COMMUNICATIONS

PERSONAL RECEIVERS

CRYSTAL FILTERS

TELEVISION

APRIL

1941

Sorry, Mister Janus

Mr. Janus, the old Romans said, was a smart guy. But why not, being double-headed as he was? ¶ We were thinking the other day that it would be handy to have him around. And then taking stock, we decided we could dispense with the idea because here at Collins we have not two but many heads. ¶ Our recently expanded factory is manned by a skillful personnel trained to build radio equipment of excellence. Collins engineering department abounds in every kind of mechanical and electrical proficiency.

COLLINS RADIO COMPANY

CEDAR RAPIDS, IOWA NEW YORK, N. Y: 11 WEST 42 ST.

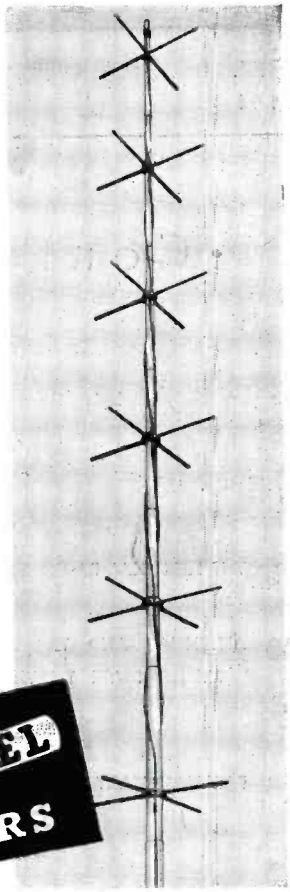
LINGO FOR

FM TURNSTILE

(PATENTED DESIGN)

ANTENNA

The First and Only Antenna of its Kind in the Industry



IMPORTANT NEW FEATURES:

Radiates horizontal polarized signal with substantially uniform circular field pattern.

Custom built, factory adjusted to operating frequency. No field adjustments necessary.

Improved design greatly simplifies method of feeding and coupling.

Turnstile elements fed by coaxial lines. No open turnstile wires used.

Lighting equipment, climbing steps installed without interfering with operation of turnstile.

Heating elements may be used in turnstile arms for sleet melting where necessary.

Available with 2, 4, 6, 8 and 10 layers of turnstile elements, depending upon desired gain.

Now Ready to Quote on Turnstile for Any Station up to 50 KW

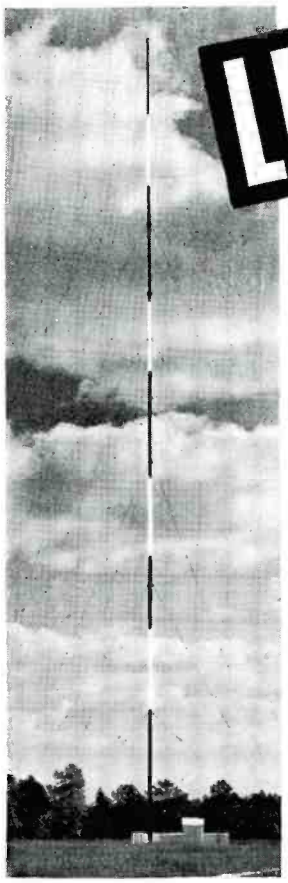
Improved in design—completely developed—the Lingo FM Antenna comes to you as a "finished product" offering distinct improvements over all previous designs. Lingo has a definite, important place in your FM plans and offers you antenna performance and efficiency based on *experience* and not experiment!

Quotations will be gladly submitted for individual applications only and will include the essential tubular steel mounting pole, turnstile elements, coupling equipment, transmission lines feeding the elements, etc. Climbing steps, lighting equipment and sleet melting units available as optional equipment. Erection on your supporting tower or building roof can also be included.

JOHN E. LINGO & SON, INC.

LINGO VERTICAL TUBULAR STEEL RADIATORS

Dept. C-4, CAMDEN, N. J.



LINGO FOR

AM VERTICAL

TUBULAR STEEL

RADIATOR

Engineered to Give the Utmost in Antenna Performance

Reduces Maintenance Costs
Increases Station Performance

If overhead costs are as important with you as performance is with your engineers—then all will enjoy the satisfaction of a Lingo Tubular Steel Radiator. Facts prove that you can expect highest efficiency and pay less for maintenance. The moderate initial cost and low upkeep cost, plus assured peak performance combine to give you more profits through better coverage.

PARTIAL LIST OF INSTALLATIONS:

WTAR	Norfolk	WFPG	Altoona
WIBW	Topeka	WMOG	Brunswick
WCSH	Portland	WOLF	Syracuse
WBOC	Salisbury	WGKV	Charleston
WWSW	Pittsburgh	WAOV	Vincennes
KTSW	Emporia	WSLS	Roanoke
WSAV	Savannah	WAJR	Morgantown
WFBG	Atlantic City	WIBM	Jackson
WBTH	Williamson	WLLH	Lawrence
WCOU	Lewiston	CFAC	Calgary, Alb.
WPID	Petersburg	CJKL	Kirkland Lake Ont.
WRJN	Racine	CKGB	Timmins, Ont.

★ Yes, we want to tell YOU our important story. Our engineering staff will be pleased to provide you with technical details as they apply in your own particular case—without obligation, of course. In writing please give location, power and frequency of station.

COMMUNICATIONS

APRIL 1941

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

VOLUME 21
NUMBER 4

RAY D. RETTENMEYER
Editor

• Contents •

COVER ILLUSTRATION

The young lady displaying the personal radio reminds us that our lead article this month presents data on the latest models of this type receiver. See page 5. Photo courtesy General Electric Co.

• Comments •

CONVENTIONS are again the order of the day. To begin with, the University of Illinois is sponsoring an Interference Conference in Urbana, Illinois, on May 10. The program of the meeting appears on page 24.

In Rochester, N. Y., the AIEE are holding their North Eastern District Meeting (Sagamore Hotel)—April 30 through May 2. Some of the papers presented will be of interest to communication engineers. We refer to such subjects as: "Communications in National Defense," by Dr. R. H. Manson; "Unusual Applications of Electrical Engineering Principles in Television," by Dr. George R. Town; "High Speed Photography with the Edgerton Lamp," by Frod M. Brown; "A New Method for Radio Guidance of Aircraft," by D. G. C. Luck; "Carrier-Current Relay Equipment and Its Other Uses," by S. L. Goldsborough.

Following the AIEE gathering, the Society of Motion Picture Engineers take over at the Sagamore Hotel in Rochester, for their 1941 Spring Convention—May 5-8. Of interest in the SMPE technical sessions will be papers on the following subjects: "Multi-Speaker System," by H. I. Reiskind; "Fantasound," by N. A. Hawkins and W. Garity; "Vitasound," by N. Levinson and L. T. Goldsmith; "Motion Picture Technique and Multi-Horn Reproduction," by L. L. Ryder; "The Subjective Sharpness of Simulated Television Images," by M. W. Baldwin; "A Compact Direct-Reading Reverberation Meter," by E. S. Seeley; "Notes on the Mechanism of Disk Recording and Playback," by O. Kornei; "Analytic Treatment of Tracking Error and Notes on Optimum Pick-up Design, by H. G. Baerwald. In addition there will be an interesting symposium on the Stereophonic Sound Film System conducted by Harvey Fletcher, E. C. Wente, R. Biddulph, L. A. Elmer, A. B. Anderson, W. B. Snow, J. C. Steinberg, and A. R. Soffel.

Last, but far from least, comes the Annual Convention of the National Association of Broadcasters. This event will take place May 12-15, New Jefferson Hotel, St. Louis, Mo. Further data on this meeting will appear in the May issue.

BRYAN S. DAVIS
President

JAMES A. WALKER
Secretary

Published Monthly by the
BRYAN DAVIS PUBLISHING CO., Inc.
19 East 47th Street
New York City
New York Telephone: PLaza 3-0483

PAUL S. WEIL
Advertising Manager

A. GOEBEL
Circulation Manager

Chicago Office—608 S. Dearborn Street
Telephone: Wabash 1903

Wellington, New Zealand—Te Aro Book Depot
Melbourne, Australia—McGill's Agency

Entered as second-class matter October 1, 1937, at the Post Office at New York, N. Y., under the act of March 3, 1879. Yearly subscription rate: $2.00 in the United States and Canada, $3.00 in foreign countries. Single copies: twenty-five cents in United States and Canada, thirty-five cents in foreign countries.

THE PERSONAL RADIO RECEIVER

By HENRY HOWARD

A SERIES of personal miniature receivers, thought to be the last word in neat design, were recently brought out by the industry. But, almost as soon as they hit the store windows, the public was asking for a-c/d-c line operation, having been educated along this line through the experience of the previous few years when the popular type of standard large portables went through the same procedure. Now we hear that honest-to-goodness pocket sets will be coming along soon which won't require a policeman's overcoat pocket!

Portable sets have always had unique appeal—probably because of complete isolation from home surroundings, antennas and power lines. Even in the comparatively early days of radio, cigar box receivers were continually appearing in amateur and experimenters' magazines. They were not commercial designs, however, being the product of hobbyists.

Just as the low drain series of 1.4-volt tubes made the standard portable loop receivers possible a few years ago, the new series of miniature tubes and small i-f transformers made the present personal models feasible. The power requirements haven't changed, but the new tubes are very much smaller. They are more fragile, too, having no bases. The prongs are supported by the glass

General Motors' personal radio. Case is molded of Tenite. Photo courtesy Eastman Kodak Co.

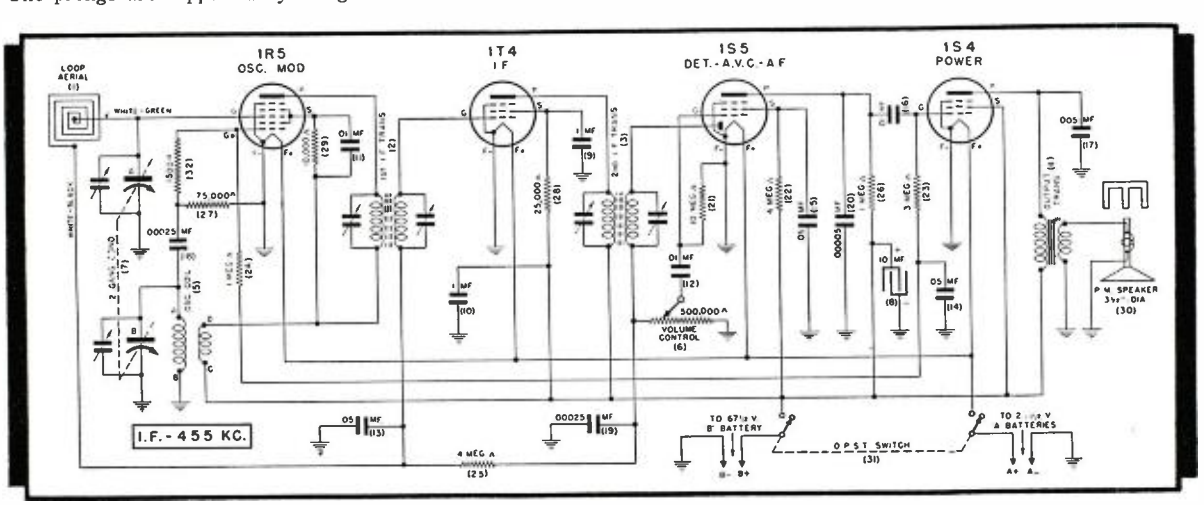
itself which can cause cracked envelopes. Socket manufacturers have to design the small sockets for these miniature tubes since misfits cause strains.

The tube types are as follows: 1T4 r-f and i-f, 1R5 oscillator-converter, 1S5 diode pentode for detector and first audio, and 1S4 power output. The filament of the last tube draws 100 ma, the others 50 ma. The type 3S4 is sometimes used in place of the 1S4, the only difference being that the filament is tapped for either parallel or series operation, making it convenient for line operation with the filaments in series. The converter and i-f tubes have a tendency to be microphonic, so shock-proof sockets must be used.

A-c/d-c operation creates a serious ventilation problem in personal sets, there being so little chance for heat dissipation. Screen bezels are generously used, the back of the cabinet is sometimes left open by means of a leather tab with two snaps, resistance line cords are still employed and special efficient rectifier tubes are being developed—all for the sake of line operation. One type of gas rectifier takes no cathode power during operation, thus eliminating most of the heating. Due to the low voltage, a filament is needed to start rectifying action, but this is connected only momentarily. A new tube, the 45Z3, is just being announced. Rated at 75 ma with 60 ma d-c output, this miniature size rectifier will have UL approval when used with a 5-watt, 1000-ohm internal resistor.

Cases

Whereas all the large battery portables had wooden cases with simulated leather or airplane luggage covering, there is considerable variety in the per-



Circuit of General Electric Model LB-412 receiver.

sonal receiver cases. While DeWald, Fada, Garod and Silvertone are among those using covered wood cases, Crosley is using aluminum, RCA and Motorola are using metal, and Sentinel, Admiral, General Electric and Detrola and Farnsworth have tenite or acetate cases partially covered with cloth giving a neat two-tone effect. These plastic cases come in a variety of colors and are very attractive. In most personal sets the loop antenna is contained within the door so all doors are of insulating material including bakelite and several plastics. Motorola uses a maroon polystyrene cover. As some of these plastics will cold flow at rather low temperatures (140 degrees), the cases should not be subjected to excessive heat. Zenith has a camera model which really looks like a camera.

One of the most appreciated features of all portables is the instantaneous operation obtained, there being no appreciable thermal lag in the filaments. The personal designs accent this feature by providing automatic on-off switching as the door is opened or closed. A few models use the converse system of having the on-off switch open the door automatically through the use of spring hinges. On non-metallic cases, the hinges also act as loop connectors. Metal case sets must have insulated strip connectors—note those on Crosley's photo.

Loops

Due to the location of loops in the doors of pocket sets, higher Qs can be realized than in the larger portables. While the larger sets have Q values of 200 at the low-frequency end to 125 at the high-frequency end when in open air, these values drop to 80-100 at l-f to about 60 at h-f when the loops are in position close to the chassis. In the personal sets representative Q values with door open are 140 at l-f to 80 at h-f. It is advisable to use Litz wire in the small loops because the advantages are realized, whereas, in the large loops, chassis absorption largely cancels the effect of Litz.

I-F Transformers

The successful performance of pocket sets, particularly with respect to sensitivity and selectivity, is largely due to the development of tiny i-f transformers, some as small as $\frac{3}{8}$-inch in diameter. The coils are potted—entirely surrounded with iron—eliminating any external field and preventing any can absorption. The Q varies from 80 to

Personal radios: (A) General Electric; (B) RCA Victor; (C) Zenith; (D) Admiral (Continental); (E) Philco; (F) Garod; (G) Crosley; (H) General Electric.

Circuits of portable receivers: (1) RCA BP-10; (2) Admiral 29-G5; (3) Emerson FF; and (4) Zenith 4K600. Additional circuits on pages 8 and 9.

100 and the gain is equal to that of standard large i-f transformers. Designed to conserve space, the transformers fit right on top of the miniature sockets or between two sockets, while the trimmers are separately located at some point convenient for adjusting. Some transformers use permeability tuning which requires a small fixed condenser, eliminating the need for trimmers. R-f coils are of similar size and performance.

Condensers

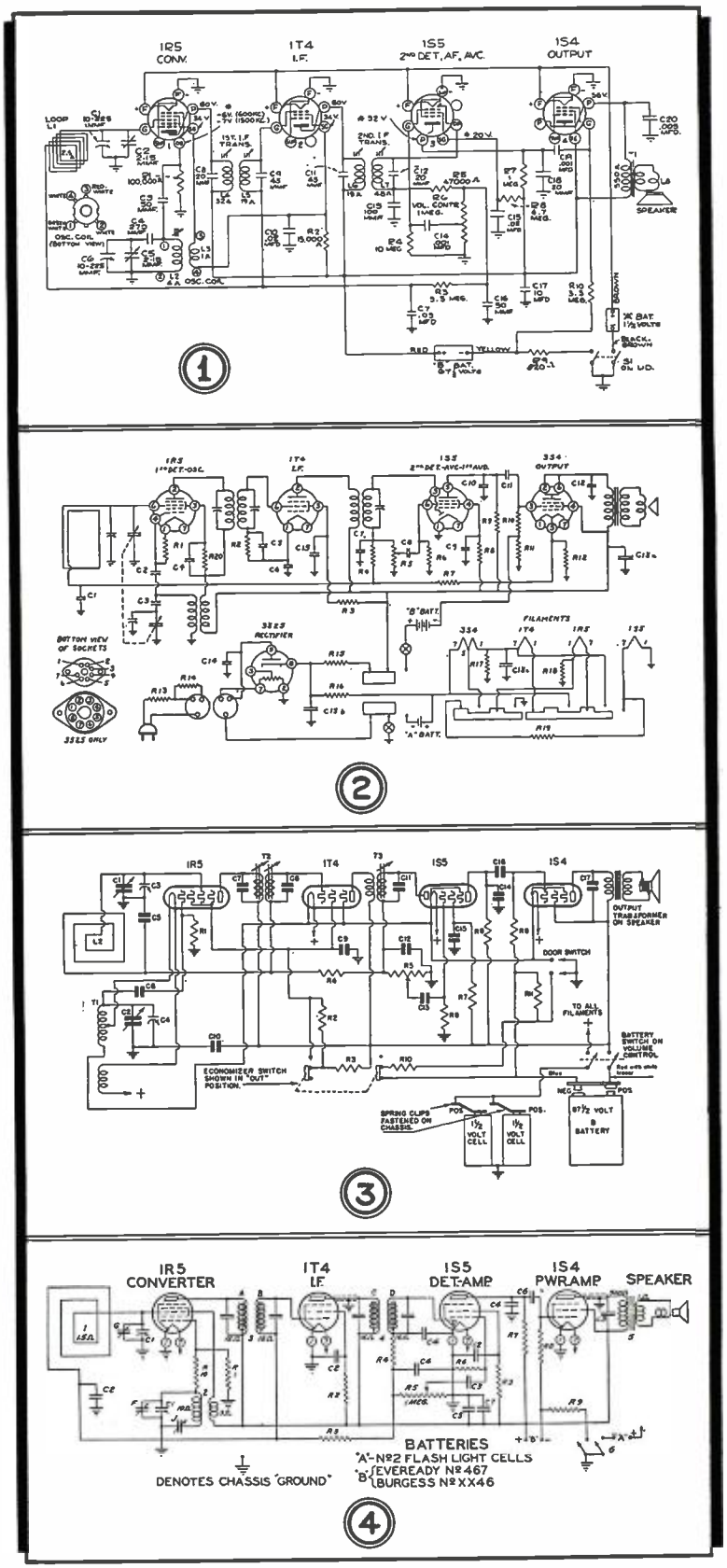
The new two-gang variable condensers are about the same size as a single section of condenser two years ago. Aluminum plates are used (if they can still get it) and very accurate flat stock—it has to be for the spacing is only .008 inch, which is mighty close for a tuning condenser. Both direct drive and an 8:1 reduction drive are used, the reduction being a planetary arrangement of a shaft within a shaft, the balls of the bearing doing the friction driving. This is probably the most difficult commercial condenser ever put out in quantity production.

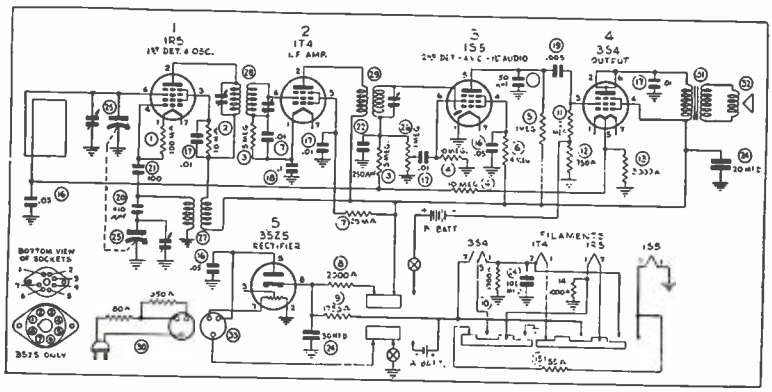
A brand new line of midget tubular paper condensers was developed expressly for the pocket receivers. These condensers are rated at 120 volts and are smaller in both length and diameter than standard tubulars. Built with two sheets of .0003 paper and foil proportionally thin, a very high grade of workmanship is required for soldering the foil and for other assembly operations.

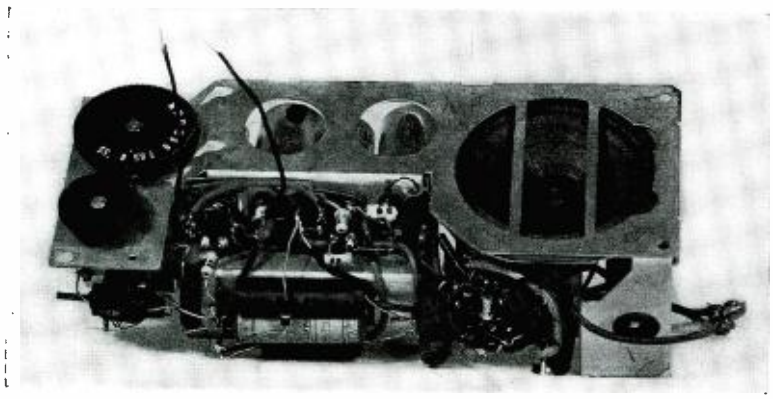
Electrolytics, too, have been shrunk commensurately with other components. A 3-section filter is used in all a-c/d-c battery models consisting of two high-voltage sections of 20-60 mfd, and a low-voltage section of 100-200 mfd for filament bypassing. Etched or fabricated plate types are used having physical dimensions for 3 sections approximating the size of the old type 8-mfd, 450-volt tubular dry electrolytics.

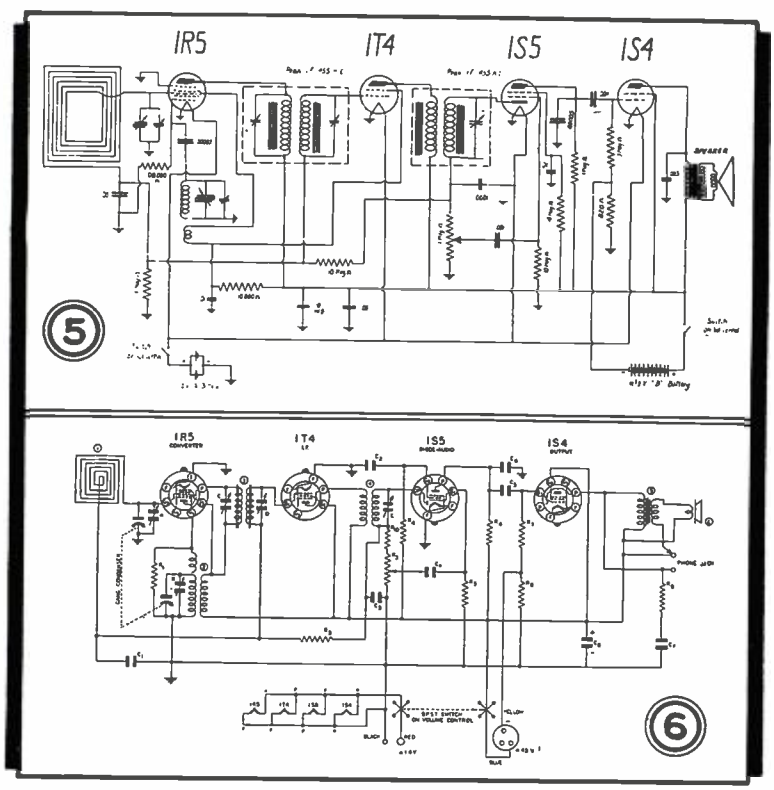
Batteries

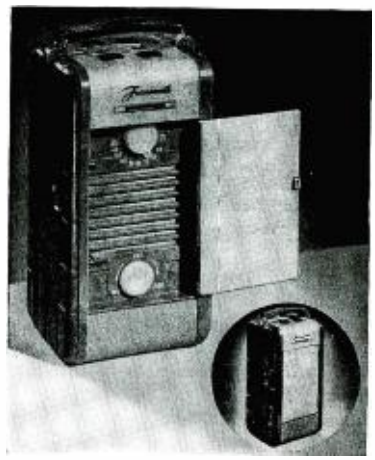
The developments of the Eveready type 467 "B" battery, a midget 67½ volt long life unit known as Mini-Max has been a boon to the industry. The few models not using this battery make use of a standard midget 45-volt battery produced by many manufacturers. The Mini-Max was specifically developed for the 8 to 11 milliampere load and will give from 40 to 60 hours of service under average conditions. From 1 to 5 standard flashlight cells serve as











Above and Top left: The Farnsworth Model CT-59. Left: An RCA receiver with cover removed to show chassis.

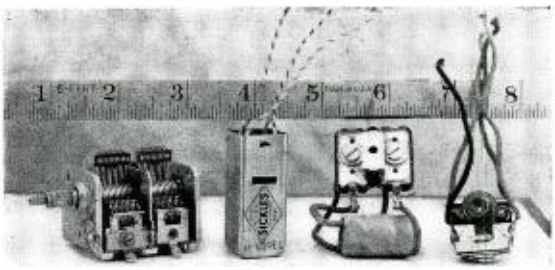
"A" batteries. The lightest sets, weighing 3¾ to 4 lbs., use only a single cell which will last from 3 to 5 hours, depending upon the period of operation and recuperation. Most of the plastic models use two "A" cells providing 10 to 15 hours of operation; a few including Fada, are using three cells, allowing 22 to 30 hours, and Motorola's three-power model 3A5 uses 5 cells with a corresponding increase in life. This model uses series filaments on both line and battery operation. The flashlight cells, while seemingly adequate for the job, are not used under optimum conditions in most cases, so new "A" cells are being designed specifically for a 125-ma load, figuring on two cells in parallel for the standard 250-ma filament drain.

Emerson obtains a greater "B" battery life at some sacrifice in performance by including an "economizer" in model FF-411. The economizer increases the bias on the 1S4 power tube and also lowers the screen grid potential on the converter 1R5 and the 1T4 i-f stages dropping the "B" current from 7.5 to 5.5 ma.

Dry batteries sometimes swell considerably when used up, so sufficient tolerance must be allowed for the easy removal of forgotten cells. While button contact slips are used on the "B" batteries, the "A" cells depend on springs for contact. The current being comparatively high, a sliding action must take place in order to insure low contact resistance.

Most companies are working on new volume controls, the present controls being several years old and obviously too large! In all sets, the volume con-

Circuits of the DeWald Model 410 (5) and Air Castle (6).



Showing the relative size of parts used in the personal type radio.

trol serves also as the diode load resistor. Fixed resistors are all insulated and of very small dimensions suitable for mounting on the sockets. Grid leak bias is used on the 1S5 first audio pentode, the value being 10 to 15 megohms. The use of a-v-c is advantageous in minimizing the directional effect of the loop antenna, which would otherwise be objectionable. No pilot lights are seen in this series of pocket sets; for one reason, the sets are so compact there just isn't any room!

Speakers

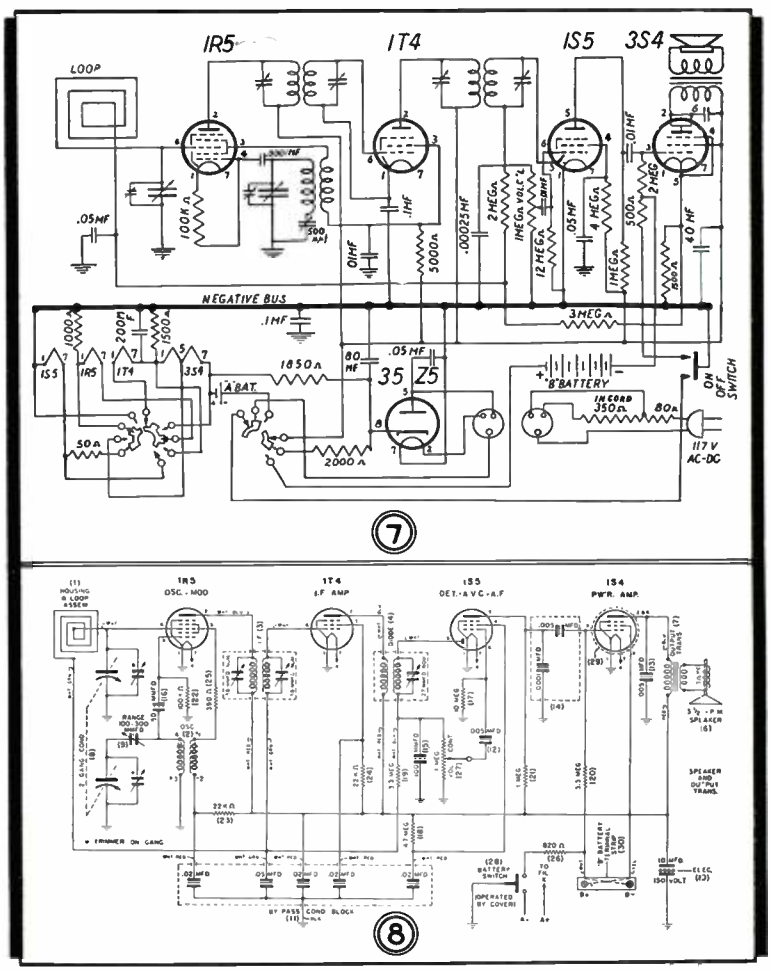
3 to 4-inch p-m speakers having 1½ to 4 oz magnets are used. The quality is surprising when the amplifier is not overloaded. Because of confined space, which doesn't allow much back pressure, the resonant point is set high. This doesn't admit much bass, but it prevents muffling. The majority of output transformers are mounted on the chassis, the designs not permitting room on the speaker. Because of very limited power output (0.04 to 0.1 watt) the transformer must be efficient, so they appear to be of reasonable size in spite of confined space. For real tiny pocket sets, 2 inch and oval 2 x 3 inch speakers are being developed with up to 4 oz. alnico magnets.

All 3-way sets run the filaments in series on line operation and all except Motorola run them in parallel on batteries. This leads to a complicated switching problem. Admiral pioneered a well-designed switch using a single wafer. Instead of a knob, the switch uses a lever with an insulated knurled fibre piece for shock protection. Line cords are usually rolled up in rear of case. In other cases, the cords plug into an outlet, being completely removable. The photo of Farnsworth's model CT-59 shows the level type switch. Garod's model BP-20 shows the switching diagram. This model has a floating chassis being isolated from the negative bus by a 0.1-mfd condenser.

Farnsworth model KD-57 shows a tapped line cord with plug-in feature. The tap allows for a 80-ohm series resistance which acts as a buffer or surge preventer, protecting the rectifier cathode and the first filter condenser. This model also uses a type of regeneration by running the low side of the first i-f primary to the hot side of the tickler coil instead of to the positive "B" bus.

(Continued on page 26)

Right: Circuits of Garod BP20 (7) and Motorola A-1 (8). Below: The DeWald Model 564.



Antennas and transmission lines at the

EMPIRE STATE TELEVISION STATION

By N. E. LINDENBLAD
RCA Communications, Inc.

The second of three articles on this interesting development in antennas and transmission lines. The first article appeared in the May, 1940, issue of COMMUNICATIONS, page 13. — Editor.

RADIATOR PRINCIPLES

THE variation of the input impedance of a radiator, with frequency, depends not only upon the general characteristics of the radiator, but depends also upon where and how the input power is applied.

A simple form of radiator is a quarter-wave extension of the center-line conductor of a coaxial transmission line. An ideal case for illustration is an arrangement where a flat conductive surface, perpendicular to the line forms the continuation of the outer conductor and where the center conductor extension forms a radiator, also perpendicular to the surface as in Fig. 5.

When disregarding the radiation, a quarter-wave radiator may be considered as an open-ended line terminated by an infinite resistance. The reciprocal resistance at the input end of this quarter-wave line section would then equal zero. Due to radiation, however, the input resistance is between 36 and 37 ohms. The transmission line feeding into the radiator may then be made to have such ratio between outer and inner conductor diameters so that its characteristic impedance becomes equal to about 36 ohms.

The input impedance of a free-ended quarter-wave radiator as shown in Fig. 5 is resistive and a minimum. As the frequency is varied, the location of this minimum impedance point will vary and no longer coincide with the end of the 36-ohm transmission line. This line will then no longer be matched. The causes of reflection on the line will be two-fold. At any location on a conductor, having standing waves, other than at maximum or minimum, the impedance includes reactive components. The radiation from any point on a radiator is proportional to the square of the current at this point. The current in a quarter-wave-long radiator is a maximum at the input end. When the frequency is varied so that the length of the radiator no longer corresponds to a quarter wave a greater or a smaller portion of the heavy-current region will be exposed above the surface. The radiation resistance of the radiator will thus vary considerably.

The reflection set up on the transmission line feeding into the radiator will thus be of both reactive and resistive origin.

The resistive component at any point on a line, having standing waves, equals the quotient between the power passing through the point and the square of the current. The radiation from a certain point on a radiator is proportional to the square of the current at that point. In the region of low current, there is therefore little radiation. Since very little power is drained from the total power while it passes through the low-current region, the power variation will be small in this region. If at the same time the characteristic impedance of the conductor in this region is constant and made to coincide with the power-to-current-square ratio, there should be very little change in impedance conditions in the low-current region as the frequency is varied.

The characteristic impedance along a rod-shaped radiator, perpendicular to a conductive surface increases with distance from the conductive surface. In order to minimize this variation in characteristic impedance, the radiator diameter should expand with distance from the feed end. In order to obtain input resistance of low variability at the input, the radiator should be given such length that the input is located in the low-current region of the radiator.

Carter and Bushbeck have shown that conical radiators having a length of approximately three-eighths of a wave possess the above described desirable characteristics.

It may be of interest to analyze the effect upon the frequency-response characteristic from increased radiator diameter. Since the radiation resistance is substantially independent of radiator diameter as long as the diameter remains a small fraction of a quarter wave, the power factor of the radiator will increase due to the lower reactance when diameter is increased.

The capacitive and the inductive re-

Illustrating the composite radiator.

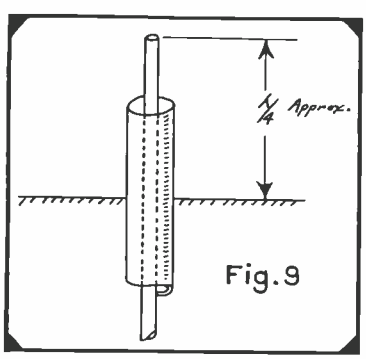


Fig. 9

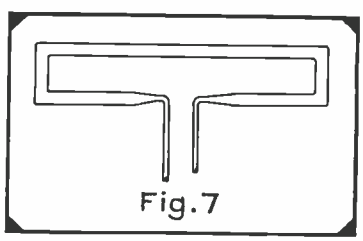


Fig. 7

Illustrating the folded dipole.

Parallel (a) and series (b) circuit for constant input impedance at variable frequency.

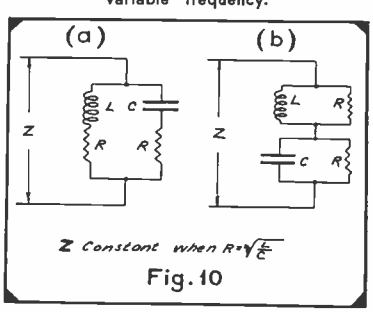


Fig. 10

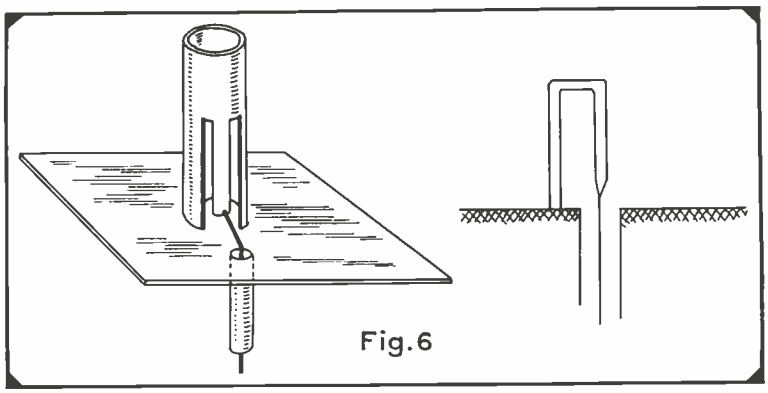
actances of a quarter-wave radiator may be considered as series tuned and in series relation to the radiation resistance. This refers to a radiator which is fed at one end and free at the other. For a certain deviation from resonance frequency the differential series reactance then become less the lower the reactance and the reactive cause of reflection becomes smaller. However, the benefit is only partial since the current at the feed end is high.

If instead the quarter-wave radiator is grounded at one end and fed at the other, it may now be looked upon as a parallel circuit. The input is thus located in the low-current region and the power variation along the radiator should be small with frequency. The tendency for resistive constancy cannot, however, be taken advantage of unless the characteristic impedance of the radiator at the same time tends to agree with the power-to-current-square ratio in this region. The larger the diameter of the radiator, the greater is the distance from the feed point at which such agreement occurs. The chief benefit from increased diameter under the low-current feed condition is that the necessary expanding connection of constant characteristic impedance between the feed point and the radiator becomes longer.

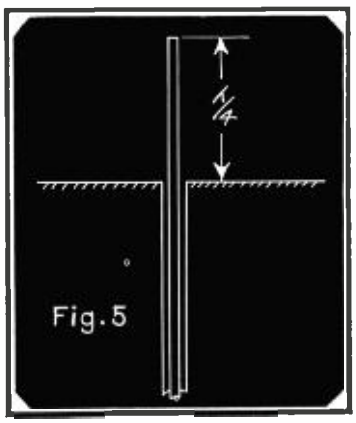
This method applied to the end feed of half-wave cage-type radiators has been used at the Alexandria Palace television station.

It should be noted, that in the case of a free radiator, not connected to any feed, but energized by a space wave, a higher power factor naturally results in a directly corresponding widening of the frequency-response characteristic.

It is, however, possible to considerably improve the characteristics of a quarter-wave radiator by splitting its current path so that only a portion of the total radiator current has to form a continuity with the transmission-line current.



Above: Split current radiator and folded modification of split current radiator. . . . Below: Simple quarter-wave radiator perpendicular to perfectly conductive surface. Impedance of line equals resistive input impedance of radiator at resonance.

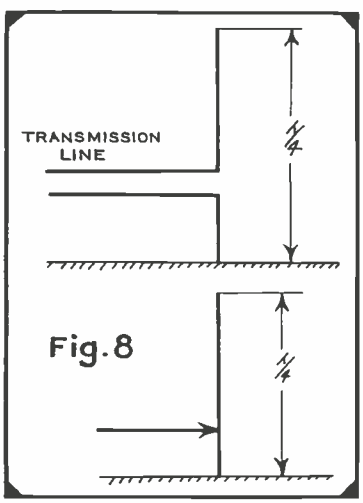


Assume a quarter-wave-long, hollow, cylindrical radiator extending perpendicularly from a flat conductive surface to which it is electrically bonded. Beginning near the free end of the radiator, two parallel, longitudinal slots may be provided, as shown in Fig. 6-a by means of which a current strip is separated. A transmission line can then be connected to the bottom end of this strip. At the free end of the radiator it is connected to the rest of the cylinder. For a certain power fed into the radiator system the voltage at the free end of the radiator will be practically the same regardless of whether the power is fed so that all of the radiator current or only a portion thereof forms a continuity with the transmission-line current. The ratio between input impedances at split-current feed and total-current feed equals the inverse square of the corresponding feed currents. The input voltage for split-current feed must therefore be higher. In this way there is less voltage variation from the standing wave between the input and the free end of the radiator. The power factor of the feed branch is therefore increased. Since at the same time only the portion of the total current maximum at the base of the radiator, which belongs to the feed branch, can shift position, both reactive and resistive reflection effects will be smaller as the frequency is varied.

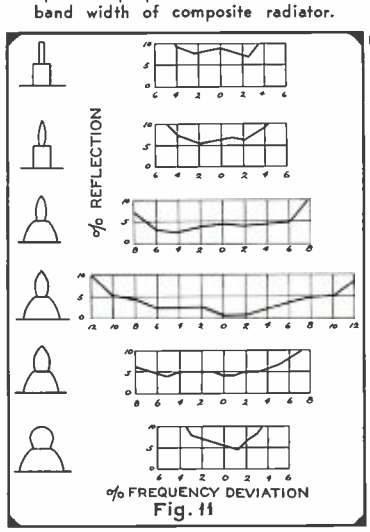
In practice, the split current radiator can be made to consist of two adjacent parallel rods connected together at the free end, Fig. 6-b. Such radiators are sometimes called "folded" radiators. Experiments have shown that it is not possible to derive increasing benefit from proportioning the feed branch for currents much less than half of the total radiator current. When the feed current is half of the total current, the input impedance becomes equal to four times 36 or 144 ohms.

Two such radiators may be joined

Shunt-fed quarter-wave radiator, and series-fed quarter-wave radiator.



Experimental steps in determining optimum proportions for maximum band width of composite radiator.



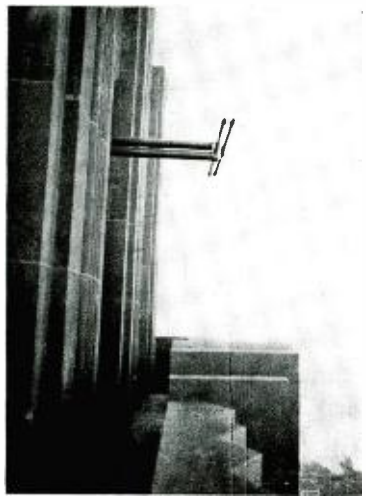


Fig. 19-b. A folded dipole on Empire State Building. See also Fig. 19-a, page 14.

oppositely as shown in Fig. 7 and form a so-called folded dipole. The push-pull impedance into such a dipole then becomes equal to 288 ohms. This type radiator, although not having sufficient band width for use in the transmission of 441-line pictures over long lines between transmitter and antenna, is very handy in emergency cases and provides an efficient dipole for general short-wave purposes.[1]

The folded dipole can, of course, also resonate at about half the frequency considered in the above discussion. In this case the voltage maximum does not occur at the folding point, but instead at the input end. The currents in the two branches are then flowing in opposite directions. In the previously discussed case the currents in both branches tapered toward the folding point. In the case now being discussed the current in the feed branch tapers toward the input end. Only the differential between the currents in the two branches can therefore cause radiation. For this reason, there is much circulating current and the radiator has a low power factor. The radiator is nevertheless useful in instances when such a characteristic becomes a virtue and when small radiator dimensions are desirable.

The radiation resistance of a radiator, expressed in terms of input resistance depends upon the location of the input connection in respect to the voltage and current distribution on the radiator.

Since the distribution on a quarter-wave radiator is such that voltage increases and current decreases toward the free end, the input impedance will rise the nearer the feed is located toward the free end. This is equally true for both the parallel and the series type feed as shown in Fig. 8-a and Fig. 8-b.

The most practical way of arranging a series feed according to the principle shown in Fig. 8-b is to let a portion of the outer conductor of the transmission line become part of the radiator as shown in Fig. 9. In this way, the transmission line will be out of the field from the radiator. This is a great advantage which cannot be duplicated in the case of the parallel feed. In the radiator shown in Fig. 9, the current of the center conductor and the current on the inside of the outer conductor are such that they produce no external field when the outer conductor consists of reasonably good conductive material. When the diameter of the outer conductor is a small fraction of a quarter wave, the current of the center conductor and the current on the inside of the outer conductor are practically equal and of opposite directions. The line is therefore very nearly completely uncoupled from external influences.

The current on the outer surface of the outer conductor is, of course, the continuity of the current on the inner surface. Near the end of the outer conductor the inside and the outside currents are then alike and opposite. The current going into the center conductor extension and the outside current of the outer conductor near the line opening are thus equal both as to direction and magnitude. The components of the composite radiator thus radiate cooperatively.

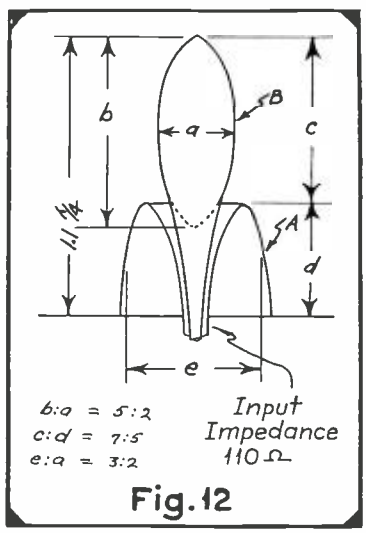
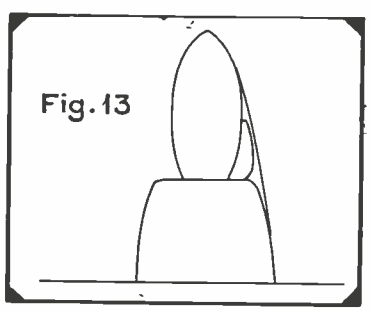


Fig. 12

Above: General relative dimensions of single composite radiator (modified for supporting bracket) over a conductive surface. . . . Below: Composite radiator with bracket.



The composite radiator shown in Fig. 9 has a total length of approximately a quarter wave. The radiator components then each become shorter than a quarter wave. In reference to the input location the center line extension is free ended and becomes capacitive whereas the sleeve component is grounded and therefore becomes inductive. Each component radiates and their impedances therefore include resistance.

Representative circuits in which each inductive and capacitive component is associated with a resistance are shown in Fig. 10-a and Fig. 10-b. If in such circuits the resistance in each branch equals the square-root of the inductance-capacity quotient, the input impedance will become totally resistive and equal at all frequencies.

For the parallel case in Fig. 10-a, the inductive reactance at zero frequency is equal to zero and the capacitive reactance equals infinity. Current therefore only passes through the inductive branch and the total parallel impedance equals the resistance in this branch.

At infinite frequency according to similar reasoning, the total parallel impedance becomes equal to the resistance in the capacitive branch.

General arrangement of quarter-phase turnstile antenna.

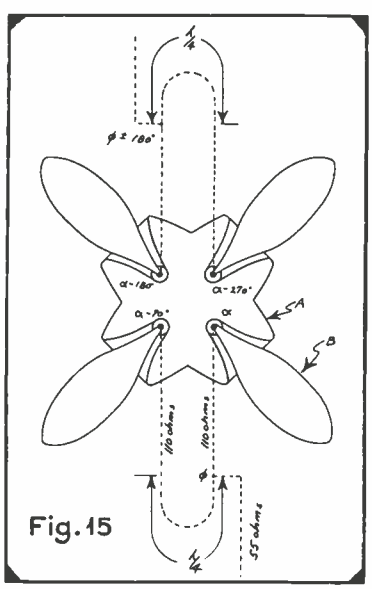


Fig. 15

For constant impedance over an infinite frequency range, the impedances of the limit cases must be equal. The resistances of the inductive and the capacitive branches must therefore be alike. Furthermore, the total parallel impedance at any frequency must be equal to the resistance of one of the branches.

At some frequency the inductive and the capacitive reactances will be alike. The currents in the two branches must then be alike. In the limit cases there is current only through the resistance of one branch. When there are equal currents in both resistors, the current in each must be equal to the current in the limit case divided by the square root of two, in order that the total resistive loss may remain constant. The voltage across the circuit is the same at all frequencies. At the frequency when the currents in the branches are alike and when these currents are equal to the current through the one resistor of the limit case divided by the square root of two, the reactance required to reduce the branch currents by this ratio is equal to the resistance.

When now the frequency deviates from that which results in equal reactance, one reactance will become the reciprocal of the other in respect to the reactance (X) at the balancing frequency:

$$\omega L : X = X : \frac{1}{\omega C} \; ; \; \therefore \; X = \sqrt{\frac{L}{C}}$$

Since the branch reactance at the balancing frequency are equal to the branch resistances, the reactance of one branch will at any frequency become the reciprocal of the reactance of the other branch in respect to the branch resistance.

$$\omega L : R = R : \frac{1}{\omega C} \; ; \; \therefore R = \sqrt{\frac{L}{C}}$$

It has thus been proved that under the particular conditions set forth above, the input impedance to the circuits of Fig. 10-a is equal and resistive at zero frequency, infinite frequency and at the frequency at which the reactances of inductance and capacity become alike.

The relations become similar in the series case. At zero frequency the inductive reactance is zero and shunts its parallel resistance; the capacitive reactance is infinite and the total input impedance becomes equal to the reactance across the capacity. At infinite frequency the total input impedance becomes equal to the resistance in shunt with the inductance. At the frequency at which the reactances become alike, the current in the resistors must be alike and each equal to the current of the limit case divided by the square-root of two. Since the current of the reactive and the resistive branches add in phase quadrature and since the total input current must be equal to the current in the limit case, it follows that the reactive and the resistive currents must be equal.

When the frequency again deviates from that at which the reactances are equal, the reactances will become each other's reciprocals in respect to the resistances. This is the same relation as already expressed for the parallel case.

Proof will now be furnished, that the total impedance is resistive and constant at any frequency:

In the parallel case the voltage across the reactance is equal to the voltage (e) across the resistance, either multiplied or divided by the reciprocity factor (a)

$$(e_1 a)^2 + e_1^2 = E^2$$

The square of the voltage across the resistor is then:

$$e_1^2 = \frac{E^2}{a^2 + 1}$$

Thus the energy in the resistor

$$\frac{e_1^2}{R} = \frac{E^2}{R\,(a^2 + 1)}$$

The square of the voltage drop across the reactance in the same branch is then

$$(e_1 a)^2 = \frac{E^2 a^2}{a^2 + 1}$$

The reactance is Ra.

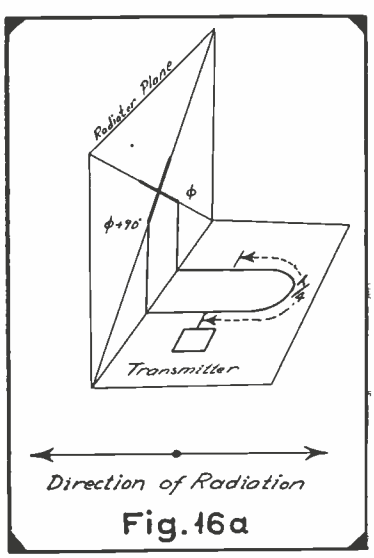
Hence the reactive energy

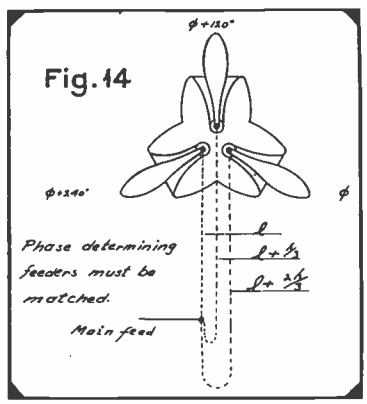
$$\frac{E^2 a^2}{Ra\,(a^2 + 1)} = \frac{E^2 a}{R\,(a^2 + 1)}$$

In the other branch

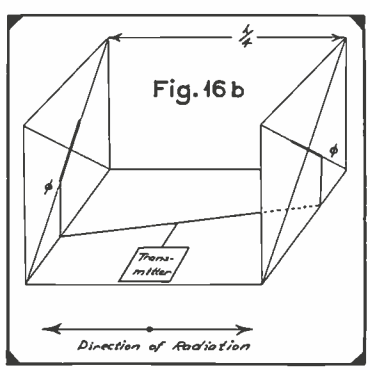
$$\left(\frac{e_2}{a}\right)^2 + e_2^2 = E^2$$

Split-phase arrangement for rotary polarization from radiators in the same plane.





Above: Radial, three-phase, radiator combination. . . . . Below: Rotary polarization from radiators in the same phase but in different planes.



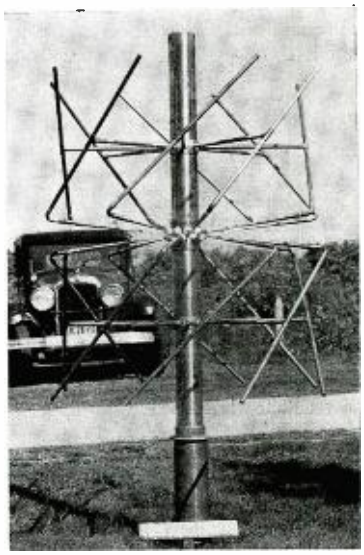


Fig. 17. Hyperbolic cylinder array of tilted radiators for broadcasting circularly polarized radiation.

The square of the voltage across the resistor is then

$$e_2^2 = \frac{E^2 a^2}{a^2 + 1}$$

Thus the energy in the resistor

$$\frac{e_2^2}{R} = \frac{E^2 a^2}{R(a^2 + 1)}$$

The square of the voltage drop across the reactance in this branch is then

$$\left(\frac{e_2}{a}\right)^2 = \frac{E^2}{a^2 + 1}$$

The reactance is $\frac{R}{a}$

Hence the reactive energy:

$$\frac{E^2}{\frac{R}{a}(a^2 + 1)} = \frac{E^2 a}{R(a^2 + 1)}$$

It can be seen that the reactive energies are alike. The capacitive and the inductive energies will thus balance each other at all values of reciprocity factor (a). There will therefore be no reactive effect across the input at any frequency.

The sum of the resistive energies is:

$$\frac{E^2}{R(a^2 + 1)} + \frac{E^2 a^2}{R(a^2 + 1)} = \frac{E^2}{R}\,\frac{1 + a^2}{a^2 + 1} = \frac{E^2}{R}$$

The sum of the resistive energy is thus equal to the energy of the limit cases at the same input voltage.

The input impedance in the parallel case is therefore resistive and constant at all frequencies.

In the series case,

$$(i_1 a)^2 + i_1^2 = I^2$$

The square of the current through the resistor is then

$$i_1^2 = \frac{I^2}{a^2 + 1}$$

Thus the energy in the resistor

$$i_1^2 R = \frac{I^2}{a^2 + 1} R$$

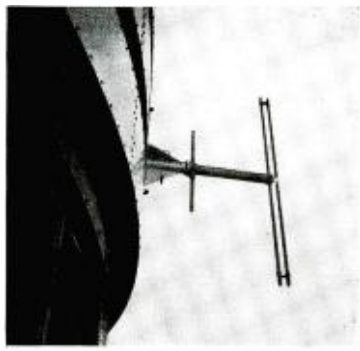
The square of the current through the associated reactance is then

$$(i_1 a)^2 = \frac{I^2 a^2}{a^2 + 1}$$

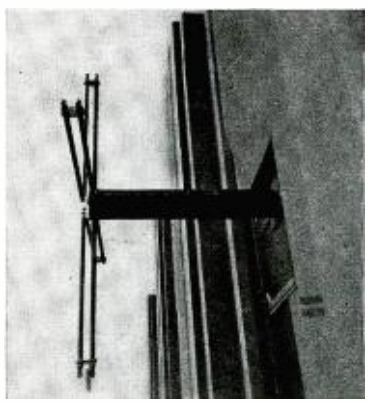
The reactance is $\frac{R}{a}$

Hence the reactive energy

$$\frac{I^2 a^2}{a^2 + 1}\,\frac{R}{a} = \frac{a}{a^2 + 1} I^2 R$$



Above: Fig. 19-a. A folded dipole in use at Empire State Building. See also Fig. 19-b. . . . Below: Fig. 20. Folded dipole turnstile antenna for study of propagation characteristics of circular polarization.



For the other group:

$$\left(\frac{i_2}{a}\right)^2 + i_2^2 = I^2$$

The square of the current through the resistor is then

$$i_2^2 = \frac{I^2 a^2}{a^2 + 1}$$

Connections for hyperbolic antenna shown in Fig. 17.

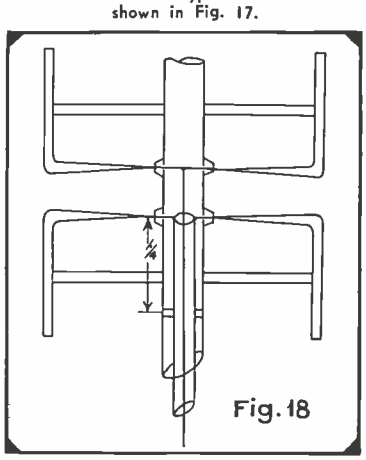


Fig. 18

Thus the energy in the resistor

$$i_2^2 R = \frac{I^2 a^2}{a^2 + 1} R$$

The square of the current through the associated reactance will then be

$$\frac{i_2^2}{a^2} = \frac{I^2}{a^2 + 1}$$

The reactance is Ra. Hence the reactive energy is:

$$\frac{I^2}{a^2 + 1} Ra$$

The reactive energies are again alike. The sum of the resistive energies is:

$$\frac{I^2}{a^2 + 1} R + \frac{I^2 a^2}{a^2 + 1} R = I^2 R \frac{1 + a^2}{a^2 + 1} = I^2 R$$

The sum of the resistive energies is thus again equal to the energy of the limit cases.

The constant-impedance circuit has therefore been proved in its entirety.

If the resistance from radiation of each component in Fig. 9 is transformed to its parallel equivalent the corresponding schematic circuit will be the same as the circuit shown in Fig. 10-b. For a certain frequency band, it is therefore reasonable to expect more resistive and less variable input impedance the more nearly alike the equivalent component resistances of the radiator can be made and the more nearly each resistance value approaches the square-root of the inductance-capacity quotient. In the case of a radiator, inductance, capacity and resistance all depend on the field distribution and thus vary with frequency. It has, however, been found that in spite of the limitations imposed from variable field distribution, radiators of the highest order of band width can be provided when applying these principles.

In Fig. 11 is shown a series of frequency-response curves for composite radiators having progressively increasing transverse dimensions. It can be seen how the frequency response is almost entirely resistive and less variable for greater frequency variation as the transverse dimensions are increased up to a certain value. Upon further increase it can be seen how the frequency response again becomes more variable. The least variable frequency response then corresponds to the most nearly correct inductance capacity ratio. It may be noticed how the larger diameter radiators have a general elliptic shape This shape fits best with the gradual expansion of the transmission line into the

(*Continued on page* 24)

Parliamentary SOUND SYSTEM

By S. D. WILBURN
and
S. C. TENAC*

• ***Sound system for Argentine Chamber of Deputies. Features quality reproduction, individual microphones, instantaneous switching, concealed loudspeakers.***

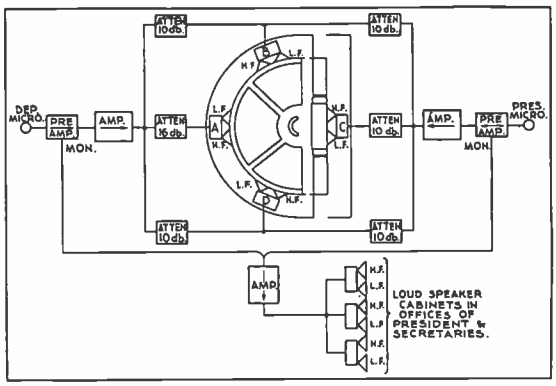
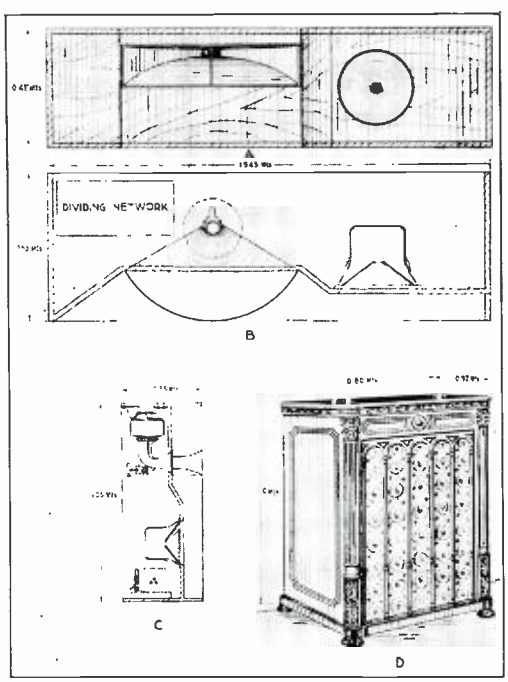


Fig. 1. Block schematic showing arrangement of microphones, amplifiers, attenuators, speakers.

FROM the standpoint of appearance, the architecture, furnishings and decorations of the Argentine Chamber of Deputies leave little to be desired. An observer is at once impressed with its atmosphere of stability, utility, quiet, comfort and beauty. However, it would be difficult to find an auditorium with acoustic qualities less suitable for parliamentary purposes. The voice of a speaker at any point on the floor of the Chamber is muted to an unusual degree due to the almost total absence of reverberations.

The National Capitol building in Buenos Aires was constructed during the period 1896-1906; and, beginning with the inauguration of the Chamber of Deputies in the latter year, acoustical difficulties were the subject of

Fig. 2. Front elevation (A), plan of loudspeaker cabinet (B) and structural details (C and D).



frequent compaints and discussions during congressional sessions. A number of investigations were made and, early in 1936, definite steps were taken to improve the acoustical conditions. A system of loudspeakers and microphones was installed. Unfortunately, due to defects in design and the use of unsuitable equipment, that system proved entirely unsatisfactory, members of the Chamber considering that it made matters worse instead of better. The failure of this first effort toward a solution of the problem left considerable feeling of skepticism as to the utility of loudspeaker installations for this purpose and resulted in general pessimism in regard to the final solution of the particular problem in the Chamber of Deputies.

In December, 1936, the Union Telefonica installed in the Chamber of Deputies for the use of the Inter-American Congress for the Consolidation of Peace a combined high-fidelity translating and loudspeaker system. The success of that installation in overcoming the unfavorable acoustic properties of the Chamber impressed the deputies with the possibilities of a properly designed sound system; hence. they asked the Union Telefonica engineers to make a full investigation of their problem and to submit a recommendation for its solution. The investigation was immediately carried out and it was found that the acoustical difficulties were due solely to the absence of reverberation, brought about mainly by the following conditions in the Chamber:

(1) Floor completely covered with soft carpeting; (2) Irregular horizontal ceiling of frescoes, panels and stained glass 21 meters above the floor, only 5 meters less than the greatest horizontal dimension of the auditorium; (3) Practically no hard, smooth reflecting wall surface; (4) Cushioned chairs closely spaced and sloped top desks covered with relatively soft leather.

The report of the investigation, which was sent to the President of the Chamber of Deputies on December 22nd, 1936, indicated that it would not be feasible to improve acoustical conditions by structural changes in the Chamber or by changes in the furnishings and decorations, and recommended a loudspeaker system along the lines indicated by the following brief translation from the report:

"A loudspeaker system for a permanent parliamentary auditorium of this character should be designed to meet the following requirements:

"(1) It should amplify the normal speaking voice to sufficient volume to be heard from any point to all other points in the auditorium.

"(2) It should transmit the voice with clearness and

*Union Telefonica del Rio de la Plata, LTDA., Buenos Aires, Argentina.
*Data from article in *Electrical Communications*, Vol. 19, No. 3, (1941) p. 37.

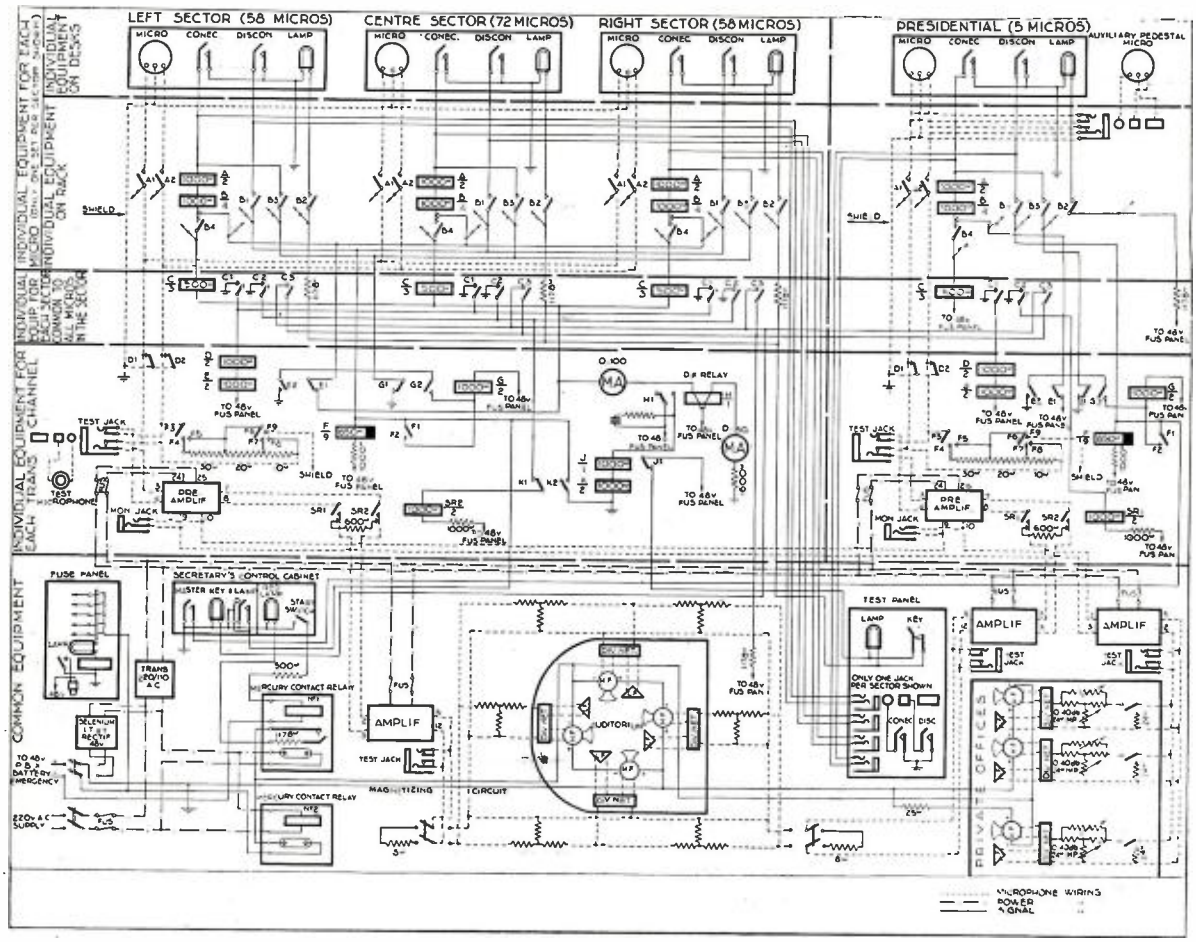


Fig. 3. Schematic circuit diagram of transmission, switching and power circuits.

naturalness so that individual voices coming from the loudspeaker will have practically the same quality and timbre as the same voices without the loudspeaker. In order to accomplish this with some degree of perfection, the system as a whole should transmit with reasonable fidelity voice tones ranging from approximately 40 to 10,000 cycles per second.

"(3) If practicable, the loudspeakers should not be visible from the auditorium and should be so located that at no point will there be confusion between the voice going into the microphone and that coming from the loudspeaker.

"(4) On account of the close spacing of the desks and the chairs of the deputies, it is not possible to move about freely in the Chamber when the seats are occupied. For this reason it is desirable that the microphones be so located that each deputy can speak with comfort and in a moderate tone of voice without moving from his normal speaking position. To accomplish this, individual microphones should be provided for each deputy. This also applies to the President, the secretaries and the ministers, as it is not practicable for them to move from their seats during the proceedings and normally there would not be sufficient time between usage to move the microphone from one to the other.

"(5) The microphones should be inconspicuously and permanently located and the mounting arrangement should harmonize with existing furniture, changing as little as possible the excellent general appearance of the auditorium.

"(6) The system should function simply and rapidly and should not require an attendant for its operation."

In September, 1939, the recommendation of the engineers was accepted and the installation was made on the basis of the above requirements. The system was first used officially at the opening session in 1940; it has given satisfaction and has received unanimous approval. As might be expected from the practical viewpoint of the users, the most attractive features of the system proved to be the rapidity and ease with which the individual microphones can be switched, and the naturalness of reproduction which leaves little indication that the amplified voice is not coming directly from the lips of the speaker. This latter is due to the high-fidelity reproduction, distribution of sound from properly located loudspeakers and, it is thought, the concealment of the loudspeakers.

The system comprises 193 microphones and four loudspeakers in the Chamber. It has two independent channels of transmission; one with five microphones consisting of one each for the President of the Chamber and the two secretaries, and two on the ministers' table; the other channel is equipped for 188 individual microphones for the deputies. This corresponds to the total number of seats for deputies in the Chamber, including 160 now

(*Continued on page* 32)

60 MILLION WATTS must be right!

"How To Plan an FM STATION"
by W. R. David
. . . is a valuable aid to any FM-minded organization. Ask the G-E representative who serves you for a free copy, or write direct to General Electric, Radio and Television Department, Schenectady, N. Y.

60 MILLION WATTS—that's the production record *in 862's alone* since our engineers developed the tube years ago. It's undeniable evidence of sound design, thorough engineering. And today GL-862's are setting enviable performance records wherever they are used. Be sure *your* next 862's are GL-862's.

WHATEVER YOUR TUBE-NEEDS
whether you operate at 50 watts or 50 thousand, tube-up next time with General Electric. Five warehouses with carefully regulated stocks speed up deliveries. A nation-wide sales organization saves you time and money.

AND HISTORY REPEATS ITSELF
for today G.E. is a leader in the field with high-power tubes for FM and television. Just another way that G-E research and foresight speed the progress of your industry.

NEED TUBES TODAY?
Call the nearby G-E office for quick service. And be sure you have your copy of our new transmitting-tube bulletin GEA-3315B. General Electric, Schenectady, N. Y.

GENERAL ELECTRIC

161-19-8850

Speaking of Crystal Filters

The answer to the question of what constitutes a crystal filter and how it works. The author considers the crystal filter as a bridge circuit, consisting of an input, bridge, output circuit.

By J. E. WILLSON
Webster-Chicago Corp.

WHEN speaking of crystal filters, one thinks mainly of a piece of quartz between two metal plates, vibrating at a high frequency. Of course this is true, but exactly what constitutes a crystal filter and how does it work? This question is asked very often and in this article the author is attempting to give a different view of the crystal filter.

A crystal filter is in reality a bridge circuit consisting of three parts, namely an input, bridge and output circuit. The input circuit usually consists of an r-f transformer with tuned primary and secondary, resonant at the intermediate frequency of the receiver, which couples to the detector and supplies the voltage for the bridge. The bridge circuit as in Fig. 1-c consists of C_1, C_2, C_3 and the crystal. The output circuit is the coupling condenser C_6 and the tuned circuit in the grid of the following stage.

Before attempting to solve the crystal filter bridge, one must understand the generalized solution of any type of impedance bridge. In the circuit for a general impedance bridge, Fig. 2, a source of alternating current is impressed across the points 3 and 4 and the output is taken across the points 1 and 2. When the bridge is balanced, the points 1 and 2 are at the same potential and no current will flow through the output circuit.

With the output disconnected the current I_1 will flow through the series impedances Z_1 and Z_3, and the current I_2 will flow through the impedances Z_2 and Z_4. This being true

$$I_1 = \frac{E}{Z_1 + Z_3}$$

$$I_2 = \frac{E}{Z_2 + Z_4}$$

If the points 1 and 2 are at the same potential and the point 3 is common to both branches, then the voltage drops in Z_1 and Z_2 must be equal both in magnitude and phase relation in order to obtain a balance.

Then

$$I_1Z_1 = I_2Z_2$$

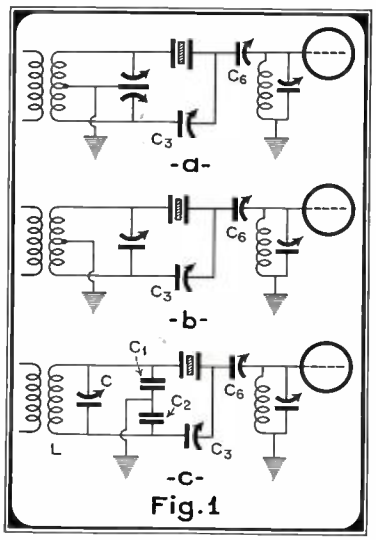


Fig.1

Fig. 1. Three types of circuits which may be used in crystal filters.

Fig. 2. Circuit of the general impedance bridge.

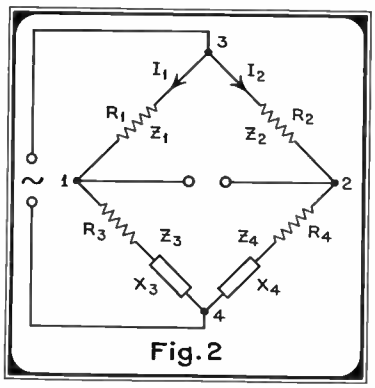


Fig.2

By substituting for I_1 and I_2 from the previous equations and solving algebraically

$$\frac{Z_1}{Z_1 + Z_3} = \frac{Z_2}{Z_2 + Z_4}$$

$$\frac{Z_1}{Z_2} = \frac{Z_3}{Z_4}$$

The impedances in the above equations may be either resistances or reactances and therefore must be expressed in vector values. Both the magnitude and phase relation of the impedances must have the proper values. This expressed in the polar form is:

$$\frac{Z_1 \angle\theta_1}{Z_2 \angle\theta_2} = \frac{Z_3 \angle\theta_3}{Z_4 \angle\theta_4}$$

In an impedance bridge, two of the arms are usually pure resistance and in this case the phase angle of the impedance is 0. The previous equation can be rewritten:

$$\frac{R_1 \angle 0}{R_2 \angle 0} = \frac{Z_3 \angle\theta_3}{Z_4 \angle\theta_4}$$

To satisfy one of the conditions for balance, that is that the phase angles must be equal, then:

$$\theta_3 = \theta_4$$

$$\frac{R_1}{R_2} = \frac{Z_3}{Z_4}$$

In the case of inductances and capacities in the arms Z_3 and Z_4, and the fact that no impedances are pure and therefore must have some resistance:

$$Z_3 = R_3 + JX_3$$
$$Z_4 = R_4 + JX_4$$

By substitution.

$$\frac{R_1}{R_2} = \frac{R_3 + JX_3}{R_4 + JX_4}$$

$$R_1R_4 + JR_1X_4 = R_2R_3 + JR_2X_3$$

For Your Problem...TRY

UTC

THERE IS NO SUBSTITUTE FOR EXPERIENCE

UNITED TRANSFORMER CORP.

150 VARICK STREET ★ NEW YORK, N. Y.

EXPORT DIVISION: 100 VARICK STREET NEW YORK, N. Y. CABLES: "ARLAB"

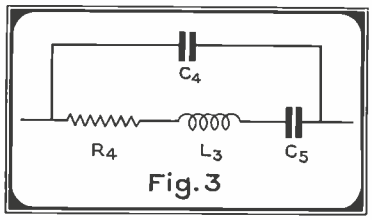


Fig. 3

An equivalent electrical circuit for a quartz crystal.

By equating the real parts of the equation the resistance of the bridge will be obtained, and by equating the imaginary parts the equation for reactance balance will be obtained.

$$R_1R_4 = R_2R_3$$

$$\frac{R_1}{R_2} = \frac{R_3}{R_4} \quad \text{Resistance Balance}$$

$$JR_1X_4 = JR_2X_3$$

$$\frac{R_1}{R_2} = \frac{X_3}{X_4} \quad \text{Reactance balance.}$$

Figs. 1-a, 1-b and 1-c show three types of circuits which may be used in crystal filters. These circuits are usually connected between the first detector and the first i-f stage. Fig. 3 shows the equivalent electrical circuit for a quartz crystal such as those used in a filter network. Here

R_4—Resistance due to internal losses
l_3—Mechanical inductance due to inertia
C_4—Capacity between crystal holder plates
C_5—Mechanical capacity due to momentum.

With this equivalent network inserted the result will be as in Fig. 4. This resultant network in the form of a bridge is shown in Fig. 5.

For balance of this bridge

$$Z_1Z_1 = Z_2Z_3$$

but

$$C_1 = C_2$$
$$R_1 = R_2$$
$$\therefore Z_1 = Z_2$$

Because Z_1 is equal to Z_2, they may be eliminated from the solution of the bridge. The solution of the crystal bridge is as follows

$$\frac{(R_4 + JXL_3 - JXC_5)\ (-JXC_4)}{R_4 + JXL_3 - JXC_5 - JXC_4} = \frac{R_3\ (-JXC_5)}{R_3\ (-IXC_3)}$$

$$-JR_3R_4XC_4 + R_3XL_3XC_4 - R_3XC_4XC_5 - R_4XC_3XC_4 - JXC_3XC_4XL_3 + JXC_3XC_4XC_5 = -JR_3R_4XC_3 + R_3XC_3XL_3 - R_3XC_3XC_4 - R_3XC_3XC_5$$

Equating the real parts

$$-\frac{R_3}{\omega^2C_4C_5} - \frac{R_4}{\omega^2C_3C_4} = -\frac{R_3}{\omega^2C_3C_4} - \frac{R_3}{\omega^2C_3C_5}$$

$C_3 = C_4$. This is because the condenser C_4 is used to balance out C_3 which is the capacity between the plates of the crystal holder. Then

$R_3 = R_4$ Resistance balance

Equating the imaginary parts

$$JXC_3XC_4XC_5 - JR_3R_4CX_4 - JXC_3XC_4XL_3 = -JR_3R_4XC_3$$

$$\frac{\omega^2R_3R_4C_3C_5 - \omega^2L_3C_5 + 1}{\omega^2C_4C_5} = R_3R_4$$

But

$$C_3 = C_4$$
$$(-\omega^2L_3C_5 + 1)\ C_3 = 0$$
$$\omega^2L_3C_5 = 1$$

$$F_r = \frac{1}{2\pi\sqrt{L_3C_5}} \quad \text{Reactance balance.}$$

When C_3 equals C_4 the bridge will be balanced and there will be no signal voltage of the resonant frequency, F_r, passing to the following stage through the output circuit, therefore maximum selectivity is obtained. When C_3 does not equal C_4 there will be a residual reactance in parallel with the crystal.

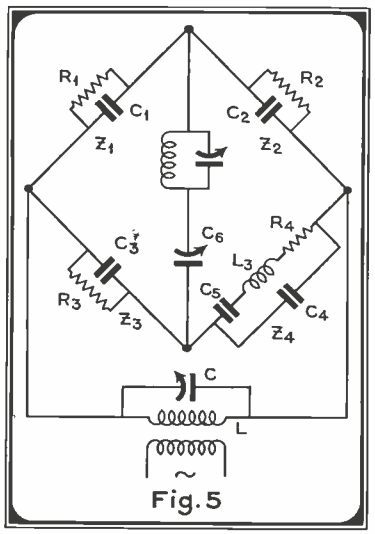


Fig. 5

The resultant network (Fig. 4) in form of bridge.

Showing effect of change in series resistance.

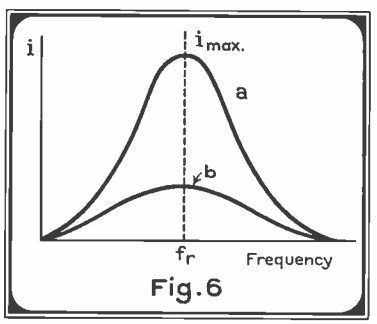


Fig. 6

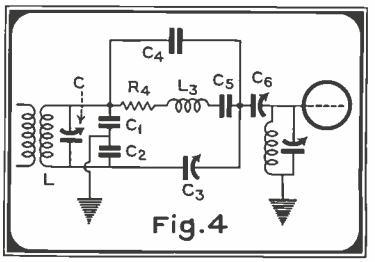


Fig. 4

Circuit with equivalent network (Fig. 3) inserted.

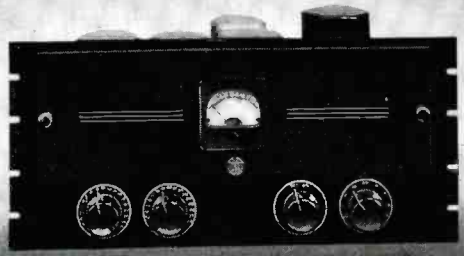
This causes the crystal to go into parallel resonance at a frequency very close to the series-resonant frequency. Because of the high impedance of a parallel circuit compared with that of a series-resonant circuit there is very little coupling at a frequency differing only slightly from that required for maximum coupling. This frequency of high attenuation and the frequency of maximum response is controlled by the adjustment of the condenser C_3, and may be made as low as 1000 cycles.

The width of the response band of the crystal filter is largely controlled by the resistance which the crystal sees when looking back toward the circuit that excites it. This is because the resistance is effectively in series with the crystal and so reduces the equivalent Q of the combination. The band width can be controlled by the condenser which varies the resonant frequency of the input circuit. At resonance with the crystal, the circuit impedance is high and maximum band width results. When the circuit is detuned, the impedance which faces the crystal is low, being mainly reactive, the effective Q of the circuit is very nearly the actual Q of the crystal itself. It is possible to vary the band width from about 100 to 5000 cycles. Fig. 6 shows the effect on the response curve of changing the resistance in series with the circuit. Curve "a" shows the response curve with a small resistance and curve "b" shows the effect of flattening the curve when the resistance is increased. The sharpness of resonance is greatly decreased when the series resistance is increased.

This article was written to show that the crystal filter is in reality a bridge and that it can be solved in the same manner as any impedance bridge. It is similar in all respects to a general impedance bridge, and is a true bridge which is shown by the fact that there are two solutions for balance, namely the resistance and reactance balances. It is also shown that the bridge at balance is resonant at a frequency which is the resonant frequency of the crystal itself. At this point there is maximum selectivity of the filter circuit. Off resonance the selectivity will depend on the adjustment of phasing condenser C_3.

FOR *Higher Fidelity* AUDIO

THESE TWO RCA AMPLIFIERS!



RCA Model 86-A

LIMITING AMPLIFIER

- ★ Compression-ratios to 18 db.
- ★ No audible "thumps" on peaks
- ★ Optimum return-time value
- ★ Flat within 2 db., 30-15,000 cycles
- ★ Calibrated level controls
- ★ Meter indicates reduction in db.
- ★ Meter measures plate currents
- ★ Built-in power supply
- ★ Ideal for recording

$275* with one set of tubes

(Less 36-B Mounting, shown above)

You can raise the average program level of your transmitter several db. . . . with corresponding increase in coverage . . . easily and at low cost with this RCA Type 86-A Limiting Amplifier. Protection against overmodulation and transmitter outage is safe and certain—for the 86-A provides fast pickup time. Return time is slow enough to prevent low-frequency distortion, fast enough to avoid obvious level-reduction following a volume peak. Controls are calibrated in VU, to indicate exact input and output levels on the verge of compression. And even with maximum compressor-action suddenly applied, there are no audible "thumps" to mar your program. Write for the complete story of this low-cost, flexible Limiter Amplifier.

RCA Model 82-C

MONITORING AMPLIFIER

- ★ High fidelity at low cost
- ★ Flat within 2 db., 30-15,000 cycles
- ★ High gain—105 db.
- ★ Output level: 12 watts (3% distortion)
- ★ Less than 1½% distortion, 50-7500 cycles, 8 watts
- ★ Compensating Network Available
- ★ Built-in power supply
- ★ Remote volume control furnished

$85* less tubes

($15.00 extra for rack mounting)

Here is an improved version of the highly popular Type 82-B Monitoring Amplifier. Like its predecessor, it affords high-fidelity audio at extremely low cost . . . is flexible and easily adapted to your studio arrangements. Because of its high gain it can be used directly in studio talk-back circuits without preamplifier or for driving speaker directly from turntable. High output level insures low distortion even when feeding into several speakers. Inverse-feedback keeps the overall response low in distortion and unusually uniform in frequency-response.

•

* F. O. B. Camden, N. J. Prices subject to change without notice.

Use RCA Radio Tubes in your station for finer performance

RCA Broadcast Equipment

RCA Manufacturing Co., Inc., Camden, N. J. • A Service of Radio Corporation of America • In Canada, RCA Victor Co., Ltd., Montreal

New York: 1270 Sixth Avenue Chicago: 589 E. Illinois Street Atlanta: 530 Citizens & Southern Bank Building Dallas: Santa Fe Building
San Francisco: 170 Ninth Street Hollywood: 1016 N. Sycamore Avenue

VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

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

Letters

WE acknowledge with thanks the following letter from General J. O. Mauborgne, Chief Signal Officer of the Army:

"I have been intending to write you to tell you how much I appreciated the very handsome Marconi Memorial Medal of Service which was bestowed upon me by the Veteran Wireless Operators Association, and which was safely transmitted to me by Colonel John C. Moore, Signal Corps.

"It is an extremely beautiful and artistic piece of workmanship which has been admired by my many friends and acquaintances. The Association may be sure that I shall guard it as one of my most cherished possessions. Again, I want to thank you and the Association for what you did in presenting this medal to me and also in having present the Signal Corps Officers from Governors Island.

"The broadcast arrangements were fine, and Admiral Noyes and I were permitted to hear the entire proceedings as far as they came to Washington. It seemed to me that the entire broadcast went off in fine fashion. However, I regret that I was not present in person to receive that outstanding decoration.

"I wish to thank you also for the package I received by mail this morning containing a large number of copies of the Year Book, which, in itself, is a very fine souvenir of the occasion. I shall take great pleasure in distributing these copies among my friends and throughout the Signal Corps.

"I hope to be present on your next cruise since I was unable to be present on this one. With warmest regards. Sincerely yours, J. O. Mauborgne, Major General, Chief Signal Officer of the Army."

We very much appreciate Admiral Noyes' letter which follows:

"Will you please accept my sincere thanks to you and the members of the Veteran Wireless Operators Association for the Marconi Memorial Medal of Service which you so kindly and graciously presented me.

"The medal itself has arrived and I greatly admire its appearance and workmanship, and am most proud to have it.

"I am sure you realize how sorry I was not to be present in person at the dinner, but I hope that the radio procedure was satisfactory.

"Once more, with thanks and best wishes for the coming year to you and the membership of the Veteran Wireless Operators Association, please believe me, Very sincerely yours, Leigh Noyes, Rear Admiral, United States Navy, Director of Naval Communications."

Boston Cruise

Report from Francis C. W. Lezenby, Sec.-Treas., Yankee Chapter, VWOA:

On the evening of February 11th, 1941, the "Yankee Chapter" Veteran Wireless Operators Association gathered at the Hotel Manger, Boston, Mass., for their sixth Annual Cruise. At 7:30 p. m. the members sat down to an excellent chicken dinner.

During the course of the dinner many of the members present were greeted by means of a tape transmitter and audio oscillator, which was operated at a low level yet clearly readable. The tape and equipment were generously loaned for the occasion by T. R. McElroy.

After the dinner, Chairman Stockellburg introduced the guest speakers of the evening. Lieut. R. T. Smith, Asst. DSC of the Boston Navy Yard, 1st District; Lieut.

Over 30 members of Chicago Chapter, V.W.O.A., attended a dinner at the Lake Shore Athletic Club. Here retiring chairman, George I. Martin, RCA Institutes, is presenting a Life Membership Certificate to the new chairman, W. J. Halligan, president of Hallicrafters, Inc.

R. E. Dumas of Signal Office Headquarters, 1st Corps Area and Lieut. Colonel George S. Boyden of the newly organized State Guard. Each of these men spoke interestingly on what is being done in the various services in regard to National Defense. Following this Chairman Stockellburg called on Frank Sullivan of Providence, Walter Butterworth of the Federal Communications Commission and Guy R. Entwistle to say a few words.

The members and guests were then treated to a very fine entertainment ably arranged by Jim Barnes, chairman of the entertainment committee.

Los Angeles

From Hal Styles, chairman, Los Angeles-Hollywood Chapter VWOA:

"To all those who were assembled at the 16th Anniversary Dinner Cruise of the Veteran Wireless Operators Association: Greetings!

"Los Angeles-Hollywood Chapter comprising almost 150 real old timers salutes you. May your presence together create new friendships and rekindle the fires of professional kinship so that they will burn brighter than ever before. May each of you, remembering the days when you sailed the high seas as "Sparks," always be true to the lofty traditions of Wireless. May you always hold the torch high, remembering that whether it be New York, Shanghai or Timbuctoo, a true wireless man never forgets! In titling your 16th Annual Dinner Cruise—"National Defense," you told the world that the important profession of Wireless can always be counted on to do its duty when America calls.

"May Bill McGonigle continue to enjoy the confidence of the entire membership, which he so richly deserves. The same goes for that poet-laureate George Clark, and Sam Schneider, Pete Podell, John B. Duffy, Bill Fitzpatrick, Fritz Muller, Charlie Guthrie, and others whose names escape me. To our beloved Dave Sarnoff, and to Chairman Fly, Major-General Mauborgne and Admiral Noyes, Los Angeles-Hollywood Chapter and its patron saint, Dr. Lee de Forest, extend the heartiest of greetings. Long live VWOA and every last one of its members!"

Scholarship

Through the cooperation of Mr. E. H. Rietzke, President of Capitol Radio Engineering Institute, our Association will conduct a contest and award to the winner a Scholarship in Practical Radio Engineering at the Capitol Institute in connection with National Defense. Further details will be announce in a later issues of COMMUNICATIONS.

Memorials

In addition to the tribute to the memory of our former Honorary President, the late Senatore Marconi, in the form of a combined Operators Monument and Marconi Memorial in Battery Park, our Association plans, during the coming year to mark a number of historic spots in American Wireless.

Under consideration now are the site of the 'Ship's Mast' on which Marconi raised his first antenna in America, at the lighthouse reservation, Highlands of Navesink, during the 1899 reporting of the International Yacht Races; Wellfleet—first Marconi station in the United States, whose huge towers, now fallen and in tangled array, are rapidly disintegrating; the scene of Professor Fessenden's first experiments at a point in North Carolina. We invite comment on other spots to be commemorated.

• • •

TECHNICAL BOOK CATALOGS

The new spring 1941 catalog of the Chemical Publishing Co., Inc., 234 King St., Brooklyn, N. Y., contains many new titles. Books of importance in all technical fields, and to national defense, have been added to the previous works. Upon receipt of a 3c stamp to cover postage, a copy of the catalog will be sent to the writer.

Barnes & Noble, Inc., Fifth Ave. and 18th St., New York City, have issued Catalogue No. 6-T. This catalog lists technical books that are available from this organization. The listing includes over 2,000 titles of all publishers, both new and used.

PERFORMANCE:

Unusual capabilities as yet unequalled in actual service. Used in hundreds of 1KW to 5KW stations up to 60 megacycles

DEPENDABILITY:

Many of the world's most important commercial stations report 10,000 to 15,000 hours of extremely superior service

ECONOMY:

Replaces tubes that cost more than twice as much . . . gives more watts of carrier and more watt-hours per dollar

When the Eimac 450T tube first made its appearance several years ago, some of radio's engineers scoffed at the idea of using so small a tube for such enormous powers as required for most commercial transmitters. It was a radical idea . . . unfeasible to their minds.

Today, however, it is a different story. This tube is now occupying the key sockets of some of the most important radio transmitters in the world. The ground stations in service for practically every major airline are built around the unusual capabilities of the Eimac 450T. Throughout the world hundreds of police radios and thousands of commercial transmitters requiring 1KW to 5KW output find the Eimac 450T vastly superior to most other tubes of like ratings. In Frequency Modulation too, Eimac tubes lead the way. This recognition is proof enough, not only of its feasibility but of the decided advantages to be gained by adopting Eimac tubes . . . the only tubes which are unconditionally guaranteed against failures caused by gas released internally.

Be sure you get the original, the tried and proven tube
LOOK FOR THE EIMAC SIGNATURE ON EACH BULB

Eimac 450T sets the pace in modern radio!

EIMAC REPRESENTATIVES

California, Nevada
HERB BECKER, 1530 W. 104th St., Los Angeles, Cal.

Wash., Ore., Idaho, Mont.
GENERAL SALES CO., Verner O. Jensen, 2605-07 Second Ave., Seattle, Wash.

Colo., Wyo., New Mexico, Arizona, Utah
RICHARD A. HYDE, 4253 Quitman St., Denver, Colo.

Ohio, Mich., Ky., Ind., Minn., Mo., Kan., Neb., Iowa
PEEL SALES ENGINEERING CO., E. R. Peel, 154 E. Erie St., Chicago, Ill.

N. Y., N. J., Penn., Md., Del., Dist. of Col., Maine, N. H. R. I., Conn., Mass.
ADOLPH SCHWARTZ, 14726 Elm Ave., Flushing, New York.

Texas, La., Okla., Ark.
J. EARL SMITH, 2821 Live Oak St., Dallas, Texas.

Chicago, Illinois, Wisconsin
G. G. RYAN, 549 W. Washington Blvd., Chicago, Ill.

N. Caro., S. Caro., Georgia, Tenn., Flor., Ala., Miss.
JAMES MILLAR, 316 Ninth St. N. E., Atlanta, Georgia.

Eitel-McCullough, Inc. San Bruno, Calif.

RADIO INTERFERENCE CONFERENCE

THE Radio Interference Conference, mentioned in the last issue of COMMUNICATIONS, is to be held at the University of Illinois, Urbana, Illinois, on May 10. The program of this gathering follows:

8:30—9:30 Registration

9:30—9:35 Welcome—President A. C. Willard, University of Illinois

9:35—10:00 "The Generation of Combination Frequencies in a Non-Linear Element"—Professor H. J. Reich, University of Illinois

10:00—10:50 "Multiple Response in Receivers in Strong Radio Frequency Fields"—R. M. Planck, Radio Manufacturing Engineers

11:00—11:50 Panel Discussion on Amateur-broadcast Interference—Larry Bargarrye W9Q1, a radio amateur; Ted Giles, WMBD, a broadcast engineer; and a radio listener to be selected

11:50—1:15 Time Out for Lunch

1:15—1:30 A Message from the National Association of Broadcasters—Mr. L. C. Smeby, NAB

1:30—2:20 "Detection and Analysis of Damped Wave Radio Interference"—Leon Podolsky, Sprague Products Company

2:30—3:20 Case Histories in Interference Trouble Shooting and Public Relations in Interference Work—Professor M. A. Faucett, University of Illinois and Representatives of Public Service Companies

3:30—4:20 "Interference Reducing Antenna Systems"—Alfred Crosslev and Nickolas Hogenbirk, Belden Manufacturing Company

4:30—5:15—"The Design and Adjustment of Transmitters to Eliminate Spurious Radiations"—Mr. Dana Pratt, RCA Manufacturing Company

6:00—Banquet: Principal Speaker—Dr. L. P. Wheeler, FCC's Engineering Department

Topic: The Commission's Place in the Interference Problem

(Banquet to be held in the new Illini Union Building)

There will be no registration fee and the price of the banquet tickets will be nominal. While no advance registration is necessary, the Conference committee would appreciate hearing from all those who plan to attend so that appropriate facilities may be reserved. Address all communications to A. James Ebel, WILL, University of Illinois. Urbana, Illinois.

• • •

TELEVISION ANTENNAS

(*Continued from page* 14)

radiator and also assists in widening the frequency-response characteristic and smooths out irregularities.

When considering amplitude reflection of less than 5 per cent as acceptable, the optimum band width obtained with experimental radiators in the 100-150 mc region was 20 per cent. The optimum proportions of a single composite radiator as determined by experiments is shown in Fig. 12.

The input resistance at midfrequency is 110 ohms. This is, of course, due to the fact that the input is not located in the region of current maximum. The location of the input is naturally determined by the relative lengths, of the radiator components, required to make the resistive effects alike for the inductive and the capacitive component. Since the input is not in the region of maximum current some benefit is also derived from this condition.

The nomenclature devised for the convenience of describing the composite radiator is as follows:

The capacitive component forming an elliptic extension of the transmission line center conductor is called the ellipsoid. The expanding portion of the outer conductor of the transmission line is called the throat and the inductive portion of the radiator forming a continuation of the throat is called the collar.

By careful experimental procedure it was found possible to improve the mechanical features of this radiator and to render it immune against lightning strokes by supporting the ellipsoid with a metallic bracket fastened to the collar, Fig. 13. The bracket, of course, could not be allowed to interfere with the frequency-response characteristic of the radiator. The determination of optimum dimensions for maximum mechanical strength was very difficult under such specific conditions. It required the consideration of many factors such as the most favorable point of connection, proper self inductance, mutual inductance, etc.

This bracket naturally adds a certain amount of shunt inductance across the input since it was found impossible to make it a quarter-wave long without affecting the frequency-response characteristic. The inductive shunt effect from the bracket must therefore be compensated by an equal capacity effect. It was found most expedient to provide this capacitive effect by tapering the diameter ratio between center conductor and outer conductor of the expanding portion of the transmission line which forms the throat of the radiator. This taper of ratio is toward the radiator.

The characteristic impedance in the throat which is held constant when no bracket is used must be made to decrease toward the opening when a bracket is used.

RADIATOR COMBINATIONS

For broadcasting of vertically-polarized waves a single vertical radiator may be used. For horizontally-polarized waves and for any system calling for increased vertical directivity a combination of radiators must be employed.

To obtain horizontally-polarized waves, a number of radiators may be combined in the horizontal plane. They may be combined to form the sides of a loop or they may be combined radially.

When the radiators are combined to form a loop, they must be of the dipole type, i.e., the elementary units previously described must be arranged in pairs with the two members of each pair connected in series. All dipoles of a loop will then be connected to operate at the same phase. A horizontal loop of this type will then have no radiation in a vertical direction.

When the radiators are combined radially they must be energized in progressive phase in order that a rotating field may be obtained. This is necessary since a radially arranged group cannot produce an instantaneous field uniform in all directions in the plane of the radiators. It is evident then that the radiators do not necessarily have to be arranged in pairs of opposite radiating elements as long as phase and number is such that the currents in one radiator can form the continuation of the currents flowing from the others and as long as the radiation remains reasonably uniform in all directions when the radiators are energized in phase rotation. A typical example of an odd number of radiators combined according to this principle is when three elements are combined in three phase, Fig. 14.

The most common radial arrangement, however, is the turnstile. This antenna can be most simply referred to as consisting of two dipoles crossing each other at right angles and operated in phase quadrature. It can be equally referred to as consisting of four radiating elements radially combined at 90-degree angular spacing and operated in progressive phase quadrature, Fig. 15. As may be remembered from the discussion on transmission lines, there are special band-widening characteristics inherent with phase-quadrature connection.

In cases when vertical directivity is desired whatever element or groups of elements is required to fulfill the horizontal requirements must be repeated at vertical intervals. The interconnection of such groups then becomes important.

If it is desired to retain the band

width obtained with one level of elements, the vertical groups must be connected together by branch feeders in such a way that the length of the feeders to the main line junction have equal length from any level of radiators. In the case of radially arranged radiators it is possible, by proper order of connection, to advance the phase of the next higher level and then connect them through a feeder one-quarter wave longer. In this way a pair of levels may be combined so as to further increase the band width of the total system. Since only the difference in length of the feeders has to be a quarter wave, the spacing between radiator levels is, of course, independent of the line arrangement and can instead be made to conform with optiumum vertical directivity requirements.

In order to obtain a rotating field from angularly displaced radiators it is not necessary that the radiators operate at a certain phase difference as, for instance, determined by different lengths of matched transmission line sections as shown in Fig. 16-a. The radiators may have any or equal phase if they are correspondingly spaced in the direction of propagation. In Fig. 16-b the case is illustrated when the radiators operate at the same phase. The radiators then have the same angular displacement of 90 degrees as in Fig. 16-a but are spaced a quarter wave in the direction of radiation.

An interesting example of the application of this principle may be furnished by referring to one of the experimental models of broadcast antennas for circular polarization, Fig. 17 and Fig. 18.

A number of dipoles at a 45-degree incline were cylindrically located around a vertical axis. The geometric envelope described by the dipoles then became equivalent to a vertical, hyperbolic cylinder. For the sake of increased vertical directivity and on account of the less troublesome electrical conditions, when using a balanced system, two such groups, one above the other, were provided. The lower ends of the upper dipoles and the upper ends of the lower dipoles were then fed in phase opposition from a line balance converter located within the central supporting column as indicated in Fig. 18. The currents in all the dipoles were thus equal and of the same phase.

The diameter at the center of the hyperbolic envelope was made a little more than half a wave so that the average distance between groups of diametrically opposite radiators became a half wave. Since the currents in all the radiators are in phase, the radiation from oppositely tilting radiators, in a diametrical direction, will combine into a horizontally-polarized maximum resultant. The value of the vertically-polarized resultant becomes zero. The radiator groups which, with respect to the direction of propagation, lie half way between the diametrically opposite groups, do not, for this direction, appear as having any tilt. They, therefore, produce only vertically-polarized radiation components in a plane perpendicular to the direction of propagation. Their location being intermediate, the radiation from the groups providing the vertically-polarized radiation component is in phase quadrature with the radiation from the groups providing the horizontally-polarized component. The energies of the two components are of equal magnitudes. Thus circular polarization is obtained.

The model shown in Fig. 17, which was made for a mean frequency of 150 mc, indicated frequency-response characteristics sufficiently wide for a single television channel to permit application of its principles at any carrier frequency above 60 mc.

For propagation tests from the Empire State Building, which were conducted for the purpose of comparing the merits of various types of polarization[3], it was not necessary to use antennas having uniform radiation in all directions. Folded dipoles, therefore,

were used for this purpose, Fig. 19. Circular polarization for these tests was thus provided by using a turnstile made up of two folded dipoles located in a vertical plane as shown in Fig. 20. This arrangement then conformed with that shown in Fig. 16-a.

• • •

PERSONAL RECEIVER

(*Continued from page* 9)

Zenith's model 4K600 uses a real pi section filter to isolate the r-f and a-f output of the detector. All the other sets use a single by-pass condenser only. The oscillator circuit is also unusual, the padding condenser also serving as a grid condenser. A 680-ohm resistor is used in series with the grid to cut down the oscillator voltage at the high-frequency end, thereby preventing a decrease in sensitivity. G. E.'s model LB-412 uses a 1500-ohm resistor similarly.

Emerson's FF models have the 1R5 filament "hot," being tapped above ground on the oscillator coil. The other side of the filament must be run through an r-f choke. Air Castle uses only a 45-volt "B" battery; also provides a phone jack for headphones. Motorola's model A-1 has five by-pass condensers combined in a condenser block.

• • •

OVER THE TAPE

NBC APPOINTMENT

Appointment of Robert E. Shelby as development engineer of the National Broadcasting Co., has been announced by O. B. Hanson, NBC vice-president and chief engineer. Shelby, supervisor of NBC's television activities, succeeds R. M. Morris, who recently joined the company's radio recording division. Simultaneously, Hanson announced the promotion of George M. Nixon to the position of assistant development engineer, replacing W. A. R. Brown who resigned from NBC to accept a post in the RCA Central Frequency Bureau.

ALLIED RADIO APPOINTMENT

Mr. A. D. Davis, president and general manager of Allied Radio Corp., announces the appointment of Mr. Walter F. Marsh to the position of sales manager of the Chicago metropolitan district. Mr. Marsh has been identified with the radio industry in a number of capacities for the past 23 years.

LEARADIO FOR PANAGRA FLEET

The entire fleet of Douglas airliners on the 6000-mile route of Pan American-Grace Airways is now being equipped with Learadio ADF-8 automatic direction finders, it was announced by William P. Lear, president of Lear Avia, Inc., manufacturers of aircraft radio and accessories. Each ship is equipped with a complete ADF-8 direction finder, comprised of an automatic station-seeking direction finding loop with "Fastop" electromagnetic clutch mounted underneath the fuselage; a special five-band Learadio ADF-8 receiver remotely controlled from the radioman's post; and two 360° azimuth indicators: one located in front of the pilot, the other in front of the radioman.

CANNON BULLETINS

Cannon Electric Development Co., 420 West Ave., 33, Los Angeles, Calif., have made available two interesting bulletins. One bulletin, designated as Bulletin AP, describes in considerable detail the Cannon Type AP plugs for radio and telephone circuits. Bulletin P is devoted to the Cannon Type P and O plugs for sound and allied applications.

HALLICRAFTERS BOOKLET

Hallicrafters are now offering a 12-page illustrated booklet entitled "A Short Story on Short-Wave Radio Receivers." This booklet is said to be written for those listeners interested in more reliable reception of European short-wave stations. Write to Hallicrafters, 2611 Indiana Ave., Chicago.

INDUSTRIAL BUSINESS UP

A huge new market for virtually all radio test equipment and other merchandise handled by RCA tube and equipment distributors has been opened up by the tremendous expansion of industry under the National Defense Program, according to Bill Bohlke, RCA's director of test equipment merchandising. Mr. Bohlke has just returned from a trip through seven western states during which he contacted more than 300 distributors and representatives.

GRAY JOINS HILL

Ralph M. Hill, electrical manufacturer's representative, located at 1 N. Crawford Ave., Chicago, announces that Gordon E. Gray has joined his organization to aid in

WHEN YOU CHANGE YOUR ADDRESS

Be sure to notify the Subscription Department of COMMUNICATIONS at 19 E. Forty-seventh St., New York City, giving the old as well as the new address, and do this at least four weeks in advance. The Post Office Department does not forward magazines unless you pay additional postage, and we cannot duplicate copies mailed to the old address. We ask your cooperation.

the sale of their electrical industrial lines. Gordon Gray is a graduate of the University of Illinois in electrical engineering. After graduating, Mr. Gray joined the electrical research department of Sears Roebuck & Co. and later served the North American Car Corp. as engineer in charge of electrical design of mechanically refrigerated freight cars. Mr. Gray entered sales engineering work in 1936 when he became associated with the Ohmite Mfg. Co. where Mr. Hill was general sales manager.

HALLICRAFTERS APPOINTMENT

Royal J. Higgins, for the past five years in charge of sales promotion for The Hallicrafters, Inc., Chicago, has been appointed director of advertising and sales promotion for Hallicrafters. The appointment became effective March 24.

ERIE RESISTOR EXPANDS

The plastics division of Erie Resistor Corp., have expanded their molding facilities and are now producing continuous extruded plastics. Custom designed moldings in the form of solid rods, tubing, half rounds or any other shapes that lend themselves to the extrusion process, are molded in continuous lengths of any desired size up to a maximum diameter of ⅞ inches. Very small threads and strips for weaving purposes can be molded with exacting tolerances, it is said. These plastics can be made from a wide range of materials in any desired color from opaque to translucent. Literature available from Erie Resistor Corp., 640 W. 12th St., Erie, Pa.

DOOLITTLE BULLETIN

Doolittle Radio, Inc., 7421 Loomis Blvd., Chicago, have issued a 12-page bulletin describing their line of police radio equipment. Both a-m and f-m units are described. Copies may be secured by writing to the above organization.

WGEO HONORED

The only short-wave station to be honored in the first annual awards by University of Georgia in the George Foster Peabody awards for meritorious public service was General Electric's station WGEO in Schenectady. This station was cited for its service to the U. S. Antarctic Service expedition, which consisted of a radio program every other Friday night, sponsored by some prominent newspaper, followed by the reading of 150 to 200 letters from relatives and friends back home, known as the "Byrd mail bag." The Little America service was inaugurated in December 1939 and will continue until May 1.

ISOLANTITE APPOINTMENT

Isolantite, Inc., 233 Broadway, New York City, has just announced the appointment of Howard Quick to handle sales of the radio specialties division.

RCA BOOKLET

RCA's new 16-page booklet on transmitting and special purpose tubes is just off the press. This booklet catalogues all RCA non-receiving types—transmitting tubes, transmitting rectifiers, television tubes, oscillograph tubes, phototubes, acorn tubes, gas-tubes, voltage regulators, and special amplifier tubes. Special charts facilitate the selection of tube types for particular services. Tube types especially suited for u-h-f uses at frequencies of 100 mc and above are indicated in red for convenient reference. Copies of booklet TT-100 may be obtained from nearest RCA distributor

or by sending 10c to Commercial Engineering Section, RCA Manufacturing Co., Inc., Harrison, N. J.

C-D CAPACITOR MANUAL

The Cornell-Dubilier "Capacitor Manual for Radio Servicing" for 1941 contains over 300 pages. It includes a great deal of data pertaining to capacitor replacements in standard receiver models as well as some advance information on receivers not yet announced. Copies may be obtained by writing to the Cornell Dubilier Electric Corp., South Plainfield, N. J.

WESTERN ELECTRIC APPOINTMENT

Reese F. Clifford has been appointed personnel director of the Western Electric Co. Mr. Clifford has completed 30 years of service with Western Electric.

CHEMICAL PUB. CO. MOVES

The executive billing and shipping offices of the Chemical Publishing Co., Inc., publishers of technical and scientific books in all fields, have moved into new and larger quarters at 234 King St., Brooklyn, N. Y.

FINCH APPOINTMENT

Mr. W. G. H. Finch, president of Finch Telecommunications Inc., Passaic, N. J., has announced the appointment of Dr. Frederick A. Kolster, prominent radio engineer, as chief consultant to the company.

GATES BOOKLET

The Gates American Corp., Quincy, Illinois, is making available to broadcast stations interested in equipment modernization a new booklet compiling complete cost data, FCC data for filing, illustrations of installations, and helpful hints in putting the new station on the air. Requests for the booklet should be addressed to the above organization.

W71NY STARTS OPERATION

New York had its first regularly licensed f-m station starting April 1 when W71NY, owned and operated by WOR, went on the air at 8:00 a.m. The station will be on the air daily from 8:00 a.m. to 11:30 p.m. broadcasting on 47.1 mc. The call letters W71NY replaces W2XOR the experimental station.

WAKEFIELD JOINS COMMISSION

Ray C. Wakefield of California was sworn in March 22 as a member of the Federal Communications Commission. The oath was administered by Associate Justice Justin Miller of the United States Court of Appeals for the District of Columbia. On March 5, Mr. Wakefield was nominated by the President for a seven year term, succeeding the late Thad H. Brown. He was confirmed by the Senate on March 17.

CORNELL DUBILIER EXPANDS

The Cornell-Dubilier Electric Corp., manufacturers of electrical capacitors, announces through its president, Octave Blake, Jr., the purchase of the million-dollar plant of the Kendall Company at New Bedford, Mass. This new plant will add over a quarter million square feet of manufacturing floor space to C-D facilities now existing at South Plainfield, N. J. It is being equipped as rapidly as possible for large-scale production to meet the requirements of volume defense orders and the rapidly growing regular commercial production of the company.

ANTENNA MANUAL

The Premax Antenna Manual, just off the presses, contains a great deal of useful and practical data on antenna design, construction and use for amateur, public and commercial services. Edited by Arthur H. Lynch, there is considerable practical information on fixed rotary beam antennas, the extended double Zepp antenna, antennas at the New York World's Fair, 24 practical ideas for using vertical units, a ten-meter hi-Q vertical, working drawings for rotary beam antennas, and 20 designs for building rotary beam antennas. In addition a suggested reference list of articles on antenna design and feeding is included. Antennas for f-m reception and commercial services are also discussed. This manual may be obtained from Premax Products Division, Chisholm-Ryder Co., Niagara Falls, N. Y., for the sum of 25c.

SPRAGUE DEFENSE FACTORY

Faced with a heavy influx of national defense orders, some of them calling for special machinery and methods, the Sprague Specialties Co. and Sprague Products Co., North Adams, Mass., have found a solution to the problem of giving these orders wholehearted priority while still not neglecting its regular radio business. Several years ago, Sprague acquired a big second factory on Brown Street, North Adams, just about a mile from its original plant. With defense orders piling in, this Brown Street plant has been devoted almost exclusively to them. New machinery has been installed, workers carefully trained, and Sprague technicians put in charge of every detail of the work. Meanwhile, the original Sprague factory is turning out more of its regular products for the radio trade than ever before.

MEYER JOINS LEAR AVIA

Miss Dickey Meyer, formerly of TWA, has joined the staff of Lear Avia, Inc., it was announced by Henry W. Roberts, Lear Avia's director of public relations. She will handle press liaison work at the company's New York offices at 30 Rockefeller Plaza. Miss Meyer, a native of Milwaukee, studied aeronautical engineering at the Massachusetts Institute of Technology.

SIMPSON EXPANDS

The Simpson Electric Co., instrument manufacturers of Chicago, have just announced that they have a new factory under construction which will double the capacity of the present plant.

IRC APPOINTMENT

Backed with a broad trade and technical experience, Harold G. Beebe has joined the staff of the industrial division of the International Resistance Co. Mr. Beebe is well known throughout the trade, having served as Sales Manager of Isolantite, Inc., for seven years.

LEAR AVIA BULLETIN

Lear Avia, Inc., Dayton, Ohio, have made available a 20-page bulletin covering the Learadio ADF-8 automatic direction finder. Rather complete data and operating instructions are given. Write to the above organization.

DeJUR-AMSCO BULLETIN

DeJur-Amsco Corp., Shelton, Conn., have announced Catalog I-21. This bulletin is devoted to the DeJur-Amsco line of "Precision Electrical Instruments." Voltmeters, milliammeters, and microammeters

are described. Copies available from the above organization.

ALLIED CATALOG

Allied Radio Corp., 833 W. Jackson Blvd., Chicago, have made available their new 180-page spring catalog. Complete new lines of almost everything in radio are included in this new book. All equipment is carefully arranged in special sections and indexed for speedy reference.

ATR CATALOG

The American Television and Radio Co., 300 E. 4th St., St. Paul, Minn., have announced their 1941 catalog, No. 141, covering the complete ATR line of vibrator and rectifier power supplies including a-c/d-c inverters, A battery eliminators, battery chargers, etc.

LEAR AVIA EXPANDS

With the biggest backlog in the company's history, Lear Avia, Inc., opened another factory this month, it was announced by T. S. Harris, the company's vice president. The new factory is located at Piqua, Ohio, and is comprised of three buildings with 71,000 square feet.

FEDERAL TELEGRAPH BULLETIN

The Federal Telegraph Co., 200 Mt. Pleasant St., Newark, N. J., have issued a bulletin on their new F-898 transmitting tube. This tube is a high-power water-cooled unit which will operate up to frequencies of 1.6 mc.

CHANGE OF NAME

Anticipating further broadening of its activities in plastics, the American Cyanamid Co., has changed the name of its Beetle Products Division to Plastics Division, according to an announcement made by the company on April 1. C. J. Romieux is sales manager and Dr. K. E. Ripper is chief technologist.

WESTINGHOUSE BULLETIN

Intricate porcelain shapes for high-voltage applications are described in a new leaflet announced by Westinghouse. Dielectric and mechanical strength, heat shock resistance, and dimensional fidelity of Prestite are discussed and compared to wet and dry process porcelain. Applications are listed. Photomicrographs show texture of Prestite, wet and dry process porcelain. A copy of Descriptive Data 39-600 may be secured from department 7-N-20, Westinghouse Electric and Manufacturing Company, East Pittsburgh.

RING RESIGNS FROM FCC

After nearly 12 years of active Government service in radio broadcast engineering, Andrew D. Ring has resigned as assistant chief engineer of the FCC to engage in private engineering practice. He will be associated in Washington with Ralph L. Clark, who has resigned from the Commission engineering staff for this purpose.

NEW PRODUCTS—

See also pages 33 and 34

RCA TUBES

The RCA Manufacturing Co., Inc., Harrison, N. J., are making available three new receiving tubes of the single-ended type. They are designated as follows: RCA-6SF7 diode super-control amplifier pentode, RCA-6SN7-GT twin-triode amplifier, RCA-12SF7 diode super-control amplifier pentode.

The 6SF7 is a multiunit, single-ended, metal tube containing a remote cutoff pentode and a single diode detector. The tube is recommended for use as a combined i-f amplifier and detector. When so used in phono-combination instruments, the 6SF7 minimizes the difficulty from "play-through" from the radio set. The 6SF7 may also be used as a resistance-coupled a-f amplifier and will give the same high gain and voltage output as other similar pentodes.

The 12SF7 is identical with the 6SF7 except for its heater rating of 12.6 volts and 0.15 ampere.

The 6SN7-GT is a single-ended, twin-triode amplifier having separate cathode terminals for each triode unit. It is recommended for use in resistance-coupled circuits as a voltage amplifier or phase inverter. The 6SN7-GT has a T-9 bulb. From the circuit designer's standpoint, the 6SN7-GT with its separate cathode terminals for each unit offers much greater flexibility in application.

GENERAL UTILITY AMPLIFIER

The Model 451-T amplifier offered by the Lafayette Radio Corp., 100 Sixth Avenue, New York City, is designed to fill the needs of p-a dealers and specialists for equipment midway between the "economy" and "de-luxe" classes. It provides 32 watts normal output, 45 watts on instantaneous peaks.

STATION LOCATOR

Allied Radio Corp. meets the demand for resetting radio set push-buttons by placing on the market a new low-priced Knight station locator, No. B10060. Approximately 784 American stations made a ten to forty kilocycle shift on March 29th, making it necessary to re-set receivers in accordance with these frequency changes. No direct connection to the radio is necessary. A drift-free oscillator generates either a modulated or unmodulated signal at the flip of a switch. An easily read and simply calibrated dial identifies all stations; covers the entire broadcast band. This unit may also be used to service auto radios. Operated from self-contained standard batteries, the station locator measures 3" x 4" x 5" and is housed in a portable black crackle-finished case. Allied Radio Corp., 833 West Jackson Blvd., Chicago.

ALCO RECORDING DISCS

National Recording Supply Co., Hollywood, has just taken on national distribution for the Alco blank recording discs manufactured in Los Angeles by the Record Sales Co. In view of the current aluminum shortage, the Alco line may be widely accepted where acetate discs have been used. Initial shipments of Alco started March 15 with both professional and home blank discs in 6½, 8, 10 and 12-inch sizes.

The home recording type will be the ordinary "run of line" material, while the professional discs will be selected and tested material. Both will be manufactured in coated form on steel alloy base and with a glossy finish in silver blue. Alco blanks are said to be unbreakable and are not affected by abrupt climatic changes. They may be played back immediately or processed and pressed the same as the usual aluminum recording blanks.

Sound System—continued from page 16

occupied and 28 for future additions. Relay switching equipment and cabling to the benches were provided for these 28 but the benches were not equipped with microphones. The two transmission channels were connected to the group of four loudspeakers by means of a network of six attenuators of proper impedance and loss, so arranged that each channel has one individual loudspeaker and uses two others in common with the other transmission channel. Fig. 1 shows in block schematic the two transmission channels, the arrangement of the attenuators and the location of the loudspeakers with respect to the plan of the Chamber. Loudspeakers A, B and D are used by the deputies' channel and correspond, respectively, to the center, left-hand and right-hand sectors of deputies' seats, one loudspeaker being located behind and about five meters above the center of each sector. These three loudspeakers emit the same volume of sound. The presidential transmission channel uses loudspeakers B, C and D, C being located about 2.5 meters back of and five meters above the President's chair.

The Chamber, which corresponds to four floors in height, is completely surrounded by two walls with a three-meter corridor between. The corridors on the three upper floors are provided with chairs and serve as galleries for visitors who observe the proceedings in the Chamber through the 24 curtained openings in the inner wall on each floor. The four loudspeakers are located behind the horizontal curtains in the upper part of four of these openings into the Chamber from the first gallery. The curtains are of heavy, soft plush material and have the loudspeaker cabinets. The front elevation and plan of the loudspeaker cabinets are shown at A and B, respectively, in the upper portion of Fig. 2.

In the lower portion of Fig. 1 there is indicated in block form the connections to three loudspeaker cabinets in the private offices of the President, the Parliamentary Secretary and Executive Secretary of the Chamber. These offices are located in another wing of the building. Either one of the secretaries or the President may be in his office engaged in routine or administrative matters during less active periods of a session, but it is necessary for them to return to the Chamber when there is a resumption of activities. The loudspeaker cabinets provide a means for keeping in touch with the Chamber so that they may return to the session when it becomes desirable.

Each of the loudspeakers in the installation is made up of one permanent-magnet dynamic speaker of the cone type and a Western Electric 594-A unit equipped with a Western Electric 31-A horn. These are connected to a dividing network so that the cone speaker handles frequencies from about 35 to 400, and the 594-A unit frequencies from 400 to above 10,000 cycles per second.

The individual microphones are Western Eelectric 633-A and are mounted in a felt-lined fixture carved from mahogany with a design and finish matching the mahogany desks on which they are located. Immediately below and above the face of the microphone there are two non-locking push-button type keys, located in the mahogany fixture, and a small green pilot light, respectively. By momentarily operating the key on the right the microphone is connected to the system and, at the same time, the green pilot light is lit to indicate that the connection has been established. The microphone is disconnected by momentarily operating the key on the left.

Fig. 3 shows a schematic circuit diagram of the system. This diagram includes only one microphone and switching circuit for each of the three sectors of deputies' seats and one for the presidential transmission channel. The other microphone and switching circuits are multipled at the A and B relay contacts, respectively, as indicated.

The system contains 406 switching relays but, as will be seen from Fig. 3, the circuit is relatively simple, involving no complicated operations. The only switching features which might be considered special are those of the F relay and the H relay. When a microphone is disconnected, contacts 3 to 9 of the F relay function in sequence to prevent noise in the loudspeaker by first connecting a 60-ohm resistance across the microphone circuit and then reducing it to 0 in consecutive steps of 30, 20 and 10 ohms. The F relay is fast operating and slow releasing. By the time it has released, the microphone circuit is short-circuited at the D relay contacts, the amplifier circuit opened at the SR relay contacts, and the microphone disconnected at the A relay contacts. The function of the H relay is to avoid the possibility of more than one microphone being connected at the same time to the deputies' transmission channel. As indicated, relay H is differentially wound with permanent biasing current in one winding. Battery for the A, B and C relays is supplied in an opposite sense through the other differential winding. The current for the operation of one set of A, B and C relays is not sufficient to overcome the biasing current in the H relay, but should two or more connect keys be operated at the same time and before the E-1 contact is broken, the operating current overcomes the biasing current, operates the H relay which, in turn, operates relays J and K which remove the battery for the pilot lights, short-circuit the microphone leads at the F relay contacts and open the circuit between the amplifiers, thus making the channel inoperative.

TIME DELAY SWITCH

This new time delay switch was developed to provide a predetermined time delay in electrical control. Designed for laboratory and industrial application in conjunction with magnetic relays and generally used where temperature changes are fairly constant and slight variation in timing are not detrimental. (Special compensating switches are provided where ac-

curate delay is essential.) The switches are made as small as possible without sacrificing the performance, it is said. Provided with four terminals, two for the heater coil, two for the main circuit and adjustable within the time limits of one second to five minutes. Available in immediately or not immediately recycling types, normally open or normally closed models. Size with soldering lugs 3"x⅞"x⅞"; with binding posts 3"x⅞"x1¼". Wiring diagrams and timing chart sent on request. Betts & Betts Corp., 551 W. 52nd St., New York City.

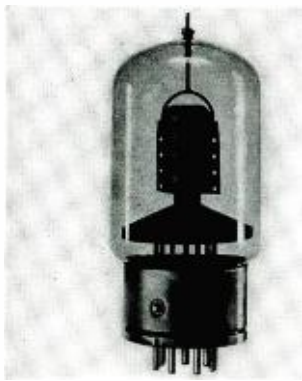
AVIATION PORTABLE RADIO

An efficient portable radio receiver which receives such aviation information as CAA weather reports, radio range courses, and airport control tower signals, in addition to standard broadcast programs, has been announced by the aviation

section of RCA Manufacturing Co., Camden, N. J. The unit, shown in the accompanying illustration, is equipped for operation from self-contained dry batteries, or from a-c or d-c outlets. It is designated as Model AVR-102. Complete information from the above organization.

257 GAMMATRON

In the accompanying illustration is shown the Gammatron 257, beam pentode. This tube is said to have excellent ultra-high-frequency characteristics because of its low interelectrode capacities and low grid-to-plate capacity. Also, it has dual screen grid and suppressor grid leads which make it possible to effectively by-pass these portions of the tube to ground at ultra-high frequency. The Type 257 has been found useful in frequency-modulation



transmitters, and is often used as the driver for the final stage. Because its driving power requirements are extremely low, the frequency multiplier system ahead of the Type 257 may be kept to a minimum power. Further information may be secured from Heintz & Kaufman, Ltd., South San Francisco, Calif.

MULTIPLE SPOT WELDER

The Eisler Engineering Co., 740-770 So. 13th St., Newark, N. J., has recently placed a multiple spot welder on the market. Adjustments can be made to make circular, straight, square, rectangular or any odd shape welds, to conform with any need. From 2 to 12 spots can be made simultaneously, depending on the nature of the job. These machines are primarily intended for the spot welding of light sheet metal work where a large range of adjustments for various spots and shapes are to be considered. Pressure electrodes are used with suitable air operation equipment. The electrodes have an individual adjustment so as to maintain an even pressure on all the spot welds being made.

AVIATION RECEIVER

The Western Electric 33A radio receiver is a three-band superheterodyne receiver designed for use in aircraft or other applications where space and weight restrictions are severe. This receiver is constructed in two units—a radio-frequency unit and an audio-power unit. The radio-frequency unit containing all the controls is designed to mount near the pilot or operator. The audio-power unit can be installed anywhere in the airplane, base down, within the limits imposed by the interconnecting cable and battery cable (usually ten feet). This unit comprises the intermediate-frequency amplifier and second detector together with the continuous-wave oscillator, audio-frequency amplifier and dynamotor power supply. Two radio-frequency units, and a single power unit

may be used in conjunction with a radio transmitter and suitable control boxes to form a complete two-place aircraft radio equipment and intercommunicating system. The interphone employs the audio amplifier of the receiver and up to 700 milliwatts of power may be readily secured. Frequency coverage: 250-625 kc, 3,900-7,500 kc, 6,750-12,200 kc. Further information may be secured from Western Electric Co., 195 Broadway, New York City.

RESISTORS FOR FLUORESCENT FIXTURES

The IRC Type FL resistors, specifically designed in small size with low temperature rises for d-c operation of fluorescent lamps and listed under the Underwriters Laboratory Re-examination service, are now available in a complete line of voltages and sizes to fit all standard wiring strips. The resistance units are of the wire-wound

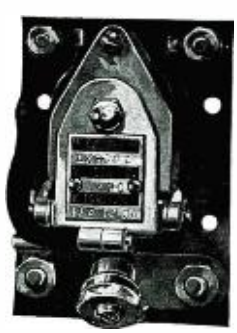
type with molded 1250-volt insulation topped by a metal strip to aid in heat dissipation. Write for Resistor Bulletin No. 13. International Resistance Co., 401 N. Broad St., Philadelphia, Pa.

NEW TUBE LINE

A new line of Knight radio tubes has been announced. This line will offer a selection in all-glass, all-metal, octal base glass, miniature, and GT octal base types. Complete information may be secured from Allied Radio Corp., 833 W. Jackson Blvd., Chicago, Ill.

DUNCO RELAYS

Two new Dunco relays, light in weight, vibration-proof and designed and tested primarily for aviation service for control of air flaps and similar applications where dependability is required, are also proving popular for many industrial requirements, according to Struthers Dunn. Special non-



welding contacts make them suitable for use with lamps, motors or other devices where high inrush loads are likely to be encountered. Design modifications make the units suitable for keying and many other purposes. The standard Type C3007 Dunco relay is single-pole, single-throw with normally open contacts rated 50 amperes at 12 or 24 volts d-c. It will stand an inrush of 100 amperes. Contact pressure is 10 pounds. Coils are rated 8 watts continuous and are for operation only on d-c. The dimensions are 2¾" high x 1⅞" wide x 2" deep, and the weight 8 ounces. Two Type CX3007 relays mounted on a common base for motor reversing are only 3⅜" high x 4" wide x 3" deep, and the weight is 15 ounces. A larger relay, Dunco CXA3008, is rated 100 amperes at 12 volts d-c or 80 amperes at 24 volts d-c and will stand an inrush of 300 amperes. Complete data given in the new Dunco Bulletin P 246. Copy will gladly be sent upon request to Struthers Dunn, Inc., 1335 Cherry Street, Philadelphia, Pa.

SAPPHIRE NEEDLE

Electrovox Co., 424 Madison Ave., New York City, announce the WN-55 Walco sapphire needle for low-pressure pickups. According to the manufacturer this new stylus was developed in conjunction with

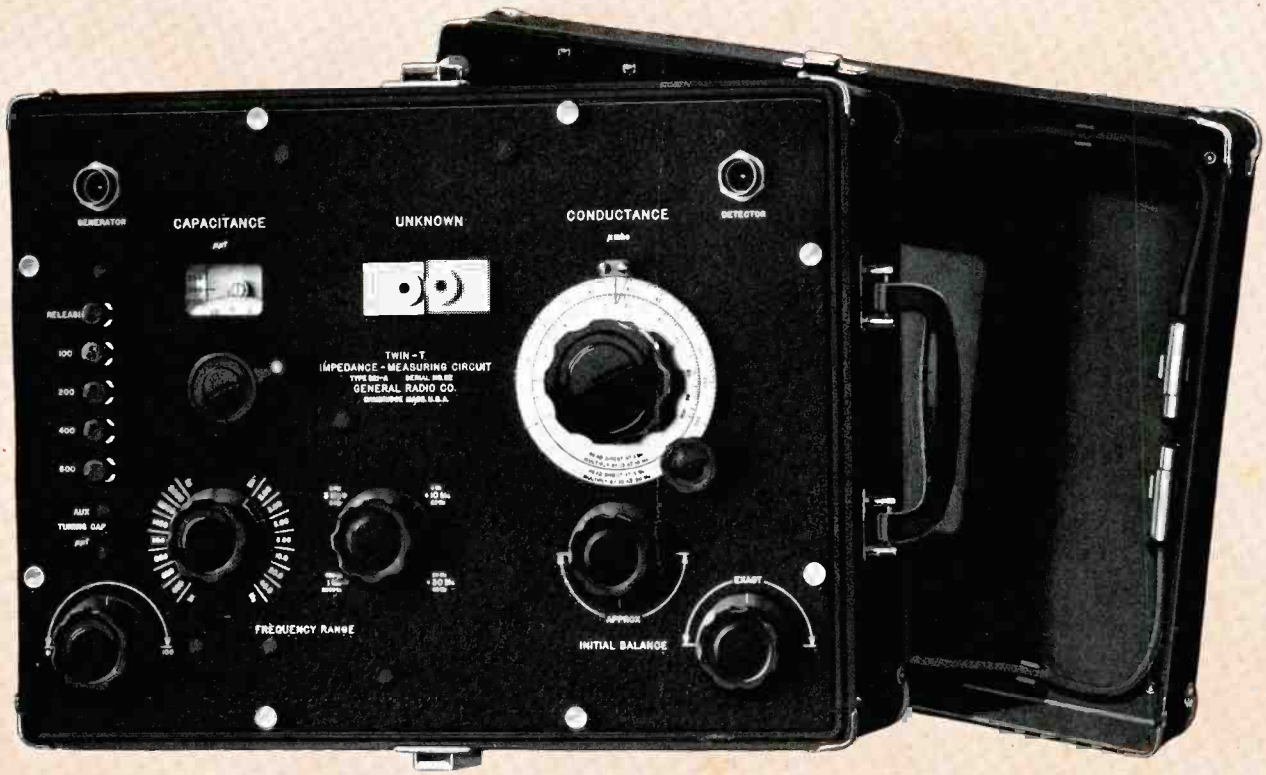
the engineers of several large radio-phonograph manufacturers who are adopting it as standard equipment. The specifications of this new needle include a genuine sapphire point mounted in a straight duralumin shank. The shank has two parallel in-cut flats ground near the tip to provide a lateral flexibility to minimize surface noise.

SPEAKER CABINETS

A new line of "tri-angle" acoustic enclosures, for corner mountings, side-wall hanging, and cluster arrangement in groups of two, three and four, are available from Atlas Sound Corp., 1449 39th St., Brooklyn, N. Y. Finished in natural grain walnut with musical motif and acousti-cloth grille. Infinite baffle with bass reflex design permits good quality reproduction, it is said. Model TR-12 for all 12" cones has overall height of 22", width 19" and depth 10".

Index to Advertisers

With This NEW R-F Measuring Circuit



Up to 30 Mc You Can Measure

- CAPACITANCE OF CONDENSERS
- POWER FACTOR OF CONDENSERS
- INDUCTANCE OF COILS
- Q OF COILS
- RESONANT IMPEDANCE OF PARALLEL CIRCUITS
- SERIES TUNED CIRCUITS
- HIGH AND LOW RESISTANCES
- GROUNDED ANTENNAS
- COAXIAL TRANSMISSION LINES
- TERMINATED AND UNTERMINATED LINES
- MATCHING SECTIONS

THIS NEW G-R circuit is a null instrument for measuring impedances at high frequencies. While null methods give the most accurate comparisons, until now it has been impossible to use them for measurements at the higher radio frequencies since the accuracy of these measurements depends, among other things, upon the accuracy with which the impedance standards can be constructed and calibrated. The inadequacy of existing standards at the higher frequencies has restricted the use of bridge circuits to audio and the lower radio frequencies.

The new instrument is a parallel-T circuit which is used for a parallel-substitution measurement of the unknown admittance. Measurements can be made with satisfactory accuracy up to at least 30 Mc. The parallel-T circuit provides several features which make it particularly useful for r-f measurements: (1) a ground common to many points of the circuit eliminates the need for the shielded transformer required in bridge circuits and renders harmless many residual circuit capacitances; (2) the conductive component is measured in terms of a fixed resistor and a variable condenser which provide the equivalent of a continuously variable resistance standard. This combination is much freer from residual parameters than any variable resistor available.

Measurements with the new circuit are simple. The frequency range is 420 kc to 30 Mc and the capacitance range 110 to 1100 μμf, direct reading. The instrument has direct-reading conductance ranges at four frequencies: 0 to 100 μmho at 1 Mc; 0 to 300 μmho at 3 Mc; 0 to 1000 μmho at 10 Mc and 0 to 3000 μmho at 30 Mc. For other frequencies the range of the conductance dial varies as the square of the frequency.

Accessories required for operation comprise a suitable r-f generator (such as the G-R Type 684-A Modulated Oscillator with addition of a coaxial output jack, or the Type 605-B Standard-Signal Generator) and a well shielded radio receiver covering the desired frequency range.

Users of this new G-R instrument are enthusiastic over its performance, its ease of operation, its accuracy and its extended frequency range.

TYPE 821-A TWIN-T IMPEDANCE MEASURING CIRCUIT.....$340.00

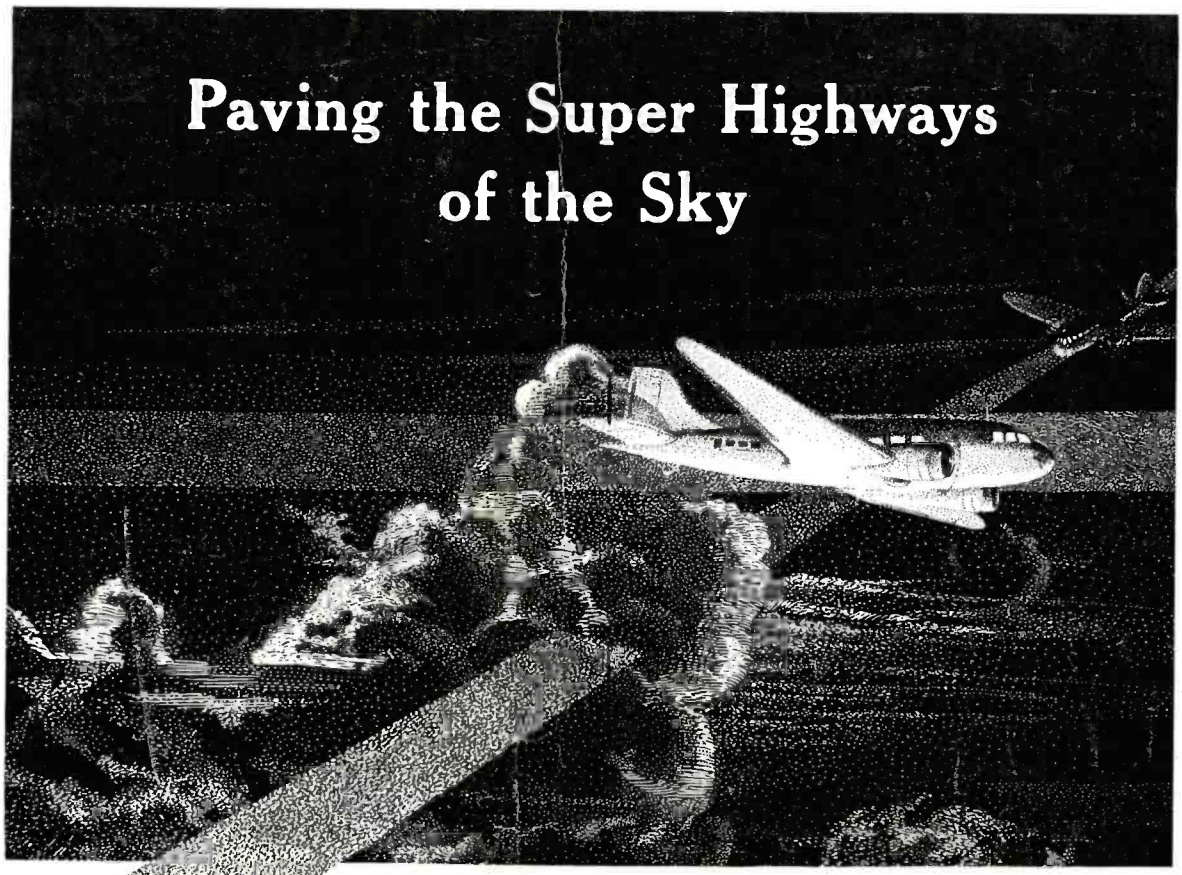
Write For Bulletin 683 For Complete Data

GENERAL RADIO COMPANY

CAMBRIDGE, MASSACHUSETTS

Branches in New York and Los Angeles

Paving the Super Highways of the Sky



The Part that Mallory Plays

These days, you are just as apt to find a Stratoliner time table in the pocket of a busy man as you are his suburban commutation ticket. Coast to coast hops have become an American habit. Ever mounting millions of safe, speedy passenger miles have made it so.

Behind this glorious record of American flying safety are a host of factors. Pioneering! Engineering! Men! Materials! Machines! All of these are inextricably interwoven into the world's greatest peace-time flying achievement . . . and likewise is the name Mallory.

The part Mallory plays is largely unsung. But it is nearly impossible to take a scheduled transport passenger flight without having Mallory working in behalf of greater safety from take-off to happy landing. Before take-off time in fact, it's usually a Mallory Mobile Battery Charger that stores up the vast reserve of electrical energy needed to spin the giant motors into life. The speed with which these giant motors "catch", and their unfailing service in the air is due in no small part in most cases to electrical contacts of a Mallory Metal.

Once in the air, planes follow magical sky highways . . . radio directional beams. No matter how dark the night, nor how "soupy" the weather, these remain as clearly defined to pilots as the Lincoln Highway on a bright Fall morning. Many Mallory parts work to make these directional beams operative and keep them dependable. More Mallory parts . . . vibrators, Vibrapacks,* capacitors, switches; work in the planes to make and keep their instruments responsive to the directional beams.

After sundown at almost any modern airport, ribbons of Mallory tungsten turn the darkest night into vivid day for the guidance of landing and leaving planes. And at many of the largest airports, another miracle of flying safety . . . the landing beam . . . will guide any properly instrumented plane safely down onto the runway through the thickest fog.

Next time you fly . . . give a thought to the many ways in which Mallory is at work . . . for your greater safety. Meantime, it might be wise to give a thought to the many ways in which your business may put Mallory to work . . . for your greater profit. A representative group of Mallory's services and products is to be found below. P. R. Mallory & Co., Inc., Indianapolis, Indiana, Cable Address—Pelmallo.

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

P.R. MALLORY & CO. Inc.

MALLORY

SERVES THE AERONAUTICAL, AUTOMOTIVE, ELECTRICAL, GEOPHYSICAL, RADIO AND INDUSTRIAL FIELDS WITH . . . ELECTRICAL CONTACTS, WELDING ELECTRODES, NON-FERROUS ALLOYS, POWDERED METAL PRODUCTS AND BI-METALS . . . RECTIFIERS, DRY ELECTROLYTIC CAPACITORS, SPECIAL HIGH RATIO ANODE PLATE CAPACITORS, VIBRATORS, VITREOUS RESISTORS, POTENTIOMETERS, RHEOSTATS, ROTARY SWITCHES, SINGLE AND MULTIPLE PUSH BUTTON SWITCHES, POWER SUPPLIES, BATTERY BOOSTERS AND CHARGERS