TELE·TECH

Formerly the TELE-communications TECH-nical Section of

ELECTRONIC INDUSTRIES

DESIGN AND OPERATION OF RADIO · FM · TELEVISION
RADAR AND ALL COMMUNICATIONS EQUIPMENT

July · 1947

IN THIS ISSUE

CALDWELL-CLEMENTS, INC.

your Noise Problems, too can be Solved Better with C-D Quietones

Just because Mom wants to bake a cake is no reason why she shouldn't hear her pet soap opera. And sooner or later she's bound to find out that *some* mixers *don't* cause radio interference. Mixers equipped with C-D Capacitors, for example.

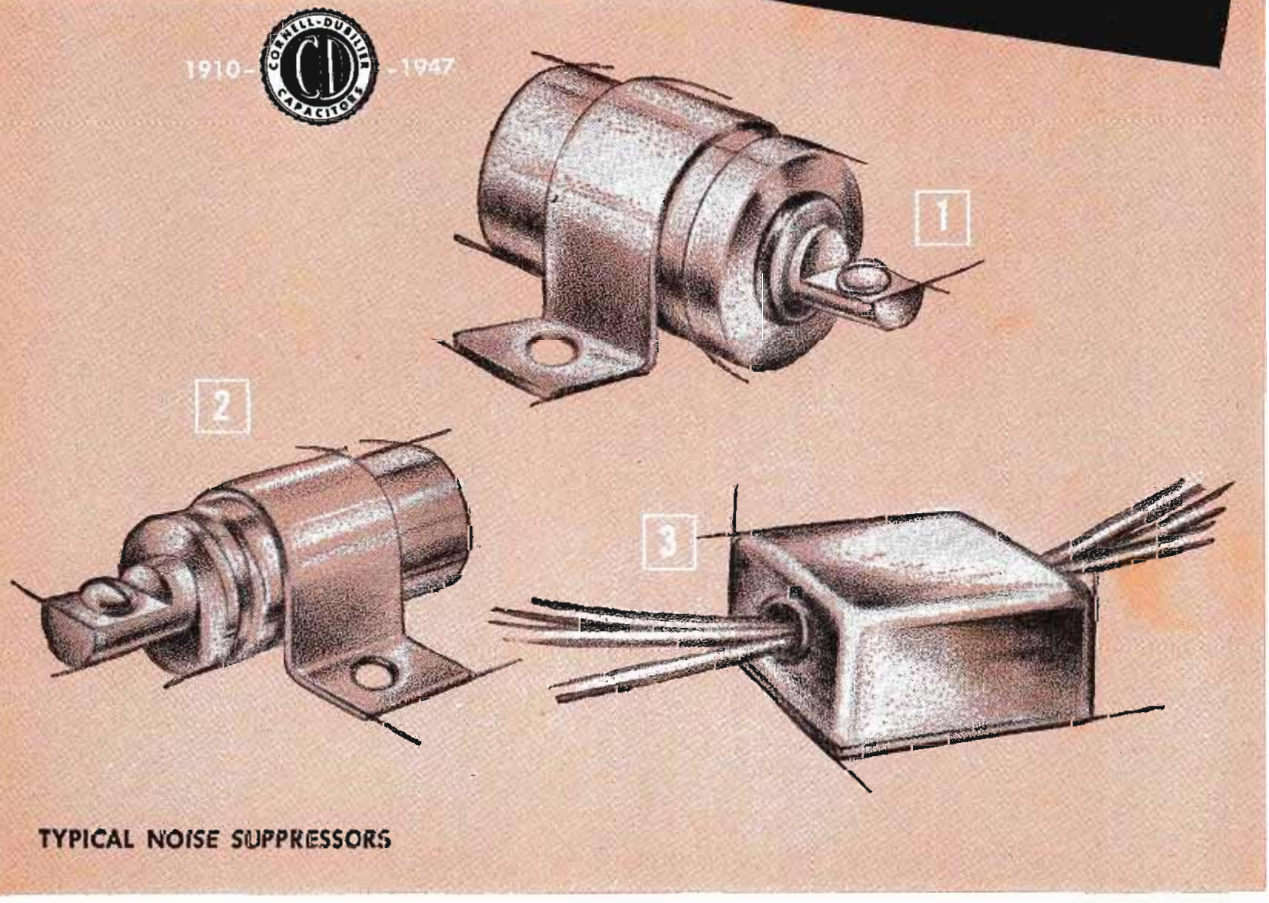
C-D's experience in designing and building noise suppressors is unequalled in the capacitor industry. We are now manufacturing hundreds of types of noise filters for electrical appliances and equipment. It's possible, of course, that the exact unit for solving *your* noise problem is not included. In that case, our engineers are ready and anxious to design and build the suppressor best suited to your specific requirements—*better, faster, more economically. Consult with them.*

Catalog of standard types will be mailed on request. Cornell-Dubilier Electric Corporation, Dept. J7, South Plainfield, New Jersey. Other large plants in New Bedford, Brookline and Worcester, Mass., and Providence, R. I.

CORNELL-DUBILIER
world's largest manufacturer of
CAPACITORS

MICA • DYKANOL • PAPER • ELECTROLYTIC

1910 – 1947



TYPICAL NOISE SUPPRESSORS

CAPACITORS #1 AND 2

Two of the Type MC Filter Capacitors designed for heavy duty service on buses, trucks, etc. for spark and noise suppression. Mechanically rugged, oil filled and impregnated and hermetically sealed.

CAPACITOR #3

A general purpose filter effectively controls radio noise energy created by fluorescent lamps. This capacitive – inductive type filter is compact and can be quickly installed in a variety of positions. Convenient leads simplify installation.

TELE·TECH

Formerly the TELE-communications TECH-nical Section of

ELECTRONIC INDUSTRIES

JULY, 1947

Editorial Contents

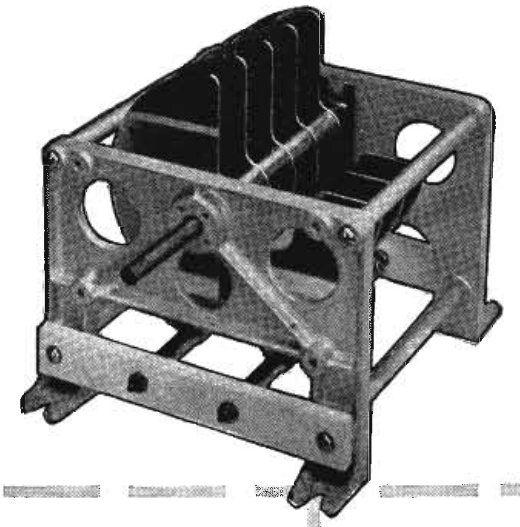
CALDWELL-CLEMENTS, INC., Publication Office, Orange, Conn., Editorial and Executive Offices 480 Lexington Avenue, New York 17, N. Y., Tel. Plaza 3-1340

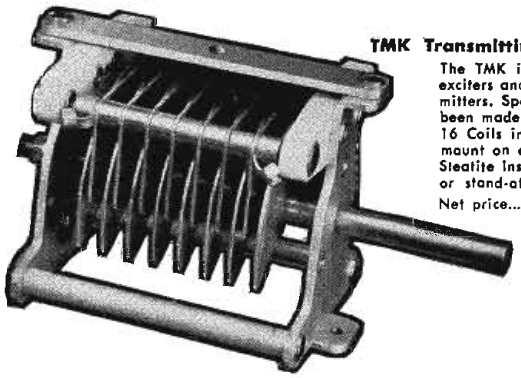
BRANCH OFFICES — Chicago 6, R. Y. Fitzpatrick, 201 N. Wells St., RAN 9225; Cleveland 14, D. J. O'Rourke, Citizens Bldg., 850 Euclid Ave., Main 8270; Los Angeles 5, The Robert W. Walker Co., 684 So. Lafayette Park Pl., Drexel 4388; San Francisco 4, 68 Post St., Sutter 5568.

TML Transmitting Condenser

The TML condenser is a 1 KW job throughout. Special Steatite insulators prevent flashovers. Thick capacitor plates provide high voltage ratings. Sturdy cast aluminum end frames and drual tie bars permit an unusually rigid structure. Precision end bearings insure smooth turning and permanent alignment of the rotor. End frames are arranged for panel, chassis or stand-off mountings.

Net price.....From $11.50 to $24.60





TMK Transmitting Condenser

The TMK is a condenser for exciters and low power transmitters. Special provision has been made for mounting AR-16 Coils in a swivel plug-in mount on either top or rear. Steatite insulation. For panel or stand-off mountings.

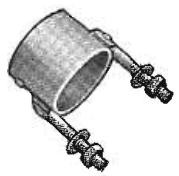
Net price.....From $2.30 To $5.11

The XOA Socket for Miniature Button 7-pin base tubes 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. Axial or radial contacts can be used in the same socket base.

XOR Type Socket....Net price....$ .50

XOA Type Socket....Net price....$ .50

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 (for 1-3/16" tube body), XOS-2 (for 1½" tube body), and XOS-3 (for 2" tube body).



XOS-1 Shield.....Net price.....$ .48
XOS-2 Shield.....Net price.....$ .48
XOS-3 Shield.....Net price.....$ .48

QUALITY

IS THE ONLY BARGAIN IN RADIO PARTS

If you're building fine apparatus, National parts will help to deliver the kind of performance your equipment must have to sell successfully in today's competitive market.

That's why National parts are a fine investment. They may cost a little more — but in return you get quality materials, careful workmanship and long-life.

Send today for your copy of the new 1947 National catalog, containing over 600 parts.

National Company, Inc.
Malden, Mass.

National
EST. 1914

Please write to Department #13 National Company, for further information.

MAKERS OF LIFETIME RADIO EQUIPMENT

SERVICE-PROVED COMPONENTS

Now Available Over Wider Range of Ratings

The extensive experience gained by General Electric in design and manufacture of electronic components for the Armed Forces is now available to builders of commercial electronic equipments. In many cases the range of available ratings is wider than ever before.

RESONANT REACTORS, OIL-FILLED, HERMETICALLY SEALED

Resonant-charging reactors, accurately designed and constructed for radar service. Usually required in ratings of 40 kv and below, 1 ampere and below and 300 henries and below. Higher ratings are being built, and can be considered. When required, small- and medium-size designs can be provided with 3 to 1 range of inductance adjustment.

PULSE TRANSFORMERS, OIL-FILLED, HERMETICALLY SEALED

Pulse transformers for use with either hard-tube or line-type modulators. Available in voltage ratings of 10 kv or above. These units are ideal for radar applications, stepping up or down, impedance matching, phase reversing and plate-current measurements. Also suitable for nuclear physics research work, television and numerous special applications in and out of the communications field.

FILAMENT TRANSFORMERS, OIL-FILLED, HERMETICALLY SEALED

Filament transformers available with or without tube socket mounted integral with the high-voltage terminal. Low capacitance. Ratings to match any tubes; insulated to practically any required level.

For price and delivery on components to meet your requirements, write your nearest General Electric District Office or direct to Apparatus Dept., General Electric Company, Schenectady 5, N. Y.

GENERAL ELECTRIC

401-46

TELE-TECH

Formerly the TELE-communications TECH-nical Section of ELECTRONIC INDUSTRIES

O. H. CALDWELL, *Editorial Director* — M. CLEMENTS, *Publisher*

S. P. McMINN, *Executive Editor* — RALPH R. BATCHER, *Contributing Editor*

JOEL PETERSON, *Associate Editor*

JOSEPHA ZENTNER, *Wide Reading* — H. JACOBOWITZ, *New Products*

H. G. SHEA, HAROLD ELLIS, *Contributing Editors*

CHARLES DREYER, *Art Director*

WASHINGTON, D. C.

R. C. DAVIES, *News Editor*, *National Press Bldg.* — DR. A. F. MURRAY, *Consulting Editor*, *4707 Windom Pl.*

CIRCULATION

B. V. SPINETTA, *Circulation Director*

B. GOLLUB, M. GROENING, B. RUCHAISKY, *Subscriptions, List Compilation*

BUSINESS DEPARTMENT

M. H. NEWTON, *Business Manager*

J. J. BROOKMAN, *Sales Manager* — DODD COSTER, *New England Mgr.*

R. Y. FITZPATRICK, *Western Manager*

S. M. GASKINS

N. McALLISTER, *Production Manager* — A. O'ROURKE, *Make-Up*

BEN MORRIS, *Promotion Manager* — W. W. SWIGERT, *Credit Manager*

W. KENNETH REYNOLDS, E. CALLAHAN, D. SIEB, F. B. MYERS, F. V. ECKHOFF, M. TEMMEL, M. SCHNEIDER, GRACE JESSE

Tele-Tech*, July 1947, Vol. 6, No. 7. Regular price per copy 25 cents. Published Monthly by Caldwell-Clements, Inc., Publication Office Orange, Conn., Editorial, Advertising and Executive Offices 480 Lexington Ave., New York 17, N. Y. Direct all subscription inquiries to Orange, Conn., or to 480 Lexington Avenue, New York 17, N. Y. M. Clements, President; Orestes H. Coldwell, Treasurer. Subscription rates: United States and possessions, $3.00 for two years. Canada (Canadian Funds Accepted) $4.00 for two years. Pan American Countries $5.00 for two years. All other countries $7.50 for two years. Entered as second class matter June 9, 1947, at the Post Office at Orange, Conn., under the act of March 3, 1879.

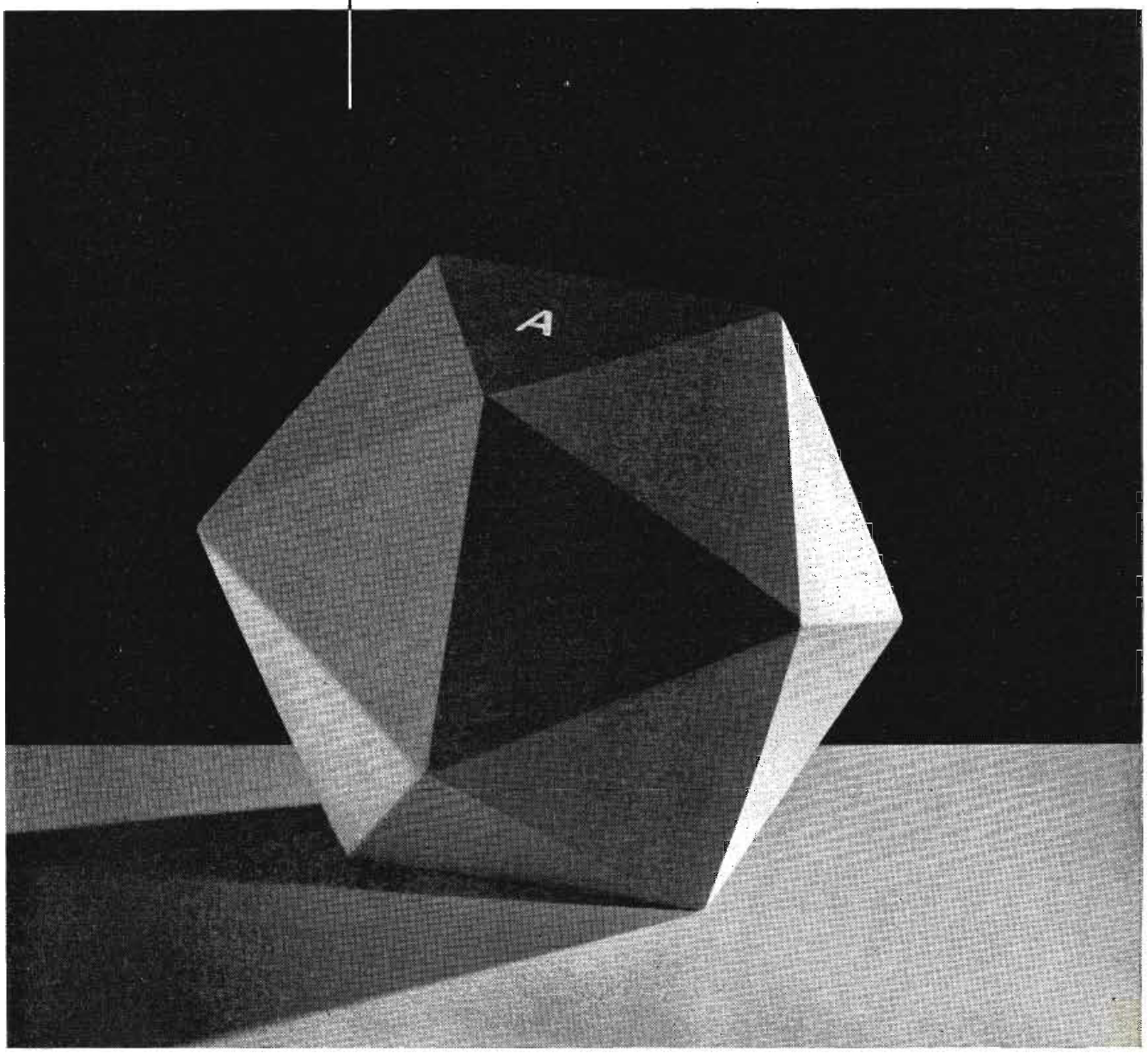
Printed in U.S.A. *Reg. U.S. Pat Off.

It tells how often you will telephone

"It" is an icosahedron—a solid with twenty regular faces. The laws of probability say that if you roll a hundred icosahedrons on a table, eleven or more will come to rest with side "A" on top only once in a hundred throws.

Identical laws of probability rule the calls coming into your local Bell Telephone exchange. Suppose you are one of a group of a hundred telephone subscribers whose practice is to make one three-minute call each during the busiest hour of the day. The chance that eleven or more of you will be talking at once is also only one in a hundred. Thus it would be wasteful for the Bell System to supply your group with a hundred trunk circuits. Eleven trunks will suffice to give you good service.

Telephone traffic conditions vary. But you can be sure, wherever you live, that Bell Telephone Laboratories research, which pioneered in applying probability theory to telephone traffic, is everywhere helping to make the most use of costly equipment.



BELL TELEPHONE LABORATORIES

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

Listen IT'S A New Jensen SPEAKER

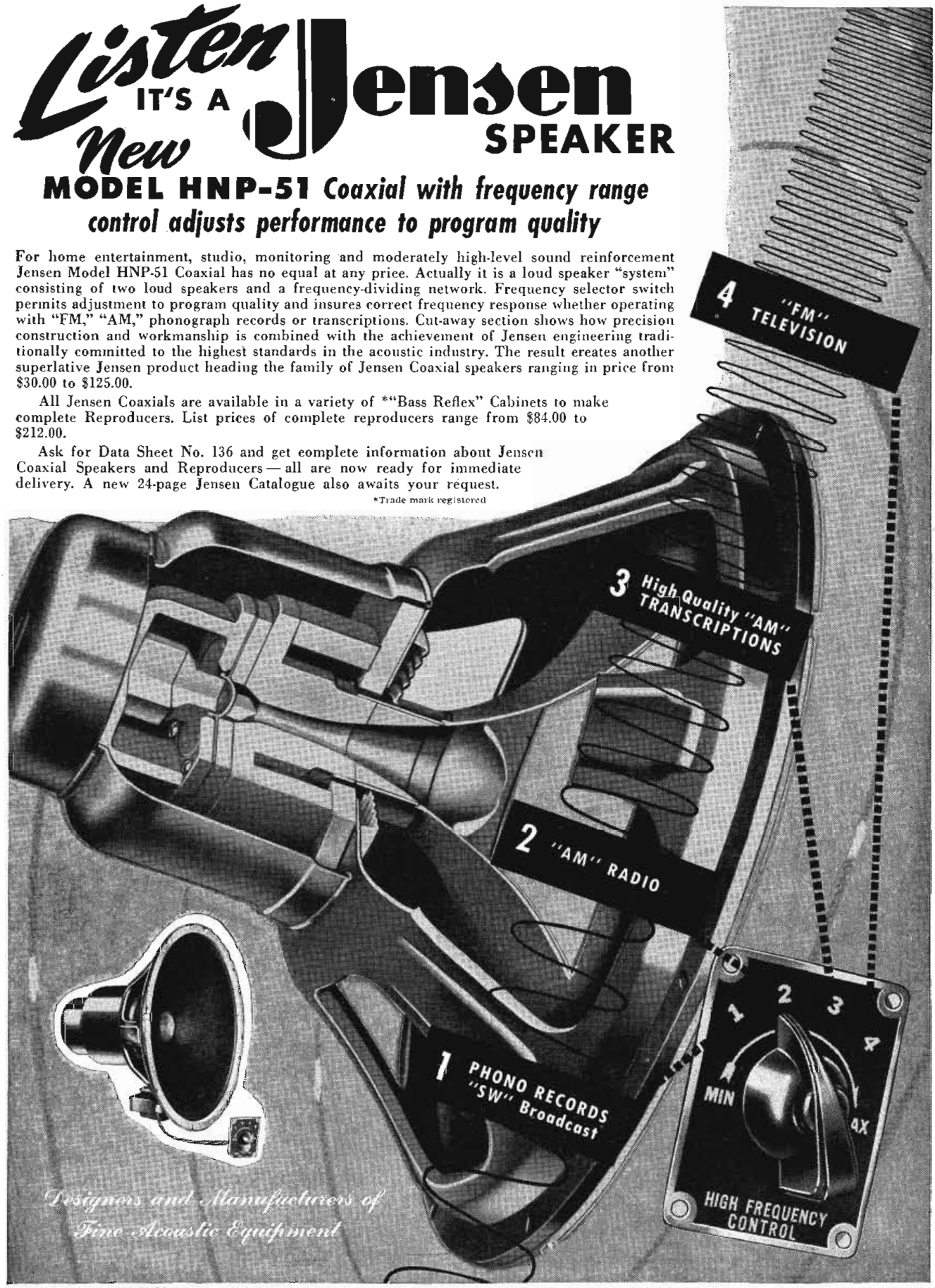
MODEL HNP-51 *Coaxial with frequency range control adjusts performance to program quality*

For home entertainment, studio, monitoring and moderately high-level sound reinforcement Jensen Model HNP-51 Coaxial has no equal at any priee. Actually it is a loud speaker "system" consisting of two loud speakers and a frequency-dividing network. Frequency selector switch permits adjustment to program quality and insures correct frequency response whether operating with "FM," "AM," phonograph records or transcriptions. Cut-away section shows how precision construction and workmanship is combined with the achievement of Jensen engineering traditionally committed to the highest standards in the acoustic industry. The result ereates another superlative Jensen product heading the family of Jensen Coaxial speakers ranging in price from $30.00 to $125.00.

All Jensen Coaxials are available in a variety of *"Bass Reflex" Cabinets to make complete Reproducers. List prices of complete reproducers range from $84.00 to $212.00.

Ask for Data Sheet No. 136 and get eomplete information about Jensen Coaxial Speakers and Reproducers — all are now ready for immediate delivery. A new 24-page Jensen Catalogue also awaits your request.

*Trade mark registered



JENSEN MANUFACTURING CO., 6625 S. LARAMIE AVE., CHICAGO 38, U.S.A.

IN CANADA: J. R. LONGSTAFFE, LTD., 11 KING STREET, TORONTO

Let Trouble be our Introduction

THERE'S nothing like trouble to bring people together. That's how some of Revere's closest friends were gained—through a mutual struggle against difficulties. troubles such as occasionally beset any business.

Take the case of an important electronic product, originally developed for war use, since the war finding increasing applications in peacetime services. When manufacture began, rejections ran extremely high, over 40%, costs were skytocketing, and badly-needed production was being lost. The maker asked if we would care to collaborate in solving the problem. Of course we would! After studying the subject in detail (and also under conditions of the greatest secrecy), we suggested a radical change in the properties of a non-ferrous product used in the manufacture of the vital part with which so much trouble was being experienced. New processes of manufacture were developed, and in a short time test runs of the recommended material proved successful. Rejections of finished units dropped to less than 1%. Thus an expensive and vexing bottleneck was broken, and we gained a new customer and a firm friend.

This success story demonstrates that Revere has an open mind as well as an informed one, and is always ready to question the customary, find new answers to new problems, or to old ones, for that matter. If something is worrying you in your employment of non-ferrous metals in electronics, get in touch with Revere, not for ready-made answers, but for wholehearted cooperation, a joint search for better resulrs. This help is given freely, without obligation, through the Revere Technical Advisory Service, which has at its command the knowledge and facilities of our laboratories, and the accumulated experience of the entire Revere organization.

REVERE

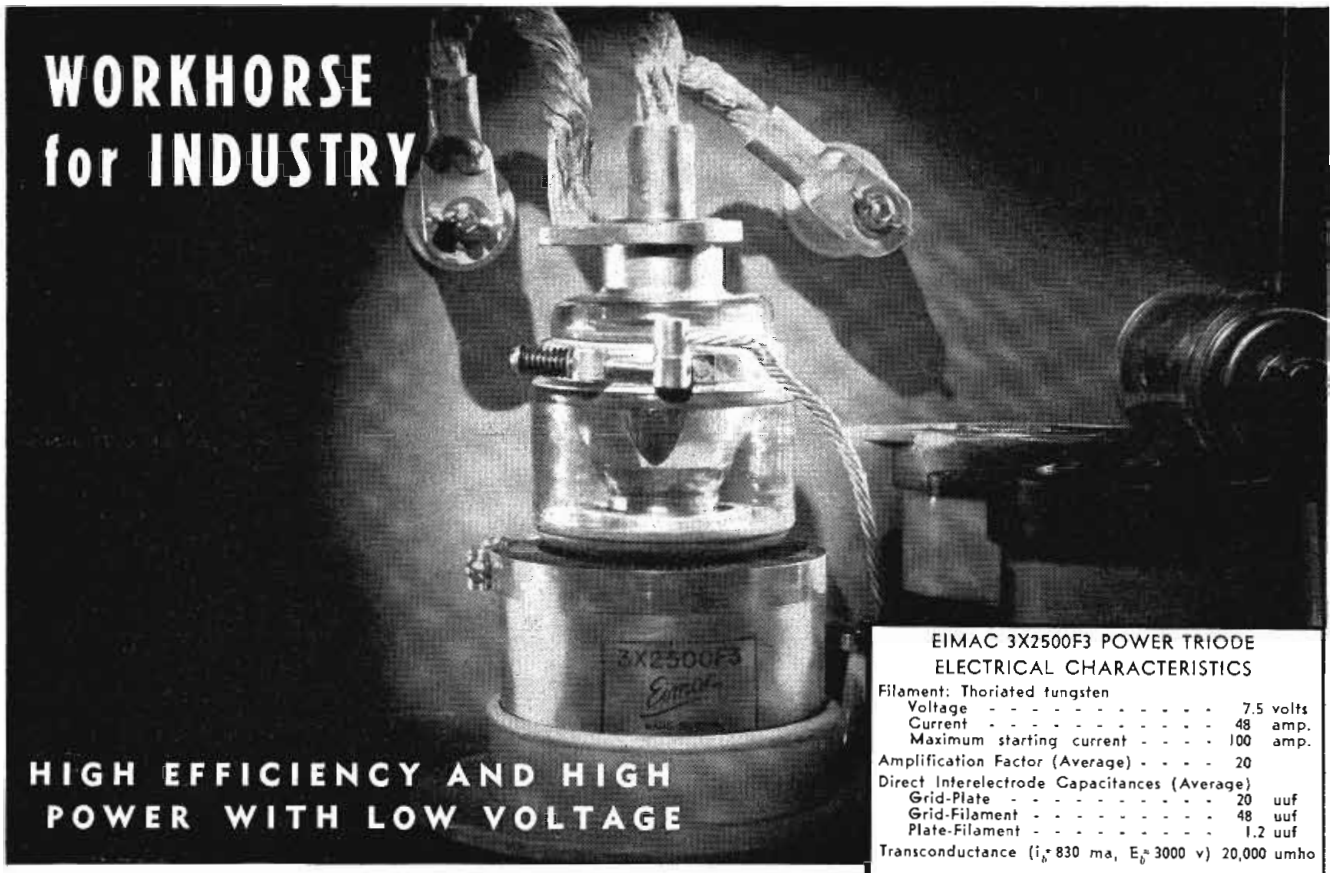
COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, New York

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

WORKHORSE for INDUSTRY



HIGH EFFICIENCY AND HIGH POWER WITH LOW VOLTAGE

HERE'S AN EIMAC TRIODE . . . THE 3X2500F3 . . . specially designed to deliver 5 kw into industrial loads with a plate voltage of only 3500 volts. This low plate voltage contributes to safety as well as reliability of equipment. The tube operates at efficiencies as high as 80 per cent, not only in induction heating service at 200-500 kc, but also in dielectric heating service at 1.5-40 Mc. Operation at 5000 plate volts gives an output of 7.5 kw.

Physically the 3X2500F3 bears the following specific advantages for industrial application:

COOLER ..... Unusually efficient..only 74 cfm of air at ambient temperature of 25 C and static pressure of 1 in. of water required to keep cooler core at rated 150° C.

TERMINALS ... Flexible leads..convenience and economy of mounting and connection. Rugged design for rough service.

FILAMENT .... Thoriated tungsten gives required electron emission with minimum power consumption and long useful life. Operates at 7.5 volts, 48 amp.

***PRICE* $165 each**

Further details on this useful new triode, the 3X 2500F3, are yours for the asking. Write:

EITEL-McCULLOUGH, INC.
1722 San Mateo Ave., San Bruno, California

EXPORT AGENCY: FRAZAR & HANSEN
301 Clay St., San Francisco 11, California, U.S.A.

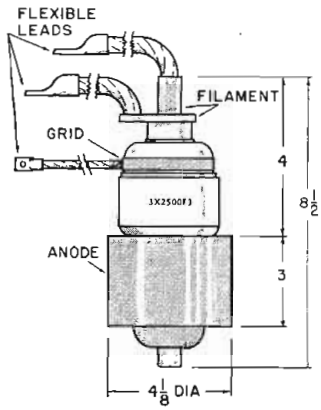
EIMAC 3X2500F3 POWER TRIODE ELECTRICAL CHARACTERISTICS

Filament: Thoriated tungsten	
Voltage	7.5 volts
Current	48 amp.
Maximum starting current	100 amp.
Amplification Factor (Average)	20
Direct Interelectrode Capacitances (Average)	
Grid-Plate	20 uuf
Grid-Filament	48 uuf
Plate-Filament	1.2 uuf
Transconductance (i_b = 830 ma, E_b = 3000 v)	20,000 umho

RATINGS AND OPERATION

Class-C Grounded-Filament R-F Oscillator or Power Amplifier

Maximum Ratings Below 40 Mc			
D-C Plate Voltage			5000 volts
D-C Plate Current			2 amp
Plate Dissipation			2500 watts
Grid Dissipation			150 watts
Typical Operation Below 40 Mc, per tube			
D-C Plate Voltage	3500	4000	5000 volts
D-C Plate Current	1.8	1.6	2.0 amp
D-C Grid Voltage	−420	−360	−400 volts
D-C Grid Current	0.5	0.4	0.5 amp
Peak R-F Grid Input Voltage	735	630	710 volts
Driving Power (Approximate)	325	237	337 watts
Grid Dissipation	120	88	148 watts
Plate Input	6.3	6.4	10 kw
Plate Dissipation	1.3	1.4	2.5 kw
Plate Power Output	5	5	7.5 kw



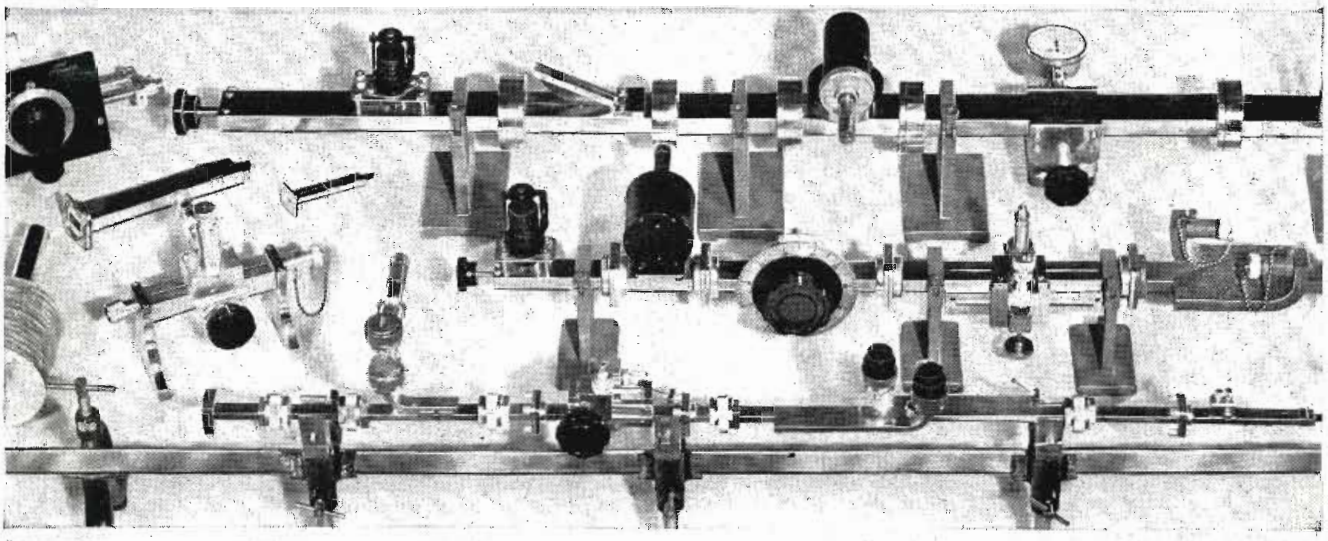
Follow the Leaders to

Eimac TUBES REG. U.S. PAT. OFF.

The Power of Industry

DE MORNAY BUDD STANDARD TEST EQUIPMENT

For Precision Measurements in the Microwave Field



The complete line of De Mornay·Budd standard test equipment covers the frequency range from 4,000 mcs. to 27,000 mcs. It provides all R. F. waveguide units necessary for delicate, precision test work requiring extremely high accuracy in attenuation measurements, impedance measurements, impedance matching, calibration of directional couplers, VSWR frequency measurements, etc.

To eliminate guesswork, each item of this De Mornay·Budd test equipment is individually tested and, where necessary, calibrated, and each piece is tagged with its electrical characteristics. All test equipment is supplied with inner and outer surfaces gold plated unless otherwise specified.

NOTE: Write for complete catalog of De Mornay·Budd Standard Components and Standard Bench Test Equipment. Be sure to have a copy in your reference files. Write for it today.

The three test set-ups illustrated above include:

- Tube Mount
- Flap Attenuator
- Frequency Meter
- Calibrated Attenuator
- Tee
- Stub Tuner
- Tunable Dummy Load
- Standing Wave Detector
- Type "N" Standing Wave Detector
- Directional Coupler
- Hight Power Dummy Load
- Cut-Off Attenuator

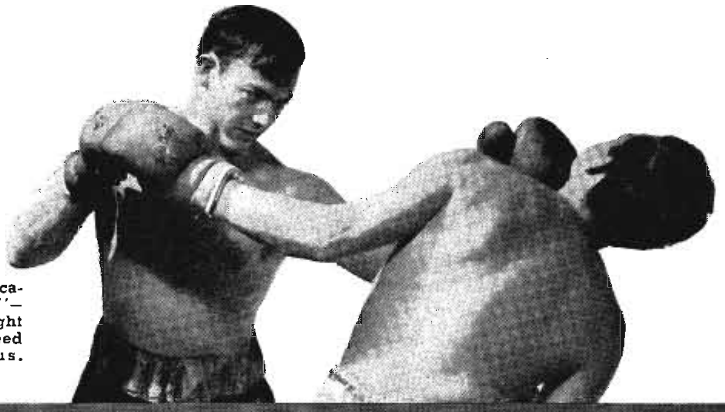
Stands, etc.

DE MORNAY BUDD

EQUIPMENT FOR 97% OF ALL RADAR SETS

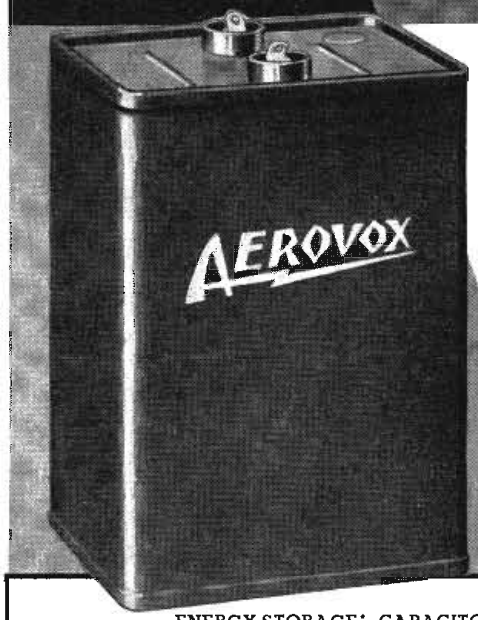
DE MORNAY • BUDD INC., 475 GRAND CONCOURSE, NEW YORK 51, NEW YORK. CABLE ADDRESS "DEMBUD," N. Y.

Typical discharge application—the "Syncroflash"—AC operated light-weight 100-watt-second high-speed photo-flash apparatus.

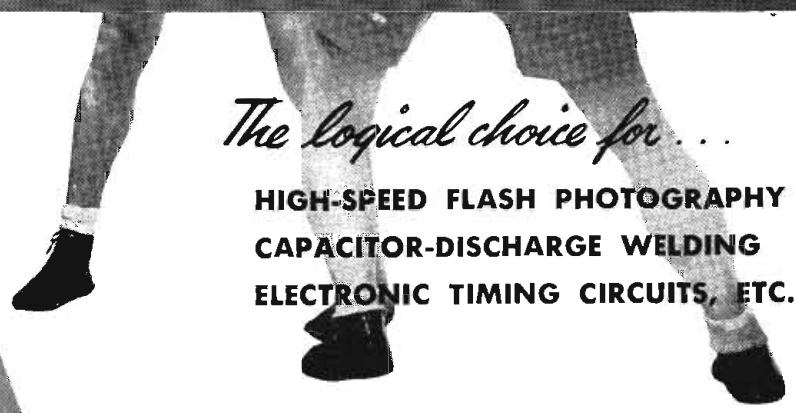


Maximum Storage Capacity per Ounce and Cubic Inch...

AEROVOX SERIES PX *Energy-Storage* CAPACITORS



12.5 mfd. 4000 volt DC peak Hyvol Energy-Storage Capacitor.



The logical choice for . . .

HIGH-SPEED FLASH PHOTOGRAPHY
CAPACITOR-DISCHARGE WELDING
ELECTRONIC TIMING CIRCUITS, ETC.

ENERGY STORAGE* CAPACITORS
PREFERRED RATINGS

WATTS—SECONDS	VOLTS—E	TYPE NO.	DIMENSIONS HT.	WT. LBS.
22.5	1.5 KVDC peak	PX10F1	2½ x 3¾ x 4⅝	2¾
50	1.8 " "	PX13D1	4-9/16 x 3¾ x 4⅝	4⅜
50	2.0 " "	PX14D2	4-9/16 x 3¾ x 4⅝	4⅜
100	2.5 " "	PX15D1	4-9/16 x 3¾ x 6½	6⅛
75	3.0 " "	PX18D1	4-9/16 x 3¾ x 4⅝	4⅜
550	3.0 " "	PX22F1	5⅛ x 13½ x 13	App. 64
100	4.0 " "	PX20D1	4-9/16 x 3¾ x 4⅝	4⅜
500	4.0 " "	PX32F1	5⅛ x 13½ x 13	63

*Stored Energy = ½ CE² Watts-Seconds (C in farads)

• Interested in storing a large amount of energy in a small space—and at low cost, first and last?

If so, Aerovox Series PX Energy-Storage Capacitors are your logical choice. Here's why:

Light. Fast discharge. Easily installed. Exceptionally rugged mechanically and electrically. Time-proven Hyvol impregnant and fill for the generously-proportioned paper-and-foil sections, insures dependable service and longest life. Positively the maximum energy-storage with minimum bulk and weight.

Preferred ratings available for prompt delivery, are listed at left. Other ratings can be designed and made to order for exceptional requirements.

• Our engineers will gladly discuss the advantages of Aerovox Energy-Storage Capacitors as applied to your specific problems or needs.

AEROVOX capacitors

FOR RADIO-ELECTRONIC AND INDUSTRIAL APPLICATIONS

AEROVOX CORPORATION, NEW BEDFORD, MASS., U.S.A.
SALES OFFICES IN ALL PRINCIPAL CITIES • Export: 13 E. 40th St., New York 16, N. Y.
Cable: 'ARLAB' • In Canada: AEROVOX CANADA LTD., HAMILTON, ONT.

Studying the output of pulsed oscillators?

ANALYZE THEIR SPECTRA VISUALLY WITH THIS COMPACT INSTRUMENT!

THE SYLVANIA SPECTRUM ANALYSER

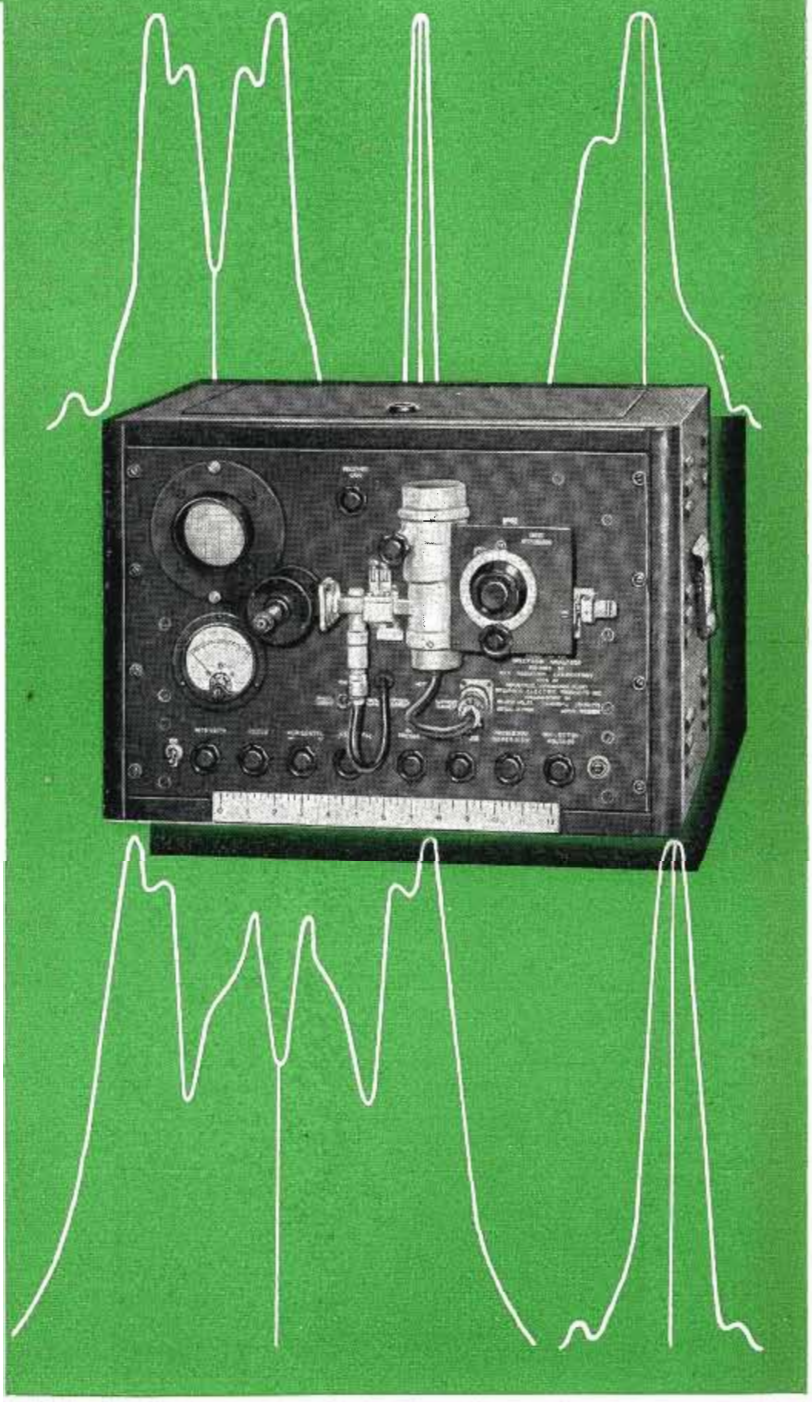
provides a convenient means of studying the energy spectrum of microwave generators operating as pulsed oscillators or modulated CW oscillators. The output of magnetron, klystron, rocket and similar UHF and SHF tubes can be readily investigated.

Essentially, the Sylvania Spectrum Analyzer consists of a sharply tuned superheterodyne receiver with a cathode ray oscilloscope indicator. The instrument incorporates a sawtooth generator, which performs the two functions of frequency-modulating the local oscillator and of providing the horizontal sweep for the oscilloscope. Thus automatic synchronization is assured at all times.

An input probe is provided for insertion into cavities or wave-guides.

The energy emitted by the oscillator at various frequencies is displayed on the cathode ray tube as a pattern of vertical lines. The envelope of the pattern represents the spectral distribution.

The Spectrum Analyzer illustrated—the TSX-4SE—is designed for the 9,300 Mc region. A second model—the TSS-4SE—is available for the 3,000 Mc region, and a third model—the TSK-2SE—is available for the 24,000 Mc region.



TYPICAL APPLICATIONS OF THE SPECTRUM ANALYZER

Some of the possible uses include:

Viewing the output of a radar system, to make sure that the output energy is not being wasted by being distributed over a wider frequency band than the radar receiver can accommodate.

Determining the frequency of a pulsed oscillator.

Adjusting the local oscillator frequency of a radar receiver to space it properly with respect to transmitter frequency.

Checking of pulling or shifting in frequency of the pulsed oscillator of a radar transmitter, by observing the spectrum while the antenna is in motion.

Measurement of standing wave ratios by using the Spectrum Analyzer in conjunction with a slotted section.

WRITE FOR DETAILED SPECIFICATIONS

SYLVANIA ELECTRIC

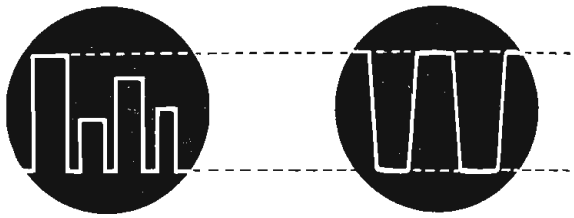
Electronics Division . . . 500 Fifth Avenue, New York 18, N. Y.

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

A *New* Du Mont instrument for peak-to-peak voltage measurements! Measures any waveform! Can be used with any oscillograph!

DU MONT TYPE 264-A *Voltage Calibrator*

PLACE IT RIGHT ON TOP OF YOUR OSCILLOGRAPH!



Example: Typical complex signal; peak-to-peak voltages unknown.

Adjust amplitude of this calibrating signal to match desired peaks of unknown signal. Read voltage from dial settings of calibrator.

HIGHLIGHTS...

Independent of line-voltage variations.

Direct-reading.

Convenient to use.

Low-priced.

Small and compact.

Overall accuracy of ±5%. Better than requirements of most electronic circuit tolerances.

SPECIFICATIONS...

RANGE: 0-0.1; 0-1.0; 0-10; 0-100 volts.

ACCURACY: ±5% of full scale on each range, with variations in line voltage as great as ±10%.

INPUT IMPEDANCE: 20 uuf (signal connected through calibrator).

FUSE: ½ amp.; 115 volts, 50-60 cps., 20 watts.

SIZE: 4½" x 8" x 5¾".

WEIGHT: 5 lbs.

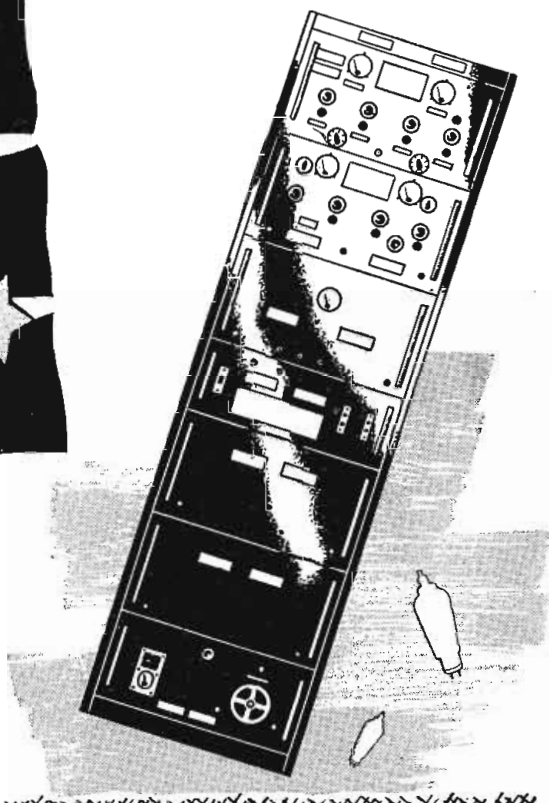
The Du Mont Type 264-A Voltage Calibrator is designed to measure the peak-to-peak voltage of any signal being viewed on a cathode-ray oscillograph. Small, low-priced, convenient, it may be used with *any* commercial cathode-ray oscillograph. The output is essentially a square wave the amplitude of which is continuously variable from 0 to 100 volts. By merely throwing the selector switch, either the unknown signal or any of four ranges of calibrating voltage may be applied to the input of the oscillograph. There is no need for switching leads between signal and calibrating voltage. Unlike a voltmeter, measurements may be made of any part of a complex, composite waveform with Type 264-A.

Descriptive bulletin sent on request.

DUMONT *Precision Electronics & Television*

ALLEN B. DuMONT LABORATORIES, INC., PASSAIC, NEW JERSEY • *CABLE ADDRESS:* ALBEEDU, PASSAIC, N. J., U. S. A.

MANUFACTURERS
JOBBERS
WHOLESALERS



Valuable, hard-to-get, electronic materials and equipment can be obtained through *your* WAA Approved Distributor.

Huge inventories, declared surplus by the Armed Forces, have been allocated to these Approved Distributors for efficient disposal.

The names and addresses of our distributors are listed below. They are equipped to serve your needs and will know what is immediately available.

BOSTON, MASS.
Automatic Radio Mfg. Co., Inc.
122 Brookline Ave.
Technical Apparatus Co.
165 Washington St.

BUCHANAN, MICH.
Electro-Voice, Inc.
Carroll & Cecil Sts.

CANTON, MASS.
Tobe Deutschmann Corp.
863 Washington St.

CHICAGO, ILL.
American Condenser Co.
4410 N. Ravenswood Ave.
Belmont Radio Corp.
3633 S. Racine Ave.

EMPORIUM, PENNA.
Sylvania Electric Products, Inc.

FORT WAYNE, IND.
Essex Wire Corp.
1601 Wall St.

HOUSTON, TEXAS
Navigation Instrument Co., Inc.
P.O. Box 7001, Heights Station

LOS ANGELES, CALIF.
Colel nstrument Co.
1320 S. Grand Ave.
Hoffman Radio Corp.
3761 S. Hill St.

NEWARK, N. J.
National Union Radio Corp.
57 State St.
Standard Arcturus Corp.
99 Sussex Ave.
Tung-Sol Lamp Works, Inc.
95—8th Ave.

NEW ORLEANS, LA.
Southern Electronic Co.
512 St. Charles St.

NEW YORK, N. Y.
Carr Industries, Inc.
1269 Atlantic Ave., B'klyn.
Communication Measurements Laboratory
120 Greenwich St.
Electronic Corp. of America
353 W. 48th St.
Emerson Radio & Phonograph Corp.
76—9th Ave.
General Electronics, Inc.
1819 Broadway
Hammarlund Mfg. Co., Inc.
460 W. 34th St.
Jahanns & Keegan Co., Inc.
62 Pearl St.
Newark Electric Co., Inc.
242 W. 55th St.
Smith-Meeker Engineering Co.
125 Barclay St.

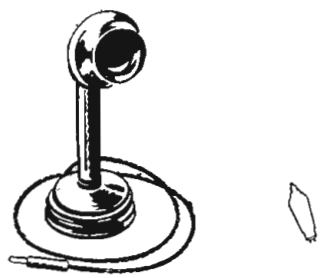
NORFOLK, VA.
Radio Parts Distributing Co.
128 W. Olney Road

ROCHESTER, N. Y.
W. & H. Aviation Corp.
Municipal Airport

SALEM, MASS.
Hytron Radio & Electronics Corp.
76 LaFayette St.

SCHENECTADY, N. Y.
General Electric Co.
Bldg. 267, 1 River Road

WASECA, MINN.
E. F. Johnson Co.
206—2nd Ave., S. W.



OFFICE OF AIRCRAFT AND ELECTRONICS DISPOSAL

WAR ASSETS ADMINISTRATION

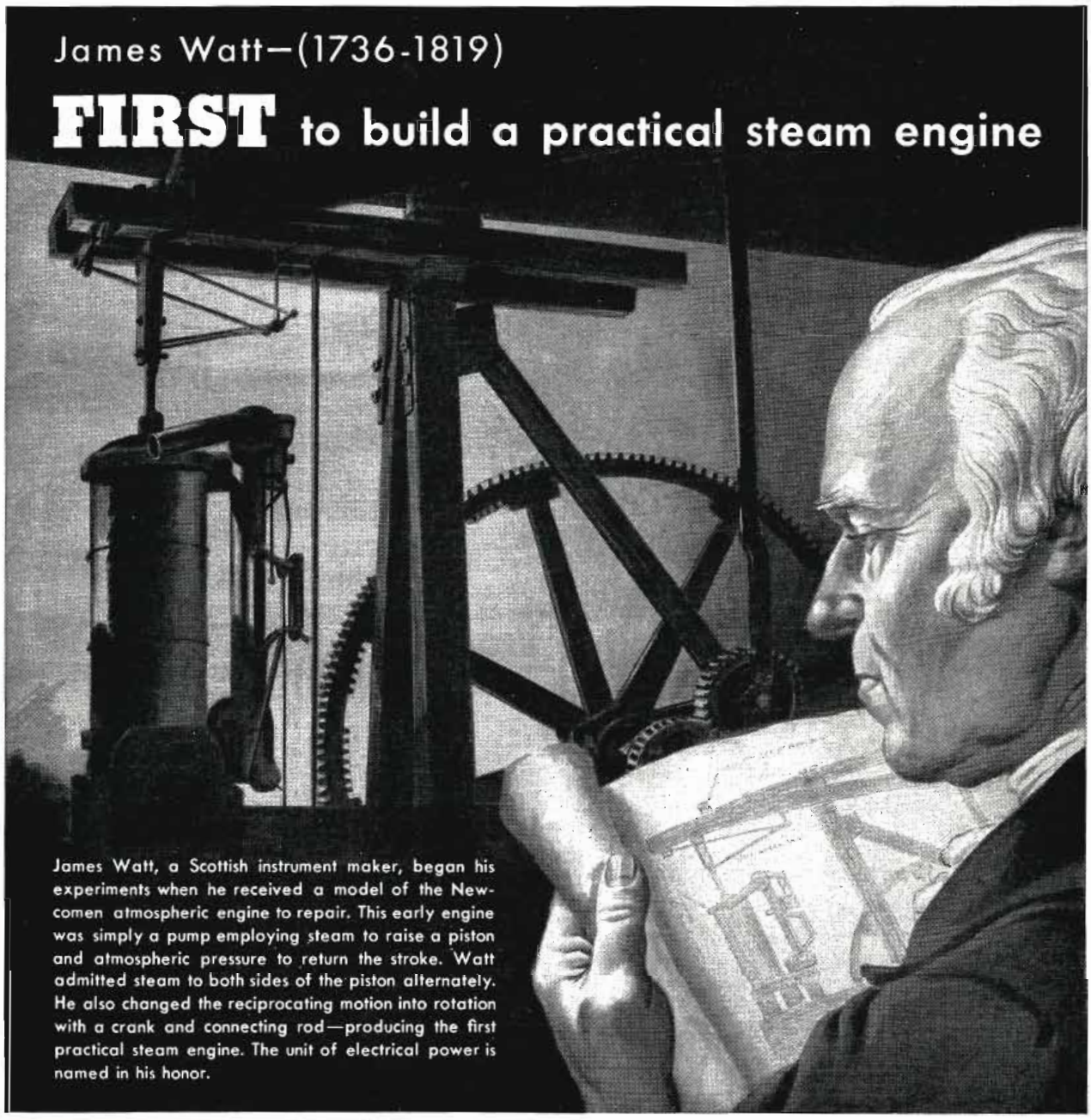
GOVERNMENT WAA SURPLUS

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

1223

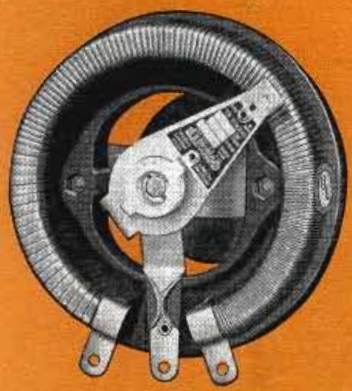
James Watt—(1736-1819)

FIRST to build a practical steam engine



James Watt, a Scottish instrument maker, began his experiments when he received a model of the Newcomen atmospheric engine to repair. This early engine was simply a pump employing steam to raise a piston and atmospheric pressure to return the stroke. Watt admitted steam to both sides of the piston alternately. He also changed the reciprocating motion into rotation with a crank and connecting rod—producing the first practical steam engine. The unit of electrical power is named in his honor.

OHMITE...



FIRST in rheostats . . . today

More manufacturers have standardized on Ohmite rheostats for their products . . . more companies are buying these rheostats for their own use . . . than any other make on the market today. One of the important reasons for this preference is that Ohmite rheostats have established a reputation for dependability under frequent service and adverse operating conditions. It will pay you to standardize on Ohmite rheostats for your product.

Be right with OHMITE • Rheostats • Resistors • Tap Switches

OHMITE
Close Control
RHEOSTATS

...Available with many additional features

On this page are shown some of the many forms in which standard Ohmite rheostats can be furnished. All models have the distinctive, time-proved features of Ohmite design. They are all-ceramic in construction—ceramic parts insulate the shaft and mounting, and the resistance winding is permanently locked in place by vitreous enamel. Smoothly-gliding, metal-graphite brush provides contact with every turn of the resistance winding. Ohmite rheostats are known for their smooth, gradual, close control and their long, trouble-free life.

Write for Catalog and Engineering Manual No. 40, on your letterhead. It contains information on the complete Ohmite line, plus a wealth of helpful engineering information.

Be Right with...

OHMITE

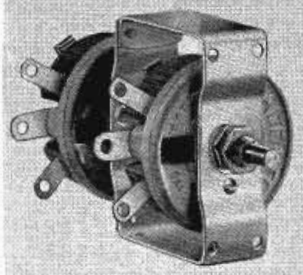
RHEOSTATS • RESISTORS
TAP SWITCHES

Industry's First Choice

OHMITE MANUFACTURING COMPANY
4906 Flournoy Street — Chicago 44, Illinois

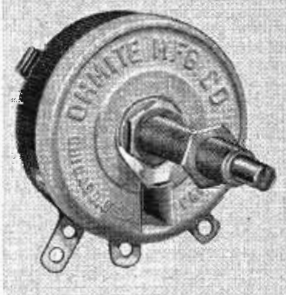
TANDEM ASSEMBLIES

Ohmite rheostats can be mounted with two, three, or more in tandem, for simultaneous operation of several circuits by one knob.



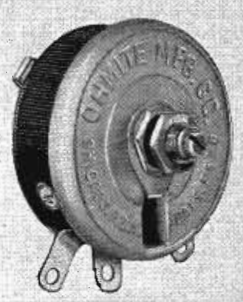
with BUSHINGS for special panel thickness

Rheostats can be furnished with extra-long bushings and shafts for panels over ¼" and up to 2" in thickness. Five bushing lengths.



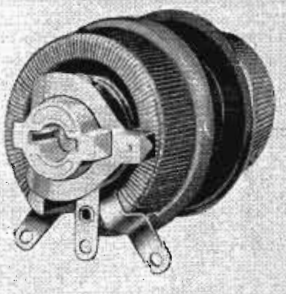
with SCREW DRIVER SLOT SHAFT

Shaft ends can be slotted for operation with a screwdriver, where few adjustments are needed. Minimizes tampering with setting.



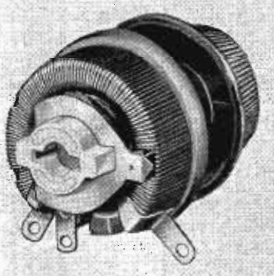
with DEAD LUG OFF-POSITION

Opens the circuit at the high resistance position as the contact passes on to the lug, which is disconnected from the winding.



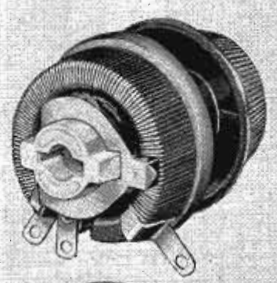
with SNAP-ACTION OFF POSITION

Opens the circuit at the high or low resistance position. The contact brush snaps into an insulated notch next to the lug, providing indexing.



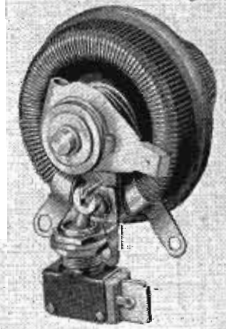
with DEAD-SECTION OFF POSITION

Opens the circuit at the high or low resistance position as the brush passes off the lug onto an insulated section. Medium duty.



with TOGGLE SWITCH

Toggle switch is operated with a positive snap by the rheostat arm at either end position. Used for heavy duty applications.

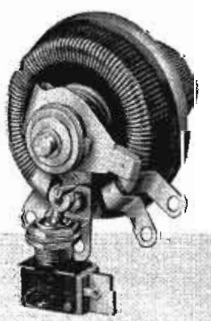


in TABLE MOUNTING CAGES

Used to prevent mechanical injury to the rheostat or human contact with electrically "live" parts. Tabletop mounting, ventilated enclosures.

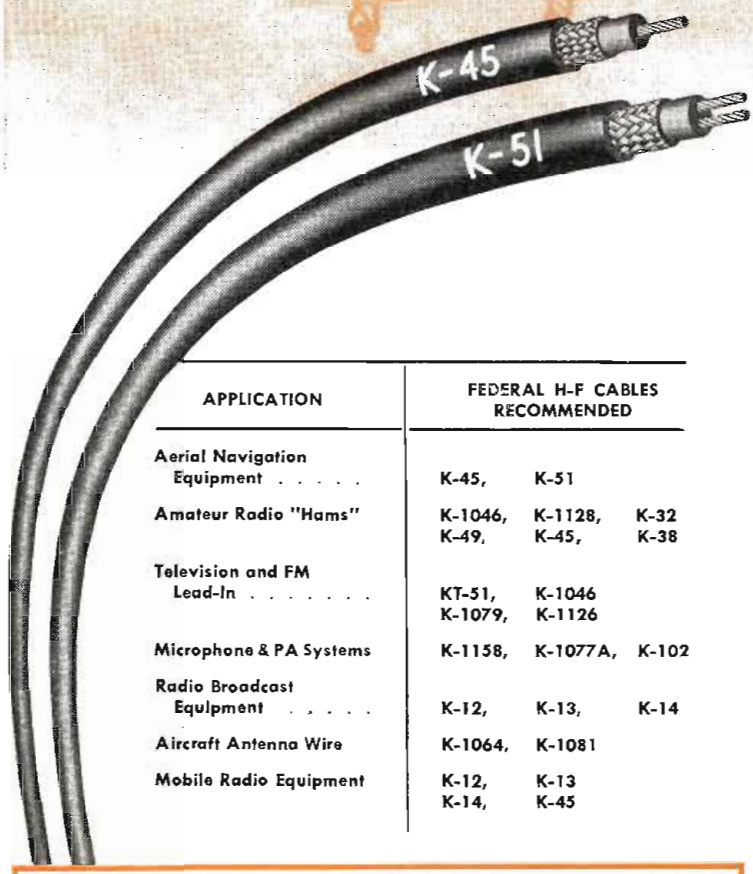
with TOGGLE SWITCH and EXTRA LUG

Permits dual switching of rheostat and independent circuits. Rheostat winding is terminated at an extra lug located where the switch opens.



WHERE SAFETY COMES FIRST!

These Federal H-F Cables are helping to make instrument landing systems safer.



APPLICATION	FEDERAL H-F CABLES RECOMMENDED
Aerial Navigation Equipment	K-45, K-51
Amateur Radio "Hams"	K-1046, K-1128, K-32, K-49, K-45, K-38
Television and FM Lead-In	KT-51, K-1046, K-1079, K-1126
Microphone & PA Systems	K-1158, K-1077A, K-102
Radio Broadcast Equipment	K-12, K-13, K-14
Aircraft Antenna Wire	K-1064, K-1081
Mobile Radio Equipment	K-12, K-13, K-14, K-45

DATA FOR K-45 AND K-51 CABLES

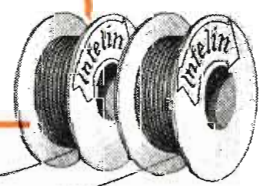
Nominal Attenuation (db/100ft)	K-45	K-51
at 30 Mc	.....	1.7
100 Mc	2.0	3.6
300 Mc	4.0	7.0
400 Mc	5.3	10
1000 Mc	8.5	.....
3000 Mc	17	.....
Characteristic Impedance—Ohms	52	95
Capacitance per Foot (uuF)	29	16
Volts (rms)	15000	5000

.. and you get the same dependability and performance in Every Federal Cable — for Every High-Frequency Application

AT MAJOR AIRPORTS from coast to coast, Federal's high-frequency cables, Types K-45 and K-51, are being used for the most vital of all electronic jobs — in instrument landing systems for aircraft! This selection of Federal cables is a recommendation that assures top performance for *all* of its varied uses, covering the entire high-frequency spectrum. For Federal makes the world's largest quantity of high-frequency cables, of greatest variety.

Wherever high-frequencies are used — wherever superior performance and dependability are required — you'll find Federal cables on the job. Their unusually low attenuation losses assure maximum energy transfer with minimum radiation. And their flexibility, resistance to weathering, abrasion and corrosion, mean longer life, even under the most severe conditions.

Write for Federal's latest bulletin — Dept. D-66.



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.

Make it MALLORY... and Make SURE

Types and sizes vary, but standards of quality never!

YOU don't need more than an elementary knowledge of vitreous enamel resistors to know that if they're conservatively rated to withstand severe overloads . . . if they're solidly constructed and strongly resistant to moisture, fumes and heat . . . if they're more reliable, more accurate and have a better appearance than the average . . . they're the kind of resistors *you* want. Mallory resistors *are* that kind, and that's why you'll find them in so many communications, industrial and laboratory applications, or whenever dependability is essential.

The Mallory line includes a large variety of standard fixed tab, adjustable and ferrule types . . . the famous series of "RN" resistors that meet JAN Specifications, Characteristic F. There are many different sizes and wattage ratings available, but the emphasis always is on premium quality. Write for our Engineering Data Folder giving full information, including charts and photographs, on all Mallory Vitreous Enamel Resistors.

P. R. MALLORY & CO. Inc.

MALLORY RESISTORS

(FIXED AND VARIABLE)

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

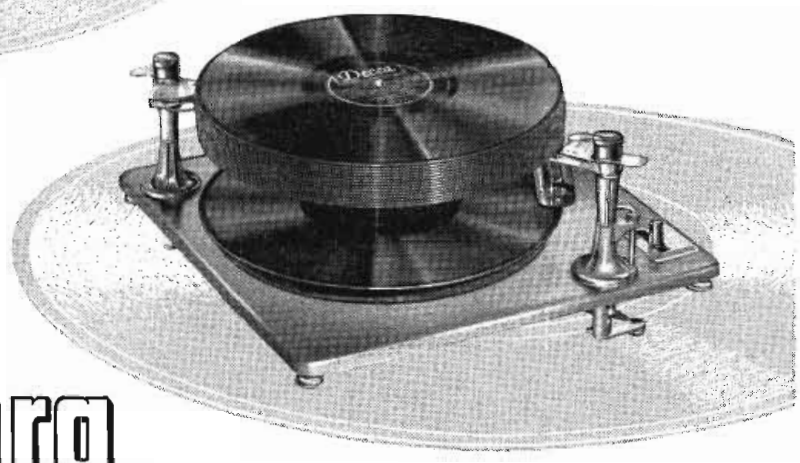
Seeburg's ON RECORD WITH THREE FINE CHANGERS!

You know how much a dependable record changer can contribute to the performance of a radio-phonograph combination. Then why not go on record with Seeburg Changers in the phonographs you manufacture?

Seeburg produces three changers—the new intermix "M", the "L" and the "K". While each is designed for combinations of varying price range, all three are engineered to provide the last word in listening pleasure. When the changer is a Seeburg, you can count on quiet, simple operation . . . constant, sustained speed . . . minimum time between changes . . . long record life.

Seeburg "M" *Three-post construction. CAPACITY: fourteen 10-inch records, or twelve 12-inch records, or twelve 10 and 12-inch records intermixed. SIZE: 14¼ x 14¼ inches.*

Seeburg "L" *Two-post construction. CAPACITY: fourteen 10-inch records, or ten 12-inch records. SIZE: 14¼ x 14¼ inches.*

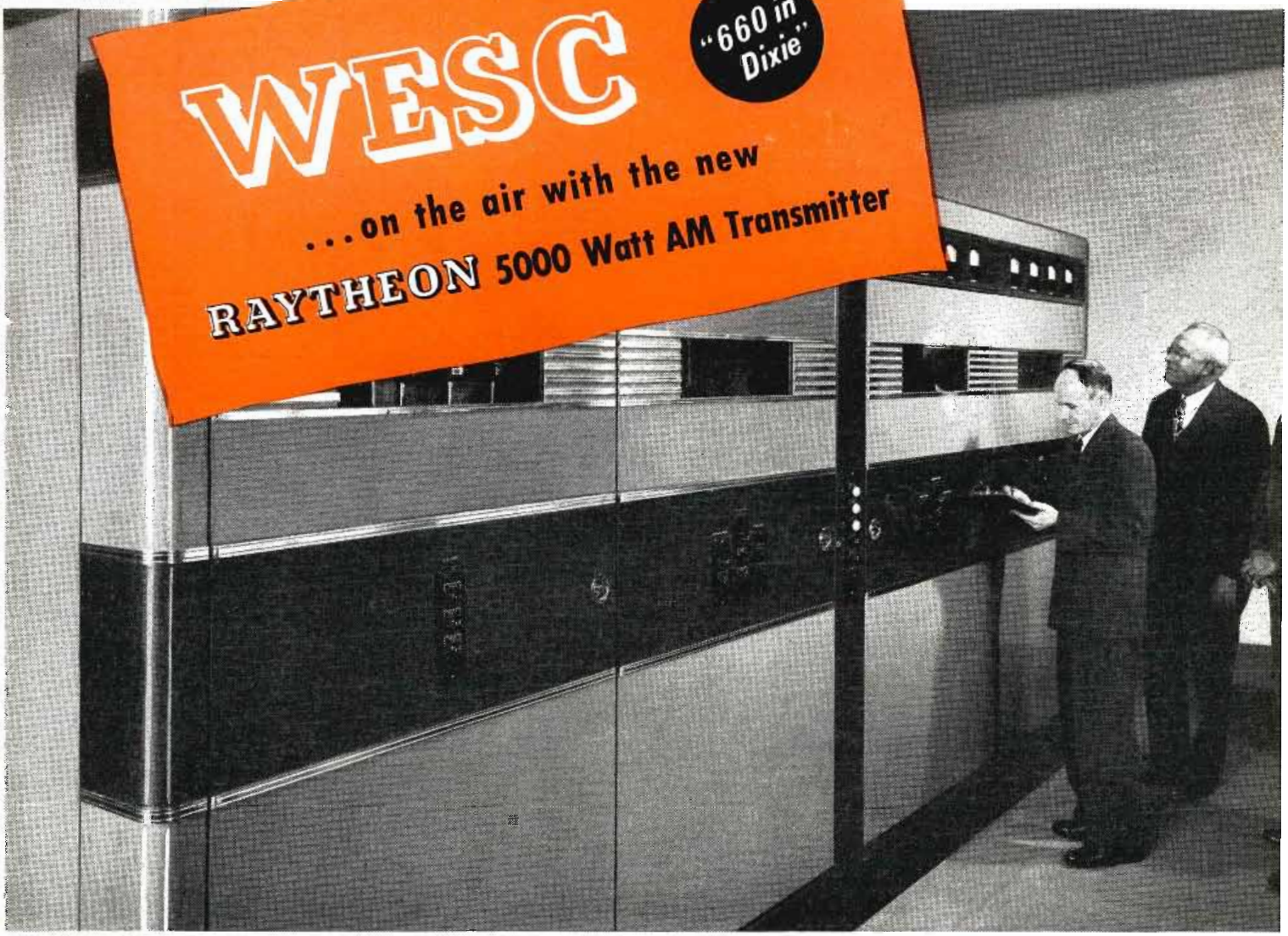


Seeburg "K" *Two-post construction. CAPACITY: fourteen 10-inch records, or ten 12-inch records. SIZE: 12½ x 12½ inches.*

Seeburg

RECORD CHANGERS ★ MUSIC SYSTEMS

J. P. SEEBURG CORPORATION
1500 N. Dayton Street · Chicago 22, Ill.



Exacting specifications of South's most powerful independent station met by RAYTHEON precision engineering

We're mighty proud to see "660 in Dixie" on the air with a complete station installation featuring Raytheon's modern new 5000 Watt AM Transmitter.

Big station engineers all over the country designed this transmitter. It is custom-engineered to their specifications, to give *you* exactly what you've always wanted—providing the utmost in broadcast excellence and reliability.

Consider just a few important points of superiority: HIGH FIDELITY SIGNAL • SIMPLIFIED CIRCUIT DESIGN • LOWER OPERATING COST • AUTOMATIC RECYCLING • COMPLETE OPERATIONAL CHECKS • FAST, EASY MAINTENANCE—through convenient servicing from within • INSTANTANEOUS POWER REDUCTION for nighttime operation.

Truly, Raytheon is establishing new standards of excellence in broadcast equipment. Get all the facts before ordering *your* transmitter. Write or wire today for eight-page illustrated folder, including complete technical specifications and schematic diagram.

The Raytheon Control Console provides fully automatic remot control of all transmitter operations, plus ample studio switchin facilities for emergency programs originating at the transmitte

RAYTHEON

Excellence in Electronics

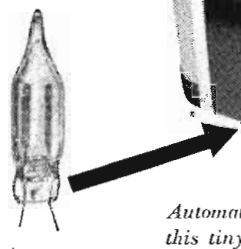
RAYTHEON MANUFACTURING COMPANY
COMMERCIAL PRODUCTS DIVISION
WALTHAM 54, MASSACHUSETTS

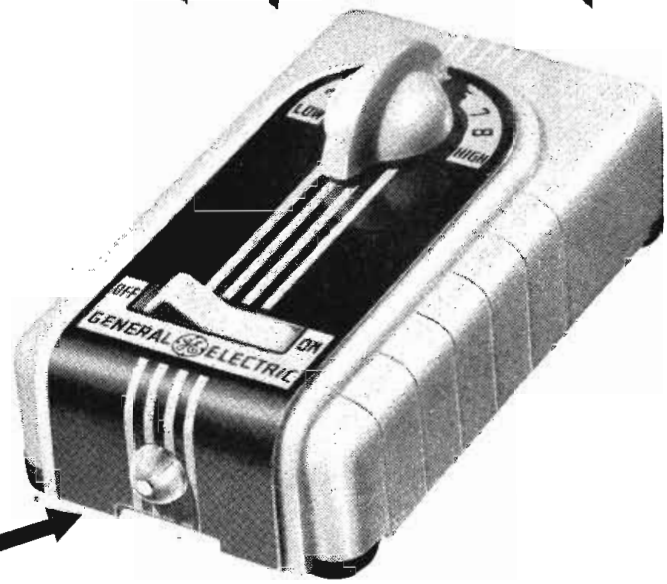
Devoted to Research and Manufacturing for the Broadcasting Industry

It stays awake to help you sleep

EVER see a blanket with a brain? This little bedside control case is the "brain" of the General Electric Automatic Blanket — the last word in sleeping comfort. It keeps the blanket at the right warmth, despite changes in room temperature. An important feature of the control case is the G-E Neon Glow Lamp that lights up when current is on and serves as a reminder to turn off the blanket in the morning. This tiny lamp uses less than two cents worth of current a year!

Successful appliances for every home use are similarly equipped with G-E Neon Glow Lamps—*"the glow that lets you know."*



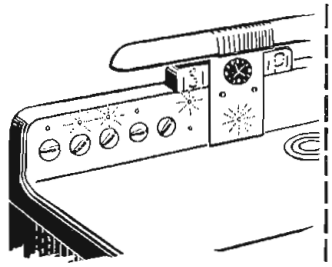


Automatic blanket control keeps an eye open all night — this tiny G-E lamp, that glows when blanket is "on."

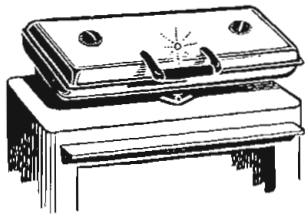
...and it keeps an eye on profits too!

TYPICAL APPLIANCES USING G-E GLOW LAMPS

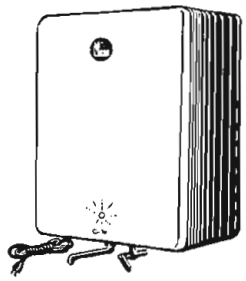
AUTOMATIC IRON *uses glow lamp to indicate when heat is just right.*



ELECTRIC RANGE. *Glow lamps indicate when any switch or any oven setting is "on."*



IRONER. *Glow lamp pilot light helps to avoid leaving appliance "on" by mistake.*



WATER HEATER. *Glow lamp lights up when desired water temperature is reached.*

THESE few appliances merely hint at the hundreds of ways General Electric Glow Lamps are used to add convenience, beauty, safety and sales appeal to electrical equipment of all kinds. Perhaps you, too, will find a valuable profit opportunity in the following G-E Glow Lamp features:

1. Distinctive orange-red glow—high visibility.
2. Dependable long life—NE-2, featured above, has life rating in excess of 25,000 hours.
3. Low current consumption—as little as 1/25 watt.
4. Low brightness, low heat.
5. High resistance to shock and vibration.
6. Can be installed in small space.
7. Variety of sizes and wattages.
8. Operate directly from regular 105-125 and 210-230 volt circuits, AC or DC.

REMEMBER—***Every electrical device should have a live circuit indicator. G-E Glow Lamps are ideal for this purpose.***

SEND FOR free bulletin containing full information on G-E Neon Glow Lamps and their application to your product.

G-E LAMPS

GENERAL ELECTRIC

Nela Specialty Div. Lamp Dept., 1 Newark St., Hoboken, N. J.

The Collins 18S-1 Aircraft Transmitter-Receiver

Reliable Aircraft Communication for Commercial and Executive Planes

The Collins 180K-1 Antenna Loading Unit

Commercial airlines and owners of executive type planes have found that the Collins 18S-1 gives them the dependable long range communication they want. They are able to establish and maintain firm contact with ground stations, even under adverse conditions.

The 18S-1 delivers more than 100 watts of power on any of twenty crystal controlled frequencies. The receiver section, of superheterodyne design, also has twenty crystal controlled frequencies. Frequency range is 2.7-12.0 mc. After the equipment has been pretuned to desired channels, all frequency selection is automatic. Remote control is provided.

A single 1½ ATR unit cabinet contains the transmitter, receiver, and dynamotor power supply. The receiver operates directly from the 28 volt d-c power source. Weight, including shock-mount, is 60 pounds.

Other models:

The 18S-2 *includes CW facilities.*

The 18S-3 *includes CW facilities and has a frequency range of 2.7 to 18.0 megacycles.*

The 180K-1 antenna loading unit efficiently transfers the power output from an 18S to any standard commercial fixed antenna. Remote controlled, pretuned operation for ten channels is provided. Nominal input impedance is 50 ohms. Weight 12 pounds. Size 12″ w, 7½″ h, 10½″ d.

IN RADIO COMMUNICATIONS, IT'S . . .

COLLINS

COLLINS RADIO COMPANY, CEDAR RAPIDS, IOWA

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

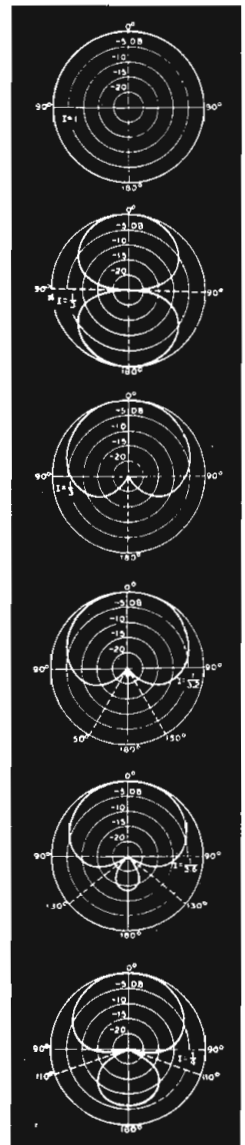
AM-FM-TV

...the ideal mike for all 3

Broadcasters keep on buying more and more of these popular Western Electric Cardioids. That's because they deliver quality performance, are attractive in appearance, and offer six pick-up patterns . . . omni-directional, bi-directional, true cardioid and three modified cardioid patterns . . . which enable you to master 'most any pick-up assignment in AM, FM, or Television broadcasting. For all-around *quality* of pick-up—there's *nothing better than a 639B Cardioid.* For full information, get in touch with your local Graybar Broadcast Representative or write Graybar Electric Co., 420 Lexington Avenue, New York 17, N. Y.

Western Electric 639B CARDIOID

Performance... Appearance ...Versatility



These six pick-up patterns are available with the 639B Microphone.

Distributed by Graybar
OFFICES IN 95 PRINCIPAL CITIES

— Quality Counts —

TELE·TECH

Formerly the TELE-communications TECH-nical Section of
ELECTRONIC INDUSTRIES

O. H. CALDWELL, EDITOR ★ M. CLEMENTS, PUBLISHER ★ 480 LEXINGTON AVE., NEW YORK (17), N. Y.

Pulse Possibilities Loom Large

Pulse technics for communications purposes are attracting an increasing amount of attention. Already several such systems have emerged from the laboratory stage, have demonstrated their value for commercial applications and appear to hold great promise in multiplying the usefulness of an already crowded spectrum.

How far pulse methods can be carried is still an engineering question, but advantages so far revealed indicate the need for continued, and accelerated, investigation. There are those who hold that pulse technics have no inconsiderable possibilities for broadcasting, particularly for FM—perhaps for TV—and that some day soon the industry may be in for a revolution.

TV's Increasing Appeal

A group of radio men who have television sets, were recounting their experiences "looking in" on TV, day after day, month after month. All agreed on one point, to wit: Not until one has a television set in his own home and uses it nightly, does he fully realize the tremendous impact of television as a new force in everyday living! All these men had heard the familiar television arguments for years, and were only casually impressed. But when some circumstance actually put a TV set into the living-room, a new enthusiasm affected the whole family.

This is evidence that the new television industry is being built on a mighty sound basis, as members of the general public duplicate these experiences. It means big growth and development for all who have a part in the coming TV era.

Space-Radio's Beginnings

Full moons of recent summer evenings remind us that radio liberties with Luna's fair face were first considered just 18 years ago. For it was in 1929 we learned from a personal visit to the Naval Research Laboratory at Washington, D. C. that Dr. A. Hoyt Taylor even then considered radio reflections from the moon perfectly feasible.

Dr. Taylor had been picking up delayed echoes of as much as a quarter of a second, corresponding to two complete encirclements of the globe. From this he estimated that a ten-fold increase in either transmitter power or receiver sensitivity should get echo signals from the moon, 238,000 miles distant. Later, on 32 mc, a bulky fixed array was tested when the moon came within its beam, but without adequate power, definite results were not obtained.

But as all the world now knows, it was from this radio-echo work that radar itself was born!

Noise Pressure of Fish Sounds

It is now well known that sensitive hydrophones used to detect the presence of enemy vessels, submarines, torpedoes and other engines of war, were seriously affected by the noise made by schools of fish. These fish sounds often gave false alarms and caused great confusion. Extensive work resulted and numerous records were made at the Navy's Underwater Sound Laboratory at New London, Conn., of various kinds of fish noises.

Interesting to note is that schools of fish managed to create a sound pressure of around 100 dynes per sq. cm, in the water. As to the kinds of noises made, these vary from grinds and hisses to roars similar to those made by sea lions at the Zoo.

THE ENGINEER MUST RE-ORIENT HIS THINKING. *He must act in a way that will give his special training and abilities greater influence on industry and on society. He must adjust his ideas to a new set of standards for personal conduct. The responsibilities that go with any type of engineering are enormous, and now more than at any other time in the world's history the "man in the street" should be able to look to the engineer for guidance in a scientific world. I am confident that application of the orderly thinking and the precise method of science to the problems of society would pay as high dividends as they have in the production of material wealth.—Dr. C. B. Jolliffe, Executive Vice-president, RCA Laboratories, Princeton, N. J.*

Pulse Code Modulation Method

Instantaneous sampling of speech represented by multi-unit code of on-or-off pulses permits distortionless reconstruction without noise

• At one time the whole communication art found it possible to get along with only two forms of modulation—amplitude and frequency. Now the engineer who can even enumerate the various modulation methods in use is in a class by himself. A few of the newer methods under serious investigation are pulse amplitude modulation, pulse frequency modulation, pulse time modulation, pulse width modulation, and the method to be described here—pulse code modulation, (known also in some quarters as pulse count modulation.) A comparision of these systems is illustrated in Fig. 1.

Most of the newer communication systems use modulation methods based on time variations, so as to get away from difficulties attending the transmission of amplitude level variations. As indicated, most of them are pulsed systems. The first consideration in analyzing the value of any modulation system is its capability of transmitting speech with clarity under all practical operating conditions. Circuit noise and interference on long circuits, where many repeater points are required, may build up to values greatly in excess of what the service can tolerate. A problem of similar nature may occur when an uhf communication circuit is established with many relay points. For example, the PCM system, illustrated at the bottom of Fig. 1 has important capabilities inasmuch as there is a chance of reconstructing pulses at repeater points so that the accumulation of noise effects over long circuits is avoided. All one needs to do is to reconstruct or "regenerate" the pulses before they have deteriorated to where the noise approaches the signal level.

WITH the development of coded pulse transmission for the first time the cumulative noise no longer affects transmission over long circuits, because it permits the regeneration of the pulses to their original characteristics at each repeater point. The system is known in some places as pulse count modulation.

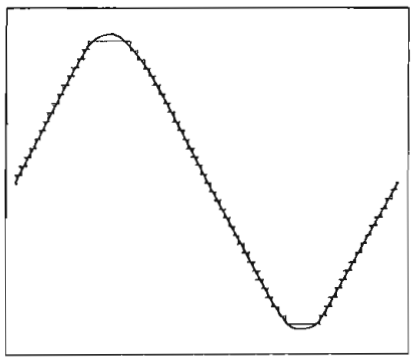
PCM is expected to find great use in conjunction with pulse transmission over microwave radio relay communications systems on which many simultaneous conversations can be carried. In such transmissions the higher quality requirements can be attained by using a six or seven digit code.

Theoretically there need be no distortional effects attending any type of pulsed modulation system, provided the ratio of the audio frequency to the pulsing frequency is less than 0.5. However, good intelligibility in communication also depends on other factors besides transmitting a certain minimum range of audio frequencies. Practically it has been found that in commercial communication systems having intelligibility capabilities suitable for average applications, the pulse rate can be almost as low as twice the value of the highest audio frequency to be transmitted. In this discussion a value for the latter of approximately 4000 cycles will be assumed, which calls for a minimum pulse rate of 8000 p.p.s.

Of course this means that some cycles of the speech wave, having a fundamental near the upper end of this transmitted band would be represented by only two pulses, but lower down, at frequencies near and below the middle frequencies a cycle of the waveform would be sampled ten or more times at equispaced intervals during its length.

This condition is found with all forms of modulation where the wave is sampled as to its amplitude at definite intervals. It must be kept in mind that the amplitude of the wave that is found during the passing of some particular pulse may depend on both from the summation of the instantaneous levels of cycles of many different unrelated frequencies that may appear in the voice wave at that instant, and the average sound level of the speaker's voice. To carry an accurate picture of all these conditions many levels of amplitude must be portrayed accurately. This holds for all pulse modulation systems. They differ only in the methods whereby the AM pulses are converted to forms that will pass the data relating to the amplitude levels through the system to the detector without thereafter actually dealing with those amplitudes as such.

Fig. 2—Instantaneous amplitudes of a wave are represented by 32 discrete level notations



for Multi-Channel Telephony

By RALPH R. BATCHER,
Consulting Editor, Tele-Tech

The advent of many new pulse-handling technics using electron tube circuits has made practical the utilization of many modulation schemes that once would have been considered fantastic because of equipment complications. At present, pulses now can be controlled as to amplitude, rate of recurrance, length (or duration), and wave shape, by simple circuits. In the following analysis the term "pulses" describes the envelope of the carrier that handles the modulating information, with no regard to the actual number of carrier frequency cycles composing each pulse.

In any pulsed system it is possible to utilize the idle time between pulses for several other series of pulses, interleaved but offset as to time with respect to the original series. Time division will permit, say, eight or more separate conversations to be carried on simultaneously, each channel operating during its allotted intervals.

Two papers (1), (2) have recently been presented covering the basic concepts of pulse code modulation, describing two methods for carrying out the process. This article will review briefly the basic concepts of the system as reported in these papers.

Basically the PCM concept is unique among pulsed modulation systems. As with other pulse methods a number of samples are in effect taken of the amplitude of the voice wave, at a rate that will give at least two per cycle for the highest frequency but many more than this at lower tones as previously described. These samples are short pulses whose amplitude represents the instantaneous height of the signal wave at the selected time intervals. Where the system differs is that information as to these heights is conveyed over the system by a special code, usually

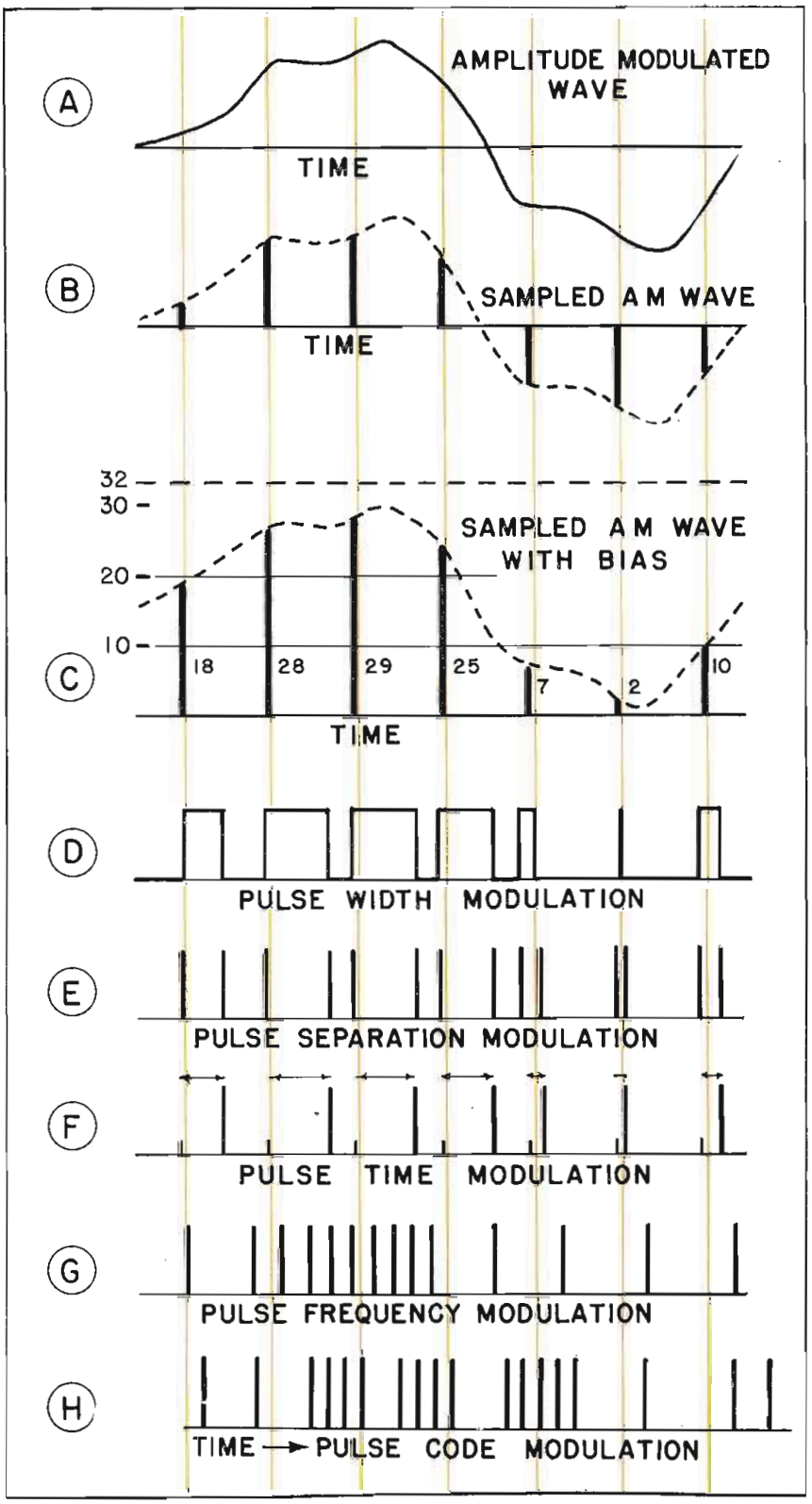


Fig. 1—A comparison of pulse modulation systems with the basic PCM system of sampling AM wave, shown at C, with coded equivalents of the seven sample pulses shown at H

a five-digit code permitting the handling of $2^5 = 32$ levels as described later. This would permit any possible amplitude level to be described by noting which step in the 32-level standard system is its nearest equivalent, (as in Fig. 2). Each step in this series is designated by a coded signal. These code conversions are made automatically by special electronic circuits.

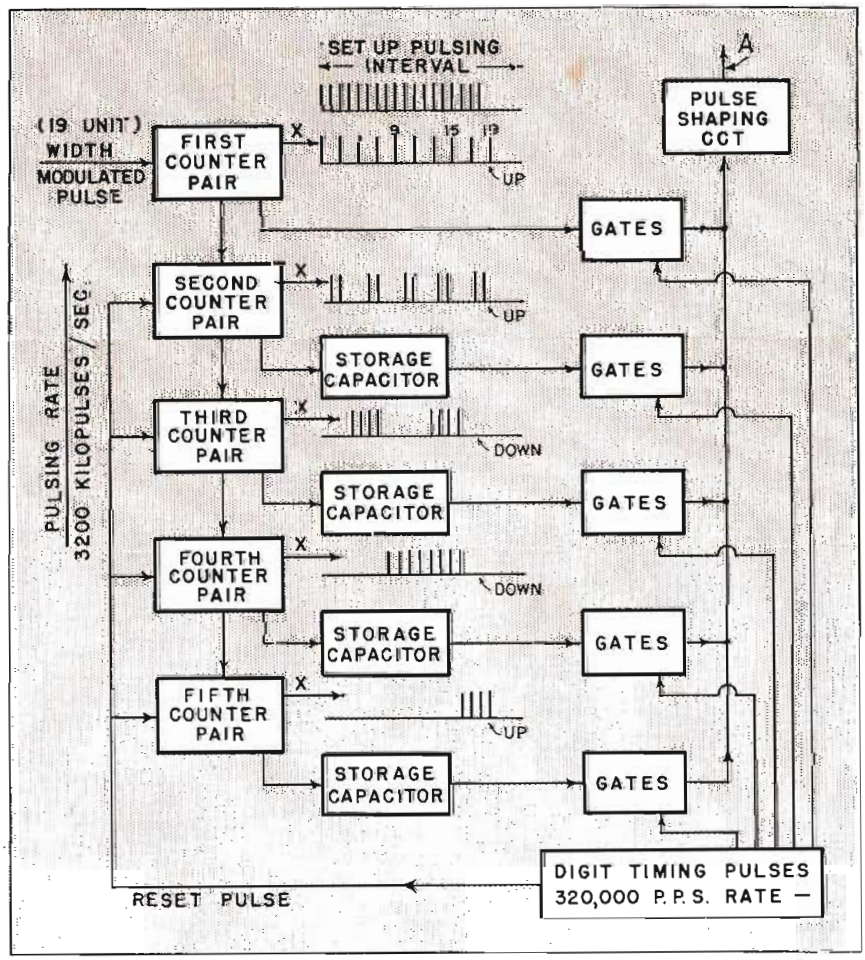
The use of codes in transmitting intelligence is very old. In the Morse code, combinations of two pulse-duration intervals handle all the transmitted information, but the unscientific manner in which the code was set up* prevented the utilization of simple electrical circuit coders and decoders to do the translation. Complete automatic operation was impractical. The teletype code was better in this regard since it permitted combinations of relays to operate or not, simultaneously, to set up and print the desired character.

In the pulse code modulation system information concerning the amplitudes of the successive pulses, obtained by sampling the voice wave signal, is transmitted by sending out the correct succession of code signals. The resulting code shown in Fig. 2 seems to be formidable, but the value of this particular arrangement can be explained.

First it uses the binary system of counting whereby a plurality of information units can be specified uniquely by particular combination of two-valued digits. For example, a single pulse system could telemeter two values of information such as "yes" or "no," "up or down" etc. By permutation a two-pulse code could convey four levels, "off-off," "off-on," "on-off" and "on-on." Similarly by ordinary permutation rules, a three-pulse code would handle 8 levels, etc. The exact relation in this binary system is that N code digits will convey 2^N discrete values of information. Next, the binary system of counting is readily handled by electron tubes. The code uses exactly the same operating sequence found in the well-known scale-of-two counting systems used in G-M counters, etc.

* The Morse code was based on the plan of having the simpler combinations represent the most often used letters, an excellent plan for manual operation but less efficient and complex in automatic systems. On the other hand the code used in the teletype system has a definite number of on or off signals in a group representing each character.

Fig. 3—Method of counting up equispaced pulses and converting to coded equivalent. Output waveform at (A) is shown as item 19 in Fig. 2A. Operating times of counters are shown at X. At the end of the 19th pulse, first, second and fifth counterpairs are left operated



Decoding Methods

At the receiving end, the waveform is reassembled according to the 32 levels of signal amplitude as indicated by the decoding of pulses. The process is not unlike that of plotting a curve on graph paper from the information assembled on data sheets, but in the PCM arrangements all coding and decoding is done automatically and very rapidly with electronic circuits. As usually set up, 16 of the 32 code units show amplitudes in the negative direction and 16 in the positive direction. Each single code group consists of from zero to five successive pulses present or absent from assigned positions in the group.

Another advantage of the system is that a sort of logarithmic relation exists between the number of digits in the basic code and the capability of the system—the addition of one digit in any case doubling the accuracy of the transmission. Six-pulse code would give 64 levels, and seven pulses 128 levels, etc. A seven-pulse code system is sufficient for high quality message service.

Lastly the pulse levels can be converted to a binary code signal by simple electronic circuits at extraordinary speeds — several hundred thousand complete code combinations per second being a commonly used speed. Similar circuits can be used to decode the signals and to reconstruct the original waveform from the resulting information.

An experimental system of producing such coded signals from amplitude changes of the sampled pulses, shown in Fig. 3, as described by Black, [1] was set up to produce eight voice channels on a time sharing basis. The system uses

[1] A. S. Black and J. O. Edson, (BTL) presented at Summer Meeting AIEE 1947 "Pulse Code Modulation."

a chain of five scale-of-two counter pairs. This arrangement, long used in numerous other applications, consists of a succession of so-called flip-flop circuits. In this case it might contain ten tubes in five pairs, with cross connections between the pairs so that no more than five of the tubes can pass anode current at any instant. The five pairs are interconnected so that the first pulse will operate the first tube in the first pair. The second pulse will operate the second tube (thereby releasing the first tube), and the operation also sends a pulse into the next pair. Each pair delivers one pulse to the output for each two pulses received so that the last pair does not "operate" until 16 pulses are received.

Therefore in this PCM system each column of digits shown in Fig. 2a can be handled by one pair of tubes in such a counting chain. Here the second tube of the first pair alternately operates and releases on successive pairs of pulses. The process continues through other pairs and the last pair operates on the 16th pulse and stays up for 16 more. Here the word "operate" refers to a conductive state in the second tube of the pair.

As described by Black, the 8-channel system operates as follows. The voice signals in each channel are first passed through a low-pass filter (4kc cut-off) and applied to a circuit that operates 8000 times a second giving a sample of the voice signal amplitude in the channels at those intervals. These sampling pulses have uniform length but vary in amplitude. For multichannel, time-shared operation, between the sampling pulses of any one voice channel, samples of the amplitudes of seven other conversations are successively taken.

This is accomplished by two frequency dividers; one a scale-of-five ring counter which delivers a series of pulses at 1/5 the standard frequency rate (i.e. 64,000 cycles) and a scale-of-eight ring counter which distributes this series of pulses into eight circuits, each then receiving 8000 equispaced pulses per second. Each pulse length is equivalent to one-half cycle of the 64,000 cycle frequency, that is, nearly 16 microsecond duration.

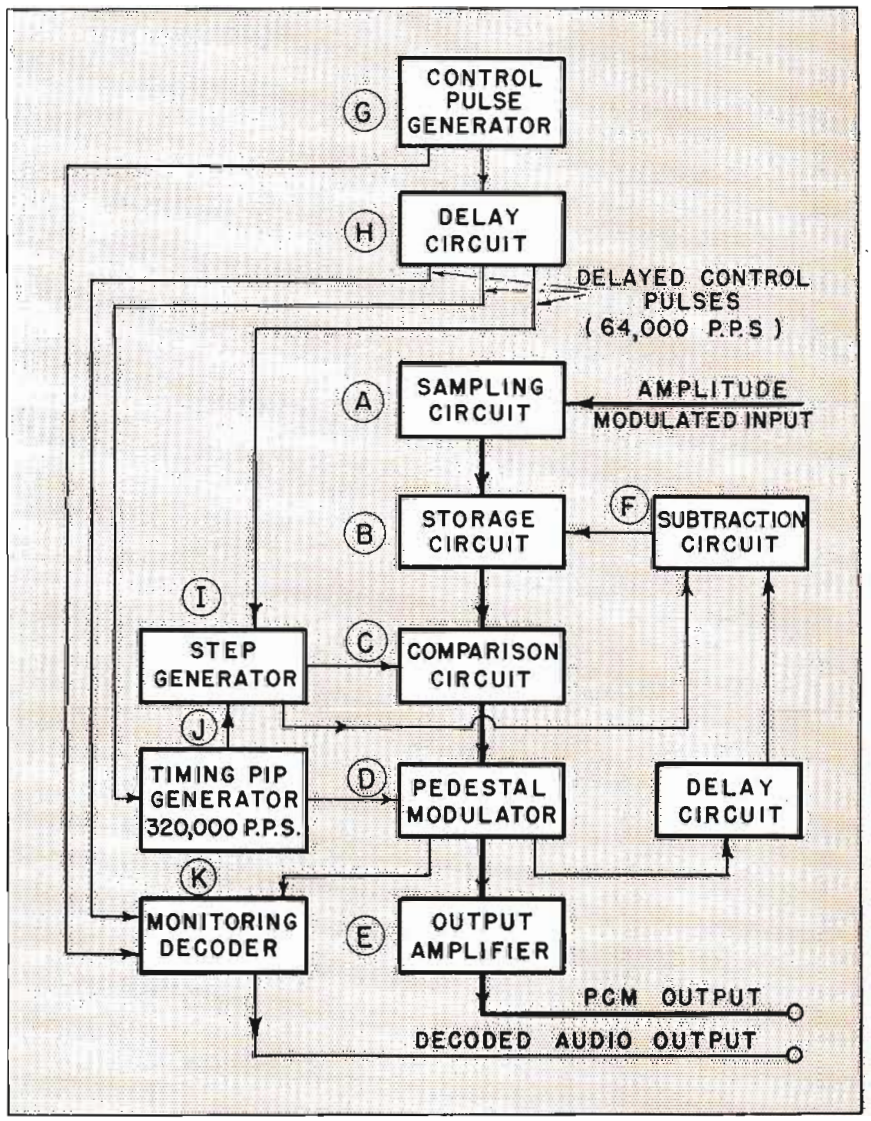
They are then converted by electronic circuits to pulses having constant amplitude and lengths having a logarithmic relation with respect to the original amplitude. The starting times of the pulses are still equidistant so that the condition so far is the same as in a pulse length modulation system (Fig. 1). In the latter, however, the logarithmic relations are not necessarily maintained.

Logarithmic Conversion

In this logarithmic conversion from AM to length-modulated pulses, a capacitor is charged with a potential that is definitely related to the height of the amplitudes of the sample pulses. The time required for this capacitor to discharge to a specified voltage depends on the strength of the charge, so the duration of the discharge current furnishes a means of obtaining pulse length modulation, each pulse having a definite starting time and a duration that is varied as required.

These PLM signals are used to key a 1600-kc sine wave signal (obtained from the amplified fifth harmonic of the 320-kc signal) which sends a group of pulses representing half cycles of the 1600-kc signal into the first stage of the five digit binary counter described above. Depending on the width of the keying pulse, from 0 to 31 counting pulses get through and set up the code signal. When the count has been established and the tubes are either "operated" or not, a rather intricate problem must be

Fig. 5—Block diagram of PCM transmitter coder. Values stated assume system requirements similar to Fig. 3. Original charge on capacitor (B) is reduced step by step by subtraction circuit, and remainder compared with local voltages



handled—the conversion of the information resulting from the condition of the counter tubes into a transmittable code signal.

At the end of each count this is done by having each pair of the binary counting system "condition" a storage capacitor whenever the pair is at its "operated" level. These counters have already converted the particular value of the 32 possible signal levels into a five-digit setup combination. This combination appears simultaneously but must be read off consecutively, since the pulses occupy assigned positions in a group.

This is handled by picking off in succession the potential of those storage capacitors of each counter pair which has been left operated as described above. To do this gating, amplifier tubes are connected to each storage capacitor and are turned on one after the other in quick succession to "report" whether its own particular binary pair is operated or not.

Incidentally, a reset pulse restores the counters to their normal quiescent state to await the next series of pulses coming along approximately 16 microseconds after the start of the first set.

Briefly, the rest of the system uses typical pulse handling technics. The output from this pulsed amplifier is a series of up to five more-or-less similar pulses having definite time positions in a group. They are then applied to a pulse shaper to equalize their shapes and duration. The shaper delivers an output of pulses at a 320 kc rate, having uniform amplitude and duration. The transmitted signal contains a prominent 320 kc component that is separated out at the receivers by tuned amplifiers to produce a synchronizing signal. This signal is divided by 5 and then by 8 to give an 8000 cycle control signal at the receivers. This division develops an ambiguity, however, which must be settled by "framing" pulses or other synchronizing methods known in other fields.

At the receivers, the five-digit code groups are decoded in a manner somewhat the reverse of the above, and the resulting amplitude modulated pulses are passed through a low pass filter to reestablish the voice channels. PCM requires (with the foregoing frequency and channel assumptions) the transmission of a 320-kc pulse rate over the system. Such signals have been transmitted successfully over radio and a transmission path whose bandwidth was limited to 420 kc. The bandwidth requirements per channel are somewhat higher than with some of the older systems of modulation.

A somewhat different approach to the coding and decoding problem has been described by Goodall(*). This system accomplishes similar results insofar as the transmission of AM pulses into a five-positional signal code is concerned but uses radically different circuits. (It may be mentioned here that a five-digit code is just a nominal value in either case and that codes with more or less digits can be worked up, using either method, if the quality of transmission is to be up-graded or degraded). The experimental circuit developed has been called a "feedback subtraction circuit" and functions as outlined in Fig. 5.

The AM pulses, sampled from the original signal are applied to charge a storage capacitor to equivalent potential levels. This voltage is successively compared as to magnitude with five locally provided reference voltages. The comparison is done with high impedance circuits so that negligible drain on the capacitor charge occurs. The first reference voltage has a value of 16 units, one-half of the maximum of the assumed 32-step range over which the AM pulses might fall. If the capacitor charge happens to be more than 16 units, a pulse is transmitted on into the pedestal modulator which alters its shape and magnitude to conform with a standard, and passes it on to the output amplifier.

Thereafter, after a predetermined delay, a definite reverse charge is transmitted back to wipe off 16 units of charge from the storage capacitor. Of course if the

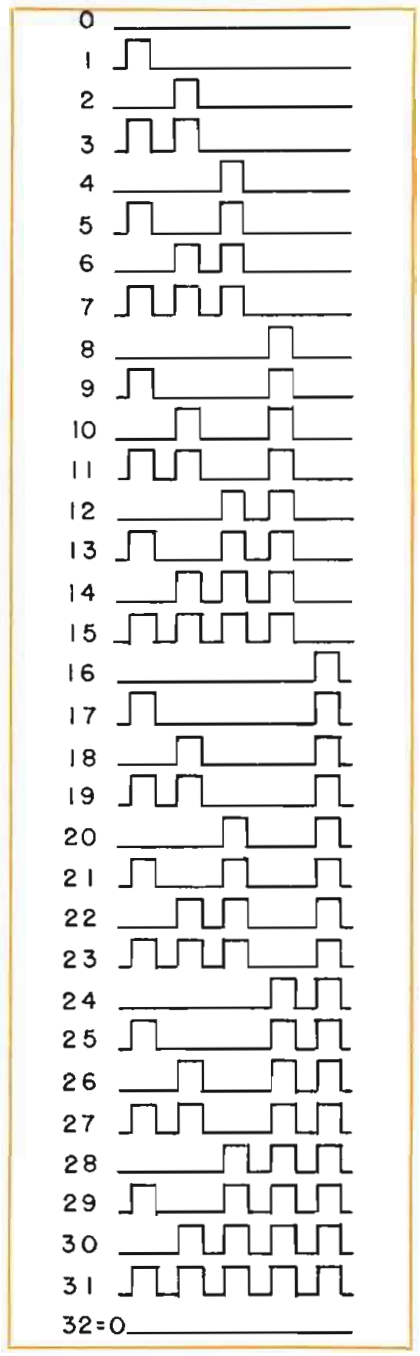


Fig. 2A—32-step code requiring five digit transmission

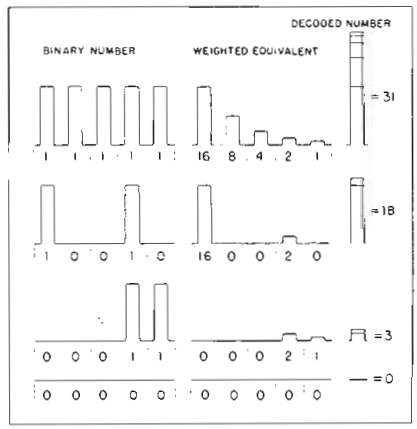


Fig. 4—Method of decoding reported by Goodall sums up the weighted values of the transmitted code

(*) W. M. Goodall (BTL) presented at U.R.S.I. Washington, D.C. (1947) "Telephony by Pulse Code Modulation."

original charge had been less than 16 units, no output pulse would have appeared and no wipe-out voltage would flow from the subtracting circuit. If the charge happened to be exactly 16 units, it would be completely wiped out by reverse charge from the first output pulse. In any case the remaining charge is always less than 16 units, since 32 units represents the total charge possible under the assumed conditions.

Thereupon another comparison is made with an eight-unit reference level and a second digit of the code appears if this remnant is more than eight units of potential. A second charge subtraction of eight units is then made, leaving possibly still smaller levels to be compared subsequently at the four-, two- and one-unit levels. Irrespective of the level of comparison at which it was produced, the output pulse has a constant amplitude and duration characteristic. Its position in the group of five pulses is the sole criterion that shows the importance of the amplitude level that produced it. A complete 32-level code turns out to be the same as that shown in Fig. 2A except that the five digits appear in reversed order—the 16 unit level coming first instead of last and the single unit level at the end. This is a minor detail and it is evident that some arrangement will become standard when commercialization is started.

At the receiving position each pulse of the group of five acts to apply a particular unit of potential to an accumulator circuit as shown in Fig. 4. The first pulse (if present) would add 16 units of voltage; the second, 8 units; etc. If any pulse is missing in the 5-unit group the accumulator receives a lesser charge depending on the position of the missing pulse or pulses.

One of the important advantages of PCM comes from the fact that it uses on-off pulses to carry the modulation data, giving the possibility of regenerating the pulses repeatedly without destroying the information they contain, provided this is done before they have been distorted too badly from noise and selective attenuation of the transmission mediums.

Equipment to regenerate pulses transmits an undistorted pulse even though a distorted pulse is received, and transmits nothing in the absence of an incoming pulse even though a certain amount of noise is possible. A regenerated pulse provides a "fresh" group having conveyed the identical intelligence, a quality similar to the original. Therefore with PCM distortional variations are non-existant and therefore do not add up even in the case of long lines with many repeaters. This feature alone offsets the disadvantage of any possible equipment complications at the terminal positions.

Although the new system is expected to be used primarily as an adjunct to the telephone network, it can also be used to transmit radio programs, pictures and teletypewriter signals. For multichannel applications it is believed entirely practical to build a PCM system on which 100 telephone conversations could be carried at one time. Such a system, if using the seven digit code, would require the handling of some 5,600,000 pulses per second.

New England Engineers Discuss UHF Technics

By the recent action of the Institute of Radio Engineers a plan has been set in operation to permit the sections in various geographical areas to plan and execute activities of local interest in affairs pertaining to that area and as a regional unit to have definite representation to an even greater degree in the national decisions.

A view of what is possible by regional cooperation was afforded by the one day New England "town" meeting held in Boston (May 17), organized by the Boston and Connecticut sections, which make up the North Atlantic region of the I.R.E. Here some 650 radio engineers heard the presentation of six well-selected technical papers and visited the exhibits of thirty equipment manufacturers and representatives.

Such meetings (others in Chicago and Cincinnati have been held) may be forerunners of a series of annual local area meetings aimed to serve members who are not able to attend the off-times over-crowded national conventions.

In the first paper, "A Low Drag Aircraft Antenna" J. V. N. Granger (Harvard) described a novel radiation structure consisting of a recessed, folded dipole element, a part of which is provided by the wing structure itself. Experimental data were presented as applied to a P80 wing.

A review of "Wartime Developments in Wave Guide Theory" presented by J. S. Schwinger (Harvard) gave a rigorous treatment of waveguide structures and accessories, including approximate mathematical approaches to methods of solving design problems.

"Recent Developments in Frequency Stabilization of Microwave Oscillators" was presented by W. G. Tuller, F. P. Zaffarano, and W. C. Galloway, all of Massachusetts Institute of Technology. Tuller described particularly the reference-cavity stabilization scheme of Pound and reported recent developments in this circuit which operated over a wide frequency band, capable of modulation with good linearity. A theoretical stability of 2 cycles per second at 10,000 mc was reported with a 10 cycle per sec. stability at this frequency attained.

In "Design Problems of Frequency Modulation Receivers" Aldo Miccioli, (Associate, Dale Pollack, New London, Conn.) disclosed the problems affecting the design of frequency-modulation receivers including the relative merits of variable-inductor and variable-capacitor tuning. Proper limiter and discriminator design was considered, and the over-all performance of a typical receiver was described.

In a paper, "The Commercial Design of Geiger-Mueller Counter Tubes", Herbert Metten, (Sylvania) introduced a brief survey of conventional methods for detection of radioactivity, followed

(*Continued on page 97*)

Passenger Entertainment Systems for Railroad Use

By JOHN A. CURTIS, Manager, Mobile Communications Div., Farnsworth Television & Radio Corp., Ft. Wayne, Ind.

Four channel equipment giving automatic level control feeds any or all cars with radio or wire recorder programs and train announcements

• The first complete passenger program distribution systems engineered specifically for railway use now are being produced by the Farnsworth Television & Radio Corporation and are being installed by several railroads. In addition to providing sound distribution facilities for recorded music, radio programs and train announcements, these systems have been designed to overcome technical and operating problems encountered in daily railroad use.

Production was undertaken only after the completion of nearly two years of laboratory and field tests. Some of the problems, such as the designing of units which could withstand severe unilateral shock and vibration over a period of many years, and the utilization of special reproducing equipment, were solved through the adaptation of war-born engineering principles not previously used in railway operations.

Care also was taken to make the systems sufficiently flexible to meet the passenger service requirements of any railroad. All cars on a train may be equipped to receive recorded and radio entertainment, for example, or only certain cars such as diners may be equipped. Radio systems without wire reproducers may be used, with more than one radio channel provided. Or a railroad may choose to use only recorded entertainment. The number of channels or scope of program distribution of a system, once installed, may be modified or expanded.

In deluxe installations, a trainline is used to carry four or more program channels to all cars in the train. For example: (1) a channel of semi-classical music, (2) a channel of popular music, (3) a channel of standard broadcast reception, and (4) a channel for travel talks or train announcements.

THE difficulties of providing for satisfactory reception of broadcast programs in passenger cars of moving railroad trains are manifold and have resulted in the development of new technics. Wire recorders appear best suited for "canned" entertainment because of their long-playing ability, immunity to shock interference and lack of loss of fidelity due to wear resulting from continued playing.

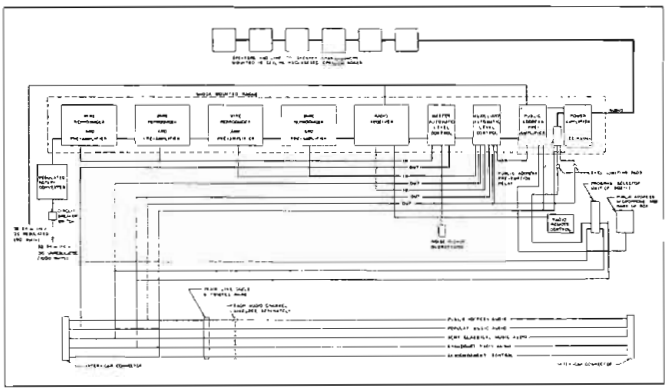
Room passengers may select the channel they prefer, or may listen to none. Chair car passengers as a group have available to them these same selections. The program selecting equipment in chair cars, however, can be operated only by the car attendant, who chooses the type of entertainment most suitable for the occasion. Except in the case of broadcasts of national importance and universal interest, only recorded music usually is distributed in chair cars. Club car passengers as a group have all programs available, subject to the discretion of the attendant, but ordinarily the use of the popular music channel or the radio channel predominates in the lounge car.

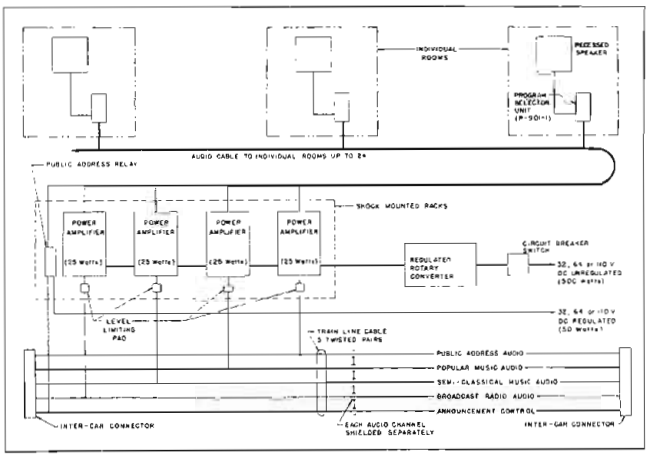
The diner may carry its own separate and fully automatic music system which reproduces special magnetically-recorded luncheon or dinner music. After being started by a pushbutton at the time the meal commences, this system operates unattended during the entire time the diner is open, rewinding the wire and turning off all units automatically at the termination of a three-hour musical program.

In diner installations the "start" pushbutton on the control panel turns on the converter, the wire reproducer and all amplifiers. After the music has played continuously for three hours (or any shorter period desired) all amplifiers in the diner turn off automatically and the recorder begins rewinding. When the wire is completely rewound, the reproducer and the converter automatically turn off, and the channel is ready for re-use.

Wire reproducers, radios and preamplifiers to feed the train-line are located in a locked compartment in the lounge or some other convenient car where only maintenance personnel at terminals have access. This program source supplies all the cars of the trainline except the diner. Remote controls — capable only of turning equipment on and off, selecting the program for the car in which the equipment is located, and changing from one radio station to another—are under the supervision of the car attendant.

All signals are fed to the trainline at about zero level (reference one milliwatt) under the influence





Left is the wiring arrangement for a typical program source consisting of four wire recorders and radio receiver together with PA microphone. Right is a typical room car installation with its channel distribution system

of an automatic level control.

Train announcements may be made from microphones in one or more cars. Announcements automatically interrupt programs in group listening cars, and, if desired, in the diner. Room passengers do not hear train announcements automatically but are notified by a control panel light that an announcement is to be made, thus giving them an opportunity to select the train announcement channel if they desire.

One reason the nation's railroads until recently were hesitant to install electronic equipment aboard trains was the high cost of servicing. Previously, whenever it was necessary to make routine checkups or do maintenance work, train cars containing such equipment had to be moved into a yard and kept out of service while personnel worked on the electronic units. To remedy this uneconomical and impractical practice, unitized plug-in construction has been used in the design of all units in the Farnsworth systems. Automatic breakaway plug-in type connectors on the units permit their removal and replacement with spare units without tools by non-technical personnel within a few seconds. Thus all cars can be kept in service and the equipment units can be taken to the railroad's shop for maintenance or repair work.

Fidelity Requirements

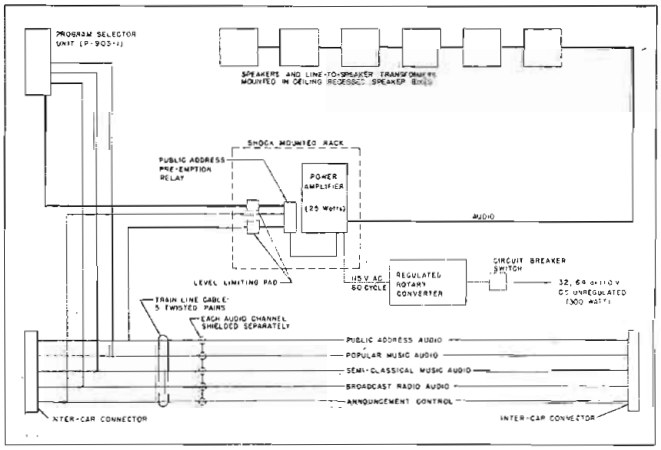
With the rapid postwar increase of FM broadcasting and its approval by the public, it was obvious that basic components of the systems—such as amplifiers, transmission lines and speakers—would have to be capable of rendering flat response beyond the present limitations of standard broadcast stations. High fidelity audio distribution systems were therefore required to secure any advantage from the future reception of FM aboard trains. To assure the long life of the systems and to provide for future FM reception, amplifiers flat 50 to 15,000 cycles and corrected for speaker response were designed.

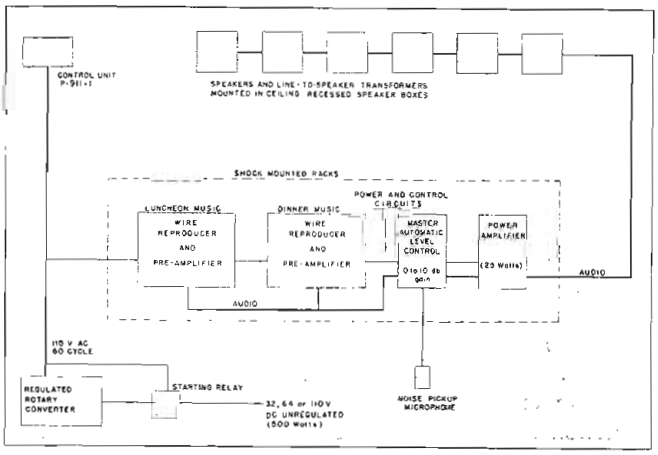
Several factors influenced a decision to use individual high impedance bridging type power amplifiers in each car rather than a single high-level source. Most important, such an arrangement permits any number of cars to be cut into or out of the train without the necessity for regulating the output level at the entertainment equipment. This also permits more satisfactory results on longer trains.

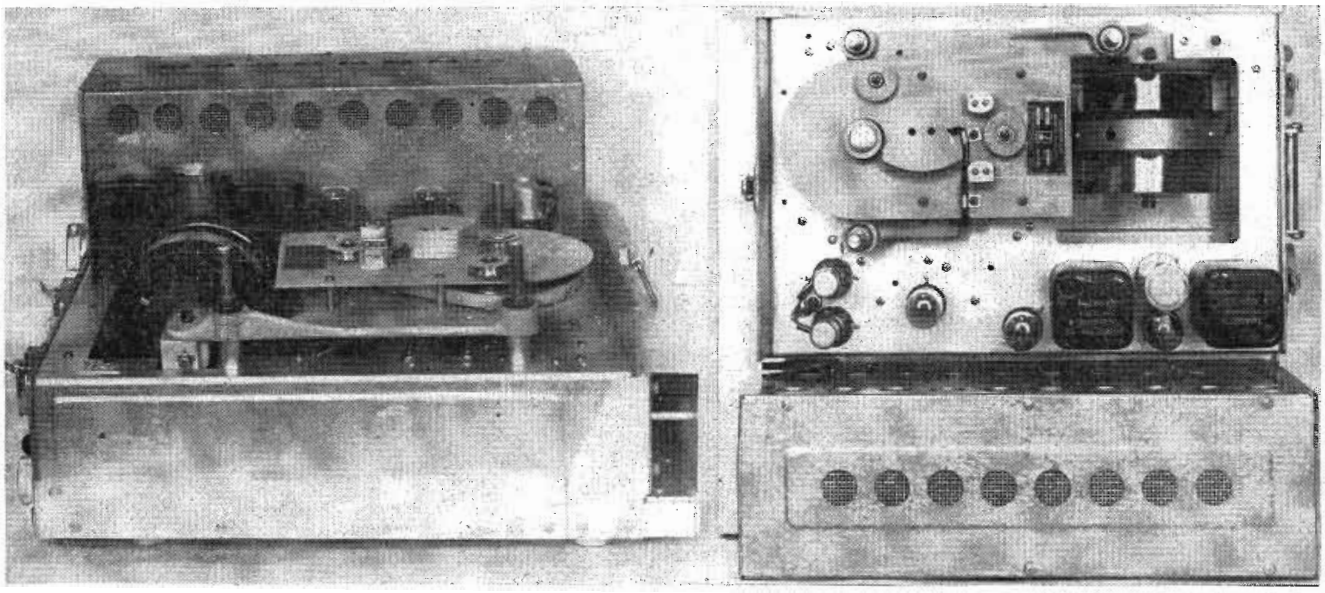
Moreover, transmission through the train-line cable at approximately zero level reduces considerably the channel cross-talk possibilities and the distortion introduced by the capacity of the cable conductor and connectors. This is an important factor inasmuch as room passengers may select and retain the "Train Announcement" channel when it is silent in order to receive automatically announcements as they are made.

In addition, train-line transmission at approximately zero level is more adaptable to the design and smooth functioning of automatic volume regulation necessary to

Left is shown the distribution system used in a typical dining car, and right is an installation for group listening







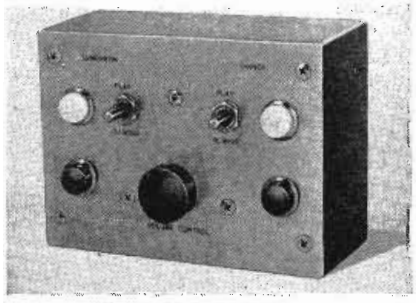
Side view of wire reproducer and public address preamplifier (rear) on shock mounting base, and a top view of the master level control and wire reproducer

offset train noises. Use of a separate amplifier in each car also minimizes transmission line termination and switching interference problems, particularly with respect to the speakers in individual rooms which may be switched from channel to channel frequently and at will.

Since all equipment is interchangeable, the same amplifier may be used in a diner having only six speakers or in a roomette car having as many as twenty-four or more speakers. In each car an attenuator on the equipment rack can be adjusted with a screwdriver to limit the amount of audio reaching the amplifier from the train-line. Thus, the maximum audio power for each car, depending upon the number of speakers, can be individually set, and the maximum volume available on the selector unit cannot exceed the pre-selected level even though twenty-five watts of audio at less than 1% distortion are available when the power amplifier is driven at its rated input value. Of course, the maximum chosen on the selector unit by the car attendant actually is a mean level since it is varied by the automatic volume control.

The train-line cable consists of one shielded pair of wires for each entertainment channel, including the train announcement channel, and one extra pair of wires for train announcement relay control functions. Each channel has a separate return, making a complete two-wire circuit. No simplex circuits are used in connection with the control of the systems.

A specially-developed cable containing shielded pairs for audio circuits and conductors for control circuits is used. This cable has polyethylene dielectric and its capacity is less than 20 mmfd. per foot. When this cable is used in the train-line, the propagation velocity is such that termination of the line in the equipment units is quite satisfactory, even for long trains. This avoids the problem of providing automatic line termination facilities at each fixed portion of inter-car connectors so that



Wire reproducer program selector panel

proper termination will be inserted if an inter-car connector jumper is not inserted.

The installation of conventional radio receivers in club cars in recent years in many cases has proved unsatisfactory. The chief objection stems from the fact that a uniform distribution of the sound throughout a car is not possible from one or even two speakers. Passengers sitting beside the radio may be annoyed by the uncomfortable loudness, those sitting a few chairs away may consider the volume setting satisfactory, while passengers less than half a car length away can scarcely hear the entertainment. Moreover, the different ambient noise levels encountered on a train—when it is standing and when it is running, and as the character of the roadbed changes—cause conventional entertainment systems to achieve a condition of almost continuously unsatisfactory level for the majority of passengers.

To correct these faults and insure proper volume at all times in every part of a car, Farnsworth engineers have perfected automatic level controls and have designed the distribution systems for use with a number of speakers in each car.

Two types of automatic level control can be used with the systems. The linear electronic type regulates the level of the entertainment so that it remains approximately 3 db. above the ambient noise at all times. This type uses a variable gain amplifier, the gain being regulated by the volume of noise in the car.

Level control is accomplished through a bias voltage developed by an amplifier from the average noise pickup of a contact type microphone rigidly attached to a portion of the car. The control voltage

is directly proportional to the vibration experienced by the car, which is in turn directly proportional to the noise caused by train movement and roadbed condition. This system automatically compensates for noise peaks developed at resonant frequencies. These noise peaks cannot be compensated for, of course, by the use of a voltage relay operating on the output of the battery charging generator.

Level Control

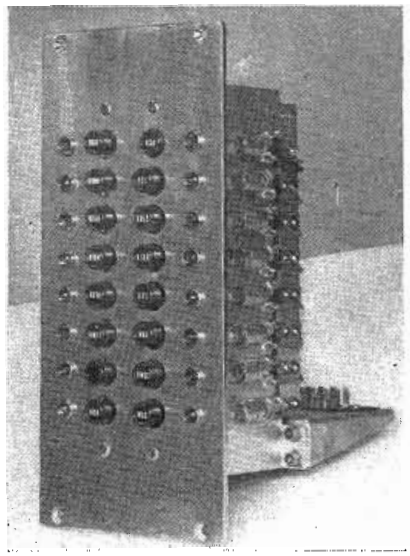
The other type is a relay which operates automatically from the battery charging circuit so that the volume increases when the train reaches a predetermined speed. This does not compensate for noises of the roadbed as does the linear type, but it is less expensive and has been used and considered fully satisfactory by some railroads.

To achieve true fidelity, it is necessary to place a number of speakers in every car so that each passenger will be sitting in a position no more than a 30-degree angle from a line perpendicular to the plane of a speaker at its center. This is essential because the cone of high quality coverage from a modern concert speaker is approximately 60 degrees.

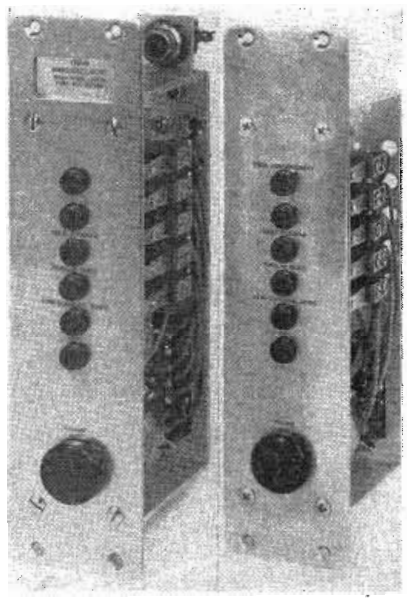
The speakers, contained in nonresonant base reflex, are recessed in the ceiling of the car. In each open car six to ten speakers are used, depending upon the size of the open section. The distribution of entertainment throughout the car is such that noise meter readings are flat within 1 or 2 db. at any location within the open section of the car.

The predominant noises on a train are of low audio frequency, and ordinary music results in practically inaudible signals below the medium register when the train is in motion. To compensate for this, the systems over-equalize or accentuate the bass somewhat in recordings and in reproduction amplifiers.

Two basic types of program selector switch and volume control units are available. One is utilized in group-listening cars where train announcements always take precedence over entertainment and are heard automatically, irrespective of the setting of the pushbuttons on the control panel. The other type is utilized in private rooms where train announcements do not automatically interrupt entertainment programs; instead, room passengers are notified that an announcement is to be made by the lighting of a transparent panel at the top of the control unit.



Radio control panel which provides for selection of 16 frequencies



Left, program selector unit installed in private rooms, and right, multi-channel selector for group listening operated by the car attendant

Public address stations have high quality dynamic microphones and are so arranged that interruption of an announcement from a multiple channel is not possible. When a microphone is removed from its hang-up bracket, a 32-v direct current is placed on the train-line control pair. This voltage operates a relay in each car of the train and locks out all other public address stations, switches power amplifiers in group-listening cars to the "Train Announcement" audio pair, and lights informative transparent panels on individual room program selector units to acquaint the occupant with the fact that an announcement is to be made.

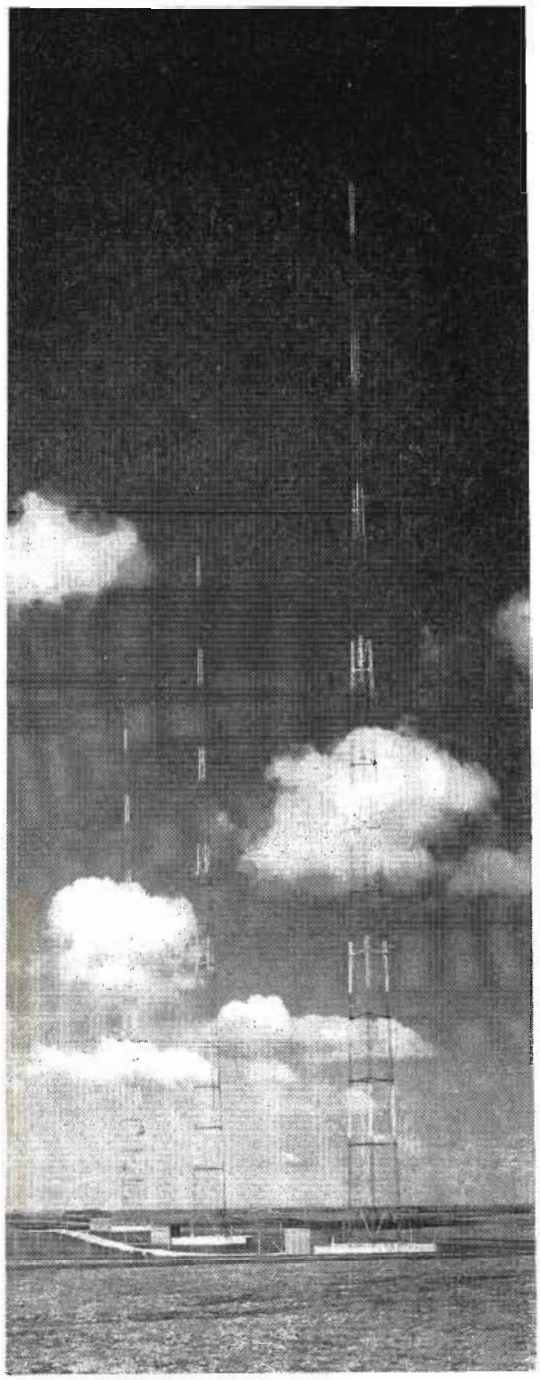
Radio Receiver

The broadcast receiver, designed to withstand extended operation aboard trains without extensive maintenance and deterioration in the quality of entertainment rendered, permits 16 frequency selections. Thus, with 16—or 32, in the case of dual installations—possible frequency selections at the touch of pushbuttons, an attendant may follow a predetermined pattern from one end of a run to the other in selecting stations which are known to be within primary service range of sections of the railway right-of-way. Because local stations duplicate frequencies, as many as 25 or 30 stations may be received on the 16 frequencies.

This crystal-controlled, pretuned radio is extremely sensitive, giving 3 volts AVC on a 5 microvolt input. This permits enjoyable listening on rather weak signals. There is no variable condenser dial drive mechanism to wear out or get out of adjustment and calibration, and there are no knobs or dials for passengers to mutilate or remove. Volume output from the receiver may be pre-set, and volume adjustments necessary due to variations in strength of received signals or ambient noise in cars will be met automatically by the automatic volume control incorporated in the radio and the automatic level control which is a separate part of the amplifying system.

The specially-designed wire reproducer is a three-hour machine. It provides flat response from 50 to more than 8,000 cycles, automatic cycling of two machines so that one rewinds while the other plays, and automatic stopping of a particular machine in case of wire

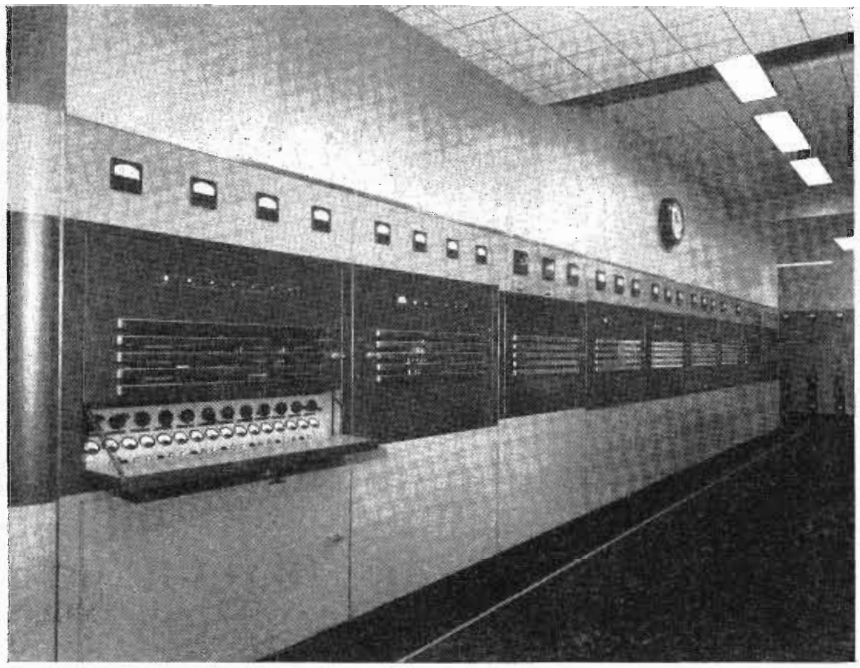
(*Continued on page 96*)



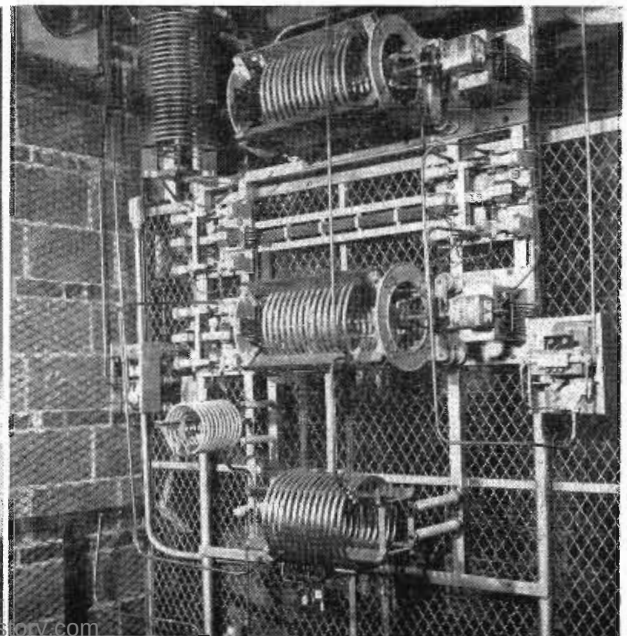
Modern AM Broadcast Station Arrangement

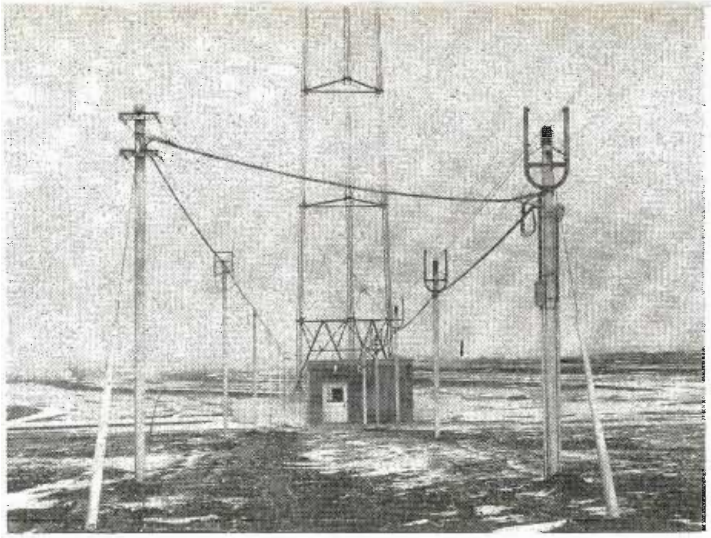
Three towers radiate Omaha's Westinghouse-equipped KFAB 50kw high-level modulated standard broadcasts

Of the three towers the center tower is used alone for daytime non-directional operation. There is a sampling loop half way up. Antenna tuning house in foreground

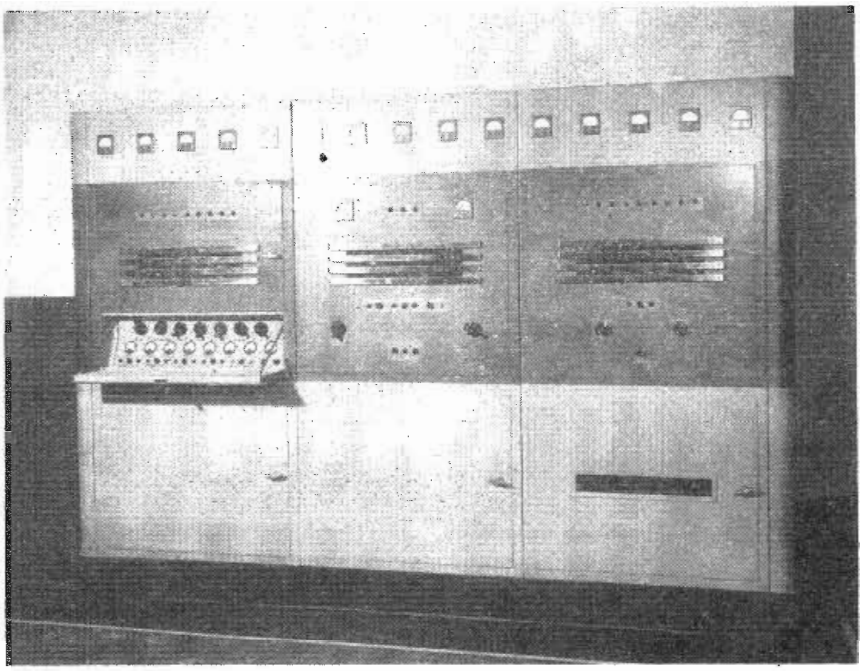


Below at the left is a general view of KFAB's modernistic transmitter house, with a picture (right) of the antenna tuning equipment located in the center tuning house. Above is a view of part of the transmitter room showing the main 50kw Westinghouse unit

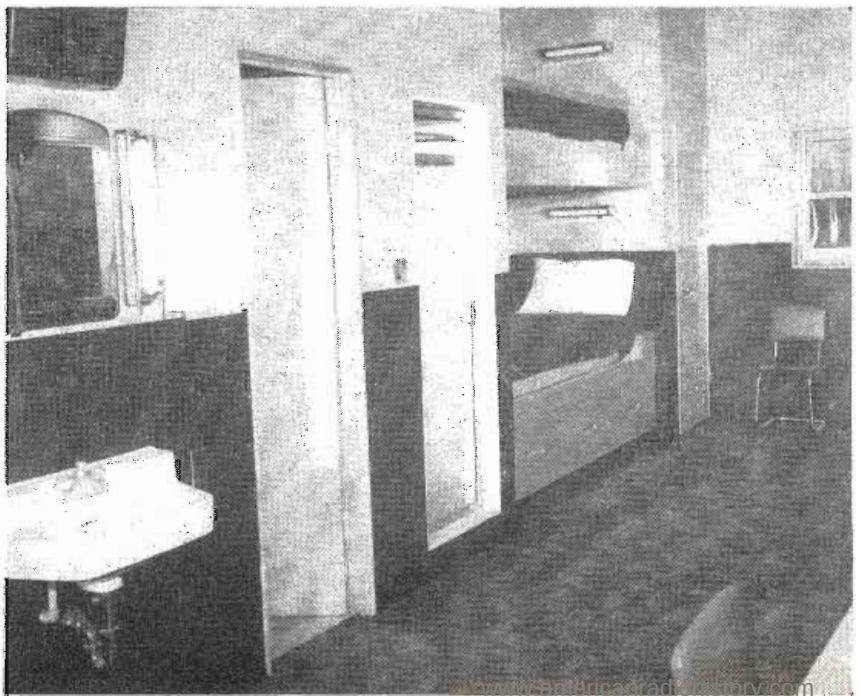


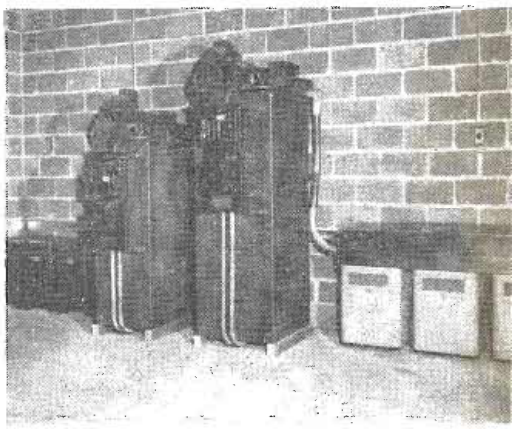


Left above is shown the base of the center tower used for daytime operation with the transmission line and quarter-wave shunt line used for tower lights and sampling line isolation. Right is a view of the RF transmission line showing lightning protection

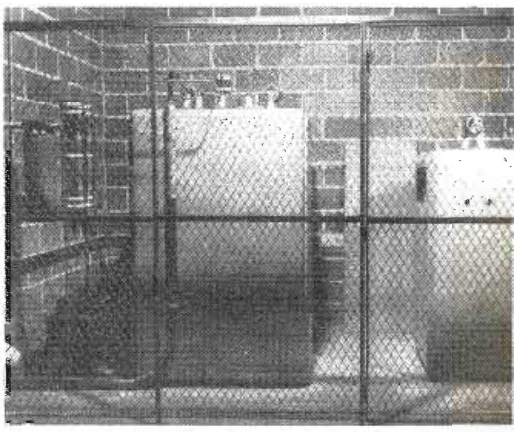


Above is a view of the Westinghouse model 5-HG auxiliary transmitter and below is a corner of the completely equipped emergency living quarters for engineer personnel





Distribution transformers, filament and plate induction regulators and plate transformers, all dry type



Above, high level modulators. Below, switch gear panel

Design of FM Receiver Front Ends

By ALDO R. MICCIOLI* and DALE POLLACK
Consulting Engineers, New London, Conn.

Development of vane type tuner and reduction of drift through operation of local oscillator at half frequency give improvement

THE advent of frequency modulation — almost everyone now agrees that it is an advent—has changed the philosophy of radio receiver design greatly. The jump from 1 mc to 100 mc is a long one, one which some will find difficult to make. Unlike shortwave bands which often are added merely as sales features, the FM functions must perform well, since in many sections of the country FM will replace AM for broadcasting within the next few years. A poor FM design will, therefore, often react as much to a manufacturer's disadvantage as will a poor AM design. This is especially true at this early stage in the development of the FM system. Listeners have been led to expect a great deal of FM—a deal which they can receive if they are presented with good receivers, good transmitters, good allocations, and good programs.

• In this article we will consider some of the problems which confront the designer of the receiver front end. These are problems concerned with the rf stage, the mixer, and the oscillator, problems of oscillator stability, gain, cost, spurious responses, and the like.

In some parts of the country reception in the new FM band (88-108 mc) will not be satisfactory, especially in the densely populated areas of the Eastern part of the United States where the Federal Communications Commission has seen fit to limit transmitter power and antenna heights within, we feel, too low values. In such areas the only FM reception obtainable, except from small local stations, when such stations exist, is in the old FM band (44-50 mc). Almost everyone agrees that coverage is better in the low band.

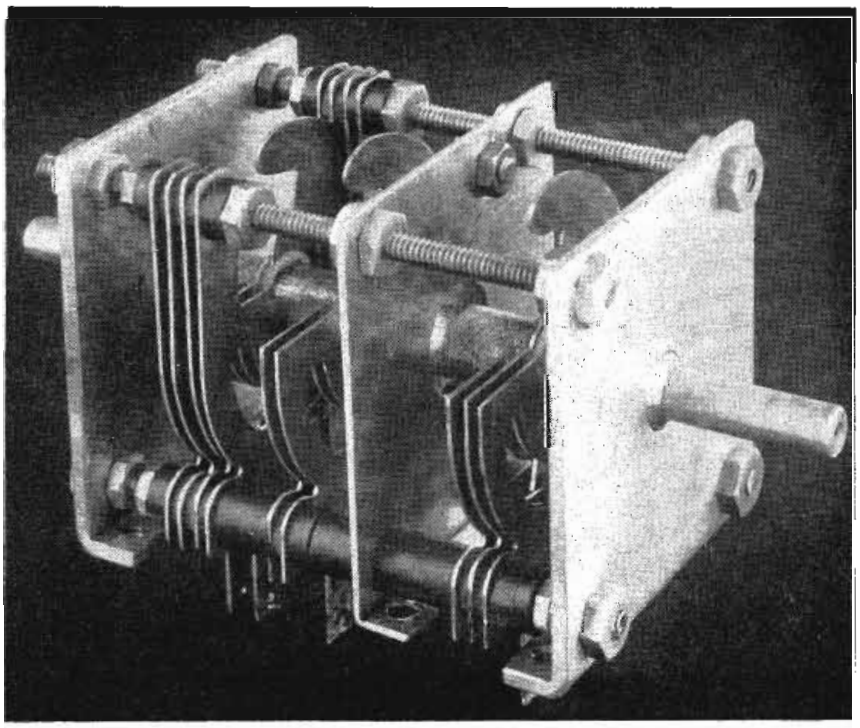


Fig. 1—Vane type tuner with three tunable sections of two turns each, two sections having extra coupling turns

We believe, therefore, that the old band is not yet dead and we discourage the design of receivers which will cover only the new band. It is believed that if the service on the old band is superior, federal regulations cannot prevent people from recognizing this fact and compelling the reassignment of a lower frequency band for FM broadcasting. Three of the larger receiver manufacturers and several of the smaller ones acknowledge this and are providing for reception of both bands in their designs.

Present receiver designs covering both the new and old FM bands use either variable capacitor or variable inductance tuning for the rf and oscillator circuits. Variable inductance tuning consists of either permeability tuning or the varia-

*Associate, Dale Pollack. This paper, with some changes, was presented at the New England Radio Engineering meeting, North Atlantic region of the IRE, May 17, 1947.

tion of inductance by introducing a vane between two or more turns of a coil. Until recently, the latter has not been used extensively.

The variable capacitor, a holdover from standard broadcast and short wave designs, has not proved as satisfactory at 100 mc as it is for lower frequencies. A variable capacitor increases the minimum capacitance and, naturally, varies the capacitance across its associated coil, resulting in reduced impedance and gain over the tuning range of the system.

Another disadvantage of a ganged tuning capacitor is the common coupling through the rotor shaft which tends to cause instability unless great care is taken to insulate each section or to use split stator capacitors. Furthermore, the microphonic oscillator problem is difficult to lick with a capacitor tuner.

Permeability Tuning

Permeability tuning, with a properly designed mechanical assembly, insures freedom from common coupling through the tuner and permits operation with a minimum of capacitance across each coil, increasing the gain that can be realized in the rf amplifier. As a result of the variation in inductance and slight change in Q as the tuner is tuned over the band, there is less tendency for the gain to vary and the selectivity is more nearly constant.

A "vane" tuner is shown in Fig. 1.* The tuner consists of three tunable sections of two turns each with two of the sections having extra coupling turns which might be used as an oscillator tickler and antenna coil primary. Each turn is a copper stamping, as shown in the figure, connected at the base to form a two-turn coil. The variation in inductance is accomplished by the copper vane which is inserted between the two turns of each coil.

As the vane is introduced, the eddy currents set up cause it to act as a shorted turn, reducing the inductance, and at the same time the vane shields the two turns from each other, reducing the mutual coupling. This method of changing the inductance of a coil was first proposed, we believe, by A. N. Goldsmith. A similar system is used in General Electric's "guillotine" tuner.

The vane tuner has the same advantages of low minimum circuit capacitance and high gain as permeability tuning. Its other advantage is the ease with which it can be incorporated in a circuit and ganged with a variable capacitor for AM reception. The variation in Q, though moderate, is not in the proper direction to compensate for tuning changes as in the permeability tuner. Fig. 2 shows the variation of frequency versus rotation for the vane tuner.

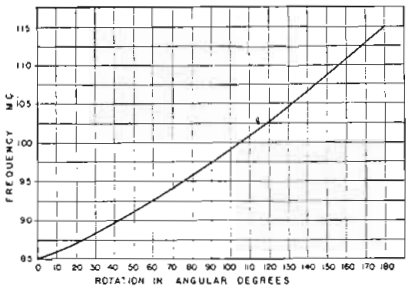


Fig. 2—Typical tuning curve for vane tuner

Local oscillator stability at 100 mc, a prime requisite for satisfactory receiver performance, is difficult to attain if the oscillator is operated at fundamental frequency. Most of the capacitance in the frequency determining circuit, if not all, consists of the tube and circuit wiring capacitance. As a result, the oscillator will drift badly as the tube warms up and retuning is necessary during the initial warm up time.

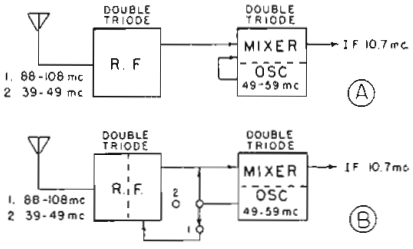


Fig. 3—A (above) block diagram for subharmonic operation. B, double conversion operation

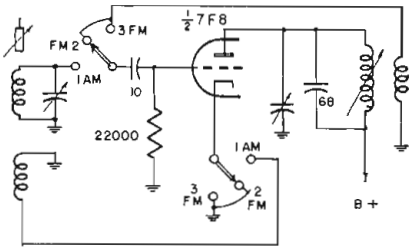


Fig. 4—Oscillator for low and high band FM and for AM

Since the circuit wiring capacitance is a large portion of the total frequency determining capacity, a shift of oscillator frequency would be noticeable with each use of the bandswitch. The solution, obviously, is to make any capacitance variation a small portion of the total capacitance in the frequency determining circuit. Two methods are indicated below.

To a close approximation,

$$\Delta f = \tfrac{1}{2} f \frac{\Delta c}{c}$$

where f is the frequency of the oscillator and Δf is the change in frequency due to a change in capacitance, Δc. If the frequency is halved by keeping the tuned circuit inductance constant and increasing the capacitance to four times its original value, then for a constant Δc, Δf is one-eighth of its former value. The frequency drift for the second harmonic, f, of this oscillator would be one quarter the drift of the oscillator operating at the fundamental frequency, f.

Oscillator Systems

Two systems lend themselves adequately to the operation of the oscillator at approximately half frequency. In Fig. 3 (a) the straightforward second sub-harmonic injection to the mixer is shown. For low band reception, the fundamental frequency of the oscillator mixes with the incoming signal and, at 100 mc, the second harmonic is used.

A system of double conversion is shown in Fig. 3(b). Low band conversion is straightforward and the first tube is used as a mixer for reception of high signals only. Oscillator injection in the rf tube can only be tolerated if the oscillator voltage can be prevented from radiating from the antenna. A twin triode, such as the 7F8, may be used, as explained below, to provide the necessary isolation between antenna and oscillator.

Further reduction in oscillator drift is obtainable when either of the two above systems is used, since no oscillator tuned circuit switching is required in switching to the old FM band.

Most FM receivers must provide for reception of the AM band. If the FM oscillator circuit is

*Such a tuner is being made by The National Co., Malden, Mass.

switched to provide for an AM oscillator, the oscillator stability gained by not switching in the FM bands is lost. Since economy calls for a single tube to function as an oscillator on all bands, the oscillator circuit shown in Fig. 4 was developed to provide an oscillator for all bands without the necessity of switching the FM frequency determining circuit. For AM reception, the FM tickler in the grid is replaced by the AM tuned circuit and the AM tickler is placed in the cathode circuit of the oscillator. The FM tuned circuit remaining in the plate circuit has no appreciable effect on the operation of the AM oscillator.

Temperature Compensation

An attempt is made to compensate for temperature drift in the oscillator tube and oscillator inductance by the use of a negative temperature coefficient capacitor. With current commercial tolerances on ceramic capacitors, it is not possible to do a totally effective job of such compensation. Typical distribution curves for production runs on two types of compensating capacitors are illustrated in Fig. 5.

These temperature coefficients were measured by assuming a linear relation between 25 and 85°C. To show the difficulty of designing a temperature stable oscillator, assume that a coefficient of −750 ppm/°C is required. From Fig. 5, only 90% of the capacitors will fall between −700 and −800 ppm/°C. Thus, with a temperature rise inside the receiver of 20°C, as many as 10% of the receivers will drift more than 50 kc on warm-up! It is apparent also from the curves that the coefficient of the compensating capacitor should be kept as close to zero as possible, because such compensating capacitors have smaller tolerances.

The need for a low-cost adjustable temperature coefficient capacitor has been recognized and one is in development at the present time.

A crystal-controlled oscillator has been suggested by a number of engineers as a solution to the problem of oscillator drift. Aside from the high cost of switching crystals and rf circuits for each desired signal, the spurious responses would be numerous and troublesome, as a result of the frequency multiplication of the oscillator required.

Another approach to the problem is the use of AFC. In this respect the output of the balanced discriminator appears made to order. Some difficulty may arise, however, in tuning from one signal to an adjacent channel signal as the oscillator tends to pull toward the former.

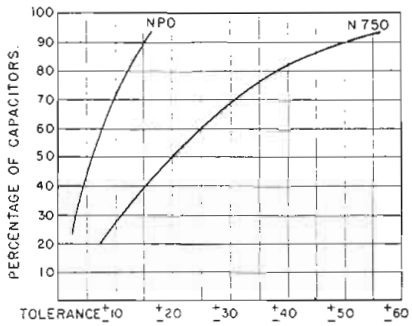


Fig. 5—Distribution curves for production runs on two types of compensating capacitors

The Mixer

In a broadcast receiver economy dictates a single tube to serve the function of mixer and oscillator. Pentagrid converters, such as the 6SB7, have proved satisfactory at 100 mc. A twin triode also may be used, one section as the mixer and the other as an oscillator.

There are two reasons, however, for using the twin triode, such as the 7F8 or the 12AT7, rather than the 6SB7Y. First, the noise generated in a multigrid tube is greater than for a triode. Second, pentagrid converters do not lend themselves to circuit designs where the FM oscillator tuned circuit is not switched in switching to the AM bands. The pentagrid converter is advantageous in the alignment of the IF stages since a signal of IF frequency can be placed on the control grid whereas the mixer plate IF transformer of a triode must be aligned at receiver input frequency.

Conversion Gain

High conversion gains are obtainable from a high mutual conductance twin triode, such as the 7F8, if the loading of the grid circuit at the input frequency and degeneration effects to the intermediate frequency can be reduced. Both are the result of large grid to plate capacity of triodes. The degeneration of the intermediate frequency can be minimized if the impedance of the grid circuit is made low to the IF frequency.

If the plate circuit is made inductive, a negative resistance component is introduced in the grid, reducing the loading to signal frequency. Input resistances as high as 40,000 ohms can be achieved in this manner with conversion gains of better than 20. A plate which is too inductive can result in negative input resistance and instability.

The effect of an inductive plate circuit on the characteristics of one section of a 7F8 used as a mixer at 108 mc is shown in Table 1.*

Oscillator injection to the second mixer is not a problem when a double conversion scheme is used.

*William P. Mueller, "High Frequency Conversion With Type 7F8", Sylvania Engineering News Letter, April 30, 1946.

Plate Circuit Arrangement	Input Resistance in Ohms	Plate Resistance in Ohms	G_c Micromhos	Conversion Gain
Plate bypassed directly to socket with 15 mmf.	12,700	34,600	1,930	22
Plate connected to I.F. transformer with 2″ lead.	36,000	43,500	1,670	20.5
Additional inductance in plate lead.	−58,500	43,500	1,550	19

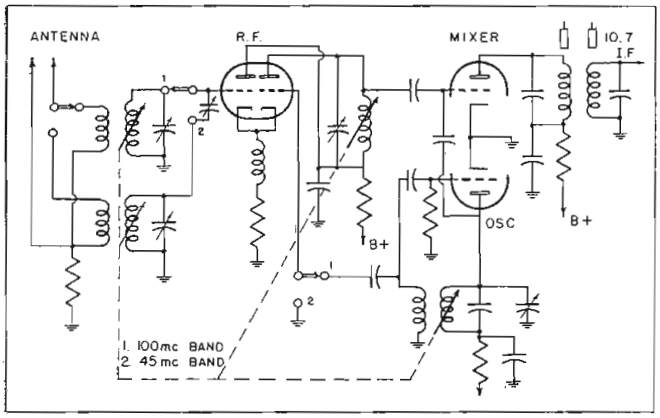


Fig. 6—Circuit diagram for double conversion RF end

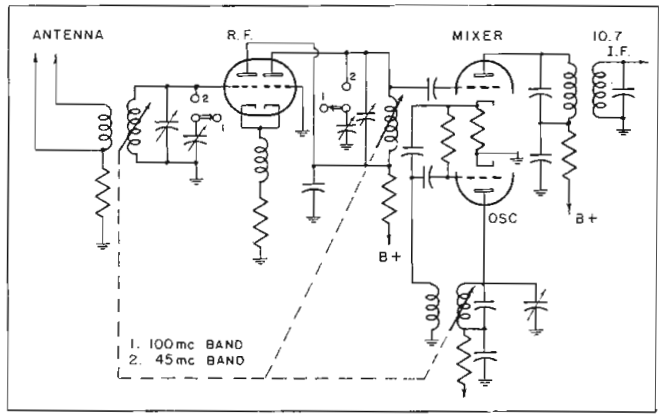


Fig. 7—RF end with oscillator sub-harmonic operation

The signal appearing across the tuner interstage at the grid of the mixer covers the approximate frequency range of 40 to 50 mc for both the new and old FM bands, the 100 mc signal of the new band having been converted in a previous stage. No difficulty is encountered in injecting the oscillator voltage, which differs from the frequency of the tuner interstage by the IF frequency, on the grid of the mixer across the interstage coil. Enough voltage can be developed across the mixer grid impedance to give satisfactory conversion gains. The circuit is shown in Fig. 6.

When the second sub-harmonic of the oscillator is made to mix with the incoming signal, grid injection proves unsatisfactory for the 100 mc band. The 100 mc tuned interstage coil provides a low impedance at the grid for 45 mc oscillator voltage. Fig. 7 indicates one method of injection into the cathode of the mixer. The injection voltage is taken from the tickler rather than the tuned oscillator circuit to increase oscillator stability.

RF Amplifier

Rf gain and image and spurious response rejection should be considered in designing the rf end. One stage of rf amplification is common in most sets but many cheaper models are being produced with no rf stage. Sets that are to be marketed in large communities, which are the center of many FM stations. do not have to meet the sensitivity requirements for suburban sets and, therefore, the lack of an rf stage could be tolerated if gain were the only consideration.

However, the image and spurious response rejection would be very poor and strong interference from amateur, television, and air to ground communications could be expected. Furthermore, oscillator voltage will appear on the antenna and the radiation will interfere with FM and other sets in the vicinity. Oscillator radiation has been picked up two to three miles from offending receivers, clearly an intolerable condition. In the present state of the art, until other methods of reducing radiation are developed, the use of an rf stage is considered mandatory.

Image Rejection

A twin triode of the 7F8 type, used as a common cathode grounded grid amplifier, appears to be most suitable in overcoming the problems presented above. Used in this manner, the tube's high input impedance results in better image and spurious response rejection. Moreover, excellent isolation is obtained between the antenna and oscillator.

A typical front end system for second harmonic oscillator injection is indicated in Fig. 7. The 45 mc band is covered by adding capacitance across the 100 mc antenna and interstage coils. A gain greater than 10 through the tube is readily obtainable. Measurements on the laboratory model show an image rejection of better than 50 db. The most troublesome spurious responses are frequencies that are the sub-harmonics of the frequency to which the receiver is tuned. With the receiver tuned to 102 mc, the rejection of 51 mc was 44 db and of 34 mc, 41 db.

With a system of double conversion, as indicated in Fig. 6, the 7F8 rf stage is a common cathode grounded grid amplifier for low band reception. To receive the 100 mc band, the input signal is converted to a 45 mc band frequency by mixing with the oscillator in the rf amplifier. The oscillator voltage is injected on the grid of the second section of the twin triode, the tube functioning as a mixer.

Spurious Responses

One disadvantage of such a system is its inability to reject spurious responses of low band frequency when tuned to the 100 mc band. Since the interstage coil remains tuned to the 45 mc band, the tuned antenna coil provides the only selectivity in rejecting low band signals. As a result of the antenna loading, the rejection of the 45 mc band is necessarily poor. However, the low band antenna coil can serve as a tuned trap on the grid of the RF amplifier, as indicated in Fig. 6, with a resulting 55 db rejection of low band signals when tuned to the high band.

For a higher priced set, another low gain rf stage would be appropriate to increase the rejection of the numerous spurious responses resulting from double conversion and to reduce input tube noise. Since the plate circuit of the second stage is tuned to the first conversion frequency, better rf stability at high gain can be expected than by operating two stages of rf amplification conventionally.

NOMOGRAPH for MICROPHONE DISTANCES in LIVENESS BROADCASTING

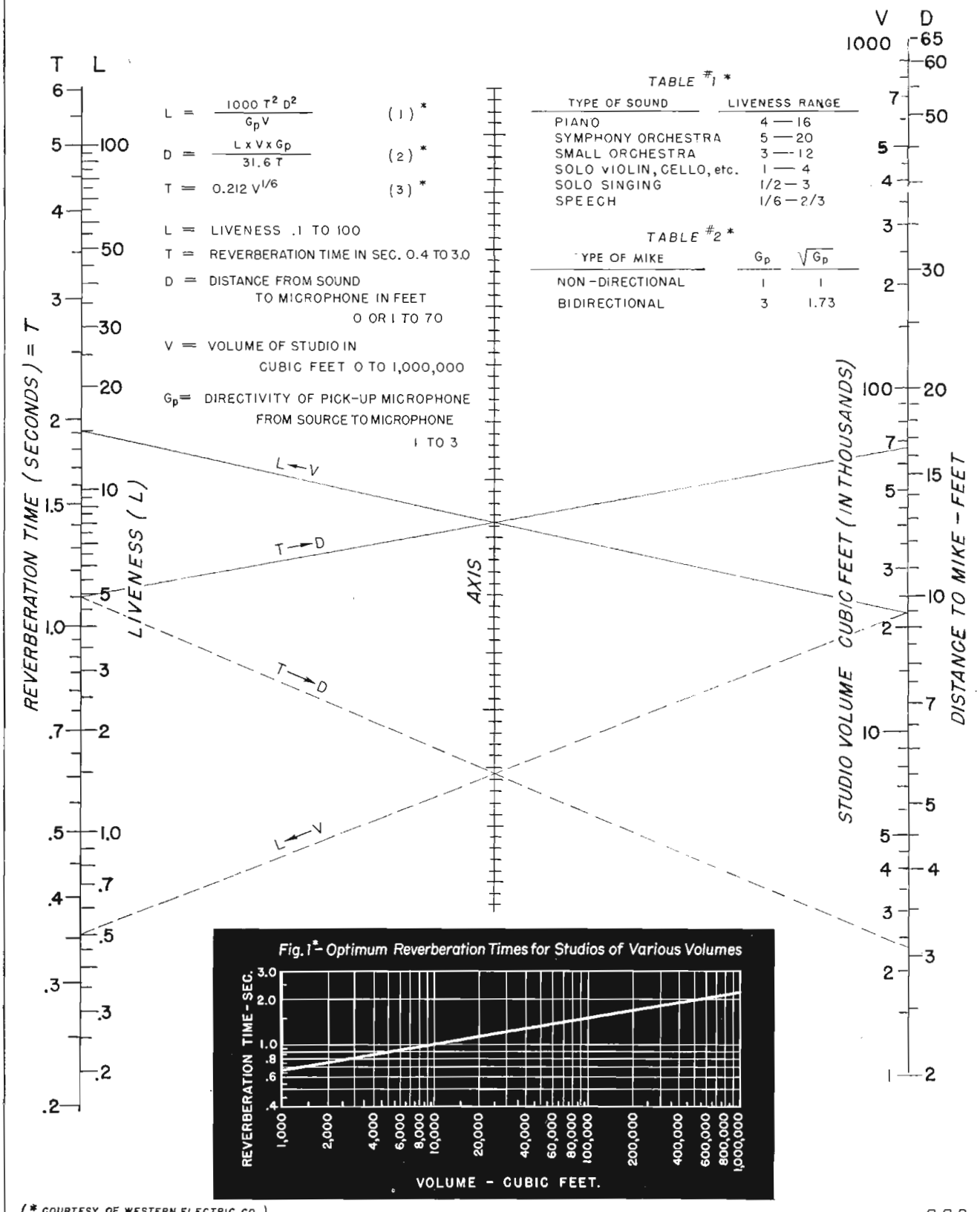


TABLE #1 *

TYPE OF SOUND	LIVENESS RANGE
PIANO	4 — 16
SYMPHONY ORCHESTRA	5 — 20
SMALL ORCHESTRA	3 — 12
SOLO VIOLIN, CELLO, etc.	1 — 4
SOLO SINGING	1/2 — 3
SPEECH	1/6 — 2/3

TABLE #2 *

TYPE OF MIKE	G_p	$\sqrt{G_p}$
NON-DIRECTIONAL	1	1
BIDIRECTIONAL	3	1.73

(* COURTESY OF WESTERN ELECTRIC CO.)

R.R.B.

Constants V = 22,000 cu. ft.; T = 1.1 sec.

EXAMPLE 1: (solid lines) Placement of general microphone. From Table 1 use liveness of 15. Connect 22000 on V and 15 on L. Mark reference on the axis. Then extend a line from 1.1 on T through reference on axis to 16.5 ft. on D. Answer: 16½ ft. from mike to sound source.

EXAMPLE 2: (dash lines) Placement of solo vocal microphone. From Table 1 use liveness of ½. Connect 22000 on V and ½ on L. Mark reference on the axis. Then extend line from 1.1 on T through this reference to 3 ft. on D. For bidirectional mike multiply 3 ft. by √3 or 1.73. This yields 5 to 6 ft. for actual distance.

Microphone Placement for Studio Liveness

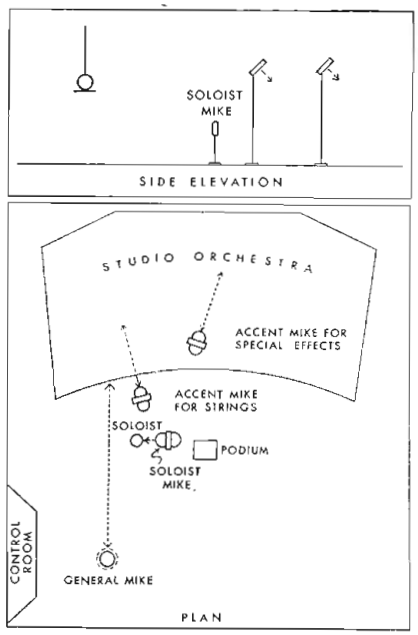
New technics based on acoustic properties of studios and location of mikes gives great advantages in permitting realistic reception

• Modern microphone technic in broadcasting studios is involving an increasingly scientific approach in the use of electrical mixing and spatial effects where two or more pickups are used. Its aim is to replace systems which are "blind" to instrument discrimination and realistic values inherent in an acoustically well-designed studio.

The new technic is based on an acoustical constant called the *liveness,* which "represents the acoustic properties of an enclosed space." An empirical formula for liveness has been derived mathematically, and is useful for practical application of the new method in positioning the microphones.

J. P. Maxfield, Bell Telephone Laboratories physicist, chief exponent of liveness in broadcasting describes some experimental results in a recent paper* on this subject:

"One of the important advantages of this live type of pickup is as much as 6 db gain in coverage at no extra expense to the sponsor or the broadcasting company. This unexpected gain is a result of the manner in which the ears of the listener perform. For a given power supplied to the loudspeaker, the loudness of the program picked up with this new technic can be 6 to 8 db greater than the loudness of programs from 'dead' pickups. Since this gain in loudness permits the listener to operate his receiving set with a correspondingly lower electrical gain, static and other noises are reduced by this amount. Thus, this effect is a gain in coverage.



Microphone placement for orchestra with vocals. All microphones are not necessarily used simultaneously (Courtesy Western Electric Co.)

"If sound is reproduced from a pickup using this method in which the liveness is controlled within the useful range, the subjective effect might be described as the acoustical re-creation of the pickup space around and behind the loudspeaker position. This effect adds greatly to a sense of reality and renders music or speech both natural and 'easy to listen to.' Under these circumstances, it is difficult to locate the position of the loudspeaker laterally, the sound appearing to flood in from behind it through an opening completely across the room. In other words, the effect is that of adding the studio space behind the plane of the loudspeaker without any intervening wall.

"When the liveness is near the lower limit of the useful range, you get the impression that the sound is situated in the near end of this added space. In the case of a person speaking, there is the illusion of a real person speaking from the position of the loudspeaker.

"When, however, the liveness is near the upper limit of the useful range, the source of sound appears to be considerably behind the plane on the loudspeaker as if it were coming to the hearer from a position in the remote end of the added space. In the case of broadcast symphony orchestras, this control of liveness enables one to so broadcast a concert that the listener in his home may seem to occupy any seat from the front to the back row of the auditorium.

"Since most auditoria have seats which music critics consider to be best, it is desirable to control the liveness of the broadcast so that the listeners are placed acoustically in that portion of the auditorium.

"The advantages of this type of pickup may be summarized as follows:

(1)—The 6 db gain in coverage previously mentioned.

(2)—When operating within the useful liveness range, the amount of manual volume control normally necessary with dead pickup is markedly decreased without either overloading the equipment or causing the sound to sink into back-

(*Continued on page* 99)

*Maxfield, J. P., "Liveness in Broadcasting," Western Electric OSCILLATOR, January 1947.

Ratio Detector for FM Signals

AF component obtained from ratio of two voltages from frequeney-sensitive circuit is completely independent of input amplitude variations

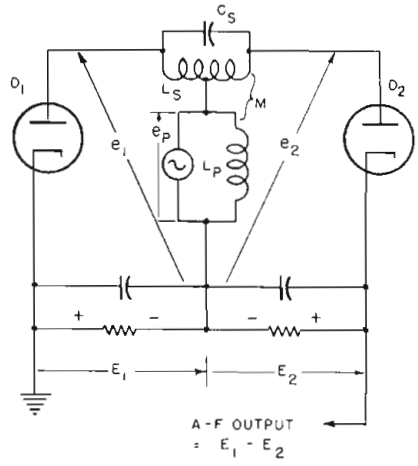
• Details concerning the ratio detector circuit as an FM to AM converter, have been the object of much research during the last few years, as a result of its popularity in receivers. A brief review of common converter methods and then operating principles will show the difference between the ratio detector and the well-known discriminator circuit. Both utilize a curious effect found in certain coupled circuits, such as those in Fig. 1. Here the primary of the final IF transformer L_p is doubly coupled to its secondary coil L_s by a mutual coupling M, and by direct coupling to a midtap on that coil. In this case M affects each part of the split circuit differently: it adds to the frequency of one and lowers that of the other.

Their frequency difference can be adjusted to have any desired center frequency and any range (the range being the frequency band over which this special effect is useful). The net result is that E_1 (in either circuit Fig. 1) may increase as the frequency increases while E_2 decreases.

In Fig. 1a, the typical discriminator circuit, these two voltages are in opposition because of the polarity of the rectifiers, so that they deliver an output depending on $E_1—E_2$. The difficulty is not in the effectiveness of this circuit in making the FM to AM conversion, but in the fact that if the amplitude of the applied signal varies independently with the frequency, it also introduces an AM component into the output signal. Hence the need for limiters in FM receivers using the discriminator circuit.

Fig. 1b shows the ratio detector circuit developed by Stuart W. Seeley director of the Industry Service Division of RCA Laboratories. Here the rectifiers are now connected aiding, so that the total voltage across the capacitors is equal to E_1+E_2 instead of to their difference.

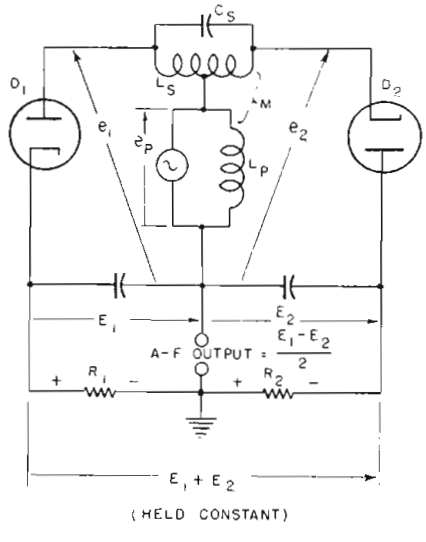
Now if this summation voltage is forcibly stabilized, such as by



(a)

Fig. 1a—Basic circuit of balanced discriminator

Fig. 1b—Basic circuit of ratio detector using the same phase shift input circuit as in 1a



(b)

connecting a battery across the $E_1 + E_2$ terminals, it has been shown that the ratio of the rectified voltages E_1 and E_2 is the same as the applied frequency-sensitive IF voltages. In other words the forced stabilization of the summation voltage does not upset the maintenance of this ratio of voltages. The output therefore tends to be independent of amplitude changes of the original signals. These relations are shown in Fig. 2. It will be noted since all of these voltages result from resonance effects, the linearity of the FM/AM conversion is linear over only a limited range. It is therefore one of the design problems to arrange matters so that the desired range is obtained.

The utility of this circuit has caused the application of many months of intensive research on the various phases of the problem and its application to FM receivers, in the R.C.A. service laboratories. From this reasearch the relations between various circuit parameters and the input signal conditions have been found giving a basis for arriving at an optimum design.

The summation voltage stabilization may of course be simply handled by a battery across its terminals. Unfortunately this arrangement introduces undesirable effects, such as the limitation of operation to signals at least great enough to overcome this fixed bias. However a large capacitor connected here will assume a charge proportional to the average signal amplitude and thus will automatically adjust itself to the correct level. The voltage so collected will serve as a source for AVC control as well. In this way amplitude rejection can be secured over a wide range of signals, starting from a

low level value. This lower threshold of good operation is set by the rectifier tubes, in the region where inefficient rectifier action occurs.

Capacitance values of several microfarads, giving time constants of the order of 0.1 to 0.2 second are used, large enough to carry over changes due to the audio frequencies. Actually when either a battery or a large capacitor is used for stabilization, variations in the input signal automatically cause the effective load resistance to vary so as to tend to keep the audio frequency output constant.

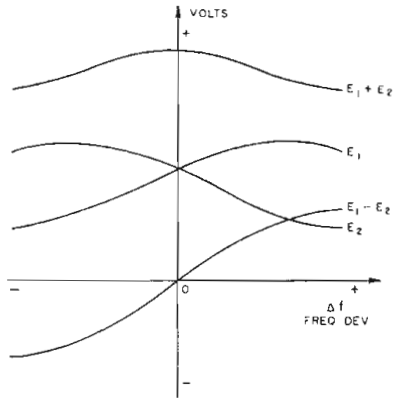


Fig. 2—A plot of the individual, summation and difference voltages at the off-center frequencies for circuit Fig. 1b

To maintain efficient operation at very low signal levels it has been found effective to use a high value of secondary Q and a relatively low value of diode load resistance so the operating Q of the secondary is about ¼ of its unloaded Q value.

Maintenance of Balance

In any system where operation depends on attaining a satisfactory balance of a bridge circuit it is likely that secondary effects become important. It is essential that the effects of amplitude modulation be taken care of, whether they be from fading, cancellation by multiple path reflection effects, selectivity in the RF or IF stage, or in unbalances in the detector itself. One form of this unbalance, which depends on the input signal level, has been called the residual AM balanced signal. Another depends on circuit unbalancing effects. It is desirable that all of these causes be reduced at their sources. Balance adjusting expedients applied to the circuit all have the effect of reducing the audio output signal.

To start with, the two sections of the twin diodes must have the same characteristics. While this may not be so critical as to require selected tubes, it does introduce consideration in the circuit designs. For example, applied AM might cause the slope of the detector characteristic to vary. Depending on circuit conditions the output AM variations may shift either in phase with the applied AM, or out of phase. Basically the magnitude of the unbalanced AM component depends on the ratio $\frac{1}{2}e_s/e_p$ in Fig. 1b. This ratio of the secondary voltage across half the coil to the effective primary voltage introduced into the circuit is referred to as the S/P ratio. (In some actual circuits the primary voltage injection is by means of a closely-coupled tertiary winding).

Both tests and theory indicate that for values of S/P greater than a critical value (close to unity) good AM rejection in the output is difficult. Also that below this critical value AM rejection is possible only if a certain amount of the original amplitude variation present in the input signal is allowed to pass through. This phase balance is possible when the circuit is such that the input AM and output AM signal components are out of phase (Fig. 3.)

A convenient and effective way of accomplishing this is to use a value of S/P slightly less than the critical value and to allow a certain amount of AM to remain across the $E_1 + E_2$ terminals of Fig. 1b. Two methods for doing this are shown in Fig. 4. Each consists of reducing the effect of the stabilizing capacitor by series resistors.

Besides needing to reduce the above mentioned residual AM it is necessary to consider the other AM signal effects appearing at the IF terminals because of circuit unbalances.

The ratio detector circuit shown in Fig. 5 contains two effective and simple methods for reducing the unbalanced component. One of these consists of making the two resistors R_3 and R_4 unequal. Cancellation takes place because the differential drop across these resistors, which varies with AM modulation, feeds into the AF output. In practice, R_3 and R_4 are adjusted so that the unbalanced component as observed when frequency modulation and amplitude modulation are applied simultaneously, goes to zero. During this adjustment the sum of R_3 and R_4 remains essentially constant since

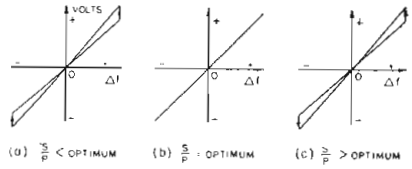


Fig. 3—On either side of the optimum value of S/P for which the balanced component of AM is zero, there is a reversal in the phase of the AM in the output. Since for a given transformer, the value of S/P changes with coupling, the figure shows that for loose coupling the output AM is 180° out of phase with the input AM, while the two are in phase for close coupling

their value together depends upon the ratio S/P rather than upon any unbalance which may be present. In addition, a resistor R_5 is used in series with the tertiary winding common to both diode circuits. This modifies the peak diode currents and particularly at high signal levels, has the effect of appreciably reducing the unbalanced AM component.

Another method for reducing the unbalanced component is to vary the effective center-tap on the

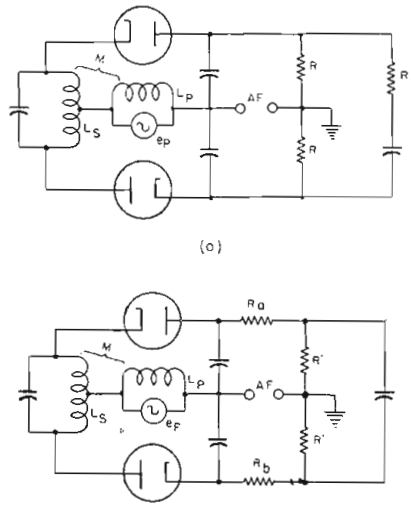


Fig. 4—Two methods of stabilizing any desired fraction of the rectified output voltage. In each case the fraction of the output voltage stabilized is approximately equal to $2R/(2R+R_1)$

secondary winding slightly from the nominal position. Where a bifilar secondary winding is used, this is accomplished by using a slightly shorter length of winding in one half than in the other half;

at 10.7 mc, the difference in the windings usually will amount to less than a turn. A ratio detector transformer is shown in Fig. 6.

Typical Detector Circuit

The circuit shown in Fig. 5 includes the unbalance rejection expedients mentioned. Here the major part of the rectifier output voltage is stabilized by means of the 8 mfd capacitor C_3, which with diode load resistors R_1 and R_2 gives a discharge time constant of approximately 0.1 second. The rectifier voltage drop across R_3 and R_4, permits minimizing the residual balanced AM component in the output. R_3 and R_4 are not equal in value to produce a compensating unbalanced component which cancels the unbalanced components which would otherwise appear in the output, such as from the variation in the input reactance of the diodes. The 47-ohm resistor R_5 modifies the peak diode currents and further reduces the unbalanced AM component, particularly at high signal levels. C_4 bypasses the secondary system to ground at the intermediate frequency.

The output characteristics of this circuit arrangement were found to be:

Input Signal=100 millivolts
Rectified Voltage=6 volts
AVC=2.5 volts
AF Output (75-kc deviation)= 0.7 volt RMS
Distortion: 100% mod. (75 kc)= 2.5%
30% mod. (22.5 kc)= 0.75%
Maximum Downward Amplitude Mod.=70%

In arriving at the design of the ratio detector transformer a number of circuit parameters are involved. These include the unloaded and loaded values of primary and secondary Q, the percentage of critical coupling between primary and secondary, and grid-to-plate gain under various conditions. They are tabulated below:

Primary: Unloaded Q=70; Operating Q (with diode loading)=40.
Secondary: Unloaded Q=89; Operating Q (with diode loading 21.
Half-secondary/tertiary voltage ratio: 0.65
Coupling: 0:50 of critical, including the effect of the capacitance unbalance due to the difference between the input capacitance of the two diodes; The normal grid-to-plate gain is 100.

Good ratio detector performance can be obtained with either high-perveance diodes such as the 6AL5 or medium-perveance diodes such as the 6H6. The 6AL5 has a perveance approximately four times that of the 6H6; with four volts applied between plate and cathode, the plate current of the 6AL5 is approximately 14 milliamperes while the plate current of the 6H6 is 3.5 milliamperes. Diodes having a perveance lower than the 6H6 give less satisfactory performance in the ratio detector because the residual balanced component of amplitude modulation becomes appreciably large. In general, better performance has been obtained with ratio detectors using the 6AL5 than with those using 6H6, although identical circuits should not be used for both types.

It is desirable to make the secondary L/C ratio as high as possible, consistent with keeping the secondary tuning capacitance high enough so that stray capacitances and variations in tube capacitances do not have an excessive effect on the tuning.

The primary L/C ratio should also be as large as possible in order to obtain the greatest sensitivity. In practice the primary Q is made as high as possible, consistent with obtaining the required peak separation and not exceeding the maximum allowable grid-plate gain during downward amplitude modulation.

The secondary Q in general should be as high as possible, consistent with the desired peak separation. At intermediate frequencies of the order of ten megacycles, this will mean a Q of the order of 75 to 150. Use of the higher values of Q will result in improved sensitivity for a given AM rejection. The value R of the diode load resistors can be selected so as to reduce the operating secondary Q to a value approximately one-fourth or less of its unloaded value. The load resistors used with the ratio detector are not critical in themselves, since the effective load resistance varies over wide limits during the AM cycle.

Operation Characteristics

Receivers using the ratio detector have characteristics which differ from limiter and locked-oscillator receivers in a number of respects. Since the rectifier voltage across the long time-constant load circuit of the ratio detector automatically adjusts itself to the input signal level, there is no fixed threshold, and the AF output and the stabilizing voltage (which may also be used for AVC) are proportional to the input signal. Less IF gain is required, since the ratio detector in typical designs will provide appreciable amplitude rejection with as little as ten to fifty millivolts of input signal to the grid of the ratio detector driver tube. As a result, receivers using this type of detector tend to be quiet between stations. When AVC is used, the selectivity of the receiver is main-

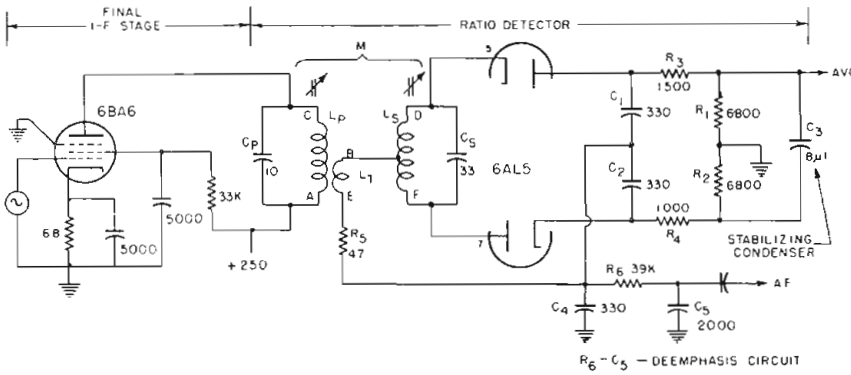
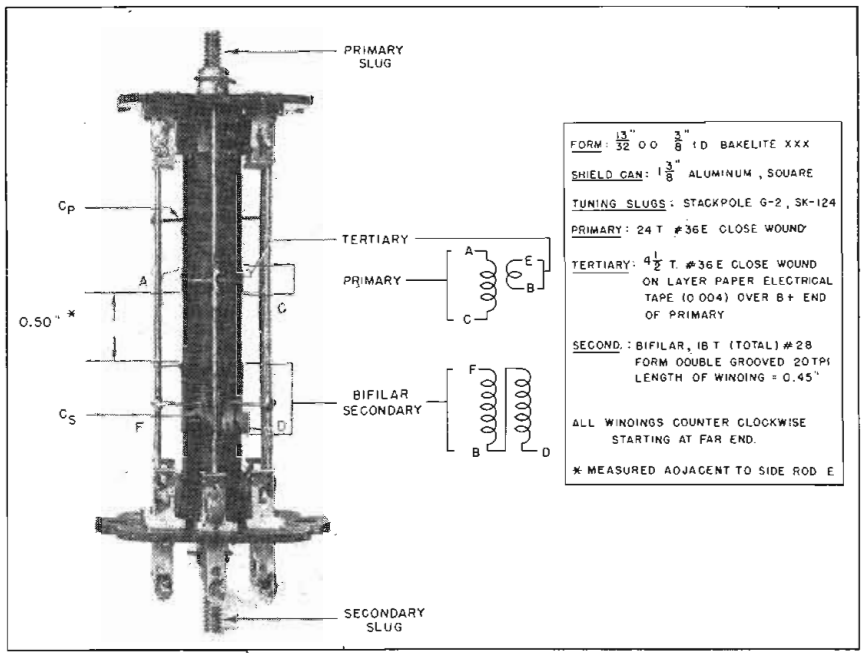


Fig. 5—Ratio detector circuit using a balanced phase shift transformer feeding a 6AL5 double triode. The closely coupled tertiary winding L_t is wound over the B+ end of the primary to provide impedance matching and improved sensitivity

Fig. 6—Details of construction of the ratio detector transformer used in the circuit shown in Fig. 5. The bifilar connections are brought out symmetrically to prevent unbalance



tained for strong as well as weak signals.

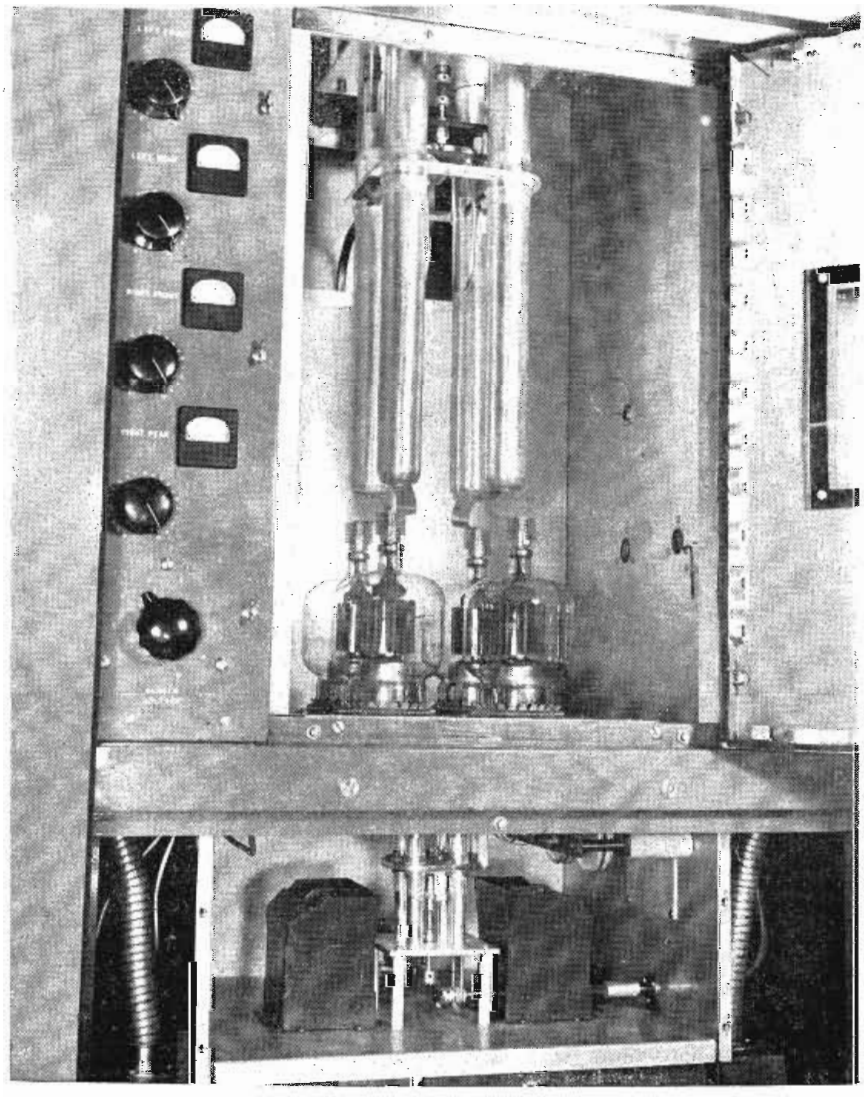
The tuning characteristic of a receiver using the ratio detector is characterized by comparatively low side responses. This results in part because the high degree of amplitude modulation which an off-resonant FM signal acquires as it is modulated up and down the steep IF selectivity curve produces relatively little output from the ratio detector. The extent to which the side responses will fall below the main response depends upon the amount of AVC, the IF selectivity, and the ratio detector peak separation.

TWO-STAGE 10 KW FM TRANSMITTER

• Making possible the production of 10 kw of FM energy at frequencies in the 88-108 mc band with but two stages, a newly designed transmitter has been developed and is being produced by Radio Engineering Laboratories, Long Island City, N. Y. Designation of the equipment, styled Quadriline, stems from the fact that a four-line symmetrical final tank is used and is energized by four newly developed Eimac 4-1000A air-cooled, internal anode tetrodes. The amplifier delivers 10 kw with a single-stage 750-watt driver.

With four silver-plated pipes mounted above tubes positioned at the four corners of a square, each line in effect has two other lines of opposite polarity to work against rather than one, as in the case of the conventional open wire line. All four lines are shorted together at a distance above the anodes depending on the frequency of operation. Two small loops cross-paralleled are coupled to two lines each and operate into a half-wave matching section. Key to high efficiency design is the minimization of external field.

Operating characteristics for 10 kw: Plate voltage, 4.95 kv; plate current, 2.48 amp.; grid voltage, —400 volts; grid current, 400 ma; screen voltage, 300 volts; screen current, 130 ma each.



Video Switching and Distribution System

By R. D. CHIPP*, Radio Facilities Engineer
American Broadcasting Co., New York

Technical details of method and equipment developed for Navy use in switching PPI indications to any or all of 20 remote repeaters

ALTHOUGH this project was set up for wartime application, the basic problems are the same as those encountered when planning the switching and distribution of television signals from several sources to a large number of receivers or monitors.

• Video switching and distribution problems are of great interest to engineers as the television art grows. In 1942 a general set of operational requirements for a video distribution system were set forth as follows: (a) Provide for selection of the output of any receiver from any remote viewing station. (b) Transmit the video without degradation. (c) Arrange the units of the system so that damage to any part from shock or enemy action will not disturb the operations of the other units. With these broad specifications to follow, there began the design of a complete video switchboard for the U. S. Navy. It is of interest, therefore, to review briefly the history of the radar distribution switchboard.

Among the several types of radar indicators, one of the most useful aboard ship is the Plan Position Indicator, or PPI. With this type of presentation, the position of the ship is at the center of an oscilloscope, the top of the 'scope represents North, just as in any conventional map or chart, and the targets which are picked up by the radar as it scans the horizon appear on the 'scope face at a point which indicates both range and bearing from the ship. The oscilloscope screen is treated with a persistent phosphor[1] so that a given target echo will remain visible during the time that the antenna is making a complete revolution. In this way the observer has, in effect, a continuous picture of the objects around the ship.

The usefulness and effectiveness of this type of presentation may best be described by quoting Commander W. B. Porter, USN, in the June, 1946, *Proceedings of the U. S. Naval Institute:* "The adoption of the circular cruising formations so widely used by the carrier task forces, with simultaneous turns by all ships during air operations a necessity, would have been an impossibility, particularly during night or low visibility operation, without the bridge PPI available to the Officer of the Deck. Even the most complex formations, formerly difficult even for more senior officers to visualize, are now plainly apparent and the station-keeping and station-changing problem, particularly at night or in thick weather, has lost its fears. It is an understatement to say that many of the operations in which our fleet has taken part would have been impossible to carry out without the vivid radar picture which can be seen at a glance by the Officer of the Deck."

As indicated in Commander Porter's article, the PPI on the bridge was most useful to the Officer of the Deck. In similar fashion, PPIs located in combat information center, chart house, flag bridge, etc., were of equal importance to the individual whose particular tasks or decisions were aided thereby.

In view of the above, the Navy undertook a long-range program to equip combat vessels and many auxiliaries with PPI repeaters, which would be located at strategic positions on the ship and which would be capable of being switched so as to select the output from any one of the search radar systems. The first step in this program was standardization of the input signals required by all types of PPI repeaters, and standardization of the outputs from all types

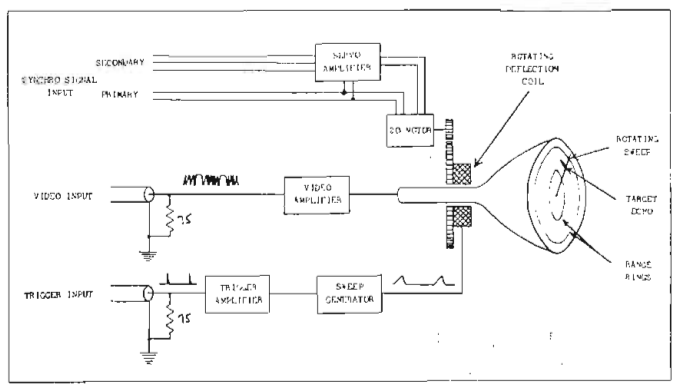


Fig. 1—Simplified block diagram of a PPI repeater, showing how the trigger, synchro and video signals are fed into the equipment

*Formerly Lt.-Commander USNR, Bureau of Ships, Washington, D. C.

of search radar sets. After suitable standards were determined, they were incorporated in every specification for shipboard radar equipment.

The operation of PPIs has been adequately described in the literature[2,3,4] so it will suffice to repeat briefly that a PPI basically requires but three principal signals for its operation, namely: (a) Trigger Signal; (b) Synchro Signal; (c) Video Signal.

The trigger is a 25- to 50-volt positive pulse derived from the transmitted radar pulse, and fed over a coaxial cable to the PPI repeater for the purpose of starting the radial sweep. The synchro signal is a 5-wire 60-cycle circuit comprising the primary and secondary voltages of a synchro generator or "selsyn." These voltages are used to position the PPI deflection yoke in such a way that the sweep on the PPI tube follows the direction in which the radar antenna is pointing.[5]

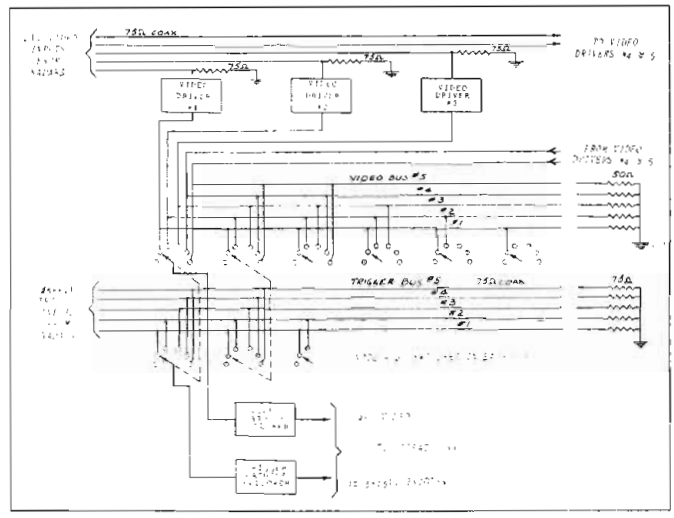
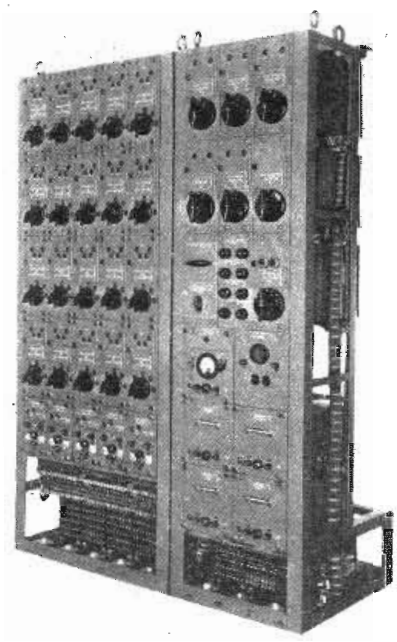
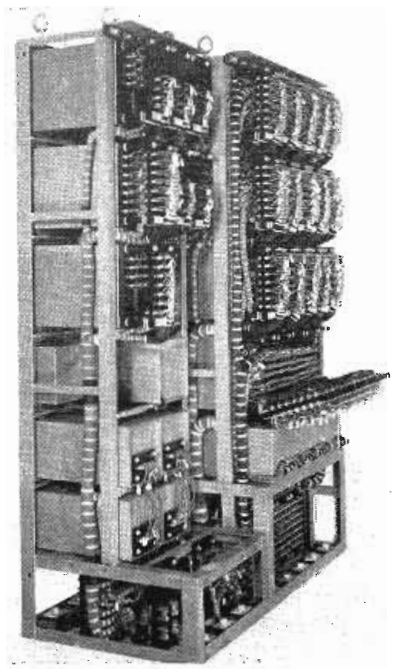


Fig. 4—Block diagram of a single complete channel showing only the video and trigger circuits. Switchboard handles inputs from 5 radars and feeds signals to a total of 20 repeaters



Figs. 2 and 3—Front and rear views of the final design of switchboard for routing signals to a number of remote indicators



The video signal is the output of the radar receiver, positive in polarity, limited to 2 volts, and fed over a coaxial cable to the PPI repeater video circuit. This signal brightens the sweep to show the presence of targets. Fig. 1 is a simplified block diagram of a PPI repeater, showing how the trigger, synchro and video signals are fed into the equipment, and how they cause the type of presentation described.

To briefly restate the problem—the Navy required a "radar central," which would accept certain output signals from search radar sets and would feed them to a number of remote locations where PPI repeaters were installed. It was decided to use unit construction, with all units built into a large switchboard, which would then be placed in one of the least vulnerable locations aboard ship, and to which all cabling to the radars and repeaters would lead.

A front view of the final design of such a switchboard is shown in Fig. 2. Two lower panels have been removed to show the cable terminal compartments. The left panel contains power supplies, power switches, synchro amplifier switches, gyro compass switches, and various other gyro signal cutouts and alarms. No attempt will be made to describe the details of switching the synchro circuits, the power and alarm circuits, the gyro compass circuits, or the control circuits. It will suffice to say that all of these circuits are 115 v 60 cps, and their switching and distribution follow 60 cycle practice. The complexity of the interunit cabling is indicated by Fig. 3, a rear view of the switchboard with one row of the hinged terminal boards unscrewed and dropped down to provide access to the inner terminal board. Note the cabling technic employed—particularly the large bundles of coaxial cable.

As shown in Fig. 1, the trigger and video signals may be of .3 to 5 microseconds duration, at repetition rates from 60 to 1,000 pulses per second. For purposes of comparison, consider that the horizontal synch pulses in the standard television synchronizing wave form are approximately .5 microsecond wide, with rise time of approximately .025 microsecond. To transmit these radar pulses through a distribution system without degradation requires that the system have adequate bandwidth, as is the case with standard television equipment[6,7,8,9]

It is well known that bandwidth can be improved at the expense of stage gain, and that any amplifier design is a compromise between permissible bandwidth, phase shift, and gain per stage. More stages mean greater current drain, larger power supply, increased

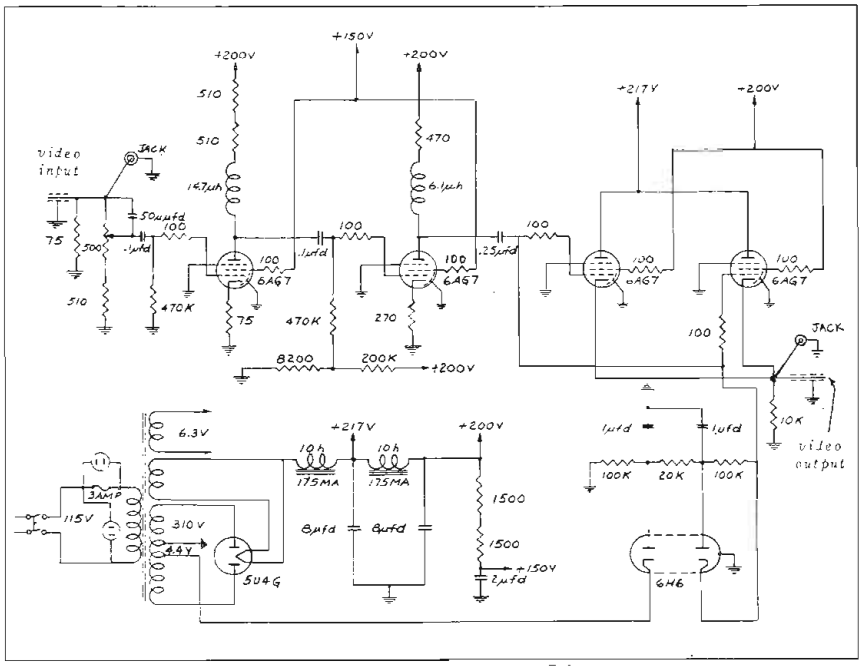


Fig. 5—Schematic of the video driver in which the incoming video signal is amplified and board, one for each radar feeding information to repeaters

transformer size, larger chassis, etc. Hence for shipboard use, where space is at a premium and weight has to be held to a minimum, a balance is necessary between size, weight, etc., and fidelity of reproduction.

It was decided, therefore, to design the radar switchboard with an overall video bandwith from 60 cycles to 6 megacycles. Fig. 4 is a block diagram showing only the video and trigger circuits. It will be noted that for simplification we have shown only one complete channel feeding through to a repeater. Actually the switchboard handles inputs from 5 radars and feeds signals to 20 repeaters. Each radar set develops standard video and trigger signals which are delivered to the switchboard through type RG-12/U 75-ohm coaxial cable.

As indicated in Fig. 4, the trigger signal from each radar is bussed to each of 20 selector switches, whereas the video signal from each radar is fed to a video driver, the output of which is likewise bussed to another deck of the same 20 selector switches. Each selector switch is associated with a PPI repeater, and may be positioned so as to select the trigger and video signal from the desired radar set.

Let us first consider the design and construction of the video driver. It is a conventional resistance coupled video amplifier, designed for 2 v positive input and 4 v positive output. As shown in the schematic diagram, Fig. 5, the incoming radar video signal is fed to a 75-ohm terminating resistor, where it develops approximately 2 volts across the input terminals of the driver.

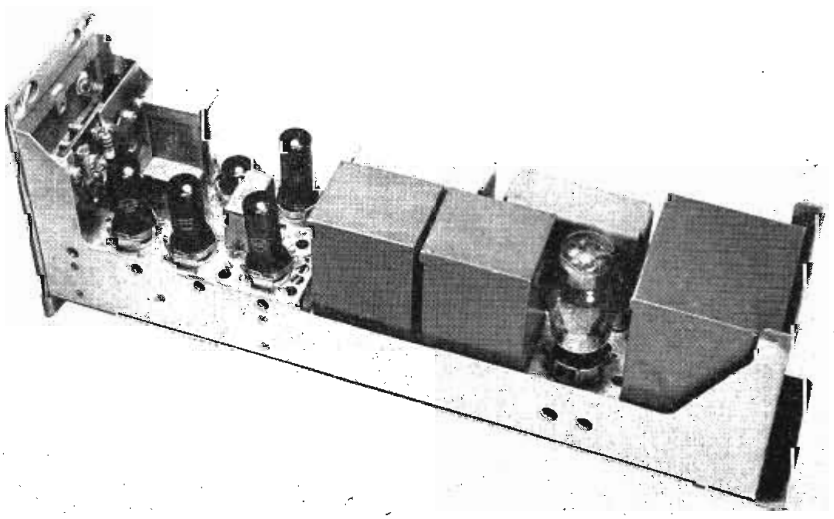
Reference to the schematic will show that the input stage is a 6AG7, with 200 v on the plate and 150 v on the screen grid, using cathode bias and shunt peaking. The bias resistor is not by-passed, to provide negative current feedback. The value of the peaking inductance was determined in conventional fashion using the expression $L = MRC^2$, where R is the load resistance, C is the total shunt capacitance. For this application a value of M equal to 0.41 was used. This value is considered as one which gives optimum time delay. The calculated stage gain was 4.9 with low limit JAN tubes and 6.1 with high limit tubes, or approximately 5.5 with average tubes.

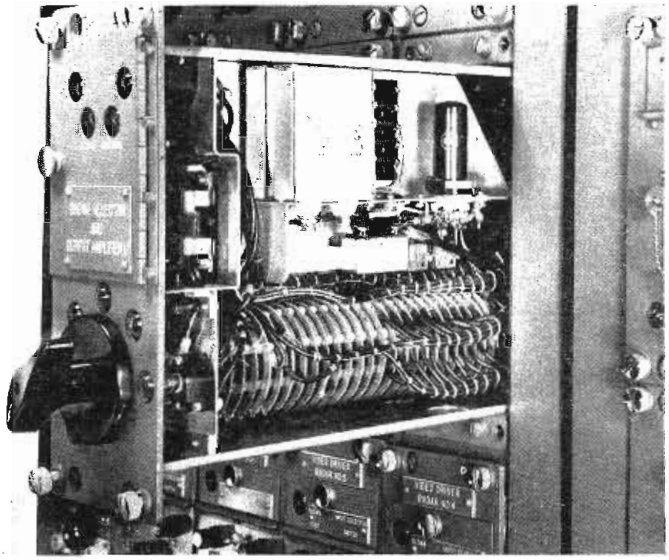
The second stage also has a 6AG7 tube, with shunt peaking using a factor of M equal to .41. Plate and screen voltages are 200 and 150 volts, respectively. Note the interesting arrangement used for obtaining bias and degeneration, whereby a slight positive voltage is tapped from a bleeder across the 200 v B+ supply, to permit the use of a higher value cathode resistor and thus secure greater negative current feedback. The stage gain was calculated to be .95 and 1.05 with low limit and high limit JAN tubes, respectively, or unity with normal tubes.

The third stage consists of two 6AG7's in parallel, arranged as cathode followers, with a gain of .44, .52 and .60 for low limit, high limit and normal tubes. The circuit is conventional, with a 10,000-ohm resistor in the cathode circuit to bias the stage to cut off should the load be removed. Bias is often obtained from a 4.4 v tap on the power transformer and one section of a 6H6 used as a half wave rectifier. The other half of the 6H6 is used as a dc restorer.

This cathode output stage feeds a 51-ohm coaxial cable bussed to the 20 selector switches and then

Fig. 6—Rear view of one of the video driver units. There are five of these in the switchboard, one for each radar feeding information to repeaters





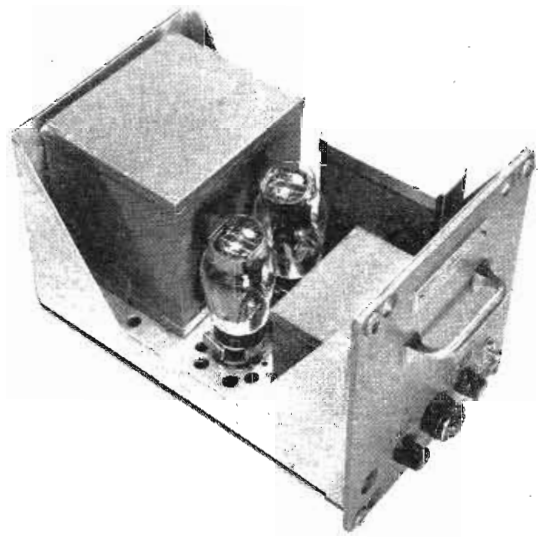


Fig. 7—(Left) Construction of the selector switch and output cathode follower; and (Fig. 9) power supply chassis for the cathode follower

properly terminated. The power supply for this video driver is a conventional full wave rectifier, using a 5U4G, with choke input. 100 ohm anti-parasitic resistors are used in all control grid and screen grid circuits. The nominal overall gain of the driver amplifier is two.

During normal operation the 2-v video signal may be varied in amplitude by a potentiometer at the input. A screwdriver potentiometer covered with a screw cap was used in order to discourage too frequent adjustment by unauthorized personnel. The control has sufficient leeway to adjust for low limit or high limit tubes, as well as to adjust for a $+\frac{1}{2}$ volt tolerance in the input signal, and within these limits provide at the output a 4-v positive signal across 50 ohms. Fifty ohms was the least possible terminal resistance which would permit two 6AG7's to develop 4 volts, and yet be low enough to minimize the shunting effect of the capacity load of the 20 switches.

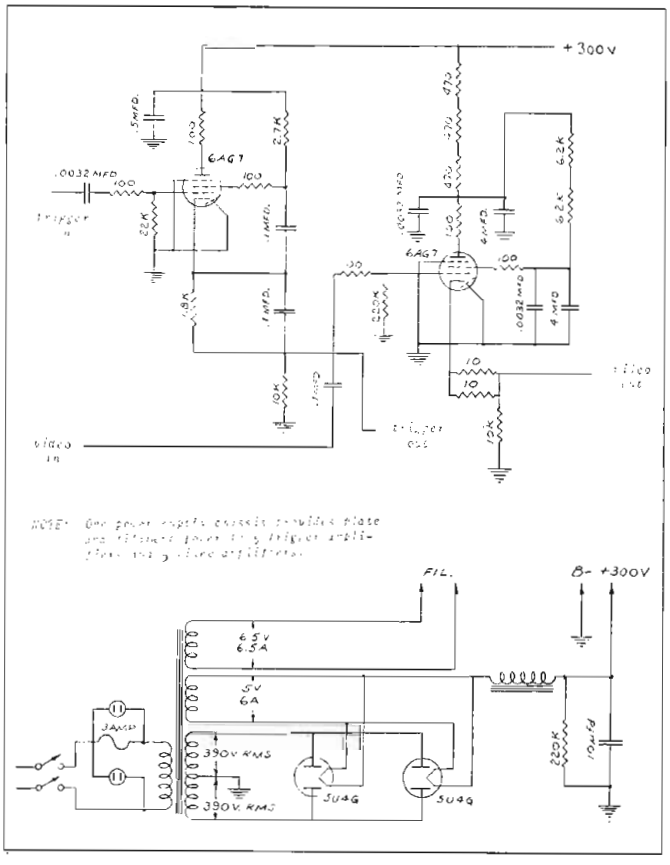
Test jacks are provided at the input and the output to permit checking video voltages with a vacuum tube voltmeter. The vacuum tube voltmeter is built into the switchboard, and will be described later.

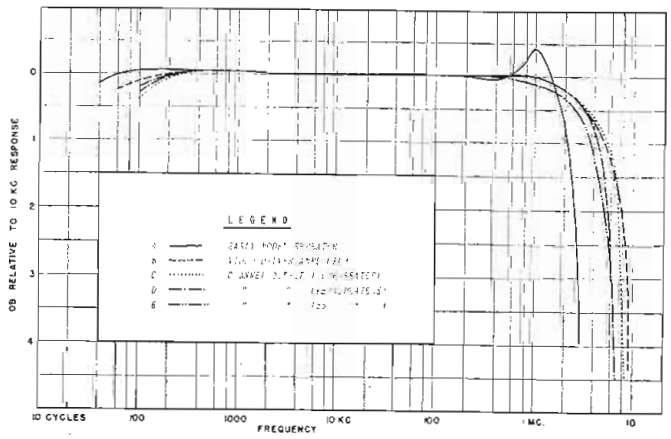
Driver Amplifier

Fig. 6 shows the construction of the video driver amplifier. Note the clamps to prevent unseating of tubes during high shock. Even the 6H6 is clamped securely in place. Note, also, the physical arrangement of components to permit short leads. For access to the under side of the chassis the amplifier may be easily pulled out from its slot in the switchboard, and turned over, while all of the cables remain connected.

Returning to Fig. 4, we see that each switch now has a 4-v video signal and a 25- to 50-v trigger

Fig. 8—Schematic of output amplifiers and power supply. Fig. 10 — Measured response curves made with standard sine wave technic





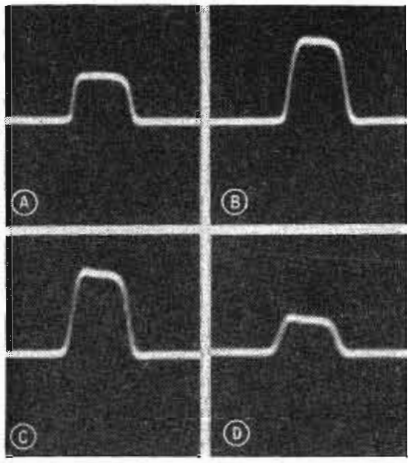


Fig. 11—Transient response photographs: (A) input pulse; (B) driver output 51-ohm termination; (C) driver output 51-ohm, 500 mmf termination; (D) cathode follower output

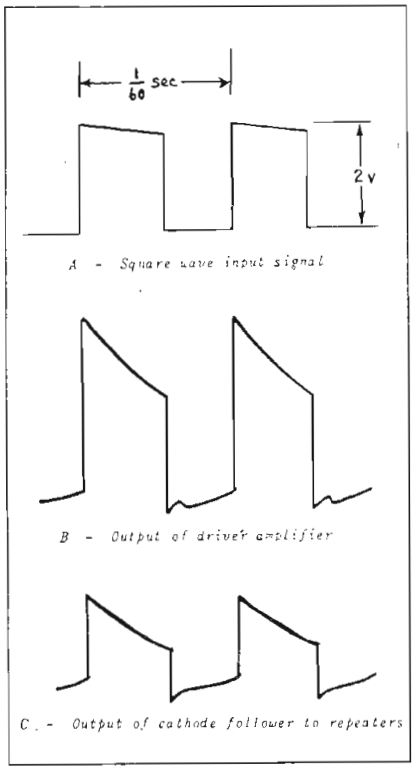


Fig. 12—Graphs showing low frequency square wave response taken at the output of the driver and at the cathode follower

signal from each of 5 radars, appearing on two adjacent decks and available for selection by the rotor arm.

It should be noted in passing that a trigger driver amplifier is not required because the trigger voltages from the radars are between 25-50 volts, and the average PPI repeater operates satisfactorily with input trigger pulses of the order of 10 volts or more.

The selector switches used for this application are heavy duty manually-operated rotary switches (Navy Type JR). They were selected instead of relays, in view of the stringent shock requirements. It is important to remember that in addition to the video and trigger circuits which we are considering there were 25 power and control circuits to be switched as well. In a fixed installation this would perhaps be accomplished with relays, but for equipment to be used on large combat vessels subject to the shock of heavy gunfire and possible damage from enemy action, it was considered that heavy rotary switches should be used. Fig. 7 shows the general construction of a Type JR switch. It can be seen that it is made up of a number of decks or "biscuits." In this application one deck was used for each circuit, making a switch approximately one foot long.

Returning to consideration of the video and trigger signal, we see that each of the 20 selector switches connected to the circuit must represent a certain shunt capacity. This capacity is approximately 15 mmf when the switch is open, and approximately 35 mmf when the switch is connected to feed signals through. Thus it can be seen that the minimum load on any driver is 51 ohms and 300 mmf, occurring when no repeaters are connected to the driver in question. The maximum load is 51 ohms and 700 mmf, when all 20 repeaters are connected to the same radar.

In order to keep this load as low as possible, an interesting design was developed. A chassis with two cathode followers was arranged to be mounted as an integral part of the selector switch. This construction is shown in Fig. 7. One cathode follower is shown, and the other one, not visible in the illustration, is mounted on a second sub-assembly designed as a mirror image of the first one, the two together fitting snugly directly over the selector switch. It can be seen that the lead from the switch to the input grid of the 6AG7 cathode follower is less than 6 in. long. Note the ever-present tube clamp. Note, also, the stand-off insulators supporting the coupling capacitor away from the chassis, to minimize its capacity to ground.

Fig. 8 is a schematic of the cathode follower circuits. One 6AG7 serves to feed the video signal to the repeater, the other feeds the trigger signal. The design follows usual practice, predicated on delivering pulses of 2 volts and 12.5 to 25 volts into a resistive load of 75 ohms for the video and trigger circuits respectively. The gain is therefore .5, and the output connections feed RG 12/u 75-ohm coaxial lines leading to the various PPI repeaters. It should be noted that these circuits are "safe" when the output cables are short-circuited, either of which could easily result from damage to the lines or repeaters.

In the case of a short-circuit, plate, screen and component dissipation do not exceed maximum ratings, and in the case of open-circuit the 10,000 ohm resistors prevent insulation breakdown between 6AG7 cathode and filament. The physical arrangement of these output amplifiers made it necessary to locate the power supply for them in another section of the switchboard.

As indicated in the schematic, a single power supply has the capacity to handle 10 cathode followers, so that four identical power supplies furnish filament and plate power for the 40 output amplifiers that feed video and trigger to 20 PPI repeaters. A photograph of the power supply is shown in Fig. 9. Note the draw type unit

(*Continued on page* 107)

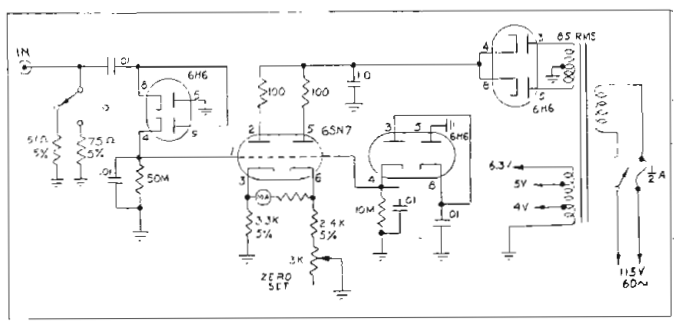


Fig. 13—Schematic of peak-to-peak vacuum tube voltmeter

Radiators for Centimeter Waves

Abstracted from the French*, by JOSEPHA E. ZENTNER, PH.D., Digest Editor, TELE-TECH

Tapered rods of circular cross-section consisting of solid dielectric material may be used as short wave radiators

•In many short-wave applications high directivity of the transmitting antenna is desirable; it increases the radiated energy density and in radar applications, for example, it provides a means to locate an object in space. There are essentially three types of short wave radiators, the horn antenna, the antenna-reflector combination, and the dielectric antenna.

A formula is derived for the intensity of the electric field, E, in front of a rectangular opening. It can be shown that maximum ratio of field strength to surface area, maximum E/A, is obtained for uniform electric field intensity in the opening, at a given value of energy flux through the opening. At a distance, d, from the center of the opening in a direction at right angles to the plane of the opening, this maximum value is

$$E = E_o\ A/\lambda\ d \text{ volts/cm}$$

as a function of the uniform field strength, E_o, in the radiating opening and equal to

$$E = 19.2\ \sqrt{WA}/\ \lambda\ d \text{ volts/cm}$$

as a function of the energy flux traversing the opening, W, in watts, the surface area of the opening, A, in centimeter square, the wavelength, λ, and the distance d, in centimeters.

It follows that the gain of the directional system, or the ratio of the energy radiated from a non-directive source of equal power to the energy radiated in the optimum direction, is equal to:

$$G = 20 \log (\sqrt{4\pi A}/\lambda) \text{ decibels.}$$

For a rectangular opening with an area of 1 square meter, the maximum gain is 31 decibels for a 10 cm wave and 41.4 decibels for a 3 cm wave.

In another approach to the problem, the distribution of the field intensity in the opening is computed for a desired directional characteristic of the radiator. If a non-symmetric, directional diagram is desired, the phase of the wave in the opening must be varied.

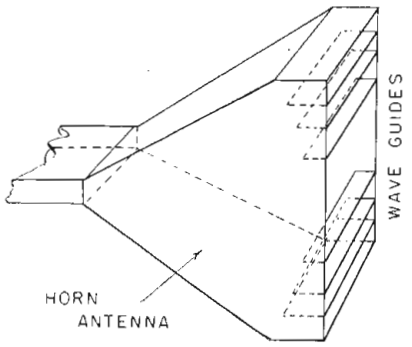


Fig. 1—Horn antenna with metal lens consisting of parallel metal plates which form waveguides of different cross sections anl lengths. This structure emits an electromagnetic radiation with a plane wavefront

For optimum efficiency of a horn antenna, the width of the horn mouth should not exceed $2\sqrt{l\lambda}$ where l is the length of the antenna.† For instance for a wavelength of 10 cm and an opening of 1 meter length, the minimum antenna length is 2.5 meter. This limit in length is imposed by the spherical shape of the wavefront. To reduce the required length of the horn, an electromagnetic lens is mounted in front of the horn mouth. The lens may consist of suitably shaped, parallel metal plates, acting as waveguides of different lengths and cross-sections, see fig. 1. These guides introduce varying phase shifts and thereby transform the spherical wave into a plane wave.†† The provision of metallic vanes inside the horn antenna at right angles to the electric field permits establishment of a desired configuration of the electric field at the opening which influences the directional radiation pattern.

Parabolic, spherical or cylindrical reflectors are used to shape and direct electromagnetic radiation. To avoid loading of the high frequency source by the reflector, the part reflecting the wave back towards the source may be omitted and an annular-shaped reflector designed. If a wide but narrow beam is desired, a cylindrical mirror proves advantageous. It may be fed by means of a waveguide mounted at its focal line, terminated in its characteristic impedance and provided with radiating slots along its length. The slots are so spaced as to provide equal phase and constant amplitude radiations. A metallic reflector surface should not deviate by more than one-eighth of a wavelength from the prescribed shape.

Another type of short wave antennas are solid dielectric rods of circular cross-section, see insert Fig. 2. They are fed at one end. Due to the partial reflection of the

*Henry Gutton, Laboratoire de recherches physique de la Compagnie Generale de T. S. F., in L'Onde Electric, December, 1946, pp. 459-466

†A similar relation, where the factor of two is replaced by the square root of two, may be found in "Radar Engineering" by Donald G. Fink, page 232, formula (340). (Translator's note)

††See "Radio Lenses" by Winston E. Kock, Bell Laboratories Record, May 1946, summarized Electronic Industries, July 1946, p. 81. (Translator's note)

wave at the surface wave propagation takes place inside the rod which behaves as a guide; the wave in free space constitutes a continuation of the guided wave. For optimum efficiency, it is advantageous to have a constant radiated electric field intensity along the antenna. As the field inside the rod diminishes towards the far end, an increasing proportion must be radiated to maintain the radiated field constant. For this purpose, the rod is slightly tapered. To avoid reflection at the far end, the rod is terminated as a semi-sphere.

The expression for the intensity of the electric field in a direction inclined at angle α to the direction of the axis of the antenna rod is given by:

$$E=\frac{\sqrt{2-2\cos[2\pi l\ (\lambda_g\cos\alpha-\lambda)\ /\lambda_g\lambda]}}{2\ \pi\ l\ (\lambda_g\cos\alpha-\lambda)\ /\ \lambda_g\ \lambda},$$

where l designates the length of antenna, λ wavelength in air, and λ_g wavelength in dielectric.

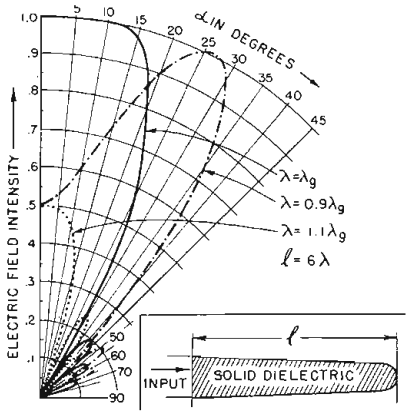


Fig. 2—Directional patterns of dielectric rod antennas which are six wavelengths long for different wavelengths inside the rod. Insert illustrates shape of antenna rod

The maximum field intensity, which occurs in the direction of the antenna axis, or for l equal to zero, may be evaluated from:

$$E=\frac{\sqrt{2-2\cos[2\pi l\ (\lambda_g-\lambda)\ /\lambda_g\lambda]}}{2\ \pi\ l\ (\lambda_g-\lambda)\ /\ \lambda_g\ \lambda}.$$

The directional pattern for an antenna six wavelengths long is illustrated in the polar diagram (Fig. 2) for a wavelength in the dielectric equal to the wavelength in air, equal to 0.9 times the wavelength in air and equal to 1.1 times the wavelength in air. In practice the antenna is so dimensioned that the wavelength in the dielectric is shorter but almost equal to that in air.

An antenna array of this type of antennas may be built up to increase the directivity and the power output. A radiator for a radar transmitter has been designed which is small and can be rotated readily at a rate of ten times per second or a coverage of 3600 degrees per second.* (However no indication of the radiated power is given in the article.) A great number of metal vanes surround the rotating antenna and form a multitude of horns which guide the emitted beam.

*The AN/MPG-1, a mobile search and track radar for coastal gun-fire control scans a 10 deg. sector at 16 scans per second; in other words it covers 160 deg. per second. This is the fastest scanning listed in the Table IX, pages 304-309, of "Radar Engineering" by Donald G. Fink. (Translator's note)

Chicago Engineers Discuss Communications Equipment

The Chicago section of the IRE held their second local one-day "convention" at Northwestern Technological Institute at Evanston, Ill., on April 19. Three simultaneous sessions were in progress for almost 700 registrants, and many unusual equipment setups in the electronic and physics laboratories of the school were open for inspection. In addition, 22 booths displayed the latest products of various electronic manufacturers.

Fifteen papers were presented during the three morning and afternoon sessions. Of general interest to those assembled were "Patents and the Engineer," by C. F. Prangley (Moore, Olson and Trexler) and "The Engineer in Research," by J. E. Hobson (Armour Foundation). In the latter paper, the need for fundamental research as a national asset to the general welfare was stressed.

In the industrial electronics session, the various uses of electronic principles in automatic controls were described and demonstrated by W. H. Kliever (Minneapolis Honeywell) and a review of some types of photosensitive devices and their characteristics was presented by H. S. Snyder of Northwestern University.

Modulation Systems

The majority of the papers were on communication subjects. Television receiver production test requirements and practical production line setups were described by D. Shankland (Farnsworth). A new high efficiency modulation system for video signal transmitters using an unconventional grounded grid version of the Doherty-Terman method of high efficiency grid modulation was described by J. F. Bell (Zenith). A third television paper by R. M. Cohen (RCA) described tubes and circuit design details for RF amplifier and converter circuits.

On one subject of high current interest—FM—a description of a narrow band variable frequency oscillator of particular value to amateur communication transmitters was given by L. A. Mayberry (Hallicrafters). The problems involved in the development of an FM monitor were described by C. A. Cady (General Radio), and the cascade phase-shift modulation system of Raytheon was covered by M. Marks.

Several other papers received widespread attention. The precision permeability-tuned master oscillator of Collins was described and its stability characteristics demonstrated by T. A. Hunter. A magnetostriction coupled mechanical filter for the 455 kc range was demonstrated by R. Adler of Zenith and a new "bimorph" pick-up of the ammonium phosphate type was shown by T. E. Lynch of the Brush Company.

Mobile radio communication equipment working in conjunction with the telephone system by R. R. O'Connor of Illinois Bell, and personal plane radio systems by D. H. Mitchell of Galvin completed the program.

Trends in Development of Parts and Components

By CHESTER I. SOUCY
Consulting Engineer, Toronto, Canada

Use in wartime communications equipment shows up shortcomings of resistors, batteries, shock mounts and RF cables and fittings

THIS is Part II of an article pointing out shortcomings of many commercial products which have limited the usefullness of military equipment. Part I was devoted largely to capacitors, and, like this installment, it showed the desirability and the necessity of material and constructional changes in components to improve their performance in service.—Ed.

• Several designs of low- and high-wattage resistors have been produced to meet the standard humidity cycling, salt-spray, and thermal shock test requirements of the Armed Services. Some types are far from uniform in the initial effectiveness and stability with aging of their sealing provisions. Probably the glass-enclosed type is the best, but it is not yet as compact or as low in cost as would be desirable for more general use.

The main problem at present in resistors is the provision of hermetically-sealed variable types. Here again, the probable solution is to use some new form of construction. Part of the moisture and salt-spray resistant qualities of the improved fixed resistors and their ability to withstand on test rapid transfers from boiling water to ice water are due to improved coatings.[9] Wider application of such improved construction technics to other types of resistors and components may be helpful.

The temperature limitations of several types of fixed and variable resistors are obvious in Fig. 3. The large magnitude of the prescribed deratings indicates the need for new types that are adequate for operation at commonly attained higher temperatures.

It should be noted that hermetic sealing of components, like resistors and capacitors, may not be adequate enough protection against low leakage resistance under conditions of moisture condensation. The provision of non-wetting surfaces between terminals through use of coatings such as Dow-Corning DC-200 silicone fluid[1,10] or General Electric "Dri-Film"[11] probably will be added to many such components in future.

Battery Improvements

The improvements made in the chemical efficiency of dry batteries thereby increasing their effectiveness in miniature sizes have been well publicized. Considerable improvements have been made to extend their shelf life under high ambient temperature conditions. Some improvements have been made in the design of batteries to give greater output under low-temperature conditions where ordinary types fail completely, but the results so far are not startling nor yet generally commercialized, undoubtedly because the peacetime demand for such performance characteristics is probably small.

The usefulness of the recently developed R-M mercury cell would be increased if it could be produced with a higher average voltage to suit the voltage cut-off characteristics of battery-operated tubes. Its greatly enhanced shelf life at high ambient temperatures contrasts sharply with the poor performance of standard types which caused such serious difficulties in military equipment used in the South-Pacific during the war.

It is obvious that both for commercial and military uses considerable research effort would be warranted with respect to the problem of improving the present highly unsatisfactory performance of lead-acid storage batteries at low and high temperatures. It has been reported that batteries developed by the Germans of the nickel hydroxide / nickel / copper chloride-potassium hydroxide type have superior performance at higher temperatures compared to the lead-acid type.

The loss of charge of lead-acid storage batteries at low temperatures (attained in aircraft) is illustrated in Fig. 4. The daily loss of capacity due to self discharge at higher temperatures is clear from Fig. 5, which does not show, however, the extremely rapid deterioration at electrolyte temperatures above 135°F. These characteristics preclude exposure to the tropical sun or charging normally at high ambient temperatures. They also cause short life and low operational efficiency in the tropics despite the higher charge capacity.

Electron Tubes

The pressing war need for SHF and microwave oscillators, detectors, and amplifiers led to extremely rapid advances in the development of new tubes of the magnet-

ron, velocity-modulation and other types. According to a recent paper[17] progress is being made in obtaining reasonable power output from special magnetron types for CW operation in the microwave region to fill the needs of industrial electronic equipment.

There seems to be little doubt that the development of a new type of tube capable of producing oscillations in the millimeter-wave region will proceed to meet coming needs. It was apparent for some time that to obtain higher stage amplifications and wider bandwidths in the super-high-frequency range or to extend the frequency limits of oscillators capable of reasonable power outputs, some new principles of operation must be applied to avoid the limitations due to transit time and inter-electrode capacitances. The recent Bell Telephone Laboratories development of the travelling-wave tube[18] is a very important one for solving this problem, and probably will stimulate further developments along allied lines to overcome the limitations imposed by physical dimensions of the tube structure in ordinary designs.

A wider range of subminiature tubes undoubtedly will be produced. Further extension of wartime developments in the ruggedization of standard size tubes can also be expected to take care of those mobile and other uses of electronic equipment where severe shock and vibration are sustained.

Power Supply Components

Considerable improvement in dynamotors and vibrators for use with electronic equipment was made during the war years including improved brushes for motors and generators used at high altitudes. The improved brushes became possible through understanding the relation between the tremendously increased rate of wear at high altitudes to the diminished oxygen and water-vapor pressure in the air at such levels. However, extension of operating life and increases in efficiency for both vibrators and dynamotors would be desirable further improvements.

One possible solution to the vibrator life problem may be found in the use of commutator-less rotary converters with permanent-magnet fields, similar in principle to a small type of unit that has been developed recently. The recent improvements in vibrator efficiency, output waveform, and regulation may be expected to continue and to extend their usefulness and reliability.

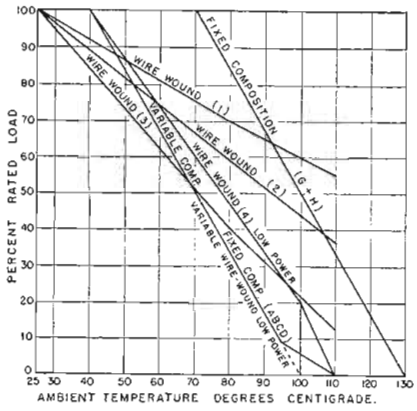


Fig. 3—Power deratings of various resistor types (per JAN specifications) showing need for high-temperature types

The benefits in the reduction in the weight of aircraft wiring and in the reduction of the weight and size of components such as power transformers and motors through the use of 400-cycle and higher power distribution frequencies[14]

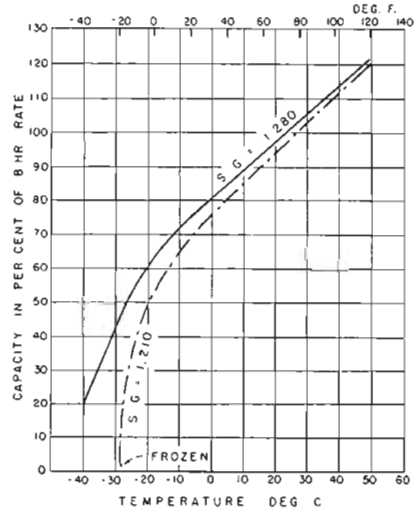


Fig. 4—Stored energy in lead-acid storage batteries cannot be released at low temperatures

have been so great that the benefits of such practices will not only be extended more widely in aircraft but also for use in other mobile forms of electronic equipment.

Operational economies and weight-saving also result from the use of voltages of the order of 100 in place of 12 or 24-volt battery systems[15], and through the use of improved steel laminations such as "Hypersil"[16] and permalloy tape[4]. For equipment operated from storage batteries the voltage factor previously mentioned combined with the availability of a line of tubes with 28-volt heaters will increase the trend to 28-volt operation in place of lower battery voltages.

Dry disc rectifiers have been given protection against moisture in some available hermetically-sealed designs. The low maximum operating temperatures allowable, 104°F (40°C) for copper oxide types and 167°F (75°C) for selenium types render the development of types having higher temperature ratings desirable.

Shock and Vibration Mounts

Only recently has it become clear to equipment designers that there has been no more neglected subject than the isolation of electronic equipment from vibration and shock, and no more badly engineered component of such equipment. In many cases, mountings of the usual type used on equipment in aircraft and vehicles have subjected components, especially tubes, to worse destructive forces than if no mounts at all had been used.

Recently, improved designs of mounts have become available commercially, so that the major need at present is for equipment designers to take note of the fact that equipment mounted on elastic suspensions constitutes a mechanically resonant system with three degrees of freedom, and the mounting system must be engineered if it is to be a vibration and shock isolator instead of an amplifier.

RF Cables and Fittings

Polyethylene-insulated, flexible, coaxial RF cables are limited in their maximum operating temperatures, and are greatly restricted in carrying capacity at the higher temperatures reached in enclosed locations or where exposed to the sun. No satisfactory jacketting material has yet been produced which is non-contaminating so far as the inner dielec-

tric is concerned and has also the desired flexibility at the extremely low temperatures existing in cold climates and in aircraft at high altitudes. Furthermore, improvements in manufacturing technics are required to produce cables free from transmission irregularities at microwave frequencies due to "periodicity" arising from cyclical variations in the electrical constants along the cable.

Higher temperature ratings for hookup wire with synthetic insulation are needed, and coverings that are more satisfactory with respect to abrasion resistance, slow-burning qualities, and moisture and fungus resistance.

Technics in constructing waterproof RF and power cables and sealed cable fittings can be expected to advance. Considerable development along such lines has been carried out for military use in the United States and Great Britain, and such developments should find a considerable amount of commercial use when available.

The use of waveguides and microwaves reduces the temperature and humidity troubles experienced with coaxial RF cables. Electroforming construction technics for fittings and increased use of flexible types of waveguides will ease the problems of the designer of microwave equipment, but the narrow-band transmission characteristics of such "plumbing" constitutes a serious difficulty in frequency allocations. At present standardization of additional sizes of waveguides and fittings seems to be the only possible solution.

Crystal Limitations

It has been necessary to exercise precautions in the use of rochelle-salt crystals as components of crystal type microphones, phono pickups, and hydrophones, even when used only in the temperate zones. Besides the undesirably low safe operating limit of 120°F (48.9°C) in temperature for such units, it is necessary to protect them from moisture and from dehydration in very dry atmospheres.

ADP crystals (ammonium dihydrogen phosphate), recently developed by the Bell Telephone Laboratories[17], which are stable at

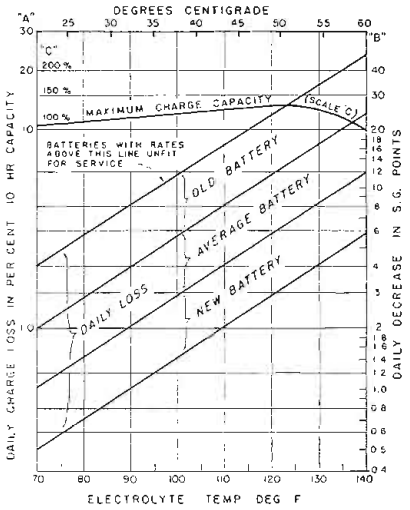


Fig. 5—Self-discharge of storage batteries increases rapidly with temperature while maximum charge capacity increases slightly. 135° F is limiting electrolyte temperature

temperatures up to 100°C (212°F), indicate the possibilities of improvements in electro-mechanical transducer components using piezoelectric crystals.

Many more examples of the deficiencies of the best available components could be given. However, the purpose of this presentation is to dispel the common conception that the war developments have given us a set of electronic components that are highly perfected and suited for use in the equipment designs in which designers are commonly more concerned about their knowledge of circuits than of components. Yet we can build no better than the capabilities of our building blocks permit.

9. E. E. Marbaker, "Coatings For Wire-Wound Resistors", Jour. Am. Ceramic Soc., vol. 28, No. 12, Dec. 1945, pp. 329-342.
10. O. K. Johannson and Julius J. Torok, "The Use of Liquid Dimethylsilicones to Produce Water-Repellent Surfaces on Glass-Insulator Bodies", Proc. I.R.E., vol. 34, No. 5, May 1946, pp. 296-302.
11. F. J. Norton, "Organo-Silicon Films", G. E. Rev., vol. 47, No. 8, August 1944, pp. 5-16.
12. C. G. Suits, "Physics of Today Becomes the Engineering of Tomorrow", address to the National Electronics Conference, Chicago, Oct. 4, 1946.
13. J. R. Pierce and L. M. Field, "Traveling-Wave Tubes", Proc. I.R.E. vol. 35, No. 2, Feb. 1947, pp. 108-111.
14. P. C. Sandretto—"Principles of Aeronautical Radio Engineering", McGraw Hill, N. Y., 1942, pp. 338, 341
15. Vernon H. Grant and Melville F. Peters, "Determination of Optimum Voltage for Airplane Electrical Systems", Elec. Eng., Oct. 1939, vol. 58, No. 10, pp. 428-431.
16. Reuben Lee, "Recent Transformer Developments", Proc. I.R.E., vol. 33, No. 4, April 1945, pp. 240-245.
17. W. P. Mason "ADP and KDP Crystals", Bell Lab. Record, vol. 24, No. 8, July 1946, pp. 257-260.

German Scientists Study Thermistors

C. W. Hansell of RCA, who had made a trip to Europe as U. S. Government Scientific Representative, reported on a few German gadgets in a lecture at the Engineering Societies Building in New York City.

Possibly the most interesting apparatus described was a simple device indicating "vertical", for instance in an airplane. It consists of a heated wire and two thermistors arranged in a glass container filled with rarified gas. If the heated gas, which has a tendency to move vertically upward, passes both thermistors at an equal rate, their temperatures will be identical and their resistances will balance. This position is made to indicate "vertical". Any deviation will result in one thermistor wire being heated to a higher temperature than the other and unbalance of the thermistor wires will result.

Thermistors using uranium oxide as basic material were made. The insulator is mixed with a gum-like substance and then backed. Additional oxide or metal has to be squeezed into the structure to break it up and make a semi-conductor out of the insulator. If metal is in excess electronic conduction takes place, while excess oxygen provides "hole" conduction. Titanium dioxide baked in hydrogen or vacuum at 1500 deg. C is a good thermistor. The Germans produced it on a large scale. The thermistors were shaped as rods, 30 microns in diameter, or as sheets. 30 microns thick. Titanium oxide was sometimes mixed with other oxides to dilute it.

Another feature mentioned was the prevention of losses in metal-to-glass seals at very high frequencies. These losses are caused by currents flowing in the outer metal layer, because of the skin effect, which layer is oxidized and therefore a comparatively poor conductor. To provide an outer layer of high conductivity, the metal is covered with a thin layer of gold which does not oxidize when sealed into the glass. —*J.Z.*

Photographing Pulse Wave Shapes of Radar Modulators

By L. W. MARKS, Power Transformer Engineering Div. General Electric Co., Schenectady, N. Y.

Equipment and methods used in making permanent records of modulator performance as a means of assuring uniformity of results

• All of the power transmitted by a Radar system is generated in the modulator. The modulator supplies power pulses of proper shape, magnitude and frequency to the microwave generator or magnetron. These pulses must be held closely to a very exact wave shape, because even if they vary by a few percent from requirements, the result may be a serious loss of power, double moding, misfiring, frequency modulation and other troubles in the transmitter. In addition to the power pulse, modulators normally provide several monitoring outlets for checking wave shapes at selected, strategic points in the circuit. One type of power modulator for marine application is shown in Fig. 1.

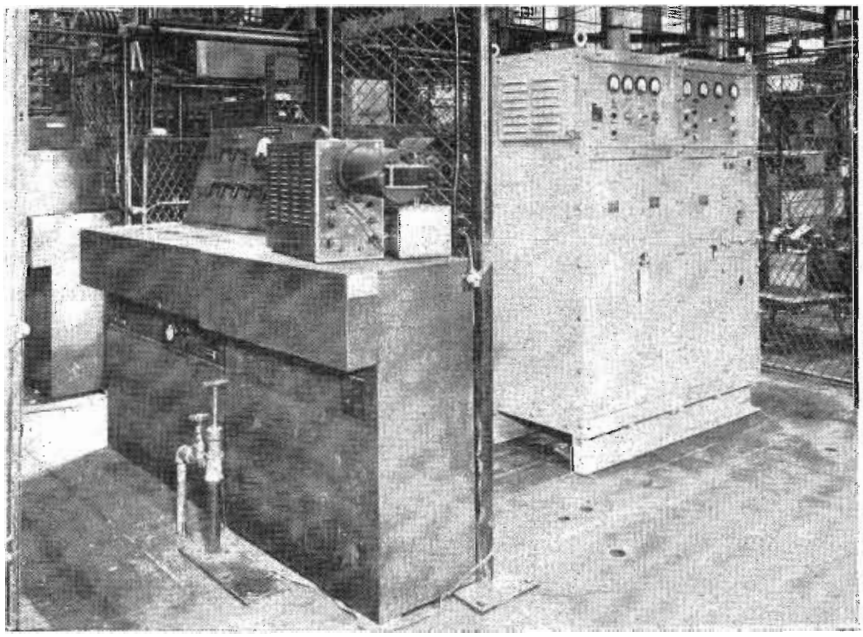
The manufacture of large and costly equipment of this precision type requires that extensive tests be made to insure satisfactory operation in service. An essential adjunct to successful testing is the obtaining and recording of all necessary data.

During the testing of a modulator the wave shape of the output pulse and the various monitoring circuits is inspected by means of cathode ray oscilloscopes or synchroscopes. These waves may be complicated in shape and even slight deviations may be indicative of possible trouble. Therefore, such wave shapes must usually receive engineering approval before shipment is authorized. On quantity production this would require an engineer in almost constant attendance.

The pulses emitted by a modulator are repetitive and may be photographed using specially-designed equipment. The photograph is an exact reproduction of the wave trace and permits the engineer in the office to inspect the shape before shipment, without actually being present during the test. Such a permanent record is a valuable tool in permitting the engineer to locate differences by comparison with a model photograph and may serve as a means for diagnosing a possible source of trouble.

Because a photograph is an exact reproduction, it may be used for inspection even though the inspector was not present at the time of the test. Moreover photographs may be filed and are always available for future reference.

Fig. 1—One type of power modulator developed for marine radar service appears at the right with the wave shape photographing equipment in the foreground



Power Modulator Circuits

There are two fundamental circuits for line type power modulators: 1—Ac charging of pulse network; 2—Dc charging of pulse network.

In the ac charging type the pulse network is charged by a resonant transformer and discharged by a synchronized spark gap. For this type of modulator only the output pulse is photographed.

The dc charging circuit energizes the pulse network from a rectifier and the network is then discharged by a high-voltage trigger circuit. In this case not only the output pulse but also the input to the trigger circuit (Trigger Input), the

thyratron grid voltage, and the trigger output voltage are photographed. In some cases additional circuits may be monitored and the waves photographed.

The principal circuits involved in testing one type of power modulator are shown in the block diagram of Fig. 2. This particular modulator is energized from a 3-phase, 60-cycle source which supplies power to the main rectifier, and the driver unit.

The reactor and pulse network are designed to resonate at some predetermined frequency dependent upon the pulse rate. When the pulse network is charged to maximum voltage (approximately twice dc voltage), it is discharged through the spark tubes and applies a pulse to the resistance dummy load.

The resistance load does not give a pulse identical with a magnetron load due to non-linear characteristics of magnetrons. However, once the proper shape of pulse has been determined on a magnetron load, and compared with operation on a resistance load, the resistor may be used for routine production testing. Development testing should normally be made using a magnetron load.

At the proper time interval during the charging cycle the spark tubes are triggered by a trigger pulse from the driver unit. This consists of a cathode follower type input amplifier feeding into the grid of a hydrogen thyratron. The thyratron circuit may be fired by an input trigger pulse of only a few volts supplied by other circuits in the Radar equipment, or by a synchroscope as shown in the test diagram. The trigger rate may be altered by means of the driving audio oscillator.

The "Input Trigger" may be placed upon the screen of the synchroscope by connecting to "signal input" and phased by means of the synchroscope trigger phase circuit. In like manner the "thyratron grid" circuit and the "driver output" circuit may be connected through concentric cable to the signal input jack of the synchroscope.

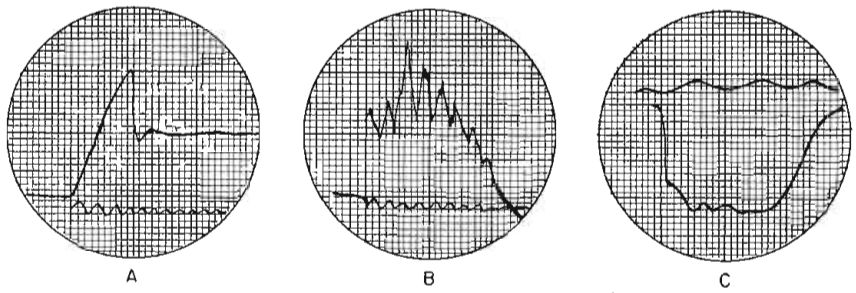


Fig. 4—Repetitive high speed transients—(A) thyratron grid voltage; (B) trigger output voltage; (C) output pulse

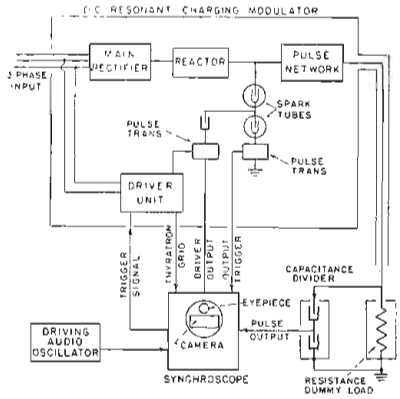


Fig. 2—Block diagram of the test circuit set-up for photographing wave shapes

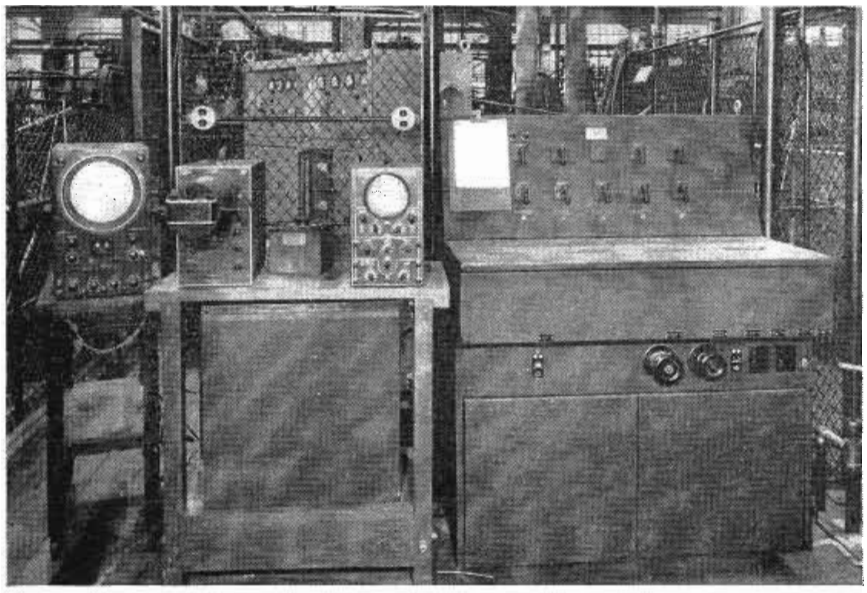
Test Equipment

The pulse output is normally too high in voltage to connect directly to the deflection plates of the synchroscope. Therefore, only a fractional part of this voltage is taken from a capacitance divider. The capacitance divider must be specially designed so as to reproduce exactly the pulse shape and must have an accurately determined ratio.

The various component parts of the test circuit are pictured in Fig. 3. On the right is the power control panel which houses all power control and auxiliary circuits and power instruments, located below the horizontal surface of the compartment.

On the table next to the control panel are from right to left, a cathode ray oscilloscope for measuring repetition rate, a control box for an edge light on the synchroscope screen, and the synchroscope. Over the screen of the synchroscope is mounted a hood equipped with camera and viewing eye piece. Below the table top is a compartment containing the water-cooled noninductive output resistor, capacitance divider, and pulse cable. At the extreme left is a 9-in. CRT used for viewing the charging wave to the pulse network and the thyratron plate. In the background may be seen a modulator under test. Missing from

Fig. 3—Complete test bench for high power modulators showing auxiliary equipment including synchroscope and camera. Modulator in background



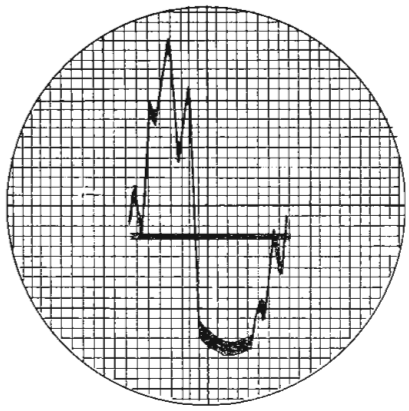


Fig. 5—Repetitive oscillations at 60-cycle fundamental in high voltage cable testing

the photograph is the driving audio oscillator.

One obvious method for obtaining reproduction of the wave shape is by sketching upon coordinate paper. This cumbersome method is not free from error, is slow, and places great reliance upon the diligence and care of the test operator.

Accurate Reproduction

Photographed wave shapes, however, are free from these disadvantages, resulting in an accurate reproduction, free from errors, in a minimum of time. The engineer inspecting the wave shapes has no doubt as to the accuracy. The method for photographing wave shapes described in this article may be used whenever accurate reproductions of repetitive wave shapes are required. The method is extremely simple and requires no expensive photographing equipment. Its application to high power modulators as made at the Pittsfield Works of the General Electric Company resulted in all of the advantages mentioned above, together with decreased time for tests and resulting cost reduction.

Fig. 4 illustrates the reproduction of repetitive high speed transients. Film (a) is the "Thyratron grid voltage", (b) the "Trigger Output voltage", and (c) the "Output pulse" on the resistance load without despiking circuit. The frequency of the small horizontal calibrating wave is 2 megacycles.

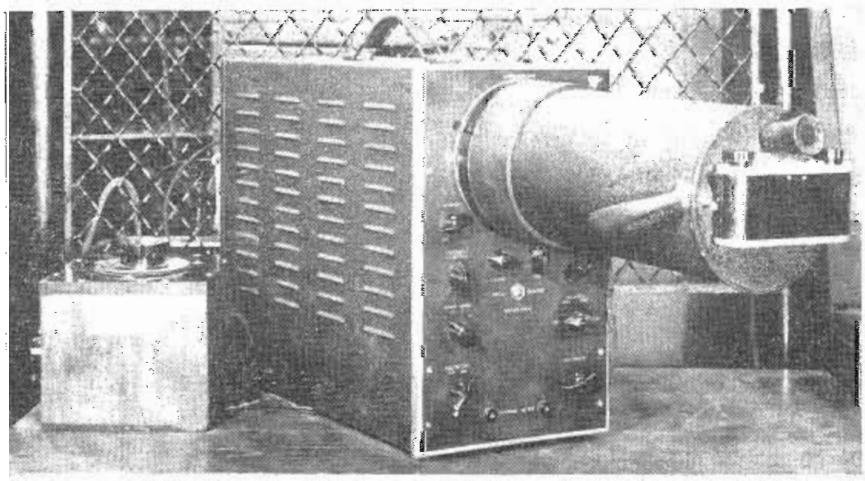
The photographing equipment has been used on applications other than modulators. As an example, during an investigation into the reasons for resonance in a high-voltage cable testing rectifier, photographs of a slower speed wave (60 cycle fundamental) as shown in Fig. 5, were obtained. This film is enlarged 5 diameters.

A closeup view of the complete photographing equipment is shown in Fig. 6. Mounted over the screen of the synchroscope is the viewing hood with camera and eyepiece on the extreme right end of the hood. At the left is the control box used to adjust the brilliance of the edge-lighted screen.

The camera, equipped with a 2 in. f3.5 Velostigmat lens is focused upon the synchroscope screen. No focusing adjustment is provided; therefore, no difficulty with false focus can be obtained on production work. The small eyepiece just above the camera is also constructed with a fixed focus on the screen.

The addition of the viewing hood to the synchroscope prevents external light from falling upon the screen and thus makes it possible to distinguish clearly and to photograph rapidly changes in the cathode trace. This, however, also prevents the observer or the camera from seeing the ruled grid. A clever method for illuminating the grid without appreciably increasing the light inside the hood was developed at Massachusetts Institute of Technology and was modified for use in the modulator testing equipment at the Pittsfield Works of the General Electric company.

Fig. 6—Tesl equipment for photographing wave shapes showing the viewing hood mounted on camera with edge-lighl control box



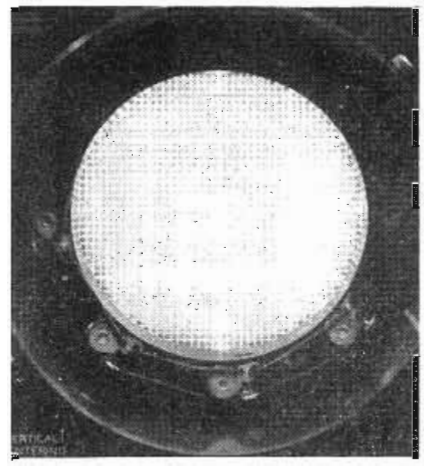


Fig. 7—Close-up view of the edge-lighted screen illuminated at full intensity

Edge-Lighted Screen

The edge-lighted screen at full intensity is shown in closeup view in Fig. 7. Enough external light entered the short mounting cylinder in this picture to show the details of three lower edge light bases and connecting wires.

The modified edge-lighted screen is composed of a disc of clear lucite 5 3/16 in. in diameter mounted on a ring of herkolite ¾ in. in axial length. The Lucite is ruled on the side toward the synchroscope screen and drilled part way through at eight equally-spaced positions from the side adjacent to the herkolite ring. Eight miniature lamp bases are mounted in the ring opposite the blind holes in the lucite as shown in Fig. 7. Radio or aircraft dial lamps project part way into the lucite when placed in the sockets.

A comparison between wave shapes photographed with and

(*Continued on page* 103)

Design of Regulated Power Source

By LEO L. HELTERLINE, Jr., Chief Engineer
Sorensen & Co., Inc., Stamford, Conn.

Electronically reproducing desirable battery characteristics to give 0.5% regulation and recovery time of 2 and 3 cycles

• To accomplish the objective of electronically reproducing the desirable characteristics of a battery, at the same time eliminating the undesirable ones, poses an interesting technical problem.

The desirable characteristics of a wet cell battery are load characteristics which represent an internal resistance of approximately 30 milliohms for a 10-ampere unit. This would give regulation of from no load to full load between 3% and 7%.

The ripple voltage of a battery, of course, is negligible as is the electrical noise generated thereby. Among the other characteristics which should be investigated are those of independence from other factors such as line supply voltage, temperature and time.

The battery unit is, of course, dependent on time since any installation which is expected to draw appreciable amounts of current has a discharge characteristic of some 10% over an eight hour period. Thus, we may tabulate a summary in the form below.

Characteristic	*Wet Battery*	*Nobatron Unit*
Internal impedance (for 10 ampere units of similar voltage range)	+ 0.03 ohms	± 0.002 ohms
Noise level from line voltage fluctuations or other causes or ripple	Negligible	1% maximum
Discharge voltage rate of change per hour in percentage of initial voltage	5% per hr.	Negligible

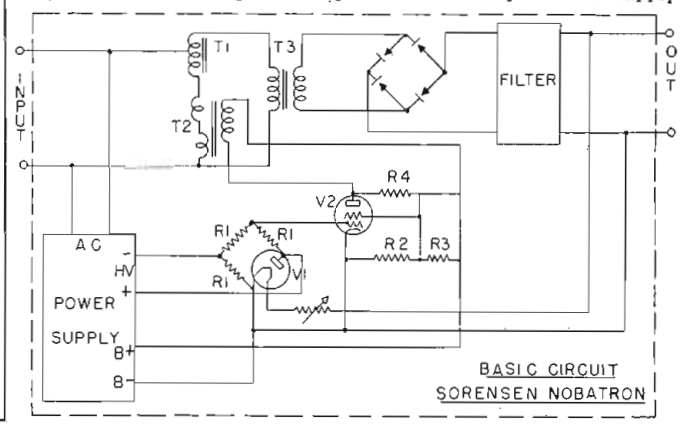
THE high-current, regulated, dc source described in this article is designed to replace its corrosive, gassy, non-automatic counterpart, and to provide a clean and self-sustaining electronic battery to operate switching relays in broadcast stations, for voice current in telephone service, for dc heated filaments in broadcast and television tubes, to power military surplus communications equipment, etc.—Ed.

Other substitutes for batteries have been used for many years. One of the more common sources is the dc generator with an ac operated prime mover. The basic advantage of a system of this nature is that inertia helps in stabilizing sudden transients. This is due primarily to the inertia of a rotating mechanical system such as the motor-generator set. It is often necessary to make these units large and ponderous to be certain that sufficient inertia is present to average out some of the line voltage fluctuation. Compared with a battery, however, most of these units have a considerable degree of output voltage fluctuation both with incoming line voltage and load. The high installation cost, the noise factor, and maintenance are problems that cannot be overlooked.

Various other mechanical systems of regulating dc output voltage have been proposed and used. These are generally attended by slow correction rates as well as fundamental limitations as to their basic accuracy. There are, of course, many applications where these types of corrections are workable.

The characteristics outlined in the table below indicate that the Nobatron makes a reasonable approach to the highly desirable characteristics of a battery unit and eliminates some of the more objectionable ones. To fully understand how this is accomplished, reference is made to Fig. 1 which is a schematic diagram of a typical Nobatron unit.

Fig. 1—Schematic diagram of typical Nobatron regulated dc supply



The basic power circuit of this unit is one wherein the power is derived from the ac mains and goes through an electronically controlable variable ratio transformer; thence into a more or less conventional arrangement of rectifier transformer, selenium rectifier stack and filter combination. This power circuit combination will normally furnish output voltage filtered to 1% RMS or less depending upon the particular requirements.

Diode Regulator

The problem of regulating such a circuit can most readily be understood by tracing back the sampling voltage taken from the output of the unit. This sampling voltage is fed to the filament of a pure tungsten filament diode, in this case V_1. This diode is a unit manufactured by Sorensen, and has a highly reproducible retrace characteristic of plate impedance versus filament voltage. Fig. 2 illustrates this characteristic which will be more fully described later.

To understand the action of the diode, assume that a change in output voltage in the upward direction results either from a reduction in load or an increase in line voltage. This in turn heats the diode filament, moving the operating point along the curve shown in Fig. 2 in such a direction that the plate impedance is lowered by an appreciable factor. This plate impedance constitutes one leg of a bridge circuit, and this leg voltage is fed into the grid of a beam power tube. The bridge is phased so that this signal will cause the circuit to lower the output voltage. This is accomplished by the beam power tube in the following manner.

As the diode becomes hotter, the power tube grid takes on a more negative signal. This negative signal reduces the current through the dc winding of transformer T_2. Looking at the voltage divider combination T_1-T_2, it can be seen that the voltage across the primary of T_1 is dependent upon the impedance of T_2. If the impedance of T_2 is lowered, the voltage across the primary of T_1 is greater and thus the voltage fed into the rectifier stack transformer T_4 also is greater. When the output voltage drops, converse circuit operation returns it to normal.

In the case where the diode has lowered its impedance by greater output voltage, the reduction in the current through the dc winding of T_2 as a result of a more negative grid increases the impedance of T_2 and by the action described lowers the output voltage. This process continues until the output voltage is restored to its pre-set value.

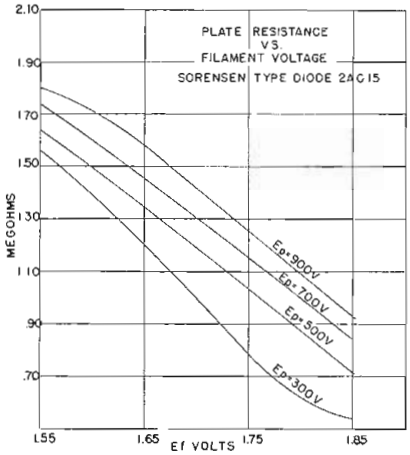


Fig. 2—Characteristics of tungsten filament diode which governs regulation

The circuit of this particular arrangement runs as high as 50,000 when measured as the ratio of voltage change across the dc portion of the transformer T_2 divided by $\triangle E_{dc}$ out. This high degree of accuracy is sufficient to restore the output voltage within much less than 0.5% over wide fluctuation of supply line voltage and load current.

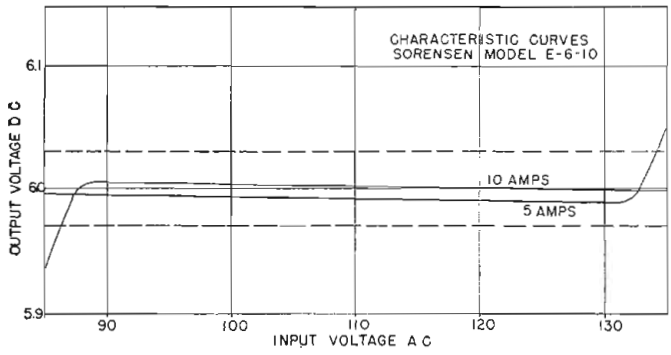


Fig. 3—Performance curves showing regulation ability around the 6-volt point

Fig. 2 demonstrates the temperature limited characteristic of the diode, in this case the 2AC15 tube. It is observed that the relation between plate resistance in megohms and ac filament voltage is very nearly linear. This makes possible an accurately reproducing circuit providing the diode tubes are properly processed and designed.

The manufacture of these tungsten filament diodes is critical in order to obtain the best possible characteristic. In this instrument, the diode is used as true voltage reference. This means that it must be independent of all factors except the voltage across the filament of the tube. Possible sources of other dependency arise from thermal ambients, change in filament emission with time, general changes in tube characteristics with life. All these problems have been investigated in the manufacture of this type of diode.

It has been found that very high vacuum, higher than that obtained in commercial tube practice, is necessary for purposes of producing a truly stable source. It has also been found that it is possible to temperature compensate these tubes by taking into account the various thermal expansion coefficients of the metals in the tube. Also, certain stabilization schedules are important while the tube is on the exhaust manifolds as well as after the tube has been finished and ready for use as a voltage reference source.

In comparison with the VR tubes of the gaseous discharge type, the order of stability of these units constitutes an improvement over the VR units by a factor of at least 10. The life characteristics of these units when used at low plate current values exceeds that of practically any commercial vacuum tube. The simple analogy of life comparison would be that of running an incandescent lamp bulb at approximately one half of its rated voltage. The life is a strong multiple-powered function of filament temperature as has been established by Langmuir and others.

Stability is of the utmost importance and can only be obtained

by careful technics. Assume, for example, that there is a plate voltage of 500 across the diode element. If this is in series with a one megohm resistor, a change of 1/10th of a volt in the filament supply will produce a change of 300,000 ohms in the plate impedance of the tube, thus shifting the plate potential approximately 100 volts. If this 100 volt signal is placed upon the grid of a properly biased beam power tube, it is obvious that this signal will more than control the tube over its full range of grid control characteristics.

Regulation Accuracy

Referring to Fig. 3 which shows performance curves of the model E-6-10 unit, observe the following behavior. It is noticed that the rated limit accuracies of this instrument are ±.03 of a volt around the 6 volt point. At full load with 10 amperes and with the input voltage varying over the range of 85 to 135 volts, it is observed that the voltage declines with rising input voltage. This is made possible by the extremely high gain of the diode and beam power tube combination in addition to a slight amount of compensation which exists in the wound components of the unit. This can be made sloping in the other direction simply by reducing the overall gain of the circuit.

As was pointed out before, with the gain of approximately 50,000 for a given voltage signal in the diode to a given change in plate signal, such characteristics are made possible as long as T_2 is within the range of the saturating current. After the current in the beam power tube has reached a certain level, the saturation point of the iron is exceeded and relatively little change in the ac impedance of component T_2 results. When this point is reached, the regulation unit loses control and the voltage drops sharply. This is observed at approximately 85 volts with a load of 10 amperes. It is observed that the break-out point is very sharp. This is due primarily to the large scale of magnification which is necessary to show the slight changes of voltage with load and line. At the other end of the curve, the grid of the beam power tube is signalled completely to cut off. At this point the reactor is at maximum impedance.

When, however, the reactor has reached its impedance limits and the line voltage continues to rise, particularly at light load, then the output voltage rises sharply, roughly proportional to the input line voltage changes. As the load is increased beyond 10 amperes, the break-out portion of the curve on the low input voltage side increases toward a higher voltage value of break-out on the ac portion of the coordinate. Conversely, as the load is decreased beyond the 5-ampere curve which is indicated, the break-out portion of the curve on the high input voltage side moves toward lower value on the ac input voltage coordinate. Prior to break-out, however, the instrument is extremely accurate due primarily to the high gain as mentioned before.

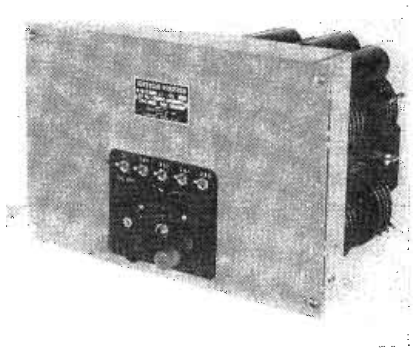


Fig. 4—Front view of Nobatron arranged for panel mounting

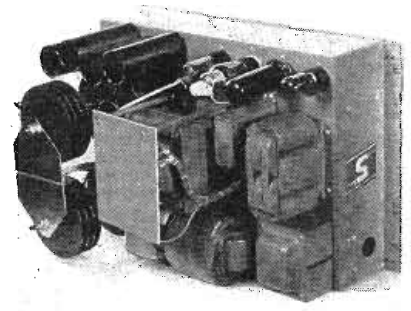


Fig. 5—Rear view of Nobatron unit especially designed for calibrating meters

It is noticed also that with rising load the output voltage of the instrument rises. This is very often the case and can be made to go in the other direction if desired. This is highly desirable in most applications since there is generally lead drop when connecting such an instrument to the load.

The rising characteristic with load is extremely unusual when one considers the internal impedance of a selenium rectifier stack particularly at these lower voltages. It has been found that there is considerable difference particularly at these high currents and these low voltages of the various selenium stacks which are on the market, since internal impedance is, of course, very important in this particular region of current and voltages.

In the case of a Nobatron designed to operate at 120 volts and at 5 or 10 amperes, the plate resistance of the rectifier stack is considerably minimized inasmuch as operation is at an appreciably higher voltage and the ratio of the voltage to the stack resistance is much higher. Stated another way, the internal resistance of the rectifier stack is low compared to the resistance of the load into which the instrument is working. This puts less stringent requirements on the range to be covered by the reactor and thus improved characteristics over and above those listed in Fig. 3 are obtainable, particularly in regard to load range and line voltage range.

Output Voltage Adjustable

Another interesting feature of the Nobatron units which makes them particularly adaptable to many applications is the fact that the output voltage is adjustable. This allows precision setting of voltage for such applications as the photographic field where it is desired to compensate for various times of exposure, for setting correct temperatures in color photography, as well as in meter application uses. This is done basically by inserting a variable resistance in series with the diode filament. This may take the form of a potentiometer of rather low resistance and may be supplemented by fine control over a coarse control if this is desired. Setting of voltages within 1/10 of 1% and with positive assurance that these voltages will be maintained in this order of accuracy is possible.

A brief description of how this is accomplished by means of this series potentiometer is appropriate.

(*Continued on page* 106)

Survey of World-Wide Reading

Electronic news in the world's press. Review of engineering, scientific and industrial journals, here and abroad

Vacuum Tube as Electro-Mechanical Transducer

Harry F. Olsen (Journal of the Acoustical Society of America, March, 1947, pp. 307-319)

The mechano-electronic transducer described converts mechanical vibrations into voltage variations by means of the microphonic effect* in a vacuum tube. In other words, the mechanical vibrations of an electrode give rise to electron current variations which cause voltage variations across the output resistor of the tube.

The vibrating electrode of a transducer tube, see Fig. 1, passes

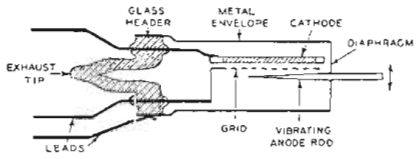


Fig. 1—Schematic diagram of mechano-electronic transducer with vibrating anode shaped as tapered rod

through a thin metal diaphragm which permits the transfer of mechanical vibrations while establishing a vacuum-tight seal. Diodes, triodes, tetrodes, or pentodes are feasible; either the control grid or the plate may be mounted for vibration. The relative change in electron current is greater in a grid-controlled triode than in a diode, and the triode plate resistance is higher. Because of their large mass, plane electrodes are not suitable as vibrating elements and the vibrating electrode is constructed as a bar.

It is shown that the voltage output of a mechano-electronic transducer is proportional to the deflection of the bar; for varying deflection, the output voltage amplitude is proportional to the amplitude of the mechanical vibration regardless of frequency. In the frequency range below the resonant frequency of the rod, which

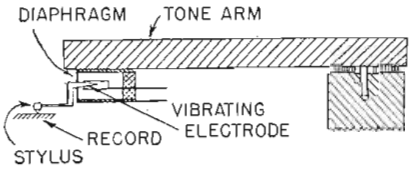


Fig. 2—Phonograph pickup incorporating transducer tube

is of interest, and for a rod rigid compared to the elastic diaphragm, the rod moves as a rigid member with the diaphragm as the fulcrum. For linear frequency response the driving force must be proportional to the square of the frequency.

Analysis of the mechanical vibrating system (i.e., the rigid bar supported by the elastic membrane and driven by a force acting on the end of the bar outside the envelope) reveals that a small effective mass of the rod is favorable for high sensitivity of the system. By using a tapered or conical bar instead of a bar with circular cross-section the effective mass can be reduced considerably. For the same fundamental resonant frequency, the total mass of the cylindrical bar will be 63 times the total mass of the conical bar; the sensitivity will be increased 36 db by the use of the conical bar. An even larger ratio of effective masses at the fundamental resonant frequency facilitates damping of the mechanical vibrations of the conical compared with the cylindrical bar. It appears that a tapered bar is superior to a cylindrical bar as the vibrating electrode in a mechano-electronic transducer. The mechano-electronic transducer illustrated in Fig. 1 was the most promising of several tested types. The plate consists of a tapered rod mounted in a flexible metal diaphragm which permits the transfer of mechanical vibrations.

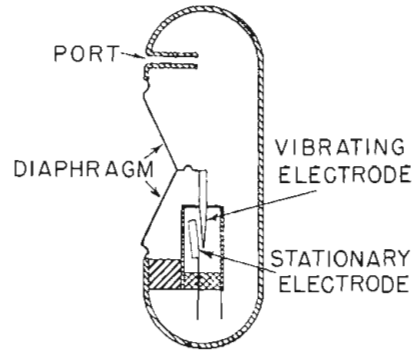


Fig. 3—Microphone based on the mechano-electronic transducer

A mechano-electronic phonograph pick-up for the reproduction of standard phonograph records is illustrated in Fig. 2; it has a cut-off frequency of 5000 cycles. Another pick-up suitable for the reproduction of transcription records and with a cut-off frequency of 12,000 cycles has also been developed and built.

A microphone based on the mechano-electronic principle may

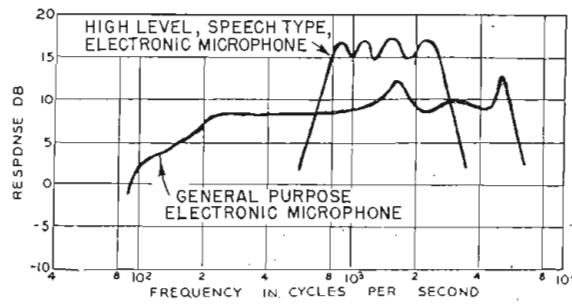


Fig. 4—Frequency response curves of general and high level mechano-electronic microphone

* See e.g. Journal of Applied Physics, February 1947, pp. 239-245.

be constructed to have approximately the same sensitivity as a carbon microphone without the high distortion, carbon packing, and variation of response with orientation inherent in the carbon microphone. Fig. 3 shows the construction of the microphone. In Fig. 4 the response curves for a high level, speech-type electronic microphone and for a general purpose electronic microphone are plotted; the useful frequency ranges extend from 800 to 3000 cycles and from 100 to 6000 cycles, respectively. The diaphragms in both instances are molded paper cones, 2 inches in diameter.—*JZ*.

Apparatus for Magnetizing Loudspeaker Magnets

H. Gilloux (La Radio en France. Paris, France, Vol. 1, 1947, pp. 14-16)

A simple apparatus for the magnetization of loudspeaker magnets is described. A capacitor bank is charged by a full-wave rectifier and discharged through a coil. A thyratron is inserted in the discharge path to interrupt the circuit when the voltage reaches zero and to prevent the following negative current from passing through the coil. Constant amplitude charging of the capacitor bank is assured by a neon lamp which also provides positive grid voltage for the thyratron at the start of the manually initiated discharge.—*JZ*.

Transmission-Line Load with Water as Dielectric

F. M. Leslie (Wireless Engineer, London England, April 1947, pp. 105-108)

A short-circuited, concentric transmission line using water as dielectric may be used as dummy load to measure the power output of a high frequency generator by comparing the input and output temperatures of the water flowing through the line.* The high dielectric constant of water and its heat dissipating capabilities are of advantage in this arrangement.

In practice two short-circuited, quarter-wave, concentric lines are mechanically connected. For an outer and inner radius of 25.5 mm and 16 mm respectively, and a frequency of 30 mc, an input impedance of 20.6 (5.7°) ohms is obtained. Experimental results are reported. 5 kw output power were dissipated satisfactorily.—*JZ*.

* See paper by A. G. Kandoian and R. A. Felsenheld on "Power Loads at Very and Ultra High Frequencies" read at the IRE National Convention in March 1947.

Frequency Meter

H. L. Schultz (Review of Scientific Instruments, April, 1947, pp. 223-225)

An instrument, designed as a direct-reading pulse counting meter for nuclear research, may be readily adapted to operate as a frequency meter covering a range from a few cycles per second to several hundred kilocycles per second with an accuracy of several percent. The actual instrument had four operating ranges: 0-50 pulses per second, 0-500 pulses per second, 0-5000 pulses per second and 0-50000 pulses per second.

The biased diode, see figure, permits the level of the recorded pulses to be adjusted by variation of the biasing potential. Pulses a fraction of a volt above the established level will be recorded. The blocking oscillator is trigged by the incoming pulses and supplies pulses of uniform shape and duration to the microammeter. For low counting rates, the pulse length of the blocking oscillator pulses are extended by an increase in the grid-circuit capacitance.

At the lowest frequency range, a "flip-flop" circuit is triggered by the pulses to be counted and in turn operates a power tube with a mechanical recorder in its plate circuit.—*JZ*.

Manufacture of Synthetic Mica

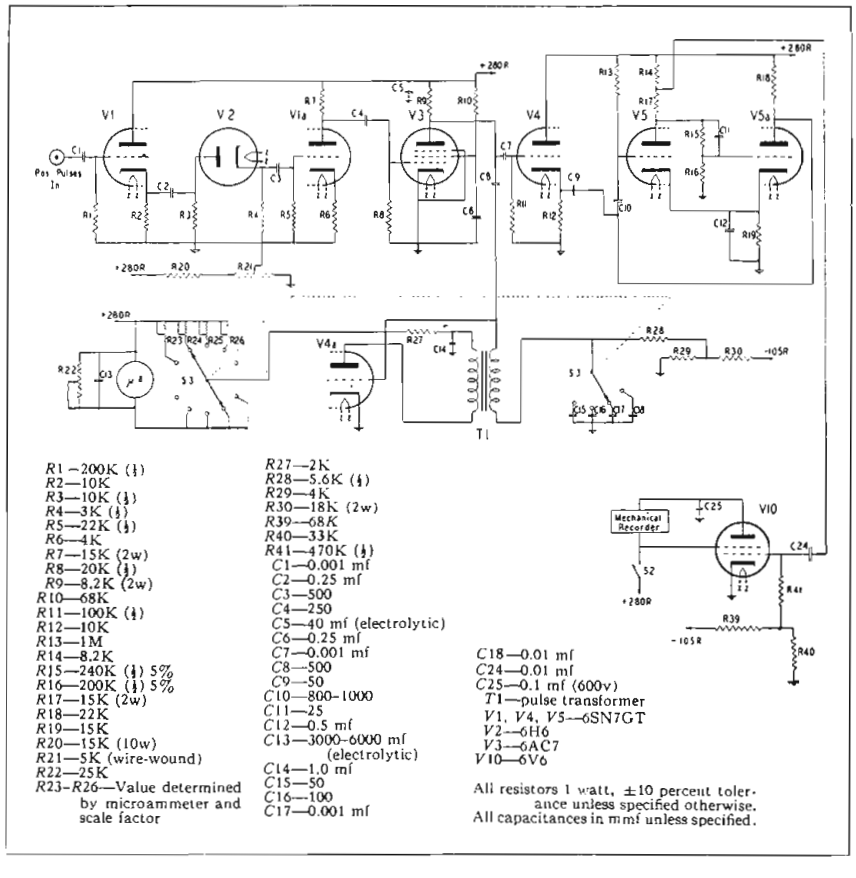
A. E. Link (Chimie & Industrie, Paris, France, Vol. 56, No. 1, p. 21).

Due to the shortage of mica in Germany, a process for its synthetic manufacture has been developed at the Kaiser Wilhelms Institute at Berlin-Dahlen. The best synthetic product is comparable in every respect to natural mica. Its composition is as follows:

SiO_2	35-39%	(weight)
$(Al,Fe,Cr,V)_2O_3$	11-12%	"
$(Mg,Fe,Mn,Zn)O$	29-35%	"
$(Na,K)_2SiF_6$	11-13%	"
$(Na,K)F$	6-7 %	"

The principle adopted to secure large squares of mica was to care-

Direct-reading frequency meter covering a range of from several cycles to 100 kc with an accuracy of several percent



R1—200K (½)
R2—10K
R3—10K (½)
R4—3K (½)
R5—22K (½)
R6—4K
R7—15K (2w)
R8—20K (½)
R9—8.2K (2w)
R10—68K
R11—100K (½)
R12—10K
R13—1M
R14—8.2K
R15—240K (½) 5%
R16—200K (½) 5%
R17—15K (2w)
R18—22K
R19—15K
R20—15K (10w)
R21—5K (wire-wound)
R22—25K
R23-R26—Value determined by microammeter and scale factor
R27—2K
R28—5.6K (½)
R29—4K
R30—18K (2w)
R39—68K
R40—33K
R41—470K (½)
C1—0.001 mf
C2—0.25 mf
C3—500
C4—250
C5—40 mf (electrolytic)
C6—0.25 mf
C7—0.001 mf
C8—500
C9—50
C10—800-1000
C11—25
C12—0.5 mf
C13—3000-6000 mf (electrolytic)
C14—1.0 mf
C15—50
C16—100
C17—0.001 mf
C18—0.01 mf
C24—0.01 mf
C25—0.1 mf (600v)
T1—pulse transformer
V1, V4, V5—6SN7GT
V2—6H6
V3—6AC7
V10—6V6

All resistors 1 watt, ±10 percent tolerance unless specified otherwise.
All capacitances in mmf unless specified.

fully control the cooling temperature of the melted mass, particularly in the critical range between 1,270 and 1,230 deg. C. A magnetic field was applied to increase the size of the final plates. The melting pot was made of graphite. The laboratory process is described and changes necessary for industrial applications are suggested.—JZ

Losses in Organic Isolating Materials

H. Staeger, B. Frischmuth and F. Hel (Schweitzer Archiv fuer angewandte Wissenschaft und Technik, Solothurn, Switzerland. Vol. 12, No. 12, December, 1946, pp. 372-390).

Investigations were carried out to clarify the relation between the molecular structure of the constituents in layer-shaped substances and the dielectric losses of isolating materials. Particular atomic groups and their contribution to the dielectric loss were systematically studied. Variations in the molecular structure liable to reduce the dielectric loss were established.—JZ

Flux Plotting Method Applicable to Magnetrons

P. D. Crout (Journal of Applied Physics, April, 1947. pp. 348-355)

A method is developed for plotting electric and magnetic flux for fields satisfying Maxwell's equations. Conditions to be satisfied by the values assigned to an elementary rectangle are derived. A probable field distribution is assumed and the method of successive approximations used. From the values of the final plot, the resonant frequency may be found. The method is applied to a hole-and-slot type magnetron and to a vane type magnetron.—*JZ.*

Design of Parallel-T Networks

L. E. V. Lynch and D. S. Robertson (A. W. A. Technical Review, Sydney, Australia, Vol. 7, No. 1, 1946, pp 7-25).

Unbalanced parallel-T networks for RC oscillators are discussed in detail and curves to facilitate the design of suitably dimensioned networks are presented. Fig. 1 illustrates a one-stage oscillator incorporating a parallel-T feedback network.

For easier mathematical treatment, the parallel-T network is reduced to its equivalent π-section and formula pertaining to the frequency selectivity and attenuation are derived.

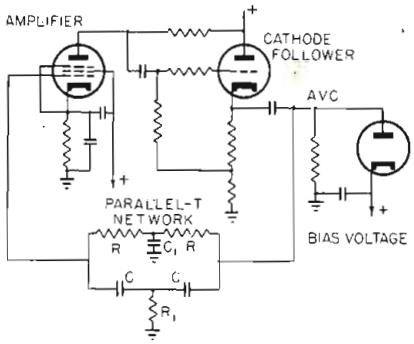


Fig. 1—Oscillator circuit incorporating unbalanced parallel-T network in feedback path

Infinite attenuation occurs at an angular frequency ω given by:

$$\omega_o = 2/R^2CC_1 = 1/2C^2RR_1 \quad (1)$$

provided the balance condition:

$$4R_1C = RC_1 \quad (2)$$

is met. By disturbing the balance of this network a practical phase-shift oscillator circuit is possible.

Two methods of adjusting the amount of unbalance will be considered:

Case 1: Adjustment of R_1 and $C_1 = C$, then the unbalanced constant

$$K_1 = 4R_1/R, \quad (3)$$

balance obtains for K_1 equal to unity, compare equation (2). For convenience the identity

$$\alpha_1 = \omega RC \quad (4)$$

is introduced, where ω represents the angular frequency for which the phase-shift is equal to 180 deg.

Case 2: Adjustment of C_1 and $R_1 = R$, then the unbalance constant

$$K_2 = 4C/C_1, \quad (5)$$

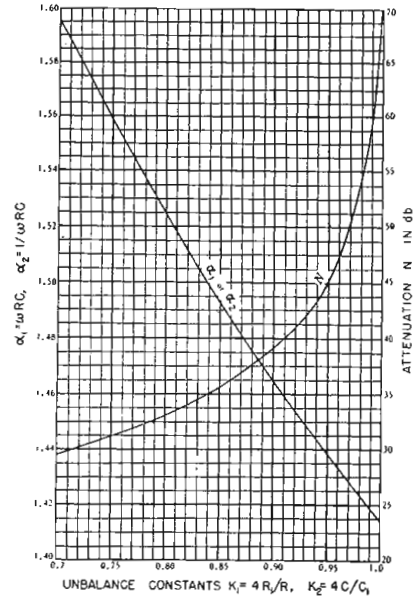
balance obtains for K_2 equal to unity. For convenience the identity

$$\alpha_2 = 1/\omega RC \quad (6)$$

is introduced, where ω again represents the angular frequency for which the phase-shift is 180 deg.

In Fig. 2 curves of the attenuation N, and of α_1 (α_2) as functions of the unbalance constants K_1 (K_2) have been plotted for a range of K-values where the phase-shift frequency characteristic is steep at 180 deg. phase-shift. The order of frequency stability or the change in phase shift with frequency increases as K_1 (K_2) tends to unity. However, the attenuation also increases and a larger amplifier gain is necessary.

Fig. 2—Attenuation and α_1 (α_2) plotted as functions of K_1 (K_2) to facilitate design of parallel-T network



Network Design

Assuming the maximum available gain and the operating frequency to be known, the curves in Fig. 2 will permit to design the network. From the available gain and the curve for the attenuation, the value of K_1 (K_2) is determined so that the network attenuation is slightly less than the maximum amplifier gain. For this value of K_1 (K_2) the value for α_1 (α_2) is read off the other curve in the figure and the RC product found from equation (4) or (6) and the operating frequency. For variable frequency oscillators with capacitor tuning, case 1 is preferable, as ganged capacitors with equal sections may be used for C_1 and C.

It is desired that the output impedance of the amplifier be small and the input impedance large. In the circuit shown in Fig. 1, the cathode follower provides the low output impedance and the network is loaded by the high input impedance of the amplifier tube. Automatic gain control voltage is fed to the grid of the amplifier tube over the conductive path of the network.

Suppose an oscillator is required to operate at a frequency of 5 kc. Let the amplifier have a maximum gain of 40 db, an output impedance of 500 ohms, a phase shift of 180 deg., and an input capacitance of 10μF. Then K_1 (K_2) will be 0.9 and α_1 (α_2) equal to 1.465. In case 1, $RC = 0.466 \times 10^{-4}$ so that for R = 20,000 ohms; C will be 2,330μF; R_1

(*Continued on page 106*)

Secondary-Emission Amplifier Tube

By MARC CHAUVIERRE, Vice-President of the G.T.I.R., Consulting Engineer, Television Branch, C.N.E.T.*

The secondary-emission electrode in the EE50 — an RF amplifier tube for wideband transmission — increases its transconductance

• It has occurred to many specialists to use the secondary-emission effect or the electron multiplier principle in amplifier tubes to achieve a considerable increase in transconductance without unduly increasing interelectrode capacitances. However, in studying the feasibility of such amplifier tubes, great difficulties are encountered. In spite of the difficulties involved, certain European firms have studied the problem; in 1938 a one-stage secondary emission tube, the EE50 was put on the market by Philips.

Figs. 1A and 1B illustrate elements in the EE50, a single-stage secondary-emission tube. The electrons emitted by the cathode are directed to impinge upon the secondary-emission cathode; the secondary electrons, which may be a multiple of the number of primary electrons, travel to the plate

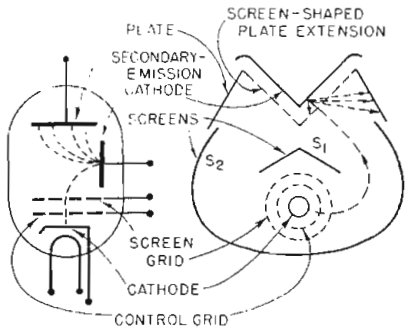


Fig. 1. A and B—Schematic diagram and cross section of EE50, illustrating electron paths and position of shields S_1 and S_2 which protect the secondary-emission cathode

and constitute the plate current. Consequently, for identical plate current, the transconductance of a secondary-emission amplifier tube may be made considerably greater than that of a conventional tube. The increase in transconductance is limited by the emissive power of the auxiliary cathode and by the maximum admissible plate dissipation; it is therefore important to know to what extent the transconductance depends on the secondary emission coefficient α. The cathode current, I_k, shall be given by:

$$I_k = A(V_g + b)^k$$

where A, b and k are constants for a given plate voltage and V_g is the grid voltage. Then it can be shown that for equal plate currents, the transconductance increases by a factor equal to $\alpha^{1/k}$ by secondary emission. For large enough plate current, the constant k has a value of approximately 1.6. Assuming a secondary emission coefficient of 5 for the auxiliary cathode, the transconductance, for an equal value of plate current, will be $5^{0.6} = 2.6$ times the original transconductance without secondary-emission.

However, in trying to realize a tube of this type practical difficul-

(*Continued on page 98*)

*Adapted from the French by Josepha E. Zentner, Ph.D.

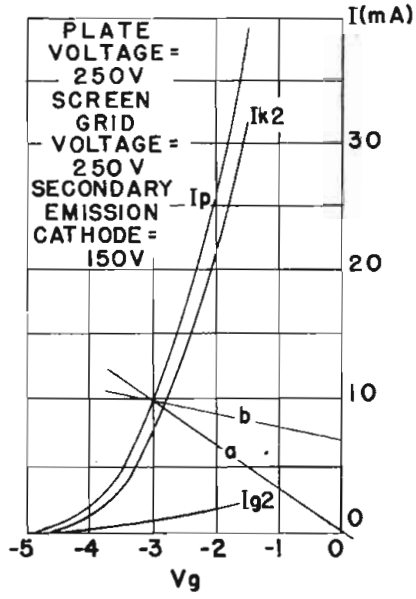
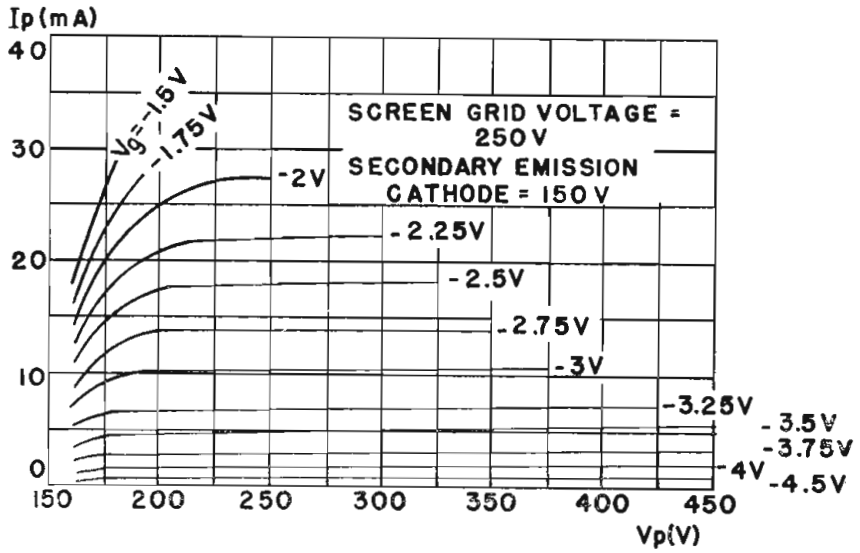


Fig. 2 Left—Plate current I_p, secondary-emission current I_{k2} of the EE50, and screen grid current I_{g2} as functions of the control-grid voltage V_g

Fig. 3 Below—Plate current I_p of the EE50 as a function of plate voltage V_p for different values of grid voltage V_g



Tele-Communications 'round the World

By ROLAND B. DAVIES,
Tele-Tech Washington Bureau

News of engineering matters of importance and of markets in various foreign fields

INTERNATIONAL RADIO CONFERENCE — With formulation of broad base of allocations of frequencies for the major radio services of world-wide usage, global engineering definitions and principles and operating regulations well achieved, the International Radio Conference at Atlantic City accomplished its major objectives or "targets" by the end of June. Only one significant task remained—the compilation of the new International Frequency List and, as the result of the move of the United States Delegation, all of the countries and radio administrations are transmitting their circuit requirements for the Fixed Point-to-Point Service to the Frequency List Committee of the Conference by July 15. After reconciling the Fixed Service requirements with the needs of the Aeronautical and Maritime Mobile Services they will submit their circuit applications for the latter two services by the middle of August. Short-wave broadcasting will share its assignments to be designated definitely during the August High-Frequency Conference with the Fixed Services and, of course, the Amateur Service operates in bands, not specific circuits. There has been a most notable spirit of cooperation among the approximately 60 nations at the Conference to evolve the best possible world radio "master-plan" and much of the credit for the Conference's success goes to its Chairman Charles R. Denny, who heads the FFC and the U. S. Delegation.

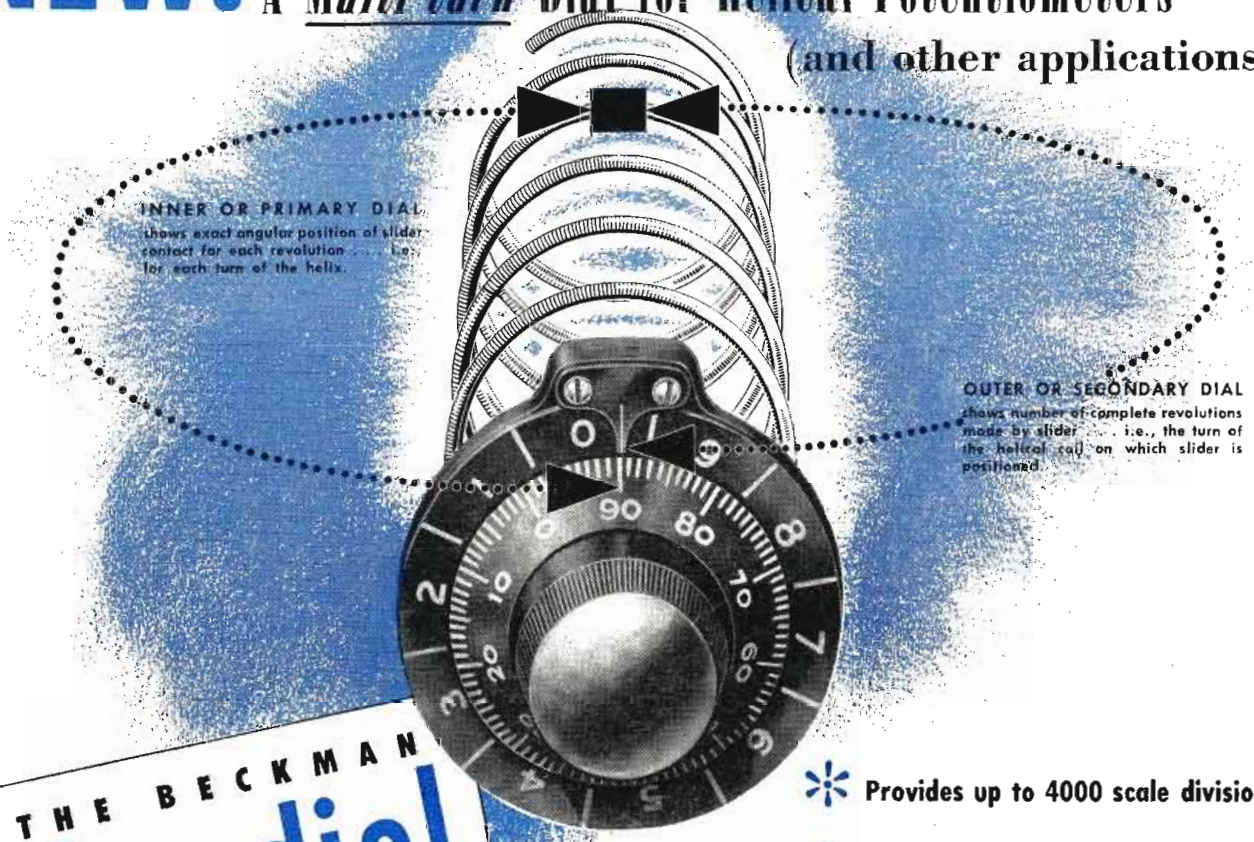
BROADCASTING IN RUSSIA—While much has been published in the daily press about the fine reception by the Moscow radio audience of the new "commercial advertising" announcements over the broadcasting station in the Soviet capital, the significance of the development in its indirect endorsement of the American system of broadcasting has not received general publicity. The Russian radio listeners are reported to be enthusiastic about the advertising announcements and are demanding more. The announcements are different from the American type being worded more like newspaper classified advertisements.

BRITISH PLAN THEATER TELEVISION—A prominent British film producer, J. Arthur Rank, is reported to be planning a television network in that country for reception in movie theaters in addition to private homes. While granting of his request by the Postmaster General for authority to build a transmitting station and assignment of frequencies would mean the breaking of the BBC monopoly, British sources are inclined to believe the government will grant his request in the interests of scientific and technical progress. Rank's plans are said to call for construction of the world's largest studio and the transmission of a combination program of outdoor television pickups of major sports events, stage shows and films.

RECEIVING SETS IN SWEDEN—According to recent government statistics, there is one radio receiver for each 3.5 persons in Sweden, or a total of 1,915,602 licensed radio receiving sets. It is stated that practically all receivers sold there during the past 10 years have been equipped for short-wave reception.

ARGENTINA PLANS RADIO EXPANSION—President Peron of Argentina recently proposed the creation of a Telecommunications Administration or Ministry in his government which would establish a new national structure of communications and broadcasting. One of its chief tasks will be the direction of the five-year government program of expansion and replacement of the existing radio communications and broadcasting installations. Meanwhile, the United States, through its State Department, has protested to the Argentine Government about the latter's recent ban on the importation of American radio receiving sets which the United States states was in violation of the provisions of the 1941 Reciprocal Trade Agreement between the two nations.

NEW! A *Multi-turn* Dial for Helical Potentiometers (and other applications)



THE BECKMAN **Duodial**

- Provides up to 4000 scale divisions
- Requires only 2" diameter space

HERE'S A DIAL development entirely new in operating simplicity, convenience and versatility. It's the Beckman DUODIAL — a multi-turn rotational-indicating unit consisting of a primary knob-dial geared to a concentric turns-indicating secondary dial, *and the entire unit so compact it requires a panel space only 2" in diameter.*

The DUODIAL permits extremely accurate vernier adjustment of driven controls and, when used with helically-wound devices such as the Beckman Helipot, it registers *both* the angular position of the slider contact on any given helix and the position of the slider along the helical winding. The DUODIAL is so designed that — as the primary dial is rotated through each complete revolution — the secondary dial moves one division on its scale.

Thus the secondary dial counts the number of complete revolutions . . . or, when used with helical potentiometers, it indicates the helical turn on which the slider contact rests.

Although developed originally for use with the well-known Helipot Potentiometer, the DUODIAL is readily adaptable to other helically-wound devices of similar nature, as well as to many conventional gear-driven controls where extra dial length is desired without wasting panel space. Its compactness and simplicity — and unique advantage of providing an accurate rotational indication from a minute fraction of a turn through as many as 40 full turns — make the DUODIAL invaluable for many applications where maximum dial accuracy is essential.

Complete information on the DUODIAL can be secured from your nearest Helipot representative . . . or write direct.

IMPORTANT DUODIAL FEATURES

- The DUODIAL contains only two moving parts. Mechonical wear and operating torque are reduced to an absolute minimum, assuring long, trouble-free life. All parts, including knob itself, ore made entirely of metal for maximum strength and durability.
- The primory scale, which indicates angular position, is on integrol part of the knob, and, by meons of o set-screw, is rigidly affixed to the shaft of the driven device. Thus, in contrast to most turns-indicating mechanisms, the scale readings are not subject to error from backlash of internal gears. For maximum convenience in making decimal notations, this diol is groduoted 0 to 100.
- The DUODIAL cannot be damaged through jamming of the driven unit, or by forcing beyand ony mechonicol stops. The dial can readily be used with power-driven devices, because, due to the absence of worm gears, it can be operated from either the shaft or knob end.
- The DUODIAL is currently available in turns-ratios of 10:1, 15:1, 25:1 and 40:1 (ratio between primary and secondary dials). Other ratios can be provided on speciol order. The 10:1 ratio DUODIAL can be readily employed with devices operating fewer than ten revolutions and is recommended for the Model C three-turn Beckman Helipot. All ratio-types are identical in size and appearance except for the numbering of the secondory (turns-indicating) dial.
- The DUODIAL is designed for mounting directly on ¼" diameter round shaft, and in all sizes the primary dial and shaft operate with a 1:1 ratio.

* Ronge for 40:1 ratio DUODIAL.

THE HELIPOT CORPORATION

1011 Mission Street • South Pasadena 3, Calif.

WASHINGTON

Latest Electronic News Developments Summarized by Tele-Tech's Washington Bureau

TELEVISION'S NETWORK FUTURE—Most important engineering conference between principal television broadcasting companies, the A.T.&T. and Bell System and leading video and microwave equipment manufacturers was staged in early June by FCC to formulate a schedule of the expected installation of common carrier coaxial cable and radio relay facilities for television broadcasting relaying. On eve of FCC conference, the A.T.&T. filed for the first time a tariff with rates for coaxial cable television transmission to become effective on August 1. For full service at eight consecutive hours the charge is to be $40 a circuit mile monthly; for occasional or part-time service the rate is $1.25 an hour per circuit mile; and for each station connected on a monthly basis $750 a month for eight consecutive hours daily, together with a monthly station connection charge of $250 plus $15 for each hour of use. A.T.&T. plans to complete 6500 miles of coaxial cable by end of 1947 and over 9000 miles by end of 1948. In another field, where it has no direct governmental interests, the FCC is following closely efforts of television broadcasters and their organizations to secure sanction by apartment house owners of a standard TV antenna structure as the Commission feels such agreement will stimulate television's progress considerably.

FM BROADCASTING IS NATIONWIDE—With FM broadcasting stations in 47 states, the District of Columbia and Puerto Rico, the vision of FM becoming a nationwide service has been realized. Last month, the FCC recorded that more than 500 communities in these states (all except Montana) had FM stations and that there had been a total of nearly 1,000 authorized or projected FM stations. California leads all states in the number of places with FM stations, while Ohio, New York, Pennsylvania and Texas come next in that order and there is also considerable FM broadcasting activity in Illinois, North Carolina, Michigan and Massachusetts.

MOBILE RADIOTELEPHONE SERVICE—With the rapid growth of mobile radio service both under the aegis of telephone companies' operation and by taxicab companies and other vehicular organizations, the FCC staff is busily engaged this summer in correlating all essential data on the extent and value of wartime equipment developments in this field, potentialities for expanded use of the spectrum by the mobile services and the definite outlook of the various elements engaged in this service so as to have this information available for the all-important hearing in September. The scope of the mobile operations was illustrated to TELE-TECH by FCC sources by figures of investment in equipment—some $12 million by the Bell System alone in its urban and highway mobile operations and over $17 million by taxicab companies up to the end of June. Because of the present large investment, Commission definitely is inclined toward granting establishment of services on a permanent basis instead of present experimental license status.

AVIATION MAY WIN OVER TELEVISION IN SPECTRUM SPACE DISPUTE—Because of the strong showing of the Radio Technical Commission for Aeronautics with the support of such leading manufacturers as RCA with its Teleran, Federal Telephone & Radio Corp., Hazeltine Electronics, Sperry Gyroscope and General Railway Signal Corp. and with the backing of Aeronautical Radio Inc., and Air Transport Association, television interests appeared likely to lose out before the FCC in their opposition to the shift of the present video pickup and experimental relay band of 1350 megacycles to 1800 mc. The shift has been proposed because the aviation interests desire an unbroken exclusive band from 960 to 1600 mc for aeronautical navigational services. This would be necessary, according to the RTCA, for the development of an all-weather flying system through integrated electronic aids like Teleran, Navar, Navaglide, Lanac and Sperry microwave instrument landing system. That the FCC was inclined to support the aviation industry's request even though television spokesmen like Philco and the Television Broadcasters' Association claimed television programming and the video art itself would be set back a year with the shift to 1800 mc was evidenced not only by the aviation presentation but with the fact that the dominant viewpoint at the Atlantic City World Radio Conference was for unbroken exclusive bands for air navigation as the best utilization of the spectrum.

ROLAND C. DAVIES
Washington Editor

News of the Industry

National Electronics Conference

The date and place for the 1947 edition of the National Electronics Conference have been set. The gathering is to be held at the Edgewater Beach Hotel, Chicago, during November 3-4-5. As usual, the convention and exhibit are to be sponsored by the Illinois Institute of Technology; Northwestern University; the University of Illinois; the American Institute of Electrical Engineers; the Institute of Radio Engineers and the Chicago Technical Societies Council. Chairman of the exhibit committee is O. D. Westerberg, 72 West Adams Street, Chicago.

65 TV Stations Authorized

As of the first of June, there were 65 commercial television stations authorized by FCC. Of these, six are licensed, 59 have received construction permits. In addition nine applications are pending. This adds up to eventual television service in 37 cities in 24 states and the District of Columbia. California leads with 13 grants or applications, followed by New York, Ohio and Pennsylvania in that order.

Theater Television

Theater television, with an actual demonstration of modern equipment and technics, will be a major topic at the 62d semi-annual convention of the Society of Motion Picture Engineers. Gathering is scheduled for Oct. 20-24, will be held at the hotel Pennsylvania, New York. It is styled a theater engineering conference.

IRE's '48 Convention

The Institute of Radio Engineers 1948 National Convention and Radio Engineering Show are to be held in New York opening on Monday, March 22 and closing the following Thursday evening, March 25. As was the case for the 1947 gathering, the exhibit is to be held in Grand Central Palace with most of the convention gatherings scheduled for the Hotel Commodore and some of them to be held in the auditoriums of the Exhibition Hall. Exhibit manager is William C. Copp, 303 West 42nd Street, New York.

TBA Seeks More Space

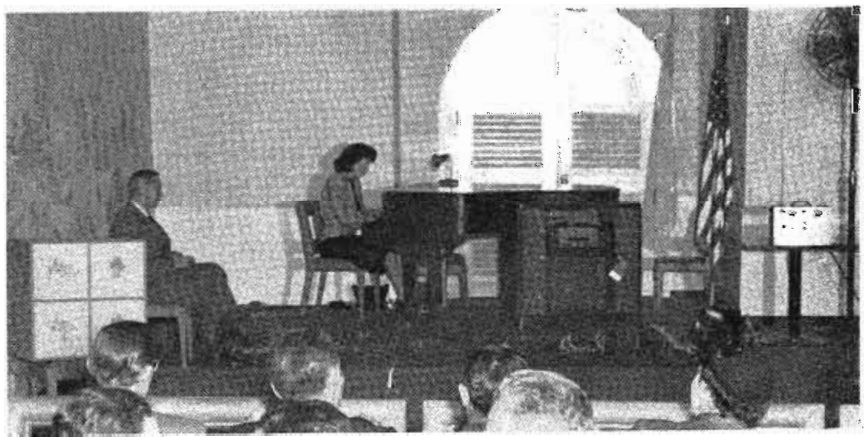
Television Broadcasters Association plans soon to make a formal application with FCC for more video space. Thad. H. Brown, counsel for TBA, told FCC at the hearing held early last month in Washington that the presently allocated 13 channels are not enough to permit expected expansion. The plan is to ask for more TV space between channels 6 and 7 (88 to 174 mc) now occupied by FM, and a variety of government, airport, railroad and mobile services.

Cowles Proposed Tower World's Tallest Structure

That tall tower proposed by the Cowles Broadcasting Corp for FM and for television, when and if color television becomes available, is still more or less held up. Federal Communications Commission has placed its stamp of approval on the use of the tower but the CAA is not so sure. The tower as planned would be the world's tallest structure and would rise 1530 ft. above ground. By comparison New York's Empire State Building stands 1250 ft. above ground level.

Cowles has an option on the land necessary for the tower—a location viewed as best for air safety—but CAA's approval has not yet been forthcoming. Manufacturers of towers state that such a struc-

(*Continued on page* 111)



Half guessed wrong—when they were asked whether they were hearing the "live" pianist or a reproduction piped in to loudspeakers by RCA Victor during demonstration at convention of National Association of Music Merchants in Chicago

CONVENTIONS AND MEETINGS AHEAD

August 7-8 — Institute of Aeronautical Sciences, annual summer meeting, Los Angeles.

August 26-29 — Pacific General Meeting, American Institute of Electrical Engineers, San Diego Hotel, San Diego, Cal.

September 8-12—Second National Instrument Conference and Exhibit—Hotel Stevens, Chicago.

September 15-18—Annual convention National Association of Broadcasters, Convention Hall, Atlantic City.

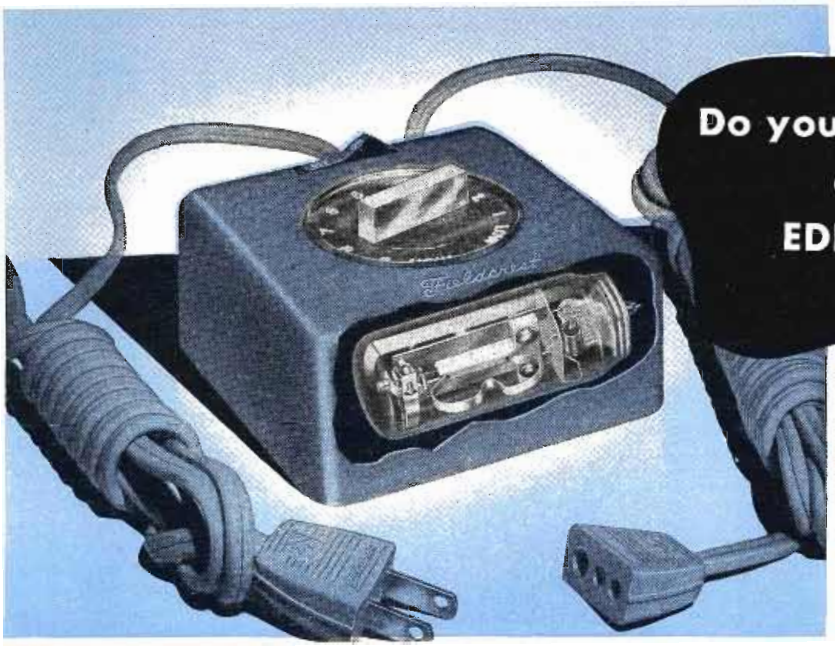
September 24-26—West Coast IRE convention, Palace Hotel, San Francisco.

September 26-28—West Coast Electronic Manufacturers' Association third annual Electronics trade show, Hotel Whitcomb, San Francisco.

October 20-24—Society of Motion Picture Engineers. Theatre Engineering conference, Hotel Pennsylvania, New York.

November 3-5—National Electronics Conference, Edgewater Beach Hotel, Chicago.

March 22-25—IRE convention and Radio Engineering show, Grand Central Palace and Hotel Commodore, New York.



Do you know all the extra advantages of this EDISON *sealed-in-glass* control?

Here's how sealed-in-glass features solved one manufacturer's problem

Fieldcrest Mills (Division of Marshall Field Company, Inc.) needed a control for their new "Fieldcrest" Thermostatic Blanket. So they asked EDISON engineers to work with them. EDISON adapted one of its *sealed-in-glass* controls, a thermal relay, to fit this special need, made use of its *extra* advantages, and solved the problem completely. This blanket control is now produced in quantity by EDISON exclusively for Fieldcrest Mills.

An EDISON sealed-in-glass control might solve one of your problems

The EDISON *sealed-in-glass* thermal relay times, delays, limits, or sequences automatically over a considerable range. It displaces magnetic relays in many applications. It integrates pulses and intermittent current into accumulated heat energy to operate controls.

It controls loads to eliminate magnetic relay chatter and resultant false starting. It continues, starts, or delays the operation of certain elements after a main circuit is opened or closed.

The extra advantages of this EDISON sealed-in-glass *control are:*

1. Protects working parts from dust, dirt, corrosion, and tampering.
2. Minimizes contact fouling, pitting, or transfer.
3. Equal AC or DC ratings.
4. Compensates for ambient temperatures.
5. Safer operation in hazardous atmospheres.
6. Small size.
7. Light weight.
8. Rugged simplicity.
9. Silence.
10. Operates in any position.
11. Operates at any altitude.
12. Insensitive to transients.
13. Operates continuously or intermittently.
14. Freedom from maintenance or adjustment.
15. Long, consistent operating life.
16. Low cost.

EDISON sealed-in-glass thermal relay

ELECTRICAL HEATER (5 watts nominal; 150 volts AC/DC max.) deflects a bi-metal to actuate a moving contact.

CONTACTS are s.p.s.t., normally open or closed. Rated at 6 amperes at 250 volts AC/DC for delays less than 1 minute. For longer delays, rating can be increased to 450 volts AC/DC if reduced to 3 amperes.

SPRING PRESSURE ARM, on which one of the contacts is mounted, applies contact pressure immediately and noiselessly.

PRE-SET OPERATING TIME, from 5 seconds to 8 minutes.

AMBIENT TEMPERATURE COMPENSATION, from −60° C. to +70° C.

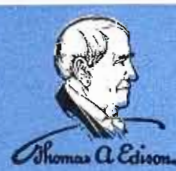
CUSHIONING SPRINGS, between ceramic internal support and glass envelope, absorb vibrations and shocks.

DIMENSIONS: 1¼" diameter; 3¼" height (seated).

WEIGHT: 0.08 lb.

MOUNTS: 4-pin or octal radio tube base, or special mount and lead-in arrangements, if required.

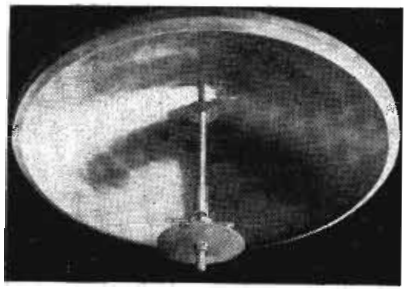
The services of EDISON engineers **are available to help you work out your electrical control problems. Please include all pertinent data with your inquiry.** ***Write for descriptive literature.***



EDISON SEALED - IN - GLASS ELECTRICAL CONTROLS

THOMAS A. EDISON, INCORPORATED · INSTRUMENT DIVISION · 90 Lakeside Ave., West Orange, New Jersey

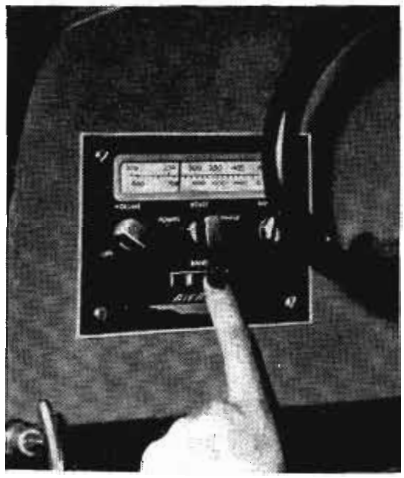
Communications Components



PARABOLIC ANTENNAS

(Use Inquiry Card, Mentioning No. 762)

Special parabolic antennas of varying diameters and focal lengths with or without feed components, in diameters up to 10 ft. can be supplied to specifications. Also available are standard production units for ST relay work (illustr.) for use on either the 920 to 960 mc or the 1295 to 1425 mc relay bands. Vertical or horizontal polarization can be obtained by simple adjustment at the rear of the reflector. — *The Workshop Associates, 66 Needham St., Newton Highlands, Mass.*



AIRCRAFT RADIO

(Use Inquiry Card, Mentioning No. 763)

Assuring dependable two-way communication between plane and tower, radio range flying, standard broadcast reception, and passenger-pilot interphone the Airadio Super "52" has a combined weight of only 10 lbs., 10 oz. for receiver, transmitter, and power supply. The 5-tube superheterodyne is provided with built-in range filter, tuned rf stage, and automatic and manual volume control. Frequency range is from 195 to 420 kc on band A, and from 550 to 1500 kc on band B. The receiver has a sensitivity of 3 microvolts and an undistorted power output of 300 milliwatts. Primary power requirements are 5.2 amps. at 12 volts.—*Airadio Inc., Stamford, Conn.*

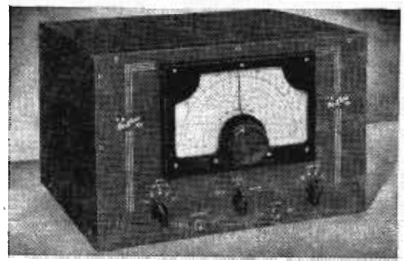
ANNOUNCEMENT

For the convenience of readers, all descriptions of new products have been assigned IDENTIFYING NUMBERS. For further information, please use the Prepaid Inquiry Card appearing at page 83 in this issue and *Identify the product by the number assigned to it.*

FM LEAD-IN LINES

(Use Inquiry Card, Mentioning No. 764)

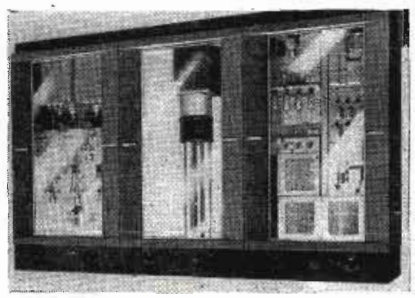
Combined high signal to noise ratio with very low attenuation the ATV 150 shielded FM and television lead-in lines are particularly useful in congested areas, or wherever there is excessive electrical interference. They eliminate the need for a matching section between dipole and receiver as the 150 ohm line in multiples of a quarter wavelength will act as a matching section. The flat oval cable consists of twin parallel stranded bare copper conductors, polyethylene insulation, bare copper braid, and a fireproof Densheath jacket overall.—*Anaconda Wire and Cable Co., 25 Broadway, New York.*



CRYSTAL EXCITER

(Use Inquiry Card, Mentioning No. 765)

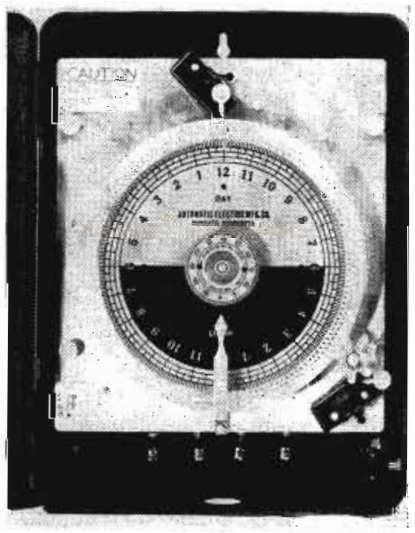
Twenty watts output are provided by the VX-101 Deluxe VFO or crystal exciter, which uses all band-switching to cover the 80, 40, 20, 15 and 10 meter amateur bands. Provisions for four 80-meter crystals permit a total of 20 crystal-controlled output frequencies. Tuning is ganged for all bands to permit fast band shifting. An 807 type tube is used as final straight-through amplifier. Both oscillators utilize compound voltage regulation. —*Electro-Mechanical Mfg. Co., Long Island City 5, N. Y.*



FM TRANSMITTER

(Use Inquiry Card, Mentioning No. 766)

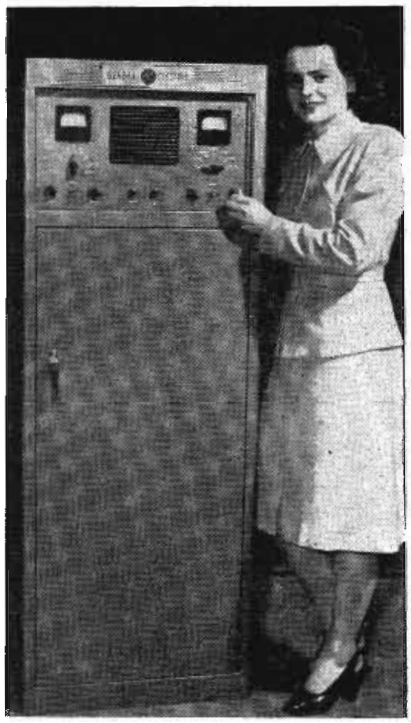
Unusual in appearance and design the "Transview" 10 kw FM transmitter uses a grounded plate amplifier, which has an amplification factor of better than 10:1. Distortion for ±75 kc swing is less than 0.5% from 30 to 15,000 cps. The 506B-2 transmitter uses a single-tube, single-stage grounded plate amplifier driven by a 1 kw transmitter. Full length hinged glass doors permit a clear view of the layout of all components. This unit is one of a series of new transmitters, available in power ratings up to 50 kw.—*Western Electric Co., Inc., 195 Broadway, New York 7.*



PROGRAM TIMER

(Use Inquiry Card, Mentioning No. 767)

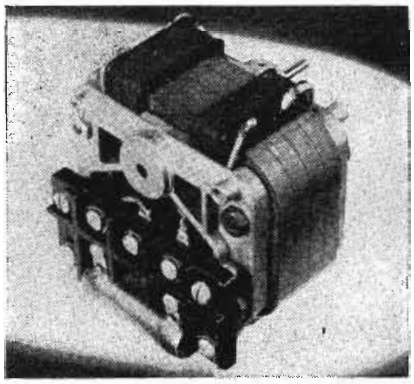
Equipped with Sunday and holiday cut-out, this program timer can be adjusted for signals spaced in five-minute intervals with a duration of five to thirty seconds. Variation in programming is accomplished by adjusting a tapped dial which controls the full 24-hour period. The unit, which is provided with a tamperproof locking arrangement, operates on 110-volt ac and controls signal systems operating on low voltage ac or dc. The circuit may be manually controlled without interfering with regular program.—*Automatic Electric Mfg. Co., Mankato, Minn*



FM TRANSMITTER-RECEIVER

(Use Inquiry Card, Mentioning No. 768)

Designed for fixed-station use by police, power, forestry and public utility groups the SC-9 60-watt FM transmitter-receiver permits remote operation over a single-pair telephone line. A preamplifier, tone oscillator and local remote control adapter may be plugged into the rack-mounted control panel. A floor-mounted unit, the SC-9 operates from a 117 volt 50/60 cycle power source.—*General Electric Co., Transmitter Div., Electronics Park, Syracuse, N. Y.*



REVERSING MOTOR

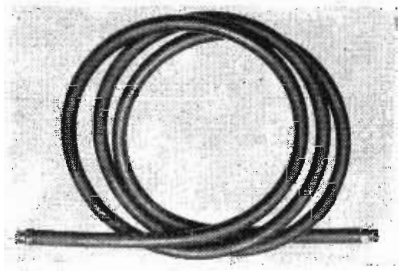
(Use Inquiry Card, Mentioning No. 769)

For use in servo mechanisms, potentiometer drives, and similar applications this small reversing motor has a starting torque of .2 lb-in with a rating of .0045 horsepower. At full load the field coil consumes 55 watts at .82 amps, while the shading circuit operates at 31 volts with a current of 1.2 amps. Speed of the unit is 1900 rpm. Weighing 4 lbs, 14 oz, the motor has an overall length, width and height of 3⅞ in. It is not available with gear reductions.—*Barber Colman Co., Rockford, Ill.*

INTERCOM SYSTEM

(Use Inquiry Card, Mentioning No. 788)

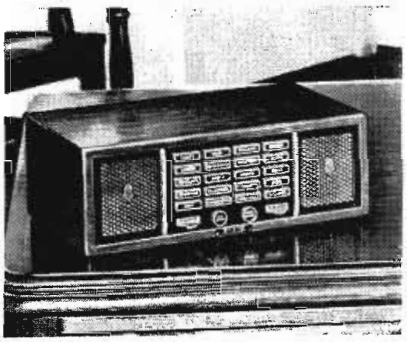
Available as packaged units Model CM-10 '47 Callmaster electronic intercommunication units consist of a master and sub-station combination, housed in mahagony plastic cabinets. The units are easily installed by the user. A new 6-station model CM-20 soon will be available.—*Lyman Electronic Corp., 12 Cass St., Springfield, Mass.*



WATER-COOLED CONDUCTOR

(Use Inquiry Card, Mentioning No. 770)

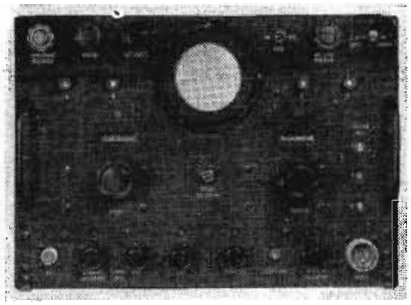
Suitable for the transmission of high power, high frequency current this new type water-cooled hf conductor is provided with tough, flexible insulation, having good dielectric properties, chemical inertness and water resistance. The conductor consists of a brass, water-tight convoluted inner core with an outer braid conductor. Power losses are lower than for the conventional ¼ in. copper tube. The conductor is especially suitable for high frequency heating equipment.—*Titeflex, Inc., 500 Frelinghuysen Ave., Newark 5, N. J.*



PRIVATE TELEPHONE SYSTEM

(Use Inquiry Card, Mentioning No. 771)

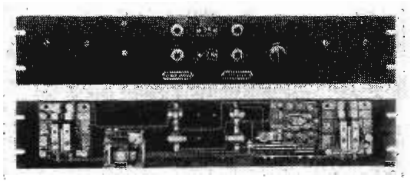
Up to 36 private lines are provided in the fully automatic Select-O-Phone telephone and paging system, which is designed to take the load off the switchboards in standard telephone service due to "inside" calls in factories and offices. Consisting of an executive station, any number of staff stations (up to 36), automatic switchboard, power unit, call bells and horns, the system permits an unlimited number of simultaneous conversations and also full conference facilities. Optional provisions include paging and general call service, fire or burglar alarm signals, and an executive "right-of-way". Installation is simple, only three wires being required between each staff station and the switchboard.—*Kellog Switchboard & Supply Co., 310 West Sixth St., Kansas City, Mo.*



LIGHT WEIGHT LORAN

(Use Inquiry Card, Mentioning No. 772)

Revising, simplifying and quite considerably lightening its Loran equipment Philco has developed a new instrument which will be sold under the trade name "Seaguide". The equipment, self-contained and weighing 35-lb, differs from previous Loran instruments in a number of important respects. Except for the rectifier and CR tube, the unit is built around miniature tubes; instead of a single reading it gives two readings so that the first need not be wiped off in order to get the second upon which the "fix" depends; it covers two Loran bands, both low, between 180 and 220 kc where two channels are provided, and high, between 1700 and 2000 kc where there are four channels; automatic frequency control of the oscillator has been incorporated, eliminating the need for crystal phasing, though such a control is retained for emergency use. Net result of all these improvements is that obtaining a "fix" has been greatly simplified and speeded up and accuracy of results improved. Three pulse repetition rates are provided for, 20, 25 and 33 1/3, permitting reception of eight shore station pairs on each rate, improving flexibility and accuracy of positioning. The marine model weighs slightly more than the 35-lb-airborne model.—*Philco Corp., Philadelphia, Pa.*

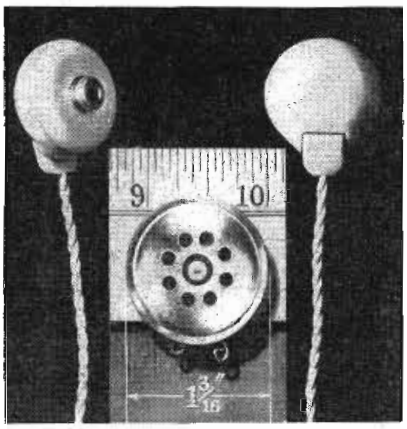


TRANSMITTER CONTROL PANEL

(Use Inquiry Card, Mentioning No. 773)

Automatic control and protection in one compact panel for low, medium, and high power ham rigs are being offered either in kit form or completely assembled and wired for mounting directly on a standard relay rack. The transmitter control panel gives automatic protection against damage to tubes, transformers and other components from overloads and power failures; finger tip control of filament and plate supply is provided. The panel includes a filament relay and a plate relay—both double pole with 15 amps. contacts—a time delay relay, an overload relay and two push-buttons. Operation is from ac line. — *Ward Leonard Electric Co., 53 West Jackson Blvd., Chicago 4, Ill.*

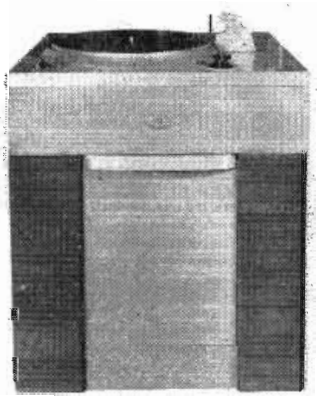
Sound and Recording Equipment



HEARING AID EQUIPMENT

(Use Inquiry Card, Mentioning No. 774)

Model HM 11, one of the smallest hearing aid microphones available, measures only 1.187 in. diameter x .187 in. thickness. Output level of "Tiny Tim" is 50 db below 1 dyne/cm² at 1000 cycles. The unit has good frequency response and is hermetically sealed for moisture proofing. Also available is Model RC10 lightweight magnetic insert receiver, which has been especially designed for hearing aids, personal radio receivers, etc. Impedance of this unit is 60 ohms, the output level being 115 db above .0002 dynes/cm² for 1 milliwatt of available power. — *Shure Brothers, Inc., 225 West Huron St., Chicago, Ill.*



TRANSCRIPTION TURNTABLE

(Use Inquiry Card, Mentioning No. 775)

The Presto 64-A transcription turntable is directly gear driven and uses two separate motors for 33-1/3 and 78.26 rpm. speeds. No mechanical shift is required to change speeds. Mechanical disturbances are reduced to 50 db below program level by a mechanical filter placed between gear box and turntable. More than ample power is provided by the 1800 rpm, 110 volt single phase, synchronous motors. The new reproducer shown in the illustration is not available as yet, but any make of reproducer will be installed by the company on request.—*Presto Recording Corp., 242 W. 55 St., New York 19.*

ANNOUNCEMENT

For the convenience of readers, all descriptions of new products have been assigned IDENTIFYING NUMBERS. For further information, please use the Prepaid Inquiry Card appearing at page 83 in this issue and *Identify the product by the number assigned to it.*

SELECTOR INTERCOMS

(Use Inquiry Card, Mentioning No. 776)

Designed to give flexibility of intercommunication in offices, factories, and retail stores, this line of "selector" intercom systems features five different models of master and remote stations which may be hooked up in any combination, up to 12 substations. Two models of the master station have six selector keys, two have 12 keys, and the fifth station is "remote" for receiving and initiating calls from a master station. Master stations have a combination "on-off" and volume switch, a "talk-listen" switch, and are provided with extra earphones for private conversations. Cabinets are matte-black plastic with satin-chrome speaker grilles.—*Radio Corp. of America, RCA Victor Div., Camden, N. J.*

TRANSCRIPTION TYPE PICKUP

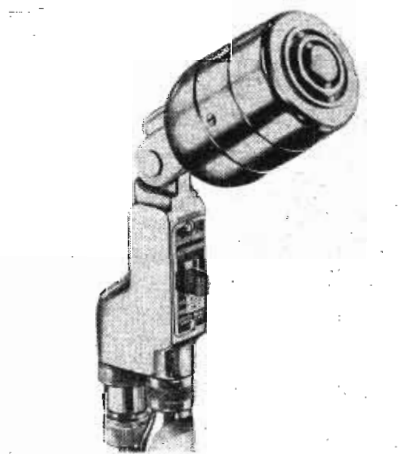
(Use Inquiry Card, Mentioning No. 777)

The Nylon 400 transcription arm is intended primarily for use on lateral transcriptions of all sizes in broadcast and recording studios. Equipped with Nylon I-J cartridge with replaceable sapphire - tipped Nylon needle, it has a needle pressure of 1½ oz. Frequency range extends from 50 to 8,000 cycles and output is 1 volt across a 0.5 megohm load at 1000 cps. Length of arm is 12⅛ in.—*Astatic Corp., Conneaut, Ohio.*

"PLASTIC" MICROPHONES

(Use Inquiry Card, Mentioning No. 778)

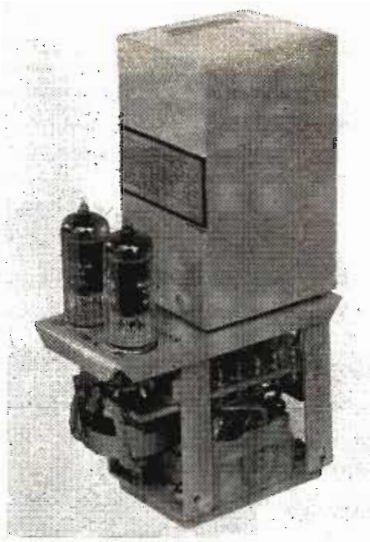
Microphones with speaker housings of colorful Tenite plastic and available in a choice of green, red, orange and yellow for matching appearance to prevailing color schemes. The Tenite housings, used on crystal and dynamic "Colortone" microphones, are tough and have good insulating properties. Made by Chicago Molded Products Corp., Chicago, Ill., the housings are rapidly produced by injection molding in three pieces. The color is an integral part of the material.—*The Turner Co., Cedar Rapids, Ia.*



DYNAMIC MICROPHONE

(Use Inquiry Card, Mentioning No. 779)

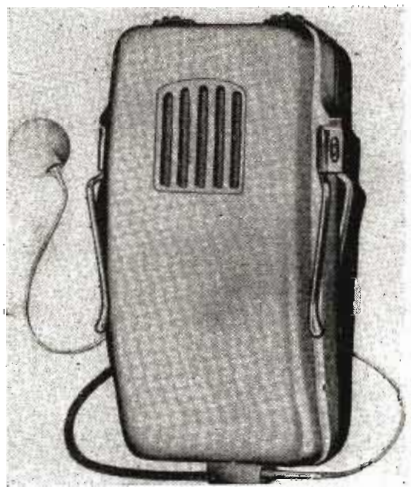
Through use of the new Acoustalloy diaphragm the Electo-Voice model 630 dynamic microphone provides high fidelity reproduction of voice and music, the frequency response being substantially flat from 40-9,000 cycles. Output level of the unit is 53 db below 1 volt/dyne/cm². The new-type diaphragm withstands high humidity, extremes of temperature, and severe mechanical shocks.—*Electro-Voice, Inc., Buchanan, Mich.*



ISOLATION AMPLIFIER

(Use Inquiry Card, Mentioning No. 780)

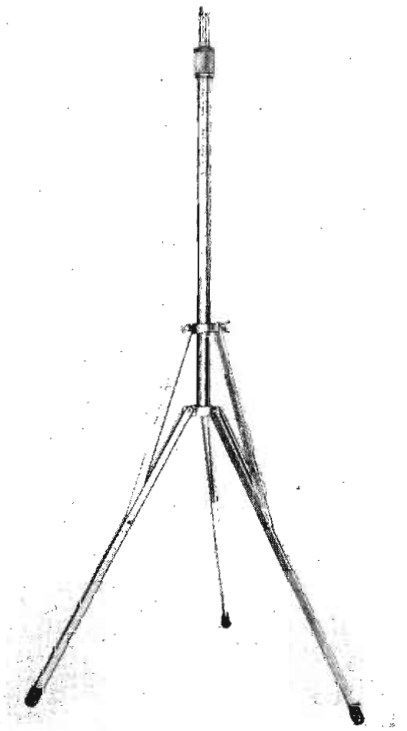
Designed to bridge a 600 ohm line the Langevin 118-A plug-in bridging-isolation amplifier operates as a zero gain device with only sufficient gain to overcome losses and provides better than 70 db isolation between line and buss. The unit is a single stage, push-pull amplifier utilizing two 6AK6 type tubes and is provided with a special Cannon plug having gold-plated terminals. Output power is +24 dbm and frequency response is flat within ±1 db from 50 to 15,000 cps. Twelve of these amplifiers can be mounted in 10½ in. of rack space, with a Langevin 205-A selenium rectifier power supply providing filament and plate voltage.—*The Langevin Co., 37 W. 65 St., New York.*



HEARING AID

(Use Inquiry Card, Mentioning No. 781)

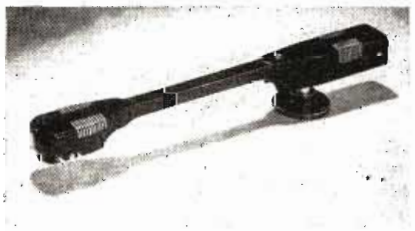
Reduction of size and weight, greater convenience and economy of operation have been achieved in the model 64 hearing aid, which by use of new miniature batteries reduces operating costs to less than ½ cent an hour. Undistorted amplification over a broad range makes possible improved quality of hearing correction. The model is supplied in black or flesh tint with a choice of three types of midget battery cases. —*Western Electric Co., 195 Broadway, New York 7.*



MICROPHONE STAND

(Use Inquiry Card, Mentioning No. 782)

Having an extended length sufficient for normal applications, the collapsed length of this new microphone stand is only 23 in. overall. The leg braces are above the legs, thus offering little obstruction when the stand is placed amidst a group of microphones in remote broadcast pickups. Collapsible legs are made of plated steel, the tubes of brass chromium plated. Total weight of the stand is 5¼ lbs.—*Atlas Sound Corp., 1445 39th Street, Brooklyn, N. Y.*



PICKUP ARM

(Use Inquiry Card, Mentioning No. 783)

Combined with dynamic cartridge and equalizer for AM and FM broadcasting and other professional uses the 542-MI lateral pickup arm is balanced to reduce skating over the record, caused by vibrations. Tracking of warped records is achieved by "floating" design. The pickup has a frequency response within ±2 db over the 30 to 10,000 cps range. Impedance of the unit is 50 ohms, output at 1000 cps (equalized)—60 db, and stylus pressure is 25 grams. The mounting base is adaptable to varying heights of turntable platters by a set-screw adjustment.—*Fairchild Camera and Instrument Corp., Jamaica, N. Y.*

For More Information use Inquiry Card at Page 83.

PORTABLE AMPLIFIER SYSTEM

(Use Inquiry Card, Mentioning No. 784)

Designed for musical applications model MAP-120 amplifier combines 12-watt power output at less than 5% harmonic distortion with a frequency response flat within 2 db from 50 to 10,000 cps. Hum level is 20 db below zero level and .015 volts are required for full output. Two inputs are provided suitable for microphone or instrument pickups. An extra heavy duty speaker is built-in. Separate volume and tone controls permit any desired setting. The amplifier is for operation on 117 volt, 60 cycle, ac and consumes 75 watts. —*Mark Simpson Mfg. Co., Inc., 32-28 49 St., Long Island City 3, N. Y*

WIRE RECORDER

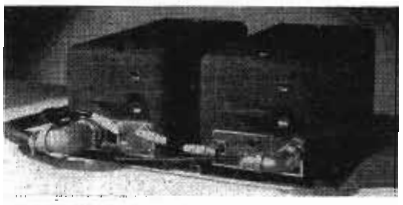
(Use Inquiry Card, Mentioning No. 785)

Developed for the needs of the modern office, transcriptions of technical talks, business conferences etc., the Sound-On-Wire dictating machine utilizes magnetization of a hair-thin wire to provide an hour of continuous recording. Rewind speed of the recorder is ten times the recording speed, so that an hour's recording can be rewound in 6 minutes. A demagnetizing coil clears the wire ahead of new recordings. Each magazine is equipped with a counter in sequence with the wire, permitting the logging of any part of the dictation to the accuracy of a word. For transcribing the unit is equipped with two pedals for forward, backspace or reverse operation.—*Standard Business Machines Co., 720 South Dearborn St., Chicago 5, Ill.*

MULTI-PURPOSE SOUND CONSOLE

(Use Inquiry Card, Mentioning No. 786)

Intended to provide factories, plants and large offices with complete voice-paging facilities, as well as with "Music-at-Work" the model P-20 console contains in a single cabinet all central control elements for a 50 watt sound system. Power output can be increased through the addition of Executone 50 watt district amplifiers at remote locations. Any number of microphone control stations can be used in the system, with a "one-button control" permitting automatic cut-off of a music program for the duration of a message. Model P-20 also contains an intermix automatic record changer, and a monitor speaker with four-step volume control. Bass and treble control are provided for the amplifier which has six separate music or paging channels.—*Executone, Inc., 415 Lexington Ave., New York 17.*



MOBILE RADIO TELEPHONE

(Use Inquiry Card, Mentioning No. 787)

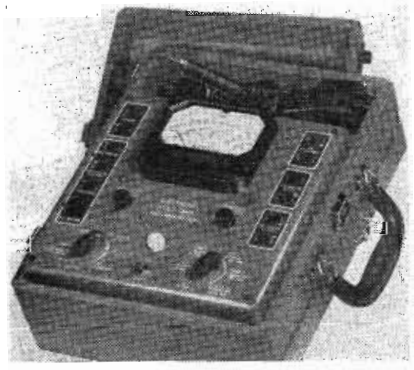
Selective calling of any mobile unit or the same frequency by means of a selector dial unit is incorporated in the Western Electric type 38 mobile transmitter and receiver, designed to operate in the 152-162 mc band. Normally mounted in the luggage compartment of an automobile, or beneath the body of trucks and buses, the equipment is light and compact. A type 41A control units mounts underneath the dashboard. Quartz crystal control of transmitter is provided. RF carrier of the transmitter is phase-modulated. Receiver is a triple superheterodyne with crystal control for both conversion oscillators.—*Western Electric Co. Inc., 195 Broadway, New 7.*

New Lab and Test Equipment

INSULATION TESTER

(Use Inquiry Card, Mentioning No. 71)

Model B-7 Megohmer is a combined precision ohmmeter and insulation tester which utilizes a vibrator transformer circuit to step up the voltage from two No. 6 dry cell batteries to a test potential of 500 volts for the 0-200 megohm range, or 250 volts for the 0-20 megohm range of the instrument. Resistance ranges from 0-200, and 0-20,000 ohms are also provided, using a 3-volt test voltage. Batteries are contained in a separate compartment. The instrument compartment is sealed by a rubber gasket for protection against dust and moisture.—*Herman H. Sticht Co., 27 Park Place, New York 7.*



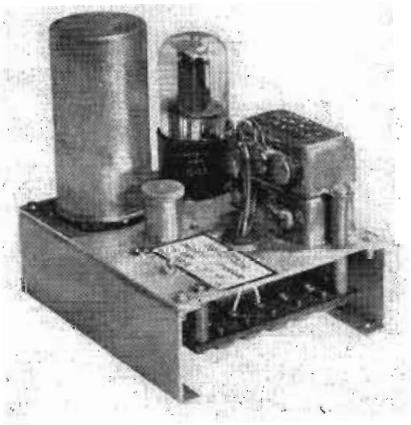
ELECTRONIC ANALYZER

(Use Inquiry Card, Mentioning No. 72)

The electronic analyzer, model 769, incorporates within one instrument a stable high frequency vacuum tube voltmeter efficient for frequencies up to 300 mc, an electronic volt-ohmmeter and a complete 10,000-ohm-per-volt dc and 1000-ohm per volt ac multimeter. Accuracy of the VTVM, which has four ranges of 3/12/30/120 v., is 5% to 150 mc and 12% from 150 to 300 mc, direct reading. Input resistance of the polystyrene insulated rf probe is 5 megohms, capacity 5 mmfd. Electronic volt ohmmeter ranges are from 3 to 1200 v. and 2000 ohms to 2000 megohms full scale. Power requirements are 105-130 v. ac. The analyzer section provides six high sensitivity dc voltage ranges, six ac voltage ranges to 1200 v., three ohmmeter ranges to 200,000 ohms and six dc ranges to 600 ma. Power supply is self-contained for the analyzer section.—*Weston Electrical Instrument Corp., Newark 11, N. J.*

ANNOUNCEMENT

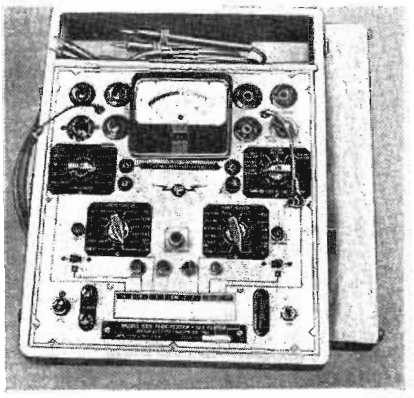
For the convenience of readers, all descriptions of new products have been assigned IDENTIFYING NUMBERS. For further information, please use the Prepaid Inquiry Card appearing at page 83 in this issue and *Identify the product by the number assigned to it.*



FREQUENCY STANDARD

(Use Inquiry Card, Mentioning No. 73)

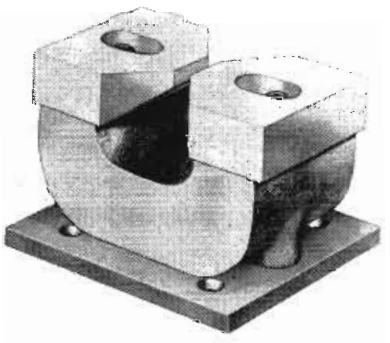
To provide an accurate stable source of any electrical frequency from 40 to 1000 cycles these two types of tuning fork frequency standards are designed to permit their integration into basic equipment and to utilize its power supply. The fork of bimetallic construction, which has close to zero temperature coefficient, is housed in a hermetically anti-shock mounted container, immune to barometric or altitude changes and vibration. Frequency accuracy of the units is one part in 100,000 and output is 5 volts into 150,000 ohms impedance. Type 2001 is available in the frequency range from 200 to 1000 cps, while type 2001L is supplied in the range from 40 to 200 cycles. —*American Time Products, 580-5th Ave., New York 19*



PORTABLE TESTER

(Use Inquiry Card, Mentioning No. 74)

Provided with the tube sockets for all standard base tubes as well as for tubes with miniature and subminiature bases the model 805B portable tube and set tester combines in one unit a volt-milliammeter, tube tester, battery and capacitor leakage tester. It is mounted in a sturdy oak carrying case, with a compartment for test leads and a self-latching cover. A built-in "Rolindex" roll-chart carries full data for all tube settings. By use of a Germanium crystal diode rectifier, freedom from temperature and frequency errors on ac measurements is assurred.—*Radio City Products Co., 127 W. 26 St., New York 1.*



MAGNET CHARGER

(Use Inquiry Card, Mentioning No. 75)

Fabricated from Alnico V alloy this series of permanent magnet chargers is produced in two sizes, offering a usable magnetizing force up to 3400 oersteds and variable air gaps from zero to 1¼ in. A convenient mounting plate with four holes for screws or bolts is anchored to the base of the charger. The units are cadmium plated to resist rusting and shipped in magnetized condition.—*Thomas & Skinner Steel Products Co., 1038 E. 23 St., Indianapolis, Ind.*

Need More Information?

FILL OUT THESE POSTAGE-FREE CARDS

mail to TELE-TECH

Formerly Tele-Communications Section of ELECTRONIC INDUSTRIES

Caldwell-Clements, Inc., 480 Lexington Avenue, New York 17

TELE-TECH is the all-communications magazine serving the entire communcations market.

TO GET MORE information about the new products shown in this issue, select the numbers of products on which you want more information, fill out the *postage-free* cards and mail to us today. We'll do the rest.

TELE-TECH offers the fullest editorial coverage of specialized TELE-communications TECHnics available anywhere. Each issue contains by far the largest amount appearing in any monthly magzine in this field.

UNIQUE among its features are the exclusive technical descriptions and pictures of notable communication installations in aviation, railroads, television, AM and FM broadcasting, microwave and pulse transmission, multiple channel systems, etc., complemented with color charts and diagrams, plus pages of new product photos and descriptions.

This card not good after August 31

Write in boxes the number of New Product Item for which you want more information.

Your Company.....

Address .....

.....

Your name.....

Your title.....

TELE-TECH — July 1947

CALDWELL-CLEMENTS, INC., 480 Lexington Avenue, New York 17

Write in boxes the number of New Product Item for which you want more information.

Your Company.....

Address .....

.....

Your name.....

Your title.....

TELE-TECH — July 1947

CALDWELL-CLEMENTS, INC., 480 Lexington Avenue, New York 17

TELE-TECH

Formerly Tele-Communications Section of ELECTRONIC INDUSTRIES

For TELE-Communications TECHnics

Design Manufacture Operation

Increased reader inquiries from each issue re-emphasize the need for a single magazine such as TELE-TECH, devoted exclusivly to tele-communications. In radio, broadcasting (AM and FM), television, railroad, aviation and commercial communications; in microwave, facsimile and uhf applications, engineers and executives in design, manufacture and operation are finding TELE-TECH a new and valuable source of help. Its profusely illustrated technical descriptions of installations, its color charts, new products, and other features are making TELE-TECH more necessary to readers and a greater aid to advertisers.

No Postage Necessary — Not Good After August 31

Postage Will be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY CARD

First Class Permit No. 22273, SEC. 510, P. L. & R., New York, N. Y.

TELE-TECH

480 LEXINGTON AVENUE

NEW YORK 17, N. Y.

Caldwell-Clements, Inc.

Postage Will be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY CARD

First Class Permit No. 22273, SEC. 510, P. L. & R., New York, N. Y.

TELE-TECH

480 LEXINGTON AVENUE

NEW YORK 17, N. Y.

Caldwell-Clements, Inc.

FOR ADVERTISERS

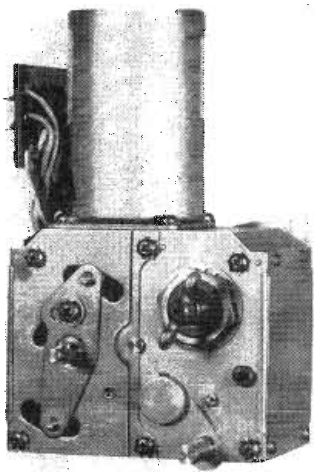
A greatly expanded communications market—fully covered by one specialized tele-communications magazine. No waste circulation. Greater return on advertising dollars through increased inquiries and resulting sales.

FOR READERS

TELE-TECH is the specialized medium to cover the specific interests of men responsible for tele-communications design, manufacture and operation. Here is a complete magazine devoted each month to exclusively tele-communications material. And, TELE-TECH is publishing more on tele-communications than any other magazine. It tells you more, better, faster.

FOR MORE NEW PRODUCT INFORMATION

Mail these POSTAGE-FREE Cards Today!



POSITIONING MECHANISM

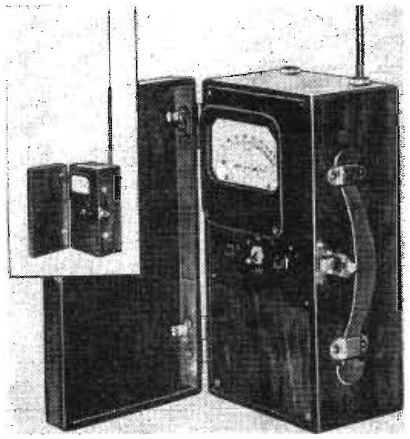
(Use Inquiry Card, Mentioning No. 76)

Finding application as positioning control for radio receivers and industrial equipment the 496A Autotune mechanism can be operated from a remote position using either push-buttons or a tap switch. It provides 10 positions, each being independently adjustable over a 360 degree rotation of a positioned shaft. Reset accuracy is within .05 degrees. Operating time is a max. of six seconds, output torque being 6 in.-lbs. The unit can be built for operation from any ac or dc voltage. Unidirectional or reversible models are available.—*Collins Radio Co., Cedar Rapids, Iowa.*

RECORDING OSCILLOGRAPH

(Use Inquiry Card, Mentioning No. 77)

Though designed primarily for use in engineering colleges and technical schools Hathaway type S-14A oscillograph is a simple, low cost six-element recording instrument, suited for many industrial and laboratory applications. To permit simultaneous recording of six quantities the oscillograph accommodates 6 Hathaway type OA-2 galvanometers, which are supplied in a wide range of sensitivity and natural frequencies. A calibrated viewing screen is mounted on the top panel for observing the position and deflections of the recording spots. The record magazine holds a 100 ft. roll of 6-in. recording paper, driven at standard speeds of 6, 12, 24, and 48 in. per second. The instrument is operated from 110 volt, 60 cycles. *Hathaway Instrument Co., Denver. Colo.*

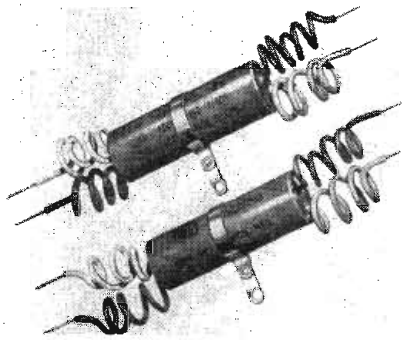


STATIC METER

(Use Inquiry Card, Mentioning No. 78)

Damage caused by discharges of static electricity can be avoided by use of the Davis Statometer, a portable, self-contained instrument, which is sensitive enough to detect static charges on the order of fractional volts, either negative or positive. Provided with a 2-position range switch the instrument will measure any static voltage up to 750 volts. The unit is equipped with two sockets for the insertion of an air terminal, one for positive, one for negative charges. The Statometer is fast in operation and measures both above and below the sparking voltage.—*Davis Emergency Equipment Co., Halleck St., Newark 4, N. J.*

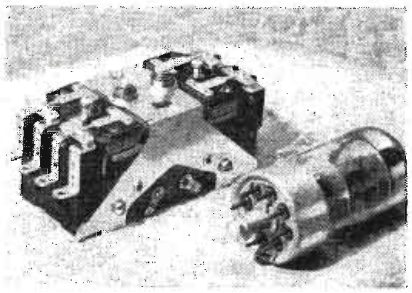
Parts for Design Engineers



DUAL CAPACITOR

(Use Inquiry Card, Mentioning No. 79)

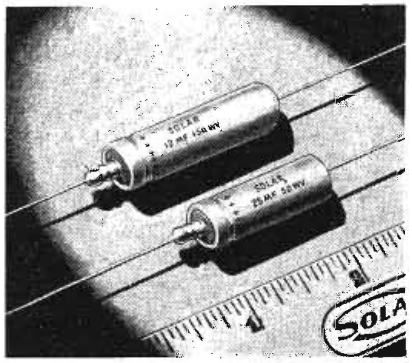
Permitting many combinations not possible with a common negative terminal the Type BRL-2215SS dual 20 mfd., 150 W.V. capacitor (illustrated) contains two leads for each 20 mfd. section. The unit can be used in many cases where two separate capacitors ordinarily would be required. It is 15/16 in. in diameter and 2⅞ in. long. The company has also improved its type UP electrolytic capacitors to permit higher operating temperatures and eliminate intercoupling between sections at FM and television frequencies. — *Cornell-Dubilier Electric Corp., South Plainfield, N. J.*



LATCHING RELAY

(Use Inquiry Card, Mentioning No. 710)

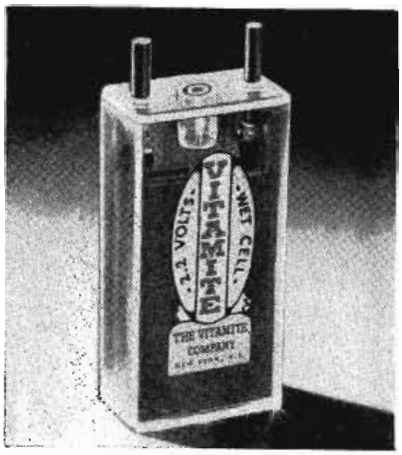
Freedom from the effects of vibration and shock and a mechanical life of millions of operations has been attained for the 6FZ series multicircuit switching relays of the latching type. Eight individual switch positions may be normally open or closed and are rated at 5 amps., 110v. ac or 24 v. dc. Contacts may be ganged or arranged in pairs for a maximum of 4 double-break circuits. The coils, operating from dc, require pulses of less than 0.5 watt for tripping and are available from low resistance up to 1000 ohms. Applications range from momentary contact controls to overload, underload and other protective circuits.—*Sigma Instruments, 70 Ceylon St., Boston, Mass.*



MINIATURE DRY ELECTROLYTICS

(Use Inquiry Card, Mentioning No. 711)

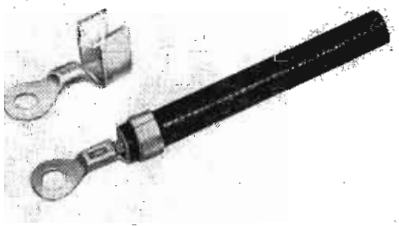
Very high gain and stable etched foil is the basis of the size reduction achieved in type LB miniature dry electrolytic capacitors, intended for use in bypass, coupling, and audio filter applications. Capacitance values in a ⅜ x 1⅛ in. container range from 8 mfd at 150 wvdc to 200 mfd at 1.5 wvdc; in a ⅜ x 1⅝ in. tube values range from 12 mfd at 150 wvdc to 300 mfd at 1.5 wvdc. Maximum ac ripple voltage which can be applied to units rated at 100 wvdc and greater is 7 volts at 60 cycles, or 3.5 volts at 120 cycles.—*Solar Mfg. Corp., 285 Madison Ave., New York 17.*



MINIATURE STORAGE BATTERY

(Use Inquiry Card, Mentioning No. 712)

Efficient for use with miniature and subminiature type tubes in small radios, hearing aids etc., the Vitamite flyweight rechargeable battery is non-spill. The miniature battery is smaller than two pen-light dry cells—case size being 9/16 x ⅞ x 1 3/16 in., but it delivers more wattage than two class C dry cells upon a single charging. The unit has indefinite shelf life due to its dry charge; it weighs one ounce.—*Vitamite Co., 227 W. 64 St., New York 23.*



ONE-PIECE TERMINALS

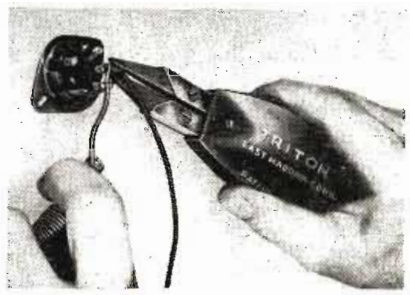
(Use Inquiry Card, Mentioning No. 713)

Designed to accommodate the extra-thick insulation of conductors used in switchboard wiring, radio transmitters, etc., these one-piece Hylug terminals are provided with U-shaped tabs, which grip a wide range of insulation sizes and prevent fraying. The connectors are indented onto conductors by means of a Hytool or Hypress, the longitudinal indent providing a permanent, low-resistance connection.—*Burndy Engineering Co., 107 Bruckner Blvd., New York 54.*

VHF BEAM PENTODE

(Use Inquiry Card, Mentioning No. 714)

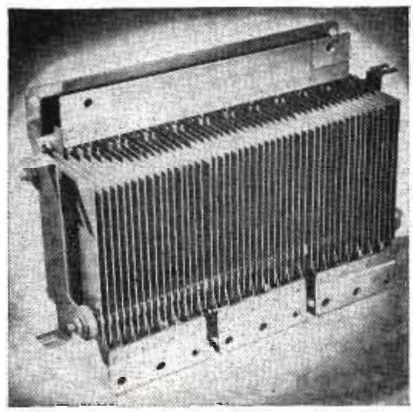
The Hytron type 5516 is a compact, 18 watt VHF beam pentode with useful power output at 165 mc and requiring no neutralization in properly designed circuits. Designed for VHF mobile equipment it is efficient as class C frequency multiplier or class C amplifier, high output at low plate potentials being achieved by low internal tube drop. Instant-heating filaments (2 sec. heating time) operate at 6 v., 0.7 amps., and when used in conjunction with other instant-heating types, filaments may be turned off during transmitter stand-by periods. Maximum VHF ratings are made possible by a zirconium-coated plate, gold-plated control grid, and carbonized screen grid.—*Hytron Radio & Electronics Corp., 76 Lafayette St., Salem, Mass.*



SOLDERING TOOL

(Use Inquiry Card, Mentioning No. 715)

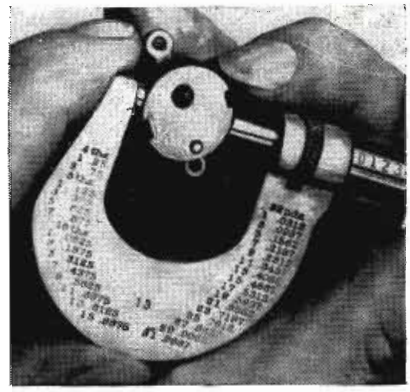
Designed for special soldering operations not easily handled by conventional electric soldering irons, the Pres-to-Heat soldering tool operates from an ac line, using a six volt transformer and a light weight heating unit. A spring-actuated lever, when compressed closes two plier-like carbon electrodes on the parts to be soldered. Further compression switches the current on for melting the solder. A slight release turns off the current, and permits holding the work between the jaws until the solder has cooled. The high degree of heat generated makes the tool adapted to silver-soldering, brazing, tempering, annealing and heat-treating of small parts.—*Triton Manufacturing Co., East Haddam, Conn.*



SELENIUM RECTIFIER

(Use Inquiry Card, Mentioning No. 716)

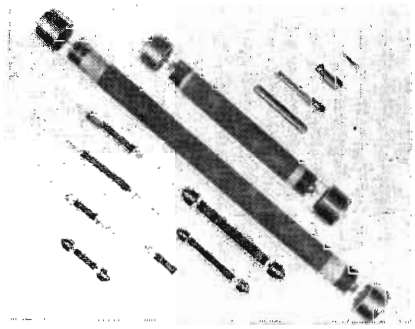
Flexibility of plate arrangement makes this new series of selenium rectifiers suitable for a wide variety of specific applications. A representative model, the 48-plate, three phase, bridge connected rectifier furnishes 200 amperes at 30 volts dc with the plates connected in parallel. By connecting the plates of each arm in series or in series-parallel the output can be changed to 240 volts, 25 amps., or 120 volts, 50 amps. The 48-plate unit weighs 17¼ lbs. and provides a more efficient space factor through its rectangular design. Plates will withstand 26 volts ac back voltage.—*Federal Telephone and Radio Corp., Newark, N. J.*



MINIATURE SWITCH

(Use Inquiry Card, Mentioning No. 717)

Compactness and rugged construction are characteristics of the "Q-switch", a snap-action miniature switch no larger than a dime designed for use with electrical appliances and electronic equipment. The unit has high current-carrying capacity and meets any circuit requirement, normally open or closed, single or double throw, single pole.—*Mu-Switch Corp., Inc., Canton, Mass.*



DEPOSITED CARBON RESISTORS

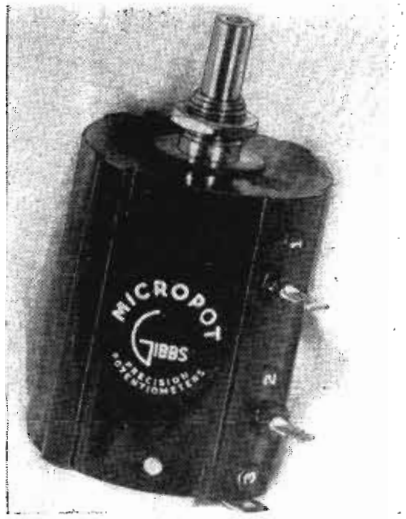
(Use Inquiry Card, Mentioning No. 718)

Available in precision, general use and power types, in values from 1 ohm to 50 megohms, and power ratings from 0.5 to 600 watts, the Western Electric deposited carbon resistors are efficient in electronic circuits where close control of the resistance value and stability over long periods of time is required. Having extremely low capacitance and inductance per unit, they are useful in high frequency applications. The units consist of a very thin film of vapor deposited carbon on the surface of a ceramic base or core. Nominal tolerances are 1,2, and 5%.—*Western Electric Co., 195 Broadway, New York 7. Distributed by Graybar Electric Co.*

DECALS

(Use Inquiry Card, Mentioning No. 719)

A complete line of stock decalcomania transfers for radio and electronic applications consists of over 300 different titles, all sizes of dial plates, numerous sizes of alphabets, high voltage warning signs, etc. Stock titles and dial plates are available in white, red, black and luminescent, made of high quality lacquer type decal. Any title can be made to specifications.—*Kullman Mfg. Co., 4307 Winona Ct., Denver 12, Colo.*



HELICAL POTENTIOMETERS

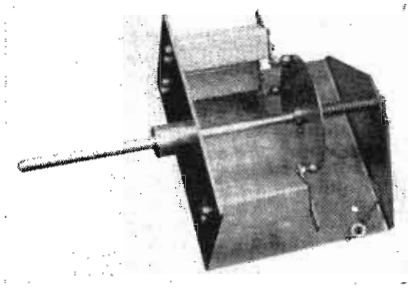
(Use Inquiry Card, Mentioning No. 720)

Available in resistance values from 1000 to 30,000 ohms Micropot ten-turn helical potentiometers have a resistance variation linear to 1/10 of one percent over the entire range. Ten full turns on the standard ¼ in. shaft drives a sliding contact across more than 40 in. of wire-wound resistance element. Running torque is less than 1½ in-oz at room temperature and not greater than 3 in-oz between −55° and 70°C. The complete unit is 2⅛ in. in diameter and extends 2⅛ in. behind the panel.—*Gibbs Div., George W. Borg Corp., Delavan, Wis.*

GERMANIUM VARISTOR

(Use Inquiry Card, Mentioning No. 721)

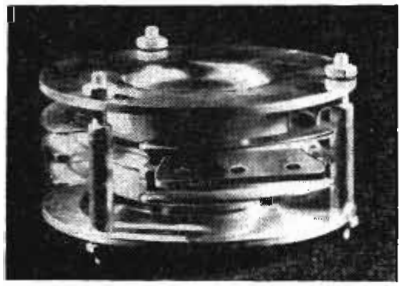
Providing stable, low capacity, four element modulation for communication and radar applications the type V-301 varistor contains four balanced germanium crystal diodes with a forward resistance of 85 to 120 ohms at 1.5 volts. Diode pairs are balanced within 2 ohms at 1.5 volt. Modulator ratings for the diodes are: 25 volts max. inverse voltage, 20 ma. max. average current, 40 ma. peak, and 50 ma. max. surge current. Modulation occurs when carrier and modulated frequency are applied simultaneously to the non-linear diode varistor elements. Type V-301 is a plug-in unit supplied with 8-pin octal base. Also available is type V-307 with solder type terminals for top or sub-panel mounting.—*Electronics Div., Sylvania Electric Products Inc., 500 Fifth Ave., New York 18.*



GROUNDING SWITCH

(Use Inquiry Card, Mentioning No. 726)

Safety from high-voltage injury to personnel performing maintenance work inside transmitters or other high-voltage units is assured by this new-type automatic grounding switch, which accommodates one to three circuits and operates automatically when the door is opened. With the door closed, driver rod and disk are pushed back and ground is disconnected from circuits. The switch is made in two sizes for voltages up to 10,000 and for voltages up to 20,000 volts.—*J. H. Bunnell & Co., 81 Prospect St., Brooklyn 1, N. Y.*



HIGH KVA CAPACITOR

(Use Inquiry Card, Mentioning No. 727)

Suitable for high kva applications, industrial heating etc., the type 2688 high kva ceramicon capacitor assembly consists of silvered ceramic dielectrics and attendant metal parts. Load tests with the unit mounted in position, and conducted at 15 mc at an ambient temperature of 25°C, indicate good performance with temperature rise of 50°C under load well in excess of 20 kva. With forced-air cooling the rated load may be considered above 50 kva at 15 mc. Maximum operating temperature is 85°C. The units are available in 500 and 1,000 mfd capacities.—*Erie Resistor Corp., Erie, Pa.*

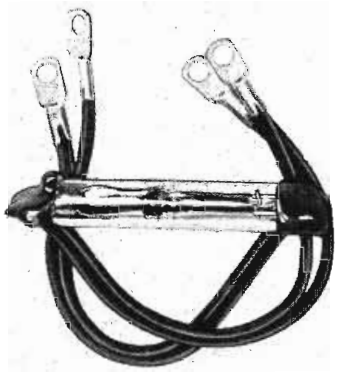
PLASTIC-MOLD CAPACITORS

(Use Inquiry Card, Mentioning No. 728)

Complete sealing against humidity, secure anchoring of leads, and unchanging capacity values are some of the advantages offered by the type 30 paper tubular capacitors which are molded in thermo-setting plastic. The units have a low power factor, long life, and permit high-temperature operation.—*Sangamo Electric Co., Springfield, Ill.*

ANNOUNCEMENT

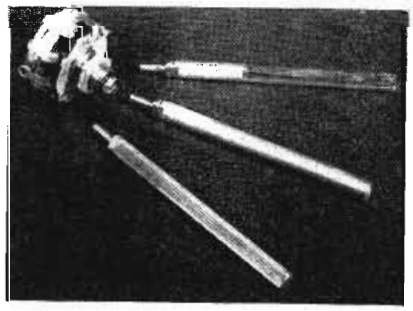
For the convenience of readers, all descriptions of new products have been assigned IDENTIFYING NUMBERS. For further information, please use the Prepaid Inquiry Card appearing at page 83 in this issue and *Identify the product by the number assigned to it.*



MERCURY SWITCHES

(Use Inquiry Card, Mentioning No. 722)

Because open sparking or arcing is eliminated these hermetically sealed mercury switches are safe in hazardous locations and are unaffected by moisture, dust, corrosion or oxidation. The switches are compact, light in weight, and have quick make and break action. Any contact arrangement can be supplied including polyphase and multiple contact types in a single unit. Contacts are always clean and cannot pit or burn.—*Chatham Electronics, 475 Washington St., Newark 2, N. J.*



ALUMINUM-SHAFT CONTROLS

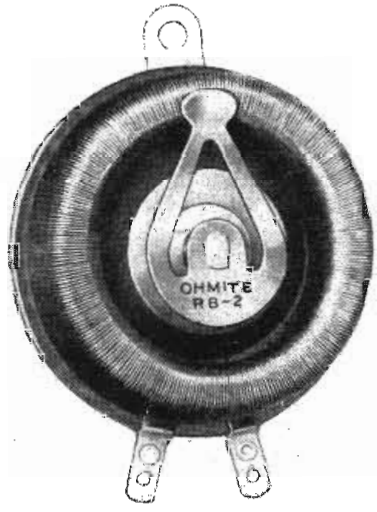
(Use Inquiry Card, Mentioning No. 723)

The Clarostat aluminum shaft, incorporated in the company's replacement controls, can be snipped off at one bite of standard pliers instead of sawing off the excess length as required with conventional steel shafts. Another addition to their line is the Ad-A-Shaft replacement controls (illust.) which permit completely separate selection of control and shaft according to requirements. The shaft is simply slipped into the slot of the control bushing and then hammered on a hard surface, which provides a rigid, permanent mounting.—*Clarostat Mfg. Co. Inc., 130 Clinton St., Brooklyn 2, N. Y.*

BASIC RESISTOR KIT

(Use Inquiry Card, Mentioning No. 724)

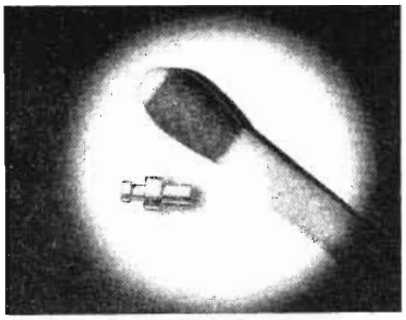
A wide variety stock of most-needed resistor sizes and types, suited to the needs of servicemen, schools, and research labs, are contained in the IRC basic kit. Assortments are so arranged that a shortage of stock in one range may be compensated by using two other ranges in series or parallel. The kit contains approximately 470 resistors in all ranges and sizes from ½-watt metallized filament units to 80-watt wire-wound adjustable power resistors and bleeder-type units. An all-metal cabinet is supplied without extra charge with the kit.—*International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.*



DIRECTION-INDICATOR POT.

(Use Inquiry Card, Mentioning No. 725)

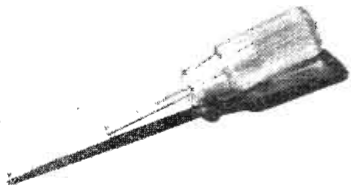
To provide a simple, low-cost method of indicating the position of a rotary-beam antenna, wind vane, or other rotating device, the model RB-2 Direction-Indicator Potentiometer is coupled to the rotating device so that the shaft of the potentiometer rotates with it. The potentiometer is then connected to a 6-volt battery and a low-current dc milliameter to indicate the position of the rotating device. Maximum current drain is only a few milliamps.—*Ohmite Manufacturing Co. 4855 Flournoy St., Chicago 44, Ill.*



TERMINAL LUGS

(Use Inquiry Card, Mentioning No. 731)

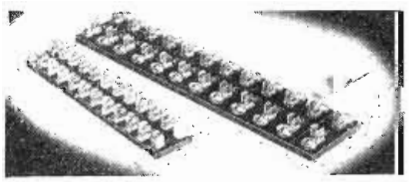
For wiring miniature carbon resistors, ceramic capacitors, etc. in extremely small units, hearing aids, meters and test equipment this new miniature terminal lug (compare size with match in illustration) has a 3/32 in. above the mounting board. The mounting shank of the "Mini-Lug" is .025 in. long for fastening to a 1/64 in. board. A shank of .045 in. is available for a 1/32 in. mounting board. The lugs are made of silver-plated brass.—*Cambridge Thermionic Corp., Dept. 7, 445 Concord Ave., Cambridge, Mass.*



ALIGNMENT TOOLS

(Use Inquiry Card, Mentioning No. 732)

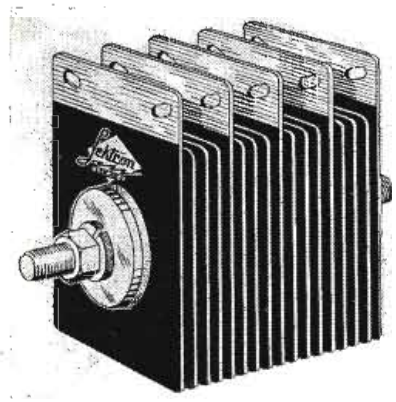
One of the first alignment tools with nylon insulation for manufacturers of elcctronic equipment, this nylon-shafted screwdriver is strong, resists heat and provides good insulation against high voltages. The shaft is cemented and staked in a handle of cellulose acetate butyrate. Nylon was adopted as the shaft material because it provides the necessary rigidity and strength for a shaft of extremely small diameter and also meets requirements of heat resistance and moisture absorption.—*E. I Du-Pont de Nemours and Co., Wilmington 98, Del.*



FUSE-MOUNTING PANEL

(Use Inquiry Card, Mentioning No. 733)

Stocked in 12-pole units these open-type fuse mounting panels may be ordered cut into single or multiple mountings of 2,3,4 or more poles, and are available with solder terminals as Type "S", or with screw terminals as type "T". Solder-terminal types are offered in 3 and 8 AG capacities, while screw-terminal types are available in 3, 4, and 5 AG capacities. — *Littelfuse Inc., 4757 Ravenswood Ave., Chicago 40. Ill.*



HEAVY DUTY RECTIFIER

(Use Inquiry Card, Mentioning No. 734)

Ability to operate at peak efficiency over a temperature range from —40 to 284°F, and light weight are characteristics of Lectron heavy duty magnesium-copper sulphide rectifiers, which are useful as a source of dc from 50 to 50,000 amps., and up to 60 volts for battery charging and plating operations. Rugged construction makes the units trouble-free and capable of withstanding severe electrical and mechanical abuse. Models are available for full wave and half wave rectification for operation from single phase or multi-phase systems.—*Electronic Rectifiers, Inc., 737 N. East St., Indianapolis, Ind.*

MULTIPOLE SEQUENCE RELAY

(Use Inquiry Card, Mentioning No. 735)

Adaptable to applications involving the addition and subtraction of loads, as in switching individual units from a bank of capacitors the Type 96 AFA two-coil multipole sequence relay is of the reversing, separate circuit type and is ratchet-operated. One operating coil steps the cam shaft forward, while the second coil steps the shaft in the reverse direction. Mechanical stops limit forward and reverse travel. Standard ratchets have 12 teeth, permitting a total of 12 contacts in sequence with up to 6 separate contacts between each pair of bearing supports. The coils are for ac use only. — *Struthers-Dunn, Inc., 146-150 No. 13th St., Philadelphia 7, Pa.*

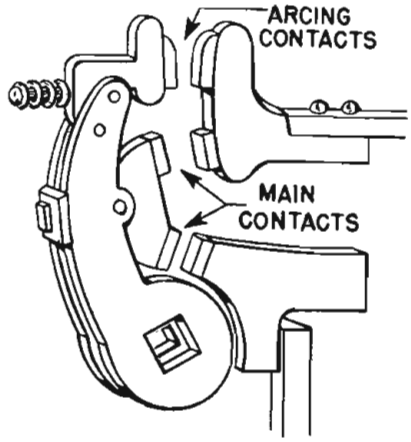
CATHODE RAY TUBE

(Use Inquiry Card, Mentioning No. 737)

Intended for applications in the industrial and medical fields the Type 7Z8P11 eight-gun cathode ray tube is particularly useful for registration on a single screen of eight independent phenomena of transient or recurrent nature at VHF frequencies, where an electronic switching system would be impractical. The eight electron guns, which are completely shielded from each other, are of the tetrode type and have separate connections to all electrodes and deflection plates. Any standard phosphor can be supplied for the screen, which is 7 in. in diameter. Deflection factors for each gun are 70 volts per inch ±20% for plates 1D2 and 3D4.—*Electronic Tube Corp., 1200 E. Mermaid Ave., Philadelphia 18, Pa.*

ANNOUNCEMENT

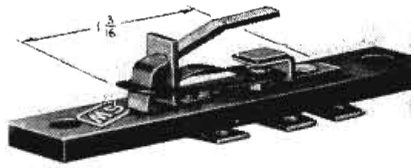
For the convenience of readers, all descriptions of new products have been assigned IDENTIFYING NUMBERS. For further information, please use the Prepaid Inquiry Card appearing at page 83 in this issue and *Identify the product by the number assigned to it.*



ELECTRICAL CONTACTS

(Use Inquiry Card, Mentioning No. 729)

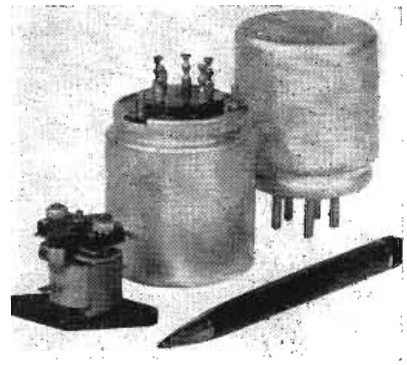
Silver-molybdenum electrical contacts having arc resisting characteristics are supplied in two grades: Gibsiloy M-10 and M-12, the latter containing a higher percentage of molybdenum. Gibsiloy M-12, having a hardness of 85 Rockwell B with 45% conductivity, is used on heavy circuit breakers where great mechanical and electrical stresses are encountered; grade M-10—with a hardness of 75 Rockwell B and 50% conductivity—is used on smaller circuit breakers. *Gibson Electric Co., 8350 Frankstown Ave., Pittsburgh 21, Pa.*



SNAP ACTION SWITCH

(Use Inquiry Card, Mentioning No. 730)

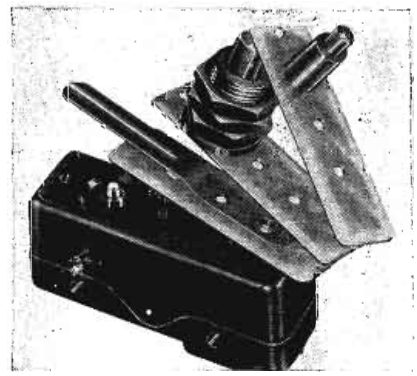
Providing accurate repeatability, long life, high electrical capacity and resistance to vibration and acceleration the "SK" series of unhoused, skeleton type, snap action switches are particularly adapted to actuation by rotating or sliding cams. The switches are single units, available in normally-open, normally-closed, or double throw circuit arrangements. Tentative rating is 10 amps, 125 or 250 volts, ac. Operating force is 3 to 8 oz; release force 2½ to 7 oz., and the net weight .01 lbs.—*Micro switch, Freeport, Ill.*



DC RELAYS

(Use Inquiry Card, Mentioning No. 738)

Designed for applications where switching must be performed by amounts of power as small as 10 milliwatts this line of eight different types of single-pole, double-throw, current-sensitive dc relays has input ratings ranging from 10 to 180 milliwatts, with currents from .47 to 1470 ma, and resistance of .07 to 67,000 ohms. Contact voltage ratings vary from 12 to 110 volts, ac or dc. At 24 v. the contacts will handle 2 amps. non-inductive, or .05 amps inductive. — *Apparatus Dept. General Electric Co., Schenectady, N. Y.*



AUXILIARY SWITCH ACTUATORS

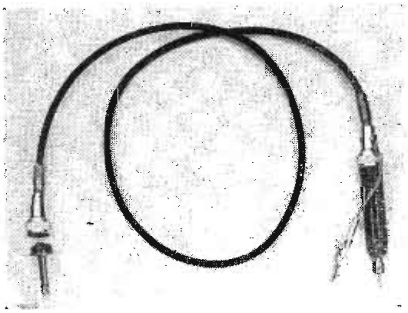
(Use Inquiry Card, Mentioning No. 739)

Removable and interchangeable actuators for the Unimax snap-action switch allow the basic switch to be adapted to various uses and reduces inventory requirements for manufacturers. All actuators are applicable to all Unimax switches and can be interchanged without disassembling the switch. The actuators are mounted on strong stainless steel mounting plates. Ratings of the SPDT basic switch is 15 amps, at 125 volts or 5 amps. at 250 volts, 60 cycle, ac. — *Unimax Switch Corp., Subsid. W. L. Maxson Corp., 460 W. 34 St., New York 1.*

SMALL SOLDERING IRON

(Use Inquiry Card, Mentioning No. 736)

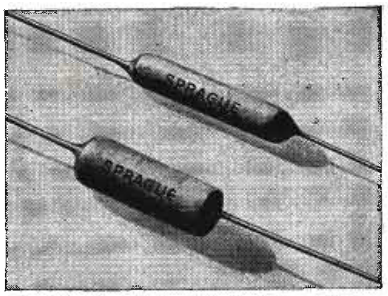
Finding application wherever a small continuous-duty industrial iron is needed, model 350 midget iron has a mica wound unit which consumes 35 watts on 110 volt, ac or dc. It is provided with two tips, one standard ⅛ in. straight tip, and a special 45° angle tip. The iron is 7 in. long and requires no stand.—*Drake Electric Works, Inc., 3654 Lincoln Ave., Chicago 13, Ill.*



GERMANIUM CRYSTAL PROBE

(Use Inquiry Card, Mentioning No. 740)

This new miniature crystal rectifying probe Type MI-8263 adapts the RCA VoltOhmist and Chanalyst for circuit testing of TV, FM and other VHF applications within the sensitivity range of these instruments. It uses a germanium crystal to rectify applied ac voltages which are measured in the dc circuit of the meter. The probe is equipped with an alligator clip ground lead and a special connector and detachable phone plug for use with all models of the Volt-Ohmist.—*Radio Corp. of America, RCA Victor Div., Camden, N. J.*



TUBULAR CAPACITORS

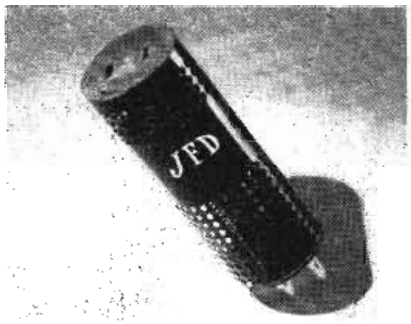
(Use Inquiry Card, Mentioning No. 741)

The first small, commercially-produced tubulars to operate at 85°C and have ample humidity protection, this line of Sprague 68P and 69P Midget paper dielectric capacitors is efficient for use with small radio receivers and other electronic equipment where minimum size must be combined with high-temperature and humidity operation. Type 69P units have side leads to permit wiring them across the sockets of miniature tubes, while type 68P capacitors have conventional end leads—*Sprague Electric Co., North Adams, Mass.*

CURRENT REGULATOR

(Use Inquiry Card, Mentioning No. 742)

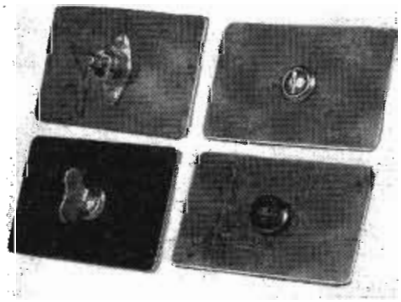
Where space is important the Amperite regulator tube in the miniature T5½ bulb offers a convenient and compact method for regulating currents from 60 ma to 1 amp., with a maximum dissipation of 3 watts for the longer tube and 2 watts for the shorter tube. With 10% change in current through the tube, the voltage drop across it will increase 200%. The regulator will withstand 25 G and is not affected by altitude, climatic conditions, or changes in ambient temperature of –40 to 70°C.—*Amperite Co., 561 Broadway, New York 12.*



STEP-DOWN BALLASTS

(Use Inquiry Card, Mentioning No. 743)

Designed to convert 110 volt radio receivers and other electrical appliances for use on 220 volt circuits these plug-in step down resistor ballasts are equipped with American, British, and Continental male plugs. The female sockets are American. The ballasts are especially useful for "personal" appliances such as electric razors, clocks, electronic blankets, etc.—*Dept. F, JFD Manufacturing Co., 4117 Fort Hamilton Parkway, Brooklyn 19, New York.*



GENERAL PURPOSE FASTENER

(Use Inquiry Card, Mentioning No. 744)

Originally designed for aircraft use the series 2600 Camloc fasteners are now available for general industrial applications. The fasteners, which incorporate a removable stud assembly made of aircraft quality tool steel, require no special tools for installation and will handle loading up to 250 lbs. The receptacle is all die cast silicon-bronze, cadmium-plated to army-navy specifications. The units are graduated in increments of .03 in. The high receptacle cam rise provides sufficient take-up for gasket compression and low operating torque.—*Camloc Fastener Corp., 420 Lexington Ave., New York 17.*

VARIABLE CAPACITOR

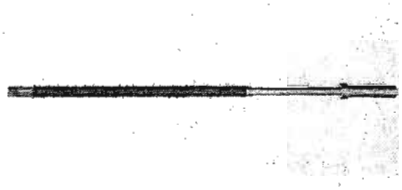
(Use Inquiry Card, Mentioning No. 745)

Efficient for use in commercial radio communication and industrial electronic applications this air-dielectric variable capacitor is virtually impervious to mechanical shock and has negligible vibration capacitance modulation under adverse conditions. Range between minimum and maximum capacitance is 30:1, the minimum capacitance being 5 mmfd, maximum 150 mmfd. The capacitance curve is substantially linear; flash rating is 500 volts. Max. outside diameter of the unit is ⅞ in., overall length 1¾ in., weight 16 grams.—*North American Philips Co., 100 E. 42 St., New York 17.*

METER ILLUMINATION

(Use Inquiry Card, Mentioning No. 746)

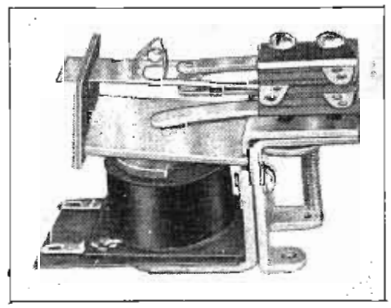
Eliminating translucent dials and shadow spots the Simpson illuminated meters, available in 2 and 3 in. sizes — rectangular or round — flood the dial face with an even, shadowless illumination. This is accomplished by means of a lucite cone which carries the light from a recessed bulb in the back of the instrument through the front edge of the cone surrounding the dial face. — *Simpson Electric Co., 5200-18 West Kinzie St., Chicago 44, Ill.*



2 MILLION VOLT X-RAY TUBE

(Use Inquiry Card, Mentioning No. 747)

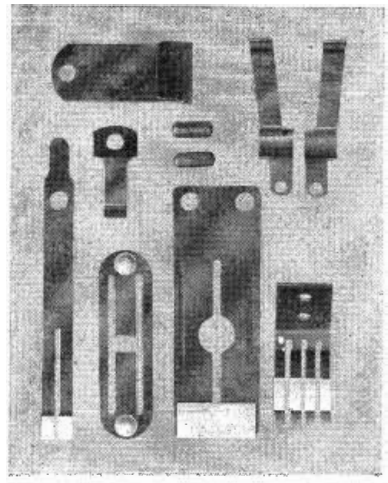
Adaptable for industrial radiographic purposes, constant potential two million volt X-ray tubes of sealed-off design have been developed. Increasing the voltage from 1 to 2 million volt constant dc makes it possible to reduce exposure time in investigating heavy steel objects from a week to less than an hour. The tube must be operated in conjunction with an electrostatic generator. Approx. 180 accelerating sections are used to provide uniform steps of 12,000 volts each.—*Machlett Laboratories, Inc., Springdale, Conn.*



SNAP-ACTION SWITCH

(Use Inquiry Card, Mentioning No. 748)

To be used in conjunction with standard Guardian relays this line of snap-action switches is particularly suited to control applications that involve slow-moving, mechanical devices or where a given stroke is required to provide quick, positive "make" or "break" contact action. The tension of the hair spring retains the contact assembly in either "open" or "closed" position until the armature has completed its travel. Chattering, arcing, intermittent contact pressure etc. are eliminated with snap-action switches. For motor starting circuits the series 100 relay with snap action switch has been successfully used.—*Guardian Electric Mfg. Co., Dept. Sa, 1622 West Walnut St., Chicago 12, Ill.*



CONTACT SPRINGS

(Use Inquiry Card, Mentioning No. 749)

Recommended for use where exceptional spring properties and high electrical conductivity are required, these electrical contact springs are made of beryllium copper, which has a modulus of elasticity of 18,500,000 and a tensile strength from 175,000 to 200,000 psi. Its electrical conductivity is 25 to 32% IACS. Comparable ratings for phosphor bronze are considerably lower. Complete contact assemblies can be supplied with electrical contacts of silver, silver alloys, or powder metal compositions attached to contact supports of various metals.—*Gibson Electric Co., 8350 Frankstown Ave., Pittsburgh, Pa.*

INDICATOR BUTTON

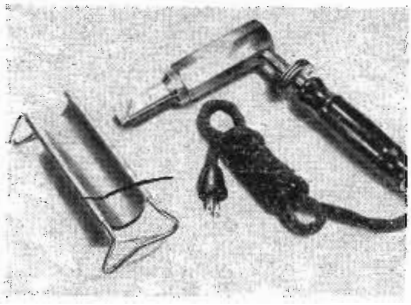
(Use Inquiry Card, Mentioning No. 750)

Engineered to replace expensive machined parts, this specially designed plug indicator button for electrical appliances features a molded plastic window framed in chrome and snaps into place by hand. The indicator buttons can be made in many sizes with windows of any color. They are adaptable to a wide variety of uses.—*United-Carr Fastener Corp., Cambridge 42, Mass.*

SUB-MINIATURE TUNED INDUCTORS

(Use Inquiry Card, Mentioning No. 751)

Suitable where a variable inductance is required in confined space, such as on filters, wavetraps, oscillators, etc., this line of slug tuned inductors is only ⅞ in. high, when mounted in a single #19 hole. Type LSM midgets are equipped with spring lock assuring positive maintenance of adjustment. The units will be available in a group of windings covering normal inductance ranges. *Cambridge Thermionic Corp., Dept. 6, 445 Concord Ave., Cambridge 38, Mass.*



SOLDERING IRON

(Use Inquiry Card, Mentioning No. 752)

Because of balanced weight, inherent in hatchet design, the type 300H electric soldering iron does not have to be gripped tightly, but it rests in the hand in a naturally balanced position, thus eliminating operator's fatigue. The heating element, made of mica-insulated, nickel-chromium resistance wire, is housed in a damage-proof hexagonal shaped barrel, which permits easy clamping in a vise for tip removal. The iron is equipped with a 6 ft., 10,000 cycle, approved heater cord and rubber plug.—*Hexacon Electric Co., 157 West Clay Ave., Roselle Park, N. J.*

NEON INDICATING LIGHT

(Use Inquiry Card, Mentioning No. 753)

Developed for control panels of radio, television and other electronic equipment the "Post-Lite" neon indicator may be used in circuits ranging from 65-130 volts ac, or from 90-130 volts dc. Normal life of the unit, which has a 100,000 ohm limiting resistor, is 15,000 hours at rated voltage. Case is made of molded clear plastic, resistant to shock and salt water air. Overall length of the assembly is 2¼ in. — *Littlefuse Inc., 4757 N. Ravenswood Ave., Chicago 40, Ill.*

MINIATURE CAPACITORS

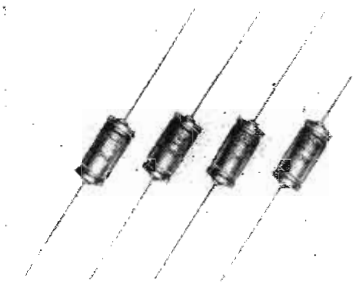
(Use Inquiry Card, Mentioning No. 754)

Assuring good performance even under adverse humidity conditions and maintaining high insulation resistance, the Sprague miniature capacitors 63P and 64P are available in both round and flat types for use in hearing aids and other small devices. Standard units include capacities ranging from .00025 to 1 mfd. Insulation resistance at 25°C after a 2 minute charge at 180 volts dc is such that the time constant (RC) is not less than 1,000. Power factor at 1000 cycles is not more than 2%.—*Sprague Electric Co., North Adams, Mass.*

RESISTOR TUBES

(Use Inquiry Card, Mentioning No. 755)

To supply needed voltages for pilot lamp operation in ac and dc receivers and to aid voltage reduction functions, ten universal resistor tubes have been developed, meeting most replacement requirements. High leakage resistance between elements and chassis of these tube-type wirewound resistors permit their use in sensitive circuits without introduction of ac hum. The tubes have a maximum safe power dissipation of 20 watts.—*Specialty Div., G-E Electronics Dept., Wolf Street Plant, Syracuse, N.Y.*



HIGH-VOLTAGE CAPACITORS

(Use Inquiry Card, Mentioning No. 756)

Electrical and mechanical characteristics of the type TMC high-voltage capacitors are such that they will adequately fill many of the special needs of television equipment. Housed in tubular, hermetically-sealed containers of seamless drawn metal tubing the compact units are impregnated and filled with "Dykanol" to provide long life at high ambient temperatures. Available capacities range from .005 to .05 mfd., dc voltage ratings from 2,000 to 5,000. — *Cornell-Dubilier Electric Corp., South Plainfield, N. J.*

SOLDERING IRON

(Use Inquiry Card, Mentioning No. 757)

Efficient for precision soldering where space is limited, the Calrod "Midget" soldering iron is 8 in. long, weighs 1¾ oz. and is available with tips ¼ and ⅛ in. in diameter. The unit is rated at 25 watts, 6 volts, and is used with a 115/6 volt transformer. A transformer providing 4 taps for variable heat can be supplied. To reduce heat loss, the Calrod heater is built into the tip to within ½ in. of the working end. Tip and heater can be replaced as a unit. — *General Electric Co., Schenectady, N. Y.*

VACUUM CAPACITORS

(Use Inquiry Card, Mentioning No. 758)

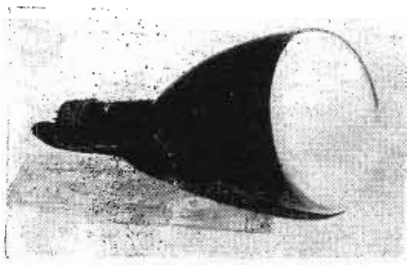
The first of a new series type CAP 50/-60/-30 vacuum capacitor has a capacitance of 50 mmfd within a tolerance of ±2% or ±1 mmfd. Capacity of the unit is 60 amps., peak potential 30 kilovolts. Efficient in high-frequency applications, because of low-loss construction, all metal parts of the capacitor are hard brazed copper. Large elements and large periphery glass-to-copper seals are used resulting in a low temperature coefficient. End caps are gold plated to minimize oxidation.—*United Electronics Co., Newark, N. J.*

PLASTIC FILM CAPACITOR

(Use Inquiry Card, Mentioning No. 789)

In a description of the Plasticon Glassmike which appearded in the May issue of Tele-Tech, capacity of the LSG unit was erroneously stated to be 150 mmfd, whereas it should have been 1500 mmfd. DC rating of the unit, which has a Q of more than 5000, is 5000 volts—*Condenser Products Co., 1369 North Branch St., Chicago, Ill.*

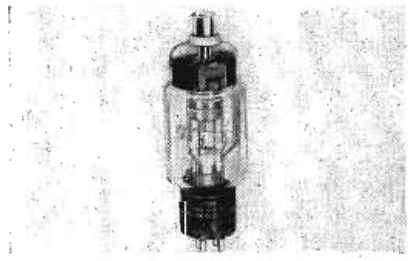
For more information use inquiry card at page 83.



CATHODE-RAY TUBE

(Use Inquiry Card, Mentioning No. 759)

Developed for direct-view television receivers and industrial oscilloscopes the type 7GP4 cathode-ray tube has a high deflection sensitivity rate. The deflection factor for two of the 7GO4 electrodes is 108 volts dc per in., while the two remaining electrodes function at 89 volts dc per inch. Both the focusing and deflecting methods used are electrostatic. Maximum ratings of the tube apply to 4000 volts. Grid-circuit resistance is 1.5 megohms.—*Tube Div., General Electric Co., Electronics Dept., Schenectady, N. Y.*



XENON RECTIFIER

(Use Inquiry Card, Mentioning No. 760)

Type 5594 is a Xenon filled thyratron suitable for operation through an ambient temperature range from —55 to +90°C. Xenon gas eliminates the need for auxiliary equipment to maintain bulb temperatures. Peak forward anode voltage of the unit is 2,500 volts, peak inverse rating being 5,000 volts. Average anode current is 0.5 amps, peak is 2 amps. The tube operates from a 2.5 volt filament source at 5 amps. current.—*Chatham Electronics, 475 Washington St., Newark 2, N. J.*

AC-DC POWER SUPPLY

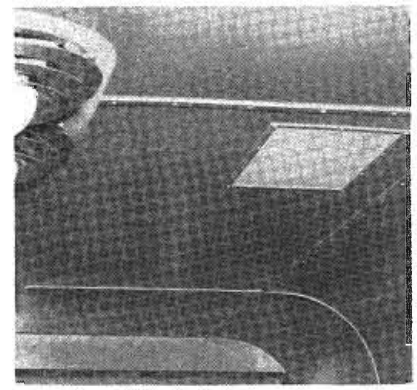
(Use Inquiry Card, Mentioning No. 761)

Operating on 115 volt, single phase 50-60 cycle, ac with a maximum demand of 605 va., portable model 700-S ac-dc power supply unit is provided with two independent output circuits, which are separately controlled and electrically isolated for establishing phantom loads for double coil instruments such as wattmeters and power factor meters. Circuit No. 1 provides 0-10 amps. ac at 5 v., or 0-30/75/150/300/750 volts ac at 300 ma max. or dc at 200 ma. Max. ripple on dc output is less than 0.25%. Circuit No. 2 has an ac output of 0-5 amps. with a maximum of 5v., and an output of 0-115 volts at 3 amps. max., including 115 volt constant potential terminals. —*Arthur E. Booth Co., 210 West Seventh St., Los Angeles 14, Calif.*

PASSENGER ENTERTAINMENT

(*Continued from page 37*)

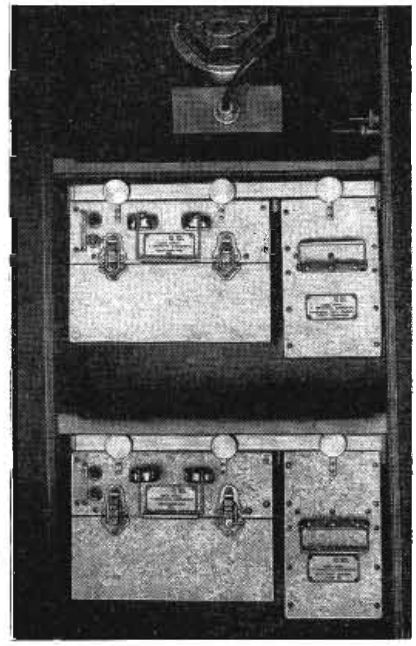
breakage or other trouble. The brass wire used for reproduction is plated with a highly magnetic material and is .046 in. in diameter. Since most railroads plan to change programs monthly to keep



One of the Santa Fe cars showing how speakers are recessed in the roof

music seasonal, the systems are specifically designed to operate without more than monthly maintenance attention.

Units are contained on shock-mounted bases to which the permanent wiring of the car is attached. All equipment units which



Complete wire recorder, amplifier and regulated converter installation, units being quickly replaceable for service

contain vacuum tubes or condensers—the parts which fail most often—can be removed and replaced by other similar units within a few seconds.

All equipment operates from

117 volt, 60 cycle, single-phase ac. Frequency regulation within 5% and voltage regulation within 6% are required.

Future improvements which may occur in broadcasting and recording will not outmode the systems, because the use of unitized construction makes them readily adaptable to the absorption of new or different units such as FM tuners, which can be directly substituted for regular broadcast receivers on the standardized racks or can be added to the systems as new and additional units.

Farnsworth railway passenger entertainment program distribution systems are now in service on deluxe trains of the Atchison, Topeka & Santa Fe, the first railroad in the nation to use wire-recorded music aboard trains, and on the New York Central. Passenger entertainment equipment currently is being installed by the Northern Pacific, with installations scheduled for completion on twelve trains of that road this month. Farnsworth systems also will be installed this summer by the Baltimore & Ohio, Norfolk & Western, and Penn. R. R.

The installations vary on each of these six railroads; none has exactly the same type of installation. However, all are using one or more of the following: wire-recorded music, radio, public address. This is possible because any combination of entertainment facilities in the Farnsworth systems may be adapted to an individual railroad's desires or passenger requirements.

NEW ENGLAND ENGINEERS

(*Continued from page* 33)

by a simplified description of the mechanism involved in the detecting action of Geiger-Muellen tubes. The effect of various gas fills and other production items was described from the standpoint of tube life, stability, operating voltage and recovery time.

"A Very-High-Frequency Bridge for impedance Measurements at Frequencies Between 20 and 140 mc"—R. A. Soderman (General Radio Co.) described a modified Schering arrangement developed for impedance measurements on distributed parameter circuits utilizing coaxial transmission lines, as well as on lumped parameter circuits.

SECONDARY-EMISSION TUBE

(*Continued from page 69*)

ties are met because the auxiliary cathode is covered with dust originating at primary cathode by volatilization; this causes disturbances of secondary-emission process.

In the EE50 secondary emission tube, the difficulties due to volatilization of the cathode have been eliminated by shielding the secondary-emission cathode. Fig. 1B shows schematically the structure of the EE50 tube. The cathode, the control grid and the screen grid constitute a conventional screen-grid tube. The auxiliary secondary-emission cathode which is at 150 volts positive with respect to the cathode, is protected by a screen S_1 (at cathode potential) against deposits originating through volatilization at the cathode. The screen S_2, which is also at cathode potential, is shaped to guide the electrons over the paths indicated by the dotted line and arrow in the Fig. 1B to the secondary-emission auxiliary cathode. In front of the auxiliary cathode at a distance of 1.5mm, is an extension of the plate shaped as a metal-screen which prevents space charge to be built up by the secondary electrons. A small fraction of the liberated secondary electrons is captured by the screen-shaped section of the plate, while most electrons impinge upon the solid section of the plate.

The following table lists the characteristics of the EE50:

heater voltage	6.3	V
heater current	300	mA
plate voltage	250	V
screen-grid voltage	250	V
secondary-emission cathode	150	V
control grid bias	—3	V
plate current	19	mA
secondary-emission cathode	—8	mA
screen-grid current	0.7	mA
transconductance	14000	micromhos
internal resistance	0.1	Meg Ω
control grid-plate capacitance less than	0.003	mμF

This tube is constructed similar to conventional European glass-envelope tubes and looks like the EF50 (Sylvania).

Plate current, I_p, auxiliary cathode current, I_{k2}, and screen grid current, I_{g2} are plotted in Fig. 2. against control grid voltage V_g. Fig. 3 shows plate current as function of plate voltage with grid voltage as parameter.

If these tubes are used in amplifiers, a tendency for oscillations should be watched. Another feature which should be given careful consideration is the negative control grid bias supply. In a preferred circuit, it is derived from a cathode resistor. Then the operating point of the tube may be found from the intersection of the resistor line *a* and the tube characteristic, see Fig. 2. However, spurious cathode-current variations are multiplied by secondary emission and produce much larger variations in the plate current. The additional plate current does not traverse the cathode resistor and no compensation is effective; special compensating measures must be taken. Automatic regulation of the plate current could be assured if the line *a* had a more gradual slant, line *b*. For that purpose a larger cathode resistor is inserted, and a positive voltage applied to the grid to adjust bias. Operation now follows line *b* and current will not vary much if operation shifts to another characteristic.

The auxiliary cathode is connected to a separate potentiometer:

(*Continued on page 105*)

MICROPHONE PLACEMENT

(*Continued from page 45*)

ground noise, and therefore permits a higher average modulation percentage?

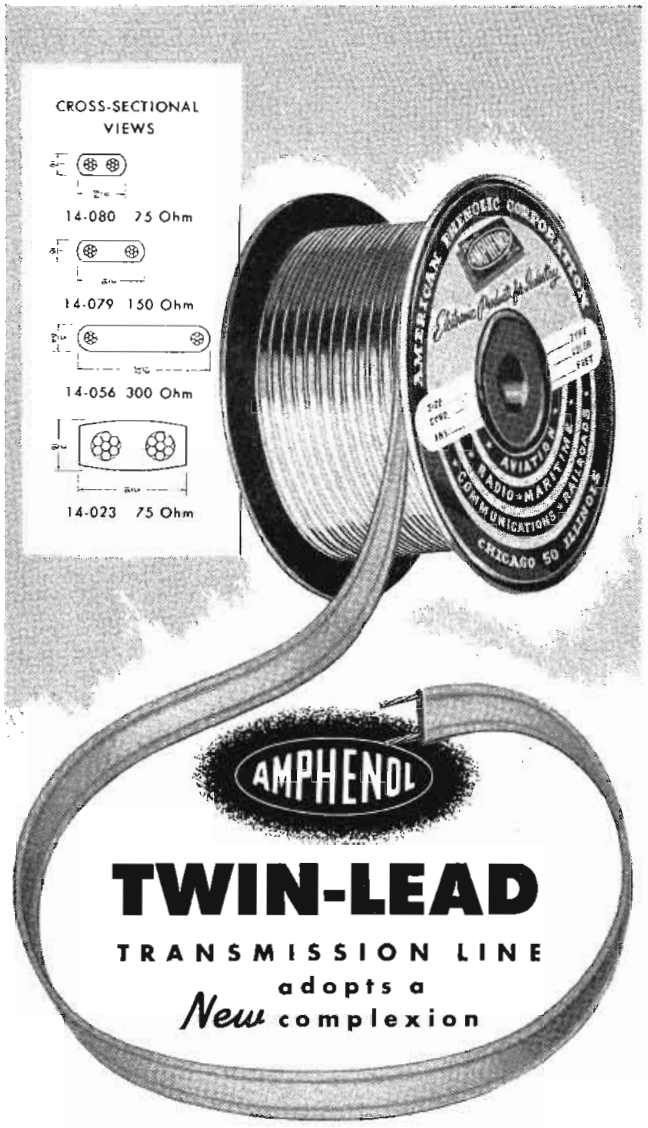
(3)—For a given volume range as indicated by the vu meter, reproductions from monaural sound pickups made within the useful range and an apparent volume range are nearly twice that of similar reproductions from dead pickups.

(4)—The change in quality of the monaurally reproduced sound as a function of the loudness of reproduction is materially reduced."

A nomograph has been charted and is illustrated together with tables and formulas. The liveness formula (1 on chart) contains all of the essential dimensions of an enclosed space, including the more important ones of volume and reverberation time. As a practical example of the nomograph, assume a studio whose volume is 22,000 cu. ft. and in which an orchestra of size commensurate with the studio dimensions is to perform.

From Fig. 1 we have the reverberation time for a 22,000 cu. ft. studio as 1.1 second. From Table 1 we have the liveness range as from 5 to 20; use 15 (see above). On the chart draw a straight line connecting the volume 22,000 on the V scale to a liveness of 15 on the L scale thus positioning a reference on the axis line. Then from the time scale T at 1.1 seconds, draw a line through the axis reference point and extend it to D scale. Read the distance for the general microphone as between 16 and 17 feet. This nomograph is based on a non-directional microphone and has a G_p value of 1 for general pick-up.

To calculate the distance for a directional microphone it is only necessary to multiply the resultant distance as obtained by the processes of the previous example by the square root of G_p. As an example, let us determine the proper microphone distance for a vocalist. The room volume and the reverberation time are the same as before, but from Table 1 we see the liveness range of from ½ for close-up performers. Operating on



• Amphenol, originator and long-time producer of extruded polyethylene insulated Twin-Lead for transmitting and receiving, now announces an important improvement.

At no increase in price, the dielectric insulation has been changed to solid brown Amphenol Ethylon-A containing an anti-oxidant. This new insulation is equal to the old in low loss properties. It is far superior in resistance to the effects of sunlight and moisture.

Preferred by amateurs for antennas and transmission lines, Twin-Lead transmits signals with minimum loss, is durable and inexpensive. The Ethylon-A dielectric is full thickness edge to edge, minimizing impedance changes caused by moisture collecting on the surface. Amphenol Twin-Lead is unaffected by acids, alkalies and oils. Flexibility remains unimpaired at temperature down to —70°F

The new *brown* Amphenol Twin-Lead is available in 75 ohm, 150 ohm and 300 ohm impedances for receiving use, and in 75 ohm type for transmitting. Write today for full data on electrical characteristics and prices.

AMERICAN PHENOLIC CORPORATION
1830 SOUTH 54TH AVENUE • CHICAGO 50, ILLINOIS

COAXIAL CABLES AND CONNECTORS • INDUSTRIAL CONNECTORS, FITTINGS AND CONDUIT • ANTENNAS • RADIO COMPONENTS • PLASTICS FOR ELECTRONICS

RADIO MANUFACTURERS:

Resistance cords for dropping line voltage made with highest grade materials to exacting specifications.

Tell us about your requirements and we will be glad to furnish samples and quotations.

THE LEWIS ENGINEERING CO.

WIRE DIVISION—SECTION E
NAUGATUCK, CONNECTICUT, U. S. A.

"ALNICO" PERMANENT MAGNETS

Specializing in the production of highest quality Alnico Magnets in all grades including new triple strength No. 5.

Production material checked to assure highest uniform quality of product.

Castings made to customer's special order on the basis of sketches or blueprints furnished.

Information and suggestions furnished on request.

Manufacturers of High Coercive Magnetic Alloys

GENERAL MAGNETIC CORPORATION

10001 ERWIN AVENUE
DETROIT 5, MICHIGAN

the nomograph in the same manner as before, we find a microphone distance of approximately 3 ft. However, since we are now dealing with a bi-directional microphone we must add a correction factor equal to the square root of G_p, where the latter value is taken as 3. Multiply the distance of 3 feet by the square root of 3 or 1.73, and we have a solo singing microphone distance of 5 to 6 feet. If this microphone distance seems too much for the crooner type of singing, it can be cut down to a lesser value and the microphone level can be mixed in such a way as to compensate for it.

Microphone Energy

In the paper previously mentioned, a formula is given which enables the studio engineer to determine the amount of energy which each microphone must contribute to obtain an overall pleasant listening effect. For an accurate solution to this mixing problem the reader is referred to that article for more details. However, an accentuation microphone mixer setting of approximately 15 db below the general microphone setting is found from experience to be a good ratio. The program producer may adjust around this point to obtain what seems to him a good balance.

To circumvent the fact that microphones have different sensitivities, the producer may resort to a simple practical expedient. First have the orchestra play with only the general microphone in circuit at its normal level and observe program peaks. Now cut out the general microphone, cut in the accentuation microphone and raise the level until the same peaks are observed. From this point it is merely necessary to reduce the gain of the accentuation microphone by approximately 15 db as read on the mixer dial.

This system hsing microphonic disparity is now being used by CBS for the New York Philharmonic Symphony concerts aired each Sunday afternoon from Carnegie Hall. The following values of distance and mixer settings are

used for the various microphones.

Microphone	*L*	*db*
General	21	o (reference)
Violin Accentuation	0.6	−18 to −12
Cello Accentuation	0.6	−18 to −12

The unsolicited response since the change in pickup technic, holds promise that an entirely new dimension in broadcasting has been discovered.

It appears likely that obtaining *liveness* in broadcasting may move some major networks to modify broadcasting technics and carry on further experimentation.

PHOTOGRAPHING WAVES

(*Continued from page 62*)

without the edge-lighted screen is depicted in Fig. 8. Film (a) represents a trace photographed without

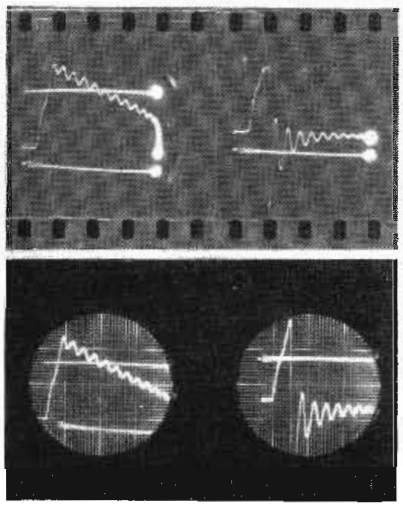


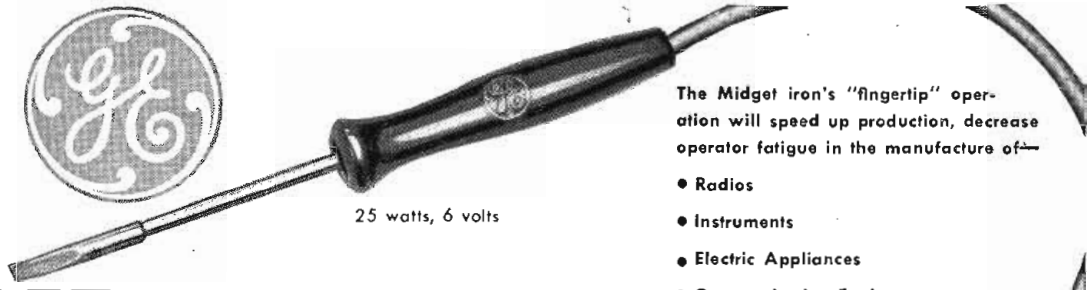
Fig. 8—Comparison between photographs made without (above) and with edge-lighted screen

the edge-lighted screen and film (b) one taken using the edge-lighted screen. It will be observed that practically no reduction in definition of the trace is caused by the edge light. On the other hand the grid is so clearly represented that such characteristics as time to crest may be accurately determined.

Miniature Dry Cells

Dry cell batteries for personal or the miniature camera-type radios are on summer production schedules of the Winchester Repeating Arms Co. division of Olin Industries, Inc., New Haven, Conn. The company is one of the largest producers of flashlight batteries.

NEW GE MIDGET SOLDERING IRON



The Midget iron's "fingertip" operation will speed up production, decrease operator fatigue in the manufacture of—

- Radios
- Instruments
- Electric Appliances
- Communication Equipment

. . . and many other products requiring high-speed, precision soldering.

FOR PIN-POINT PRECISION WITH HANDY, LOW-COST OPERATION

Only 8 inches long . . . weighs less than 2 ounces . . . with 1/8- and 1/4-inch tips! The new G-E Midget soldering iron really "goes places" in those complex, close-quarter assemblies. Its cool, easy-to-grip handle and its feather weight make it as simple to use as a pencil—permitting pin-point precision . . . giving faster, stronger, neater joints.

This new G-E iron combines big-iron performance with midget-iron economy. The famous Calrod* heater is built right into its Ironclad-copper tip—giving a rapid heat flow, delivering a full 25 watts to the work. The Midget soldering iron will do jobs formerly requiring much heavier, higher wattage irons. Only $5.40, list (without transformer).

SEE YOUR LOCAL G-E APPARATUS DISTRIBUTOR TODAY!

*Reg. U. S. Pat. Off.

GENERAL ELECTRIC

675-164

TELEVISION IN YOUR HOME

NOW $159.50 complete

The easy-to-assemble Transvision Kit plus a few hours time gives you a highest quality television set . . . at about **half** the price of the lowest priced set on the market!
Designed by television experts, kit contains **everything** . . . dipole antenna, 7" picture tube, pre-tuned R.F. unit . . . even solder! **Nothing extra to buy.** Only a screw driver and soldering iron needed. Instructions are simple to follow. All complex units are pre-assembled by experts at the transvision factory.

EQUALS HIGH-PRICED SETS IN PERFORMANCE

Perfectly focused, clear picture even in brightly-lit room. Versatile chassis arrangement gives hams wonderful opportunity for improvising and experimenting. Order one now and see the ball games in the comfort of your living room! Factory guarantee. If you wish, handsomely designed, walnut finish cabinet is now available at low cost.

BEACON TELEVISION, Inc.

Distributors for Transvision Television Kits
143 E. 49TH ST., NEW YORK 17, N. Y.

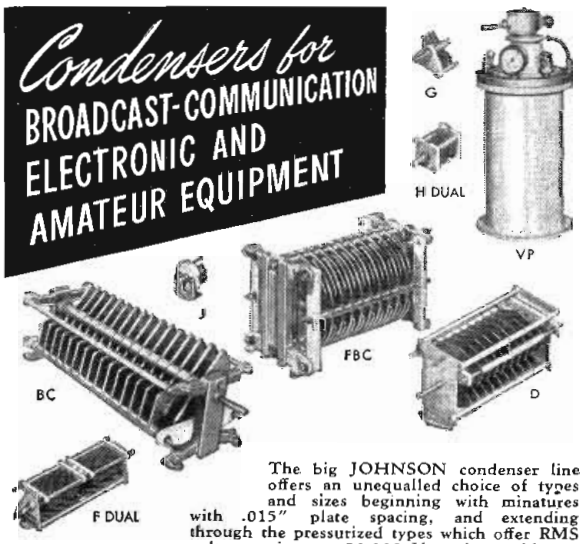
BEACON TELEVISION, INC.
143 E. 49th St., N. Y. 17, N. Y. TT-7

Gentlemen: ☐ I'm interested in your easy-to-assemble Transvision Television Kit. Please send me more information.
☐ Please send me a Transvision Kit at once at $159.50. Enclosed is my check (or money order) for $$25.00 as deposit. Ship it C.O.D., F.O.B. N.Y. and I will pay balance on delivery.

Name..... Street.....

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

Condensers for BROADCAST-COMMUNICATION ELECTRONIC AND AMATEUR EQUIPMENT



New Catalog #969 MG Free on Request. Specific Data furnished separately on larger types.

The big JOHNSON condenser line offers an unequalled choice of types and sizes beginning with minatures with .015" plate spacing, and extending through the pressurized types which offer RMS voltage ratings to 30,000 V. and capacities to 10,000 mmf. Each type is carefully designed by electronic engineers for maximum circuit efficiency. Many exclusive JOHNSON developments such as the heavy, beaded edge plates on commercial types not only increase electrical efficiency, but reduce mounting space, and through the savings in material, lower your costs.

Johnson Products Include

Transmitting Condensers — Inductors — Tube Sockets — R.F. Chokes — Q Antennas — Insulators — Connectors — Plugs and Jacks — Hardware — Pilot and Dial Lights — Broadcast Components — Directional Antenna Equipment.

JOHNSON . . . *a famous name in Radio*
E. F. JOHNSON CO. WASECA, MINNESOTA

SECONDARY-EMISSION TUBE

(*Continued from page 98*)

the supply voltage is adjusted to initiate secondary electron emission. As soon as the secondary emission current starts, it provides a voltage increase to the required value of 150 volts.

The EE50 is particularly recommended for wide-band amplifiers, where the plate impedances are small; e.g., intermediate frequency television stages. The large transconductance, 14000 micromhos, and the internal resistance value of approximately 100,000 ohms permit realization of a large gain with a low plate circuit impedance.

In a Philips television receiver, a high frequency amplifier stage, using an EE50, feeds a converter which is followed by two EE50 tubes as IF amplifiers. The IF output is detected and modulates the cathode-ray tube. This receiver, similar to most European receivers, incorporates comparatively few tubes. Particularly no video amplifier is incorporated. This is made possible by the large IF gain (EE50) and by the fact that European tubes are easily modulated (3 volts peak-to-peak for black to white with the Philips tube MW 22-9 inches).

The secondary emission tubes have other applications. It will be understood that the directions of current variations are of opposite polarity at the secondary-emission cathode and at the plate, while the transconductances are almost equal. By inserting a load in the secondary emission cathode lead, two equal voltages of opposite phase can be derived from the secondary emission cathode load and the plate load. This circuit may be used in push-pull pre-amplifiers.

The EE50 was put on the market in 1938. At this time another tube, the EE51 has been developed and will be available soon; it is similar to the EE50, but its transconductance is equal to 28,000 micromhos.

In Europe secondary emission tubes are frequently used in wide-band receivers. However, their use requires great care and the supply voltages have to be adjusted with precision. Further, because of a high rejection rate at the manufacturer, they are more expensive than conventional tubes.

SURVEY OF WIDE READING

(*Continued from page 68*)

$= 4{,}500$ ohms. Case 2: $RC = 2.17 \times 10^{-5}$; assume $R = 220{,}000$ ohms, then $C = 1080\mu F$ and $C_1 = 4{,}800\mu F$. Equations (7) and (8), see below, are satisfied for both cases.

The ratio of the resistance R to the output impedance R_o of the amplifier should satisfy the inequality:

$$\frac{R}{R_o} \gg \left\{ \frac{2K_1}{4+K_1^2a_1^2} + \frac{1}{4+a_1^2} \right\} \left\{ a_1^2 + a_1^4 \right\} \quad (7)$$

for case 1. The same inequality should hold for case 2 with a_2 substituted for a_1 and K_2 for K_1.

At audio frequencies and for the particular circuit shown in Fig. 1, the load impedance will be determined by the input capacitance, C_{in} of the amplifier tube. The ratio of this input capacitance to the capacitance C should satisfy the inequality:

$$\frac{C_{in}}{C} \ll \frac{K_1a^2}{4+K_1^2a^2} + \frac{2+a^2}{4+a^2} \quad (8)$$

in case 1. The same inequality should hold for case 2 with a_2 substituted for a_1 and K_2 for K_1. Inequality (8) is usually satisfied at audio frequencies. When all network values are found, relations (7) and (8) should be checked.

REGULATED POWER SOURCE

(*Continued from page 65*)

With the filament at a certain operating temperature or, in other words, at a certain plate resistance point on the curve (Fig. 2), assume an increase in resistance in series with the diode. This amounts to the same action, as far as the plate circuit of the diode is concerned, as if the output voltage of the unit had fallen below the pre-set value. The diode then signals the remainder of the circuit to increase the output voltage, and the new point about which the output voltage is stabilized is therefore at a higher value.

Fig. 4 illustrates a commercial Nobatron unit of the type described. Units as large as the 12 volt-15 ampere capacity are contained on a 12¼ in. recessed panel type mounting.

The speed of correction of the Nobatron units is limited only by electronic circuit parameters. The

response time of the diodes, for example, can best be described by the fact that the attenuation of a signal of 20 cycles per second on the filament is approximately 3 db below that of a dc signal. This means that the response time of the control circuit elements is two or three cycles, depending upon the definition of response time which you use and on the magnitude of the upsetting disturbances. Beyond the control circuit elements, the only limiting factor in the case of Nobatron units will be the time constants of the filter circuit on the output of such a unit. This has been minimized by the type of filter construction used at low voltages. The inductive surges which correspond to the relation

$$L \frac{di}{dt}$$

have been reduced to a minimum by reducing the value of the inductance. To do this, a filter is used which will give effective filtering in spite of the restrictions placed on the electrical value of the inductance.

NOTE: Nobatron is Sorensen & Co's trade name for an instrument of the type described in this article.

Bibliography

Langmuir and Mott-Smith: Gen. Elec. Rev., 27 (1924)
Langmuir: Phys. Rev., 7, 302 (1916)
Langmuir: Phys. Rev., 2, 461 (1913)
Jones and Langmuir: Gen. Elec. Rev., 30, 310, 354 (1927)
Jones and Langmuir: Gen. Elec. Rev., 30, 312, 354 (1927)
Langmuir and Blodgett: Phys. Rev., 22, 347 (1923)
Lahgmuir: Phys. Rev., 21, 435 (1923)
Langmuir: Phys. Rev., 2, 450, (1913)

VIDEO SWITCHING SYSTEM

(*Continued from page* 54)

construction, the hermetically sealed components, and the spare fuse mounted in a holder on the front panel.

Now that we have traced through the switchboard video and trigger circuits from input to output, let us consider the performance of these units. Fig. 10 shows a number of measured response curves, made with standard sine wave technic. Curve A is the response of an early model shipboard PPI Repeater, shown here for the purpose of indicating that any signals fed through the switchboard to that particular repeater would suffer more degradation in the repeater circuits than in the distribution network.

Curve B is the response of a

typical video driver amplifier terminated in a 51-ohm resistance load. The 3 db point is in the neighborhood of 9 megacycles, and the general shape of the curve indicates that the value of peaking inductance will provide good transient response with but slight overshoot.

Curves C, D and E show the overall response of a video channel, from radar output to PPI repeater input, measured respectively with 1, 12 and 20 selector switches connected to the driver output. Curve C thus represents a load of approximately 51 ohms and 320 mmf, if we assume 15 mmf for each of the 19 open switches and 35 mmf for the closed switch. In similar fashion it can be calculated that Curves D and E represent loads of 51 ohms and 540 mmf, and 51 ohms and 700 mmf. For Curve E the 3 db point has dropped back to slightly under 6 mc.

Fig. 11 shows some extremely interesting photographs of the transient response of these units, measured by applying a 1/3 microsecond 2-v pulse to the input of the driver amplifier. The photograph labeled "A" is the input pulse. The transition time may be measured as approximately .035 microsecond. The output of the driver amplifier terminated in 51 ohms is shown at B. In this case the amplitude is 4 v, and the transition time may be measured as about .07 microsecond. A slight tendency to overshoot may be observed.

The picture C, at the lower left, was taken at the video driver output when terminated in 51 ohms and 500 mmf, a condition considered representative of normal operation, inasmuch as it is doubtful if more than 10 or 12 repeaters would normally be switched to the same radar. This photograph shows an increase in the amount of overshoot, though not enough to approach the permissible limit of 10%. It may be seen, also, that the transition time has not increased.

The last photograph, labeled "D," represents the 2-volt input to a repeater, with the driver terminated in 51 ohms and 500 mmf, and the repeater line terminated in 75 ohms. This is truly the overall response of the system. The transition time may be taken as approximately .09 microsecond, and the overshoot approximately 7%.

Using one of the generally accepted expressions which relates bandwidth to rise time, or transition time, $\triangle f = \frac{.3}{t}$ we see that the sine wave and pulse measurements are in substantial agreement. For consideration of the lower end of the pass band, there are shown in Fig. 12 some typical tracings of the response to a 60-cycle square wave, taken at the output of the driver, and again at the output of the cathode follower.

Test Methods

In addition to the sine wave and pulse response checks discussed above, there were given the customary continuity checks and high potential tests. A cross-talk test was also made, by feeding 50-volt pulses to the trigger circuits with no signals on the video lines, and looking at the video output terminals with an oscilloscope. Cross-talk was in all cases at least the specified 40 db down. As a practical matter, this is sufficient isolation, inasmuch as maximum trigger signals of 50 volts would produce no more than 0.5 volt on any video line, and a 0.5 volt spurious signal would be covered by the noise on the video line during normal operation.

Reference was made earlier to a vacuum tube voltmeter. This item of test equipment was built into the switchboard, for use in setting gain of the drivers and for general checking of the trigger and video circuits. Due to aging of tubes or other causes the trigger and/or video output voltages frequently fall very close to the outside limits of required specifications, necessitating readjustment of the repeater when it is switched from one channel to another. For example, the mutual conductance of a 6SN7 tube may vary from 3600 to 2400 micromhos and still remain within JAN specifications. Likewise, the mutual conductance of a 6AG7 tube may vary between 14,200 and 9200 micromhos and still be within limits.

For all practical purposes these variations can be eliminated by checking the incoming signals every 24 hours, and adjusting the gain so that every video driver has a 4-v output signal. In this way the entire radar system on a battleship or aircraft carrier may be set up so that a repeater can be switched from one set to another at random without the necessity of making any readjustment. The same thing should be true when a television monitor is switched from one circuit to another, and it would be indeed a pleasure if the same thing were true when a television receiver is switched from one station to another. The vacuum-tube voltmeter circuit diagram is shown in Fig. 13. The unit reads peak-to-peak values by holding negative peaks at ground potentail through one half of a 6H6, and building up a charge equal to the positive peaks on an RC combination. This charge is impressed on one half of a 6SN7 connected as a cathode follower. A second 6H6 connected to the other half of the 6SN7 provides a nice balancing arrangement, and a 0-1 milliammeter connected between the two cathodes of the 6SN7 is calibrated in peak volts. Using this scheme, changes in line voltage will not affect the meter reading.

Another feature of this instrument is the low potential operation of the tubes in order to reduce leakage currents and gas currents. The two 6H6 heaters are operated at 4 volts, while the 6SN7 heater is operated at 5 volts. A third 6H6 operated as a full-wave rectifier furnishes plate voltage to the 6SN7. As in the other units, 100-ohm anti-parasitic resistors are used.

The readings on the meter are correct peak-to-peak values for signals with duty cycles of .01 or greater, dropping to 90% of peak when the duty cycle is .001 and 60% of peak when the duty cycle is .0001.

Another feature of interest is the method of connecting the many coaxial cables entering and leaving the switchboard. In any video system of this kind the importance of good coaxial connections cannot be overstressed. Separate video and trigger line come from each radar, and go out to

each repeater. Note that the clamps serve as a mechanical fastening as well as a ground for the shield. Then, in addition, individual ground leads of braid are carried through to ground terminals spaced between pairs of active terminals. It was found that this arrangement permitted good electrical and mechanical connnections to be made without the expenditure of too many valuable Navy Yard man-hours. Furthermore, later experience showed that this type of connection stood up well under severe service conditions.

Mechanical Construction

There are other general items worthy of note. The mechanical construction of the switchboard emphasizes unit construction which permits withdrawal of selectors, drivers, power supplies, etc., for replacement and service — and which also permits to a considerable degree standardization of sub-assemblies and complete chassis. The spare parts complement can thus be reduced by providing complete units for ready replacement if necessary. As a matter of fact, a good deal of thought was given to keeping the number of required spare parts to a minimum. For example, with a total tube complement of 82, there are but 4 tube types used. As another example, later models of the switchboard were modified to utilize the same type of lamp for pilot lights, as well as control indicating circuits, and to use the same type of combination fuse holder and fuse alarm for all applications.

This video distribution system developed for the U. S. Navy has been presented in brief review, since many of the design features may be applicable to the design and construction of television, video monitoring, and other wide band distribution systems. The solution of this particular problem was in no wise unique. Other circuits, other arrangements of parts, and different design compromises could have been chosen, and yet produced the same results. Certainly an installation of this kind for use on shore, with no control, gyro compass, or antenna bearing circuits involved, would be considerably more impact. It is signifi-

cant though, that since the original installation of the first Radar Distribution Switchboard, and the subsequent installation of many more, there have been few reports from the field. This can be taken to mean that from the standpoint of the users, in this case the men who look at the repeaters, the system has performed satisfactorily without fanfare and yet without failure.

REFERENCES

1. Luminescence and Tenebrescence as Applied in Radar. Leverenz—RCA Review—June, 1946.
2. Radar. Schneider—IRE Proceedings—August, 1946.
3. MPG-1 Radar. Electronics—December, 1945.
4. Surface Search Radar. Electronic Industries—November, 1945.
5. Synchro Controls for Meters and Servos. Electronic Industries—September, 1945.
6. Analysis and Design of Video Amplifiers. Seeley & Kimball—RCA—Review—January, 1939.
7. Television Receiving Equipment. W. T. Cocking—Nordeman Publishing Co.
8. Transient Response. Kallmah, Spencer & Singer—IRE Proceedings—March, 1945.
9. Transition Time and Pass Band. Eaglesfield—IRE Proceedings—February, 1947.
10. Cathode Follower Circuits. Schlesinger—IRE Proceedings—December, 1945.

COWLES PROPOSED TOWER

(*Continued from page 74*)

ture is entirely feasible but that before a design can be started a down payment of $40,000 will be necessary.

If and when erected, the tower would be used by station KRNT and it is expected would permit a service range up to 120 miles. Cowles already is the owner of another tall tower, the 927 ft. radiator of AM Station WNAX in Yankton, South Dakota.

Wilmotte Leaves New York

Raymond M. Wilmotte, Inc., consulting engineers on radio and electronics applications, has closed its New York office. Henceforth, all business will be transacted from the company's Washington address at 1469 Church Street, N.W.

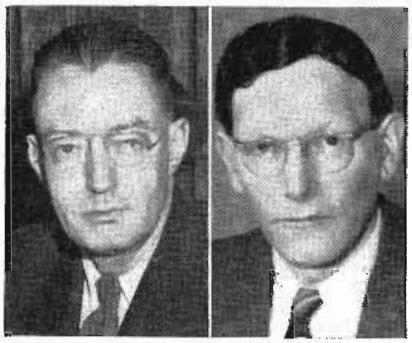
Raytheon Consolidates

Raytheon Mfg Co., Waltham, Mass., has formed a Commercial Products Division to include the broadcast equipment division, recently transferred from Chicago to the home plant and what was formerly known as the industrial electronics division. Consolidation of the former separate divisions and departments has been made in order that full advantage can be taken of Raytheon's production and engineering facilities located at its Waltham plant.

PERSONNEL

Dr. Stephen J. Zand has been elected vice-president in charge of engineering for the Lord Mfg. Co., Erie, Pa. He has been consulting vibration engineer for Lord since 1933, henceforth will devote his full time to the job.

L. M. Temple has been appointed chief engineer of the battery division of the Winchester Repeating Arms Division of Olin Industries, Inc. He goes to Winchester from Raytheon where he was head of the Minitronics division, was previously chief engineer of the Eveready division of National Carbon Co.



L. M. Temple E. F. Cahoon

Edward F. Cahoon has rejoined TelAutograph Corp., New York, after a stretch of five years as a development engineer on Navy projects, and been appointed chief engineer. He had previously been associated with TelAutograph.

Joseph H. Gillies has been elected vice-president of Philco Corp., Philadelphia, and will have charge of radio production. **Robert F. Herr** was elected vice-president in charge of the company's service division.

James F. White, previously associated with Hazeltine, the New Haven railroad and the W. L. Maxson Corp., in engineering capacities, has been made assistant sales manager of the Andrew Co., Chicago. During the war he was a project engineer at MIT Radiation Labs.

A. D. Heller has been appointed chief mechanical engineer of the United States Television Mfg. Corp.,

New York. He was formerly with Telecommunications Labs and the General Electric Co.

Charles Rinderle, Jr., has been made executive vice-president and general manager of Eastern Air Devices, Inc., Brooklyn, N. Y. He has been secretary and treasurer of the company, was formerly affiliated with Bendix Aviation Corp.

Harry F. Mickel has joined the radio engineering products division of Raymond Rosen & Co. as engineering sales manager. Associated with RCA Victor for 21 years, Mickel served in the capacity of manager of the communications equipment section in Camden, N. J.

Royal V. Howard, chief engineer of KSFO, San Francisco, has been appointed director of engineering of the National Assn. of Broadcasters. He joins NAB after 14 years with the Associated Broadcasters, Inc., licensee of KSFO, KSFO-FM, television station KWIS and international broadcast stations KWID and KWIX. He is a director of Universal Research Laboratories, engineering consultants.

BULLETINS

SPECIAL PURPOSE GEARS

A 4-page bulletin showing some of the steps in the manufacture of medium and small-size spur, helical or straight bevel gears in fine and extra-fine pitches has been issued by Beaver Gear Works, Inc., 1025 Parmele St., Rockford, Ill. The back of the bulletin contains a table of gear tooth parts having a pitch from 30 to 200.

CAPACITORS

Specifications for a wide variety of capacitors for industrial electronic use are summarized in a 4-pg. catalog issued by Chicago Condenser Corp., 3255 West Armitage Ave., Chicago 47, Ill. Listed types include tubular paper capacitors, vacuum type bath tub, transmitting and industrial oil capacitors, and various generator and ignition type units.

TUBE REFERENCE DATA

A condensed 8-pg. catalog listing Amperex electronic tubes, and giving their general ratings and characteristics has been issued by Amperex Electronic Corp., 25 Washington St., B'klyn., New York. The reference guide includes a wide variety of radio and industrial amplifiers, oscillators, rectifiers, electro-medical, amateur, an special purpose types. Maximum plate ratings, frequency, filament ratings, mu, and g_m are given for each type. Also included are two types of vacuum condensers.

Mellen Heads Weston

A number of changes have been made in the executive personnel of the Weston Electrical Instrument Corp, Newark, N. J. Edward F. Weston, son of the founder of the company and its president for many years, becomes chairman of the board; president Caxton Brown has been made chairman of the executive committee and the new president is Earl R. Mellen, who since 1944 has been executive vice-president and treasurer. Other changes involve John H. Miller, who becomes vice-president and chief engineer; H. Leigh Gerstenberger, vice-president in charge of sales; Reginald R. Lambe, vice-president in charge of manufacturing; Ross Nichols, secretary and treasurer; and F. G. Hawthorne, comptroller and assistant secretary.

Warner Heads ICAO

Dr. Edward Warner, largely responsible for the organization of the Provisional International Civil Aviation Organization (PICAO) and latterly its president, has been elected president of the Council of the International Civil Aviation Organization (ICAO) successor to the former body. At the same time, Dr. Albert Roper was appointed secretary-general of ICAO.

Sola's Own Home

Sola Electric Co is now housed in its own building in Chicago. The new plant is located at 4633 West 16th Street. The company is a manufacturer of transformers for constant voltage applications, luminous tube signs, etc.

TELE-TECH

Advertisers, July 1947

While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.

NAB Tops 1300

Membership in the National Association of Broadcasters has increased 100% since January 1, 1945. At the present time the total roster adds up to 1301.

Sound Apparatus Moves

Sound Apparatus Co. has moved into its production plant at Stirling, N. J. Main office remains at 233 Broadway, New York. Research laboratories are maintained at Millington, N. J. The company makes graphic level recorders for acoustical and electrical measurements.

Electrical Engineers Elect

Blake D. Hull, chief engineer, Southwestern Bell Telephone Co. St. Louis, Mo., was elected president of the American Institute of Electrical Engineers at the annual meeting of the Institute held in Montreal, June 11. The other officers elected were: Vice-Presidents G. W. Bower, Haddonfield, N. J., J. H. Berry, Norfolk, Va., I. M. Ellestad, Omaha, D. I. Cone, San Francisco, D. G. Geiger, Toronto, Directors, W. L. Everitt, Urbana, Ill., A. C. Monteith, East Pittsburgh, Elgin B. Robertson, Dallas; Treasurer, W. I. Slichter.

Speedx to Johnson

E. F. Johnson Co., Waseca, Minn. has taken over production of the Speedx line of telegraph keys from the Les Logan Co., San Francisco.

DRIVER-HARRIS

Your dependable source for

Wire and Ribbon Resistor and Radio Alloys

FOR RESISTANCE

There are Driver-Harris Alloys for every electrical resistance requirement. Most widely used are:

. . . **Nichrome*** and **Nichrome* V**, for winding large value resistors where overall size is limited, but dependability is a must.

. . . **Manganin**, when specifications require fixed stability and constant resistance under normally variable operating conditions; examples being precision bobbins, potentiometers, National Bureau of Standards type resistance standards.

. . . **Advance***, most frequently specified for precision resistors in electric *meters and laboratory testing devices, because in its finer sizes it has a* temperature coefficient of only ±.00002/°C.

. . . Plus a total of more than 80 *electrical heat and corrosion-resistant* alloys which singly, or in combination fill any electrical resistance specifications.

FOR RADIO

Always abreast of the latest developments in radio metallurgy, Driver-Harris has been headquarters for Radio Alloys since the earliest days of the industry. In greatest demand are:

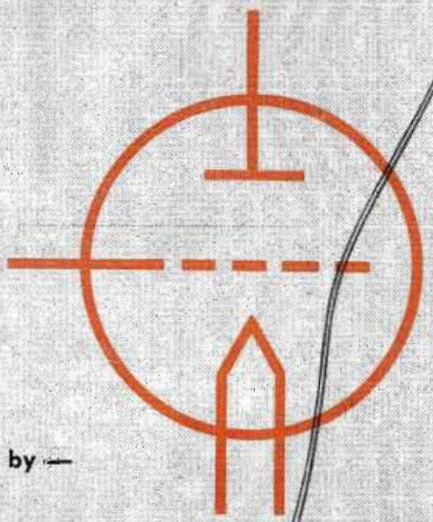
. . . **Nickel and Nichrome***, for plate strip. Thin but rigid, they take a tightly adhering heat radiation coat.

. . . **Filnic* Alloys**, in both fine wire and ribbon, take a tightly adhering oxide coat. They are spooled and packed with unusual care to assure retention of original properties in transit.

. . . **Gridnic* Alloys**, having a very low electron emission — especially suitable in tubes where back-emission is involved.

. . . **Cathode Sleeve Material**: special melted Nickel Alloys to meet any emission requirements.

Other widely accepted D-H Alloys, meeting or exceeding most radio specifications are: *Nilvar**, *#42 Alloy*, *#52 Alloy*, and *Nickel "A", "D", "E", "Z"*.



For efficiency and dependability —
Specify Electrical Resistance and Radio Alloys by —

Driver-Harris COMPANY

HARRISON • NEW JERSEY

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

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

For compactness PLUS maximum performance... design around RCA Miniatures

RCA Miniatures offer the engineer a wider latitude in equipment designs for all services where light weight and compactness are necessary or desirable features. And RCA has complements for virtually all applications.

MIDGET SETS
RCA Miniatures permit closer spacing of components on a smaller chassis. They are the equal of larger, comparable tube types in performance.

AUTO SETS
RCA Miniatures make feasible the design of small two-unit receivers for dashboard mounting with greater installation flexibility. Audio outputs up to 10 watts can be obtained.

TELEVISION SETS
RCA Miniatures have already accounted for a reduction of 60 per cent in chassis area, thus permitting the design of more compact models.

FM SETS
For the FM bands, RCA Miniatures have the additional advantage of providing performance superior to metal and glass types because of their lower inter-electrode capacitances, reduced lead inductance, and low-loss, button-stem bases.

COMMERCIAL AND BUSINESS EQUIPMENT
The compactness gained by using RCA Miniatures is accompanied by a proportionate reduction in weight . . . a matter of considerable importance in the design of business machines and mobile communications equipment.

RCA TUBE APPLICATION ENGINEERS will be pleased to consult with you on the utilization of RCA Miniatures in designs you now have under consideration. For further information write RCA, Commercial Engineering, Section R63G Harrison, New Jersey.

RCA Laboratories, Princeton, N. J.

THE FOUNTAINHEAD OF MODERN TUBE DEVELOPMENT IS RCA

TUBE DEPARTMENT

RADIO CORPORATION of AMERICA

HARRISON, N. J.