COMMUNICATIONS

$1.00

INCLUDING "RADIO ENGINEERING" AND "TELEVISION ENGINEERING"

JUNE ★ U-H-F/S-H-F VARIABLE-TUNING SYSTEMS ★ HIGH POWER TUBES FOR V-H-F 1946

★ PREVENTIVE MAINTENANCE FOR BROADCAST STATIONS

LITTLE COMPONENT*

HUGE SUCCESS

... THANKS TO

MYCALEX

THE "PERFECT" LOW LOSS INSULATION

The problem was to mold insulating material of exceptionally low loss factor and high dielectric strength into a closely integrated bond with a metal insert of high conductivity. The difficulty was acute, for both materials had to have virtually the same coefficient of expansion in order to insure an efficient electrical and mechanical seal. High resistance to arcing in the insulator was also imperative. It had to be moisture-proof and heat-resistant.

MYCALEX 410 (Molded Mycalex) proved to be the only solution after many other insulators had been tested and rejected . . . because MYCALEX has the ideal combination of electrical and mechanical properties for today's high frequency applications.

Have you a problem involving the sealing of highest type insulation with metal? Are your specifications particularly exacting? More than 25 years of leadership in solving the toughest high frequency insulating problems make MYCALEX a "natural" to solve yours. Our engineers will be pleased to cooperate.

*PANEL JACK

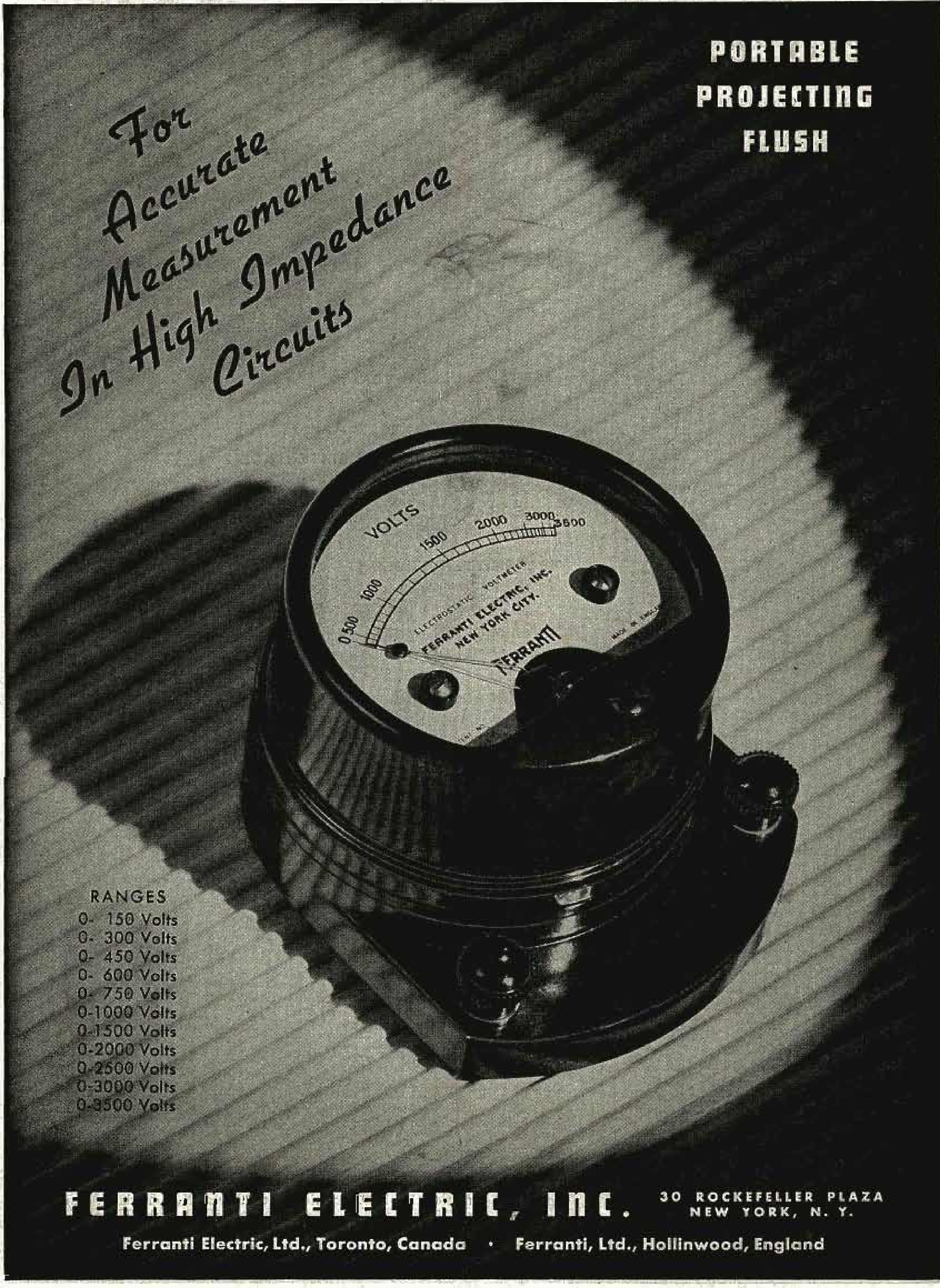
SINCE 1919 MYCALEX THE INSULATOR TRADE MARK REG. U. S. PAT. OFF.

MYCALEX CORPORATION OF AMERICA

"Owners of 'MYCALEX' Patents"

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

ELECTROSTATIC VOLTMETER



LEWIS WINNER, Editor

F. WALEN, Assistant Editor

We See...

BROADCAST STATION-CONSTRUCTION activity, which has been gradually increasing, is expected to hit its stride in the late summer. The CPA ruling, which many expect to be modified this Fall, is not expected to interfere with too many of the new and improved station-construction plans. Wartime temporary building conversion methods, that have already solved housing problems of many broadcasters, are being adopted throughout the country. Rehabilitated farm houses, camp sites and wartime temporary buildings have now become transmitting homes.

While many of the f-m sites have been difficult to find because of the unusual heights required for the f-m antennas, engineers have managed to find the necessary spots.

Construction activity is not only keen in the a-m field, but in f-m and television, too. Constructional approvals are now being granted to metropolitan, rural and community f-m stations, with powers ranging from 250 watts to 30 kilowatts, and installations are proceeding in many cases. Incidentally, the metropolitan stations will hereafter be in the Class *A* group and the rural and community stations will be in Class *B*, according to a new FCC proposal, which also recommends an increase in the power of the community stations from 250 watts to 1 kilowatt.

WITH WIDE-RANGE HIGH-FIDELITY gaining wider and wider prominence, audio facilities are receiving particularly careful attention, not only in studio design, but in equipment, too. Broadcasters are adopting many new concepts of acoustics and employing wide-range recording and modulation control equipment to assure them of the maximum high fidelity. Studio and recording background noises are scheduled to really disappear in the new type studios.

With the new postwar high-fidelity sets entering the home now, prewar f-m and a-m high-fidelity-type broadcasters now on the air are finding that they must dispense with prewar shellac recordings and their comparatively narrow-range recording equipment if they are to retain their high-fidelity audiences.

ENGINEERING CONFERENCES DURING THE MONTH OF OCTOBER have now increased to *five*. The National Electronic Conference is scheduled for October 3rd, 4th and 5th and will be held in Chicago; Television Broadcasters Association will hold their conference in New York on October 10th and 11th; a National Electronics Exhibition will be on display at the Grand Central Palace in New York from October 14th to the 19th; NAB will hold their meeting in Chicago from October 21st to the 23rd, and APCO will meet in Buffalo from October 28th to the 30th. In addition, the month of October will also feature the usual engineering sectional meetings and quite a few special demonstrations. Looks as if October will be the engineering conference month of the year!—L. W.

COMMUNICATIONS

Including Television Engineering, Radio Engineering, Communication & Broadcast Engineering, The Broadcast Engineer. Registered U. S. Patent Office.
Member of Audit Bureau of Circulations.

JUNE, 1946 VOLUME 26 NUMBER 6

COVER ILLUSTRATION

New York City police public address truck in action.
(Courtesy Three Lions)

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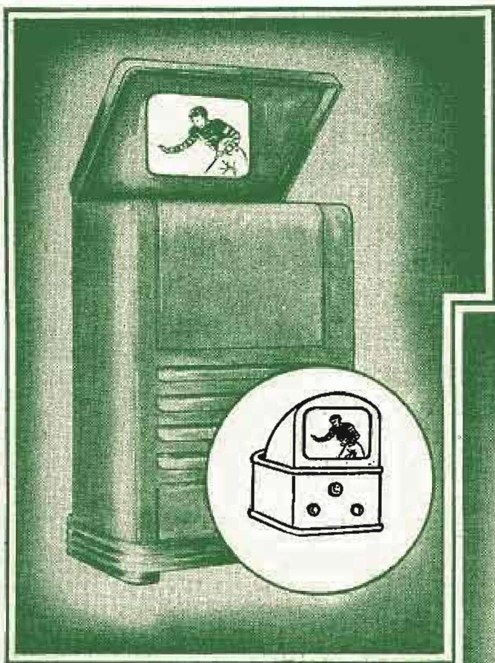
SYLVANIA NEWS

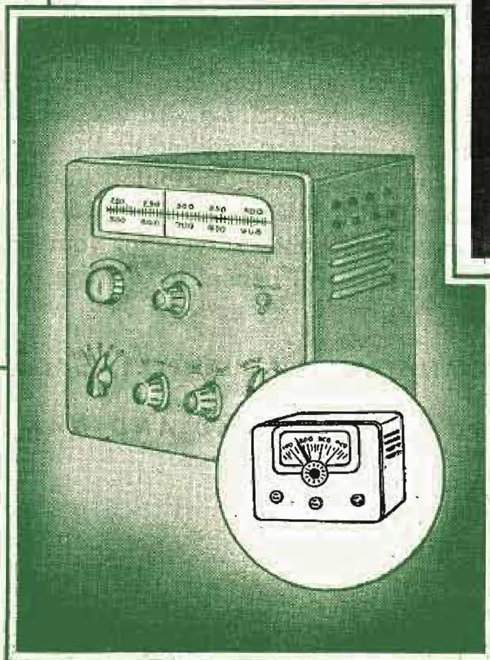
CIRCUIT ENGINEERING EDITION

JUNE • *Prepared by* **SYLVANIA ELECTRIC PRODUCTS INC., Emporium, Pa.** **1946**

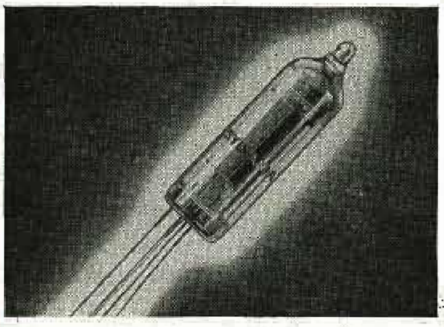
RUGGED ELECTRONIC TUBE TINY ENOUGH TO REVOLUTIONIZE DESIGN OF RADIO RECEIVERS AND OTHER EQUIPMENT



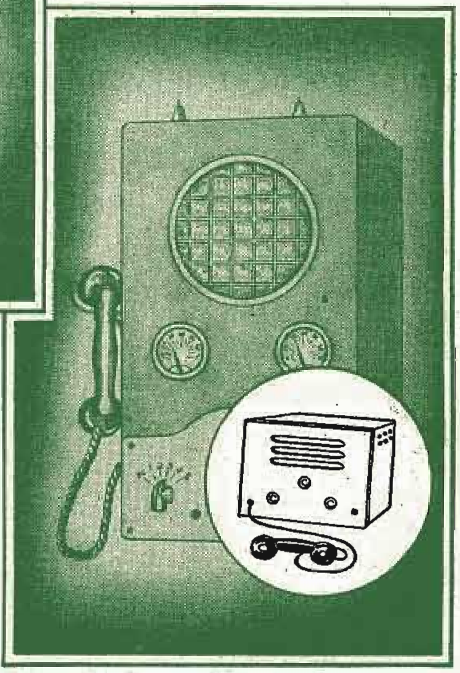
More compact television receivers will be made possible by the T-3.



Weight-saving features of the T-3 will be of special value in air-borne equipment.



The T-3 tube is shown here in its actual size.



Equipment for motor boats and yachts can be made smaller and lighter.

Much Smaller Sets Possible

Radical reductions in the size and weight of many types of electronic equipment are seen as a distinct possibility arising from Sylvania Electric's development of the extremely small T-3 tube. The T-3 is the commercial version of the peanut-sized electronic tube of proximity fuze fame.

Tiny as it is, the T-3 tube is characterized by exceptional ruggedness. It has a life of hundreds of hours, and is ideally suited for operation at high frequencies.

Savings in Space and Weight

The small size of the T-3 contributed directly to compactness and lightness in the design of radio and television receivers and other types of electronic equipment. Other features of the tube make possible still further reductions in space and weight.

Range of Applications

The design possibilities opened by the T-3 are naturally of greatest interest in the case of portable and air-borne equipment. However, its potentialities are not limited to these fields. *Write Sylvania Electric Products Inc., Emporium, Pa.*

SYLVANIA ELECTRIC

Emporium, Pa.

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

Something New HAS BEEN ADDED TO IRC DISTRIBUTOR SERVICE . . .

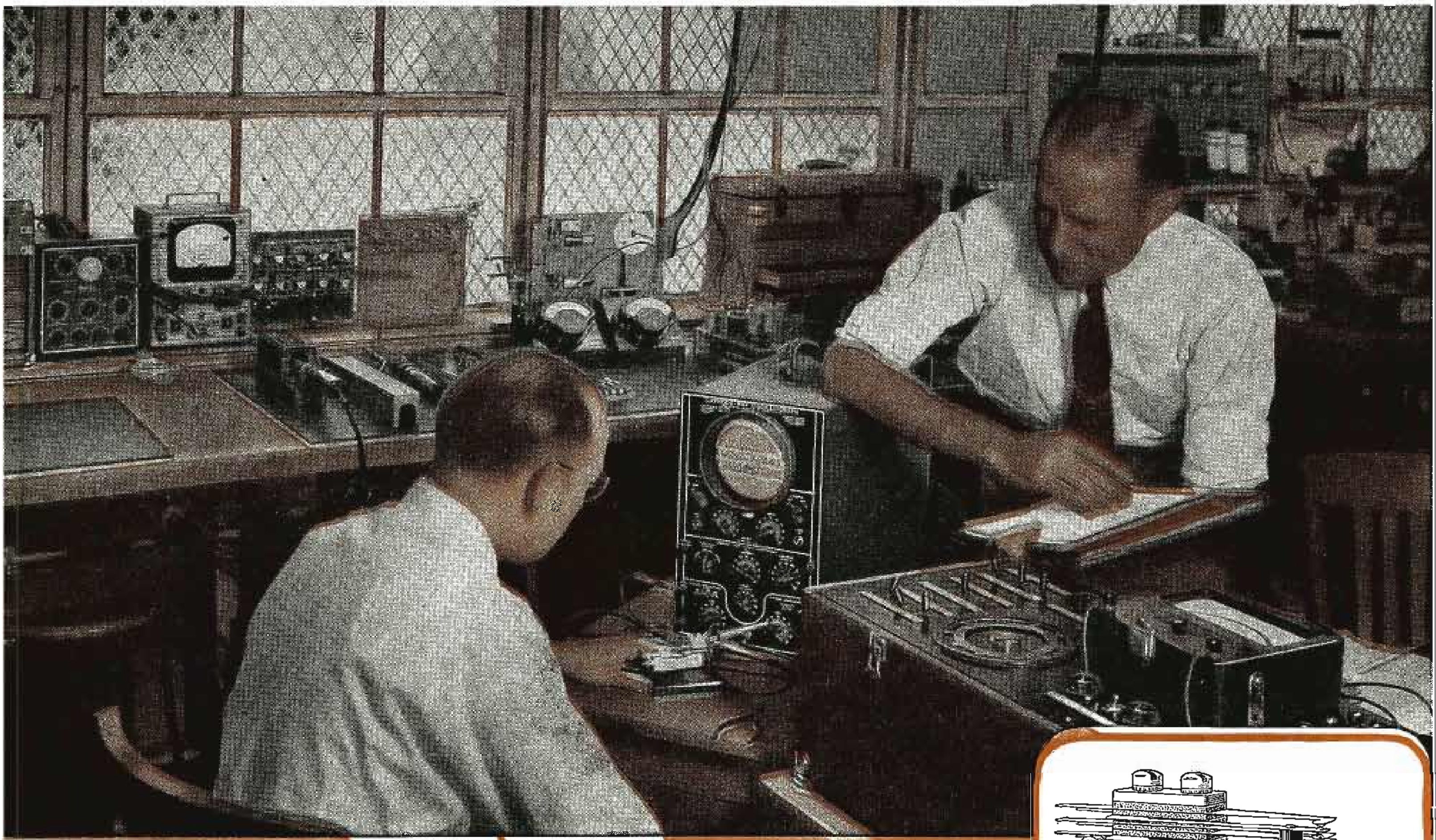
NEW INDUSTRIAL SERVICE PLAN GIVES YOU QUICK DELIVERIES ON STANDARD RESISTORS!

Now, IRC Distributors are better prepared than ever before to give manufacturers quick, complete and intelligent service. The IRC Industrial Service Plan, developed by IRC in cooperation with its more than 300 distributors, gives you "just around the corner" sources of supply for the resistance units you need in experimental work, pre-production models, pilot runs, smaller production runs and for service and maintenance!

The IRC Catalog #50 lists standard IRC products stocked by distributors. By aiming toward standardization of your resistor requirements on these items, you will find that reasonable quantities can be delivered quickly by local distributors. In addition, the wider use of standardized items will eventually result in lower unit cost, it will provide better emergency service for your products when in use, and your customers will benefit by a more dependable piece of equipment.

FOR BETTER-THAN-STANDARD QUALITY . . . *Standardize on IRC*

WRITE TO DEPT. 8-F FOR IRC CATALOG #50 AND NAMES OF LOCAL DISTRIBUTORS



It's What's Behind CLARE RELAYS That Keeps Them in Front

● Clare Relay engineers have "thrown away the book." They are not restrained in their relay designs by hidebound ideas, outmoded methods.

From this modern equipped research laboratory, pictured above, come the forward looking Clare "Custom-Built" Relays that free design engineers from old-time relay limitations.

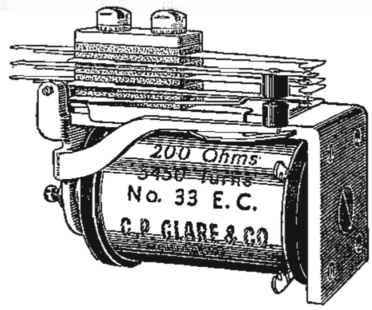
Products of a progressive company, entirely devoted to making relays to meet the most exacting applications, Clare "Custom-Built" Relays encourage engineers in every branch of industry to count on the flexibility of Clare Relays and the skill of Clare engineers to provide unusual, new, and improved features to meet every requirement.

Do you want smaller, more compact construction to fit into streamlined equipment? Is your need for more efficient operation . . . ability to withstand unusual vibration . . . new and different electrical characteristics? Look to Clare for all these things . . . and more.

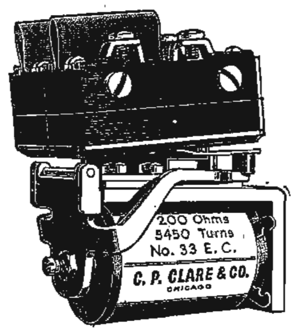
Clare Sales Engineers are located in all principal cities to help with your relay problems. The Clare Engineering Data Book will be mailed at your request. Address: C. P. Clare & Co., 4719 W. Sunnyside Avenue, Chicago 30, Illinois. Cable address: CLARELAY.

CLARE RELAYS

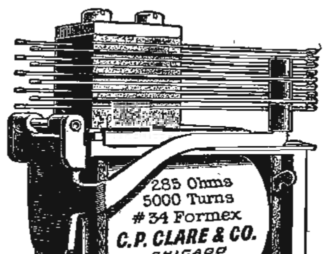
"Custom-Built" Multiple Contact Relays for Electrical and Industrial Use



This Clare Type "G" d.c. Relay is a relay for the spot where inches and ounces count. Measures 2½" long.



Clare Type "GMS" Relay uses standard Type "G" frame for operation of one or two snap-action switches.



The Clare Type "GAC" Relay gives an equally compact relay for a.c. operation. Design permits very quiet operation.

UTAH POLICE NOW ON THE *Motorola* PARTY LINE

FROM COAST TO COAST IT'S *Motorola*

Typical Motorola transmitting and receiving unit as installed for Miami Police Department.

HIGHWAY POLICE OF 34 STATES AND OVER 1000 COMMUNITIES NOW USE *Motorola* 2-WAY F-M RADIOTELEPHONE

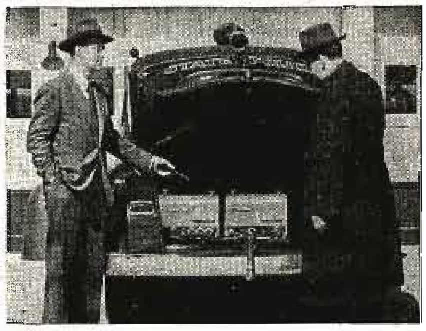
● When the Utah Highway Patrol turned to Motorola F-M Radiotelephone, the total of states using Motorola equipment was raised to 34. From coast to coast and beyond, to Hawaii and the Canal Zone, Motorola is overwhelmingly the number one choice for emergency radio communications.

THERE MUST BE A REASON!

EASY TO OPERATE—No technical knowledge of radio-electronics is necessary. Any police officer can use the Motorola Radiotelephone *without special training*.

EFFICIENT—The outstanding range and power of Motorola F-M Radiotelephone enables patrols to maintain contact at distances up to fifty miles.

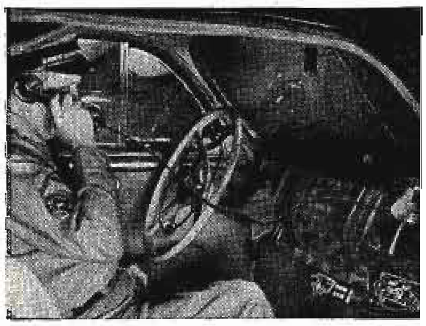
DEPENDABLE—The Motorola Radiotelephone is made by the makers of the battle-famous "Handie Talkie" and "Walkie Talkie," your guarantee that your Motorola Radiotelephone will deliver *all* the time under *all* conditions.



A standard mobile transmitting and receiving unit in use by Michigan State Police.

IN YOUR DEPARTMENT, TOO . . .

Motorola Radiotelephone has proved itself in thousands of difficult applications. Check with Motorola Engineers and let them show you how Motorola can solve your communications problem. Write today for specific recommendations—no obligation.



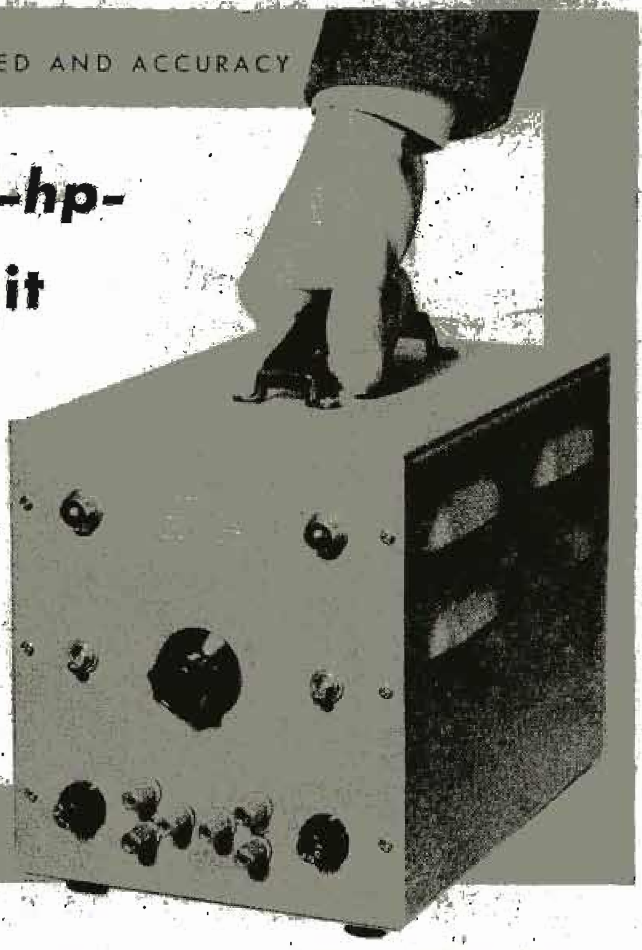
A California State Patrolman checks with the station via Motorola Radiotelephone.

GALVIN MFG. CORPORATION • CHICAGO 51
COMMUNICATIONS AND ELECTRONICS DIVISION

F-M & A-M HOME RADIO • AUTO RADIO • AUTOMATIC PHONOGRAPHS • TELEVISION • "HANDIE TALKIES" • POLICE RADIO • RADAR

LABORATORY INSTRUMENTS FOR SPEED AND ACCURACY

A New Versatile -*hp*- Power Supply Unit



- **Portable**
- **Compact**
- **Light Weight**
- **1% Regulation**
- **Low Cost: $75.00**

New -*hp*- Model 710A

With good regulation, light weight and small physical size, the new -*hp*- Model 710A Power Supply is now available at the exceptionally low price of $75.00. Every laboratory and production department will find hundreds of uses for this versatile power source. The low cost makes it practical and economical to utilize several of them.

RANGE 180—360 VOLTS

The -*hp*- Model 710A Power Supply will deliver any required voltage between 180 and 360 volts, with less than 1% variation for output currents of from 0 to 75 ma. (Maximum current is 100 ma).

Line voltage variations of ± 10% cause less than 1% change in output voltage.

Since total noise and hum output is less than .005 volts for any condition of operation, the -*hp*- Model 710A may be used to supply low-level, high-gain amplifier stages without the necessity of additional filtering.

6.3 FILAMENT VOLTS

Either positive or negative terminal may be grounded to provide maximum flexibility. To increase its usefulness even more, the -*hp*- Model 710A supplies up to 5 amps at 6.3 volts AC for heating filaments. Either terminals or center-tap may be grounded.

These features, combined with its compact portability, make the -*hp*- Model 710A the ideal power supply for general use. It can simplify your equipment problem tremendously. Get your order in early for immediate delivery.

SPECIFICATIONS

Supplies any DC voltage between 180 and 360

Either positive or negative terminal may be grounded

Small size, consumes a minimum of bench space

Holds DC voltage constant from 0 to 75 ma load

Holds DC voltage constant with ± 10% change in line voltage

Low AC ripple output

Low cost . . . $75.00

HEWLETT-PACKARD COMPANY

BOX 1198E • STATION A • PALO ALTO, CALIFORNIA

Audio Frequency Oscillators · *Signal Generators* · *Vacuum Tube Voltmeters* · *Noise and Distortion Analyzers* · *Wave Analyzers* · *Frequency Meters* · *Square Wave Generators* · *Frequency Standards* · *Attenuators* · *Electronic Tachometers*

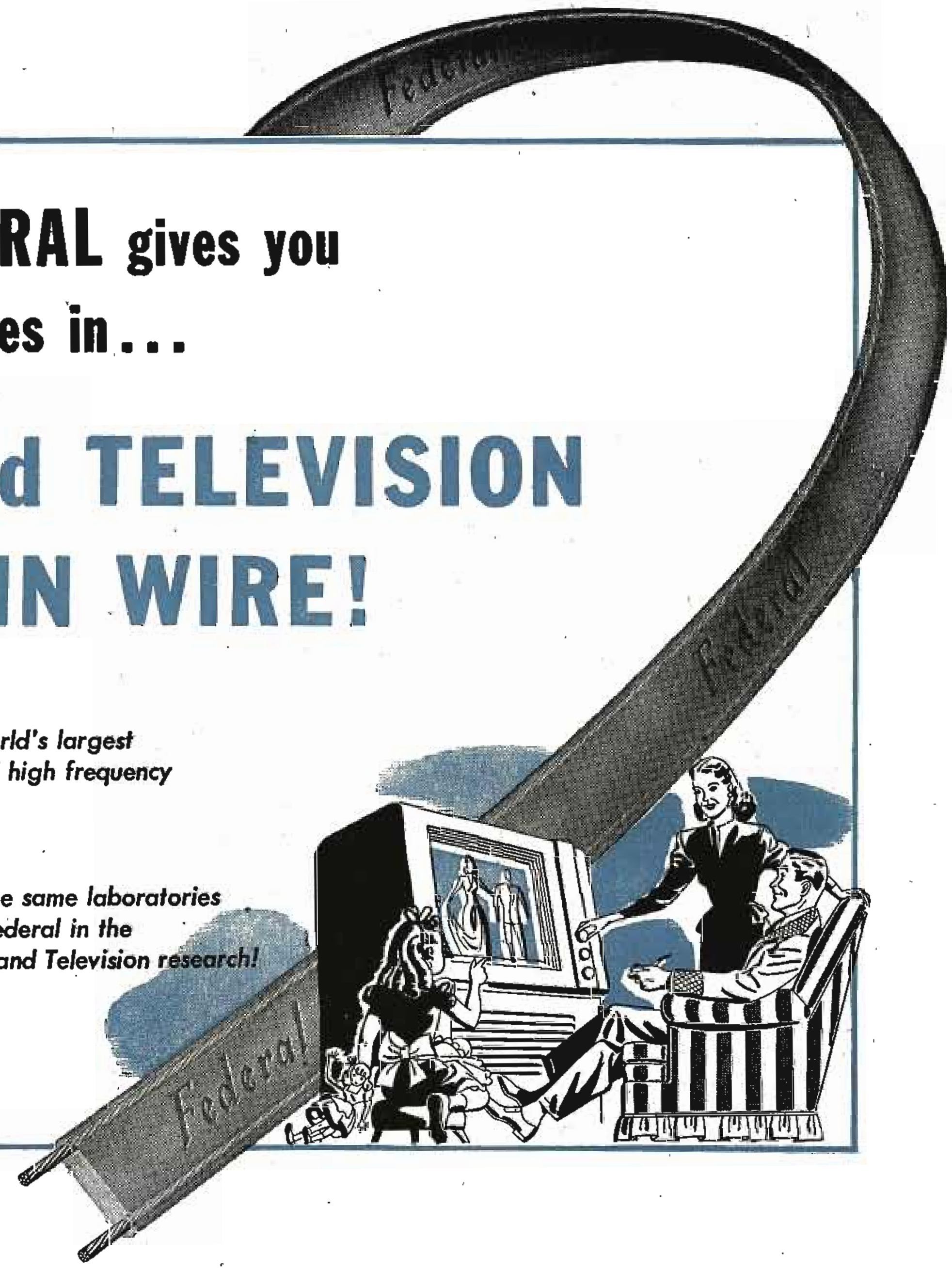
1198

Only FEDERAL gives you 2 plus values in...

FM and TELEVISION LEAD-IN WIRE!

1. *Produced by world's largest manufacturer of high frequency cable!*

2. *Engineered in the same laboratories that have put Federal in the forefront in FM and Television research!*



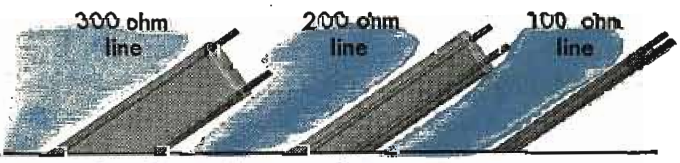
FEDERAL'S high frequency cable is *really engineered* for low-loss signal transmission from antenna to receiver . . . the product of years of experience in FM and Television.

It's a solid, polyethelene insulated type . . . resisting water, acids, alkalies, oils . . . won't embrittle or age in sunlight. It retains flexibility in sub-zero temperatures; and dimensional precision even in hot weather. Elliptical cross section enables it to withstand twisting and abrasion—eliminates any moisture conduction path.

Federal's lead-in cable is available to you now, in various sizes. Write for complete details.

Federal lead-ins have dual, stranded conductors. Characteristic impedance for commercial telecasts is 300 ohms—capacity per foot is 5 mmf.

Other types produced for special applications and experimental work have characteristic impedances of 200 and 100 ohms.



Federal Telephone and Radio Corporation

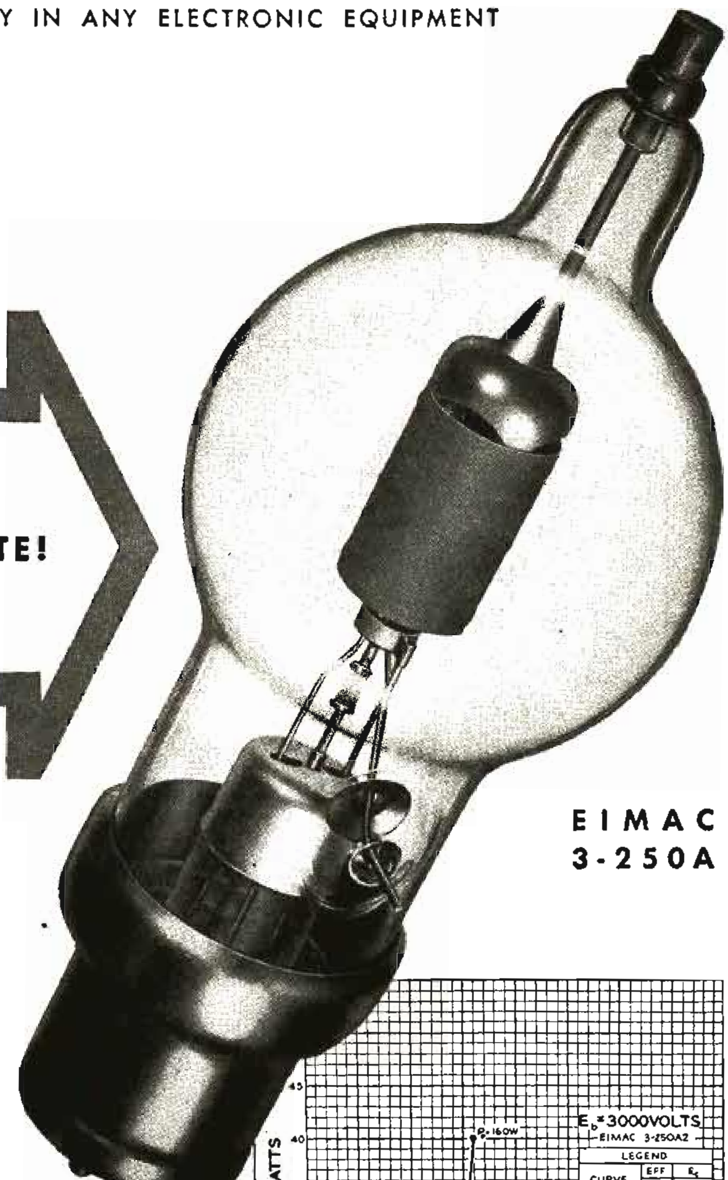
Export Distributor:
International Standard Electric Corporation

Newark 1, New Jersey

THE COUNTERSIGN OF DEPENDABILITY IN ANY ELECTRONIC EQUIPMENT

NEW ELEMENTS IN THIS EIMAC TRIODE ADD MANY EXTRA HOURS PERFORMANCE

NEW NON-EMITTING GRID!
NEW LOW-TEMPERATURE PLATE!
NEW FILAMENT STRUCTURE!



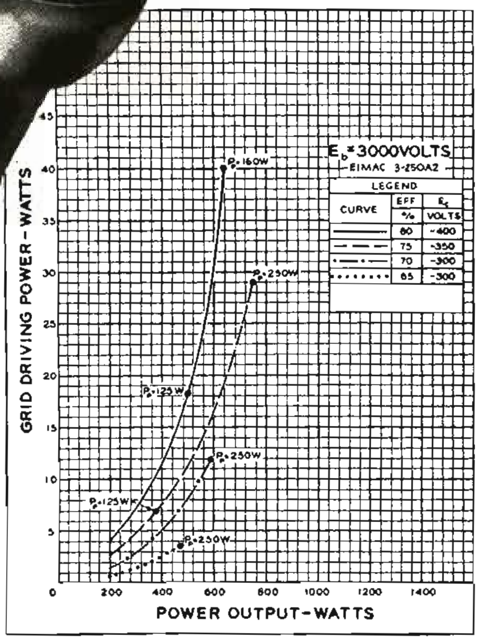
EIMAC 3-250A

Physically the new Eimac 3-250A triode is interchangeable with the old Eimac 250T. The new elements result in better performance and even longer life in a tube that has long been famous for its long life and stamina. This new tube is available in both low mu (3-250A2) and high mu (3-250A4) tube versions.

Its outstanding performance characteristics are exemplified by its low driving power requirements. For example, in R. F. Class C telegraphy, with 3000 plate volts on a single tube, the Eimac 3-250A2 (low mu) will deliver 750 watts output with only 29 watts (approx.) of driving power. (See chart.)

You can depend upon Eimac year in and year out for leadership in vacuum tube developments.* That's one reason why Eimac tubes are today, and have been for years, first choice of leading electronic engineers throughout the world.

**Ask your dealer to give you a copy of "Eimac Electronic Products" just off the press. Or write direct.*



Follow the leaders to

Eimac TUBES

EITEL-McCULLOUGH, INC., 1211-H San Mateo Ave., San Bruno, California

Plants located at: San Bruno, Calif. and Salt Lake City, Utah

Export Agents: Frazar and Hansen, 301 Clay St., San Francisco 11, California, U.S.A.

CALL IN AN EIMAC REPRESENTATIVE FOR INFORMATION

ROYAL J. HIGGINS (W9A10)...600 South Michigan Avenue, Room 818, Chicago 5, Illinois. Phone: Harrison 5948.

V. O. JENSEN, General Sales Co., 2616 Second Avenue, Seattle 1, Washington. Phone: Elliott 6871.

M. B. PATTERSON (W5C1)... 1124 Irwin-Kessler Building, Dallas 1, Texas. Phone: Central 5764.

ADOLPH SCHWARTZ (W2CN)...220 Broadway, Room 2210, New York 7, New York. Phone: Cortland 7-0011.

HERB BECKER (W6QD)... 1406 So. Grand Avenue, Los Angeles 15, California. Phone: Richmond 6191.

TIM COAKLEY (W1KKP)...11 Beacon Street, Boston 8, Massachusetts. Phone: Capitol 0050.

ELECTRICAL CHARACTERISTICS

	3-250A2	3-250A4
Filament: Thoriated tungsten		
Voltage	5.0 volts	5.0 volts
Current	10.5 amperes	10.5 amperes
Amplification Factor (Average)	14	37
Direct Interelectrode Capacitances (Average)		
Grid-Plate	3.1 uuf	2.9 uuf
Grid-Filament	3.7 uuf	5.0 uuf
Plate-Filament	0.7 uuf	0.7 uuf

Techniquality

Every product that enjoys the full confidence of those who use it has its "priceless ingredient." In Bliley crystals it's "techniquality."

Cutting, grinding, and finishing alone do not transform raw quartz into a sensitive frequency control device. Behind these operations there must be a background of technical skill and creative engineering that is gained only through years of experience.

Bliley crystals have a reputation for "techniquality" that started fifteen years ago. Today, the fact that Bliley crystals are used in practically every phase of radio communications is tacit proof that leading engineers have found it is best to specify Bliley "techniquality" crystals.

Bulletin 27 describes the crystal units engineered for the needs of today. Write for your copy.

Bliley CRYSTALS

BLILEY ELECTRIC COMPANY • UNION STATION BUILDING, ERIE, PENNSYLVANIA

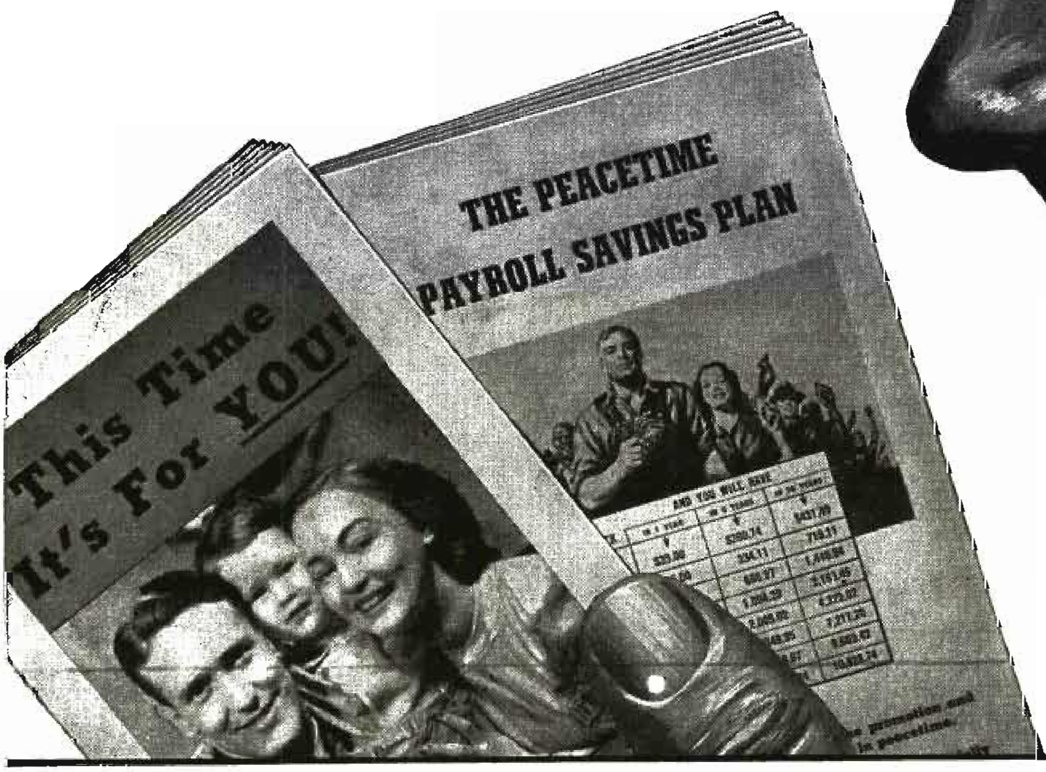
To help increase "Take-Home Savings"

THE Treasury Department has published two new booklets to help you and your employees realize the utmost benefit from your Payroll Savings Plan—benefits proportioned to the extent your employees add to "take home savings" by buying and holding U. S. Savings Bonds.

"Peacetime Payroll Savings Plan" for key executives offers helpful suggestions on the conduct of the Payroll Savings Plan. In addition, it quotes leaders of Industry and Labor and their reasons for supporting the Plan.

"This Time It's For You" is for distribution to employees. It explains graphically how this convenient, easy thrift habit works. It suggest goals to save for and how much to set aside regularly in order to attain their objectives. If you have not received these two booklets, or desire additional quantities, communicate with your State Director of the Treasury Department's Savings Bond Division.

See your Payroll Savings Plan through to maintain your share in America's future. It is sound economics and a powerful force for good today—and tomorrow—as a safeguard for stability and a reserve of future purchasing power—money that is kept within your community.



The Treasury Department acknowledges with appreciation the publication of this message by

COMMUNICATIONS

This is an official U. S. Treasury advertisement prepared under the auspices of the Treasury Department and Advertising Council

It's Collins!

It's new!

It's ready!

. . . the Collins 30K—a NEW transmitter for amateur radio—thoroughly engineered for the continuous exacting requirements of "ham" operation. Check this partial list of features against your desires:

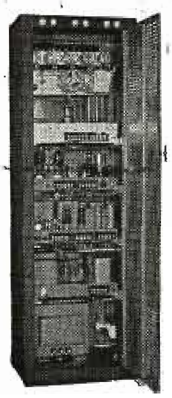
5 band operation • 500 watts input on CW • 375 watts input on Phone • Push-to-talk • Clean, sharp keying • Speech clipper • Bandswitching • Fully metered • Break-in operation • Vfo controlled

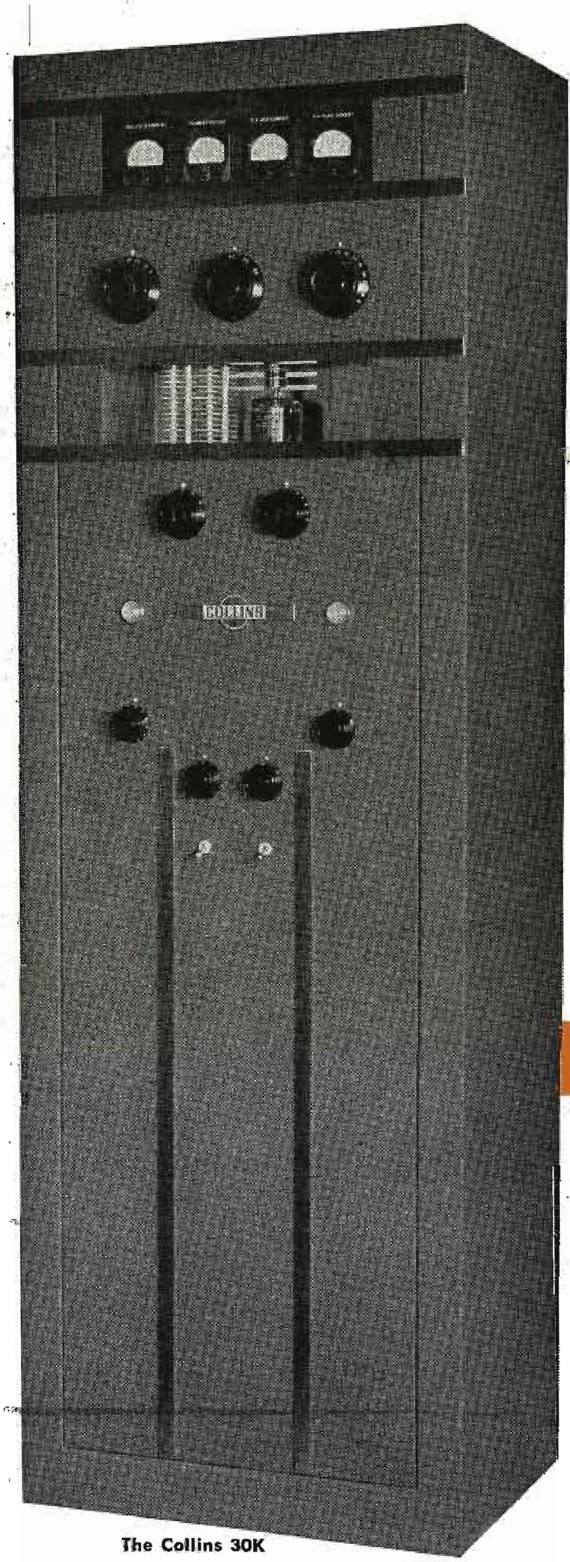
The high efficiency of the 30K assures a strong signal. In addition, the speech clipper circuit assists in maintaining a high modulation level, with no danger of overmodulation. Speech clipping also improves intelligibility. Brass pounders will proudly note the clean keying at any speed.

The exciter unit, built into a receiver type cabinet, may be placed on the operating desk. A highly accurate and stable variable frequency oscillator, the product of years of research and manufacturing experience, is calibrated directly in frequency. The frequency can be varied considerably without retuning the final.

The attractive appearance of this up-to-the-minute transmitter will improve any "shack." Its smooth, easy operation will please you.

Write today for complete details. Collins Radio Company, Cedar Rapids, Iowa; 11 West 42nd Street, New York 18, N. Y.



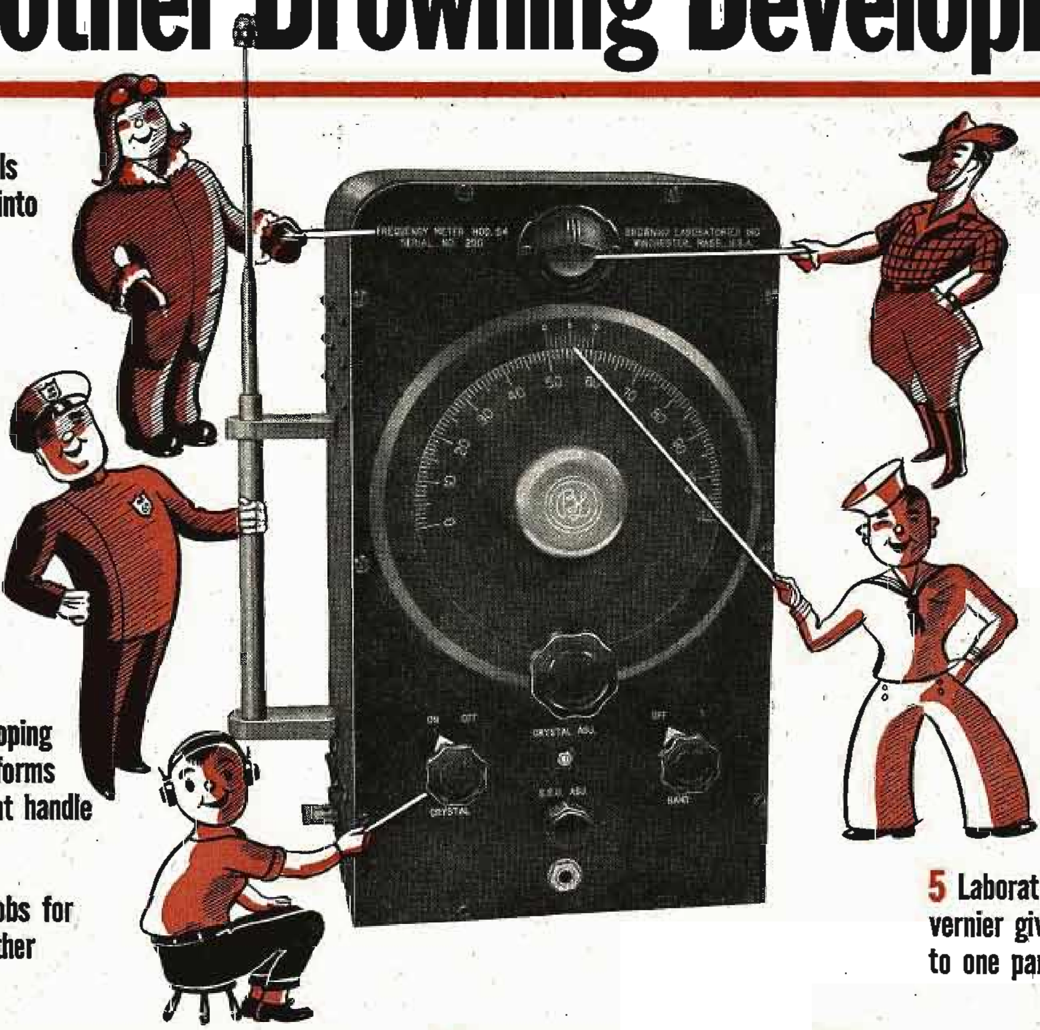


The Collins 30K

FOR RESULTS IN AMATEUR RADIO, GET... COLLINS

Another Browning Development

1 All labels engraved into panel



4 Visual determination of zero beat by cathode ray indicator

2 Telescoping antenna forms convenient handle

3 Big knobs for cold weather handling

5 Laboratory-type dial with vernier gives readability to one part in one thousand

6 New non-jamming vernier drive for fine adjustment **7** Uses WWV as primary standard **8** Rugged steel cabinet and ⅛" aluminum panel

9 Audio output for audibly detecting beats **10** 110-115 AC-DC operation — checks AM or FM

BROWNING'S Model S-4 Frequency Meter was designed especially for marine, police, aircraft, fire department, and other special service radio operators, who must be certain that transmitters are on frequency.

Completely new, it incorporates all the features that supervisors of emergency radio systems have requested — plus many new refinements perfected during our war experience in designing high-precision radar test equipment.

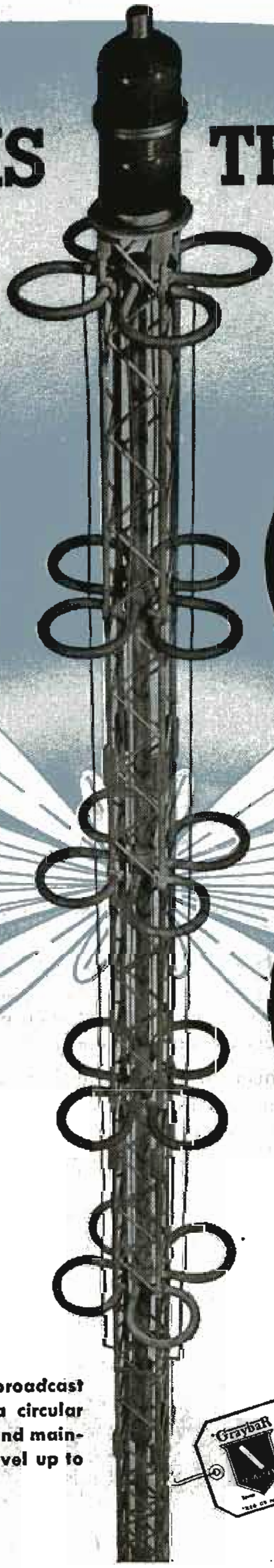
For example, we have included a vernier on the new laboratory-type scale, permitting reading accuracy to one part in one thousand. A telescoping antenna has been added to the side of the case. When telescoped, it forms a convenient carrying handle. Big, easy-to-hold knobs let you operate the meter with gloves on, in cold weather.

The highest degree of stability has been built into the Model S-4 by the use of improved circuits and voltage regulation within the unit. FCC requirements of plus or minus .00025% accuracy are exceeded by the crystal-controlled BROWNING Frequency Meter. Using 110-115 volt A.C. or D.C. current, it checks both AM and FM equipment.

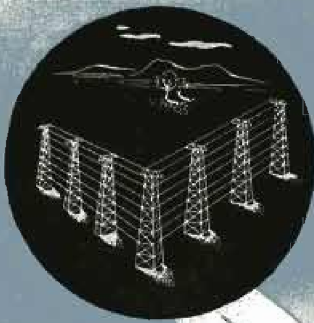
The S-4 is custom built and hand calibrated for testing frequencies in any five bands from 1.5 to 100 mc., according to the user's requirements. For additional technical data and other information, address BROWNING LABORATORIES, Inc., Winchester, Mass.

BROWNING LABORATORIES, INCORPORATED
WINCHESTER, MASSACHUSETTS

Why THIS TEAM IS



1920 Loop antenna for 400-500-meter ship-to-shore radio telephone receivers. Its design enabled earliest measurements of field strength.

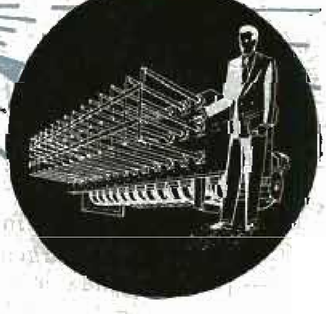


1929 Curtain antennas developed for beaming short-wave radio telephone messages to Europe and South America . . . improved commercial service.

1930 Half-wave vertical radiator, now in general use, was developed into practical form. It greatly improved signal output of broadcast stations.

1934 One of the first directional antenna arrays for broadcasting. Designed for WOR to concentrate signals in service area, eliminate radiation over ocean.

1938 Coaxial antenna for ultra high frequency communications, designed by Bell Laboratories, gave increased signal strength. Widely used in police radio systems.



1941 Polyrod radar antenna was an important war contribution . . . helped sink many Jap ships. Its exceptionally narrow beam and rapid scanning gave high accuracy to big Navy guns.

1946 New 54A CLOVER-LEAF FM broadcast antenna has high efficiency and a circular azimuth pattern; is simple to install and maintain. May be used for any power level up to and including 50 KW.

Distributed by GRAYBAR ELECTRIC COMPANY

Up ON ANTENNAS

As pioneers and leaders in radio, Bell Telephone Laboratories and Western Electric have been vitally concerned with the development of improved antennas for more than 30 years.

From the long-wave days of radio's youth, right through to today with its microwaves, this team has been responsible for much of the progress in antenna design.

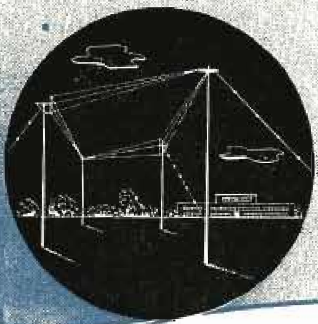
Progress based on Research

Following their long-established method of attack, Bell Laboratories scientists are continually *observing, investigating* and *measuring* the action of radio waves in space. Their research has covered wave lengths ranging from hundreds of meters to a fraction of a centimeter. In over a quarter-century of intensive study, they have learned how radio waves behave, day and night, under all sorts of weather conditions.

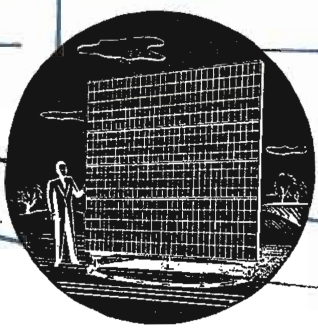
Out of this fundamental research have come such outstanding developments as the rhombic antenna, musa antenna, vertical half-wave radiator, curtain antenna, directional array, the polyrod and other improved radar antennas, the metal lens for microwaves and the new CLOVER-LEAF antenna for FM broadcasting.

What this means to YOU

Whether you are interested in AM or FM—equipment for broadcasting, point-to-point, aviation, mobile or marine use—here's the thing to remember. Every item of radio apparatus designed by Bell Laboratories and made by Western Electric is backed by just such thorough scientific research as has been given to antennas. It's designed right and made right to give you years of high quality, efficient, trouble-free service.



1930 Rhombic (diamond-shaped) antenna for 14-60 meters. It covers wide frequency range without adjustment. Still standard for this band.



1944 Metal lenses, another Bell Laboratories development, focus microwaves like light. One type has a beam width of only 0.1°—or less than that of a big searchlight.

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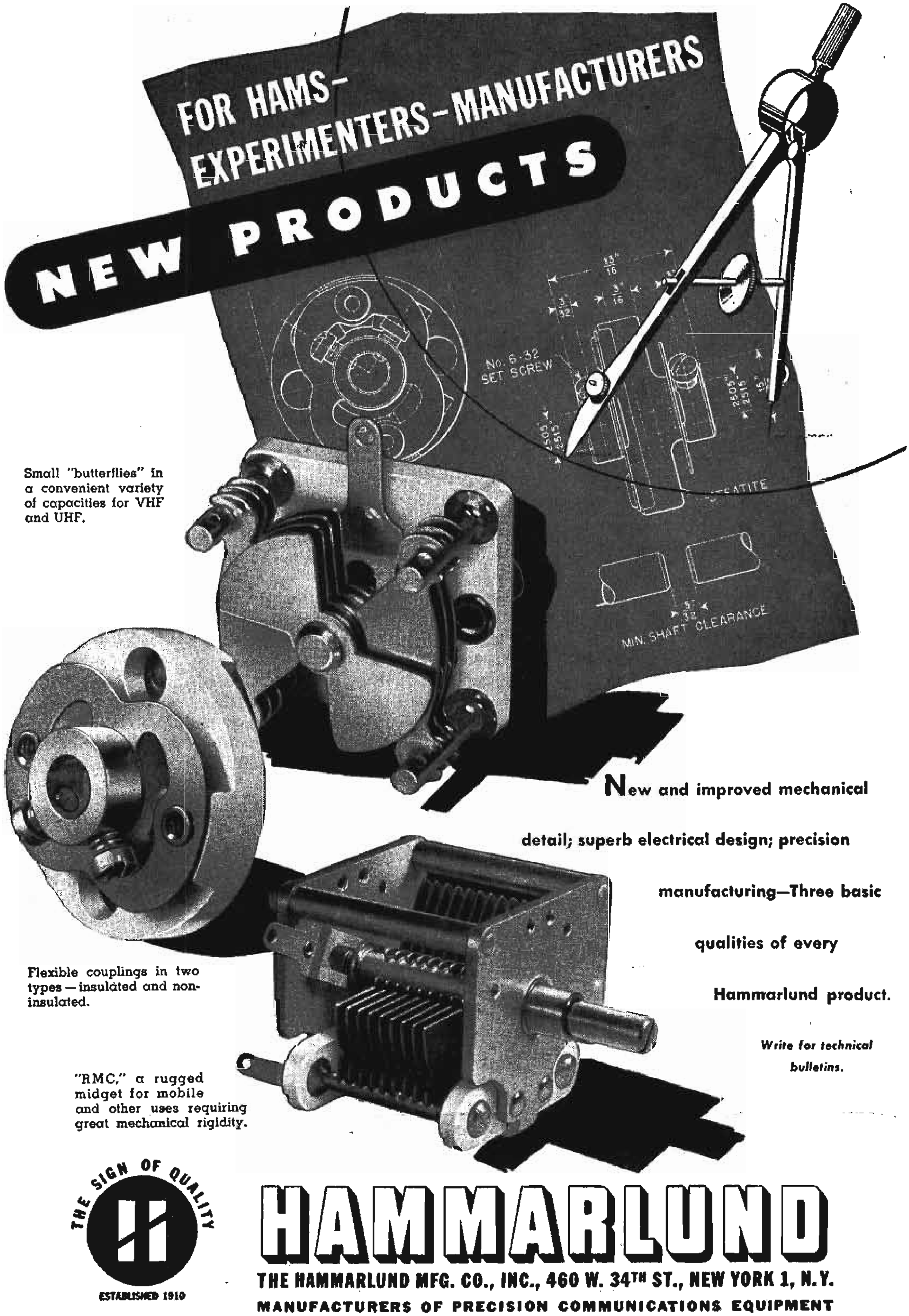
Manufacturing unit of the Bell System and the nation's largest producer of communications equipment.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COMMUNICATIONS

LEWIS WINNER, Editor

* * JUNE, 1946 * *

TUNED CIRCUITS for the U-H-F and S-H-F Bands

by

FREDERICK C. EVERETT

Engineer, Radio Facilities Group, NBC

Review of U-H-F and S-H-F Variable Tuning Systems and a Discussion of a New Type of Tuning Unit That Provides Center-Point Symmetry for Push-Pull Systems and Reduction of Tuned-Circuit Loading.

As WE APPROACH the increased use of the higher frequencies for peacetime applications, we find that component designs demand a variety of careful considerations. It is necessary to critically evaluate component dimensions and even lead lengths, which must be reduced to close to zero.

In tuning-element construction appears one of the major new-concept requirements. For at u-h-f and s-h-f the amount of inductance presented even by a small, single turn of wire often is too great to resonate with the circuit and tube capacitance.

Transmission Lines

The possibilities of the short-circuited transmission line, less than ¼ wavelength long, and its inductive-reactance characteristics, have been well explored. It has also been found that the concentric line is particularly desirable since the field is confined. This field confinement reduces interaction with other circuit components and minimizes radiation losses which might be expected with a single-turn loop or open-wire line.

In the concentric line where the conductors are large, the losses are low. However, the line has a disadvantage; it is difficult to connect to tube elements and other devices.

As the center conductor vanishes progressively we have a re-entrant resonant chamber and when the center conductor disappears entirely we have a resonant cavity; Figure 1. These resonant cavities are very useful at frequencies of the order of thousands of megacycles.

Variable Tuning Problems

When variable tuning is used in transmission-line circuits, difficulties occur in varying the frequency. Either the line length must be changed or a variable capacitor placed across the line. In changing the line length we are confronted with the problem of a suitable moving shorting device. The variable capacitor usually presents mechanical difficulties, plus the fact that the ordinary variable capacitor has undesired reactive and resistive effects.

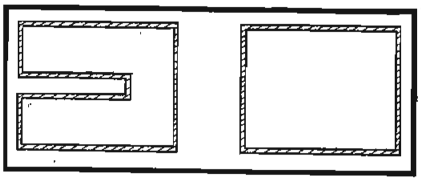
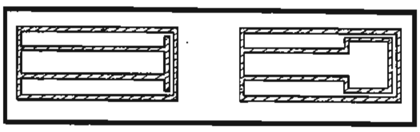


Figure 1
A typical resonant cavity.

Figure 2
Fore-shortened line with capacitance built into end of line.



Interesting modifications have been proposed to make tuning feasible. In Figure 2 appears one such modification. A fore-shortened line is used with the capacitance, which may or may not be variable, built into the end of the line. The length of the line is reduced with this construction which often is desirable at the lower frequencies. Another interesting design solution[1] appears in Figure 3. Here a variable capacitance is used in conjunction with a sylphon bellows for the current path.

Numerous attempts have been made to reduce the length of the transmission line by folding; Figure 4, *a* and *b*.[2] In Figure 5 appears a folded concentric line that corresponds to a multi-turn coil.[3]

Another inductance-capacitance development appears in Figure 6.[4] Here metal cylinders furnish the inductance and discs the capacitance; they might be considered as fore-shortened transmission lines "turned inside out."

The inductance of a loop of a single turn can be decreased by closing the area of the loop with a metal plate, although it need not actually touch the inductance. Several turns may be connected in series or parallel to obtain the desired inductance; Figure 7[5]. This method provides a variable in-

[1]Works, Dakin, Boggs, *A Resonant-Cavity Method for Measuring Dielectric Properties at Ultra-High Frequencies*, Proc. IRE; April 1945.
[2]A. Peterson, *An Ultra-High-Frequency Oscillator*, COMMUNICATIONS; December 1937.
[3]W. L. Carlson, U. S. Patent 2,363,641.

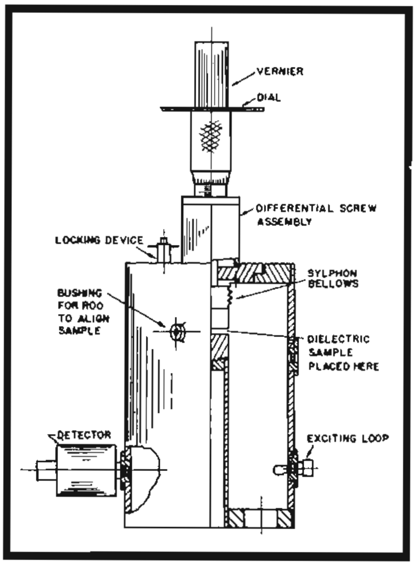
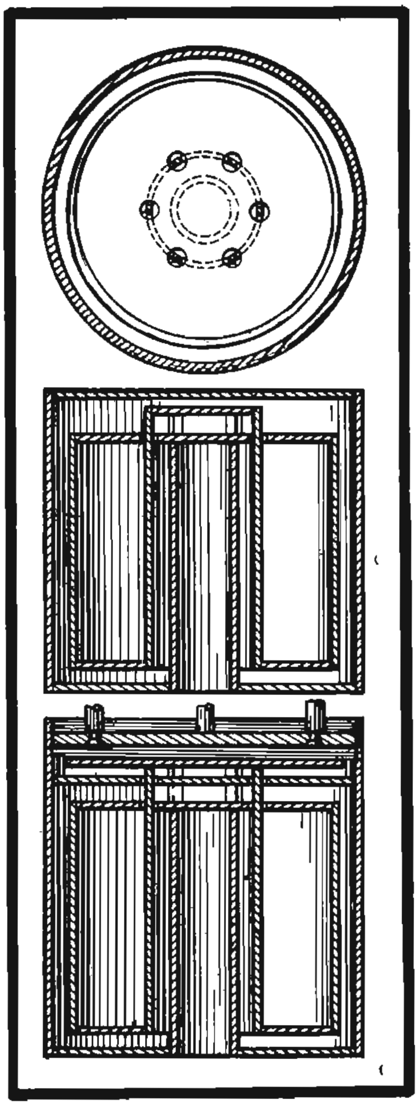


Figure 3
Variable capacitance with a sylphon bellow for current path.

Figure 5
Folded concentric line that corresponds to a multi-turn coil.



ductor that looks like a variable capacitor, although it is the inductance which is varied.

By arranging the components so that the rotor can enter the stator-plate section of a capacitor, and at the same time be removed from the inductance, a circuit[6] can be built to vary both inductance and capacitance. Thus a much wider range of frequencies may be covered than if just one parameter were varied; Figure 8.

To eliminate the use of wiping contacts or pigtails and prevent any passage of r-f through the bearings, the capacitor should be in *split-stator* form, with two sets of stator plates so arranged that the capacitance between them is as small as practical.

This compact construction was adopted in the General Radio *butterfly* circuit, so called because of the shape of the rotor plates in certain models. These circuits are quite satisfactory for wide-range tuning. However variation of inductance and capacitance in the circuit is not symmetrical about a center point, since it is essentially a two-terminal system.

New Symmetrical Unit

To overcome this difficulty the unit shown in Future 9 was developed.[7] It consists of a cylinder, cut to form the stator plates of a split-stator capacitor and a one-turn inductance loop. The rotor is half a cylinder, arranged to rotate within the other cylinder. The rotor and stator plates form a cylindrical capacitor which can be varied by turning the rotor. As the rotor turns to decrease the capacitance, it also re-

(*Continued from page* 51)

[4]F. A. Kolster, *Generation and Utilization of Ultra-Short Waves in Radio Communication*, Proc. IRE; December 1934.

[5]H. R. Summerhayes, Jr., *Converter Unit for G.E. F-M Station Monitor*, Proc. IRE; June 1943.

[6]E. Karplus, *The Butterfly Circuit*, General Radio Experimenter; October 1944.

[7]U. S. Patent pending.

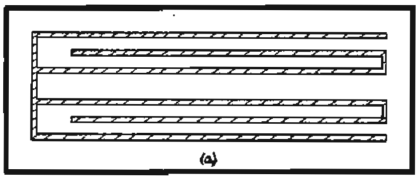


Figure 4
Two methods of reducing transmission line length by folding.

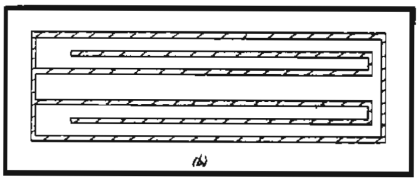


Figure 6
Metal cylinders that serve as an inductance, and discs as capacitance corresponding to a foreshortened transmission line.

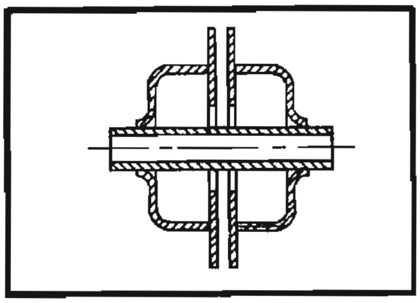


Figure 7
Variable control, that resembles a capacitor, used to provide inductance variation.

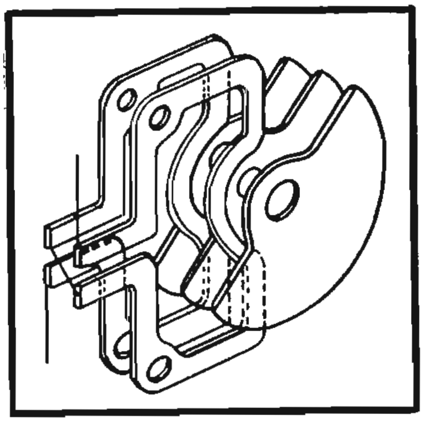


Figure 8
A G.R. butterfly tuning unit with split stator arranged so that capacitance between plates is small. Unit provides variation of inductance and capacitance over wide ranges.

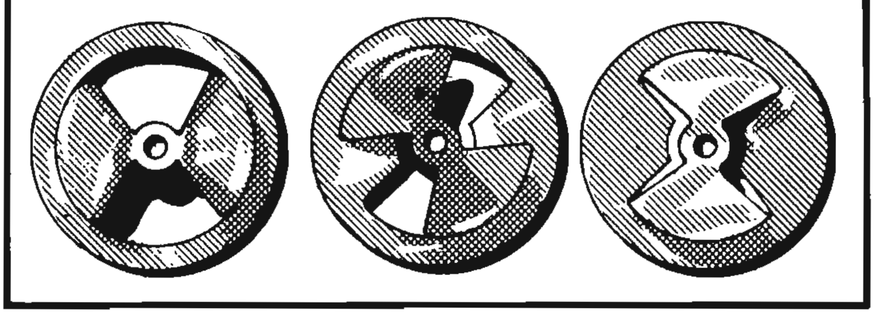


Figure 10
Three views of new type tuning units developed by the author.

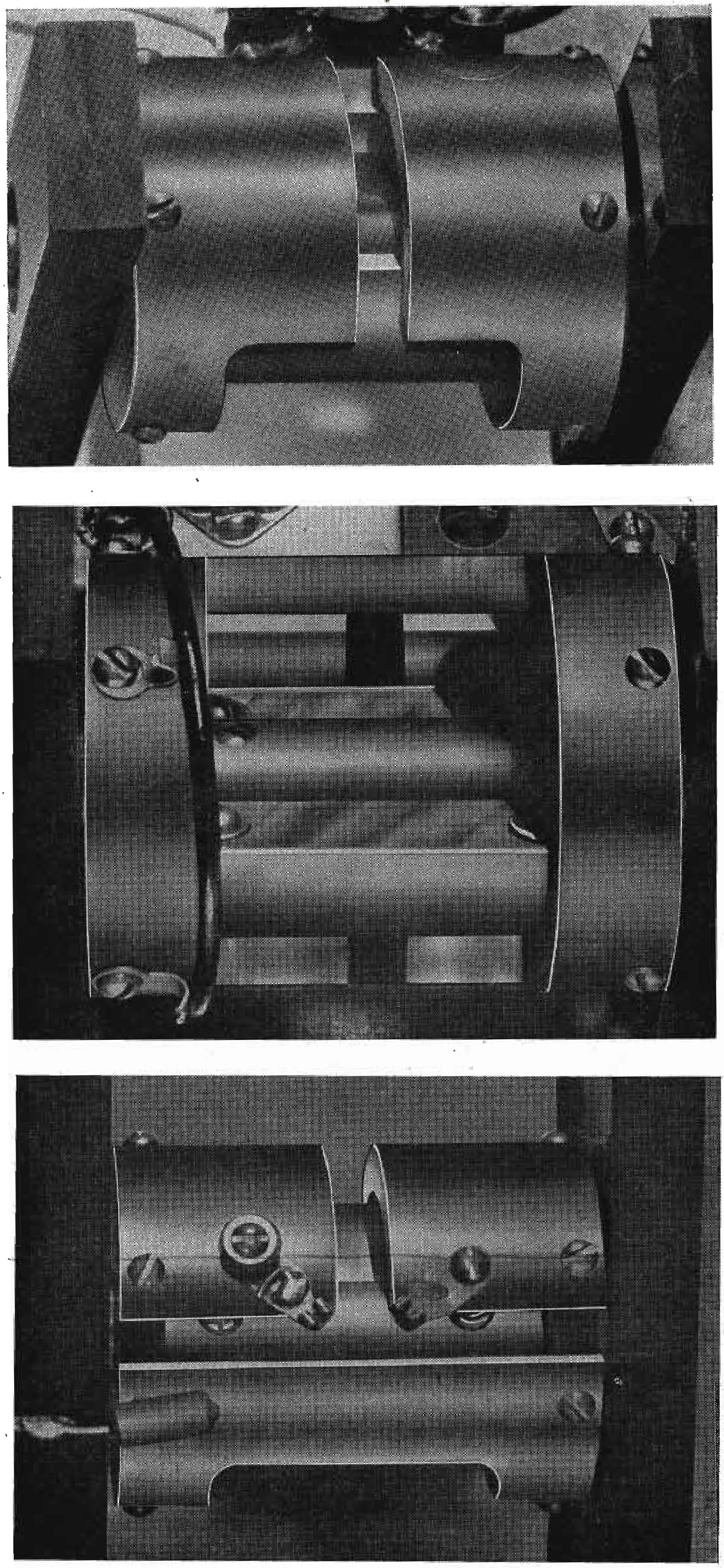
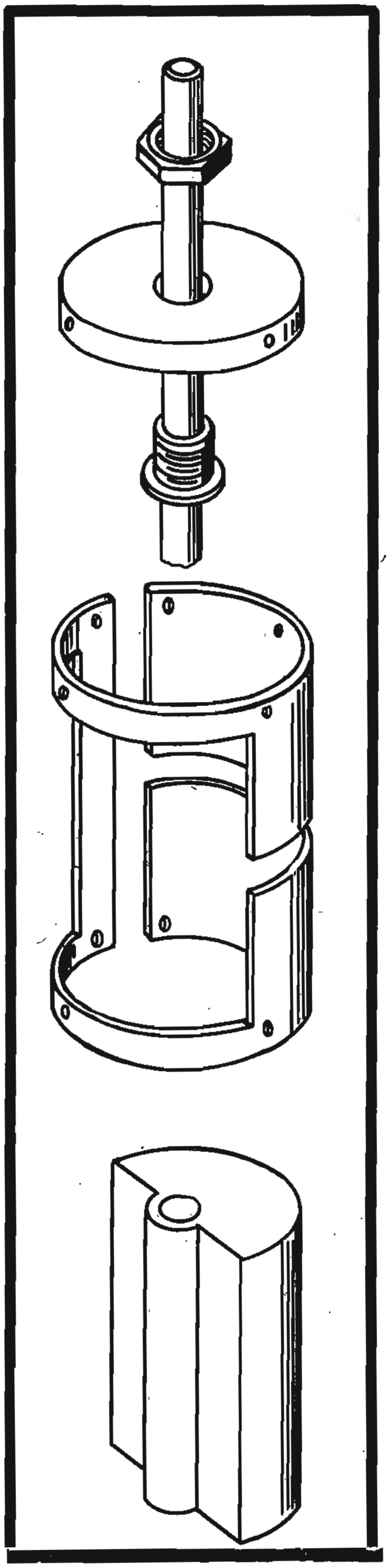


Figure 9
New type of tuning unit that affords a symmetrical circuit arrangement for push pull, etc.



PREVENTIVE MAINTENANCE for Broadcast Stations

First of a Series of Papers[1] on Preventive Maintenance Methods Used to Prevent Breakdown and Avoid the Necessity of Repair. Discussion Covers Various Tools Used for Maintenance and Constructional Data on Special Types of Preventive Maintenance Tools.

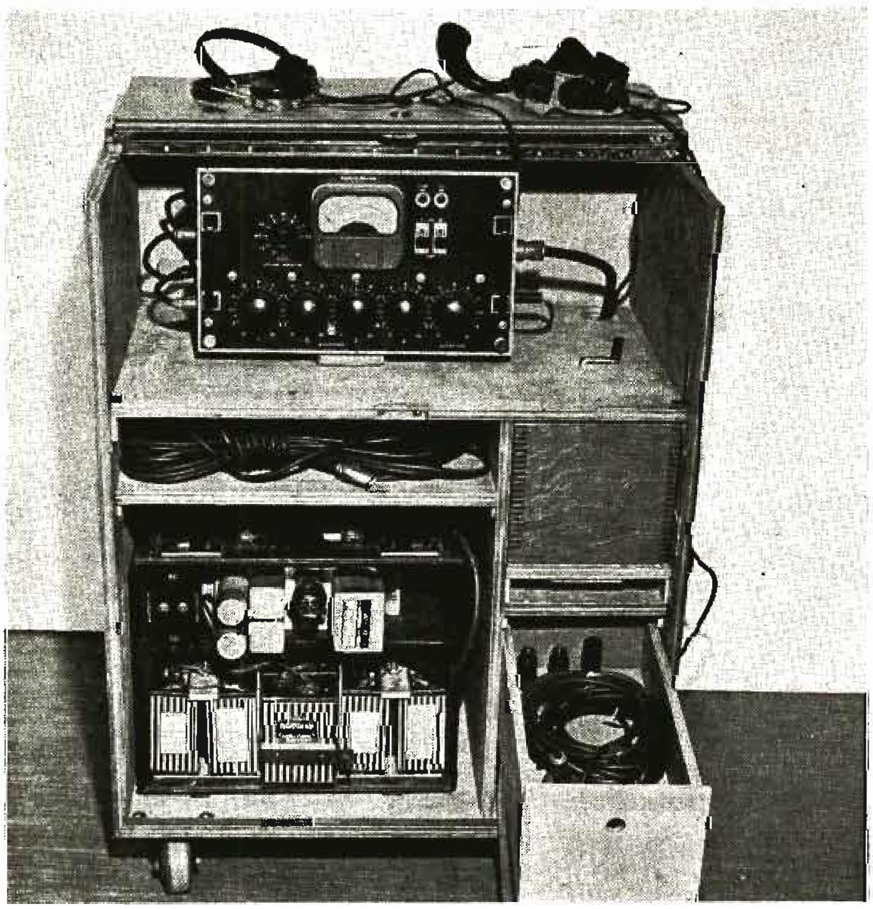
by **CHARLES H. SINGER**

Assistant Chief Engineer
WOR-WBAM

THE DEPENDABILITY OF STATIONS can be attributed primarily to two factors: a systematized plan of operation and a systematized plan of maintenance practices which are followed hour by hour, day and night, year in and year out. These plans should be set down in book form, listing every routine duty to be performed as well as the procedure to be followed in emergencies, with every procedure described in the minutest detail. The process of starting and stopping the transmitter, for example, is performed using one method and only one method at WOR's 50-kw and WBAM's 10-kw transmitters. Every piece of equipment should be operated, tested, adjusted and cleaned in the prescribed routine manner without variation.

It is possible to operate the entire plant efficiently by simply reading and following instructions. Instruction manuals should be readily changeable so that when a suggestion for better procedure is accepted, the books can be changed correspondingly. Invariably such suggestions come from the operators themselves. These should be put through in the form of office memorandums and later discussed and passed upon at round-table meetings attended by the entire staff. Thus the man making the suggestion has an opportunity to advocate his own proposal.

Figure 1
WOR field cabinet with equipment used to maintain field pickup equipment.



The Station Plant

The radio station is composed of three major technical operations groups: (*a*) transmitter division; (*b*) studio technical facilities division; and (*c*) field engineering division.

The transmitting plant is usually located at some distance from the studios. This is necessary in the case of high-powered a-m stations to provide land for a suitable radiating system and to sufficiently remove the transmitter from the population center so as not to encompass too great a population within its blanketing signal contours.

A typical a-m transmitter plant consists of a regular transmitter and sometimes an auxiliary transmitter for emergencies, a power switch room, a transformer vault, generators for supplying special power needs, a gasoline engine generator for emergency power, a pump room for circulating cooling water, an audio facilities control room for combining the modulating intelligence with the carrier, and many other associated apparatus.

In sharp contrast, the f-m transmit-

[1]*Portion of this paper was presented before the Sixth Annual Broadcast Engineers Conference at Ohio State University; a report on the paper appeared in the April issue of* COMMUNICATIONS.

for every control need . . .

RELAYS *by* GUARDIAN

Whether the principle is electronic or magnetic . . . here are some of the latest, greatest basic design Guardian Relays, Solenoids and Stepping Switches we are privileged to present to design engineers.

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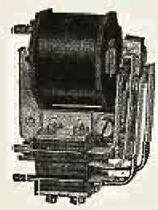
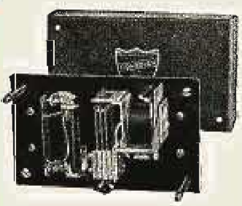


Series 40 A. C. Laminated Relay

This laminated relay is designed to produce maximum output with minimum current input. Typical uses include control of call system bells; auxiliary for automatic radio tuning; remote control of fractional motors; safety devices; instruments; sound movie auxiliaries.

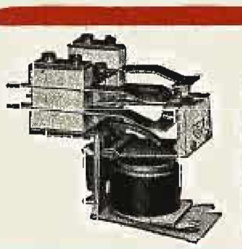
Series 1-A Solenoid

The series 1-A Solenoid by Guardian is one of numerous types for intermittent and continuous duty. Applications include valve control and operation; electrical locking; clutch and brake operation; material ejector; spray gun operation among others.



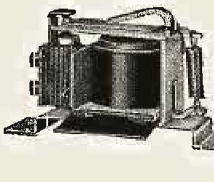
Series T-110 Time Delay Relay

This relay employs a resistance wound bimetal strip to achieve a delayed operation from 10 to 60 seconds. Current flows through the windings generating heat, causing the bimetal strip to bend, closing a contact after the required time delay.



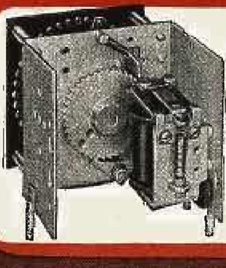
Series A-100 High Frequency

This A1SiMag insulated relay is compact, convenient, low in cost. In radio applications it is used for antenna changeover, break-in, high voltage keying, grid controlled rectifier keying, remote control of receiver and transmitter, and other high frequency applications.



Series 120

The Series 120 is a small, compact relay. It is an economical unit designed for control needs which do not exceed single pole, double throw combination. Economy and simplicity of construction make it possible to offer the Series 120 at a low price compared with its high quality performance.



Series R Stepper

This Relay is built in three basic types for A.C. and D.C. operation: (1) Continuous rotation, (2) Electrical reset, (3) Add and subtract. Its principle application is automatic circuit selection including automatic sequence, automatic wave changing on short wave transmitters, automatic business machines, totalizing units, conveyer control.

GUARDIAN G ELECTRIC

1610-G W. WALNUT STREET CHICAGO 12, ILLINOIS

A COMPLETE LINE OF RELAYS SERVING AMERICAN INDUSTRY

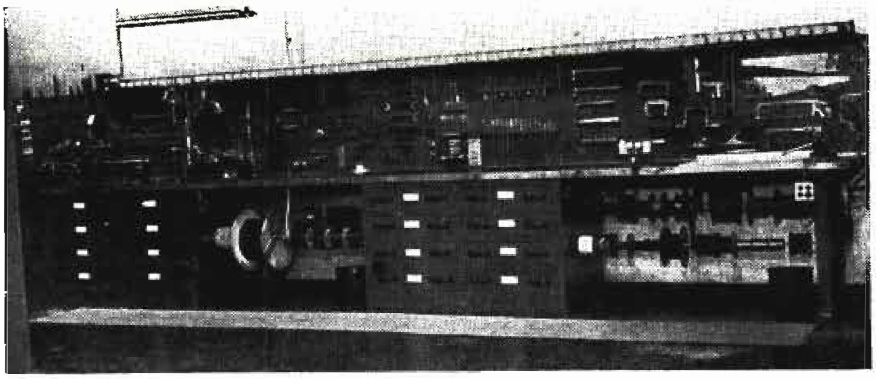
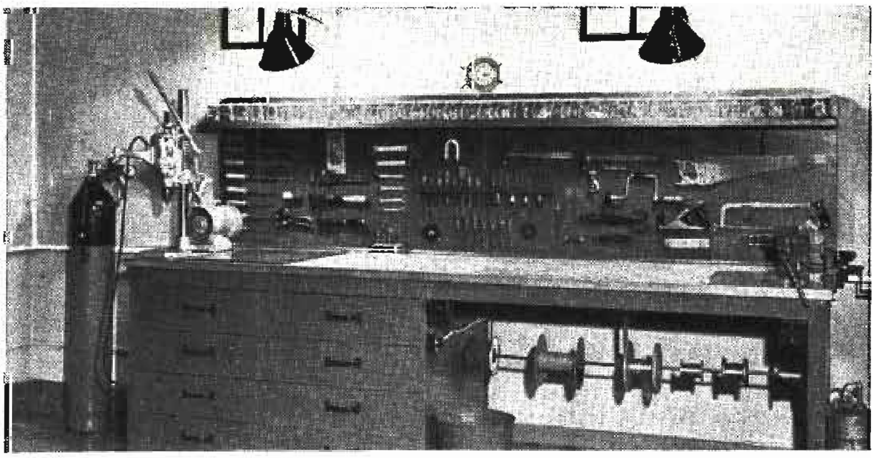


Figure 2
Work bench at WOR's 50-kw transmitter.

Figure 4
Checking the 10-kw f-m transmitter of WBAM.

Figure 3
Work bench at WBAM's 10-kw transmitter



ter because of different propagation characteristics at the higher frequencies is located in the heart of the population center, preferably at the top of a high building if the use of tall antenna supporting structures is to be avoided. The area of coverage is also sharply limited by the FCC, a factor which contributes to the reduced power rating of the f-m transmitter as against the a-m transmitter. It is therefore apparent that the a-m equipment facilities are *not* by nature as extensive as those for an a-m transmitter, but no less elaborate.

The studio plant is generally located in the heart of the metropolitan area which it serves. Primarily, this is for the convenience of the artists, performers and business people who deal with the station. Typical studio equipment for both a-m and f-m consists of an appropriate speech input console, and a small power room for each group of studios supplying power requirements, various amplifiers and cross connections to master control. In addition to the live talent studios, there are usually one or more *e-t* (electrical transcription) studios where an entire program or a large percentage of the program is produced and put on in the control room by the control-room engineer. Of course, no station is complete without its master control room, the central coordinating point for the entire station.

The field engineering division provides the facilities for picking up programs which originate outside of the studio proper. This calls for pickups originating in hotels, on the streets and other points where telephone program lines are not available and radio links must be used. The usual field pick-ups are conveniently taken care of by the equipment which is a part of a standard *field cabinet.*

Care and Handling of Tools

The proper use and care of tools and maintenance equipment are of the utmost importance. Tools and maintenance equipment should be used with extreme care and kept in good condition at all times.

A good maintenance technician never uses the wrong tool for a job or abuses his tools. At WOR-WBAM, twelve tool-care rules are strictly observed. These are:

(*1*) Do not use pipe to increase leverage on a wrench.
(*2*) Do not use a wrench for a hammer or pry.
(*3*) Do not neglect to replace the tops on bottles or cans of cleaning agents.
(*4*) Do not use cleaning liquid unless there is good ventilation.
(*5*) Do not place tools or parts on the ground or on a dirty floor; put them on a piece of canvas in order to avoid damage or loss.
(*6*) Do not allow tools to become dull.
(*7*) Do not allow tools to rust.
(*8*) Do not lose tools.
(*9*) Do not let dirt, dust, or grime collect on the tool box.
(*10*) Do not throw tools or materials away. Keep a miscellaneous parts box; a broken bolt, an off-sized nut, or a piece of insulation or scrap of steel may be useful at a later date.
(*11*) Do not allow the supply of maintenance materials to get low. Watch supplies of cleaning agents, sandpaper, emery cloth, and lubricants, and replenish when necessary.
(*12*) Keep tools clean at all times.

When the wrong tools are used while working on a unit, unnecessary damage to the equipment may result. If pliers are used to loosen or tighten nuts, the corners of the nuts become rounded; it is then difficult to remove the nuts with the proper wrench. A screwdriver of the wrong size damages the slots and heads of screws. This type of damage shortens the life of the equipment and often necessitates replacements of critical parts.

Each tool is made for a specific purpose and should be used for that purpose only. Correct storage of tools is important. Cutting and boring tools

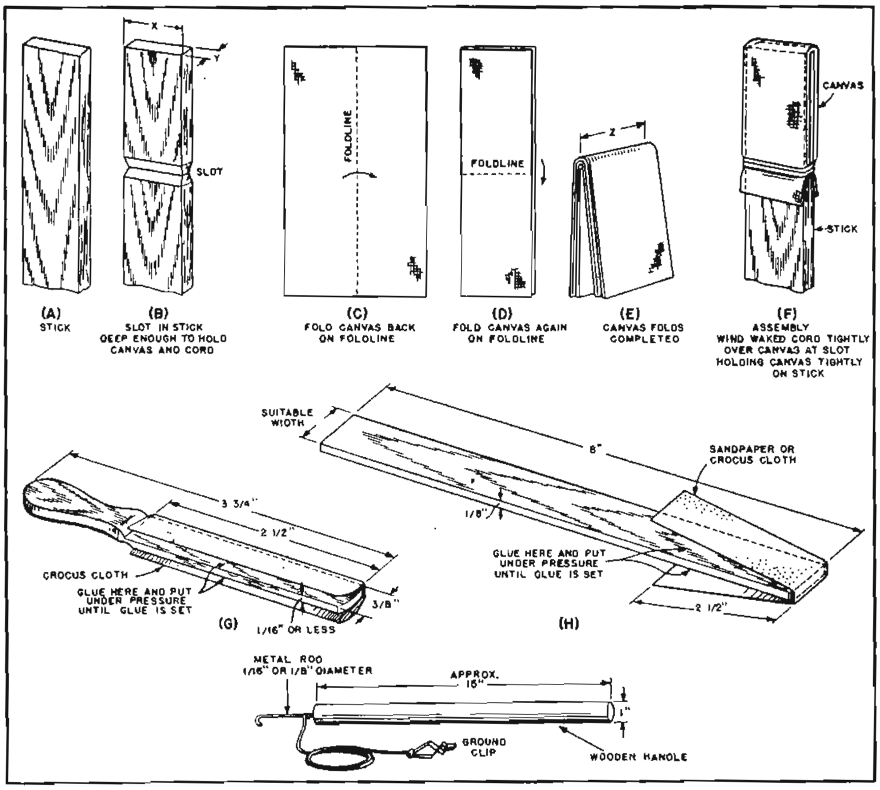


Figure 5
Relay and commutator-tool construction.

should be placed in racks or drawers so that their cutting edges are protected. The joints of tools such as pliers should be oiled occasionally to keep them working freely. The handles of driving tools, such as screwdrivers, should be inspected to see that they are tight. All metal parts of tools should be wiped with an oily cloth after use to prevent rusting.

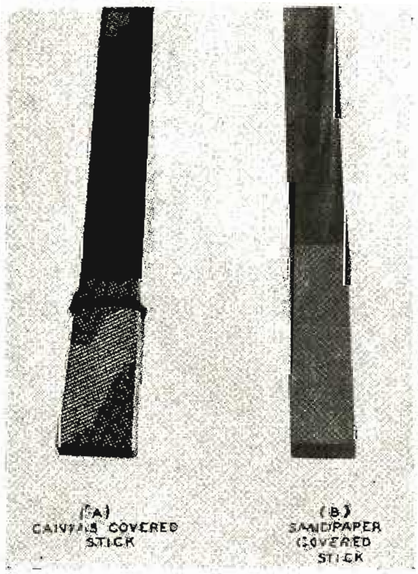
Condition and Placement of Tools

The condition of tools is an indication of the efficiency and quality of the station's maintenance technicians. To accomplish good work tools should be kept in the best possible condition at all times.

When tools, in good condition, are used properly and all safety precautions are taken, accidents rarely occur. When tools are misused, when improper tools are used, or when safety precautions are violated, we have accidents which may result in damaged equipment, loss of time, danger to workers, and loss of life. Tools left in unexpected places are a serious hazard. Tools should never be left in the equipment.

When tools and maintenance equipment are kept in an orderly condition, a quick check will show if anything is missing. A continuous inventory is important, because lost or misplaced items must be found or replaced at once. It is also of vital importance that test instruments and meters be checked periodically for proper operation and correct calibration. A delay caused by misplaced tools and instruments or improperly operating maintenance equipment may keep the radio station inoperative for many hours with serious results. The maintenance technician can rarely achieve a higher state of efficiency than that of his maintenance facilities.

Figure 6
Tools used to clean commutator and collector rings.



Tools for Maintaining Relays and Contactors

A number of items in the preventive-maintenance schedule require work of a special and somewhat delicate nature. These include cleaning and smoothing of relay contacts, cleaning and polishing commutator and collector rings, checking brush spring tension, removing brushes, springs, etc. To do the work properly, special supplies and a few specially-constructed tools are needed. Most of the required materials will be found around the shop, but a few must be improvised. The special supplies and tools, including those which must be built, are:

(*1*) Carbon tetrachloride, or stoddard solvent.
(*2*) Lint-free cloths.
(*3*) Sheets of crocus cloth.
(*4*) Sheets of *0000* sandpaper.
(*5*) Sheets of *000* sandpaper.
(*6*) Relay-contact burnishing tool.
(*7*) Non-magnifying dental mirror.
(*8*) 1" cleaning brush (camel's hair).
(*9*) 2" cleaning brush (camel's hair).
(*10*) Canvas cloth.
(*11*) Tube of household cement.
(*12*) Small marker tags.
(*13*) Crocus-cloth stick (small) for relays; *built*.
(*14*) Crocus-cloth stick (large) for contactors; *built*.
(*15*) Sandpaper-covered stick (large) for commutators and collector rings; *built*.
(*16*) Canvas-covered stick (large) for commutators and collector rings; *built*.
(*17*) Small fine-cut file.
(*18*) Walscolube or vaseline.
(*19*) Small pocketknife.
(*20*) Airblower.
(*21*) Vacuum cleaner.

Construction of Special Relay and Commutator Tools

To construct the crocus cloth, canvas and sandpaper sticks, we first obtain one length of wood (or suitable substitute) 1/32" thick, 3/8" wide, and 3 3/4" long, and three lengths of wood (or suitable substitute) 1" thick, 1" wide and 8" long. Then we cut off one piece of crocus cloth and one piece of *0000* sandpaper, each 1" wide and 5 1/4" long.

The small piece of crocus cloth is cemented to the small stick; both sides of the stick should be covered. The stick is then placed in a vise until the cement hardens. The pieces of crocus cloth which extend over the *back* edge of the stick may be cut off with a knife.

The long, narrow pieces of crocus cloth and sandpaper are now cemented to the two long sticks. In this case, the fold is over one end of the stick rather than over the side. Again the vise should be used to hold the cover material flat on the stick until the cement has hardened.

A convenient sized piece of canvas is then folded double, securely attached to a convenient size stick smoothly with

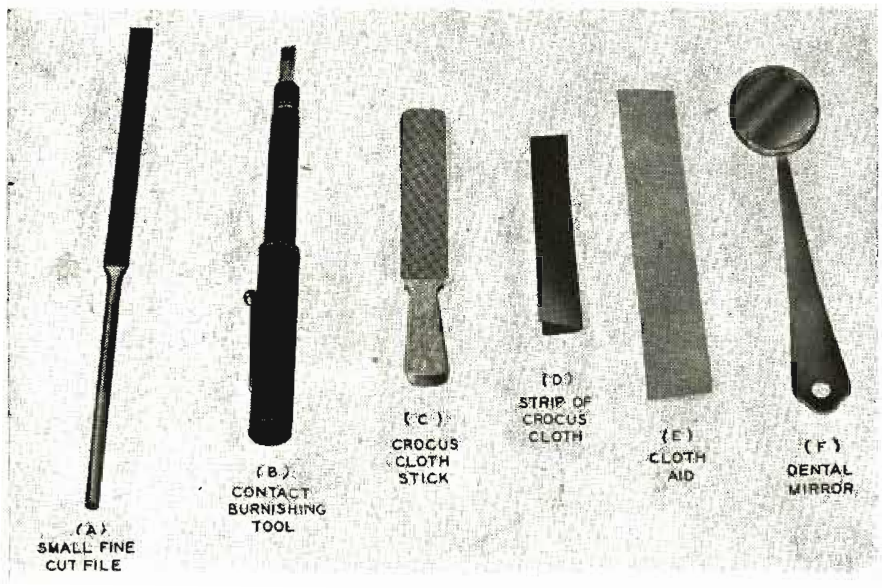


Figure 7
Relay contact maintenance tools.

cord or twine; all loose strings or ravelings are cut off.

Relay Servicing Tools

To service relay contacts, several different tools are needed. Each of these has a special function.

The burnishing tool. The relay-contact burnishing tool, which resembles a fountain pen, uses replaceable blades of finely etched steel. It has extra blades inside the removable handle.

This tool is used to clean the small contacts of telephone type relays which have extremely hard contacts made of palladium or elkonium. It is not a file in the usual sense. A contact should not be burnished unless it is found to be dirty, corroded, pitted or oxidized, and then not any more than is necessary to restore a smooth, clean contact surface. The original shape of the contact must be retained.

It is very important to keep the blades of contact-burnishing tools clean. The blades should not be touched or rubbed with the fingers. The blade must be wiped off with a clean dry cloth before placing it against the relay contacts and then wiped frequently with a cloth dampened with carbon tetrachloride. In operation, the relay contacts are pressed lightly against the blade of the burnisher and at the same time the blade is moved back and forth. While burnishing the burnisher must be held parallel to the springs upon which the contacts are mounted.

The small fine-cut file is similar to an ignition-point file. It is to be used only on the larger contacts if they have become very badly burned or pitted and a replacement is not available. This tool is not to be used on the contacts of telephone type relays.

Contacts should not be filed any more than is necessary to remove ridges from the rim of the pit. The original contour of the contact surface must be preserved. After filing, *0000* sandpaper should be used, followed by the crocus cloth aid to secure a smooth finish on the contact surface. A clean dry cloth serves for polishing. The file must be kept clean and free from all foreign matter before applying to the relay contacts. A wire brush and carbon tetrachloride will serve for cleaning the file.

Crocus cloth. This maintenance aid, available in two forms, as a tool custom built, and as a strip, serves a two-fold purpose. It may be used to remove corrosion from all relay contacts following the use of the fine file and *0000* sandpaper. *Neither the file nor sandpaper leaves a finish which is considered smooth enough for proper relay operation.* The use of crocus cloth is needed to bring the surface of the contact to a polish. The choice between the stick and the piece of cloth depends upon relay contact accessibility. If the location of the relay and the position of the contacts permit the use of the crocus cloth stick, then it should be used. Otherwise, the strip of crocus cloth must serve.

The 0000 sandpaper stick. This *tool* is made in the same way as the crocus cloth stick, except that sandpaper is used instead of crocus cloth. The use of sandpaper is limited, as is the use of the fine-cut file, to the treatment of badly burned or pitted contacts on the larger relays or contactors. Sandpaper is never used on silver contacts. Following the use of sandpaper on contacts, they should be wiped with a clean cloth. All residue should be thoroughly removed from the relay. The sandpaper should, of course, be removed when it becomes dirty or worn.

The cloth aid. This relay-service aid is a narrow piece of clean folded, lint-free cloth such as fine silk (or canvas, if cloth is not available). It serves a two-fold purpose. It is suitable for polishing a clean surface, and it is used as a follow-up to crocus cloth. It is intended to remove grains of pumice which come off the crocus cloth and adhere to the contact surface.

Large commutator sticks. These sticks (which have a covering of sandpaper or canvas) are used for cleaning the commutator and collector rings of generators and motors (when accessible) while running.

Cleaning brushes. These brushes, one small and one large, of good grade soft hair, preferably camel's hair, are used for cleaning various parts of the

(Continued on page 52)

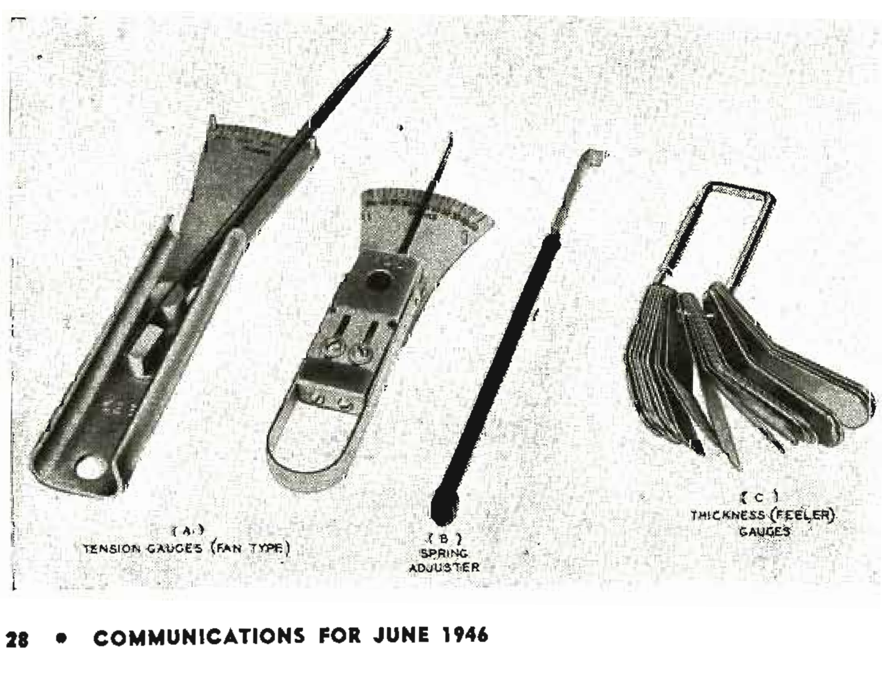
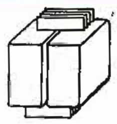


Figure 8
Relay adjusting tools.

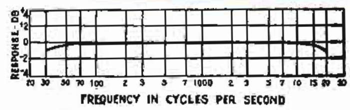
ENGINEERING DEVELOPMENT

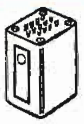
Since its inception, the designs of the UTC Engineering Department have set the standard for the transformer field.



1933 — **Hum Balanced Coil Structure:** Used by UTC in practically all high fidelity designs. . . . Hum balanced transformers are now accepted as standard practice in the transformer field.

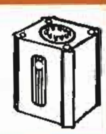
1934 — **Linear Standard Audio Units:** Flat from 30 to 20,000 cycles . . . A goal for others to shoot at.





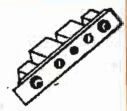
1935 — **Ultra-Compact Audio Units:** A complete series of light weight audio and power components for aircraft and portable applications. Ultra-Compact Audio units are hum balanced . . . weigh approximately six ounces . . . high fidelity response.

1936 — **Tri-Alloy Shielding:** The combination of Linear Standard frequency response and internal tri-alloy magnetic shielding is a difficult one to approach. Used by G. E., RCA, Western Electric, Westinghouse, M G M, Walt Disney, NBC, etc.



1937 — **Ouncer Audio Units:** Extremely compact audio units for portable application were a problem until the development of the UTC Ouncer series. Fifteen types for practically all applications . . . range 40 to 15,000 cycles.

1938 — **Universal Equalizers:** The UTC Universal Equalizers, Attenuators, and Sound Effects Filters fill a specific need of the broadcast and recording field. Almost any type of audio equipment can be equalized to high fidelity standards.

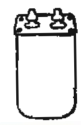


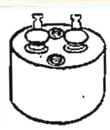
1939 — **Plug-In Audio Units:** These units are a modification of our Ouncer series, incorporating a simple octal base structure. Fifteen standard items cover all applications.

1940 — **Sub-Ouncer Units:** A series of ⅓ ounce miniature units with non-corrosive—long life construction for hearing aid, miniature radio, and similar applications. Five types cover practically all miniature requirements.

1941 — **Light Weight Aircraft Filters:** RRF-5 Radio Range Filters and other special filters for light weight applications embody unique size and weight saving features. A typical unit, made by another source with 32 lb. weight, weighed 1¾ lbs. after UTC design.

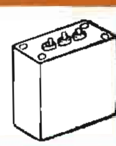
1942 — **Hermetic Seal Pioneering:** Realizing the essentiality of hermetic sealing for many applications, UTC pioneered a large number of the terminals and structures for hermetic transformers . . . now available for commercial use.

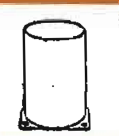




1943 — **Toroidal Wound High Q Coils:** UTC type HQA and HQB Coils afford a maximum in Q . . . stability . . . and dependability with a minimum of hum pickup. Standardized types available for all audio requirements.

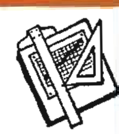
1944 — **Standardized Filters:** UTC type HPI, LPI, and BPI (low pass, high pass, and band pass) Filters are standardized to effect minimum cost and good delivery time. Available for frequencies throughout the entire audio range.





1945 — **Sub-Audio and Supersonic Transformers:** Embody new design and constructional principles, for special frequency ranges. ½ to 60 cycles for geophysical, brain wave applications . . . 8 to 50,000 cycles for laboratory service, 200 to 200,000 cycles for supersonic applications.

1946 — **New Items:** The UTC Research Laboratory is developing new items and improving standard designs in 1946. While some of these developments will be described in our advertisements, many are applied to customers' problems.



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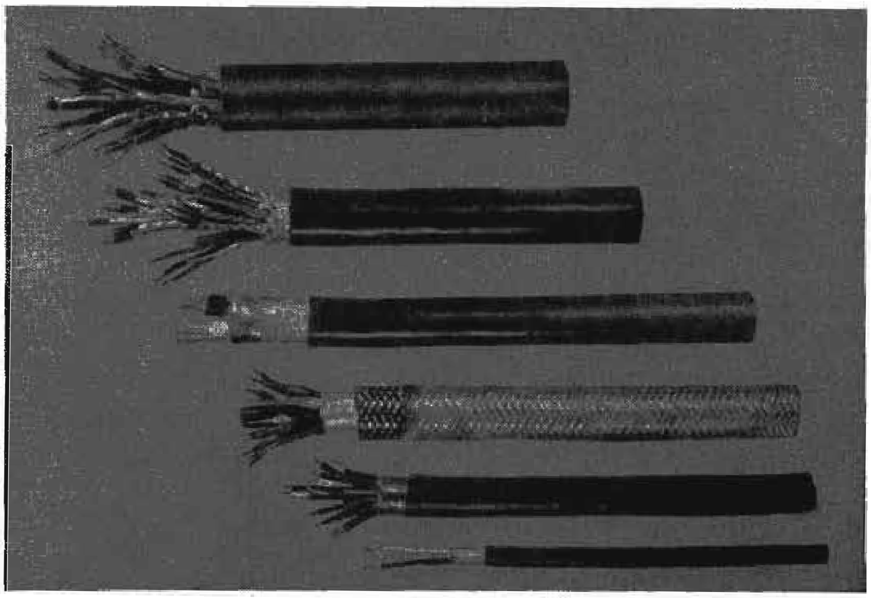
INSULATED WIRE and CABLE in Communications Today

by A. P. LUNT

Chief Chemist
Ansonia Electrical Company

Discussion of Wire and Cable Available for Communications Applications Today.



Six types of cables used in communications services today.

ONE OF COMMUNICATIONS' major building blocks is insulated wire and cable. Proper use of this building block is a major factor in obtaining the ultimate in efficiency in any engineering design.

There are nine basic categories which may be used to segregate different types of insulating materials available for use; table 1.

The basic types outlined in table 1, of course, have innumerable variations in actual manufacturing design because of the different types of equipment in use in various wire and cable plants and because of the many varied insulating materials available to the wire and cable engineer.

There are six major insulating materials in common use in today's communication cables; table 2.

Material Properties.

(1) Cotton—A relatively high-dielectric strength, low-loss factor material used both as primary insulation material and for mechanical protection, whose prime handicaps are its high susceptibility to moisture and poor chemical resistance. It is seldom used as an insulating material unless in its final stages it has been impregnated to keep out moisture.

(2) Cellulose yarns — Offer better service life, better chemical resistance and far less moisture susceptibility than cottons with comparable insulating qualities.

(3) Paper — An excellent low-dielectric loss, long-lived insulating material, unfortunately highly subject to moisture conditions and mechanically weak. Its use in wire and cable is primarily restricted to permanent installations where moisture can be effectively sealed out.

(4) Rubber and vulcanizable rubber substitutes — This class of materials constitutes the moderate dielectric - strength, moisture - resisting,

(*Continued on page* 53)

(A)—Antenna wire or leadin wire (normal a-m type)
(B)—Antenna wire or leadin wire (normal f-m and television types)
(C)—Audio-frequency hookup wire
(D)—Radio-frequency hookup wire
(E)—Ultra high-frequency transmission cable
(F)—Portable cables, light duty
(G)—Portable cables, heavy duty
(H)—Permanently installed power cable
(I)—Permanently installed radio-frequency transmission cable

Table 1

General Wire Type (From table 1)	Recommended Insulations for Wire Types (From table 2)
A	1, 2, 5a
B	4a, 4b, 4e
C	1, 2, 4a, 4b, 4e, 5a, 5c, 5d Most of these items can be flame-proofed by using a glass braid (6).
D	4a, 4e, 5b 5b is sometimes jacketed with 5e.
E	4e, 5b Sometimes special construction required also.
F	Insulations: 4a, 4b, 5a Jackets: 4a, 4b, 4c, 4d, 5a
G	Insulations: 4a, 4b, 5a Jackets: 4a, 4b, 4c, 4d, 5a
H	Insulations: 3, 4a, 4b, 5a Jackets: 1 (saturated: 4a, 4c, 4d, 5a)
I	Insulations: 4a, 5b and special construction to suit need Jackets: 4a, 4c, 4d, 5a, 5b

Table 3

(1)—Cotton: wrapping and braids
(2)—Cellulose acetates and modified acetates: wrapping, braiding, lacquers
(3)—Paper: made from specially treated pulps
(4)—Rubber and vulcanizable rubber substitutes: (a)—Rubber; (b)—Butadiene styrene copolymers; (c)—Polychloroprene; (d)—Butadiene acrylonitrile copolymers; (e)—Butyl rubber.
(5)—Thermoplastics: (a)—Plasticized polyvinyl chlorides; (b)—Polyethylene; (c)—Celulose acetate; (d)—Ethyl cellulose; (e)—Nylon
(6)—Glass: yarns and tapes

Table 2

MORE *POWER* FOR FM BROADCAST SYSTEMS!

with

Federal's "Specialized" Triodes

1000 and 3000 Watts at

88 to 108 MEGACYCLES

(MAXIMUM OUTPUT UP TO 150 MC)

7C 26

7C 27

THESE TWO high-performance power triodes have been especially designed in every detail, to provide the best possible combination of operating characteristics for FM transmitters.

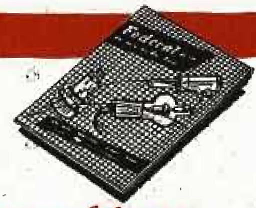
Every feature—from electrical characteristics to the most minute detail of mechanical construction—has been "custom tailored" to meet the specific requirements of frequency-modulated transmission service up to 150 megacycles.

Highly efficient forced-air-cooling is assured by the use of pure copper anodes, joined to the cooling fins by a thin solder film of high thermal conductivity. Radial cooling fins provide large surface area and unrestricted airflow path. Federal's vast tube-making facilities, backed by 37 years of experience, give you real assurance of matchless performance, rugged dependability and maximum tube life.

RATINGS FOR FM BROADCAST SYSTEMS IN THE 88 TO 108 MEGACYCLE BAND
(MAXIMUM OUTPUT UP TO 150 MC)

	7C 26	7C 27
Maximum plate dissipation	1000 watts	3000 watts
Filament voltage	9.0 volts	16.0 volts
Filament current	29.0 amp	28.5 amp
Amplification factor	17	21
Mutual conductance	20,000 Umhos	20,000 Umhos
Cooling air velocity at maximum output	75 cu ft/min	150-175 cu ft/min
Maximum overall dimensions		
Height	4¼ in	8 in
Diameter	2½ in	3½ in

"Federal tells how to make tubes last longer—" Write to Department K310 for this interesting and informative 20-page book which gives helpful hints on how to get the most out of your electronic tubes.



Federal Telephone and Radio Corporation

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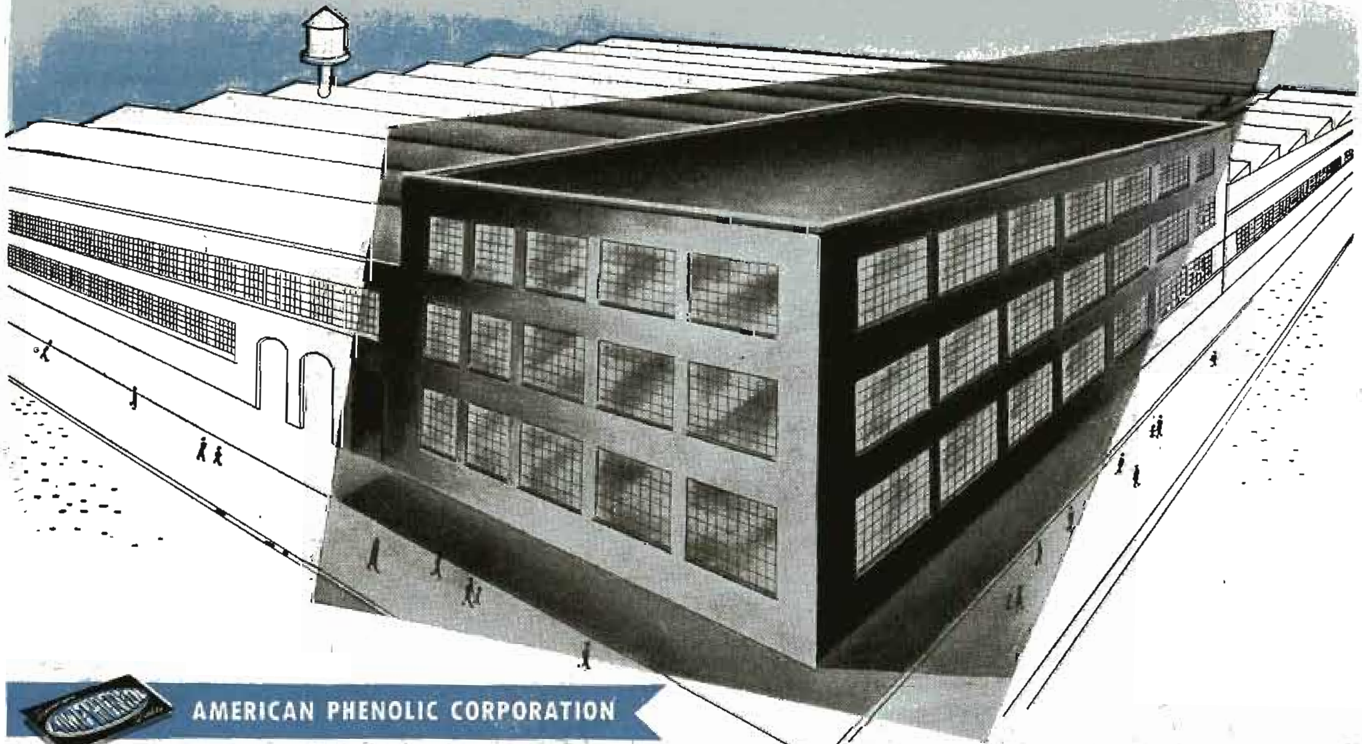
By this timely expansion of facilities American Phenolic Corporation is meeting its responsibility of leadership and specialization in mass production of quality components to better serve the rapidly expanding electronics industry.



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HIGH POWER TUBES for V-H-F Operation*

W. W. Salisbury

Survey of High-Power Commercial Tubes Used for C-W Operation at Frequencies Above 100 MC.

by **WINFIELD W. SALISBURY**
Director of Research
Collins Radio Company

THIS DISCUSSION covers a survey of tubes used at frequencies above 100 megacycles and powers above one kilowatt for continuous-wave operation. The commercial tube types surveyed represents an effort to be impartial, although it is realized that not all tube manufacturers are represented and some pertinent tube types may not be mentioned. However, it is hoped that the data presented will give a typical cross section of what industry has to offer.

There are several factors about existing commercial tubes that warrant comment. One is that filament power and emission requirements are increased as the frequency increases. This is principally due to the fact that this frequency range is on the edge of the region where distributed constant circuits must be used and, therefore, in a range where circuits are limited in regard to the surge impedance which can be built into them. The surge impedance of the distributed constant circuits varies logarithmically with the ratio of certain dimensions, so that a factor of 1,000 in this ratio gives only a factor of three in surge impedance. This limits the value of surge impedance obtainable to a region between a few tens of ohms and 100 or 200 ohms. The electrons from the tube see an impedance equal to $Q \times Z_0$ ohms, so that heavy currents are required at maximum voltages to give broad band operation with any degree of efficiency. This is because efficient operation requires a near match between the electron impedance and the circuit impedance. Broad band operation requires that the Q have a low value. These limitations, coupled with the fact that copper losses put a specific limitation on the operating Q, if any efficiency is to be obtained, make it necessary for efficient tubes to have a low electron impedance.

A second important point will be noted with respect to the physical construction of the tube. Lead connections must be large and circular structures of the order of the full diameter of the tube. This is necessary to reduce lead inductance to the point where coaxial circuits can be efficiently used in connection with the tube. In this region of frequency, conventional neutralization of amplifiers can be used, but it borders on the region where grounded grid operation must be used. Thus this type of circuit may be desirable because of the shielding it offers between input and output, and because of its freedom from parasitics; however, grounded grid operation has low power gain compared to neutralized circuits.

It is also worthy of note that, at present, there are no commercial tubes which are capable of power outputs at 100 megacycles of greater than 10 kilowatts.

The Future

The immediate future of high-power tubes operating at hundreds of megacycles is probably contained in the wartime developments which have not yet become commercial. For wartime use, magnetrons have been produced capable of output powers up to 25 kilowatts with frequencies as high as 700 megacycles, and powers of 1 kilowatt at frequencies as high as 4,000 megacycles have also been produced. One such tube was operated at about 2,500 volts with 1 ampere and was tunable over a 8-to-12-centimeter range with 1 kilo-

(*Continued on page* 49)

Manufacturer	Tube	Type	Max. freq.; mc	Power out.; kw	Filament; volts	Filament; amperes	Plate; volts	Plate; amperes
G. E.	**7C29**	**Triode**	110	1.0	10.5	28	3,000	0.4
G. E.	**7D21**	**Tetrode**	110	2.0	6.3	30	4,000	1.0
G. E.	**8002-R**	**Triode**	200	2.0	16	38	4,000	1.0
G. E.	**9C24**	**Triode**	110	6.4	6.3	250	6,500	2.0
G. E.	**9C24**	**Triode**	220	3.4	6.3	250	5,000	2.0
Westinghouse	**WL-473**	**Tetrode**	110	2.5	..	..	3,500	1.0
Westinghouse	**WL-478R**	**Tetrode**	120	3.0	5	70	5,000	..
Westinghouse	**WL-479R**	**Tetrode**	120	7.5	5	206	6,000	..
Eimac	**3X2500A3**	**Triode**	110	3.5	7.5	48	3,500	2.0
RCA	**A2261B**	**Triode**	108	4.0	12.6	29	5,000	1.0

Figure 1
Chart of commercial v-h-f tubes.

**Delivered before the Sixth Annual Broadcast Engineers Conference at Ohio State University.*

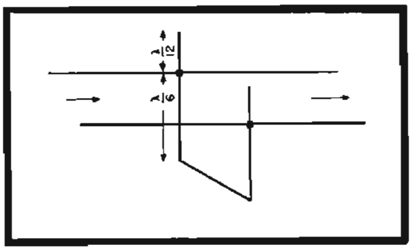


Figure 1
Third harmonic suppression filter.

TRANSMISSION LINES

Second Installment Offers Transmission-Line Harmonic Data, Basic Filter Equations and Typical Filter Designs for U-H-F. Matching Filter Systems Also Analyzed.

by L. R. QUARLES

Associate Professor of Electrical Engineering, University of Virginia

In the initial installment[1] of this series, it was pointed out that a quarter-wave line appears resonant regardless of the point along its length at which the circuit is connected. This characteristic offers a simple form of third harmonic suppression filter.

Suppose we wish to suppress the third harmonic in a signal being transmitted along a line as shown in Figure 1. An open line a twelfth wavelength long connected as shown will be a quarter wavelength long for the third harmonic. As previously shown,[1] this appears as a short circuit to the third harmonic, but presents a capacitive reactance at the fundamental frequency (since it is less than a quarter-wavelength long at this frequency). This capacitive reactance may be cancelled by an inductive reactance of equal value connected at the same point. Since a short-circuited line less than a quarter wavelength long presents inductive reactance, such a section may be connected as shown below the main line in Figure 1. The capacitive open section has a reactance, at fundamental frequency,

$$Z_c = -j\,Z_o \cot \beta l = -j\,Z_o \cot 30^\circ$$

This must be balanced by the inductive reactance of the short circuited section, given by the equation,

$$Z_L = j\,Z_o \tan 360/x,$$

where 1/x is the length of the section in terms of wavelength. Hence, equating these values,

$$\cot 30^\circ = \tan 360/x,$$

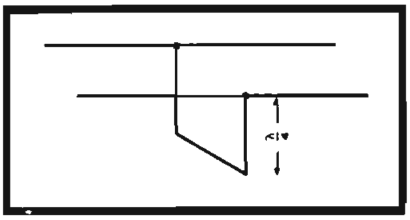
or x is 6. Thus the shirt-circuited line is 1/6 wavelength long. This combination of the open and short-circuited sections is in parallel resonance, and, for a dissipationless line, presents an infinite impedance across the main line. Even for a practical line with small losses the impedance is very high. It will be noted that the total length of the bridging sections is λ/4, thus bearing out the principle that a short-circuited quarter-wave line is resonant at any point along it.

To suppress even harmonics on the transmission line a short-circuited quarter-wave line may be bridged as shown in Figure 2. At the even harmonic frequencies this line is some multiple of a half-wavelength long and hence presents a very low impedance[1]. The bridged stub is thus almost a short circuit to the undesired even harmonics and a very high impedance to the desired signal, thereby suppressing the harmonics without appreciably affecting the fundamental signal.

These harmonic suppressing stubs should be mounted so their fields do not disturb the field of the main line. Hence, for open lines the suppressor sections should be mounted at right angles to the line. For coaxial lines, since the fields are contained within the line, the orientation of the stubs may be chosen to suit the designer.

While these circuits serve for single-frequency elimination filters, it is possible to use transmission-line sections as components of more elaborate networks to give band-pass filter characteristics. In such applications they offer the same advantages as were presented for their use as resonant circuit elements, i. e., ease of construction at very-high frequencies, high Q, low or zero external fields, etc. The high Q offers the possibility of sharper cut-off and smaller percentage band widths than can be obtained with lumped inductances and capacitances.

Figure 2
Even harmonic suppression filter.



Basic Filter Equations

Before discussing the use of lines as filters let us briefly review the basic filter equations and characteristics. It can be shown[2] that the propagation constant of a four-terminal network is given by the relation,

$$\cosh \gamma = 1 + \frac{Z_1}{2Z_2}, \qquad (1)$$

where γ is the complex propagation constant, Z_1 is the series impedance, and Z_2 the shunt impedance of the network, as shown in Figure 3. The propagation constant consists of two parts, the attenuation constant, α, and the phase constant, β. The first of these is a measure of the attenuation in the network, and the other is a measure of the phase shift caused by the network. If the attenuation constant is zero a signal suffers no loss in magnitude in passing through the network, but the wave may be shifted in phase, i. e., β may have a value other than zero. For such a case we can write

$$\gamma = \alpha + j\beta = j\beta .$$

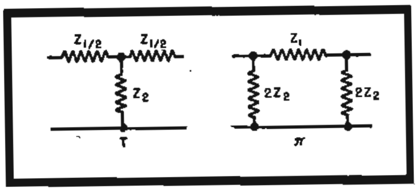
[1]Communications; May 1945.

[2]Everitt, W. L., *Communication Engineering*, p. 174; McGraw-Hill.

as FILTERS

Figure 3

Illustrating propagation constant of four-terminal network, where Z_1 is the series impedance and Z_2 is the shunt impedance of the network.



Equation (*1*) becomes, under this condition,

$$\cosh \gamma = \cos \beta ,$$

and hence $\cosh \gamma$ has values between + 1 and − 1. Outside of this range of values for $\cosh \gamma$ the network will attenuate, so, in filter terminology, we can say that the network is a filter having a pass band in the region where $\cosh \gamma$ has values between + 1 and − 1. For those who are unfamiliar with hyperbolic functions, briefly, they are mathematical functions bearing relations to the hyperbola very similar to those which the ordinary trigonometric functions bear to the circle. Values of these functions may be obtained from suitable tables just as for the more familiar circular functions.

Returning now to the study of the lines, we can consider a few special cases to indicate their possibilities as filters. Referring to Figure 4, the circuit consists of two identical sections of line, l_1 units long and having a characteristic impedance of Z_{01}, in series and a third section, l_2 units long and with a characteristic impedance of Z_{02}, connected as shown at the junction of the first two sections.

If we neglect the losses, the general equations of the transmission line[3],

$$E_s = E_r \cosh \gamma l + I_r Z_o \sinh \gamma l , \qquad (2a)$$

and

$$I_s = I_r \cosh \gamma l + \frac{E_r}{Z_o} \sinh \gamma l , \qquad (3a)$$

reduce to

$$E_s = E_r \cos \beta l + j\, I_r Z_o \sin \beta l , \qquad (2b)$$

and

$$I_s = I_r \cos \beta l + j \frac{E_r}{Z_o} \sin \beta l . \qquad (3b)$$

E_r and I_r are the receiving-end voltages and current, E_s and I_s are the corresponding generator and quantities, Z_o is the characteristic impedance, β is the phase constant, and l is the length of the line. βl is often more conveniently expressed in one of the equivalent forms:

$$\beta l = 2\pi l/\lambda = 2\pi f l/c .$$

Here λ is the wavelength, f the frequency, and c the velocity of propagation of the signal. Applying (*2b*) and (*3b*) to the line sections of Figure 4, and letting $l_1 = l_3 = l$, we get

$$E_m = E_r \cos 2\pi l/\lambda + j\, I_r Z_{01} \sin 2\pi l/\lambda , \qquad (4)$$

and

$$I_3 = I_r \cos 2\pi l/\lambda + j \frac{E_r}{Z_{01}} \sin 2\pi l/\lambda , \qquad (5)$$

Using Kirchoff's laws we have

$$I_2 = E_m / j\, Z_{02} \tan 2\pi l/\lambda , \qquad (6)$$

and

$$I_s = I_2 + I_3 . \qquad (7)$$

The solution of these equations for E_s and I_s lead to rather involved expressions, but by comparing them with the line equations, (*2a*) and (*3a*), we can get relations for the characteristic impedance and the propagation constant of the circuit of Figure 4. This leads to the equations[4]

$$Z_o = Z_{01} \sqrt{\frac{2 + \dfrac{Z_{01}}{Z_{02}}}{2 - \dfrac{Z_{01}}{Z_{02}} \cot^2 2\pi l/\lambda}} \qquad (7a)$$

and

$$\cosh \gamma = \cos^2 2\pi l/\lambda + \frac{Z_{01}}{Z_{02}} \cos^2 2\pi l/\lambda - \sin^2 2\pi l/\lambda .$$

From the relation for the pass band of a filter, this network will have a pass band when $\cosh \gamma$ is equal to or less than unity; hence cut-off occurs when

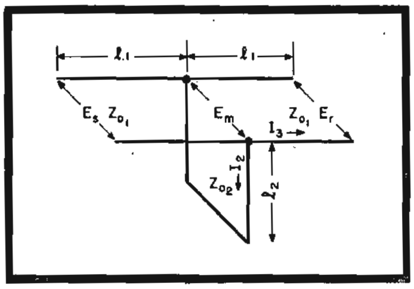


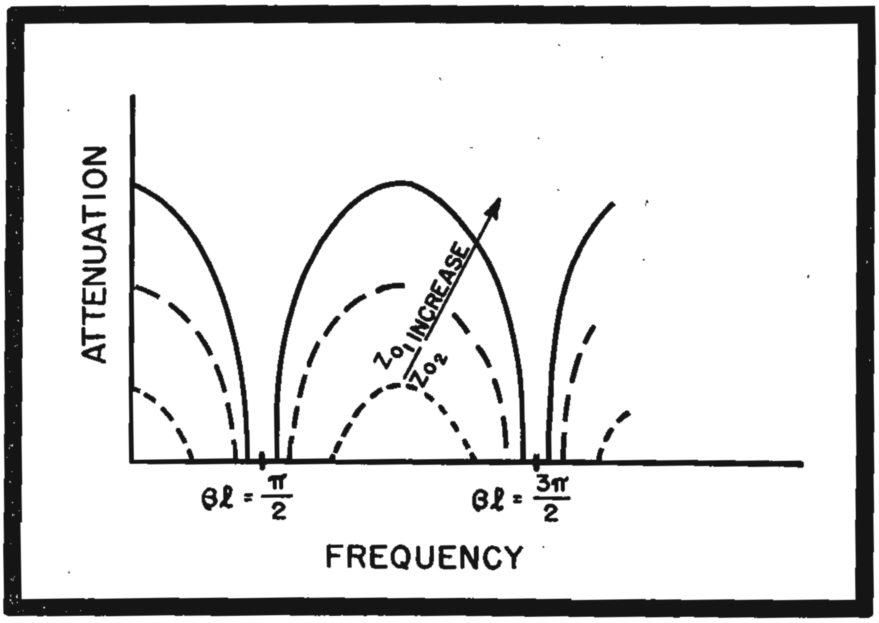
Figure 4
Band-pass filter.

$$\tan 2\pi f l/c = \sqrt{Z_{01}/2\, Z_{02}} . \qquad (8)$$

A given value of the tangent corresponds to an infinite series of angles 360° apart. Thus this filter represents a multi-band type, the centers of the

(*Continued on page* 44)

Figure 5
Frequency response of a line filter.



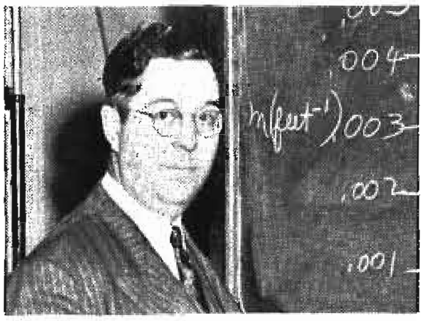
[3] Ware and Reed, *Communications Circuits*, p. 55; John Wiley.

[4] Mason and Sykes, *Bell System Technical Journal*, p. 275; July, 1937.

VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

W. J. McGONIGLE, President RCA BUILDING 30 Rockefeller Plaza New York, N. Y. GEORGE H. CLARK, Secretary

BEST WISHES TO V. Ford Greaves, pioneer member of VWOA, upon his retirement from the FCC. VFG joined the radio service unit of the Department of Commerce in 1912 and organized the Washington office. He served as traveling radio engineer and later as assistant chief engineer in charge of the broadcasting branch of the old Federal Radio Commission. He moved to San Francisco in 1934 and was very active in organizing the San Francisco chapter of VWOA. At the time of his retirement Mr. Greaves was supervisor of the western area of the Radio Intelligence Division of the FCC engineering department. Many happy days VFG. . . . Life member Arthur H. Lynch, in addition to his duties as New York manager for the National Company, also represents the Islip Radio Corporation who sell marine communications equipment. . . . Glad to hear from the Chicago group. L. W. Bear is chairman of the Windy City chapter; Herbert Wareing, vice chairman; G. G. Crose, secretary treasurer; and former Chicago chapter chairman George Martin is chairman of the membership committee. Expect to be receiving lively notes covering Chicago activities during the coming months. . . . R. J. Iversen, with the New York *Times* for 26 years, was teaching radio back in 1917. At seventeen he had joined the Navy as a petty officer. He served as a radio engineer installing the high-power transatlantic station at Chatham, Mass. An amateur in 1913, RJ went through the usual stages of spark coils, silicon detectors, eventually obtaining a copy of the then much coveted *audions*. He was in charge of the handling of around three million words of copy to the Byrd Antarctic expedition over a 9,000-mile link, building and installing the necessary high-frequency transmitters and receivers. In 1936 he initiated continuous communications for three years with the Ellsworth expedition around the Antarctic, the L. A. Boyd expedition in the North Polar regions and the Archibald Museum of Natural History expedition to Dutch New Guinea. RJ spent one year with the Marconi Company before joining the *Times*. . . .



Veteran member Ed Content, acoustical consultant at WOR and acoustical consulting engineer, during his recent appearance at the Ohio State Broadcast Engineers Conference, where he presented a paper on acoustical problems in broadcasting.

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Everett D. Gibbs is now chief engineer of the Radio Receptor Company, which is headed by life member Ludwig Arnson. . . . Charter and life member Frank Orth was an amateur in 1910, marine operator from 1912 to 1917 and then chief radio electrician in the United States Armed Guard for the duration of World War I. He then entered the marine radio construction field and remained until 1924, when he joined WNYC as radio supervisor. Leaving the New York City owned station in 1930, he joined CBS as chief construction engineer. Then he left CBS and for two years served as chief engineer of the Ed Wynn network. Returning to CBS he was appointed supervisor of master control in New York. . . . Jack Poppele, now vice president and chief engineer of the Bamberger Broadcasting Service, in addition to being a director of VWOA and president of the Television Broadcasters Association, is a member of IRE, AIEE, the Acoustical Society of America and the Motion Picture Society. . . . A pioneer wirelessman, now vice president of the Westinghouse Electric Corporation, Walter C. Evans, has joined our ranks as a veteran member. A cheery hello WCE. . . . W. C. Roberts is now at Ellington Field, Houston, Texas, with the Air Corps. . . . R. E. Smith has transferred from New Orleans to Norfolk, Va. . . . J. A. Balch, formerly president of the Mutual Telephone Company of Hawaii, is now located in Washington, D. C. . . . P. N. Partridge of Los Vegas, Nev., is now with us. . . . A. J. Martin of Forestville, Conn., is also another new VWOA member. . . . Harvey Butt, long a veteran member and a former director of VWOA, is now general sales manager of the Radiomarine Corporation of America. . . . John F. Hill, recently returned to this country, is now located at Allenhurst, N. J. . . . Just received an interesting memo from former secretary H. H. Parker. . . . Arthur H. Ehlert, one of the genuine oldtimers, has mailed in the necessary for '46. . . . T. H. Ellis, formerly with the Tropical Radio organization, is now with the Hazeltine Radio Corporation, Bayside, N. Y. . . . Carl Coleman, veteran member of VWOA, formerly chief of the radio department of Arnessen Electric Company, is now field engineer for Tropical Radio. . . . Stanley W. Fenton, until recently in the Washington offices of I. T. and T., is now with Federal Telephone and Radio Corporation at Newark. . . . It is now Major M. Fernandez, HQ 1300th AAF BU ICDATC, care of postmaster New York. . . . Our own 'Bill' Halligan is chairman of the committee on amateur activities of the Radio Manufacturers Association. Sorry WJH couldn't be with us in February. He always enjoys our cruises so. And especially when he has the opportunity of meeting his old Boston crony Ted McElroy, who during World War II did his bit by earning five Army-Navy "E" Flags, and serving with merit in the United States Maritime Service as a Radio Officer. Ted will never tell you, but the next ship in his convoy was sunk by enemy action and on many occasions things were really hot. . . . James Marcroft, of Globe Wireless, after winning one of the door prizes at our last informal social decided to become a VWOArian. . . . D. A. Myer of the Westinghouse radio stations in Philadelphia has also mailed in the necessary. This and the splendid response from the majority of VWOA members in keeping their dues up to date, has made executive secretary 'Bill' Simon very happy.

F-M Transmitters Using PHASE MODULATORS

by N. MARCHAND*

Consulting Engineer
Lowenherz Development Company

OTHER MEANS OF OBTAINING PHASE modulation for use in a f-m transmitter were described by W. E. Phillips and M. Marks of Raytheon at the recent sixth annual conference of broadcast engineers at Ohio State University. In the systems analyzed a crystal oscillator is used to obtain the stabilized center frequency and is phase modulated with corrected audio voltages so that true f-m is obtained at the output.

Describing the systems, they said:

"One of the simplest means of obtaining a voltage of variable phase is by the use of a series circuit. A resistor in series with a reactance has a voltage impressed across the combination. The drop across the resistor may be made to vary in phase with respect to the applied voltage by varying the resistor. If this resistor is replaced by a linear element such as a vacuum tube anode circuit, phase modulation may be accomplished at signal frequency."

(A circuit employing two such phase shifters in series is shown in Figure 1.)

"Another interesting circuit uses a bridge method in which variations in R from zero to infinity cause a phase shift of 180° without amplitude changes."

(This bridge circuit is shown in Figure 2. The bridge circuit consists of R_A, R_B, and a series combination of *R* and a capacitor. *R* is paralleled with a 6AC7 that varies the effective resistance across the terminals of *R*. As the effective resistance of *R* in parallel with the 6AC7 is varied, the voltage between the tap where R_A and R_B join, and the point where *R* joins the capacitor, varies in phase while maintaining a constant amplitude.)

"A constant-impedance circuit has also been used. This consists of an inductance in parallel with a capacitor with a variable resistance connected in the capacitor branch. This circuit, when supplied from a constant-current source, will have a voltage across it which may be varied in phase with respect to the generator internal voltage."

(This circuit with its phasor diagram is illustrated in Figure 3.)

"It must be remembered that a direct f-m system is a *flat* system when frequency response is taken from modulator input to discriminator output, while a phase modulator, under such conditions, has a rising characteristic which is normally corrected in the audio stages ahead of the modulator. Under such conditions, a phase modulator would have a greater noise level than a system using direct f-m everything else being equal.

"To correct a phase modulator to give results equivalent to that of a direct f-m system a filter could be used, this filter having the required slope characteristic and inserted in one of the r-f stages following the modulator.

"A number of circuits have been built up and tested to obtain experimental data as to distortion, noise level and frequency response. The simplest is the series circuit. This circuit suffers from the disadvantage that the attenuation per section is considerable and results in a rapid decrease in voltage along the string.

"The bridge circuit has the advantage of almost complete freedom from amplitude modulation. The greatest disadvantage is the fact that the output voltage of each stage is balanced to ground and must be converted to an unbalanced voltage to supply the next section. This can be done by means of a balancing transformer but the transformer must have a bandwidth of at least twice the highest signal frequency. It adds to the complexity of adjustment and to the components required. Four or five stages of this type of shifter give acceptable results.

"The most promising circuit investigated is the constant-impedance type which makes use of the cathode-to-ground re-

Instructor in Graduate Electrical Engineering courses, Columbia University.

Figure 1 (below)
A phase shifter using a series circuit of resistor and capacitor, where the plate resistance of a 6J5 is used as the resistor. Two cascaded stages of phase shift are shown.

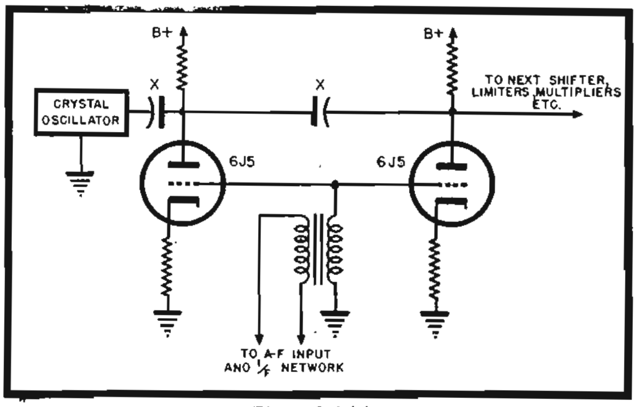
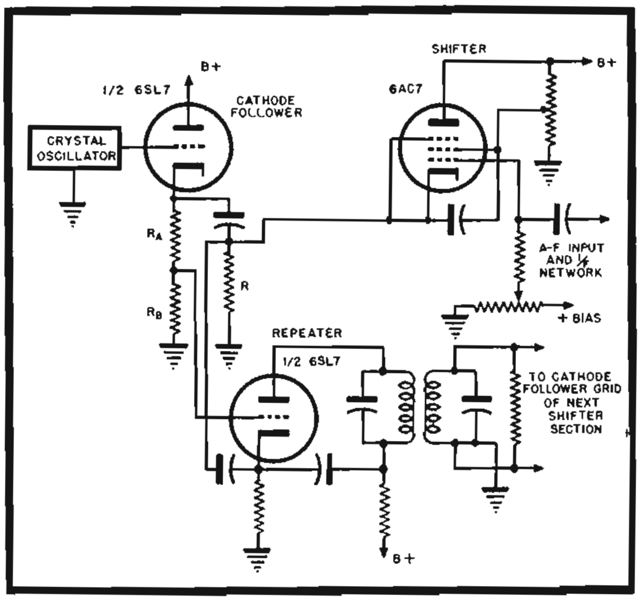


Figure 2 (right)
Bridge-type phase shifter composed of two fixed resistors, R_A and R_B, variable resistance *R* in parallel with a 6AC7 and a capacitor. The output is taken between the junction of R_A and R_B, and the junction of *R* and the capacitor.



sistance of the vacuum tube to change the phase angle of a parallel inductance-capacity circuit which is fed from a constant-current source such as a pentode plate circuit."

(This circuit is illustrated in Figure 4.)

"This circuit has the advantage of being a double angle shifter and has relatively constant impedance.

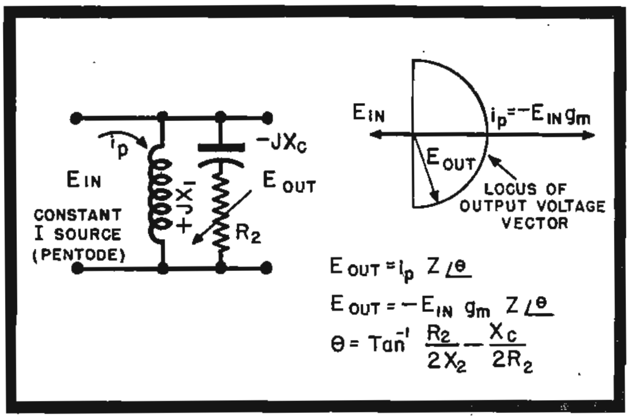
"It was found that distortion lower than that obtained by analysis of the tangent function curvature could be obtained by measurement. This was due to the choice of tube operating points such that the effects of tube curvature compensates the tangent curvature.

"The performance of any of the circuits could be improved by using inverse feedback from a discriminator back to the signal input of the modulator. It is desirable to have the discriminator operate at a fairly high frequency multiple of the crystal oscillator. The 1/F correcting network must, of course, be included in the feedback loop."

In the May Issue Installment, Methods of Obtaining F-M from Phase Modulation Were Discussed. It Was Shown That if the Audio Voltage Were Properly Corrected by Having Its Amplitude Inversely Proportional to its Frequency, the Output of a Phase Modulator Would be True Frequency Modulation. In This, the Sixth Installment, Phase-Modulator Circuits Used in Commercial Transmitters are Analyzed.

Frequency Deviation Multiplication

The source of r-f in the Armstrong method of f-m generation is a crystal oscillator at about 200 kilocycles. The phase deviation employed is less than 0.2 radians so that there will be negligible distortion present in the output. This means that the multiplication necessary is in the neighborhood of 8,000 times. If the 200-kc signal were multiplied 8,000 times directly it would yield an output frequency for the transmitter of over a thousand megacycles. Inasmuch as an output frequency of about 100 megacycles is desired a method of double conversion is usually employed. The first method that was employed is shown in the block diagram of Figure 5. Also shown are some frequencies and multiplication figures which may be used to obtain a signal at 105 mc. The original oscillator, at a frequency of 200 kc, and the modulator, with a maximum phase deviation of 0.2 radians, generate a signal with a frequency deviation, at the lowest modulating frequency, of about ±10 cycles. To obtain a frequency deviation of 75 kc it is necessary to use frequency multipliers with a resultant multiplication of 7,500. As shown in the diagram, frequency multipliers with a multiplication of 100 are first used to obtain a signal at 20 mc with a frequency deviation of 1 kc. A converter used at this point steps the frequency down to one-seventy-fifth of the final carrier frequency desired. For instance, if a final carrier frequency of 105 mc is desired, the frequency is stepped down to 1.4 mc by beating it with a crystal generated frequency of 18.6 mc. Since this is equivalent to subtracting the beating frequency, the deviation remains the same at the out-



$$E_{OUT} = i_p \, Z \angle\theta$$

$$E_{OUT} = -E_{IN} \, g_m \, Z \angle\theta$$

$$\theta = \tan^{-1} \frac{R_2}{2X_2} - \frac{X_c}{2R_2}$$

Figure 3

A constant-impedance (Z) phase-shift circuit with its phasor diagram. A constant-voltage output is obtained and as R_2 is varied, the phase of the output voltage is varied. A pentode with a transconductance of g_m is used as a constant-current source.

Figure 4

Constant-impedance type of phase modulator which makes use of the cathode-to-ground resistance of a vacuum tube to change the phase angle of a parallel-inductance capacity circuit.

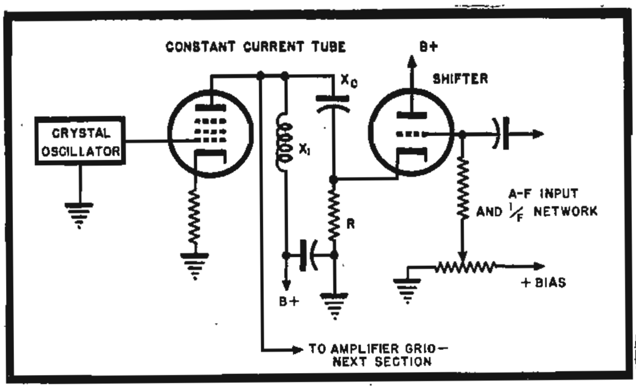
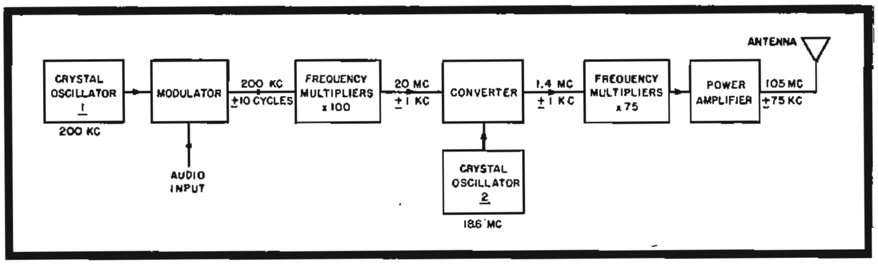


Figure 5

Original method of multiplication employed to obtain large-scale multiplication. Any deviation of either crystal affects the output.



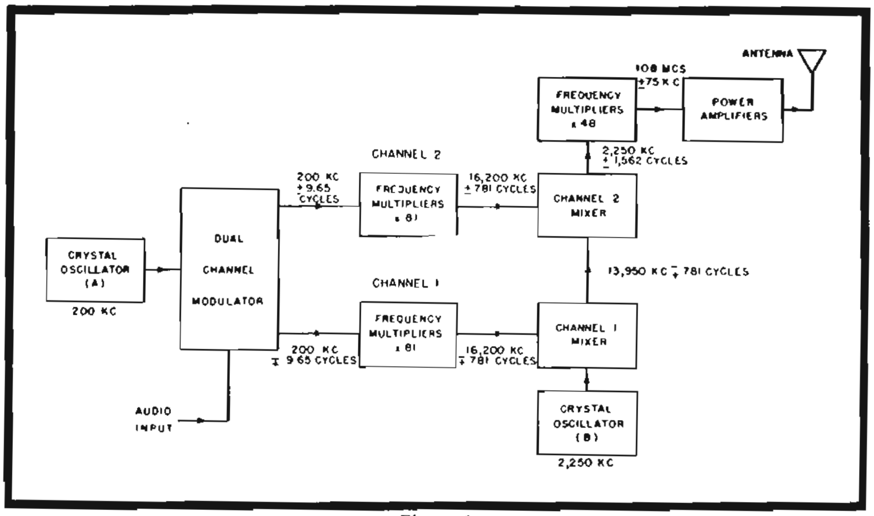


Figure 6

Block diagram of the circuit used to obtain large scale multiplication of small-frequency deviations where the output frequency stability is only dependent on the stability of one crystal-generated frequency.

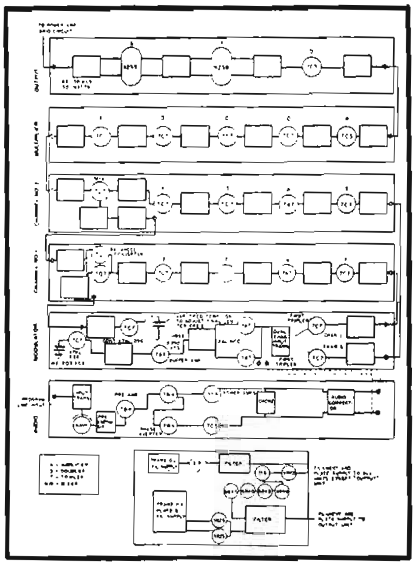


Figure 8

Block diagram of the dual-channel modulator used in REL transmitters.

put of the converter as at the input. Thus a 1.4-mc signal is obtained with a deviation of 1 kc. A series of multipliers with a multiplication of 75 is then utilized to obtain the final desired signal to apply to the power amplifier stage.

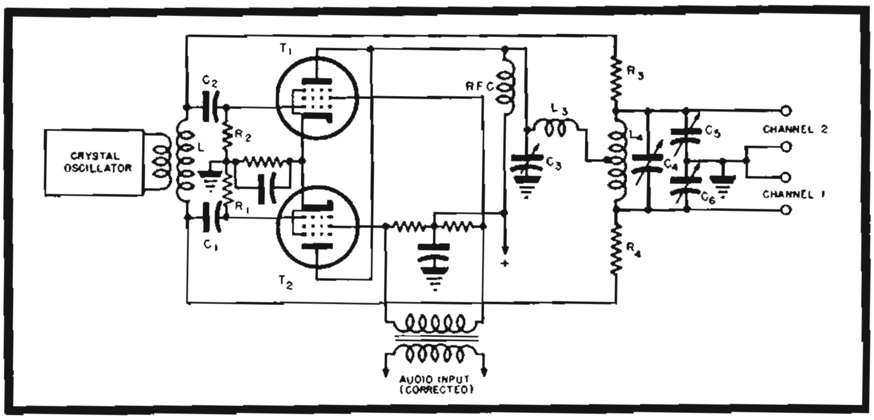
This method of multiplication suffers from one very bad defect inasmuch as the final frequency is dependent on the stability of both crystal oscillators. If either one drifts then the output frequency will also drift. Thus the final stability of the output frequency will suffer. To avoid this defect the circuit shown in the block diagram of Figure 6 is employed. This circuit yields an effective multiplication factor of 7,776 so that a frequency deviation of about 9.65 cycles is necessary. The dual channel modulator can be considered to be two modulators, back to back, using the same oscillator and the same audio input. It produces two outputs. They both have the same center frequency, but when one deviates in the plus direction the other deviates in the negative direction. It is equivalent to reversing the phase of the audio voltage for one of the outputs; indicated in the figure by using ± for one output and ∓ for the other output. The outputs are fed into two separate channels, channel *1* and channel *2*. Each of these channels consist of a number of multiplier stages with an overall multiplication of 81. Hence at the output of each channel the signals have a frequency deviation of 781 cycles, each deviation still being the reverse of the other. A crystal oscillator, *B*, at 2,250 kc is used to convert the frequency of channel *1* to 13,950 kc with a deviation of ∓781 cycles. This signal is then mixed with the output signal of channel *2*. The center frequency of the output of this mixer will always be the frequency of crystal oscillator *B*. In other words, the frequency of oscillator *A*, at the input to the dual-channel modulator, does not enter into the determination of the frequency of the signal obtained from the channel *2* mixer, and therefore its stability does not enter into the stability of the final signal output. Thus the stability of the transmitter is only dependent now on the stability of a single crystal oscillator.

Since the deviations obtained at the output of the channel *1* mixer and at the input from channel *2* are opposite in sign, the two deviations will add resulting in a signal at 2,250 kc with a frequency deviation of ±1,562 cycles. The final frequency multiplier stages have a resultant frequency multiplication of 48. Accordingly the input to the power amplifier stages is at 108 mc with a frequency deviation of ±75 kc.

In Figure 7 is shown a dual channel modulator. Two tubes, T_1 and T_2, are employed with push-pull audio and push-pull r-f inputs. Grid modulation is employed using the screen grid. The outputs of the two tubes are combined in parallel in the plate circuits so that the carrier is eliminated and only the sidebands are obtained. The sidebands are shifted 90° in phase by having the carrier input to the tubes shifted 90° through the two resistor and capacitor networks, consisting of R_1 and C_1, and R_2 and C_2. The reactances of capacitors C_1 and C_2 are very much greater than the values of resistors R_1 and R_2, so that the voltages fed into the two tubes are 90° out of phase with the voltage across the inductance *L*. The carrier frequency appearing across *L* is now combined with the sidebands so that two channels with opposite deviations are obtained. This is done in the inductance, L_4. The carrier is applied

Figure 7

Dual-channel modulator with two modulator tubes fed with r-f in push pull and audio voltage in push pull, while their plate circuits are in parallel. The carrier and sidebands are combined at the output to yield a dual-channel output.



across the coil, being in reality in push-pull, while the sidebands are applied from the center tap of the coil to ground, actually in parallel across each half of the coil to ground. Resistors R_3 and R_4 are isolating resistors. Inasmuch as one signal is in push-pull and the other is in parallel the sum will be obtained across one terminal of L_4 to ground, and the difference will be obtained across the other terminal of L_4 to ground. This means that one output will have the reverse frequency deviation of the other output if the outputs are taken from each terminal of L_4 to ground, as shown. The inductance, L_3, is used to compensate for the fact that the currents from the sideband generator will flow in opposite directions in the two halves of the coil, L_4. The variable capacitors shown are tuning capacitors.

A Dual-Channel Modulator and Transmitter

In Figure 8 is shown a unit block diagram of the dual channel modulator used in the REL transmitters. This modulator unit follows the pattern shown in Figure 6 where two channels serve to eliminate any instability due to the original oscillator used at the input to the dual channel balanced modulator. Thirty watts of power at anywhere from 88 to 108 megacycles is available at the output of the modulator unit. A convenient construction allows each chassis in the modulator section of the cabinet to be mounted on hinges thus allowing them to be swung out separately into position for easy access to all components. In maintenance procedures it is necessary that operating voltages be measurable on all principal components. Accordingly the principal circuits in the modulator chassis are equipped with built-in meters and all other circuits may be examined through tip jacks. For this latter use a high-impedance volt-ohm meter is supplied as an integral part of the transmitter. The audio input level for 100% modulation is + 12 ± 2 dbm. The input impedance is 600 ohms balanced to ground and the overall frequency response is within ± 1 db from 50 to 15,000 cycles at 25%, 50%, and 100% modulation. It of course maintains a center frequency within ±2,000 cycles which is the FCC ruling. The maximum frequency swing available is ±100 kc.

One of the great advantages in an f-m transmitter is that class C amplifiers can be used in the power amplifier stages inasmuch as the amplitude of the output signal is constant. This

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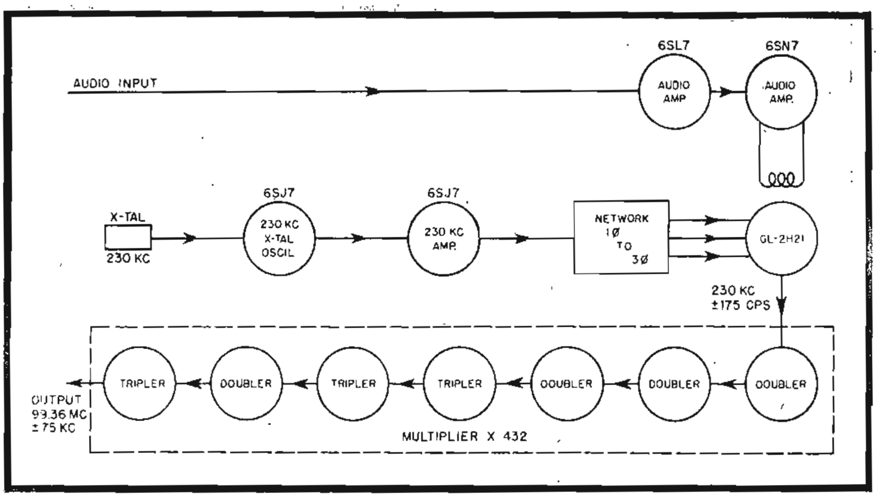


Figure 10
Block diagram of the exciter unit of a phasitron transmitter.

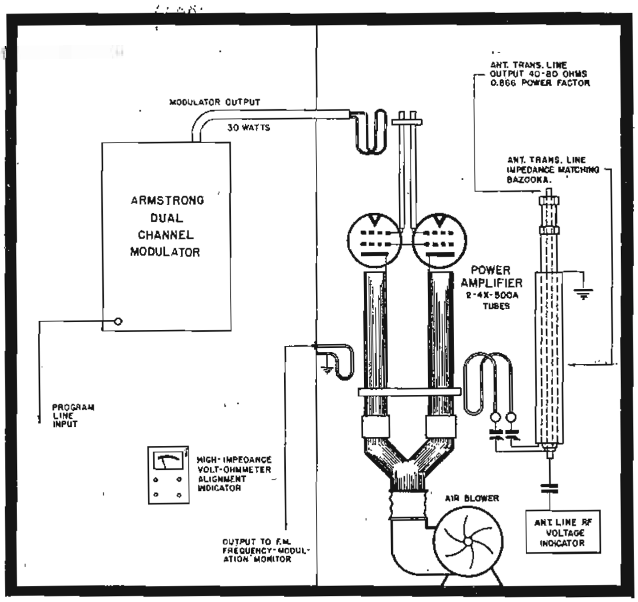
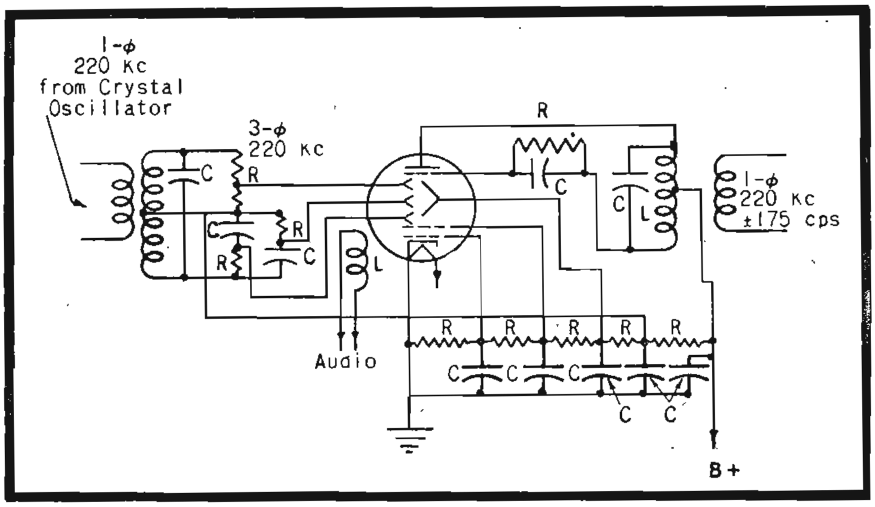


Figure 9
Power output stage for a 1-kw output employing two 4X-500As in push pull. (*Courtesy REL*)

Figure 11
Circuit for the GL-2H21 phasitron modulator. Audio voltage is applied to a coil, *L*, surrounding the tube.



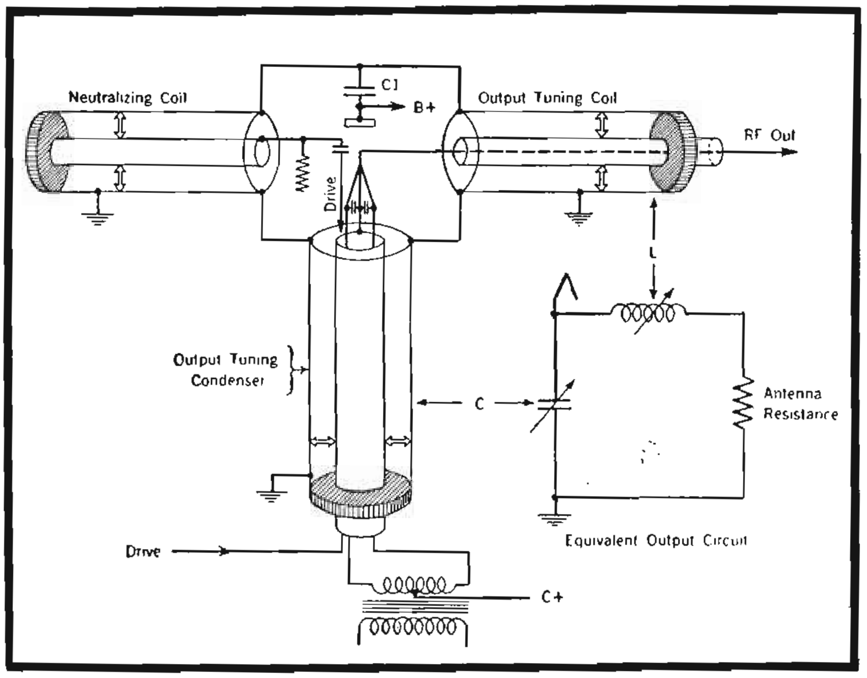


Figure 12
Grounded plate circuit used in the power amplifiers of the W.E. f-m transmitters of 1 to 10-kw output.

means usually a very efficient use of power in the final stages. In Figure 9 is shown the power amplifier stage of one of the transmitters using a dual-channel modulator. Inasmuch as the frequencies are in the neighborhood of 100 mc, transmission line tuning is used throughout. The 30 watts of power is coupled from the dual channel modulator into the grid transmission line which constitutes the input circuit of two 4X-500A tubes in push-pull. This circuit is tuned by means of a moveable shorting bar. The output circuit is also a tuned transmission line, but this time the lines are made large to carry the power and also to conduct the cooling air to the plates of the tubes. A small amount of power, 2 watts, is taken off for use at the monitor and the remainder is coupled into a transmission-line conversion and matching transformer so that the output is matched into a ⅞" diameter single concentric antenna transmission line. This power amplifier has a plate efficiency of over 70% under normal operating conditions. For 1,000 watts output the transmitter power input, including the dual-channel modulator is 3,750 voltamperes.

For other power outputs only the power amplifier stage has to be changed. To obtain an output of 250 watts the output of the dual channel modulator is fed into a pair of 4-125As. This transmitter can be converted into a 3-kw transmitter by feeding the output from the pair of 4-125As into a pair of WL478s. It will be noticed that in f-m it is possible to pyramid a transmitter If a low-power transmitter is desired it is obtained with the power output that is needed. If the power has to be increased at any future time it is only necessary to add another stage of power amplification, or more if necessary, and the original transmitter used as an exciter unit.

Phasitron Transmitter

In Figure 10 is shown a block diagram of a G. E. transmitter exciter unit employing the phasitron tube, GL-2H21. In this circuit a deviation of ±175 cycles at 230 kc is obtained at the phasitron. A series of multipliers are used, resulting in an overall multiplication of 432. This produces an output of 99.36 mc with a frequency deviation of ±75 kc.

The circuit for the GL-2H21 phasitron modulator, which is used, is shown in Figure 11. Single-phase voltage from a 220-kc crystal oscillator is broken up into a three-phase voltage by means of a center-tapped transformer and a number of *RC* circuits. These voltages are impressed on the proper terminals of the tube and the audio voltage is fed into a coil surrounding the tube. From plate 2 to ground through B+ is placed the tuned circuit across which the output is taken off. To change the output frequency of the transmitter it is necessary to change the frequency of the crystal oscillator so that the r-f frequency input to the phasitron is 1/432 of the final frequency desired.

The output from the exciter unit can be used to obtain whatever output power is desired. This is done by using the proper power amplifier unit following the exciter unit. For an output of 250 watts, an intermediate power amplifier using a GL829B and a final power amplifier with two Eimac 4-250As are utilized. The carrier frequency stability is ±1,000 cycles, half of that required by the FCC. It is capable of a carrier swing of ±100 kc, with less than 3% rms distortion over a 50 to 15,000-cycle frequency range. The power input, for an output of 250 watts, including the exciter unit is 1.3 kw at 208/230 volts, 50/60 cycles. A continuously variable input voltage control makes it possible to operate with any power supply voltage in the range 195-245 volts.

Grounded Plate Amplifier

A power-amplifier circuit that may be employed in the 1 to 10-kw output range, was recently described by J. F. Morrison of Bell Telephone Labs at the Ohio State broadcast engineering conference.

Describing this amplifier, Mr. Morrison said that at the higher frequencies, lead lengths and stray capacities to ground result in reactances of the same order of magnitude as are normally required in the tuned circuits for input and output and for those necessary for neutralizing.

These difficulties have been overcome, he reported, by the use of an air-cooled tube in a circuit which permits the tube to be used as a grounded plate amplifier and by employing sections of short-circuited transmission lines of the tuning elements; Figure 12.

In the usual conventional form of a radio amplifier circuit, he said, the large stray capacitance between plate and ground results not only in large tuning coil losses but in sharpening the tuning and thus introduces distortion. With the grounded plate circuit, the stray plate capacitance to ground is in parallel with the grounding capacitor which is used to block the d-c path to ground of the plate supply, and thus has no effect on the operation of the circuit. Only the capacitance of the filament to ground need be considered with this arrangement, and this capacitance is very much smaller than that between the plate and ground.

Thus, he continued, the usual plate tuning coil is replaced by a coil between filament and ground. If this coil be formed by a pair of copper tubes in parallel, the filament leads may be threaded through the bore of one of the tubes, and the grid driving potential supplied through an inner conductor of the other. At the filament end of this coil the copper tubes are connected to the filament through capacitors, and the other end of the coil is grounded, he explained. Thus, the filament current and grid-driving voltage are delivered at the required circuit locations with the sources (driver and filament transformers) maintained at ground potential.

References

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W. E. Phillips and M. Marks, *Phase Modulators*, Sixth Annual Broadcast Engineer's Conference; 1946.
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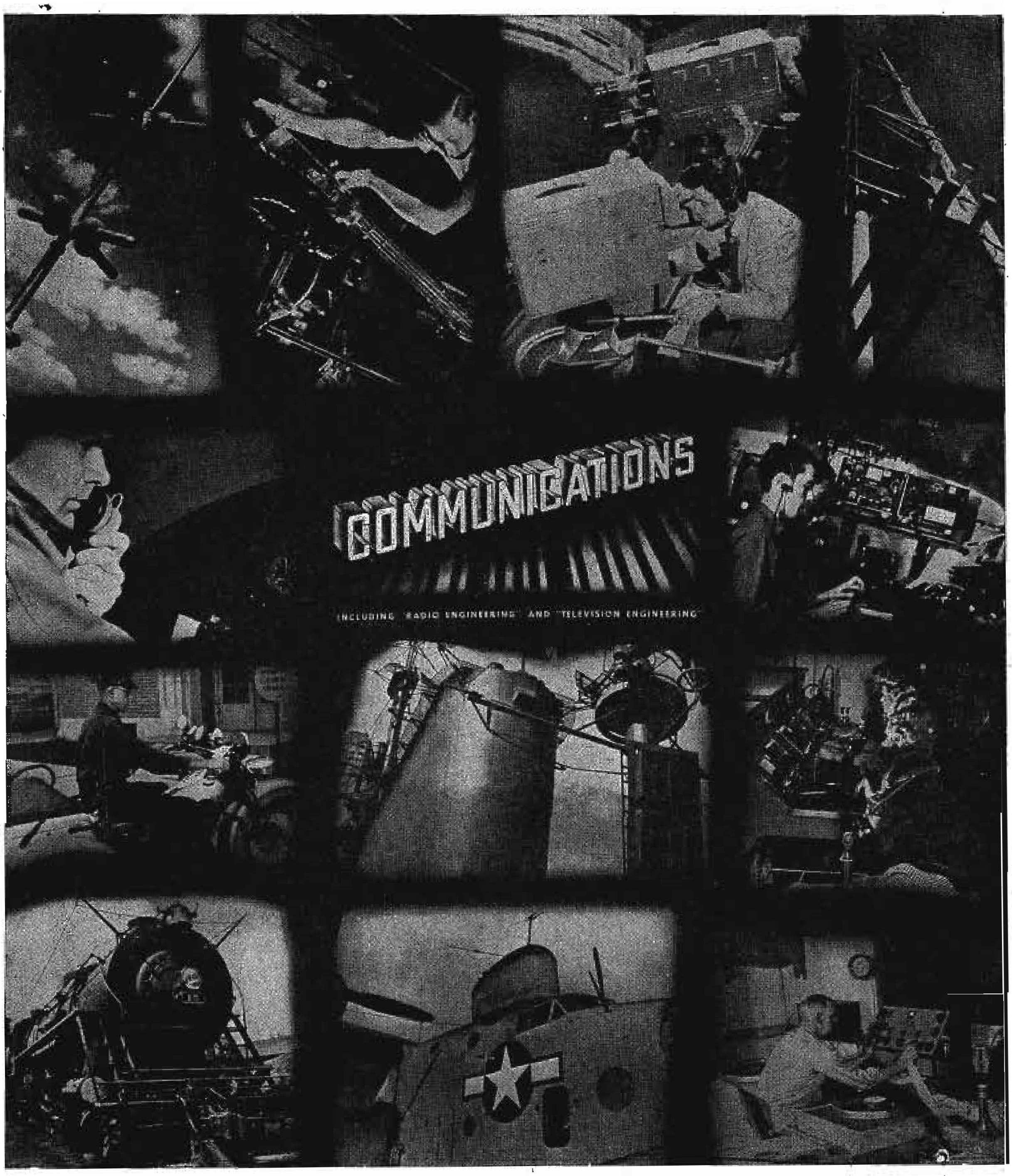

COMMUNICATIONS
INCLUDING "RADIO ENGINEERING" AND "TELEVISION ENGINEERING"

TRANSMISSION LINES

(*Continued from page* 35)

pass bands being given by the relation

$$f_m = (2n + 1)c/4l \,. \qquad (9)$$

where n is 0, 1, 2, 3, ... and the other quantities are as defined before. Figure 5 shows the attenuation characteristic of such a filter for various values of Z_{01}/Z_{02}. It is seen at once that the width of the pass band and the sharpness of cut-off can be regulated to some extent by a choice of Z_{01}/Z_{02}. This range of charactertistics is not, however, unlimited since the range over which Z_{01} and Z_{02} can be varied is limited by the physical construction of the lines.

Filter Design

As an example of such a filter, let us design a filter to match a 300-ohm source and to have a pass band of approximately 400 megacycles with a mid-frequency of 700 megacycles. From (*9*) we get, by substituting for f, n, and c,

$$700 \times 10^6 = \frac{(2\times 0 + 1)\,3\times 10^{10}}{4l} \,.$$

This gives a value of 10.75 cm for l, the length of each line section. Assuming, for a trial, Z_{01} as 130 ohms, and using equation (*7a*) to find Z_{02}, we get upon substitution for Z_0, Z_{01}, l, and λ:

$$300 = 130\sqrt{\frac{2+\dfrac{130}{Z_{02}}}{2-\left(\dfrac{130}{Z_{02}}\right)^2 \cot\dfrac{2\pi\times 10.75}{43}}}$$

Hence

$$Z_{02} = 20 \text{ ohms.}$$

Now substituting 130 for Z_{01} and 20 for Z_{02} in equation (*8*), we have for the cut-off frequencies:

$$\tan\frac{2\pi f_1 \times 10.75}{3\times 10^{10}} = \sqrt{\frac{130}{2(20)}}$$

$$f_1 = 475 \text{ mc.}$$

$$\tan\frac{2\pi f_2 \times 10.75}{3\times 10^{10}} = -\sqrt{\frac{130}{2(20)}}$$

$$f_2 = 925 \text{ mc}$$

These are close enough to our specified limits, but if such had not been the case, a new value of Z_{01} would have been necessary. This would give a new value of Z_{02}. Thus the process of trying values of Z_{01} would have to be repeated until the limits were satisfied. The radii of a coaxial line or radius and spacing of an open line can be computed from the equations for the characteristic impedance,

$Z_0 = 276 \log b-a/a$ for the parallel line, and

$Z_0 = 138 \log b/a$ for the coaxial line,

where b and a are spacing and radius for the parallel line and the respective radii for the coaxial line.

If we now examine a circuit similar to Figure 4, but make $Z_{01} = 2Z_{02}$, and the lengths of the sections adjustable, and follow an analysis similar to the one outlined above, we get still other conditions for pass bands. Omitting the details we find that the cut-off frequencies of such a network are given by the equations

$$f_1 = \frac{c}{4(l_1 + l_2)} \quad \text{and} \quad f_2 = c/4l, \qquad (10)$$

where l_1 is the length of the series line sections, and l_2 is the length of the short-circuited bridging line. Here we can adjust the pass bandwidth by the choice of l_2 since this varies f_1 without affecting f_2. If the section is very short, f_1 and f_2 have almost the same value and the band is very narrow. For such narrow bands the characteristic impedance is given by the relation

$$Z_0 = \frac{4l_1 Z_{01}}{\pi l_2} \,. \qquad (11)$$

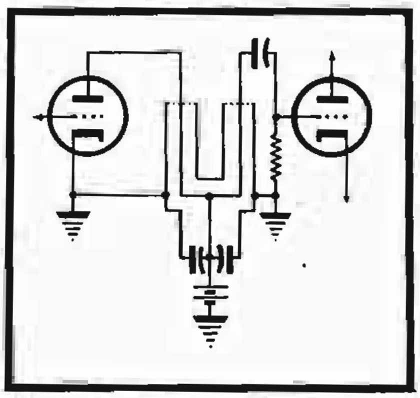
The mid frequency of the pass band is given by the equation

$$f_m = \frac{c}{(4l_1 + 2l_2)} \,. \qquad (12)$$

The attenuation versus frequency curve for this filter is very similar to the one shown in Figure 5.

Such a filter, with proper choice of characteristic impedances may serve as the interstage coupling device for

Figure 6
A line filter applied to a vacuum-tube circuit.



vacuum tubes. In this application it gives a more uniform gain over a band whose width is easily controlled than could be obtained with more conventional circuits. Interelectrode capacitance effects can be absorbed in the lines by adjusting their lengths.[1] Figure 6 shows a circuit for such an application.

The transmission line filter can be constructed to serve the dual functions of filtering and impedance matching. Such an impedance transforming network will introduce only small losses because of the high Q of the lines and will also be capable of carrying a large amount of power. As an example of such an application let us consider a network, Figure 7, which consists of a short-circuited line of length, l_2, and characteristic impedance, Z_{02}, bridged across the output of a line of length, l_1, and characteristic impedance, Z_{01}. We can further simplify the problem by limiting it to two special cases, first when $Z_{01} = Z_{02}$, and second when $l_1 = l_2 = l$.

In the first case a solution of the network, in a manner similar to that outlined for the filter considered earlier, yields the relations:

$$\cosh\gamma = \cos\frac{\omega l_1}{c}\sqrt{1+\frac{\tan\frac{\omega l_1}{c}}{\tan\frac{\omega l_2}{c}}}, \qquad (13)$$

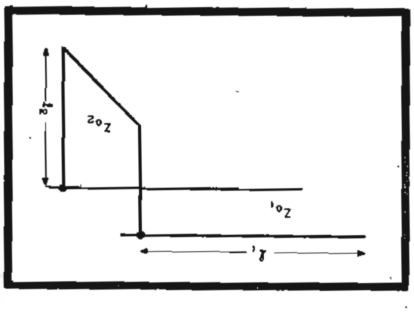
$$Z_{in} = Z_{01}\sqrt{-\tan\frac{\omega l_1}{c}\tan\frac{\omega(l_1+l_2)}{c}}, \qquad (14)$$

$$n^2 = 1+\frac{\tan\frac{\omega l_1}{c}}{\tan\frac{\omega l_2}{c}}, \qquad (15)$$

where Z_{in} is the input impedance of the network, n^2 is the effective impedance transformation ratio, i. e., $n^2 = Z_{in}/Z_{out}$, and ω is the angular velocity, $2\pi f$. Other quantities are

(*Continued on page* 48)

Figure 7
An impedance matching filter.



V-H-F COIL

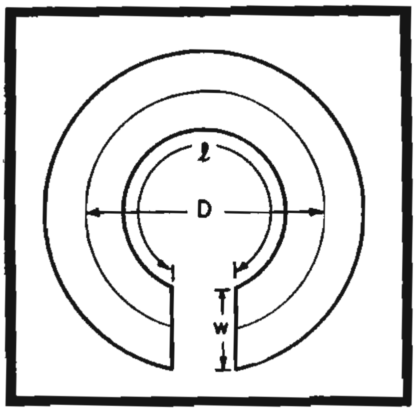


Figure 2

Disc type of coil constructed of sheet stock. When this type of coil expands due to heat, the length, width and diameter increase. Increases in length and width increase the value of inductance while any increase in width serves to decrease the inductance value.

In a previous paper[1] it was noted that the use of single turn or loop-type coils displayed a marked superiority to standard-type coils at the higher frequencies, in both Q and frequency stability. In addition, it was noted that flat, disc-type coils offered the best stability for ambient-temperature conditions.

Additional experiments have been conducted to determine if there were other forms of inductance whose Q might be comparable to that of the disc-type coil, but with improved temperature stability.

New Inductances Studied

Some of the inductances tested are shown in Figure 1. In *a*, *b*, and *c* are shorted resonant lines constructed of tubing, metal strip, and sheet stock. The strip and sheet stock types were cut from 16-gage copper sheet. A tubing-type resonant line, bent in a semi circle is shown in *d*. In *e* we have the semi-circular resonant line of *d*, with the two lines bent at an angle of 90°.

Essentially, the problem of constructing inductance with high Q and good temperature stability involves both mechanical and electrical issues. Most inductance shapes will be found to have some dimension which compensates for increases in inductance value, due to expansion. Figure 2 shows a disc-type coil, which may be used to explain this action. Ordinarily, a coil would have three dimensions influencing its value of inductance. These are length, width, and thickness of the metal used. In the disc-type coil shown the influence of thickness has been reduced to a minimum. Any increase in the length of the inductance would be accompanied by an increase in the diameter of the coil, and an equivalent increase in its width. An increase in the width serves to decrease the value of inductance, while an increase in the diameter of the coil increases the inductance value. Thus, the width of the metal is a form of temperature compensation. It would seem that if the width of the coil were made large enough, sufficient compensation could thereby be created to produce a zero-temperature coefficient. However, this does not work out in practice, since the compensation effect decreases with an increase in width. This non-uniformity in compensation was found to hold for all types of inductance tried.

An inductance constructed of copper was found to increase its dimensions approximately .17% for an ambient temperature range of 100° C. Therefore, tests were conducted with only a slight change in dimensions, since large changes in dimensions would not be indicative of the particular form's stability. At the same time the possibility of error would be increased if very small changes in dimensions were used. For this reason 10% changes were used as the most reasonable compromise. It should be pointed out that any improvement in stability is important, since the constant expansion and contraction of an inductance causes an elongation of the component. Therefore, improved temperature stability would insure less adjustment of LC circuits over a period of time.

In every inductance shape studied the first step was to determine the Q. If the value of Q was found to be comparable to the disc-type coil, for equal values of inductance, the next step was to determine the compensating dimension, and the extent of its influence. In some shapes the compensation increased as the inductance value decreased, so that fairly close values of inductance had to be used in comparing stability.

Resonant Lines As Inductances

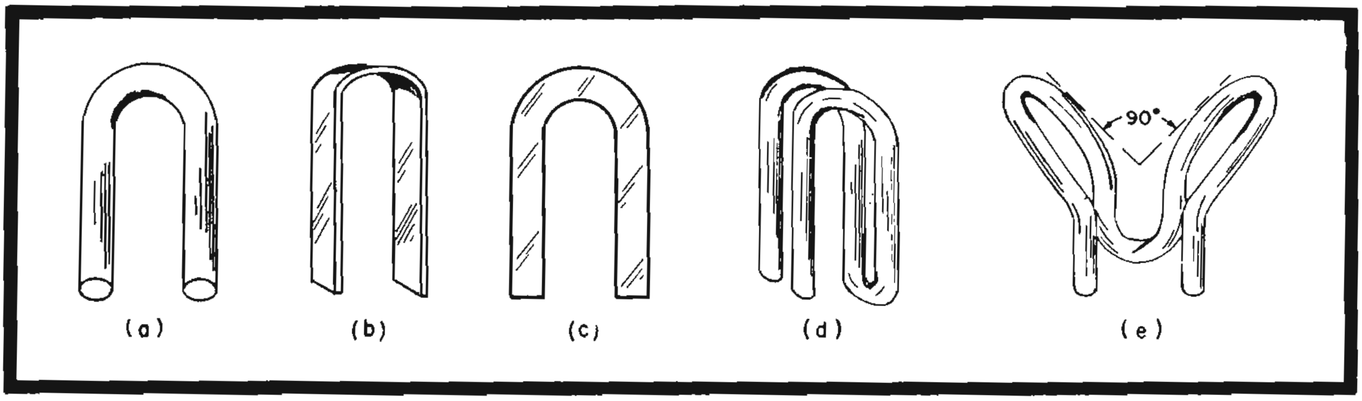
The first coil shape tried was the resonant line used as an inductance. When used as inductances, at other than resonant lengths, or over a range of frequencies, the Q of resonant lines was found to be less than that of the disc-type coil.

Their frequency stability is a func-

[1]September, 1945, Communications.

Figure 1

Various types of coil forms tried for both Q and stability. Forms shown in *a*, *b*, and *c* are resonant lines constructed respectively of tubing, strip and sheet stock. In *d* we have a resonant line bent in a secondary loop to conserve space. In *e* appears the same coil as *d* with the two loops spread at an angle of 90°.



DESIGN

Analysis of Shorted Resonant Lines Constructed of Tubing, Metal Strip and Sheet Stock; Temperature Stability Problems; Influence of Stock Shapes on Q. Relative Qs of Strap, Flat and Tubing Coil Shapes Offered.

by ART H. MEYERSON

New York Fire Department Radio Laboratory

tion of their increase in length; from the equation

$$Z_s = Z_o \tan \frac{2\pi l}{\lambda}$$

$$\text{where: } Z_o = 276 \log D/r$$

Since the D/r ratio remains constant for any increases in dimensions, the sole influence on the reactance of the line would be the increase in l.

As a practical example, let us take a resonant line, 40-cm long, whose D/r ratio is such that the line has a characteristic impedance of 143.31 ohms. This would represent a D/r ratio of approximately 3.3, and is taken for mathematical convenience. At 100 mc, a 10-mmfd capacitor has a reactance of 159.155 ohms, the same as the 40-cm line. Assuming that the capacitor does not change value, to permit tuning to 95 mc the resonant line length would have to be increased to 40.32 cm, or .8%, for a .5 mc decrease in frequency. If the inductance values were substituted, this would be equivalent to an inductive increase of 1.001%. It can be seen then that the inductive value for this particular resonant line would increase more rapidly than the line length.

If the line length were changed to 20 cm, its characteristic impedance would be 357.47 ohms, or a D/r ratio of 19.7. If this line were to tune to 95 mc, its line length would have to be increased to 20.19 cm, or a line increase of .95%. Since the equivalent inductance change is the same as for the 40-cm line, or 1.001%, the inductance again increases faster than the line length. However, it will be noted that the change in length necessary to provide the .5-mc change is greater for the 20-cm line than for the 40-cm line. Therefore, for the same terminal im-

(Continued on page 50)

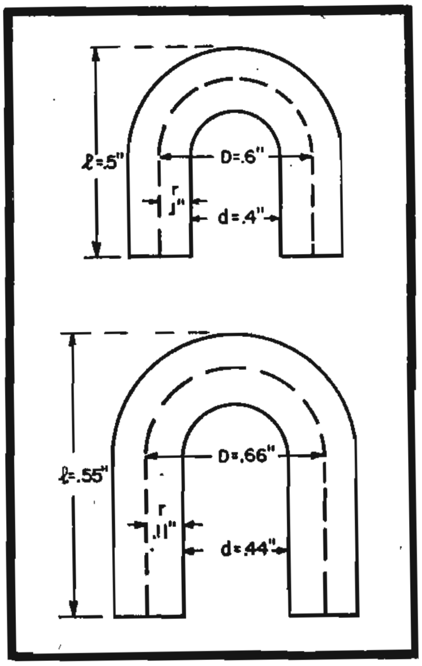
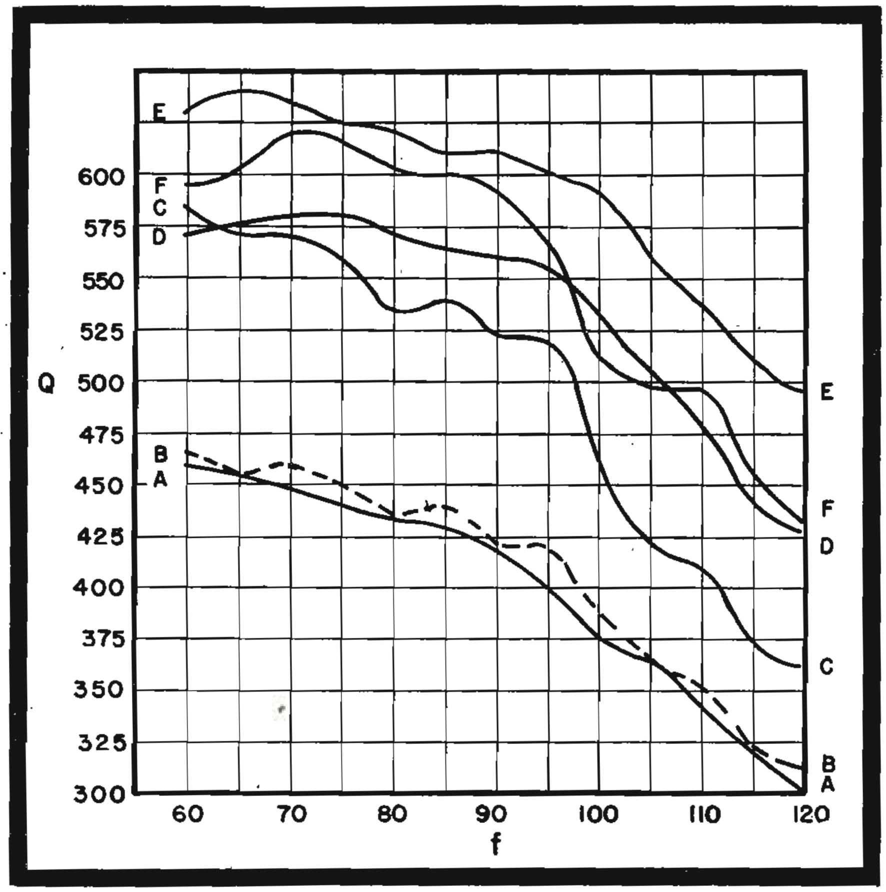


Figure 3

When a resonant line is affected by temperature, all its dimensions increase. The D/r ratio remains constant, while the length increases. Therefore, the only influence on its inductance value is the increase in length.

Figure 4

A graph of the Q response for the coil forms of Figure 1. Curves A, B and C are for resonant lines of tubing, strip, and sheet stock respectively; curve D, for a resonant line bent in a secondary loop; curve F, for a 2½" coil of ¼" tubing; Curve E, for a coil shape of the form shown in Figure 1*e*.



TRANSMISSION LINES

(*Continued from page 45*)

as defined before. The cut-off frequencies are given by the equations,

$$f_1 = \frac{c}{4(l_1 + l_2)} \quad \text{and} \quad f_2 = \frac{c}{4l_1} . \qquad (16)$$

While the ratio of transformation varies with frequency, the network can be used to transform between any two resistances at a given frequency by the proper choice of l_1 and l_2.

The second case, $l_1 = l_2$, gives a transformation ratio which is constant over the pass band. Here the solution yields the equations:

$$\cosh \gamma = \sqrt{1 + \frac{Z_{01}}{Z_{02}} \cos \frac{\omega l}{c}} , \qquad (17)$$

$$Z_{in} = Z_{01} n \sqrt{\frac{1}{1 - \frac{Z_{01}}{Z_{02}} \cot^2 \frac{\omega l}{c}}} , \qquad (18)$$

$$n^2 = 1 + \frac{Z_{01}}{Z_{02}} . \qquad (19)$$

where the quantities are as defined before. The mid-band frequency is the frequency which makes the length of the line sections, l, equal a quarter wavelength. This value of l substituted in equation (*18*) gives, for mid-band,

$$Z_{in} = n Z_{01} . \qquad (20)$$

Applying the criterion for the pass band, $-1 < \cosh \gamma < +1$, gives, from (*17*) and (*19*),

$$f_1 = \frac{c}{2\pi l} \cos^{-1} 1/n \quad \text{and}$$

$$f_2 = \frac{c}{2\pi l} \cos^{-1} (-1/n) . \qquad (21)$$

Here the angle is expressed in radians. This filter will have a flat attenuation characteristic over most of this theoretical pass band when it is terminated in impedances n, Z_{01} and Z_{02}/n on the high- and low-impedance sides.

The design equations for such an impedance transforming filter are:

$$n^2 = R_{in}/R_{out} ,$$
$$Z_{01} = R_{in}/n ,$$
$$Z_{02} = R_{in}/n\,(n^2 - 1) . \qquad (22)$$
$$l = c/4f_m ,$$

where R_{in} and R_{out} are the resistance between which the network is linked.

Matching Filter

As an illustration, let us design a matching filter of the second type to work between resistances of 200 and 100 ohms at 500 megacycles. Equations (*22*) yield:

$$n^2 = 200/100 = 2$$
$$Z_{01} = 200/\sqrt{2} = 141 \text{ ohms}$$
$$Z_{02} = 200/1.4\,(2 - 1) = 141 \text{ ohms}$$
$$l = 3 \times 10^{10}/(4 \times 500 \times 10^6) = 15 \text{ cm.}$$

If we assume the radius of the inner conductor of a coaxial line as .1 cm, then, since

$$Z_0 = 138 \log b/a = 141,$$
$$b = 1.05 \text{ cm.}$$

Substitution in equations (*21*) gives for the cut-off frequencies,

$$f_1 = \frac{3 \times 10^{10}}{2\pi \times 15} \cos^{-1} .5 = \frac{3 \times 10^{10}}{2\pi \times 15} \cdot \frac{\pi}{3} = 330 \text{ mc} .$$

and

$$f_2 = \frac{3 \times 10^{10}}{2\pi \times 15} \cdot \frac{2\pi}{3} = 660 \text{ mc.}$$

Thus a network consisting of two sections of coaxial line 15-cm long, inner conductor radius .1 cm, and inside radius of outer conductor 1.05 cm, will match 200 ohms to 100 ohms and have a pass band from 330 to 660 mc.

While there are a great many different combinations of lines which will give filter-type operation, those presented here will serve as an indication of the possibilities.

V-H-F TUBES

(*Continued from page* 33)

watt output and efficiency of 60-70 per cent. So far, magnetrons of this type and other types have been almost impossible to modulate in a linear manner either with amplitude modulation or frequency modulation. These tubes cannot be used as amplifiers, because so far it has been impossible to separate their input and output functions. Frequency control is, therefore, not possible along conventional lines and must be worked out. It might be done by a system similar to the Pond's system used on klystrons, and in connection with this system an effective frequency modulation may be possible. Magnetrons have an advantage in that little modulating power is required because of their extremely low modulation impedance; that is, a small change in voltage gives a large change in current with a fixed magnetic field.

Another wartime development which shows great promise in this frequency range is the resnatron. This tube consists of a set of tetrode electron elements, combined with appropriate tuned circuits, that provide a grounded grid tetrode oscillator or amplifier with the circuits and electron structure intimately connected and mounted in the same vacuum.

High frequencies and high powers have been obtained. In a typical application, the filament voltage was 2½ with a current of 1,800 amperes. Powers as high as 85 kilowatts continuously have been obtained with plate voltage of the order of 14 kilovolts at frequencies of 600 megacycles. A redesign of this tube at 100 megacycles should make available powers of 100-200 kilowatts, if desirable. A band width of 2 to 4 megacycles is readily obtainable at present with a gain as a grounded grid amplifier of 10 to 12 db. The most suitable use for this tube is as an amplifier in a class *B* amplitude modulation or class *C* for frequency modulation. If the tube itself is to be modulated, grid modulation is possible and efficient but is not likely to be linear with more than 25% modulation. Plate and screen grid may be modulated together and will be reasonably linear. The interesting point about this tube is that transit time is not so important as in other types of tubes and a heavy electron structure can be used for heavy current at high powers. This seems to be because the shielding of the screen grid permits the electrons, while in the influence of the control grid, to be free from the effect of changing plate voltage.

V-H-F COIL DESIGN

(*Continued from page 47*)

pedance, a shorter line is more stable.

For the same terminal impedance, the shorter line has a greater D/r ratio. Increasing the D/r ratio, therefore, would decrease the necessary line length. This would increase the stability of the inductance. The eventual inductance shape would then become a circle, which should prove the most stable form of inductance.

Use of Flat and Round Stock

Resonant lines were constructed of flat and round stock, to determine the influence of the stock on circuit Q. The flat stock was used in two shapes, as shown in *b* and *c*, Figure 1. Their relative Qs are shown in Figure 4. For the same spacing, and same length, tubular types were found to have the highest Q, although the flat type of Figure 1*b* was found to be less spotty in Q response over a band of frequencies. The resonant line of Figure 1*b* had the highest value of inductance, with the type of Figure 1*c* second, and the tubing types last. The Q of tubing types were found to increase with an increase in either spacing or tubing diameter.

A popular form of resonant line is shown in Figure 1*d*. Here the line has been bent into a second loop. This method is usually used to conserve space. The addition of this second loop again changes the Q, inductance, and frequency stability of the lines. The Q of the lines is increased, but the inductive value of the lines is decreased. This type of line should prove less stable than a straight resonant line, since any increases in the distance between the shorted and open ends of the line would increase the inductance.

Distortion Studies

The next form tried was a distortion of Figure 1*d* to that of Figure 1*e*. In making this form the two loops of a bent resonant line were spread apart, so that they were at a 90° angle. Although no effort was made to determine the stability of this type of inductance, several characteristics were noted.

A 3¼" loop using No. 10 wire was found to have a Q of 425 at 100 mc when tuned with a capitance of 13.5 mmfd. As a hairpin loop, or resonant line, with a center-to-center spacing of ½", and 4¾" long, the same piece of wire had a Q of 370 at 100 mc, when tuned with a capacitance of 20.5 mmfd. Bent again in a 2½" circle, as in Figure 1*d*, the Q increased to 380 and the capacitance to 22 mmfd. When bent into the shape of Figure 1*e*, the Q increased to 440, and the capacitance reduced to 15.5 mmfd. We noted also that changes in inductance value, induced by approaching the hand to the coil shape, were not as severe as for other coil shapes.

Figure 4 shows the relative Qs of all types of coil shapes tried. The inductance values for the various shapes were kept as close as possible. Curves A and B are for resonant lines constructed of strap (Figure 1*b*), and flat (Figure 1*c*) stock. It will be noted that the Qs are relatively low. Curve C is for a resonant line constructed of tubing. The general Q response was found to be much higher. Curve D is for a resonant line constructed of tubing, bent in a secondary loop. This type of inductance showed a higher and more uniform Q. Curve F resulted from a circular coil constructed of ¼" tubing. The Q was found to be generally higher than for the previous types. Curve E is for the type of inductance shown in Figure 1*e*: a bent resonant line with its loops spread. It will be noted that this type of inductance displayed the highest and most uniform Q.

TUNED CIRCUITS

(*Continued from page 20*)

duces the inductance of the loop. Thus capacitance and inductance are simultaneously varied.

The symmetry about the center point is advantageous for push-pull circuits or where it is desired to tap down on the inductance to reduce loading on a tuned circuit, or for other coupling reasons.

The cylindrical section which is cut out to form the inductance and the stator plate shape may be designed to produce any type of variation of frequency with rotation desired. It will be noted that the currents in the two single-turn loops are in opposite directions. Thus their mutual inductance tends to reduce the total inductance, so that the total inductance is the sum of the two loops, plus the cross-connection bar, less the mutual inductance between the loops. The maximum capacitance can be estimated by using half of the value (or whatever proportion is left for the stator plates), determined by the usual formula for cylindrical capacitors.

When considering wide-range tuning devices in general, it must be remembered that a small amount of rotation on the dial means a change of several megacycles. This complicates the mechanical and electrical problems. If the frequency is to be held exactly, the difficulties will preclude sufficient frequency control, and the dial and bearings may be practically impossible to construct. The slightest vibration or thermal change will cause detuning and reset accuracy will suffer. Fortunately at the higher frequencies such accurate control of frequency is not usually necessary, because of the bandwidth of the services located there.

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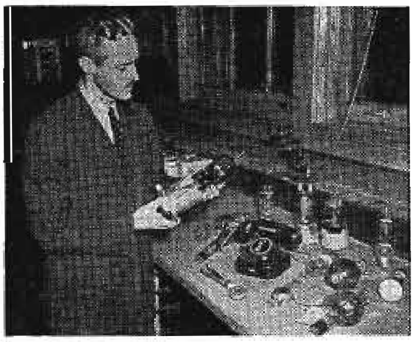
JAPANESE TUBES



Roger I. Wilkinson, of the technical staff of Bell Telephone Laboratories, with Japanese tubes he collected during his two-month survey of Japanese radar and communications equipment in the home islands.

PREVENTIVE MAINTENANCE

(*Continued from page 28*)

equipment, with the aid of a blower if available.

The small brush should be used on small parts such as relays and selector switches. The large brush should be used on larger parts. The brush should be applied lightly and the user should be very careful not to spring or break any small contacts or leads.

Brush bristles should be kept clean and dry at all times or their use will not be effective. Carbon tetrachloride is useful in cleaning the bristles.

Air blower. One of the best methods of cleaning out a dusty component or part is with a blower or a soft brush. The air blown into the equipment should be clean and dry. A vacuum cleaner is an alternate in the absence of a blower. The use of too strong an air blast on delicate parts should be avoided. In case of a strong air blast the nozzle should be backed away from the part to avoid damage.

Duck bill or parallel jaw pliers. These pliers are designed especially for making adjustments on relay contact springs in the absence of a spring adjuster of the required size and shape. Care should be taken not to deface the inside surface of the jaws of the pliers, so that they will not damage the springs upon which they are used.

Spring adjuster. The spring adjuster is sometimes called a relay-spring bending tool, and is used to place a bend or bow in relay contact springs to increase their tension or change their relative position.

Tension gage (fan type). This tool is used to measure the tension of the contact and tension springs of relay contacts. Unless otherwise specified, a gage should be used to indicate the specified tension at or near the upper limit of the scale.

To use the tool, the gages are held in such a position that the reed and the spring under test are practically in a straight line as approximated by eye. The tip of the reed is applied to the free end of the spring, with the flat surface at the end of the reed in approximately the same plane as the surface of the spring. If it is not convenient to measure the tension as specified, the gage may be held at right angles to the length of the spring, keeping the flat surface of the end of the reed in the same plane as the surface of the spring whose tension is being measured.

Thickness (feeler) gages. This tool is used to measure accurately the spacing between certain parts of a relay; in some cases the distance between open contacts when the relay is de-energized; or in other cases, the distance between the armature and heel piece of a relay when energized. A gage of the specified thickness is inserted between the surfaces and parallel to them, and the gap is adjusted until the two surfaces rest snugly against each side of the gage, but not so tightly that the gage cannot easily be withdrawn or that the gap distance changes when the blade is withdrawn due to tension on the elements to be separated.

[*To be continued*]

Errata

In the diagram of the Summerhayes discriminator on page 74, April, 1946, the diode-plate connections of 6H6 should be reversed.

WIRE AND CABLE

(*Continued from page* 30)

chemical-resisting, moderately-tough, insulating medium used as the *work horse* of the insulation manufacturer. Electrical properties vary from fair to very good. They have the inherent weakness of non-saturated hydrocarbon materials. That is, they are subject to chemical ageing with consequent loss of physical properties and sometimes electrical properties as well. Where compounded as jacketing materials, i.e., made mechanically tough, the best electrical properties are sacrificed.

(5) Thermoplastics—Relatively new insulating materials whose real worth and usability were proved in wartime use. The various resins are nearly all mechanically tough, chemically practically inert, and electrically from fair to excellent in properties.

The most widely used of the thermoplastics are the plasticized vinyl resins. They combine moderate dielectric loss factor with mechanical toughness, chemical inertness, heat resistance, flameproofness and moisture resistance.

The acetates and other cellulose derivatives have mechanical toughness and heat resistance, good dielectric loss properties, but are too stiff for flexible applications in heavy wall thicknesses. They have fair to good moisture-resisting properties. They support combustion.

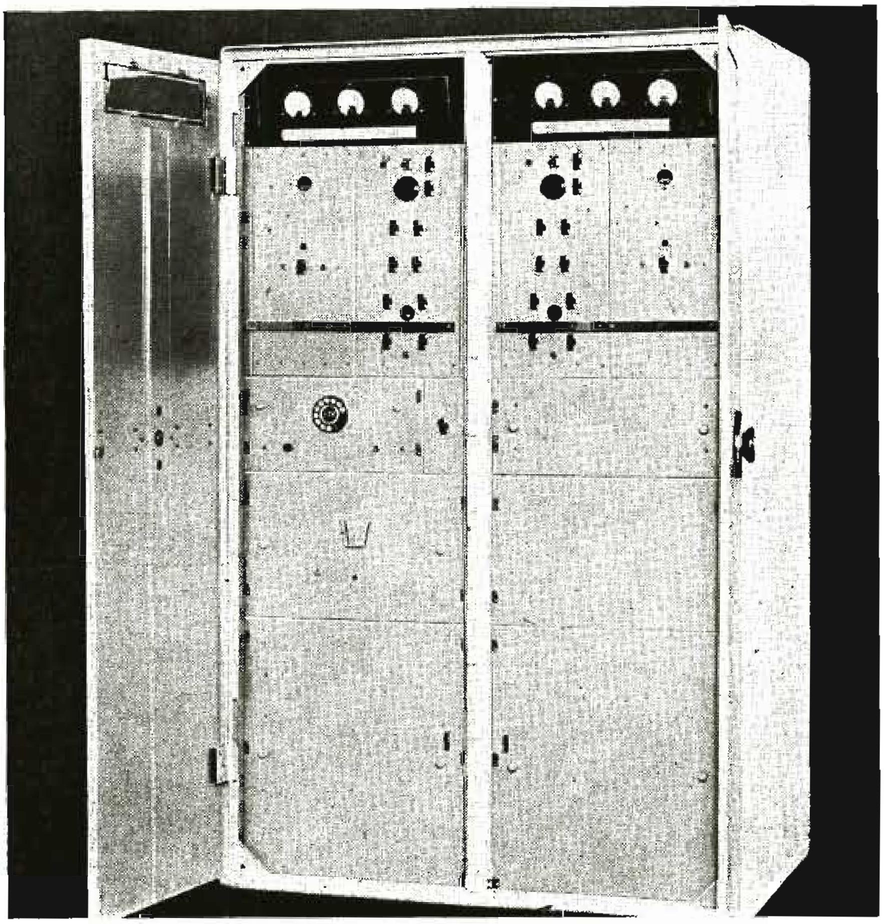
Nylon is an extremely tough but stiff material of moderate dielectric losses and fair moisture resisting qualities. Its principal use is in thin insulations or as a mechanical protection over more tender insulations. It will support combustion once ignited.

Polyethylene is the excellent flexible low-dielectric-loss insulating material for most high-frequency applications. Its mechanical properties are such that it is seldom used without additional mechanical protection. It has excellent moisture resistance and good chemical stability.

(6) Glass (glass yarns and cloths) —These materials give the fire protection and heat protection required under extreme temperature conditions. They are not usually used however as primary dielectrics (unless treated with high heat-resistant insulating varnishes) but rather as safety space factors where at least some circuit continuity must remain intact even after extreme temperature conditions such as fire or severe current overloads. The glass braids are not mechanically tough and must be protected by lacquers or varnishes to make them serviceable.

In table *3* is presented a general-usage versus suggested insulation-material chart.

UNIT-TYPE MULTI-CHANNEL Aircraft Ground Transmitter



by RALPH G. PETERS

Figure 1
Interior view of multi-section aircraft ground transmitter.

Sectional-Type Aircraft Ground Transmitter Affords Coverage of 200 to 540 kc, 2 to 20 mc and 108 to 140-mc Channels. R-F Units for Each Band Available.

To ACCOMMODATE THE VARYING peak traffic demands of today's busy airports, flexible transmission systems that offer high or low powers on either of the m-f, h-f or v-h-f bands have been found quite essential. To provide this type of service, a multi-service, multi-channel sectional-type ground transmitter[1] has been developed.

This transmitter, for use in the 200 to 540 kc, 2 to 20 mc and 108 to 140 mc bands, is available with three types of r-f units, one for each channel. The output of the 2-20-mc unit is 500 watts, while that of the 108-140-mc unit is 200 watts.

Simultaneous operation of two r-f units on c-w or one unit on voice and one on c-w is possible. To provide this service a keyer, power supply, modulator, local and remote control, and four r-f units are required. Simultaneous operation of two r-f units on voice and two on c-w is available when a second modulator and power supply are added.

Transmitter Features

The v-h-f r-f unit in this transmitter is a 5-stage affair. The crystal required is a low-temperature coefficient type cut for operation in the 4.0 to 5.18-mc range. It can be installed in a thermostatically controlled oven-type holder if a high degree of frequency stability is desired. The first stage utilizes an 807 tetrode as an oscillator and frequency tripler. The plate of this tube is tuned to the third harmonic of the crystal, thus multiplying the original crystal frequency three times, to provide an output in the 12.0 to 15.54-mc range.

Frequency Triplers

The output of this stage is fed through two more frequency tripler

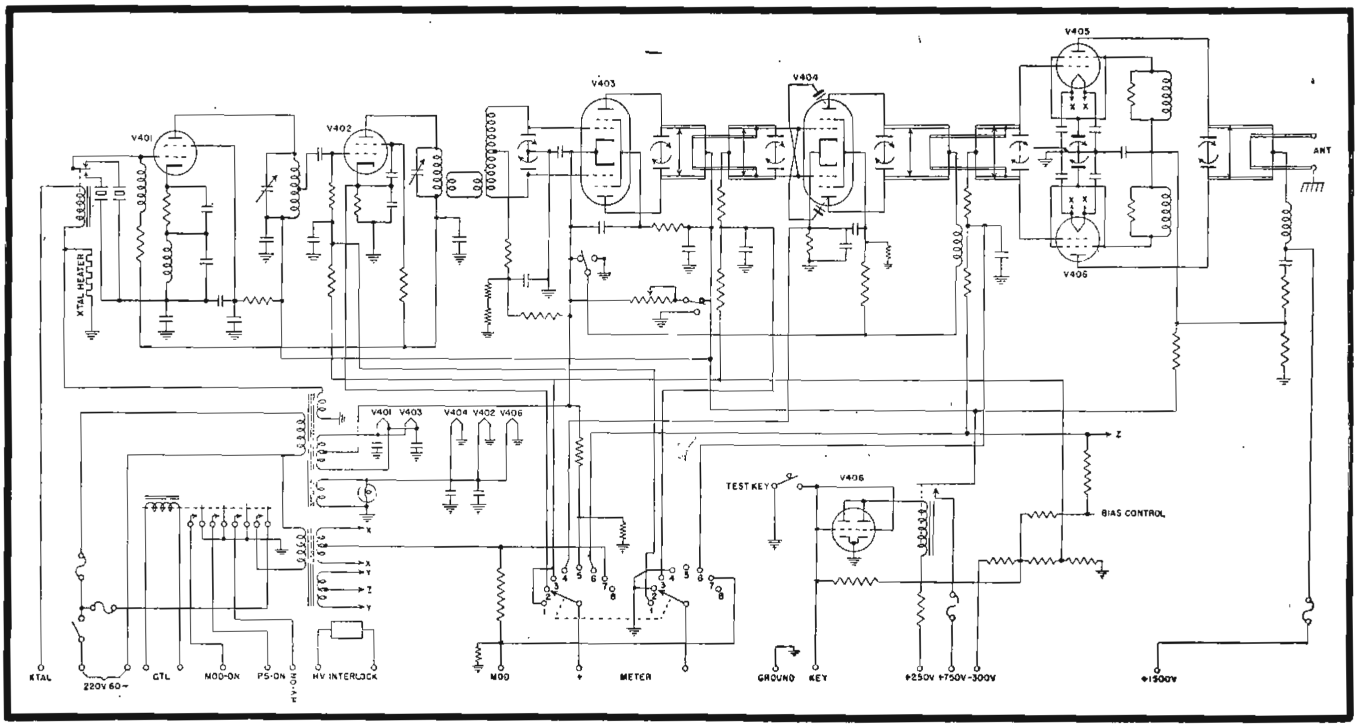


Figure 2
Schematic of the 108 to 140 mc r-f unit of the aircraft ground transmitter.

circuits, the first using an 807 tube and the second an 815, providing a final frequency of 108 to 140 mc (approximately). The fourth stage is an intermediate power amplifier which also employs an 815 and acts as the driver stage for the power amplifier.

Class C Pushpull

Two 4-125As operating in class *C* push-pull are used in the power amplifier stage. The plates and screens of the output tubes are modulated and the r-f output is fed to the antenna by means of a 72-ohm coaxial transmission line.

The output of this v-h-f r-f unit is 200 watts when fed into a 72-ohm load. At a slight sacrifice in power output this unit may also be operated in the 140- to 160-mc range by using a higher crystal frequency.

Modulator

The modulator unit, the input impedance of which is 500 ohms, can be used to modulate any one of the r-f units. It employs four stages, two amplifiers utilizing 6SN7s, an audio driver with two 6B4s in push-pull and two 805 audio power amplifiers. A 1,000-cycle audio input signal, 25 db below 6 milliwatts, will produce 100% modulation at rated full carrier output.

Distortion Control

Distortion is below 10% at 95% modulation and the carrier noise level more than 35 db below full modulation. In addition, essentially uniform frequency response (± 3 db with respect to 1,000 cycles) is maintained over a 300 to 4,000-cycle frequency range.

The transmitter can be operated either by local or remote control.

[1]*Federal Telephone and Radio Corporation.*

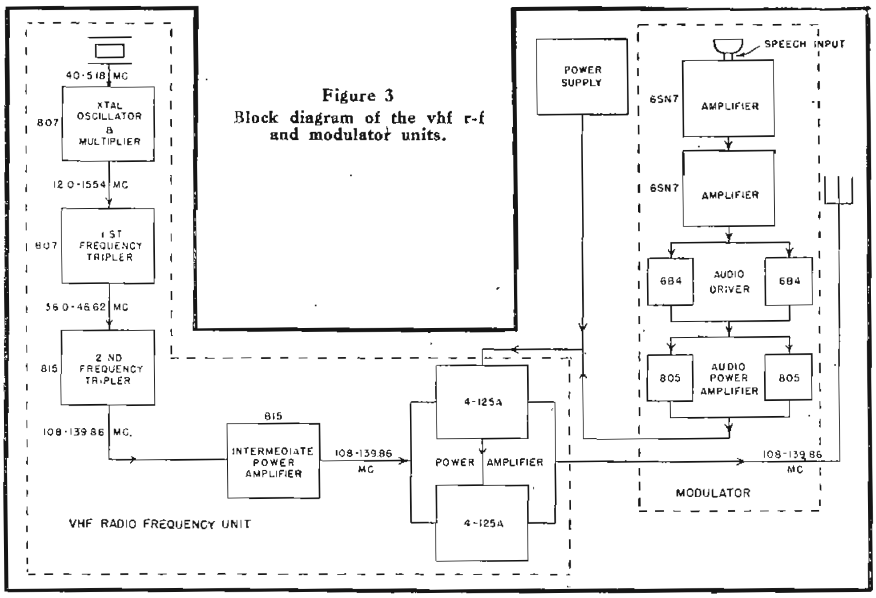


Figure 3
Block diagram of the vhf r-f and modulator units.

NEWS BRIEFS

M. R. STOECKER TO HEAD RCA REPLACEMENT PARTS SECTION

Marshall R. Stoecker has been named manager of the replacement parts section of RCA.

Mr. Stoecker comes to RCA after three years of service with the U. S. Navy where he was officer in charge of the Mark 5 and 6 program. He was formerly manager of the radio department of the Chevrolet division of General Motors.

* * *

A. T. & T. RECEIVES RADAR LECTURE TOUR LICENSE

The American Telephone and Telegraph Company recently received a Class 1 experimental portable license to be used in connection with a public, educational lecture tour to illustrate some of the technical and operational characteristics of radar.

The station will operate within the 8,600 to 8,700-kc band, with instantaneous (peak) power not to exceed 50,000 watts. Pulse modulation will be employed.

* * *

FERGUSON ELECTED BENDIX PRESIDENT

Malcolm P. Ferguson was recently elected president of Bendix Aviation Corporation to succeed Ernest R. Breech, who has resigned to become executive vice president and a director of the Ford Motor Company.

Mr. Ferguson has been a director and vice president of Bendix.

* * *

SERDEX, INC., ORGANIZED

Serdex, Inc., 91 Cambridge Street, Boston, Mass., has been formed to engage in development work in meteorological instrumentation, electronics and specialized communication problems.

D. C. Bradford is chief engineer. Members of the engineering staff include C. M. Hammel; W. K. Coburn, Jr.; E. L. Sulkowski; and P. A. Hiltz.

* * *

TARZIAN TO CONDUCT H-F A-M BROADCAST TESTS

A 500-watt 87.75-mc a-m station, W9XHZ, was recently placed in operation in Bloomington, Indiana by Sarkes Tarzian, to study broadcast-station possibilities. Also being tested is a special converter developed to receive this h-f a-m station on standard single-band receivers.

Transmission is over a 235′ self-supported tower with a five-element antenna.

* * *

NANCE JOINS G.E.

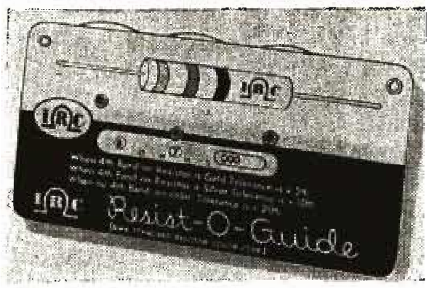
J. J. Nance has joined the president's staff of G. E. For the last five years Mr. Nance has served as vice president of Zenith Radio Corporation.

* * *

IRC RESISTANCE-RANGE GUIDE

A pocket-size resistance-range guide, Resisto-O-Guide, has been prepared by IRC.

Turning three wheels, to correspond with the color code on composition type resistors, indicates standard RMA ranges. Color coding data is also provided by wheel turns. Available at IRC distributors for ten cents.



* * *

KINDALL JOINS C. P. CLARE

John E. Kindall has been appointed by C. P. Clare and Company as sales representative for eastern Missouri. Mr. Kindall is proprietor of K-S Electrical Sales, 2004 Locust Street, St. Louis 3.

* * *

WALL NOW DETROLA HOME RADIO S-M

Harley R. Wall, who joined International Detrola Corporation in July, 1945, as Michigan state radio sales manager, has been appointed home receiver sales manager.

* * *

ECA ACQUIRES ADDITIONAL SPACE TO HANDLE WAR SURPLUS

Electronic Corporation of America has rented an eight-story warehouse at 49-51 John Street, Brooklyn, for use in the sale of surplus electronic equipment.

* * *

SHEVE REJOINS STROMBERG-CARLSON

Henry C. Sheve has rejoined Stromberg-Carlson and appointed staff engineer.

At the time of his release from active service in March, 1946, Mr. Sheve was assistant director of the electronic test division of the U. S.

Naval Air Test Center at Patuxent River, Maryland, with the rank of commander.

* * *

TUTTLE AND CLARK ELECTED DIRECTORS OF RADIOMARINE

Arthur B. Tuttle, treasurer of RCA, and Edwin N. Clark, managing director of RCA International, have been elected directors of Radiomarine Corporation of America.

* * *

ALBRIGHT NOW BENDIX RADIO PRINCIPAL ENGINEER

Robert B. Albright has been appointed principal engineer to head laboratory operations of the Bendix Radio division of Bendix Aviation.

* * *

WALSCO CATALOG

A 16-page catalog, 46, describing hardware items, adhesives, solvents, polishes and other chemicals has been released by Walter L. Schott Company, Beverly Hills, California.

* * *

SPARKS NOW V-P OF RCA COMMUNICATIONS

Sidney Sparks has been elected vice president and traffic manager of RCA Communications, Inc., 66 Broad Street, N. Y. City.

* * *

G. E. PLASTICS BROCHURE

The annual "One Plastics Avenue" brochure has been published by the G. E. plastics divisions. A 20-page booklet, it describes plastics facilities available at G. E., One Plastics Avenue, Pittsfield, Mass., and other plants.

* * *

MUTUAL BECOMES A MEMBER OF NAB

The Mutual network recently joined the National Association of Broadcasters.

* * *

LEWYT WINS CERTIFICATE OF APPRECIATION

A Certificate of Appreciation from the War Department has been awarded to Alex H. Lewyt, president of Lewyt Corporation, Brooklyn, New York, for patriotic service during World War II.

* * *

WHITMORE JOINS ATOMIC BOMB TEST GROUP

Will Whitmore of Western Electric sailed recently aboard the U. S. S. Avery Island, en route for Pearl Harbor and Bikini Island where he will take part in the electronic engineering activities in connection with the atomic bomb tests to be held this summer.

Mr. Whitmore is a member of the electronics staff of Captain Christian L. Engleman, Electronics Coordinating Officer, Joint Army-Navy Task Force One.

* * *

GIVEN NOW WITH AVIOMETER

Deam W. Given has been appointed general sales and advertising manager of the Aviometer Corporation, N. Y. City.

Mr. Given was formerly sales manager of Engineering Sales Laboratories, Inc., Tulsa, Oklahoma.

* * *

FCC GRANTS 2-WAY PERMITS TO 13 CAB COMPANIES

Thirteen cab companies have been granted construction permits authorizing use of 2-way

(*Continued on page* 58)

NEWS BRIEFS

(Continued from page 57)

radiotelephone systems for cab-dispatching operations.

Cab companies receiving permits include: 44 Cab Company (10 cabs), Pine Bluff, Arkansas; Yellow Diamond Cab Co. (70 cabs), Charleston, So. Carolina; Blue & White Cab Co. (40 cabs), Corpus Christi, Texas; City Transportation Co. (10 cabs), Los Angeles, California; United Cab & Drivurself, Inc. (40 cabs), Rockford, Illinois; Yellow Cab & Baggage Co. (20 cabs), Topeka, Kansas; Longview Transit Co. (4 cabs), Longview, Texas; Six-O-Six Taxi (25 cabs), Hattiesburg, Mississippi.; Jolly Cab Co. (70 cabs), Memphis, Tennessee; Tiller Cars (10 cabs), Norfolk, Virginia; Diamond Taxi, Inc. (3 cabs), Lowell, Massachusetts: Flamingo Cab Co. (6 cabs), Miami Beach, Florida; Yellow Cab Co. (5 cabs), Twin Falls, Idaho.

According to Galvin Manufacturing Corp., Motorola 2-way systems will be used on many of these cabs.

* * *

THIRD ISSUE OF W. E. OSCILLATOR PUBLISHED

The third issue of the "W. E. Oscillator," recently published features data on the "Cloverleaf" f-m microwave lens antenna, speech input and audio facility equipment.

* * *

MACKENZIE AND KOESSLER NOW WITH NEELY

Louis G. MacKenzie, recently discharged as a Captain in the Signal Corps, U. S. Army, recently joined the staff of the Norman B. Neely Enterprises, 7422 Melrose Avenue, Hollywood 46, Cal.

Frank Koessler, who was recently released from the Armed Forces, has returned to the Norman B. Neely Enterprises staff.

* * *

PAUL WHITE RESIGNS FROM CBS NEWS POST

Paul W. White has resigned as director of news broadcasts for CBS, to write a book.

Wells Church, assistant director of news broadcasts, becomes acting chief.

* * *

DON G. MITCHELL ELECTED PRESIDENT OF SYLVANIA

Don G. Mitchell, former executive vice president of Sylvania Electric Products, Inc., was elected president recently. Walter E. Poor, who has been president of Sylvania since 1943, has become chairman of the board of directors.


W. E. Poor D. G. Mitchell

* * *

FEDERAL TELECOMMUNICATION RECEIVES CBS COLOR-TELEVISION TRANSMITTER LICENSE

Federal Telecommunication Laboratories, Inc., has been licensed by CBS to manufacture color-television transmitter equipment based on CBS' inventions.

* * *

TUTTLE ELECTED TREASURER OF RCA

Arthur Brewster Tuttle has been named treasurer of RCA. Mr. Tuttle succeeds George S. DeSousa, who has held the position of treasurer since the formation of RCA in 1919. Mr. DeSousa will continue as vice president.

* * *

CAHILL BECOMES DIRECTOR OF RCA COMMUNICATIONS AND NBC

John T. Cahill has been elected a director of RCA Communications, Inc., and NBC. Mr.

Cahill will fill vacancies caused by the recent death of DeWitt Millhauser.

* * *

G. E. HAM BULLETIN

The first issue of a four-page bi-monthly for radio amateurs, the "G. E. Ham News," was published recently.

George H. Floyd, W60JK/2, is editor.

* * *

CORNELL-DUBILIER EXPANDS

Cornell-Dubilier Electric Corporation purchased an eight-story building in Worcester, Mass., recently.

* * *

PROF. SAMUEL JOINS UNIV. OF ILL.

Professor Arthur L. Samuel, formerly with Bell Telephone Laboratories, has joined the electrical engineering faculty of the University of Illinois.

Professor Samuel will carry on research and development work on electron tubes, and direct the work of graduate students in this field.

* * *

JOHN BROWN JOINS RAYTHEON

John L. Brown has been named sales manager of the replacement tube department of the Raytheon Manufacturing Co., Newton, Mass.

During the past three years Mr. Brown served as a Lieutenant Commander in the U. S. Navy.

* * *

METROPOLITAN ELECTRONIC CATALOG

A 16-page catalog with data on signal generators, tube testers, multimeters, combination tube and set testers, signal tracers, etc., has been published by the Metropolitan Electronic & Instrument Co., 6 Murray St., New York.

* * *

SUN RADIO SYMBOL CHART

A condensed 2-page chart of standardized graphical symbols has been prepared by Sun Radio & Electronics Co., Inc., 122-124 Duane St., New York 7.

* * *

BURLINGTON INSTRUMENT CATALOG

A 20-page catalog, 46, describing indicating instruments and auxiliary equipment, has been released by the Burlington Instrument Company, Box 589, Burlington, Iowa.

* * *

ACME ELECTRIC BULLETINS

A 12-page bulletin describing air-cooled power transformers, audio transformers, and transformers for cold-cathode lighting, neon signs, etc., has been released by Acme Electric, Cuba, New York.

* * *

HEBAL NOW WTMJ TECHNICAL SUPERVISOR

William Hebal has been appointed as broadcast technical supervisor of the Milwaukee Journal stations, WTMJ and WTMJ-FM. He succeeds Dan Gellerup, who has resigned.

Mr. Hebal has been WTMJ transmitter supervisor.

* * *

KDKA VIDEO STATION TO BE NEAR PITTSBURGH U. STADIUM

The video station of KDKA, Pittsburgh, will be erected near the University of Pittsburgh stadium. Bids for a 500' steel self-supporting tower have been asked and ground-breaking ceremonies are expected to be held soon.

* * *

G. E. TRANSMITTER SALES STAFF MOVE TO SYRACUSE PLANT

J. D. McLean, manager of sales; E. Lawrence. Jr., marine electronic equipment sales manager; W. R. David, broadcast equipment sales manager; H. M. Wales, aviation electronic equipment sales manager; and R. D. Jordan, advertising and sales promotion manager of the transmittter divison of G. E. have transferred from Schenectady to the plant at Thompson Road, Syracuse.

* * *

STANTON NAMED BELDEN SALES SERVICE MANAGER

Edgar Stanton has been appointed service and advertising manager of the industrial division at the Belden Manufacturing Company, Chicago.

* * *

AEROVOX NAMES MONTGOMERY CREDIT MANAGER

Harold Montgomery has been appointed credit manager and assistant treasurer of the Aerovox Corporation, New Bedford, Mass.

* * *

MALLINSON RECEIVES PORTABLE-MOBILE MEDICAL-STATION SYSTEM BUILDING PERMIT

The FCC has granted authority to Frank C. Mallinson, operating the National Electronics Laboratories, to construct a class 2 f-m experimental station at 815 King Street, Alexandria, Virginia, and to install 25 portable mobile units, to experiment for the purpose of inaugurating "a system which will provide two-way radiotelephone service for automobiles owned by doctors, nurses, taxicabs, ambulances, buses, public service trucks, and other bona-fide carriers."

Service is proposed for Virginia, Maryland and the District of Columbia.

The land station was temporarily assigned the 30.56-mc band, with 250 watts power. Mobile station was assigned 39.54-mc band, with 20 watts power.

* * *

DR. ELLETT JOINS ZENITH

Dr. Alexander Ellett, formerly head of division 4 of the National Defense Research Committee, has joined Zenith Radio Corporation as director of research.

* * *

GAWLER-KNOOP OPEN FACTORY REP OFFICE

Harry Gawler and Walter Knoop have opened a sales engineering service, Gawler-Knoop, Inc., with offices at 1060 Broad Street, Newark, N. J. Mr. Gawler and Mr. Knoop were formerly with duMont.

* * *

PEERLESS ELECTRICAL PRODUCTS OPENS SPECIALTY DIVISION

A specialty division to handle short order samples and special runs of transformers has been announced by Peerless Electrical Prod-

(*Continued on page 60*)

NEWS BRIEFS

(*Continued from page* 59)

ucts Co., 6920 McKinley Avenue, Los Angeles 1, Calif. In charge of the new division will be Harry Caseldine, project engineer.

BENDIX RADIO APPOINTS LAMONT PRODUCTS MANAGER

M. B. Lamont has been named products manager, in charge of electrical detail, of the radio and television Bendix radio division, Bendix Aviation Corp.

CINAUDAGRAPH FACILITIES MOVED TO SLATER, MISSOURI

Production facilities of Cinaudagraph Speakers, Inc., division of Aireon, have been transferred from Chicago to Slater, Mo.

The Aireon speaker division will have direct supervision of all Cinaudagraph speaker activities.

PACENT APPOINTED RADIO SPEAKERS WORKS MANAGER

Louis Pacent Jr. has been named works manager of Radio Speakers, Inc., Chicago, Illinois, subsidiary of Emerson Radio and Phonograph Corporation.

MT. WILSON TELEVISION SERVICE BEGINS

The television transmitter atop 6000' Mt. Wilson was recently placed into operation.

The transmitter was built and will be operated by Television Productions, Inc., for its television station, W6XYZ, which heretofore transmitted programs direct from the Paramount studios in Hollywood.

DEN BREEMS TO DIRECT DU MONT EXPORT SALES

Arie den Breems has been named export sales director of Allen B. DuMont Laboratories, Inc. Mr. den Breems has headquarters in suite 3469 of the International Building, New York City.

CONCORD RADIO CATALOG

A 112 page catalog describing receivers, amplifiers, components and accessories has been published by Concord Radio Corporation, 901 W. Jackson Boulevard, Chicago 7, Illinois.

CHAMBERS NOW INSULINE ADVERTISING MANAGER

Alfred S. Chambers has been appointed advertising manager of the Insuline Corporation of America.

Mr. Chambers was formerly in the advertising department of the RCA radio-victrola division.

LEWYT TO MARKET OWN RADIOS

Lewyt Corporation, Brooklyn, New York, have announced that they will produce a line of home receivers and phonographs, under their own name.

ELECTRONICS ENGINEERING COMPANY FORMED

The Electronics Engineering Company, recently opened offices at 1448 Broadway, Gary, Indiana.

Members of the company include: Henry B. Young, Elmer E. Crump, Henry J. Bell, John Hudson, P. A. Brown, Eugene Smith and Edward W. Brown.

TACO ANTENNA BULLETIN

A 12-page bulletin describing receiving antennas for f-m and television, store systems, noise-reducing systems, and accessories, has been released by Technical Appliance Corporation, Flushing, New York.

* * *

INDUSTRIAL TRANSFORMER CORP. DATA

A four-page bulletin describing insulation test breakdown sets, has been released by the Industrial Transformer Corporation, 2540 Belmont Avenue, New York 58, N. Y.

* * *

HABER NOW RCA TUBE DEPT. AD MAN

Julius Haber has been appointed advertising and sales promotion manager of the RCA tube department. Mr. Haber will be located at Harrison, N. J.

* * *

WESTON ENGINEERING BULLETIN

The first issue of a bi-monthly entitled "Weston Engineering Notes," has been published by the engineering laboratories of the Weston Electrical Instrument Corporation, Newark 5, N. J.

Featured were articles on "The Galvanometer and the Bridge" and "Copper Oxide Rectifiers as Used in Measuring Instruments."

John Parker is editor.

* * *

WARD LEONARD CATALOG

A 16-page catalog describing adjustable resistors, disc-type resistors, line-voltage resistors, sliding-contact tubular rheostats, etc., has been released by Ward Leonard Electric Company, Mount Vernon, New York.

* * *

MACHLETT BI-MONTHLY

The April-May issue of the bi-monthly "Cathode Press" recently published by the Machlett Laboratories, Inc., Springdale, Conn., features a paper on the high-power hydrogen thyratron, and data on x-ray progress, radar developments and allied Machlett activities.

* * *

CARBORUNDUM BROCHURE

An 84-page book, "Sanding and Finishing," containing information about coated abrasives, has been released by The Carborundum Company, Niagara Falls, N. Y. Offered are data on uses of coated abrasive products in metalworking, woodworking, shoe and leather, floorsanding, printing, plastics, and pipe trades, and specifications for belt sanding, belt splices and speeds.

* * *

METCALF NOW MANAGER OF G. E. ELECTRONICS LAB.

G. F. Metcalf has been appointed manager of the G. E. electronics laboratory.

L. M. Leeds has been named consulting engineer in the G. E. transmitter division.

Mr. Metcalf and Mr. Leeds will headquarter at the Thompson Road Plant in Syracuse, N. Y.

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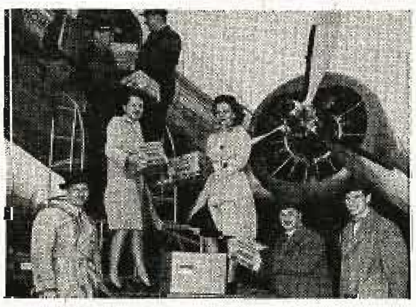
CRYSTAL KITS IN AIR



Amateur radio crystal kits being shipped via air express to distributors throughout this country and South America by Crystal Research Laboratories, Hartford, Conn.

THE INDUSTRY OFFERS . . .

CENTRALAB CAPACITORS

Transmitting capacitors, high-accuracy capacitors, silver micas, and other types have been added to the line of Centralab, 900 E. Keefe Avenue, Milwaukee 1, Wisconsin.

The transmitting group includes types 850S, 853S, 854S and 855S. Features are said to be low-power factor, stable retrace characteristics and maximum flashover commensurate with physical size. Plates are pure silver fired to the ceramic surface. Capacity tolerance is said to be ±10%.

High-accuracy capacitors are another capacitor addition. Coefficient is said to be maintained within ±10 parts per million. Standard working voltage is 500, d-c; capacity tolerance is ±5%. Types available are the 841S in 200, 350 and 500 mmfd, and 950S in 500, 1,000 and 2,000 mmfd.

High-dielectric-constant ceramic tubulars, HDC, also have been added. Power factor is approximately 2.5% at 1 kc; recommended working voltage 350, d-c, test voltage 700, d-c. Units are available in 1,000, 5,000 and 10,000 mmfd capacities.

Silver mica capacitors are recommended for high-frequency applications. Working voltage is 350, d-c., or 250, a-c. Flash test is 1,000 volts d-c. Leakage resistance is said to be more than 10,000 megohms.

Complete information appears in catalog 25.

* * *

HYTRON MINIATURE INSTANT-HEATING BEAM TETRODE

A filamentary type of beam tetrode, 2E30, designed for use in higher-frequency mobile equipment as a class A_1 audio-frequency amplifier, class AB_2 modulator, class C oscillator, neutralized class C amplifier, and class C frequency multiplier where it is desired to eliminate filament drain during standby period, has been announced by the commercial engineering department, Hytron Radio & Electronics Corp., Salem, Mass.

Filament is oxide coated; a-c or d-c volts, 6 ±10%; 0.7 ampere. For most applications, d-c plate potential, 250; and d-c screen grid potential, 250.

* * *

HALLICRAFTERS ALL-WAVE RECEIVER

A six-tube all-wave superheterodyne table model, S-38, has been announced by the Hallicrafters Company, Chicago.

Provides continuous coverage in four frequency ranges from 540 kc to 30 mc.

Features an automatic noise limiter and beat oscillator.

* * *

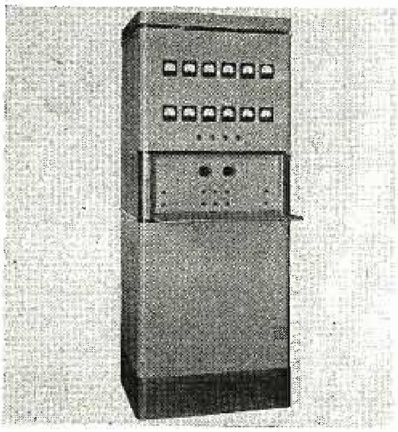
RAYTHEON A-M TRANSMITTER

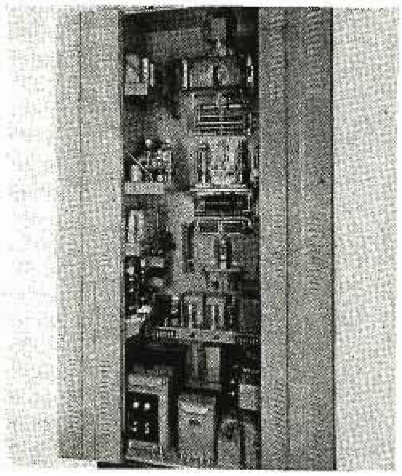
A 250-watt a-m broadcast transmitter has been announced by the Raytheon Manufacturing Co., Waltham, Mass.

The transmitter uses two tuned stages, r-f amplifier and power amplifier. These stages are tuned by a low-speed motor, equipped with a clutch. Has a video-type amplifier in the buffer stage.

Frequency response is said to be from 30 to 10,000 cycles, ±1 db.

A 6J5GT crystal oscillator is followed by a 807 buffer amplifier connected as a normal shunt-peaked video amplifier. The high frequency cut-off of this amplifier is somewhat above 1.6 mc to provide adequate excitation to a 813 r-f driver without the use of tuned circuits. The r-f driver stage uses a split capacitor output circuit to provide balanced excitation to the final amplifier.





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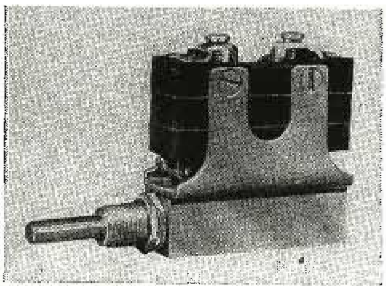
CLICK-ACTION D-C MU-SWITCH

A switch assembly, type EP-203, with standard mu-switch in a rigid bracket in which is incorporated a long-throw overtravel mechanism, has been announced by the Mu-Switch Corporation, Canton, Massachusetts. The operating force is applied in a direction parallel to the moving elements of the switch rather than perpendicular. Normal overtravel is 9/16" and the movement differential at actuating point is 1/32".

Assembly can be furnished with switches for a-c loads up to 15 amperes, or with a switch for d-c loads up to 1¼ kw at 250 volts.



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CHERRY RIVET, LIGHT-DUTY BLIND RIVET GUN

A one-hand, plierlike tool, Cherry Jr. Riveter, that is said to install the rivet with a simple *pull*, has been developed by the Cherry Rivet Company, 231 Winston Street, Los Angeles 13, California. Installs a new 3/32" diameter blind rivet, provided in three grip lengths.

* * *

G. E. HEAVY-DUTY OIL-FUSE CUTOUTS

Heavy-duty oil-fuse cutouts for overcurrent protection of power distribution systems in the 2,400-, 4,160-, 4,800-, and 7,200-volt classes have been developed by the transformer division of G. E.

The cutouts utilize universal fuse links. Unit design provides 100-, 200- and 300-amp rating

(*Continued on page* 64)

THE INDUSTRY OFFERS . . . —

(Continued from page 63)

cutouts, with maximum short circuit interrupting ratings previously limited to 2,500 volts extended to 5,000.

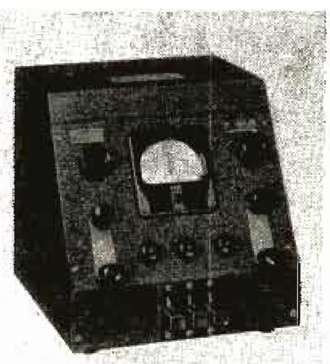
* * *

ASSOCIATED RESEARCH RESISTOR LIMIT BRIDGE

A low-range resistance limits bridge, model 81-A, has been announced by Associated Research, Inc., 231 S. Green St., Chicago 7, Illinois.

Resistance from a fraction of an ohm to 20,000 ohms may be checked; tolerances said to be ±1 per cent to ±20 per cent.

Uses three No. 6 dry cells.



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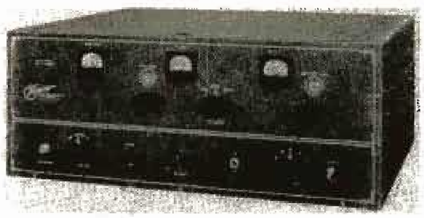
TEMCO 75/100-WATT MULTI-FREQUENCY PHONE-CW TRANSMITTER

A five-band 75/100-watt amateur transmitter, type GA, for telephone and telegraph operation featuring a multi-frequency variable-frequency oscillator and crystal control, has been developed by the Transmitter Equipment Manufacturing Company, 345 Hudson Street, New York City. It covers the five amateur bands from 3.5 to 28 mc



* * *

SILASTIC COATED FIBREGLASS TAPE

Fibreglas tape coated with Silastic, the Dow-Corning silicone rubber made from sand, has been announced by the Connecticut Hard Rubber Company, New Haven.

The tape is said to have high dielectric properties, 1100 volts per mil, retain this strength at temperatures up to 500° F and not breakdown and carbonize.

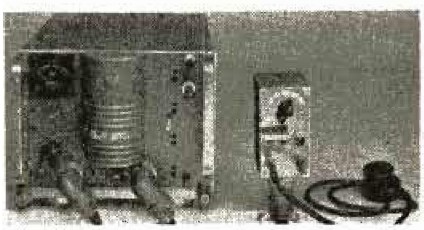
The tape is known as Cohrlastic. Available in rolls of various lengths, widths, and thicknesses; at present, it is being made in .010" and .015" thicknesses.

* * *

RCA 4-CHANNEL, 50-WATT AIRCRAFT TRANSMITTER

A 3 to 13-mc four-channel 50-watt transmitter, AVT-49, has been designed by the engineering products department of RCA.

Transmitter permits channel combinations: with one 3105-kc crystal it is possible to set up



the first channel on a short fixed antenna for taxiing, and the second channel on trailing wire antenna while in flight; by doubling, the third channel will provide 6210 kc on short fixed antenna, and the fourth channel will provide 6210 kc on trailing antenna in flight.

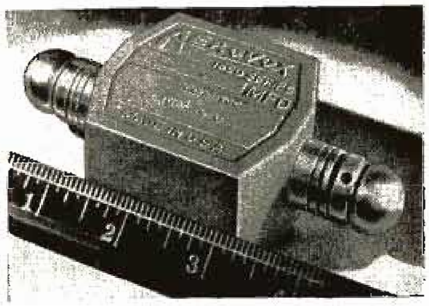
* * *

AEROVOX BAKELITE-MOLDED MICA CAPACITORS

Molded-in-bakelite mica capacitors, series 1690, have been developed by Aerovox Corporation, New Bedford, Mass.

Capacitor has rounded hardware to eliminate sharp edges and corners that cause corona loss; silver plating for all conducting members to minimize skin resistance; and yellow low-loss bakelite body.

Size: 2 3/8" wide x 2 3/16" deep x 1 3/8" high, and 4 3/4" overall between rounded terminal tips. Units are available in ratings up to 20,000 volts d-c test or 10,000 volts operating, and in capacitance values up to .001 mfd at the highest voltage rating.

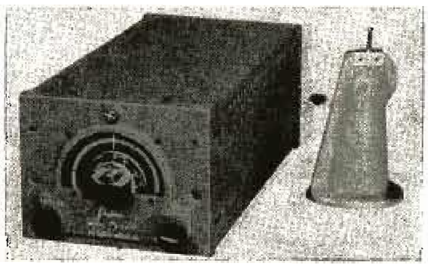


* * *

HALLICRAFTERS AIRCRAFT TRANSMITTER-RECEIVER

An 8-pound radiotelephone, type CA-2, for the personal aircraft field, has been announced by the Hallicrafters Company, Chicago.

Covers all the frequencies of radio ranges, control towers and beacons for navigational purposes, and includes a broadcast band.



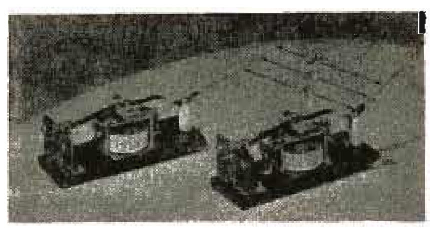
* * *

LEACH ANTENNA SWITCHOVER RELAYS

High-frequency antenna switchover relays, types 1723/1723-S9, for a-c use, and 1623/1623-S9 models for d-c use, have been developed by the Leach Relay Company, Los Angeles, Calif.

Relays have s-p-s-t contact arrangement. All contacts are ¼" diameter pure silver. Stationary contacts are mounted on a Mycalex panel. Relays are said to withstand over 4,000 volts rms, 60-cycle in hi-pot test between contacts and between frame and ground and the contacts.

In application, a pair of these relays are connected in either series or parallel. The S9 feature, designating an auxiliary s-p-s-t ⅛" pure silver contact, insulated for 125 volts, permits relay to be used for grounding, controlling a light power circuit, or for operating a power relay.

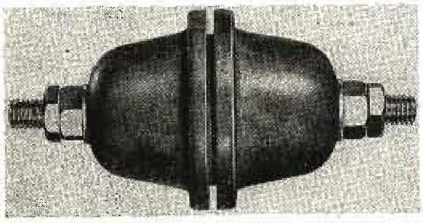


* * *

MYKROY INSULATORS AND BUSHINGS

Feed through insulators in ¼" to 5" ranges,

molded Mykroy (glass-bonded mica ceramic) have been announced by the Electronic Mechanics, Inc., 70 Clifton Boulevard, Clifton, N. J.
High-voltage transformer bushings using Mykroy, have also been developed.



* * *

SOUNDVIEW MARINE RECEIVER

A 5-tube portable 2-band marine receiver for 540 to 1.750 and 1,700 to 6.000 kc, has been announced by Soundview Marine Company, Inc., 267 City Island Avenue, City Island, New York.
Features a removable telescopic antenna, 10" to 40" fully extended

* * *

ANDREW CODE BEACON

A code beacon, 32¼" high, for lighting radio towers of 150' or higher, has been announced by Andrew Co., 363 E. 75th St., Chicago 19.
Has two 500-watt prefocus lamps, red pyrex glass filters and cylindrical fresnel lenses.

* * *

MAGUIRE AIRCRAFT TRANSMITTER

An 8-watt 3,105-kc aircraft transmitter has been announced by the commercial department of Maguire Industries Inc., 1437 Railroad Ave., Bridgeport, Conn.
Uses an antenna loading coil adjustable for resonance with any fixed antenna from 11' to 40' long.

* * *

G. E. MAGNETICALLY-CONTROLLED DIODE

A high-vacuum magnetically-controlled diode tube, type 2B23, has been announced by the tube division of the G. E.
Diode has a d-c plate voltage of 150 and a plate current operating range of 30 ma when used as a d-c amplifier or electronic switch.

* * *

SYLVANIA PENTODE VOLTAGE AMPLIFIER

A semi-remote cut-off pentode amplifier, 1LG5, for portable battery and a-c/d-c receivers has been announced by the radio tube division of Sylvania Electric Products, Inc., 500 Fifth Avenue, New York 18, N. Y.
Filament is rated at 1.6 volts maximum for battery operation and has a design center of 1.3 volts for a-c/d-c operation.
Typical operating conditions with 45-volt plate supply in class A1 amplifier service, with suppressor grid connected to negative filament at

(Continued on page 68)

BOOK TALK . . . .

PULSED LINEAR NETWORKS

By Ernest Frank, Garden City Research Laboratories, Sperry Gyroscope Co., Inc. . . . 267 pp. . .. New York: McGraw Hill Book Co. . . . $3.00

Technical men are familiar with the fact that most working calculations are based on steady-state conditions where voltages and currents either vary periodically or do not vary at all. They are also aware that such calculations ignore transients in which currents and voltages change in non-repetitive style. Although such transients are often important considerations, many engineers tend to shy away from the mathematical manipulations involved in handling them.

Mr. Frank's book shows that a great many problems involving transients may be satisfactorily treated with an elementary knowledge of differential equations of a level attained by all engineering undergraduates. To treat problems in this manner, Mr. Frank introduces a number of simplifying assumptions:

(*1*) Distributed resistance, inductance, and capacitance are lumped.

(*2*) The transient behavior of a network is analyzed by examining its output when a single rectangular voltage pulse is impressed across its input terminals.

(*3*) The analysis is limited to homogeneous linear equations of the first degree. This third assumption excludes many series-parallel networks from consideration but permits all series nets to be analyzed.

Mr. Frank offers first an examination of the nature of transient phenomena and a short review of the basic necessary electrical concepts. This includes Kirchoff's laws and voltage across *L*, *C*, and *R* defined as functions of time. He then touches upon the elementary differential equations used throughout his text and points out how hyperbolic rotation may be useful in simplifying mathematical expressions. A major part of the text is devoted to investigation of series networks comprising various combinations of *R*, *L*, and *C*. Another section treats similar series-parallel combinations by establishing equivalent series networks. Mr. Frank is careful to point out, however, that the majority of series-parallel *RLC* networks give rise to differential equations of higher than the second order which cannot be analyzed through his method.

The text concludes with examination of a diode detector, a tuned amplifier, and simple filters as examples of practical applications. In each case a complete circuit, including all stray elements, is presented. Then, on the basis of experience and common sense, the circuit is simplified by the omission of elements having negligible influence upon the pulse-response characteristic. The simplified series circuit is analyzed directly; the simplified series-parallel circuit must be converted to the equivalent series. When the conversion cannot be made, a more powerful mathematical tool becomes necessary.

Mr. Frank is well aware of the limitations of his method of analysis. At the same time his method enables many types of problems to be handled with a minimum knowledge of higher mathematics. His book, therefore, helps fill the gap between the elementary texts requiring no appreciable mathematical background and those others requiring a background of advanced study.

•

ELECTRONIC EQUIPMENT AND ACCESSORIES

By R. C. Walker. . . . 393 pp. . . . Brooklyn, N. Y.: Chemical Publishing Co., Inc. . . . $6.00

Mr. Walker's book is intended primarily for practical technical men who have a working knowledge of electricity and magnetism. It offers a good qualitative and descriptive discussion of many elementary electronic topics. The emphasis throughout is upon industrial applications.

Mr. Walker's procedure is to explain the fundamental characteristics of a class of electronic devices and then to follow up with a number of practical applications. He begins with a discussion of thermionic tubes and low frequency amplification and describes their applications to vacuum-tube voltmeters and other instruments. Short but very interesting descriptions of the electronic micrometer, viscometer, and the fatigue testing of metals by vibrating samples to destruction, are offered.

The next section of Mr. Walker's book discusses gas-filled tubes and their applications as relays, rectifiers and inverters, and saw-tooth wave generators. In another section appears data on light-cells and their use in illumination measurements, as relays, and in reproducing desired wave forms. Another chapter is devoted to a discussion of cathode-ray tubes and their application to testing and to measurement. Finally, Mr. Walker discusses a number of miscellaneous devices, including voltage and current regulators, small switches, impulse recorders, selsyns, and piezoelectric devices.

The text concludes with an appendix that summarizes some mathematical relationships.

Mr. Walker has succeeded in compressing a large amount of information into his book. He is concise, he is readable, he avoids advanced mathematics. His diagrams are clear and well chosen. Under the circumstances omissions are unavoidable and it is admittedly somewhat unfair to point them out. To go on nevertheless, Mr. Walker's examples of actual applications refer almost entirely to British equipment with which many American readers are not acquainted. Secondly, the applications described might well have emphasized current industrial practice to a greater extent. The inclusion of surface hardening by high-frequency induction as a thermionic application would have been useful. The section on light-cell application might profitably have discussed the use of infra-red in greater detail (in burglar alarms, for example). The electronic devices used in photography—photoelectric exposure meters, electronic timers—might have been touched on here. Medical applications of electronics are mentioned once or twice but deserve more space. Such topics as raidography, electro-cardiography, and colorimetry would have been instructive.

The chapter on small switchgear collects much material on low power switches together for the first time.

The fact is, of course, that the field of electronics requires a library rather than a single book for complete coverage. Within the space limitations of a single volume, Mr. Walker has produced an excellent and useful piece of work.

THE INDUSTRY OFFERS . . . —

(*Continued from page 65*)

socket, are: filament voltage, d-c, 1.4; filament current, 0.05 ampere; plate voltage, 45; screen-grid voltage, 45; control-grid voltage, 0; control-grid resistance, 2.0 megohms; plate current, 1.5 ma; and screen-grid current, .45 ma.

* * *

PRECISION APPARATUS CIRCUIT TESTER

An a-c/d-c portable industrial circuit tester, series 856-J, has been announced by Precision Apparatus Company, Inc., 92-27 Horace Harding Blvd., Elmhurst, N. Y.

Portable provides selection of 52 a-c/d-c voltage and current ranges. The a-c unit incorporates an internal heavy duty current transformer designed for operation on 25 cycles and higher. Two 4½" full vision meters are provided. Meter has a 50-microampere full-scale sensitivity and provides calibration at both 20,000 and 1,000 ohms-per-volt.

Unit is said to provide simultaneous measurements of a-c current and voltage with independent readings on the separate meter dials.

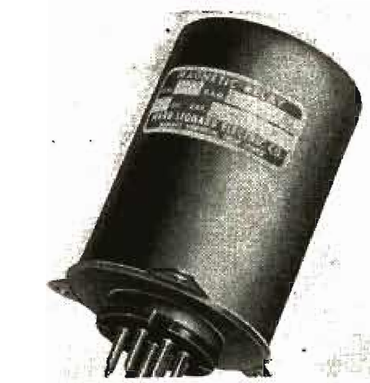
Ranges are: seven d-c (voltage), at 20,000 ohms per volt, up to 6,000 volts; seven d-c (voltage), at 1,000 ohms per volt, up to 6,000 volts; seven a-c (voltage), at 1,000 ohms per volt, up to 6,000 volts; seven d-c (current), 0-60 microamperes to 12 amps; three resistance ranges . . . 6,000 ohms, 600,000 ohms and 60 megohms, self-contained; six decibel ranges from —12 to +70 db; seven output ranges at 1,000 per volt, up to 6,000 volts; and eight a-c current ranges, 0-300 milliamps to 60 amps.

* * *

WARD LEONARD PLUG-IN RELAYS

Hermetically sealed plug-in octal-base relays, for a-c or d-c operation in small radio transmitters, aircraft control circuits and other applications, has been announced by Ward Leonard Electric Co., Mount Vernon, N. Y.

Available in contact combinations to double pole, double throw with a-c contact ratings of 4 amperes, from 0 to 115 volts and d-c contact ratings of .5 ampere from 25 to 115 volts.



* * *

FTR MIDGET SIZE SELENIUM RECTIFIERS

A 1¼" x 1¼" x 11/16", 5-plate, square stack selenium rectifier has been designed by Federal Telephone and Radio Corporation.

Known as type 403D-2625, the rectifier consists of five squares of selenium plates made on aluminum base plates, connected in series, with center contact.

Unit has a rated current carrying capacity of 100 ma d-c and a peak inverse voltage of 330.

* * *

SPRAGUE UNIVERSAL VERTICAL CHASSIS MOUNTING CAPACITORS

Type LM etched-foil type capacitors for vertical chassis mounting have been announced by the Sprague Products Company, North Adams, Mass. Capacitors are designed to replace screw can mounting and will fit any chassis hole from 3/16" to ⅞" diameter.

Capacitors have separate positive and separate negative leads which can be connected together to obtain common positive or negative sections. Available types include single, dual, and triple capacities.

* * *

PANORAMIC PANADAPTOR

A Panadaptor for visual sprectrum study, that may be attached to communications receivers with an i-f of 450-470 kc, has been announced by the Panoramic Radio Corporation, 242 West 55th Street, New York 19, N. Y.

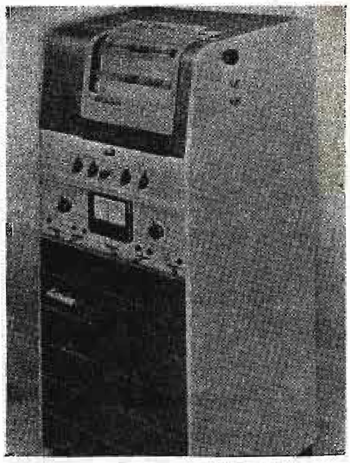
A band of frequencies 100 kc on either side of the frequency to which the receiver is tuned is visible with the unit.

* * *

FINCH FACSIMILE EQUIPMENT

Facsimile equipment, designed primarily for f-m broadcasters, has been announced by Finch Telecommunications, Inc., Passaic, N. J.

Features a studio facsimile transmitter-monitor system which consists of two Finch broadcast facsimile scanners, each with associated monitor receiver, power units, amplifiers and selective switching arrangements. System provides automatic copy loading and ejection.



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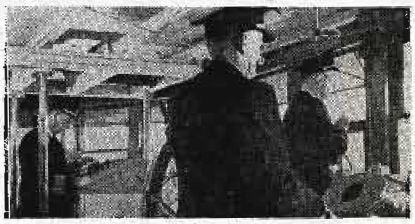
WESTINGHOUSE MARINE RADAR

Marine radar equipment designed to provide navigational aid and anti-collision protection from 100 yards to 32 miles has been announced by Westinghouse.

Provided with a plan position indicator scope.

Peak power output is over 15 kw at a repetition rate of 2,000 cycles per second. Operating frequeny is 9.320-9.430 mc.



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G. E. F-M H-F POWER TUBE

A screen-grid h-f f-m transmitting tube, type GL 7D21, has been announced by G.E.

Uses ring-seal contacts; filament, grid and screen terminals are designed to permit plug-in methods of installation.

Designed as a class C r-f amplifier with low driving power.

The plate is forced air-cooled and is capable of dissipating 1,200 watts. Maximum ratings apply up to a frequency of 110 megacycles.

A total driving power of less than 150 watts is said to be achieved, for two tubes.

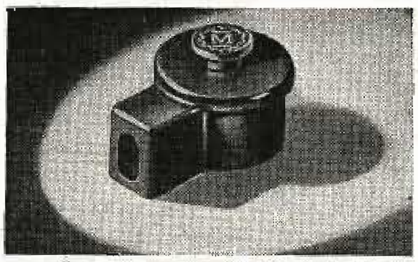
* * *

MILLEN SNAP-LOCK PLATE CAP

A plate cap, 36,011, with a contact that is self-locking when cap is pressed into position, has been announced by James Millen Manufactur-

ing Company, Inc., 150 Exchange St., Malden, Mass. Insulated snap button at top releases contact grip for removal.

Molded black bakelite, to fit all tubes with 9/16" diameter contact ferrule.



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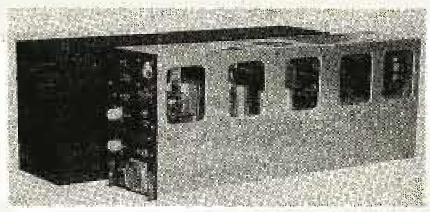
COLLINS AIRCRAFT TRANSMITTER

A 5-watt five-frequency, crystal controlled transmitter, 17K-1, for commercial and itinerant aircraft use in the 122-132 mc band, has been developed by the Collins Radio Company. The complete transmitter, including a dynamotor power supply, is in a single ½ ATR unit cabinet.

The audio circuit employs peak clipping to raise appreciably the effective modulation level and allow full use of the carrier power.



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GENERAL CONTROL PUSH-BUTTON SWITCH

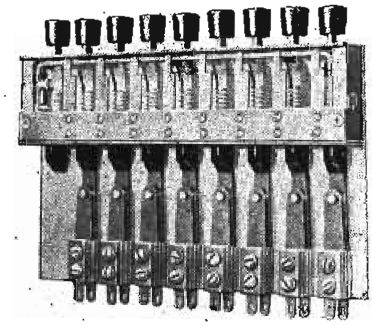
A 9-position push-button switch in locking and non-locking frame types, type MPB, has been

(*Continued on page 70*)

announced by General Control Co., 1200 Soldiers Field Road, Boston 34, Mass. The locking frame type has eight positions and one reset position.

Contacts are fine silver, permanently riveted to the phosphor-bronze contact springs.

Ratings are 5-10 amperes, 125 volts, 60 cycles a-c (non-inductive load).



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FAIRCHILD LINEAR POTENTIOMETERS

Wire-wound linear potentiometers have been developed by the Fairchild Camera and Instrument Corporation, Jamaica, N. Y.

The linear series consists of three models. Accuracies are said to be .05% in the 5" diameter size, and .15% in the 2" size.

Angle of rotation is from 352° to 357°, leaving a maximum unwound sector of 8° in the smallest size and an unwound sector of 3° where the maximum wound length is required.

* * *

AMPHENOL RAILROAD ANTENNA

A broadband 160-megacycle ground-plane antenna for two-way communication between train and fixed station and end-to-end service has been announced by American Phenolic Corpora-

THE INDUSTRY OFFERS . . . —

(*Continued from page 69*)

tion, 1830 South 54th Avenue, Chicago 50, Illinois.

Antenna utilizes the metal top of the car for its ground plane. It is fed by an armored 52-ohm coaxial transmission line. The radiation pattern in the horizontal plane is circular in shape and the voltage standing wave ratio is said to be less than 1.5 to 1 from 152 to 162 mc; gain of the antenna is 0.5 db less than a dipole.

Assembly is constructed of steel, and has an overall height of 14½". It is secured to the car by three ¼"-20 bolts.

* * *

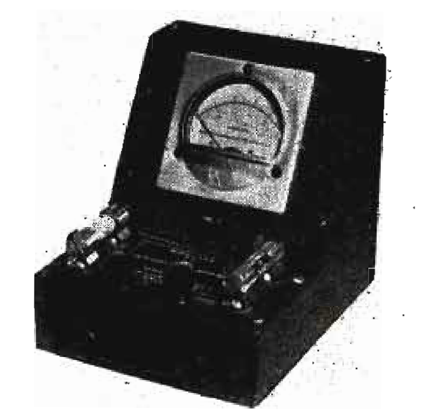
REINER LABORATORY TESTER

A volt-ammeter lab unit, type 333, that is said to permit a check on circuit connection and range of shunts and multipliers when measuring voltage or current has been announced by Reiner Electronics Company, Inc., 152 West 52nd Street, New York 1, New York.

Uses a hermetically sealed meter.

Voltage multipliers will give a range from 1 to 1,000 volts and shunts a range from 2.5 milliamps to 10 amperes.

Model 333 is for d-c; model 334 for a-c/d-c.



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GENERAL CERAMICS HERMETICALLY-SEALED TRANSFORMER BUSHINGS

Hermetically-sealed sealex bushings, multiple and single-terminal styles, with 1 to 20-ampere current-carrying capacities, have been announced by General Ceramics and Steatite Corp., Keasbey, New Jersey. Voltage flash-overs are said to range from 2,000 to 40,000 volts rms.

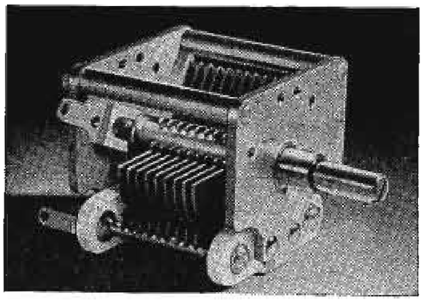
Bushings are made of steatite glazed permanently to stainless steel. Metal used in these bushings is hot tin coated.

* * *

HAMMARLUND MIDGET CAPACITORS

Four types of midget capacitors, type RMC, with capacities ranging from 7.3 to 50; 9.5 to 105; 11 to 143.5 and 17.5 to 327 mmfd, have been announced by the Hammarlund Manufacturing Company, Inc., 400 West 34th Street, N. Y. 1.

Features silicone-treated ceramic insulating bars; silver-plated beryllium forked-spring bearing contacts, and soldered rotor and stator assemblies.



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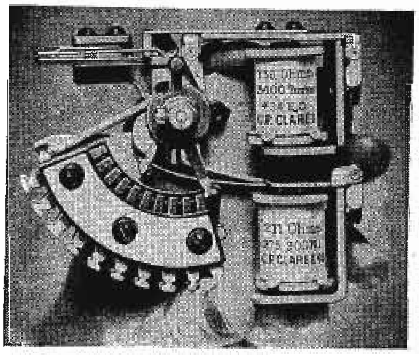
CLARE MULTI-CONTACT SWITCH

A multiple-contact switch for the selection of any of ten channels has been announced by C. P. Clare & Company, 4719 West Sunnyside Avenue, Chicago 30, Illinois.

Ten-point unit has a direct-drive stepping switch with a reset magnet, and is supplied with one, two or three bank levels.

The maximum operating speed of a 48-volt switch under ideal conditions is 35 steps per second. Release time is 0.03 second. Operating voltages are: nominal . . . 6, 12, 24 and 48; maximum . . . 8, 16, 32 and 58.

Overall height is 4½", width 1½" and length (from mounting surface) 3⅝".



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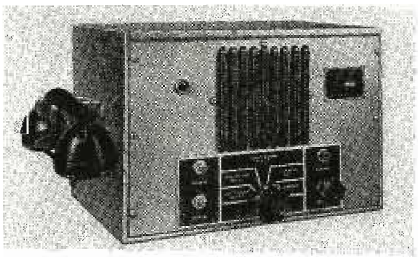
ISLIP MARINE RADIOTELEPHONE

A 10-watt, crystal-controlled marine radiotelephone has been developed by Islip Radio Manufacturing Corp., N. Y. Power supply may be 6, 12 or 32 on special order.



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CINEMA PROGRAM EQUALIZER

A program equalizer, type 4031, graduated in 2 db steps, to permit control over a range of 16-db attenuation and 12-db equalization, has been announced by Cinema Engineering Co., 1510 W. Verdugo Ave., Burbank, California.

Attenuation is peaked at 100 cycles on the low end. Key selector permits switching high frequency peak equalization to 3 kc, 5 kc, or 10 kc. Designed with a constant "K" circuit. Supplied on a 3½" panel to fit a standard relay rack.

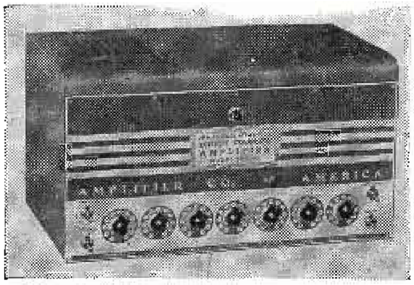
• • •

ACA DIRECT-COUPLED AMPLIFIERS

Direct-coupled 5-stage amplifiers, type ACA, with a signal self-balancing and current drift-correcting direct-coupled output circuit, have been developed by Amplifier Co. of America, 398 Broadway, New York 13, N. Y.

Response is said to be 20 to 20,000 cycles ± 1 db. Develops 23 watts. Overall gain, 96 db. Hum and noise level, — 40 vu. Two independent inputs (each of 500,000 ohms) are provided.

Tubes used include: two 12SC7; two 12SK7; two 6SJ7; two 6L6G; one 5U4G; one 5V4G and one ballast. Size, 17¼" x 10" x 10".



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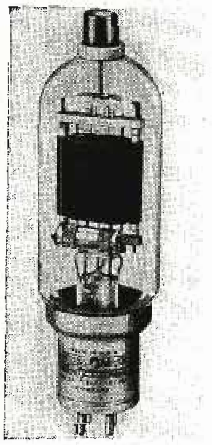
UNITED ELECTRONICS 300-WATT GRAPHITE ANODE TUBE

A graphite-anode power tube, type V700, rated at 300 watts, featuring a crystal clear glass envelope, has been announced by the United Electronics Company, 42 Spring Street, Newark, N. J.

The graphic anode is zirconium impregnated. Designed as a high power renewal for soft glass tubes with 7.5-volt filaments. Filament amperes, 3.25; maximum plate dissipation, 85 watts; maximum plate volts, 1,750 at 200 mils.



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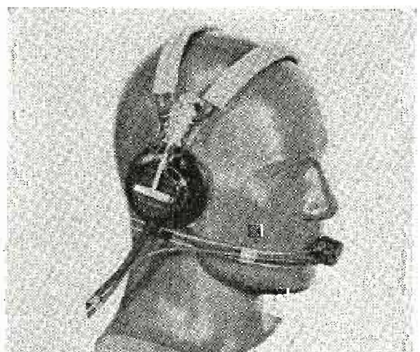
AVIOMETER PILOT-LIP MIKE

A pilot-lip carbon communications microphone has been announced by the Aviometer Corporation, New York. Microphone supplied with a noise-excluding high-fidelity headphone.



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PIERSON COMMUNICATIONS RECEIVER

A 5-band, 550 kc to 40 mc, communications receiver, type KP-81, has been announced by the Pierson Electronic Corporation, 533 East Fifth Street, Los Angeles 13, California.

Features include electrical band spread, slide-coil-drawer band changing, inter-channel noise suppression, electron-coupled oscillator, crystal filter, two r-f stages, three i-f stages, silencer circuit, etc.

ADVERTISERS IN THIS ISSUE

COMMUNICATIONS—JUNE, 1946

NEW VARIACS with these 12 Features

for

Improved Performance
Greater Convenience
Longer Life

● This new Type V-5 VARIAC replaces the popular Type 200-C. Through entirely new design and radical changes in basic structure the new model is 25% lighter, with the same rating of 860 va. This is achieved both through improved magnetic performance of the core and less copper, and through use of aluminum in most of the structure.

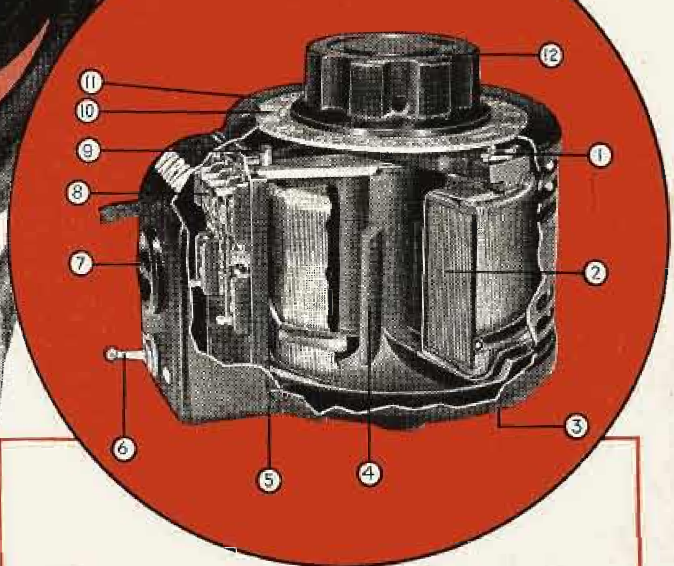
Some of the new VARIAC's many features are listed at the right. Externally, the new VARIAC has been streamlined to eliminate all sharp corners. The cord on the mounted model is arranged to be wound around the VARIAC, plugged into the outlet, and then used as a carrying strap.

This is the first radical change in basic design of the VARIAC since it was introduced by G-R almost 15 years ago. These many changes were made not to dress up the VARIAC in a new case but to provide real improvements to better its performance, increase its convenience and lengthen its life, and to be sure that when you use a VARIAC you are using the best means possible for controlling any alternating-current operated device where perfectly s-m-o-o-th variation in voltage is desired.

TYPE V-5 860 va VARIAC

TYPE	STYLE	PRICE
V-5	Basic (115-volt input) unmounted model	$16.50
V-5M	Above with protective case around winding	17.50
V-5MT	A V-5 with protective case, terminal cover, 6-foot cord, switch and outlet	20.00
V-5H	Same as V-5, except for 115- or 230-volt input	21.50
V-5HM	Same as V-5M, except for 115- or 230-volt input	22.50
V-5HMT	Same as V-5MT, except for 115- or 230-volt input	25.00

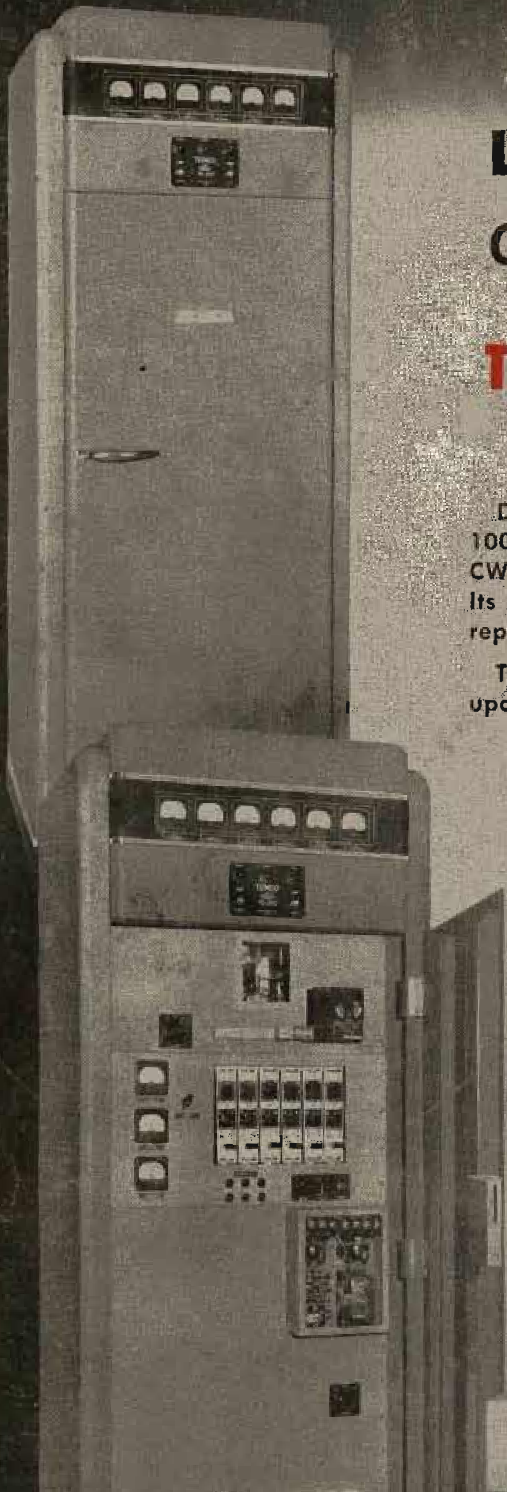
WRITE FOR COMPLETE DATA



1. *New G-R Unit Brush — low sprung weight reduces hammering and arcing under vibration — correct pressure provided by coil spring — holder cannot make contact with winding and cause short-circuit — brush changed quickly without tools.*
2. *New grain-oriented core of cold-finished silicon-steel with guaranteed maximum core loss — strip wound.*
3. *Three rubber feet prevent marring table top and make it unnecessary to screw units down to prevent slippage.*
4. *Aluminum structure contributes to greatly increased output per pound.*
5. *Only two screws hold both case and terminal cover — a screwdriver or a spare dime remove each in a second.*
6. *Heavy-duty switch breaks both sides of the line, in mounted models.*
7. *Polarity indication provided in convenience outlet — useful if one side of line is grounded.*
8. *Improved molded terminal plate protected by a metal, fiber-lined cover — molded barriers between terminals prevent short-circuits from whiskers on stranded wire — both screw and solder terminals — engraved circuit diagram shows normal VOLTAGES between terminals — 2 extra terminals for use with auxiliary transformers.*
9. *New resilient stop allows brush arm to bounce instead of break if you are too vigorous in rotating knob.*
10. *BIG calibration figures and extra points on dial — easy to read at a distance — easier to reset — pointer provided for panel mounting.*
11. *A single screw, readily accessible under dial, loosens shaft for reversing dial and knob to change from table to panel mounting without affecting brush or stop settings.*
12. *Newly designed, larger knob — easier to hold — easier to turn.*

GENERAL RADIO COMPANY Cambridge 39, Massachusetts

90 West St., New York 6 920 S. Michigan Ave., Chicago 5 950 N. Highland Ave., Los Angeles 38



Presenting the 1000-J6

LATEST TEMCO 1 K. W. Communication TRANSMITTER

featuring

TEMCOMATIC Frequency Selection

and NEWEST TETRODE TUBES

Designed for point-to-point commercial service the new Temco 1000-J6 is conservatively rated at 1 K.W. output for phone and CW on 6 crystal controlled frequencies from 2 to 20 megacycles. Its most outstanding feature—TEMCOMATIC Frequency Selection representing a major contribution to radio communication.

This new, exclusive Temco system combines and improves upon the best and most desirable features of several earlier automatic frequency selection systems. The operating mechanism is remarkably simple and foolproof in its conception and construction. By turning a selector switch to the pre-set frequency desired, switching is accomplished in a second or two—automatically and dependably. *You turn the switch . . . the transmitter does the rest.*

Paralleling this long sought for improvement is the use of the latest type tetrode tubes in the power amplifier—2 type 4-250A's. The lower driving power characteristic of these new tubes permits great simplification of the preceeding exciter stages.

Servicing, heretofore a serious and objectionable drawback of other systems, has been reduced to a negligible minimum. The handsome, dignified appearance of the 1000-J6 reflects the excellence of its electrical design. Let us tell you more about this finer post-war transmitter *that has everything.* Write for Bulletin T-6 today.

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