JUNE 16
1928

AUTOMATIC SYNCHRONY IN TELEVISION

15
CENTS

RADIO WORLD
Vol-13 No-13 REG. U.S. PAT. OFF.
The First and Only National Radio Weekly
325th Consecutive Issue—Seventh Year

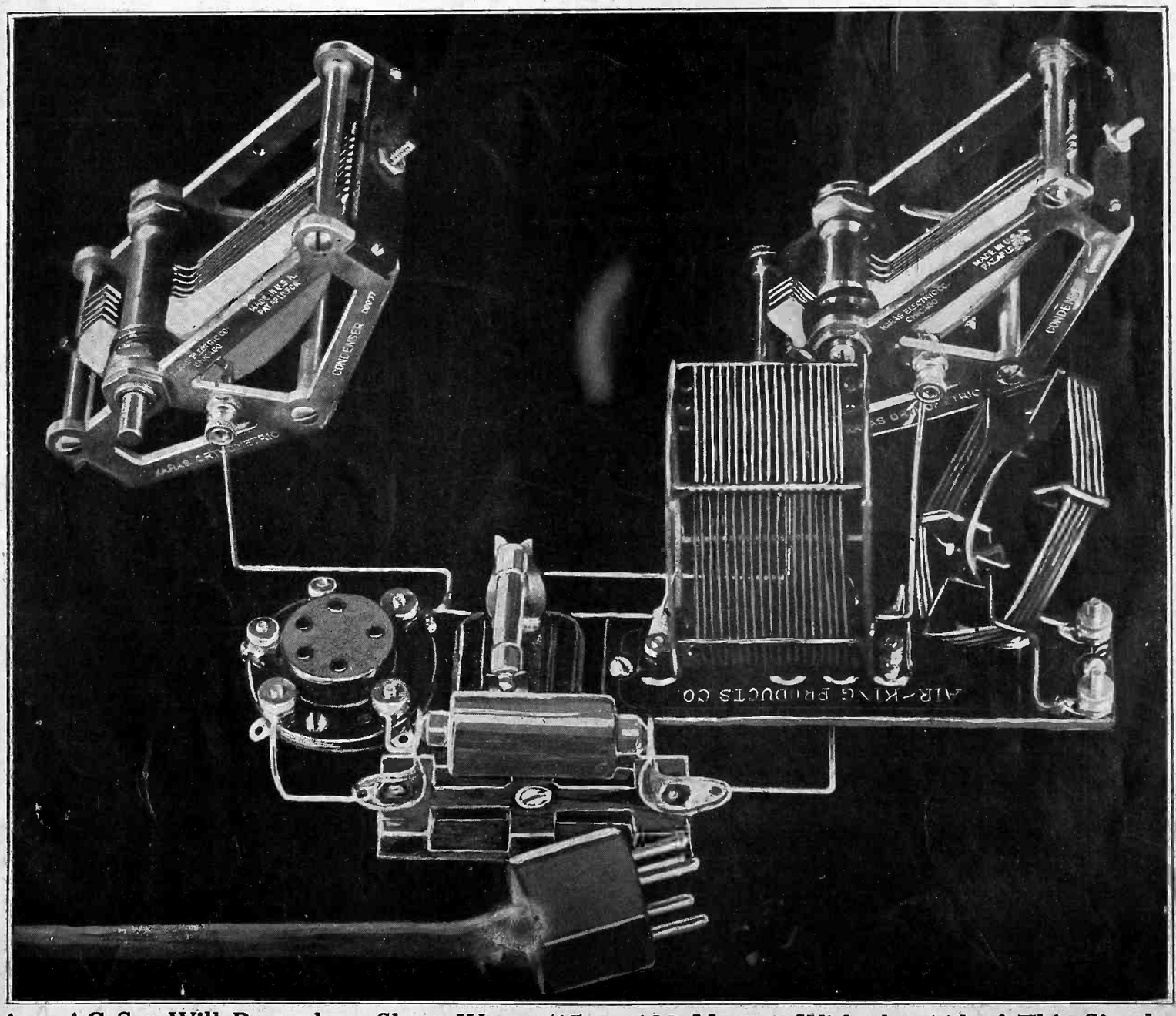
A DYNAMIC SPEAKER

IMPROVE YOUR AERIAL

ARE WAVES BROAD?

ONE METER FOR AC AND DC

A SHORT WAVE ADAPTER FOR AC SETS



Any AC Set Will Reproduce Short Waves (15 to 133 Meters) With the Aid of This Simple Adapter Requiring No Extra Tubes.—See Page 3

A Two-in-One Universal AC and DC Scientific Trouble-Shooting Test Set!

A New Product Made in Response to a Demand for a Single Combination Meter Outfit That Measures Voltages and Currents of Both AC and DC Tubes

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(1) One newly-designed Two-in-One 0 to 10 voltmeter for AC and DC. Same meter reads both. Scale especially legible at 1½ to 7½ volts. This meter reads the AC and DC filament voltages.
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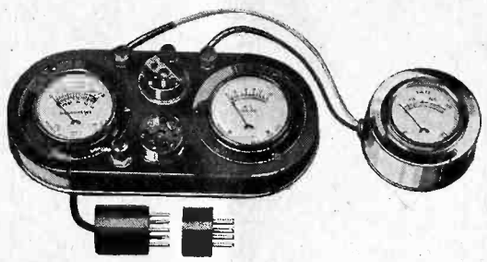
(5) One grid switch to change bias.
(6) One 5-prong socket.
(7) One 4-prong socket.
(8) Two binding posts.
(9) One handsome noire metal case.
(10) One instruction sheet.

[Outfit consists of two units, one being the 0-300 voltmeter (Cat. No. 346), the other the tester with enumerated parts built in. (Cat. No. 215.)]



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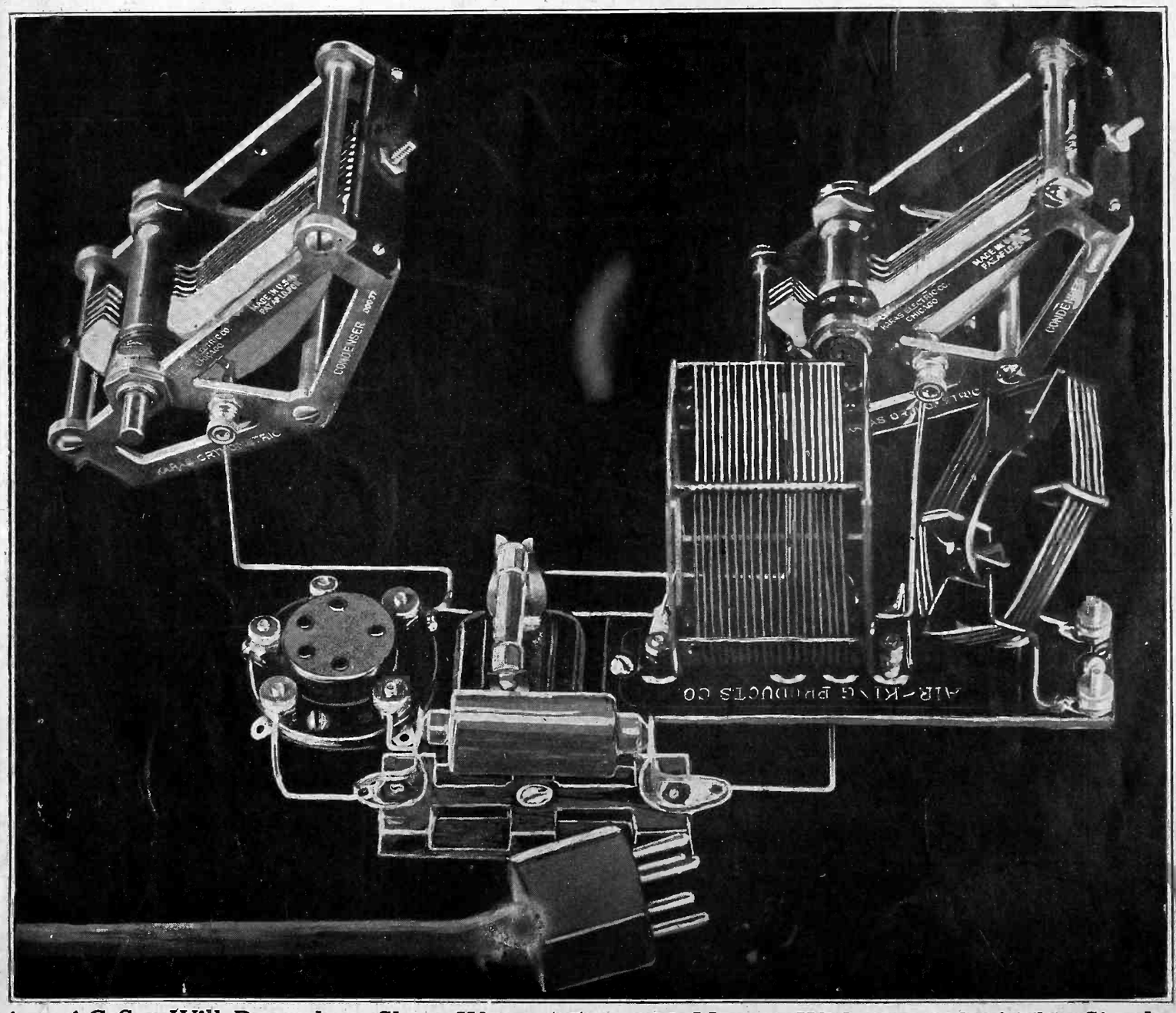

Any AC Set Will Reproduce Short Waves (15 to 133 Meters) With the Aid of This Simple Adapter Requiring No Extra Tubes.—See Page 3

NEXT WEEK

Just the portable you've been looking for—light in weight, only four tubes, sensitive and moderately loud. Also a shielded two-stage AC audio amplifier, with filament transformer, built into a Hammarlund shield. How to build a C eliminator is another interesting article in next week's issue, dated June 23.

"UNINTERRUPTED READER INTEREST"
EVERY WEEK — EVERY YEAR

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Air-King?

An AC 1-Tube Adapter for Short Waves

By Herbert E. Hayden

MANY short wave receivers, and adapters for receiving short waves on broadcast receivers, have been described. These have been for DC operation. But here is an adapter which will convert any AC operated broadcast receiver into a short wave set, provided that the detector in that receiver is of the —27 type, as it nearly always is.

Fig. 1 shows the circuit diagram of the adapter. It is the conventional short wave receiver which has proved to be the most popular for all short wave purposes. With this circuit the new Air-King short wave kit works excellently.

The antenna coil L1 is of fixed inductance and is used for all the coils that may be plugged into the circuit. It is mounted on hinges so that the coupling between it and the secondary may be adjusted to any desired value. This adjustable primary coil can be seen in Figs. 2 and 3 in front of the tuning condenser.

L2, the secondary, and L3, the tickler winding, are wound on the same form for any one of the radio frequency transformers in the plug-in set. The secondary is wound with heavy enameled wire on a rugged, squirrel-cage bakelite form having six lateral ribs. These ribs are grooved for the wire so that the turns cannot shift about. Thus the inductance of any given coil remains fixed in value.

The tickler winding is placed inside the secondary in a peripheral groove cut in the lateral ribs and it is cemented so that it cannot work loose. Fine wire is used for this coil so as to minimize capacity between the windings. The wide air space between the tickler and the secondary windings also reduces the capacity greatly.

Prong Terminals Used

The four terminals on the plug-in coil are brought to four long prongs similar to phone tip terminals and are rigidly secured to the coil frame. The terminals are spaced so that they can be inserted into the coil receptacle in only one way, thus preventing short circuit.

There are three coils in a set, as shown in Fig. 4. The approximate wavelength range of each coil when tuned with a .00014 mfd. condenser is stamped on each coil. Thus the largest has a range of 57 to 133 meters, the intermediate a range of 31.5 to 68 and the smallest a range of 15 to 33.5 meters.

The largest coil has 19 turns on the

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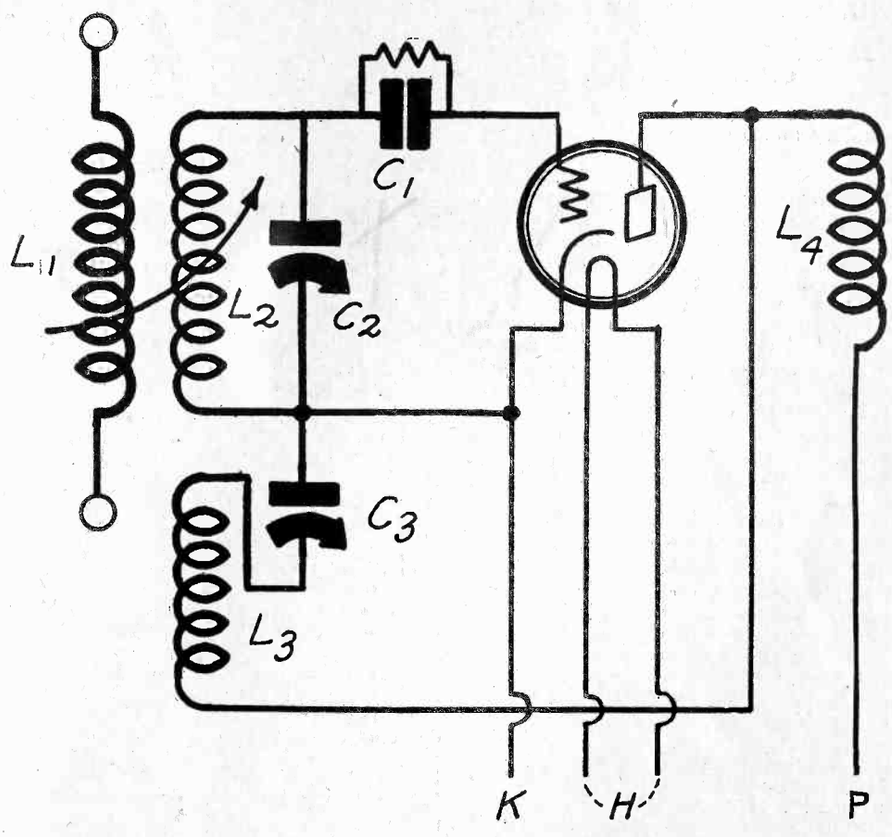


FIG. 1

THE CIRCUIT DIAGRAM OF AN ADAPTER WHICH CONVERTS ANY AC OPERATED BROADCAST RECEIVER INTO A SHORT WAVE RECEIVER.

LIST OF PARTS

L1, L2, L3—One set of Air-King short wave coils with receptacle, with three coils 15-33.5, 31.5-68 and 57-133 meters.

L4—One National RF choke coil.

C1—One Sangamo .00025 mfd. grid condenser with resistor clips.

C2—One Karas .00014 mfd. straight line frequency condenser.

C3—One Karas .00025 mfd. straight line frequency condenser.

R1—One Lynch 2 megohm grid leak.

One Benjamin Y type socket (five spring).

Two Karas Micrometric dials.

Two American Hardware aluminum sub-panel brackets 7x1 inches.

One Formica front panel, 7x14 inches.

One Formica sub-panel, 7x13 inches.

One four lead cable, 27 inches long, with five prong plug.

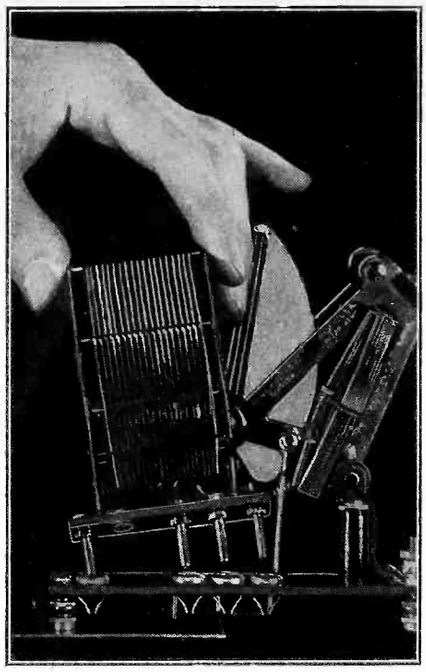


FIG. 2

CLOSE-UP VIEW OF THE COIL AND RECEPTACLE OF THE AIR-KING AC SHORT WAVE ADAPTER. NOTE THE GRID PRONG IS INSERTED FIRST AS A GUIDE FOR THE OTHERS. NO MISTAKE CAN BE MADE IN INSERTING THE COILS, BECAUSE THE PRONGS FIT IN ONLY ONE WAY.

(*Continued from preceding page*)

secondary and 6 turns on the tickler. The intermediate coil has 8 turns on the secondary and 4 on the tickler. The smallest coil has 3 turns on the secondary and 2 turns on the tickler.

The antenna coil has 10 turns.

The coil receptacle or base is provided with terminal sockets so shaped that the coils may be inserted with greatest ease. Each receptacle jack is provided with two stiff springs which will make two wiping contacts on each terminal when a coil is inserted. Terminal soldering lugs are also provided, and these are integral parts of the spring detail. This eliminates four possibilities of poor contact.

The antenna coil is connected with two flexible leads to two binding posts mounted on the coil receptacle.

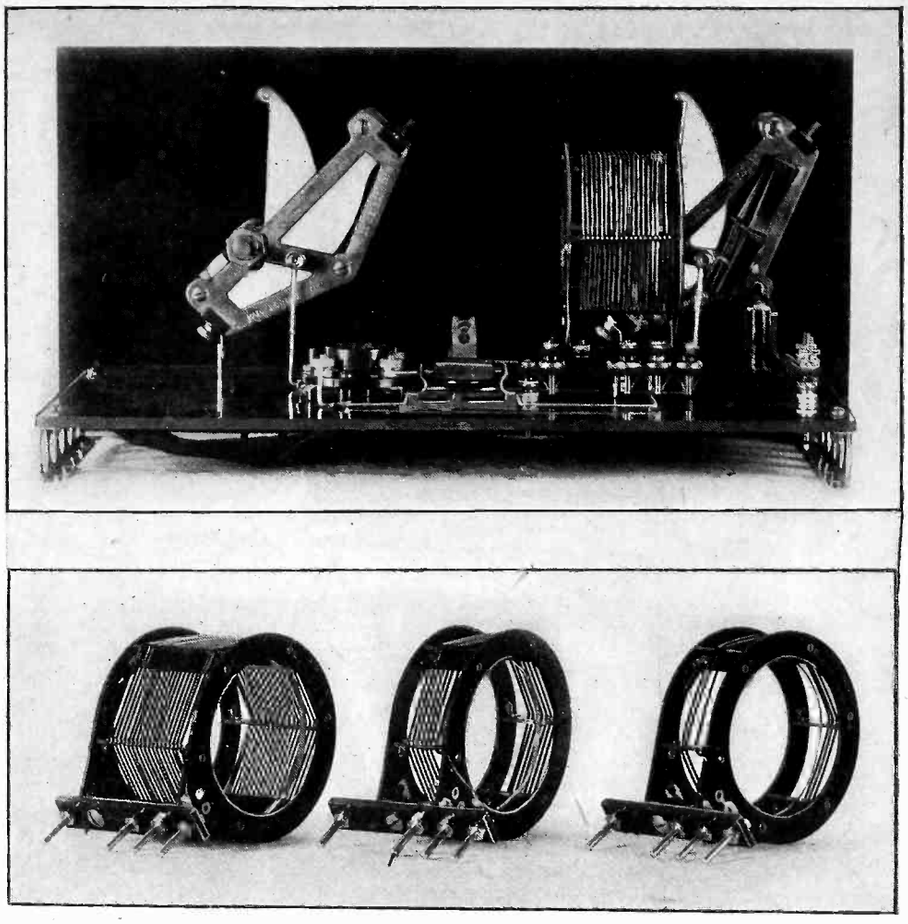
Straight Line Frequency Condensers

The tuning condenser C2 is a Karas .00014 mfd. straight line frequency condenser, which is controlled with a Karas Micrometric dial. Thus accurate and micrometric control of the tuning is possible over the entire tuning range of any coil.

The tickler control condenser C3 is a similar instrument, of .00025 mfd. maximum capacity. It also is controlled with a Micrometric dial, which enables close adjustment and control of the regeneration. The rotor of this condenser should be connected to the cathode K.

The grid condenser C1 is a Sangamo .00025 mfd. unit which is provided with clips for the 2 megohm metalized grid leak R1.

A radio frequency choke coil L4 is put in the plate circuit of the tube. Without this coil the regeneration will not be definite at some settings of the tickler condenser and for some of the coils. Also this choke coil must be wound so that it will be a choke for all frequencies in the tuning ranges of the three coils. It should be wound in slots which are separated by a short distance in order that the distributed capacity be as low as possible. If there is considerable capacity in the coil the choke coil will not be effective at the shorter waves to which the adapter may be tuned. A choke coil of 60 millihenrys is suggested, but other values may be used provided that the distributed capacity of any coil chosen is low. The one shown on the front cover is a National RF choke coil, which fits into a Lynch single mounting.



FIGS 3 AND 4

REAR VIEW OF THE AC SHORTWAVE ADAPTER AND A VIEW OF THE THREE COILS IN THE AIR-KING KIT.

Heater Tube Used

Since the adapter is intended for use in conjunction with an AC receiver in which the detector is a —*27* type heater tube, a Y type, five prong socket is employed. The one used was a Benjamin spring cushion type.

For plugging into the socket in the broadcast receiver a four lead cable terminating in a five prong plug is used. The grid prong on the plug is not used. The proper connection between the plug and the adapter tube is shown in the circuit diagram Fig. 1. This plug may be the base of a burnt-out —*27* tube, into the prongs of which four flexible insulated leads are soldered.

To make the adaptation the —*27* type detector tube is taken from the broadcast receiver and the adapter plug is inserted in its place. Then the tube is inserted in the socket in the adapter. When the power is turned on the broadcast receiver the short wave receiver is ready to operate.

The panel is of hard rubber and is 7x14 inches. The sub-panel is of the same material and is 7x13 inches.

Regeneration Pointers

The characteristics of a short wave receiver are such that the wavelength tuning dial may be calibrated, with not much danger of variation from day to day, but the regeneration control can not be calibrated, because it depends on a series of cumulative effects.

In every instance the degree of coupling between the antenna coil and the secondary is influential on regeneration. While the feedback is caused by the regeneration condenser, the antenna resistance effect is controlled by the degree of inductive coupling. The looser the coupling, the less the effect of the antenna reactance upon the secondary, and the greater the regenerative possibilities. Hence, with a given setting of the regeneration condenser, and a given degree of antenna coil coupling, a point just under oscillation, which is the most sensitive point, may be reached. Then, by increasing the inductive coupling, the capacity feedback would have to be increased, for regeneration may have been lost, and the added capacity brings it back. A reciprocal relationship exists.

Also, the condition of the B supply has some effect. If batteries were used this might prove serious as the voltage of the batteries approached the cutoff limit, but with an AC operated B supply, where the line delivery is utilized in rectified form, only the variations in line voltage would have any effect. This is a negligible item as influencing regeneration.

How to Insure Regeneration

Therefore it is well to keep a record of the stations heard, by noting the dial setting of the left-hand condenser, which controls wavelength. No need to try to calibrate the regeneration condenser, because you simply swing that until regeneration sets in, increasing or reducing regeneration as needed. If no regeneration is obtained, loosen the antenna coil coupling simply by pushing the antenna coil a little farther from the secondary. This is done in an eye's twinkling.

The long outdoor antenna used for broadcast reception works well on short waves, for the antenna picks up waves of all radio frequencies. But often improved results on short waves are obtainable by reducing the electrical size of the antenna. This may be done by physical reduction or by retaining the regular outdoor antenna, and using a small fixed condenser in series with it.

One side of this series condenser would go to the antenna binding post, which is built into the coil form, and the other

(*Continued on page 23*)

How to Connect Any Set's Output for Television Reception

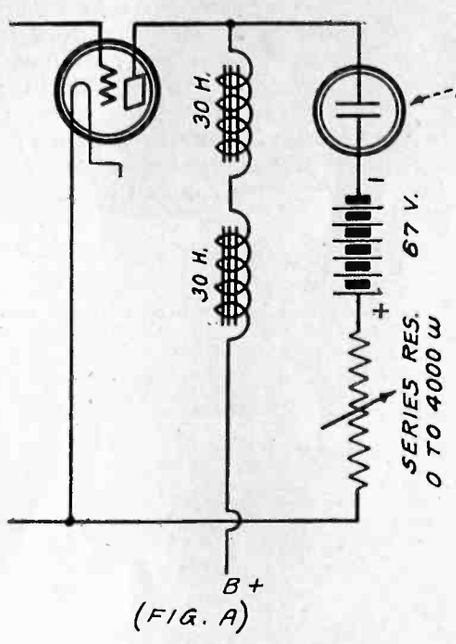
By Neal Fitzalan

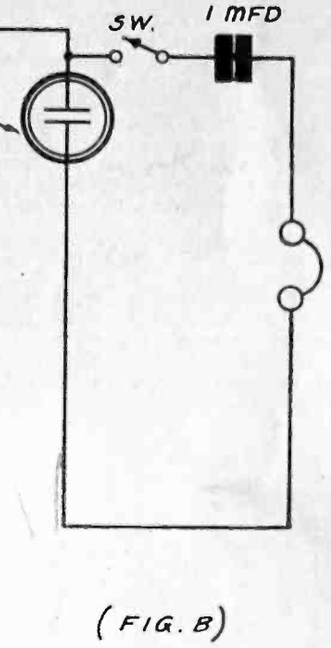
TUNE, listen and look for television pictures broadcast three times a week by WGY, from Schenectady, N. Y., 1:30 to 2 p.m. Eastern Daylight Savings Time—Tuesdays, Thursdays and Fridays.

Tuning for television is done the same as for radio broadcast sound, and it is done with the same apparatus. Listening to the characteristic 18 cycle per second flutter of television is done with the aid of a headset or loudspeaker in the ordinary way. Listening to the reception is not essential. It is merely a convenient way of telling when the receiver is tuned in on the desired carrier wave.

The final object of a television receiver is to give the fan a picture to look at. He gets it by looking at a flickering neon or Kino lamp through tiny holes in the scanning disc which rotates in synchronism with the corresponding disc of the transmitter. The speed of the motor driving the local disc is controlled manually with a rheostat.

The only change in the broadcast receiver to adapt it to television reception is confined to the output side of the last tube. There are several circuit arrangements which may be used, the choice depending on the type of output circuit already in the power tube of the receiver. Fig. A shows one hook-up.





AT THE LEFT IS THE CIRCUIT DIAGRAM OF THE OUTPUT TUBE OF A RADIO RECEIVER, TO WHICH A NEON GLOW LAMP HAS BEEN CONNECTED FOR TELEVISION RECEPTION. AT RIGHT IS A DIAGRAM FOR AID IN TUNING IN A TELEVISION CARRIER. A LOUDSPEAKER OR HEADSET MAY BE CONNECTED ACROSS THE NEON LAMP FOR LISTENING TO THE CHARACTERISTIC FLUTTER.

Arrangement of Output Circuit

Two 30 henry choke coils connected in series are put between the plate of the tube and the positive terminal of the plate voltage supply. The total effective inductance of these coils is 60 henrys. Such high inductance is used in order that the choking effect be high at the low frequency fluctuations which may be contained in the visual signal.

The neon glow lamp is connected in shunt with the two chokes and the plate voltage supply. In addition to the lamp a variable resistance and a 67 volt battery are connected in the shunt circuit. The 67 volt battery is so connected with reference to the B voltage source that the voltages add up in the circuit containing the neon lamp. Thus if the voltage applied to the plate is 180 volts and the voltage in the shunt circuit is 67 volts the total voltage in the neon lamp-choke coil circuit is 247 volts. It takes something over 200 volts to cause some neon lamps to glow.

As soon as the glow appears, a current flows in the neon tube circuit. The intensity of this current depends on the voltage and the resistance effective in that circuit. If the current is excessive the neon lamp will glow too brightly and its life will be shortened. For that reason it is advisable to insert a variable resistance in series with the lamp to limit the current to the value recommended by the makers of the tube. Serious damage to the lamp is likely to result if the series resistance is omitted.

Why Lamp Flutters

When a single voltage is impressed on the grid of the power tube the plate resistance of that tube varies. The signal current through the neon lamp varies in the same manner and thus the light flickers with the incoming signal.

As an aid in tuning in the headset or loudspeaker can be connected across the neon tube. When doing this it is necessary to connect a condenser in series with the speaker to prevent heavy direct current from flowing through its windings. This current would probably burn out the coils in the speaker. The condenser may have any convenient capacity which will pass enough of the 18 cycle current to be heard, for example, 1 or 2 mfd.

The telephone shunt circuit across the lamp is shown in Fig. B. A switch Sw is also put in series with the telephone so that the shunt circuit may be opened when the set has been tuned in. When the switch is open none of the vision carrying current passes through the shunt and all is forced through the lamp, thus making contrasts between the lights and shades greater and the reproduced picture more clearly visible.

The resistance in series with the neon lamp should consist of two sections, one a 1,000 ohm fixed resistor and another a 0-4,000 ohm variable resistor. The current carrying capacity of both should be well over 20 milliamperes.

The object of using two resistors, one 1,000 ohms fixed value and another of adjustable value with a range of 0-4,000 ohms, is to make the circuit foolproof by insuring that there will always be 1,000 ohms in the circuit.

The lamp used should have been designed especially for television reception. Lamps made for night lights and signs do not as a rule have a luminous plate large enough to cover the image, and most of them have no plate at all but simply two luminous points.

World Experts Agree On Sun Spot Effects

Washington.

A definite connection exists between solar activity and radio transmission when observations are averaged over long periods according to Dr. L. W. Austin, of the Bureau of Standards, in a report made public by the Department of Commerce. The full text of the Department's statement follows:

"Dr. Austin has just submitted the report to the Committee on Solar and Terrestrial Relationships of the International Research Council in Brussels for its approval. It gives a summary of the conclusions which may be drawn from the work of Espenschied, Anderson and Dailey, and C. N. Anderson of the American Telephone and Telegraph Company, of G. W. Pickard, of the Wireless Specialty Apparatus Company, and of Dr. Austin on the relationship of radio transmission to solar activity.

"Year by year, and probably month by month, the daylight signals in the medium and long wave ranges rise and fall with the sunspot numbers in the changing sunspot cycle, while the night signals appear to change in the inverse sense, the report reveals. There is evidence of changes in reception in the period of the sun's roation (27 days)."

"It also appears that the daylight static is less in years when sunspots are numerous and greater when sunspots are few, according to the report."

This confirms previous beliefs.

Automatic Television

By Paul L. Clark

[One of the most important problems in connection with television is that of syn chronization of the receiver scanning element with that of the transmitter. Preci synchronization is absolutely necessary or the received picture will not be distinct.

Various schemes for synchronization have been proposed. In one method the receiv is maintained in synchronous speed with the transmitter by a manually operated rheosta The operator of the receiver continually manipulates the rheostat so as to keep the imag received as clear as possible. This method is akin to maintaining a camera in focus o an object when the distance between the object and the camera is subject to continu changes, either because of motion of the camera or of the object, or both.

While manual synchronization is not exceedingly difficult it distracts the operato attention from the contents of the picture and concentrates it on its mechanical feature

THE apparatus hereinafter described comprises a conventional type of scanning elements geared together and run by a constant speed motor. The basic requirement of television transmission is synchronization of the apparatuses at both the sending and receiving stations, and even the slightest variation from synchronism causes displacement of the picture signals on the receiving screen relative to corresponding signals derived from the image to be transmitted.

Tolerable Variation

For precise results the deviation should be zero; but a slight variation, say, the width of a single picture point (area) is permissible. A greater variation causes the received images to flicker and consequently produces inaccurate delineation and blurred pictures.

The object of the present system is two-fold: (a) to synchronize constantly and synchronously with the transmission of each visual signal, and (b) to hold the receiver motor and scanning elements rigidly keyed-in to corresponding elements of the transmitting apparatus, so that the departure from synchronism cannot vary more than the fraction of the width of a single picture point.

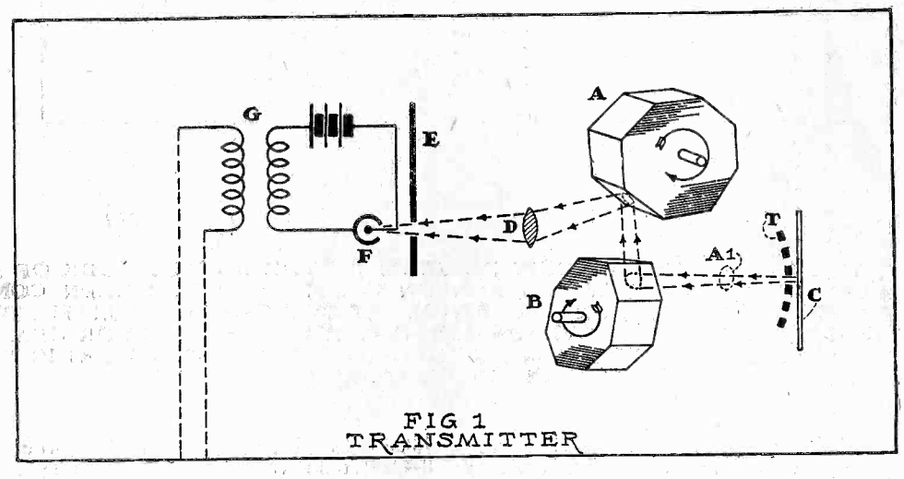


FIG 1
TRANSMITTER

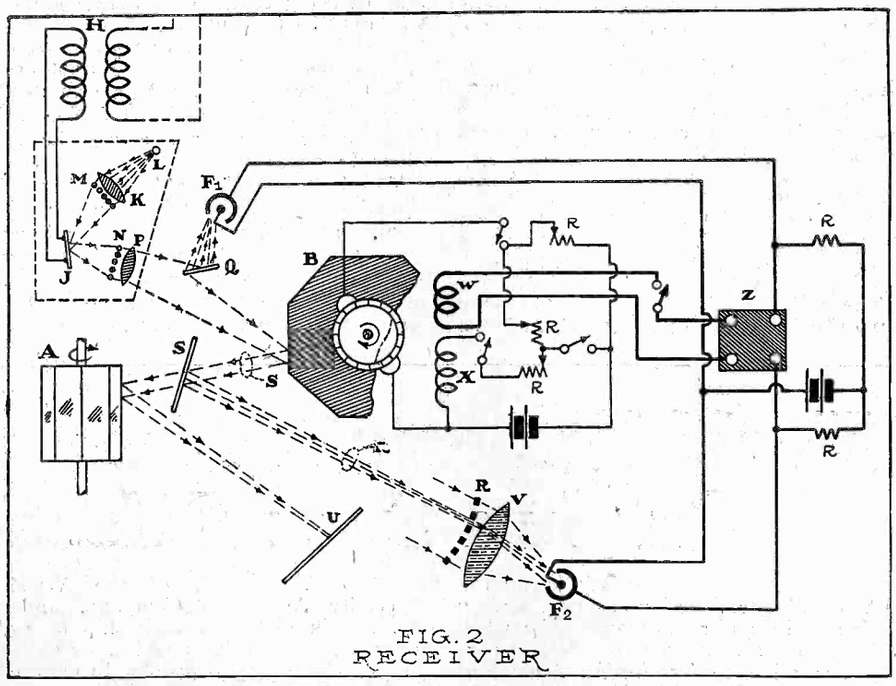


FIG. 2
RECEIVER

FIG. 1
THE TRANSMITTING APPARATUS IN PAUL L. CLARK'S SYSTEM OF TELEVISION, SHOWING THE LIGHT CHOPPER T WHICH IS AN ESSENTIAL FEATURE OF THE AUTOMATIC SYNCHRONIZATION.

FIG 2
THE RECEIVING APPARATUS OF MR. CLARK'S SYSTEM OF TELEVISION, SHOWING THE LIGHT MODULATOR MJN, THE RECEIVER LIGHT CHOPPER R AND THE TWO PHOTO-ELECTRIC CELLS IN THE ARMS OF A WHEATSTONE BRIDGE THAT IS USED FOR CONTROLLING THE SPEED OF THE SCANNING MOTOR.

Similar Light Choppers Used

To accomplish this result, similar light choppers T Fig. 1, and R Fig. 2, are used both in the transmitter and the receiver, so that with the apparatuses in synchronism, the beam of light A1 from the illuminated image to be transmitted, and which passes through the second aperture of the chopper T, must register with the beam R of the receiver, and beam R must pass through corresponding aperture number two of the receiver chopper R.

As long as synchronism prevails, successive light beams pass through successive apertures of the chopper as shown at R1, Fig. 3; but if the receiver motor speeds up, a non-registration occurs, as shown at the upper part of Fig. 3, producing an interception of the successive light beams and consequently varying the amount of light on photoelectric cell F1 proportional to the instantaneous out-of-phasing of the receiver.

As will be seen by reference to the following detailed description, this interception of light by the chopper R is used to control the speed of the motor which drives the optical scanning elements of the receiver.

Constant Speed Motor

By referring to Fig. 1, the transmitter is seen to comprise a familiar type of scanning elements A, B, which are geared together so that the high-speed polygonal mirror B, revolves much faster than the mirror A, and these mirrors are driven by a constant-speed motor (not shown).

As these mirrors revolve at the required speed, successive points of the illuminated image C are translated by the photo-electric cell F into electrical signals of equal and short duration but of values variable in accordance with corresponding light or dark points on the picture, the principle employed in most forms of television transmission.

The use of a light chopper was first disclosed by Rosing (Patent No. 1,161,734, Nov. 23, 1915) and is used by several experimenters to break up the direct and uneven pulsations of a picture into separate impulses of equal length, say, one hundred-thousandth of a second, thereby producing substantially an alternating current comparable to a radio frequency of 100,000. The chopper of Rosing is, however, used only in his transmitter, whereas the writer uses a corresponding chopper in his receiver for the purpose of regulating the motor speed, and obtaining synchronizing precision within narrow limits.

Action of Transformer

The electrical impulses or signals produced in the cell F are transformed into the required form by the transformer G, and transmitted to the transformer H, at

Synchronizing Apparatus

h practically excludes the operator from enjoying the picture, although other spectators r enjoy it unless the operator forgets the mechanical features. This is not unlike rring, where the driver must keep his eyes on the road if the passengers are to enjoy a cenery in comfort and safety.

The ideal arrangement of the synchronizing elements is such that the transmitter d the receiver are maintained at the same speed automatically. This can be brought ot by making a part of the visual signal control the speed of the receiver. A very nous method of automatic synchronization has been devised by Paul L. Clark, of cklyn, N. Y. In this method the picture modulated signal itself is used to retard celerate the receiver to synchronize its speed with that of the transmitter.

—EDITOR]

the receiving station, employed to control the deflection of an oscillograph mirror J. and thereby produce a beam of light of intensity proportional to the strength of the corresponding electrical signal.

New Light Valve

The light valve devised by the writer consists of a source of light L, a lens K which focuses the light upon the oscillograph mirror J and a lens P which receives the light from the mirror J and directs the light to fall upon the scanning elements B and A. Adjacent each lens is a grid comprising a plurality of equi-spaced bars, the function of the valve being to produce by means of the oscillograph mirror J, an optical image of the grid M through variable degrees of registration with the grid N, so that a maximum deviation of the mirror J permits a maximum amount of light to pass through the grid N.

The chief advantage of this arrangement is that high frequencies are obtainable because a complete valving is accomplished with an almost infinitesimal mirror deflection.

The beam of light from the lens P falls upon the rotating mirror B, and is reflected thereby to the rotating mirror A, thence to traverse the viewing screen U and produce thereupon a picture corresponding to that of the illuminated image in the transmitter.

Thus far the description is characteristic of previously used television apparatus.

Photo-Electric Cells Used

In the beam from the mirror P is placed a small fixed mirror Q, which reflects a certain part of the light derived from the light valve, to fall upon a photoelectric cell F2. A second fixed mirror S, is placed to intercept a certain part of the light which is reflected by the highspeed mirror B, and rapidly deflect the light so intercepted in the form of a beam R, to rapidly traverse the chopper R, pass therethrough, and be directed by the lens V, to fall upon a photelectric cell F1.

The cells F1 and F2 are connected together in a suitable Wheatstone bridge circuit and to an amplifier (occupying the place of the usual galvanometer).

To the output side of this amplifier is connected a small auxiliary field winding W, placed preferably on the pole-tips of the small driving motor of the receiver. As long as synchronous conditions persist, the current supplied to the amplifier by the cells F1 and F2 will be zero; but a displacement of the beam R from exact registration with the chopper aperture corresponding to that of the chopper of the transmitter will initiate a flow of electric current into the amplifier, tending to weaken or strengthen the coil W and thus control the motor speed.

Manually Controlled Motor

The motor must be manually controlled close to synchronism, preferably slightly above synchronous speed, using the automatic control merely to check the speed, and restrict the angle of "hunting."

By referring to Fig. 3 it is seen that the light signals are continuously projected upon the photoelectric cell, but in variable ratios, depending upon the accuracy of registration, and that the exciting current of the auxiliary field coil is varied in accordance with the registration of the high-frequency light beams R on the chopper R.

Instantaneous Response

The response of the photo-electric cells to different amounts of light is practically instantaneous, so that the regulation may be considered instantaneous, except for the time lag due to the hysteresis of the motor pole-tips.

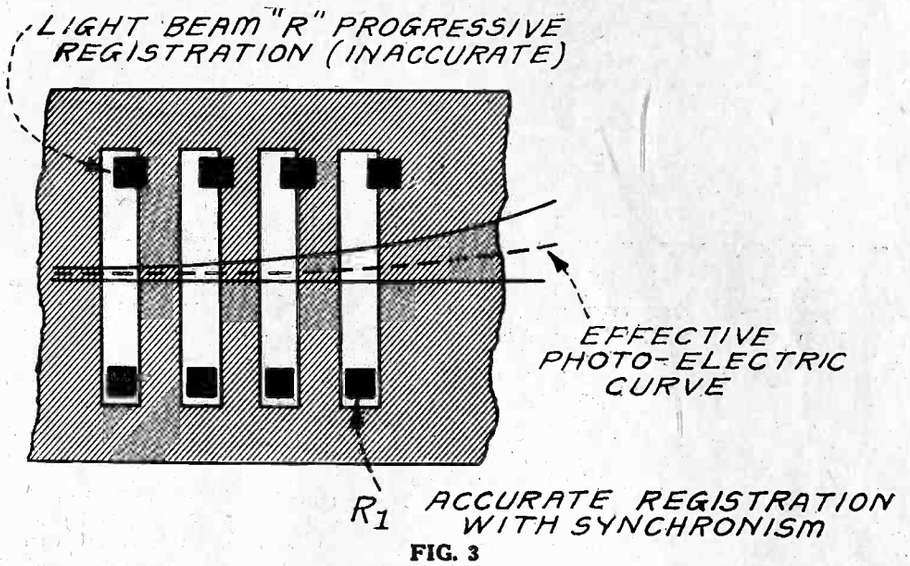


FIG. 3

A CLOSE-UP OF THE LIGHT CHOPPER R, SHOWING EXACT REGISTRATION AND SYNCHRONISM (LOWER) AND FAULTY REGISTRATION (ABOVE). THE WHEATSTONE BRIDGE IS BALANCED WHEN LOWER CONDITIONS PREVAIL. WHEN UPPER CONDITIONS PREVAIL IT IS UNBALANCED AND RETARDING OR ACELERATING CURRENT FLOWS IN THE OUTPUT COIL.

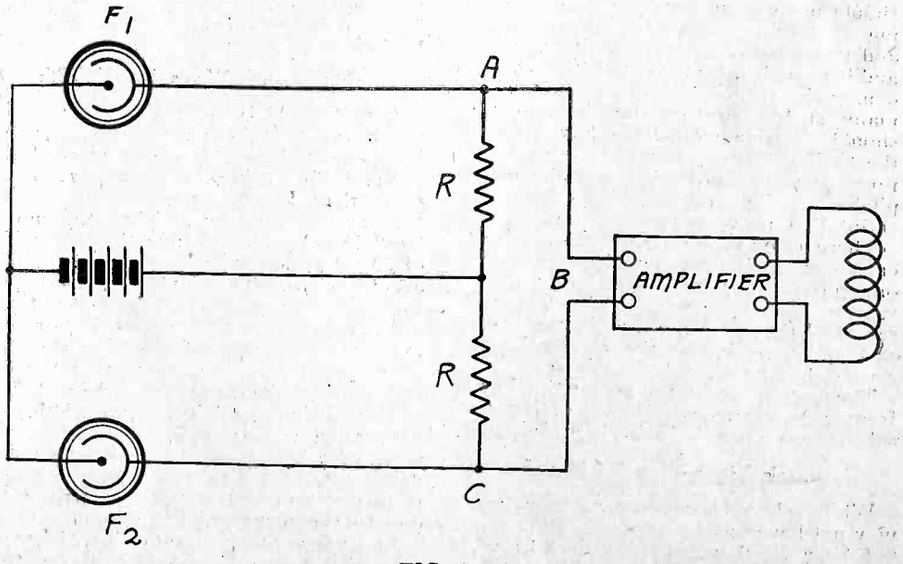


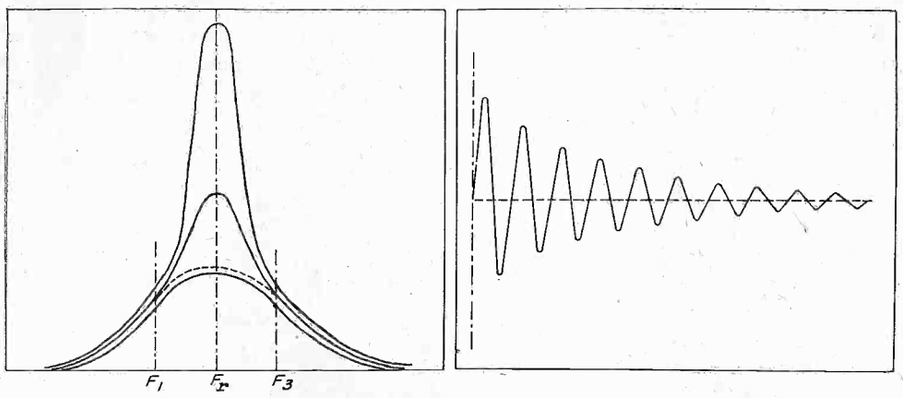
FIG. 4

SIMPLIFIED DRAWING OF THE WHEATSTONE BRIDGE, SHOWING THE TWO PHOTO-ELECTRIC CELLS F1 AND F2 IN TWO ARMS, RESISTORS R, R IN THE OPPOSITE ARMS, AND AN AMPLIFIER IN THE BRIDGE CIRCUIT, B.

Carrier Has No Width—How Is Wave Broad?

By J. E. Anderson

Technical Editor



AT LEFT ARE THREE DIFFERENT RESONANCE CURVES, INDICATING THREE DEGREES OF SELECTIVITY. THE HIGHEST IS THE MOST SELECTIVE. THE DOTTED CURVE INDICATES THE LIMITED RESPONSE DUE TO DETECTOR OVERLOADING. AT RIGHT IS REPRESENTED A DAMPED WAVE PRODUCED BY THE DISCHARGE OF A CONDENSER IN A TUNED CIRCUIT. SUCH A WAVE WILL INDUCE OSCILLATION IN A TUNED CIRCUIT EVEN IF THAT CIRCUIT HAS NOT THE SAME RESONANT FREQUENCY AS THE WAVE.

WHAT is a broad wave? We often hear that the carrier wave of a certain station is broad. Complaints are sent in to authorities that a wave is so broad that it interferes with the reception of other stations.

Just what does the broadness of a wave mean, if anything?

If a wave is broad it must mean that it contains many frequencies close together. Otherwise it would have no "width" at all. It would all be at one point in the frequency spectrum. If the wave is broad and it has many frequencies close together that fact should be evident when an oscillating receiver is tuned in. There should not be one series of squeals, starting at a high pitch, going down to zero and then rising to a very high and super-audible pitch again as the tuning condenser is turned, but there should be many such series of squeals, and they should coincide so that at any point on the tuning condenser within the squealing range there should be squeals of all pitches.

But that never occurs.

There is only one series of squeals for each broadcast station and there is only one pitch squeal at each setting of the tuning condenser within the squealing range of the carrier. That is, the broadcast wave, so far as the carrier is concerned, has no width!

The carrier is located at a point in the frequency spectrum. Hence saying that a broadcast wave is broad is meaningless.

Spark Wave May Be Broad

While a broadcast and continuous wave may not have any broadness, a wave emitted by a spark transmitter may be wide in effect, because it induces resonant frequency currents in any circuit by shock excitation.

But the complaints are not so much against broad spark waves as against broad broadcast waves. The complaints are directed against waves which have no broadness, waves which are fixed in frequency.

There may be conditions in broadcast transmission under which the harmonic frequencies of the fundamental carrier are radiated with considerable intensity. That station does not then send out one broad wave but it sends out several waves, but none of them has any width.

Harmonics are sent out by a station when the antenna is coupled too closely to the oscillating system and when no provision has been made for eliminating harmonics from the antenna current. Cases in which considerable power is radiated on the harmonics of a station carrier are so rare that the subject may be dismissed.

Modulated Wave Has Width

A modulated broadcast wave has some width, for with the carrier frequency may be associated side frequencies of lower power which differ in frequency by not more than 10,000 cycles above or below the carrier frequency. Thus the modulated broadcast wave may have a width of 20,000 cycles or less. But these widths are transient. They only occur momentarily and occasionally. At other times the width is only 2,000 cycles, 200 or perhaps only 60 cycles wide. Whenever the signal carries a frequency of F cycles, the width of the wave is 2F cycles. When it carries no signal it has no width.

When a radio fan complains that the wave of a broadcast station is broad it is not the width due to the modulation which is in question. It is the apparent width due to the power of the station.

And when the fan complains of broadness of the wave he simply confesses that his receiver is not selective. It is the receiver which is broad and not the wave of the station.

His receiver does not have the power to discriminate among frequencies. It responds to several frequencies with almost the same readiness. It may be tuned nominally to 750 kc but it accepts 550 and 950 kc with practically the same volume.

Every receiver, no matter how selective, accepts all frequencies to some extent. When a receiver is tuned to one frequency it accepts that frequency much better than others. In fact, so strong is the signal received on the resonant frequency in comparison with signals accepted on non-resonant frequencies that it seems that they are absent. But they are there and can be brought up by amplification.

Selectivity of Receiver

The relative values of the resonant and non-resonant accepted signals depend on the selectivity of the tuned circuit, which in turn depends on the resistance in that circuit. If the resistance is low the selectivity is high and the accepted signals on non-resonant frequencies are very small in comparison with the accepted signal on the resonant frequency. If the resistance is high the selectivity is low and there is relatively little difference between the accepted signals at resonant and non-resonant frequencies.

The individually tuned circuit in a broadcast receiver may be quite selective, yet the receiver as a whole may not be any more selective, although it may have several tuned circuits in tandem. In fact, the overall selectivity may be lower than the selectivity of any one of the tuned circuits.

There are many reasons for this condition. First, the several circuits may not be tuned to the same frequency; second, the accepted signal may not pass through the tuned circuits; third, the detector tube may become overloaded long before the resonant point is reached.

Lack of precise tuning of all the tuned circuits in the receiver is a common source of lack of selectivity, especially when several condensers are controlled from a single shaft, without trimmers. This condition may be remedied by trimmers on the individual circuits, or by readjusting the capacities and inductances in the tuned circuits.

Signal Skips the Tuners

The second cause for broadness mentioned above was that the signal does not pass through the tuners but reaches the detector directly. The only tuner effective in that case is the one preceding the detector, and even that may not be as effective as if the signal had entered solely by the antenna. This case is exemplified when the tuning coils are exposed and mounted so that they act as antennas.

The battery leads also aid this condition. The remedy is shielding of the entire receiver, except the antenna, and also shielding the different tuners from each other. It is only local and powerful stations which will come in strong without first passing through the proper selective channel.

The third cause of broadness in a receiver containing two or more selective, tuned circuits is that the detector becomes

(*Continued on page* 20)

Meters That Measure Both AC and DC

By Reginald Forrester

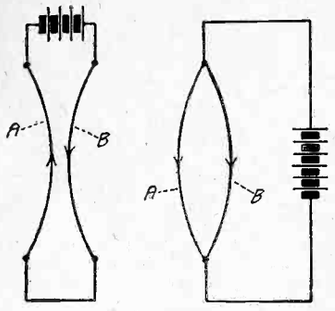


FIG. 1

FIG. 2

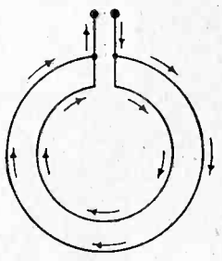


FIG. 3

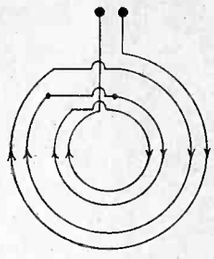


FIG. 4

ATTRACTION AND REPULSION AS SHOWN IN FIGS. 1 AND 2 ARE USED IN THE CONSTRUCTION OF METERS. IN FIG. 1, TWO PARALLEL WIRES HAVE A CURRENT THROUGH THEM BY VIRTUE OF THE VOLTAGE AND CURRENT SUPPLIED BY THE BATTERY AT TOP. ATTRACTION TAKES PLACE. HOWEVER, WHEN SERIES CONNECTION IS RESORTED TO, REPULSION RESULTS. IN FIG. 3 THE WIRE IS COILED, AND PARALLEL CONNECTION RESORTED TO, AS IN THE CASE OF THE STRAIGHT WIRE IN FIG. 1. THE RESULT IS THE SAME—ATTRACTION OF ONE COIL TO THE OTHER. ONE COIL IS MADE MOVABLE. IN FIG. 4 EXEMPLIFIED THE SERIES COIL CONNECTION. NOTE THAT THE CURRENT CAN FLOW IN THE SAME DIRECTION EVEN THEN. THE REPULSION TYPE OF METER IS POPULAR JUST NOW FOR A UNIVERSAL DC AND AC FILAMENT VOLTAGE TEST METER, WHERE A SINGLE METER SERVES FOR BOTH TYPES OF CURRENT

THE need for meters capable of measuring alternating currents and voltages is incresing daily in proportion to the number of AC receivers put into service. Ordinary meters adapted for direct current installations are useless for this purpose.

There are many types of meters suitable for AC measurements. One type makes use of a thermo-couple made of two dissimilar metals. The alternating current to be measured is made to heat one of the junctions of two metals. The heat generated will set up an electromotive force which will send a small direct current through the circuit and this current is measured with a sensitive direct current meter such as a 0-1 milliameter or a microammeter. The thermo-couple can be used to measure both direct and alternating currents.

Another type of AC meter makes use of the expansibility of a wire when it is heated. The current to be measured is sent through the wire, heating it. The expansion is measured by means of scale and pointer. This meter also measures both alternating and direct current.

The Repulsion Type

A third type of AC meter makes use of the mechanical force exerted by one conductor upon an adjacent conductor carrying current. It is known as the repulsion type meter because the forces are so adjusted that one conductor repels the other. We shall discuss the principle of this meter in greater detail.

Suppose two wires A and B in Fig. 1 are mounted close to and parallel to each other and subjected to some tension. If the two wires are connected in series and a current is caused to flow through them in opposite directions the wires will attract each other, as shown in Fig. 1. Now, if the two wires are connected in parallel, as in Fig. 2, the currents in both will flow in the same direction and the two wires will repel each other. The wires will bulge outward as shown.

These two cases come under the general rule that two bodies charged oppositely attract each other and that two bodies charged in the same sense repel each other, or that two unlike magnetic poles attract and two like pole repel.

Coils Repel

Fig. 2 contains the principle of the repulsion type of meter, as well as the principle of the repulsion type of motor.

Suppose two coils are mounted so that one is inside the other and in the same plane. The turns in the two coils will then be parallel. Let one of the coils be rigidly mounted and one so that it can turn easily about a pivot. Connect the two in parallel as in Fig. 3. This connection is the same as in Fig. 2, the only difference being the coiling of the wires. Connect the terminals across a battery. Current will flow in both coils and at every point the two currents will flow in the same direction.

Thus one coil will repel the other. Since one coil is fixed and the other is pivoted the moveable coil will turn. This turning is resisted by a spring. The angle through which the coil turns will depend on the stiffness of the spring and on the intensity of the current flowing in the coils. It also depends on the number of turns in the two coils. Hence to make a senstive repulsion type meter a large number of turns and a weak spring should be used.

If the battery supplying the current is reversed the current will be reversed in both coils and the direction of the turning will remain the same. Therefore, this type of meter will measure alternating currents as well as direct. In other words, the meter is a universal motor.

Connected in Series

It is clear that the two coils can be connected in series and still have the current in the two coils flow in the same direction. This is shown in Fig. 4. A voltmeter built on this principle should be connected in series while an ammeter might better be connected in parallel. In universal motors the stator and the rotor coils are either connected in series or in parallel, just as as they can be in meters.

The repulsion principle is invoked in several popular meters today, particularly meters used for measuring the voltage of AC tube filaments. This is important, because some of these tubes, like the —*27*, are short-lived when over-voltaged. One may introduce a resistance at the input to the filament transformer (in the primary circuit) and, by watching the meter in the filament circuit, testing a single tube while the other tubes in the set are still working, can make sure the voltage at the filament of the —*27* does not exceed 2.25 volts. In fact, many experienced set builders prefer the slightly lesser gain obtained at 2 volts, because of the much longer life of the tube and the consequently reduced need of replacement, even though 2.5 volts are regarded as "safe."

Such a replusion type of AC-DC meter where one instrument serves both purposes, is employed in the Universal AC-DC Scientific Set Tester and Trouble Shooter. It is well to use a high resistance voltmeter, to determine plate voltage, in addition to the replusion meter and the double reading DC milliammeter incorporated in the foundation unit.

Kennedy Is Appointed Jensen Representative

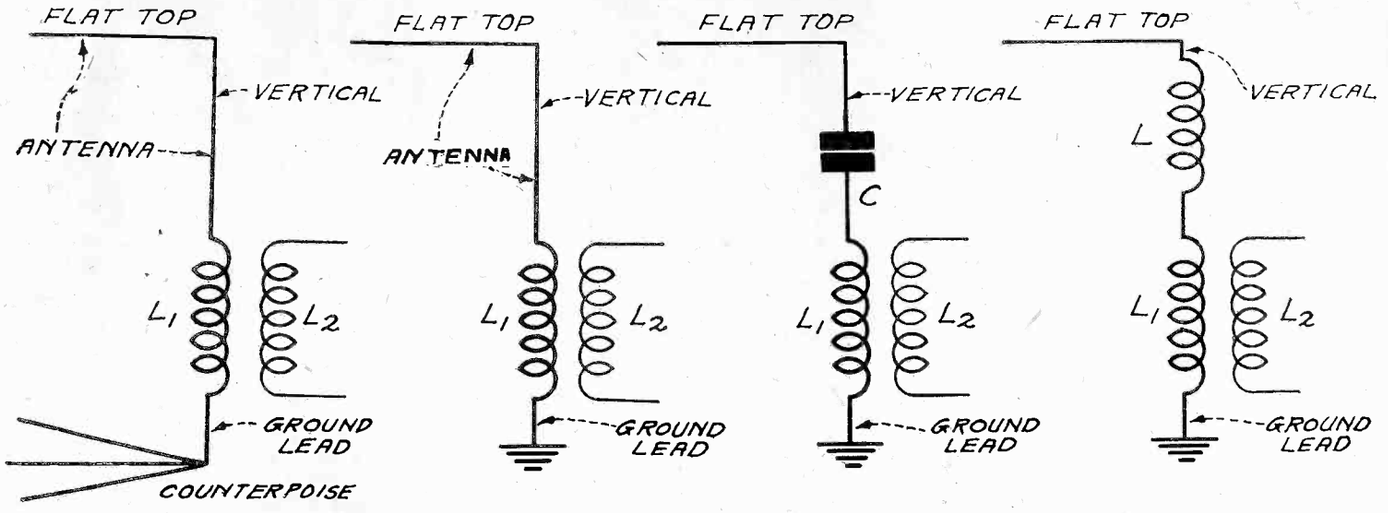
James A. Kennedy, formerly vice-president and field executive of Arthur H. Lynch, Inc., has severed his connection with that concern to become the metropolitan representative of the Jensen electro-dynamic speaker. The Jensen Radio Mfg. Co., is located in Oakland, Calif., and Mr. Kennedy's office is at 1775 Broadway, New York City (General Motors Building). Telephone, Circle 7571.

Mr. Kennedy was congratulated by his friends on obtaining this attractive line, to which he is devoting all his time, as it was a tribute to his sales ability and popularity. One of the heartiest handshakes came from Arthur H. Lynch himself, who also handles a loud speaker, the Decatur, also William H. Beardsley, treasurer of the Lynch organization, congratulated Mr. Kennedy and induced him to have his office in the same building, so that the three of them would not lose constant touch with one aonther.

Mr. Kennedy was reluctant to leave the Lynch organization, but the Jensen Company wanted an exclusive office to take care of the sales volume. The Jensen speaker is taking the country by storm.

A Good Antenna Is Best

By James



FOUR DIFFERENT ANTENNA CIRCUITS. AT THE LEFT A REGULAR ANTENNA AND COUNTERPOISE ARE SHOWN. THIS IS PARTICULARLY SUITABLE FOR SHORT WAVES AND WHERE A GOOD GROUND IS NOT AVAILABLE. LEFT CENTER SHOWS THE REGULAR ANTENNA AND GROUND CIRCUIT. RIGHT CENTER THE SAME CONNECTION IS USED EXCEPT THAT A CONDENSER C IS INSERTED IN THE LEADIN TO MAKE THE CIRCUIT EFFICIENT ON SHORT BROADCAST WAVES. AT THE RIGHT THE SAME ANTENNA IS SHOWN WITH A LOADING COIL L IN THE LEADIN TO ADAPT CIRCUIT TO LONGER WAVES.

ONE of the most important factors conducive to good radio reception is the one that is most frequently overlooked in building and installing the set. And that is, the means of picking the signals out of the air, whether outdoor or indoor antenna, loop, light-socket pickup, etc.

The greatest magician (radio, electric or of the stage) cannot reproduce a signal that is not picked up.

A conservative estimate would be that not 25% of all the antennas in the country that feed the 12,000,000 receivers in use throughout the nation are 100% efficient. A set is purchased by the layman (we are not now speaking of the experienced fan or set builder), and a makeshift aerial is hastily put up, either on the roof or indoors; the set performs seemingly beautifully but, alas, it is by no means working with 100% efficiency. If it does one-half of what a properly calculated and rightly installed antenna system would do, it is performing miraculously.

Twisting and Twirling

The locals probably come in with good volume and occasionally, through some fortuitous accident, some distant station, but poor John Layman sits many a night through twisting, twirling, thumbing and perchance kicking at the unfortunate dials, but nothing else seems to be on tap. The desired stations are there for the "asking," but his antenna does not "ask." The set owner hears his more advanced friends crowing about distant stations they bring in regularly and he naturally blames his lack of DX on his set, and yet, the set may be capable of outdoing even the records of his friends.

Almost any one of the present-day receivers will bring in good results if the location is fairly good, if the set is properly handled, and if fed by a good antenna system.

The Constants of an Aerial

With the coming of summer, the present is a good time to consider the aerial, cleaning it, revamping it, as it were, or installing a new one complete from end to end with an eye to the utmost in efficiency.

The first step to this end is the consideration of its constants. Whether your antenna is an excellent, poor or medium pickup of the radio waves depends mainly upon its constants. These are its electrical properties which can be determined by exact measurements, or computed to a fair enough degree for ordinary requirements by another of its properties, namely, its effective height.

The term constant is not a fixed one by any means, because some of these electrical properties of the antenna vary greatly with the length of the radio waves to which the antenna is attuned. But at any particular wavelength, the constants of an aerial when used with a ground, will remain practically the same.

Accumulations of dirt, snow and ice will affect the constants of the antenna. However, these changes and variation will not affect the aerial of the home receiver to any serious extent. They are only serious in the cases of laboratory experimental equipment with which we are not at present concerned.

Importance of Electrical Properties

Using the term constants to cover the electrical properties of our proposed antenna, we find them to be inductance, capacity, resistance and the resulting fundamental wavelength. Antenna inductance is an inherent electrical inertia which retards the changes in the rapidly reversing current induced in the antenna by the incoming radio wave.

The antenna capacity is a property which enables it to hold a certain electrical charge, afterwards to discharge this in the form of electrical energy through the receiver into the earth. This capacity is expressed in microfarads.

The aerial's resistance is the opposition which it offers to the flow of the high-frequency currents induced in it. High-frequency, or radio frequency, currents flow only on the surface of a conductor. It follows, then, that if the surface resistance is increased the efficiency will be reduced.

Functions of Antenna Constants

This antenna resistance is a complex quality, but it may readily be expressed in ohms. The length of the wave to which the antenna will respond when it is connected directly to earth is the fundamental wavelength of the antenna. Thus, if an antenna has a fundamental wavelength of 710 kilocycles, strong electrical vibrations or oscillations will be set up in the receiving antenna by a transmitting station that is sending out signals on 710 kilocycles.

If the inductance and capacity of your antenna are increased its fundamental wavelength is also increased. However, the capacity is more easily changed than the inductance. The resistance has little effect on the fundamental wavelength, but if the resistance is increased the current induced by the radio wave is decreased.

Thus we may connect a variable condenser across the terminals of our tuning coil to vary the capacity and thereby increase the wavelength to which the complete antenna system will respond. This gives us a remedy for many tuning troubles in various types of receivers.

These facts are important to remember to get the most out of our antenna installation. The smaller the dimensions of our complete antenna system, the less the energy it will pick up, ergo, less volume on locals and weaker signals on distant stations, but the greater the selectivity. Extraneous noises, like static, nearby and local electrical interferences and discharges, however, will be loud enough to annoy the most insensitive ear.

This small antenna must be kept perfectly clear of all objects that will have a shielding effect to insure functioning with even small efficiency.

Do not get the impression from this that a small aerial is useless, for in many cases a short aerial is the only available one, and it can be highly efficient.

Other Contributing Factors

Many factors should be considered in setting up your antenna. Avoid freak installations, hoops, triangles, balloon, umbrella and other unusual forms. Usually, the straight, single wire is best, with the lead-in taken off from the end pointing toward the stations from which you favor reception. If the antenna slopes, the high end should be favored for lead-in.

Continuing the antenna throughout for the lead-in, right to the binding post, avoids losses from improper connections as it is not always possible to solder the joint perfectly.

Considering the constants and meeting them as nearly as possible in the antenna

Aid to DX and Volume

H. Carroll

will give the best results.

With a two-wire antenna you will have a higher fundamental wavelength which is due to higher capacity and inductance as compared with a single wire.

In figuring out your antenna constants it is not possible to be exact unless you have the equipment. It is merely our purpose to enable you to get better results than those ordinarily obtained. Figuring on first your location, the swing allowable and the direction to be favored, the constants may now be figured with an eye to the length and height. However, as to height, the higher that one is able to erect the antenna, the better.

Installing the Antenna System

Bear in mind, before proceeding with your installation, that a high antenna not only means lower capacity—i. e., the electrical capacity existing between the aerial and ground—but it also means a longer lead-in wire which is part of the aerial system, and the value of which must be considered in calculations of wavelength. The natural wavelength of your antenna should never be greater than the lowest wavelength to be received. A rough approximation of wavelength in meters is obtained by multiplying the linear length by three.

Keep the antenna and lead in as rigid as possible in order to avoid swaying which results in fading effects upon reception. Keep the lead-in away from and clear of all obstructions. After the wire has been brought into the room, it should not be tacked to the wall.

Many sizes of wire are used, insulated in many forms, but number 14 copper wire is large enough for efficient reception in all average installations. The larger, or stranded wire is better only insofar as it is mechanically stronger. The resistance is lower on a greater surface area, but there are so many other features of resistance involved in practice that a larger conductor than this is not necessary for our purpose. The wire used may be bare or insulated and enameled wire is good as it offers better resistance to dirt and oxidization.

Importance of Proper Ground

As we have pointed out before, all connections should be soldered, if possible thus insuring permanently low resistance. The water pipe makes the best ground and the radiator pipe is next, if the former is not available. Never use a gas pipe or an electrical wire conduit for this purpose. The ground connection can best be made with a clamp, being sure that all contact surfaces are absolutely clean and insuring this by a liberal use of sand or emery paper. Make the ground wire as short as possible.

If the location should be so unfortunately situated that any form of natural ground is not available, an iron pipe driven deep into moist soil or a copper plate buried in the earth may be used. As a last resort, a counterpoise, which is simply another aerial suspended near the surface of the earth under the working antenna may answer the purpose. This counterpoise may consist of several wires paralleled.

A high antenna should be supported by masts, preferably of wood, well braced. Lower antennas may be supported from chimneys, dumbwaiter tops, adjoining higher roofs, etc., but in every case should be well insulated and kept free and clear from all objects and other aerials.

Get Yours Highest

In the case of a multiplicity of aerials, run yours above the highest and at right angles to the nearest. Good insulators are now to be had everywhere but glazed porcelain is best for this purpose.

In case the fundamental wavelength of the antenna proves to be above 250 meters, a condenser connected in series with the lead-in will adjust it. If a fixed condenser is used, its capacity should be around 0.0003 microfarads. A variable condenser connected in series with the coil or shunted across the terminals will allow for a wider tuning range. If trouble is experienced in taking the lead-in from either end of the antenna it may be taken off from the center. Although the single wire antenna is most efficient, if space is limited, a two, three or four wire cage antenna will answer, figuring the fundamental wavelength as of the single wire originally intended.

If the reciver is of the tuned radio frequency type or has a regenerative tuner, it is not necessary to install a high antenna. However, if the receiver utilizes but one stage of radio frequency amplification with a non-regenerative detector, it is well to have the antenna as high as possible remembering to keep it clear of all obstructions.

Connecting the receiver in the ground lead, close to the ground, will increase the effective working height of the antenna and improve reception. There are many opinions and ideas of improving reception by unorthodox installations, but the foregoing facts are based on sound principles and should give best results. No means of picking up signals is better than a good aerial system, properly installed.

How to Get Long Life From Your AC Tubes

Ask the first AC set owner you meet just what the value of line voltage is in his home. The answer will undoubtedly be: "Why, 110 volts, of course!" He may even appear offended that one should question his knowledge of so fundamental a radio and electrical matter.

His answer may be correct—and then again it may not be.

The true value of voltage at the convenience outlet or lamp socket actually may be anywhere from ten to twenty-five volts higher. One prominent manufacturer of AC sets states that the value of voltage used in New York City for radio operation is closer to 130 volts in most cases than to 110 volts.

No one can tell the exact AC voltage value in his home if he has not checked it with an accurate AC voltmeter. Failure to do this very thing has resulted in no little trouble and needless expense to thousands of owners of AC sets, because tubes in the receiver, exposed to excess voltage, have been blown out or their life reduced. AC tubes cost anywhere from $3 to $6 apiece, depending upon the type. One set of tubes ruined, or even the useful life cut in half, involves an expenditure far greater than the cost of checking up on line voltage and making the addition of a resistor to cut down voltage to the correct value.

Filament Delicate

The filament of a vacuum tube, and particularly that of the AC heater type, is a delicate thing. It will not stand much abuse. It is made to operate at a definite voltage and current rating. Naturally, if the actual values exceed those for which it is designed, a shortening of useful life, or complete destruction of the filament may tubes will have a life practically equal to that of the five-volt, general purpose type, or approximately 1,000 hours.

A point overlooked frequently, is that AC sets are usually designed to operate at a fixed line voltage. Provided the incoming voltage does not rise above the limit taken by the manufacturer in designing the set, the tubes will give long and efficient service.

Tips to Users of AC Tubes

However, a majority of commercial receivers using AC tubes has no provision for compensating for line voltage increases above the point of safety.

Where the line voltage exceeds the arbitrary value assumed by the manufacturer, immediate damage to tubes may occur, or certainly a very marked shortening of useful life, unless some means is taken to reduce the incoming line voltage to safe limits.

The man who has already experienced trouble with short tube life will be quick to profit by suggestion and immediately check up on the value of line voltage in his home. He will make certain that his receiver is operating within the correct limits. For those who have recently installed AC sets or are about to build or buy one, the suggestion that line voltage be checked is certainly worth while.

Trouble with excess voltage can be forestalled at slight cost, and uninterrupted enjoyment of the new receiver is assured. Gambling and guessing in the matter of line voltage can only mean that one stands an excellent chance of having the annual tube budget much higher than it should be.

Check Up

If the value of line voltage is found after a careful reading to be above that of the arbitrary figure assumed by the manufacturer, there is only one sensible and economical thing for the wise man to do.

The work of checking line voltage is not difficult, and can be done by any set owner by one simple measurement and a few equally simple computations. An AC voltmeter with range from 0 to 150 volts is used to measure the incoming line. If the voltage is found excessive for radio operation of AC tubes, a screw driver, and about two dollars worth of equipment will remedy the trouble once for all. Fifteen minutes work, another check with the AC voltmeter, and it will be found that the voltage across the transformer primary is down to or slightly below the maximum figure for safe operation of tubes.

For ease of handling and ready mounting, Ward Leonard Resistors of the EB type (equipped with Edison screw base) have been found satisfactory. They have high current and watts rating.

* * *

[*A table showing how to select the proper resistor to eliminate the excess live voltage has been prepared by Ward Leonard Electric Co., 31 South Street, Mt. Vernon, N. Y., and will be sent free on request to the company. Mention* RADIO WORLD.]

Electrical Recording

By Sebastian

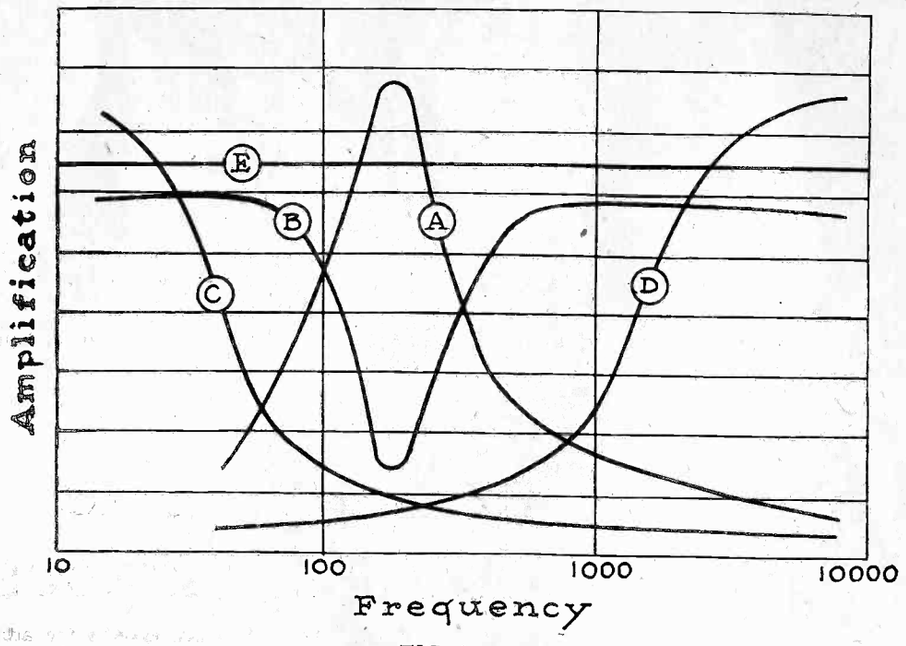


FIG. 1
CURVES ILLUSTRATING THE PROCESS OF EQUALIZATION OF TRANSMISSION IN THE EQUIPMENT FOR BROADCASTING ELECTRIC PHONOGRAPH RECORDING AND IN HIGH QUALITY AUDIO AMPLIFIERS.

IS IT electrically recorded? Every buyer of phonograph records asks that question. If the record in question is not electrically recorded the prospective buyer will not have it, because he knows that quality reproduction is not possible with it.

What makes the electrically recorded phonograph record so superior to the old mechanically produced record?

The answer lies in equalization. And what is equalization? There is where our story begins.

In the process of recording there are many moving parts which are actuated by the sound to be recorded. These moving parts must move in exactly the same manner as the sound waves impinging on the diaphragm. If they do not, the record will not be the equivalent of the sound, and the reproduction will be distorted.

Moving Parts in Reproducer

There are also moving parts in the reproducer. The record must make these parts move in the same manner as the undulations in the groove. If they do not, the sound reproduced will not correspond with the sound recorded.

Thus there are at least two sources of distortion in mechanical recording and reproduction. One is the possibility that the recording mechanism does not follow the original sound accurately and the other is the possibility that the reproducing mechanism does not follow faithfully the record as it exists.

There is of course the possibility that one of these sources of distortion counteracts the other, but that possibility is very remote. The two sources of distortion are both of the same type, that is mechanical, and hence they are additive, so that the net distortion may be very great. That they are additive no one will dispute who has played the same composition with the mechanically and the electrically produced records.

Mechanical Impendances

Sound is a vibratory phenomenon. Therefore the record will be undulating or wave shaped, the complexity of the wave depending on the complexity of the sound. To produce this undulating groove the recording and the reproducing mechanisms must vibrate. But all the moving parts have mechanical impedance, that is, they resist rapid changes in position. And this impedance varies with the frequency of the vibration.

A heavy mechanism will resist rapid vibrations more than slow. Therefore the high notes will neither be recorded nor reproduced accurately. The low notes will fare much better. Thus the fidelity of the reproduction would be better the lower the pitch, if there were no other factors.

But there is also resilience in both the recording and the reproducing mechanisms, that is there is spring action. The two diaphragms are the main sources of resilience.

Spring action is just opposite to mass action. Whereas mass retards the high notes, spring action retards the low. A spring or other resilient mechanism offers very little impedance to high frequencies and very much to low. Therefore the diaphragms and other springs involved in the processes of recording and reproduction suppress the low pitch sounds and brings out the high.

Resonance Effects

It would seem then that neither high nor low notes would be recorded or reproduced, looking at the problem from one point of view. Or it would seem from another point of view that both the high and low are recorded and reproduced equally well. But there are many more effects which cause wide differences between the original and the reproduction.

Resonance perhaps is the greatest of these effects. At one or more frequencies the retarding effect of resilience will just neutralize the retarding effect of massivity. At this frequency there will be very little impedance in the moving parts. A sound of that frequency will exaggerate the undulations in the record and the reproduced sound.

At frequencies near the resonance frequency there will be some exaggeration but less than at the exact frequency of resonance. This exaggeration usually falls in the middle registers. Hence the middle notes will be reproduced enormously louder than either the lowest or the highest.

The resonance frequency of the recorder may be different from that of the reproducer. In that case there will be at least two frequencies which will be exaggerated, but much less than if the two resonance points occurred very close together.

Even when there are two resonance points the high and the low notes will not be brought out as well as those in the middle registers, and the reproduction will not be good. However, one resonance may fall at a very high audio frequency, in which case the high notes would fare well.

More Than Two Resonance Point

Even when we confine ourselves to the two diaphragms there will be more than two resonance frequencies. In fact there will be many for each diaphragm. Every one introduces distortion to some extent.

But all the distortion possible is not confined to the moving parts. Some of it is introduced by the horn sound collector of the recorder and of the sound distributor of the reproducer. Any horn of reasonable length usually cuts out the low notes, and it is in the two horns perhaps that most of the distortion enters. Most of the old phonograph reproduction was painfully weak on the low notes.

Resonance in the horns also contributes to the distortion. Both the recorder and the reproducer horns have several resonance frequencies which are both recorded and reproduced too loudly in comparison with other frequencies.

Electrical Recording

Electrical recording presents a different picture. The sound collector is a microphone such as is used in broadcasting. All troubles introduced by the horn are eliminated at once. The microphone is so constructed that it is almost equi-sensitive for all frequencies. To be sure, the diaphragm has resonance points, but they can be damped out to any desired extent. And they are. Low volume of output is of no consequence, for it can be amplified. In mechanical recording all the volume possible must be preserved, for it cannot be amplified. Volume by resonance is depended on largely.

The microphone is subject to one difficulty. The very high notes are picked up with about twice normal strength. But that is only a momentary difficulty.

The output of the microphone then is a faithful electrical copy of the sound that fell on the diaphragm. But it is weak. It is necessary to amplify it, and for that a high quality audio amplifier is used. The construction of an audio amplifier which will preserve the relative intensities of the high, the middle and the low notes is simple. This is not one of the problems of electrical recording.

The Recording

But the output of the audio amplifier must actuate the recorder. This contains moving parts, which contain mass and resilience. Thus it will take more power to record the low and the high notes than the middle. And resonance is possible. As in the microphone, resonance peaks can be leveled down by damping and it is only necessary to increase the amplification to bring the output up to the required value. Thus the record will be a faithful copy in wax of the original sound, provided that the lows and the highs are up to normal. More leveling is necesary to bring them up if required.

Equalization

At this point equalization enters the picture. If the record will not be a faithful

Effects Equalization

de Groot

copy of the original sound when the electrical system is faithful, there is no reason why the electrical system should be kept faithful. After all, it is only a link between the original and the reproduced sounds. Distortion can be introduced into the electrical system, provided it is of the right kind and amount, to make the undulations in the record an exact copy of the original sound. That is what is done. And the process of introducing the right amount of distortion, of proper frequency distribution, to make the record faithful to the original, is called equalization.

Filters and Networks

Equalization is accomplished by means of suitable electrical networks or filters composed of inductance, capacity and resistance. The distortion in the record without the equalizer is measured and then the audio amplifier and filter are designed so as just to effect equalization.

When that amplifier is used for recording the undulations in the record will correspond faithfully to the original sound.

Now suppose we have a record which in every respect is true to the original sound. Will the reproduced sound from every phonograph also be faithful? It will not. But it will be improved to a marked extent. If it is true that the horn of the reproducer is the main cause of distortion in the reproduction the low notes will be weak even if the record is true.

Intentional Exaggeration

This weakness in the reproduction of low notes in the average phonograph can be corrected in the recording by so designing the electrical equalizer as to over-exaggerate the low notes.

What constitutes proper over amplification and recording of the low notes would depend on the length of the horn on the reproducer. No two types of phonographs have the same length of horn. Hence if the over amplification is made correct for one horn it will not be sufficient for a shorter horn and it will be too much for the longer horn. The reproduction from the machine with the shorter horn will lack depth, that from the machine with the longer horn will be boomy.

Electrical Reproduction

When the record is played mechano-electrically another problem enters. When a good pick-up unit and a high quality audio amplifier and loudspeaker are used the reproduction will be true to the undulations in the record. If the record has been exaggerated on the low notes the output of the loudspeaker will be boomy, comparable with that from the best phonographs with long exponential horns.

The reproduced sound will not be faithful to the original but somewhat exaggerated on the base notes.

Big Power All Right

But this is not a weakness of the electrical system of playing, for it is better to have a great deal of power on the low notes than to have them weak and almost inaudible. If they are too strong to suit the individual it is a simple matter to suppress them to the desired extent. The simplest method perhaps would be to connect a condenser in series with the speaker. The smaller this condenser is the more the low notes will be depressed. It is much easier and less expensive to depress the volume on low notes, than to build it up if it is weak.

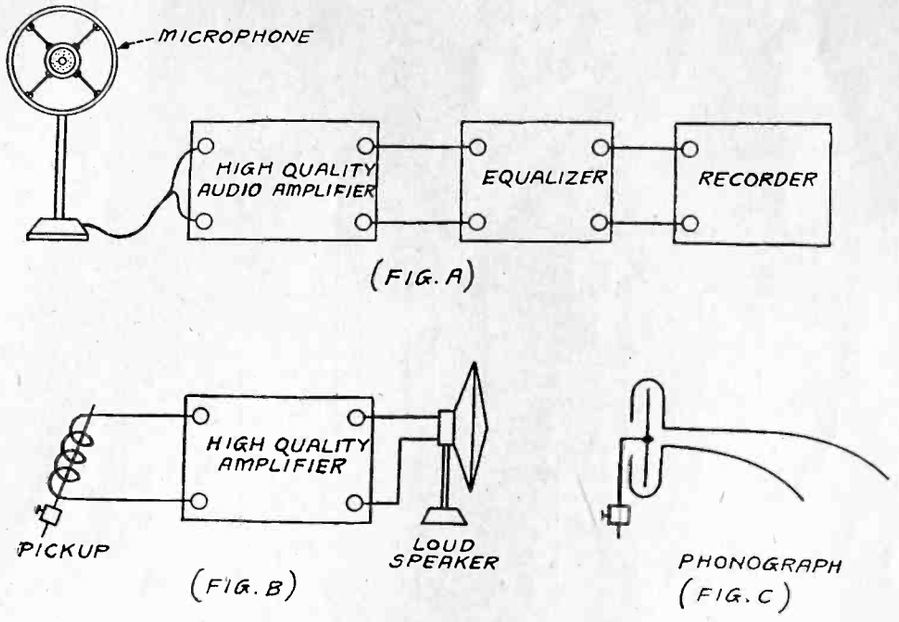


FIG. 2

A. THIS SHOWS A POSSIBLE ARRANGEMENT FOR EQUALIZING PHONOGRAPH RECORDING. THE MICROPHONE IS FOLLOWED BY A HIGH QUALITY AMPLIFIER, WHICH IS FOLLOWED BY THE EQUALIZER NETWORK. FINALLY THE EQUALIZED SIGNAL IS DELIVERED TO THE RECORDING MECHANISM. B. THE ESSENTIAL STEPS IN ELECTRIC REPRODUCTION OF PHONOGRAPH RECORDED SOUND. C. THE ESSENTIALS OF MECHANICAL PLAYING OF A RECORD.

Audio Equalization And Its Workings

The principles of equalization are shown in the curves in Fig. 1. A shows a characteristic in which both the high and the low notes are suppressed while the middle are transmitted too strongly. The hump indicates either regeneration or resonance, or both. B shows a characteristic which is almost the reverse of A. There is a sharp depression in the middle registers. If a circuit having the characteristic of B is combined with an amplifier having the characteristic of A the hump in the middle is leveled.

B is produced by a condenser and an inductance coil in series connected across the line, for example across the loudspeaker leads or across a coupling resistor or a transformer winding. This condenser and inductance circuit is tuned to the frequency of the hump in curve A. The sharpness of the dip in curve B must be the same as sharpness of the hump in curve A. This is effected by using more or less resistance in series with the condenser and the inductance.

But the combination of curves A and B is not enough to equalize the deficiencies in A. Both the high and the low notes must be brought up. Curve C shows a characteristic which has a high transmission on the low notes and a negligible transmission on the high. This is a characteristic of a low pass filter of a certain design. It can be designed so that when combined with A and B the low note transmission is just brought up to the desired level.

High Notes Amplified

The high note transmission is still deficient because the slight rise in B is not sufficient to compensate for the drop in curves A and C. Therefore a high pass filter of suitable design must be put into the line. D is a characteristic of such a filter. The curve is practically the reverse of curve C. The rapid rise in the transmission of the highs compensate for the drops in curves A and C.

The ideal curve toward which the designer of the equalizing network works is shown by curve E. It is a perfectly straight line from the highest to the lowest frequencies. This curve should be the overall transmission characteristic from the original sound to the reproduced.

Of course it is not practical to make the overall transmission curve straight, but any deviation from rectilinearity can be made as small as is desired.

COLUMBIA ANNOUNCES SET

The Columbia Phonograph Company is going into radio. A set, to be known as the Columbia, will be ready early next season. This set will be manufactured through special arrangement with the Kolster Radio Corporation.

A DC-AC Electric Set, And One of the

By N.

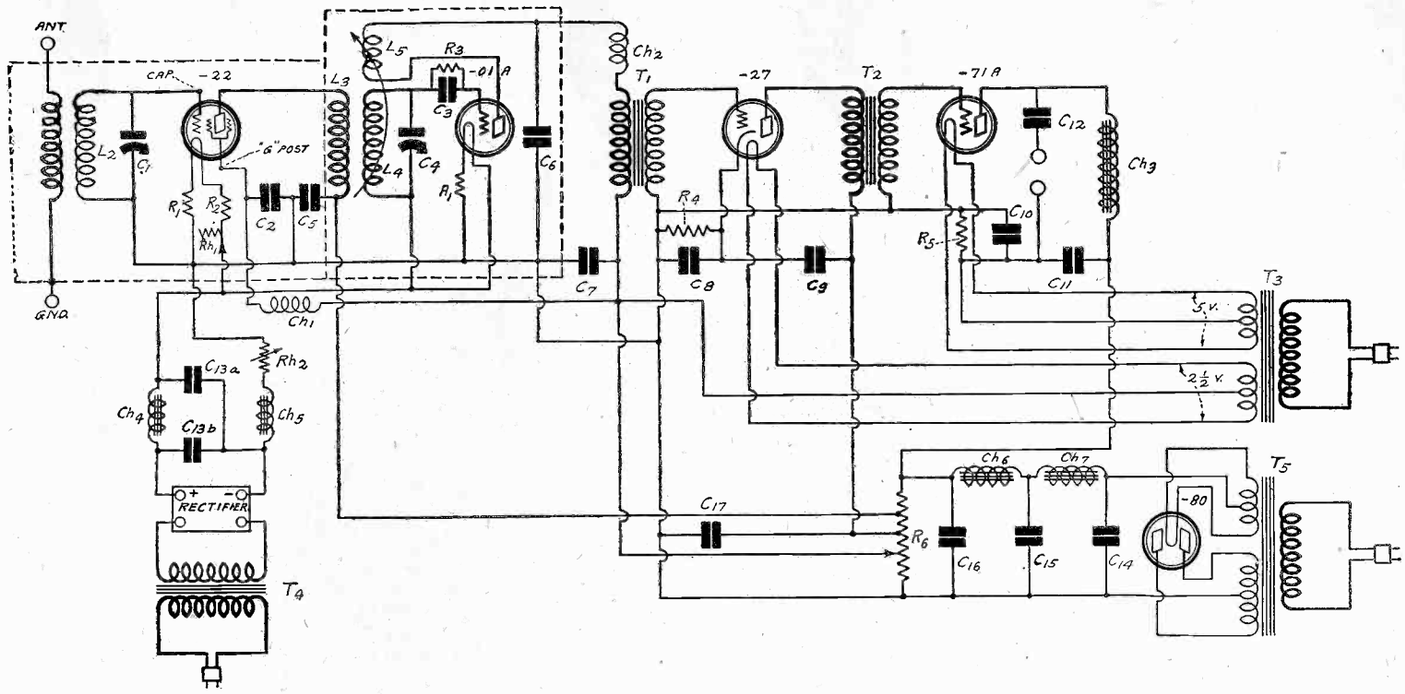


FIG. 1
BOTH AC TUBES AND DC TUBES ARE USED IN THIS ELECTRIC SET

COMPLETE electrification of receivers is now possible without the use of so-called AC tubes throughout. Relays which often get out of order are dispensed with. Trickle charges to throw on and off are not used as such. Storage batteries are banished from the set. Only one switch is used in the set and that may be installed in the 110 volt power line. That switch controls the entire power for the set.

Complete electrification means that all the voltages, A, B and C, are derived from the power line. How is it done without the use of AC tubes throughout? That question will be answered in the description of a four-tube all-electric receiver.

Screen Grid Tube for Sensitivity

To insure the highest possible sensitivity in a four-tube receiver the first tube should be a screen grid tube, and this tube must be properly operated. Another feature necessary for high sensitivity is regeneration in the detector circuit. Hence a three circuit tuner is used in conjunction with a standard —01A tube as detector.

Hum elimination demands that the filaments of these two DC model tubes, that is of the screen grid and the detector, be heated with direct and steady current. How this is accomplished without the use of batteries will be taken up later.

Hum elimination also requires that the first audio tube be of the heater type. This tube is ordinarily used for detection, but as it is an excellent amplifier as well as a detector it is used in the first stage of audio.

The power tube, which may be a —71A tube, can be heated directly from a 5-volt winding on the filament transformer without the introduction of appreciable hum. Therefore this is done. The two AC heated tubes, the —27 and the —71A, are heated by two secondaries on the same transformer T3 in Fig. 1.

A Battery Eliminator Used

The steady direct current for the filaments of the first two tubes in the circuit is derived from an A battery eliminator. This is made of a rectifier and a filter circuit capable of delivering at least .382 ampere. There are many trickle chargers available which can be operated with an output as high as .75 ampere. An output of .5 ampere is considered as a low rate. Hence one of these can be used to deliver a current of .382 ampere for an indefinite time without any danger of overtaxing the charger.

There are several types of charger capable of delivering a current up to .75 ampere. Some are dry and operate on crystal rectifier principle. Others are dry on the exterior but contain an active paste which constitutes the electrolyte. Still others work on the principle of unidirectional gas conduction. All of these are suitable for the purpose of a low current drain A battery eliminator, and all can be obtained in radio stores.

The main element in the filter is a high capacity electrolytic condenser. Several manufacturers make these condensers now in capacities from 1,000 to 4,000 mfd. They are dry on the exterior and contain the electrolyte in paste form. They are sealed like dry cell batteries.

Choke Coils Necessary

A high capacity condenser is not sufficient to take out the ripple in the output of the rectifier. One or two choke coils must be used in addition. These need not have a high inductance if the capacity of the condenser is high. Neither can chokes for this be made of high inductance without making them too large for practical use.

The inductance required depends on the current drain as well as on the capacity of the condenser. For a capacity of 3,600 mfd. and a current drain less than 2 amperes two chokes of .01 henry each can be used. For a current drain as low as .382 ampere each choke may have an inductance of as high as .25 henry.

Ready made filters having two electrolytic condensers of a total capacity of 3,600 mfd. and two choke coils of .01 henry each can be purchased in most radio stores. The rectifier and filter of the A battery eliminator are shown in the lower left section of Fig. 1. T4 is the step-down transformer which feeds the rectifier. This transformer comes with the charger. The electrolytic condensers are labeled C13a and C13b, and the chokes Ch4 and Ch5. The chokes and the condensers may be obtained in one unit.

Voltage Adjustor

A rheostat Rh2 of about 20 ohms is put in the negative lead of the output of the filter for adjusting the voltage applied to the filaments. This should be set so that the voltage across the filament binding posts is 6 volts. The rest of the filament adjustment is made by an amperite 1A for the detector and by R1, R2 and Rh1 for the screen grid tube. R1 should be a fixd rsistor of 10 ohms, which is put in the negative lead for giving a small negative bias to the grid of the tube. R2 is a

with Trickle Charger New A-Filters

C. Fellish

List of Parts

LoL1—One radio frequency transformer for .0005 mfd. condenser.
L3L4L5—One three circuit tuner for screen grid tube and .0005 mfd. condenser.
Ch1, Ch2—Two 85 mh radio frequency chokes.
Ch3—One 30 henry audio frequency choke.
T1, T2—Two audio frequency transformers.
T3—One filament transformer having one 2½ and one 5 volt windings.
R1—One fixed 10 ohm resistance
R2—One fixed 5 ohm resistor.
R3—One 2 megohm grid leak.
R4—One 1,200 ohm fixed resistor.
R5—One 2,000 ohm fixed resistor.
Rh1, Rh2—Two 20 ohm clarostats.
1A—One No. 1A amperite.
C1, C4—Two .0005 mfd. tuning condensers.
C2, C5—Two fixed .O1 mfd. condensers.
C3—One .00025 mfd. grid condensers with clips.
C6—One fixed .0005 mfd. condenser.
C7, C8—Two 1 mfd. by-pass condensers.
C9, C10—Two 2mfd. by-pass condensers.
C11, C12—Two 4 mfd. by-pass condensers.
Three X Type sockets.
One Y type socket (five prong).
Four binding posts.
Two aluminum shields.
One Vac-shield for screen grid tube.
Two Micrometric dials.
One B battery eliminator.
One trickle charger giving at least .5 ampere.
One Tobe A filter.
One three socket block.
One 7x21 panel.
One 10x20 baseboard.

5 ohm fixed resistor. This is put in the positive to enable the grounding of the rotor plates of condenser C1. It is used to prevent excessive filament current when the rheostat is turned down. The rheostat should have a maximum resistance of 20 ohms, and it may be used for controlling the volume.

Two separate tuning condensers C1 and C4 are used because it is considered that separate tuning controls are preferable to a ganged control and trimmers. Each of these condensers should have a capacity of .0005 mfd. The secondary coils L1 and L4 should be wound for this capacity.

The first RF transformer L0L1 may be any standard coil of good make, designed for .0005 mfd. tuning. The three circuit tuner must be of special design. The primary L3 must have many turns on it. In a regular three circuit tuner provided with a neutralizing winding equal to the primary winding the entire winding may be used for the primary with the screen grid tube. There are many three circuit tuning coils on the market now which have been recommended. But the first condition is designed especially for the screen grid tube. One of these is that the number of turns on the primary winding be from 50 to 90 per cent of the number used on the secondary L4. If an ordinary three circuit tuner is adapted for this purpose by ading turns to the primary, it may be necessary also to add 25 per cent more turns to the tickler winding L5.

Sorting the Waves

A radio frequency choke coil Ch1 of about 85 millihenrys should be put in the 45 volt lead running to the screen grid. This is for the purpose of preventing signal current in the screen grid circuit of the tube from getting into the high voltage source. To make this filtering more effective a .01 mfd. condenser C2 is connected from the screen grid to the minus A line. Another condenser C3 of the same capacity is connected from the B plus side of L3 to the filament to prevent signal current in the plate circuit from getting into the high voltage source.

A choke coil Ch2 of not more than 85 millihenrys is put tickler return and the plate binding post of the first audio transformer. It prevents the transmission of high frequency currents into the audio amplifier. A by-pass condenser C6 of .0005 mfd. is connected as indicated to make detection and regeneration efficient.

The grid condenser C3 and the grid leak R3 have the usual values of .00025 mfd. and 2 megohms, respectively.

Audio Transformers Used

The receiver is transformer coupled, and two good audio transformers T1 and T2 should be selected for it. The quality of the output depends largely on the choice of these. There are many good ones to choose from.

The output of the power tube is filtered by means of a chok ecoil Ch3 and a condenser C12. The coil should have an inductance of at least 30 henrys when a current of 20 to 30 milliamperes flow. The condenser should be about 4 mfd. It may be larger but the use of smaller values depresses the amplification on the low notes.

Grid Bias Automatically Obtained

The grid bias for the heater tube is obtained with the aid of a fixed resistor R4 placed in the cathode lead. Its value should be 1,200 ohms. This resistor is by-passed with a condenser C8 of 1 mfd. A by-pass condenser C9 of 2 mfd. is also put in the plate circuit between the B plus binding post on the transformer T2 and the cathode. This condenser is often placed in the B battery eliminator, but it is more effective if placed where indicated.

The bias on the power tube is also obtained with a resistance R5. This should have a value of 2,000 ohms for a —71A type tube. It is put in the lead to the mid-tap on the heating transformer. It is by-passed with a condenser C10 of 2 mfd. A by-pass condenser C11 is also connected between the B plus side of the choke coil Ch3 and the mid-tap on the 5 volt winding. This condenser also is often placed in the B battery eliminator. It is more effective when connected as in Fig. 1. Note that C10, C11 and the loudspeaker all are connected to the mid-tap. This connection gives the best results when a receiver is operated by a B battery eliminator.

Any good standard eliminator giving a maximum output voltage of 220 volts at 40 milliampere drain may be used. Many of the by-pass condensers shown in Fig. 1 will be contained in the eliminator and it is then not necessary to use all, or it is not necessary to use as large values. For example, C16 may have a value of 4 mfd. If it has it will not be necessary to make C11 more than 2 mfd., but without C16 the capacity of C11 should be at least 4 mfd. If the eliminator is assembled C16 should be omitted and put in the C11 position. C17 is in the B battery eliminator. It is not necessary when C8 and C9 are used.

Voltages Used

The screen grid, the plate of the detector, and the mid-tap on the heater winding for the —27 tube are all connected to the 45 volt tap on the voltage divider. The connection of the mid-tap on the 2½ volt winding to plus 45 reduces hum to a great extent. The plate on the screen grid tube is returned to the 135 volt tap on the voltage divider and the return of the plate circuit of the power tube is to the top of the voltage divider.

For best results the detector with its input coil should be enclosed in a metallic shield at least 1/16 inch thick, and this should be grounded. In answer to the question "Is it really necessary to use the shield?" which is often asked, it must be stated that it is necessary for best results. The screen grid tube with its input circuit should be enclosed within a similar shield. The dotted lines show where the shields should be placed, that is in reference to the plate of a tube and the tuning coils.

There are three plugs in the circuit for plugging into a 110 volt AC source. It is suggested that a three socket block be made a part of the circuit and that the line switch be placed between this block and the outlet socket in the wall. If this is done the single switch can be used for turning on and off the receiver.

A Screen Grid Problem

The screen grid tube is a high amplifier, consequently by using a given number of standard tubes and comparing them with screen grid tubes, altering the circuit to provide high plate load impedances, for screen grid plates, one finds the screen grid tubes give much more amplification. They have been called the greatest advance in radio tubes in five years.

Operating in the other direction, one may reduce the size of the antenna very considerably, when using the screen grid tubes, even down to five feet of wire dangling behind the receiver. The volume may be as great as it was when a long, high outdoor antenna was used with other tubes. Therefore, if one reduces the size of his aerial, and gets the same volume, some wonder whether the extra cost of the screen grid tubes does any more than enable one to reduce antenna size—an extra cost of several dollars, compared with a saving of an old stretch of wire.

The Dynamic Speaker

Hemstreet Adams Brookman

DYNAMIC means forceful, in one sense of the word. And when that word is applied to the electro-dynamic type of speaker, it aptly characterizes that speaker, for it is the embodiment of force. It radiates power most effectively.

There are many advantages in principle of the electro-dynamic speaker over some other types. One is that there is no hysteresis loss in the iron armature, for it has no iron armature, unlike most other types of speaker. There is practically no hysteresis loss in the magnetic circuit, for the magnetic flux in the circuit is constant and unvarying. It is only variations in the flux in the magnetic circuit which causes hysteresis loss. Since in the dynamic unit these losses are absent the sensitivity of the instrument is greater, that is for a given input of electrical energy there will be a greater output of sound energy. The energy ordinarily lost in hysteresis is converted into sound energy.

No Rigidity

Another noteworthy advantage in the electro-dynamic speaker is that the armature coil is not rigidly supported. It is free to move without restraints from the supports. Thus wide swings, such as will occur at the low notes, are not impeded. Full low note sensitivity is thus insured. The flexibility of the support also prevents resonance effects in this section of the unit. Thus there will be no frequencies which will be brought out more strongly than non-resonant frequencies. This has a great deal to do with the naturalness of the reproduction.

Of course the unit is not the entire speaker. It is possible that the sound radiator is so constructed that resonance effects will enter. But there is no reason why the sound radiator, a cone for example, should be mounted rigidly. If this also is mounted on flexible supports resonance effects are avoided and the radiation of sound will be uniform over the whole frequency range, provided that the size of the radiator permits it.

The flexibility of the supports of the sound radiator and the armature coil insures low note reproduction, but not high note reproduction. If the moving parts are heavy the rapid vibrations of the high notes will be impeded. Thus a necessary condition for high note reproduction is that all the moving parts shall be as light as possible. This requires a light weight form for the armature winding, light wire and a light cone structure.

The coil form can be made of a light paper cylinder treated with shellac to give it some rigidity. The coil can be made of fine copper wire, or better still, aluminum wire. The insulation on the wire may be enamel, for this gives the least bulk and at the same time it is the lightest.

The number of turns on the coil would depend on the diameter of the coil form as well as on the desired impedance. As to the choice there is much latitude for the output transformer which must be used can be made to match any power tube to any desired armature winding.

There is one important limitation. If the number of turns be small a high ratio step down transformer must be used. This means that a heavy signal current will flow in the armature, which requires heavy wire. This in turn increases the weight of the armature. The wire used should be finer than that which would be used if the coil were stationary, and the heat generated can be dissipated by making the diameter of the coil larger and using fewer layers on the coil.

A small, light paper cone may be used as the main radiating surface, and the armature coil should be mounted directly on this cone. This will eliminate the coupling rod and the lateral vibrations in this which sometimes mar the purity of the output.

As a means of forcing the cone to "take hold" of the air in front of it and of preventing the sound wave produced by the vibration from returning to the back of the unit a rather large baffle should be used around the front of the cone. This may be made of wood or stratched fabric. The larger this baffle is the more effective will the speaker be.

One point on which the electro-dynamic unit is superior to other types is that there are no pole pieces to stop the vibration of the armature coil. Thus even on the loudest passages and the lowest tones the upit will not chatter.

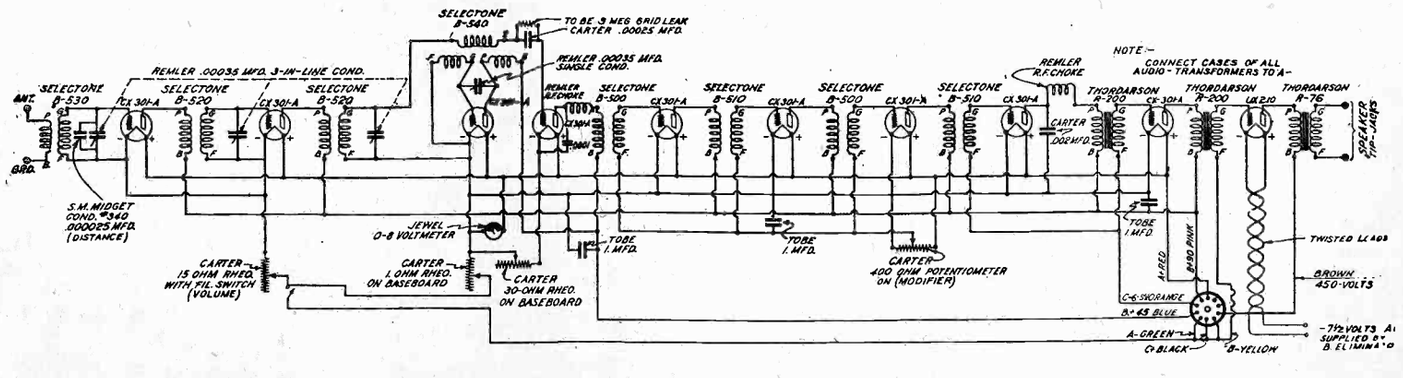
The armature coil moves in a strong magnetic field. The motion is such that the wire on the coil cuts the lines of magnetic force at right angles. For fidelity of reproduction the turns of the coil should always be in a constant magnetic field. Thus the region of uniformity of the field should be a little longer than the length of the coil. If the turns on the coil should move into a weaker region of the field in either direction the force actuating the cone will decrease towards the peaks of the signal wave. This would introduce harmonics into the reproduced sound.

Electro-Magnet Sets Up Field

The motion of the coil is very small as compared to its dimensions and those of the pole faces of the magnet and therefore the dimensions of the pole faces do not need to be very much larger than the coil to insure that the coil remain in a constant field. This is particularly so when the coil is mounted symmetrically with the pole faces, for then when some of the turns move into a weaker field others move into a stronger. Thus the effects of non-uniformity of the field are cancelled nearly out.

The field in an electro-dynamic speaker is produced by a magnetizing coil carrying direct current. The coil may be designed for either low voltage or high voltage operation. For example, it may be wound so that when it is conencted across the 6 volt storage battery the proper strength of magnetic field is produced. Or it may be designed so that it may be connected to a tap on the B battery eliminator. It may also be wound so that the magnetizing coil can be used as one of the filter coils in the filter circuit.

WHY USE AN RF CHOKE IN SUPER'S FIRST DETECTOR?



IN SOME SUPER-HETERODYNES A LOW PASS FILTER IS USED IN THE PLATE CIRCUIT OF THE FIRST DETECTOR AS WELL AS IN THE PLATE CIRCUIT OF THE SECOND DETECTOR. SUCH A FILTER IS USED IN THE PLATE CIRCUITS OF NEARLY ALL ORDINARY RECEIVERS FO RTHE PURPOSE OF ELIMINATING THE RADIO FREQUENCY CURRENTS FROM THE AUDIO FREQUENCY AMPLIFIER. IF THE LOW PASS FILTER IN THE PLATE CIRCUIT OF THE FIRST DETECTOR HAS THE SAME ELECTRICAL DIMENSIONS AS THOSE USED IN THE SECOND DETECTOR THE INTERMEDIATE FREQUENCY CURRENTS ARE PREVENTED FROM PASSING INTO THE INTERMEDIATE AMPLIFIER AND THE RECEIVER WOULD LOOSE ITS SENSITIVITY. FOR THIS REASON IF A FILTER IS USED AT ALL IN THE PLATE CIRCUIT OF THE FIRST DETECTOR IT MUST BE DIMENSIONED TO FIT THE INTERMEDIATE FREQUENCY. IT MUST PASS THE INTERMEDIATE FREQUENCY SIGNAL WITH MINIMUM ATTENUATION AND IT SHOULD SUPPRESS AS MUCH AS POSSIBLE THE BROADCAST FREQUENCY CURRENTS. A SMALL BY-PASS CONDENSER AND A LOW VALUE INDUCTANCE CHOKE SHOULD BE USED.

Build a Dynamic Outfit

By J. W. Fitzpatrick, Jr.

Fanspeaker Radio Co.

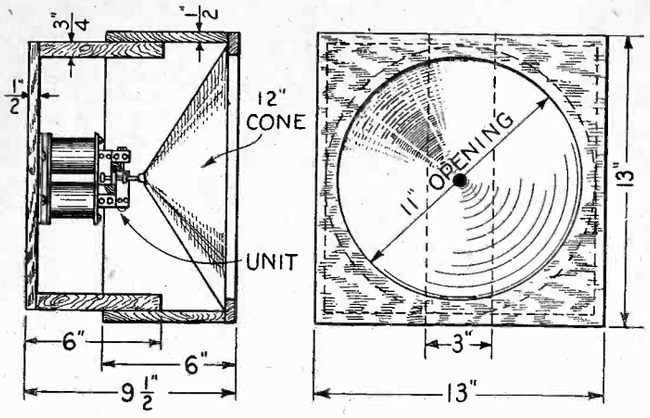
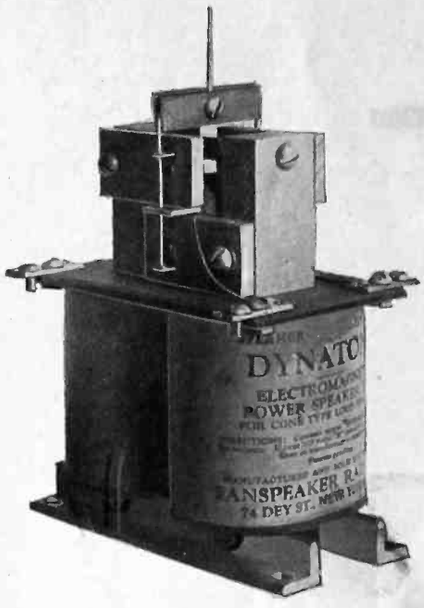


Diagram of baffle box construction, showing front and side views with exact measurements (at left).



THE RUGGED AND POWERFUL ELECTRO-MAGNETIC UNIT USED IN BUILDING THE ELECTRO-DYNAMIC SPEAKER.

THE trend of public favor is toward the dynamic speaker. Under every possible test the dynamic unit truly faithfully reproduces the entire musical scale range, bringing out the basses with the utmost realism, and stand high plate voltages. The radio constructor, including the custom set builder, will be able to build a modern type of speaker of this kind at moderate cost.

A practical and resultful speaker of this type is the one illustrated, using a small cone mounted in a baffle box, or the sound chamber of your phonograph or radio console. This gives practically the results of the large-sized diaphragm of linen or paper and yet a neat, small speaker, easy to mount anywhere, handy where space is limited. It also gets away from the ungainly effect of the large box and paper cone speakers. Wide experimentation with various sized surfaces of different materials, with varying depths for unit mounting, has proven the deep baffle box the best means to house the dynamic unit for finest reproduction.

Making the Baffle Box

The baffle box may easily be made at home, or the neighborhood carpenter will put it together for a small fee, or these boxes may be procured already made.

Your baffle box should be constructed out of a good grade of wood, which should be at least three-eighths of an inch thick. The front should have an eleven-inch circular opening to accommodate the twelve-inch cone. The back of the box should be left open and a three-inch strip of hard wood screwed across the exact center for the support of the unit. The edge of the cone should be covered with felt to prevent rattling against the cover of the box. The edge is merely pressed securely against the front of the box, exactly behind the opening, and is held in place by the pressure of the unit.

The cone should be twelve inches, and to accommodate this cone, the box should measure at least 13x13x10 inches deep inside. Bear in mind that the larger the box, the lower the frequency "cut off" point at the lower end of the scale.

The job is very simple and quickly done if one is apt with tools. The illustrations show clearly the details of assembling the box, mounting the cone and attaching the unit. Any cone about this size may be used or a very fine cone for this purpose may be procured all ready to use.

Considerations in Choosing Unit

The unit must be of rugged construction to handle the full load of the new power tubes without blasting. It should give good volume which may be toned down for home use, at the same time giving true and natural reproduction of the full orchestra, either turned on full or tuned low. A unit of this type is illustrated and has given full satisfaction.

Designed primarily for this purpose, the Fanspeaker electro-dynamic unit fully answers the purpose and helps us to build the complete dynamic speaker at a very reasonable price, complete. The outstanding feature of this unit and one in which it differs from all others is in the use of an electro-magnet instead of a permanent magnet for polarization.

The advantage of the use of an electro-magnet for a power speaker will be readily apparent to the reader when it is considered that an average stock model of the unit illustrated picked up a weight of eighty-five pounds—nearly twenty-five times its own weight—whereas a permanent magnet is considered good if it lifts four or five times its weight. And the electro magnet used less than one-half ampere when connected to the 6-volt storage battery.

Prevents Chattering

Another advantage is that while the sensitivity is not greatly increased, the powerful magnetic strength allows the use of longer air gaps without decreasing sensitivity, thereby allowing greater room and freedom for the armature to vibrate without striking the pole tips and chattering.

To get the true fundamental bass notes from a speaker these vibrations must be present in the unit and it is the low frequency vibrations that produce the greatest amplitude of movement in the armature, so that to produce them faithfully the unit must be low pitched and this requires long airgaps between the armature and pole tips, otherwise chattering is bound to occur, not to speak of various other forms of distortion.

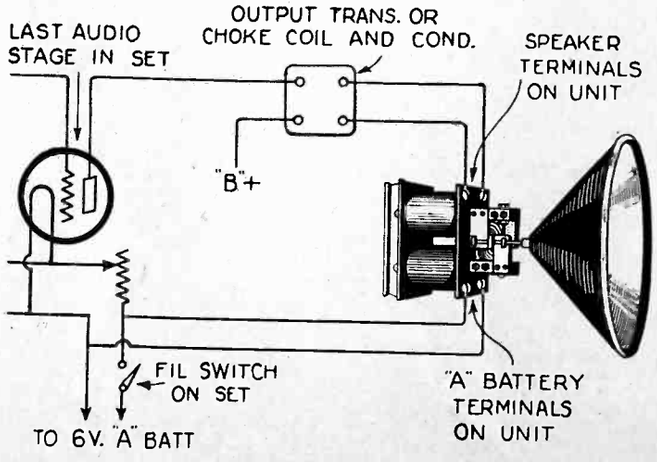
If an A battery is not used with the set, for instance, if you have an AC set, or if it is not convenient to use the A battery of the set, a trickle charger connected to the 110 volt AC line may be used to supply the low voltage direct current required. No filter is necessary between the trickle charger and the speaker unit.

The diagram clearly shows the method of connecting the unit for operation from the storage A battery.

Method of Connection

Connecting the unit is a very simple matter. It is only necessary to connect four wires to the completed speaker—two for the regular speaker terminals on the set and two for connection to the A battery or trickle charger for supplying the direct current to the electro-magnet

(*Continued on page 22*)



The method of connecting the A battery to the unit. If a trickle charger is used, the A battery terminals on the unit are connected to the charger instead of to the set switch.

A THOUGHT FOR THE WEEK

IF you want to do something big, build a television receiver, invite two hundred radio manufacturers to a demonstration of reception, and DEMONSTRATE!

RADIO WORLD

The First and Only National Radio Weekly

Radio World's Slogan: "A radio set for every home."

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Entered as second-class matter March 23, 1922, at the Post Office at New York, N. Y., under the Act of March 3, 1879.

Holland Clearly Hears India, 11,160 Miles

Cologne.

A direct radio telephone service between Holland and the Dutch East Indies was opened here at the international press exhibition. The first message was sent by Dr. J. R. Sloetemaker, Dutch Minister of Labor, in the presence of Mayer Adenauer of Cologne and a number of high German and Dutch Government officials. Connection was established with the Governor of the Dutch East Indies at Bandoeng. The radio link was between Kootwijk and Rantja Ekek.

Replies came from Malabar, India, to Meyendal, Holland. The conversation was astonishingly clear and easy to follow, although the distance traveled by the radio waves was more than 11,160 miles.

WGY Narrow on Television

EXPERIMENTAL interest in television is running abnormally high for a field of endeavor so far removed from easy development and comprehension, and so hampered in its ability to cope with the extensive interest.

So far the reception of waves modulated with moving vision has not been a success with independent experimenters, although the transmitting agencies, like the General Electric Company and the Bell Laboratories, have been able to make commendable demonstration over short distances.

For the time being, in the East at least, interest focusses on WGY broadcasts on its regular wave, 380 meters. Three afternoons a week — Tuesday, Thursday and Friday, 1:30 to 2 P. M., Eastern Daylight Saving Time — television is broadcast by this station.

What with the necessity of a receiver bringing in the wave, of the construction of a scanning disc with staggered apertures 35 one-thousandths of an inch in diameter, of the operation of a motor in perfect synchrony with that at the transmitter, and of the faultless functioning of a neon or Kino lamp, all in an effort to bring in a picture 1 1/2 inches square, the difficulties are severe enough. But if WGY is to remain the chief goal it should transmit television at hours somewhat more accommodating.

The present attitude of the General Electric Company is merely to tolerate, but not encourage, independent television experimenting. Martin P. Rice, manager for broadcasting of the General Electric Company, recently approved a publicity release from his institution which set forth:

> "The schedule is adopted to assist the General Electric Company engineers in the development of a system of television transmission and reception and, while the public is welcome to experiment with the signals, it should be understood that the plan is purely experimental and subject to change at any time. To offer circuits or plans for a television receiver, Mr. Rice states, would be unfair, as it might imply that the station will continue indefinitely the transmission of signals suitable for the type of receiver described."

And this from "the Father of Broadcasting!"

It is not to be expected, of course, that the General Electric Company will publish hookups, for indeed the system now used may be discarded just as unexpectedly as was the one that Dr. E. F. W. Alexanderson, chief consulting engineer of the same company, described before the Institute of Radio Engineers last year. And the company no doubt is besieged by inquirers, most of whom do not understand what television is all about, hence the company must do something to discourage the motley descent of questioners. But it is one thing to fortify oneself against undesired interrogation and dodge the encouragement of televisor construction of short-lived utility, and another thing to pretend to be tolerating independent angling for the televised wave, while actually discouraging it.

The meagre half hour three days a week, at a very awkward period of the day, and likewise at a time when it is hard to bring in WGY at all throughout much of the East, to say nothing of points farther away, might well be supplanted by television broadcasts nightly, after the program broadcasts of the station. That would give independent experimenters a fairer show, and perhaps from their efforts something worth-while would develop.

That the assistance of outside experimenters is not wholly distasteful to the company was proved by the short wave tests of recent memory, likewise the tests of increased power on the 380 meter wave. From all over the world reports were requested, and these were expertly digested and compiled, until they looked as important as a statistical report of the Department of Commerce. And the General Electric Company was pleased not only to disseminate the digested results of this volunteer reporting, but send forth its public thanks, as well. Why the same spirit can not prevail as to television is hard to understand, particularly as it must be assumed the company is more deeply interested in the development of the art than in the adoption of any particular system of television that may be developed in the sacred precincts of Schenectady, N. Y.

The company's good intentions are well established even in the television field. Dr. Alexanderson two years ago wrote a special article, which the company distributed, in which the theory and application of television were treated, with special emphasis on the difficulties to be solved. The distinguished engineer's lecture before the Institute, and the company's virtually public demonstration of transmission and reception of television in Schenectady, made only a few months ago, command public confidence. But a more considerate and co-operative mood in the company's councils in respect to transmission of television, so that this great, fascinating field may not seem to be too strictly and dubiously confined, would do the company no harm, and perhaps do the world at large a lot of good.

Freed's Great Patent

NEARLY everybody should be surprised to learn that a patent has been granted to Joseph D. R. Freed, president of the Freed-Eisemann Radio Corporation, on the use of by-pass condensers at radio frequencies, particularly as Mr. Freed's publicity release on the subject sets forth that he discovered this fetching use for a condenser in 1924. Some radioists remember such use respectably prevalent in 1920, while others, of riper memory, may go back still farther.

Nevertheless Mr. Freed is to be congratulated on his invention. It shows enterprise extraordinary. It puts him in a class with Fleming, deForest, Fessenden, Armstrong and Alexanderson. It gives him a new right to be banqueted by his many admirers. It fixes at last the identity of that individual to whom the radio public owes so much. Scarcely a set user in this land, or anywhere else in the world, for a fact, who does not appreciate the deep significance of the by-pass condenser, enemy of common impedance, eradicator of stray noises, killer of self-oscillation, friend of rich and poor alike!

By the grant of the Patent Office (No. 1,671,959) doth Mr. Freed become entitled to the excited admiration of the populace. May all the blessings that such astuteness deserves descend upon him in quantity production, and if there are any other things that he fancies, may the generous gods oblige him!

'PHONE TO UNITE AMERICAS

The American Telephone & Telegraph Company is formulating plans for connecting North and South America with a system of radio telephone, according to a statement by Frank B. Jewett, vice-president. The proposal is first to effect an intercontinental short-wave radiophone service between Buenos Aires, Argentina, and New York, for which transmitting and receiving apparatus is already being constructed.

AC TUBE HINT

Operate the —27 type tube at 2 to 2¼ volts on the filament; no more.

10 PER CENT STATION CUT HELD ENOUGH

A "house-cleaning" on not more than 10 per cent of the wave channels in this country should make the general broadcasting structure ideal from the viewpoint of the listener, said Paul W. Morency, field representative of the National Association of Broadcasters, after completing a six-week tour of the Middle West and South.

There is no apparent need, according to Mr. Morency, of a complete juggling of the radio system to get the best conditions for the listeners. He said that the changes made in the wave assignments by the Federal Radio Commission had resulted in vastly improved reception through the states of Texas, Kentucky, Oklahoma, Louisiana, Kansas and other states in the region.

Tells of "Vast Improvement"

"The general improvement has resulted from reductions in power where needed and a few shifts in the waves of several offending stations throughout the United States," said Mr. Morency.

"If such a vast improvement as has been indicated by reports from listeners in the territory mentioned has resulted from such comparatively few changes, it is reasonable to suppose that the complete picture can be clarified with comparatively few more shifts, intelligently made.

"Many persons believe that the broadcast structure must be entirely upset and rebuilt to gain radio perfection, but apparently this will not be necessary."

Fewer Stations Needed

Mr. Morency believed the number of broadcast stations in the United States must be reduced somewhat to bring the service to the average listener up to a high level.

He pointed out that because of the long Summer season in the Southern and Southwestern states listeners in those regions needed high powered transmitter to enable them to get clear reception through atmospherics.

Shorthand Message Sent by Photoradio

A photograph of a greeting written in shorthand was transmitted by the Radio Corporation to a conference of educators and shorthand experts attending a banquet at Liverpool commemorating the fortieth anniversary of Gregg shorthand.

This was the first time that a message in shorthand had ever been transmitted by photoradio and according to R. C. A. engineers, opens up new possibilities for condensing lengthy messages and statements into smaller spaces with a consequent reduction in cost of the picture transmitted.

The received photoradiogram was clearly legible and even the experts assembled could read the message without the aid of a stenographer.

WOO DISCONTINUED

Philadelphia.

WOO, Philadelphia, owned by the John Wanamaker store, signed off indefinitely, having decided that the station did not benefit the store in proportion to the expense.

Freed Gets a Patent on Bypass Condenser

There was Marius Latour, of France, with his claims that nearly everything infringed his patents.

There was the Radio Corporation of America, with its patents that required set manufacturers to be licensees with a lease of life or infringers doomed to dissolution.

There was Lektophone in the speaker field.

There were others.

And now comes Joseph D. R. Freed, president of the Freed-Eiseman Radio Corporation, with a patent that his company says "causes almost every receiver used to be an infringement."

And the patent is on nothing less than the use of a bypass condenser at radio frequencies. Conception date in 1924. Patent No. 1,671,959, granted recently.

Mr. Joseph D. R. Freed's Opinion

"In my opinion," said Mr. Freed, "every tuned radio frequency set now in use embodies the invention contained in the above patent. Because of the universal use of this principle, most engineers and manufacturers have assumed that it was old. However, it has proven to be an original conception of the utmost importance and I am now being granted a patent on the basic rights to this invention."

Mr. Freed stated that he discovered early in 1924 that the only way to prevent reactive coupling in the amplifier circuits and loads common to all stages was to use the by-pass condenser method which is the subject of the patent. Now that the patent is granted, Mr. Freed has determined to get after the set manufacturers and collect!

Technically, the patent is granted for "means for eliminating reactive coupling in radio circuits."

Lists Specifications

In his specification to the Patent Office Mr. Freed stated:

"It is well known that in tuned multi-stage radio frequency amplifiers it is essential to eliminate all couplings between successive stages. This coupling may be either magnetic, capacitative, or reactive, or it may be due to all three kinds of coupling.

"The magnetic coupling, as is known, can be eliminated for, for instance by placing the inductance coils contained in the several circuits in proper geometrical relation to each other to prevent linkage by stray flux.

"The capacitative coupling, such for instance as may be due to the internal capacities of the thermionic tubes employed in the circuit, can be avoided, as is also known, by properly neutralizing or balancing these capacitative effects so that capacitative coupling between stages is avoided.

"A reactive coupling commonly occurs in these circuits due to the fact that the different stages of the amplifier circuit have certain leads in common. Since high frequency currents flow in some of these common leads, and since these leads have a certain amount of inductance, reactance voltages are set up therein. The effect of these voltages is that for instance the reactive voltage set up by the current flowing in one stage, would effect the current which tends to flow normally from the other stage through the same conductor, thereby modulating it unduly and bringing about an undesired coupling between the two stages.

"Such reactive coupling arises particularly in the unavoidable leads between the amplifier circuits and the batteries, which for practical reasons are usually common to all stages. Since these leads are of appreciable length, they have an appreciable inductance, which may represent a considerable reactance at high frequencies, and thus bring about a substantial coupling between the several radio frequency stages. This coupling may be sufficient to produce undesired oscillations, notwithstanding the fact that all other coupling may have been eliminated by suitable provisions known in the art."

The Claims Freed Made

Mr. Freed's claims were phrased thus:

"1.—A radio circuit comprising a plurality of radio frequency amplifier stages having thermionic tubes arranged in cascade with a portion of their output circuits in common, and a condenser shunting substantially all of the common portion of their output circuits and of sufficient capacity to keep the reactance voltage, tending to occur in the common portions of the output circuits, below the value at which it may cause self-oscillation.

"2.—In a multi-stage radio frequency amplifier circuit a plurality of thermionic amplifier tubes, each having a filament, a grid and plate, each tube having its output side coupled with the input side of the succeeding tube, the filaments of all of said tubes having a common, grounded filament lead, a source of direct current connected into the output circuits of all of said amplifier tubes and having a lead in common with all of said output circuits, and a condenser connected between the junction point of said lead with said output circuits and said grounded filament lead, to shunt the reactance voltage tending to develop in said common output circuit lead."

In applying for the patent Mr. Freed submitted blueprints and everything!

WEBC Power Higher So Coolidge Can Hear

Washington.

Increase in broadcasting power for the radio station situated nearest President Coolidge's summer camp on the Brule River, in Wisconsin, was announced by the Federal Radio Commission. The full text of the announcement follows:

"To make sure that the President may have radio reception from the outside world, the Federal Radio Commission has decided temporarily to increase the power of station WEBC, at Superior, Wis., from 250 to 1,000 watts for evening broadcasting during the summer months. WEBC is operated by the Head of the Lakes Broadcasting Company.

"While the Commission is standing firmly behind its policy of not changing frequencies or increasing power pending its new regulation to conform to recent legislation by Congress, it deemed this exception necessary in the case of WEBC out of deference to the President of the United States."

KARAS SHORT WAVE SET, three tubes, 13 to 750 meters, described in the March 31, April 7, 14, 21 and 28 issues. Send 60 cents for these five issues and get blueprint free. RADIO WORLD, 145 W. 45th St., N. Y. City.

EVERY FRIDAY at 5.40 P. M. (Eastern Daylight Time) Herman Bernard, managing editor of Radio World, broadcasts from WGBS, the Gimbel Bros. station in New York, discussing radio topics.

THE NATIONAL SCREEN GRID 5, described by James Millen in April 14th, 21st and 28th issues. Fully illustrated, including picture diagrams of wiring. Uses screen grid tube for the single RF stage, four other tubes standard. Send 45c for these three copies and get blueprints free. RADIO WORLD, 145 West 45th St., New York City.

Broadness is Not In

(Continued

overloaded long before the resonant frequency is reached. The output of the detector is proportional to the square of the input voltage as long as the input voltage is low. As the voltage is increased the output is no longer proportional to the square of the input. Indeed, the output may not increase at all as the input voltage is increased beyond a certain value.

It is conceivable therefore that in tuning in a strong broadcast station the overloading point will be reached long before all the tuned circuits are in resonance. For example, two of three tuned circuits

5000-Watt Station Costs $90,000 a Year

In an article in "The N. A. B. News," organ of the National Association of Broadcasters, Adelaide L. Fitch gives a tabulated expense list of a typical 5,000 watt station, with a total expenditure of $90,000 for one year. The article follows:

$90,000 was spent by a representative 5,000 watt station last year. The distribution of costs is shown below, and we think the amount spent on each department shows careful thought and planning. Perhaps the Program Department spent a little too much in comparison with the Commercial Department, but this can be remedied, if necessary, this year.

Commercial Dept. (Two people)	5%	$ 4,500
Program Dept. (Five people, including announcers)	35%	31,500
Engineering Dept. (Six men)	25%	22,500
Publicity Dept. (One man)	3%	2,700
Office Service & Supplies (Two people)	7%	6,300
General Overhead (This includes taxes, insurance, rent, depreciation and other charges	25%	22,500
	100%	$90,000

in Set, Transmission

(from page 8)

in a receiver may appear sharp but the third has no apparent effect on the volume. The detector is then overloaded, or nearly so, for all settings of the third condenser.

The remedy is to limit the input to the circuit so that the detector will not be overloaded at any time, even when all the tuned circuits are in exact resonance with the desired signal. This remedy may require shielding of the set, as in the second case discussed above, and also the insertion of some volume control in the antenna circuit.

A spark signal may come in at all settings of the tuning condensers even when the receiver is very selective.

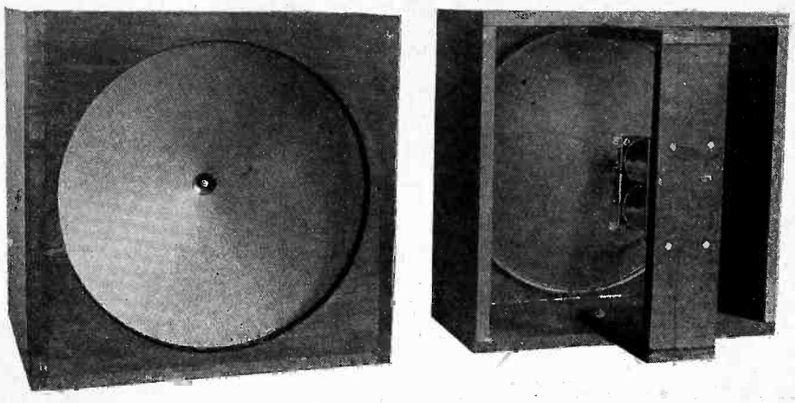
Even for Low Power Power Tube Helps

Some persons, even grandparents, prefer low volume. They never use enough volume to require a power tube. However, that is no reason why they should not use a power tube. True, they can get along well enough without one, but if they do use one they will improve quality.

The power tube is likely to have an impedance with which the speaker impedance works better, particularly if an up-to-date speaker is used., as is frequently the case.

A Dynamic Speaker Easily Constructed

(*Continued from page* 17)



FRONT AND BACK VIEWS OF THE COMPLETED SPEAKER, SHOWING METHOD OF MOUNTING UNIT AND CONE. NOTE DEPTH OF BOX.

windings of the unit. Four terminals are provided on the unit for these wires.

In operation, you can feed it the full power of your set, whether 90 volts, or 550 volts, and it will withstand the voltage without choking or blasting, rendering the finest of reproduction. No speaker filter is needed, but one may be used if desired.

If the completed speaker has been properly constructed according to directions and the unit rightly mounted as shown, the builder will have one of the finest speakers obtainable, up-to-date in every respect.

The writer has long experimented with all types of speakers, specializing for some time past on the dynamic having discarded all others in favor of this type. He will be glad to help out fans, custom set builders and all in search of quality in radio reproduction. Address J. W. Fitzpatrick, Jr., care of RADIO WORLD, 145 West 45th Street, New York City.

Short Waves Awarded for Commercial Use

Washington.

The Federal Radio Commission has allocated seventy-four short-wave channels for commercial transoceanic service and issued operating licenses for fifty-two channels.

The Mackay Company were issued twenty-three operating licenses on construction permits previously issued for transoceanic public service communication. The Radio Corporation of America received twenty-nine operating licenses on construction permits previously granted.

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We do not like to take your name from our subscription list without specific instruction to do so because many of our readers wish to keep a complete file of the paper.

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Subscription Dept., RADIO WORLD, 145 West 45th Street, New York City.

Short Wave Adapter for Any AC Circuit

(*Continued from page* 4)

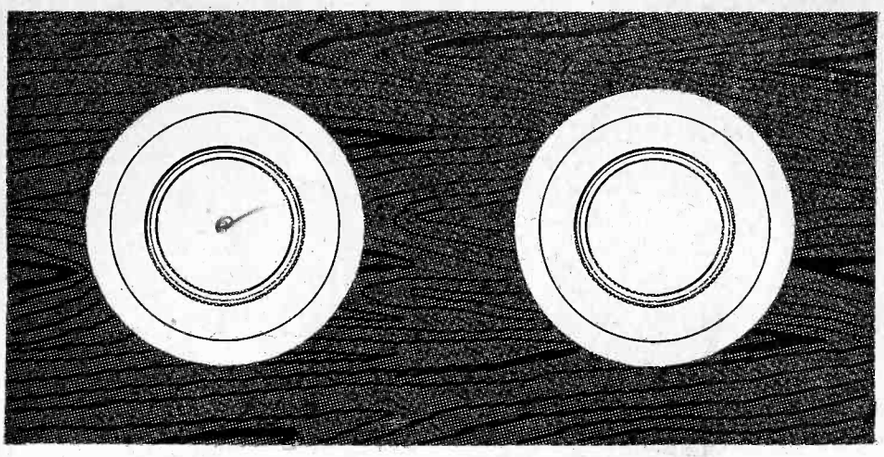

FIG. 5. FRONT PANEL VIEW AS IDEALIZED BY AN ARTIST

would go to the antenna. What size this condenser should be is best determined experimentally, but in any event not more than .00025 mfd. should be used, and often as small a capacity as .00005 has given good results, particularly when the lowest of the three short wave range coils is used.

Where Short Antenna Helps

Only this smallest coil ever presents any problems in regeneration. If the choke coil that assists regeneration is of too high inductance, it may have too high a distributed capacity, and at the very high frequencies such capacity might bypass the radio frequencies around the choke coil, preventing the necessary choking effect. If regeneration fails for this coil, resort to a short antenna, say 10 to 25 feet of wire in the room, or the series condenser. Always decrease the antenna coil coupling very materially for these higher frequencies.

It is lots of fun to listen in to short waves. In last week's issue, dated June 9, was published on page 16 a list of short wave stations in the United States, many of which send regular programs, and all of which are well worth fishing for.

When to Complain

With the aid of the wavelength ranges given on the Air King coils, and with the assurance of correct capacity, as when using the Karas straight line frequency .00014 mfd. short wave condenser, one can determine on what wavelength the station is being received.

This is extremely helpful, because some stations have variable short waves, some of the most interesting ones use two short waves simultaneously, and all too often short wave reception is obtained from additional transmission of a regular broadcast program, without the announcer ever stating the short wave call letters or the short wavelength.

When you run across such objectionable and annoying tactics, you should write to the broadcast station, complaining about this neglect of the listener's welfare.

But there's little enough to complain about, and much to rave about, on the short waves, even the reception of programs, while somewhere in the promising future lurks the possibility that the short waves will carry television, hence we must familiarize ourselves with short wave reception.

(Other illustration on front cover).

Let Radio World Follow You on Your Vacation

If you are a subscriber and are going away this summer, send us your name and change of address and we will see that the paper reaches you every week.

If you are not already a subscriber, send us one dollar and your name will be placed on our subscription list from now until Labor Day and your address will be changed as often as you desire. Such change should reach subscription office two weeks in advance of date of publication.

Subscription Dept., RADIO WORLD, 145 West 45th Street, New York City