-modulated 500-kc signal passes into a permeability tuned phase shifting network (Fig. 4) which is balanced to ground. Because L_1 C_7 and L_2 C_8 are tuned to 500 kc they are resistive at the fundamental frequency. Since L_3 is tuned to 500 kc by C_9 and C_{10}, the current in the resistive mesh will be 90 degrees out of phase with the voltage developed across L_3 which is applied to the grids of V_{11} and V_{12} through the eccentricity control R_7. The purpose of the grid networks L_1 C_7 R_{10} and L_2 C_8 R_{11} is to give equal frequency discrimination to any harmonics that may be present in both branches of the phase shifting network and thus reduce the amount of distortion of the circle pattern.

The push-pull vertical deflection amplifier (V_{11} and V_{12}) is in phase with the 500-kc tuned circuit voltage, whereas the horizontal amplifier (V_{13} and V_{14}) is 90 degrees out of phase. Therefore when their equal outputs are applied to the deflection plates of the oscilloscope tube, a circular deflection pattern is produced. Since the 500-kc input is modulated by a single sawtooth, during the recording interval this circular pattern will degenerate into a linear spiral during the interval that the beam is turned on.

The screens of all the deflection tubes are fed from a common cathode follower V_{15}. Thus, when a positive pulse is fed in on the screen bus through the input jack, the plate current is increased instantaneously in all of the amplifier tubes and the beam is deflected radially. This same cathode follower serves to damp oscillatory wave trains originating in the input circuit and to sharpen the breaks in the recorded pulse signals.

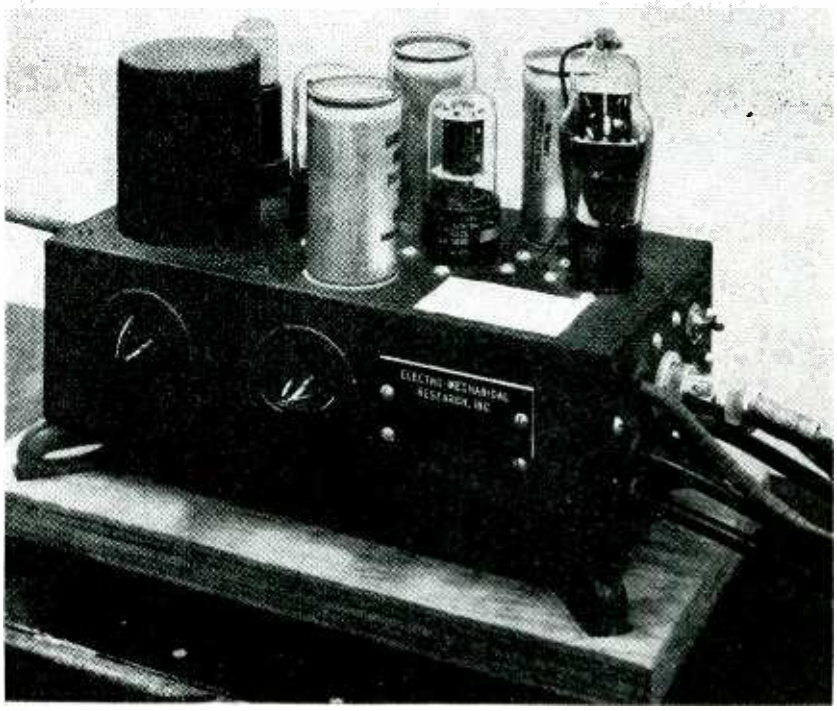
All operating controls and external connecting points appear on the front panel. A sweep control gives four different total sweep times of 30, 50, 75, and 100 microseconds. The equipment can be tested using a 60-cycle source that will repeatedly trip the sweep. The manual tripping control is used as a final check just before a photographic recording. The external position can be used with an oscillator or pulse generator, whereas aperiodic impulses are connected through the single-trip channel to avoid double exposure resulting from spurious signals following the desired pulse.

Acknowledgements

Credit should go to the entire development, Pasadena Task Group of the Electronic Section, U. S. NOTS, Inyokern, as almost everyone in the group has contributed in some way to this project. Special credit should go to Owen Peet, Walter Lovingfoss, and Joseph Strapp who did the major part of the construction and testing and furnished useful suggestions.

By CHARLES B. AIKEN
and W. C. WELZ

Electro-Mechanical Research, Inc., Ridgefield, Connecticut



Compact low-frequency amplifier uses a battery for the plate supply of low-level stages to dispense with bulky decoupling filters

D-C AMPLIFIER for Low-Level Signals

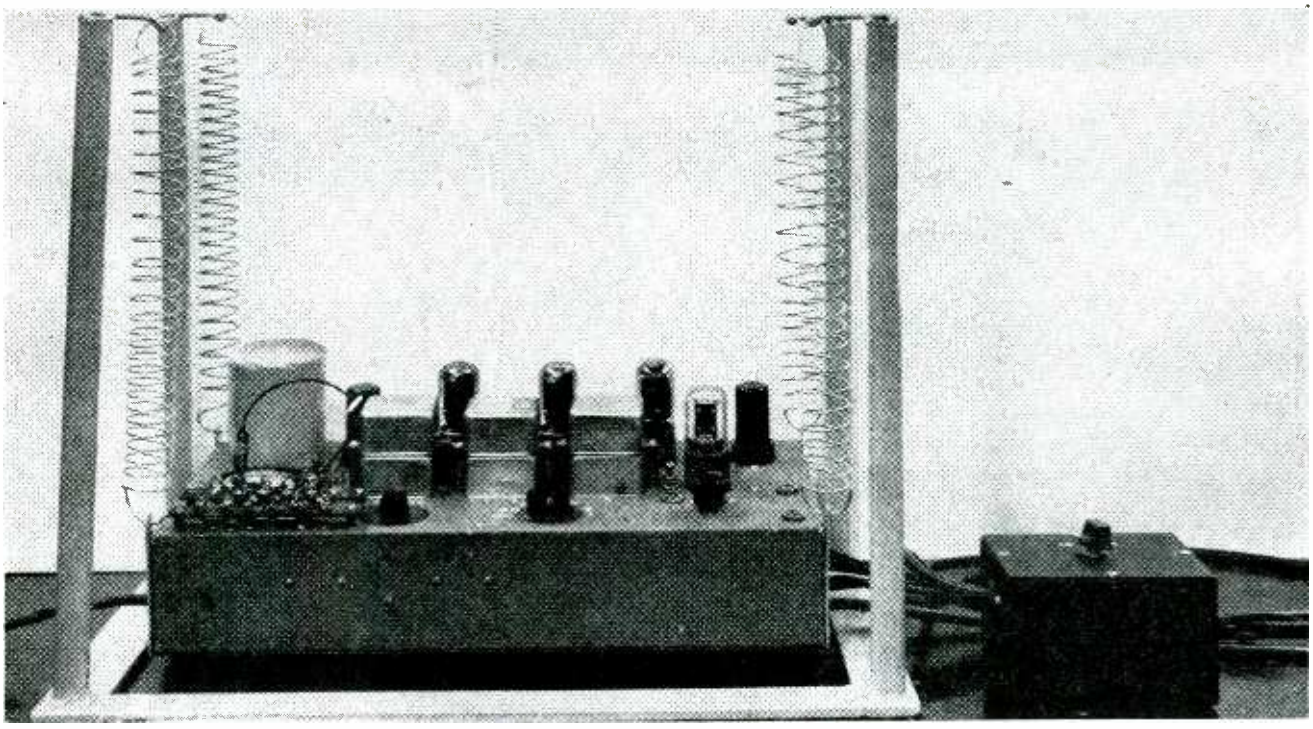
AMPLIFIERS for extremely low input levels are often required in the measurement of physical quantities in both research and materials testing laboratories. One important field of instrumentation where such amplifiers are required is the measurement of various forms of radiation.

Design Considerations

The conventional method of using an a-c amplifier instead of a d-c type is to modulate a local high-frequency carrier with the input signal, amplify the modulated a-c, and finally obtain the signal by detection. Recently the thermal time constants of bolometers and thermocouples have been substantially reduced, so it is possible to interrupt the radiation falling on them, by means of a mechanical shutter for example, and thus directly obtain an a-c output that is proportional to the incident radiation.

To measure minute amounts of radiation, such as those involved in astronomical investigations, it is necessary to deal with signals of the order of millimicrovolts. To distinguish such signals in the presence of noise, it is necessary to employ an exceedingly narrow bandwidth in the amplifier. The frequencies of operation of the newer bolometers and thermocouples range from 5 to as high as 150 cycles. During the course of work on a National Defense Research Committee contract, amplifiers for use with these bolometers and for general testing at low frequencies were developed; the amplifiers operate at frequencies below 50 cps with bandwidths less than 5 cps wide. Although these units are of specialized nature, they do have many uses in instrumentation beyond the purposes for which they were originally designed.

In electrical design, it is desirable to operate at as low a frequency as possible, because the minimum achievable bandwidth becomes narrower as the operating frequency is lowered, thus reducing the noise against which the signal must compete. But too low a frequency presents apparatus problems, particularly in the design of the input transformer and in the size of the by-pass capacitors. Fre-



Chassis suspension system has long period to prevent microphonics in this carrier-type d-c amplifier operating at 12 or 24 cps

Bandwidths of only a few cycles, input impedances not over 20 ohms, and averaging rectifiers are used to minimize noise when amplifying signals below a microvolt. Speed of amplifier response is analyzed. Construction of two laboratory amplifiers is described

quencies in the vicinity of 60 cycles are to be avoided because of the universal presence of hum fields from power circuits.

One of the most important design aspects affecting the level of circuit noise is the rectifier used at the amplifier output to convert the a-c into d-c for actuating an indicator or recorder. Peak-type diode voltmeters accentuate the noise component more than averaging rectifiers, so the averaging type is preferred. Perhaps the best rectifier from the standpoint of minimizing noise is the mechanical rectifier; it is a motor-driven switch operated from the same shaft that drives the mechanical shutter. The switch thus reverses the polarity of the amplifier output in synchronism with the a-c signal generated by the shutter so that the output is rectified on a purely average basis, independently of the absolute value of the signal. The mechanical rectifier is strictly linear, and when used with a filter, provides selectivity dependent only on the characteristic of the filter.

Input Circuits

Balanced input circuits and a suitable input transformer are essential if maximum sensitivity is to be realized when the amplifier is connected to thermal receivers or other devices of low impedance. The stepup of this transformer should be high, so that the irreducible thermal noise across its input terminals is made large enough to override by a substantial margin the noise generated in the first vacuum tube. For operating frequencies of 10 cycles or above, this condition is easily fulfilled, and it is then unnecessary to take extreme precautions to reduce tube noise to the lowest possible level.

The transformer used is the Thermador Type TG-3, originally intended for geophysical use. It has a six-element shield and a rated secondary inductance of 2,400 henries ±10 percent, at low voltages. The stepup obtainable from a balanced 10-10 ohm input circuit is 150 at 50 cycles, 107 at 12 cycles, and 84 at 7 cycles, the secondary being tuned for maximum output in each case. However, unless the secondary Q is greater than two,

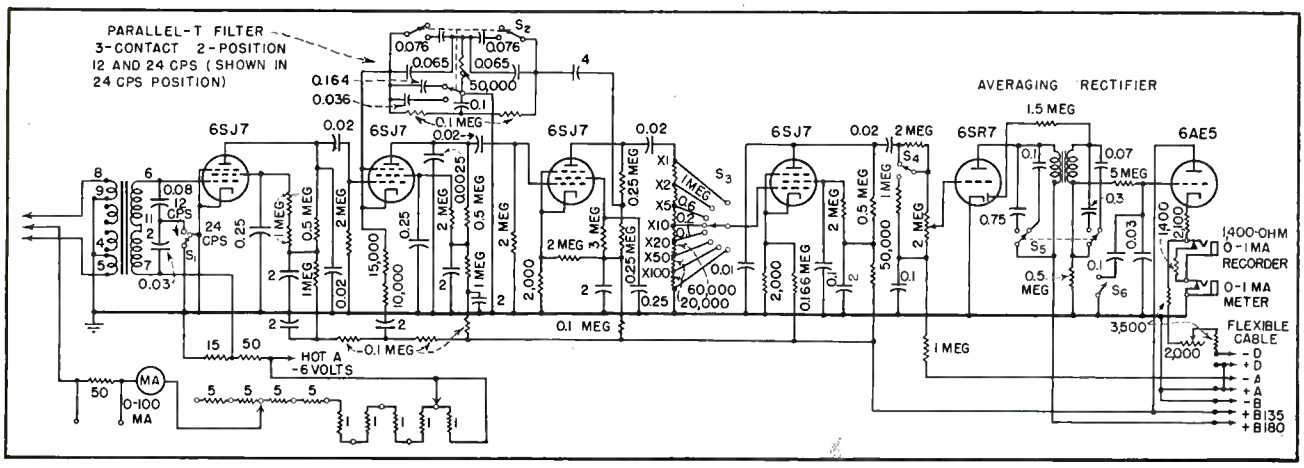


FIG. 1—Parallel-T filter and averaging rectifier minimize noise in this amplifier for use with bolometers

tuning the secondary provides little improvement.

The layout of the amplifier should take account of the obvious precautions required in any high-gain device, such as in-line sequence of stages, adequate separation of high-level and low-level regions, and shielding of critical elements. Moreover, at the gains involved here, certain additional precautions are necessary, especially in the first stage, although it has been found that elaborate constructions are not always necessary. In some cases, protection provided by the sextuple shielding on the transformer, the metal case of the first tube, and a standard metal chassis enclosing the transformer tuning capacitor and the wiring has proved satisfactory, provided the device is not subjected to severe electrical interference. In other cases, moderate additions to this shielding have been necessary.

Tubes recommended for the first stage are the 6SJ7 and the 1620. It is desirable to test tubes for electrical and microphonic noise, and to select the quietest units, because individual tubes differ greatly.

A very substantial plate decoupling filter is required in the first stage; the second stage is also apt to call for special attention in this regard. The necessary filtering can be realized either by using two or three sections of R-C filter (multiple sections require less total R and less total C than a single section of the same effectiveness), or by using gas voltage-regulator tubes, which act as excellent low-frequency bypass elements.

It is well to use precision wirewound resistors in all parts of the first stage, except the sections of decoupling filter which precede the last section. Oil-filled by-pass capacitors should be used, and very high resistance mica coupling capacitors; capacitors having even a small leak can cause severe noise. The use of one-point grounds, as is common in high-gain radio-frequency amplifiers, is especially desirable.

Selective Circuits

In the first amplifiers constructed in our laboratories, inductance-capacitance selective circuits were used. Besides tuning the input-transformer secondary, the grid circuit of the third stage, which utilized the primary of a Thermador Type TG-26 transformer, was tuned. This type of tuning is simple and results in a fairly high gain. However, the inductance of the coil changes slightly with voltage level, thereby causing detuning and moderate nonlinearity.

In the later amplifiers, a twin-T selective feedback circuit has been employed for tuning purposes, usually from the plate of the third stage to the cathode of the second. Feedback from the third plate to the suppressor-grid of the first stage has also been successfully used. In most cases, a well balanced twin-T network gives sufficient selectivity. However, in some cases a narrower band was required; it was achieved by increasing the shunt capacitance in the twin-T circuit above the normally used value, which makes the feedback voltage regenerative near what would normally be the zero transmission frequency of the twin-T.

Signal Rectifier

Considerable use has been made of a simple peak-type diode rectifier, which is satisfactory unless it is necessary to measure signals just above circuit-noise level. Circuit noise contains peaks that are several times the average noise level. These peaks register on a peak-type voltmeter, and keep the rectified noise voltage unnecessarily high.

This difficulty can be remedied by arranging the diode to respond to the true average of the impressed alternating voltage by using a circuit in which no by-pass capacitors are used across the resistors in series with the diode. With amplification adjusted so as to obtain the same sinewave output in both cases, the average noise level with a peak rectifier was 74 percent greater than with the average-type rectifier, and in addition, the latter gave a more uniform noise level, relatively free of surges, than the peak type.

As has been mentioned, synchronous mechanical rectifiers have also been employed. This rectifier has been used successfully in the amplification of direct potentials that are interrupted, fed into an alternating-current amplifier, and then synchronously rectified. The rectifier and the filter to which its output is delivered give an effective selectivity to the amplifier which is determined entirely by the characteristics of the filter.

In order to get full output from a

synchronous rectifier, the phase of the impressed voltage must be correct. For this reason the amplifier should be provided with a continuously variable phase adjusting network so that the correct relationship between signal and rectifier phase can be easily reached, and so that effects of small drifts in the tuning of the amplifier, or slight changes in the operating frequency, can be compensated.

If full advantage is to be taken of the useful characteristics of the rectifier-filter system, it is essential that there be no interference, either microphonic or electrical, from the rectifier itself. Such interference, being synchronous, is very detrimental and great care must be taken to avoid it.

Speed of Response

There is no simple relation between the effective overall time constant of the amplifier and the bandwidth at some specified amplitude, such as 3 decibels down, or 6 decibels down. However, certain simple formulas make it possible to decide on the approximate value of bandwidth to be employed when a given response speed is required.

When a sinusoidal electromotive force is suddenly impressed upon a series-tuned circuit, the resulting current consists of a steady-state term plus a transient term, which gradually dies away. The transient is of the form of a damped sine-wave, and the time constant t_1 of the circuit is the time required for the amplitude of the transient to decrease to 37 percent of its initial value. Let f_2 and f_1 be frequencies at which the resonant curve of the tuned circuit falls to a fraction F of its maximum. If X is the total reactance around the circuit at either one of these frequencies

$$F = 1/(1 + X^2/R_1^2)^{1/2} \qquad (1)$$

from which two relations follow

$$(2\pi f_2 L/R_1) - (1/2\pi f_2 C R_1) = (-1 + 1/F^2)^{1/2} \qquad (2)$$

and

$$(1/2\pi f_1 C R_1) - (2\pi f_1 L/R_1) = (-1 + 1/F^2)^{1/2} \qquad (3)$$

adding these two expressions

$$[2\pi f_2 L + 1/2\pi f_1 C] - [2\pi f_1 L + 1/2\pi f_2 C] = 2R_1 (-1 + 1/F^2)^{1/2}$$

furthermore $2\pi f_2 L$ is very nearly equal to $1/2\pi f_1 C$, and $2\pi f_1 L$ is equally close to $1/2\pi f_2 C$, hence

$$f_2 - f_1 = (R_1/2\pi L)(-1 + 1/F^2)^{1/2} \qquad (4)$$

in addition, the rise of current in the circuit is determined by the time constant t_1 which is $2L/R_1$; this term can be used to eliminate L/R_1 from Eq. 4 giving, on rearrangement

$$t_1 = (-1 + 1/F^2)^{1/2}/\pi (f_2 - f_1) \qquad (5)$$

which equation relates time constant to bandwidth. For half-amplitude bandwidth $F=0.5$ and Eq. 5 gives

$$t_1 = 0.552/(f_2 - f_1)$$

showing that a frequency response one cycle wide at half amplitude gives an effective time constant of slightly over half a second. If bandwidth is considered to be between the 3-db points, then $F=0.707$

$$t_1 = 0.318/(f_2 - f_1)$$

which results indicate that, for a given definition of bandwidth, the time constant depends, as does the noise, on the absolute bandwidth.

Response of Synchronous Rectifier

The synchronous rectifier used with this amplifier and its associated filter also has an effect on the response time of the system. When the voltage impressed on the mechanical rectifier is synchronous with the rectifier switching, as will always be the case with the desired signal, the output will contain a direct-current term. If a signal is suddenly impressed on the rectifier, the voltage appearing across the output of the filter will require some time to reach its maximum value. The time constant t_1 is the interval required for the output to reach 63 percent of its final value.

If the filter consists of two identical resistance-capacitance networks, the ratio of the instantaneous output voltage to the impressed direct voltage is

$$e_2/E_0 = 1 - \epsilon^{-1.5t/RC} \times [1.342 \sinh (1.118t/RC) + \cosh (1.118t/RC)] \qquad (6)$$

from which it can be found that the output reaches 0.63 of its final value when $t/RC=3.03$, hence t_1 is $3.03RC$ for this filter.

To relate this time constant to the effective selectivity, let f_0 be the synchronous frequency, and f_1 and f_2 be the higher and lower frequencies of the incoming signal at

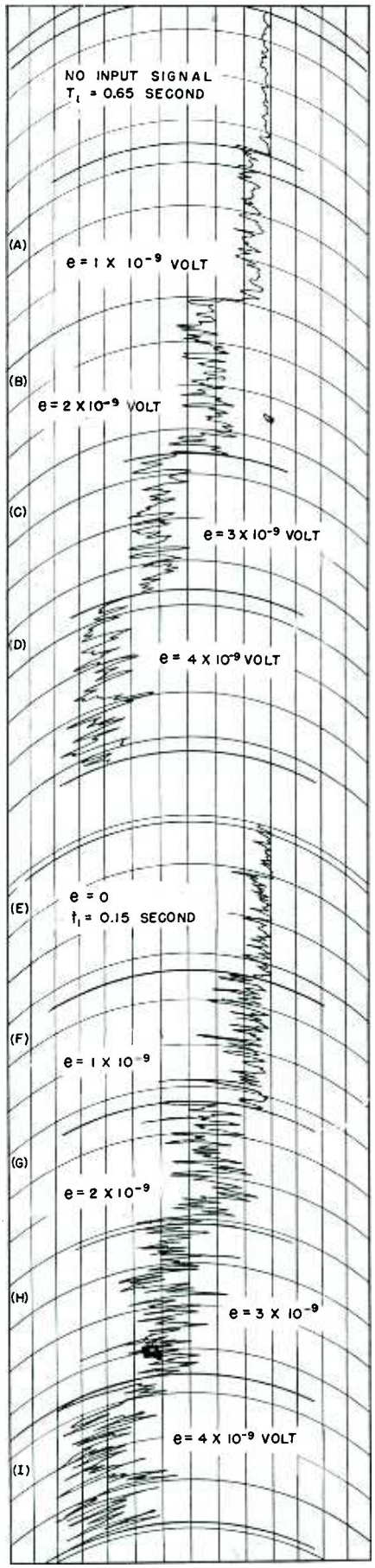


FIG. 2—Output from amplifier of Fig. 1

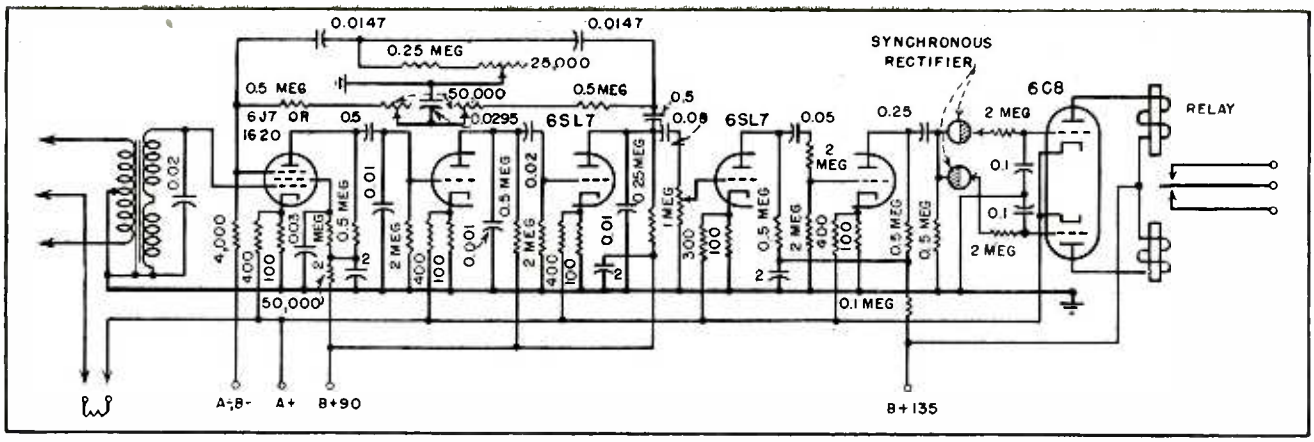


FIG. 3—Synchronous rectifier, consisting of two rotating commutators, averages noise in amplifier output

which the filter output is reduced to a fraction F of its maximum steady state value. Then

$$F^2 = 1/\{1 + 28[\pi RC(f_2 - f_0)]^2 + 16[\pi RC(f_2 - f_0)]^4\} \quad (7)$$

and also an identical expression in which $(f_0 - f_1)$ appears in place of $(f_2 - f_0)$. Eliminating f_0 between these two similar expressions and eliminating RC by means of the previously obtained time constant

$$t_1 = [3.03/\pi(f_2 - f_1)] \times [-3.5 + (11.25 + 1/F^2)^{1/2}]^{1/2} \quad (8)$$

which, for $F = 0.5$, gives

$$t_1 = 0.614/(f_2 - f_1)$$

corresponding roughly to the time constant of the tuned circuit at its half-amplitude bandwidth. The time constant of the two-mesh filter is slightly greater than that of a single-mesh one, however this disadvantage is offset by the greater attenuation of the synchronous frequency provided by the two-mesh filter.

Description of Amplifier

The circuit of a two-frequency laboratory amplifier is shown in Fig. 1. A spring suspension used to support it has sufficient stiffness to provide a period of 0.8 second for oscillations in the vertical direction. This gives adequate protection against ordinary mechanical disturbances. Construction and layout are not greatly different from those of any ordinary low-gain amplifier, the chief difference being that the output transformer (which feeds the rectifier) is mounted in an entirely separate box to prevent objectionable magnetic coupling with the input.

It is to be noted that both the bolometer current and the grid bias for the first stage and for the fifth stage are obtained from the A-battery, without developing trouble from feedback. The bias connection to the fifth stage is rather heavily filtered, however.

No by-pass capacitor is provided in the rectifier circuit, so that the direct voltage developed is proportional to the average value of the signal. A part of this voltage is impressed, through a low-pass filter, upon the grid of the output tube. Switch S_6 allows the time constant of this filter to be set at either 0.15 seconds or 0.65 seconds.

The frequency of maximum amplification can be changed from 12 to 24 cycles by switching capacitances in the twin-T network, across the secondary of the input transformer, and across each winding of the output transformer. Because maximum amplification is often not required, the switch S_4 has been provided to lower the gain by a fixed amount. Further adjustment to a desired sensitivity is made by the volume control in the grid circuit of the fourth stage which is composed of precision wirewound resistors, and provides attenuations up to 100 times, as indicated in the circuit diagram.

Performance Data

Full-scale deflection of the output meter is obtained with 0.05 microvolts developed in a 10-ohm resistor in one side of the balanced input circuit, with the attenuator at 0.1. When there is no attenuation, and the impressed signal is reduced to 0.005 microvolt, the total deflection obtained is greater than full-scale (because of the addition of the circuit noise to the signal), but we can rate the maximum full-scale sensitivity as 0.005 microvolt. When 24-cycle tuning is used, the sensitivity is 0.0042 microvolt.

Figure 2 shows a record of the 12-cycle circuit noise made with a recording milliammeter when the input cable is terminated in a pair of 10-ohm wire-wound resistors. The average noise voltage is 1.1×10^{-9} volt. Figures 2B to 2D, inclusive, show the result of adding successively greater amounts of signal. It will be noticed that a signal of 0.001 microvolt can be very definitely detected, although it is not greatly above noise level. In these runs the time constant switch was in the 0.65-second position. Figure 2E to 2I, inclusive, show similar data except that the switch S_6 is in the 0.15-second position, and hence the oscillations of the recorder needle are more rapid.

Records of the noise level made with the secondary of the input transformer short-circuited, show it to be 3×10^{-10} volt, in terms of the equivalent primary circuit voltage or approximately a quarter the circuit noise developed with 10-10 ohm resistors at the input cable.

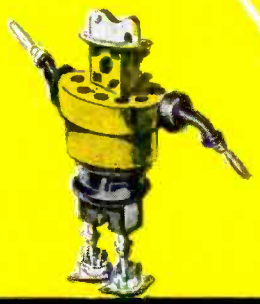
The average noise level indicated by the recordings is 1.1×10^{-9} volt on the 12-cycle channel, and 1.3×10^{-9} on the 24-cycle channel. The half-amplitude bandwidth of the former is 2.0 cycles, while the latter is 5.4. The root-mean-square thermal noise voltage in an idealized frequency band 2-cycles wide,

FOR TELEVISION

Cinch DUODECAL SOCKETS ARE STANDARD

Cinch Duodecal socket is made of general purpose and low-loss molded phenolics. It is especially designed to give complete security in tube removal by a peripheral protective barrier. A new feature incorporates wire strain relief as an integral part of the contact. The Cinch Duodecal socket is no larger in diameter than the tube base and only slightly longer than the tube pin. Easy to solder . . . simple assembly! Other Cinch Standard Tube Sockets are being used in television sets with both ceramic and low-loss molded phenolic insulators to meet every requirement.

CINCH DUODECAL SOCKETS can also be had with wire leads attached



Cinch MANUFACTURING CORPORATION

2335 WEST VAN BUREN STREET • CHICAGO 12, ILLINOIS

Subsidiary of UNITED-CARR FASTENER CORPORATION, Cambridge 45, Mass.

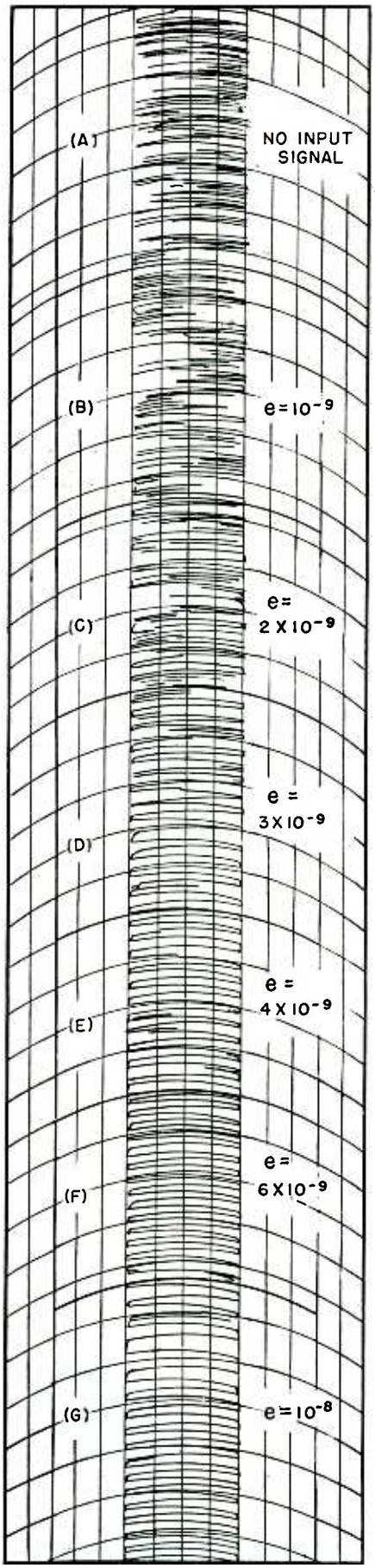


FIG. 4—Output from amplifier of Fig. 3

generated by a 20-ohm resistor, is 0.8×10^{-9} volt, while that corresponding to a 5.4-cycle bandwidth is 1.3×10^{-9} volt. It is necessary to consider the full 20 ohms of the two 10-ohm resistors in the input circuit, because the voltages they generate are in series with the primary, in the same way that the signal voltage developed in a 10-ohm thermal receiver is in series with the primary. The above figures show that the total noise of the amplifier approaches thermal limit.

The root-mean-square voltage across the secondary of the rectifier transformer corresponding to full-scale deflection of the recording milliammeter in the output of the direct-current amplifier stage is 46 volts. This means that the total voltage amplification from 10-ohm input circuit to transformer secondary is 9.2×10^{9}. Of course, not all of this gain is effectively used, because there is a four-to-one voltage division in the rectifier circuit proper, and because the direct voltage developed is proportional to the average value of the impressed alternating voltage, or to $2\sqrt{2}/\pi$ times the root-mean-square impressed alternating current. Hence the rectified voltage applied to the filter is only 5.2 volts, and the useful voltage gain may be taken as 1.04×10^{9}. However, the larger figure, relating to the transformer secondary voltage, is effective in determining the possibility of there being stray feedback of alternating voltages within the amplifier itself.

A Compact Amplifier

Figure 3 shows a small amplifier, having only four tubes, intended to be used with an external synchronous rectifier (shown as part of the diagram). The unit is designed for nominal 24-cycle operation, and the half-amplitude bandwidth is 4.0 cycles. Tuning over a 10 percent range is provided by the ganged variable resistors in the twin-T network.

The first three stages take a total B-battery current of less than 0.6 milliampere at 90 volts, and hence a small separate B-battery is used for them. Using a battery greatly reduces the amount of plate-circuit filtering that is required and avoids the necessity for numerous bulky capacitors.

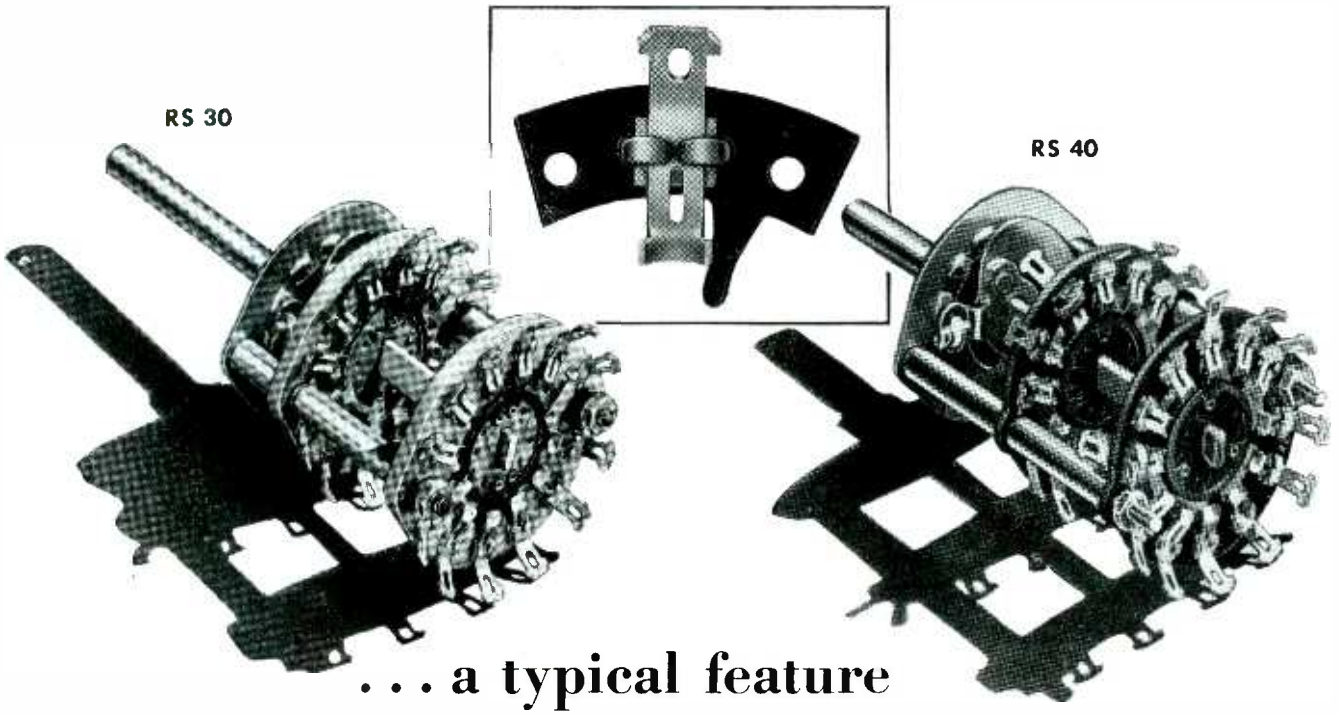
Because (1) no proportionality of output versus input was required with this device and (2) a rather wide range of input voltages had to be handled, the last stage was provided with a series grid resistor, and thus acted as a limiter. The next to last stage also limits somewhat on strong signals. The resulting phase shift with amplitude, while appreciable, is not enough to interfere with the action of the synchronous rectifiers. Ranges of input voltage in excess of one-thousand to one can be handled without difficulty.

There are two half-wave sections in the rectifier, each of which feeds a separate filter and a triode direct-current amplifier, so that one triode will respond to a signal of a certain phase, and the other to one of opposite phase. A differential relay with one winding in series with each output-tube plate is provided.

The amplifier was designed to give reliable operation on input signals down to 10^{-8} volt acting in one side of a 10-10-ohm balanced circuit. Actually, it does rather better than this, as is indicated by Fig. 4. Figure 4A shows the operation of a recorder connected to the differential relay. The pen moves in one direction when the relay closes due to current through the upper triode section and in the opposite direction when the relay closes on the other side. Because of the very high gain, circuit noise keeps the relay in operation always.

The frequency of the signal recorded in Fig. 4B was adjusted to differ by 0.2 cycle per second from that of the mechanical rectifiers, so that with a strong signal the relay and recorder move regularly back and forth. In Fig. 4B the change in the character of the record clearly shows the presence of a signal of 10^{-9} volt, although the operation can hardly be described as satisfactory. With twice as much input voltage, the regular pattern becomes more evident (Fig. 4C) although noise is still quite troublesome. With 3×10^{-9} volt (Fig. 4D), the operation is fairly good, and at 6×10^{-9} or more, it is substantially perfect.

TWO-POINT FASTENING

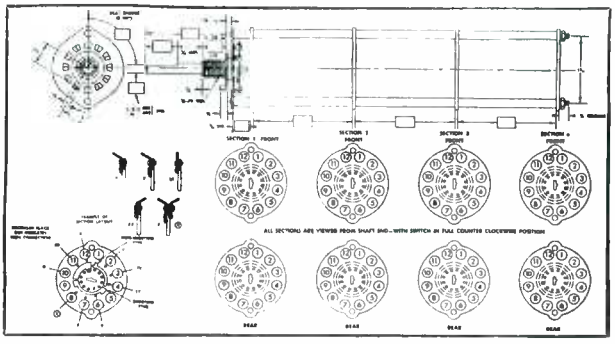


. . . a typical feature that insures accuracy, dependability and long life

ONE thing you'll like about the RS 30 and RS 40 is the Mallory method of fastening the terminals. By means of heavy staples and round hole stator design, terminals are held securely at two different points so they can't twist or work loose. Proper contact alignment is thus also assured.

There are lots of other features you'll like, including: the unlimited circuit possibilities . . . the improved stator design embracing adequate rotor supports to assure proper rotor and contact alignment . . . new silver-to-silver double wiping contacts, formed to maintain high contact pressure . . . where desired, the exclusive Mallory silver-indium process may be applied to rotor segments, permitting higher contact pressure with smooth operating torque and a minimum of contact resistance with extremely low noise level and long life.

Both switches have high torque definite snap indexing, and both permit 12 terminals on either side per section. Insulation is different, however—the RS 30 featuring high grade ceramic, and the RS 40 having low loss phenolic. Write for RS engineering data folder. Many standard circuit combinations in Mallory RS 30 switches are obtainable from convenient Mallory distributors under catalog numbers 160C, 170C and 180C series.



Ask for RS Specification Sheets

Printed on thin paper to permit blueprinting, these sectional drawings indicate standard and optional dimensions—make it easy for you to specify Mallory RS switches built to meet your specific circuit and mechanical requirements.

P. R. MALLORY & CO. Inc.

MALLORY SWITCHES

(ELECTRONIC, INDUSTRIAL and APPLIANCE)

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

TUBES AT WORK

Including INDUSTRIAL CONTROL

Edited by VIN ZELUFF

Television Production Line 132
Locates Grounds in Shielded Room 134
General Purpose Portable Amplifier 150
Tube Production Techniques 160
Diode Contact Potential for Negative Bias 164

Television Production Line

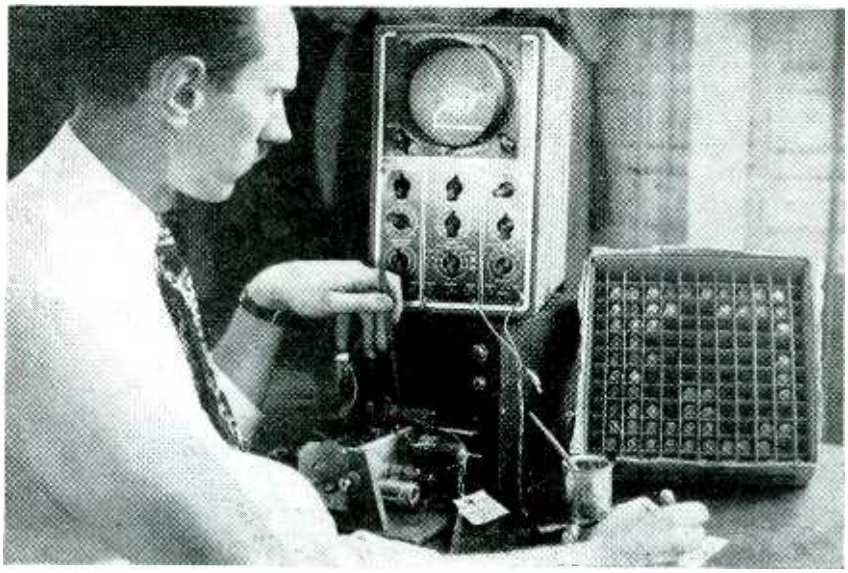
POPULAR problem in the industry is that of converting drafting-room data into a continuous production operation resulting in finished television receivers. At RCA Victor, production supervisors with long experience in radio manufacturing helped simplify this job. With an average of 18 years of radio production experience, these supervisors supplied the know-how for making a systematic analysis that enabled the many operations to be broken down into individual assignments and the assembly line to be balanced.

In television assembly at the RCA Victor plant, each line, laid out as a double-return unit, consists of a belt conveyor moving at approximately 50 feet per hour past 80 assembly stations. Chassis are carried through practically all operations while supported on trunnion legs and inverted to bring the chassis bottom into convenient working position. Besides the 80 assemblers, each line also requires 8 inspectors, 3 wire dressers, 4 repair men, and 10 testers.

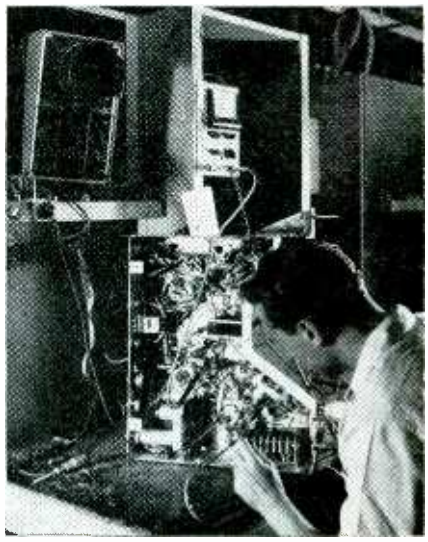
Most assembly operations are performed in 2-minute cycles, making a total chassis-assembly time of 160 minutes. Designed to eliminate batch production and work-area storage, conveyorized assembly paces production at a rate established by standard-data time values.

Mechanical Operations

Automatic riveting is the first assembly operation on chassis that have been formed, pierced, welded and cadmium-plated. Tube sockets and holders, terminal boards, ground lugs, a-c sockets and receptacles, electrolytic sockets, foot brackets and capacitor clamps, transformers and coil bases—a total of 66 pieces on the 10-inch chassis



Each switch-tuned front end consists of a subassembly which is here aligned to the frequency of channel 6. All 13 channels are aligned with an oscilloscope



Trimmers, padders, and iron cores tuning the i-f stages are adjusted at this station

—are attached by brass-plated steel tubular rivets. Operations are broken down to 1-minute cycles, each operator having nine operations to perform in each cycle.

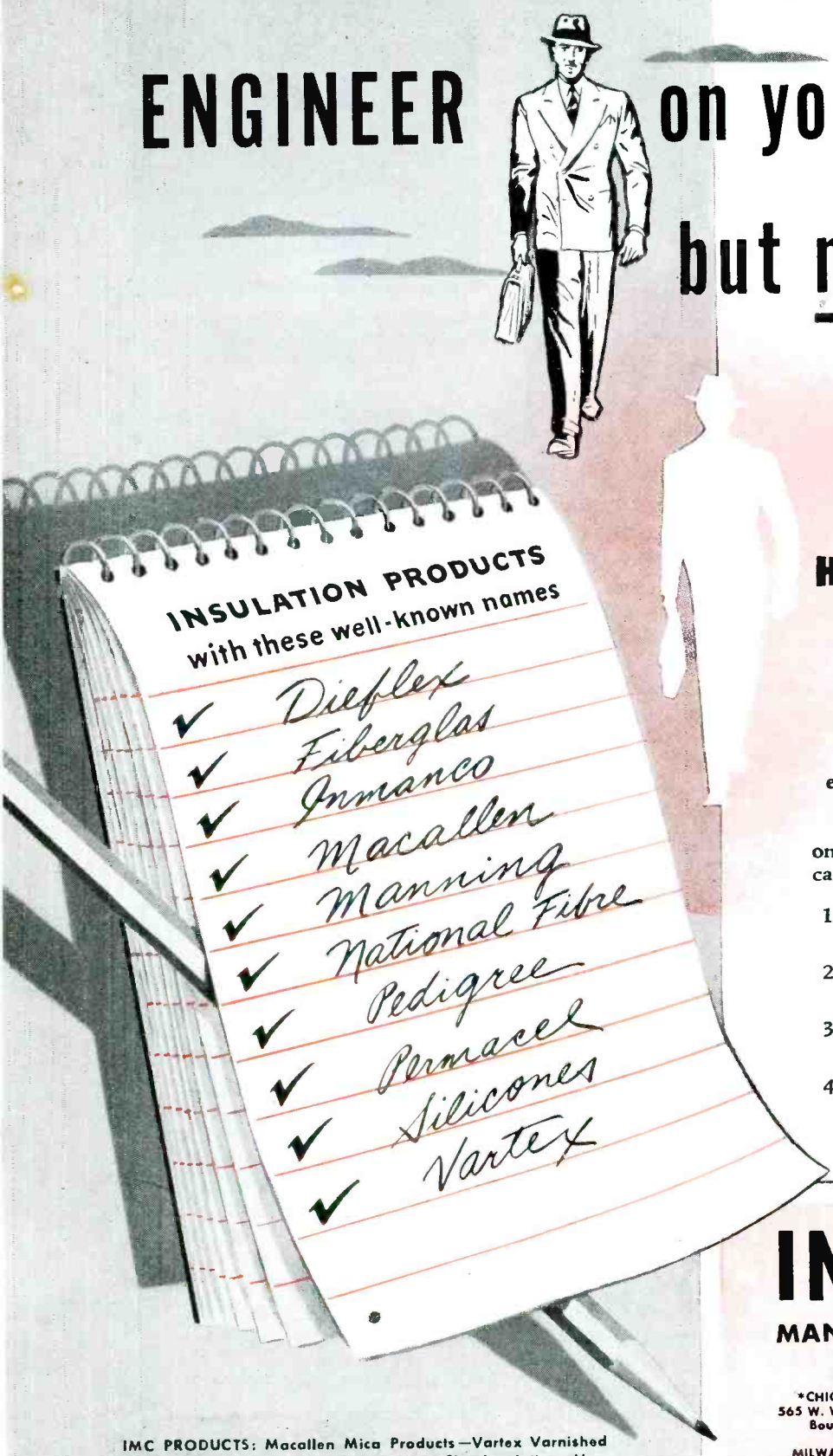
Mechanical operations require 10 of the 80 operators on chassis assembly for attaching parts and subassemblies, usually by air-gun nut runners or screw drivers for speed and ease. On the only fixture needed, the transformer is placed on an inclined block, the chassis inverted over it and the transformer bolted in place. Trunnion legs are fastened to each end of the chassis to carry it through subsequent operations on the belt conveyor.

Soldering and crimping wires are done by operators on a 2-minute cycle. All operations are timed by standard data. Each worker is guided by an operation sheet, placed directly in front of the station, that shows all joints to be soldered and wires to be crimped at that station. Work progresses from left to right on each chassis so the operator need not work at uncomfortable angles as the conveyor belt carries sets past his station. Wherever possible, the process is arranged so several operators crimp sufficient wires and parts so following operators need only solder.

Coil Winding

Tuning of the television receiver is done by a switch consisting of 7 stacks of wafers on which front-end coils are mounted to cover all 13 television channels. Twenty of the

The IMC ENGINEER on your Staff— but not on your payroll . . .



HAS THE RIGHT INSULATION TO SOLVE YOUR PROBLEM

The imposing list of electrical insulation products which the IMC Engineer represents can be a valuable help to you in solving your electrical assembly problems. Ask him to help you. His knowledge and experience qualify him to be the electrical insulation consultant on your staff. Because of his wide experience, he can help you save money. Just ask him to:

1. Assist in selection of the best insulating materials for the specific job.
2. Familiarize you with the proper application of these materials.
3. Suggest ways to use these materials to eliminate waste.
4. Help you increase the production of your electrical products.

IMC PRODUCTS: Macallen Mica Products—Vartex Varnished Cloth and Tapes—Varslot Combination Slot Insulation—Varnished Silk and Paper—Fiberglas Electrical Insulation—Manning Insulating Papers and Pressboards—Dow Corning Silicones—Dieflex Varnished Tubings and Saturated Sleevings of Cotton and Fiberglas—National Hard Fibre and Fishpaper—Phenolite Bakelite—Permacel Adhesive Tapes—Asbestos Woven Tapes and Sleevings—Cotton Tapes, Webbings and Sleevings—Pedigree Insulating Varnishes—Wedgie Brand Wood Wedges.

INSULATION MANUFACTURERS CORPORATION

ELECTRICAL IMC INSULATION

*CHICAGO 6
565 W. Washington Boulevard

*CLEVELAND 14
1231 Superior Ave., N. E.

MILWAUKEE 2
312 East Wisconsin Avenue

DAYTON 2
1315 Mutual Home Building

*Local Stocks Available

Representatives in: DETROIT 2: 11341 Woodward Avenue
MINNEAPOLIS 3: 1208 Harmon Place PEORIA 5: 101 Heinz Court

As the conveyor belt carries the chassis past this assembly station, the operator crimps into place the parts indicated on her operations sheet which remains in view at all times

In the deflection test, the test pattern from the monoscope shows vertical and horizontal linearity, contrast, resolution, definition, and transient interferences

coils mounted on the switch wafers have non-inductive windings in the form of a double-reverse figure 8. When pilot-model coils, each one smaller than a finger nail, were first made by hand, girls became wire-happy as the winding motion was not rhythmic.

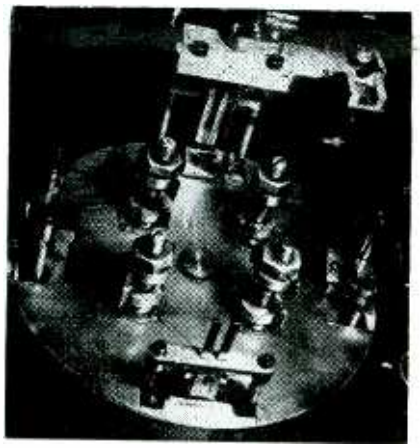
The machine illustrated winds from 450 to 1,300 coils per hour, depending on the number of turns required. A finger, through which the wire passes, winds each coil over the projecting prongs. The plate indexes to the next position where the coil is compressed and set with a hot molding compound. Two more indexings cool the molded coil, a blade snips the wire and an air blast pops it into a basket as a plunger pushes it off the winding prongs.

The switch subassembly is built up on a metal fixture in 9 stations: 3 crimping, 3 crimping and soldering, 2 mounting wafer stack in base and 1 mounting end plates. Assembly is followed by inspection of soldered joints and testing of electrical characteristics. Each unit is balanced by peaking the trimmers for all 13 channels with an oscilloscope setup.

Alignment

Testing operations are broken down into i-f, r-f, and deflection tests, each of which is based on signals generated in a master signal generator cage and distributed over coaxial cable to individual test locations where alignment is done.

In i-f test, the operator checks continuity of leads and aligns various trimmers and powdered-iron cores in the i-f section of the set by using as basis for alignment an image signal generated by a master oscillator.



Indexing plate and jigs of the winding machine for the figure-8 coils used for tuning to the television channels

Deflection test is the final chassis electrical test in which the test pattern, from a monoscope generated in the signal generator cage and piped by coaxial cable to test cages, permits perfect balancing. As reproduced on the screen of the receiver, the test pattern should show circles round and concentric for horizontal and vertical linearity and no distortion. The radial resolution-wedge lines should be straight and distinct to obtain good black and white contrast in closely spaced lines. The shading wedges in black, gray, light gray and white are for checking contrast, while the numbers indicate resolution, the blocks the definition, and the parallel lines any transients due to ignition and other electrical interference.

From test, assembled chassis go overhead, conveyed on trolleys to final assembly where cabinets, television chassis, radio chassis and phonograph units (for the console) are assembled on conveyor lines and passed through final test and touch-up to packaging and shipping. Even shipping cartons are delivered by conveyor from receiving to packing. All material movements have, as far as possible, been mechanized to spot parts where needed and when needed without tying up manpower.

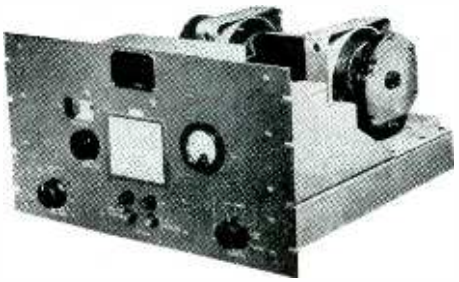
Locates Grounds in Shielded Room

ENGINEERS that build screened rooms often discover a fault or ground between the inner and

(Continued on p 148)

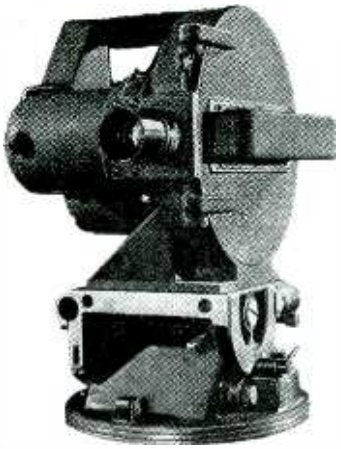
To control products and processes

More accurately!



PRIMARY FREQUENCY STANDARD

This new instrument provides a 100 kc reference frequency accurate to one part per 100,000,000 per day, regardless of moderate changes in ambient temperature, humidity and air pressure. Designed for time-frequency measurements or the synchronous operation of two or more independent systems.



FASTAX CAMERA

The world's fastest portable motion picture camera comes in three models: 8mm (up to 10,000 pictures per second); 16 mm (up to 5,000 pps); 35 mm wide angle (up to 3,500 pps). It bares secrets of fast-moving parts and short-duration phenomena. It's ideal for research, design engineering, and testing.

NOISE ANALYZER

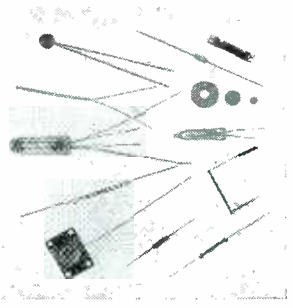
Provides a simple, reliable means to measure the magnitude and frequency composition of noise. An optional vibration pick-up can be used to measure vibrations not accompanied by noise. Two models: RA-361, which operates from self-contained batteries, and RA-362, from 110 volt, 60 cycle line.

MERCURY CONTACT RELAYS

Make possible greater accuracy and dependability of high speed switching machines and virtually eliminate relay maintenance problems. Hermetically sealed against dirt, immune to atmospheric conditions, tamper-proof, good for a billion or more operations, they assure high operating speeds and constant operating characteristics.

THERMISTORS

Ideal for temperature measurement, control and many other electronic applications. The resistance of thermistors varies greatly with changes in temperature—*decreasing* as temperature goes up, *increasing* as temperature goes down. They permit use of simpler, more economical electrical circuits than are possible otherwise.



Western Electric

—QUALITY COUNTS—

Distributed by Graybar
OFFICES IN 95 PRINCIPAL CITIES

Graybar Electric Company E
420 Lexington Ave., New York 17, N. Y.

Please send literature on Western Electric
☐ Fastax Camera ☐ Primary Frequency Standard
☐ Noise Analyzer ☐ Thermistors
☐ Mercury Contact Relays

Name.....

Company.....

Address.....

City..... State.....

THE ELECTRON ART

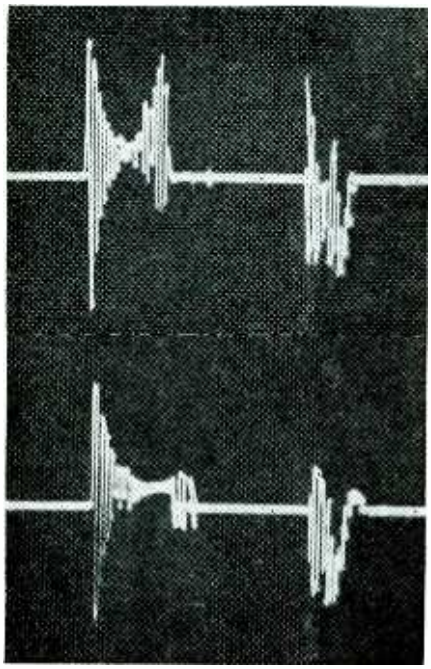
Edited by FRANK ROCKETT

Diagnosing Engine Trouble 136
H-F Automobile Ignition 136
Optimum Parameter for Gas Tube Voltage Regulators 136
Variable Time Constant 138
High Gain D-C Amplifier 138
Variable-Frequency Stimulator for Electrophysiology 182
Survey of New Techniques 188

Diagnosing Engine Trouble

AIRCRAFT internal combustion engines are subject to failure from various causes. To determine and isolate the cause of engine troubles so that air liners can be serviced quickly, engineers of Sperry Gyroscope Co. have developed equipment for analysing engine operation. The analyzer, which can be installed on the ship with indicators at the flight engineer's position, includes vibration, knock, and ignition data.

Ignition is observed by means of a three-inch cathode-ray oscilloscope, the accompanying figure showing two typical traces. The vertical deflection plates are connected across the primary of the high-voltage transformer. A three-phase generator is driven by the engine shaft to produce the sweep, which can be used to display all plug voltages in order across the screen, or can be expanded and phased to display only one preselected plug voltage. The trace indicates actually the voltage across a network consisting of transformer, commutator, and spark plug, but effects of each component can be recognized. In addition to being useful in checking engine operation and locating faults, the equipment is being applied to studies of engine design and fuel technology.

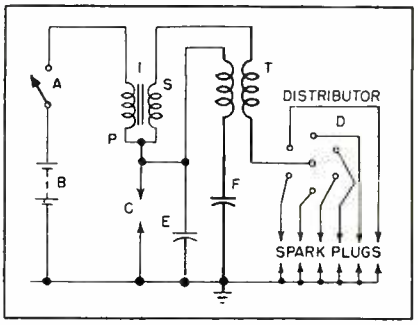


In both traces, the lefthand fluctuations are from the spark. Upper trace shows normal operation; lower trace shows effect of fouled gap

H-F Automobile Ignition

EFFECTIVENESS of spark ignition in automobiles can be increased by combining high-frequency oscillations with conventional heat sparks. Engineers of Tucker Corp. (Chicago, Ill.) have found that h-f spark emanation at the plugs is such that ionization of the gases during combustion is enhanced, and maximum engine power is produced with a gas-air mixture ratio approaching 16 to 1, whereas normal ignition produces maximum power with a mixture ratio of about 12.5 to 1.

The circuit used to product h-f sparks is shown in the accompanying drawing. A secondary capacitor F and Tesla coil T in the secondary circuit of the high-voltage transformer produce oscillation. Continuance of spark across the plug has been increased to about 35 deg of crankshaft rotation. Other circuits have been suggested (ELECTRONICS, p 180 July 1947) but the one illustrated here has given convincing practical results, and in fact, because instrumentation capable of oscillographic presentation could not be located, the h-f ignition has been evaluated on automotive performance rather than electrical criteria.



Heavy lines show additions of the Holthouse circuit to the conventional automobile ignition system

Optimum Parameter for Gas Tube Voltage Regulators

BY WALTER R. BERG
Research Assistant
Engineering Research
Ordnance Research Laboratory
The Pennsylvania State College

CIRCUIT CONSTANTS of the familiar gas tube voltage regulator can be adjusted to give a maximum possible regulation. This analysis is to determine the optimum conditions. The straight line current-voltage characteristic shown in Fig. 1A of neon gas tube voltage regulators such as the 991 and VR-75 makes a simple mathematical analysis possible. In the use of regulators that

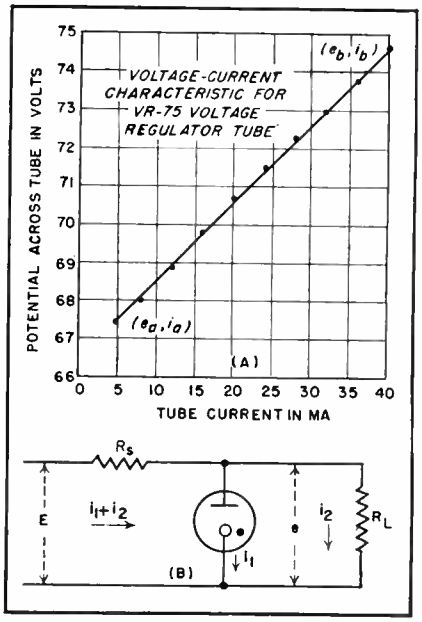
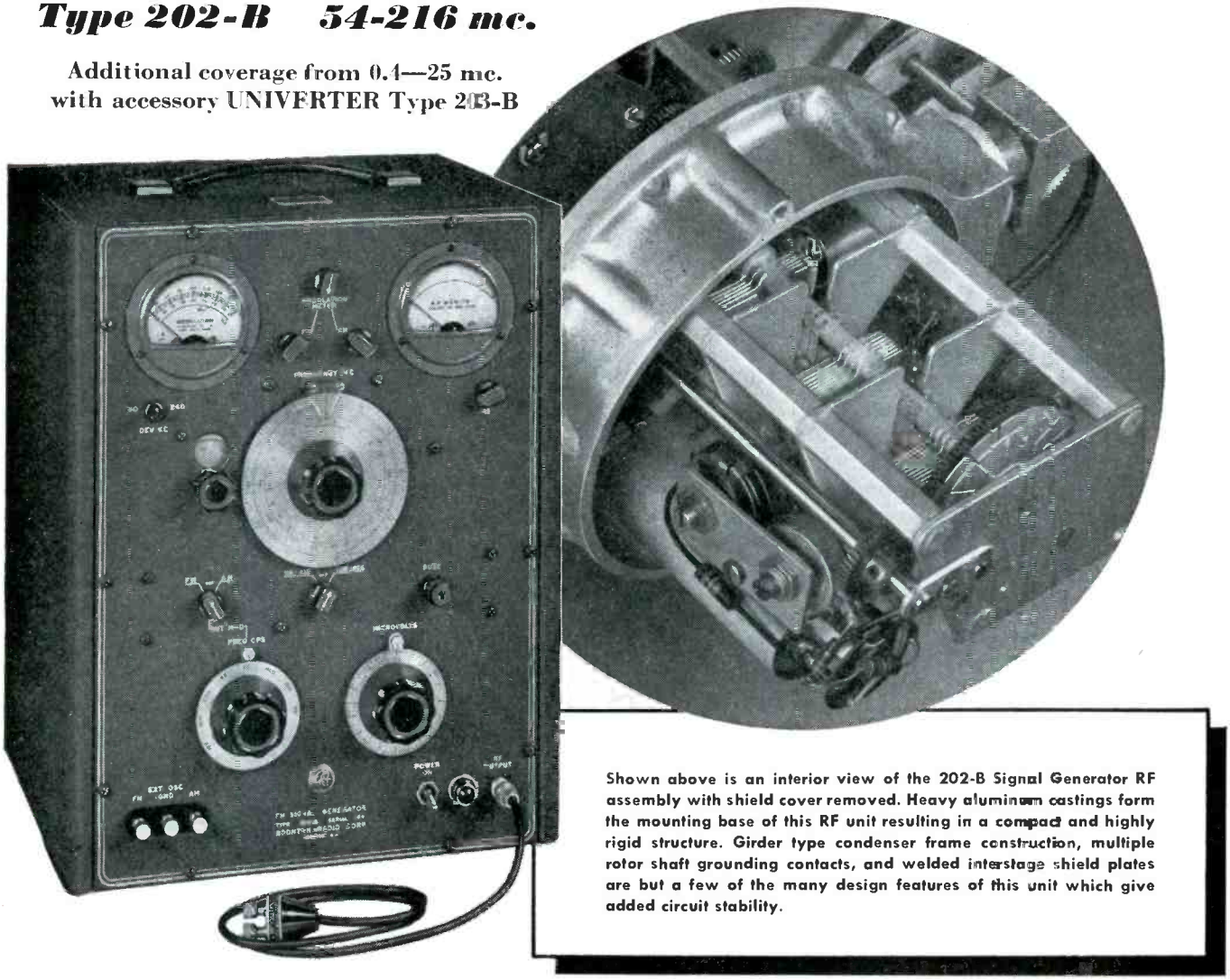


FIG. 1—If characteristic of gas tube is a straight line (A), its regulating action in a circuit (B) can be analysed

FM SIGNAL GENERATOR

Type 202-B 54-216 mc.

Additional coverage from 0.4—25 mc. with accessory UNIVERTER Type 203-B



Shown above is an interior view of the 202-B Signal Generator RF assembly with shield cover removed. Heavy aluminum castings form the mounting base of this RF unit resulting in a compact and highly rigid structure. Girder type condenser frame construction, multiple rotor shaft grounding contacts, and welded interstage shield plates are but a few of the many design features of this unit which give added circuit stability.

Designed to meet the exacting requirements set forth by leading FM and television engineers throughout the country, the 202-B FM Signal Generator has found widespread acceptance as *the* essential laboratory instrument for receiver development and research work.

Frequency coverage from 54 to 216 megacycles is provided in two ranges, 54 to 108 megacycles and 108 to 216 megacycles. A front panel modulation meter having two deviation scales, 0-80 kilocycles and 0-240 kilocycles, permits accurate modulation settings to be made.

Although fundamentally an FM instrument, amplitude modulation from zero to 50%, with meter calibrations at 30% and 50%, has been incorporated. This AM feature offers increased versatility and provides a means by which simultaneous frequency and amplitude modulation may be obtained through the use of an external audio oscillator.

The internal AF oscillator has eight modulation frequencies ranging from 50 cycles to 15 kilocycles, any one of which may be conveniently selected by a rotary type switch for either amplitude or frequency modulation.

The calibrated piston type attenuator has a voltage range of from 0.1 microvolt to 0.2 volt and is standardized by means of a front panel output monitor meter.

The output impedance of the instrument, at the terminals of the R.F. output cable, is 26.5 ohms.

AVAILABLE AS AN ACCESSORY

is the 203-B Univerter, a unity gain frequency converter which, in combination with the 202-B instrument, provides the additional coverage of commonly used intermediate and radio frequencies.

R.F. Range: 0.4 mc. to 25 mc.

R.F. Increment Dial: ±250 kc. in 10 kc. increments.

R.F. Output: 0.1 microvolt to 0.1 volt. Also approximately 2 volts maximum (uncalibrated).

For further information write for Catalog E

UNIVERTER
Type 203-B

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

DESIGNERS AND MANUFACTURERS OF THE "Q" METER . . . QX-CHECKER . . . FREQUENCY MODULATED SIGNAL GENERATOR . . . BEAT FREQUENCY GENERATOR . . . AND OTHER DIRECT READING TEST INSTRUMENTS

Table I—Measured Regulation

E	R_L	R_s	e	ΔE, change in input voltage	Δe, change in output voltage
VOLTS	OHMS	OHMS	VOLTS	VOLTS	VOLTS
145	∞	15,500	67.40	20	0.25
165	∞	15,500	67.65		
230	∞	32,500	67.40	20	0.15
250	∞	32,500	67.55		
230	3,000	5,850	67.40	20	0.60
250	3,000	5,850	68.00		

contain gases other than neon (VR-90, VR-105, VR-150) the voltage-current curve cannot be assumed to be a straight line; however, the general choice of circuit constants as derived in the following analysis holds for all types of gas tube voltage regulators.

The equation of the characteristics line is

$$e = ai_1 + b \tag{1}$$

where $$a = \frac{e_b - e_a}{i_b - i_a} \tag{2}$$

and $$b = e_a - ai_a \tag{3}$$

Figure 1B represents a typical gas tube voltage regulator circuit. In it

$$E = (i_1 + i_2)\,R_s + e \tag{4}$$

where R_s is the resistance of the current limiting resistor commonly used with stabilizer tubes. Also

$$e = R_L i_2 = ai_1 + b \tag{5}$$

$$i_1 = \frac{e - b}{a} \tag{6}$$

$$i_2 = \frac{e}{R_L} \tag{7}$$

Rewriting Eq. 4 gives

$$E = \left(\frac{e - b}{a} + \frac{e}{R_L}\right) R_s + e \tag{8}$$

or

$$e = \frac{aR_LE + bR_LR_s}{R_LR_s + aR_s + aR_L} \tag{9}$$

Equation 9 is the expression for the regulated voltage as a function of the supply voltage and the circuit parameters.

Differentiating Eq. 9 gives

$$\frac{de}{dE} = \frac{aR_L}{R_L(R_s + a) + aR_s} \tag{10}$$

Substituting in Eq. 9 and 10 gives

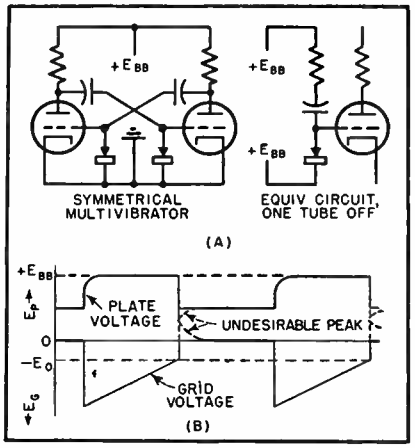
$$\frac{de}{dE} = \frac{ea}{aE + bR_s} \tag{11}$$

For the best regulation de—dE should be made as small as possible; for perfect regulation de—dE should equal zero. In the design of voltage regulator circuits e and a should be made small and b, E, and R_s should be made as large as possible. An analysis of Fig. 1B shows that R_s can be made larger if the value of R_L is increased. In other words, the regulation becomes better as the load current is decreased. In adjusting the circuit constants for maximum regulation it should be remembered that the above mathematical analysis holds only over the working range of the gas tube used. Table I shows the results of tests on the VR-75 tube of Fig. 1A used in the circuit of Fig. 1B.

Variable Time Constant

By Thracy Petrides
New York City, N. Y.

Diode crystals can be used as variable time constant circuit parameters. One application illustrating their employment and advantage is to a multivibrator. Figure 1A shows a multivibrator employing typical diode crystals as grid resistors. Where the negative voltage developed at the grid of the circuit is to be used, the positive peak due to grid current can be annoying.



Crystal diodes, either alone or in parallel with grid resistors, prevent undesirable overshoot of multivibrator voltages

Using the diode crystals as grid resistors provides a variable time constant allowing the charging time of the coupling capacitor to be negligible compared to the discharging time. Thus during the time that the grid is tending to be positive, the diode resistance to the charging current is only about 100 ohms as compared to about 1,000 ohms during the rest of the cycle. Figure 1B compares the waveshapes obtained with and without the diodes showing their utility.

High Gain D-C Amplifier

By W. G. Shepard
Calibration Engineer
Boeing Aircraft Co.
Seattle, Wash.

Unbalance resulting from shifting grid bias is eliminated by a parallel balanced directly coupled amplifier that has high gain, low drift, flat response from 0 to 50,000 cps, and negligible phase shift to 20,000 cps.

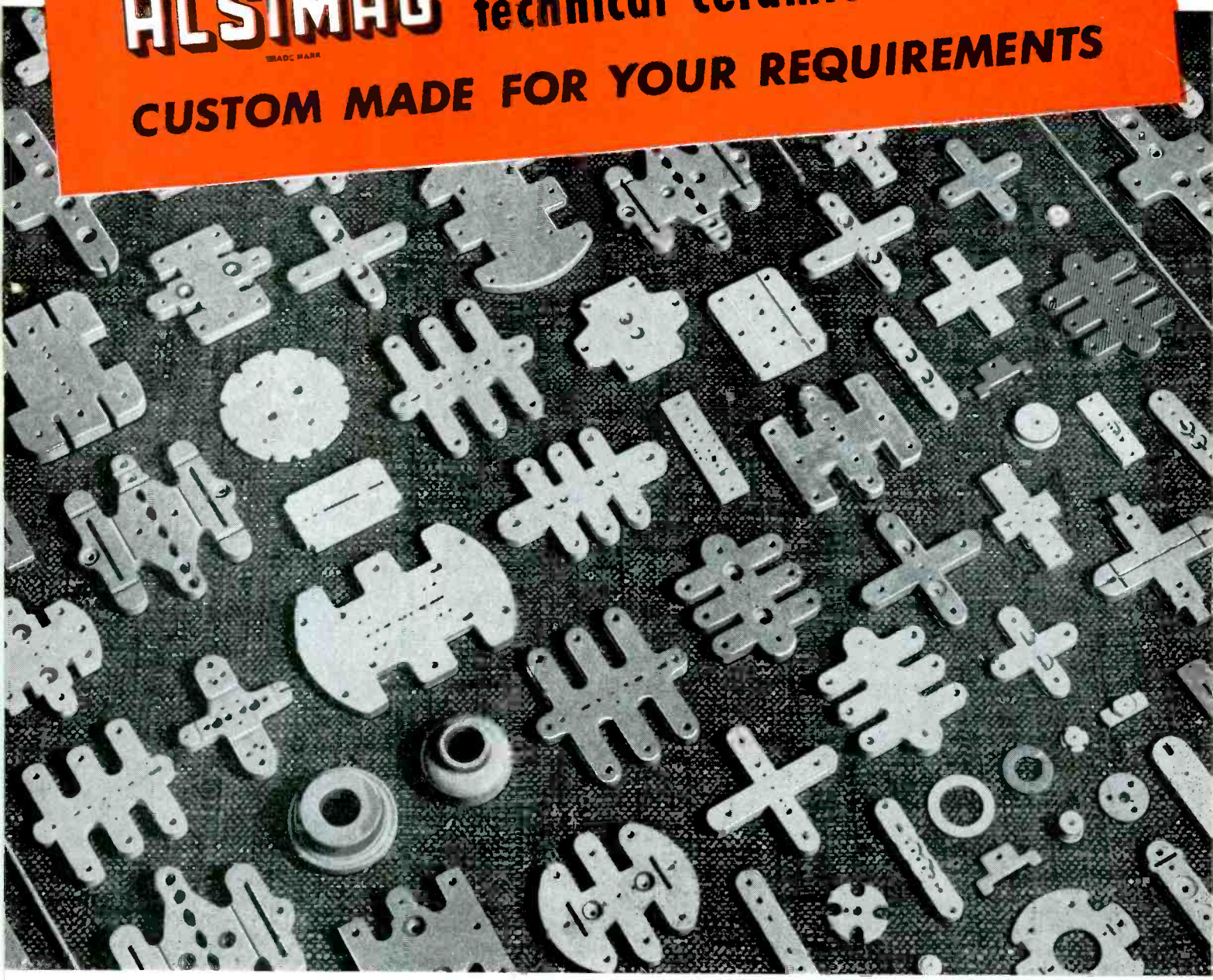
Counteracting Unbalance

Figure 1 shows several directly coupled amplifiers. The amplifier in Fig. 1A is of the push-pull type in which the signal is of equal amplitude but opposite phase in the two channels. Because drift voltage is in phase in each channel it does not add to the signal. Common cathode resistors in each stage tend to equalize the signal in each channel. When several stages are cascaded to give very high amplification, adjustments on any one stage seriously disturb other stages by affecting the bleeder current common to all stages. To obtain amplifier stability, these interrelating biases need to be eliminated.

In a circuit such as that of Fig. 1B where individual batteries are used to furnish the voltage drop between the plate of one tube and the grid of the next, any drift voltage in a stage appears equally on the grids of the next stage and therefore does not interfere with the signal. However, the drift does change grid biases of subsequent stages. As this change in grid bias is amplified by subsequent stages, it may reach proportions that shift the bias of final stages

(continued on p 174)

ALSIMAG technical ceramic insulators CUSTOM MADE FOR YOUR REQUIREMENTS



AlSiMag versatility is illustrated by these AlSiMag inserts for electronic tubes

The insulation requirements of electronic tubes vary with the function and design of the tube. Factors of primary importance are: Resistance to extreme heat shock without cracking and without reduction in strength; resistance to formation of electrical conduction paths; long life and strength even in tubes operated at relatively high temperatures. They must also be readily degassed and uniform in quality and dimension.

There is an AlSiMag technical ceramic composition with the physical characteristics suited to almost any electronic tube insulator or to any product requiring electrical insulation. That composition can be custom made in the size and shape which best meets your requirements. Most designs can be produced in quantities quickly and at low cost by die pressing. If you will send us your blue prints and technical data, we will be glad to outline the facts about AlSiMag Custom Made Technical Ceramics as they apply to your product.

46TH YEAR OF CERAMIC LEADERSHIP

AMERICAN LAVA CORPORATION

CHATTANOOGA 5, TENNESSEE

SALES OFFICES: ST. LOUIS, MO., 1123 Washington Ave., Tel: Garfield 4959 • CAMBRIDGE, MASS., 38-B Brattle St., Tel: Kirkland 4498 • PHILADELPHIA, 1649 N. Broad St., Tel: Stevenson 4-2823 NEWARK, N. J., 671 Broad St., Tel: Mitchell 2-8159 • CHICAGO, 9 S. Clinton St., Tel: Central 1721 • SAN FRANCISCO, 163 2nd. St., Tel: Douglas 2454 • LOS ANGELES, 324 N. San Pedro St., Tel: Mutual 9076

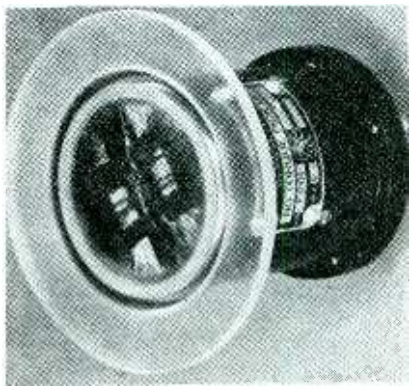
NEW PRODUCTS

Edited by A. A. McKENZIE

New equipment, components, packaged units, allied products; new tubes. Catalogs and manufacturers' publications reviewed.

Instrument Pointer Pickup (1)

FAIRCHILD CAMERA & INSTRUMENT CORP., 88-06 Van Wyck Blvd., Jamaica 1, N. Y. The No Torque pickup replaces the covering glass window on the aircraft or industrial instrument to be read at a distance, and a small permanent magnet is then mounted on the indicator



shaft. There is no mechanical connection between pickup and instrument. Indication is obtained by the phase of the magnetic couple between the stationary magnetic field of the instrument pointer and the rotating field of the instrument pickup. A piezoelectric crystal is used to convert this mechanical couple into an electrical voltage. Phase angle is a function of the indicator pointer position.

Equalizer (2)

A. F. SCHMUCKLER & Co., 338 East 23rd St., New York 10, N. Y. The Afgsco equalizer 200X-1B is a small general purpose device for use where the nominal level is minus 10 db to 0 db. It can be incorporated in a console or used with relay rack mounting. It introduces no insertion loss or change in gain

at 1,000 cycles for any setting of the controls. It equalizes at 50 and 7000 cycles. Available in steps of 3 db from minus 15 to plus 15 db, when the position of both high and low controls is zero, its transmission is substantially flat from 50 to 15,000 cycles.

Reflection Meter (3)

KAY ELECTRIC CO., 34 Marshall St., Newark 2, N. J. The Mega-Match measures reflected energy over a frequency range from 10 to 250 megacycles or higher, giving a visual display for bands as wide as 30 megacycles. A precision wavemeter is incorporated in the device.

USING THE NUMBERS

Readers desiring further details concerning any item listed in the New Products department can obtain the information by using the cards furnished as a stiff, colored insert elsewhere in this department.

Place the number (appearing to the right of the heading) of one item in which you are interested in a circle and then fill out the balance of the card according to directions appearing on the colored sheet. Unnumbered items listed at the end should be procured direct from the manufacturer or publisher upon payment of the fee noted.

Mismatches can be immediately observed and measured in transmission lines, antennas, and coupling impedances. A descriptive circular is available.

Talkie (4)

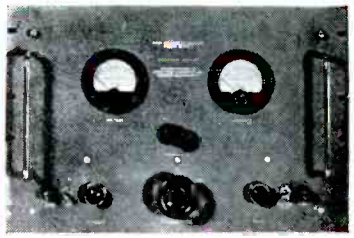
MOTOROLA INC., 4545 Augusta Blvd., Chicago 51, Ill. A handie-talkie operating in the 25 to 44 megacycle band weighs 7 pounds and can be used for reliable communi-

cation up to two miles. The frequency-modulated transmitter and the receiver use 18 tubes and the equipment operates from standard dry batteries.

Shutter Speed Meter (5)

HICKOK ELECTRICAL INSTRUMENT CO., 10527 Dupont Ave., Cleveland 8, Ohio. An electronic instrument to measure the shutter speed of any camera consists of a light source and photosensitive element connected to a meter that reads shut-

MODEL 106-PA



MODEL 206-PA

Regulated Power Supplies

MODEL 106-PA

Characteristics:

D.C. Voltage Range	200-300V., 140 Ma.
A.C. Fil. Power	(2) 6.3V., 5 amps.
Ripple Content	1/10 of 1%
A.C. Input	115V., 50/60 cycles
Size	5" x 19" x 9" deep

Output remains constant within 1%, even though line voltage varies between 95—130 volts. Price $225 (f. o. b. Cambridge, Mass.)

MODEL 206-PA

Characteristics:

D.C. Voltage Range	500-700V., 250 Ma. 700-1000V.,200 Ma.
Ripple Content	.05 of 1%
A.C. Input	115V., 50/60 cycles
Size	12¼"x19"x13" deep

Output is constant from no load to full load of each range within 1%.

Interlocking relay protection at all voltages insures safe operation. Time delay for high voltage circuit applications prevents tube damage. Price $490 (f. o. b. Cambridge, Mass.)

MODEL 207-PA

Characteristics:

D.C. Voltage Range	0-3500V., 1 amp. positive or negative grounding
A.C. Input	220V., 50/60 cycles (Variac Control)
Overload Relay	Adj. 0.6—1 amp.
Size	26⅛"x32"x36"deep

Meters on front panel indicate line voltage, output voltage, and output current.

Power supply is mounted on casters for portability Access doors provided with interlock safety switches.

MODEL 306-PA

Characteristics:

D.C. Voltage Range	300-750V., 30 Ma. 750-1800V., 30 Ma. 1800-3600V., 30Ma.
Ripple Content	300-750V., 0.0 1% 750-1800V. } 0.1% 1800-3600V. }
A.C. Input	115V., 50/60 cycles
Size	17½"x19"x13" deep

Regulation control is provided for adjustment to perfect load regulation, or to provide over-regulation, if desired.

Safety devices are incorporated to protect operating personnel. Meters indicate line voltage, output voltage, and output current.

For Every Purpose

MODEL 207-PA

HAR-CAM

MODEL 306-PA

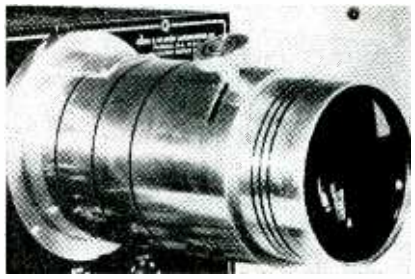
HARVEY RADIO LABORATORIES, INC.

439 CONCORD AVENUE • CAMBRIDGE 38, MASSACHUSETTS

ter timing directly in fractions of a second. Model 166 tells the story quickly.

Oscilloscope Projection Lens (6)

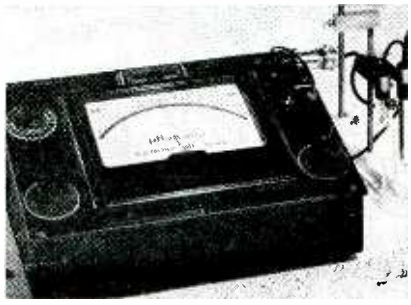
ALLEN B. DUMONT LABORATORIES, INC., 2 Main Ave., Passaic, N. J. Large-screen oscillograms can be obtained with the type 2088 projection lens on oscilloscopes employ-



ing the type 5RP-A high-voltage cathode-ray tubes. A pattern can be projected to distances beyond 8 feet.

pH Meter (7)

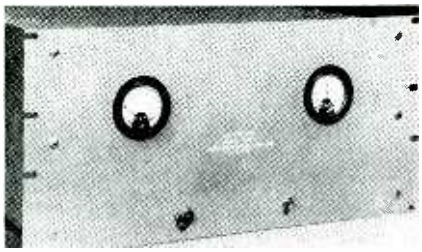
PHOTOVOLT CORP., 95 Madison Ave., New York 16, N. Y. The new model 100 pH checker uses a meter that covers the complete pH range on a single dial. A wide-range temperature control simplifies use of the equipment which requires no batteries. The model 105 unit includes



a carrying handle and hood. The equipment is described in a single page sheet.

Relay Receiver (8)

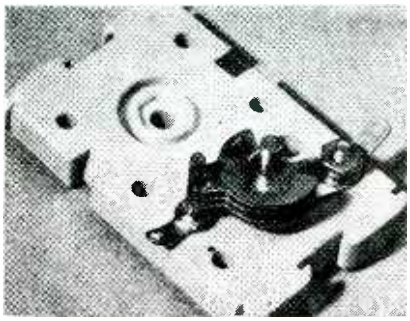
RADIO ENGINEERING LABS., INC., 35-54 36th St., Long Island City 1, N. Y. Type 670L relay receiver is essentially a custom built job for broadcasters interested in receiv-



ing only one frequency. The equipment has been used for f-m broadcast relay service in the 88- to 108-megacycle band. Low distortion, high fidelity, and crystal control are a few of the main features of the equipment.

Small Air Capacitor (9)

HAMMARLUND MFG. CO., INC., 460 West 34th St., New York 1, N. Y. The type 533 trimmer is a precision capacitor of not more than 15 microfarads. It uses for its base the



insulated support of any component in the chassis at the physical point it is needed. Available only to manufacturers, it is sold mounted on bases supplied or as rotor and stator assemblies together with parts required for installation.

VHF Crystal (10)

BLILEY ELECTRIC CO., Erie, Pa. Type BH-6 vhf crystal can be used

in the range between 15 and 100 megacycles. Special circuits are employed to select the third, fifth, and seventh harmonics of the crystal fundamental mode. Crystals are lapped to 0.004 inch, silver plated, and clamped rigidly between ceramic rings.

Oven Temperature Control (11)

W. S. MACDONALD CO., 33 University Road, Cambridge 38, Mass. A proportioning electronic tempera-

ture controller is available that maintains the temperature of electrically heated ovens within less than 0.1 degree at temperatures up to 1,200 F. Power flow to the oven is continuous rather than in on-off cycles. A large vernier type dial allows quick and accurate selection of desired temperature. Power is not throttled until the furnace reaches a point within 15 degrees of the preset value, thus speeding the initial heating.

Coax Relay (12)

ADVANCE ELECTRIC AND RELAY CO., 1260 West 2nd St., Los Angeles, Calif. The Series 7200 a-c and 8200 d-c relays are designed for spdt switching of 50-ohm coaxial

(continued on p 192)

YOU CAN BUY THE SKILL THAT MADE THESE GEARS

The same skill with which we fabricate Small Gears for so many of America's most particular users, is also available for *you*. Get started now depending upon this one BIG source for all of the Small Gears you need. Here, you'll enjoy the advantage of all the large, highly specialized facilities developed thru a quarter century of concentrating on the manufacture of finer Small Gears exclusively.

If you need production runs of Fractional Horsepower Gears that perform more smoothly and accurately, that measure up to highest *uniform* standards of quality and precision, by all means discuss your requirements with a G.S. Engineer! Possibly he may suggest a better design, a more practical material, a method of production that will result in better gears, at moderate cost. Will you write or telephone us *today*?

SEND FOR OUR CATALOG BULLETIN

GEAR Specialties

Spurs • Spirals • Helicals • Bevels • Internals • Worm Gearing • Racks • Thread Grinding

2635 WEST MEDILL AVENUE • CHICAGO 47, ILLINOIS

MEMBER OF AGMA

WORLD'S LARGEST EXCLUSIVE MANUFACTURERS OF FRACTIONAL HORSEPOWER GEARS

NEWS OF THE INDUSTRY

Edited by JOHN MARKUS

Status of civilian GCA; first issue of Nucleonics; program of Chicago Electronics Conference; Soviet television plans

Electronic Computing Service

AN INSTITUTE of Numerical Analysis is to be established at the University of California in Los Angeles, utilizing electronic apparatus to do research in applied mathematics and provide an ultra-speed computing service for the West.

The Institute will be a unit of the National Applied Mathematics Laboratories now being organized at the National Bureau of Standards. It will have two basic functions: (1) research and training in applied mathematics, with particular emphasis on the efficient exploitation and development of high-speed electronic computing machines; (2) the provision of an expert computing service for groups located in the West.

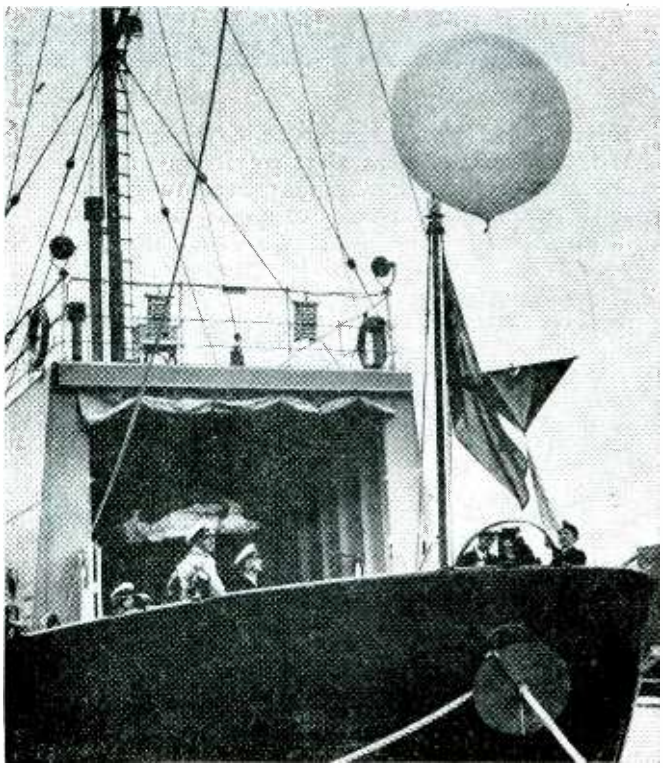
One of the giant high-speed electronic computing machines, now under development by the Bureau of Standards, will be installed at the Institute when completed. These computers will solve problems in minutes that now take days to work out, and will solve in days problems that are now out of the reach of scientists. Design specifications call for high memory capacity and automatically sequenced mathematical operations from start to finish.

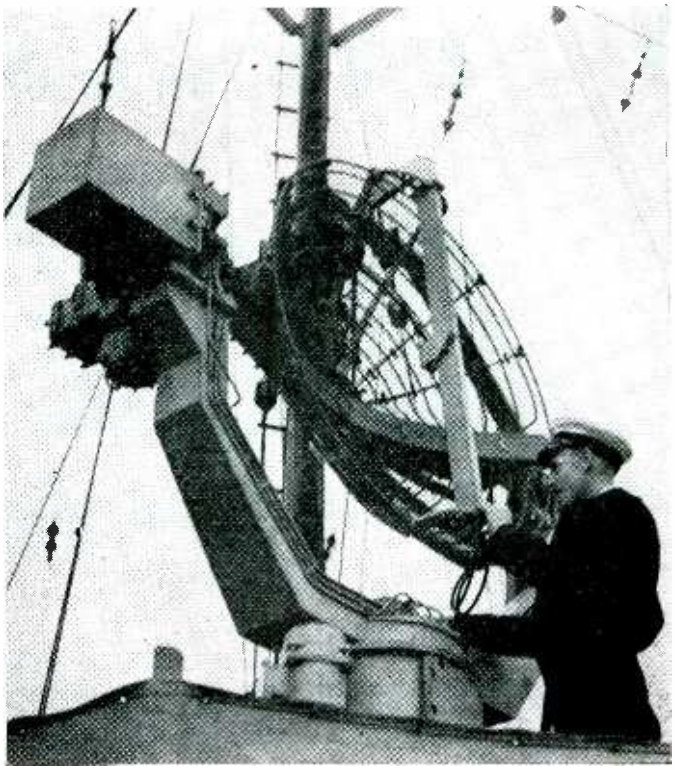
The Institute has two primary functions. The first is research in applied mathematics aimed at developing methods of analysis which will extend the use of the high-speed electronic computers. The second is to act as a service group for Western industries, research institutions, and government agencies.

Proposed Changes in Television Allocations

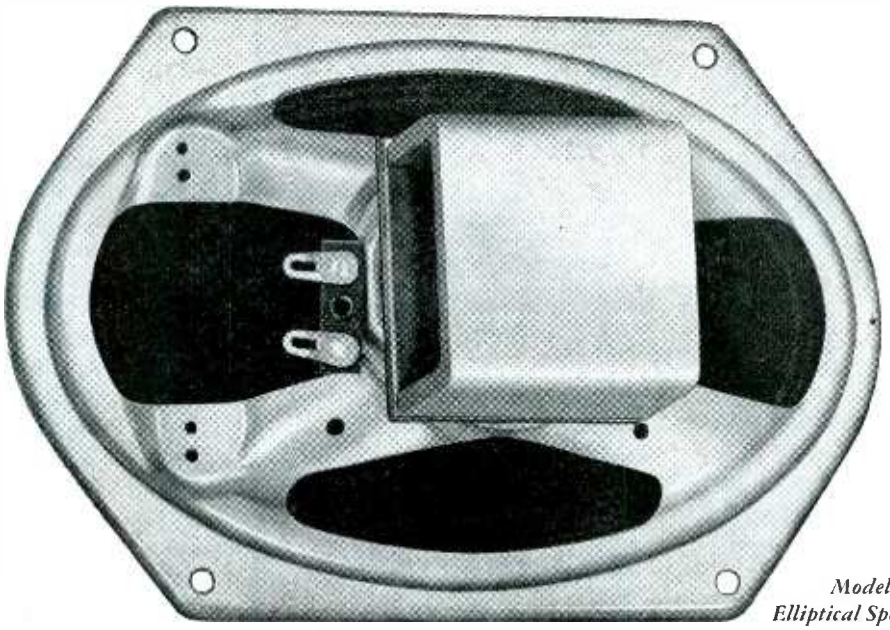
SHARING of television channels with other radio services having proved

TRACKING RADIOSONDE WITH RADAR ON WEATHER SHIP





LEFT: Releasing weather balloon from which is suspended a triangular metal rawin reflector for observing winds aloft by tracking with radar. A conventional radiosonde is carried below the reflector for transmitting temperature, pressure, and humidity data to this British weather ship "Weather Observer." RIGHT: Radar antenna used on ship for tracking the weather balloons during their ascent into the stratosphere. This is the first weather ship to be outfitted under a recent agreement wherein 10 nations will provide 13 such ships for stations in various parts of the Atlantic to provide meteorological data and navigational aids for aircraft, as well as assist in aircraft rescue when necessary. Every few hours each ship will radio data to its base, from which the information will be pooled and made available to airline operators, weather-predicting agencies and similar services



Model 57B2226, 5" x 7"
Elliptical Speaker shown above

Magnavox presents...

a new 5" x 7" Elliptical Speaker

NOW The Magnavox Company, pioneer in the production of elliptical speakers, offers you another important new addition to its family of famous component parts—Model 57B2226, 5" x 7" Elliptical Speaker.

This model is immediately available in electrodynamic or permanent magnet design, in various field and magnet sizes to meet any requirement. Your inquiries are invited.

The Elliptical Speaker offers decided advantages in design and performance for a wide variety of applications. Where space is at a premium (especially height), or when a certain sound pattern is desired, the popular oval speaker has proven itself to be the answer.

Over 100 different speaker models are made to supply every production need. Capacitors and other component parts are "tailor-made" to the individual manufacturer's requirements. In your planning, be sure to consult with loud speaker headquarters. The Magnavox Company, Components Division, Fort Wayne 4, Indiana.

Magnavox

has served the radio industry for over 32 years

SPEAKERS · CAPACITORS · SOLENOIDS · ELECTRONIC EQUIPMENT

MEETINGS

SEPT. 24-26: West Coast IRE Convention, Palace Hotel, San Francisco, Calif., Prof. Karl Spangenburg, general chairman, Stanford University, Palo Alto, Calif.

SEPT. 26-28: Third annual Electronics Trade Show, Hotel Whitcomb, San Francisco, sponsored by West Coast Electronic Manufacturers' Association, W. Noel Eldred, secretary, care of Hewlett-Packard Co., Palo Alto, Calif.

SEPT. 26-28: Hudson Division ARRL Convention, Convention Hall, Asbury Park, N. J.; technical papers and exhibits of electronic equipment for radio amateurs.

SEPT. 29-OCT. 2: Annual meeting, International Municipal Signal Association, Inc., Pantlind Hotel, Grand Rapids, Michigan; technical papers and exhibits of police and fire radio equipment.

SEPT. 30-OCT. 11: National Radio Exhibition, Olympia Hall, London, sponsored by British Radio Industry Council and featuring new British radio, electronic control, radar, and television equipment.

OCT. 20-22: Joint meeting of International Scientific Radio Union and IRE, Washington, D. C.; technical papers.

OCT. 20-24: SMPE Theater Engineering Conference, Hotel Pennsylvania, New York.

OCT. 23-25: Annual Meeting, Optical Society of America, Netherland Plaza, Cincinnati, Ohio; symposium on microwave optics.

NOV. 3-5: National Electronics Conference, Edgewater Beach Hotel, Chicago.

NOV. 3-7: AIEE Midwest General Meeting, Chicago, Ill.

NOV. 7-8: Conference on X-ray and Electron Diffraction, Mellon Institute of Industrial Research, Pittsburgh, Pa.

NOV. 17-19: Rochester Fall Meeting, Sheraton Hotel, Rochester, N. Y.; technical papers and exhibits.

NOV. 19-23: Television Exposition, Kiel Auditorium, St. Louis, Mo.; exhibits and telecasts.

MARCH 22-25: IRE Convention and Radio Engineering Show, Hotel Commodore and Grand Central Palace, New York City.

impracticable because of serious interference to television reception, the FCC proposes to abolish channel-sharing provisions. In order to accommodate the nongovernment fixed and mobile radio services for which provision was formerly made on a shared basis on television channels 1 through 5 and 9 through 13, the assignment of channel 1 (44-50 mc) is to be changed from television to nongovernment fixed and mobile. At the present time there is no television station operating on this channel and only one construction permit is outstanding.

The band 72-76 mc is to be limited to use by the 75-mc aeronautical marker beacons and to fixed circuits on an engineered basis with a view to avoiding adjacent-channel interference to television broadcasting. Radio stations presently authorized for this band would be permitted to continue for a five-year period.

An oral argument will be held before final action only if comments received before Sept. 15, 1947 appear to warrant holding such a hearing. If the proposed changes are adopted, the table of frequency allocations published in June 15, 1946 ELECTRONICS, p 82, will be modified as follows:

BAND IN MC	UNITED STATES
44-50	Nongovernment fixed & mobile
50-54	Amateur
54-60	Television broadcasting, channel 2
60-66	Television broadcasting, channel 3
66 72	Television broadcasting, channel 4
72-76	Nongovernment fixed
76 82	Television broadcasting, channel 5
82-88	Television broadcasting, channel 6
174-186	Government fixed & mobile
174-180	Television broadcasting, channel 7
180-186	Television broadcasting, channel 8
186 192	Television broadcasting, channel 9
192-198	Television broadcasting, channel 10
198-204	Television broadcasting, channel 11
204-210	Television broadcasting, channel 12
210-216	Television broadcasting, channel 13

Status of Civilian GCA

THE ARMY AIR FORCES has given CAA full title to the three ground controlled approach radar sets operated by the CAA on loan from the AAF at New York (LaGuardia Field), Washington, and Chicago. The CAA had requested appropriations for the purchase of these three sets and of 20 additional, but was given funds for purchase of only two sets.

As a further step toward full utilization of available funds for air safety, it has been agreed that CAA and the AAF will explore the possibility of joint procurement of improved GCA sets to be ordered by both agencies about January, 1948. It is hoped that in this way the CAA, with funds to purchase only two sets, can obtain the savings of mass production while specifying modifications which it may require for civil use.

With continued availability of the sets assured, CAA has inaugurated 24-hour GCA service at the three locations.

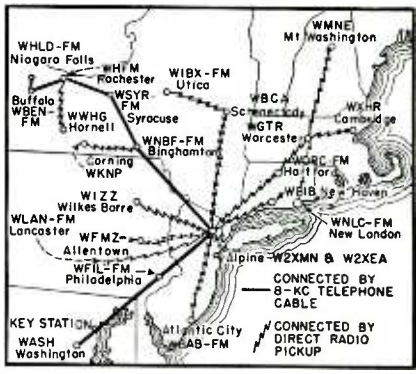
Earlier this year, the AAF had offered CAA a loan of 20 additional GCA sets, but in view of the elimination by Congress of funds requested for operating them, CAA has notified the Army that it is unable to accept this offer.

Narrow-Band F-M Authorized

USE OF narrow-band frequency modulation for radiotelephony by class A amateur radio operators in the bands 3,850-3,900 kc and 14,200-14,250 kc has been authorized by the FCC on an experimental basis until further order, but in no event beyond Aug. 1, 1948. In addition, the holder of any class of amateur radio operator license is authorized to use narrow-band f-m radiotelephony at any licensed amateur radio station on frequencies from 28.5 to 29 mc

(continued on p 240)

F-M NETWORK



Status of Continental F-M Network as of August 1947, when three programs a week were being carried by a total of 20 stations, 8 connected by AT&T lines equalized to over 8,000 cycles, and the remainder using direct radio pickup and rebroadcasting

INCREASED PRODUCTION to meet increased demand permits NEW LOW PRICES for FRANKLIN AIRLOOPS*

* AIRLOOPS . . . *back panel and loop antenna in one unit*

More and more manufacturers of receiving sets are adopting **AIRLOOPS** as standard for their loop antenna and cabinet back requirements . . . this increase in demand permits manufacturing economies which are going right back to **AIRLOOP** users, in the form of NEW LOW PRICES . . . competitively **AIRLOOPS** are the lowest cost loop antenna and cabinet back and more important **AIRLOOPS** incorporate many superior features which in themselves improve set performance . . . no set builder can afford to overlook the significance of the **AIRLOOP**.

. . . FRANKLIN AIRLOOPS are flat sheets of copper die-stamped into perfect super sensitive loops . . . are air dielectric throughout . . . are lower in cost . . . are back panel and loop in one unit . . . have high uniform "Q" over entire band . . . have low distributed capacity . . . have 27% greater effective loop area . . . have electrical and mechanical stability . . . increase set sensitivity . . . eliminate individual loop adjustment . . . eliminate haywire.

FRANKLIN *Airloop* **CORPORATION**

43-20 — 34th ST., LONG ISLAND CITY 1, N. Y.

TUBES AT WORK

(continued from p 134)

outer screens upon completion. The usual procedure is then to tear out the inner screen and rebuild it. One government laboratory reconstructed the inner screen three times before it was ground free.

At the Cook Research Laboratories in Chicago, a technique has been used for this purpose employing an oscilloscope, a solenoid exploring coil, and a 1-kva, 60-cycle, step-down transformer.

The low-voltage secondary of the transformer was connected with one terminal to the outer screen and one terminal to the inner screen. With its primary energized from the laboratory power circuit, approximately 100 amperes of current flowed from one screen to the other through the one or more faults. The solenoid exploring coil was connected to the vertical deflecting circuit of the oscilloscope and was moved along the

Reversal of polarity shown on the scope screen indicates location of faults in screening

inside wall of the room, particularly along the wall-ceiling and wall-floor junctions.

While moving the coil, the operator could observe on the c-r tube the increase or decrease of signal produced by the magnetic field of the fault current flowing in the inner screen. As a fault was approached, the signal amplitude would build up and when going di-

rectly over the fault, the amplitude would go to zero and reappear with reversed polarity. In every case, the faults were found to be at the exact points where the polarity reversal took place. To prevent getting false indications of polarity reversal the operator had to take care not to rotate the exploring coil about any of its own axes as he moved it along.

General Purpose Portable Amplifier

By C. R. Smitley
Research Assistant
Ordnance Research Laboratory
The Pennsylvania State College
State College, Pa.

Small versatile amplifiers are commonly required in the laboratory or classroom in conducting various experiments or demonstrations. In filling this need, an amplifier system was developed to meet the following specifications: (1) Frequency range of 1kc to 100 kc; (2) Flat gain within 0.5 db over the above frequency range; (3) Voltage gain of 20 db or 40 db to be switch selected; (4) Equivalent input noise level less than 90 db below one volt; (5) Incorporation of high-impedance input stage to prevent loading of electronic circuits by the amplifier; (6) Operation from a 115-volt a-c line; (7) Shock mounting of the amplifier to reduce microphonics; (8) Small physical size and portable construction.

Amplifier Circuit

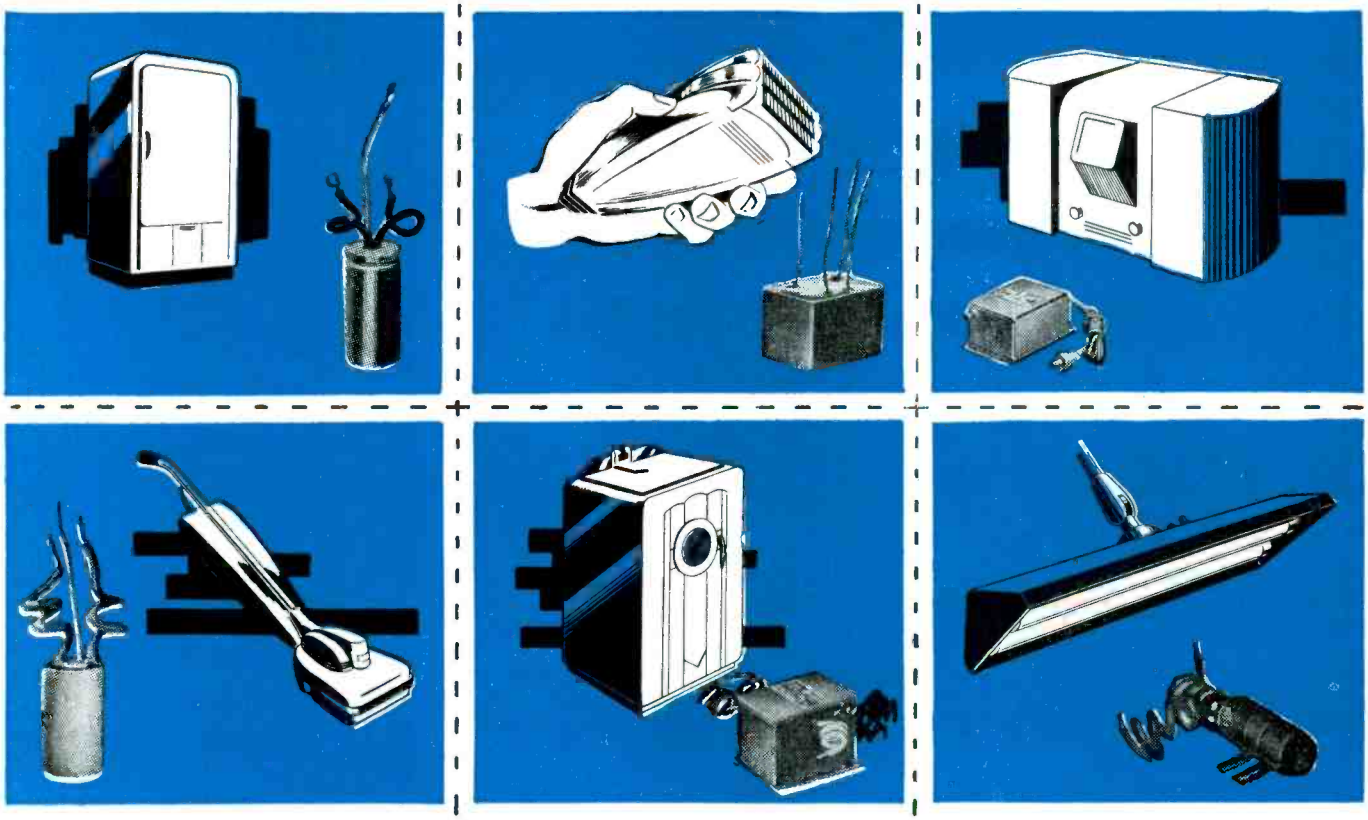
The schematic diagram of the amplifier appears in Fig. 1. Tubes V_1 and V_2 are 6SJ7's used as R-C coupled high gain voltage amplifiers. The R-C constants are so chosen that the gain-versus-frequency characteristic in the range 1 kc to 100 kc is constant within 0.5 db. The output of V_2 is applied to V_3, a 6SH7 cathode follower output tube. Tube V_4 is a 6SH7 connected as an auxiliary cathode follower to serve as an impedance transformer for use in making measurements across high-impedance circuits.

Rotary switch S_1 is used to change the gain of the amplifier or to connect the impedance trans-

YOUR PRODUCT, TOO

CAN BE RADIO NOISE-PROOFED WITH C-D *Quietones*

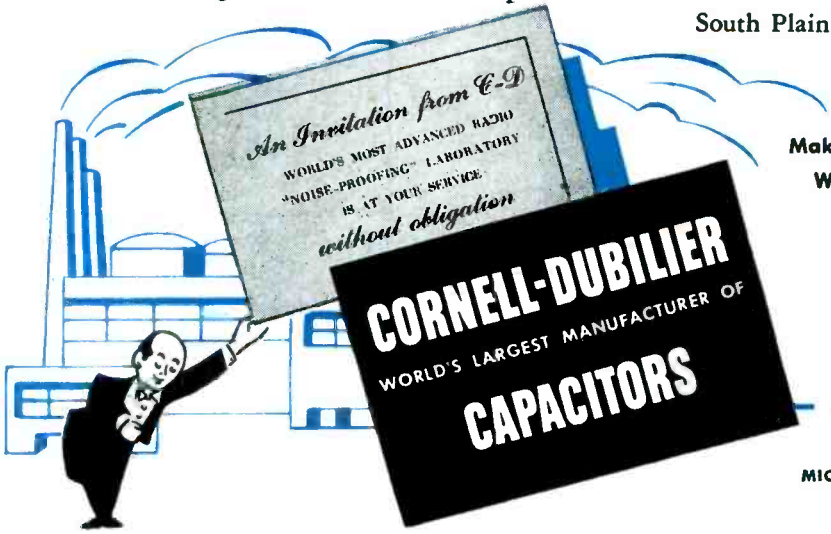
Reg. U.S. Pat. Off.



When we say Radio Noise-*Proofed*—we mean Radio Noise-*Proofed*. It's no trick at all to build a filter with high attenuation at 150 kc *or* 100 mc . . . but to build one which filters at 150 kc *and* 100 mc—*as well as all points in between*—is a horse of a different color. We know because we've done it. It is only one of hundreds of *available* types of C-D Quietones designed for all standard requirements.

Among these stock types there may be one which will bring the interference level of your product down to the level of a rabbit's bark. If not, we invite you to make full use of our Radio noise-proofing laboratory and our engineers for the development of a unit designed for your specific needs.

Your inquiries are cordially invited. Address: Cornell-Dubilier Electric Corporation, Dept. K-10, South Plainfield, N. J. Other large plants in New Bedford, Worcester and Brookline, Mass., and Providence, R. I.



Make Your Product More Saleable With C-D Quietone Radio Noise Filters and Spark Suppressors

1910 1947

MICA • DYKANOL • PAPER • ELECTROLYTIC

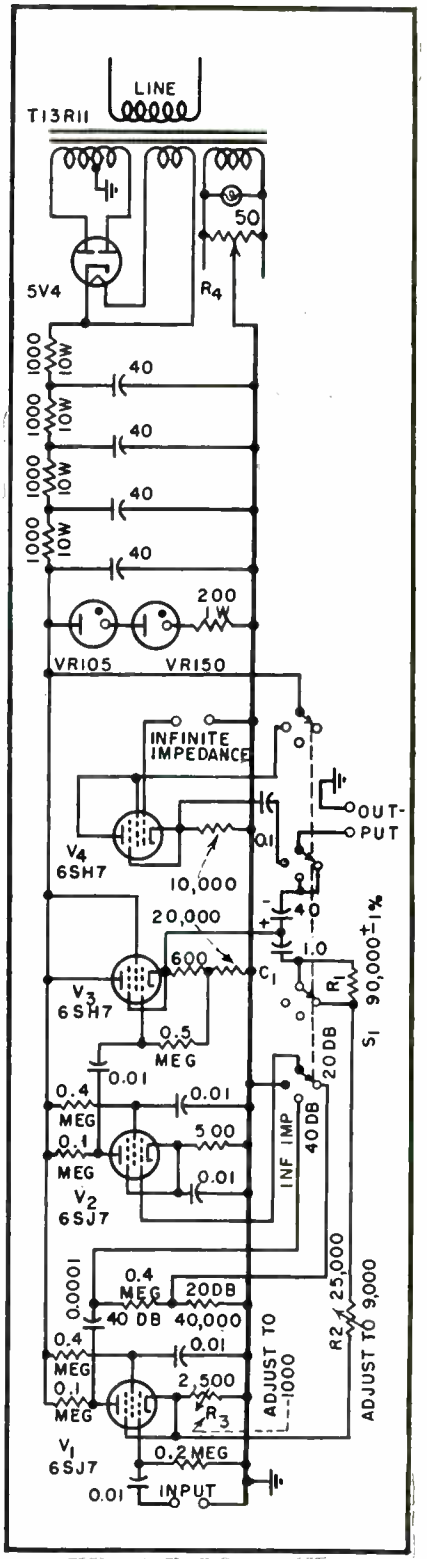
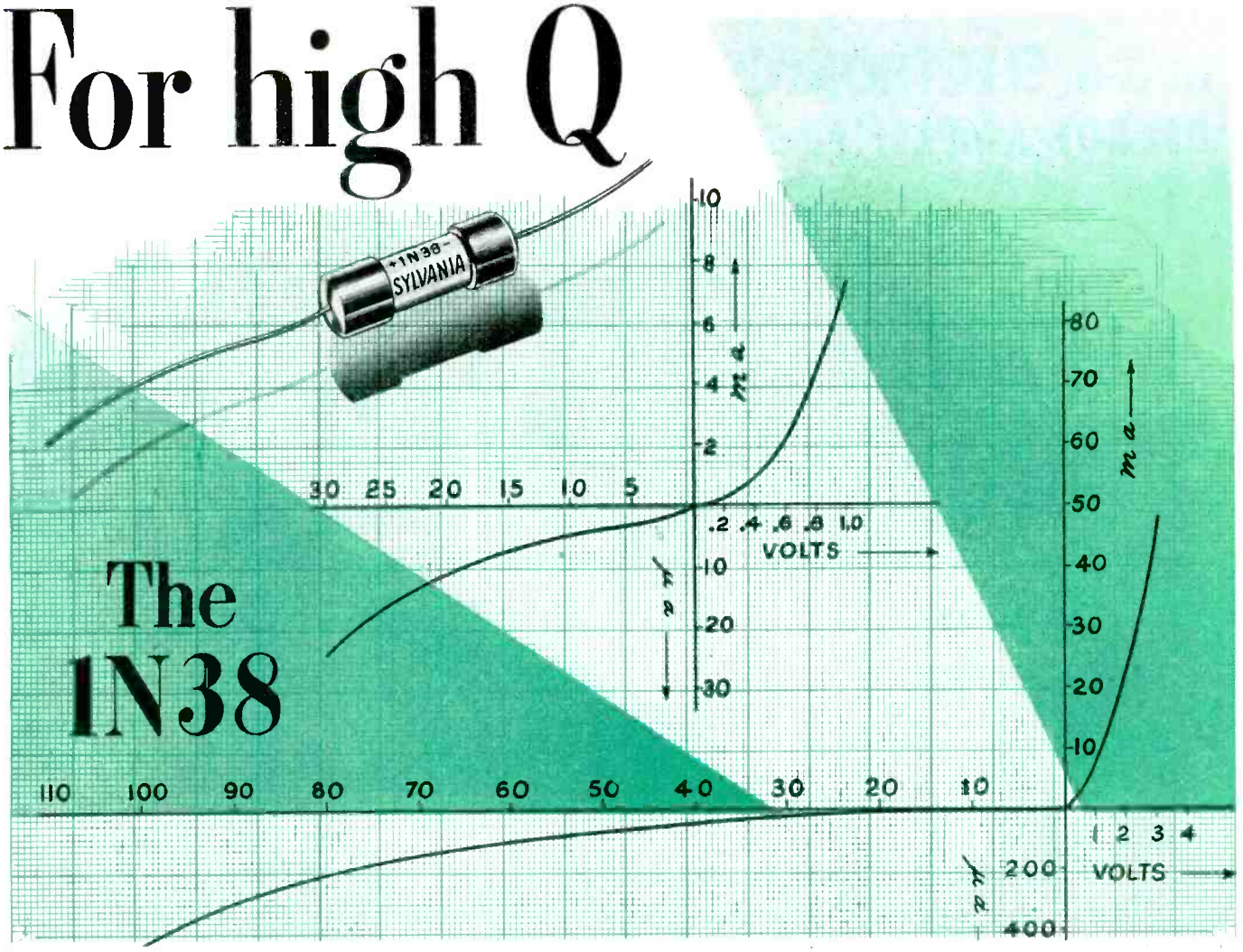


FIG. 1—The amplifier incorporates a two-position gain control, and auxiliary cathode follower for measurements across high impedance electronic circuits

forming cathode follower to the output terminals. With the switch in either the 20-db or 40-db position, the output of V_3 is connected to the output terminals; when the switch is in the infinite impedance position, the cathode of V_4 is connected

For high Q



A megohm at −3 volts. .5 megohm at −1 volt. 2 megohms at −5 volts.

.8 megohm at −2 volts. .35 megohm at −½ volt. 2 megohms at −18 volts.

A megohm at −33 volts. .25 megohm at −100 volts.

The 6,000,000th crystal Sylvania made was a 1N38!

Let Sylvania engineers help you with your crystal problems.

SYLVANIA ELECTRIC

Electronics Division, Dept. E1410, 500 Fifth Avenue, New York 18, N. Y.

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

across the output terminals and the voltage to be measured is impressed across the infinite impedance input terminals. Negligible loading of the circuit under measurement will take place when any ordinary type of instrument is connected across the output of the amplifier.

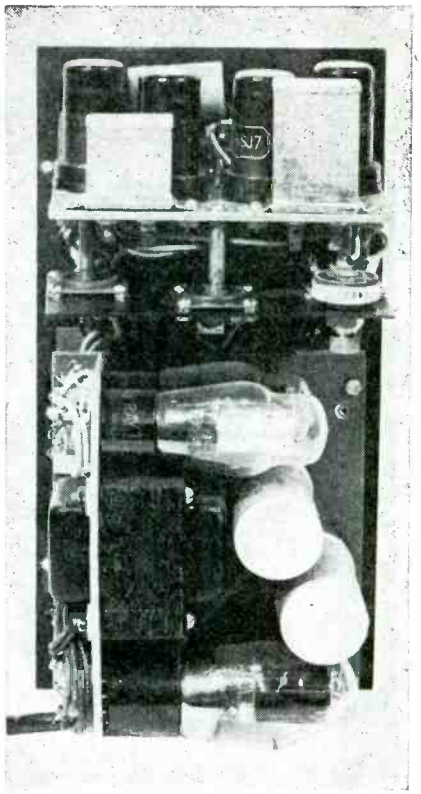


FIG. 2—Rear view of unit shows amplifier stages above, and power supply below

The normal gain of the amplifier system without feedback is approximately 70 db. However, to obtain gain stability, feedback through C_1, R_1 and R_2 is obtained from the output terminals of V_3 to the cathode of V_1. With switch S_1 in the 40-db position, the overall gain is adjusted to 40 db by means of R_3, a rheostat placed at the rear of the chassis. The divider in the grid circuit of V_2 prevents overloading of this stage at higher input levels.

With switch S_1 thrown in the 20-db position, R_1 in the feedback path is shorted out, the feedback is greatly increased and the overall gain is adjusted to 20 db by means of R_2. There is interaction between the 20-db and 40-db adjustments so that these must be made two or three times in succession until the proper settings are obtained.

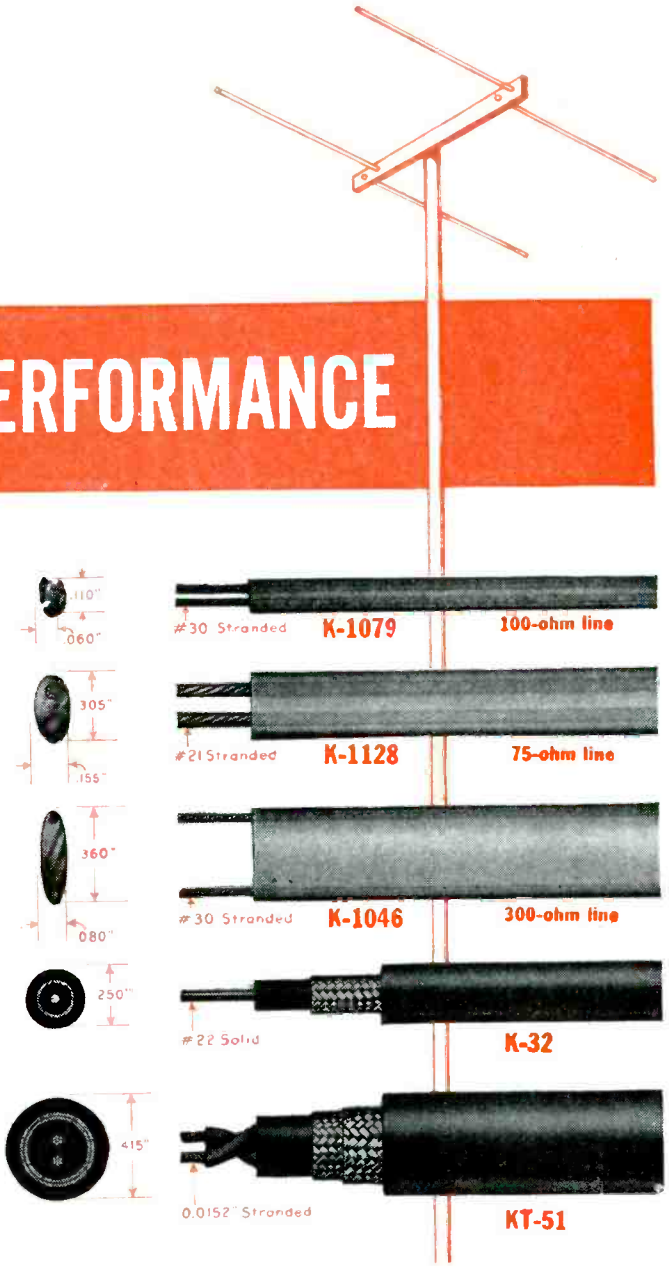
It will be noted that the feedback factor is large for both the 20 and

Here's Why Your Antenna Installations Will Give

LONGER-LASTING PERFORMANCE

with Federal's Intelin® H-F Transmission Lines

1. **Their unusually low attenuation losses assure the most efficient transfer of energy between antenna and receiver or transmitter.**
2. **Their uniformity and permanence of characteristics permit peak receiver performance, without annoying distortion from locally-induced interference.**
3. **Their flexibility and outstanding resistance to weathering, moisture and abrasion contribute to years of trouble-free service.**



IN THE FIVE ITEMS listed here, there's a high-frequency cable for practically every antenna application. The K-1128 75-ohm line, for transmitter use—the K-1079 and K-1046 lines for general FM and Television service. The smooth oval cross-section of these 75, 100, and 300-ohm lines prevents the accumulation of foreign matter, thereby maintaining stable capacity characteristics. The K-32 and KT-51 coaxial cables offer peak performance for applications where locally-induced interference is severe.

For complete information and prices on these cables, see your local distributor. For other high-frequency cables —write to Federal, Dept. D113.

DATA FOR FEDERAL H-F CABLES

Type Number	Characteristic Impedance Ohms	Velocity of Propagation (in percent)	Capacitance Per Ft. mmf	Attenuation, Db per 100 Ft. Frequency in Megacycles				
				1.0	1.7	30	100	300
K-1079	100	71	15.5	.6	.75	2.8	5.2	8.8
K-1128	75	71	19.5	.3	.4	2.0	4.0	7.3
K-1046	300	81	4.0	.38	.57	.85	2.0	—
K-32	73	66	22	—	—	2.0	3.8	7.0
KT-51	95	56	16	—	—	1.8	3.8	7.5

•Reg. U. S. Pat. Off.

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

Federal Telephone and Radio Corporation

SELENIUM and INTELIN DIVISION, 1000 Passaic Ave., East Newark, New Jersey

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

40-db gain settings. Consequently, the gain values are independent of variations in tubes, components, and supply voltage to a very good approximation.

So that it will present a high-impedance to an external circuit, the impedance transformer, V_4, is connected as an open-grid-circuit cathode follower. Consequently, a d-c isolation network must be connected to the input terminals of this stage when high d-c voltages to ground appear across the portion of the circuit under measurement. The gain of V_4 is very nearly unity due to the large cathode resistor incorporated in this stage.

The power supply is straightforward. The R-C filters are utilized in view of the space requirements. The V-R tubes are used to obtain a relatively constant B+ output of 255 volts. A potentiometer R_4 connected across the heater supply winding is used as an adjustable center tap to minimize hum output.

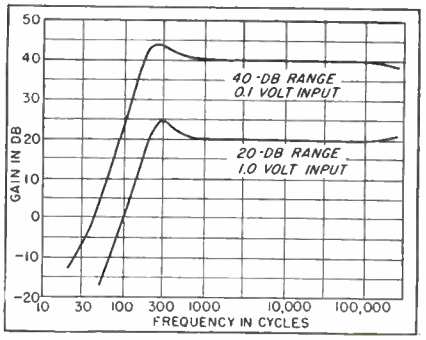


FIG. 3—Amplifier gain-versus-frequency characteristics for the 20-db and 40-db gain settings

The lower frequency pass characteristic of the amplifier was restricted to 1 kc to minimize hum resulting from the use of the 60-cycle filament-supply voltage and consequent 120-cycle variation of the plate current.

Construction and Alignment

The instrument is mounted in a case having the same physical dimensions as a Ballantine Model 300 voltmeter.

A rear-view photograph of the device with the cover removed appears in Fig. 2. Tubes V_1, V_2, V_3, and V_4, together with associated resistors and capacitors, are mounted

HERE ARE SIMPSON'S "BASIC 3" PROFIT-MAKERS FOR SERVICEMEN...

The serviceman who tries to "get along" with cheaply-made, run-of-the-mill test instruments is taking an outside chance on success. The business of radio servicing must be *built* from the bottom up on an endless succession of perfect jobs. Knowing what the trouble is, in a receiver, and knowing when that trouble is eliminated *can be no better than the test instruments that reveal them.*

The "Basic 3" Simpson instruments shown here are an extremely profitable investment for any serviceman. He needs all three and, in their price range, he cannot buy better anywhere else. In fact, in their price range they are unequalled. They will do more than many instruments selling for substantially more. These are facts easily demonstrable to any serviceman who will take the time to check up. And it is worth the time in the *cold cash of profits* to discover how Simpson engineering skill and uncompromising quality construction produce the *staying* accuracy for which Simpson instruments are famous.

MODEL 315 SIGNAL GENERATOR. Designed down to the most minute detail for highest accuracy, greatest stability, minimum leakage, and good wave form **$67.35**

MODEL 305 RC TUBE TESTER. Tests all tubes. Provides for filament voltages from .5 volts to and including 120 volts. Spare sockets for future tube developments **$59.50**

MODEL 260 HIGH SENSITIVITY SET TESTER. 20,000 ohms per volt, D.C. Voltage ranges to 5,000 volts A.C. and D.C. Resistance ranges to 20 megohms. Current ranges to 500 milliamperes, also 10 amperes D.C. **$38.95**

In New Roll Top Safety Case **$43.75**

SIMPSON ELECTRIC COMPANY • 5200-5218 West Kinzie Street, Chicago 44

In Canada, Bach-Simpson, Ltd., London, Ont.

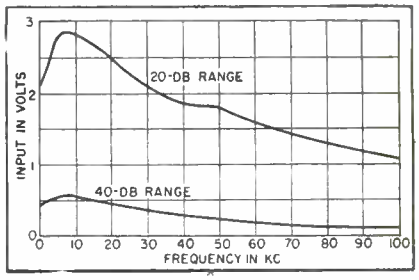


FIG. 4—Maximum input signals that the amplifier can handle without distortion are shown here as functions of frequency

on the small metal plate at the top. This entire assembly is mounted on Lord shock mounts to avoid microphonic difficulties. Flexible leads to this unit are provided for the same reason. The shock mounts are mounted on a metal plate bolted to the front panel and used as a shield between the amplifier section and the power supply.

The power supply, at the lower portion of Fig. 2, is a self-contained unit which is also bolted to the front panel.

In aligning the amplifier, a known input voltage source is connected to the input terminals and a voltmeter connected to the output terminals. The 20-db and 40-db gain adjustments are made and repeated until the two positions check satisfactorily after which the rheostat arms are locked in position.

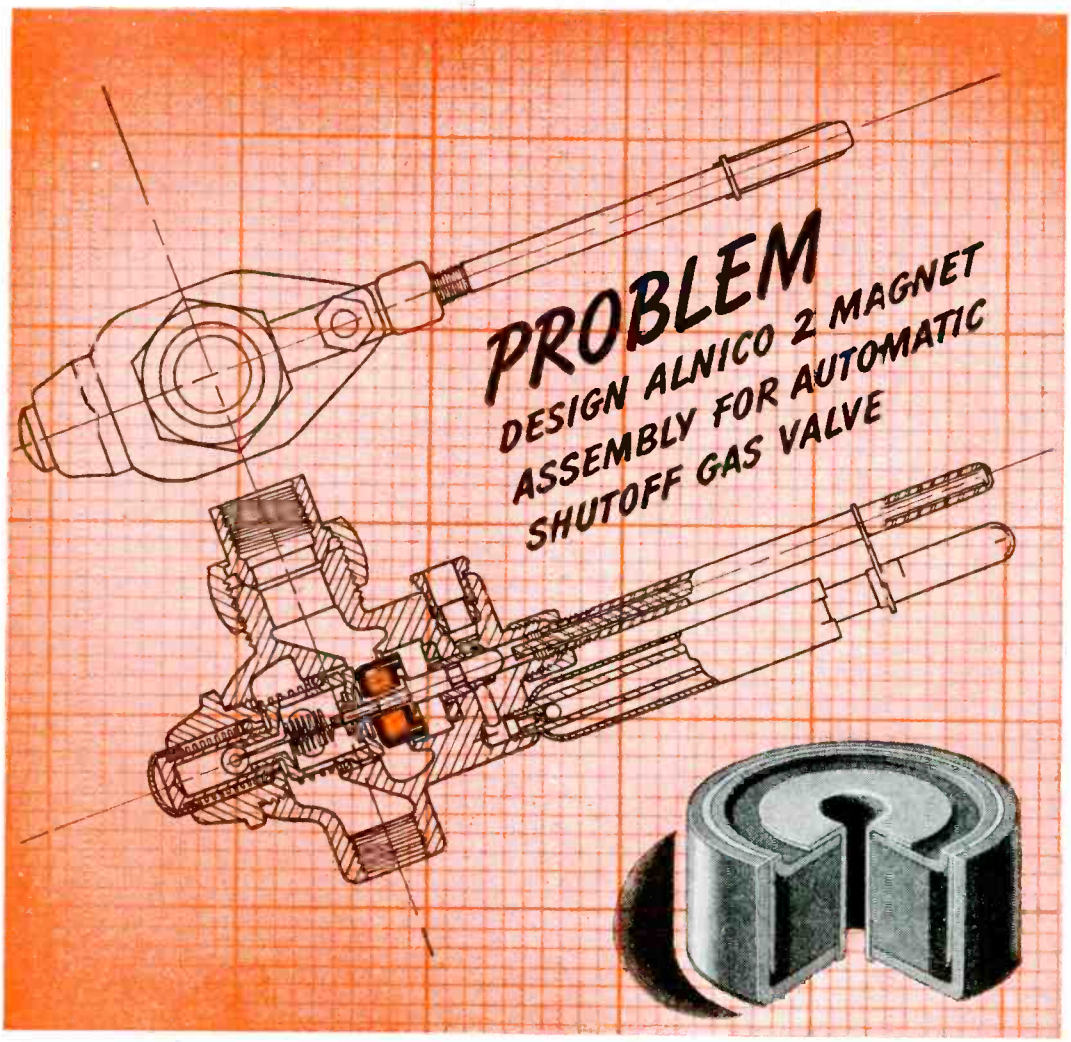
Hum-adjustment potentiometer R_4 is adjusted by connecting an oscilloscope across the output terminals and, with the input terminals shorted and switch S_1 in the 40-db position, adjusting R_4 for minimum output signal.

Performance

The pass characteristics of the amplifier for the 20-db and 40-db gain positions are shown in Fig. 3. It will be observed that the response meets the specification of being flat within 0.5 db over the frequency range of 1 kc to 100 kc. It will also be noted that 60- and 120-cycle signals are greatly attenuated relative to the signals in the pass range of the amplifier.

Figure 4 shows the maximum voltage that may be impressed across the input terminals as a function of frequency under the condition that negligible distortion occur. Distortion was checked by

YOU GET QUALITY PLUS ENGINEERING SERVICE WITH G-E PERMANENT MAGNETS



Designed by G-E engineers, this ALNICO permanent magnet holding assembly insures positive snap action in the Titan 100% Shutoff Automatic Safety Pilot manufactured by the Titan Valve and Mfg. Co.

The Magnet that Safeguards your Gas Heater

Here's a magnetically controlled pilot light for your gas heater that's 100% safe. While the pilot flame is burning, the ALNICO permanent magnet assembly grips a steel ring, keeping the gas line open. When the flame goes out, a thermal device and retaining spring force the holding magnet assembly away from the ring, shutting off the gas supply.

We shall be glad to help you also with your magnet application problems. Backed by years of research and magnet design experience, General Electric engineers are always at your service.

The precise quality control methods used throughout G-E magnet production plus accurate testing and rigid inspection, assure you of receiving magnets of the highest uniform quality for your application.

Moreover, greater flexibility of magnet design is possible with the many G-E permanent magnet materials now available. These include cast and sintered ALNICO, the ductile alloys CUNICO, CUNIFE and SILMANAL and lightweight non-metallic VECTOLITE. *Metallurgy Division, Chemical Department, General Electric Company, Pittsfield, Mass.*

Send for our new bulletin, CDM-1, "G-E Permanent Magnets," specifically designed to help you with your permanent magnet problems. This bulletin contains information about the characteristics and properties of G-E permanent magnet materials, their application and design.

METALLURGY DIVISION, Sec. FA-10
CHEMICAL DEPARTMENT
GENERAL ELECTR C COMPANY
PITTSFIELD, MASS.

Please send me your new bulletin, CDM-1, "G-E Permanent Magnets."

NAME..... TITLE.....
COMPANY.....
ADDRESS.....
CITY..... STATE.....

PERMANENT MAGNETS

GENERAL ELECTRIC

CD47-JA8

placing an oscilloscope across the output terminals while the data for these curves were being obtained.

The equivalent input noise level of the amplifier was found to be 90 db below 1 volt on the 40-db range and 96 db below 1 volt on the 20-db range. These results, in conjunction with those given in Fig. 4, determine the operating range of the instrument in terms of input signal level.

Tube Production Techniques

By Vincent G. Jarman

Electronics Shops
Western Electric Co.
New York, N. Y.

Two innovations in tube assembly have improved the quality and reduced the cost of manufacturing vacuum tubes. One is a new type electrode holder on bench welders, and the other is an adjustment fixture for examining alignment of grid laterals.

Holder for Welder Electrodes

Resistance welding is used in assembling intricate metal parts of vacuum tubes. The former practice

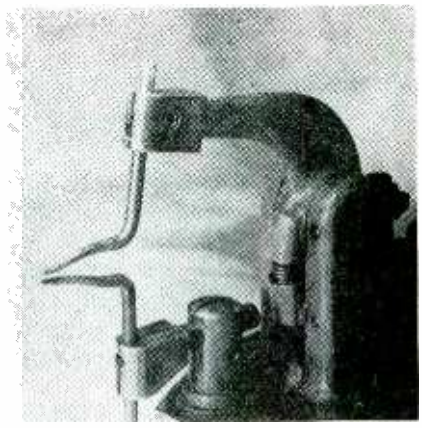
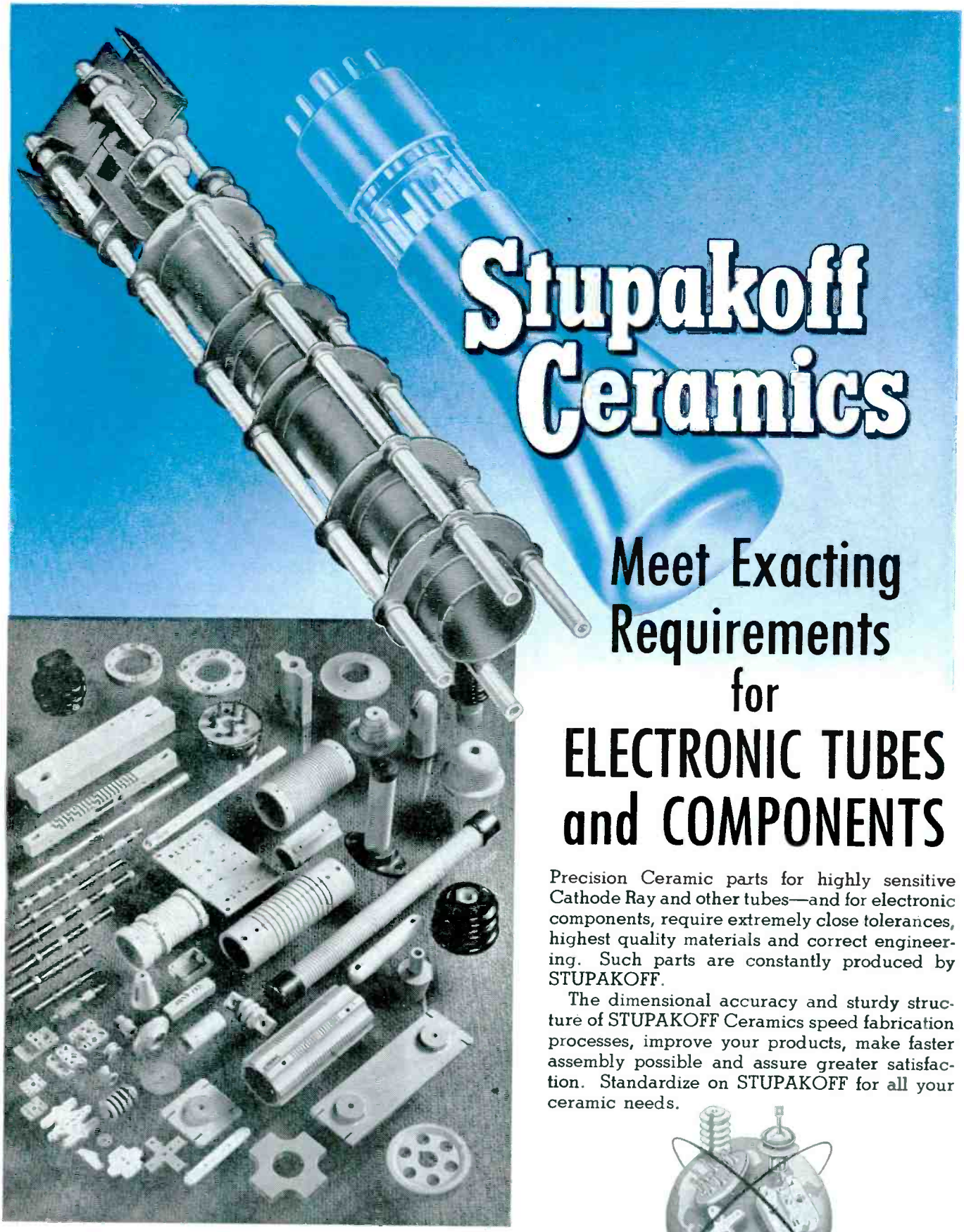


Fig. 1—Oldstyle welding electrodes

involved insertion of electrodes directly in the head of the welder as illustrated in Fig. 1. The entire electrode was made of costly rod and was turned down and tipped in the company shop. As the tip wore, a maintenance man refaced it until it had to be replaced, although a great part of the original material remained.

To simplify maintenance and reduce waste the electrode holder shown in Fig. 2 was developed. It fits into the welder head exactly as



Stupakoff Ceramics

Meet Exacting Requirements for ELECTRONIC TUBES and COMPONENTS

Precision Ceramic parts for highly sensitive Cathode Ray and other tubes—and for electronic components, require extremely close tolerances, highest quality materials and correct engineering. Such parts are constantly produced by STUPAKOFF.

The dimensional accuracy and sturdy structure of STUPAKOFF Ceramics speed fabrication processes, improve your products, make faster assembly possible and assure greater satisfaction. Standardize on STUPAKOFF for all your ceramic needs.

STUPAKOFF CERAMIC AND MANUFACTURING COMPANY . . . . LATROBE, PA.

Cable Address: STUPAKOFF, LATROBE

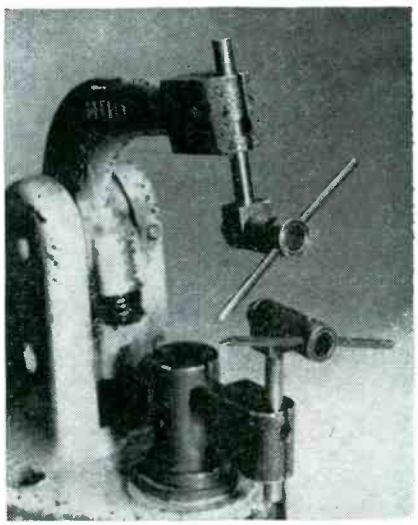


Fig. 2—New electrodes in holders

did the former electrode. As the new electrodes are held in swivels, they can be moved toward each other as they wear; faces can be prepared and maintained by the operators. The new electrodes are either $\frac{3}{8}$ or 3/16 inch as compared to the $\frac{1}{4}$ inch size used formerly. Average life of the old electrodes was about three weeks, and about 80 percent of the material was discarded.

The new electrodes last over three months and have been used in assemblying the 2K56 metal klystron and such miniature tubes as the 403B, 2C51, 399A, and 400A. Whereas the old type electrode tip became larger as the electrode wore, the tip of the new type electrode remains the same. Also, an extension of the use of electrode holders permits holding several electrodes to make multiple welds.

Grid Alignment Fixture

In assembling tubes that employ two or more grids with aligned lateral wires, operators held the tubes for inspection and adjustment in different positions with the result that the alignment was along the same axis. The variations in manufacture could well have caused important variations in tube performance. With the new adjustment fixture shown in Fig. 3, the grids can be inspected from only one position.

The fixture consists of a viewing mask with a slit in it. The grid support is placed in a block that can be moved vertically and turned over 180 degrees. The view-

The Rauland VISITRON 10FP4/R6025

. . . the NEW Picture Tube with Unprecedented Brilliance

No Ion Trap Required

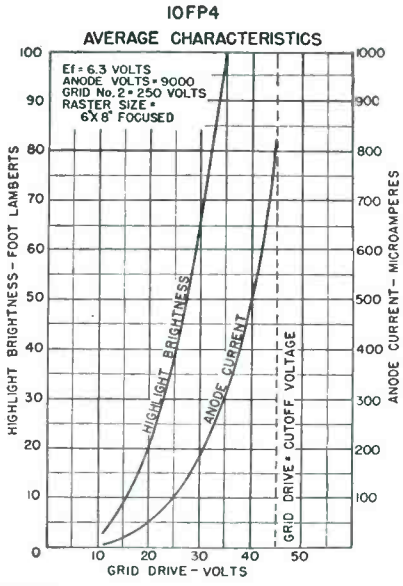
Virtually Flat Face

Direct Viewing

NEW!
ALUMINIZED REFLECTOR-SCREEN

Doubles the Brilliance
Highlight: 75 Foot Lamberts (avge.)
Contrast Range: Over 100 to 1
No Ion Spot—No Cathode Glow

Specifications of the Rauland Visitron 10FP4/R6025	
Heater Voltage	6.3 A.C. or D.C.
Focusing Method	Electromagnetic
Deflection	Electromagnetic
Deflection Angle	50 Degrees
Screen	Phosphor P4 Aluminized Reflector
Bulb Diameter (Max.)	10⅝" at screen end
Length	17⅝" ± ⅜"
Base	Small Shell Duodecal 7 Pin
Anode Terminal	Cavity
Anode Volts (Max.)	13,000
Anode Volts (Operating)	9,000
External Coating (Optional): 500 mmf.	



· WRITE FOR INTERESTING BULLETIN ·

RADIO • RADAR • SOUND • **Rauland** COMMUNICATIONS • TELEVISION

Electroneering is our business

THE RAULAND CORPORATION • 4265 N. KNOX AVE. • CHICAGO 41, ILLINOIS

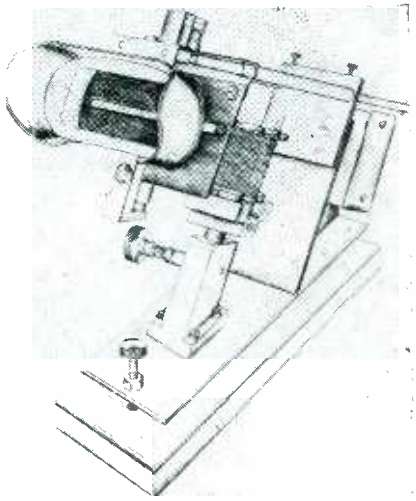


Fig. 3—Grid adjustment fixture for viewing lateral grid wires

ing mask with its magnifying lens can be moved relative to the block for accommodation to various operators eyes. A fluorescent lamp behind one vertical edge of the screen illuminates the grid assembly.

The operator mounts the grid assembly on the block and moves it upwards, viewing the individual windings through the slit. At the last winding, the block is reversed and the operation repeated for the other side of the grid as the block is lowered. A small probe can be inserted to adjust laterals that are out of line. The fixture has increased both the thoroughness of inspection and the consistency of tubes produced in this shop.

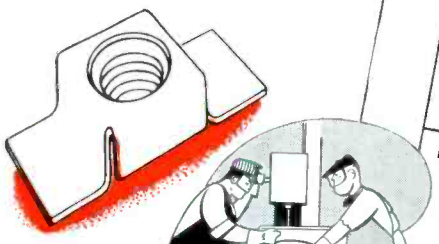
Diode Contact Potential For Negative Bias

By Howard T. Sterling
New York, N. Y.

Ever since the discovery of the so-called Edison effect, contact potential has been a source of interest and frequently of annoyance to workers in electronics. It can, however, serve as a convenient source of bias in high gain audio amplifiers and in the r-f and i-f stages of receivers.

When a diode is connected as shown in Fig. 1 there will be a d-c output voltage of from zero to something over 1 volt depending upon the value of the load resistor. The curve in Fig. 1 shows this char-

Here's how Speed Nuts really cut costs!



ATTACHING CAGE NUTS

ATTACHING SPEED NUTS

COST REPORT

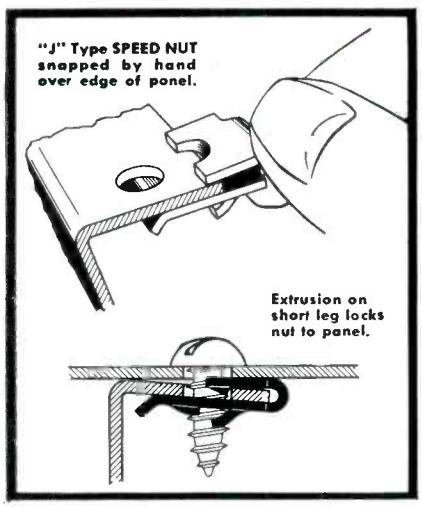
ITEM: Fastening Rear Fenders To Body

DESCRIPTION	No. per car	Material	Direct Labor	Overhead	Mfg. Cost
Cage Nut (Welding Type)	18	.1512			.1512
Bolt (5/16 - 18 x 1)	18	.0918			.0918
Lock Washer	18	.0072			.0072
Plain Washer	18	.0234			.0234
Spot weld 9 welding nuts to R & L Wheelhouse Panels			2200	3850	.6050
Assemble R & L Fenders to Body			.1800	.3150	.4950
TOTAL for Welding Nut		.2736	4000	.7000	1.3736
Speed Nut ("J" Type)	18	.1116			.1116
Bolt (5/16 - 10 x 5/8)	18	.0828			.0828
Plain Washer	18	.0234			.0234
Attach 9 Speed Nuts to R & L Wheelhouse Panels			1100	1925	.3025
Assemble R & L Fenders to Body			.1350	.2363	.3713
TOTAL for Speed Nut		.2178	.2450	.4288	.8916
SAVINGS		.0556	1550	.2712	4820

Proof...that SPEED NUTS slash overhead and handling costs

- LOCK WASHER ELIMINATED
- SPOT WELDING ELIMINATED
- SPEED NUT COSTS LESS
- BOLT COSTS LESS
- LABOR COST IS LESS
- OVERHEAD IS LESS

Total saving for one operation using only 18 SPEED NUTS



On this one simple operation, a prominent automobile manufacturer saved 48c per car by changing over to the SPEED NUT System of Fastening. Simple mathematics point out the phenomenal savings made possible by widespread use of SPEED NUT brand fasteners.

42c of this total was saved by reducing overhead and handling costs. With SPEED NUTS on the assembly line, welding machines were eliminated. Less floor space needed. Less material handling. Easier final assembly—and ⅓ of the men transferred to more productive work.

Look this report over carefully. Compare those direct labor and overhead charges and then drop us a line and find out for yourself what the SPEED NUT savings factor can do for you.

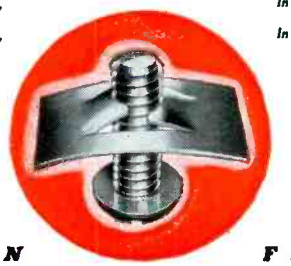
TINNERMAN PRODUCTS, INC. 2106 Fulton Road, Cleveland 13, Ohio

In Canada: Wallace Barnes Co., Ltd., Hamilton, Ontario
In England: Simmonds Aerocessories, Ltd., London
In France: Aerocessoires Simmonds, S. A., Paris
In Australia: Aerocessories, Pty. Ltd., Melbourne

Speed Nuts* PATENTED

MORE THAN 4000 SHAPES AND SIZES

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



FASTEST THING IN FASTENINGS

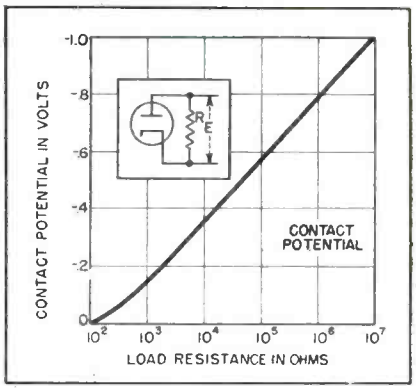


Fig. 1—Diode contact potential increases as value of load resistor is increased

acteristic for a typical 6H6 diode. This curve should be taken merely as indicative; the exact voltage developed will depend on several factors, such as heater voltage and the condition of the cathode. Other rectifiers will conform approximately to this characteristic.

In a triode, the grid will demonstrate the same sort of phenomenon, since it acts as a diode plate. It has become common practice to operate high-mu triodes as shown in Fig. 2A, using a high value of grid resistance, and hence permitting the tube to bias itself. A refinement of this system is to use one of the diodes of a tube like a 6SQ7 to provide bias, as shown in Fig. 2B. In this case the audio bypass capacitor *C* is necessary only when the peak signal approaches the bias voltage.

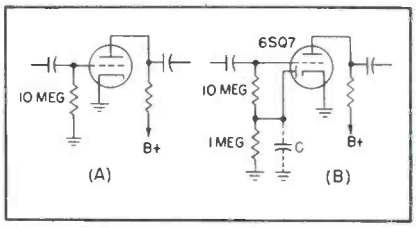
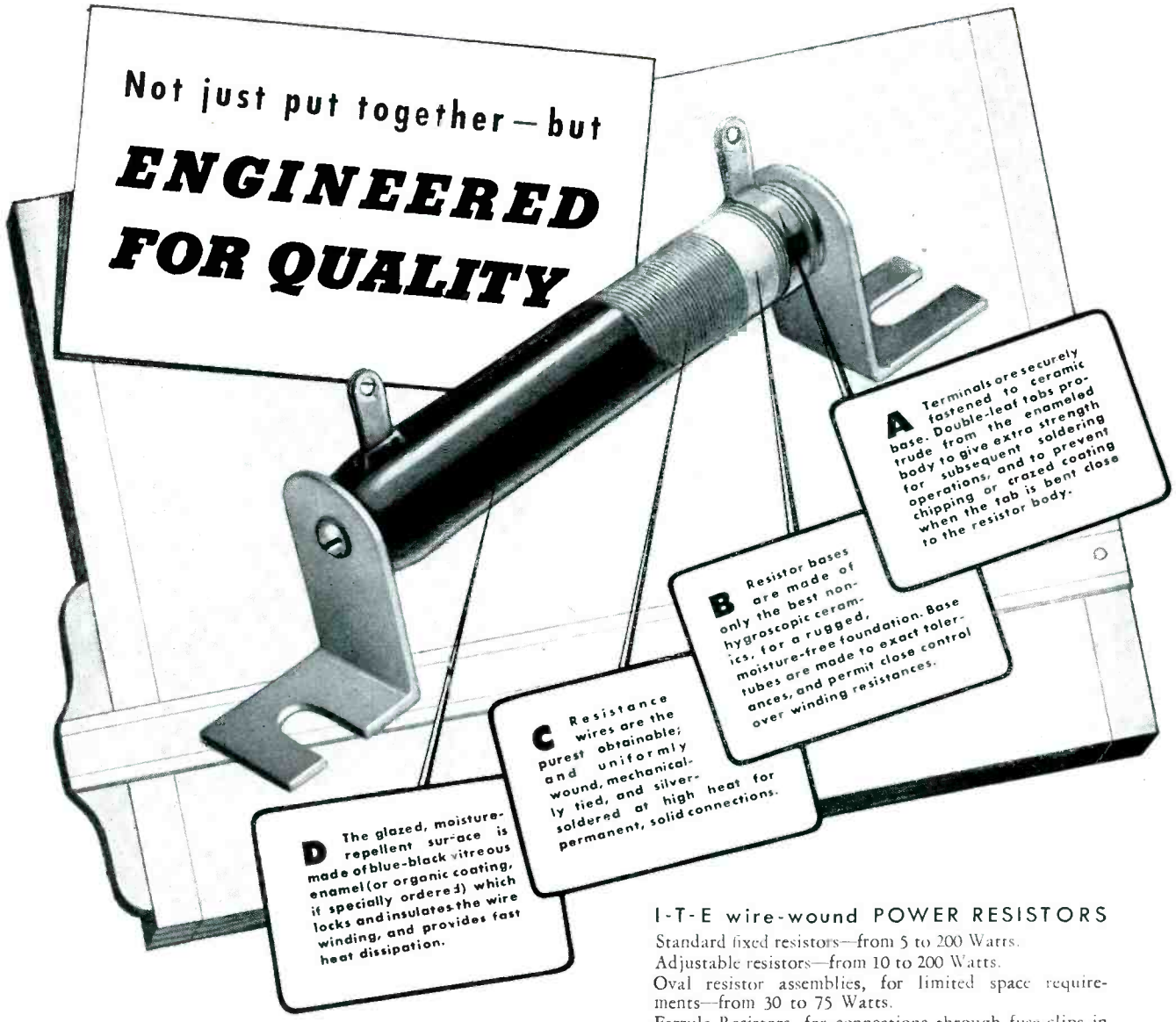


Fig. 2 — Conventional self-biasing circuit used with high-mu triodes (A). Diode section of duo-diode triode is used to furnish bias (B)

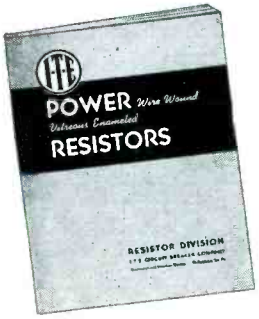
In a receiver with a number of r-f and i-f stages, considerable saving in cathode resistors and bypass capacitors may be achieved by the use of an initial diode bias on the avc line, as shown in Fig. 3. Two diode sections are shown connected in series across the avc line with an avc decoupling resistor of two megohms. With a load of one megohm per diode, it can be seen from Fig. 1 that there will be an



I-T-E wire-wound POWER RESISTORS

Standard fixed resistors—from 5 to 200 Watts.
Adjustable resistors—from 10 to 200 Watts.
Oval resistor assemblies, for limited space requirements—from 30 to 75 Watts.
Ferrule Resistors, for connections through fuse-clips in installations where rapid insertion and removal is a factor—from 13 to 200 Watts.

• Resistors for special applications made to specifications. I-T-E Power Resistors are made with a normal tolerance of 10%. Tolerances of 5% and less made to order.



RESISTOR construction is too often taken for granted—*but not by* I-T-E! The same care and engineering skill that are applied in making the most complicated units of switchgear are also applied in the manufacture of I-T-E wire-wound Power Resistors. The result is a ruggedly constructed resistor fully capable of meeting the most critical conditions over a long period of heavy usage.

Complete information on I-T-E Resistors is contained in the new I-T-E Resistor catalog. Illustrated throughout, it contains technical information, handy charts and formulas for selecting resistors, and complete listings of I-T-E sizes and ratings. Send for it today.

I-T-E **POWER RESISTORS**

The Leader In Technical Excellence

31 Offices in United States and Canada

I-T-E CIRCUIT BREAKER CO., Resistor Division, 19th & Hamilton Sts., Philadelphia 30, Pa.

SWITCHGEAR • UNIT SUBSTATIONS • ISOLATED PHASE BUS STRUCTURES • AUTOMATIC RECLOSING CIRCUIT BREAKERS • RESISTORS • SPECIAL PRODUCTS

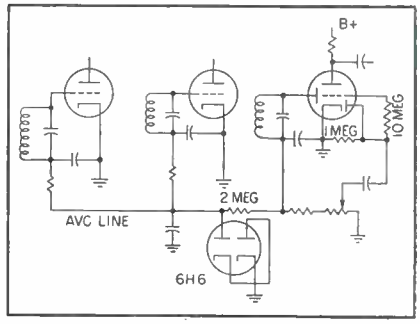


Fig. 3—Initial diode bias on avc line saves capacitors and resistors in r-f and i-f cathode circuits, also provides threshold voltage for delayed avc

initial bias on the r-f and i-f tubes of 0.8 volt per diode or 1.6 volts total, which is more than enough for most modern tubes. In the circuit shown, the 1.6 volts furnished by the series diodes acts as delayed avc threshold voltage. If more bias and/or more avc delay is desired, a second double diode may be connected in series with the first. It may be noted that one of the diodes of the duo-diode triode is used for triode bias in this circuit.

In a diode detector, the major source of distortion apparently lies in the fact that the d-c load and the audio load on the diode are not equal. In a typical circuit shown in Fig. 4A, the d-c load consists of R_1 and R_2 in series. For audio frequencies, however, there is the additional load of R_3 plus the effect of R_4 in parallel with whatever part of R_2 is in use. Common practice is to make R_4 as high as possible, usu-

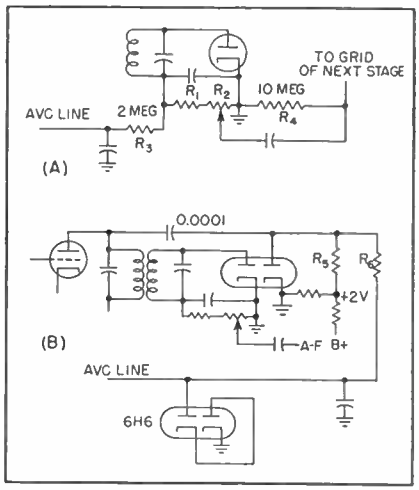
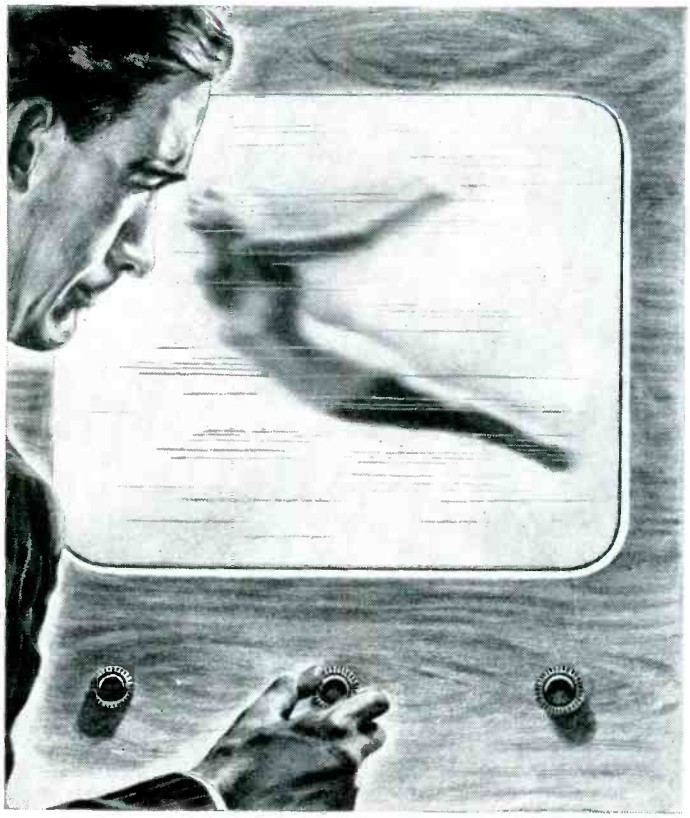
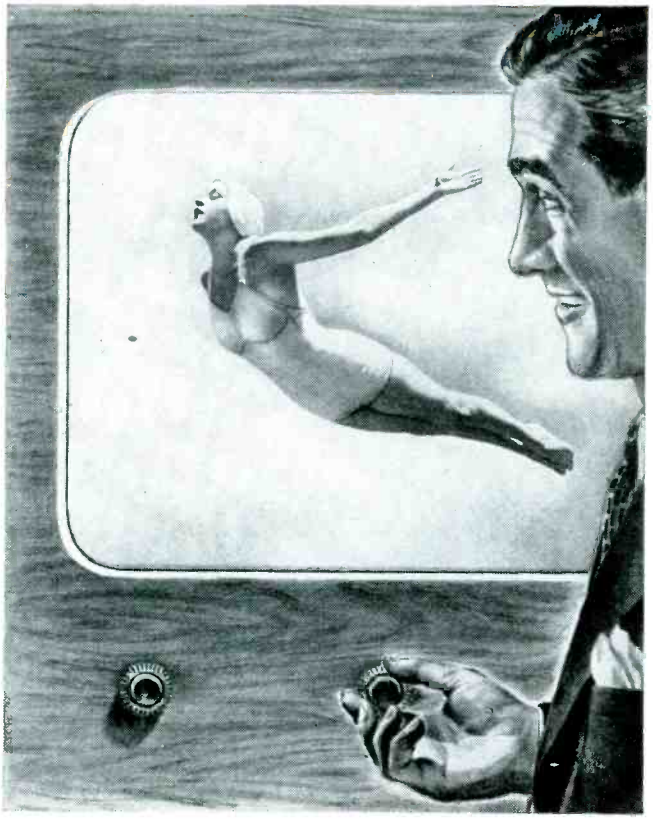


Fig. 4 — Conventional detector-avc circuit uses common diode (A). To minimize distortion, separate detector and avc diode are combined with contact-potential bias circuit (B)

Nerves? OR Curves!



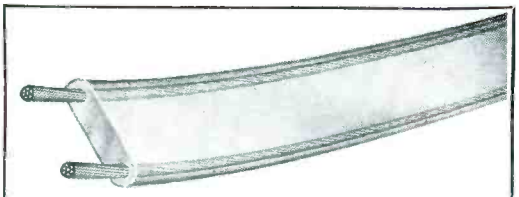


A Type ATV* Television Lead-In Line Can Make All the Difference

ANACONDA Type ATV lead-in lines are playing an important part in helping to give television buyers the kind of reception they want.

The well balanced design of conductors and dielectric in ATV lead-in lines minimizes the effects of attenuation and impedance mismatch. Satin-smooth polyethylene insulation sheds water readily — thus avoiding subsequent impedance discontinuities.

ATV line fulfills the most exacting requirements of wide-band reception — providing maximum freedom from distortion. Television buyers expect a lot. See that an ATV lead-in line helps your set to deliver! 47402



A Type ATV Lead-In Line for Every Need

Anaconda offers a complete selection of Type ATV lead-in lines for 75, 125, 150 and 300 ohms impedance unshielded and 150 ohms shielded. For an electrical and physical characteristics bulletin, write to Anaconda Wire and Cable Company, 25 Broadway, New York 4, New York. Also, write for the characteristics of the complete line of Anaconda coaxial cables.

ANACONDA
from mine to consumer

ANACONDA WIRE AND CABLE COMPANY

*An Anaconda Trade-Mark

ally about 10 megohms. This is in keeping with the use of contact potential bias in a high-mu triode. R_3 is made as high as is permissable for use in the grid circuit of the r-f and i-f tubes. This value is usually limited to 2 megohms, representing a somewhat more serious load on the diode. Distortion from this source, that is, the audio load of the avc decoupling resistor, may be eliminated by the use of a separate diode as avc rectifier, as was common practice several years ago.

A simple form of delayed avc may be realized in this manner by biasing this diode so that it will not conduct until the avc threshold has been reached. The disadvantage of this method is that with signals of the same order of magnitude as this threshold, the avc voltage will be dependent upon the modulation. With normal modulation percentages this effect is not too serious.

A separate avc rectifier lends itself to use with contact potential bias as shown in Fig. 4B. In this case, since R_6 is returned to the negative bias voltage, R_5 will have to be returned to a point several volts positive with respect to the cathode so that the diode will not be cut off.

A number of combinations suggest themselves in assembling a

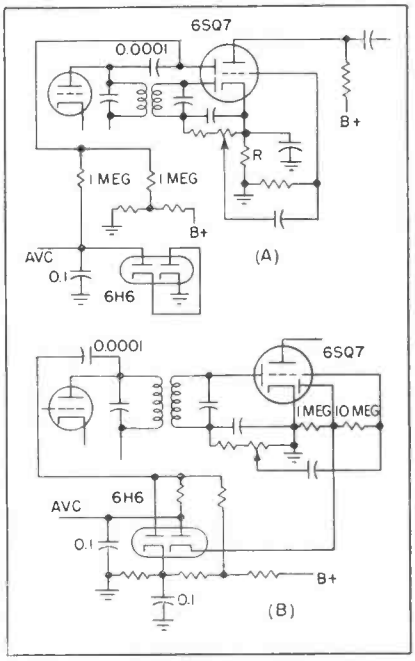


Fig. 5—Additional avc delay may be had by increasing value of R (A). Maximum simplicity and economy of parts are achieved by use of one diode section for both audio grid bias and r-f and i-f bias (B)

WILCOX

First Choice of The Great Silver Fleet

Eastern Air Lines Chooses WILCOX VHF For Their Fleet of New-Type Constellations

New Features Offered in the 118-132 Mc. Band by the Wilcox Type 361A Communications System

• UNIT CONSTRUCTION FOR EASE IN HANDLING

The 50 watt transmitter, high sensitivity receiver, and compact power supply are each contained in a separate ½ ATR Chassis. Any unit may be readily removed from the common mount for inspection. Individual units are light in weight, small in size, and easily handled.

• 70 CHANNELS COVER PRESENT AND FUTURE NEEDS

Both the receiver and transmitter contain a frequency selector mechanism with provisions for 70 small hermetically sealed crystals. Selection of the crystals automatically adjusts the radio frequency amplifiers and harmonic generator circuits to operate at their maximum performance for each selected frequency. Either simplex or cross-band operation may be obtained.

• SIMPLICITY OF CIRCUIT DESIGN MEANS EASY MAINTENANCE

Simple, conventional circuits minimize the number and types of tubes, and require no special training or techniques for adjustment. All components are accessible for routine inspection and service.

Write Today **FOR COMPLETE INFORMATION AND SPECIFICATIONS**

WILCOX ELECTRIC COMPANY, INC.

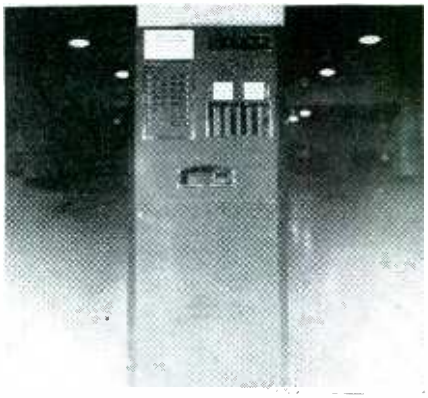
14th AND CHESTNUT STS. • KANSAS CITY 1, MO.

practical circuit. The double-diode triode can be used together with another double diode as in Fig. 5A. Here, the triode is conventionally biased and any additional avc delay desired may be achieved by increasing the value of the resistor *R*. A circuit similar to that in Fig. 3 may be used with an additional double diode, of which one section can be the avc rectifier and the other section can be put in series with the bias diodes to provide additional bias and delay voltage. A system using one diode for both audio grid bias, and as part of the r-f and i-f bias, is shown in Fig. 5B. This circuit makes use of all the considerations put forth in this paper, and represents what is probably the maximum in simplicity and economoy of parts.

In using any of these diode biasing systems, it should be remembered that the contact potential will vary widely with change in heater voltage, and should be used for bias in circuits where stability is important only when the circuit is balanced. Examples may be found in some vacuum-tube voltmeters where the contact potential of the diode used as rectifier is balanced by that of a second diode.

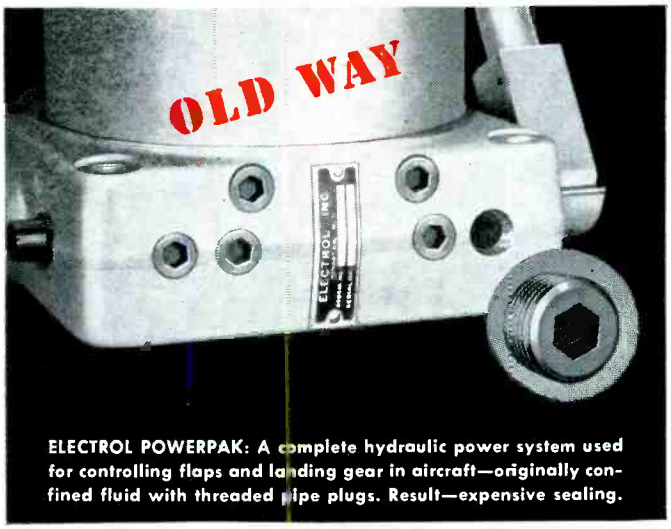
Another source of bias has been suggested which, while it does not use diodes, is rather interesting. A number of photronic cells, connected in series and illuminated by a single pilot lamp, provide a significant bias voltage with a fairly low internal impedance.

TICKET SELLER



An electronic ticket vendor in Philadelphia sells 15,000 suburban tickets a month; saves an estimated 50 to 60 percent of personal selling costs for Penn RR

Redesign eliminates 12 operations, reduces Unit Cost 65 cents



ELECTROL POWERPAK: A complete hydraulic power system used for controlling flaps and landing gear in aircraft—originally confined fluid with threaded pipe plugs. Result—expensive sealing.

NEW DESIGN: Waldes Truarc rings provide positive seal up to 3000 P.S.I. for plugs without threads. Changeover eliminated two milling, ten tapping operations. Result—inexpensive sealing.

Redesign with Waldes Truarc rings not only saved us 65 cents a unit and 6¼ minutes production time, it made a more compact and finer product—reports Electrol, Inc., of Kingston, N. Y. Truarc helped cut 4 ounces a unit, eliminated milling and tapping, allowed switching from skilled to semi-skilled labor. Maintenance was cut more than a half.

Redesign with Truarc, and you will cut costs and increase production, too. 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. All Waldes Truarc retaining rings are precision engineered, easy to assemble and disassemble, always circular to give a never-failing grip. They can be used over and over again. Send us your problem. Waldes Truarc engineers will be glad to show how Truarc can help you.

15 Waldes Truarc Retaining Rings effect these Savings

	SAVING
• Eliminate 2 milling operations . .	$.10
• Replace 10 tapping operations with grooves	.15
• Increase accuracy of mating parts	.03
• Replace pipe plugs with plugs made in automatics	.16
• Cut plug assembly time over 50%	.15
• Reduce production test time . . .	.06
Total savings per unit . .	**$.65**

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

Waldes Kohinoor, Inc., 47-10 Austel Place 18-T
Long Island City 1, N. Y.

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

Name_____

Title_____

Company_____

Business Address_____

City_____ Zone_____ State_____

WALDES TRUARC

U. S. PATENT RE. 18,144

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK
Canadian Rep.. Controlite Engineering & Sales Ltd., 20 Bloor Street W., Toronto 5

ELECTRON ART
(continued from p 138)

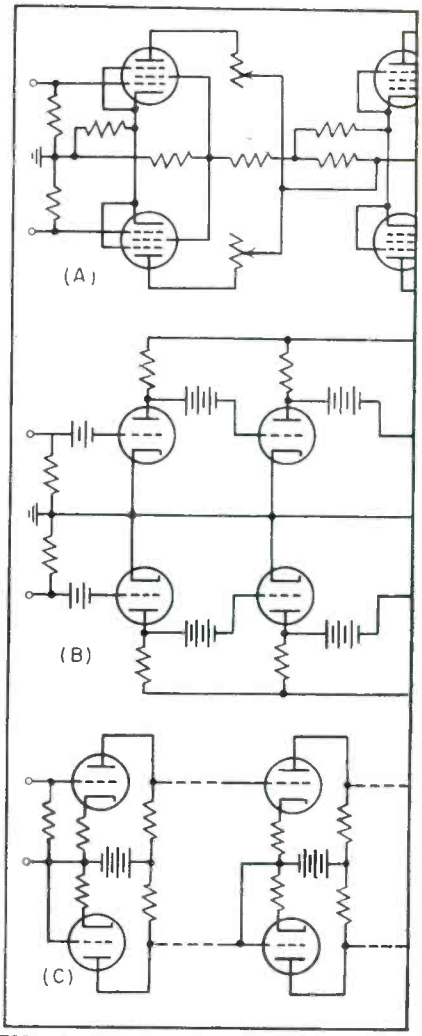


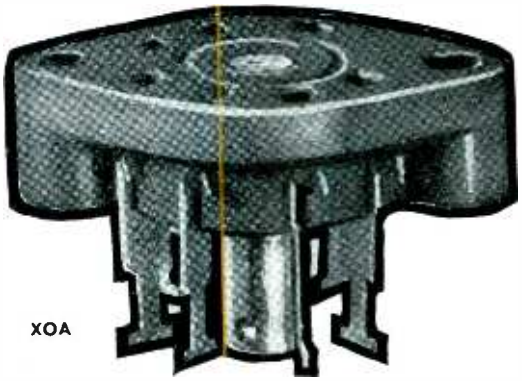
FIG. 1—The top two circuits illustrate common types of direct coupling; the lower one shows an improved method

beyond satisfactory operating limits. Were common cathode resistors used, the effect would be decreased, but would not be eliminated.

Difficulty of adjustment and the passing on of drift voltages can be eliminated by the circuit of Fig. 1C. The amplifier consists of a series of independent stages linked with only two connections (shown dotted). One connection carries the signal; the other, the reference voltage. To keep each stage separate, individual power supplies are used. Only one side of each stage carries the signal, the other being to cancel drift voltages. Any drift affecting both tubes of a stage equally will not produce a change in voltage at the coupling out of that stage.

Circuit Behavior

Because only one channel of the balanced amplifier carries signal,

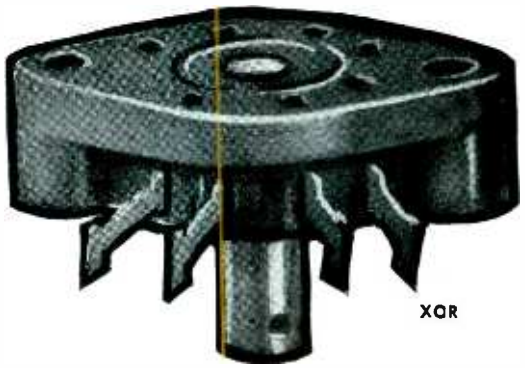


XOA

● The XOA Socket for Miniature Button 7-pin bases is made of low-loss mica-filled bakelite. It mounts with two 4-40 screws. Terminals for the Type XOA extend axially from the socket. Type XOR is identical to Type XOA, but has terminals extending radially. Short heavy terminals reduce contact inductance. Lower effective capacity between terminals reduces circuit capacity.

XOA Type Socket.....Net Price.....$ .50

XOR Type Sacket.....Net Price.....$ .50



XOR

● The XOS tube shield is a two-piece shield for Miniature Button 7-pin base tubes. It mounts with the XOA or XOR socket and is available in three sizes, XOS-1 (1-3/16" high), XOS-2 (1½" high), and XOS-3 (2" high).

XOS-1 Shield
Net Price.....$ .48

XOS-2 Shield
Net Price.....$ .48

XOS-3 Shield
Net Price.....$ .48

Special price quotations may be obtained for bulk orders. Please write for further information.

First-rate PARTS mean *first-rate* EQUIPMENT

National
EST 1914

If you're planning to build the type of precision-built equipment that will sell in today's competitive market, it will pay you to order National parts.

Through long practical experience manufacturers, engineers and laboratory research workers have all found that National parts can be relied upon for dependability and long life.

If you need good material and exacting workmanship in your parts, see your nearest National dealer today.

National Company, Inc.
Dept. No. 10
Malden, Mass.

XR-50

● XR-50 coil forms may be wound as desired to provide a permeability tuned coil. The form winding length is 11/16" and the farm winding diameter is ½". The iron slug is ⅜" diameter by ½" long.

AR-5

AR-2

● The AR-2 and AR-5 coils are high Q permeability tuned RF coils. The AR-2 coil tunes from 75 mc to 220 mc and the AR-5 coil tunes from 37 mc to 110 mc with suitable capacitors.

MAKERS OF LIFETIME RADIO EQUIPMENT

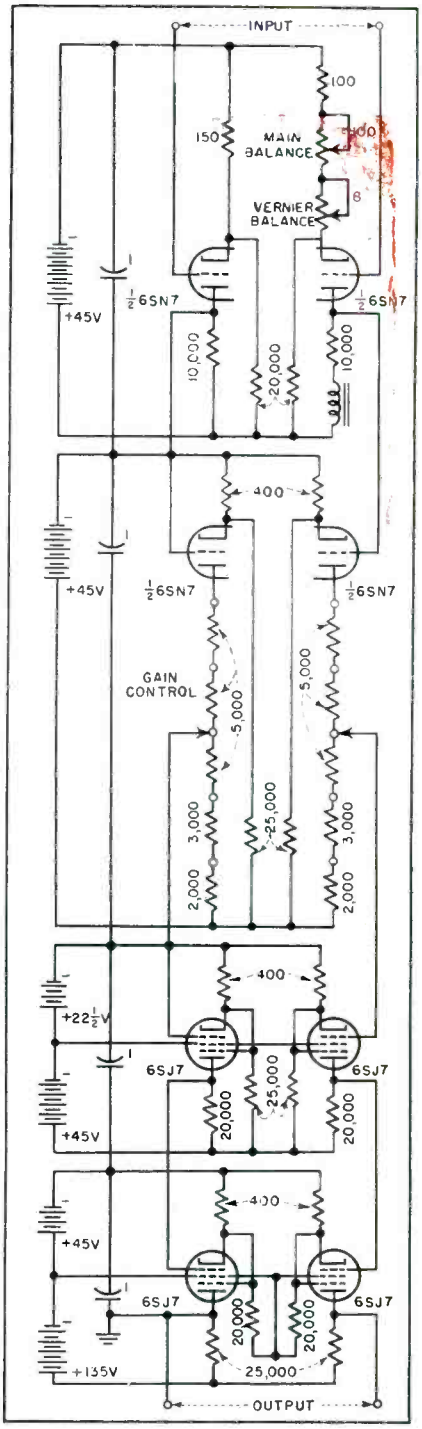


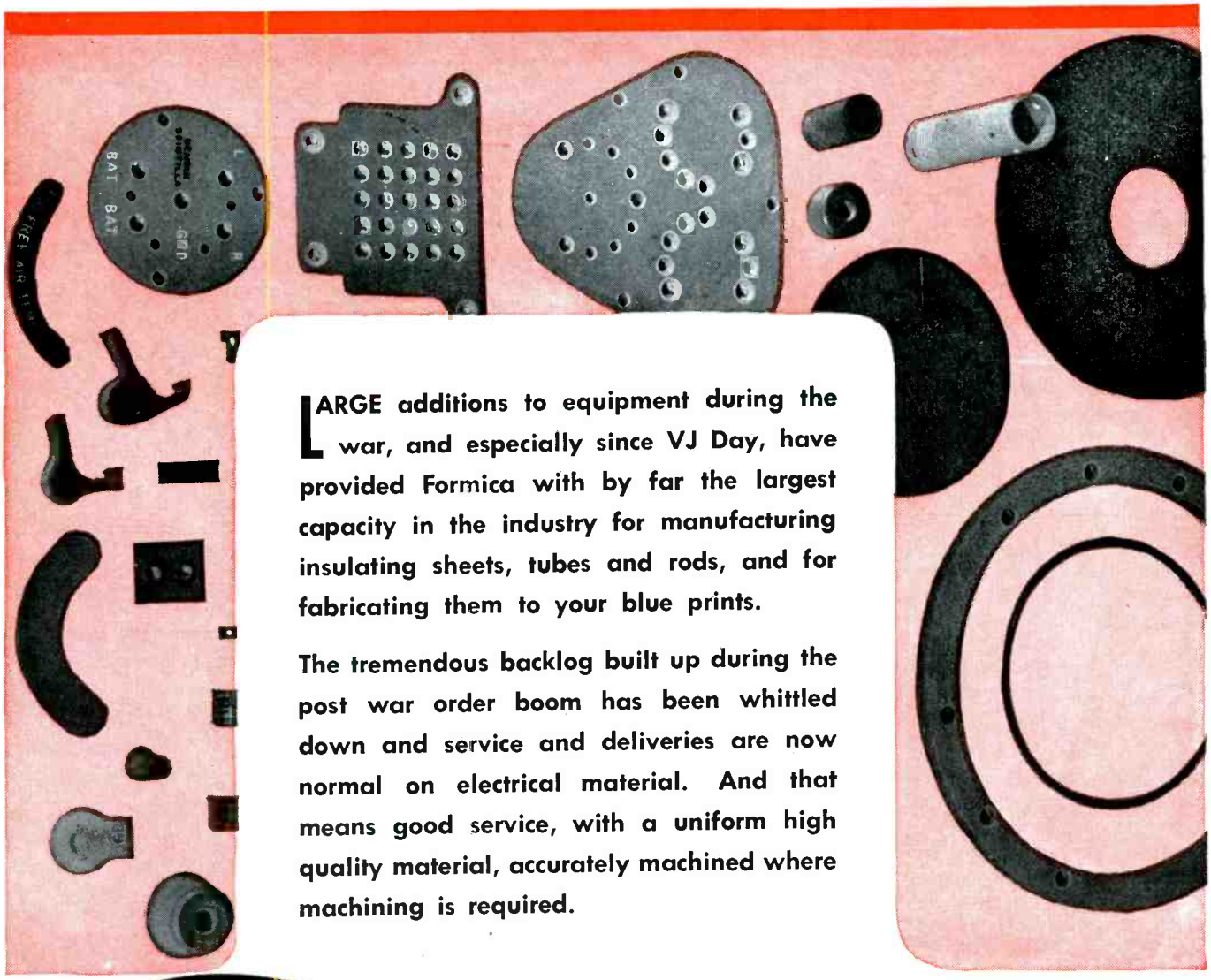
FIG. 2—Four stage directly coupled amplifier is stabilized against drifts

no special shielding or placement of parts is necessary in the nonsignal channel. Furthermore there can be no interaction between a nonsignal half of a stage and any other stage, or, because no common cathode resistor is used, between nonsignal and signal halves of a single stage. As a result the nonsignal halves of the stages can be adjusted without affecting the rest of the amplifier, and once it is adjusted, that half of the amplifier

BIG CAPACITY

COMPLETE FABRICATING EQUIPMENT

GOOD SERVICE



LARGE additions to equipment during the war, and especially since VJ Day, have provided Formica with by far the largest capacity in the industry for manufacturing insulating sheets, tubes and rods, and for fabricating them to your blue prints.

The tremendous backlog built up during the post war order boom has been whittled down and service and deliveries are now normal on electrical material. And that means good service, with a uniform high quality material, accurately machined where machining is required.

FORMICA
TRADE MARK REG. U.S. PAT. OFF.

THE FORMICA INSULATION COMPANY
4661 Spring Grove Avenue, Cincinnati 32, Ohio

ELECTRON ART (continued)

can be forgotten. (It is assumed that there is no grid current in the signal channel. If there is grid current, low plate loads can minimize its effect.)

Because it is impractical for components of both channels to exactly correspond, some adjustment is necessary. Fortunately adjustment of grid bias in the first stage will satisfactorily correct all succeeding stages. If corresponding components of both channels are closed matched, changes in grid bias from such a single adjustment will not move the tubes out of operating limit.

Figure 2 shows a four stage version of this type amplifier; filament wiring and battery disconnects are omitted. The voltage gain is about 10,000. A final amplifier stage (not shown) has been used to bring the over-all amplification to either 250,000 or 1,000,000.

Two variable resistors in the cathode circuit if the first stage provide balancing adjustment. Cathode degeneration is reduced by using bleeder resistors. A stepped gain control is introduced between the second and third stages that does not destroy amplifier balance or drift cancelation. The capacitors, by lowering a-c impedance between power supplies, prevents oscillation. A dual type tube was chosen for the first stage as the two sections, being in the same envelope, are more apt to be subjected to the same changes. Because of the high gain, battery power is used to avoid hum. Medium size B-batteries (Burgess No. 5308) have shown a surprisingly long life. A 6-volt storage battery supplies the heater current. The final stage can be operated from an a-c powered supply.

Construction and Performance

Two amplifiers were constructed using standard parts. Resistors were of the ordinary metallized variety, each one in the signal channel being matched to within two percent of the corresponding one in the nonsignal side. To obtain the necessary fineness of adjustment, the 8-ohm vernier was a specially made spiral slide wire. Signal-carrying wiring was kept isolated from other parts where

FOR TROUBLE-FREE WIRE PERFORMANCE

125 Permanently Insulated ROCKBESTOS Wires, Cables and Cords

From the three basic designs illustrated Rockbestos has developed a complete line of 125 failure resisting wires, cables and cords, a few of which are described. All have the same performance guaranteeing characteristics detailed below. Write for information or samples.

Rockbestos Permanent Insulation Insures Long-Lived Service

1. A tough impregnated asbestos braid, resistant to heat, flame, moisture, oil, grease, alkalies and corrosive fumes.
2. Felted asbestos insulation impregnated with heat, flame and moisture resistant compounds will not dry out with age, burn, or bake brittle under high temperatures.
3. Lubricated varnished cambric for high dielectric strength and added moisture resistance — protected from heat, flame and oxidation by felted asbestos walls.
4. Impregnated asbestos insulation that withstands heat of overloads and aging and won't become brittle, crack, rot or burn.
5. Conductors are perfectly centered in helically applied non-flowing insulation and will always remain so.

ROCKBESTDS ALL-ASBESTOS APPLIANCE LEAD WIRE

Sizes No. 8 to 20 AWG solid or stranded copper, monel or nickel conductors insulated with .031" or .040" of impregnated felted asbestos in black, white or colors.

Whether you make waffle irons, hot-plates, small motors, ranges, water heaters, radios, ovens or blueprint machines, we can give you an asbestos lead wire made to fit the electrical and mechanical requirements of your product.

ROCKBESTOS A.V.C. 600 VOLT MOTOR LEAD CABLE
(National Electrical Code, Type AVA)

Size No. 18 AWG to 1,000,000 CM insulated with two walls of impregnated asbestos and a high-dielectric varnished cambric insert, with a heavy asbestos braid overall.

Use this apparatus cable for coil connections, motor and transformer leads exposed to overloads or high ambient temperatures. It makes a permanent installation as it is resistant to heat, flame, oil, grease and moisture.

ROCKBESTOS A.V.C. 600 VOLT SWITCHBOARD WIRE
(National Electrical Code, Type AVB)

Sizes No. 18 to No. 4/0 AWG with varnished cambric and impregnated asbestos insulation and gray, black, white or colored flameproof braid.

Combine fire insurance and fine appearance in your switchboards with Rockbestos Switchboard Wire. It is fireproof and will not dry out under heat. Sharp, clean bends can be made without cracking as the asbestos wall acts as a cushion under the braid. Rockbestos A.V.C. Hinge Cable and Switchboard Bus Cable have same fireproof and heatproof characteristics.

ROCKBESTOS ALL-ASBESTOS 600 VOLT FLEXIBLE CORD

Sizes No. 10 to 18 AWG with two or three conductors insulated with impregnated felted asbestos and covered with a heavy asbestos braid.

This heavy duty heat-resisting flexible cord is ideal for high wattage lighting units, apparatus, floodlights, etc., that are used in hot spots or develop heat in operation. For moisture resistant type specify Rockbestos A.V.C. construction.

ROCKBESTOS APPARATUS HEATING CABLE

No. 19 AWG nickel-chromium resistance wire insulated with .040" of impregnated felted asbestos and covered with 4/64" waterproof lead sheath.

Manufacturers of photographic developing tanks, candy making equipment, soil heating cable kits and other devices requiring controlled distribution of mild heat can use this pliable heating cable to advantage.

ROCKBESTOS THERMOSTAT CONTROL WIRE

Sizes No. 14, 16 and 18 AWG in two to six conductors with .0125", or .025" or (for 115 volt service) .031" of impregnated felted asbestos insulation and steel armor.

A multi-conductor control wire for low voltage intercommunicating, signal, and temperature control systems. Lifetime heatproof, fireproof insulation and rugged steel armor give trouble-proof circuits.

ROCKBESTOS ASBESTOS INSULATED MAGNET WIRE

Round, square and rectangular asbestos insulated conductors finished to meet varying winding conditions and coil treatment requirements.

Protect your motors against heat-induced breakdowns with class B windings of Rockbestos Heat-Resisting Magnet Wire. Leads of Rockbestos A.V.C. Motor Lead Cable will complete the failure-proofing.

ROCKBESTOS A.V.C. 600 VOLT POWER CABLE
(National Electrical Code, Type AVA)

Sizes No. 18 AWG to 2,000,000 CM insulated with laminated felted asbestos, varnished cambric, and asbestos braid. Other constructions for service voltages to 5000.

For protection against failure caused by conductor-heating overloads and high ambient temperatures use this permanently insulated heat and flame resistant power cable for the internal wiring and power leads of products.

ROCKBESTDS FIREWALL HOOKUP WIRE

Sizes No. 22 to 4 AWG in 1000 volt rating, and No. 12, 14 and 16 AWG in 3000 volt insulated with high dielectric synthetic tape, impregnated felted asbestos and covered with color coded lacquered glass braid.

Originally designed to meet the demand of airborne radio equipment manufacturers for a flame and heat resistant wire and widely used since in ground, marine and mobile communications systems, electronic devices and apparatus. Operating temperature range 125° C. to minus 50° C. Ideal for wiring harnesses in compact apparatus and small motor, coil, transformer and dynamotor leads. Also in twisted pair, tripled or cabled multi-conductor constructions.

ROCKBESTOS ALL-ASBESTOS 600 VOLT RHEOSTAT CABLE
(National Electrical Code, Type AIA)

Sizes No. 18 AWG to 1,000,000 CM insulated with a heavy wall of felted asbestos, covered with a rugged asbestos braid finished in black, white or colors.

Use this power and rheostat cable for wiring rheostats, switchboards, elevator, locomotive control panels and equipment exposed to heat, fumes and fire hazard. For flexible stranded conductor specify Rockbestos All-Asbestos Flexible Apparatus Cable. For solid conductor specify Rockbestos All-Asbestos Rheostat Wire.

ROCKBESTOS 300 VOLT HEAT RESISTING DUPLEX FLEXIBLE CORD
(Underwriters' Type AFPD)

Sizes No. 10 to 18 AWG stranded plain copper conductors insulated with impregnated felted asbestos, polarized, twisted together and covered with a cotton braid.

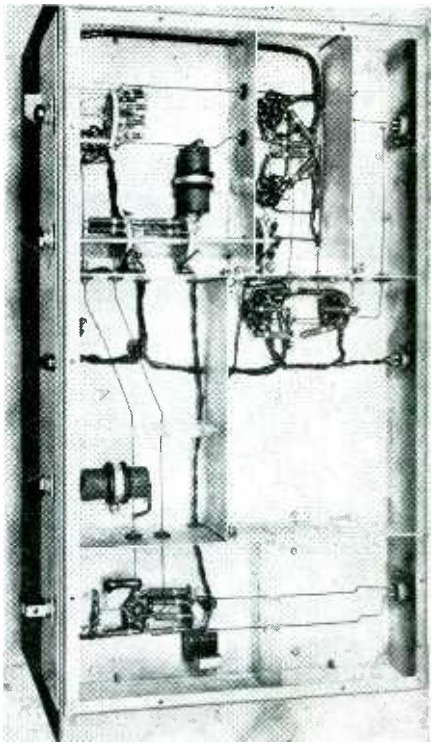
This duplex heat resisting flexible cord is approved by the Underwriters' Laboratories for use in fixtures and is recommended for apparatus leads where moisture resistance is not required. Other types also available.

ROCKBESTOS PRODUCTS CORP.
452 NICOLL STREET, NEW HAVEN 4, CONN.

ROCKBESTOS

The Wire with Permanent Insulation

ELECTRON ART (continued)

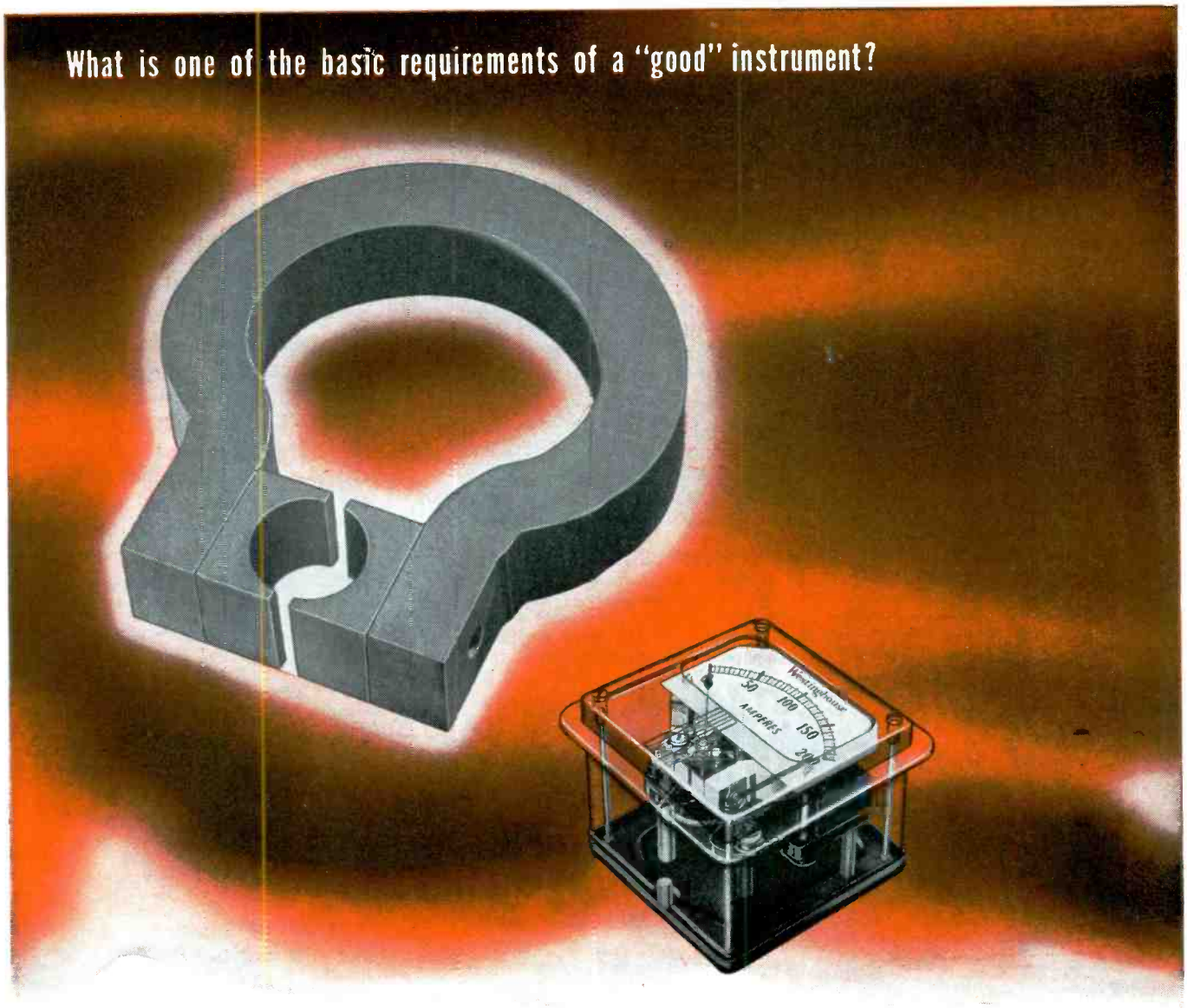


Signal and balancing circuits are kept separate in wiring; batteries for individual stages are on top of chassis with tubes and additional shielding

possible; a shield was put between stages. Input and output leads were kept well separated. The 6SN7 tubes were tested to obtain those having the least drift and being the least microphonic; the the 6SJ7 tubes were selected in matched pairs. Both amplifiers have performed very well for over two years.

Amount of drift depends largely on how closely the input tubes are matched and how long a warm-up is allowed. Because most of the drift is caused by change of cathode temperature, the heater current is turned on first. Tests with carefully selected tubes indicate that, after 10 minutes of warm-up, a drift equivalent to about 0.5 millivolt input signal can be expected over two hours. After the first hour, if no overloading has occurred, the equivalent drift has decreased to about 50 microvolts over a two hour period.

The frequency response is essentially flat from zero to at least 50,000 cps, and could be further extended if compensation in addition to the 85-mh inductance in the first stage were added. This inductance, wound on a high permeability iron core, reduces phase shift, which



MAGNETS that never age

. . . one of the reasons why Westinghouse instruments are good!

Westinghouse instrument magnets retain full field strength for life.

The pole faces are machined with extreme tolerance control to give maximum scale linearity. The skill acquired by Westinghouse instrument craftsmen and engineers . . . throughout 58 years of research and specialization . . . has resulted in parts designed to meet every standard of perfection. Herein lies the secret of making good instruments. It is the harmonious operation of all parts, designed and built by Westinghouse, that assures you *unfailing* performance under the most adverse operating conditions.

The wide scope of the Westinghouse line provides the electrical measuring instruments to fill your needs exactly. If you have an instrument problem, consult a Westinghouse instrument specialist. Call your nearest Westinghouse office or write Dept. E-10, Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

★ ★ ★

IMMEDIATE DELIVERIES on many instruments . . . others up to 90 days.

J-40353

Westinghouse INSTRUMENTS

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

Built for Unfailing Performance

comparison of input and output signals on an oscilloscope shows to be less than 10 degrees at 20,000 cps. The use of screen-grid tubes accounts for the high-frequency response with high gain because low plate resistances can be used without sacrificing amplification, as would be the case with triodes. This circuit lends itself to the use of screen-grid tubes, whereas in many d-c amplifiers their use is difficult.

The amplifier output is necessarily at a relatively high positive potential (150 to 200 volts) with respect to the input. Thus, only the input or the output, not both, can be grounded; the other must be well insulated from ground and handled accordingly. If the amplifier drives an oscilloscope, it is ordinarily more satisfactory to ground the output of the four stages shown in Fig. 2, allowing the final amplifier plates, which should be connected directly to the deflection plates of the cathode-ray tube, to assume a positive potential with respect to ground, and the input to the four-stage amplifier to assume a negative potential.

Variable-Frequency Stimulator for Electrophysiology

WALTER I. WEISS
Development Engineer
Rahm Instruments, Inc.
New York

IN MANY fields of biophysical and medical research, equipment for the electrical stimulation of living tissue is required. The stimulator to be described was designed to include a maximum of flexibility from all standpoints.

In general there are three variables to be considered, namely amplitude, waveshape, and repetition rate. All are interdependent from the standpoint of stimulation. The amplitude of stimulus required may be 3 to 5 volts for such applications as the location of motor areas of the brain in neurosurgery, or a few millivolts for the stimulation of the nerve in the gastrochemous muscle preparations.

Using this stimulator to contract the gastrochemous muscle of a frog by stimulation of the sciatic nerve, minimal stimulus was 12 millivolts

An Offer

TO USERS OF SMALL PERMANENT MAGNETS

Frequently, Stackpole Permanent Magnets of *Sintered* Alnico II mean both a worthwhile cost saving and an improvement in magnet efficiency. It all depends on such things as design, size, shape and weight.

In general, this Stackpole molded-sintering process offers its greatest economies in magnets up to 2 ounces in weight. Besides the production of rectangular and cylindrical types, the method extends to many odd shapes where costly machining is often eliminated.

Thus, to make it easy for quantity users to judge for themselves, we make this offer:

Send full details of your magnet requirements for recommendations and free samples to specifications (but not heavier than 2 ounces). Your own tests of these actual units will speak more convincingly than any mere claims we might make on their behalf.

STACKPOLE CARBON COMPANY • ST. MARYS, PA.

STACKPOLE SINTERED ALNICO II

SMOOTH SURFACES—for easier brazing or soldering.

CLOSE TOLERANCES—with a minimum of costly grinding.

FINE GRAIN STRUCTURE—for greater mechanical strength.

REAL ECONOMY, HIGHER UNIFORMITY—for odd shapes and small sizes.

for the sawtooth wave and 34 millivolts for the peaked wave at a basic repetition rate of 90 cycles per second and an ambient temperature of 26.6 C. The stimulator has a maximum output of 10 volts, while on the lowest of the three output ranges, variations of 2 millivolts can easily be set and read on the output meter. Continuously variable output is available over the entire range.

Choice of Waveshapes

Much has been said concerning the desirability of various wave shapes for stimulation, but as yet there has been no standardization, the choice being one of personal preference. Sinewave stimulators, both 60-cycle and variable-frequency, are in use to some degree. Rectangular waves have been used with success and there are many points in favor of this waveshape.

To date, however, little has been done in the development of a commercially available rectangular wave generator of sufficient flexibility. Perhaps the most widely used waveshape is the sawtooth, which is a close approach to the theoretically ideal exponentially rising voltage. Therefore, the sawtooth is one of the waveshapes included in the stimulator.

Making use of the linearizing circuit of Newsam, it is possible to obtain exceptionally good waveshape while at the same time increasing the efficiency of the thyratron to some 50 percent. In Fig. 1, cathode-follower stage V_2 is shunted across the greater portion of the charging resistor, R_4, R_6, and R_8. As the cathode to grid voltage is nearly constant for a cathode follower whose gain is nearly unity, the current

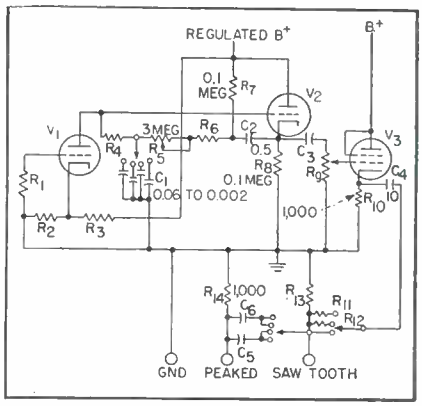


Fig. 1—Maximum output of 10 volts is provided by this electrophysiological stimulator

MIRAGLAS IS THE NAME

4 FOR THE 4 GRADES OF VARNISHED TUBINGS TO MEET OR EXCEED SPECIFICATIONS

SET BY VARNISHED TUBING ASSOCIATION AND AMERICAN SOCIETY FOR TESTING MATERIALS

STANDARD GRADE

for maximum flexibility, has little varnish and is recommended for high temperatures where dielectric strength is not a factor.

DOUBLE SATURATED

has all qualities of the STANDARD GRADE but with additional coats of varnish to bring the dielectric rating up to 1500 volts.

TRIPLE STRENGTH

is built up with coats of especially flexible insulation varnish for dielectric ratings up to 2500 volts and is particularly suited where assembly operations include the possibility of rough handling.

IMPREGNATED

is the Optimum in Superiority for high gloss, non-hydroscopic, resistance to high temperatures, oils, acids, etc. IMPREGNATED has a dielectric rating beyond 7000 volts and is unequalled for Long Life Under Most Severe Conditions. *Write For Samples.*

FOR USERS OF COTTON YARN VARNISHED TUBINGS The Mitchell-Rand MIRAC and HYGRADE Varnished Tubings of long staple fiber yarn are comparable to Fiberglas Tubings in dielectric ratings, tensile strength, flexibility and long life.

Write today for your free copy of the M-R WALL CHART with its engineering tables, electrical symbols, carrying capacities of conductors, dielectric averages, thicknesses of insulating materials, tubing sizes, tap drills, etc.

MITCHELL-RAND INSULATION CO. Inc.

51 MURRAY STREET · COrtlandt 7-9264 · NEW YORK 7, N. Y.

A PARTIAL LIST OF M-R PRODUCTS: FIBERGLAS VARNISHED TUBING, TAPE AND CLOTH · INSULATING PAPERS AND TWINES · CABLE FILLING AND POTHEAD COMPOUNDS · FRICTION TAPE AND SPLICE · TRANSFORMER COMPOUNDS · FIBERGLAS SATURATED SLEEVING · ASBESTOS SLEEVING AND TAPE · VARNISHED CAMBRIC CLOTH AND TAPE · MICA PLATE, TAPE, PAPER, CLOTH, TUBING · FIBERGLAS BRAIDED SLEEVING · COTTON TAPES, WEBBINGS AND SLEEVINGS · IMPREGNATED VARNISH TUBING · INSULATED VARNISHES OF ALL TYPES · EXTRUDED PLASTIC TUBING

through the resistor is almost constant and capacitor C_1 charges linearly.

Distortion is further minimized by the use of cathode-follower output stage V_3, which serves as an impedance transformer to the low output impedance. This low value is a requisite for good regulation since the preparations to be stimulated are apt to be low-impedance loads.

A second wave shape is available by differentiation of the sawtooth wave. The resultant sharp pulse is often of use when a stimulus of short duration is desired. It may also be used simultaneously with the sawtooth to trigger a single sweep circuit for observation on a cathode-ray oscilloscope. The output meter reads approximately the average value of the sawtooth wave and is calibrated in equivalent rms value for sinusoidal voltage.

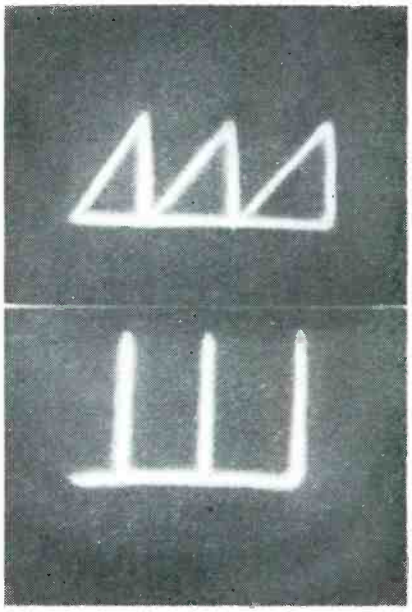


Fig. 2—Sawtooth and pulse output wave shapes of the electronic stimulator as seen on a c-r tube

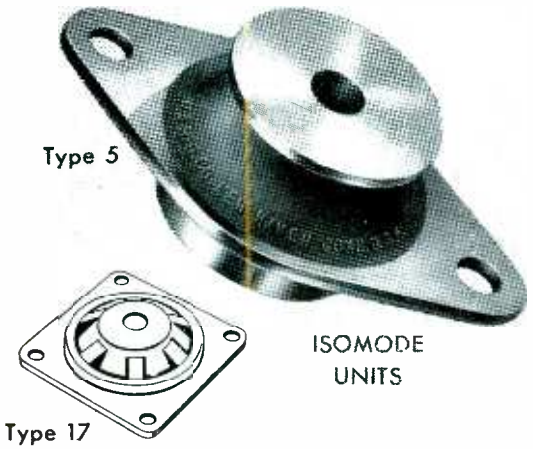
The frequency is determined by charging resistor R_6 and capacitor C_1. It is felt that the range incorporated, 11.5 to 1,300 cycles per second, is more than sufficient to meet most electrophysical requirements. Good frequency stability for line voltages from 95 to 125 volts is obtained by use of a regulated voltage supply for the oscillator section.

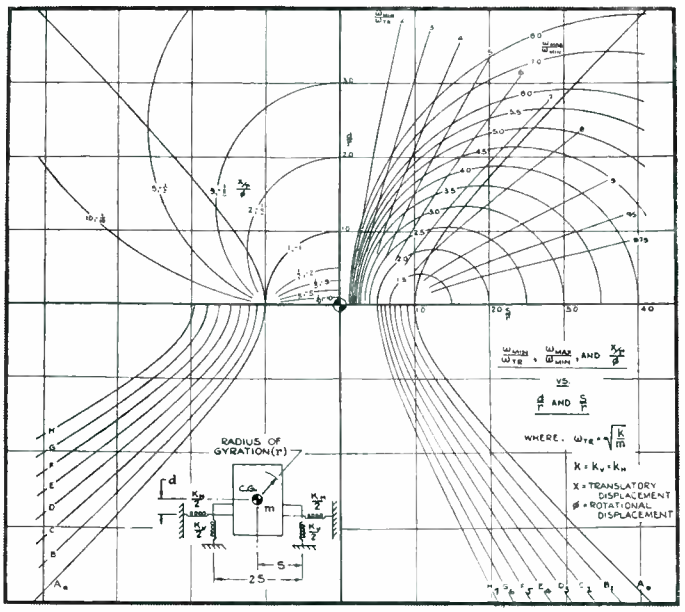
A 600-volt, hermetically sealed, oil-filled capacitor is used to couple the cathode of output stage V_3 to output resistor R_{13}. The instantane-

GREAT NEWS!

VIBRATION CONTROL now SIMPLIFIED

...with MB developments in vibration engineering





ISOMODE DESIGN CHART

HERE'S A REMARKABLE, new method of locating support points for flexible mountings. It reduces your difficult design problem to an almost routine job. And what's more, it assures you *optimum* isolation every time, from standard units, with mathematical certainty! Here are partial details:

THE MB ISOMODE* DESIGN CHART SAVES WORK, SAVES TIME

Set down graphically are the relationships you formerly found by trial and error. Each quadrant covers a different phase of the entire vibration problem. You outline your product right onto the chart. Then read your solutions directly from intersections of various curves and mount-locations of product.

SEND FOR FREE REPRINT

This technical paper gives the information you need for better vibration control design. It describes the chart—shows you how to use it. No obligation, of course. Write Dept. B5

THE MB ISOMODE* UNIT— CLINCHES THE RESULTS

You can install these units at any convenient angle—because MB engineered them with an equal spring rate in all directions. That's also why they isolate with extra high efficiency. For the same radial and axial softness absorbs not only vertical, but *horizontal* and *rocking* motions as well! They have high deflection capacity, yet are thoroughly stable. Safe, self-snubbing, compact sizes are available for loads of ½ pound to 2500 pounds.

Why not investigate this simplified MB method? Give your product the benefit of vibration control accomplished in the *design stage*—and make no compromise on efficiency. You'll get a product that works more smoothly, lasts longer—and sells better!

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

THE MB MANUFACTURING COMPANY, INC.
1060 State Street
New Haven 11, Conn.

VIBRATION ISOLATOR UNITS • VIBRATION TEST EQUIPMENT

VIBRATION DIVISION

ous peak voltage is never more than 50 volts.

Examples of output waveshape, both sawtooth and pulse, are given in Fig. 2. A switching arrangement is provided externally to allow for keying of the stimulus in applications where continuous stimulation is not desired.

SURVEY OF NEW TECHNIQUES

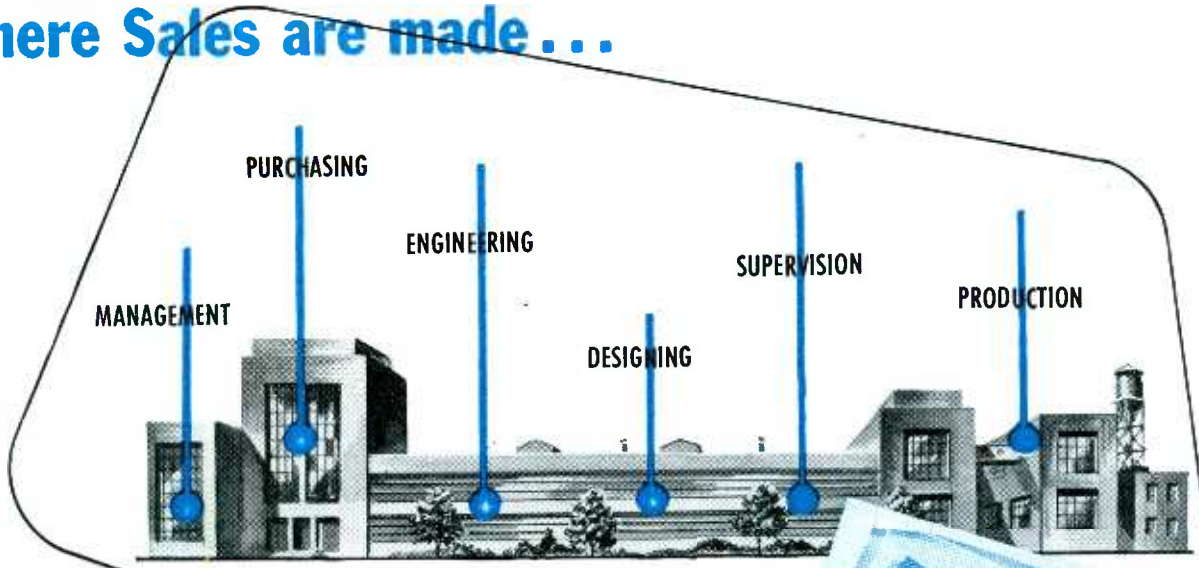
ELECTRONARCOSIS, electrically induced sleep, is a modification, developed by scientists working with Dr. K. M. Bowman at California Institute of Technology, of electroshock. It is being tried out clinically in the California State Hospital under research funds from University of California. Treatment for some forms of insanity, consisting of applying current through electrodes for about seven minutes as shown in the illustration, is given on an empirical basis pending collection of enough case histories for thorough evaluation. Initially 170 to 250 ma are applied, dropped after about 30 seconds to around 70 ma, and then gradually increased depending on the patient's reactions.

Electrical shock therapy may cure some forms of insanity

In the Glissando technique, reported by Dr. E. B. Tietz of Los Angeles, the current is stepped up during the first few seconds from zero to the initial dosage. The patient returns to consciousness shortly after the current is removed.

COLD-CATHODE RECTIFIERS in which a corona discharge at atmospheric and higher pressures of hydrogen and nitrogen were found to be useful for low-current applications by W. H. Bennett, now at the National Bureau of Standards. Discharge is produced from the tips of wires of

Where Sales are made . . .



you'll find electronics BUYERS' GUIDE

. . . on the desks of the engineers and executives throughout industry — those all-important men whose decisions and plans are the final factors in the purchase of electronic components, "packaged" equipment, or allied products.

These men have learned to rely on, and use the Buyers' Guide for information on product sources *and* technical data on those products. A handy desk package for the time-pressed designers — the only directory of its kind — containing accurate information on all products concerned with their work. When they look up a needed component or product and find one with correct characteristics — a sale has been made.

As a matter of fact, that is your Point of Sale. Once a product has been designed into the pilot model the time for selling, 9 times out of 10, is passed. It is either too late or too difficult to change or fit in a substitute. Don't overlook this year round salesman — be sure to include it in your 1948 advertising budget.

THE MEN YOU MUST REACH . . .

If you are going to sell your product, the best time to reach them is when their product is on the drafting table and components or complete equipment is being designed in. That's the point of sale — and it's the time they're using the Buyers' Guide.

electronics BUYERS' GUIDE

The reference buying guide used by every industry

330 WEST 42nd ST., NEW YORK 18, N. Y. • PUBLISHED YEARLY • IN JUNE • A McGRAW-HILL PUBLICATION

0.4 to 3 mils diameter. Atmospheres free from electron attaching components are necessary. Anodes in the tubes can be formed by coating the envelope with Aquadag. As the tubes require no heater, they can be conveniently arranged in a voltage-multiplier rectifier and require no warm-up period; tubes can be built for 10 kilovolts at about 100 microamperes per wire.

VIDEOTELEPHONE comprising a small television set combined with the telephone apparatus has been built by I. P. Zakharov of the USSR Television Research Institute. The

Telephone position includes lighting, iconiscope (behind round dark opening), and kinescope (in recessed box)

equipment, showing the person at the other end of the line, is installed at the Institute.

VELOCITY OF PROPAGATION of centimeter radio waves must be accurately known in making range measurements by radar. Measurements directed by F. E. Jones of the British Telecommunications Research Establishment and conducted over clear optical paths up to 40 miles long over sea show that the velocity of propagation is 186,217 $\pm$ 16 miles per second, which is substantially the velocity computed by taking into consideration the refractive index of the atmosphere. The measuring technique consisted of accurately surveying the distance between two sites, measuring the radio time between them with oboe blind-landing radar range equipment (9 cm) whose timing and sweep had been accurately calibrated, and computing the wave velocity.

one-two-three! insert engage actuate!

3 simple steps to fast, secure fastening with **CHERRY** blind rivets

ONE MAN REPLACES TWO. Bottom of soda fountain shows Cherry Rivets. Body fastened with self-plugging rivets, foot with pull-through hollow rivets. One man does a fast, secure job.

IT'S JUST THAT SIMPLE. Insert the Cherry Rivet in the hole, engage the rivet, actuate the gun. A powerful controlled pull does the rest. This adds up to speed, speed, speed.

DYNAMIC EXPANSION of the rivet shank during installation means tight, strong, vibration-resistant joints. One man does it all. No bucking bars, no hammering. Just three simple steps to fast, secure fastening.

SCREWS WORK LOOSE. Cherry Rivets replace sheet metal screws in construction of refrigerated creamery trucks at Los Angeles Automotive Works. Screws had a bad record: 60% of screws would work loose within 6 months. Cherry Rivets have a perfect record of tight, vibration-resistant joints.

Tight-clinching pull-through hollow type Cherry Rivet

High strength self-plugging type Cherry Rivet

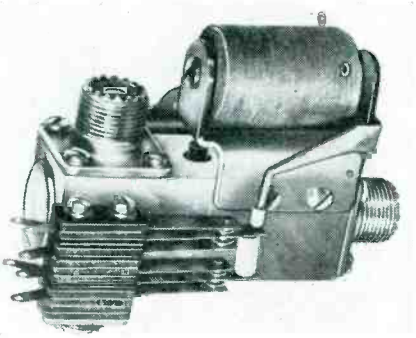
For more information write to Dept. J-120, Cherry Rivet Co., 231 Winston Street, Los Angeles 13, Calif.

VIBRATION DOESN'T MATTER NOW. Screws and bolts used to work loose when the stoves were in transit. So J. H. McKie Co. now fastens stove frames with Cherry Rivets. Fast production. Tight, vibration-resistant joints.

CHERRY RIVETS, THEIR MANUFACTURE & APPLICATION ARE COVERED BY U.S. PATS. ISSUED & PEND.

Cherry Rivet Company
LOS ANGELES 13, CALIFORNIA

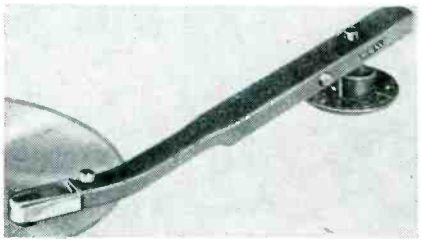
NEW PRODUCTS
(continued from p 142)



lines. An inspection port is provided for the internal contacts, and external contacts are available for the control of indicator lights or associated circuits. Connectors are Amphenol 83-1R for RG-8U coaxial cable.

Reproducer (13)

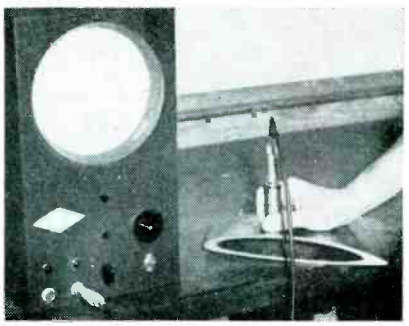
AUDAK Co., 500 Fifth Ave., New York, N. Y. Model 74-A tuned ribbon reproducer has high output without amplification. The jewel



stylus can be replaced by the user. Response is linear to 10 kilocycles. Pressure is 24 grams.

Ultrasonic Gage (14)

SPERRY PRODUCTS, INC., 15th St. and Willow Ave., Hoboken, N. J. The Reflectogage is an ultrasonic thickness-measuring device that requires access to only one side of the material. It measures thickness of tubes and flat parts directly in the range 0.005 to 0.300 inch, or indi-



Millions of knobs to prove one thing about plastics

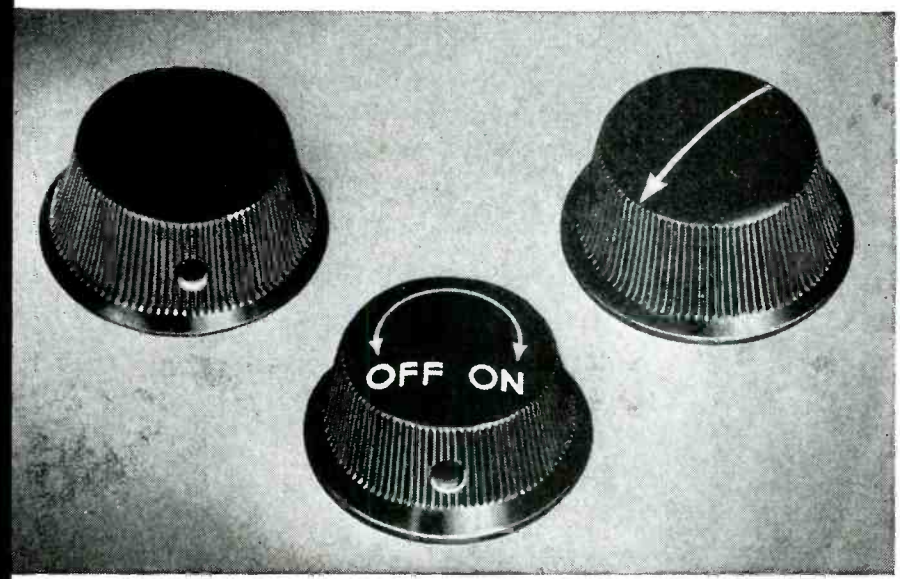
KURZ-KASCH FOR STANDARD KNOBS

A functionally clean and logical design, this knob has served radio, electrical and other industries for over a generation. It has been an indicator control on everything from kerosene stoves to mammoth panel-boards and airplane cockpits. It and its many companion radio, instrument and pointer knobs have made Kurz-Kasch the foremost source of standard plastic knobs in America. For full details, send for the newly-revised Catalog 103A.

Good plastics applications pay off—especially when they are designed with an eye on the years ahead. By "good applications", we mean those that improve products quality-wise or cost-wise—or by supplying special characteristics. There's not much future for plastics used otherwise, for you or your moulder.

For example, we built the first mould for these control knobs 25 years ago. They proved immediately popular, and have continued throughout the years to be a top-selling standard item—so much so that three additional moulds were quickly built to satisfy demand. We've produced million after million of them *from these four original moulds.*

Whether it's a stock or custom job up for consideration, we pride ourselves at Kurz-Kasch on correct plastics applications designed and engineered *to get the most out of initial mould costs.* We maintain that it is the long-running job proving the foresight and capabilities of the established custom moulder that really expresses the plastics industry's bid for the future.



Kurz-Kasch

FOR OVER 31 YEARS PLANNERS AND MOULDERS IN PLASTICS

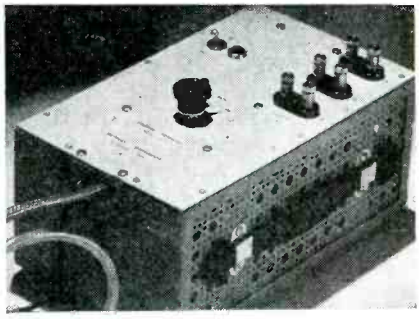
Kurz-Kasch, Inc. • 1425 South Broadway • Dayton 1, Ohio

Branch Sales Offices: New York • Chicago • Detroit • Los Angeles • Dallas St. Louis • Toronto, Canada • ***Export Offices:*** 89 Broad Street, New York City

rectly up to several inches. Bore eccentricity or lack of bond can also be detected. Typical materials on which the gage can be used are steel, brass, silver, copper, aluminum, magnesium, and glass, as well as certain plastics and rubbers.

Instrument Amplifier (15)

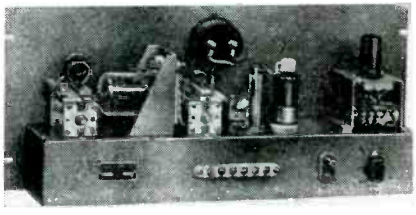
KEITHLEY INSTRUMENTS, 1508 Crawford Road, Cleveland 6, Ohio. Phantom Repeater model 102 is essentially an instrument amplifier with a high-impedance input, used to bridge measuring instruments across high-impedance circuits, give simultaneous indication of voltage, waveform, and aural tone,



and increase the sensitivity of voltmeters and cathode-ray oscillographs. The device has an input of better than 200 megohms and 5.5 micromicrofarads.

H-F Transmitter (16)

JAMES MILLEN MFG. CO., INC., Malden, Mass. A new high-frequency transmitter with output on the 10-11, 6, and 2 meter amateur bands is



crystal controlled by means of a newly developed Bliley unit. The final uses an 829B tube with 100 watts plate input.

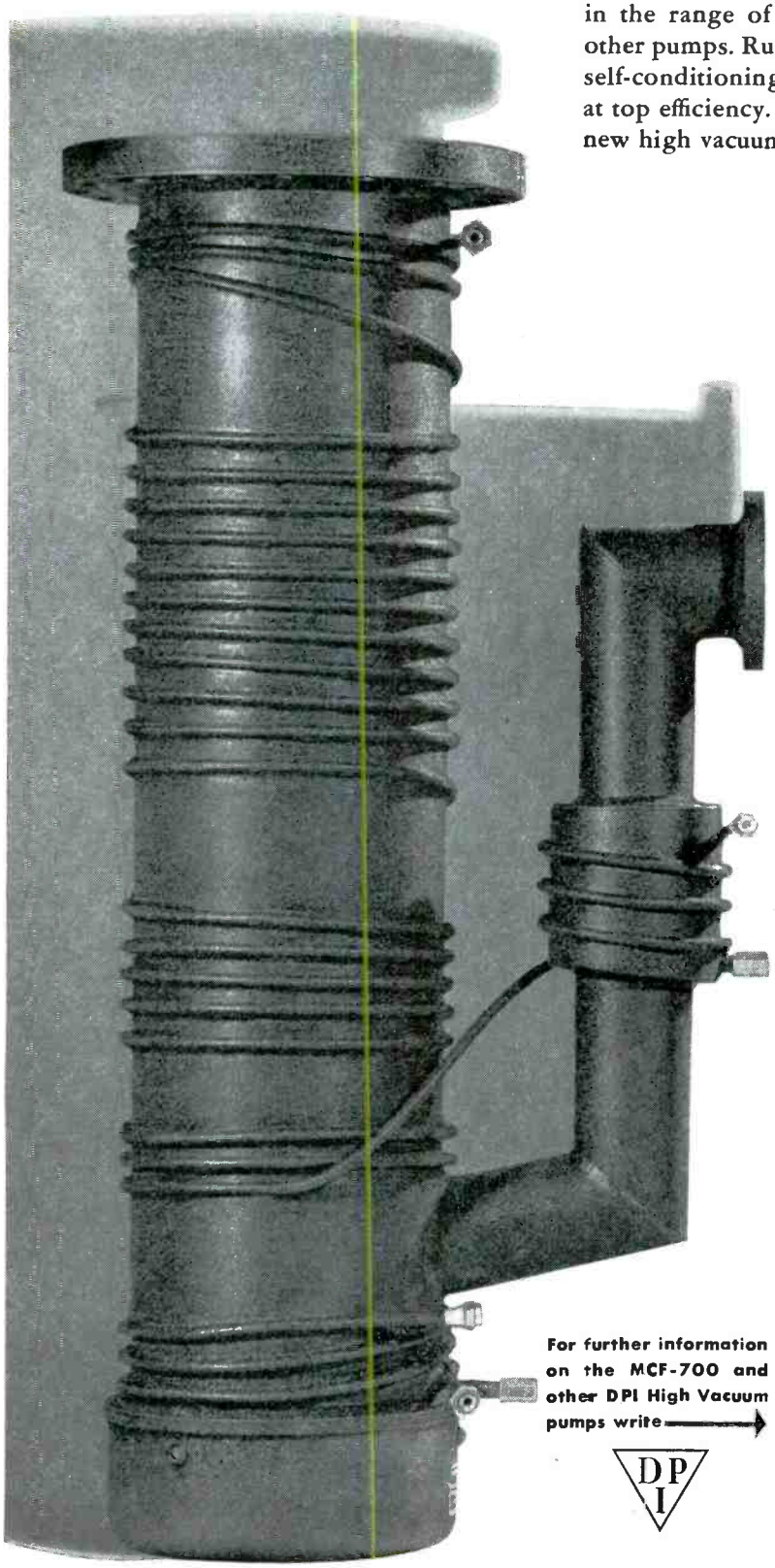
VR Tube Checker (17)

WESTON ELECTRICAL INSTRUMENT CORP., 617 Frelinghuysen Ave., Newark 5, N. J. Model 798 Type 5

For New High Speeds in the Lower Pressure Ranges—

THE MCF-700 HIGH VACUUM PUMP

WHEN you need high pumping speeds in pressures down to 10^{-6} mm of mercury, the performance of the new MCF-700 will meet your specifications exactly. This pump delivers from 100 to 500 liters per second in the range of 10^{-6} to 10^{-5} mm, — performance unduplicated by any other pumps. Ruggedly constructed, the MCF-700 operates on a unique, self-conditioning principle which keeps the fractionating jets operating at top efficiency. The tables below outline the essential features of this new high vacuum pump.



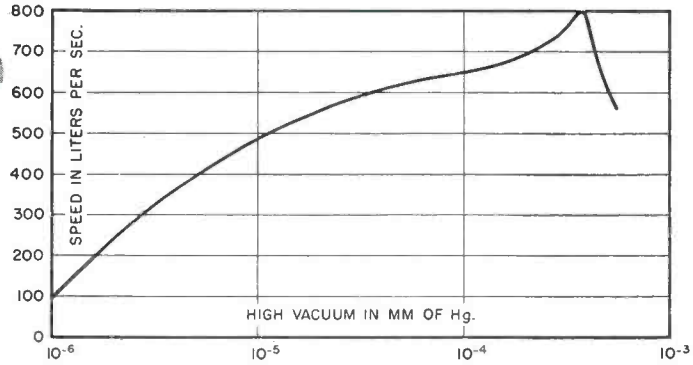
PHYSICAL DATA

High Vacuum Flange	6″ i.d., 9″ o.d. 8″ bolt circle
Forepump Flange	2⅜″ i.d., 3¾″ o.d. 3 5/16″ bolt circle
Height	29″
Length	14″
Width	9″
Construction:	
Casing	Seamless Steel
Jet Assembly	Aluminum and Steel
Cooling	Water
Weight	Approx. 40 lbs.

OPERATION DATA

Amount of Oil	500 grams
Recommended Oil	Octoil or Octoil-S
Forepressure	0.10 mm
Heater Power	800 watts
Heater Current	7.0 amp.
Heater Voltage	115 volts A.C. or D.C.
Speed	700 l/s
Ultimate Vacuum	5 x 10-7 at 25° C.

PERFORMANCE



For further information on the MCF-700 and other DPI High Vacuum pumps write →

DPI

Vacuum Equipment Division

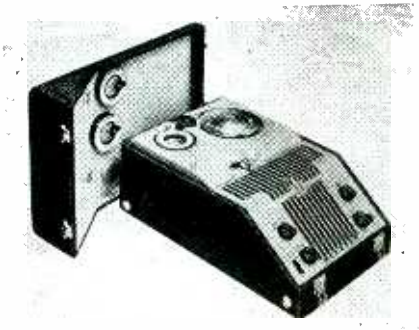
DISTILLATION PRODUCTS, INC.

Rochester 13, N. Y.

proportional mutual conductance tube checker tests all receiving tubes as well as voltage regulators and low-power thyratrons. Three signal voltages of 0.75, 1.5, and 3 volts provide mutual conductance ranges of 12,000, 6,000, and 3,000 microhms without danger of damage to the tube under test. Sixty cycle a-c is used on the tube elements and a separate 5-kilocycle signal is applied to the control grid. The resulting plate component of the high-frequency signal is measured on a rectifier meter.

Wire Recorder (18)

WEBSTER-CHICAGO CORP., 5610 Bloomingdale Ave., Chicago 39, Ill. Model 80 wire recorder is completely selfcontained, comprising recording and playback amplifier, loudspeaker, microphone and three



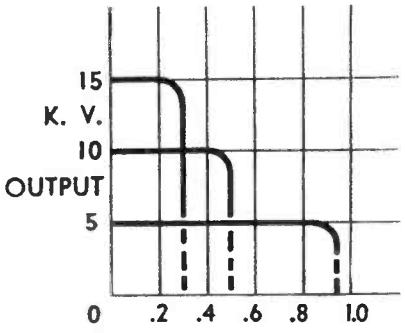
spools of wire in a carrying case. Price of the unit, east of the Rockies is $149.50. Additional wire costs from $2.40 to $6.45 depending on whether a 15-minute, half-hour or full-hour spool is purchased.

Insulation Tester (19)

RADIO FREQUENCY LABORATORIES, INC., Boonton, N. J. A new tester developed for measuring insulation resistance of power cables, transformers, and other components up

FREQUENCY-MODULATED PULSED POWER SUPPLIES

adjustable from 0 to full output



A new regulation principle for pulsed power supplies results in the regulation curves shown at the left.

Additional Features

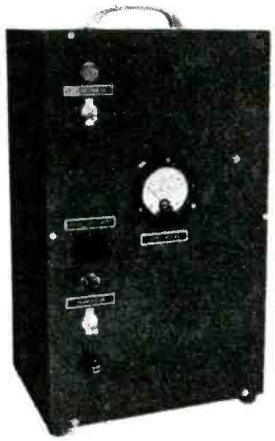
Light-Weight — Model 501-E, 0 to 15 KV, weighs 23 lbs. Housed in compact cabinet 9″ x 7″ x 15″.

Safe — High operating frequency permits use of low filter capacitances. Inherent sharp cut-off at overload protects circuit components and personel from short-circuits.

Output Kilovoltmeter — Full scale accuracy of 3%.

Low Power Consumption — 65 V.A. from 115 V, 60C line.

Also available in 0 to 30 KV range



Model 501-E

Beta Electronics Company Equipment *has been purchased by the following:*

Bell Telephone Labs.
Allen B. DuMont Labs.
U. S. Navy
Massachusetts Institute of Technology
Douglas Aircraft Co.
Northern American Philips Co.
Princeton University
American Cyanamide Co.
Sylvania Electric Co.
Winchester Repeating Arms Co.
Harvard University
G. D. Searle & Co.
U. S. Television Corp.
University of California at Los Angeles

and others

Other BETA instruments include:

MODEL 301 ELECTRONIC MICROAMMETER: Cannot be damaged by any degree of overload. Full scale ranges from 0.01 microamperes to 100 microamperes.

SERIES 101 KILOVOLTMETERS: 50,000 ohms per volt instruments, 20 microamperes full scale drain, available in ranges up to 50 KV. Portable, compact, safe. Can be used without turning off high voltage to connect meter.

MODEL 201 — 0 TO 30 KV DC POWER SUPPLY: A portable, rectified 60 cycle power supply. Variac controlled. Currents up to 2 m.a. may be drawn.

High voltage power supplies up to 150 KV made to your specifications.

for further information, write or wire to:

BETA ELECTRONICS COMPANY

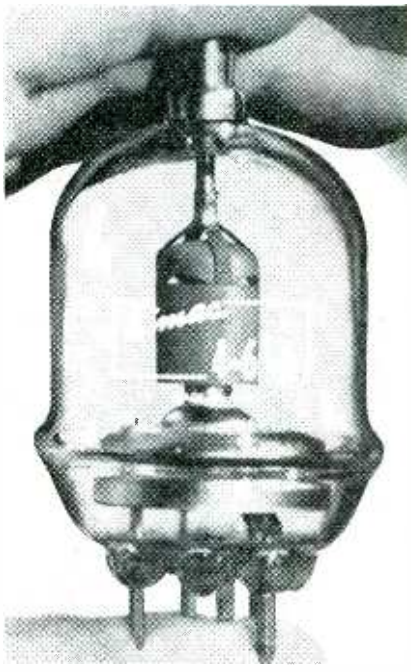
Dept. E-O 1762 Third Avenue New York 29, N. Y.

SALES REPRESENTATIVES IN ALL MAJOR CITIES

to 10 kv is arranged for rapid operation. Breakdown voltages can be determined with a minimum of damage. Full manual control allows selection of desired output voltage. Safety to personnel and equipment is insured in the design.

Low-Power Tetrode (20)

EITEL-MCCULLOUGH, INC., San Bruno, Calif. Availability of the new type 4-65A low power tetrode using a 6-volt thoriated tungsten filament has just been announced.

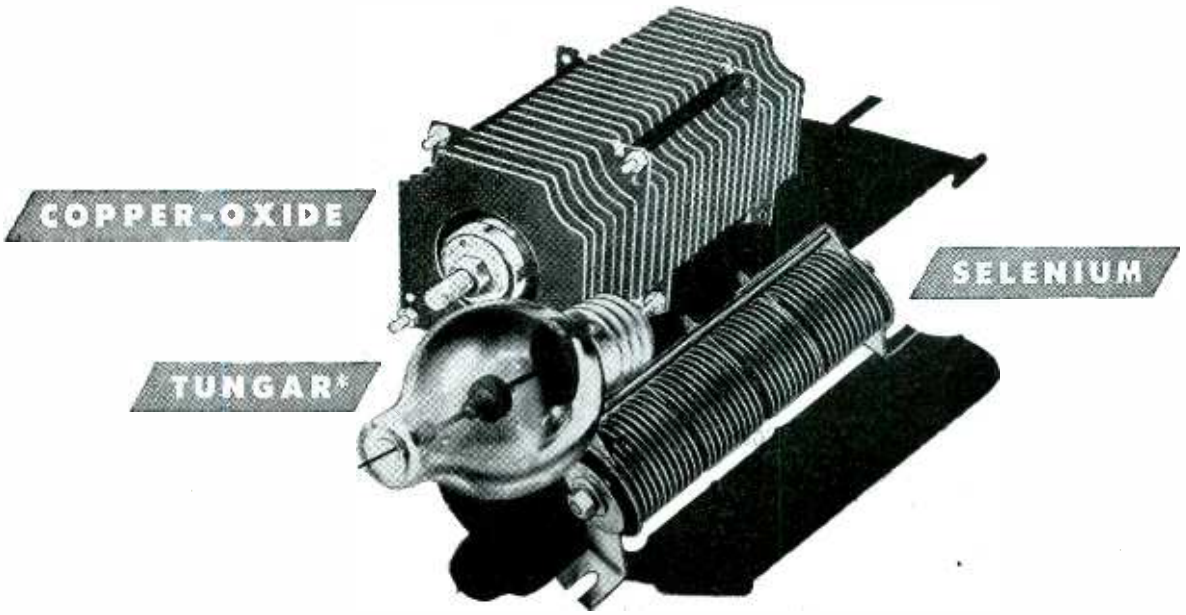


Good performance is obtained well above 200 mc and a single tube operating at 2,000 volts will provide 200 watts of power output in Class C or f-m telephony service. The tube is priced at $14.50

Variable Capacitor (21)

NORTH AMERICAN PHILIPS CO., INC., 100 East 42nd St., New York 17, N. Y. A new air-dielectric variable capacitor with a range of 30 to

ALL GOOD



but which is best for you?

Do you need a source of d-c, where space and allowable weight must be held to a minimum? General Electric has the answer . . . a selenium rectifier.

Must equipment operate where it is subject to intermittent overloads of short duration? The answer will probably be a copper-oxide rectifier.

Perhaps exceptionally low cost is the most important requirement . . . then you will want to consider General Electric Tungar rectifiers.

But, regardless of what application you have in mind, your first step should be to consult a General Electric rectifier specialist. With his years of practical experience with the only manufacturer of all three basic types of low-voltage rectifiers, he is thoroughly qualified to give you impartial advice.

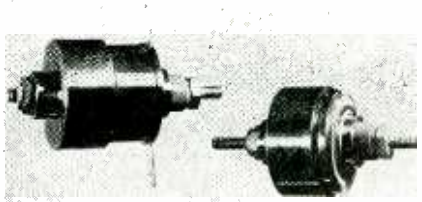
After considering all factors such as size, weight, performance characteristics, and cost that affect your designs, the General Electric engineer can readily determine the best rectifier for you.

Why not take advantage of our engineering service now? There is no obligation. Just ask your local General Electric representative to call, or send your problem to Section A98-1031, General Electric Company, Bridgeport 2, Connecticut.

*Trade-mark Reg. U. S. Pat. Off.

GENERAL ELECTRIC

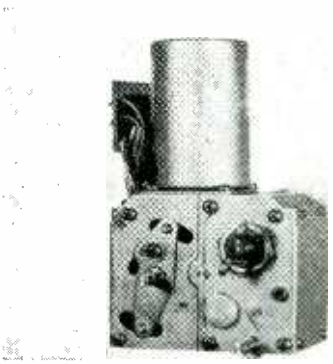
Rectifiers



1 between maximum and minimum capacitance has a maximum outside diameter of $\frac{7}{8}$ inch and an overall length of $1\frac{3}{4}$ inches. Flash rating is 500 volts and capacitance is adjustable from 5 to 150 micromicrofarads. The curve is substantially linear with rotation.

Positioning Mechanism (22)

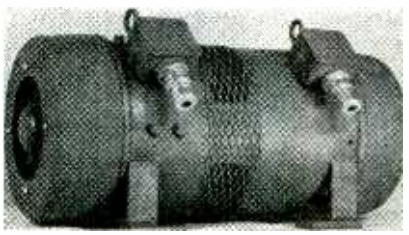
COLLINS RADIO CO., Cedar Rapids, Iowa. The type 496A Autotune is a repositioning mechanism primarily designed as a tuning control for home radio receivers and industrial



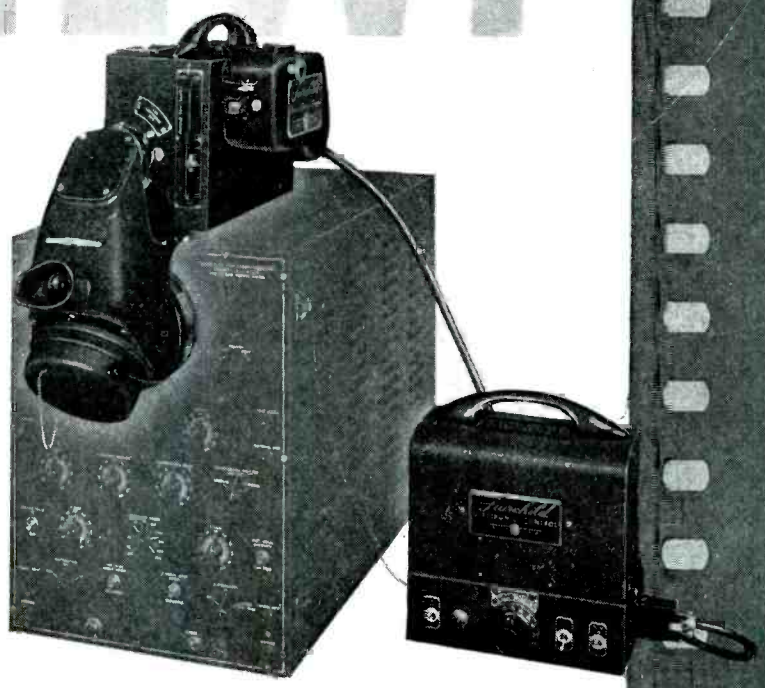
equipment. It provides 10 positions and reset accuracy is within 0.05 degree. Remote operation is by pushbutton or tap switch. Maximum operating time required is six seconds.

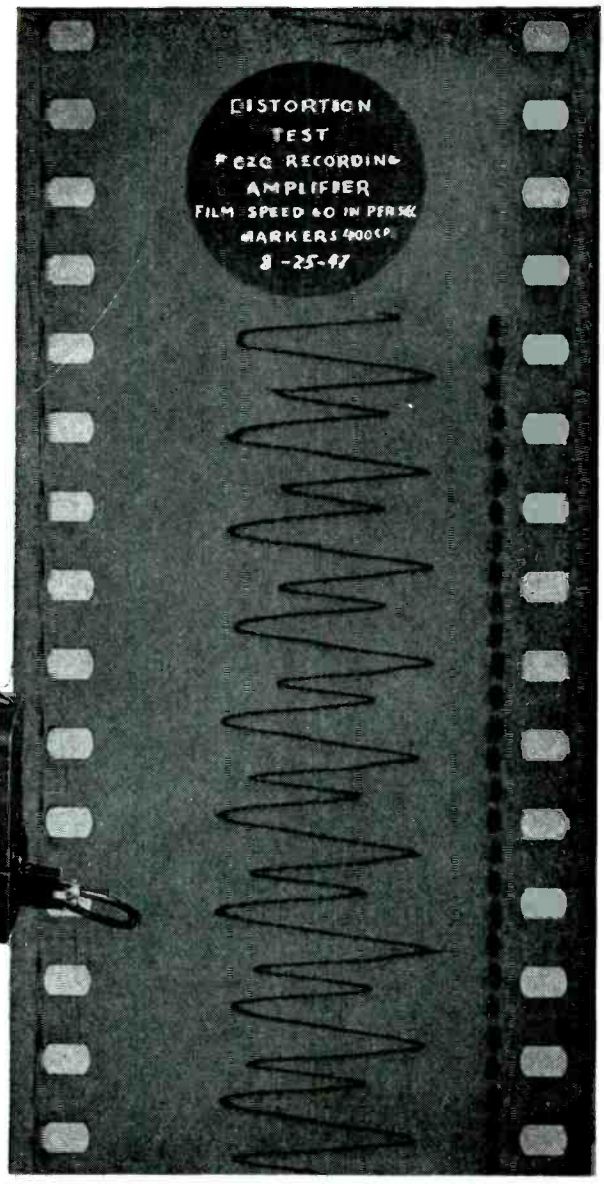
High Frequency Motor Generator (23)

KATO ENGINEERING CO., Mankato, Minn. A new 14-pole generator designed to run at 3,440 rpm produces 1,000 volt-amperes at 400 cycles. A 4-pole motor with four sets of



NEW!





35 mm Fairchild Oscillo-Record Camera

Once again, Fairchild has met a great need of the electronic laboratory—with the first general purpose, easy to use camera ever designed specifically for recording both single exposures or continuous recordings of cathode ray oscilloscope images.

Fairchild's new OSCILLO-RECORD CAMERA is so simple to set up and operate that anyone in the laboratory can make perfect photographic records of high-speed transients, stationary patterns of periodically recurring phenomena, or any other type of phenomena that can be put on a cathode ray oscilloscope.

Fairchild's new OSCILLO-RECORD CAMERA can be attached or removed from the oscilloscope instantly without tools. Special mounts make positioning automatic and leave all oscilloscope controls unobstructed. The camera is permanently in focus and can be loaded and operated in ordinary room light. The scope may be viewed during recording and hand written data may be recorded directly on the film for permanent record. And no special adapters or changes in camera equipment are required to shift from single exposures to continuous recordings.

Want more details? Address: 88-06 Van Wyck Boulevard, Jamaica 1, New York.

Records BOTH Still and Continuous Cathode Ray Oscilloscope Images

Specifications: The complete Fairchild assembly consists of a 35 mm roll film Camera, Electronic Film Speed Control Unit, Periscope Cone, Mount, Cables and Data Card Unit.

Film Speed: 1 inch per minute to 3,600 inches per minute.

Exposure Capacity: Single exposures up to double frame length. Continuous exposures up to 100 feet internal; 400 to 1,000 feet with external magazine.

Recording Time: With 100 foot reels—20 seconds to 20 hours; 1,000 foot reels—3⅓ minutes to 8⅓ days. Speed is recorded along edge of film.

Lens and Shutter: 50 mm f/2.8 lens in a Wollensak No. 2 shutter (f/1.5 lens optional) 1 to 1/400 second shutter speeds.

Data Record: A data card can be recorded at the beginning or end of each run.

Film Record: The cathode-ray beam writes a continuous record either back and forth across the film when the "X" axis is used; or diagonally across the film when the "Y" axis is used. The scope may be viewed while the camera is recording.

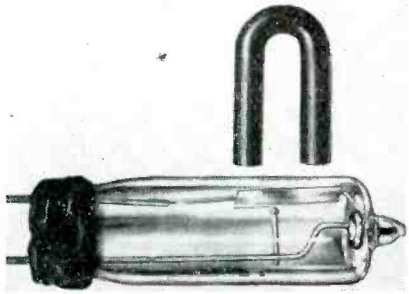
Fairchild CAMERA AND INSTRUMENT CORPORATION

MAKERS OF: AERIAL CAMERAS, MEDICAL X-RAY CAMERAS, POTENTIOMETERS, SOUND EQUIPMENT, SPECIAL MOTORS, ETC.

brushes is provided. Approximately 7 percent regulation is possible with unity power factor. Net weight of the total equipment is 210 pounds.

Magnetic Mercury Switch (24)

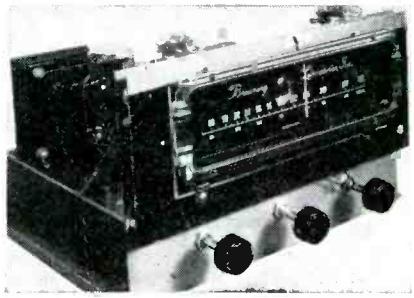
MINNEAPOLIS - HONEYWELL REGULATOR CO. A magnet attached to an actuating mechanism is used to



pull one switch electrode out of a mercury pool, thus breaking a circuit. The switch may also be operated in the reverse direction so as to close a circuit.

F-M Tuner (25)

BROWNING LABORATORIES, INC., 751 Main St., Winchester, Mass. Model RV-10 f-m tuner covers the range 88 to 108 megacycles. The Arm-



strong circuit using double limiters is employed to attain suitable reception with a 10-microvolt signal. Antenna input is designed for 300-ohm feeder and a tuning indicator is provided. Complete with power supply, the unit is also available with standard panel for rack mounting and is designated RV-11.

Heavy Duty Thyratron (26)

FEDERAL TELEPHONE AND RADIO CORP., Newark, N. J. A new 15,000 volt mercury vapor thyratron type

GLOBAR TEMPERATURE SENSITIVE RESISTORS

Where Temperature Changes Affect Performance

RESISTORS possessing negative temperature coefficients of electrical resistance are useful in electrical circuits involving wire coils. Changes in the temperature of the coils affect their resistance thus adding a variable to the overall performance of devices.

Aircraft instruments are an excellent example. Because aircraft, equipped with hundreds of instruments, operate at extreme and varying temperatures, it is important that instruments and important circuits are corrected for these changes in temperatures. This can be done by inserting resistors, having a negative coefficient of resistance, in the circuits. Here, they offset the positive coefficient of wire used in relay windings, field coils, and the moving elements of meters.

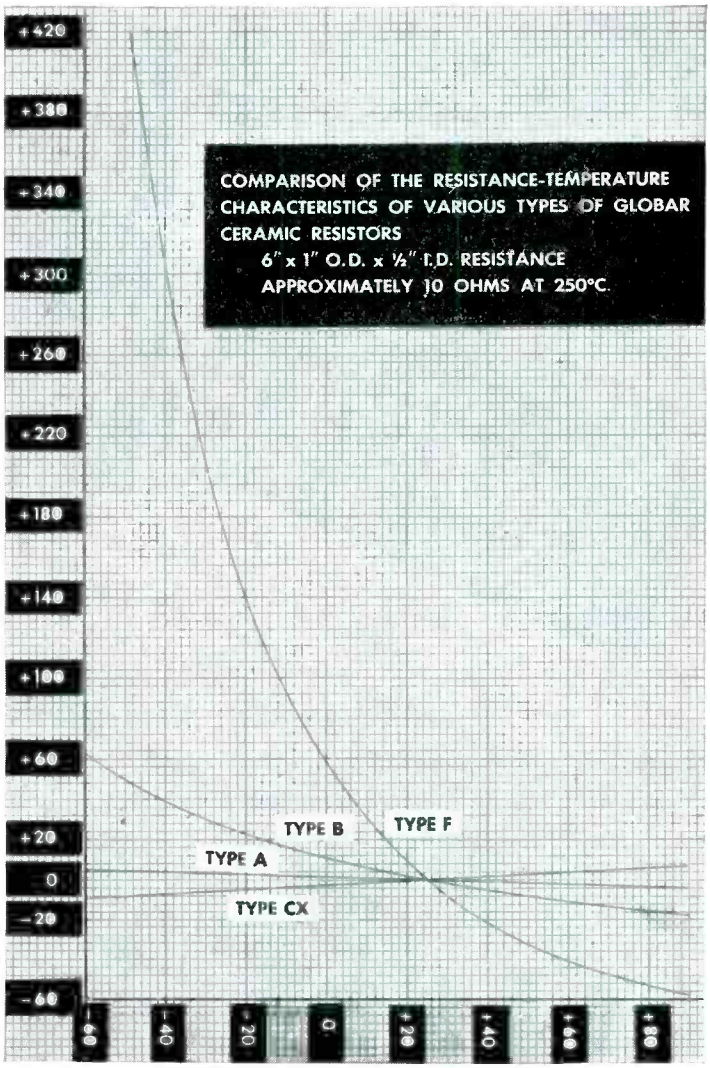
GLOBAR ceramic resistors offer a wide range of compensation as shown in this graph. The curves were plotted from performance data of resistors selected at random.

The degree of compensation obtainable is within the control of the circuit designer.

TYPICAL SUGGESTED USES ARE:

1. Temperature correction for voltmeters, ammeters, and other meters.
2. Compensation for increase in resistance of motor and generator field coils.
3. Compensation for increase in resistance of relay coils.
4. Direct measurement of low temperature up to 400°F.
5. Protection of the cathode heaters of vacuum tubes.
6. Protection of pilot lights in A.C. D.C. radio receivers.
7. Pilot flame protection.

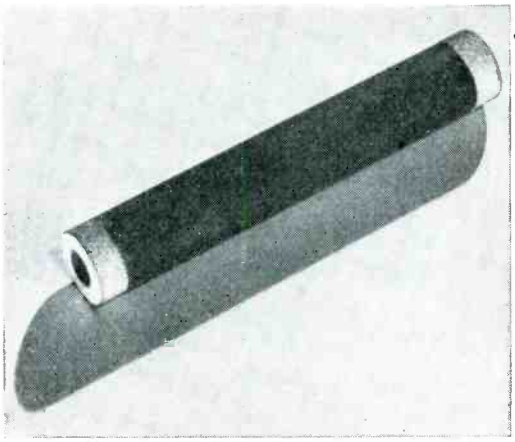
The Carborundum Company, Globar Division, Niagara Falls, New York.



GLOBAR Ceramic Resistors

BY **CARBORUNDUM**

TRADE MARK

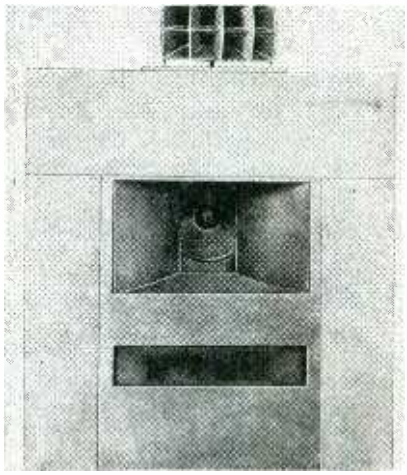


"Carborundum" and "Globar" are registered trademarks which indicate manufacture by The Carborundum Company

F-5563 has been designed for both communications and industrial use. Grid voltage in typical service would be minus 70 volts. Average anode current is 1.6 amperes and peak current 6.4 amperes.

Auditorium Speaker (27)

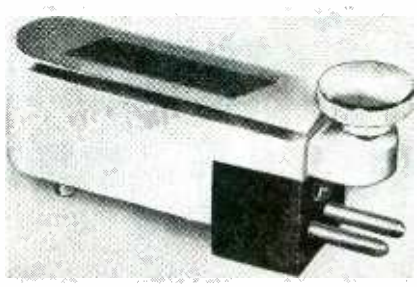
ALTEC LANSING CORP., 250 West 57th St., New York 19, N. Y. For small auditoriums and theaters seating up to 1,000, the new type



800 speaker gives a frequency response from 50 to 15,000 cycles. Two speaker units, one for low-frequencies and the other for high, are provided. Depth of the equipment is 23 inches.

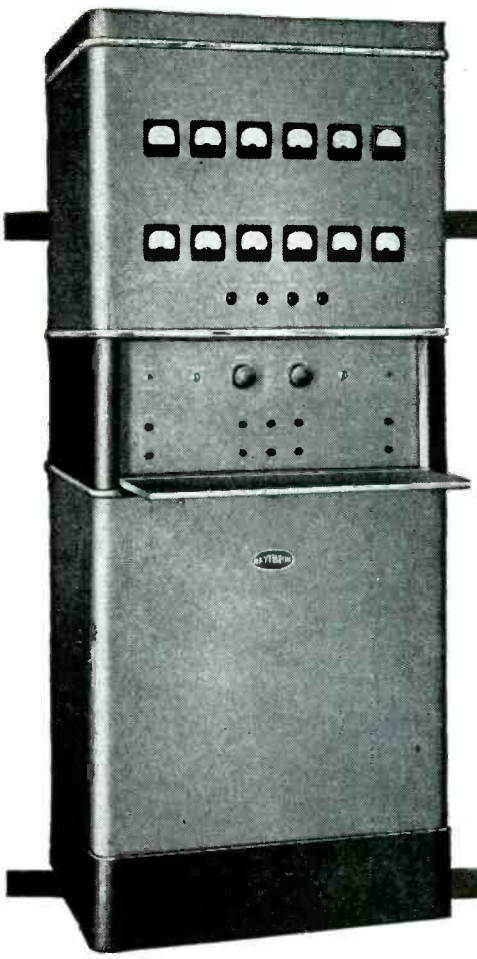
Pickup Adapter (28)

TECHNICAL PRODUCTS INTERNATIONAL, 453 West 47th St., New York 19, N. Y. The Vibromaster type M adapter makes it possible to use the G-E variable-reluctance



More and More 250 Watt Stations

are being powered by Raytheon



Here's the AM Transmitter that small-station owners are turning to...for its dependable, simpler circuits...its advanced design ...its modern, "dress-up" beauty!

HERE'S WHAT THE SMALL STATION NEEDS!

...Study these RAYTHEON features before you choose any transmitter, for replacement or new installation.

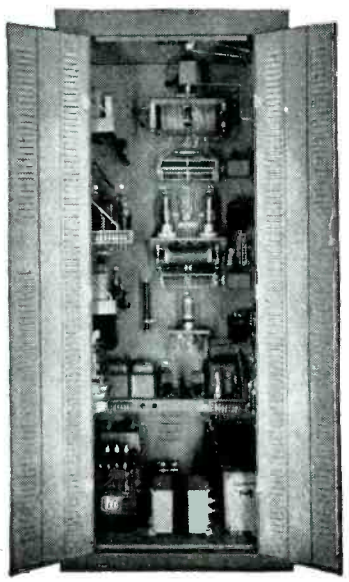
1. **Simplified, More Efficient Circuits**—A high level modulation system eliminates necessity of complicated and critical adjustment of linear amplifiers and minimizes harmonic distortion.
2. **Increased Operating Efficiency**—The use of the most modern improved components which are operated at well below their maximum capacity together with simplified circuit design greatly increases overall operating efficiency.
3. **Greater Dependability**—Due to the use of Triode type tubes, feedback failure will not cause a complete breakdown and the signal quality will still be good. Cooled by natural convective air currents, it is not subject to damage or fire caused by a blower failure.
4. **Simple, Speedy and Accurate Tuning**—All operational controls are centralized on the front panel; every circuit is completely metered and instantly checked. A clutch-equipped low-speed motor makes micrometer adjustment of the two tuned stages very easy.
5. **No Buffer Stage Tuning**—The use of a Video type amplifier in the buffer stage eliminates this complicated tuning.
6. **Silent Operation**—Natural air cooling means no blower noise, permits microphones in same room with transmitter.
7. **Low Audio Distortion**—Triode type tubes used in the audio stages have inherently lower distortion level. Specially designed audio transformers reduce audio distortion still further.
8. **Easy Servicing**—Vertical chassis, symmetrical mechanical layout and complete accessibility through double rear doors and hinged side panels make the RA-250 a favorite.
9. **Easily Meets All F.C.C. Requirements**—All electrical characteristics are well within the F.C.C. requirements. Noise level is −60 db below 100% modulation. Frequency response ±1 db from 30 to 10,000 cycles per second.

ANNOUNCED only a few short months ago, the Raytheon 250 Watt AM transmitter has already won its way into the forefront of small station broadcasting. Presented as a transmitter of unsurpassed design, unsurpassed styling and unsurpassed engineering excellence, it has proved its claims on all three points. Visitors exclaim over its striking, modern beauty . . . beauty that gives a "show-place" air to any station. Station owners are delighted with its dependable performance . . . its silent operation . . . and the high fidelity signal it puts on the air.

Before you select a 250 Watt transmitter, be sure you possess *all* the facts. Write or wire for our specification bulletin.

RAYTHEON

Excellence in Electronics



RAYTHEON MANUFACTURING COMPANY, Commercial Products Division, Waltham 54, Mass.

Industrial and Commercial Electronic Equipment, Broadcast Equipment, Tubes and Accessories

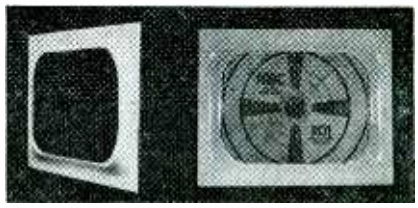
Sales offices: Boston, Chattanooga, Chicago, Dallas, Los Angeles, New York, Seattle

DEVOTED TO RESEARCH AND MANUFACTURE FOR THE BROADCASTING INDUSTRY

pickup or the Pickering 120M cartridges in the Western Electric 5A arm. A slight wiring change is necessary between arm and preamplifier, but the cartridge lugs need no soldering.

Mask and Protector (29)

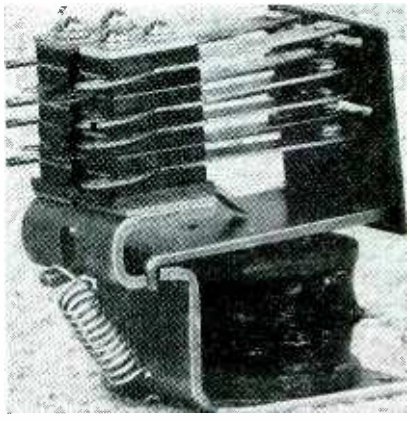
TELECTRO COMPONENTS, 141 Belleville Ave., 9, N. J. In sizes for all standard picture tubes, there is now available a combination picture



tube mask and protective plate made of optical plastic. Shadowed corners are eliminated and the entire picture tube surface can be viewed. Back view is shown at the left, and front at the right.

Vending Machine Relay (30)

GENERAL ELECTRIC CO., Schenectady 5, N. Y. A new multicontact a-c relay designed specifically for appliances and vending machines is



available in ratings of 5 amperes, 115 volts, and 5 amperes, 24 volts. Additional information is given in bulletin GEA 4864.

Voltage Regulator (31)

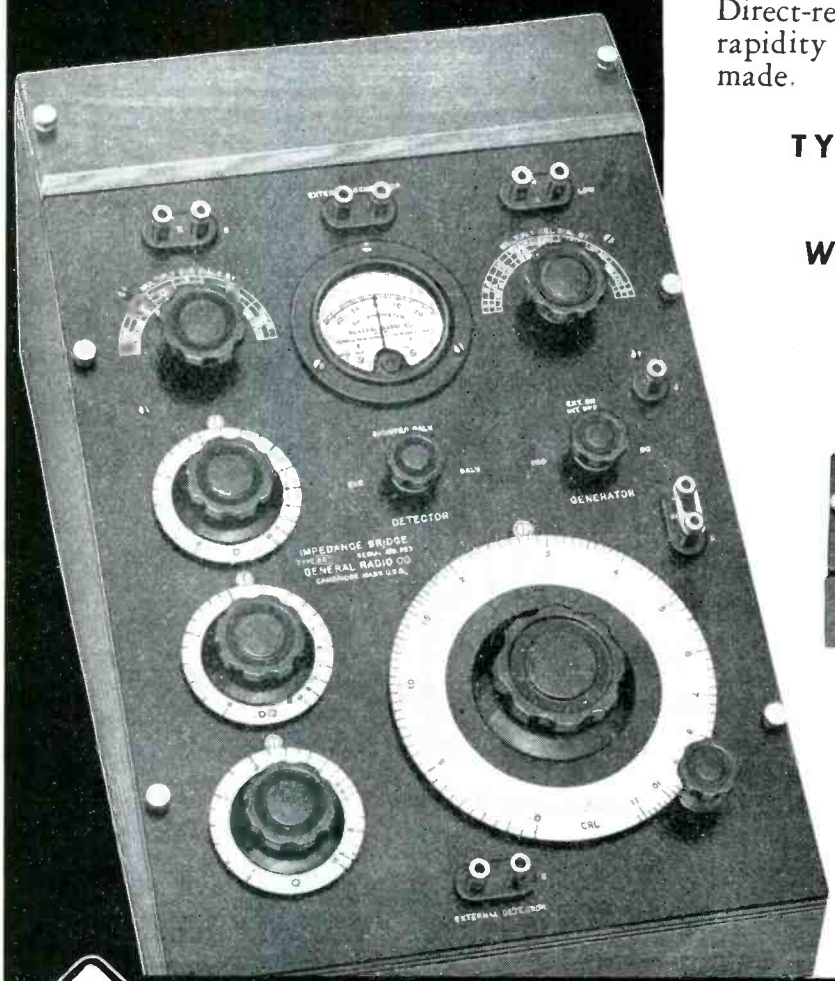
SORENSEN AND CO., INC., Stamford, Conn. Model E-3006 voltage regulator provides 6 volts and 0 to 300

TO MEASURE

- RESISTANCE
- INDUCTANCE
- CAPACITANCE
- STORAGE FACTOR
- DISSIPATION FACTOR

IN

ANY LABORATORY



IN ANY laboratory where electrical equipment is used this self-contained, portable, direct-reading bridge is indispensable. It is always set up and ready for immediate use. Its accuracy is sufficient for the majority of routine measurements over these very wide ranges:

RESISTANCE: 1 milliohm to 1 megohm

INDUCTANCE: 1 microhenry to 100 henrys

CAPACITANCE: 1 micromicrofarad to 100 microfarads

STORAGE FACTOR (X/R): .02 to 1000

DISSIPATION FACTOR (R/X): .002 to 1

The bridge includes built-in standards, batteries, a 1000-cycle tone source for a-c measurements, a zero-center galvanometer d-c null detector and terminals for a headset for 1000-cycle null detection. Provision is made for use of an external generator for measurements over a wide range from a few cycles to 10 kilocycles. Direct-reading dials add greatly to the ease and rapidity with which measurements can be made.

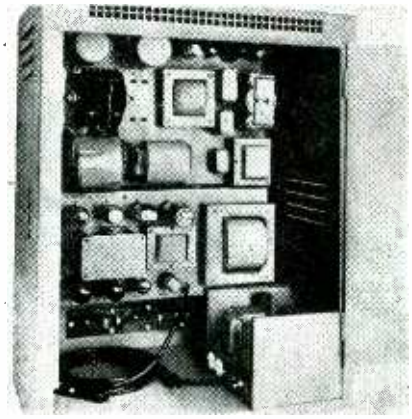
TYPE 650-A IMPEDANCE BRIDGE.....$240.00

Write for complete information

This useful accessory converts the Type 650-A bridge to a-c operation. It includes a vacuum-tube oscillator, amplifier, and rectifier for providing dc for the bridge. All are mounted in a metal cabinet with top control panel which replaces the wooden cover used on the battery compartment. The sensitivity of the bridge is increased greatly with this oscillator-amplifier for both a-c and d-c measurements. TYPE 650-P1 OSCILLATOR-AMPLIFIER — $150.00.

GENERAL RADIO COMPANY Cambridge 39, Massachusetts

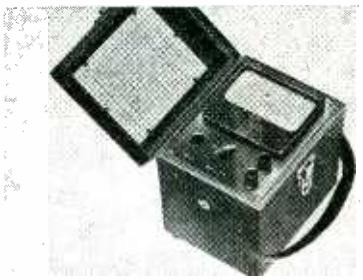
90 West St., New York 6 — 920 S. Michigan Ave., Chicago 5 — 950 N. Highland Ave., Los Angeles 38



volts d-c output with input voltage over the range 95 to 125 volts (regulation for the high voltage is even better). The low-voltage supply furnishes up to 15 amperes and the high voltage up to 100 milliamperes. Input frequency can vary between 50 and 60 cycles. The unit has been built with testing of instruments in mind.

Ohmmeter (32)

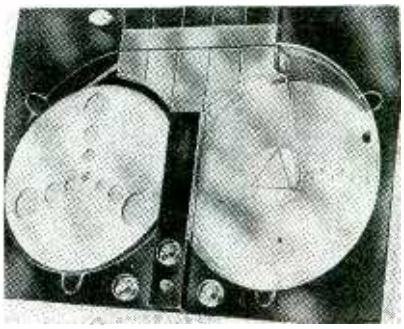
ASSOCIATED RESEARCH, INC., 231 South Green St., Chicago 7, Ill. A new precision ohmmeter measures from 1 to 100,000 ohms in four



overlapping ranges. Two No. 6 dry cells are used to operate the instrument. The model 246 ohmmeter is fully described in Bulletin 350.

Magnetic Tape Recorder (33)

SOUND RECORDER AND REPRODUCER CORP., 5501 Wayne Ave., Philadel-



electronics READER SERVICE . . .

LITERATURE and NEW PRODUCTS

Manufacturers' Literature as well as further information on New Products described in this issue are important "working tools" for design and production departments. To make it easy to keep up to date, ELECTRONICS will request manufacturers to send readers the literature in which they are interested. Just fill out card as shown in the filled-in sample *(right), being particularly careful to write out in full all the information called for in each section of each card that is used.*

Write in circle number of item describing one item wanted → (14)
Your Company Name Jones Mfg. Co.
Address 3217 Lewis Ave.
Chicago 13, Ill.
Your Name Geo. Smith
Your Title Chief Engineer
ELECTRONICS, 330 W. 42nd St., N. Y. 18

Write in circle number of item describing one item wanted → (92)
Your Company Name Jones Mfg. Co.
Address 3217 Lewis Ave.
Chicago 13, Ill.
Your Name Geo. Smith
Your Title Chief Engineer
ELECTRONICS, 330 W. 42nd St., N. Y. 18

Write in circle number of item describing one item wanted → (37)
Your Company Name Jones Mfg. Co
Address 3217 Lewis Ave.
Chicago 13 Ill.
Your Name Geo. Smith
Your Title Chief Engineer
ELECTRONICS, 330 W. 42nd St., N. Y. 18

Write in circle number of item describing one item wanted → (49)
Your Company Name Jones Mfg. Co.
Address 3217 Lewis Ave.
Chicago 13, Ill.
Your Name H. S. Towne
Your Title Adv. Mgr.
ELECTRONICS, 330 W. 42nd St., N. Y. 18

SAMPLE CARD SHOWING CORRECT FILL-IN ←

PLACE 1¢ STAMP ON CARD • DO NOT USE AFTER JANUARY 1

HOW TO ORDER:

1. There are two postcards, each divided into four parts. Each of the four parts contains a box. You must write in this box the number that appears in this issue over the literature or new product item in which you are interested. Place one number only in each box.

2. Fill out completely (name, address, etc.) for each piece of literature or new product information you desire.

Do not say "same" in lieu of writing out full information called for when requesting more than one item.

3. This service applies only to literature and new product items in this issue. It does not apply to advertisements. Write directly to the company for information on its advertisements.

PLEASE NOTE: Requests for unnumbered items must be made direct to the manufacturer.

In the event this copy of ELECTRONICS is passed along to other members of your company, please leave this sheet in for their convenience. This assures everyone in your plant the opportunity to fill in their requests. When the round is completed, cards can then be detached along perforated lines and dropped in the mail. Each individual request will be mailed by us to the company offering the information and for that reason must be completely filled out.

Write in circle number of item describing one item wanted → ◯
Your Company Name........
Address........
....
Your Name........
Your Title........
ELECTRONICS, 330 W. 42nd St., New York 18, N. Y.

Write in circle number of item describing one item wanted → ◯
Your Company Name........
Address........
....
Your Name........
Your Title........
ELECTRONICS, 330 W. 42nd St., New York 18, N. Y.

Write in circle number of item describing one item wanted → ◯
Your Company Name........
Address........
....
Your Name........
Your Title........
ELECTRONICS, 330 W. 42nd St., New York 18, N. Y.

Write in circle number of item describing one item wanted → ◯
Your Company Name........
Address........
....
Your Name........
Your Title........
ELECTRONICS, 330 W. 42nd St., New York 18, N. Y.

Write in circle number of item describing one item wanted → ◯
Your Company Name........
Address........
....
Your Name........
Your Title........
ELECTRONICS, 330 W. 42nd St., New York 18, N. Y.

Write in circle number of item describing one item wanted → ◯
Your Company Name........
Address........
....
Your Name........
Your Title........
ELECTRONICS, 330 W. 42nd St., New York 18, N. Y.

Write in circle number of item describing one item wanted → ◯
Your Company Name........
Address........
....
Your Name........
Your Title........
ELECTRONICS, 330 W. 42nd St., New York 18, N. Y.

Write in circle number of item describing one item wanted → ◯
Your Company Name........
Address........
....
Your Name........
Your Title........
ELECTRONICS, 330 W. 42nd St., New York 18, N. Y.

An electronics service designed for READERS and MANUFACTURERS

FOR THE READER... ELECTRONICS fundamental policy has always been to supply its readers with all the pertinent and timely industry news. The ELECTRONICS Reader Service supplements this policy by offering the reader an easy and effective means of obtaining complete, up to the minute data on new products and of maintaining at his fingertips comprehensive, practicable information on "who's doing what" in the industry.

In every issue of ELECTRONICS there's complete coverage of the month by month development by manufacturers of new materials, components and equipment, as well as brief mention of all the important, new, manufacturers' technical pamphlets and catalogs. Some of these items will be of particular interest to specific design and plant engineers, buyers, executives and others of our readers. They will want to make further inquiry concerning the new products described or they will want to read and make a permanent part of their industrial library some of the manufacturers' literature and catalogs. ELECTRONICS Reader Service makes it easy for them to obtain in readily accessible and usable form the information they desire.

PLACE 1¢ STAMP ON CARD • DO NOT USE AFTER JANUARY 1

Place 1¢ Stamp Here

ELECTRONICS

330 WEST 42nd STREET

NEW YORK 18, N. Y.

10-1-47

Place 1¢ Stamp Here

ELECTRONICS

330 WEST 42nd STREET

NEW YORK 18, N. Y.

10-1-47

FOR THE MANUFACTURER...

ELECTRONICS Reader Service will also be welcomed by manufacturers who are desirous of placing the complete news of their product developments as well as their technical bulletins and catalogs in the hands of those members of the electronic industry . . . including design, electrical and production engineers, researchers, physicists, executives, and buyers —who have a particular interest in, or represent a potential buying power for, their products.

SUGGESTIONS FOR THE IMPROVEMENT OF OUR READERS' SERVICE ARE INVITED

ELECTRONICS is constantly seeking new and improved ways of providing its readers with the news and information they want and need, and of assisting the manufacturer in effectively delivering his message to electronic markets. If you have any ideas for us, send them along. They will receive prompt consideration.

ADJUSTABLE MAGNETIC DAMPING

As applied by Esterline-Angus Company, Inc., of Indianapolis, Indiana, on a Model A. W. Electrodynamometer Instrument Movement

A Typical Application of Thomas & Skinner Permanent Magnets

Fig. 1—The magnets employed in this particular damping application are provided in Alnico II—which is cast with mounting holes cored. The necessity to adjust the damping posed an unusual problem in magnet engineering and fabrication—and in quality control. Note the small nub on the magnet which serves as a pointer in the installation.

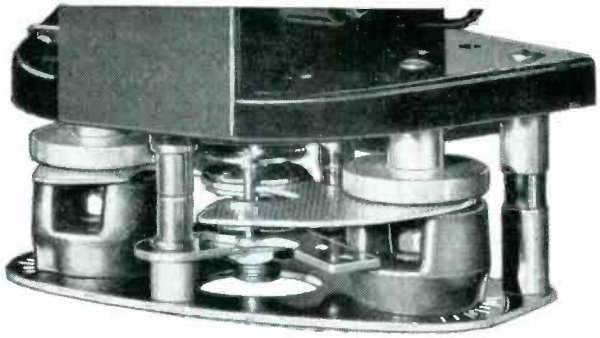
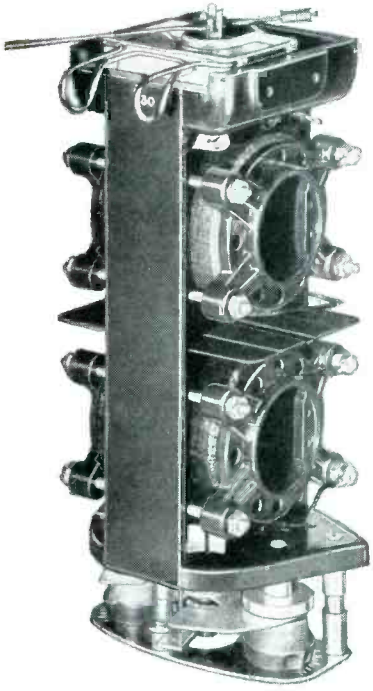
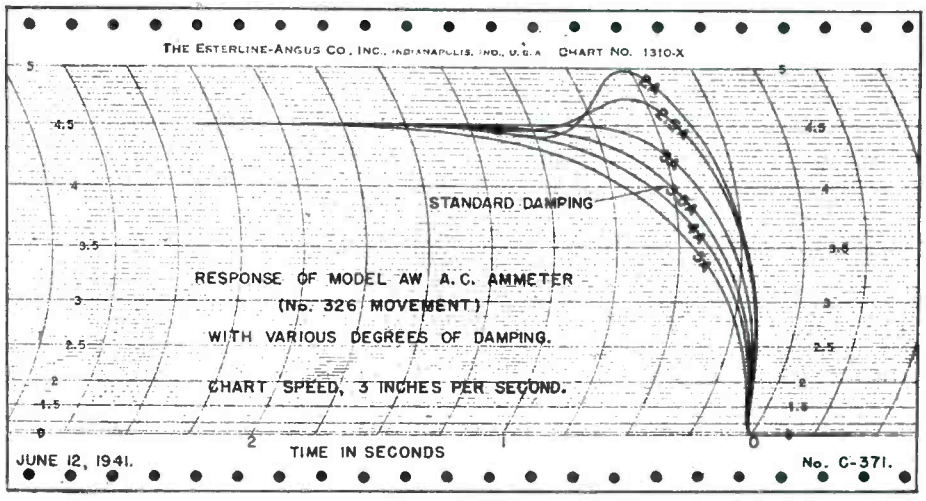


Fig. 2—Each magnet is installed so that it may be rotated on its own axis. Rotation of the magnet changes the position of the poles with respect to the moving vane passing through the magnetic field and by this method, damping is adjusted for optimum operation. The photo at lower left shows the complete measuring element of the instrument.

Fig. 3—The range of damping which these magnets make possible is shown by the chart on which response curves were plotted through a three-second period for each magnet position as indicated by a calibration on the magnet adjustment scale shown in Fig. 2.





● This is but one of many adjustable and constant magnetic damping problems solved by the wealth of technological and fabrication skill developed by Thomas & Skinner engineers and craftsmen through 46 years of permanent magnet design and production. Your inquiries on the application of permanent magnets to your products are solicited—and will be given prompt attention. Write for the latest technical bulletin on use, design and fabrication of permanent magnets.

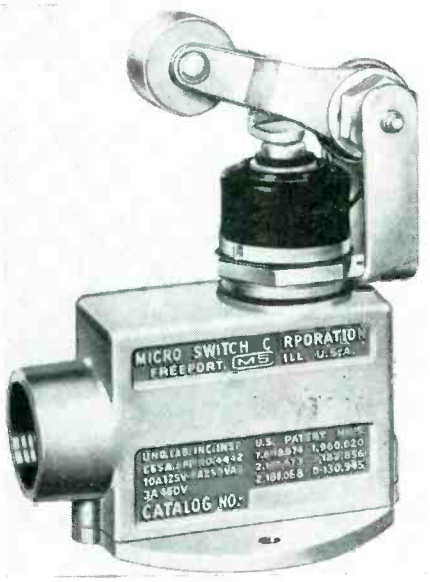
THOMAS & SKINNER STEEL PRODUCTS COMPANY

1122 E. 23RD STREET · INDIANAPOLIS, INDIANA

phia, Pa. The Magnesonic recorder-reproducer uses magnetic tape furnished on reels that accommodate up to an hour's program. The apparatus has sufficiently great audio range to allow recording of music and is designed primarily for home use.

Industrial Switch (34)

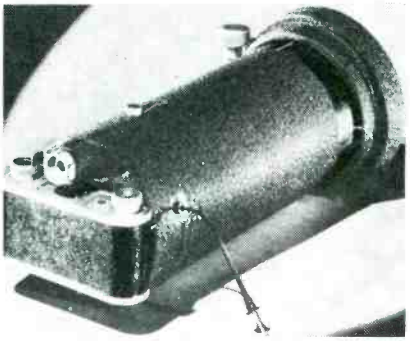
MICRO SWITCH, Freeport, Ill. Type N2 die-cast enclosed switch is designed particularly for cam and slide actuation in industrial applications. A synthetic rubber boot



covers the operating plunger and a gasket seals the switch unit when it is mounted on rigid conduit, making the switch impervious to moisture and dirt.

Scopic Camera (35)

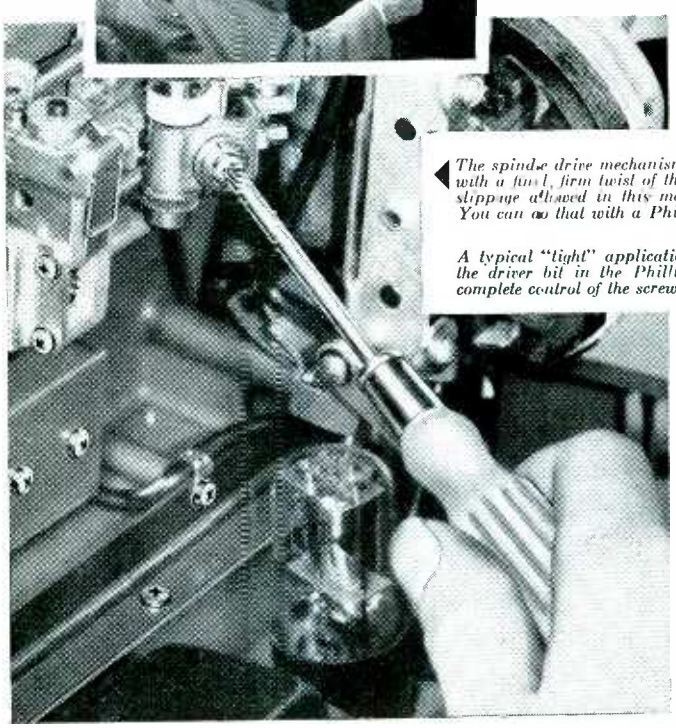
ALLEN B. DUMONT LABORATORIES, INC., 2 Main Ave., Passaic, N. J. Type 271-A oscillograph camera uses 35-mm film and is arranged with a fixed-focus hood, the far end



"Indispensable to the exacting assembly of precision electronic instruments!"

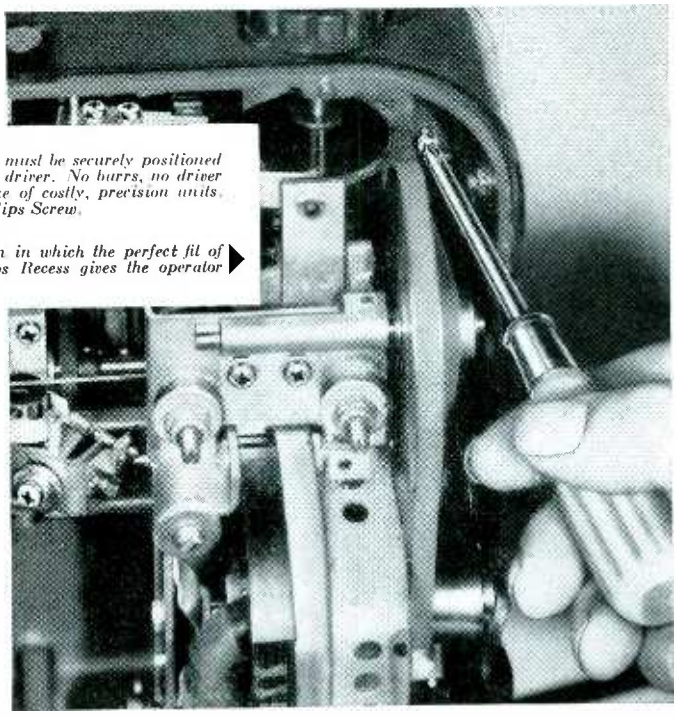
say the makers of the Gray AUDOGRAPH

High spots from an independent survey . . . part of a continuing study by James O. Peck Co., of assembly savings made with Phillips Screws in leading plants.



The spindle drive mechanism must be securely positioned with a full, firm twist of the driver. No burrs, no driver slippage allowed in this maze of costly, precision units. You can do that with a Phillips Screw.

A typical "tight" application in which the perfect fit of the driver bit in the Phillips Recess gives the operator complete control of the screw.



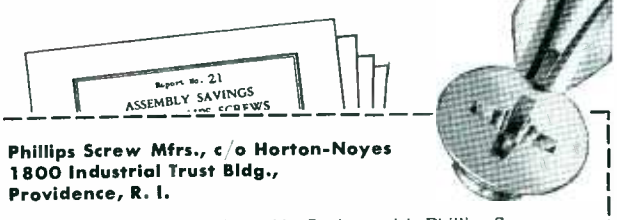
"OUR MAJOR PROBLEM on the Audograph, an advanced electronic soundwriting machine," explained Gray's chief engineer, "is assembling small precision components without disturbing fine tolerance or damaging highly finished surfaces. Phillips Screws are the surest solution of that problem.

"PRECISE ASSEMBLY EASIER WITH PHILLIPS. The perfect fit of the driver in the recessed head speeds finding the thread. Operators easily position each component precisely. Driving in constricted places and at angles is far easier with Phillips Screws.

"AVOID DRIVER SLIPPAGE. 'Skids' would be very costly where so many precision units and expensively finished parts are compactly assembled. The cost of such damage would be out of all proportion to the cost of the parts . . . when interruption of our production due to disassembly and reassembly is figured in. At several points even a slight burr on a screw head could disturb the precision of a vital part. Phillips Screws remove the possibility of such damage.

"PHILLIPS HEAD IS PART OF SMOOTH STREAMLINING. The neat, modern appearance of the recessed head complements the ultra modern design of the Audograph."

YOU'LL FIND ANSWERS TO QUESTIONS about your own assembly costs in the complete report of the Audograph assembly . . . and in other reports, covering wood, metal and plastic products . . . FREE on request. Mail the coupon TODAY!



PHILLIPS *Recessed Head* SCREWS

Wood Screws • Machine Screws • Self-tapping Screws • Stove Bolts

American Screw Co.
Central Screw Co.
Continental Screw Co.
Corbin Screw Div. of American Hdwe. Corp.
Elco Tool & Screw Corp.
The H. M. Harper Co.
International Screw Co.
Lamson & Sessions Co.
Milford Rivet and Machine Co.
National Lock Co.

24 SOURCES

National Screw & Mfg. Co.
New England Screw Co.
Parker-Kalon Corporation
Pawtucket Screw Co.
Pheoll Manufacturing Co.
Reading Screw Co.
Russell Burdsall & Ward Bolt & Nut Co.
Scovill Manufacturing Co.
Shakeproof Inc.
The Southington Hardware Mfg. Co.
The Steel Company of Canada, Ltd.
Sterling Bolt Co.
Stronghold Screw Products, Inc.
Wolverine Bolt Company

Phillips Screw Mfrs., c/o Horton-Noyes
1800 Industrial Trust Bldg.,
Providence, R. I.

Send me reports on Assembly Savings with Phillips Screws.

Name .....

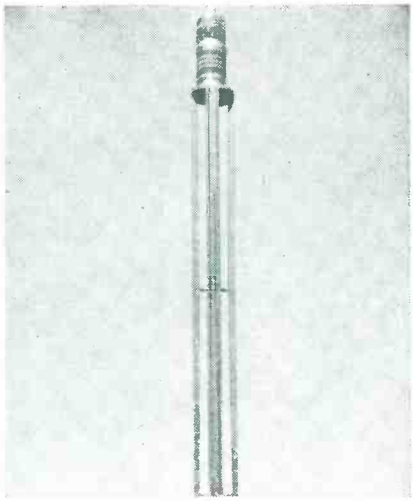
Company .....

Address E-22

of which clamps to the usual supporting ring of a 5-inch oscilloscope. All controls have been simplified and the camera is adjustable in every possible way in order to photograph waveforms appearing on the screen.

F-M Antenna (36)

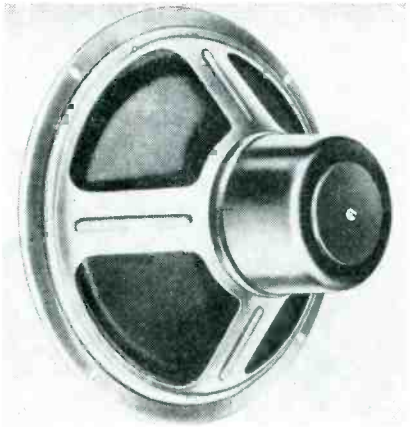
WORKSHOP ASSOCIATES INC., 66 Needham St., Newton Highlands 61, Mass. Type FMT-1 antenna is equal to or superior to a 3-bay half-wave spaced array for f-m broadcast transmitting on the high band.

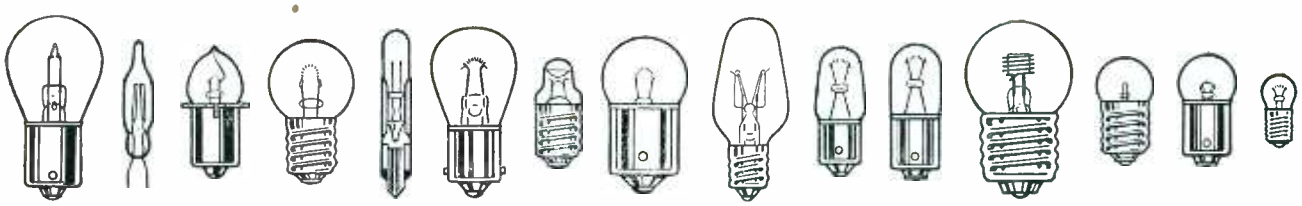


The radiation is horizontally polarized. Mechanically, the antenna consists of four aluminum alloy channels rigidly mounted to circular end castings. Provision is made for mounting a standard 300-mm beacon.

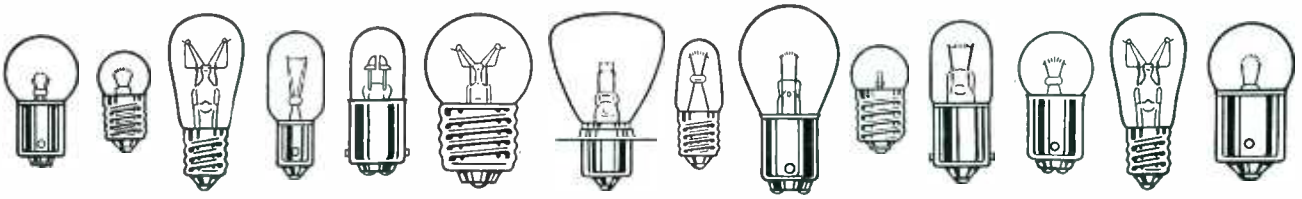
Loudspeakers (37)

PERMOFLUX CORP., 4900 West Grand Ave., Chicago. Ill. A new line of

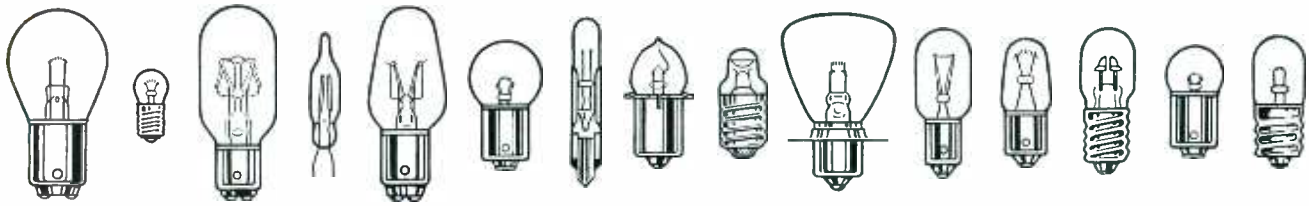




These little bulbs can make



a big difference in the success



# of your product

Whatever miniature lamps you need... incandescent or neon-glow... GENERAL ELECTRIC makes 'em all!

What can these little bulbs do for your product?

This brief check list of typical uses may suggest an idea to you:

Illuminated dials
Decorative light effects
Safety lighting
Pilot lights
Lighted toys
Inspection lights
Lighted signals
Numeral indicators
Night lights
Pinball games

WHAT progressive manufacturer doesn't ask himself almost daily—"How can I make my products more useful, more saleable, more profitable?" Many designers answer that problem by using inexpensive miniature G-E light bulbs to add safety, convenience and beauty to a wide variety of products.

Whatever job you may have for miniature bulbs, there is a G-E lamp that will suit your purpose exactly. General Electric's line is complete—all sizes and types—all wattages and voltages — filament and neon-glow lamps—for delicate service or heavy duty. And the high quality of every bulb is backed by G-E Lamp Research.

To make sure you get the right lamp for your application, entrust the selection to specialists who know all kinds of miniature lamps intimately. G-E Lamp engineers have the experience and practical knowledge to assist you. Call your nearby G-E Lamp office for full information. Ask for your copy of "Big Jobs for Small Bulbs".

General Electric Co., Lamp Dept., Nela Park, Cleveland 12, Ohio.

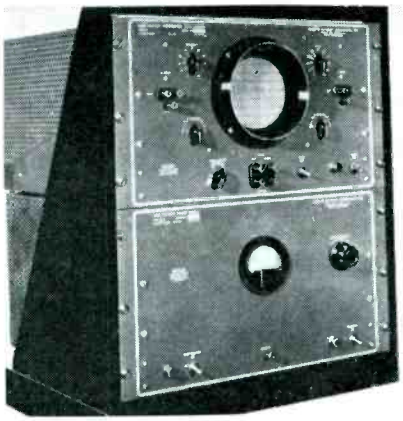
G-E LAMPS

GENERAL ELECTRIC

loudspeakers in sizes from 10 to 15 inches, using either permanent magnets or electromagnets, will reproduce sound from 30 to 12,000 cycles. Elliptical speakers and public address types with corrosion-resistant finish are also available.

High-Voltage Oscilloscope (38)

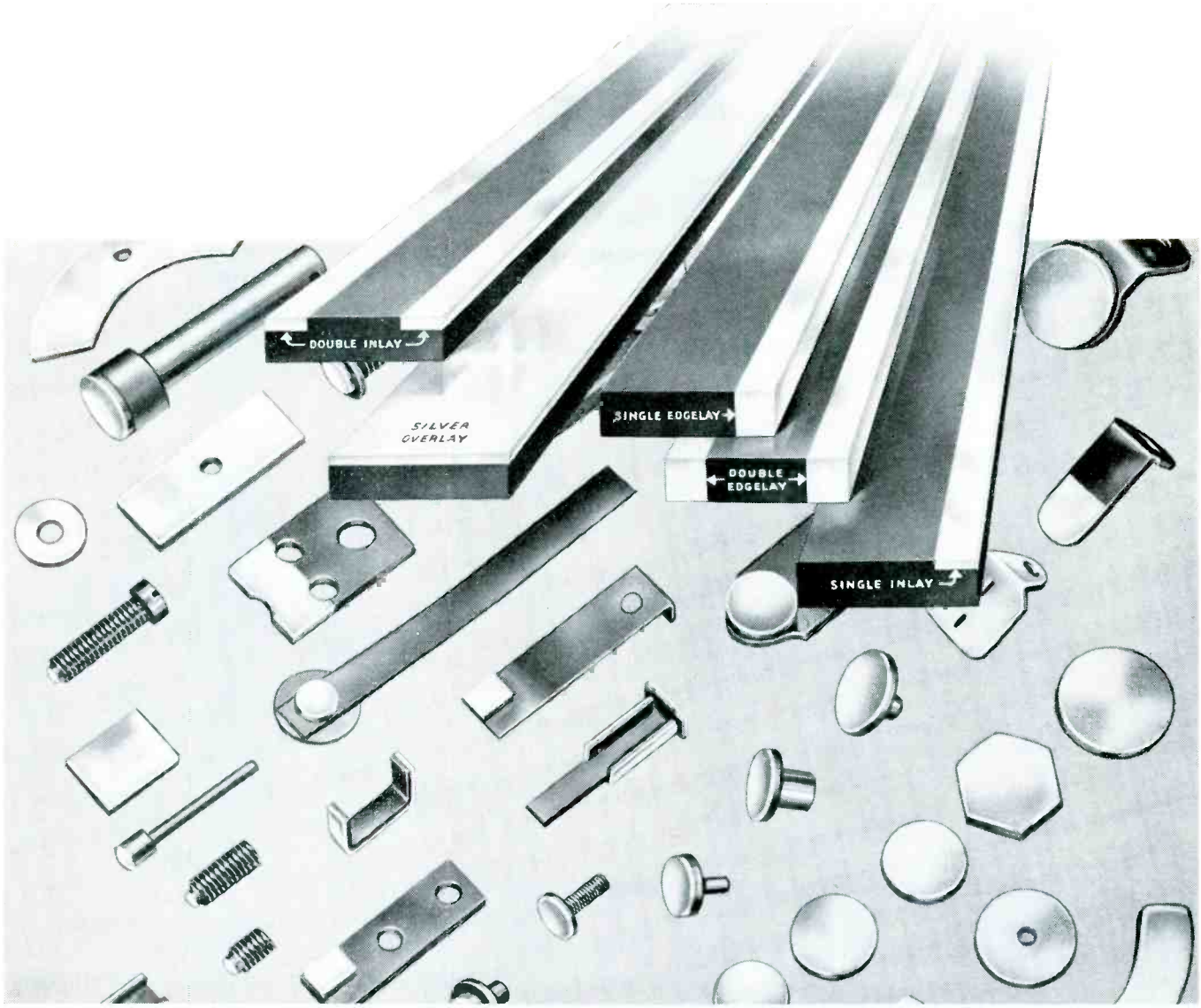
ALLEN B. DUMONT LABORATORIES, INC., 2 Main Ave., Passaic, N. J. Type 281 cathode-ray indicator and type 286 high-voltage power supply employ a type 5RP-A tube with overall accelerating potential of 29



kilovolts. Under these conditions writing rates as high as 400 inches a microsecond can be recorded. Magnetic shielding is complete so that the instrument can be successfully used near power buses, and voltage regulation employed allows operation on factory power lines.

Totalizer (39)

R. W. CRAMER CO., INC., Centerbrook, Conn. Type E7 running time meter illustrated indicates in tenths up to 10,000 hours and then repeats. It can also be reset from



YOU GET SOLID SILVER CONDUCTIVITY PLUS ECONOMY WITH GENERAL PLATE LAMINATED SILVER METALS AND CONTACTS

The big advantage of General Plate Laminated Silver metals and contacts is that they give you solid silver performance at a fraction of the cost of solid silver. Why — because General Plate permanently bonds a thin layer of silver to suitable inexpensive base metal, thus providing a contact face of high electrical conductivity at the point of actual contact.

General Plate Laminated silver metals, for your own fabrication, are available with silver bonded to base metal in the following stock . . . overlay, single or double inlay and single or double edgelay. General Plate contacts and fabricated parts are made to customers specifications. Laminated contact buttons, rivets and screw type contacts are also available. Advantages include — long contact life, greater strength, easier fabrication, and easier soldering, brazing or spot welding.

Write, specifying your problems.

GENERAL PLATE DIVISION

of Metals & Controls Corporation

ATTLEBORO, MASSACHUSETTS

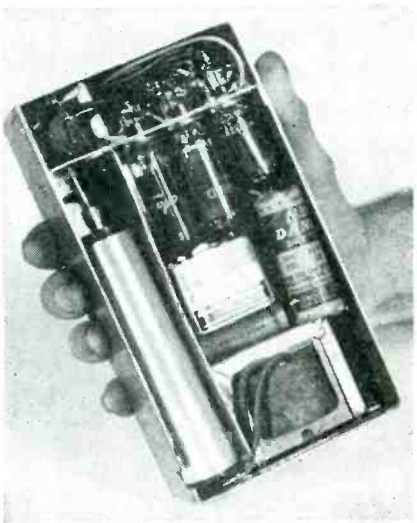
VISIT OUR EXHIBIT — METAL SHOW CHICAGO Oct. 18-24 — BOOTH No. 1817

50 Church St., New York, N. Y.; 205 W. Wacker Drive, Chicago, Ill.; 2635 Page Drive Altadena, Calif.

the front. Available for 110 or 220 volts, the meters can also be furnished for 50 or 60 cycles. Type E5 is suitable for table use, while type E6 is enclosed in a metal housing for conduit connection.

Pocket Tester (40)

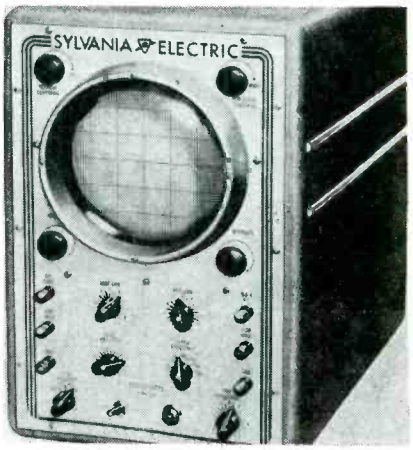
FEILER ENGINEERING CO., 422 S. Dearborn St., Chicago 5, Ill. Model TS-5 Pocket Stethoscope is a small signal tracer with its own speaker.



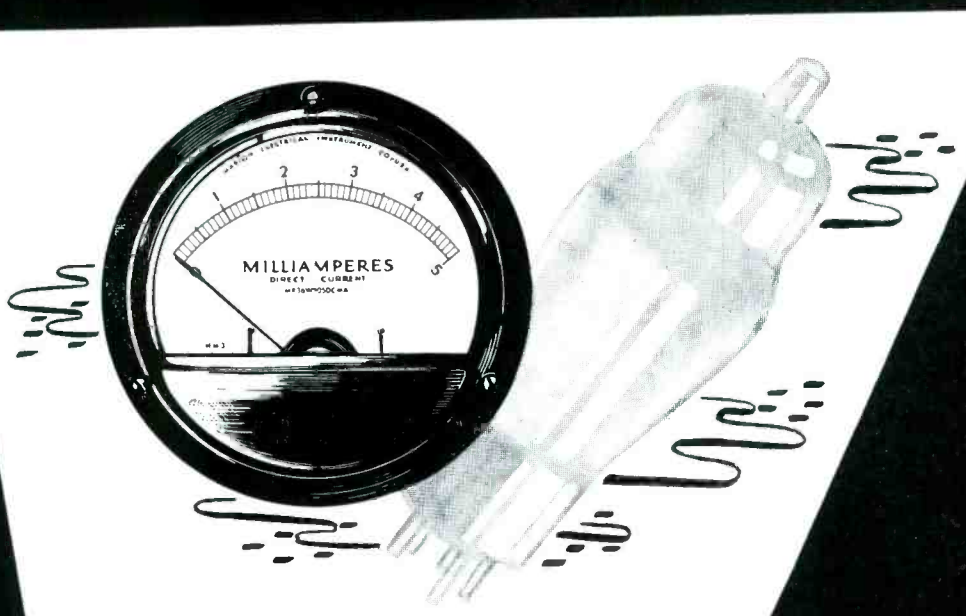
Any standard meter can be plugged in to convert the combination to an r-f vacuum tube voltmeter. An illustrated folder will be mailed on request.

Large Test Scope (41)

SYLVANIA ELECTRIC PRODUCTS INC., 500 Fifth Ave., New York 18, N. Y. A new 7-inch cathode-ray oscilloscope with higher-gain amplifiers than conventional test equipment weighs 37 pounds. The Z-axis in-



In Step with Electronic Progress . . .
Modern Hermetically Sealed Instruments



SEALED LIKE A VACUUM TUBE

100% GUARANTEED!

Progressive manufacturers of electronic equipment declare an hermetic seal is as important in a meter as it is in any other product component. That's because meters are just as susceptible to the harmful effects of dust, moisture, corrosive fumes and other destructive factors as resistors, capacitors or transformers. Therefore, hermetically sealed meters are a "must" in achieving top product performance.

MARION HERMETICS ARE NOT PREMIUM PRICED

Marion glass-to-metal hermetically sealed meters offer you the accuracy, superiority and extended life of an hermetically *sealed* component at a price no higher than most competitive *unsealed* instruments. All Marion hermetically sealed instruments are 100% GUARANTEED.

LOOK AT THE FEATURES OF MARION "HERMETICS"

DURABLE

. . . Unaffected by extremes of heat or cold . . . permanently protected against dust, dirt, moisture . . . instrument malfunctioning minimized.

SHIELDED

. . . Heavy steel case gives magnetic and electrostatic shielding so important in modern high frequency equipment.

INTER-CHANGEABLE

. . . The Marion case, with its high conductivity plating, eliminates the need for separate shielding and permits interchangeability on any type panel without affecting calibration.

MARION "4 for 1" FEATURE

Interchangeable Round and Square Colored Flanges . . . one instrument can thus fill four different needs:

1. Round
2. Round for Steel Panel
3. Rectangular
4. Rectangular for Steel Panel

WRITE FOR FURTHER INFORMATION.

THE NAME "MARION" MEANS THE "MOST" IN METERS

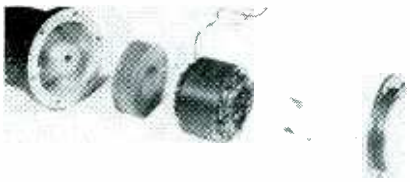
MARION ELECTRICAL INSTRUMENT COMPANY
Manchester, New Hampshire

NEW PRODUCTS (continued)

put impedance to ground is approximately 0.5 megohm shunted by 30 micromicrofarads. Such a characteristic facilitates waveform study by means of intensity modulation.

Electromechanical Control (42)

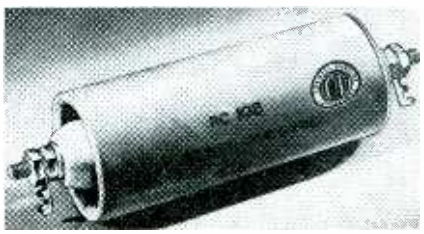
KOLLSMAN INSTRUMENT DIV., 80-08 45th Ave., Elmhurst, N. Y. The Synchrotel serves as a virtually frictionless voltage control and synchronous transmitter. The de-



vice can be attached to the pointer of the most sensitive aircraft or other instrument without affecting accuracy. It converts the reading into electrical signals that can be sent to a remote station with high accuracy.

Television Capacitor (43)

CORNELL-DUBILIER ELECTRIC CORP., South Plainfield, N. J. Type RC-108 capacitor has a rating of 0.05 mi-



crofarad and 3,500 volts d-c working voltage. Housed in a metal cylinder, the unit is 1½ inches in diameter and 3 inches long.

50-KW F-M (44)

RADIO CORP. OF AMERICA, Camden, N. J. Unique mechanical and electrical constructions have been used in the preproduction f-m transmitter amplifiers shown in order to insure safety to operating personnel and attain a power output of 50 kilowatts at 108 megacycles. The equipment employs a reactance-type modulator and frequency-correcting device, and is fully equipped for

New ways Permanent Magnets ...are doing it better!

Pushing—pulling . . . gripping—twisting . . . lifting—holding . . . magically, the permanent magnet contributes the unfailing force of "packaged energy" to the function of countless commonplace things.

Actually millions of magnets serve us daily in communications, transportation, science, medicine, and industry . . . ranging in size from the tiny magnet in the hearing aid to the huge, heavy horn-shaped radar magnets.

"Packaged energy" may do some job or process better for you . . . or, within your product, may serve you more efficiently . . . more economically. Investigate its use. Our engineers will gladly work out the way in which this *independent source of power* is best suited to your needs.

MEASURING STICK
Attracts and holds small metallic particles floating in lubricating oil.

COFFEE MAKER
"Packaged Energy" *cuts off* current when coffee is ready.

OIL PLUG
Attracts and traps fine metal filings that settle through oil at the bottom of the automobile crank case.

THERMOSTAT
"Packaged Energy" provides *snap action* for thermostats and safety controls.

TOOL HOLDER
Holds tools of all sizes, shapes . . . provides easy access.

Shown here are applications of permanent magnets utilizing *tractive* force. Other functions include:

1. Transformation of mechanical to electrical energy.
2. Transformation of electrical to mechanical energy.

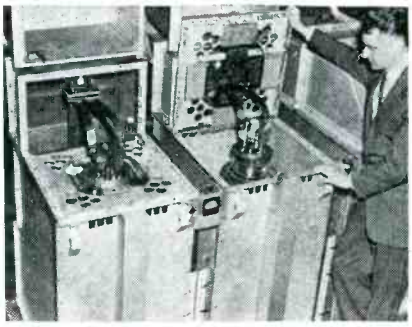
PERMANENT MAGNETS MAY DO IT BETTER

Parker "51" Magnetix Pen Holder. Magnet secures holder to base . . . yet allows it to pivot freely. Eliminates friction or other fittings which fail or wear.

★ THE INDIANA STEEL PRODUCTS COMPANY ★

PRODUCERS OF "PACKAGED ENERGY"
6 NORTH MICHIGAN AVENUE • CHICAGO 2, ILL.
SPECIALISTS IN PERMANENT MAGNETS SINCE 1910

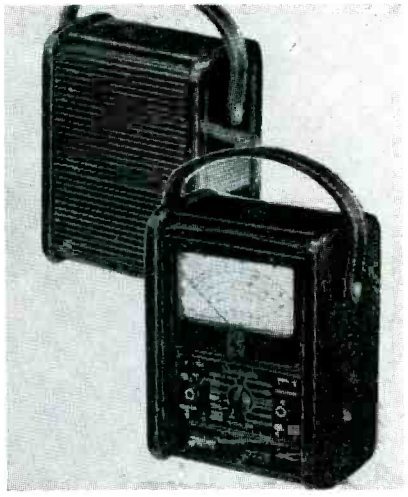
PLANTS { VALPARAISO, INDIANA
CHAUNCEY, WESTCHESTER COUNTY, N. Y.



semiautomatic operation. The antenna can be transferred from final to driver stage by a single control switch, making it possible to service the high-power equipment during broadcasting periods.

Protective Meter Case (45)

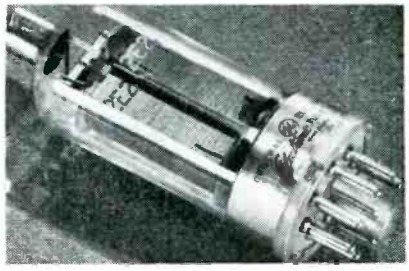
SIMPSON ELECTRIC CO., Chicago, Ill. The well-known model 260 volt-ohm-milliammeter is now available with



a roll-top safety case that completely protects it from damage during periods when it is not in active use.

Mobile Tube (46)

GENERAL ELECTRIC CO., Schenectady, N. Y. The GL-2E24 is a five-electrode beam power tube designed



Authorized WAA Electronics Distributors

EASTERN

Automatic Radio Mfg. Co., Inc.
122 Brookline Ave.
Boston, Mass.

Carr Industries, Inc.
1269 Atlantic Ave.
Brooklyn, New York, N. Y.

Tobe Deutschmann Corp.
863 Washington Street
Canton, Mass.

Electronic Corp. of America
353 West 48th Street
New York, N. Y.

Emerson Radio &
Phonograph Corp.
76 Ninth Ave.
New York, N. Y.

General Electric Co.
Bldg. 267; 1 River Road
Schenectady, N. Y.

General Electronics, Inc.
1819 Broadway
New York, N. Y.

Hammarlund Mfg. Co., Inc.
460 West 34th Street
New York, N. Y.

Hytron Radio & Electronics Corp.
76 LaFayette St.
Salem, Mass.

Johanns & Keegan Co., Inc.
62 Pearl St.
New York, N. Y.

Newark Electric Co., Inc.
242 West 55th St.
New York, N. Y.

Radio Parts Distributing Co.
128 West Olney Road
Norfolk, Va.

Smith-Meeker Engineering Co.
125 Barclay Street
New York, N. Y.

Standard Arcturus Corp.
99 Sussex Ave.
Newark, New Jersey

Sylvania Electric Products, Inc.
Emporium, Pa.

Technical Apparatus Co.
165 Washington St.
Boston, Mass.

Tung-Sol Lamp Works, Inc.
95 Eighth Ave.
Newark, New Jersey

W. & H. Aviation Corp.
Municipal Airport
Rochester, New York

MIDWESTERN

American Condenser Co.
4410 N. Ravenswood Ave.
Chicago, Ill.

Belmont Radio Corp.
3633 S. Racine Ave.
Chicago, Ill.

Electro-Voice, Inc.
Carroll & Cecil Streets
Buchanan, Michigan

Essex Wire Corp.
1601 Wall Street
Fort Wayne, Indiana

E. F. Johnson Co.
206 Second Ave., S. W.
Waseca, Minnesota

SOUTHERN

Navigation Instrument Co., Inc.
P. O. Box 7001, Heights Station
Houston, Texas

Southern Electronic Co.
512 St. Charles Street
New Orleans, La.

PACIFIC

Cole Instrument Co.
1320 S. Grand Avenue
Los Angeles, Calif.

Hoffman Radio Corp.
3761 S. Hill Street
Los Angeles, Calif.

JOBBERS
WHOLESALERS
MANUFACTURERS

You'll save—save—save when you purchase surplus electronic equipment from these Approved Distributors. They are offering electronic tubes, devices and equipment which were declared surplus by the Armed Forces. Fill your needs—*now*—while inventories still permit large purchases and wide selection.

Purchasing of this equipment has been simplified to a high degree. These WAA Approved Distributors were selected on a basis of their ability to serve you intelligently and efficiently. Write, phone or visit your nearest Approved Distributor for information concerning inventories, prices and delivery arrangements. You'll find you can "Save with Surplus".

OFFICE OF AIRCRAFT AND ELECTRONICS DISPOSAL

WAR ASSETS ADMINISTRATION

GOVERNMENT WAA SURPLUS

Offices located at: Atlanta • Birmingham • Boston • Charlotte
Chicago • Cincinnati • Cleveland • Denver • Detroit • Grand Prairie,
Tex. • Helena • Houston • Jacksonville • Kansas City, Mo. • Little Rock, Ark.
Los Angeles • Louisville • Minneapolis • Nashville • New Orleans • New York
Omaha • Philadelphia • Portland, Ore. • Richmond • St. Louis • Salt Lake City
San Antonio • San Francisco • Seattle • Spokane • Tulsa 1322

for use as a class C r-f amplifier and an oscillator, particularly in mobile and emergency communications equipment. A quick-heating filament requires only 2 seconds warmup. The anode dissipates 13.5 watts. Maximum ratings apply up to 125 megacycles.

Literature

(47)

Strain Measuring. Nosker Engineering Products, Yellow Springs, Ohio. Information and pictures of strain measuring recorders and indicators are found in bulletin 2A-4.

(48)

Crystal Units. Reeves-Hoffman Corp., 321 Cherry St., Carlisle, Pa. Bulletin RHC-3 covers the RH-7B crystal which is available with 3- to 15-mc fundamental, or 15- to 75-mc harmonic mode output frequencies. The RH-9 crystal, designed for television and f-m, is described in bulletin RHC-2.

(49)

Resistance Standards. Rubicon Co., 3614 Ridge Ave., Philadelphia 32, Pa., announce publication of a new 12-page illustrated technical bulletin, No. 100. Operation, application, construction, and other pertinent data on their complete line of resistance standards and resistance bridges are furnished.

(50)

Rectifier for Receivers. General Transformer Corp., 4321 N. Knox Ave., Chicago 41, Ill. Two catalog pages set forth the chief features of the new Perma-Power unit for converting battery radios to all-electric operation.

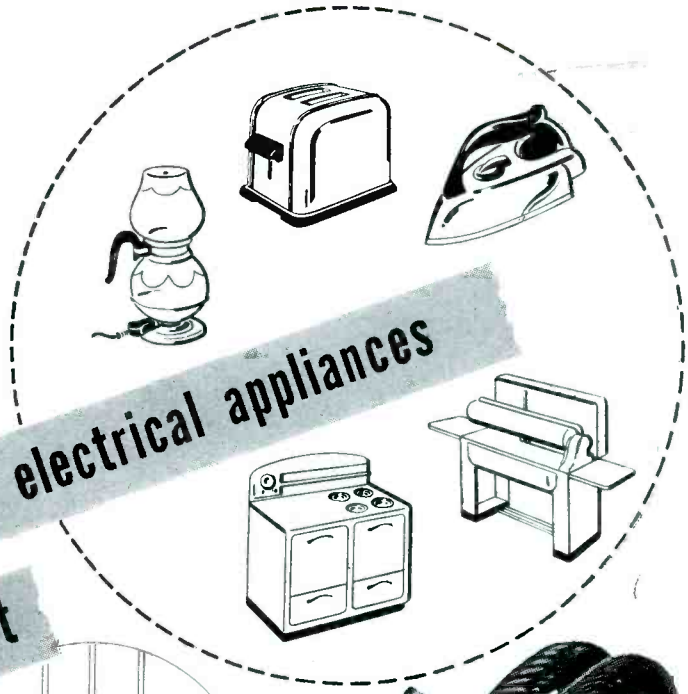
(51)

Relays. American Relay and Controls, Inc., 2555 Diversey Ave., Chicago 47, Ill., has recently published a 4-page folder on its line of relays, switches, and electrical specialties.

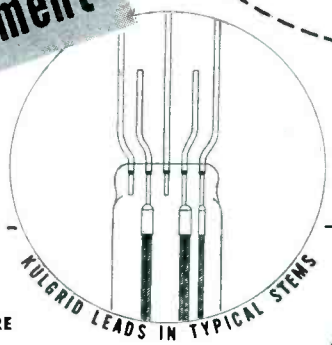
(52)

Audio Appurtenances. Atlas Sound Corp., 1443 39th St., Brook-

Callite Kulgrid*



adds a plus value to your electrical appliances and electronic equipment



KULGRID'S NICKEL "CLAD" PLUS COPPER CORE PROVIDE UNSURPASSED WIRE DURABILITY AND CONDUCTIVITY AT HIGH AMBIENT TEMPERATURES

- copper core and nickel sleeve are drawn down together.
- 70% of copper's conductivity plus all of nickel's strength.
- strands stay welded and flexible, offer lower resistance.
- will not become brittle or snap off suddenly.
- will not oxidize or flake at high fabricating and operating temperatures.
- will satisfactorily perform under high ambient temperatures without loss of elasticity or conductivity.
- resists corrosive atmospheres.
- welds readily to itself, nickel, copperclad, tungsten, molybdenum and other related metals.

*Kulgrid is covered by U.S. and foreign patents.

Leading manufacturers throughout the world are now using tons and tons of Kulgrid for electrical appliances, electronic tubes and industrial equipment. They know that only Kulgrid – an ingenious combination of nickel "clad" and copper core – can perform efficiently, and at low cost, under the severest operating or atmospheric tests. Specify Kulgrid to add a *real* plus value to your equipment. Types available for all applications. Write today for printed data or special counsel to: Callite Tungsten Corporation, 544 Thirty-ninth Street, Union City, N. J. Branch Offices: Chicago, Ill.; Cleveland, Ohio.

Callite

CALLITE TUNGSTEN CORPORATION

KULGRID & OTHER CLAD WIRES

. . . also alloy wires in tungten, molybdenum, silver and special alloys in diameters to .002" or smaller.

lyn 18, N. Y. Pages 7 and 8 of Catalog 47 show desk stands, boom stands and arms, bracket clamps, and other necessary adjuncts to the technique of picking up sound with a microphone.

(53)

Coax Relay. Signal Engineering & Mfg. Co., 154 West 14th St., New York 11, N. Y. Bulletin CR1 describes a coaxial cable relay for high-frequency switching. It has a 250-watt capacity and can be used to switch a 75-ohm line, maintaining a low standing-wave ratio.

(54)

Transmitters. Federal Telephone and Radio Corp., 100 Kingsland Road, Clifton, N. J. Three new multichannel communication transmitters, the 184-A, 185-A, and 186-A, designed for ground-to-air and point-to-point service, are described and illustrated in a recent bulletin. Flexible arrangement of basic equipment makes them adaptable for present and future needs.

(55)

Parts Catalog Sheets. Radio Corp. of America, Harrison, N. J. Of special interest to hobbyists and experimenters are the catalog sheets on television parts as well as those on antennas, speakers, and a phonograph modernization kit.

(56)

Transmitting Tetrode. Raytheon Manufacturing Co., Power Tube Division, Waltham, Mass. An 8-page brochure includes a complete set of graphs giving characteristics of the RK-6D22 transmitting tetrode. The tube has 1,000-watt r-f output with 3,000-volt plate supply and 22-watt grid drive. Plate dissipation is 450 watts.

(57)

Rectifier. Sylvania Electric Products Inc., Emporium, Pa. Type 5AZ4 full-wave rectifier ratings and characteristics are presented on a single sheet recently issued.

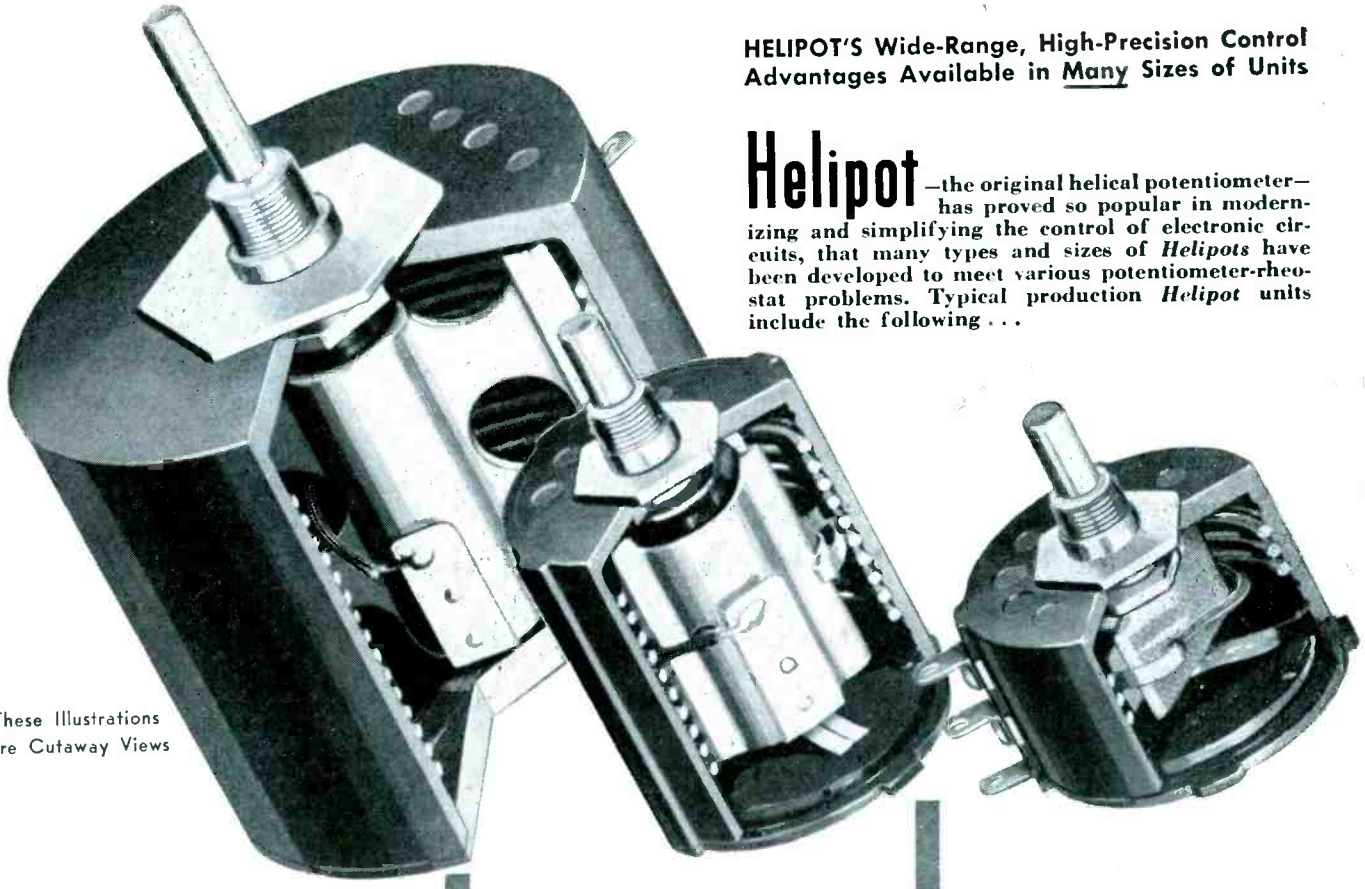
(58)

Insulated Tubing. Insulation Manufacturers Corp., 565 West Wash-

There's a Beckman Helipot

(Trade Mark of the **HELI**cal **POT**entiometer)

to simplify YOUR Potentiometer—Rheostat Problems!



These Illustrations Are Cutaway Views

HELIPOT'S Wide-Range, High-Precision Control Advantages Available in Many Sizes of Units

Helipot—the original helical potentiometer—has proved so popular in modernizing and simplifying the control of electronic circuits, that many types and sizes of *Helipots* have been developed to meet various potentiometer-rheostat problems. Typical production *Helipot* units include the following . . .

MODEL B—Case diameter—3.3"; Number of turns—15; Slide wire length—140½"; Rotation—5400°; Power rating—10 watts; Resistance ratings—50 to 200,000 ohms.

MODEL A—Case diameter—1.8"; Number of turns—10; Slide wire length—46½"; Rotation—3600°; Power rating—5 watts; Resistance ratings—10 to 50,000 ohms.

MODEL C—Case diameter—1.8"; Number of turns—3; Slide wire length—13.5"; Rotation—1080°; Power rating—3 watts; Resistance ratings—5 to 15,000 ohms.

WIDE CHOICE OF DESIGN FEATURES

Not only are Helipots available in a wide range of sizes and ratings, but also can be supplied with various design features to meet individual requirements . . .

- Available with special length shafts, flatted shafts, screwdriver slots, etc.
- Can be supplied with shaft extensions at each end to permit coupling to indicating instruments or other devices.
- May be provided in ganged assemblies of two or three units, all operating from a common shaft.
- Available with linearity tolerances of 0.1%—and even less.
- Models A & B can be modified to include additional taps at virtually any point on windings.

. . . and many other special features.

Investigate the many important advantages to be gained by using the *Helipot* in your electronic control applications. Write outlining your problem!

SPECIAL MODELS

In addition to the above standard *Helipot* units, special models in production include . . .

MODEL D—Similar to Model B, above, but longer and with greater length of slide wire. Case diameter—3.3"; Number of turns—25; Slide wire length—234"; Rotation—9000°; Power rating—15 watts; Resistance ratings—100 to 300,000 ohms.

MODEL E—Similar to Model B, but longer and with greater length of slide wire than Model D. Case diameter—3.3"; Number of turns—40; Slide wire length—373"; Rotation—14,400°; Power rating—20 watts; Resistance ratings—150 to 500,000 ohms.

Send for HELIPOT Literature!

THE Helipot CORPORATION

1011 Mission Street, South Pasadena 2, California

ington Blvd., Chicago 6, Ill. Dieflex cotton and Fiberglas tubing is attractively displayed by means of sample lengths mounted on a folder. A recent price list is included.

(59)

Microwave Test Equipment. Polytechnic Research and Development Co., Inc., 66 Court St., Brooklyn 2, N. Y. Resistive pads and attenuators, slotted lines and probes, frequency meters, and cavities are included in the line of precision microwave components listed in a newly released catalog.

(60)

Miniature Tubes. Radio Corp. of America, Harrison, N. J. Sheets describing types 1U5, 6BJ6 and 12AL5 miniature tubes have just been made available. The tube functions are, respectively, diode-pentode, r-f amplifier pentode, and twin diode.

(61)

Variable Transformers. Superior Electric Co., 277 Church St., Bristol, Conn. Bulletin 547 features Powerstat variable transformers and Stabiline automatic voltage regulators. Ratings, detail drawings, photographs, and engineering data are concisely presented.

(62)

Resonant Relays. Stevens-Arnold Inc., 22 Elkins St., So. Boston 27, Mass. The range of the company's line of resonant relays has been extended to 1,000 cycles, increasing the usefulness of these relays for remote control purposes. Read about it in Catalog 116A.

(63)

Plugs and Jacks. Switchcraft Inc., 1735 West Diversey Parkway, Chicago 14, Ill. A 2-color catalog of 8 pages lists a line of jacks, plugs, and switches. Mechanical drawings, photographs, and material specifications simplify the information for the design engineer.

(64)

Electrolytic Capacitors. Pyramid Electric Co., 155 Oxford, Paterson,

speed production — cut costs with EJECT-O-MATIC

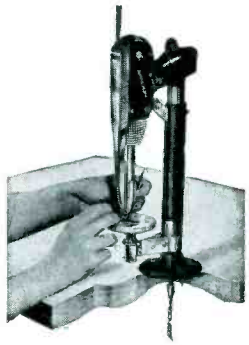
AUTOMATIC-FEED SOLDERING IRONS AND ACCESSORIES

HEAVY DUTY EJECT-O-MATIC

High-heat 100 and 150-watt models for general heavy electrical, electronic and repair work. Also available in long-nosed "instrument" model. Weight only 22 oz.

STANDARD EJECT-O-MATIC

Popular 50 and 75-watt models for general radio and electrical work. Special long-nosed models available for soldering inside deep receptacles, hard-to-get relays and assemblies. Weight only 18 oz.



VERTI-MOUNT

Treadle operated — leaves both hands free to hold work. Pre-heats and solders work with one easy foot movement. Takes all Eject-O-Matic irons.

complete line now available

TIPS— Multi-clad tips available in eight different sizes and shapes.

SPECIAL TIPS DESIGNED—
MINIMUM 10 TO ORDER.

Send for new catalog and prices.

AUTOMATIC FEED SOLDERING IRON
EJECT-O-MATIC
HOUSES · MEASURES · EJECTS THE SOLDER

MULTI-PRODUCTS TOOL CO. 123 SUSSEX AVENUE, NEWARK, N. J.

ZOPHAR

Waxes, Compounds and Emulsions

ZOPHAR MILLS INC. QUALITY SERVICE EXPERIENCE 100 YEARS

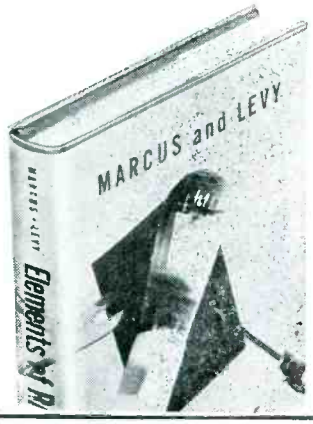
Materials for potting, dipping or impregnating all types of radio components or all kinds of electrical units. • Tropicalized fungus proofing waxes. • Waterproofing finishes for wire jackets. • Rubber finishes. • Inquiries and problems invited by our engineering and development laboratories.

Zophar Mills, Inc. has been known for its dependable service and uniformity of product since 1846.

ZOPHAR MILLS, Inc.

ESTABLISHED 1846

117 26th STREET, BROOKLYN, 32 N. Y.



How to repair RADIOS

This "how-to-do-it" radio repair manual

shows you how to handle 95% of all service problems

This handy and highly practical radio repair manual leads you in easy steps to a complete understanding of 95% of all radio servicing jobs. The manual covers the modern superheterodyne A.M. receiver, as well as phonograph-combination service problems and auto radio problems. Detailed "how-to-do-it" explanations enable you to put your finger directly on exactly what needs to be done. The book breaks the superheterodyne into natural stages, and analyzes them thoroughly from a service standpoint, covering everything from setting up the signal generator to the push-pull output stage. Clearcut schematic diagrams of modern receivers aid you throughout.

Just published!

ELEMENTS OF RADIO SERVICING

By WILLIAM MARCUS
Co-author of "Elements of Radio"
and ALEX LEVY
Instructor of Radio Mechanics, Manhattan Trade Center for Veterans and Chelsea Vocational High School

471 pages, 6 x 9, illustrated, $4.50

Here is a completely practical radio servicing manual—carefully and simply written, well illustrated, and easy to follow—designed to guide you to the best methods of making most modern radio repairs. Analyses of the stages are generalized for easy application to receivers made by most manufacturers. The most commonly used testing equipment—the multimeter and signal generator—are carefully described.

Read over some of the elements covered in this handy manual:

- Superheterodyne receivers
- Servicing procedure
- Multimeters
- Signal generator applications
- AC power supply
- Loudspeakers
- First audio-amplifier stage
- IF amplifier stage
- Converter; mixer and oscillator stages
- RF amplifier stage
- Antennas
- AC/DC power supply
- Auto radio power supplies
- Push-pull output stage
- Alignment of a superheterodyne receiver
- Survey of the servicing procedure

See it 10 days Free • Mail Coupon

McGraw-Hill Book Co., 330 W. 42nd St., NYC 18

Send me Marcus and Levy's **Elements of Radio Servicing** for 10 days' examination on approval. In 10 days I will send $4.50, plus few cents postage, or return book postpaid. (Postage paid on cash orders.)

Name .....

Address .....

City and State .....

Company .....

Position L-10-47

(For Canadian price, write McGraw-Hill Co. of Canada, Ltd., 12 Richmond Street E., Toronto 1.)

N. J. Catalog J-4 includes a wide variety of d-c electrolytic capacitors in cardboard and metal containers with capacitances ranging from 5 to 2,000 microfarads at working voltages from 6 to 600 volts.

(65)

Fuses. Littlefuse Inc., 4799 N. Ravenswood Ave., Chicago 40, Ill., offers Catalog No. 9 as an encyclopedia of fusing information and circuit protection, including complete details on fuses, mountings, testers, and accessories.

(66)

Ham Tube Types. Radio Corp. of America, Tube Division, Harrison, N. J. Form No. HAM-103 is a new 4-page folder that charts the ratings, characteristics, operating conditions, and prices of a preferred group of 27 rectifiers, oscillators, amplifiers, and modulators used in amateur transmitters.

(67)

Transmitting and Industrial Tubes. Machlett Laboratories, Inc., Springdale, Conn. An illustrated catalog of power tubes for communications and industry lists characteristics and suggested uses for the company's line.

(68)

Organization Method. Alden Products Co., 117 N. Main St., Brockton, Mass. The Red Book devotes 44 pages to an exposition of the Alden organization and its method of handling development and manufacturing problems.

(69)

R-F Generator. The Clough-Brengle Co., 6014 Broadway, Chicago, Ill. Model 299-A r-f signal generator covers the range from 100 kc to 32 mc in five bands. A complete listing of its qualifications for the job is presented on a single two-page sheet.

(70)

Tube Catalog. United Electronics Co., 42 Spring St., Newark 2, N. J. Each registered holder of a United loose-leaf catalog should have received the latest price list together

with data sheets on three industrial electronic tubes just issued.

(71)

Electronic Analyzer. Weston Electrical Instrument Corp., Newark 5, N. J. Model 769 analyzer has been designed primarily for f-m, a-m, and television service work. Circuitwise, it is a type described in the March 1947 issue of ELECTRONICS. A single-page sheet lists its functions and characteristics.

(72)

Catalog Sheets. General Instrument Corp., 829 Newark Ave., Elizabeth 3, N. J. The latest catalog sheets on the new f-m and a-m capacitors, models 2012 and 2022, are now available. Complete electrical and mechanical specifications are given. Along with the sheets, holders of the catalog may obtain a calculator for aid in rapid electrical circuit computations. This too is perforated for easy insertion in the catalog binder.

(73)

Tube Guide. Hytron Radio and Electronics Corp., Salem, Mass. A handy loose-leaf margined reference guide for miniature electron tubes has been compiled and published as a service to users. All miniature types announced to date are included regardless of the originating or producing manufacturers.

(74)

Resistors. Clarostat Mfg. Co., Inc., 130 Clinton St., Brooklyn 2, N. Y. An informative bulletin, available on request, illustrates and describes the characteristics of cement coating for power resistors.

(75)

Radio Parts. JFD Manufacturing Co., 4117 Ft. Hamilton Parkway, Brooklyn 19, N. Y. In a recently published 44-page catalog, we find described in detail over 4,000 radio parts from battery plugs to antennas.

(76)

Ceramic Capacitors. Centralab Division of Globe-Union Inc., Mil-

- *RUGGED*
- *DEPENDABLE*
- *ACCURATE*

Burlington

PANEL INSTRUMENTS

For utmost reliability—specify and depend upon Burlington Panel Instruments. They are designed, engineered and built to give satisfactory service even under most severe applications — and are fully guaranteed for one year against defects in material or workmanship.

Write today for full details

BURLINGTON INSTRUMENT COMPANY
123 FOURTH STREET **BURLINGTON, IOWA**

DESIGNED FOR DISCRIMINATING MANUFACTURERS

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.

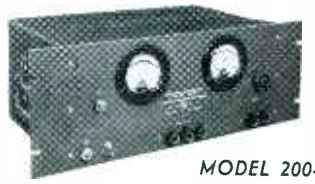
QUALITY
UNIFORMITY
SERVICE

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.

Winsted
HUDSON WIRE CO.
Division
WINSTED • CONNECTICUT

Laboratory Instruments

REGULATED POWER SUPPLIES

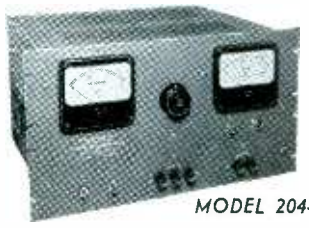


MODEL 200-B

OUTPUT VOLTAGE—0-325 Volts D.C. continuously variable at 125 Ma. Low A.C. Output—6.3 volts at 6 amps. center tapped.

REGULATION — Within 1% between 20-325 volts from no load to full load.

HUM VOLTAGE—Within ten millivolts at any voltage or load within ratings.



MODEL 204-A

OUTPUT VOLTAGE—0-500 Volts D.C. continuously variable at 300 Ma. Low A.C. Output 6.3 volts at 6 amps. center tapped.

REGULATION — Within 1% between 30-500 volts from no load to full load.

HUM VOLTAGE—Within ten millivolts at any voltage or load within ratings.

POSITIVE OR NEGATIVE GROUND.

MODEL 205-A

OUTPUT VOLTAGE—No. 1 100-325 Volts D.C. continuously variable at 150 ma. No. 2 0-150 Volts D.C. continuously variable at 5 Ma. Low A.C. Output—6.3 volts at 6 amps. center tapped.

REGULATION—100-325 Output within 1% from no load to full load within ratings. 0-150 Output within 1% at 150 volts.

HUM VOLTAGE—Within ten millivolts at any voltage or load within ratings.

ELECTRONIC MEASUREMENTS COMPANY

Red Bank — E/M — New Jersey

REGULATED POWER SUPPLIES
VACUUM TUBE VOLTMETERS
SIGNAL GENERATORS

waukee, Wisconsin. Booklet 967 tells of the development, use, and characteristics of tubular ceramic bypass and coupling capacitors.

(77)

Products Catalog. General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill. About 500 items of electronic hardware and radio products are listed by classification groups in the new catalog, No. 3051.

(78)

F-M Antenna. Radio Corp. of America, Camden, N. J. Two sides of a page serve to show the chief features, outlines, and mounting details of the new single-section low-power Pylon antenna, types BF-21A and BF-21B, suitable for f-m broadcast use.

(79)

Rotary Power Supplies. Carter Motor Co., 2664 N. Maplewood Ave., Chicago, Ill., announce release of their latest sales bulletin No. 447-J. Many models of portable converters and dynamotors are illustrated and tables of voltage input and output are included.

(80)

Neutralizing Capacitor. The Hammarlund Mfg. Co. Inc., 460 W. 34th St., New York 1, N. Y. Complete electrical and mechanical specifications about the NZ-10 neutralizing capacitor with a range from about 2 to 11 micromicrofarads are given in a 4-page folder just released.

(81)

Laboratory Report. RCA Industry Service Laboratory, 711 Fifth Ave., New York 22, N. Y. A 20-page brochure describes and illustrates the activities of the radio development and consultation center.

(82)

Automatic Synchronizer. Burlington Instrument Co., Burlington, Iowa. Bulletin SN-400 is fully descriptive of the type SN, model SF automatic synchronizer. The unit is designed for automatically

controlling circuit breaker closure of a-c generators in parallel to a common bus. It is available for either 115- or 230-v, 50 to 60-cycle operation.

(83)
Tube Notes. Radio Corp. of America, Harrison, N. J., has issued two new booklets of application notes. AN-120 gives a thorough treatment of the 6SB7-Y, a pentagrid converter tube with high conversion transconductance. Use of the 6BA6 and 6BE6 miniature tubes in f-m receivers is described in AN-121.

(84)
F-M Transmitters. Radio Corp. of America, Engineering Products Dept., Camden, N. J. In an 8-page booklet chief features of three types of f-m broadcast transmitters are set forth along with pictures of each. Types 250A, 1C, and 3B have a power of 250 w, 1 kw, and 3 kw respectively.

(85)
Microphones and Pickups. Shure Bros., 225 W. Huron St., Chicago, Ill., announce issuance of two publications. Catalog 157 illustrates microphones and acoustic devices; and 158, phonograph pickups and replacement cartridges.

(86)
Speakers. Permoflux Corp., 4900 W. Grand Ave., Chicago 39, Ill. A 4-page bulletin covers complete data on over 100 types of speakers. Included are characteristic specifications for all types: sizes, flux density, voice coil diameters and impedance, watts, dimension and recommended transformer sizes.

(87)
Resistance Products. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa. A series of ten new catalog bulletins furnishes the latest technical data on a broad line of resistance products.

(88)
Limiting Amplifier. General Electric Co., Syracuse, N. Y. A 12-page

brochure, EBR-99, on the limiting amplifier, Type BA-5-A, has been prepared. Complete with schematic drawings and diagrams, it lists the operational and constructional features of the amplifier, a unit designed to increase the average program level of broadcasting and recording systems without danger of any audio peak exceeding a predetermined maximum value.

(89)

Controlled Music. Tel-O-Matic Products, Inc., 304 Clifton Ave., Clifton, N. J. Two pamphlets completely describe and illustrate the new musical robot. A 35-w peak power, 3-channel distribution amplifier permits radio reception, planned recorded music or microphone loudspeaker unit. Each channel input is fully controllable from the front panel.

(90)

Graphic Instruments. The Esterline-Angus Co., Inc., P. O. Box 596, Indianapolis 6, Indiana, has a list of about fifty bulletins describing a variety of graphic instruments and their applications. The listing or any of the individual publications are free to engineers and executives.

(91)

Relays. Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago 12, Ill. Many basic a-c and d-c relays are illustrated in Catalog No. 10-A, with diagrams, charts giving operating and contact data, and suggested applications for each relay.

(92)

Wires and Cables. Lenz Electric Mfg. Co., 1751 North Western Ave., Chicago 47, Ill. Catalog No. 31 is a 16-page booklet that describes and illustrates a wide variety of wires, cords, and cables for radio, hookup, antenna, intercommunication, and similar use.

(93)

X-Ray Diffraction. North American Philips Co., Inc., 100 E. 42nd St., New York 17, N. Y. Folder R1063 describes the principles of

x-ray diffraction and its use in industrial control. Also available gratis on request are two reprint leaflets entitled "Sampling Techniques Applied to Quality Control" and "Metallurgical Applications of the X-Ray Difraction Spectrometer".

(94)

Voltage Calibrator. Allen B. DuMont Laboratories, Inc., Passaic, N. J. A one-page reprint describes the type 264-A voltage calibrator which is independent of line-voltage variations and can be used with any oscillograph. A descriptive bulletin will be sent on request.

(95)

Chronotron Tube. Bendix Aviation Corp., Eclipse-Pioneer Division, Teterboro, N. J. This temperature - resistance device, mounted in a miniature-size vacuum-tube envelope, was developed primarily for use in electronic control circuits providing time delay and functioning as an integrator. A complete description, together with diagrams and tables, is found in bulletin 73-3A.

(96)

Rotary Switch Catalog. United States Instrument Corp., 19 South Harrison St., East Orange, N. J. An 8-page illustrated catalog describes the various types of rotary selector switches manufactured, besides giving dimensional drawings of representative types.

(97)

Flow-Rate Meter. Fischer and Porter Co., Hatboro, Pa., has issued a new bulletin describing and illustrating instruments for measuring flow rate of liquids and gases. Write for a copy care of Dept. 2N-C.

(98)

Remote Control. Yardeny Laboratories, Inc., 105 Chambers St., New York 7, N. Y. Typical remote control systems are described in this six-page booklet. These everyday applications are particularly valuable for planes, ships and moving vehicles as well as two-wire systems.

(continued from p 146)

and 51 to 52.5 mc. The purpose is to determine whether or not it is practical for narrow-band f-m and conventional a-m to operate within the same portions of the amateur phone bands.

As used by amateurs at present, narrow-band f-m is defined as a system of frequency modulation wherein the peak deviation is kept equal to or less than the maximum modulation frequency. Experience has already shown that in many cases where a-m amateur signals caused interference to broadcast reception, such interference was completely eliminated when the amateur station changed over to narrow-band f-m occupying the same bandwidth. It is desired to determine if these advantages will always hold true under practical operating conditions and to investigate disadvantages if any.

Nuclear Technology Magazine

THE FIRST issue of Nucleonics, a new McGraw-Hill monthly devoted to the peaceful uses of nuclear fission, made its appearance in September. The publication covers the field of nuclear technology, as distinct from that of nuclear science, and will provide information on industrial, medical, and other applications of atomic power and its byproducts. Subscription price is $15 per year. It will carry no advertising.

Included in the initial issue were articles by Drs. E. U. Condon, Clark Goodman, R. D. Evans, W. Radin, L. J. Rainwater, and C. S. Wu, as well as a statement from the Atomic Energy Commission, a list of declassified Manhattan District technical papers, and another on available radioisotopes.

The editorial staff, headed by Keith Henney as editor, includes Walter M. DeCew, formerly of the Los Alamos project. Drs. John Dunning and H. H. Goldsmith are advisors.

Chicago Conference Papers

THE TENTATIVE program for the National Electronics Conference, to

be held at the Edgewater Beach Hotel, Chicago, on November 3, 4, and 5, is as follows:

MONDAY NOV. 3—MORNING

Keynote address by President G. D. Stoddard of the University of Illinois.

Electronics Comes of Age, by Dr. L. V. Berkner of the Joint Research and Development Board.

Luncheon Speaker—W. Evans, vice-president of Westinghouse Electric Co.

MONDAY NOV. 3—AFTERNOON

1. NOISE SUPPRESSION AND DISTORTION

Dynamic Noise Suppressor, by H. H. Scott of Technology Instrument Corp.

Intermodulation Method of Distortion Measurement, by W. J. Warren of U. of Santa Clara and W. R. Hewlett of Hewlett-Packard Co.

S/N Ratio in AM Receivers, by E. C. Fubini and D. C. Johnson of Airborne Instruments Lab., Inc.

Corona Discharge at High Altitude and Low Temperature, by H. J. Dana of State College of Washington.

2. ELECTRONIC INSTRUMENTATION—Chairman: M. F. Behar, Editor of Instruments.

Self-Balancing Thermistor Bridge, by C. C. Bath and H. Goldberg of Bendix Radio Corp.

Variable Ratio Inductance Bridges and Networks, by Paul Glass and Sylva May Dushkes of Askania Regulator Co.

A Miniature Gastro-manometer for Electrical Recording, by H. C. Roberts of University of Illinois.

Short-Time Oscillography, by Jean V. Lebacqz of Johns Hopkins University.

Luminescent Screens For Cathode-Ray Oscillography, by Carl Feldt of DuMont.

3. COAXIAL ELEMENTS AND MICROWAVES

Bead Supported Coaxial Attenuator (4,000 to 10,000 mc), by John W. E. Griemsmann and Herbert J. Carlin of Microwave Research Institute, Polytechnic Institute of Brooklyn.

Wave Propagation in Beaded Lines, by R. E. Beam of Northwestern University.

Coaxial Elements and Connectors, by W. R. Thurston of General Radio Co.

Broadband Matching of Impedances, by R. M. Fano of MIT.

Broadband Bolometer Type U.H.F. Power Meters, by M. J. DiToro of Polytechnic Institute of Brooklyn.

4. OPERATION OF ELECTRONIC RESEARCH—Chairman: J. E. Hobson, Armour Research Foundation.

Organization and Operation of Electronic Research, by R. M. Bowie of Sylvania Electric Co.

Electronic Research in the University, by L. T. DeVore of University of Illinois.

Electronic Research in the Research Institute, by G. E. Zeigler of Midwest Research Institute.

Electronic Research in the Government Service, by Archibald S. Brown of Wright Field.

Banquet and Floor Show—Marine Dining Room.

TUESDAY NOV. 4—MORNING

5. MICROWAVES

Higher Mode Techniques for Wave Guides, by M. W. Goodhue of Polytechnic Research and Development Co.

Multiplex Transmission Through Wave Guides Using Higher Order Modes, by R. R. Buss, W. A. Hughes, H. D. Ross, and A. B. Bronwell of Northwestern University.

Microwave Spectroscopy, by D. K. Coles and W. E. Good of Westinghouse Electric Corp.

Noise Reduction in Radar and Communications, by S. Goldman of MIT.

6. Joint session of National Electronics Conference and AIEE, program arranged by AIEE.

7. COMPUTERS

Electronic Computers, by J. W. Mauckly and J. P. Eckert Jr. of Electronic Control Co.

Storage of Numbers on Magnetic Tape, by J. M. Coombs of Engineering Research Associates.

Computers for Aeronautical Navigation, by Hugo Schuck of Minneapolis-Honeywell.

8. ELECTRONIC CIRCUIT ANALYSIS I Cathode Tap, Cathode Follower Ampli-

fiers, by Bradford B. Underhill of Penn State College.

Low Power Frequency Multipliers, by R. J. Schwarz of Columbia U.

Series Mode Quartz Crystal Oscillator Circuit, by H. Goldberg and E. L. Crosby, Jr. of Bendix.

Luncheon: An American Engineering Association, by B. D. Hull, Chief Engineer of Southwestern Bell and President of AIEE.

TUESDAY NOV. 4—AFTERNOON

9. NEW DEVELOPMENTS

Ultrasonic Guidance of the Blind, by Frank H. Slaymaker and W. F. Meeker of Stromberg-Carlson Co.

Heatless Preservation with Penetrating Electrons from the Capacitron, by W. Huber of Electronized Chemicals Corp.

Citizen's Radio Service, by R. E. Samuelson of Hallicrafters.

General Trends in Foreign Electronic Developments, by A. H. Sullivan Jr. of Wright Field.

10. INDUSTRIAL ELECTRONICS

Electronic Half-Tone Engraver, by John Boyajian of Fairchild Camera and Instrument Corp.

Electronic Servomechanism Testing Machine, by H. W. Katz of U. of Illinois.

Sealed Ignitrons for Radio Transmitter Power Supplies, by H. E. Zuvers of G-E.

Single Phase Controlled Rectifier and Inverter Circuits, by C. M. Wallis of U. of Missouri.

11. ANTENNAS

High Gain with Discone Antennas, by A. G. Kandoian, W. Sichak, and R. A. Felsenheld of Federal Telecommunication Lab.

Slot Antennas, by N. E. Lindenblad of RCA.

Measurement of Aircraft Patterns in Flight, by J. S. Prichard of Airborne Instruments Lab.

Transmission Frequencies for Line of Sight Systems, by L. S. Schwartz of NRL.

12. NUCLEONICS

Mass Spectrometer Type Leak Detector, by Robert F. Wall of Texas A. and M. College.

Scintillation Counter, by J. W. Coltman of Westinghouse.

Precision Studies of Nuclear Reactions, by W. E. Shoupp of Westinghouse.

WEDNESDAY NOV. 5—MORNING

13. MILITARY APPLICATIONS OF ELECTRONICS

Guided Missiles, by Walter N. Brown Jr., of Haller, Raymond and Brown.

Telemetry System for Guided Missiles, by L. J. Neelands and Walter Hausz of G-E.

Foreign Developments in Infrared, by E. A. Underhill of Wright Field.

Foreign Vacuum Tubes and High Frequency Techniques, by B. L. Griffing of Wright Field.

14. COMMUNICATIONS

Teleran, A Technical Progress Report, by R. W. K. Smith, D. H. Ewing, and H. J. Schrader of RCA.

Crystal Saver, by W. R. Hedeman Jr. of Bendix Radio Corp.

Pulse Count Modulation, by D. D. Grieg and S. Metzger of IT&T.

Air Traffic Control, by W. D. White of Airborne Instruments Lab.

15. BASIC SCIENCE

Semi-Conductors, by K. Lark-Horovitz of Purdue U.

Dynamic Properties of the Infrared Cesium Arc, by J. M. Frank and W. S. Huxford of Northwestern U.

Supersonic Detection of Infrared Modulation, by F. J. Fry and W. J. Fry, U. of Illinois.

Microwave Scattering, by R. T. Gabler of Westinghouse.

16. INDUSTRIAL APPLICATIONS

High Frequency Operation of Fluorescent Lamps, by J. H. Campbell and B. D. Bedford of G-E.

Magnetostriction Torquemeter, by C. M. Rifenberg and E. H. Schulz of Armour Research Foundation.

Saturable Core Magnetometer Applications, by W. E. Tolles of Airborne Instruments Lab.

WEDNESDAY NOV. 5—AFTERNOON

17. TELEVISION

The Chromoscope, A New Color Television Viewing Tube, by A. B. Bronwell of Northwestern U.

Color in Television Cathode Ray Tubes, by E. B. Fehr of G-E.

A Modern Television Transmitter, by C. D. Kentner of RCA.

Monitoring Equipment for Television

KEEP continually POSTED on ELECTRON TUBES

RCA HB-3 Tube Handbook

Now in 3 Binders—6 Volumes

No other tube handbook provides as much up-to-the-minute technical data on tube types as the RCA HB-3 Handbook, which has been a standard technical reference book for over 15 years. Indexed contents include general data, characteristic curves, socket connections, outline drawings, price lists, preferred-type lists, etc., for the complete line of RCA tubes.

New Sheets Mailed Regularly. The U. S. subscription price of $10.00 brings you the complete Handbook in three binders, plus supplementary sheets containing new or revised data as issued during the year. Annual service fee thereafter is $2.00. (These prices apply only in the U. S. and its possessions.)

Subscribe Now. Insure early delivery. Mail your remittance today to: RCA, Commercial Engineering, Section W-40J, Harrison, N. J.

TUBE DEPARTMENT
RADIO CORPORATION of AMERICA
HARRISON, N. J.

Linde

SYNTHETIC SAPPHIRE For Resistance to All Commercial Chemicals

If corrosion resistance of small parts is important to your product, it's worthwhile to consider LINDE synthetic sapphire. This new raw material resists chemical attack and wear. It has high electrical resistance—low thermal conductivity.

1. Chemical Resistance . . All acids
2. Hardness (Knoop) 1,525 to 2,000
3. Thermal Conductivity . . 0.015 (cal. sec.$^{-1}$ cm^{-1} deg. C.$^{-1}$ at 500 deg. C.)
4. Dielectric Constant . . . . . 7.5 to 10

Send for Data Sheet No. 5 for all the specific properties of this advantageous material—LINDE synthetic sapphire.

THE LINDE AIR PRODUCTS COMPANY
Unit of Union Carbide and Carbon Corporation
30 East 42nd Street UCC New York 17, N. Y.
In Canada:
Dominion Oxygen Company, Limited, Toronto

The word "Linde" is a trade-mark of The Linde Air Products Company

---

THERE'S A DRAKE SOLDERING IRON FOR EVERY TYPE OF ELECTRONIC WORK

From that mighty mite

the Drake No. 400 to the high-speed production "honey"

the Drake No. 600-10 there is a high quality Drake Soldering Iron "just right" for the job.

Drake Heat Controls and the Drake "Magic Cup" Stand are important soldering aids.

SEE YOUR RADIO PARTS JOBBER

DRAKE ELECTRIC WORKS, INC.
3656 LINCOLN AVE. CHICAGO, ILL.

MODEL No. 301-A

MILFORD FASTENING EQUIPMENT

HAVE YOU ASSEMBLIES LIKE THESE?

Heating Equipment
Small Animal Cages
Industrial Baskets
Baby Carriages *Stoves*
Leather Goods, etc., etc.

Assemblies cost more than you think. Not the material, but the time to complete them. Check time costs and you will be startled. Milford knows—from checking time costs for innumerable manufacturers. That's why they chose Milford Fastening Equipment (semi-tubular or split rivets and rivet setters). It flattens the time-cost curve, assures proved and important savings on assemblies as diverse as wrist-watches and refrigerators. Don't delay. Investigate today. Deliveries are not yet normal. Earliest ordered, earliest delivered.

The Milford Rivet & Machine Co.
859 Bridgeport Avenue, Milford, Conn.
1002 West River Street, Elyria, Ohio

Inquiries may also be addressed to our subsidiary:
THE PENN RIVET & MACHINE CO., PHILADELPHIA 33, PENNA.

Broadcast, by M. Silver of Federal Telecommunication Lab.

18. ELECTRONIC INSTRUMENTATION II
High Resolving Power Infrared Recording Spectrometers, by R. C. Nelson and W. R. Wilson of Northwestern U.
The Phase Meter, by E. O. Vandeven of G-E.
Accurate Measurement of Relative Phase, by R. Glaser of MIT.
A Null Method for Determination of Impedance in the 100-400 mc Range, by J. F. Byrne of Airborne Instruments Lab.

19. FM BROADCAST DEVELOPMENT
A 50 kw FM Broadcast Transmitter, by C. J. Starner of RCA.
A Pulse-Counter Type FM Station Monitor, by David Packard and Norman B. Schrock of Hewlett-Packard Co.
Transatlantic FM Transmission, by L. B. Arguimbau and J. Granlund of MIT.
Phase Modulation Circuit, by S. M. Beleskas of RCA.

20. ELECTRONIC CIRCUIT ANALYSIS II
Analysis of Oscillator Frequency Instability, by F. P. Fischer of U. of Connecticut.
Transient Behavior in Non-Linear Systems, by Carl S. Roys of Syracuse U.
Calculation of Operating Characteristics of Electromagnetic Devices, by R. M. Soria of American Phenolic Co. and T. J. Higgins of Illinois Institute of Technology.

New IRE Officers

B. E. SHACKELFORD, manager of the license department of RCA International Division, New York, N. Y., has been nominated as president of IRE for 1948. Election returns will be final Oct. 24, 1947.

R. L. Smith-Rose, superintendent of the radio division of the National Physical Laboratory, Teddington, England, has been nominated as vice-president.

In addition, a number of regional directors will be elected, and two directors-at-large for 1948-1950 will be elected from the following nominees: B. deF. Bayly, consulting engineer at the University of Toronto; A. B. Chamberlain, chief engineer of Columbia Broadcasting System; J. E. Shepherd, research engineer for Sperry Gyroscope Co.; J. E. Stratton, professor of physics and director of the research laboratory of electronics, MIT.

Phone Service on Trains

FOR THE first time in the United States, passengers on certain trains of the Baltimore and Ohio Railroad and the Pennsylvania Railroad, between Washington and New York, are able to call and receive calls from any telephone connected with the Bell System while the trains are in motion.

Telephone service will be available for public use initially on the B & O's "Royal Blue" and the Pennsylvania's "Congressional Limited" in both directions between Wash-

ington and New York, via Baltimore, Wilmington and Philadelphia. On August 22 the service was expanded to include Pennsylvania's "Potomac" from Washington to New York and "The Legislator" from New York to Washington.

A portion of the lounge car on each train has been redesigned and set aside for the new telephone service, and will afford privacy to passengers using it. Attendants will locate persons on the train who are being called. The new radio-telephone equipment, designed by the Bell Telephone Laboratories, utilizes one channel for sending and the other for receiving, so that conversations may be carried on in the same way as on a regular telephone call.

Telephone service from each train will be on the same basis as mobile radio-telephone service provided by the Bell System for motor vehicles and other mobile units, and the same rates will apply.

Another pioneer undertaking, though in a different category, is the application of the Chesapeake & Ohio Railway Co. for authority to construct and operate a system which would offer induction public telephone service with certain of its passenger trains en route between Orange, Va., and Cincinnati, Ohio. The estimated cost is $358,900. According to an FCC release, the railroad is of the opinion that "although direct telephone revenues may not result in an immediate profit to the applicant, the overall benefits of the project will result in increased revenues from applicant's transportation business, and will, therefore, be economically justified."

F-M Educational Networks

ACCORDING to a recent FCC survey, 23 states indicated active interest in establishment of statewide f-m educational networks. In acting upon applications for noncommercial educational f-m stations, the Commission considers carefully how the proposed stations will fit into any statewide plan for educational f-m. Construction of a sufficient number of such f-m facilities throughout a state would bring every school and home in the state

within reach of at least one station.

In 1945 the Commission prepared to reserve 20 f-m channels between 88 and 92 mc for educational service. As of July 15, 1947, 9 commercial educational f-m broadcast stations were in operation on the air, 32 construction permits were outstanding, and 8 applications were pending.

The Iowa State College of Agriculture & Mechanical Arts, Ames, Iowa, received the first construction permit for a noncommercial television broadcast station. No other educational institutions hold television authorizations.

Of the 32 licensed standard broadcast stations operated today by schools and colleges, 20 are on a nonprofit basis.

Soviet Television

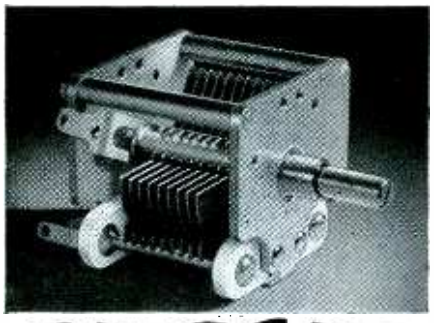
McGraw-Hill World News

TO DEVELOP television in the U.S.S.R., the Moscow television center is to be reconstructed so as to broadcast images with a frequency of 625 lines, instead of 343 lines as before, and new television centers are to be built in Leningrad, Kiev, and Sverdlovsk.

The television centers are to have an approximate range of 40 miles. Sound channels will use f-m. The Moscow television center has been operating since December 1945. Last year it broadcast over 100 shows and fifty movies.

Before the end of this year, production of three types of 625-line television receivers is to be started. There will be a table receiver with a 7-inch tube; a table receiver with a 9-inch tube; and a console receiver with a 12-inch tube. The smallest set will be manufactured on a mass scale.

Research objectives include development of a new system of television with a higher frequency, development of a system of sound and picture projection by one transmitter (on one carrier wave), development of color television, increasing the range of television transmitters, development of a system of interurban television networks (by wireless or by cable), practical solution of the problem of a large screen, facilitating demonstration of television broadcasts to



RUGGED
"RMC"
CAPACITOR

The RMC, Rugged Midget Capacitor, is designed for use where strength and solid construction are as important as sound electrical design.

Its sturdy frame consists of 3/32" aluminum end plates reinforced by three horizontal pillars which hold the assembly absolutely rigid.

The RMC is ideal for use in mobile equipment where the capacitor frame itself can be used to support other components.

WRITE FOR FOLDER

HAMMARLUND

THE HAMMARLUND MFG. CO., INC., 460 W. 34TH ST., NEW YORK 1, N.Y.
MANUFACTURERS OF PRECISION COMMUNICATIONS EQUIPMENT

PRECISION POTENTIOMETERS

Potentiometer Toroidal Type

For use in electrical computers, servo systems and other control circuits where 360° rotation, high precision and low noise levels are essential.

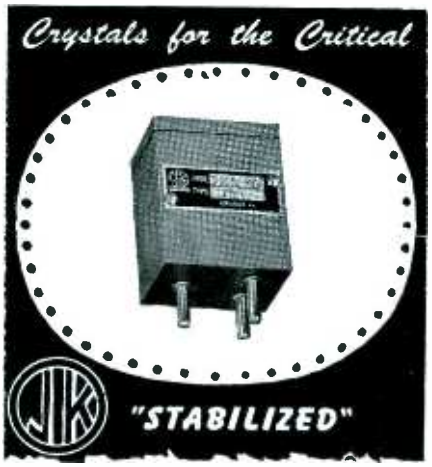
Can be supplied in a wide variety of styles within linear resistance ranges from 500 to 20,000 ohms—Linearity ±.3%; enclosed toroidal wound, low torque, electrical angle 360° or less. Capable of rotation through angles greater than 360°.

SPECIAL FEATURES: Capability of continuous rotation—Accuracy of linearity—Wide variety of contact and tapping arrangements—Durability, the RL-210 type (6000 ohms, 2 brushes) showed no serious wear nor measurable departure from initial characteristics following over one million revolutions at speed of 20 RPM—Overall diameter 3 15/16", height 2 15/16".

Write for Bulletin F-68

THE GAMEWELL COMPANY

NEWTON UPPER FALLS 64, MASSACHUSETTS



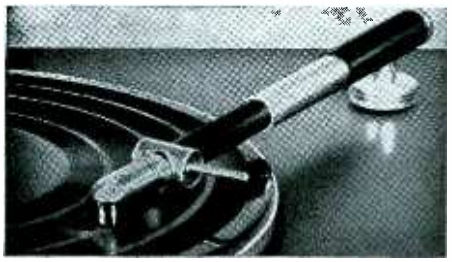
H11 FOR MARINE AND AIRPLANE APPLICATION

The H11 is known the world over as the old standby for airplane and marine application. Frequency tolerance held to .004% over a wide temperature range. 3-pin base with pin diameter .156" and spaced .500 and .812". Can be supplied with two crystals or one crystal and a heater unit for maintaining constant temperature.

Write for Illustrated Folder

The JAMES KNIGHTS CO.
SANDWICH, ILLINOIS

VIBRO MASTER TYPE K



PROFESSIONAL ARM

FOR GE VARIABLE RELUCTANCE AND PICKERING 120M CARTRIDGES

Designed by VIN BROYLES

1 . . . will neither introduce nor amplify lateral distortion.

2 . . . resonance characteristic flat plus or minus ½ DB 40 to 1000 cycles.

3 . . . balances GE cartridge at 22 grams and Pickering 120M at 15 grams stylus pressure.

4 . . . morning after handle prevents record damage when cueing.

NET PRICE . . (less cartridge) **$34.50**

see your distributor or write

TECHNICAL PRODUCTS
INTERNATIONAL
453 West 47th Street, New York City 19

The Smartest 3¢ You Ever Invested !

Three pennies in postage will bring you *the* answer to *real* cost reductions in marking wires, leads, circuits, relays, parts, etc.

• As alert production, maintenance, and repair men everywhere have discovered, *QUIK-LABELS* do the job better, faster and cheaper than string tags, roll tapes, decals, stencils, metal tabs, etc.

You can't afford not to look at *QUIK-LABELS* . . . particularly when a 3c stamp will bring you FREE SAMPLES by return mail. Clip that convenient coupon *now*. W. H. BRADY COMPANY — *Identification Specialists* — Milwaukee, Wisconsin.

W. H. BRADY COMPANY
240 W. Wells St.
Milwaukee 3, Wis.

Please send me FREE samples of QUIK-LABELS, the modern time and money saving way to mark wires, leads, circuits, relays, parts, etc.

Name_____

Position_____

Please attach to your BUSINESS letterhead

a large audience, and solution of the problem of three-dimensional television.

BUSINESS NEWS

SWITCHCRAFT INC., has moved into new and enlarged quarters at 1328-30 N. Halsted St., Chicago 22, Ill.

U. S. INSTRUMENTS CORP., formerly of East Orange, N. J., moved their executive offices and plant to 409 Broad St., Summit, N. J.

INDUCTION HEATING CORP. has moved to its recently completed

New Induction Heating Corp. plant

quarters at 181 Wythe Ave., Brooklyn 11, N. Y.

SPERRY GYROSCOPE CO., INC., Great Neck, N. Y., announces shipment of 45 loran receivers since June 1945.

ZENITH RADIO CORP., Chicago, Ill., recently bought a new two-story building at 912-22 Washington Blvd., Chicago.

THE ERWOOD CO. has moved to 214 Woodstock St., Crystal Lake, Ill. The new plant provides complete facilities for electronic consulting, development, research, and engineering.

DOONE AND MARGOLIN, ANTENNA CONSULTANTS, Freeport, N. Y., is a recently established firm. The founders were formerly with Airborne Instruments Laboratory, Mineola, N. Y.

SPERTI, INC., Cincinnati, Ohio, manufacturer of ultraviolet equipment, has purchased the Faraday Electric Corp., Adrian, Michigan.

THE *RGH* MFG. CORP. has moved to a larger plant at 365 Canal St., New York 13, N. Y.

ALTEC LANSING CORP., Hollywood, purchased the Peerless Electric Products Co., of Hollywood, thus increasing its West Coast manufac-

turing facilities to 85.000 square feet.

THE LANGEVIN MFG. CORP., New York City, has taken over the business previously carried on by The Langevin Co., Inc. except for the business of the latter's West Coast offices.

INDUSTRIAL SYNTHETICS CORP., manufacturers of flexible plastic tubing and tape for electrical insulation, have moved from Irvington, N. J. to their new plant at 225 North Ave., Garwood, N. J.

NICOLAS ANTON, formerly vice-president in charge of manufacturing, is now president of Amperex Electronic Corp., Brooklyn, N. Y.

MICHAEL HALSALL is chief engineer of Arlington Electrical Products, Inc., New York City, organized recently for manufacture of audio equipment.

THOMAS E. STEWART, JR., has been named chief of the Applied Electronics Branch of the U. S. Army Engineer Research and Development Laboratories at Fort Belvoir, Va. He received the Exceptional Civilian Service Award for his development of metallic, nonmetallic, and underwater mine detectors, a radio explosives detonator, and a barrage balloon flight analyzer.

T. E. Stewart, Jr.

P. S. Fogg

PHILIP S. FOGG, president of Consolidated Engineering Corp., Pasadena, Cal., has been appointed special advisor to the acting manager of the Chicago Directed Operation, Atomic Energy Commission.

ROBERT G. HERZOG is now vice-president in charge of engineering at Universal General Corp., New York

13, N. Y., distributors of radio and electronic parts and supplies.

HARVEY C. RENTSCHLER, after a 30-year career directing Westinghouse lamp and electronic tube research at Bloomfield, N. J., has retired.

ALFRED N. GOLDSMITH, editor of *Proceedings of the IRE* and former vice-president of RCA, is now an associate with Richard W. Hubbell and Associates, television consultant firm.

EDWARD A. MILLER was elected vice-president in charge of engineering at Acme Electric Corp. of Cuba, New York.

E. A. Miller

S. J. Deitz

STEPHEN J. DEITZ, formerly in charge of design engineering with the Ripley Co., is now head of sales engineering at The Langevin Manufacturing Corp., New York City.

A. C. KRUEGER has joined the staff of Airborne Instruments Laboratory, Mineola, N. Y. as supervising engineer for the antenna design section. He served as development engineer on a guided missiles project at Republic Aviation Corp. since February 1946. From 1943 to 1945 he worked on the Manhattan Project at the University of Chicago.

LAURISTON S. TAYLOR, chief of the x-ray section at the National Bureau of Standards, was elected associate fellow in the American College of Radiology.

DAVID SARNOFF is now chairman of the board of directors as well as president of RCA, following retirement of General J. G. Harbord, who has served as chairman since 1930.

ORRIN E. DUNLAP, JR. has been elected vice-president in charge of advertising and publicity at Radio

RAWSON ELECTROSTATIC VOLTMETERS

Type 518

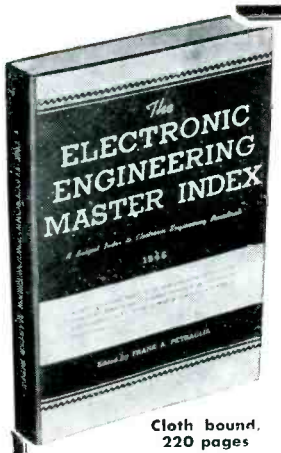
Now available to 35,000 VOLTS
Measure true R.M.S. values on A.C., no waveform or frequency errors.

NO POWER CONSUMPTION
Leakage resistance greater than one million megohms. These meters may be used to measure

STATIC ELECTRICITY
Ideal for measuring high voltage power supplies with zero current drain. Rugged, well-damped movement. All elements surrounded by metal shielding for accuracy and safety.

Write for new bulletin

RAWSON ELECTRICAL INSTRUMENT COMPANY
111 POTTER ST. CAMBRIDGE, MASS.
Representatives
Chicago - New York City - Los Angeles



Cloth bound, 220 pages
$14.50

MEMO to Chief Engineers, Research Directors, Librarians—

Your laboratory needs these idea-stimulating, time-saving, indispensable references.

1946 Supplement Edition
ELECTRONIC ENGINEERING

MASTER INDEX, 1946

This supplement to the definitive 1925-1945 edition of the Master Index covers the period from July 1945 to December 1946. Contains over 7000 bibliographical entries from 85 American and foreign periodicals grouped under more than 400 subject headings ranging over fields of communication, broadcasting, electronic applications, radar, FM, television, etc. Also contains comprehensive section of abstracts on manufacturers' catalogs.

First Compilation of Its Kind! ELECTRONIC ENGINEERING

PATENT INDEX, 1946

Presents a wealth of information on more than 2,000 U.S. electronics patents issued during 1946. Covers a wide range of design, component, and manufacturing details. Every patent lists inventor, assignor, claims granted, etc. Profusely illustrated. Here in one volume is the complete compilation from 52 weekly issues of the U.S. Patent Office Gazette. A book indispensable in design and manufacturing departments of your organization.

Cloth bound, 476 pages $14.50

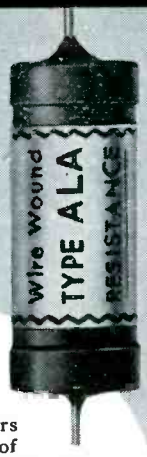
LIMITED OFFER
33⅓% DISCOUNT
allowed to individual purchasers as a professional courtesy. Deduct $4.83 from $14.50 price. This is a limited offer.

ELECTRONICS RESEARCH PUBLISHING CO.
2-4 WEST 46th ST., N. Y. 19, N. Y.

IN-RES-CO
WIRE WOUND
RESISTORS

TYPE ALA—3 WATTS
MAX RES: *25,000 ohms
MAX RES: 5,000 ohms (Manganin)
BODY SIZE: 1⅛" Lg. by ⅜" diam.
TOLERANCES: Std. 3%
*Max. Res. 0015 Nich. 10,000 ohms

TYPE BLA—5 WATTS
MAX RES: *50,000 ohms
MAX RES: 10,000 ohms (Manganin)
BODY SIZE: 1⅝" Lg. by ⅜" diam.
TOLERANCES: Std. 3%
*Max. Res. 0015 Nich. 15,000 ohms

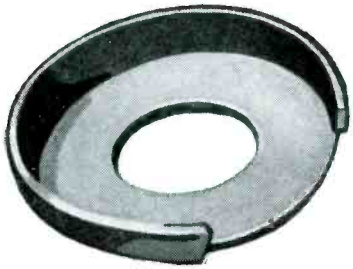


Compact - Accurate!

IN-RES-CO resistors are precision built of the finest materials obtainable. All ratings are conservative—your assurance of long dependable service. Write today on company letterhead for completely illustrated catalog.

INSTRUMENT RESISTORS CO.
1036 COMMERCE AVE.
UNION, NEW JERSEY

APPLICATION-DESIGNED RESISTORS!



Preferred
as a source of precision-made WASHERS and STAMPINGS manufactured to your specifications

CUP WASHERS
for Binding Screws

WHITEHEAD STAMPING CO.
1691 W. Lafayette Blvd. Detroit 16, Michigan

PAMARCO *DE-REELING* TENSION

PAMARCO tensions are the perfect answer to lower coil winding costs!

- ★ FINGER-TIP TENSION CONTROL
- ★ OPERATOR MAKES OWN ADJUSTMENTS
- ★ NO TOOLS OR ACCESSORIES NEEDED
- ★ FITS ALL COIL WINDERS

SHORT CUT TO PERFECT COILS!

The free-running action of the PAMARCO tension practically eliminates defective coils. Their compact size permits more simultaneous coil winds on *any* machine. Operator makes all adjustments for any gauge wire with simple thumbscrew.

Write for literature today

PAPER MACHINERY & RESEARCH, INC.
1014 OAK STREET • ROSELLE, NEW JERSEY

Corporation of America. For 18 years prior to joining RCA in 1940 he was radio editor of the New York Times.

HARRY J. WOLL, adavanced development engineer at RCA's Camden plant, is the first RCA Victor employe to receive an RCA fellowship under a new plan for encouraging the company's engineers to obtain advanced degrees. He will work toward his doctor's degree at the University of Pennsylvania in the 1947-1948 academic year.

HOWARD C. SCHUBERT, with Allen B. DuMont Laboratories for five years as research engineer, has been appointed a senior engineer at U. S. Television Mfg. Corp.

EVERETT B. BOISE, recently with National Union as chief commercial engineer, was appointed sales engineer for Hytron Radio & Electronics Corp.

T. KEITH GLENNAN, holder of the Medal for Merit as wartime director of the U. S. Navy Underwater Sound Laboratory, has been selected as new president of Case Institute of Technology, Cleveland, Ohio.

T. K. Glennan

A. Wright

ANTONY WRIGHT, with RCA for nineteen years and former manager of their television receiver engineering section, was recently appointed chief engineer of U. S. Television Mfg. Corp.

SAMUEL C. MILBOURNE, formerly chief engineer of Eastern Amplifier Corp., is now manager of engineering consulting and buying service for K. Streuber & LaChicotte, New York City.

JACK DE WITT, formerly chief engineer, has returned to station WSM, Nashville, Tenn., as president of the station.

NEW BOOKS

Television Techniques

BY HOYLAND BETTINGER. *Harper & Brothers, New York, N. Y., 1947, 237 pages, $5.00.*

THIS IS the second book stemming from the production experience at WRGB in Schenectady. The author, an artist, has made notable contributions to the art by emphasizing and analyzing its visual aspects. This study, introduced with a well-illustrated explanation of how television works, actually begins with an analysis of the medium. Although basically sound, certain generalizations regarding television's limitations are no longer true, due to technical advancements. For example, space limitations can possibly be overcome by employing the Zoomar lens and multiple cameras.

Pictorial composition and continuity, visual and audio techniques, television script writing, producing, and directing are covered in the text. Unfortunately mediocre material on play direction is included. Too sketchy, and often faulty, it is apt to mislead the uninitiated. The student of play directing can find better and fuller material elsewhere.

Occasionally the author completely misses his mark. Figure 17 on page 41 attempts to illustrate rhythmic spacing. Actually it is an example of emphasis gained by the use of (1) body position, (2) actual line, (3) area, (4) space, (5) visual line, and (6) focus, which constitute quite a battery of play-directing techniques. Illustrations for beginners are best when demonstrating only the point under discussion. The last two chapters, Motion Pictures and Film Integration and Television Lighting, are excellent little primers on their subjects.

The techniques here described imply a full quota of studio personnel, as is currently used in large studios. Since most television stations in the near future probably will require considerable doubling on the part of their staffs, suggestions along these lines would have been valuable. Even more disappointing is the lack of any discussion of program types. Vision and imagination regarding the shape of

programs to come would be welcome.

Mr. Bettinger's analytical work of an art still in the embryo stage deserves close study. Studio and technical personnel could profit by a line-by-line reading.

—VIRGINIA M. BRADLEY

Elements of Electrical Engineering

BY A. L. COOK AND C. C. CARR. *John Wiley & Sons, Inc., New York, N. Y., Fifth Edition, 662 pages, $5.00.*

A HIGHLY successful textbook, presenting a background of electrical engineering for students specializing in other fields, is here brought up to date. Four excellent chapters on electronics now include industrial applications as well as fundamentals. Circuit diagrams commendably use reasonable approximations to ASA symbols. —J. M.

Technical Dictionary

BY HANS THALI, *Hitzkirch, Switzerland. Distributed by W. S. Heinman & Co., 125 E. 23 St., New York, N. Y., 1946, 275 pages, $6.25.*

AN ENGLISH-GERMAN-FRENCH dictionary (English terms in alphabetical order, each followed by its German and French equivalents) covering terminology of electrical engineering, radio, television, electrical communication, and most-used terms of acoustics, illumination, mathematics, optics, and other related fields. Coverage of English radio and electronic terms is commendably complete and should be adequate for most users.—J.M.

Men and Volts at War

BY JOHN A. MILLER. *Whittlesey House, McGraw-Hill Book Co., Inc., New York, N. Y., 1947, 272 pages, $3.75.*

ALTHOUGH only two of the twenty chapters deal with electronic equipment exclusively in this story of how General Electric Co. mobilized for production in World War II, this entire book makes fascinating reading for those who perchance have missed similar works such as "Scientists Against Time." Radar production was one of the com-

pany's biggest war assignments, involving at one time a half million dollars a day, with G-E participating in design and manufacture of more than fifty different kinds of radar sets.—J.M.

Highways in the Sky

BY LOUIS SHORES. *Barnes & Noble, Inc., New York, N. Y., 1947, 269 pages, $3.00.*

THIS IS the story of the Army Airways Communications System that, by V-J day, was operating a thousand airways stations in every part of the world and creating highways in all the skies over this world so that man might fly safely wherever he chose. The book is filled with dramatic anecdotes of radio operators working right through strafing and bombing attacks on airport control towers to keep homing beacons in operation, bring planes down safely, and send and receive vital messages. Every radio man will enjoy the adventures set down in print here for the first time as the AACS history.—J.M.

The Strange Story of the Quantum

BY BANESH HOFFMAN, *Department of Mathematics, Queens College, New York, Harper & Brothers, New York 1947, 239 pages, $3.00.*

QUANTUM mechanics, whereby scientists have analyzed and accounted for the behavior of nuclear particles and radiations, has become interesting to laymen as the underlying explanation of atomic energy. The author has readably presented; in historical sequence, the development of the concept of the quantum, restricting himself to purely descriptive text for the benefit of the nonmathematically inclined (such as salesmen and executives) who have to know, but need not apply, modern scientific concepts. —F.R.

THE EDITORS are informed by Carl E. Smith, author of the book "Directional Antennas," reviewed in the June 1947 issue, that the book contains 15,160 antenna patterns, rather than the 238 polar charts mentioned in the review.

CONTACTS

FOR THE FIELD OF ELECTRONICS

FINE RIBBONS OF TUNGSTEN and MOLYBDENUM

Quality and accuracy in our fabrication of Tungsten & Molybdenum Ribbons have characterized our service to the Electronic industry.

A development of

H. CROSS Co.

15 Beekman St., New York 7, N.Y.

Solve Wire Stripping Problems with "SPEEDEX"

"AS IT MAKES"

The famous "Speedex" Wire Stripper complete with 7 interchangeable blades for stripping any size wire from No. 8 to No. 30 will be the handiest tool in the shop. Strips 800 to 1000 wires per hour—cuts wires too. Just press the handle and the job is done. For use with solid or stranded wires. Write today for catalog of 3,000 electronic products.

GENERAL CEMENT MFG. CO.

ROCKFORD, ILLINOIS, U. S. A.

Kahle

ELECTRON TUBE MACHINERY OF ALL TYPES

STANDARD AND SPECIAL DESIGN

We specialize in Equipment and Methods for the Manufacture of

RADIO TUBES
CATHODE RAY TUBES
FLUORESCENT LAMPS
INCANDESCENT LAMPS
NEON TUBES
PHOTO CELLS
X-RAY TUBES
GLASS PRODUCTS

Production or Laboratory Basis

Kahle ENGINEERING CO.

1309 SEVENTH STREET
NORTH BERGEN, N. J., U. S. A.

WE manufacture a complete line of equipment

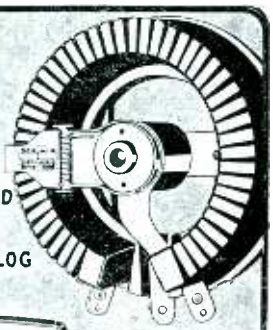
SPOT WELDERS, electric from ¼ to 50 KVA
TRANSFORMERS, special and standard types
INCANDESCENT LAMP manufacturing equipment
FLUORESCENT TUBE MAKING EQUIPMENT
ELECTRONIC EQUIPMENT, vacuum pumps, etc.
WET GLASS SLICING and cutting machines for laboratory use
GENERAL GLASS working machines and burners
COLLEGE GLASS working units for students and laboratory

AC ARC WELDERS from 100 to 400 Amps

EISLER ENGINEERING CO.

731 So. 13th St. (near Avon Ave.) Newark, New Jersey

VITREOUS ENAMELED ROUND RHEOSTATS
NEW SPRING-HINGED CONTACT ARM
WRITE FOR CATALOG



TUBULAR RHEOSTATS & RESISTORS

REX RHEOSTAT CO.

BALDWIN, L. I., N. Y.

NEW BANTAM BLOWERS!

PROMPT DELIVERY!

B-2 BLOWER FOR COOLING. Delivers 32 CFM for ventilating and for cooling electronic tubes, projectors. Powered by SM universal motor designed for efficient, long life performance, 110 volt, 60 cycle AC-DC. Unit 5⅛" x 3½" x 3¾".

E-3 BLOWER FOR VENTILATION. Delivers 100 CFM. Assures comfort in small room areas. Quiet, no radio interference. Shaded pole motor, 110-volt, 60 cycle AC only. Unit 6½" by 5½". Furnished with mounting bracket.

WRITE TODAY FOR DETAILS—PRICES

SMALL MOTORS, INC., DEPT. 50, 2076 ELSTON AVE., CHICAGO 14

Prompt Deliveries

Specializing in High Voltage Filament and Plate Transformers for Electronic Projects

ELECTRO ENGINEERING WORKS

6021 COLLEGE AVENUE - OAKLAND 11, CALIFORNIA

FLUXES
SODERING
BRAZING & WELDING

ALLEN

L. B. ALLEN CO. INC. Chicago 31, Ill.

6751 Bryn Mawr Ave.

RCA 709B SWEEP GENERATOR
MODERNIZED

To give the instrument a frequency range of 5 to 110 Mc. The unit is then useful for television I.F., six lower channels and FM. Price for modernization $100.00. Delivery one week.

CENTRAL TELEVISION LABORATORIES
601 W. 26th St., N. Y. 1, N. Y.
LOngacre 5-3238

ELECTRONIC EQUIPMENT
Custom Built
for Your Job

BUCK ENGINEERING CO., Inc.
37 Marcy St. Freehold, N. J.

MICROMETER FREQUENCY METER

for Checking Transmitters from 100 Kc to 175 Mc. within 0.01 per cent

LAMPKIN LABORATORIES
Bradenton, Fla., U. S. A.

FILMGRAPH PAT'D
Conference Recorders

UNINTERRUPTED Longtime (up to 12 hours) Conference & Telephone Recordings on Safety Film Models for Dictation "TALKIES"

ECONOMICAL PERMANENT INSTANTANEOUS PLAY-BACK

MILES REPRODUCER CO., INC. 812 BROADWAY, N.Y.3

High Speed Production Of Quality R. F. Coils and Sub-Assemblies, For Discriminating Manufacturers

Clippard INSTRUMENT LABORATORY, INC.

1125 Bank Street, Cincinnati 14, Ohio

CONTRACT SOLDERING

or

Small Electrical Assembly Work

AT COST

Our reply will explain why we can operate at cost. We are an old established manufacturer of a nationally known product.

CW-1834, Electronics
330 West 42nd Street, New York 18, N. Y.

INDUSTRIAL ELECTRONIC EQUIPMENT

Designed and Manufactured In Any Quantities to Fill Your Needs

TELEVISION manufacturing subcontracts solicited

CORONA ENGINEERING SERVICE
94-52 Corona Ave., Elmhurst, N. Y.

Backtalk

This department is operated as an open forum where our readers may discuss problems of the electronics industry or comment upon articles which ELECTRONICS has published.

Common Sync Signal

DEAR SIRS:

IN A situation where many video channels would be occupied in a locality, as in a large metropolitan area, it would be of advantage to have a common stable line sweep frequency generator for all the cameras of all the stations in the area. This standard, of course, would be a sinusoidal generator to control the rate of the various local sweep oscillators.

Of several methods . . . most convenient would be a small, low-frequency transmitter, operating in a clear channel, modulated by the sweep frequency tone, or a submultiple of it for bandwidth conservation. The maintenance of the transmitter should be assigned to one of the video stations.

All the video receivers in the area could have relatively high-Q flywheel tanks in their horizontal sync circuits, tuned to the stable common oscillator sweep frequency. These tanks would be shock-excited by the sync pulses, in turn to control the rate of the local blocking oscillators or multivibrators. This stable sweep rate would be utilized by all the video stations in the area, so that there would be no need for a front-panel sync control. Where the power line frequencies were different among the various stations, a common vertical sync rate could also be transmitted.

Variations of the system could include the transmission of the rates by a central station, as WWV.

The only complication in the actual video broadcast would be a low-frequency receiver at the camera site for reception of the sweep and frame-rate control signals from the central transmitter. This receiver should incorporate a very narrow audio bandpass filter about the sweep frequency to make it rela-

PROFESSIONAL SERVICES

Consulting — Patents — Design — Development — Measurements

in

Radio, Audio, Industrial Electronic Applications

THE APPLIED SCIENCE CORPORATION OF PRINCETON
Applied Physics, Mathematics and Electronics
Design Research — Industrial Applications — Development — Engineering Consultation
Specialist in Radio Telemetering
P.O. Box #44, Princeton, N. J.
Phone: Lawrenceville, N. J. 430
Office & Laboratory: U. S. Highway #1, RD #4, Trenton, New Jersey

ELECTRO IMPULSE LABORATORY
Consulting Physicists
Radio Interference and Noise Meters; Interference Suppression Methods for Ignition Systems and Electrical Devices.
P.O. Box 250 — Red Bank, New Jersey
Red Bank 6-4247

WILLIAM R. MEREDITH
B.A., B.SC., P.ENG. MEIC.
Barrister-at-Law
Consultant on Canadian
PATENTS, TRADE MARKS and COPYRIGHTS
National Building — Ottawa, Canada
Telephone 2-9584

H. RUSSELL BROWNELL
Consulting Engineer
Specializing in Measurements & Testing Instruments & Techniques - Electrical - Electronic - Magnetic.
188 West 4th St. — New York 14, N. Y.
Chelsea 2-4208

PAUL E. GERST & CO.
CONSULTING ENGINEERS
Specialists in Electrical Product Design
EI. Machinery Apparatus & Applications
EL. Appliances, Hi-Frequencies Apparatus
Electronics, Radio Communications
205 W. Wacker Dr. — Chicago 6, Ill.

A. JOHN MICHEL
Registered Patent Attorney
SPECIALIZING IN ELECTRONICS
United States and Foreign Patent Matters
15 Park Row, New York 7, N.Y. — Tel. CO-7-9084

CONTROLS LABORATORIES, INC.
Consulting Division
EXCEPTIONAL FACILITIES
for
RESEARCH and DEVELOPMENT
Electrical and Mechanical Problems
SPECIAL PATENT SITUATIONS
Background of over 200 research projects
Partial list of subjects available upon request
98 Union St. — Worcester 8, Mass.

HANSON-GORRILL-BRIAN INC.
Product & Mfg. Development
ELECTRICAL - ELECTRONIC
HYDRAULIC - MECHANICAL
Meadow Lane — Glen Cove, N. Y.
Glen Cove 1922

Eugene Mittelmann, E.E., Ph.D.
Consulting Engineer & Physicist
High Frequency Heating — Industrial Electronics
Applied Physics and Mathematics
549 W. Washington Blvd. — Chicago 6, Ill
State 8021

STANLEY D. EILENBERGER
Consulting Engineer
INDUSTRIAL ELECTRONICS
Design—Development—Models
Complete Laboratory and Shop Facilities
6309-13—27th Ave.
Kenosha, Wis. — Telephone 2-4213

GEORGE J. MAKI
Radiotelegraph Consultant
PRINTER - TELEMETER - MORSE SYSTEMS - APPARATUS
Moraga, California

ALBERT PREISMAN
Consulting Engineer
Television, pulse Techniques, Video Amplifiers, Phasing Networks.
Industrial Applications
Affiliated with
MANAGEMENT-TRAINING ASSOCIATES
3308-14th St., N.W. — Washington 10, D. C.

ELECTRONIC ENGINEERING CO. of CALIFORNIA
Radio and Electronic Consulting and Designing.
2008 W. Seventh St. — Los Angeles
DRexel 8323 — California

MEASUREMENT ENGINEERING LIMITED
Consultants on Special Equipment for measurements and production tests, communications and audio systems.
61 Duke St.
Toronto — Canada

JOSEPH RAZEK, Ph. D.
Consulting Physicist
Electric and Mechanical Engineering Problems
Instruments and Control Devices — Electronics
Specialists in Colorimetry, Spectrophotometry and Industrial Color Control
Laboratory and Shop Facilities
202 Darby Road — Lianerch, Pa.
Phone Hilltop 6910

ELM LABORATORIES
ELECTRONIC-MECHANICAL
RESEARCH & DESIGN
Patented ELM Developments include
PREGRAME Automatic Radio Program Tuner. Famous "Gerty" Direction Finder Loop, Sealed Xtal Holder. Home Receiver Designs.
20 South Broadway — Dobbs Ferry, New York
Phone Dobbs Ferry 4058

WINFIELD SCOTT McCACHREN
AND ASSOCIATES
Consulting Radio Engineers
TELEVISION SPECIALISTS
Philadelphia:
809B Windemere Ave. — 410 Bond Building
Drexel Hill, Pa. — Washington, D. C.
Sunset 2537-W — District 6923

YARDENY ENGINEERING CO.
Remote Controls (Wires and Wireless)
Automatic Devices
Electronic • Electrical • Mechanical
Consultation • Designing • Manufacturing
Licensing
105 Chambers Street — New York, N. Y.
Worth 2-3534, 3535

THE CONSULTING ENGINEER

"By reason of special training, wide experience and tested ability, coupled with professional integrity, the consulting engineer brings to his client detached engineering and economic advice that rises above local limitations and encompasses the availability of all modern developments in the fields where he practices as an expert. His services, which do not replace but supplement and broaden those of regularly employed personnel, are justified on the ground that he saves his client more than he costs him."

tively insensitive to interference commonly present at the lower frequencies.

LEO MACKTA
Brooklyn, N. Y.

F-M Set Standards?

Dear Sir:

I HAVE just read the July 1947 article "New Approach to FM-AM Receiver Design". The f-m design is radical in that it omits, among other things, the limiter stage. It would seem that this would be an ideal situation for a limiter to overcome other deficiencies since the r-f gain is not uniform over the band. I have not heard this set perform and am willing to be convinced.

I have serviced a popular brand f-m set with no r-f stage. I am afraid I can forsee a few years to peeps, burps, squeeks, howls, and whistles on the f-m band that we now have on the a-m band.

I would like to see an expression from the industry in general with regard to a set of standards, for f-m set manufacturers, to preserve the advantages of f-m.

RICHARD C. BOWERS
Emeryville, California

Electronism

Dear Sir:

I HAVE read with interest the article in the June issue, "Nucleonics and Electronics". The use of this new term nucleonics brings to mind a word which I first used in 1944 when working at Columbia University on the Manhattan Project.

The word to which I refer is "electronism", with the accent on the second syllable, thus e-lec'tronism. This word bears the same relation to "electronics" as does "mechanism" to "mechanics". The accent shifts by one syllable in both cases. I do not find the new word awkward to use, once the accent has been placed correctly.

Electronism eliminates the need for the term "electronic device", or worse, "electronic gadget". In its relation to mechanism it immediately connotes either a component of equipment or the entirety of equipment.

JAMES N. SMITH
Chief Engineer
Moisture Register Co.
Laguna Beach, California

Engineers, Physicist, Mathematicians, Radio Service Men, and Radio Amateurs

To fill 10 positions on seismograph field parties scattered throughout the Rocky Mountains, Mid-Continent and Gulf Coast states. Duties consist of operating seismic recording instruments, or computing seismic data, or alidade surveying seismic locations. Nature of work requires several changes of address per year; part of it is outdoor and part indoor; certain operations performed under standard procedure, others require ingenuity and initiative; salary $200-$300 per month to begin with excellent opportunity to advance for those with practical ability. To apply write giving scholastic and employment background, age, nationality, and family status to

P-1671, Electronics
520 North Michigan Ave., Chicago 11, Ill.

POSITIONS VACANT

ENGINEERS — RESEARCH and Development Project Engineers with experience in Klystron or Storage Tube development wanted by medium size nationally known manufacturing concern in New England. Attractive salary to those who qualify. Write giving details and experience. P-1552, Electronics, 330 W. 42nd St., New York 18, N. Y.

ELECTRONICS TECHNICIAN for construction and maintenance of laboratory electronic equipment. Experience with nuclear detection circuits or radar desirable. Salary $3960, with annual salary review. Address inquiries to C. S. Garner, Department of Chemistry, University of California, giving complete personal data and experience. P-1960, Electronics, 330 W. 42nd St., New York 18, N. Y.

EMPLOYMENT SERVICES

SALARIED POSITIONS $2,500-$25,000. This thoroughly organized confidential service of 37 years recognized standing and reputation carries on preliminary negotiations for supervisory, technical and executive positions of the calibre indicated, through a procedure individualized to each client's requirements. Retaining fee protected by refund provision. Identity covered and present position protected. Send only name and address for details. R. W. Bixby, Inc., 278 Dun Bldg., Buffalo 2, N. Y.

EXECUTIVES $3,000-$25,000. This reliable service, established 1927, is geared to needs of high grade men who seek a change of connection under conditions assuring, if employed, full protection to present position. Send name and address only for details. Personal consultation invited. Jira Thayer Jennings, Dept. E, 109 Church Street, New Haven, Conn.

POSITIONS WANTED

MAGNETIC AMPLIFIER Engineer. Five years development and design engineering of military and industrial equipment using saturable reactors, dry-plate rectifiers, and voltage regulators. BS EE. Metropolitan New York are apreferred. PW-1939, Electronics, 330 W. 42nd St., New York 18, N. Y.

EXECUTIVE ELECTRONIC Components Engineer, in field of coils, condensers, tuning units. Experienced in production engineering and control, all phases of mechanical drawing and specifications, design and development, standardization, purchasing, coordination. Seeks responsible position. PW-1975, Electronics, 330 W. 42nd St., New York 18, N. Y.

FOREIGN POSITION wanted by Broadcast Engineer. Desires employment with any prominent radio manufacturer or exporter to do duty in foreign territories installing, servicing and selling of radio and electrical equipment. Like travel, willing to work in most any part of the world. Age 22, single. Dependable, experienced—can supervise station construction and equipment installations. 1st class radiotelephone licensed. Practical, handy with tools. Graduate of two radio schools and one electrical. Also can install heavy electrical equipment including motors and moderate power plants. $450 minimum monthly salary accepted. Available November 1st. PW-1946, Electronics, 520 N. Michigan Ave., Chicago 11, Ill.

ENGINEER-PHYSICIST, age 34, B. S. degree desires instrument research and development work on permanent career basis with progressive organization. Has 13 years experience including 4 years Radio Communication and high quality audio systems and 9 years electronic, mechanical, optical instrument research development for physical and chemical measurements and process control, nuclear measurements, servo-mechanisms. Available now. PW-1802, Electronics, 330 W. 42nd St., New York 18, N. Y.

RADAR AND ELECTRONIC ENGINEERS
GUIDED MISSILE DEVELOPMENT

Engineers needed for new missile guidance and control project. Bachelor's degree in Electrical Engineering or Physics; Master's degree very desirable, or equivalent advanced study of mathematics, electronics, applied physics. Analysis and/or development experience in one or more; radar equipment; electronic timing and control circuits; electro-mechanical servomechanisms; guided missile control and testing. Salary to $7500 depending upon qualifications.

Write or phone Mr. C. D. Perrine, Chief Electronics Engineer

PILOTLESS PLANE DIVISION

Farmingdale Farmingdale-1410 **Long Island**

RADIO
Design Engineers

Westinghouse Electric Corp. at Sunbury, Pa., has openings for experienced radio-design engineers capable of supervision of complete home radio-receiver design.

For application write

Manager, Technical Employment,
306 FOURTH AVENUE,
PITTSBURGH 30, PA.

FOR SALE

Eastern transformer plant. Well equipped —fully staffed—good business. All types of power transformers up to 5 KVA, chokes and audio. Special apparatus transformers our specialty. Plant capacity $75,000. monthly. This is not a sacrifice sale—asking no good will, net worth only. If you want to manufacture transformers or if you are a large user this is worth investigating.

BO-1257, Electronics
330 West 42nd St., New York 18, N. Y.

FOR SALE
WAVE ANALYZER

One (1) Hewlett Packard Harmonic Wave Analyzer, type 300A, in new condition. Available immediately. Price $450.00. Contact:

THE SUPERIOR ELECTRIC COMPANY
Telephone: Bristol 3141, Bristol, Conn.

FOR SALE
ONE MILLION—1,000,000 DUAL MICA CONDENSERS
I. F. TRIMMERS

Assembled, partially assembled, unassembled, parts, and dies for plates.

FS-345, Electronics
330 West 42nd Street, New York 18, N. Y.

WANTED TO BUY

Western Electric Type C, H, H-1, CF Carrier Telephone and Telegraph equipment. EE-101A ringers, switchboards, telephone instruments, teletype equipment of all kinds.

RAILWAY COMMUNICATIONS, INC.
Box 1783 Lincoln, Nebraska

TRANSMITTER TUBE CHECKER

WESTON 786 TYPE 2 115 V AC operation. Complete with adaptors and instruction manual. List price $850.00.

Write for quotation.

KELVIN ELECTRONICS
74 Cortlandt St. New York 7, N. Y.

BELGIUM

American Firms desirous to extend their activity to Belgium, are invited to contact with

SOCIETE INDUSTRIELLE ALFA

80, rue de la Senne

BRUSSELS

Oldest importer of American radio, electrical and electronic material.

PORTABLE A.C. AMMETERS

Surplus New WESTON MODEL 528

DUAL RANGE 0-3 Amp. and 0-15 Amp. full scale for use on any frequency from 25 to 500 cycles. The ideal instrument for all commercial, industrial, experimental, home, radio, motor and general repair shop testing. Comes complete with a genuine leather, plushlined carrying case and a pair of test leads. A very convenient pocket sized test meter priced at less than 50% of manufacturers list. Your cost ....**ONLY $12.50**

PORTABLE A.C. VOLTMETERS

(See illustration of Ammeters)
SURPLUS NEW WESTON MODEL 528

DUAL RANGE 0-15 and 0-150 Volts for use on any frequency from 25 to 125 cycles. Complete with plushlined leather carrying case and a pair of test leads. This Voltmeter, with the matching model Ammeter as illustrated above, makes an ideal pair of test meters for any mechanic to carry around in his tool box .....**ONLY $9.50**

Combination Offer; 528 Voltmeter
528 Ammeter
BOTH For **$21.00**

INSULATION TESTER

0-20 and 0-200 Megohms, full scale
0-.5 and 0-5 Megohm, center scale

The original unit, The Weston Model 796 Insulation Tester operated at a 500 volt test potential supplied by eight 67½ volt batteries. This has been modified by us to utilize two 1½ volt standard No. 6 dry cells and a vibrator power supply for the 500 volt test potential thereby eliminating the high replacement cost of batteries. Enclosed in a hardwood carrying case 8⅜"x9¼"x8". The Weston Model 801, 4½" Rectangular 0—50 microampere meter guarantees extreme accuracy on all ranges. Surplus—New—Guaranteed.
NET fob, NY **$39.50**

"VIBROTEST" RESISTANCE & VOLTAGE TESTER

Associated Research, Inc. Model #201.
Resistance Range 0—200 megohms (at 500 volts potential) 0—2000 ohms.
Voltage Range 150-300-600 Volts D.C. 150-300-600 Volts A.C.
Push button action for resistance readings—no hand cranking!
Operates from internal Vibrator power supply off two number 6 dry cells.
Complete with batteries, test leads and instructions in metal carrying case.
NET fob, NY **$60.00**

WESTON 687 OUTPUT METER

3 full scale ranges 0-2, 0-10, 0-50 Volts Audio Frequency. Complete with 3' lead with pin plugs and plug (PL 55)
NET fob, NY.....**7.50**

TEST UNIT I-35-E

One of the component units required to test the "Walkie Talkie" Transmitter and Receiver BC-611. Consists of a 4" rectangular multi-range meter, Switching facilities, Microphone, receiver, earphone, R.F. oscillator, audio oscillator, crystal test socket, pin jacks, test terminal cable & plug. Comes in cabinet with removable cover 9" wide, 14" long, x 5" high with Technical Manual and circuit diagram. Full scale ranges of 3 & 150 V D.C.; 1.5, 15, 60 & 600 MA D.C.; and 60 V A.C. Suitable for modification into a versatile radio test unit.
NET fob, NY **$13.50**

TESTING PORTABLES

NEW—FACTORY GUARANTEED

WESTON MODEL 433 Accuracy within ¾ of 1%; Hand calibrated mirror scale 4.04" long. Knife edge pointer. Moving iron vane type, shielded from external magnetic fields. Dimensions 5" x 6" x 3½".

A. C. VOLTMETERS

Range	Scale Divisions	Frequency Range	Net Price
10	100	25-125 cycles	$32.40
150/300	150	25-125	39.70
150/300/600	150	25-125	50.40
150/300/600	150	25-1000	58.40

A. C. AMMETERS

1.0	100	25-500	$31.50
1.0/2.0	100	25-500	40.50
2.5/5.0	100	25-500	40.50
5.0	100	25-500	31.50
10.0	100	25-125	30.50
10.0	100	25-500	31.50

D. C. AND SINGLE PHASE A. C. WATTMETERS

WESTON MODEL 432 Accuracy within ½ of 1%, Hand calibrated mirror scale 4.04" long, Knife edge pointer, Electrodynamometer type movement shielded from external magnetic fields. Dimensions 6½" x 5¼" x 3½". Furnished complete with instruction booklet.

Volts Max.	Amps. Max.	Watts Low Range		Watts High Range	Scale Divisions	Net Price
100/200	0.15	7.5		15	75	$63.75
100/200	0.50	25		50	100	56.25
130/260	0.37	25		50	100	60.75
100/200	1.0	50		100	100	56.25
130/260	0.75	50		100	100	60.75
100/200	3	150		300	75	56.25
200/400	1.5	150		300	75	62.10
100/200	3.75/7.5	200	400	800	80	72.00
200/400	3.75/7.5	375	750	1500	75	73.35
100/200	15	.75 KW		1.5 KW	75	65.25
200/400	15	1.5 KW		3.0 KW	75	68.60
200/400	30	3.0 KW		6.0 KW	60	68.60

D. C. METERS

WESTON MODEL 430. Accuracy within ½ of 1%, Hand calibrated mirror scale 4.04" long, Permanent magnet moving coil, unshielded movement. Dimensions 5" x 6" x 3½".
0-5 D.C. MICROAMPERES, 4200 ohms resistance, 100 scale divisions .....**Net Price $61.10**
0-150/300/750 D.C. VOLTS, 5000 ohms per volt, 150 scale divisions .....**Net Price $66.00**

TUBECHECKER — WESTON MODEL 777

For Emission Type tube testing. 115 volt 60 cycle operation. In wood case 9" x 15" x 5".
New—Factory Guaranteed .....**NET $49.50**

INDUSTRIAL CIRCUIT TESTER

Weston Model 785
New - Factory - Guaranteed

Recognized throughout Industry as the most Complete Single Unit for maintenance and test purposes: Aircraft, Communications, Radio, Electronics, Laboratories, Lighting and Power, Motors, Plant Maintenance, Repair shops, etc.
D.C. VOLTAGE—Six full scale Ranges of: 1/10/50/200/500/1000 volts (20,000 Ohms per volt).
A.C. VOLTAGE—Six full scale ranges of: 5/15/30/150/300/750 volts (1,000 Ohms per volt)
D.C. CURRENT—Six full scale Ranges of: 50 Microamps 1/10/100 Milliamps 1/10 Amps.
A.C. CURRENT—Four full scale Ranges of: .5/1/5/10 Amperes.
RESISTANCE—Five Full Scale Ranges of: 3,000/30,000/300,000 Ohms, 3/30 Megohms. Center Scale Values 25/250/2,500/25,000/250,000 Ohms.
Complete with the following:
(a) I.R.C. Precision Wire Wound Resistor (Surplus—New) 1/5 or 1% accuracy to extend the 750 volt A.C. range of the 785 to 1500 Volts A.C.
(b) Current Transformer (Surplus—New) to extend the 5 Amp. A.C. range of the 785 to 50, 100 and 200 Amps. A.C.

For Shop use, less carrying case.....**$76.50**
For Field use, with oak carrying case.....**$94.50**

FILAMENT TRANSFORMER. G.E. 110 volt 60 cycle input, 2.5 volt 40 Amp. Output 100 KVA 3 K.V. insulation. @ **$1.75 each.** Minimum order Ten pieces.

STEP DOWN TRANSFORMER. Jefferson Electric 115 volt 60 cycle primary. 20 volt 10 Amp. secondary, mounted in watertight box. @ **$3.00 each.** Minimum order Ten pieces.

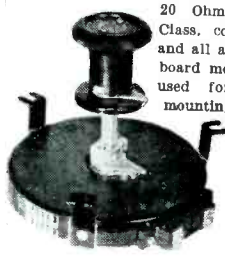
OIL FILLED CONDENSER. G.E. "Pyranol" W.H. "Inerteen", & Aerovox, .5 mfd/25,000 W.V.D.C. @ **$25.00 each.**

STRIP HEATERS
G.E. Cat. #2A305, 250 ohms 50 watt 115 V., 1½" x ½" x 6" @ **60¢ each.** Minimum order Ten pieces.
G.E. Cat. #2A244G8, 88 ohms 150 watts 115 volt 1½" x ½" x 7" @ **$1.00 each.** Minimum order Ten pieces.

MICROSWITCH. Single Pole Normally closed, 10 A, 125 V. @ **30¢ each.** Minimum order Ten pieces.

VARIABLE RHEOSTAT

WARD LEONARD



20 Ohms 4.05 Amperes 8" Class, complete with handle and all accessories for rear of board mounting. Can also be used for front of board mounting.

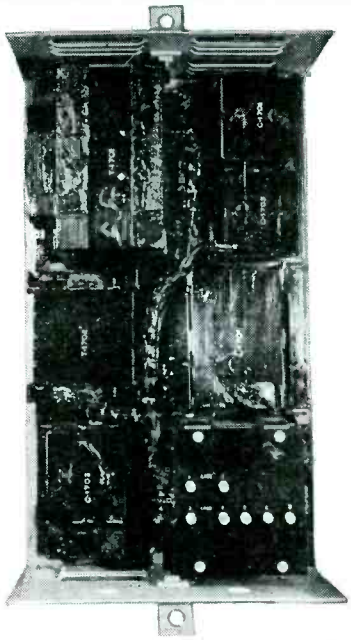
800 Units In Stock
Special Prices on Large Quantities
Minimum Order 10 Pieces .....**$2.95 Each fob N. Y.**

All items are Guaranteed and are Surplus New unless specified otherwise. All prices FOB, N. Y.— 25% deposit required on C.O.D.'s. Orders accepted from rated concerns on open account. Net 30 days

MARITIME SWITCHBOARD

338 Canal Street . . . . . Worth 4-8217 . . . . . New York 13, New York

CONSTANT VOLTAGE STABILIZER



General Electric Cat. # G 30152 Type # CG 30152.
INPUT from 103 to 127 volts at 57 to 63 c.p.s.
OUTPUT voltage taps for 110, 115, 120 & 125 volts. Output voltage under constant load will not vary more than ± 1% at normal frequency when the input varies from 103 to 127 volts.
CAPACITY 850 Volt Amperes 7.7 amperes at .93 Power Factor.
DIMENSIONS 30½" H x 15⅝" W x 10¼" D. Enclosed in a gray bake enamel steel case. (illus. with cover removed) Ship. wt. 330 lbs. Net wt. 280 lbs.

NET $59.50
fob, N. Y.

BC-1161-A RADIO RECEIVER

150 to 210 Megacycles. Can be used with the BC-1072-A, listed below for a "ham rig". Operates off 115 volt 60 cycle Power supply. Inductance tuning for R.F., Antennae, detector and oscillator. With a few modifications this unit makes an ideal F.M. Receiver. Each set complete with circuit diagram and the 14 following tubes: 1—6SN7 Cathode Follower; 1—6H6 second Detector; 2—6SH7 1st and 2nd R.F. Amp.; 1—6SH7 Video Amp.; 3—6AC7/1852 1st, 2nd, 3rd IF Amp.; 2—6AB7/1853 4th, 5th, IF Amp.; 1—9006 Mod.; 1—6J5 Osc.; 1—5U4G Rect.; 1—6E5 Tuning Indicator.
Complete in a metal cabinet 10" high, 16½" wide and 15" deep.

NET $34.50
fob, N. Y.

D. C. VOLTMETERS

W.E., 75 V, 1000 ohms per volt, 3½", rd fl bake case, concentric style.....$3.00
W.H., NX-35, 50 V, 200 ohms per volt, 3½", rd fl bake case.....$3.95
W.H., NX-35, 200 V, 200 ohms per volt, mounted on 45° metal angle panel with binding posts.....$4.95
W.H., NX-35, 1.5 KV with 1000 ohms per volt, ext prec wire wound resistor & mtg clips, 3½", rd fl bake case....$6.95
W.H., NX-35, 2.0 KV with two ext wire wound precision 1.0 KV resistors to make this a dual range, 0-1 and 0-2 KV meter. Complete with mtg clips..$7.25
W.H., NX-35, 20 KV with ext prec wire wound 1000 ohms per volt resistor & mtg clips.....$21.00
McClintock D-100-R-1, 15 V D.C., 1000 r/v Bl sc, 2½", bakelite case.....$3.00

BC-1072-A RADAR TRANSMITTER

Freq. range 150 to 210 Megacycles.
Operates off 115 volt 60 cycle power line.
THE VALUE OF THIS UNIT IS CHIEFLY FOR THE PARTS IT CONTAINS
BLOWER 115 volt 60 cycle 28 watts .38 1525 R.P.M.
VARIAC Gen. Radio type 200 B 115 volt input, 135 volt 1.5 Amps Max. output.
TUBES 2—5U4G's, 1—807, 1—2x2, 1—6SN7, 1—6J5, 1—9002, 2—9006, 2—826
METER Simpson, 3½" round, 0-5 Kilovolt and 0-10 M.A. D.C.
TRANSFORMERS
1—with primary from 0-135 volt, secondary from 0-3500 volt
1—with primary 117 volt secondary 6.3 V at 1.2 Amp. 275 volt center tap to each side, 5.0 volt at 3 Amp.
1—with 117 volt primary, secondary 4 volt at 16 Amp. and 2.5 volt at 1.75 amp.
Consists also of many other parts, relays, transformers, circuit breakers, interlocks, resistors, chokes, too numerous to itemize.
Complete in metal cabinet 18" x 20" x 17½"; wt. 150 lbs.

NET $22.50

SWITCHBOARD METERS

(Accuracy within 1%)

Weston 642, 15 A A.C., 4½", rd flanged case, surf mtd, 2" Projection.....$8.00
Weston 642, 30 A A.C., 3½", rd surf mtd non-flanged case, 2" Projection....$8.00
Weston 642, 150 V. A.C., 4½", rd flanged case, surf mtd, 2" Projection.....$9.00
Weston 640, 3 A R.F., 4½", rd flanged case, surf mtd, 2" Projection.....$9.50
Weston 643, 25 A D.C., 4½", rd flanged case, surf mtd, 2" Projection.....$8.00
Weston 643, 30 V D.C., 4½", rd flanged case, surf mtd, 2" Projection.....$9.00
Weston 643, 100 V D.C., 3½", rd non flanged case, surf mtd, 2" Projection.....$9.00
Weston 643, 150 V D.C., 4½", rd flanged case, surf mtd, 2" Projection.....$9.00

SPECIAL METERS

J.B.T. 30F Frequency Meter, from 58-62 cycles. Vibrating reed type 115 volt 3½", rd fl metal case.....$4.50
J.B.T., 30F, Dual range Frequency Meter covers frequency ranges from 48 to 52 cycles: Dual element, Vibrating Reed type, 115 volt, 3½", rd flush metal case.....$5.95
Voltage Polarity Phase Rotation Tester, Triplett 337 AVP, Checks 115, 220 and 440 line voltage; locates open circuits, blown fuses, damaged wiring, etc. Indicates whether A.C. or D.C. and polarity of D.C.; Checks phase rotation to determine direction of rotation of motors, operation of controls, etc.; Consists of a 3" square meter and a small polarized vane movement in a small handy sized case. Complete with 36" leads with test prods.....$8.50
G.E., 8KT8, Running Time Meter, 115 volt, 60 cycle, totals up to 99,999 hrs. Gray sc, 3", sq fl bake case.....$4.95
J.B.T., 3½", Frequency Meter, 58-62 cycle, 5 reed, 100-150 volts.....$4.50
Time Totalizer Indicates up to 9,999.9 hours for 50 or 60 cycle operation on 105 to 130 volts. Black scale 3" rd fl bakelite case, clamp mounted. Made by Industrial Timer Corp.....$4.00
W.H., DB Meter RC-35—10 + 6 ODB—1.897 V. 6 MW—600 ohms 3" square $4.50

D. C. MICROAMMETERS

Western Electric, 100-0-100 microampere, approximately 70 ohms resistance, 3½", rd fl bake case, concentric style...$6.50
G.E., DO-41, 200 microampere mvt, Knife edge pointer, sc mkd "Set Carrier" supp with paper V.O.M.A. sc, 3½", rd fl bake case.....$4.95
G.E., DO-41, 500 microampere mvt, sc cal 0-20 KV, supp. with paper V.O.M.A. sc, 3½", rd fl bake case.....$4.95
Triumph, 400 ua mvt, approx 500 ohms resist, sc cal 0-3, 0-15 & 60 V Ma, 4". Rect fl bake case, Knife edge pointer.....$5.50

A. C. VOLTMETERS

G.E., AO-22, 150 V, 3½", rd fl bake case.....$5.50
G.E., AO-22, 150 V, 400 cycle, 3½", rd fl bake case.....$4.00
Weston 476, 130 V, 3½", rd fl bake case.....$4.95
W.H., NA-35, 15 V, (100 MA) 3½", rd fl bake case.....$3.95
W.H., NA-35, 150 V, (10 MA) 3½", rd fl bake case.....$5.50
Triplett 332-J.P., 150 V, 3½", rd fl metal case.....$4.50

A. C. AMMETERS

Roller Smith, Type TAS, 8 A, A.C. 3½", rd fl bake case.....$4.50
Triplett, 331-J.P., 30 A, 3½", rd fl bake case.....$4.00
Weston 476, 4 A. A.C. 3½", rd fl bake case.....$4.95

RADIO FREQUENCY AMMETERS

Weston 507, 1.5 A, black scale, 2½", rd fl metal case.....$2.50
Weston 507, 2.5 A, 2½", rd fl bake case.....$3.95
W.H., NT-35, 3 A, 3½", rd fl bake case.....$5.50
G.E., DW-52, 250 MA, black scale, sc cal 0-5 mkd "Antennae Current", 2½", round fl bakelite case.....$3.50
G.E., DW-52, 3 A, black scale, 2½", rd fl bake case.....$2.95
Simpson 36, 1 A, 3½", rd fl bake case.....$4.95

D. C. MILLIAMMETERS

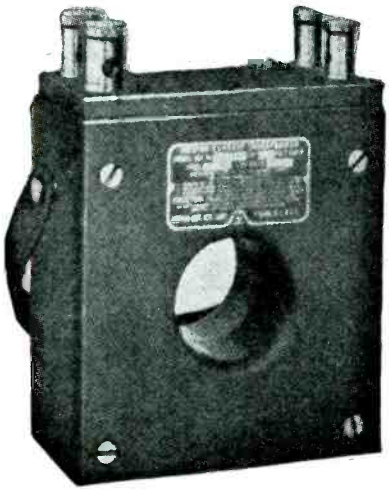
G.E., DO-41, 1 MA, black scale, supp with paper V.O.M.A. sc.....$4.50
G.E., DO-41, 30 MA, 3½", rd fl bake case.....$3.50
G.E., DO-41, 50 MA, black scale, 3½", rd fl bake case.....$3.25
G.E., DO-41, 200 MA, 3½", rd fl bake case.....$3.25
W.H., NX-35, 200 MA, 3½", rd fl bake case.....$3.95
Simpson 25, 1 MA, 3½", rd fl bake case.....$4.50
Simpson 25, 100 MA, 3½", rd fl bake case.....$4.50
Simpson 25, 200 MA, 3½", rd fl bake case.....$4.50
Weston 506, 1 MA, 2½", rd fl bake case.....$3.95
Weston 506, 50 MA, 2½", rd fl bake case.....$3.95
Weston 506, 200 MA, black scale, 2½", rd fl bake case.....$3.50
Weston 301, 50 MA, 3½", rd fl bake case.....$4.95

All items are Guaranteed and are Surplus New unless specified otherwise. All prices FOB, N. Y.—25% deposit required on C.O.D.'s. Orders accepted from rated concerns on open account. Net 30 days

MARITIME SWITCHBOARD

338 Canal Street . . . . . Worth 4-8217 . . . . . New York 13, New York

PORTABLE CURRENT TRANSFORMER



Weston Model 461 Type 4 (see illustration). This unit can be used with any precision 5 Amperes A.C. Meter to extend the ranges of the meter to 50, 100, 200, 250, 500 or 1000 Amperes A.C. Accuracy within ¼ of 1%; Normal Secondary Capacity = 15 VA; Binding Posts for 50 Ampere tap; Inserted primary for 100, 200, 250, 500 and 1000 Amperes; Insulated for use up to 2500 volts. List Price $98.00. .....**NET fob, NY $35.00**

PORTABLE A.C. VOLTMETER

Weston Model 433, 0-600 volt A.C.; accuracy within ¾ of 1% from 25 to 125 cycles. Hand Calibrated Mirror Scale 4.04" long with 150 Scale divisions; Knife edge pointer. Moving Iron Vane type magnetically shielded. Dimensions 5"x6"x3¼". List Price $59.50 .....**NET fob, NY $27.50**

PORTABLE D.C. AMMETER & SHUNTS

Westinghouse Type PX-4, Multirange 0-1000, 0-2000 and 0-4000 Amps. D.C. (50 MV movement) Accuracy within ¾ of 1%, long Mirror 3 range scale with 80 scale divisions; Knife edge pointer; Moving coil D'Arsonval movement; Dimensions 4½"x4½"x2". Complete with leads and external 50 MV shunts.....**NET fob, NY $80.00**

Meter & Leads Only	$17.00
1000 Amp shunt Only	$12.00
2000 Amp shunt Only	$20.00
4000 Amp shunt Only	$40.00

D.C. TO A.C. ROTARY CONVERTER

INPUT: 230 Volt, 3.3 Amp D.C.
OUTPUT: 110 Volt 4.55 Amp 60 cycle 1 phase .500 KVA 90 P.F. 3600 R.P.M.
Made by Pioneer Gen-E-Motor Corp. "Pincor" Type #2 K 50 X with filter unit. Drip proof housing; Dimensions 13½" L x 10" H x 7½" W.
NET fob, NY $47.50

INVERTER PU-16/AP

INPUT: 28 Volt 60 Amp. D.C.
OUTPUT: 115 Volt 6.5 Amp 400 cycle
Manufactured by Wincharger Corp. Type #MG 750, 8000 R.P.M. Complete with filter unit, carbon pile regulator, selenium rectifier, etc. and circuit diagram. Dripproof housing; Dimensions 15½" L x 10" H x 7" W.....**NET fob, NY $6.50**

INVERTER PE-206-A

INPUT: 27.5 Volt 38 Amps D.C.
OUTPUT: 80 Volts 500 V.A. 800 cycle 1.0 P.F. 1 phase 6000 R.P.M.
Manufactured by the Leland Electric Co., Type #DA. Complete with filter, carbon pile regulator, selenium rectifier, etc., with circuit diagram and handbook of maintenance instructions. Dimensions 13" L x 10" H x 6" W.....**NET fob, $6.50**

TG-10-F AUTOMATIC KEYER

OPERATION (a) Designed primarily to read standard code signals from inked tape by means of a photo electric system and to transmit these signals to a number of headsets or practice tables for code practice.
(b) Can be used as a separate tape puller and take-up unit for use in conjunction with certain types of recorders which do not perform these functions.
(c) Can be used in conjunction with a transmitter and/or code Recorder BC-1016 to send or relay messages at high speeds (etc.)
OUTPUT: Audio signal of 800 cycles. Three output impedances of either 4, 8 or 15 ohms for coil load matching.
COMPONENTS: 110 volt Variable Speed Drive Motor—Take-up reel—Practice reel of linked tape—Technical manual—Photo Electric system—25 Watt Amplifier and oscillator circuits **Complete with the following tubes:** 2-6N7's; 2-6SJ7's; 2-6L6's; 1-5U3G; 1-923
Complete ready to use in steel cabinet 11" high x 24" wide x 18⅛" deep, wt. 63 lbs. Designed to fit any standard 19" relay rack. Height is 8¾" and weight 40 lbs. when cabinet is removed for rack mounting.
Fully equipped and assembled—Just connect to your headphone, etc., and plug into your 110 volt 60 cycle power line.

NET FOB, NY **$19.95**

RADIO NOISE FILTER

General Electric Co., Cat # 1C202G2. 100 Amps. 50 Volts D.C.
Can be used on vehicles and boats, or with aircraft equipment to filter generator "noises". For use on low voltage generator outputs up to 50 volts; Dimensions 4¼" L x 3¾" W x 2½" D. 75¢ each. Minimum order 10 pieces.

REVERSE CURRENT RELAY

12-15 Volt 200 Amps.
For Generator Current Control on vehicles, boats and aircraft equipment, etc. Leece Neville # 23509.
EACH $2.50

VIBRATOR TRANSFORMER ASSEMBLY

PRIMARY WINDING—center tapped 6 volt D.C. at 1.6 Ampere on each half of winding. Center tap is brought out directly from primary winding and also through a 3.5 Millihenry series choke.
SECONDARY WINDING—center tapped 360 volts A.C. at 30 M.A. total. Center tap is brought out directly and also through a 5 Henry series choke.
DIMENSIONS—2¼" dia. x 3¾" overall height.
United Transformer Co. type #82834.

Minimum Order 50 Pieces at **60c** **Each fob N. Y.**

HYDROMETER

Storage Battery Testing Kit made for Navy Type A, lead acid batteries. Consists of:
A Hydrometer with a spare 10" glass barrel
B Two 13" mercurial thermometers from 20 to 150° F with specific correction calibration markings.
C Two pipettes for electrolyte measuring
D Two hydrometer floats from 1060 to 1240 Baume
E Two hydrometer floats from 1120 to 1300 Baume
Each set comes complete in a compartmented wood box with slide cover 5½" x 3½" x 22¾". Surplus—New.

NET FOB, NY **$2.75 each**

Minimum Order 10 Pieces.

NAVY AOX SONAR UNITS

Each unit consists of the following:
1—4" Jensen PM8 Speaker
1—Power Transformer, 115 volt 60 cycle input, output 315-0-315 volts at 70 MA, 6.3 volts center tapped at 3.5 ampere, 5 volt at 3 ampere.
1—Single variable condenser, 312 MMF with clock wise increase characteristics
1—National Vernier Drive
1—IRC Attenuator, 100,000 impedance 3 DB per step to 57 DC, type B-31P
9—Octal Sockets
2—2" Skirted knobs
1—DPST Toggle Switch
1—3 Deck, 2 pole, 5 position each wafer switch
1—Fuse post
The unit was designed to use 1.6SJ7; 1.6SN76T; 1.6U66T; 1-5Y3GT; 1-UR-150/30. No tubes supplied with unit. Has a large quantity of assorted resistors, mica condensers, bathtub condensers, potentiometer, connectors, etc.
Approximately 150 available @ $2.50 each.
Minimum order: Entire Lot.

MANUFACTURERS! EXPORTERS! DEALERS!

Can you use these meters?

We have large quantities available and can offer them to you at very attractive prices.
Send us your requirements and we will be pleased to quote you.

D.C. MILLIAMMETERS

Roller Smith miniature, 1½" square, 1.25 MA movement.
Simpson 26, 3½", rd O-15 MA.
G.E., DO-41, 3½", rd, 1 MA black scale.
G.E., DW-41, 2½", rd 1 MA full sc, calibrated 140 D.C. V & 500 MA.
W.H., NX-35, 200 MA, 3½", rd fl bake case.
G.E., DO-53, 20 MA, 3" square fl bake case.
G.E., DO-41, 30 MA, 3½", rd fl bake case.
Sun 3AP259, 1 MA, 3½", rd fl bake case.

D.C. AMMETERS

Triplett 0321-T, 15 A, 3½", rd fl bake case.
G.E., DO-41, 200 A, comp with ext 50 MV (Aircraft style) shunt, 3½", rd fl bake case.
Weston 506, 200 A, comp with ext 50 MV shunt, 2½", rd fl bake case.
U.S. Gauge 2" rd clamp mtd metal case, Auto type, 30-0-30 Amps D.C. black scale.
G.E., DW-51, 30-0-30 A, 2½", rd fl metal case
Beede, 30-0-30 A, 2½", rd fl metal case.
W.H., F-1 (NX-33, 150 A, black sc, comp with ext 50 MV (Aircraft style) shunt, 2½" rd fl bake case.

A.C. AMMETERS

Triplett 331-J.P., 30 A, 3½", rd fl bake case.

RADIO FREQUENCY AMMETERS

G.E., DW-41, 6A, black scale, 2½", rd fl bake case.
G.E., DW-52, 1.5 A, black scale, 2½", rd fl metal case.
W.H., NT-35, 3 A, 3½", rd fl bake case.

D.C. MICROAMMETERS

G.E., DO-41, 200 microampere mvt, Knife edge pointer, sc mkd "Set Carrier" supp with paper V.O.M.A. sc, 3½", rd fl bake case.
G.E., DO-53, 500 ua mvt, sc cal 0-15 KV DC supp with paper V.O.M.A. sc, 3½", sq fl bake case.

A.C. VOLTMETERS

GE. AW-41, 2½", rd 0-15 Volt, 800 cycles, rd fl bake case, black scale.
W.H., NA-35, 15 V (100 MA) 3½", rd fl bake case.
Triplett 331-J.P. 3½", rd fl bake case 0-150 volts.

D.C. VOLTMETERS

G.E., DW-41, 15 Volt, black sc, no Caption, sc cal 0-15, 2½", rd fl bake case.
W.H., DX 4½", rd fl metal case 0-150 volts, black scale.

SPECIAL METERS

DeJur Amsco 310, 1 MA sc cal 0-4 KV, 3½", rd fl bake case.
Voltage Polarity Phase Rotation Tester, Triplett 337 AVP, Checks 115, 220 and 440 line voltage; locates open circuits, blown fuses, damaged wiring, etc.; Indicate whether A.C. or DC and polarity of DC; Checks phase rotation to determine direction of rotation of motors, operation of controls, etc.; Consists of a 3" square meter and a small polarized vane movement in a small handy sized case. Complete with 36" leads with test prods.
J.B.T., 30F, Dual range Frequency Meter covers frequency ranges from 48 to 52 cycles; and 58 to 62 cycles: Dual element, Vibrating Reed type, 100-150 Volts, 3½", rd flush metal case.
Time Totalizer Indicates up to 9,999.9 hours for 50 or 60 cycle operation on 105 to 130 Volts. Black scale 3" rd fl bakelite case. Clamp mounted. Made by Industrial Timer Corp.

PRECISION RESISTORS

± 1% Accuracy—Wire—Wound—1 M.A., Weston, G.E., I R C or Sprague.

1.0 Meg 1 KV	2.5 Meg 2.5 KV
1.5 Meg 1.5 KV	5.0 Meg 5.0 KV
	20.0 Meg 20.0 KV

All items are Guaranteed and are Surplus New unless specified otherwise. All prices FOB, N. Y.—25% deposit required on C.O.D.'s. Orders accepted from rated concerns on open account. Net 30 days

MARITIME SWITCHBOARD

338 Canal Street . . . . . Worth 4-8217 . . . . . New York 13, New York

SURPLUS BARGAINS!

WESTON MODEL #1

Portable D.C. Voltmeter — 0-3/15/150 Volts — Triple Range.

Used as a reference standard. Accuracy unaffected by wide changes in temperature.

Accuracy: ¼ of 1%. Knife edge pointer—mirror scale.
Scale length: 5.18". With genuine leather case.
List: $117.13.

Your Cost $57.50

PORTABLE VOLTMETER

Westinghouse PX-14
Range: 0-3/15/150/750VDC

A rugged instrument of medium accuracy. Magnetically shielded, bakelite case. Mirror Scale. Accuracy ±1%. Scale Length: 3.2". Size: 5-¼" x 4-¼" x 1-¾".

List Price $46.00

Your Cost $17.50

STEPDOWN TRANSFORMER

Made by General Electric. Heavy duty stepdown transformer, with considerable overdesign. Ideal for rectifier applications, low voltage heating, general laboratory use, etc. Open frame type.

Input: 115 Volts—60 Cycles
Output: 15 Volts (at full load)
Capacity: 180 V.A.
Size: 3-½" x 3-½" x 4".

Your Cost $3.75

Quantity prices available

SPECIAL METERS

0-15 Amps. R. F. Weston 507..... **3.50**
Resistance Thermometer 30° F. to 230° F. with res. bulb. Weston #727..... **4.95**
Weston 637 Freq. Meter. Aircraft case 3½". Range: 350-450 Cycles, complete....**4.95**

AMPERES A. C.

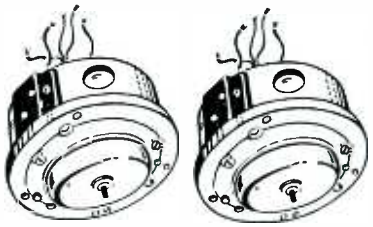
0-5 Amps. 4" Rd. Weston 642 (surface metal case) **7.95**
0-5 Amps. 4" Sq. Triplett #431 (flush bakelite case. Scale: 0-150/300 V.)... **2.95**
0-30 Amps. Triplett 3"Rd..... **3.25**

MICROAMPERES D. C.

0-100 Microamps. Res: 100 Ohms—3" Rd. Westinghouse NX-35 .....**$7.95**
(Ideal for pyrometry & Photo-electric work)
0-150 Microamps. Res: 500 Ohms—2" Rd. G. E. DW-51 or NX-33.....**$3.75**
840-0-840 Microamps (blank scale) Weston 643—4" round—metal case.....**$4.50**

All Items Listed in This Ad Are New, Unless Otherwise Specified

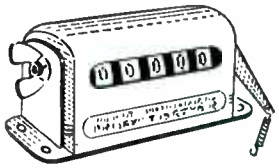
SELSYNS



Very small lightweight aircraft type aluminum housing, shaft diameter ⅛". Diam. is approximately 2¼" x 2" long. New in original boxes. Will operate on 24 volts, 60 cycles.

Your Cost $3.95 A Pair

RESETABLE COUNTER PRODUCTIMETER



MOD. 5H11R 5 DIGIT HEAVY DUTY SIZE

Approx. Size 5"x3"x2"
Size of Figures—⅜" High

Your Cost $8.50 Net Ea.

MILLIAMPERES D. C.

0-1 Mills—3" Rd. G. E. DO-53.....**$4.75**
0-1 Mills—3" Rd. Weston 301 ..... **6.75**
0-1 Mills—3" Rd. Weston 301 scale: 0-1.5 KV **5.75**
0-1 Mills—3" Rd. Marion (special scale) **3.25**
0-1 Mills—2" Rd. G. E. DW-41 (special scale) **1.95**
0-5 Mills—2" Rd. Dejur S-210 ..... **2.15**
0-15 Mills—2" Rd. Weston 506 ..... **3.25**
1-0-1 Mills—3" Rd. Western Electric Surface (scale 100-0-100) **1.35**
0-25 3" Weston 301, Metal Case..... **3.75**
0-25 M.A. 2" G.E. DW 41..... **2.75**
0-25 M.A. 3" Weston #301 fl. metal case **3.75**

AMPERES D. C.

0-1 Amp. 3" Rd. Weston 301.....**$5.95**
0.1.5 Amps—4" sq. Triplett #421.... **2.95**
0-3 Amps 4" sq. Triplett #421..... **2.95**
0-10 Amps—3" Rd. Simpson #25.... **4.95**
30-0-30 Amps 3" Rd. Simpson #25.. **4.95**
0-80 Amps—2" Rd. Weston #506 (charging Amp caption) (with ext. 50 MV shunt) **3.25**
0-300 Amps 3" Rd. Roller-Smith Type TD (with ext. 50 MV shunt)..... **4.95**
0-300 Amp. same as above (without shunt) **2.50**
0-300 Amp. 4" Rd. Weston 643 (flush metal case) Black scale—with ext. shunt.. **8.50**
0-300 Amp. same as above (without shunt) **6.00**

WESTON MODEL 269 FAN SHAPED METER

One of the Weston popular fan shaped line. Exceptionally long scale for size of instrument. Accuracy—within 1%. Scale length—4".

Spade pointer. Here is a good movement for special purpose instruments. Comes with blank scale with arc drawn in. Ready for plotting calibration points. Can be used to make up any range of volts, amps, MA., etc.

Full scale deflection—5 M.A.—40 M.V.
List $29.83

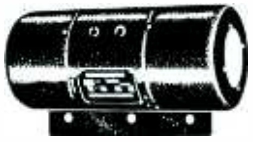
Your Cost $8.95
10 for $75.00

WHEELCO CAPACITROL #221

The original Wheelco electronically controlled temperature regulating pyrometer, cold junction compensated, high resistance movement. Scale length:

Ranges available:—0.400°F. 0-1200°F. 0-800°F. 0-2000°F.
Net Cost. $150.00 Your Cost: $98.75

DYNAMOTOR



G. E. Input 28V D.C., Output 1000V D.C., Capacity 350 M.A., with voltage regulator box on top. Approximate Dimensions 12" long x 6" Diam. Weight 30 lbs.

Your Cost $9.75

VOLTS D. C.

0-10 Volts 3" Rd. EelectroTech.....**$3.75**
0-20 Volts 3" Rd. Weston 506-1000 Ohms/V **3.50**
0-50 Volts 4" Rd. Weston NX-37 200 Ohms/V **6.00**
0-150 Volts 3" Rd. G. E. D-41..... **4.75**
0-150 Volts 3" Rd. Weston 301-200 Ohms/V. (black scale)..... **4.95**
0-150 Volts 4" Rd. Weston 643 (flush metal case—black scale) **6.75**

VOLTS A. C.

0-15 Volts—3" Rd. G. E. AO-22 (black scale) **$2.95**
0-75 Volts—4" Weston 642 (surface mtg) **7.25**
0-150 Volts—3" Sq. or Rd. Simpson 57 or 55 .....**6.00**
0-250 Volts—4" Rd. Triplett #534-B (surface mtg—bakelite) **4.50**
0-300 Volts—4" Sq. Triplett #431 Scale: 0-300/600 V. **4.50**
0-300 Volts—4" Weston 642 (surface metal case) **9.00**

POWERTRON Electrical Equipment Co.

SURPLUS DIVISION: ELECTRO-TECH EQUIPMENT CO.

119 LAFAYETTE STREET ***Phone:*** **WOrth 4-8610** **NEW YORK 13, N. Y.**

NOW AVAILABLE FOR IMMEDIATE SHIPMENT!

TWO PARTY INTERCOM SPECIAL
$29.50

Ideal for factory or office use. Momentary Press - to - Talk switch provides fast positive action. Built for rugged use, has terrific pick-up. 115 v. 50-60 cy. panel controls includes volume control 110 v. switch 11x11½x6½—weight 28 lbs. Complete with tubes and additional speaker in metal case.

HS-16 HEADSET

8000 ohms Hi-impedance
Noise proof
Most sensitive phone built
May be used as a sound powered intercom
Light, durable, efficient. Molded neoprene earcups shaped to completely envelope entire ear. Adjustable steel headband extends or retracts. Especially suited to hams, commercial operators, aircraft pilots, recording engineers and many others. Can be used with simple Xtal to make complete radio receiver. Special **$2.49**
Original cost $25.00

6 foot extension cord ..... **.49**

AMERTRAN VOLTAGE REGULATOR
(TRANSTAT)

17.4 amps. maximum output 2 KVA single phase 115 v. 50 to 60 cy. 90 to 130 v. shipping weight 20 lbs.—a marvelous buy—First come first served **$24.95**

PIONEER GENEMOTOR HIGH POWER ON WHEELS

Delivers output 500 V. @ 160 mils, input 6 or 12 V.—completely filtered—has relays and magnetic circuit breakers in specially constructed casing. The job that will deliver the watts to that mobile rig. Slightly used, perfect condition. Specially priced **$5.95**

G. E. INTERLOCK SWITCH

Hi-voltage is lethal—protect yourself and family—this switch automatically shuts off Hi-volt. circuits while adjustments are being made—low pressure—hi current capacity, positive action. Silver plated contacts. Pr..... **$2.49**

CONDENSERS

CF- 1—2MFD 400 V. DC.	$ .39
CF- 5—2MFD 600 V. DC.	.60
CF- 6—4MFD 600 V. DC.	.75
CF- 8—Tobe Dual 8MFD 600 V. DC. fits 4 prong socket	1.25
CF-10—1MFD 1000 V. DC.	.90
CF-13—4MFD 1000 V. DC.	1.10
CF-14—4MFD 1500 V. DC.	1.89
CF-19-1MFD 600 V. DC.	.39
CF-22—2MFD 4000 V. DC.	5.50
CF-27—1MFD 2500 V. DC.	1.19
CF-28—7MFD 800 V. DC.	1.50
CF-29—2MFD 2000 V. DC.	2.10
CF-30—1MFD 5000 V. DC.	6.75
CF-31—8MFD 600 V. DC.	1.20
CF-32—4MFD 400 V. DC.	.69
CF-33—10MFD 600 V. DC.	1.40
CF-37—8MFD 2000 V. DC.	4.95
CF-40—2.87MFD 3500 V. DC.	16.95
CF-41—.75MFD 12,000 V. DC.	14.95
CF-42—7MFD 600 V. DC.	1.35
CF-43—6MFD 600 V. DC.	1.09
CF-44—1000MFD 25 V. DC.	1.20
CF-45—.1MFD 3500 V. DC.	1.98
CF-46—1MFD 3500 V. DC.	3.49
CF-47—6MFD 1500 V. DC.	2.39
CF-48—.05MFD 2500 V. DC. Perfect for Television	1.09
CB-12—.2MFD 2000 V. DC.	2.75
CB-14—.5-.5 9000 V. DC.	19.95
CB-18—.25MFD 4000 V. DC.	2.95
CB-35—.5MFD 2000 V. DC.	2.10
CF-34—2MFD 440 V. AC.	.98
CB-16—.1MFD 440 V. AC.	.79
CB-21—.25MFD 20,000 V. DC.	19.95
BATH TUB	
CB-13—.1-.1MFD 600 V. DC.	.45
CB-17—.5MFD 400 V. DC.	.39
CB-19—100MFD 25 V. DC.	.59
CB-20—2MFD 400 V. DC.	.59
CB-36—.25MFD 600 V. DC.	.39

Mallory Vibrapack 12 v. input, 150 v. @ 85 mils output—Extra Special at **$3.75**

75,000 ohm bleeder, 200 watts Ohmite—special **$1.65**

50,000 ohm bleeder, 100 watts, I.R.C. ..... **.89**

DYNAMOTOR

12 v. dynamotor—ideal for portable 2 meter rig—low battery drain. 235 v. output at 90 mils. Can be run at 50% overload—gives up to 110 mils at 215 v. without damage for continuous duty—complete with filter. Special 2 for **$4.95**

Write For Latest Flyer I SL

NEW, STANDARD BRAND TUBES

TYPE	PRICE	TYPE	PRICE	TYPE	PRICE
1A3	.98c	12SA7GT	.99c	805	3.75
1A7GT	1.10	12SG7	.89c	807	.95c
1H4G	.98c	12SH7	.89c	808	2.95
1L4	1.10	12SJ7	.79c	809	1.50
1R4	1.29	12SK7	.89c	811	1.95
1T4	1.10	12SN7GT	.79c	812	3.25
1H5	.99c	12SQ7GT	.99c	812H	6.90
1N5GT	1.10	12KS	1.25	813	5.95
1N21B	.35c	14B6	.99c	814	4.49
1LN5	1.92	28D7	.75c	815	2.25
1R5	1.10	30	.78c	826	1.75
1S5	1.10	34	.98c	829B	3.95
3Q4	1.10	35Z3	.99c	830B	5.25
3Q5GT	1.10	35L6	.99c	832	2.25
3S4	1.10	32L7	1.50	832A	2.25
6AB7/1853	.99c	35W4	.89c	837	2.50
6AC7	.99c	37	.69c	838	3.75
6AG5	.99c	38	.89c	860	3.00
6AG7	.99c	39/44	.59c	5514	3.95
6AK5	.99c	41	.69c	7193	.49c
6AL5	.99c	45	.64c	8005	3.25
6AT5	.98c	46	.65c	8011	4.95
6B4	1.29	47	.90c	8012	4.95
6B6G	.89c	50B5	1.59	8016	1.49
6B8	.99c	50L6	.99c	0Z4	1.25
6C4	.64c	70L7	1.59	2D21	.75c
6C5	.51c	71A	.69c	2X2	.84c
6C21	12.95	75	.69c	3B24	1.95
6C6	.75c	713A	1.65	4C/35	7.95
6D6	.75c	717A	1.25	5R4GY	1.15
6F5	.51c	954	.75c	5T4	.98c
6F6	.95c	955	.75c	5U4	.98c
6F6G	.80c	956	.75c	5W4	.98c
6F7	1.25	957	.75c	5Y3	.60c
6F8	1.10	958A	.75c	5Y4G	.59c
6G6	1.10	959	.75c	5Z3	.89c
6H6	.59c	1614	1.75	5Z4	.89c
6H6GT	.89c	9001	1.15	6X5	.89c
6J4	1.50	9002	.98c	25Z6	.98c
6J5	.59c	9003	.98c	35Y4	.99c
6J6	.89c	9004	.98c	35Z5	.99c
6J7	.80c	9005	.98c	80	.75c
6K6	.69c	9006	.69c	82	.98c
6K7	.79c	10Y	1.50	83	.94c
6K8	1.25	15E	1.50	83V	.98c
6L6	1.25	HF100	6.95	84	.90c
6L6G	1.20	HY69	1.75	217C	7.50
6L7	.98c	HY75	1.25	250R	3.95
6N7	1.25	HY615	1.25	836	1.15
6R7	.98c	T20	1.95	866A	.75c
6SA7	.90c	TZ40	2.95	872A	2.25
6SC7	.85c	V70D	6.90	884	.75c
6SF5	.79c	100TS/	3.00	991	.50c
6SG7	.89c	2C26A	.75c	2050	.90c
6SH7	.65c	2C34	1.15	2051	.90c
6SJ7GT	.69c	2C40	2.60	8020	5.95
6SK7	.79c	2C44	1.75	RK60	1.25
6SL7	.89c	2E25	3.95	RK72	3.50
6SN7GT	.69c	2E30	2.25	VR78	.75c
6SQ7	.89c	2J32	20.00	VR90	.75c
6SR7	.89c	2J33	20.00	VR105	.75c
6SS7	.75c	2J1	1.25	VR150	.75c
6Q5	.98c	2J56	20.00	Z225	1.95
6Q5G	.98c	3C24/	1.35	874	1.95
6U5	.98c	3E29/	2.95	1613	.95c
6V6GT	.99c	75T	2.95	1616	2.95
6Y6G	.89c	304TH	9.85	1619	.98c
7AE7	.75c	304TL	4.95	1624	.98c
7C4	1.50	307A	6.25	1625	.98c
7F7	1.25	446A	2.60	2AP1	2.25
7L7GT	1.39	6C4	.64c	3AP1	3.45
12AT6	1.10	703A	7.50	3BP1	2.95
		705A	4.95	5BP1	3.95
		715B	4.95	5RP4	5.45
		723A/B	9.95	5CP1	3.95
		800	2.25	7BP7	7.95
		801A	1.25	913	3.00
		802	1.49	7DP4	14.95
		803	8.95	7EP4	18.95

NO MAIL ORDER FOR LESS THAN $5.00

AMPHENOL COAX CONNECTORS

83-1SPN	$0.45
83-1R	.45
UG-12/U	.59
83-1T	1.49
83-1AP	.79
UG-28-U	1.49
83-1F	.99

SELSYN MOTORS
Synchronous Type

Pair in Series for 110 v. AC.

Type I—5¼" long, 3" dia.—50 v. AC. 50 cy.—4 lbs. ..... $ 9.95 pr.

Type II—6¼" long, 4¼" dia.—115 v. AC. 50 cy.11 oz. ..... 12.95 pr.

Type III2½" long, 2½" dia.—50 v. AC. 50 cy.—11 oz. ..... 6.95 pr.

SYNCHRO—DIFFERENTIAL

Model #1943—C78249-CAL-11280 Bendix Aviation 115 v.—60 cy. 6" length to end of shaft x 4¼" diameter..... $ 9.95

NEW BANTAM BLOWER

Blower 6 v. AC or DC hi speed blower made by John Oster. Rated at 5000 RPM—1.8 AMP—made for continuous duty—1½" overall diameter—1" blower output—1¼" blower intake **$5.95**

CONTINUITY CHECKER

Neon type—in black metal box 3-5/8" x 5" x 3½" complete with leads & AC Cords..... **$2.50**

300 OHM TWINEX—unaffected by moisture—will handle 3 kilowatts of R.F.—losses at 40 MC per 100 ft., are 3/10 DB. Best buy in the houses, per foot..... **.08**

CRAMER TIMER

Type #7766346P2 adjustable from 1-30 sec. S.P.D.T. with starting relay for remote control motor and contacts separate. **$9.95**

Type #P7766346P4 adjustable from 4-120 sec. S.P.S.T. normally closed motor and contacts separate. **$6.95**

FULL WAVE SELENIUM RECTIFIER

Perfect for bias application — Use your DC relays from an AC source. Only requires 3" x ½" mounting space Rectifier for input up to 300V @ 40 ma output.
$.89 or 5 for $4.00

R. F. INDICATOR PROBE

Z601—has a fixed xtal (VHF) type and a pick up coil. Coax lead, coax connector at end. Probe has 4" bakelite handle. Used with a 0-1 Ma. meter across it. For checking R.F. in line, neutralizing finals, etc..... **$1.98**

HEINEMANN CIRCUIT BREAKERS

10 Amp, 117.5 V. A.C., Curve I..... **$1.25**

0.010 amp coil, 2340 V., Rect. D.C. Curve 4.2890, Res. 5000 ohms Max..... **$2.95**

TRANSFORMER SCOOP

TC-5—Western Elec—KS9547—332-0-332 v @ 240 MA, 10 v. C.T. 10 A., 2.5 v. C.T. @ 10 A., 2,000 v. ins., 5.1 v. @ 3 A., 6.4 v. C.T. @ 5 A.—Will supply every voltage for rig except plate of modulators and final..... **$4.25**

TS 5—Western Electric—D303184—Hi. Volt 4200 v. @ 9 MA Lo. Volt. 640 v. @ 200 MA—Fil. 6.4 v. @ 5 A., 5.4 v. @ 3 A., 5.1 v. @ 3 A., 2.5 v. @ 1.75 A., Complete Television Hi. & Lo. Volt. Trans. In one compact oil filled unit—Will handle any television tube... **$12.95**

TS 6—Scope Transformer—2500 v. @ .4 A., 2.5 v. @ 1.75 A., 6.3 v. Z .6 A..... **$9.95**

TCH 2—Scope Transformer 1750 v. @ 4 MA and matching fil., trans 6.3 v. @ .8 A., 2.5 v. @ 1.75 A., 2.5 v. @ 1.25 A..... **$7.95**

HF 16—Filter Choke 10 Hy. @ 150 MA **$1.95**

LC 2—25 MH R.F. Choke..... **$ .59**

METERS

MM 4-0-100MA Model 301 Weston 3½".....	$3.95
MM 10-0-1 amp DC-Model 301 Weston 3½".	3.95
MM 14-0-150MA NX 35 Westinghouse 3½"...	3.95
MM 19-0-800MA Weston Model 301MA.....	3.95
MM 33-0-1MA-MD-300 I K-McClintock 3½"	3.95
MR 13-0-8 R.F. amp—425AM-Weston 3½".	4.95
MZ-1-0.130 v. AC-25 to 125 cy.—376M Weston 3½".....	3.95
MV 8-0-4 K.V. DC—Roller-Smith 3½".....	2.95

RELAYS

KR 5—Leach Type 1357—115 v. AC—DPDT $2.00
KR 6—Struther Dunn—115 v. AC—DPDT $1.65
KR 10—Allied #KS5910—115 v. AC 10 amp contacts TPDT $1.98
KR 11—Allied #KS5910—115 v. AC 4 PDT 10 A. contact $2.50
KR 12—Struther Dunn—115 v. AC—2 relays on one mount. SPDT & SPST 10 A. cont. $3.95
KR 13—Kurman Elect. #X1400 D.C. overload relay with AC reset coil 115 v. AC SPDT $4.95
KR 15—Sperry—Thermo Time Delay ADJ 15-45 Sec. 115 v. AC 60 cy SPDT..... $3.50
KR 17—Leach—1177BF—115 v. AC Ceramic Insul. TPDT $1.75
KR 21—Wheelock Sig.—115 v. AC—5 Amp. Contacts DPDT—B3 x 4..... $2.25
KR 22—G.E. # CR2790E105—115 v. AC or 230 AC Heavy Duty DPDT $4.95
KR 24—Adlake Mercury Time Delay Relay—#1040-80 normally opened .3 to 5 sec 115 AC $8.95
KR 25—Struther Dunn—115 v. AC 30 amp. contacts DPST $4.95
KR 26—G.E. Instantaneous over current relay—Type PBC 3 amps @ 115 v..... $24.95

Birnbach No. 4175 feed thru Insulator... **.29**

ROTARY SWITCH — 3 deck 9 position non-shortening ceramic wafers. Each..... **$1.25**

R.F. Choke R154 1MH @ H600 MA with mounting bracket..... **$1.25**

R.F. Choke 3½ MH @ 100 MA on ceramic with threaded mounting hole..... **.18**

All Prices f.o.b. N. Y. C.

NIAGARA RADIO SUPPLY CORP.
160 GREENWICH STREET, NEW YORK 6, N. Y.

CREDIT EXTENDED TO RATED ACCT'S

NOW AVAILABLE FOR IMMEDIATE SHIPMENT!

TELEVISION *Values!*

TELEVISION FOUNDATION KIT

The television foundation kit consists of the most essential (and expensive) parts needed in the construction of a television receiver starting with the high voltage power supply, for the picture tube, right through to the antenna. The kit contains the high voltage picture tube transformer (for five or seven inch tube), 2X2 filament transformer, low voltage transformer for the receiver, cathode ray filament transformer, filter choke, 6.3 filament transformer for the 16 six volt tubes along with the five volt transformer for the 5U4. The two high voltage filter condensers, blocking oscillator, transformer all R.F.'s sound and video I.F.'s, peaking coils, discriminator transformer. Rectifier tubes 2X2 and 5U4, the picture tube 5BP4, an all aluminum Elincor dipole antenna are also included. Of course there is the easy-to-follow 26-page instruction book, with a large 12 by 18 schematic diagram. The instructions include television theory, circuit functions, explain scanning, give preliminary voltage measurements, parts layout and final adjustment of the television receiver which facilitates easy alignment without the use of elaborate test equipment. The only knowledge necessary to build this set is the ability to read a simple schematic diagram. Most radio men will have many or all of the minor parts not included in the foundation kit **$34.75**

Remaining set of necessary tubes $16.95

TRANSVISION TELEVISION KITS

12" Kit—Complete with all tubes —a real honey **$289.50**

7" Kit—Thousands of satisfied users **$159.50**

RAY-LECTRON COIL KIT

INCLUDES:

1 Oscillator Tank Coil. 1 Antenna Coil. 6 RF Tuning Coils, all mounted on Switch Assembly Plate: 5 Video IF Coils, Shielded, Permeability Tuned; 1 Shielded Discriminator Coil; 3 Video Peaking Coils, and Instruction Manual containing Circuit Diagram for 20 Tube Seven Inch Picture Tube Set, together with detailed Assembly Instructions, and Parts list.

The design of these Coils makes it possible to obtain satisfactory operation within the ENTIRE service range of ANY Television Station. Complete... **$23.50**

NEW TELEVISION COIL KIT 510

Build a 10" or 15" television receiver. ● Complete kit of permeability tuned video IF, RF, and Sound Coils for high quality television receiver designs. Contains all necessary coils for 3 stages 4mc. wide video, 2 stages sound, discriminator, peaking, oscillator, and RF. Complete Instructions included.
Priced at Only **$9.95**

NIAGARA COMPONENTS

CONDENSERS

CF 45—.1 mfd—3500 volt DC	$ 1.98
CF 48—.05 mfd—2500 volt DC	1.09
CB 18—.25 mfd—4000 volt DC	2.95
ER25AD—dual 25 mmf per sect. variable condenser	2.04

SOCKETS

11 prong isolant scope socket	$ 0.59
Octal socket	.12
Special hi. voltage socket for 2x2	.59

TRANSFORMERS

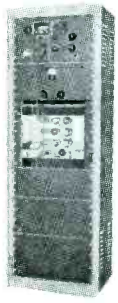
TS.6—Scope transformer—2500 v. @ .4 a., 2.5 v. @ 1.75 a., 6.3 v. @ .6 a.	$ 9.95
TS.5—Western Electric—D303184—hi. volt 4200 v. @ 9 ma lo. volt. 640 v. @ 200 ma—fil. 6.4 v. @ 5 a., 5.4 v. @ 3 a., 5.1 v. @ 3 a., 2.5 v. @ 1.75 a.—complete television hi. & lo. volt. trans. in one compact oil filled unit—will handle any television tube	12.95
TCH 2—Scope transformer 1750 v. @ 4 ma and matching fil. trans 6.3 v. @ .8 a., 2.5 v. @ 1.75 a., 2.5 v. @ 1.25 a.	7.95
HF 16—Filter choke 10 hy @ 150 ma	1.95
LC 2—25 ma R.F. choke	.59

MISCELLANEOUS

Pots—all sizes less switch	$0.69
Pots—all sizes with switch	1.09
Trimmers—single 3—30 uuf	.20
dual 5—50 uuf	.35
13" x 17" x 3" steel chassis cadmium plated	1.95
High voltage wire—50 ft. roll	1.00
Peaking coil	.45

Complete Line of Telectron Television Components in Stock
Write for Free Listing

MASTER OSCILLATOR MI-19427-B



This unit was built for R.C.A. Add a final—becomes a complete transmitter with signal shifter. 2:20 mg—also FM—only a few cycles drift from cold start. Complete with regulated power supply and heavy duty deluxe rack. Illustrated flyer giving complete description, technical summary and specifications available upon request.

COMPLETE (less tubes) **$225.00**

SOCKETS

KS- 3—Amphenol—octal type, ceramic, chassis type elastic stop nuts	$0.12
KS- 5—Isolantite—5 prong, ceramic, large chassis type	.12
KS- 6—Isolantite—6 prong, ceramic, large chassis type	.12
KS- 7—Johnson—4 prong ux base, bayonet, ceramic 25 watt	.75
KS- 8—Hammarlund—S7 — Isolantite, with hardware	.19
KS-14—Chassis type octal, mica filled bakelite, low loss. 1⅛" mounting with retaining ring	.09
KS-16—Uhf acorn steatite for 6F4, 955 etc. (metal shield with spring—10 cents extra)	.29
KS-17—Johnson—5 prong socket for RK-28, 803 ceramic, bayonet	1.49
KS-20—Johnson—ceramic for 304TH, 304TL	1.00
KS-21—7 prong for RCA 813, mykroy, 2⅝" square	.69
KS-22—Magnal—14 prong scope socket, mica filled low-loss bakelite	1.00
KS-24—Ucinite 829, 832 socket, recessed aluminum case for sub chassis mounting. Socket has built in by-pass condensers for 6 volt tubes	1.75
KS-25—Johnson—7 prong for 829, 832 tubes, ceramic	.29
KS-27—Mykroy socket for VT127/100TS	1.25
KS-28—7 prong miniature with shield	.39

OTHER TYPES IN STOCK—PRICES ON REQUEST

BAT HANDLE SWITCH

Mfgd. by Cutler-Hammer—10 amp. SPDT with neutral position—Perfect for rotary beam control—a positive steal at **29c**

WELLER Soldering Gun

A must in the kit of every man who makes soldered electrical connections. Heats in five seconds; see where you work; gets into tight corners. Operating on the same principle as the resistance welder. 100 watts, 115 volts, 60 cycles AC.

—Your COST **$12.95**

Tip Fastening Stud	.10
Copper Tip	.05

ANTENNA LEAD IN BOWLS

Made of genuine Pyrex—3" in diameter; brass rod 5½" long—complet with hardware and waterproof rubber gaskets

Special—$1.49

WESTINGHOUSE MN OVERCURRENT RELAY

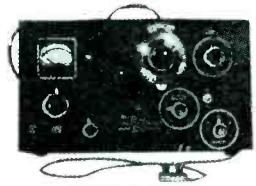
Adjustable to .4 amp. Has automatic 110 v. AC reset—glass encased—perfect for any overload application where tube damage must be avoided

A Steal—$12.95

VACUUM CONDENSER VC50

Capacity 55 mmfd—test voltage 20,000 v. peak.

WHILE THEY LAST $4.95



MODEL 18-C FERRIS MICROVOLTER

CHECK THESE FEATURES

Frequency Range: 5 to 175 megacycles in seven self-contained bands

Output Voltage: Continuously variable from a fraction of a microvolt to 100,000 microvolts.

Modulation: Internal 400 cycle and 1000 cycle modulation adjusted for approximately 30%. Provision for external modulation connection, requiring approximately 30 volts to modulate 30%. A fourth position is provided on the modulation selector switch for a pure carrier.

Power Supply: The standard power supply of the VR 90 regulated type is designed for 115 volt, 60 cycle operation. Supplies for other frequencies and voltages may be secured on special order.

Special $300.00

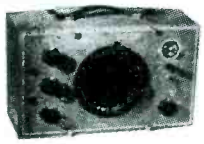
McMURDO SILVER AM-FM 906 SIGNAL GENERATOR

Available Now

What an instrument:
90 kc through 170 mc. on foundamentals . . . 8 airtrimmed bands . . . variable % 400—amplitude modulation . . . built-in variable electronic FM sweep . . . laboratory triply adjustable attenuator . . . metered microvolts . . . outout ½ microvolt to over 1 volt . . . multiply shielded . . . strays lower than $500.00 laboratory generators! Yet all this costs you only **$99.50**

Model 904 Capacitance Resistance Bridge

Net Price $49.90



¼ mmfd./ohm thru 1,000 mfd/megohm; 0-50% power factor; 0-500 volt adjustable internal polarizing voltage; 0-10 and 0-100 ma. electron-ray leakage current meter; measures resistance, capacitance under actual operating voltages!

Model 905 COBINATION "SPARX" DYNAMIC SIGNAL TRACER

Net Price $39.90

Frequency range from 20 cycles to over 200 megacycles. Contains isolating capacitor, resistor and one of the new radar U.H.F. crystal diodes. Loads a circuit being tested with only 3 mmfd. and higher than .5 megohm.

Model "Vomax" Vacuum Tube Voltmeter

Net $59.85

51 ranges directly measure d.c., a.c., a.f., i.f. and r.f. volts up through hundreds of megacycles, six resistance ranges six direct current ranges measuring from 50 microamperes through 12 amperes. Voltage ranges measure from .1 through 3000 volts d.c., .1 through 1200 volts a.c.

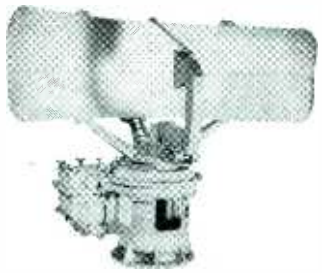
All Prices f.o.b. N. Y. C.

NIAGARA RADIO SUPPLY CORP.

160 GREENWICH STREET, NEW YORK 6, N. Y.

CREDIT EXTENDED TO RATED ACCT'S

RADAR EQUIPMENT



SO-1 Antenna Assembly Comprises:
- A drive mechanism including a drive motor and gear train.
- A synchro 400 cycle generator with gear train and mechanical differential.
- A rotating radiator system including a right angle radiator nozzle, a reflector in the form of a paraboloidal section, R.F. fittings for coupling the rotating system to a stationary waveguide.
- A supporting pedestal and base plate.

Brand new packed in export cases.

PRICE $90.00

These antenna assemblies have many uses as replacements on vessels now using SO-1 equipment, experimental radar and microwave work, amateur beam rotators, etc.

SO-8 Antenna assemblies also available, brand new and export packed.

PRICE $120.00

S.G. Radar complete sets of yard spares.
S.O.3 Radar complete sets of tender spares.
S.Q. complete portable units manufactured by General Electric Co. Brand new and ready to operate on 90-130 volts, 60 cycles, 320 watts. Choice of A, B, or P.P.I. presentation. 300 yards minimum range; max. 3, 15, 45 miles. 10 cm. Ideal for schools, laboratories, small boats, etc.
Radar crystals-98.35 kc

SYNCHROS

G.E. Selsyn Control Transformers model 2J5FB1. 115-55V. 60 cy.
Bendix Cal-18300, 115 V. 60 cy.
Diehl C-78414, 115 V. 60 cy.
(both above are army ordnance synchro generators which may be used in conjunction with G.E. Control transformers.)
Electrolux synchro repeaters, type XXI, C78863, 115 V. 60 cy.
Bendix, Mod. 4, type 5SF synchro motors, 115 V. 400 cy.
Bendix synchro repeaters type X Cal-5328A-1, 115 V. 60 cy.
Diehl synchro transmitters, type 1V C-78414, 115 V. 60 cy.
Esco synchro repeaters C-56776-1, 110 V. 60 cy. Many other types and sizes of synchros in stock.

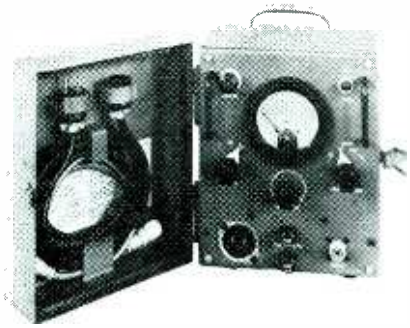
TRANSMITTING EQUIPMENT

BC-325 types B&C. Freq. range 1.5 to 18 mcs. Output 400 watts C.W. or 50 watts phone. 110 V. 60 cy., used but in excellent operating condition.
MD1/FRC Modulator units consisting of two complete 500 watt audio channels. Everything from microphone input to modulation transformer output built into metal cabinets. 110 V. 60 cy. Brand new.

METERS

Westinghouse NX35 D.C. milliammeters 0-800, 1/32" round bakelite cases.
Cramer Elapsed time meters RT21H, 3½" round bakelite cases.
Triplett D.C. Milliammeters 0-150, 2⅜" square bakelite cases.
J.B.T. 30-FX, 100-130 volt 46-64 cycle frequency meters, 3½" bakelite cases.
ID-24 Indicators.
Marion Instrument D.C. Kilovolt meters for use with 1 meg. external resistor, round 2¾" bakelite cases.
W.E.-4 to +6D.B. 1 MW in 600 ohms. FS-1 MA. A.C., 3" rd. bakelite.
Weston Model #45-0-1500 VDC
Weston Model #45-0-300 MA DC
Weston Model #1-0-300 MA DC
Weston Model #1-0-500 VDC
Weston Model #45-0-150 MA DC
Weston Model #45-75 VDC

LABORATORY EQUIPMENT



Vacuum tube Voltmeters, Model TS-487/U, Range 3-10-50 volts, peak to peak, complete in grey metal cabinet with coax input cable, AC cable, spare fuses and pilot lights.
Designed by Radiation Labs, M.I.T. for the U. S. Navy.

PRICE $72.50

Measurements Corp. Model 84 standard signal generators, 300-1000 mcs.
Ferris Crystal Calibrator, Model 34A.
Hewlett Packard Interpolation Oscillator. Model 6225B.
G.E. Model LU Radar test set.
General Radio 700A wide range B.F.O.
General Radio 561 V.T. Bridge with adapters.
General Radio 539A Variable Condenser.
Hewlett Packard 505B Tachometer.
Hewlett Packard 506 Tachometer optical head assembly.
Ferris 20A Microvolter.
Ferris 20A-1 Microvolter.
Shallcross 621H Limit Bridges.
Daven OP-961 Power output meters.
Pirani Gauges, Distilation Products Co. type PG-1A.
Synchroscopes, Browning Model P4E.
Flux Sensitive meter, Research Inst. Co. Model F.

(ALL LAB. EQUIPMENT PRICED FROM 25 TO 50% OFF LIST PRICES.)

RELAYS AND SWITCHES

Western Electric type D-168479 mercury contact relays for use in sorting machines, signaling devices, high speed keying, tabulating machines, totalizers, servo-mechanical, vibrator power supplies, etc.
Sperti Vacuum Switches. Have wide range of application in high voltage circuits, antenna switching, power supply switching, keying, etc. Voltage up to 10,000, current up to 5 amps., frequency to 30 mcs.
Leach, types 1355, 1154-A, 455C.
Struthers Dunn, types 1BXX129, 1BXX107, 1XBX105.
Western Electric, type 479H.

CABLES AND CORDS

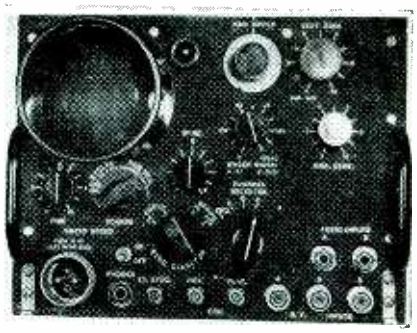
76-26-PB1 beaded coax cable.
P3J—6' patch cords. Double 241 plug ea. end.
9 conductor #16 stranded rubber covered heavy duty simplex cable.
5 conductor #18 stranded shielded cable.
Rigid Coaxial cable assemblies. Short lengths, inner cond. ¼" OD; outer cond. 17/32" ID; polystyrene bead insulation; collar and hex nut each end; ⅝" dia., 2', 2½' and 4' lengths available.

TRANSFORMERS

Large variety of filament, plate, scope and special purpose units in stock; 60-400 cycles, etc. Write in your requirements.

All prices quoted are F. O. B. Tuckahoe, N. Y. (About 20 miles north of New York City). All merchandise guaranteed. Immediate delivery subject to prior sale.

PAN-OSCILLO-RECEIVER



Ideal for laboratory, television and general service work

PERFORMS WORK OF FOUR UNITS:

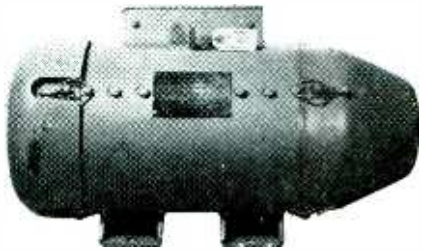
PAN-OSCILLO-RECEIVER. Ideal for laboratory, television and general service work. Performs work of four units.
1. Panoramic Adaptor: For use with any receiver with I.F. frequency of 405-505 kcs. 4.75 to 5.75 mcs., and 29-31 mcs.
2. Oscilloscope: Visually checks received signals, monitors transmitter, output-percentage modulation, carrier wave-shape, etc.
3. Synchroscope: External inputs provide synchroscope action.
4. Receiver: Three inputs provide facilities for use with convertors to cover wide range of frequencies to 10,000 mcs.

Features:
- 3" scope tube
- 21 tubes
- Aircraft type construction
- Variable sweep 35-40,000 cy
- Weight 40 lbs.
- Transformer built in for 110 V. 60 cycle operation.
- 2 I.F. stages-double conversion
- 2 Video stages in push pull to vertical plates
- Pentode output audio monitor
- Multi-Vibrator horizontal sweep (radar type)
- Horizontal sweep amplifiers P.P. to horizontal plates
- Surplus equipment tested and guaranteed in perfect operating condition. We have sold hundreds of these units during the past year to leading schools, laboratories, amateur operators all over the world.

Price $97.50

(Mail $1.00 for 80 page Technical manual and instruction book)

MOTOR GENERATORS



Brand new. Built by Allis Chalmers to rigid specifications of the U. S. Navy.
K.V.A. output 1.250 R.P.M. 3600
K.W. output 1. Cont. Duty PH. Single
P.F. 80. Cycles 60
Volts input 115 D.C. Volts output 120 A.C.
Amps. input 14 Amps. output 10.4
Length 26"; width 12⅞"; height 13". Compound accumulative A.C. and D.C. fields. Centrifugal starter. Splashproof covered. Frequency adjustable to load, plus or minus five cycles.

Price $87.50

Identical Machine, but 230 volts D. C. input, $125.00

Set of Replacement Spare Parts for Either Machine $29.50

ELECTRONICRAFT, INC.

5 Waverly Place **Tuckahoe 7, New York**

Telephone-Tuckahoe 3-0044

"Communications" OFFERS:-

COMPLETE RADAR SETS

S09-10CM. SURFACE SEARCH 4, 20 and 80 mile ranges; Raytheon. 250 KW peak power input to 2J27 magnetron. Complete set including: spare parts, tubes, wave guides and fittings.

SO13-IDENTICAL TO S09. Complete set, used. Consists of: transmitter and receiver, PPI scope modulator, motor alternator, rectifier, power unit and new rotating antenna.

SN RADAR-GE, low power, 5 and 25 mile ranges. Uses GL464 as pulsed oscillator, 5" "A" scope, "S" band. Extremely compact; ideal for demonstration and laboratory work. 115V 60C operation.

SEND FOR INFORMATION AND OUR LATEST FLYER

MICROWAVE PLUMBING

1.25 CENTIMETER

Wave Guide Section 1" cover to cover.....$2.00
T Section choke to cover..... 4.50
Mitred Elbow cover to cover..... 3.00
Mitred Elbow and "S" sections choke to cover 3.50
Flexible Section 1" long choke to choke... 3.00
Tunable Cavity with Coax input and output 6.00

10 CENTIMETER

Sand Load (Dummy Antenna) wave guide section with cooling fins. app 23" high..$28.00
Wave Guide to coax with flange, gold plated app 10" high.....17.50
Rigid Coax Directional Coupler CU-90/UP 20 DB drop, has short right angle, about 8" 5.50
Standing Wave Detector rigid coax 58 ohms. 5.00
Coax Rotary Joint with mounting plate.... 8.00
Antenna in lucite ball, for use with parabolic 5.00
Flexible Coaxial Connector, rigid coax to rigid coax 7/8" diam. 2.50

3 CENTIMETER

T Sections $5.50
Wave Guide Sections 2.5' long, silver plated with choke flange..... 5.75
Wave Guide 90 deg. bend E Plane 18" long 4.00
Wave Guide 90 deg. bend E plane with 20DB directional coupler..... 4.75
Wave Guide 18" long "S" curve..... 2.00
Feedback Dipole Antenna, choke input, (used with parabola) 4.50
Rotary joint wave guide in/out choke to choke joint 6.00
Rotary Coupler choke input; round guide output 5.25
S-Curve Wave Guide 8" long cover to choke 2.50
Wave Guide 2.5' long, silver plate, 180 deg. bend choke to cover..... 5.95
Duplexer Section using 1B24.....10.00
Wave Guide with slotted section and rotary joint 4.00
Wave Guide lengths, per foot 1.50
Pick-up loop with adjustable tuning section, used in duplexer..... 1.50
3cm Wavemeter Maguire cavity type, absorption and feed thru available.....20.00

MICROWAVE TUBES

3J31 (1cm) $17.50
Magnet for 3J31..... 8.00
2J26 (10cm) 25.00
2J32 (10cm)) 25.00
Magnet for 2J32.....10.00
2J38 (10cm with Magnet)....37.50
WE700A (L band) 45.00
WE720BY (S band 1000 KW)25.00
2K25-723AB Klystron 7.75
QK 59, QK 60, QK 61, QK 62 Tunable packaged Magnetrons (10cm) .....ea. 45.00

Small Quantities of Other Types Write For Information

THERMISTORS

D1167332 bead .....$ .95
D170396 bead ..... .95
D168391 button ..... .95
D167613 button ..... .95

COAX CABLE

RG9U 51 ohm Silver Coated.....ft $ .07½
RG8U 52 ohm.....ft .05

COAX Connectors Amphenol Loss type 831SP, 831SPN, 831R, 831AP, all.....ea .27
831F .....ea .45

MFRS WRITE FOR QUAN. DISCOUNTS ON BATHTUBS, MICAS, RESISTORS, KOOL-OHMS, CONNECTORS, HARDWARE

ANTENNAS

RELAY SYSTEM Parabolic Reflectors 2000-6000mc Size 4½ ft by 3 ft as illustrated ..$85.00
Dipole for above..... 5.00
TDY JAM RADAR rotating antenna 10 cm 30 degree beam 115 v AC 60 cy drive NEW 100.00
SO SURFACE SEARCH RADAR Rotating antenna dish complete with drive and Selsyn Motors NEW.....90.00
Used 45.00
3 CM ANTENNA WITH DISH 14½", Cutler Feed Horizontal and Vertical scan with 28 V DC Drive Motor and Drive mechanism Complete 65.00

RELAYS
Miniatures

SPDT 24 VDC .....$ .40
SPST 28 VDC ..... .40
DPDT 28 VDC ..... .45
SPST 100 V Overload 380/1800 cy..... .40

TELEPHONE RELAYS

SPDT—with cover WE D280400 48V 3500 Omega $1.05
DPST Make 1 break 1, 3.5 ma 1500 Omega .. 1.05

MISCELLANEOUS TYPES

SPDT 5VDC in can with 5 pr base.....$ .85
DPDT 6 VAC Struthers Dunn 1.45
DPST 6 VAC Struthers Dunn 1.35
2 Section SPDT 6 VAC Wheelock type..... 1.10
SPDT 115 AC Leach 1.00
SPDT 115 AC WE Wheelock type..... 1.25
SPDT 115 VAC Kurman Latch Type..... 2.49
SPDT 115 AC GE with SPST thermal delay Section 1.95
DPST 24 VDC Allied ..... .75
DPST Leach Antenna relay with SPST rcvr section 24 VDC and 12 VDC..... 1.25
SPDT 24 VDCGM..... .85
Solenoid Contactor 24VDC Leach #7220-24.. 1.05
Thermal delay 45 to 60 sec Edison type 1503 with 4 pr base 2.95
6 VDC Relay panel with 3 DPST and 2 SPST on 10" by 7" panel..... 2.75

PULSE TRANSFORMERS

All Standard name Items
Type K2450A Will receive 13KV, 4 micro-second pulse on pri., secondary delivers 14 KV Peak power out 100KW..$15.00
HI Volt. Magnetron Input transformer #D- 166173 with cooling fins..$12.00
U 4298E—Pri. 4 KV, 1 microsecond Sec. 16 KV 16 Amps. Fil. pri. 115V 400 Cycle.....$15.00
Hi Volt input pulse Transformer #D169271..$9.95
Radar pulse Tformer K2731 Diameter App. 11" vertical cooling fins.....$19.50
Pulse Input, line to magnetron K2748A....$12.00
Utah Blocking Oscillator Transformer Freq limits 790-810 cy-3 windings turns ratio 1:1:1 Dimensions 1 13/16 x 1⅛ x 19/32... .75

POWER EQUIPMENT
REGULATORS

LINE VOLTAGE REG 2 KW Saturable reactor type Pri 95-130 v 60 cy Sec 115 v 60 cy. 17.4 A 2 Kw 100% PF.....$160.00
LINE VOLTAGE REG Pri 92-138v 57/63 cy lph15A Sec 115v 7.15A .82 Kv 96% PF..135.00
CARBON PILE REG input 22-30v output 15v5.7A 1.00
22v-1-3A 1.00

TRANSFORMERS

Plate Trans. Oil Pri 115/230-Sec single winding 21000v @ 100ma.....
Plate Pri 117 v 60cy Sec 6180 @.2A $14.75
Power Pair-Use two for FW 1900VCT @ .35 A Pri 117v 60 cy-3 taps Ea trans is cased 950 v NCT. Pair.....$10.00
Plate Trans 117 v 60 cy tapped Pri sec 2000 or 2500 ea side @ 500 ma. Stancor. Limited quantity $35.50
Fil 5v3A 5v3A 5v3A 117 Pri.....$3.25
Fil 6.3@1A 6.3@1A 6.3@1A 117 Pri..... 2.45
Fil 6.3@1A 5@ 3A 5 @ 3A 117 Pri..... 2.75
Filament Trans Pri 220v50/60cy Sec. 5v 10 A 34000 volt insulation $26.50
Filament Trans 29000v test Pri 115 60cy Sec two 5v@5A Raytheon $24.50
2 KVA Trans and Choke 115v 50/60 cy 1 ph Output 17000 v @ 144 ma $74.50
2.5 KVA Amertran rectifier-Input 208 v 3 ph 50/60 cy Out 0-25000 v @ .1 A 10% Reg 2.5% Ripple .....

REACTORS

GE 0.116 HY @ 0.15A Res 5.5 ohms.....$7.50
Raytheon 0.1 Hy @ 1.4 A Test 1780v 1.50
6 Hy 0.15 A Herm sealed..... 2.00
Capacitor Unit GE #69G443..... 4.95
Capacitor Trans GE #68G366LX..... 3.00
ITE CIRCUIT BKR 600v 60 cy 115A.....12.50

OIL CONDENSERS

15 mf 220 AC 660 v DC... 1.75
5-5 mf 400 DC 1.05
.1-.1 mf 7000 DC..... 2.00
Lots of 50 ..... 1.50
10 mf 600 DC 1.10
1 mf 1000 DC ..... .75
2 mf 1000 DC ..... .89
4 mf 1000 DC 1.00
10 mfd 1000 VDC 1.40
2 mf 660 AC ..... .85
1 mf 3000 DC 4.95
1 mf 7500 DC 12.50
10 mf 1000 DC 2.00
.01 mf 25 KVDC 20.00
.25 mf 20 KVDC 17.50
10. mf 25 KVDC 75.00
.06 mf 15,000 v DC 10.00
.1 mf 10,000 v DC 10.00

ELECTROLYTICS

200 mf 250 v 2.00
4000 mf 30 v 2.50

MICAS

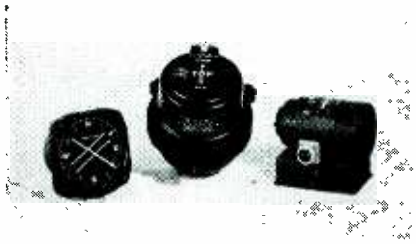
.006 mf 10000 v Sangamo G3 ..... 17.50
.00015 mf 20000 v G4 ..... 25.00
.002 mf 20000 v G4 ..... 25.00
.00 mf 15000 v G4 ..... 20.00
.002 mf 6000 v G1 ..... 10.00
.005 mf 15000 v G4 ..... 20.00
Decade Resistance Box. Two circuit 0-1250 ohms in 250 ohm steps 3" x 4" x 6"..... $2.00

NOW AVAILABLE A varied supply of telephone equipment including Switchboards, Repeaters, etc. Western Electric, Kellogg, and Stromberg Carlson Components

Mail order promptly filled. All prices: F. O. B. New York City
Send Money Order or Check. Rated firms send P. O. Shipping charges only sent C. O. D.
Send for our latest microwave flyer, also our complete parts catalog.

COMMUNICATIONS EQUIPMENT CO.
131 E. LIBERTY STREET NEW YORK CITY 7, N. Y.
Telephone Digby 9-4124

Remote Indicating Compass System —Kollsman AN-5730 Indicator and AN5730 Transmitter with Pioneer Inverter. Ideal for Marine use.



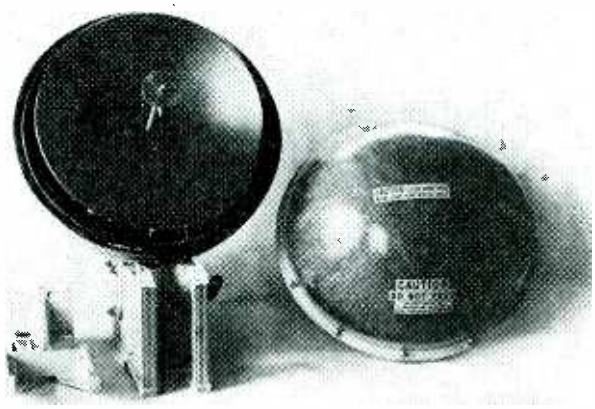
Price—$19.50 per system for 24 v DC operation, $5.00 extra for 12 volt.

Navy Ordnance Synchros
Army Ordnance Synchros
Servo Amplifiers
Torque Units
Precision Autosyns
Magnesyns
Sine-Cosine Generators
Inverters

Radio Compass Loop. Type LP-21-LM. Motor driven and electrically shielded, enclosed in zeppelin Type housin. Contains Autosyn transmitter to drive indicator.

Used with SCR-269-G and ARN-7 Radio Compass. Price—$14.50 each net. Special prices in quantities.

Micro Wave Antenna



AS-217A/APG-15B

10 centimeter dipole and 13 inch parabola housed in 16 inch weather-proof Radome with 24 v DC constant speed motor. Parabola rotates in elliptical pattern for conical scan. Price $12.50 each net. Export packed. Special prices in quantities. See Photo at left.

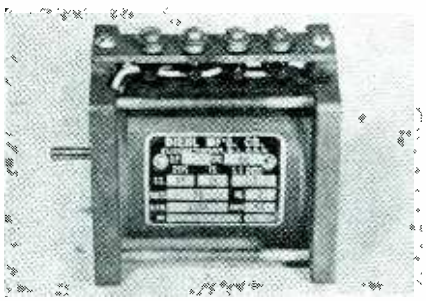
Synchronous Motor—Eastern Air Devices J-33. 3 phase 115 volt 400 cy. Price $6.75 each net. Qty prices on request.

Servo Motor—Pioneer CK-2. 2 phase, 400 cycle, Low-inertia. Price $12.50 ea.

Reversible AC Motor—0.001 h.p. Barber Colman ByAe451-1, Reversed by shorting either of two shaded pole windings. Price $3.75 ea.

Magnetic Amplifier Ass'y.—Saturable core output transformer—Operates from 6SN7 to supply one phase of 400 cycle motor. (See P125 Sept. '47 Electronics.) Price $6.75 ea.

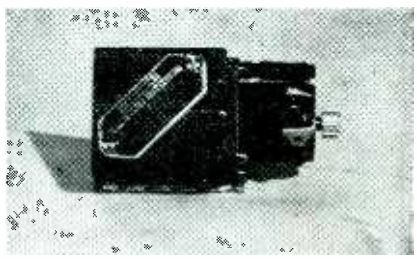
Servo Motor—Diehl Type FP-25-3 2 phase induction motor—20 volts 60 cy. each phase.



Price—$8.50 each net, $6.50 each net in lots of 100 or more.

DC Motors
AC Motors
Reversible Motors
Servo Motors
AC Rate Generators
DC Rate Generators
Position Transmitters

10,000 RPM DC Motor. Delco Type 5069466. Permanent Magnet Type.



Price—$3.75 each net, $2.75 each in lots of 100 or more.

Write or call for complete listing.

SERVO-TEK PRODUCTS CO.

INCORPORATED

Surplus Division

Open account shipments to rated concerns, others may order C.O.D.

247 CROOKS AVE. — ARmory 4-2677 — CLIFTON, N. J.

BIAS TRANSFORMER
110 V—60 cycles
120-0-120 v. at 50 ma.
4¼"X3½"X3½" Wgt. 3 lbs..... **.98**

R·H·S
SPECIALS OF THE MONTH

JOHNSON #234 Socket
For 705A, 715A, 715B, WE5D21, Raytheon RK72, RKR72 ..... **.98**

SELENIUM RECTIFIERS
Full Wave Bridge Type

INPUT	OUTPUT	
up to 18v A.C.	up to 12v D.C 1 Amp.	$1.95
up to 18v A.C.	up to 12v D.C 5 Amp.	4.45
up to 18v A.C.	up to 12v D.C 10 Amp.	7.45
up to 18v A.C.	up to 12v D.C 15 Amp.	9.95
up to 18v A.C.	up to 12v D.C 30 Amp.	14.95
up to 36v A.C.	up to 28v D.C 1 Amp.	3.45
up to 36v A.C.	up to 28v D.C 5 Amp.	7.45
up to 36v A.C.	up to 28v D.C 10 Amp.	12.45
up to 36v A.C.	up to 28v D.C 15 Amp.	18.95
up to 115v A.C.	up to 100v D.C .25 Amp.	2.95
up to 115v A.C.	up to 100v D.C .6 Amp.	6.05
up to 115v A.C.	up to 100v D.C 5 Amp.	19.95

HALF WAVE TYPE

up to 196v A.C.	up to 150v D.C .075 Amp.	1.95
up to 395v A.C.	up to 350v D.C .075 Amp.	2.95
up to 396v A.C.	up to 330v D.C .110 Amp.	3.95

OIL CONDENSERS:
G.E., AEROVOX, CD., ETC.
ALL RATINGS, D.C.

1mfd.	600v..	$0.35	2mfd. 2000v..	$1.75
2mfd.	600v..	.35	3mfd. 2000v..	2.75
4mfd.	600v..	.60	4mfd. 2000v..	3.75
8mfd.	600v..	1.10	15mfd. 2000v..	4.95
10mfd.	600v..	1.15	.1mfd. 2500v..	1.25
1mfd.	1000v..	.60	.25mfd. 2500v..	1.45
2mfd.	1000v..	.70	.5mfd. 2500v..	1.75
4mfd.	1000v..	.95	.05mfd. 3000v..	1.95
8mfd.	1000v..	1.95	.1mfd. 3000v..	2.25
10mfd.	1000v..	2.10	.25mfd. 3000v..	2.65
15mfd.	1000v..	2.25	.5mfd. 3000v..	2.85
20mfd.	1000v..	2.95	1mfd. 3000v..	3.50
24mfd.	1500v..	6.95	12mfd. 3000v..	6.95
.25mfd.	2000v..	1.05	2mfd. 4000v..	5.95
.5mfd.	2000v..	1.15	1mfd. 5000v..	4.95
1mfd.	2000v..	.95	.1mfd. 7000v..	2.95

SPECIAL 2 mfd. 3000v $4.45

HIGH CAPACITY CONDENSERS

4000 mfd.—18WVDC..... $1.95
4000 mfd.—30WVDC..... 2.95
1000 mfd.—15WVDC..... .99
2000 mfd.—50WVDC..... 1.95

BC-348 RECEIVER

Built for continuous duty, this band switching, six band receiver with a freq. range of 200 to 500 kc. and complete 1500 kc. to 18,000 kc. Has automatic noise compensator—constant sensitivity on all bands—output at 300 or 4000 ohms—xtal filter AVC-MVC-BFO; Smooth vernier tuning; 90 turns of tuning for each band. Complete with built-in dynamotor for 28v DC. 8 tubes. Conversion instructions and schematics. Wonderful buy at..... **$49.50**

Conversion kit for 110v-60 cyc. operation, complete $7.50

GIBSON GIRL TRANSMITTER
(SCR-578B)

Emergency life transmitter. 100% complete; includes balloon, hydrogen generator, kite, signal lamp, antenna and instruction manual. Self-powered merely by turning crank. Automatically transmits S.O.S. on 500 cycles.
FULLY GUARANTEED **$29.95**

PORTABLE FM TRANSMITTER
(Sonobuoy)

Operates on standard 67½v Minimac and 1½v Flashlight cells. Frequency 72 mc (easily doubled to 144 mc). Complete with 5 tubes and diagram. (Less batteries)
EXCEPTIONAL BUY at **$12.95**

DYNAMOTORS

Ideal for Mobile
Input: 6 or 12 volts
Output: 500VDC at 160 ma Volt. Regulated & Filtered.
PE-103 (slightly used)...$5.95

Input: 24-28 volts
Output: 150 VDC at 10 ma: 14.5 VDC at 5 amps. Voltage Regulated and Filtered. DA-3A (slightly used) $4.95

PERMALLOY SHIELDS
for
CATHODE RAY TUBES

3" Shield.....$1.49
5" Shield..... 1.98

TUBES (*Brand New*)
Army-Navy Inspected

1B24	$13.95	311.....	$ 5.95
2AP1...	2.25	371B...	5.95
2C40....	2.79	450TH..	44.50
2D21...	1.49	703A....	7.95
2V3G...	1.25	705A....	4.95
2X2	.84	715B....	4.95
3AP1...	3.00	721A....	4.95
3BP1...	2.95	726/AC.	7.50
3E29...	2.95	801.....	1.75
5BP1...	3.95	202.....	1.75
5BP4...	4.95	803.....	8.95
5CP1...	3.95	804.....	9.95
5JP1....	19.95	805.....	3.75
5LP1....	19.95	806.....	14.95
5R4GY..	.98	807.....	.95
5Y3....	.59	808.....	2.95
6AB7...	.99	809.....	1.50
6AC7 ...	.99	810	5.95
6AG5...	.99	811.....	1.95
6AG7...	.99	812.....	3.95
6AJ5...	1.89	812H...	6.95
6AK5...	.90	813	8.95
6AL5...	.99	814.....	4.45
6AR6...	1.29	815.....	3.95
6B4G...	1.29	826.....	2.25
6C4.....	.69	829-A-B.	3.00
6C5.....	.49	832.....	2.25
6F6.....	.89	833A...	34.50
6F6G...	.59	834.....	2.95
6J4.....	1.50	835.....	2.95
6J5.....	.59	836.....	1.75
6J6.....	.89	837.....	2.50
6L6.....	1.25	838.....	3.75
6L7.....	.98	841.....	1.20
6N7.....	1.39	861.....	89.95
6SH7...	.59	866.....	.99
6SL7...	.89	872A...	2.50
6SN7...	.69	884.....	1.10
6SR7...	.89	885.....	1.10
7A4....	.95	902.....	2.25
7F7....	1.25	913.....	3.00
7L7....	1.59	954.....	.75
9JP1...	14.95	955.....	.75
10Y....	1.50	956.....	.75
12X3...	1.50	957.....	.75
15E....	1.50	958.....	.75
HK24..	1.75	959.....	.75
28D7...	.75	1005....	1.98
30.....	.75	1616....	2.95
35T/TG.	3.50	1619....	.75
VR90...	.75	1624....	.90
VR105..	.75	1625....	.75
VR150..	.75	1626....	.75
100TH..	7.95	8001....	8.95
100TS..	3.00	8003....	9.95
211.....	1.25	8005....	4.95
75T.....	2.95	8011....	3.75
250TH..	14.95	8016....	1.65
257B...	14.95	8025A...	3.95
304TH..	9.95	1654....	1.98

SCR-522 100-156 MC.
RECEIVER AND TRANSMITTER
Licensed for Railway and Taxicab Use

The ideal all-purpose transmitter-receiver for work in the 100-156 mc. spectrum. Four channel pushbutton operation, crystal-controlled, AM, phone, mobile or fixed station service. Ideal for amateur, aircraft, marine, railroad, taxicabs, police and experimental. Amplitude modulated—High transmitter output. Receiver has 10 tubes and transmitter has 7 tubes including two 832's. 60 cycle operation. Complete conversion instructions and schematic furnished with each unit. Tube complement 2—832; 3—12A6; 1—6G6; 2—6557; 1—12J5GT; 1—12C8; 1—9002; 3—9003; 1—12AH7GT and 3—12SG7.
Complete with tubes **$14.95**

ART/13 MODULATION KIT

Consists of driver, speech amplifier, sidetone amplifier assembly and modulation transformer. With complete diagram for the famous ART/13 transmitter.
SUPER BUY at **$8.95**

TRANSFORMERS—115 v. 60 cyc.
HI-VOLTAGE INSULATION

1600v at 4ma; 700v at 150ma; 6.3v at 8A.	$8.50
3710v at 4ma; 2 X 2.5v at 3A.	9.95
2500v at 10ma	6.50
2150v at 15ma	6.50
1750v at 4ma; 6.3v at 3A	7.95
1540v at 4ma; 340-0340 at 240ma	7.50
550-0-550v at 150ma; 5v at 3A; 2 X 6.3 5A	7.95
500-0-500v at 100ma; 5v ct at 3A	4.95
442-0-442v at 1000ma	9.95
425-0-425v at 150 ma; 6.3v at 7.5A; 6.3v at 3A; 5v at 3A	5.95
400-0-400v at 200 ma; 5v at 3A	4.95
350-0-350v at 150ma; 6.3v at 6A; 5v at 3A; 7&8v at 1A	4.95
350-0-350v at 35ma-XLNT for VOLT-DOUBLER	1.49
300-0-300v at 65ma; 2X 5v at 2A; 6.3v at 2½A; 6.3v at 1A	3.49
325-0-325v at 120ma; 10v at 5A; 6.3v at 7A	3.49
350-0-350v at 85ma; 2X 5v at 2A; 6.3v at .6A; 6.3v at 3.75A	7.50
250-0-250v at 100ma; 2X 6.3 at 4A; 6.3 at 5A; 6.3v at 1A	4.95
2.5v at 2A; 5v at 3A	2.95
2.5v at 10A	3.25
5v at 115A	9.95
5v at 190A	17.50
6.3v at 6.6A	3.25
6.3v at 3.1A	1.95
6.3v at 21.5A; 6.3v at 2A; 2.5v at 2A	6.95
1600 V @ 2 Ma; 2.5 V @ 1.75A; 6.3 @ .6A	9.95

FILTER CHOKES
HI-VOLTAGE INSULATION

4 Hy at 250ma..	$1.98	12 Hy at 300ma..	$3.95
10 Hy at 250ma..	2.49	15 Hy at 100ma..	2.95
10 Hy at 400ma..	4.95	15 Hy at 125ma..	3.25
12 Hy at 100ma..	2.95	30 Hy at 70ma..	1.95
4 Hy at 600ma..	5.95	.1 Hy at 5 Amps	6.95
10 Hy at 200ma..	1.98	15 Hy at 75ma..	1.49
200 Hy at 12ma..	1.39	10/20 Hy at 85ma.	1.95

BLOWER

Hi-air blast, designed for transmitting tube service. Motor operates on 100-125v 60 cycle at 7000 RPM. Noise free with self contained chokes and filters. Enclosed in satin finish, aluminum cabinet. Measures 4" high x 2¾x3¼". Many uses.
Super buy at **$5.95**

ALL PRICES SUBJECT TO CHANGE WITHOUT NOTICE

All merchandise guaranteed. Mail orders promptly filled.
All prices F.O.B. New York City. Send money order or check.
Shipping charges sent C.O.D. Minimum order $5.00.

RADIO HAM SHACK Inc.
63 DEY STREET • NEW YORK 7, N. Y.

ATTENTION!
INDUSTRIALS—LABS—SCHOOLS — AMATEURS

Let us quote on components and equipment that you require. We have too many items to be listed on this page. Place your name on our mailing list now for new catalog.

SPECIALIZED ELECTRONIC MATERIAL

IMMEDIATE SHIPMENT—
HIGH QUALITY—LOW PRICE

TUBES

Type	Price
50	$ .95
VR90	.55
VR105	.55
6Y6	.55
807	.95
836	.75
866A	.95
3D6/1299	.75
28D7	.75
3A4	.35
3Q4	.45
1L4	.40
6SL7	.55
12SL7	.65
12SN7	.45
3B2H	.95
ELC5B	.95
RK72	1.65
RK73	1.95
724A/B	1.95
724B	1.25
1R4/1294	.65
7F7	.65
7F8	.65
7N7	.65
12SF5	.45
12A6	.35
1626	.45
1629	.45
1631	.45
1632	.35
1633	.45
1644	.85
3FP	1.95
5FP7	2.95

CONDENSERS

Oil filled in rectangular metal case

15 mfd.	100 volts sprague suitable for 300 W. V.	Price .45
4 mfd.	600 W. V.	.60
2 mfd.	600 W. V.	.35
1 mfd.	600 W. V.	.25
1 mfd.	400 W. V.	.20
1 mfd.	200 W. V.	.15
1 mfd.	1000 W. V.	.35
.01 mfd.	12000 W. V.	1.95
.1 mfd.	2000 W. V.	.55
.1 mfd.	7500 W. V.	1.55
.1 mfd.	12000 W. V.	2.25
1 mfd.	330 VAC	.25
4 mfd.	330 VAC	.25
2 10–260 mfd.	125 VAC (13/4" dia. 4")	.95
400–450 mfd.	110 VAC 2" dia. x 4"	1.65
90 mfd.	45 VAC 2" dia. x 3"	.35

CAPACITORS

Paper tubular dual	.015 at 1500 V	Price 8.50/C
Paper tubular dual	.02 at 1600	.10ea
Paper tubular dual	.0002 at 600	25.00/M
Paper tubular dual	.004 at 400	27.50/M
Paper tubular dual	.007 at 400	29.50/M
Paper tubular dual	.008 at 400	29.50/M

Multi-tap transformer 105-115 volts 25-60 cycles secondary voltages tapped from ½ to 75 volts. Price $1.95

Vibrator Transformer For auto radio or mobile transmitter primary 6 or 12 volts with links secondary 400 V C.T. at 150 Ma. ..... Price $1.25

Magnetron Filament Transformer, Pr. 115 V 60 cycles. Sec. 6.3 V. at 1 amp 2.5 at 1.75 amps Primary insulated for 7500 V. ..... Price $1.25

Ferranti Interstage Transformer, 60 to 9000 cycles 1 ldb Impedance ratio 2500 to 25000 or 10000 to 100000. Primary inductance 133 hys. at 0° DC. Humbucking construction, electrostatic shield. Price .75

Power supply for television or Oscilloscope will deliver better than 2000 volts filtered D.C. at 1 Ma. Price $7.85.

Complete with tubes and rectifier extra for 110 volt D.C. ..... Price $8.85

Tuned Reactor Inductance variable from 8 to 1.2 hys. resistance 40 ohms encased in powdered core and copper container. ..... Price .95

Timer—Adjustable 0-30 seconds 110 volts AC 50/60 cycles. Consists of: 1 Cramer timer motor, 2 Clutch —actuating relay 100 volts AC, 3 S.P.D.T. actuated timing switch contact rated at 10 amps. .$9.95

Voltage Regulator 12-15 V—Leece-Neville. ..$1.25

Circuit Breaker—Klixon 50A DC—Thermal type .35

Counter—Veeder Root—0-999 ..... .75

Instrument Case—black leather—felt lined with handle and snap lock. Size 4x7⅜x4¾ $1.75

Filter element—skinner 27417 ..... .15

Toggle Switch—bat handle, triple pole, double throw rating ½ HP, 1, 2, or 3 phases, 115-875 volts AC ..... .35

Coils—Air Wound—Barber and Williamson. Suitable for use on medium power transmitter. #20 silver plated copper wire. Length 3½" with 10 tap. Can be used from 5 to 80 meter bands. .. .65

Barrier Block Westinghouse 8 Dual terminals suitable for high voltage. Size 1⅞x6⅜x1½ ..... .45

Power Rheostat. 1EC 25 ohm with switch, 25 watt rating ..... .35

Line Adjusting Transformer Input 198 to 242 volts —60 cycles, 5 taps. Output 220 volts at 15 amps W.E. ..... Price $4.95

Audio Interstage Transformer single plate to single grid ..... .45

P.P. plate to any P.P. class grid ..... .85

Balanced line to P.P. grid ..... .85

Transceiver—mile to grid and plate to grid .. .85

Trimmers Dual Ceramic (30 mmfd) ..... .10

Gauge 2" oil 0-50 lbs. ..... .65

Gauge Oil—300 lbs. ..... .95

Vacuum—Pressure Gauge 7# ..... .65

Dial Drive ¼" shaft ..... Price 35.00/M

Dial Pointers (Slide Rule Dial) in 3" colors (red, white, black) ..... Price 35.00/M

Pilot light sockets

Bayonet type—grounded frame 5.50/C

Bayonet type insulated frame 6.50/C

Jewel light sockets (Drake #50 type) ..... .12 ea.

Write for a descriptive catalogue listing a very large variety of radio and electronic parts.

RELAYS

DESCRIPTION	PRICE
Allied 30 ohm. Operate on 9 volts DC	$ .45
Allied TYPE BNXI. Six pole double throw. Heavy contacts 24 volts DC 175 ohms.	.75
4 Pole single throw. 3 normally open 1 normally closed, 400 ohm resistance.	.65
Kurman type 509. DP. 115 Volts 60 cycles. ..	.95
G. E., CR279 two circuit coil 10 volts contacts 50/20 Amps 115 Volt AC.	.75
Allied BOH XII. Hermatically sealed DP DT Heavy contacts 110 volts DC 500 ohms.	.75
Price Bros. TYPE 36A DP DT 110 Volts AC 60 cycles. Dust Proof cased.	1.45
S. P. S. T. with red-black indicator plug 7.5-12.5 volts DC 60 ohms.	.45
Allied K2301 4 Pole D.T.—Heavy contacts 115 Volts DC 5000 ohms Dust Proof Cased..	.95
G. E. D107F 36 D. P. D. T. RF Antenna Change over type isolantete insulation 6 Volts DC 28 ohms	.95
Allied ANJ33 Single circuit normally open very heavy contacts 24 volt DC 200 ohms.	.65
G. E. two circuit 9-15 Volts DC 50 ohms.	.45
Price Bros. type TB-302 miniature isolantete spacers 24 volts DC 300 ohms.	.65
G. E. type B100J42 Three pole DT 7½-16½ Volts DC 75 ohms.	.75
Allied type DC 43 Three pole two throw Heavy Duty Contacts 24 Volts DC 250 ohms.	.75
Allied type BO13D35 two circuit heavy duty contacts 24 Volt DC 250 ohms.	.75
Ward Leonard Heavy Duty keying type 70 Volts DC 2000 ohms.	1.25
Allied type BOYX-20 Two Circuit Heavy contacts 12-24 Volts DC 130-260 ohms.	.75
Clare #814680—Miniature 4 Pole DT 24 UDC 300 ohms	.75
Vacuum Relay contacts rating 10 amps. Will break 3000 volts. Suitable for RF antenna Relay Solenoid resistance 200 volts. 24 volts D.C.	.95
Leach type 1054 DP. S.T. plus holding contact. Heavy contacts 20-28 D.C. 265 ohms..	.75
Allied type 15D35 DP. D.T. heavy contacts 240 ohms 20-28 volts D.C.	.75
Clare, miniature type, 3 pole, D.T., double contacts 24 volts D.C. 440 ohms.	.65
Clare 818062—Momentary two pole single throw 115 Volts A.C.	1.25
Telephone type 3 pole single throw normally open 1000 ohms	.65
Time Delay Relay—Thermal vacuum type S.P.S.T. 100 ohm coil—24 volt A.C. and D.C. Time 90 seconds.	.95

Plugs, P1 291 ..... Price 25.00/M

Varnished tubing and Vinelyte all sizes Price 10.00/M

Thermoswitch—Sperry Type Consists of microswitch, flat wound, 30 ohm heating element, heat expansion element, operating control. ..... Price .95

EDLIE ELECTRONIC INC.

135 LIBERTY ST. **NEW YORK 6, N. Y.** ***BArclay 7-4763***

"TAB"

• NEW GUARANTEED — That's A Buy — ELECTRONIC PARTS •

Precision Resistors
IRC, SHALLCROSS, WE MEPCO, INST. RES. CO., OHMITE FOR METERS BRIDGES, AMPLIFIERS

*½%	**5%	†10%	(REST 1%)
2000**	4300**	5100**	12000**
30000**	84000**	150000**	220000**
245000**	250000	950000	1155

ABOVE SIZES 30¢ each asstd.....10 for $1.98

1	2	2.07	3	4
5	10	11.55	20	25
30	70	100	120	150
165	200	220	260	300
400	500	550	850	1100
1150	1200	1250	1500	1600
1800	1960	2000	2080	2142*
3000	4000	4300	4500	4900
5000	5025	6000	7000	7500
7950*	8000	9710	10000	12000
14000	15000*	17000	20000*	30000*
50000	75000	80000	84000	90000
95000	100000	13000	135000	147000

ABOVE SIZES EACH 45¢.....TEN for $3.00

166750	201000	229000	250000	254000
268000	294000	400000	402000	420000
425000	478000	500000	575000	600000
654000	700000	761300	800000	900000

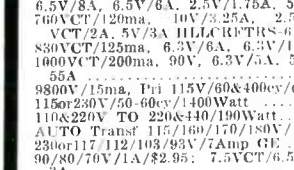
ABOVE SIZES EACH 60¢.....TEN FOR $5.00

950000	1MEG	1.2MEG	2MEG	2.855
3MEG	3.673	4MEG	5MEG	9.05MEG

10MEG 12.83MEG 90c ea.....TEN for $6.95

VICTOREEN VACUUM GLASS ENCLOSED PRECISION RESISTORS IN SIZES 0.83 to 12MEG ea 1.00
IRC Navy precision 1Meg ⅛of1% MF..... 1.69
IRC Navy precision 2Meg 1/5of1% Caged..... 4.95

TRANSFORMERS 115V/60cycles input:
15000V, 35ma/$15.95; 1200VCT; 300ma..... $5.95
500VCT/60ma, 6.3V/4A/$1.49; 1100VCT/212 ma 6.50
700VCT/120ma6.3V/2.4A, 5V/2A—$2.69..2 for 5.00
1350VCT/150ma, 6.3V/5A, 5V/2A cased UTC. 7.50
640VCT&1540V/250ma/$4.95 .....2 for 8.95
1100VCT/150ma, 6.3V/3A, 5V/3A HVins... 3.95
2500V/15ma/$5; 5V/115A, Kenyon..... 7.95
1000VCT/110ma, 6.3V/5A, 5V/3A, 4x6.3V/.65 4.25
1000V/45ma, 795VCT/80ma, 3x5V/3A, 6.3VCT/1A 6.3V/.3A Hmtelly cased HVinsltd..... 7.95
772V/2.5ma, 2.5V/3A/$3.95; 1230V/262ma... 5.98
3200VCT/200ma, 780VCT/200ma, 12VCT/.5A. 12.95
6.3/4A, 6.3VCT/1A/$2.49; 2100V/10ma..... 3.95
7.5VCT/6.5A, 6.3VCT/3A/$3.75; 10V/8A/12.5KVins 6.95
2x5V/8A/12.5KVins/$6.95; 6.3V/6A, 5V/4A &8A 3.95
300VCT/150ma, 6.3V/2.5A, 6.3V/.6A..... 3.00
1000VCT/250ma/$4.25; 30V/4A 3.25
6.5V/8A, 6.5V/6A, 2.5V/1.75A, 5V/3A..... 3.00
760VCT/120ma, 10V/3.25A, 2.5V/10A, 6.3 VCT/2A, 5V/3A HLLCRETRS-610/HVinsltd. 5.95
830VCT/125ma, 6.3V/6A, 6.3V/1A, 5V/3A.. 3.95
1000VCT/200ma, 90V, 6.3V/5A, 5V/6A, 18V/55A 4.75
9800V/15ma, Pri 115V/60&400cy/csd oil..... 7.95
115or230V/50-60cy/1400Watt 14.95
110&220V TO 220&440/190Watt..... 4.50
AUTO Transf 115/160/170/180V/1.95A..... 2.95
230or117/112/103/93V/7Amp GE 12.95
90/80/70V/1A/$2.95; 7.5VCT/6.5A, 6.3VCT/3A 3.75
7.5V/12A/HV $2.95; 10.4V/5A..... 3.95
5V/20A/Pri 220V/6.95; 2.5V/10A/Pri 220V... 3.95
Universal Vibrator Transf 6-12-24-115VDC 115/230VAC/50-60cy, 420VCT/60ma, 6.3V/2A... 1.95
TELEVISION Pulse Transf GE..... 1.49
MODULATION Transf PPparalle16L6's-807's to RF 807's/2000ohm load-cased..... 2.95
CHOKE 20hy/100ma;98¢; 50Hy/150ma..... 1.49
CHOKE Swining 15-29Hys/150ma..... 2.95
12Hy/300ma/$2.95; 12Hy/500ma/95ohm..... 9.95
15Hy/400ma or 20Hy/300ma/15Kvins..... 7.95
3Hy/40ma/3for$1; 0.5Hy/100ma.....4 for .98
3Hy/400ma/15/$2.75; 8Hy/200ma.....2 for 2.89
8Hy/150ma new UTC; Cracked Bkite T'Bd.... .89
UTC LVM11/30Watt Autoformer UTC..... 2.95
SEND "TAB" UR XMAS RADIO NEEDS
C"TAB FOR OIL CONDENSERS
Test Set Supreme 542 VOM/24ranges LN*.... 15.95
Test Set Triumph 324 ACDC/VOM/10ranges.. 10.95
TS Same as WESTON 697 VOM & Case..... 20.95



AUTOSYNS TYPE 5 NEW 115 v/60 cy Bendix, Hobart, etc. per pair $18

KIT RESISTORS BT½&1W 50to2megs.100 for $2.50
KIT CONTROLS 50-2Megs Pots ASS'T..10 for 2.50
KIT SILVER & MICA CONDENSERS.50 for 2.00
KIT LUGS RADIO TYPE ASSTD....500 for 1.00
KIT FUSES ASSTD LITTLE FUSE...300 for 1.95
KIT GROMMETS RADIO TYPE.....100 for 1.00
KIT SOCKETS OCTAL/LOCTAL etc...50 for 2.95
KIT G&P tube caps ¼, 3-8, 9-16".....50 for 2.95

RODINE REDUCTION MOTOR 115VDC/29-RPM $4.95
GE MOTOR 220VAC/1PH/One-Third HP..... 10.95
HEADPHONES HS30/98cea, 2 sets..... 1.65
Dynamic mike or speaker..... .98
MIKE WE push to talk & plug..... .98
Dynamic Mike WE D141924..... 2.49

STORAGE BATTERY 2Volt non-spill.....$1.98
ACID 1250 Sp Gravity 95oz (1gal pckg)..... 1.49
EXT CORD HVI DUTY 16' M&F plug..... 1.00
WE Dynamic microphone & 20ft cord..... 7.95
AUDIO BAND pass filter 60,90,150cy totally encased child'd each $1.95.....3 for 4.50
METER RECTIFIER dual bridge..... .98

TUBE TESTER 504 SUPREME.....$69.50
TUBE TESTER & VOM RADIO CITY 803 LN* 59.50
TELEPHONE SWITCHBOARD BD52..... 8.95
TG10/20Watt 6L6 Amplifier & Cabinet..... 19.95
TS26 TELEPHONE TEST SET..... 18.95
NATIONAL RBL-2/15to635KC Rcvr..... 45.00
CRYSTAL DIODE TEST SET 268U NEW..... 15.95
W.E. 125to250Watt multi-Ceellular NINE DRIVER TRUMPET Complete..... 125.00
REFLEX Reentrant Trumpet projector 35to55 Watts with W.E. head complete..... 29.95
WE DRIVER PM heads 25to55Watt waterproof, blastproof $12.95@.....2 for 21.95
WE Diaphragms ES671349-3/PM..... 3.95
SPEAKERS PM 4" Alnik5/$1.30; 5"Size..... 1.45
Universal Tube to Voice coil Transf..... .98
BOX metal Navy 5½"H10L9-¾"W hdles..... 1.45
WSTGHSE OnemaMTR 3½"SqBkICsd..... 4.50
WST "DB" MTR 3½"SqBkICsd —10plus6DB 4.95
WSTGHSE AN 0-100&100-0-100micromtr..... 3.95
WSTGHSE same mtr less 0 adjustor..... 1.95
WSTGHSE & GE 0-150VAC/2½"B'Csd..... 3.50
GE RF Mtr 2½"B'C either 1or5Amp..... 3.95
GE DW54 Mtr —10plus6DB 2½"Cased..... 3.95
GE GALVO 3½" B'Csd 2.5&25ma.0 center.... 3.95
GE DW41 Mtr 2000V/10000ohmsV&Resists.... 5.95
GE A022 Mtr 50VAC&LAB STD 3½" B'C.... 3.00
GE A022 Mtr 0-150VAC 3½" B'C..... 4.95
WE 0-200V-AC/DC rect mtr 1000ohmsV..... 4.25
WESTON 476AC 150Voltmtr 3½"SqBkICsd... 4.95
WESTON 506mtr —10plus6DB 2½"B'Csd.... 4.50

WESTON 0-250ma 2½"BkICsd.....$ 3.25
MICROSWITCHES 2for39c.....TEN for 1.49
GAS GENERATOR 115VAC/1400W/27VDC /400W 100.00
PARABOLIC ANTENNA COMPLETE WITH MOTOR, DRIVES & Selsyn New 16.95
BLOWER AIR 100CFM/115V AC..... 5.95
BLOWER AIR 125CFM/115VAC/CSD.... 7.95
VOLTAGE REGULATOR RAYTHEON inpt taps 95-130V/60cy; outpt115V .58 Amps, CSD 0.5% regulation..... 10.95
VOLTAGE REGULATOR Relay Rack inpt adj taps 198to242V/50-60cy Outpt 220V/500 Watts;0.5%regulation rugged dsgn tropicalized New 29.95

HAYDON Sync Clock Motor 60cy/10V.....$ .98
EDISON TIME DELAY RELAY 115V/10Amp 1.49
CW3 RCVR new Complete & book..... 14.50
CW&FR Coils 5.1-10or9.4-16.5mc's..... 2.70
TEL 1F Strip 30mc's/8-6AK5&1-6AL5..... 9.49
CRYSTAL DIODES IN21 @50c...THREE for 1.25
CRYSTAL DIODES IN26 @$1....THREE for 2.00
CRYSTAL DIODES IN34 @$1.39...FIVE for 5.75
BC1073 XMTTER&RCVR. Siggen & wremtr, Cavity tuned 150-210mcs..... 24.95
BC 191 TRANSMITTER 19.95

X BAND WAVEMETER 9290-9470mc's..$16.95
723AB OSC MTG ON 3CM Waveguide & Attnutr outpt T section & Thermistor & crystal detector MTG & head Thermistor mount & 2nd attnutr. po/TS13..... 18.95
SAME MTG & X BAND WAVEMETER... 29.95
723AB OSC MTG & TRANSITION to 2 type N Coaxial fittings (RG9UorDbl silver braid) 4.95
3CM ECHO BOX & Crystal det mtg in ½x1 waveguide transition 5.95
TUNABLE 150-200 mc's line OSC 826PP.... 5.95
GR VARIAC 200B/Variable0-135V/60c/1A 9.95
SONAR QBE echoranging equipment....1000.00
SC-1 RADAR GE NEW IN TEN CASES 2000.00

GE Volts Control RELAY PJV*115V/60cy self reset, Calib 70/85/110/160V ($36).....$ 5.95
GE TEMP CONTROL 70to170°F/250V/25 amp(818) 3.95
FOXBORO GRAPHIC 115V/60c STRIP recorder 39.95
SCR522 RCVR & XMITTER 150-200mc's LN* 18.00
RCVR BC455A & Tubes ARC5 set..... 4.50
HANDHETALKIEBC611 Chass's Coils & Xtal 7.95
AUTOSYN AY-1&AY-5/24-28V/60&400C 3.95
HRO/&AS8 COMPLETE COILS, RACK&PWR 19-KC-30mc's, SPEAKER NAVY.....285.00

KIT RMA CARBON RESISTOR...100 for $1.00
STROBOFLASH CONDENSERS GE PYRANOL 4SECT/8mfd/660VAC/2000WV-DC 8.95
FOR TECH MANUALS S.C. WRITE "TAB"
C "TAB" FOR RADIO SETS & EXMAS ITEMS
WRITE FOR "TABOGRAM" & SPECIALS
"TAB" OPEN THURSDAYS TILL TEN PM

* * * * * * * * * * * *

$2 Min. order FOB N.Y.C. Add Postage all orders and 25% deposit. WOrth 2-7230. Send for catalog 99. Specialists in International Export, School, College & Industrial trade. Money Back "TAB" Guarantee.

"TAB" FOR TUBES

1E7G	$ .89	6F8	$1.26		
1L4	.98	6J4	1.45		
2A5	.54	6T5M	.55		
2X2	.83	6J6	.88		
2V3G	.75	6K7	.66		
3A4	.75	6K8	.81		
3S4	1.00	6L6	1.15		
5W4	.97	6SA7	.81		
5R4	.97	6SC7	.84		
5U4	.63	6SG7	.54		
5Y3	.41	6SJ7	.68		
5Z3	.55	6SL7	.87		
5Z4	.89	6SN7	.68	813	$5.95
6AB7	.89	6V6	.97	815	2.20
6AC7	.80	6X5	.75	836	1.47
6AG5	.97	30	.74	864	.60
6AG7	.90	80	.41	866A & S..	1.00
6AK5	.90	VR105	.74	872A & S..	2.75
6AL5	.81	VR150	.74	954	.50
6B4	1.25	12A6	1.00	955 & S....	.90
6B8G	.95	12SA7	.81	956 & S....	.90
6C4	.65	12SQ7	.90	957 & S....	.90
6C5	.48	35L6	.90	958A & S..	.90
6C8G	1.00	35Z5	.90	9002	.80
6E5	.69	50L6	.90	9004	.90
6F6	.85	807	.95	9006	.80
6F7	1.20	808	2.50	2050	.89

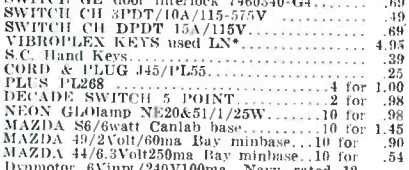
For Breakages & open filaments no guarantee.

2C26	$ .75	100TH	$5.7	6C6	$ .73
2C40	2.50	450TL	29.00	1613	.89
3B24	1.90	24G	1.50	1625	.65
703A	3.95	304TL	3.95	446A	2.50
RK60	.98	1291	.49	631P1/SN4	3.73
VT127A	2.95	1299	.49	3BP1 & S..	2.99
5BP4	3.95	5CP1	3.55	5AP1	3.55
1813-7BP7	7.90	826	2.23	5BP1	3.55
6AR6	1.28	954	100TS		2.95
6J7	.79	Five for $2.00		6H6	.58
829B/3E29	2.95	6G6	1.08	991	.39

* * * * * * * * * * * *

KEY CLICK FILTER RFC, RES, CDSRS....$ .29
CINCH miniature dual Xtal sockets.....8 for 1.00
CRYSTAL SOCKET 242 Holder 3 pins 3 for 1.00
Socket for 4Xtal holders ½" & 1" space....2 for .25
COLLINS ART/13 SPEECH AMPLIFIER.... 4.95
SAME WITH 3 Tubes (2/6V6&6SJ7)..... 7.49
SWITCH CH luminous tip SPDT.....4 for 1.00
SWITCH AH&H 60A/600V.250Amp/125V 1.00
SWITCH GE door interlock 7460340-G4..... .69
SWITCH CH 3PDT/10A/115-575V ..... .49
SWITCH CH DPDT 15A/115V..... .69
VIBROPLEX KEYS used LN*..... 4.95
S.C. Hand Keys..... .39
CORD & PLUG J45/P.L55..... .25
PLUS PL268.....4 for 1.00
DECADE SWITCH 5 POINT.....2 for .98
NEON GLOlamp NE20&51/1/25W.....10 for .98
MAZDA S6/6watt Canlab base.....10 for 1.45
MAZDA 49/2Volt/60ma Bay minbase...10 for .90
MAZDA 44/6.3Volt250ma Bay minbase...10 for .54
Dynmotor 6Vinpt/240V100ma, Navy rated 12-24Vinpt/500V/50ma PM hieff 3.49
Dynmtr 12-24Vinpt. 275V/110ma..... 1.95
Dynmtr 28V/1.4amp, outpt250V/80ma cont duty, operates 12V fields in parallel also 110VDC motor, Wgt 2lbs Contduty 1.85
Dynmtr DM-4, inpt 12-24V/225V/100ma & 440V/200ma, cont duty rugged dsgn..... 6.75
Dyn DA34,inpt28VDC/300VDC/260ma & 150V/10ma.14.5V/5amp Cont duty for Radio set SCR522, SPECIAL 3.85
Dynmtr PE-94A Bendix MG-1A, DC inpt 24-28V/Output300V/260ma,150V/10ma 14.5V/5A inpt & outpt filters,Voltage regulator & starting relays SPECIAL 9.95
Generator 430VDC/180ma Cont duty..... 8.95
BENDIX GYRO SERVO COMPLETE..... 4.95

866A's COMBINATION TRANSFORMER & SOCKET



CONSISTS OF TWO JAN NEW 866A TUBES, TRANSFORMER GARDNER ELEC. CASED 2.5V 10 AMP, 115V/60cy input, H.V. insltd 9000V wkg similar to illustrated unit; "TAB" Tested 16000 VAC Test; Same mtg as KENYON T389—SOCKETS CERAMIC JOHNSON 224.

"TAB" SPECIAL $5.95

TRANSFORMER ONLY for Two 866A's.....$ 3.95
872A's COMBINATION TRANSF. sockets..... 12.00
872A TRANSFORMER 115 60cy..... 6.95

"TAB" • Dept. 10E, Six Church Street, New York 6, N. Y., U.S.A. • "TAB"
THAT'S A BUY • • • CORNER CHURCH & LIBERTY STS., ROOM 200 • • • THAT'S A BUY

RELIANCE SPECIALS

I.F.F. RADAR TRANSMITTER—Belmont BC 1072 A, operates on 115 V, 60 cy., 150 to 200 mcs. Contains Blower 115 V, 60 cy., 28 watts, 1525 R.P.M.; variac; 11 tubes; oil filled condensers; 3½" meter 0-5 kilovolt & 0-10 M.A. D.C.; 15A circuit breaker; 3 transformers 3500 V, 700 V, 300 V all 115 V pri; relays; switches; metal case 18" x 20" x 17½"; wooden chest. Shipping wt. 245 lbs. Used. $22.50

PRECISION RESISTOR—522,000 ohms ½% accuracy, 1 watt .....18¢

BALL BEARING—Fafnir 33K5, 3/16" hole, ½" O.D. .....25¢

BALL BEARING—Fafnir S1KDD7, ¼" hole, ⅝" O.D. .....35¢

ALLEN HEAD SET SCREWS

2-56 x 1/16"	4-40 x ¼"	8-32 x ⅛"
4-40 x ⅛"	6-32 x ⅛"	8-32 x 3/16"
4-40 x 3/16"	6-32 x 3/16"	8-32 x ¼"

All sizes $1.50 per hundred

SELSYN DIFFERENTIAL MOTOR—115 V, 60 cy. Used as a dampener between a pair of Selsyn Transmitter Motors, or to indicate difference in degrees between a pair of Selsyns. Can be converted in 10 minutes to a free running motor 3600 R.P.M. Approx. 1/70 H.P. Conversion sheet supplied. Packed for overseas. $1.75

SELSYN MOTORS (TRANSMITTERS) for remote control. 115 V, 60 cy. .....$6.75 pair

SLIP RING ASSEMBLY—5 silver plated rings on molded bakelite rotor. Stator holds 2 silver carbon brushes for each ring. Rotor O.D. 3⅞". Hole in rotor fits 1¾" shaft. Complete with brushes...$2.00

BRASS BINDING POST-EBY—Chrome Plated with 8-32 screw

Push Down Type $2.75 per 100
Screw Down Type 2.50 per 100

CHROMALUX STRIP HEATER—115 V, 750 watt, semi-circular 20" x 1½".....75¢

MICRO SWITCH—Push Button Type, normally open circuit, 45¢ each, 10 for $4.00

HIGH VOLTAGE POWER TRANSFORMER—Westinghouse U.S.N. #CAY-30741-A oil filled; pri. .105-115-125 V, 54 to 66 cy.; Sec. 18,000 V at 15 mils; 15,000 V at 20 mils; 2½ V at 5A. (Can be used in a precipitron.) $30.00

TRANSFORMER—115 V, 60 cy., Sec. 6.3 V at 60 mils, center tapped .....$.65

STEEL JUNCTION BOX—Watertight, 14 ga. steel 17" x 25" x 6½". Brass screw type hinges on lid. Approx. 50 lbs. $2.75

G. E. MOTOR—1/6 H.P., 250 V D.C. on armature; 60 V D.C. on field; 1140 R.P.M.; shunt wound. $16.00

DYNAMOTOR—Input 27 V @ 1.4 A; output 255 V @ 60 mils. $1.35

CONDENSER—G.E. Pyranol .1-.1 mfd. 7000 V D.C. $1.50

CONDENSER—G.E. Pyranol .2 mfd. 10,000 V D.C. $1.95

POSTAGE STAMP MICAS

.01 mfd 300 V	.002 mfd 500 V
.001 mfd 500 V	.0012 mfd 400 V

All sizes $4.00 per hundred.
Many other sizes in stock.

MICRO-CRYSOLINE WAX — dark amber; melting temp. 165° F (similar to Sinclair Zercon A) 104 lb. block. .....3½¢ lb.

ACORN TUBE SOCKET—ceramic. 14¢ each. $11.00 per 100.

Inquire about our large selection of resistance wire.

F.O.B. PHILADELPHIA.
MINIMUM ORDER $3.00

Reliance Merchandizing Co.

Arch St., Cor. Croskey
Philadelphia 3, Pa.
Telephone RIttenhouse 6-4927

SELENIUM RECTIFIERS

FOR ALL APPLICATIONS

HALF WAVE TYPES*

Input	Output	Current	Price
From 0-18 V.A.C.	From 0-7 V.D.C.	3 AMP	$2.25
0-18 V.A.C	0-7 V.D.C.	5 AMP.	2.95
0-18 V.A.C.	0-7 V.D.C.	10 AMP.	4.95
0-18 V.A.C.	0-7 V.D.C.	15 AMP.	6.95
0-18 V.A.C.	0-7 V.D.C	20 AMP.	8.95
0-18 V.A.C.	0-7 V.D.C.	25 AMP.	10.95

Input	Output	Current	Price
From 0-36 V.A.C.	From 0-14 V.D.C.	3 AMP.	$2.95
0-36 V.A.C.	0-14 V.D.C.	5 AMP.	4.95
0-36 V.A.C.	0-14 V.D.C.	10 AMP.	7.95
0-36 V.A.C.	0-14 V.D.C.	15 AMP.	10.95
0-36 V.A.C.	0-14 V.D.C.	20 AMP.	13.95
0-36 V.A.C.	0-14 V.D.C.	25 AMP.	16.95

*USE with capacitor to obtain any voltage up to twice rated output.

FULL WAVE BRIDGE TYPES

Input	Output	Current	Price
From 0-18 V.A.C.	From 0-14 V.D.C.	5 AMP.	$4.95
0-18 V.A.C.	0-14 V.D.C.	10 AMP.	7.95
0-18 V.A.C.	0-14 V.D.C.	15 AMP.	10.95
0-18 V.A.C.	0-14 V.D.C.	20 AMP.	13.95
0-18 V.A.C.	0-14 V.D.C.	25 AMP.	16.95
0-18 V.A.C.	0-14 V.D.C.	30 AMP.	19.95

Input	Output	Current	Price
From 0-36 V.A.C.	From 0-28 V.D.C.	5 AMP.	$7.95
0-36 V.A.C.	0-28 V.D.C.	10 AMP.	13.95
0-36 V.A.C.	0-28 V.D.C.	15 AMP.	19.95
0-36 V.A.C.	0-28 V.D.C.	20 AMP.	25.95

It would be impossible to give a complete listing of all our rectifier types. Our engineering staff is at your service to help you work out the application of selenium rectifiers to your specific problems. Write us for quotations or further information on capacitors and transformers to be used in conjunction with Selenium Rectifiers.

25% Deposit required on all C.O.D.'s

Shipped via Railway Express, unless otherwise specified.

OPAD GREEN COMPANY

191 GREENWICH ST., Dept. 3
NEW YORK 7, N. Y.
Phone: BEEKMAN 3-7385

ROTARY CONVERTERS

DC to AC

One lot 325 units manufactured by Electric Specialty Company, Type R-182 with filter. Input—115 volt DC, 2.7 Amperes, 3600 R. P. M. Output—110 volt AC, 1.14 Amperes, 60 cycle 1 phase 125 VA. This unit is of the semi enclosed self-ventilated type.

Surplus New Equipment in Stock:

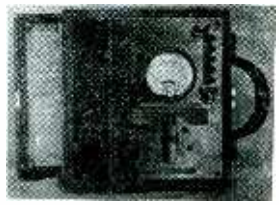
PILOT MARINE CORP.
29 Broadway New York 6, N. Y.
WHITEHALL 3-3734

SURPLUS TEST EQUIPMENT

LEEDS & NORTHRUP
5430A WHEATSTONE BRIDGE

For resistance measurements, Murray and Varley Loop Tests; Especially adapted for locating faults in communication circuits. Galvanometer of 1 megohm sensitivity. Portable oak case with batteries.
Unused ..$85.00

WESTON 663 VOLT-OHM-MILLIAMMETER

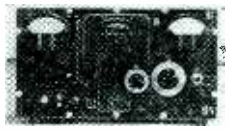


5 to 10,000,000 ohms in 6 ranges; 1 to 100 MA in 4 ranges; 2.5 to 1000 VDC in 5 ranges; 50 microamp movement. Oak carrying case. Complete with batteries and test leads.

New $29.49

G. R. TYPE 804C
UHF SIGNAL GENERATOR

7.5 to 330 MC Range in 5 bands; output continuously variable between 1 Microvolt and 20 Millivolts. Internal modulation at 1000 cycles; 115/230V. Manufactured by FED. Mfg. & Eng. Co., their type 804-CS1; Used. Excellent condition **$250.00**



VIBROTEST MEGOHMMETER—0-200 MEGOHM; COMPLETE WITH TEST LEADS AND BATTERIES. UNUSED **$35.00**

All equipment guaranteed. All or 20% with order balance C.O.D., F.O.B. New York City.

Standard Radio-Electrical Products

2507 White Plains Rd., New York 67, N. Y.
Dept. E.

IMPREGNATOR

FOR SALE

Barrett Centrifugal Impregnator 154-1 in original crates

Suitable for small wire wound coils or equivalent

STEVENS-ARNOLD, INC.
22 Elkins Street
So. Boston, Mass.

SHEET METAL MACHINERY

NEW and Used — Brakes — Shears
Forming Rolls — Folders — Punches — Di-Acro, Pexto, Niagara & Whitney Equipment

B. D. BROOKS CO., INC.
Han. 5226
361 Atlantic Ave., Boston, Mass.

TEST EQUIPMENT

General Radio, Measurements, Ferris Etc., used, 20 to 60 percent off. Surplus Selsyn Generators, Etc. Send for List.

VILLAGE RADIO EQUIPMENT
201 West 16 Street New York City

CoAx CABLE

RG 7U-5c, 8U-5c, 58U-3½c, 62U-4c

HAROLD H. POWELL
3512 Spring Garden St., Phila. 4, Pa.

IMITATED...NOT DUPLICATED

K-TRAN is a completely new type of i.f. Transformer—completely new thinking crystallized into completely new design. Permeability tuning, magnetically shielded winding, permanently fixed and uniform capacity coupling and a host of details of design perfection result in available performance superior to any other i.f. Transformer.

K-TRAN already has many imitations—but K-TRAN, unlike its imitations, is not an antiquated type of transformer disguised with a modern exterior. K-TRAN is new inside —where it counts.

K-TRAN alone can equal or exceed the performance of any existing i.f. Transformer in less space and at less cost.

Use K-TRANS! Your competition does.

Design your chassis to use K-TRAN 262 KC, 455 KC, 10.7 MC

World's Leading Trimmer Manufacturer

AUTOMATIC MANUFACTURING CORPORATION

MASS PRODUCTION COILS & MICA TRIMMER CONDENSERS

900 PASSAIC AVE. EAST NEWARK, N. J.

INDEX TO ADVERTISERS

Acheson Colloids Corporation 63
Acro Electric Co. 186
Acton Co., Inc., H. W. 241
Adams & Westlake Co. 198
Advance Electric & Relay Co. 234
Aerovox Corporation 38
Aircraft Radio Corp. 26
All American Tool & Mfg. Co. 239
Allen Co., Inc., L. B. 263
Allen Mfg. Co. 236
Alliance Manufacturing Co. 47
American Electrical Heater Co. 214
American Lava Corporation 139
American Phenolic Corp. 196
American Relay & Controls, Inc. 168
American Rolling Mill Co. 46
American Screw Company 30
American Television & Radio Co. 218
American Time Products, Inc. 50
Amperex Electronic Corporation Inside Front Cover
Amperite Company 231
Anaconda Wire and Cable Co. 169
Andrew Co. 176
Arkwright Finishing Co. 164
Arnold Engineering Co. 13
Art Wire & Stamping Co. 253
Astatic Corporation 172
Audak Company 261
Audio Development Co. 180
Automatic Mfg. Corporation 282
Avimo, Ltd. 230

Baer Co., N. S. 238
Ballantine Laboratories, Inc. 154
Barker & Williamson 246
Belden Mfg. Co. 32A, 32B
Bell Telephone Laboratories 4, 5
Bendix Aviation Corp., Red Bank Div. 202
Bentley, Harris Mfg. Co. 27
Benwood-Linze Co. 264
Beta Electronics Co. 197
Blaw-Knox Co. 42
Bliley Electric Co. 31
Boonton Radio Corporation 137
Brach Mfg. Corp., L. S. 243
Bradley Laboratories, Inc. 241, 260
Brady Co., W. H. 251
Brook Electronics, Inc. 234
Brush Development Co. 56, 152, 206
Buck Engineering Co., Inc. 263
Bud Radio, Inc. 250
Burlington Instrument Co. 232
Burnell & Co. 192

Callite Tungsten Corporation 223
Cambridge Thermionic Corp. 250
Cannon Electric Development Co. 182
Capitol Radio Engineering Institute .. 242
Carborundum Co., Globar Div. 203
Carter Motor Co. 231
Central Television Contacts Lab. 263
Centralab, Div. of Globe-Union Inc. 14, 15, 29
Cherry Rivet Co. 191
Chicago Transformer, Div. of Essex Wire Corp. 57
Cinch Manufacturing Corporation 129
Clare & Co., C. P. 24, 25
Clark Crystal Co. 239
Clarostat Mfg. Co., Inc. 240
Cleveland Container Co. 252
Clippard Instrument Laboratory, Inc. 263
Cohn & Co., Sigmund 256
Concord Radio Corporation 227
Condenser Products Co. 70
Continental-Diamond Fibre Co. 31
Continental Electric Co. 246
Cook Laboratories 224, 255
Cornell-Dubilier Electric Corp. 151
Cornish Wire Company, Inc. 162
Corona Engineering Service 263
Coto-Coil Co., Inc. 76
Cross Co., H. 263

Dazor Mfg. Corp. 68
Dinion Coil Co., Inc. 226
Distillation Products, Inc. 195
Drake Electric Works, Inc. 245
Drake Mfg. Co. 214
Driver Co., W. B. 19
Driver-Harris Company 67
Dumont Electric Corp. 8
Dumont Laboratories, Inc., Allen B. .. 18
du Pont de Nemours & Co. (Inc.) E. I. 55

Eastern Air Devices, Inc. 28
Eisler Engineering Co., Inc. 259, 263
Eitel-McCullough, Inc. 75
Electric Indicator Co. 255
Electrical Insulation Co., Inc. 235
Electro Engineering Works 263
Electronic Measurements Co. 232
Electronics Research Publishing Co. .. 257
Electrons, Inc. 174
Erie Resistor Corporation 45
Essex Electronics 281

Fairchild Camera and Instrument Corp. 16, 201, 247
Federal Tel. & Radio Corp. 61, 155
Federal Tool & Mfg. Co. 247
Fenwal, Inc. 32
Formica Insulation Co. 177
Franklin Airloop Corporation 147

Gamewell Company, The 251
Gear Specialties 143
General Cement Mfg. Co. 263
General Ceramics & Steatite Corp. ... 52
General Electric Co.
Apparatus Dept. 58
Appliance & Merchandise Dept. 199
Chemical Dept. 43, 159
Electronics Department 33, 247
Lamp Dept. 213
General Industries Co. 266
General Magnetic Corporation 219
General Plate Div. of Metals & Controls Corp. 215
General Radio Co. 207
Goslin Electric and Mfg. Co. 253
Graphite Metallizing Corp. 235
Graybar Electric Co. 216
Guardian Electric Mfg. Co. 69

Hammarlund Mfg. Co., Inc. 6, 251
Hansen Manufacturing Co., Inc. 258
Hardwick, Hindle, Inc. 190
Harvey Radio Company, Inc. 222
Harvey Radio Laboratories, Inc. 141
Hathaway Instrument Co. 255
Haydon Manufacturing Co., Inc. 160
Heinemann Electric Co. 72
Heintz and Kaufman, Ltd. 17
Helipot Corporation 225
Hewlett-Packard Company 20
Hexacon Electric Co. 224
Holliston Mills, Inc. 259
Hudson Wire Co. 232
Hunt Corp. 188
Hytron Radio & Electronics Corp. 12

I-T-E Circuit Breaker Co., Resistor Div. 167
Imperial Tracing Cloth 212
Indiana Steel Products Co. 219
Instrument Electronics 253
Instrument Resistor Company 257
Insulation Manufacturers Corp. 133
International Machine Works 247
International Nickel Co., Inc. 60

Jelliff Mfg. Corp., C. O. 242
Jensen Manufacturing Co. 54
Johnson Co., E. F., Gothard Div. 238
Jones Div., Howard B., Cinch Mfg. Co. 248

Kahle Engineering Co. 263
Karp Metal Products Co., Inc. 51
Kenyon Transformer Co., Inc. 216
Kester Solder Co. 210

Keuffel & Esser Co. 3
Keystone Electronics Co. 255
Kirkland Co., H. R. 253
Knights Co., James 251
Kurz-Kasch, Inc. 193

Lampkin Laboratories 263
Lapp Insulator Co., Inc. 59
Legri S Company, Inc. 253
Linde Air Products, Co. 245

MB Mfg. Co., Inc. 187
Macallen Co. 156
Magnavox Co. 145
Maguire Industries, Inc. 204
Mallory & Co., Inc., P. R. 78, 131
Marion Electrical Instrument Co. 217
McGraw-Hill Book Co. 228, 254
Measurements Corporation 236
Mica Insulator Co. 22, 23
Miles Reproducer Co., Inc. 263
Milford Rivet & Machine Co. 245
Millen Mfg. Co., Inc., James 212
Mitchell-Rand Insulation Co., Inc. ... 185
Multi-Products Tool Co. 228
Mycalex Corporation of America 237

National Company, Inc. 175
National Electronics, Inc. 254
National Varnished Products Corp. .. 44
New England Screw Co. 243
North American Philips Co., Inc. 64
Nothelfer Winding Laboratories 255

O'Neil-Irwin Mfg. Co. 220
Ohmite Mfg. Co. 16A, 16B
Onan & Sons, Inc., D. W. 252

Panoramic Radio Corp. 222
Paper Machinery and Research, Inc. 257
Paramount Paper Tube Corp. 230
Patton-MacGuyer Co. 237
Paul & Beekman, Inc., Sub. of Portable Products Corp. 77
Phillips Screw Manufacturers 211
Photovolt Corp. 243
Pickering & Co., Inc. 258
Plastic Wire and Cable Corp. 11
Plastoid Corp. 262
Polarad Electronics Co. 244
Precision Apparatus Co., Inc. 262
Precision Paper Tube Co. 243
Precision Tube Co. 166
Presto Recording Corp. 35
Progressive Mfg. Co. 241
Pyroferric Co. 266

Quadriga Mfg. Co. 259
Quaker City Gear Works, Inc. 170

Radio Corp. of America .....37, 245, Back Cover
Radio-Music Corp. 237
Railway Express Agency, Air Express Div. 208
Rauland Corp. 163
Rawson Electrical Instrument Co. 257
Raytheon Mfg. Co. 10, 178, 205
Reeves-Hoffman Corp. 220
Reeves Soundcraft Corp. 194
Revere Copper & Brass, Inc. 40
Rex Rheostat Co. 263
Richardson Company 149
Rider Publisher, Inc., John F. 239
Rockbestos Products Corp. 179
Rostan Corp. 239

SNC Manufacturing Co., Inc. 73
Scientific Electric Div. of "S" Corrugated Quenched Gap Co. 226
Scovill Mfg. Co. 148
Seeburg Corp., J. P. 62
Shakeproof, Inc. 9
Shallcross Mfg. Co. 158
Sherron Electronics Co. 41
Sigma Instruments, Inc. 249
Signal Enginering & Mfg. Co. 241
Sillcocks-Miller Co. 218
Simpson Electric Co. 157
Skydyne, Inc. 235
Small Motors, Inc. 263
Solar Manufacturing Corporation 74
Sorensen and Co., Inc. 229
Sperry Gyroscope Co., Inc. 71
Stackpole Carbon Company 183
Star Expansion Products Co., Inc. .. 241
Stevens-Walden, Inc. 256
Steward Mfg. Co., D. M. 259
Struthers-Dunn, Inc. 36
Stupakoff Ceramic & Mfg. Co. 161
Superior Electric Co. 2
Superior Tube Company 260
Sylvania Electric Products Inc.
Electronics Div. 153
Radio Div. 53

Taylor Fibre Company 259
Tech Laboratories, Inc. 184
Technical Products International 251
Telex, Inc. 150
Thomas & Skinner Steel Products Co. 209
Tinnerman Products, Inc. 165
Turner Co. 39
Union Carbide and Carbon Corp. 245
United Transformer Corp. Inside Back Cover

University Loudspeakers, Inc. 264

Victoreen Instrument Co. 200
Vulcan Electric Co. 237

Waldes Kohinoor, Inc. 173
Walter Co., S. 230
War Assets Administration 221
Ward Leonard Electric Co. 48, 49
Weller Mfg. Co. 248
Western Electric Co. ..4, 5, 21, 65, 135, 216
Westinghouse Electric Corp. 181
Weston Electrical Instrument Corp. .. 66
Whistler & Sons, Inc., S. B. 7
White Dental Mfg. Co. S. S. 226, 233
Whitehead Stamping Co. 257
Wilcox Electric Co., Inc. 171
Wiley & Sons, Inc., John 240, 283

Zophar Mills, Inc. 228

■

PROFESSIONAL SERVICES 265

■

SEARCHLIGHT SECTION
(Classified Advertising)

EMPLOYMENT
Positions Vacant 267
Positions Wanted 267
Selling Opp. Wanted 267

EMPLOYMENT SERVICES 267

BUSINESS OPPORTUNITIES
Offered 267

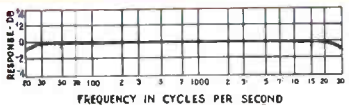
EQUIPMENT
(Used or Surplus New)
For Sale 267-281
Wanted 267

ADVERTISERS INDEX
American Electric Sales Co., Inc. 281
Ames Supply Co. 281
Blan 281
Brooks Inc., B. D. 280
Communications Equipment Co. 275
Edlie Electronics Inc. 278
Electro Impulse Laboratory 281
Electronicraft Inc. 274
Electro-Tech Equipment Co. 271
Kelvin Electronics 269
Maritime Switchboard 268, 269, 270
Microwave Equipment Co. 281
Niagara Radio Supply 272, 273
Opad-Green Co. 280
Pilot Marine Corp. 280, 281
Powell, Harold H. 280
Powertron Electrical Equipment Co. 271
Precision Electrical Instrument Co. 281
Radio Ham Shack, Inc. 277
Railway Communications Inc. 267
Reliance Merchandising Co. 280
Servo-Tek Products Co. 274
Standard Radio Electrical Products. 280
Stevens-Arnold Inc. 280
Tab 279
Tik 281
Village Radio Equipment Co. 280, 281

ENGINEERING DEVELOPMENT

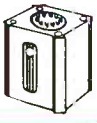
Since its inception, the designs of the UTC Engineering Department have set the standard for the transformer field.

1933 — **Hum Balanced Coil Structure:** Used by UTC in practically all high fidelity designs. . . . Hum balanced transformers are now accepted as standard practice in the transformer field.



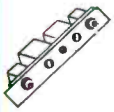
1934 — **Linear Standard Audio Units:** Flat from 20 to 20,000 cycles . . . A goal for others to shoot at.

1935 — **Ultra-Compact Audio Units:** A complete series of light weight audio and power components for aircraft and portable applications. Ultra-Compact Audio units are hum balanced . . . weigh approximately six ounces . . . high fidelity response.

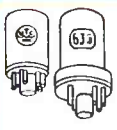


1936 — **Tri-Alloy Shielding:** The combination of Linear Standard frequency response and internal tri-alloy magnetic shielding is a difficult one to approach. Used by G.E., RCA, Western Electric, Westinghouse, Raytheon, Collins, Gates, etc.

1937 — **Ouncer Audio Units:** Extremely compact audio units for portable application were a problem until the development of the UTC Ouncer series. Fifteen types for proctically all applications . . . range 40 to 15,000 cycles.



1938 — **Universal Equalizers:** The UTC Universal Equalizers, Attenuators, and Sound Effects Filters fill a specific need of the broadcast and recording field. Almost any type of audio equipment can be equalized to high fidelity standards.

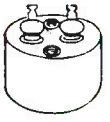


1939 — **Plug-In Audio Units:** These units are a modification of our Ouncer series, incorporating a simple octal base structure. Fifteen standard items cover all applications.

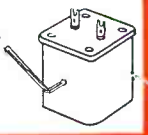
1940 — **Sub-Ouncer Units:** A series of ⅓ ounce miniature units with non-corrosive—long life construction for hearing aid, miniature radio, and similar applications. Five types cover practically all miniature requirements.

1941 — **Hermetic Seal Pioneering:** Realizing the essentiality of hermetic sealing for many applications, UTC pioneered a large number of the terminals and structures for hermetic transformers . . . now available for commercial use.

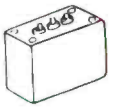
1942 — **Toroidal Wound High Q Coils:** UTC type HQA and HQB Coils afford a maximum in Q . . . stability . . . and dependability with a minimum of hum pickup. Standardized types available for all audio requirements.



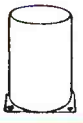
1943 — **Variable Inductors:** The type V C high Q variable inductor revolutionizes the approach to tuned audio circuits. Variation of +90% to −50% of mean inductance permits tuning any type of filter or equalizer to precise frequency characteristic.



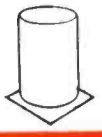
1944 — **Standardized Filters:** UTC type HPI, LPI, and BPI (low pass, high pass, and band pass) Filters are standardized to effect minimum cost and good delivery time. Available for frequencies throughout the entire audio range.



1945 — **Sub-Audio and Supersonic Transformers:** Embody new design and constructional principles, for special frequency ranges. ½ to 60 cycles for geophysicol, brain wave applications . . . 8 to 50,000 cycles for laboratory service, 200 to 200,000 cycles for supersonic applications.



1946 — **Commercial Grade:** (Now catalogued) This group of transformers covers every audio and power requirement of commercial communication equipment. The conservative design and rugged construction of these units, assure professional appearance and permanent dependability.



1947 — **New Items:** The UTC Research Laboratory is developing new items and improving standard designs in 1947. While some of these developments will be described in our advertisements, many are applied to customers' problems.

Write for new catalogue

United Transformer Corp.

150 VARICK STREET NEW YORK 13, N. Y.

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

12 Reasons Why it pays equipment manufacturers to deal with RCA

RCA TUBE APPLICATION ENGINEERING SERVICE—

Twelve field engineering specialists devote their time *exclusively* to the design problems of equipment manufacturers. They're ready to pitch in and help you at any time.

RCA TUBE APPLICATION ENGINEERING LABORATORIES—

RCA maintains tube application laboratories at Harrison, Lancaster and Chicago. The services of these laboratories are at the disposal of all RCA tube customers.

RCA CIRCUIT INVESTIGATIONS—

RCA carries on independent research in circuit design for the exclusive benefit of its customers. Engineering reports are provided as a free service.

RCA TUBE DEVELOPMENT—

RCA works years ahead in tube design—anticipates future requirements. That's why you get the types of tubes you want *when* you want them.

RCA ENGINEERING LITERATURE—

As the fountainhead of modern tube development, you can look to RCA for the most authoritative and comprehensive technical literature on tubes.

RCA MANUFACTURING FACILITIES—

RCA tubes are manufactured in ultramodern plants equipped with RCA-designed, high-speed precision machinery—your assurance of uniform, dependable quality tubes of whatever type, in any quantity.

RCA QUALITY CONTROL—

Quality controls begin with the raw material and are followed through in every successive step of manufacture and assembly to the final tube. That's why RCA tubes are consistently good.

RCA SALES SERVICE—

A staff of seasoned sales representatives are within convenient reach. They're available *when* you want them.

RCA DISTRICT OFFICES—

RCA's Tube Department maintains four convenient district offices in Harrison, Cleveland, Chicago and Los Angeles to serve equipment manufacturers. You can get prompt service from the office nearest you.

RCA DISTRIBUTION—

RCA's Tube Department maintains bulk tube stocks in three warehouses strategically located in Jersey City, Chicago and Los Angeles for quick service.

RCA PRICING—

Mass-production techniques and the RCA "Preferred-Type Tube Plan" have consistently operated to reduce manufacturing costs—which means lower prices to you.

RCA ENGINEERING LEADERSHIP—

The vast resources of experience and ability that account for RCA's engineering leadership, are of direct benefit to RCA customers—a final reason why it pays to deal with RCA.

RCA LABORATORIES
PRINCETON, N. J.

THE FOUNTAINHEAD OF MODERN TUBE DEVELOPMENT IS RCA

TUBE DEPARTMENT

RADIO CORPORATION of AMERICA

HARRISON, N. J.