A LIST OF STATIONS

RADIO WORLD

Reg. U. S. Pat Off.

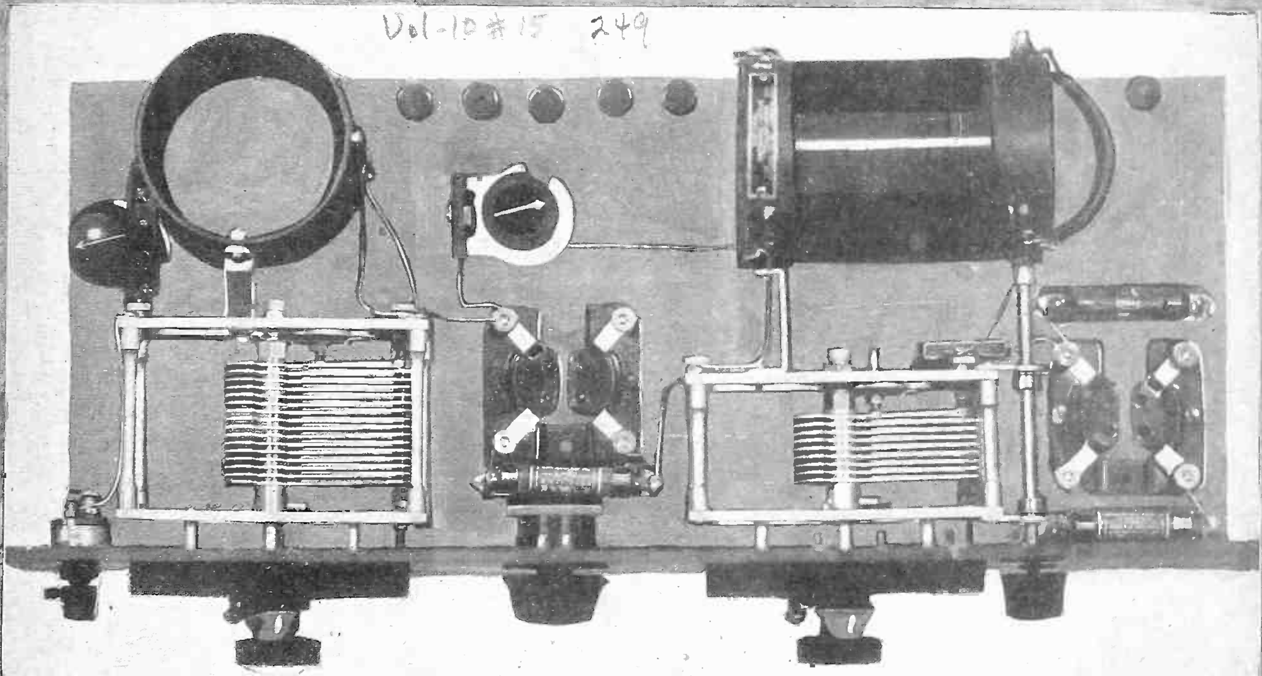
JAN. 1, 1927

15 CENTS

A 2 TUBE DE LUXE SET

by ARTHUR LYNCH

Vol-10 #15 249



THE TOP VIEW of the two tube De Luxe Receiver described by Arthur H. Lynch in this issue. See page 3. Note that the filament Equalizors are mounted beside each socket and make the use of rheostats unnecessary. The use of Airgap sockets and the National Company's complete coil and condenser assemblies make the neutralizing of the completed receiver a simple matter.

WATCH EXPIRATION DATE

RADIO WORLD, 145 West 45th St., New York City. (Phones: Bryant 0558-0559.) Subscribers will note that the end of their subscriptions is indicated on the labels on wrappers. If your wrapper shows a date earlier than the current issue, please send payment for renewal. Changes in expiration dates on wrappers appear two weeks after receipt of renewal.

FILL OUT AND MAIL NOW

SUBSCRIPTION BLANK

RADIO WORLD

RADIO WORLD *145 West 45th Street, New York City (Just East of Broadway)*

Please send me RADIO WORLD for.........................months, for which please find enclosed.................

SUBSCRIPTION RATES:

Single Copy..............$ .15
Three Months............ 1.50
Six Months.............. 3.00
One Year, 52 Issues...... 6.00
Add $1.00 a Year for Foreign Postage; 50c for Canadian Postage.

....
....
....

City and State ....

Good Back Numbers of RADIO WORLD

The following illustrated articles have appeared in recent issues of RADIO WORLD:

1926:

Mar. 27—An Economical 4-Tube Set, by Edgar T. Collins. A Practical B Battery, by Capt. P. V. O'Rourke. Tectron Trouble Shooting, by Lewis Winner.

April 3—How to Get DX, by Capt. P. V. O'Rourke. A Compact B Supply, by Lewis Winner.

April 17—The New 1-Dial Powertone, by Capt. P. V. O'Rourke. The Action of Transformers, by Lewis Winner.

May 8—To Wind a Loop on a Cardboard Frame. How to Reflex Resistance AF, by Theo. Kerr.

May 15—Super-Heterodyne Results Brought Up to Maximum, by Herman Bernard. The Truth About Coil Fields, by J. E. Anderson.

May 22—A Built-in Speaker Set, by Herbert E. Hayden. The Powertone in Operation, by Capt. P. V. O'Rourke.

June 5—Five-Tube Compact Receiver, by J. E. Anderson. A Tester for Tube Circuits, by Spencer Hood. Problems of Portables, by Hugo Gernsback.

June 19—Selectivity's Amazing Toll, by J. E. Anderson. The Light 5-Tube Portable Set, by Herman Bernard.

July 3—Set with a 1-Turn Primary, by Herman Bernard. Part 2 of the Victoreen Portable, by H. Bernard. Trouble Shooting Article for The Light 5-Tube Portable.

July 10—A Rub in Single Control, by Herman Bernard. A DX Double Regenerator, by Capt. P. V. O'Rourke. A 2-Tube Dry Cell Receiver, by Samuel Schmalz.

July 17—A Double Duty Loop Aerial, by J. E. Anderson. How to Measure Coupling, by John Rider. A 1-Control Crystal Set, by Smedly Lyons.

July 24—Why the Super-Heterodyne Is the Best Set, by Herman Bernard. A 1-Tube Reflex Receiver, by H. A. Reed.

July 31—What's Best in an AF Amplifier, by Herman Bernard. A 6-Tube Reversed Feed-back Set, by K. B. Humphrey.

Aug. 7—The 5-Tube Tabloid, by A. Irving Witz. The Wiring of Double Jack, by Samuel Lager.

Aug. 14—The Improved Browning-Drake, by Herman Bernard (Part 1). Storage Batteries, by John A. White.

Aug. 21—A New Stabilized Circuit, by E. H. Loftin and S. Y. White (Part 1). The Browning-Drake, by Herman Bernard (Part 2).

Aug. 28—The Constant Coupling, by E. H. Loftin and S. Y. White (Part 2). The Browning-Drake, by Herman Bernard (Part 3)

Sept. 4—The Four Rectifier Types, by K. B. Humphrey. A Simple Battery Charger, by J. E. Anderson.

Sept. 11—The Beacon (3-tubes), by James H. Carroll. The 1927 Model Victoreen, by Herman Bernard.

Sept. 18—The 1927 Victoreen, by Arthur H. Lynch. Eliminator in a Cash Box, by Paul R. Fernald.

Sept. 25—The Lynch Lamp Socket Amplifier, by Arthur H. Lynch. Wiring up the Victoreen, by Herman Bernard.

Oct. 2—The Victoreen (Continued), by Herman Bernard. New Equamatic System, by Capt. P. V. O'Rourke.

Oct 9—A Practical "A" Eliminator, by Arthur H. Lynch. Building the Equamatic, by Capt. P. V. O'Rourke.

Oct. 16—The Bernard, by Herman Bernard. How to Box an "A" Supply, by Herbert E. Hayden.

Oct. 23—The 5-tube P. C. Samson, by Capt. P. V. O'Rourke. Getting DX on the Bernard, by Lewis Winner.

Oct. 30—The Singletrol Receiver, by Herbert E. Hayden. How to Get Rid of Squeals, by Herman Bernard.

Nov. 6—Reduction of Interference, by A. N. Goldsmith. Variations of Impedances, by J. E. Anderson.

Nov. 13—The 4-tube Hi-Power Set, by Herbert E. Hayden. A Study of Eliminators, by Herman Bernard.

Nov. 20—Vital Pointers About Tubes, by Capt. P. V. O'Rourke. The 4-tube Diamond of the Air, by Herman Bernard.

Nov. 27—The Antennaless Receiver, by Dr. Louis B. Blan (Part 1). Short Waves Yield Secrets, by M. L. Prescott.

Dec. 4—The Regenerative 5-Tube Set, by Capt. P. V. O'Rourke. The 8-tube Lincoln Super, by Sidney Stack. The Antennaless Receiver, by Dr. Louis B. Blan (Part 2). Winner's DC Eliminator, by Lewis Winner.

Dec. 11—The Universal Victoreen, by Ralph G. Hurd. Some Common Fallacies, by J. E. Anderson.

Any copy, 15c. Any 7 copies, $1.00. All these 32 copies for $4.00, or start subscription with any issue. RADIO WORLD, 145 West 45th Street, New York City.

Vol. X
No. 15
JANUARY 1, 1927
Whole No. 249
15c Per Copy. $6.00 a Year

RADIO WORLD
REG. U.S. PAT. OFF.

A Weekly Paper Published by Hennessy Radio Publications Corporation from Publication Office, 145 W. 45th Street, New York, N. Y.

Phones: BRYant 0558 and 0559

[Entered as second-class matter, March, 1922, at the post office at New York, N. Y., under Act of March 3, 1897]

The Complete Exposition of The Two Tube DeLuxe Receiver

Theory and Construction Explained by Expert

THIS is the first of a series of four articles by Mr. Lynch. These articles set a new standard in radio for the home constructor, will be particularly well illustrated and contain real engineering information, boiled down to eliminate all the technicalities, but retaining all the practical pointers the author has gleaned from a vast amount of research work. Whether you actually build the Two Tube De Luxe Receiver or not, you will find these pointers of value in connection with any receiver. In addition to describing in a most complete manner a receiver of exceptional character this series may well be taken as a treatise on receiver design in general.—EDITOR.

By Arthur H. Lynch

THE ideal design of a modern radio receiver can be obtained only as a result of a careful consideration and harmonious combination of those underlying principles which make due allowance for selectivity, tone quality (fidelity of reproduction), ease of operation, reliability, appearance, economy of operation, and, in the case of home-built receivers, ease of construction.

After a great deal of experimental work in his laboratory at Garden City, the writer has come to believe that the receiver to be described in this series of articles most nearly complies with all the enumerated conditions.

Of course any set can readily be made to comply even more completely than the one to be herein described, in regard to one or two of the above mentioned conditions. Such procedure will result, however, in a set that is quite inferior for general service. For instance, by means of several stages of sharply tuned radio frequency amplification a set is made extremely selective. But what about quality? Such a set, even when used with a high quality audio amplifier, would be lacking in all the higher frequency audio tones that give "character" to the music or voice being received. Only the muffled and accentuated low notes would be heard.

Low notes are very desirable, but low notes alone, to the complete exclusion of all the high notes, are very undesirable, even more undesirable than high notes alone. (Fig. 6, Curve 1, on page 6).

An Improved Design

Then take the opposite point of view, where selectivity is completely ignored and perfect tone quality strived for. The result would be superb if there were only a few broadcast stations scattered at wide intervals across the country. Unfortunately for production of such a design there are in existence at the present time more than a mere half dozen or so stations. (Fig. 6, Curve 2).

Last year the writer developed a circuit —The Aristocrat—which was received with a great deal of praise. The Aristocrat was quite selective, easy to build, easy to operate, and possessed remarkably good tone quality. In fact all who listened to the receiver at that time were very much surprised by the almost unbelievable fidelity of reproduction.

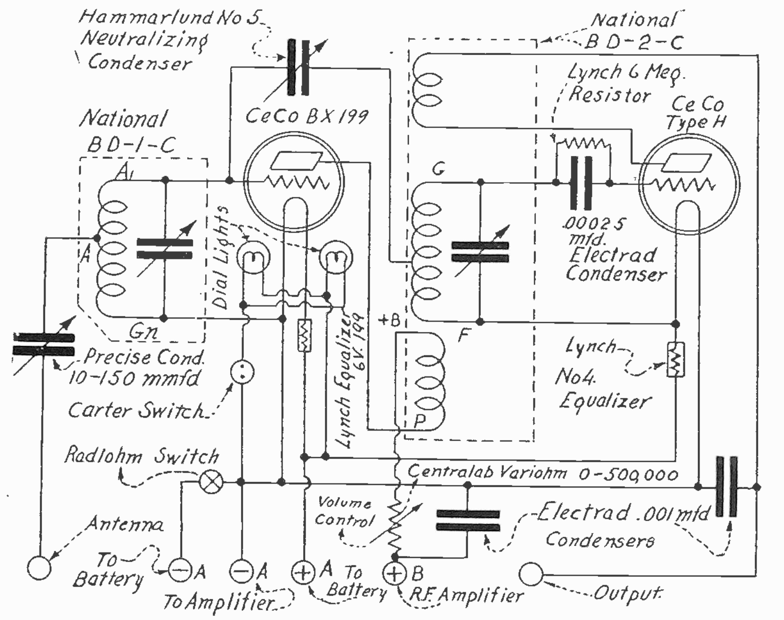


FIG. 1

The circuit diagram of the two tube De Luxe Receiver. The Carter switch controls the pilot lights on the National Illuminated Velvet Vernier dials, while the switch on the Centralab Radiohm is the master control of the filament current.

The writer's new receiver embodies the fundamental circuit of the Aristocrat with an improved layout—the separation of the radio and audio amplifiers into two distinct units and the use of coils and condensers of most efficient type. The final result is a receiver that is exceedingly simple for even the radio novice to construct; is most economical to operate, as the necessary power is obtained from the lamp socket; is very reliable in performance, as there are no batteries to run down; is most easy to operate, due to the minimization of controls and the use of the new National variable ratio velvet vernier illuminated dials of the station recording type. No matter where the receiver is located in a room, shadows or poor light will have no ill effect upon tuning, as the call letters printed on the indirectly illuminated dials stand out like the figures on the dials of the indirectly illuminated instruments on the dash boards of the newer automobiles.

Choosing the Component Parts

As for appearance, it is something that delights even the esthetic. And last, the harmonious combination of selectivity and tone quality. Selectivity sufficient to completely separate stations, and yet not that extreme selectivity that is so ruinous to the best of tone quality. (Fig. 6, Curve 3).

The National BD 1 C and BD 2 C tuning units have a great deal to do with obtaining the desired amount of selectivity with only a single stage of radio frequency amplification and at the same time obtaining in a single stage all the radio frequency amplification necessary to make the complete receiver capable of

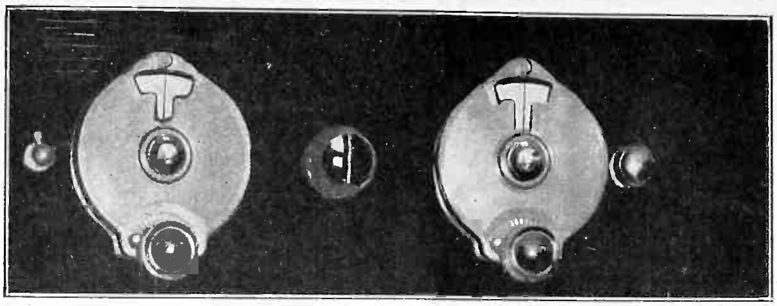


FIG. 2
The front panel view of the two tube De Luxe Receiver.

quite remarkable results in bringing in distant stations.

The coils proper are wound with heavy wire (No. 18 enamelled copper) on a threaded bakelite tubing 3" in diameter. The threads are so cut as to space the turns of wire from each other by an amount equal to one-half of their diameter. It has been found by the scientists of the United States Bureau of Standards at Washington that a coil so made was very much more efficient than one in which the insulated turns touched each other or were spaced by a different amount. Further research work conducted by the engineers of the National Company resulted in the selection of No. 18 wire and the three-inch diameter tubing so as to obtain a coil of the highest over-all efficiency.

But even the best of coils if improperly mounted or used with poor condensers and sockets will not give the results that might be expected of them. To insure against improper use in this respect, the National Company designed a special low loss variable condenser known as the Equicycle. This condenser, aside from its electrical and mechanical excellence, employs a rather unique plate shape which, when roted through 270° rather than the more common 180°, results in much easier tuning, as the effect is to give the same result as a further separation of the stations on the dials and at the same time to make the tuning non-critical.

The Tuning Is Easy

Thus until the reason is known, anyone not familiar with the set is at a loss as to why the dials can be turned through such a large number of degrees without tuning out a station and yet without resulting in introducing crosstalk from another station.

By mounting the coils and condensers together into one unit, it is possible for the manufacturer of these parts so to place them with respect to each other that the one does not introduce harmful losses into the other, as would be the case if the coils were placed too close to the condensers. Then again, with the condenser and coil constants, as well as the spacing between them, known to the manufacturer, he can so wind his coils as to insure the complete covering of the entire broadcast frequency band without crowding at any point.

As far as the ease of construction is concerned, the mounting of the coils and condensers together is of considerable advantage as the set builder has merely to drill the four holes in the panel for each condenser and the entire unit is mounted.

When the manufacturer of the tuning unit has done so much to insure the public against inferior results it would indeed be a shame for the constructor to even nullify to the slightest degree the performance possible with such excellent coils and condensers. For this reason the writer has carefully examined and tested a number of the sockets on the market before selecting one for use in this receiver. The result of the tests was the selection of the new universal type Airgap socket. It is rare indeed when one finds combined in a single unit the paramount of both mechanical and electrical design. The Airgap socket well deserves a place in this receiver in which we have gone to so much trouble to see that only the best possible of parts are used.

Minimum Capacity Coupling

But to return again to the coils proper. One of the main faults of all radio frequency amplifiers is the very undesirable capacity coupling existing between the primary and the secondary. To reduce this capacity coupling to a minimum and at the same time maintain the desired magnetic coupling between the two coils, the primary is wound with very fine wire in a small slot located in the periphery of the inner bakelite tube. Furthermore this slot wound primary is located at the low voltage or filament end of the secondary solenoid.

As a result of all of these efforts to make the best possible single stage radio

LIST OF PARTS

One National BD1-C tuning unit.
One National BD2-C tuning unit.
Two Airgap UX sockets.
One Precise No. 940 condenser.
Two electrod .001 mfd. mica condensers.
One electrod .00025 mfd. mica condenser.
One Centralab 0—500,000 Radiohm with switch.
One Lynch single mount.
One Lynch 6-meg. metallized filament resistor.
One Lynch or Elkay 199-CV Equalizer with mount.
One Lynch or Elkay No. 4 Equalizer with mount.
One Carter Imp switch.
Six Eby binding posts.
One 7x18-inch panel.
One 7x17-inch sub-panel.
One Hammarlund Jr. No. 5 Midget condenser.
One CeCo BX 199 tube.
One CeCo type H special detector tube.

frequency amplifier and detector the radio frequency resistance of the tuned circuit has been reduced to the extremely low value of less than 7 ohms at 300 meters. To the engineer this fact indicates but one thing—a remarkably good coil and condenser combination from which selectivity and distance (due to low losses) are certain to result. To permit the use of the receiver with aerials of different sizes and so as to make the two dials read alike, a variable antenna series condensers is employed. This unit is the Precise midget No. 940 and mounted on the subpanel inside the cabinet so that once adjusted it will not be disturbed by anyone not familiar with its purpose. Likewise the Hammarlund No. 5 neutralizing condenser is also mounted behind the panel.

One of the small points so often neglected and as a result the satisfactory performance of the receiver seriously endangered is the filament circuit. Poor contact made by the switch and the rheostat levers often results in a crackling sound in the loud speaker which is generally attributed to "static." A switch of the "jack" type such as the Carter Imp was selected as being the least likely to cause trouble. And this switch is used to turn the dial lights on and off. Rheostats were eliminated altogether and circuit of each tube not only to reduce Lynch Equalizers used in the filament the possibility of noise, but also to do away with unnecessary controls, to insure most advantageous operation of tubes at all times without the necessity of using an expensive voltmeter and to prevent the careless operator from damaging the tubes by improper rheostat adjustment.

The Volume Control

It will be noted from the different illustrations and circuit diagrams that two —A binding posts are provided. The additional post is so connected in the circuit that by its use in connection with the separate audio amplifier unit to be described by the writer in the next issue of RADIO WORLD, the one switch on the panel of the set can be made to control the entire receiver.

The volume control consists of a 0-500,000 ohm Centralab Radiohm variable non-inductive resistor in the plate circuit of the RF amplifier tube. The volume control is located in the radio amplifier rather than the audio amplifier so as to prevent overloading of the detector tube on very strong local signals.

The Centralab 500,000 Radiohm is provided with a battery switch so that the unit serves the double purpose of volume control as well as filament cutoff.

The importance of the grid leak has often been mentioned, not only as a means of increasing the sensitivity of the detector tube, but also as a source of

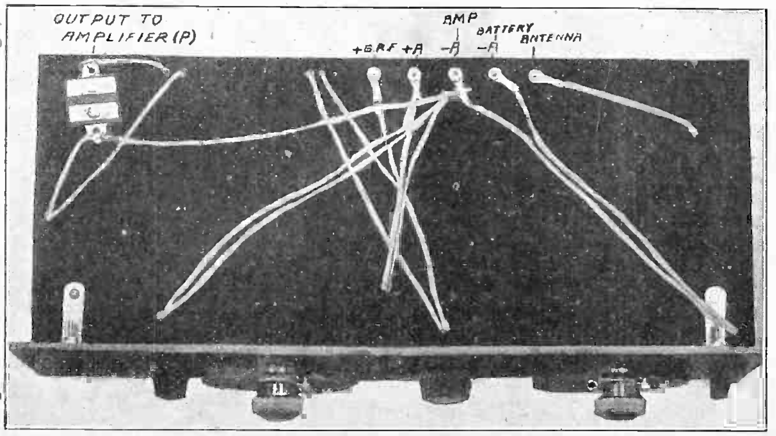


FIG. 3
A view of the sub-panel wiring and layout, seen from the bottom.

noise in the receiver. Located as it is, right in the heart of the receiver, it is extremely important that it be quiet in operation. To many the grid leak as a source of noise constitutes a mystery, but if its function in the circuit is analyzed the mystery is solved. During the operation of the receiver there is caused to flow through the grid leak a small value of current due to the positive bias applied to the grid of the tube. This current, if made to flow through a medium (the leak) which does not disintegrate under the influence of the applied voltage, or which offers a uniform path at all times, such as the Lynch metallized filament type, will not cause a fluctuating charge upon the grid. The biasing voltages will be uniform always. But if the current flows through a medium which not only minutely varies with the amount of current flow, but also is a source of electrical disturbances in the form of small spark discharges between the infinitesimal particles which compose the conducting medium, such as in the case of the impregnated paper resistors, these small disturbances will be applied to the grid of the detector tube, will be amplified by the audio amplifiers and will be heard clearly as a disturbing noise in the loud speaker or phones.

With regenerative detectors this form of noise is more forcibly brought to the fore, due to the vastly increased sensitivity of the detector tube. The values of the grid leak found best with this receiver are between 6 and 10 megohms.

Construction of the Receiver

The first step to be taken in the actual construction of the receiver is the preparation of the panel and sub-panel. A 7x18-inch size was chosen for two good reasons, first, it is just the size that will accommodate all the essential parts of the set without crowding and, second, it is a size which will fit practically all cabinets.

The sub-panel should be an inch shorter than the front panel in order to fit into the standard cabinets. If two standard 7x18 inch panels are purchased, then one of them will have to have a strip 7x1 inch cut from one end. This strip may readily be cut off with a hack saw.

The locations of the various holes on the panels should be carefully laid out with the aid of a square, steel scale, scriber, and center punch according to the data given in Fig. 4. Templates furnished with the National tuning units may be placed on the panel and used to locate the holes for mounting the condensers and dials.

With the tuning units also comes a small package of brackets, two of which are used to fasten the front panel and shelf together.

The front panel may either be given a grain finish or else the polished surface retained. If the grain finish is desired, it

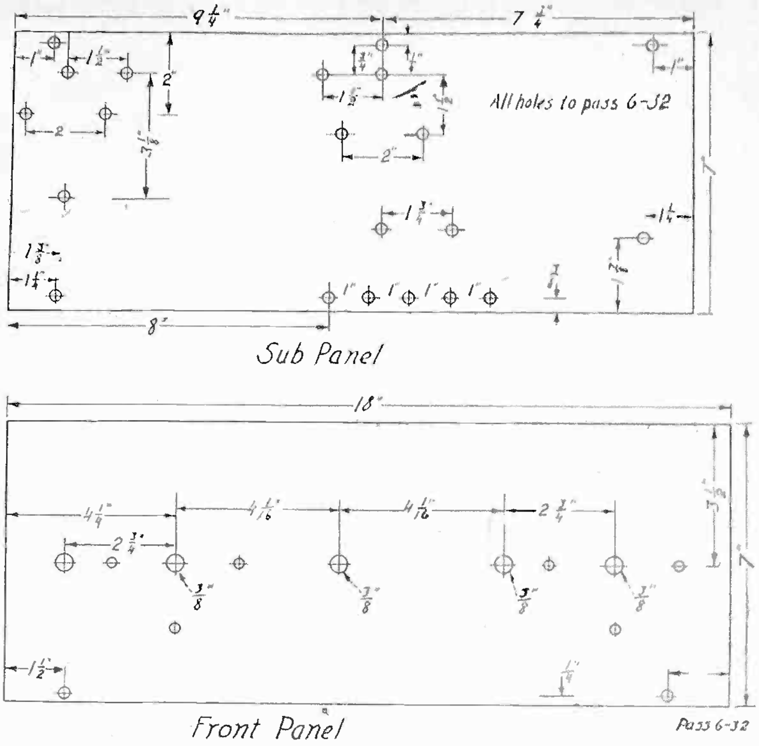


FIG. 4

CURVES SHOWING PLATE IMPEDANCE, PLATE CURRENT AND MUTUAL CONDUCTANCE OF THREE TYPES OF TUBES

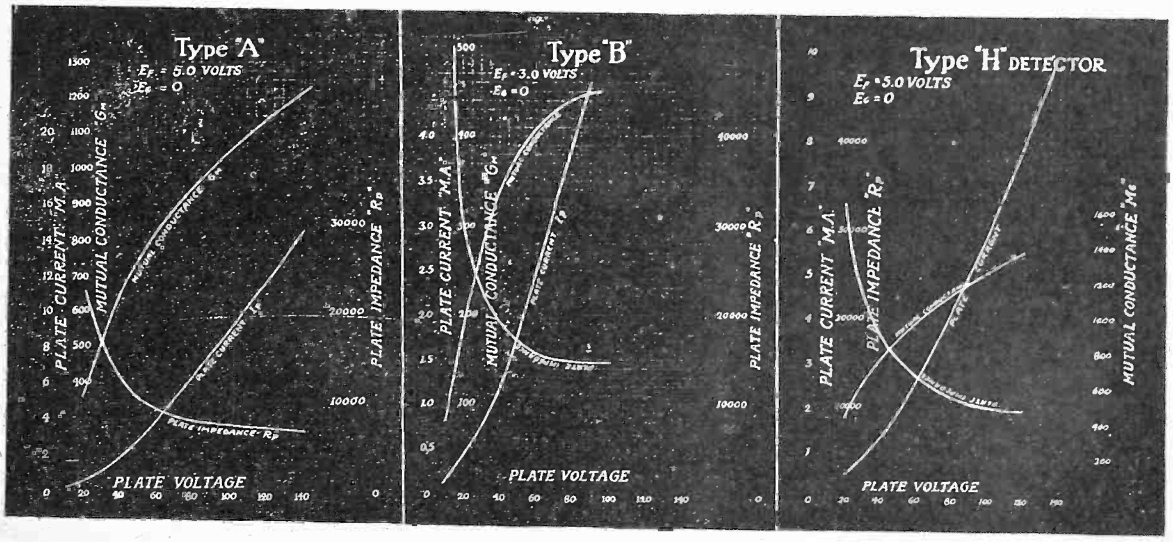


FIG. 5

THREE DIFFERENT types of tubes are charted in characteristic curves. Type A is the familiar five-volt filament tube, good as radio frequency amplifier, detector or audio frequency amplifier. Type B (or BX with large base) is the —99 variety of tube, with a filament voltage of three volts. The BX is the tube used in the De Luxe Receiver as radio frequency amplifier. The type H tube is a special detector, very sensitive, not a bit noisy and standing higher plate voltages than most other special detectors. Each curve shows the plate impedance, the plate current and the mutual conductance. Under the similar circumstances affecting tube values in the De Luxe receiver the mutual conductance may be used as the figure of merit, except that with the detector tube the plate impedance is particularly important.

may be obtained by rubbing the panel with No. 00 sandpaper. Long strokes running the full length of the panel should be made and care used to avoid any circular or cross motion. When all the "gloss" has been removed, the panel should be rubbed with a soft rag moistened with light machine oil, such as 3-in-1. Should the original high gloss finish be preferred, then extreme care should be exercised in handling the panel so as not to scratch it.

Mounting and Wiring

When the panel and sub-panel have been prepared the parts may be mounted in place. First mount the two tuning units, switch and volume control on the front panel, and then the dial. Although it is generally customary to mount the dials last, in this particular instance it will be found more convenient to mount them before mounting the sub-panel, a with the sub-panel in place, it is rather difficult to fasten the studs that hold the bottom of the dials against the panel.

With the dials mounted, next mount the sockets, Equalizors, binding posts and midget condensers on the sub-panel and finally fasten the sub-panel to the front panel.

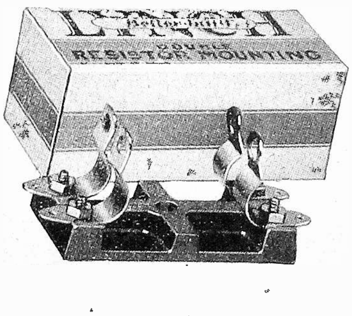
As soon as all of the different units have been fastened in their proper places the set is ready to wire. It is recommended that an insulated flexible wire, such as the Runzel-Lenz triple insulated radio set wire, be used for this purpose. There are really very few connections to be made and by carefully following the circuit diagram given in Fig. 1, and following the photographs no trouble should be encountered.

Right Tubes Improve Results

A CeCo type BX tube is used in the radio frequency amplifier. Several reasons are responsible for the selection of this tube for the purpose. First its low internal capacitance makes possible the ready neutralization of the amplifier; second, its electrical characteristics, especially internal capacitance and plate impedance, are such as to work to the best advantage with the National tuning units, and third its low filament power consumption makes its operation most economical.

At first thought it might seem as if the use of a similar tube as a detector might also be advantageous. While the CeCo type B may be used with good results where it is essential to reduce the filament power consumption to a minimum it is highly recommended that new CeCo type H special sensitive detector tube be used instead. This tube has the advantage over other special detector tubes, such as the 200A, in that it is neither noisy nor microphonic. The real merit of the special detector tube can readily be demonstrated by tuning in a distant station, using the special detector tube and then changing to a 201A type tube and attempting to tune in the same station. The result is most remarkable. Stations that were clearly audible with the special detector tube can hardly be heard with the ordinary tube.

But what concerns us most of all is the remarkable improvement noticeable in audio tone quality when using the CeCo



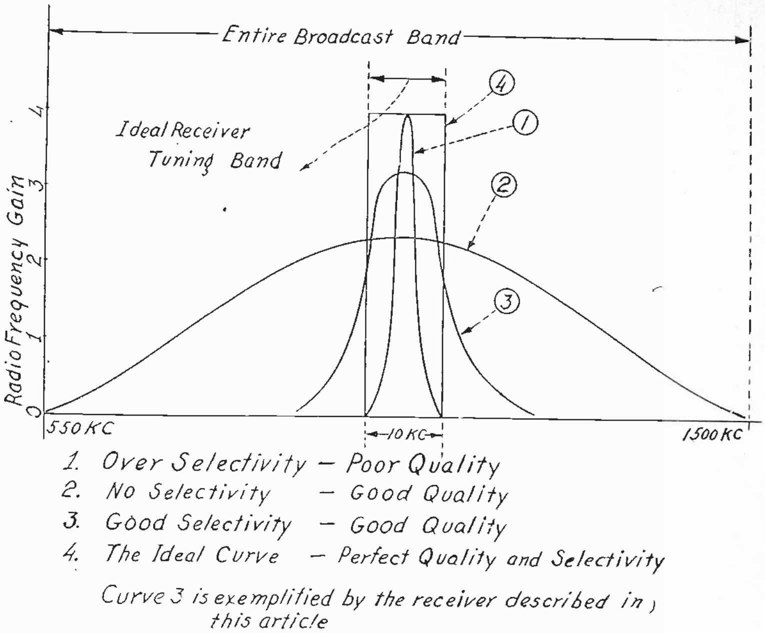


FIG. 6

type H special detector tube. It is a well known engineering fact that for the best of audio quality the impedance of the choke coil, resistance, or audio transformer primary in the plate circuit of a tube should be greater than the plate to filament impedance of the tube. Furthermore, this relation has a much more marked effect in the plate circuit of the detector tube than in any of the audio tubes. As a result, it is exceedingly important that the impedance of the primary of the first audio transformer or of the choke coil in the case of impedance coupled amplifier be quite high. Practically, however, it is not desirable to wind an audio transformer primary or a choke coil for an impedance coupled amplifier with an inductance in excess of about 100 henries. Now, suppose the lowest note that we wish our amplifier to reproduce properly is that which corresponds to three octaves below middle C on the piano, or 32 cycles, the impedance of a 100 henry inductance is $WL=2\pi f l=2\pi 32x100=19{,}840$ ohms. Now, then, in order that this impedance be equal to or greater than the tube plate to filament impedance, we must employ a detector tube with plate impedance, under operating conditions, which is less than 20,000 ohms. By studying the three curves, Fig. 6, 7 and 8, it will be seen that while the desired condition cannot be reached by any of the tubes under normal operating conditions the H tube comes very much closer to meeting the ideal conditions than either of the other tubes.

It may be of interest at this time to point out one of the many reasons why resistance coupled audio amplification is in many ways superior to all others. The impedance of a 0.1 meg. coupling resistor is always the same, 100,000 ohms, regardless of the frequency, so that even at 32 cycles, which corresponds to about as low a note as any one would want to amplify, the impedance of the coupling unit is several times the tube plate impedance.

[In the next issue of Radio World will be described the construction of the lamp socket operated power amplifier for use with this receiver. Then the following week the author will tell how to connect the amplifier and receiver together and to operate and adjust both so that the best of results may be obtained.]

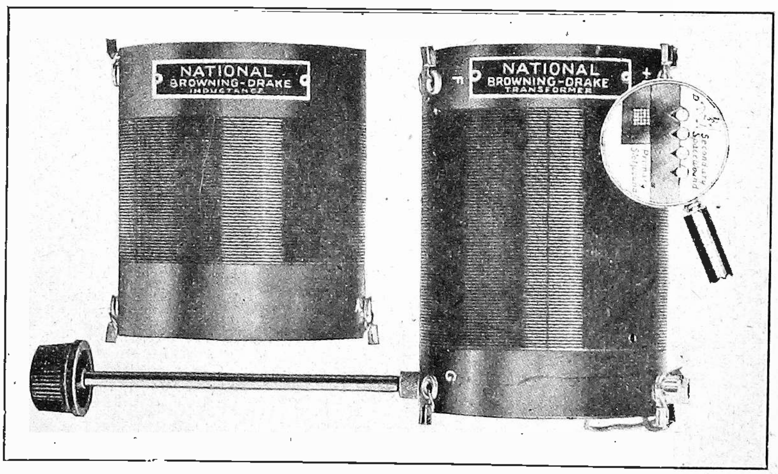
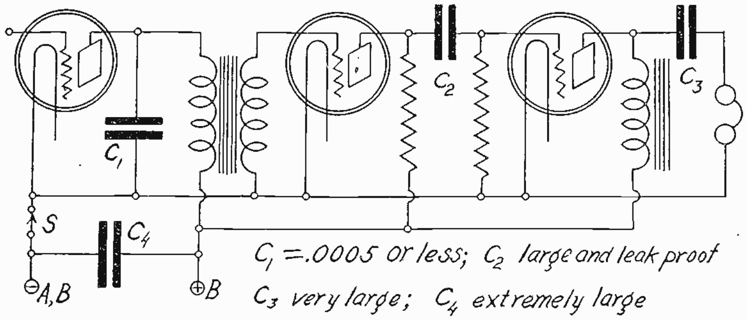


FIG. 7
The coils used in the receiver are space-wound, with primary in a slot. At left is Lynch mounting.

What Size Fixed Condensers

For High, Low and Composite Frequencies?

By J. E. Anderson
Consulting Engineer



A CONDENSER is simply a storage tank of electricity, and its capacity, like that of any other tank, depends mainly upon its dimensions. Knowing the capacity of a condenser, it is easy to determine how much electricity may be stored in it under different conditions.

The amount of electricity that may be stored in a condenser not only depends on the capacity but also on the voltage applied across the condenser's terminals. This is not because of some mysterious property of the condenser but because of a property of the stuff that is stored in it, that is a property of electricity. That property is compressibility.

Suppose we have a water tank which will hold 100 gallons. If pressure be put on the water not more than 100 gallons can be put into the tank, because water is not compressible. Thus the amount of water that may be put into the tank depends on the capacity of that tank only.

Now suppose that we fill the same tank with air at atmospheric pressure. The amount of air in the tank will of course be 100 gallons.

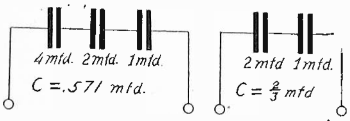
The Result of Pressure

But now suppose that a high pressure pump be attached to the tank. More air may be forced into it. If the pressure in the tank be raised to five atmospheres the amount of air in it will be just five times as great as it was when the pressure was only one atmosphere. The capacity of the tank remains at 100 gallons, but the amount of air that is in it depends also on the pressure. The same is true of the condenser or electric tank. Its capacity depends on its dimensions, and the amount of electricity that it will hold depends on the capacity and on the pressure to which the electricity is subjected, that is, to the voltage.

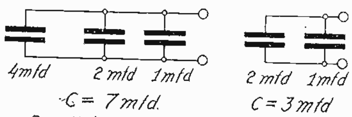
If the condenser has a capacity of one farad, one volt will force a quantity of one coulomb into the condenser, the coulomb being merely the practical unit of measure of electrical quantity. In radio one deals with microfarads and micro-microfarads. A condenser of common occurrence in radio has a capacity of .001 microfarads. If the voltage across this condenser be 100 volts, the charge in the condenser is one ten millionth part of a coulomb.

Measurement of Charge

A common size of bypass condenser used in filters is 4 microfarads, and a common voltage is 250 volts. When the voltage across the 4 mfd. condenser is 250, the charge in the condenser is one thousandth of a coulomb. This is still a small charge as far as its numerical value is concerned but enough to make itself felt should it be discharged through the hand.



Series Connections of Condensers



Parallel Connections of Condensers

Two or more condensers may be combined in different ways to form a single condenser, or rather a single capacity. The two main methods of connecting condensers are in series and in parallel. When two or more are connected in parallel the capacity of the combination is obtained by simply adding the several capacities. For example, if three condensers having capacities 4, 2 and 1 mfd. are connected in parallel the capacity of the combination is 7 mfd.

When condensers are connected in series the capacity of the combination is obtained by taking the reciprocal of the sum of the reciprocals of the several condensers. For example, if the three condensers above are connected in series the resulting capacity may be obtained in the following manner: The reciprocals of 4, 2 and 1 are respectively ¼, ½ and 1. The sum of these is 1¾.

The capacity of the three condensers in series is then the reciprocal of 1¾, which is equal to 7/4 inverted, or 4/7, or 0.571 mfd. in decimals. The capacity of a series of condensers is always less than the smallest condensers in that series, and the larger the condenser is in a series the less that condenser affects the capacity of the combination. This is illustrated in the foregoing example. The smallest condenser in the series is 1 mfd. and the capacity of the combination is not much more than half of that. Again, suppose that the three condensers have capacities of 10, 2 and 1 microfarads. The reciprocals then are 1/10, ½ and 1. The sum of these numbers is 1.6. The reciprocal of 1.6 is ⅝ or 0.625 mfd., which is the capacity of the series of three condensers of 10, 2 and 1 microfarads.

A Closed Circuit

If the first condenser is infinite, the reciprocal of its capacity is zero and it has no effect on the combination, that is, there are only two condensers in the series. The capacity of these two in series is 2/3 mfd., which is only a little larger than the ⅝ of the 10, 2 and 1 combination. A condenser of infinite capacity is equivalent to a closed circuit as far as that condenser is concerned.

The choice of a fixed condenser in a circuit depends mainly on the particular purpose for which it is to be used. The first consideration should be the voltage which it will stand without breaking down. There is a limit of voltage for every condenser, just as there is a pressure limit in an air tank. If this limit is exceeded there will be a rupture. The margin of safety in a condenser should be quite large, because in most cases a breakdown will result in disaster to some other part or parts of the circuit.

Having made sure that the condenser will stand the requisite voltage, the next consideration is that of capacity. Shall it be a large one or a small one? If the purpose is to by-pass it should be large, and how large depends on the completeness of the by-passing that is necessary and on the frequency of the current that is to be by-passed. If the freqency is high only a small condenser is required, as in radio frequencies, otherwise high notes are attenuated, but if the frequency is low the condenser must be large. For extremely low frequencies the condenser must be very large. The size required in any particular case is determined by the impedance of the condenser at the frequency in question. The impedance should be very small. It may be determined by the reciprocal of the capacity and the frequency divided by the number 6.28. Thus at 100 cycles the impedance of a 4 microfarad condenser is nearly 400 ohms, at 1,000 cycles it is 40 ohms, at 1,000,000 cycles it is .04 of an ohm. For practical purposes the impedance may be obtained by dividing the number .16 by the frequency in cycles plus the capacity in farads.

Large One for B Battery

For by-passing a B battery at audio frequencies the condenser should be not less than 1 mfd., and it should be as much larger as one's purse will permit and as necessity will dictate.

At radio frequencies, such as are used in broadcasting, a capacity of .1 mfd, is sufficient in most cases where it is to be used as a by-pass across batteries or other primarily direct current parts. But if the part also carries audio frequencies, and must carry them for successful operation of the circuit, the radio frequency bypass should be not larger than absolutely necessary to accomplish the work. Thus a by-pass condenser in the detector plate circuit, whether used across a coupling resistor or across the primary of a transformer, the condenser should not be over .0005 mfd., unless a larger value is absolutely required to make the circuit operative. If the circuit operates without any by-pass condenser at all, so much the better.

Dielectric is Different

By-pass condensers and filter condensers are the same. A by-pass condenser is a filter condenser, and vice versa. It makes no difference how large or how small a condenser may be, so far as the existence of filtering is concerned. A paper condenser of very large capacity is no more a filter than a small mica condenser.

The only difference between a paper condenser and a mica condenser is the

(*Concluded on page 8*)

may be obtained by rubbing the panel with No. 00 sandpaper. Long strokes running the full length of the panel should be made and care used to avoid any circular or cross motion. When all the "gloss" has been removed, the panel should be rubbed with a soft rag moistened with light machine oil, such as 3-in-1. Should the original high gloss finish be preferred, then extreme care should be exercised in handling the panel so as not to scratch it.

Mounting and Wiring

When the panel and sub-panel have been prepared the parts may be mounted in place. First mount the two tuning units, switch and volume control on the front panel, and then the dial. Although it is generally customary to mount the dials last, in this particular instance it will be found more convenient to mount them before mounting the sub-panel, as with the sub-panel in place, it is rather difficult to fasten the studs that hold the bottom of the dials against the panel.

With the dials mounted, next mount the sockets, Equalizors, binding posts and midget condensers on the sub-panel and finally fasten the sub-panel to the front panel.

As soon as all of the different units have been fastened in their proper places the set is ready to wire. It is recommended that an insulated flexible wire, such as the Runzel-Lenz triple insulated radio set wire, be used for this purpose. There are really very few connections to be made and by carefully following the circuit diagram given in Fig. 1, and following the photographs no trouble should be encountered.

Right Tubes Improve Results

A CeCo type BX tube is used in the radio frequency amplifier. Several reasons are responsible for the selection of this tube for the purpose. First its low internal capacitance makes possible the ready neutralization of the amplifier; second, its electrical characteristics, especially internal capacitance and plate impedance, are such as to work to the best advantage with the National tuning units, and third its low filament power consumption makes its operation most economical.

At first thought it might seem as if the use of a similar tube as a detector might also be advantageous. While the CeCo type B may be used with good results where it is essential to reduce the filament power consumption to a minimum it is highly recommended that new CeCo type H special sensitive detector tube be used instead. This tube has the advantage over other special detector tubes, such as the 200A, in that it is neither noisy nor microphonic. The real merit of the special detector tube can readily be demonstrated by tuning in a distant station, using the special detector tube and then changing to a 201A type tube and attempting to tune in the same station. The result is most remarkable. Stations that were clearly audible with the special detector tube can hardly be heard with the ordinary tube.

But what concerns us most of all is the remarkable improvement noticeable in audio tone quality when using the CeCo type H special detector tube. It is a well known engineering fact that for the best of audio quality the impedance of the choke coil, resistance, or audio transformer primary in the plate circuit of a tube should be greater than the plate to filament impedance of the tube. Furthermore, this relation has a much more marked effect in the plate circuit of the detector tube than in any of the audio tubes. As a result, it is exceedingly important that the impedance of the primary of the first audio transformer or of the choke coil in the case of impedance coupled amplifier be quite high. Practically, however, it is not desirable to wind an audio transformer primary or a choke coil for an impedance coupled amplifier with an inductance in excess of about 100 henries. Now, suppose the lowest note that we wish our amplifier to reproduce properly is that which corresponds to three octaves below middle C on the piano, or 32 cycles, the impedance of a 100 henry inductance is $WL=2\pi f l=2\pi 32 \times 100=19,840$ ohms. Now, then, in order that this impedance be equal to or greater than the tube plate to filament impedance, we must employ a detector tube with plate impedance, under operating conditions, which is less than 20,000 ohms. By studying the three curves, Fig. 6, 7 and 8, it will be seen that while the desired condition cannot be reached by any of the tubes under normal operating conditions the H tube comes very much closer to meeting the ideal conditions than either of the other tubes.

It may be of interest at this time to point out one of the many reasons why resistance coupled audio amplification is in many ways superior to all others. The impedance of a 0.1 meg. coupling resistor is always the same, 100,000 ohms, regardless of the frequency, so that even at 32 cycles, which corresponds to about as low a note as any one would want to amplify, the impedance of the coupling unit is several times the tube plate impedance.

[In the next issue of Radio World will be described the construction of the lamp socket operated power amplifier for use with this receiver. Then the following week the author will tell how to connect the amplifier and receiver together and to operate and adjust both so that the best of results may be obtained.]

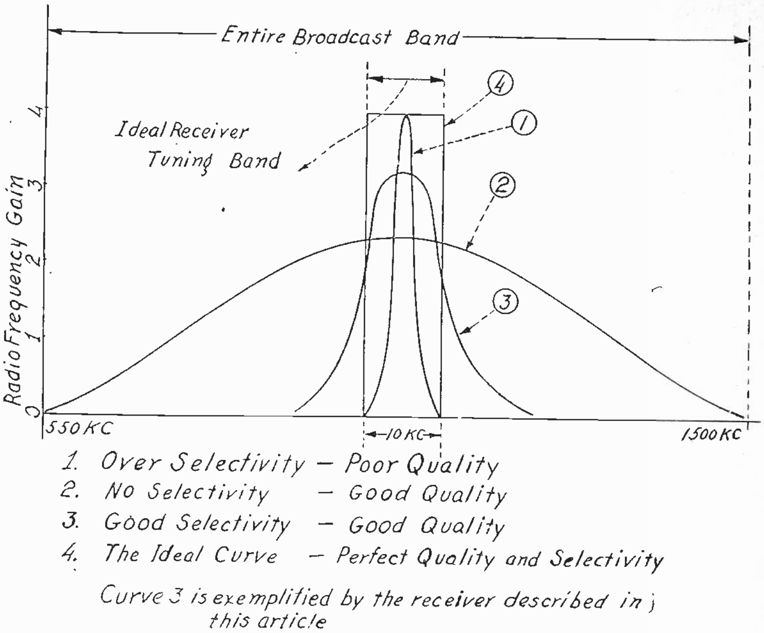
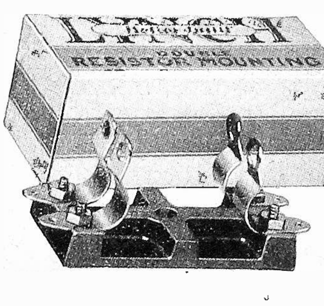


FIG. 6



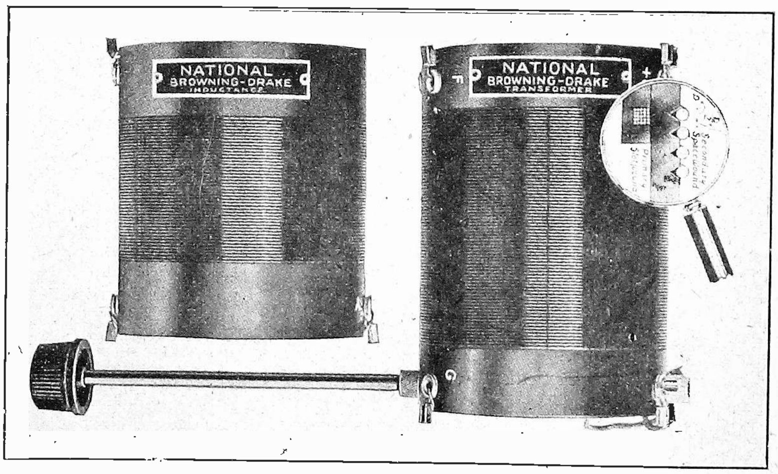
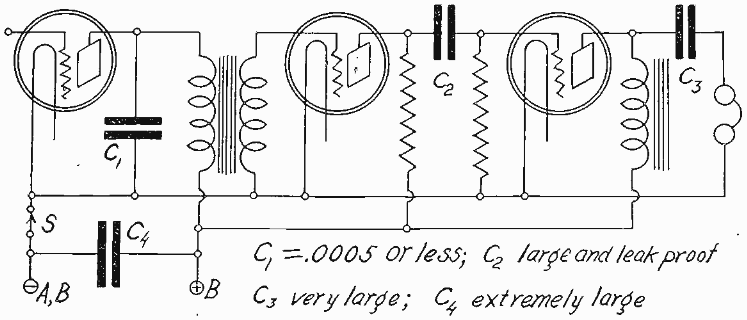


FIG. 7
The coils used in the receiver are space-wound, with primary in a slot. At left is Lynch mounting.

What Size Fixed Condensers For High, Low and Composite Frequencies?

By *J. E. Anderson*
Consulting Engineer



A CONDENSER is simply a storage tank of electricity, and its capacity, like that of any other tank, depends mainly upon its dimensions. Knowing the capacity of a condenser, it is easy to determine how much electricity may be stored in it under different conditions.

The amount of electricity that may be stored in a condenser not only depends on the capacity but also on the voltage applied across the condenser's terminals. This is not because of some mysterious property of the condenser but because of a property of the stuff that is stored in it, that is a property of electricity. That property is compressibility.

Suppose we have a water tank which will hold 100 gallons. If pressure be put on the water not more than 100 gallons can be put into the tank, because water is not compressible. Thus the amount of water that may be put into the tank depends on the capacity of that tank only.

Now suppose that we fill the same tank with air at atmospheric pressure. The amount of air in the tank will of course be 100 gallons.

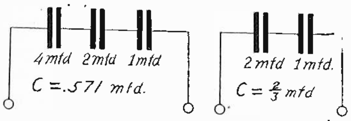
The Result of Pressure

But now suppose that a high pressure pump be attached to the tank. More air may be forced into it. If the pressure in the tank be raised to five atmospheres the amount of air in it will be just five times as great as it was when the pressure was only one atmosphere. The capacity of the tank remains at 100 gallons, but the amount of air that is in it depends also on the pressure. The same is true of the condenser or electric tank. Its capacity depends on its dimensions, and the amount of electricity that it will hold depends on the capacity and on the pressure to which the electricity is subjected, that is, to the voltage.

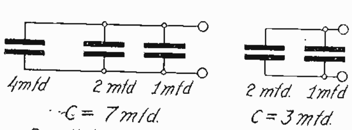
If the condenser has a capacity of one farad, one volt will force a quantity of one coulomb into the condenser, the coulomb being merely the practical unit of measure of electrical quantity. In radio one deals with microfarads and micro-microfarads. A condenser of common occurrence in radio has a capacity of .001 microfarads. If the voltage across this condenser be 100 volts, the charge in the condenser is one ten millionth part of a coulomb.

Measurement of Charge

A common size of bypass condenser used in filters is 4 microfarads, and a common voltage is 250 volts. When the voltage across the 4 mfd. condenser is 250, the charge in the condenser is one thousandth of a coulomb. This is still a small charge as far as its numerical value is concerned but enough to make itself felt should it be discharged through the hand.



Series Connections of Condensers



Parallel Connections of Condensers

Two or more condensers may be combined in different ways to form a single condenser, or rather a single capacity. The two main methods of connecting condensers are in series and in parallel. When two or more are connected in parallel the capacity of the combination is obtained by simply adding the several capacities. For example, if three condensers having capacities 4, 2 and 1 mfd. are connected in parallel the capacity of the combination is 7 mfd.

When condensers are connected in series the capacity of the combination is obtained by taking the reciprocal of the sum of the reciprocals of the several condensers. For example, if the three condensers above are connected in series the resulting capacity may be obtained in the following manner: The reciprocals of 4, 2 and 1 are respectively ¼, ½ and 1. The sum of these is 1¾.

The capacity of the three condensers in series is then the reciprocal of 1¾, which is equal to 7/4 inverted, or 4/7, or 0.571 mfd. in decimals. The capacity of a series of condensers is always less than the smallest condensers in that series, and the larger the condenser is in a series the less that condenser affects the capacity of the combination. This is illustrated in the foregoing example. The smallest condenser in the series is 1 mfd. and the capacity of the combination is not much more than half of that. Again, suppose that the three condensers have capacities of 10, 2 and 1 microfarads. The reciprocals then are 1/10, ½ and 1. The sum of these numbers is 1.6. The reciprocal of 1.6 is ⅝ or 0.625 mfd., which is the capacity of the series of three condensers of 10, 2 and 1 microfarads.

A Closed Circuit

If the first condenser is infinite, the reciprocal of its capacity is zero and it has no effect on the combination, that is, there are only two condensers in the series. The capacity of these two in series is 2/3 mfd., which is only a little larger than the ⅝ of the 10, 2 and 1 combination. A condenser of infinite capacity is equivalent to a closed circuit as far as that condenser is concerned.

The choice of a fixed condenser in a circuit depends mainly on the particular purpose for which it is to be used. The first consideration should be the voltage which it will stand without breaking down. There is a limit of voltage for every condenser, just as there is a pressure limit in an air tank. If this limit is exceeded there will be a rupture. The margin of safety in a condenser should be quite large, because in most cases a breakdown will result in disaster to some other part or parts of the circuit.

Having made sure that the condenser will stand the requisite voltage, the next consideration is that of capacity. Shall it be a large one or a small one? If the purpose is to by-pass it should be large, and how large depends on the completeness of the by-passing that is necessary and on the frequency of the current that is to be by-passed. If the freqency is high only a small condenser is required, as in radio frequencies, otherwise high notes are attenuated, but if the frequency is low the condenser must be large. For extremely low frequencies the condenser must be very large. The size required in any particular case is determined by the impedance of the condenser at the frequency in question. The impedance should be very small. It may be determined by the reciprocal of the capacity and the frequency divided by the number 6.28. Thus at 100 cycles the impedance of a 4 microfarad condenser is nearly 400 ohms, at 1,000 cycles it is 40 ohms, at 1,000,000 cycles it is .04 of an ohm. For practical purposes the impedance may be obtained by dividing the number .16 by the frequency in cycles plus the capacity in farads.

Large One for B Battery

For by-passing a B battery at audio frequencies the condenser should be not less than 1 mfd., and it should be as much larger as one's purse will permit and as necessity will dictate.

At radio frequencies, such as are used in broadcasting, a capacity of .1 mfd, is sufficient in most cases where it is to be used as a by-pass across batteries or other primarily direct current parts. But if the part also carries audio frequencies, and must carry them for successful operation of the circuit, the radio frequency by-pass should be not larger than absolutely necessary to accomplish the work. Thus a by-pass condenser in the detector plate circuit, whether used across a coupling resistor or across the primary of a transformer, the condenser should not be over .0005 mfd., unless a larger value is absolutely required to make the circuit operative. If the circuit operates without any by-pass condenser at all, so much the better.

Dielectric is Different

By-pass condensers and filter condensers are the same. A by-pass condenser is a filter condenser, and vice versa. It makes no difference how large or how small a condenser may be, so far as the existence of filtering is concerned. A paper condenser of very large capacity is no more a filter than a small mica condenser.

The only difference between a paper condenser and a mica condenser is the

(*Concluded on page 8*)

Best of Aerials Needed To-Day

To Give the Selectivity of Set Full Play

By Brewster Lee

NO other part of a receiving installation is neglected more than the aerial, and this is one of the most important parts of the entire receiving system. What is the reason for this neglect? Unwillingness to go up on the roof and get the hands dirty is one, laziness is another, the ease with which bad reception may be blamed on something else is still another.

In erecting and maintaining an antenna the radio fan very often neglects all principles of radio construction. It is not lack of knowledge of these principles that leads to atrocious antenna installations, for those who are well versed in the subject are usually just as neglectful as the novice, in this respect. But the experts attribute mediocre results to its true cause and do not blame something else, while others are likely to blame their neighbors, unwanted broadcast stations, or Congress.

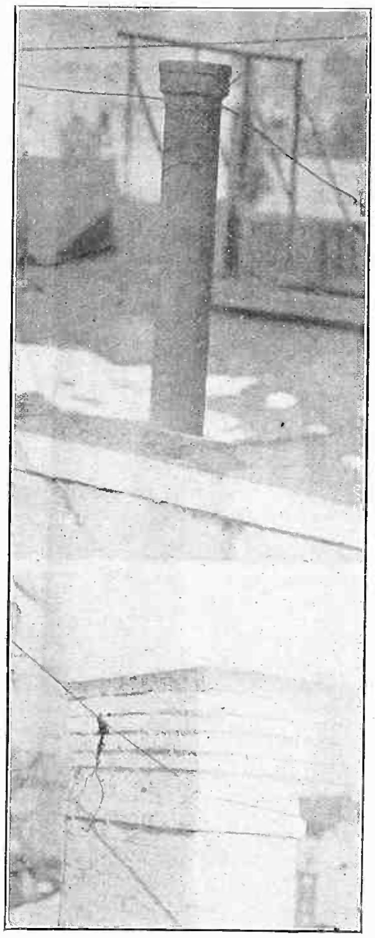
A poor antenna installation results in weak signals, lack of selectivity, cross talk between stations and receivers both, noisy signals, dissatisfaction with radio in general, and in the reception of heterodyne whistles where none need be received.

Much of this trouble could be avoided if the fan would devote part of the time he spends in complaining to attending to his antenna. If he cannot install a first-class outdoor antenna it is better by far to install a good indoor one. Most of the objections to putting up an outdoor antenna cannot be raised against the indoor one.

And when the antenna meets electrical requirements for efficiency, many of the peanut whistles now so prevalent can be reduced or eliminated, and "strange freaks" of bad reception avoided. The strangeness of them, on close inspection, proves to be merely bad installation of the antenna.

Problem for Some

What is the radio fan to do when he wants to erect an antenna on the roof and the situation is complicated? There is not only one antenna but several antennas on each roof. They run up and down, east and west, north and south, and in every conceivable intermediate direction. Yet to put up a good antenna he must run it as far away from all other antennas as possible, and by all means at right angles to the nearest antennas.



(Hayden)

FIGS. 6 AND 7.

Think what an insulator a grounded standpipe must be! (top photo) and how excellent it is to have chimney soot coming right onto your antenna!

Perhaps some Einstein will come forward and solve the problem of space for the perplexed fan. Perhaps he can give us a space with so many dimensions that each one of us will have his own. Until such a wizard comes along we will have to content ourselves with the three dimensions which are now available, and some of the antennas will have to be far from ideal. They will have to run parallel, they will have to be run near power lines, and near other objects which may distort the wave front and possibly introduce noise in the signal.

But there is no reason why an antenna should not be put up in the best possible way in the particular location in which it is to be erected. Good wire and good insulators may be used everywhere, no matter how crowded the conditions may be. In the foreground of Fig. 3 is shown a bend in a flat top antenna, and the background shows the antenna congestion in the neighborhood. The closest antenna is well put up, at least as far as the picture shows. The flat top and the leadin are continuous wire. No joint to break or corrode here. A good insulator properly used is also included.

How Not to Do It.

Perhaps the fellow who erected the antenna shown in Fig. 4 knew better, but he did not put much of his knowledge into practice. The antenna is twisted around a wooden support without any insulation. In wet weather the signals picked up by the antenna will pass into ground without making any impression on the receiver. DX will be impossible and local stations will be weak.

Fig. 7 is a photo of another example of poor antenna construction. The uninsulated wire is twisted around the chimney and tied into a fancy knot. In wet weather the chimney acts as a short circuit to ground and no appreciable signals can be received. In dry weather also there is considerable loss in the chimney due to hysteresis absorption. The signals will not be nearly as loud as if a good insulator had been placed between the antenna wire and the wire used to attach it to the chimney.

Fig. 6 is an illustration of an equally

(*Concluded on page 9*)

Isolating Condenser Must Be Leak-Proof

(*Concluded from page 7*)

dielectric, or insulating material, used to separate the conductors. Paper is used in the larger capacities because it is less expensive, and larger capacities may be put into a smaller space. However, there is a difference between the electrical properties of paper and mica, and therefore the operational characteristics of the two types will be somewhat different. Mica is a very good insulator with very low losses. Therefore condensers having this dielectric may be used in tuned circuits without introducing serious losses. They may also be used as standard condensers for measuring, because they are dependable and do not introduce losses. Paper is a comparatively poor material in avoiding losses, and condensers having this dielectric may only be used where a little loss is of no importance, such as by-passing and stopping.

One necessary property of any condenser is that it shall not leak. Paper condensers sometimes do leak, and when they do their use is limited. In some places a leaky condenser will do no harm, but in others it may completely ruin a circuit. A by-pass condenser in a B eliminator may leak without doing much or any damage; but if a condenser across a B battery leaks, it will put an additional drain on the battery and shorten the battery's life. No condenser should be left permanently connected across a B battery for this reason.

Must Not Leak Here

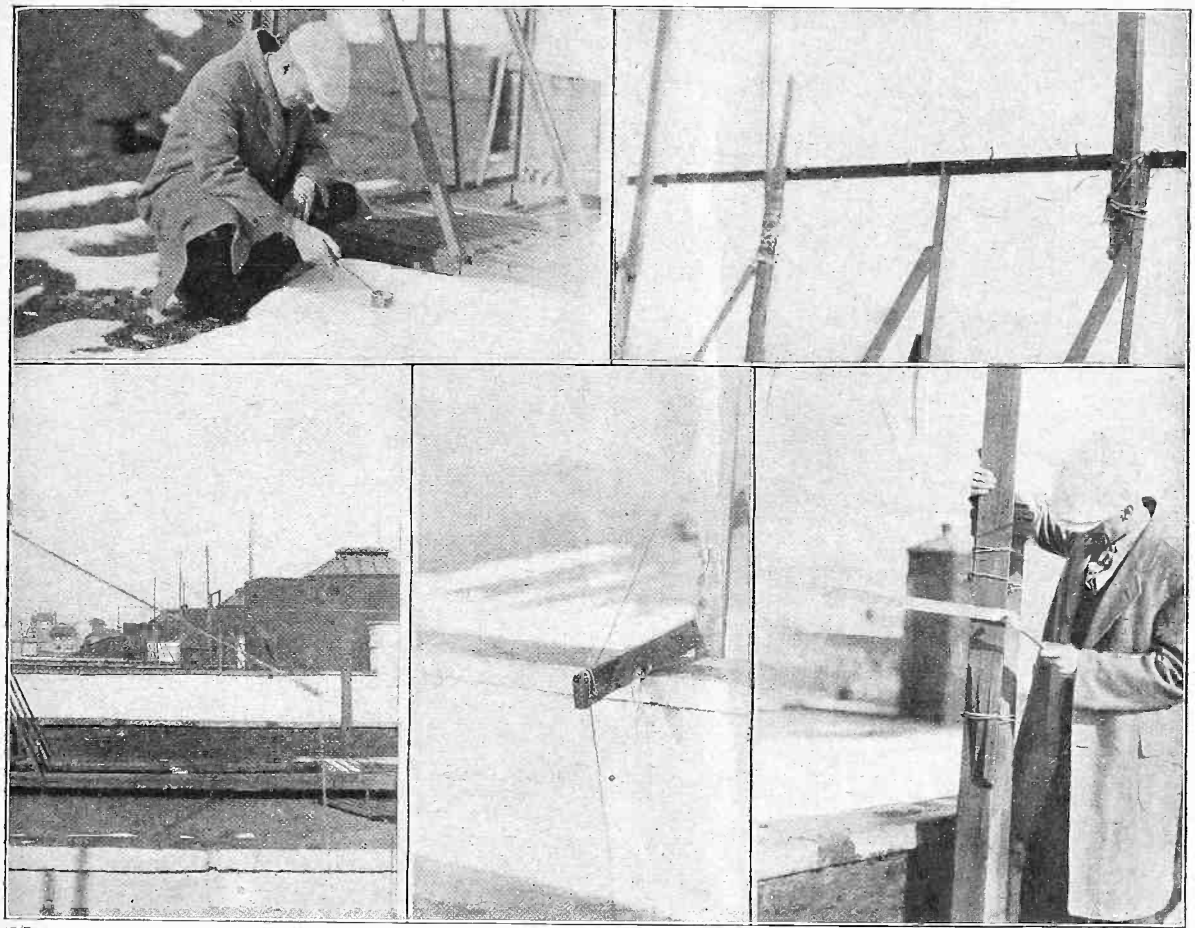
One place where a condenser must be absolutely leak-proof is in the grid circuit of a tube when it is used to isolate the grid from the plate voltage. If it leaks ever so little here the tube following it becomes erratic or absolutely inoperative. This trouble is often experienced in resistance and impedance coupled amplifiers when paper condensers are employed for stopping purposes. And here it should be pointed out that it is difficult to find a mica condenser large enough for this purpose. A small condenser will introduce distortion or suppression of the low notes, and it is almost a necessity to employ paper dielectric condensers.

One important use of a fixed by-pass condenser is to stop motorboating in circuits served by B eliminators and to stop similar audio oscillation in circuits served by B batteries of high internal resistance. In most instances the oscillation frequency is very low, as is the motor boating, and the by-pass condenser intended to stop it must be very large. A small condenser will not produce any noticeable effect. It is very difficult in some cases to get a condenser large enough to stop, or even ameliorate, the trouble.

Condenser Can Be Made

Even when paper condensers are used, cost and space are quite large. In extreme cases the only remedy may be to employ electrolytic condensers. These may be purchased in very large capacities, or they may be made at home. It is quite possible to make a 100 mfd. condenser of this type at no great expense. But electrolytic condensers are quite leaky, unless they have been very carefully made. The leakage is no particular detriment in a B battery eliminator.

Close Antennas Detune Sets
When Dials Are In Position for Same Station



(Hayden)

FIGS. 1, 2, 3, 4 AND 5

The use of canned heat solves a soldering problem (Fig. 1, top left.) Intertwined leadins are shown in Fig. 2 (top right). A good leadin but in an antenna crowded section is shown in Fig. 3 (lower left). It is poor practice to omit the leadin insulator (Fig. 4) but good practice to have a high antenna, using a mast (Fig. 5).

(*Concluded from page* 8)

bad job. Several antennas are attached to the same support and the same point of that support. And the support used is a ground iron ventilator pipe.

The Bad Effects

Several bad effects are inevitable from such construction. In the first place the energy picked up by the antenna will be shunted to ground through the iron pipe instead of going through the receiving set to ground. This energy loss takes place both through capacity and conduction. The only insulation between the pipe and the antenna wire is what insulation is on the wire. This not very thick so that capacity losses are considerable. And the insulation used is not the best for radio purposes, therefore conductive losses will be quite large. The construction is particularly bad at the far end of the antenna where the potential difference between the antenna and ground is greatest.

Another bad effect of this construction is the interaction of the various radio receivers served by these antennas. If one receiver is tuned to a certain station and then a second set is tuned in to the same station the first will be detuned. When the first is returned the second is detuned, and so on. When there are three or more antennas connected, as in Fig. 6, tuning difficulties will be multiplied. This trouble erroneously may be connected with fading or other external disturbances. Again if one set is tuned to one station and a second set to another station, both stations may be received by both receivers at the same time. This would naturally be attributed to a lack of selectivity of the receivers, where the real trouble lies in the common use of the antenna support.

Wood is No Insulator

Still another faulty antenna construction is shown in Fig. 4. The antenna and the leadin are both connected to a wooden board without any insulator. Of course the horizontal bar serves a useful purpose, in that it keeps the leadin away from the wall, reducing absorption and capacity losses to the wall. But nothing is gained when the wire is tied to the board without any insulator. There will be conductive losses to ground through the wooden strip. A couple of good insulators would have made this a good job.

One important thing for DX reception is to get an antenna up in the air. The signal picked up is proportional to the antenna height. That raises the question of how to erect the mast. In the country no difficulty is experienced, because a hole may be dug in the ground and a tall mast put into it. But in the city, where one must start with the roof of an apartment building, the problem is not so simple. One cannot dig a hole in the roof. Fig. 5 shows one way how the antenna may be raised above the roof. A light mast is securely tied to the steel pipe of the ventilator. The pipe is almost completely hidden in the picture.

Incidentally the picture also illustrates how a leadin may be kept away from the wall. A light horizontal bar is nailed to the upright mast and the leadin wire is attached to the far end of the horizontal bar. The insulator on the end of this bar is not shown but it is there.

If there are any joints in the antenna wire or leadin they should be thoroughly soldered. But to solder the iron must be hot. There is no electric outlet on top of the roof, and no stove either. Of course, a blow torch may be brought up and the iron heated with that. But not many have blow torches. The difficulty may be overcome very simply by getting some canned heat in the drug store and heating the iron with that. (Fig. 1.)

THE INTERMEDIATE MODULATION

The Super-Heterodyne intermediate frequency has all the modulation characteristics of the incoming station frequency. Only the wavelength is changed, not the modulation.

The Twin-Choke Amplifier

Uncanny In Realism, Says Kenneth Harkness

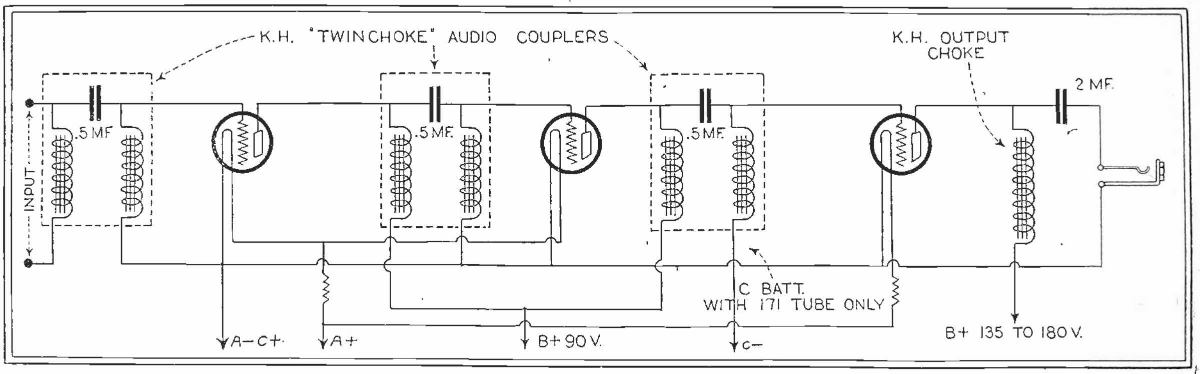


FIG. 1
The electrical circuit diagram of the amplifier unit.

By Kenneth Harkness

Noted Designer of the Harkness Reflex and the Counterflex

THE audio frequency amplifier described in this article uses an entirely new system of amplification on which patents have recently been granted. The system is known as "twin-choke" amplification.

From a technical point of view the operation of this amplifier upsets many of the hitherto accepted principles of audio frequency amplification. To the practical set-builder, however, the most interesting feature of the amplifier is the remarkable quality of tone reproduction.

It has been my privilege to devote nearly two years to experimental work in connection with audio frequency amplifying systems. During this time I experimented with almost every known type of audio amplifier in an attempt to find the most suitable for broadcast reception. In this twin-choke amplifier I believe I have found the perfect amplifier for this purpose. It has given me an entirely new conception of radio reproduction of voice and music.

Of Uniform Value

The realism of the reproduction is almost uncanny to one who hears it for the first time. It has a natural, life-like quality which is almost indescribable but is readily appreciated when heard. The rendition of pianoforte music is somewhat of a revelation. There is no rattling or crashing. The loudest chords of the fortissimo passages are just as clear and musical as the softer passages and just as free from distortion. In the recreation of orchestral music, too, each instrument is clearly heard and yet contributes its true share to the resulting harmony of sound. The deep-toned and percussion instruments, badly distorted by many amplifiers, are heard with their full and true volume. These bass notes are musically reproduced. They are not just toneless vibrations of a cone speaker.

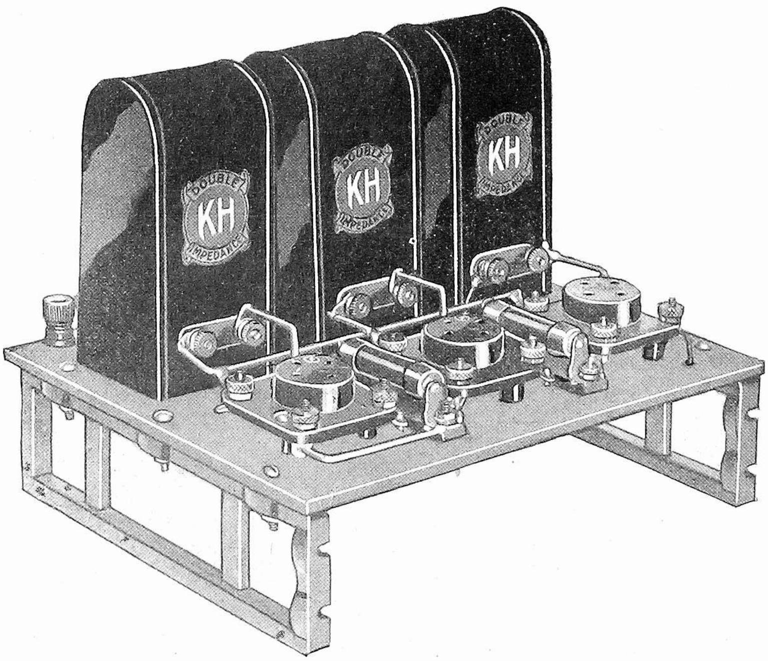


FIG. 2
Three-quarter view of the unit.

Some of the reasons for the excellent tone quality of the twin-choke amplifier follow:

It is recognized that considerable volume, or power output, is necessary to obtain good tone quality. Moreover, the greater the available power the better the tone reproduction will be, even if all the available power is not utilized. It is interesting, then, to know that the twin-choke ampli' :r can handle four times as much volume as any other type of amplifier under the same conditions. The power output is four times as great as that of any other system.

That is to say, if the overload limit of a transformer, resistance or ordinary impedance amplifier is reached by a certain volume of output it would take four times as much volume to reach the overload limit of a twin-choke amplifier, using the same tubes and battery voltages. As a matter of fact, sufficient power output can actually be obtained with ordinary tubes and battery voltages to give reproduction which other types of amplifiers can achieve only by the use of extremely high voltages and high power tubes.

Amplification Curve

The almost uniform amplification of all audio frequencies is also responsible for the realistic tone quality of this amplifier. From 50 to 12,000 cycles, from the lowest bass note to the highest overtone or harmonic, the amplification is practically even. In other words the "curve" is almost a straight line. This means that there is little or no frequency distortion in the coupling devices and that speech and music are reproduced in pure, natural tones.

As an incidental reason for the excellent tone quality of this new type of amplifier is the output tone filter, which passes all direct current to the plate of the last tube and permits only audio frequency currents to pass through the speaker.

Twin-choke Coupling Units

An additional feature of the twin-choke amplifier is the high voltage amplification it affords for an amplifier of this type. Using the same tubes and batteries, a three-stage twin-choke amplifier provides about one-third more amplification than a standard two-stage transformer coupled amplifier. Contrasted with the ordinary resistance or impedance amplifier this is extremely high amplification.

By referring to the wiring diagram of

Magnetic Coupling Avoided

And Capacity Alone Unites the Circuits

Fig. 1 it may be seen that the twin-choke amplifier is similar, in most respects, to the familiar "impedance-coupled" amplifier. However, the high resistance grid leaks used in standard resistance and impedance-coupled amplifiers are not employed in this new system. Audio choke coils, or impedances, are used instead.

Each coupling unit consists of two identical choke coils, one acting as the plate impedance and the other as the grid impedance. The two chokes are coupled only by a 0.5 mfd. condenser connected from the end of one choke to the corresponding end of the other. There is no magnetic coupling between the chokes. The two chokes and the coupling condenser are all enclosed in a metal case to form a complete unit with primary and secondary terminals. Each coupler is connected in the circuit in the same manner as a transformer, as shown in the wiring diagram.

The construction of the twin-choke coupler, as described above, is entirely new and original. This system of amplification should not be confused with "dual impedance" or any other amplifiers which have recently been introduced. Unfortunately, it is not possible to clearly show in a schematic wiring diagram the important difference between the twin-choke and other double impedance systems. The difference lies in the patented construction of the coupling unit. The two chokes of the twin-choke coupler are mounted on a "figure 8" laminated iron core which has the effect of eliminating practically all magnetic coupling between the chokes. They may, in fact, be regarded as two entirely independent choke coils, coupled only by the coupling condenser. There is no transformer action. The coupling units of other dual impedance systems are not constructed in this way although the schematic wiring diagrams may have the same appearance. The twin-choke amplifier is fundamentally dissimilar. Its distinctive features depend, in large measure, upon the absence of magnetic coupling between each stage of the amplifier.

How to Build the Amplifier

The three-stage twin-choke amplifier illustrated on this page may be used as a separate unit with any type of receiving set, taking the place of the audio amplifier in the receiver. The A and B batteries used to operate the set are also used to supply power to the amplifier.

While the amplifier is shown as a separate unit it will be realized that set-builders may, of course, incorporate the entire amplifier into their sets. The parts may be mounted on the sub-panel of the set itself in the same manner as they are mounted on the panel of the amplifier or the amplifier may be constructed separately and attached to the front panel of the receiving set. The brackets which support the amplifier are provided with holes for mounting to a front panel. The unit is very compact, being only 8½" long by 7" deep.

The parts required to build the amplifier are listed in another column. The panel on which the instruments are mounted is not a standard size but most dealers can cut this panel for you, or you can cut it yourself with a hack-saw and smooth the edges with a file.

When the panel has been cut to the correct size, the centers for boring the holes should then be laid out (See Fig. 6 in next week's issue.) Lay out the center holes on a piece of paper the same size as the panel, then fasten the paper to the panel and mark the centers with a center-punch. Finally, remove the paper template and drill the holes in the panel.

If a ready-made drilled and engraved panel is bought the work described above will not be necessary. The panel, in this case, is completely drilled and the battery markings are engraved alongside the binding posts.

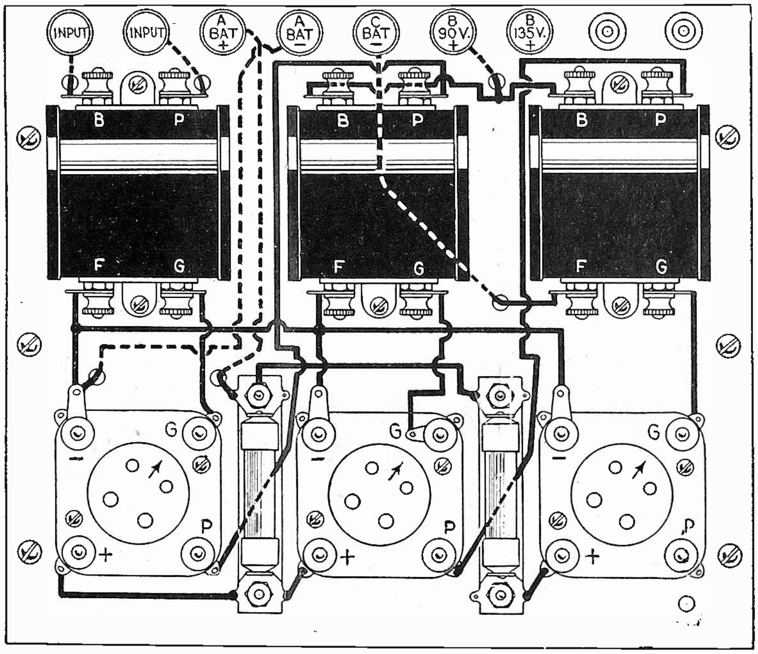


FIG. 3
Picture wire diagram of upper portion of subpanel.

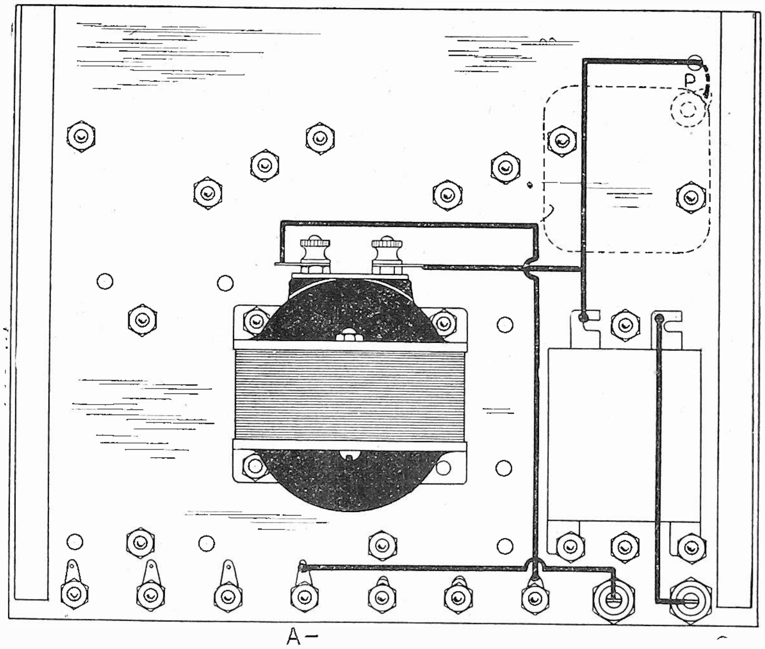


FIG. 4
Bottom wiring diagram.

When the panel has been prepared, or a ready-made panel purchased, the builder is ready to assemble the amplifier.

First attach the two bakelite mounting brackets on the lower side of the sub-panel, mounting them so that the holes for screwing to the front panel face the front of the unit, as shown in the photograph. Then mount the output filter choke coil and the 2 mfd. filter condenser

(Continued on page 27)

Sarnoff Looks to Short Waves

Expects Their Use to End Interference

[*While the use of short waves, say below 200 meters at least, for broadcast transmission and reception has been a much debated subject, with the negative side stressed, recent veiled statements of important executives gives rise to the belief that adoption is probable. Some of the stations controlled by the National Broadcasting Company and the Westinghouse Company have been conducting extensive experiments in transmission, other than those tests publicly announced. Better knowledge of the problems involved has led to more satisfactory telephony even below 100 meters. There was some talk in New York City that one station there soon would operate a short wave broadcasting station daily.*

David Sarnoff, in the article that follows, treats of short waves as well as of the problems of static, fading and wave propagation, and touches on the educational factor in radio.]

By David Sarnoff

Vice-President and General Manager, Radio Corporation of America

THE building of a transmitting or broadcasting station and the construction of a radio receiving set have become matters of practical engineering and precise manufacture. We also know that electrical energy generated at a given frequency can be radiated in the form of electrical waves which travel in every direction. We know, too, some of the laws that govern the effective detection and utilization of such electrical signals and we have developed methods of amplifying these signals till they reach an audibility satisfactory to the human ear.

But of the laws that govern the propagation of electro-magnetic waves over the earth and through the air we know little. In this field we encounter a bewildering haze of theory. Much further scientific investigation is required before the problems will be solved.

More DX Over Salt Water

We know that with the same given power at the transmitting station we can cover greater distance over salt water than we can over land; we can in general cover greater distance over flat land than over hilly country, over moist land than dry land. We have noted the absorption of wave energy by mineral deposits in the earth. We are just beginning to glimpse the possibilities of short wave transmission—that is, transmission with wavelengths of 100 meters or less. We find, in some instances, that reception is good at a point 2,000 miles from the transmitter and very poor at a distance of 200 miles. We are able to cover extraordinary ranges with low power short-wave transmission, but often are unable to communicate over comparatively short distances. But the fact remains that our understanding of the physical phenomena involved has made comparatively little advance over the theories formulated by Faraday and Maxwell. The field for exploration there is as wide as the art of radio itself.

Three Basic Technical Problems

The great technical problems of radio communication are static, interference, and fading. We have discovered many palliatives for these ills but no cures.

The proposed solutions of the problem presented by static, as Dr. E. F. W. Alexanderson so ably points out, have been dominated by two working theories. One is that static is a disturbance in the atmosphere, different in its electrical nature from a radio signal. The second theory is that the disturbing waves resemble the signal but come from all directions, while the signal itself comes from only one direction. Under the first theory we have attempted to filter out the static electrically, but we find that we often leave a residue of signal almost too weak for usefulness. The Radio Corporation of America has been much more successful in its application of the second theory, whereby a system of reception is used that responds selectively to the waves from one direction and excludes those from other directions.

Beyond the highly-selective methods of reception already adopted, one of the greatest hopes of solving the problem of interference, that jumble of transmission between signals from different stations, lies in the further exploration of short wave transmission. Short wavelengths promise to open up not only new paths for wave propagation, but a large number of useful communication channels.

Consider that almost all the long-wave transoceanic telegraph stations in the world are crowded into a frequency band about 15,000 cycles wide, whereas the available short-wave field below 100 meters includes approximately 30,000,000 cycles, and you will have some indication what the future may bring forth in the way of additional radio communication facilities.

Of the mysteries of "fading," that largely inexplicable diminution of signal strength, we know only that there are three kinds: First, is the great variation between daylight and night reception; second, is the sharp decrease of signal strength which is usually observed around sunrise and sunset; and, third, is the sudden variation of signal strength in broadcasting, when a sharp rise or a sharp drop may be noted of two or three seconds or even of many minutes' duration, down to periods so short that the variation becomes an audible frequency modulation which distorts the signal.

Radio Waves and Light Waves

One might almost wonder at the self-restraint of modern science in leaving so much to be discovered by the generations of future scientists. In our investigations of the behavior of electro-magnetic waves we seem to be trembling on the edge of many fundamental facts. Light itself, as Professor Pupin and other great authorities have shown us, is an electro-magnetic phenomenon, and the electrons that compose every atom in the blazing sun are each busy though tiny broadcasting stations, sending their messages in all directions.

A more exact knowledge of the possible transformations of light waves and electro-magnetic waves would bring the day nearer when the transmission of sight by radio would be as common as the transmission of sound. We have cleared much of the ground in this direction. We have already demonstrated the possibility of the wireless transmission of images over great distances. Photographs of current events sent by radio to and from London have been published within a few hours by the newspapers of the two cities. We have transmitted photographs by wireless across the American continent, from Honolulu to New York, and this development continues apace.

More fundamental discoveries with regard to the handling of light waves and electro-magnetic waves must be made before television, the art of transmitting instantaneously changing scenes and moving objects, can be considered an accomplished fact. The vista which such a period of radio transmission would open up, especially in the realm of higher education, is inspiring indeed. To the power of exposition now inherent in sound broadcasting would be added the power of demonstration made possible by the broadcasting would be added the power of demonstration made possible by the broadcasting of sight.

A Boon to Motion Pictures

In one respect at least this problem has been solved in our electrical laboratories, that is, in the synchronizing of sound and sight. It is no longer disclosing a laboratory secret to announce that the Radio Corporation of America will soon demonstrate publicly a method of speech and musical synchronizing particularly adapted to the motion picture art and using the latest principles of sound reproduction developed for radio.

The New Relationships

From whatever angle radio is viewed, the great opportunities are before, not behind. Radio has created a multitude of new problems, which cry to be led out of the wilderness.

Let us consider, for example, the problem of regulation, and the definition of radio rights in the air. These are entirely virgin subjects in law. One of the basic problems to be solved is the ownership of the air space above the land and water. Shall we heed or cast aside the ancient maxim, "That he who owns land owns it to the heavens above and to the center of the earth, from the denith to the nadir?" To uphold this maxim would be to prohibit aerial navigation for, as an authority points out, every flight would constitute innumerable, actionable trespasses. Radio is a greater trespasser than the flying machine. No bars or windows can completely keep out electro-magnetic waves; radio broadcasting enters into every home.

And yet this ancient maxim, adopted by the courts of England centuries ago, has the indorsement of such eminent authorities as Coke and Blackstone, for at that time the upper air space was not so utilized. Under this maxim of law it has been held to be a trespass to thrust one's arm into the space over a neighbor's land.

Fundamental Rights

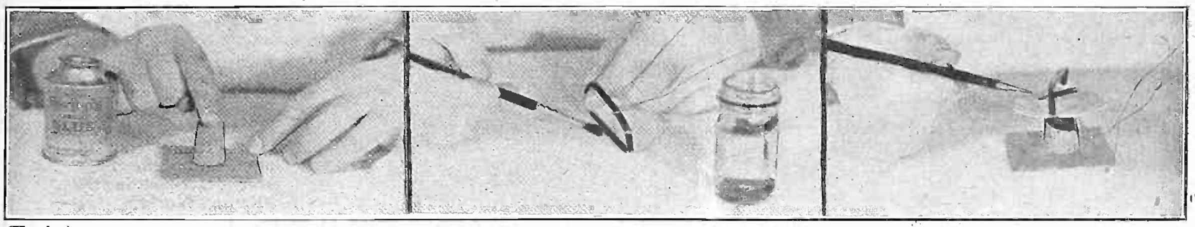
What are the fundamental rights of the pioneering broadcaster, who invests his capital in erecting a broadcasting station on land which he owns, and develops a service acceptable to the greater portion of the public which he serves? Shall his investment and property be endangered by the withdrawal of his license to operate, regardless of whether or not he obeys the regulations imposed upon him? Shall any subsequent interloper have the right to interfere with the air channel alloted to the original broadcaster by using the same wave length? The closest analogy in law is the private ownership of the bed of a navigable stream. Undoubtedly there are principles of law that will protect the fundamental rights of the radio broadcaster, and regulatory proposals eventually will be enacted by Congress, but clear distinction as between public and private interests in radio are still to be made.

The fact that broadcasting is essentially

(*Concluded on page 13*)

How to Make a Galvanometer

Out of a Coil, a Needle, a Cork and Cardboard



(Hayden)

The Construction of the Galvanometer, Showing the Application of Collodion to the Coil, the Use of a Cork for Support, and the Completed Instrument.

By Noel O'Neale

THERE is nothing mysterious or complicated about a galvanometer. The two essentials are a coil of wire and a magnet, one of which must be suspended so as to be capable of rotation. If the coil is suspended in the field of the magnet the type of galvanometer is known as the D'Arsonval, or the moving coil type. If the magnet is suspended in the field of the coil, it is called a moving magnet type. The first of these is the more common. It is used in many electrical voltmeters, ammeters, galvanometers and other instruments. The moving magnet type is not used so extensively, though it is much easier to make.

Interesting Work

For those who are experimentally inclined it is both interesting and useful to make one of the moving magnet type. First obtain a small magnetic needle of the type used in pocket compasses, or make one out of a steel needle by stroking it with a larger horseshoe magnet. Now make a coil. This should be preferably in the form of a rectangle considerably longer than it is wide. The length should be such that the needle may swing inside it lengthwise. Say for the sake of definiteness that the length of the needle is 1¾ inches. The inside dimension of the coil should then be about 2 inches. The coil should be wound in a compact form and covered with collodion to hold it together and make it self-supporting. As to the number of turns and size of wire a wide latitude is allowable since there is no definite requirement to be met. One hundred turns of No. 28 silk covered wire are suggested.

The mounting may be made very simply. Use a small piece of wood cut from a cigar box as a base. Then glue a cork to the center of this. Then mount the finished coil on top of the cork, likewise using glue for the purpose. The coil should be mounted with its plane vertical and its long axis horizontal.

For an indicator scale cut out a circle of cardboard and inscribe on it a scale similar to that used on radio dials. Mount this cardboard inside the rectangular coil on the side next to the cork, making its plane as nearly horizontal as practicable.

Now we come to the mounting of the needle. This should be placed in the exact center of the coil measured both in the short and in the long directions. The matter of suspension of the needle is important. If the object is merely to indicate the passage of a current through the coil it may be placed on a pivot without any elastic reactance, that is, without the use of any spring to resist the motion. If an attempt is made to get a value of the current flowing it will be necessary to use a spring of some sort. One of the simplest springs is a fine wire. The needle is then merely suspended over the center of the indicator scale and no supporting pivot is used. A No. 40 copper wire may be used for suspension. The current is then measured by the amount of twist in the wire.

May Get Definite Reading

In some cases a definite reading may be obtained by using the earth's magnetic field as the restoring force instead of the supporting wire. The lower pivot may then be used. If the earth's magnetic field is used the coil should be placed so that the earth's field is at right angles to the field set up by the current. The direction of the field set up by the current is at right angles to the plane of the coil. The direction of the earth's field is shown by the magnet when no current is flowing through the coil. The coil should be turned so that the plane of the coil is parallel with the magnet when no current is flowing. Then when the current is turned on the needle will deviate from the north and south alignment and will try to swing around to a direction of east and west. The needle will come to rest at an intermediate direction, depending on the strengths of the two opposing forces.

New York Leads States With Greatest Set Number

WASHINGTON.

There are more radio sets in use in New York than any other State in the Union, according to a survey completed by the Electrical Division of the Department of Commerce. Illinois is second and Ohio third.

The figures were compiled as an index to markets for radio equipment. They do not show the total number of the radio population but attempt to give the percentages of fans in each state. The percentages are based on three factors—letters received by 20 co-operating broadcasting stations of 5,000 watts and over; actual sales as reported by manufacturers, and a survey made by a radio magazine. Following is the percentage of the total in the United States assigned to each State:

Maine 0.795; New Hampshire 0.435; Vermont 0.310; Massachusetts 4.451; Rhode Island 0.792; Connecticut 1.242; New York 9.301; New Jersey 2.862; Pennsylvania 6.835; Ohio 7.555; Indiana 3.783; Illinois 8.306; Michigan 3.971; Wisconsin 3.453; Minnesota 3.446; Iowa 3.093; Missouri 3.966; North Dakota 1.465; South Dakota 1.565; Nebraska 2.756; Kansas 2.951; Delaware 0.240; Maryland 0.945; Dist. of Col. 0.499; Virginia 0.733; West Va. 0.728; North Carolina 0.615; South Carolina 0.436; Georgia 0.799; Florida 0.734; Kentucky 1.210; Tenn. 1.320; Alabama 0.531; Miss. 0.428; Arkansas 0.647; Louisiana 0.685; Okla. 2.480; Texas 4.234; Montana 0.439; Idaho 0.381; Wyoming 0.242; Colo. 0.978; Utah 0.256; Nevada 0.097; New Mexico 0.300; Arizona 0.183; Washington 0.524; Oregon 0.355, and California 5.647.

Education Called Radio's Highest Purpose

(*Concluded from page 12*)

a system of mass communication has somewhat obscured the great potentialities of radio as an instrument of education. It is true that any universal system of broadcasting must be governed largely by majority demand, and the demand for entertainment in broadcasting is much greater than the demand for education.

Nevertheless the fact remains that education is the highest purpose which broadcasting can serve. Radio offers to the educator an auditorium many times greater than the combined capacity of every college auditorium in the country. When radio can add sight to sound, demonstration to exposition, it will be able more closely to project the work of the university classroom.

An Established Art

At present the educational world still faces the task of devising a system of popular education suitable for transmission over a universal broadcasting system. The greater opportunity will come when specialized broadcasting systems are made possible by the opening of additional channels in the air, and sight is added to sound in radio transmission.

Radio is now losing the bloom of romance that characterizes the early beginnings of every new art. It is taking on the firm outline of an established art and a flourishing industry. As such it beckons to the scientist, to the artist, to the educator and to the business man, to come forward and contribute to the progress of mankind.

Radio University

A FREE Question and Answer Department conducted by RADIO WORLD for its yearly subscribers only, by its staff of Experts. Address Radio University, RADIO WORLD, 145 West 45th St., New York City.

When writing for information give your Radio University subscription number.

I WAS very much impressed by the articles on the Lincoln Super-Heterodyne described in the Dec. 4 and 18 issues of Radio World. I would consider it a great favor if you would print a picture diagram of this circuit, at the same time showing the placing of the parts. I am going to use the parts specified in the Dec. 4 issue.—Gerry Mitchell, Ontario, Canada.

This picture diagram is shown in Fig. 486. The large units with the numbers 220, are the Silver-Marshall audio frequency transformers, type 220, while the other large unit with the number 221 is the Silver-Marshall output transformer, type 221. The unit in the center of the subpanel is the Lincoln Fixt Inductance, while to the left and right hand sides, are the long wave transformers. The resistances of the rheostats are noted on the diagram. It will be noted that a single circuit closed jack is inserted in the output of the first audio stage. There is also a single circuit jack at the last output. As to the first jack, which was not shown in the circuit diagram. The top prong, is brought to the P post on the seventh socket. The second prong from the top is brought to the P post on the second audio transformer. The bottom prong is brought to the B post on the second audio transformer. This post is also connected to the B plus 135 volt post on the special plug in the back of the subpanel. The action of this jack is simple. When the plug is inserted, the plate post connection of the transformer is broken, so that there is only a circuit made up to the seventh tube. However, when the plug is taken out, the circuit is remade and the plate post of the transformer is connected to the plate post of the tube socket. The large fixed condensers, of the .5 mfd. and 1 mfd. type, are placed underneath the long wave transformers, 2 and 3. All the battery terminals are connected to the battery plug, which in the diagram is in the center of the subpanel in the rear. The subpanel is 8 x 23 inches, while panel is 7 x 24 inches.

* * *

I WOULD like to build 6-tube resistance coupled RF and AF receiver, using a crystal as a detector described in the July 10 issue of Radio World, Radio University columns. Resistance coupling is used in the second and third stages of RF and detector, as well as in the audio stages. A 3-circuit tuner is used in the first RF stage. Now I would like to know if it is possible to substitute these resistance RF stages with straight inductance coupling. I have a tuner, which has a 12 turn primary, 54 turn secondary and 40 turn tickler. The primary and secondary is wound on a 2¼ inch diameter tubing, with a ¼ inch between the windings. No. 26 double cotton covered wire is used. The tickler is wound with No. 30 single silk covered wire, on a 1 inch diameter tubing. (2)—What size wire and how many turns should be placed on tubings, 2¼ inches in diameter to constitute these transformers. (3)—Can a rheostat be used to control the filaments of the RF tubes?—Frederick Marden, Loyola, Kans.

(1)—Yes, this can be done. (2)—The primaries should all consist of 10 turns. The secondaries should all consist of 54 turns. Use No. 26 double cotton covered wire. Space the primary and secondary windings ¼ inch. (3)—A 6 ohm rheostat should be used to control the filaments of the RF tubes.

* * *

I HAVE built the Phonograph receiver described by Lewis Winner in the Oct. 24 and 31 issues of Radio World and must say it is a peach. However, my set is too sharp. It is not critical, but it takes hair breadth tuning to bring in stations. What could I do to broaden it out?—Manuel Strong, LeCrosse, Wis.

This can be done by increasing the number of turns on the primaries, e.g., adding five turns. Try bringing the primary nearer to the secondary winding.

* * *

I HAVE a diagram of a 1-tube reflex, using a tube as a RF and AF tube. A crystal detector is used. A fixed RF transformer is used for coupling the tube output to the detector input. I have a tuned RFT, which has the same number of turns on the primary and secondary as the number of turns on the other RFT in the antenna input. That is, a 15 turn primary and 44 turn secondary wound on a 3-inch diameter with No. 22 double cotton covered wire, with a ¼ inch space between the windings. Can this RFT be used in place of the untuned RFT specified? (2)—How is it wired up?—Julian Morehouse, San Francisco, Cal.

(1)—Yes this can be used. (2)—The beginning of the primary winding is connected to the plate post on the socket. The end of this winding is brought to the B plus post. The beginning of the secondary winding is brought to the B post on the audio frequency transformer. The end of this winding is brought to the high potential point on the crystal detector.

* * *

CAN I use resistance coupled audio frequency amplification in the Power Booster receiver described in the April 17 issue of Radio World? (2)—How many stages should be used? (3)—Should ballast resistances be used to control the filaments of these tubes. How many? (4)—Will I get good results if I use the -01A type tubes in the first stages and a power tube, such as the -71 in the last stage? (5)—Can the double circuit jack at the detector output be omitted?—Francis McDonald, Jersey City, N. J.

(1)—Yes. (2)—Three. (3)—Yes. Use one to control the filaments of the first two tubes, and another to control the filament of the last tube. The exact one to use depends upon the exact type of tube used. (4)—Yes. Be sure to use the proper B and C voltages. (5)—Yes. Whether this is left in or out, has no effect on the operation of the receiver.

* * *

I HAVE a circuit diagram of a 5-tube receiver diagramed exactly as per Fig. 327 in the Radio University columns, May 15 issue of Radio World. The circuit calls for a double condenser. I would, however, like to use single condensers of the .0005 mfd. variable type. Could this be used? (2)—I have tuned radio frequency transformers wound on a basket weave form, each 3 inches in diameter. No. 22 double cotton covered wire is used. The primaries consist of 12 turns. The secondaries consist of 44 turns. The primary is wound in between the primary and secondary windings, at the center of the windings. Can these be used? (3)—Is the rotor of one variable condenser brought to the A minus post, while the rotor section of the other condenser brought to one terminal of a fil. sw. (A plus). I am not going to use the filament control jack as per diagram. (4)—Is the stationary section of the con-

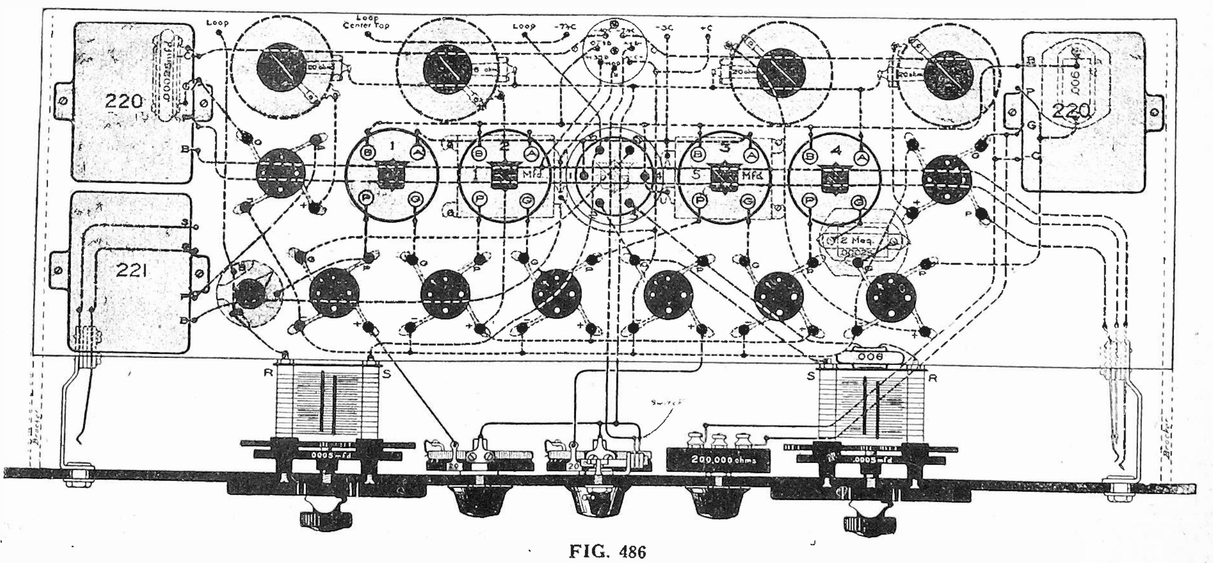


FIG. 486

The picture diagram and layout of the parts for the Lincoln Super-Heterodyne, using Silver-Marshall type 220 audio transformers and Silver-Marshall type 221 output transformers.

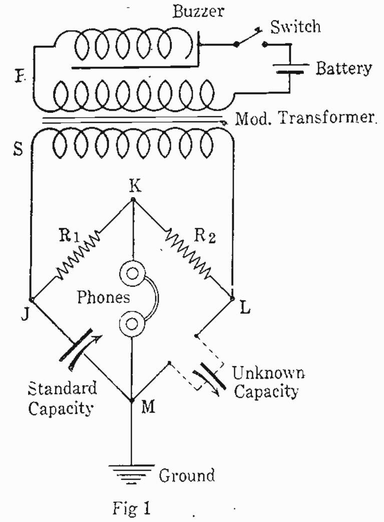


FIG. 487
The circuit diagram of the Wheatstone bridge, requested by Charles McClean.

denser having its rotor plates going to the A minus post brought to the grid post on the first socket? (5)—Is the stationary plate section of the other condenser brought to one terminal of the grid condenser? I intend to use the rheostats, resistances, as specified, etc.—Leonard Williamson, White Plains, N. Y.

(1)—Yes. (2)—Yes. (3)—Yes. (4)—Yes. (5)—Yes.

* * *

REGARDING THE circuit diagram illustrating the method of inserting a loop, via a double circuit jack, which appeared in the Radio University columns of the Nov. 6 issue of the Radio World. Is it absolutely essential that the beginning and the end of the primary and secondary windings be connected as per method shown in this diagram?—Harry Muhleman, Croton-on-the Hudson, N. Y.

Yes.

* * *

CAN AN output choke be used in the amplifier output of the Antennaless receiver described by Dr. Louis B. Blan in the Nov. 27 and Dec. 4 issues of Radio World? (2)—Can binding posts be used instead of the single circuit jack?—Malcolmn Stern, Hollywood, Cal.

(1)—Yes. (2)—Yes.

* * *

I INTEND to build a B eliminator using the Raytheon tube. (1)—Can I place the condenser block over the chokes and transformer? (2)—Can a metal container be used to house the units?—Wallace Muchell, Boston, Mass.

(1)—No, this is a bad stunt. The choke and the transformer windings have a tendency to heat up. This causes a decrease of capacity in the condenser block and a noticeable hum at the output, since the filtering system is broken down. (2)—Yes, be sure to drill holes on the sides for ventilation.

* * *

I HAVE a 6 to 1 ratio audio frequency transformer and a .0005 mfd. calibrated variable condenser. I would like to have the circuit diagram of a system, showing how to measure the capacity of various variable and fixed condensers. Please explain the operation, as well as the values of any other parts that are necessary to use.—Charles McClean, Long Island City, N. Y.

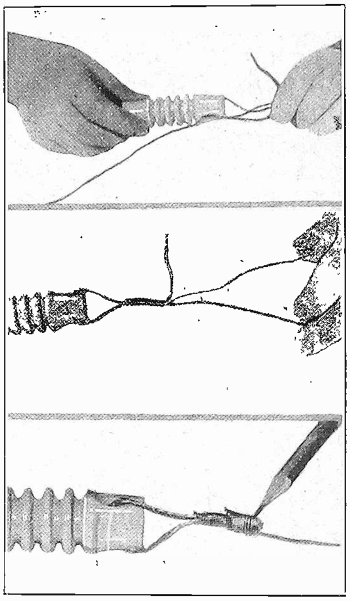
Fig. 487 shows the circuit diagram of this unit. The audio frequency transformer is labelled modulation transformer. It is so called in that it modulates as well as steps up the generated buzzer notes. The buzzer used should be of that type which may be adjusted to a very high pitch. The higher the pitch, the better. R1 and R2 are both 1000 ohm non-inductive resistances. The calibrated condenser is indicated as such. The same applies to the unknown capacity. Since the resistances between the arms J K and L K are equal, when a balance in the capacity arms J M and M L is obtained, the reactance of the two arms K J M and K L M will be equal. Therefore the voltage in one arm balances the voltage in the other arm and an absence of sound in the phones is the result. If there is a variation between the two capacities, the standard and the unknown, a difference of voltage will be obtained between the two arms. The buzzer note will then be audible in the phones. The strength of the note will be dependent upon the value of the voltage difference. To understand this better, a practical example will be given. Suppose you have on hand a condenser rated at .00025 mfd., and that you wish to know if this is the exact maximum value. This condenser is connected in the unknown condenser portion of the circuit. The buzzer is set going. The known condenser dial is turned until the sound becomes minimum in the phones. At that point, note the value on the known condenser dial. This is the value of the unknown condenser. Should there be a small sound heard in the phones, there is an indication that the balancing is not perfect. It is not advisable to use a speaker for testing, since it is difficult to hear the weak notes, due to the noise of the amplifier, etc. The method of connection for this system is very simple. The output of the bridge is connected to the input of the amplifier. This may be of the transformer, or any style, which you may have around the house. Be sure that the tubes which are used, are known to amplify quietly. Also use the best materials in the construction of this unit. Be sure to tighten all connections.

* * *

HOW CAN I wire the beginning of the antenna wire onto the porcelain insulator, so that it won't give?—Phillip Bunn, Montclair, N. J.

The photos shown in Figs. 488, 489 and 490 illustrate a method of doing this. First bring the beginning of the wire through the insulator hole. Pull this through so that a foot and a half of wire is left. Then pull this same wire through the hole again. The end of this lead is then wound tightly over the main piece of wire.

* * *



FIGS. 488, 489 AND 490
((top to bottom)

PLEASE INFORM me whether a fixed resistor changes its resistance value under a load.—Trumbull Fernis, Niagara Falls, N. Y.

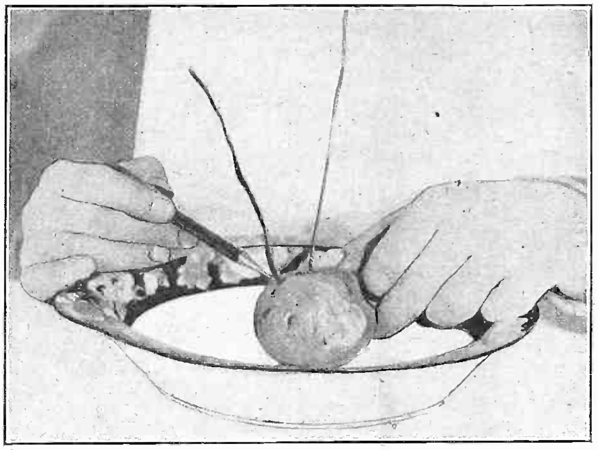
Coupling resistors and grid leak are really variable, although good ones vary only slightly under load. The actual resistance varies with the current that flows through them. No type is 100% free from this defect. The variation, however, is not very great for currents less than the maximum set by the makers of good resistors. The resistance of all types decreases with the current flowing through them. In the case of the carbon resistors the decrease is at first rapid, that is, for very low values of current, but quickly becomes very slow as the current increases. The resistance of metals ordinarily increases with increasing current, or rather with increasing temperature, which is essentially the same thing. Yet there is a decrease with current increase in a certain metal coupling resistors of 100,000 ohms rated value, although the change is too slight to be of any consequence.

* * *

HOW MANY watts does WMAQ, the Chicago Daily News station, Chicago, Ill., use? (2)—How many watts does WLIB, the Liberty Weekly, Inc., station at Elgin-Chicago, Ill., use?—Carl Oxford, Haines Falls, N. Y.

(1)—1,000 watts. (2)—10,000 watts.

YOU CAN LISTEN IN ON A POTATO!



(Hayden)

IF YOU place two dissimilar metals of any nature in a potato, and place a pair of phones at the protruding ends of the wires, a sharp click will be heard in the phones. This is due to the contact difference of potential, causing a capacity discharge.

Radio Is a Creator of Music Lovers

CHICAGO, Ill.

"Radio boosts music and is not a detriment," said Carl D. Kinsey, general manager of the Chicago Musical College, when asked his opinion as to music "on the air."

With him, it was all pro, and no con, and he unhesitatingly declared that radio was the greatest promoter of music in America and probably all over the world.

Opens New Field

"It creates music lovers and music students, and it has opened fields heretofore untouched. The smallest hamlets in the country can hear the greatest music. It reaches audiences of millions. I find its usefulness extends to every branch of music, just as I find that 'movie' music has created not only a new public but a new student body. Music is on the increase everywhere and is of a higher standard because even the youngest music pupils put forth their best work. The professional people are not satisfied to be merely broadcasting and apply themselves to doing it artistically."

Mr. Kinsey is a radio fan, and with good reason, because the concerts radioed by the people in his college have brought thousands of responses. He finds greater interest in orchestral instruments, and a desire to be better informed from a theoretical standpoint. He said also that the motion picture industry had opened up a musical vista for the younger generation and that it is becoming more generally versed in technic, not so much from a wish to become professionals, but from the love of the art itself. Now people want music in their homes and good music at that.

Finer Type of Music

Mr. Kinsey finds that "jazz music" in its commonest sense is giving place everywhere to a more melodic and finer type. It is largely attributable to the fact that only good teachers are engaged by school and conservatory managers in the small towns, and that the best credentials are required. He says that the era of the incompetent teacher has vanished and that it is surprising how many of the "provincial" teachers, after having brought their students to a certain degree of proficiency, are now sending them to the big cities to continue their work. He based his judgment on the fact that master classes are attended by leading musicians of the country towns each year, and that they are intensely serious in their work. The day has gone when anything will pass muster before provincial audiences. Only the best is now accepted. Mr. Kinsey says that the majority of those attending master classes are purposeful, sincere and imbued with the spirit of progressiveness. And for all these things he credits in large degree, the worldwide influence of the radio station.—Music Leader.

How Poten
Without Any Curre

"One May Have a Bank
Author Observes—Resista

By Brunsten Brunn

SOME confusion exists in the minds of radio fans regarding the conceptions voltage, current, and resistance, as well as about the other and less well known electrical and magnetic quantities.

Before proceeding with this discussion we shall discard the term voltage for the more accurate term potential. What is potential? Its technical definition would not be very elucidating, but a simple analogy may be used to make its meaning a little clearer. Everybody knows that the earth attracts every object, that is, objects fall to the ground when they are free. The earth exerts a force on them. If a pound weight be lifted a certain distance work has to be done on it, and the amount of work done upon it is the product of the distance lifted and the force of attraction of the earth. What has become of this work after the weight has been lifted and set at rest? It has been stored in the weight. It may be regained by letting the weight drop again. While the weight is at the higher level the work is still in it and it is possible to regain it.

In the electrical field we also have forces of attraction and repulsion. Some are magnetic and some are electrical forces. To move a quantity of electricity against an electric force, work is necessary. And the amount of work required to move a unit quantity of electricity against the electric force is the product of the distance moved and the intensity of the force. This work is stored in the quantity moved, and it becomes potential work. It may be regained by letting the quantity "drop" in the electric field.

Definition of Potential

Now potential may be defined more accurately. The electric potential at any point is the amount of work that has been done on a unit quantity of electricity in moving that unit against the electric forces from a point very far away up to the point in question. The potential difference between two points is the amount of work done on a unit charge in moving it against the electric force from one point to the other. Analogously, the potential difference between two different levels is the amount of work done on a pound weight in lifting it from the lower to the higher level against the force of gravity. Potential difference is abbreviated P. D. If it is measured in volts it is called the voltage difference between the two points in the circuit. But potential may be measured in other units than volts, and hence the reason why the term voltage was dropped.

What is current? It is the rate of transfer of electrical quantity from one point to another. Compared with the current in a river it is the total flow of water, not the spread of water. Electric current is everywhere the same in the same conductor but the rate at which the electrons move varies according to the

size of the con
a river is ever
the speed of th
cording to the
spread also va
river. Likewise
varies accordin
tween two poin
of potential p

What is resi
friction that th
ers in its flow
be compared w
a water pipe.
the quantity at
ally dissipated
to the lower l
this dissipation
useful, that is,
devices the res
of work, becau
which the work

Potentia

Can there be
Yes, there can
of potential be
any current. It
shall flow over
in order that th
level. In a sta
without having
them. One ma
without drawin
conception, curr
still another. E
other.

But there is
tween them, an
as ohm's law.
current flowing
tential differenc
portionality is t
ferently, the po
two points in a
product of the
resistance betw
if the current i
and the resista
10 ohms, the p
the points is 5
which a poten
ordinary voltme
than 50 volts.
meter is not the
though the tw
changeably.

Differe

If AC is flo
transformer the
tial difference
minals even if
open. In fact,
the secondary
closed. As soo
flows, and part
is used up in d
the windings o
they contain res
motive force (e
not change wh
The emf is sam
circuit is open
closed the emf

ial Can Exist
t Flowing in a Circuit

:ount Without Drawing On It,"
, Current and Potential Analyzed
Defined

or just as the flow in
:re the same although
ter particles varies ac-
th of the river. The
with the slope of the
speed of the electrons
the electric slope be-
iat is, to the difference
nit distance.
ce? It is simply the
ctric current encount-
conductor. This may
ie friction of water in
electric work stored in
higher level is gradu-
ie current flows down
In a heating device
:uces the heat and is
s regained. In other
ce causes only a loss
nat is not the form in
wanted.

ithout Current

ntial without current?
very great difference
n two points without
t necessary that water
precipice at Niagara
hall be a difference in
y the steps may exist
body tumbling down
ave a bank account
on it. Potential is one
nother, and resistance
may exist without the

namic connection be-
t connection is known
imply states that the
roportional to the po-
d the constant of pro-
esistance. Stated dif-
al difference between
ductor is equal to the
rent flowing and the
the two points. Thus
onductor is 5 amperes
between two points is
ial difference between
ts. That is the value
eter would give. An
vould give slightly less
the way, a potentio-
ie as a voltage divider,
:rms are used inter-

Of Potential

in the primary of a
an alternating poten-
ss the secondary ter-
secondary circuit is
P. D. is greater when
pen than when it is
it is closed current
the original potential
g the current through
e secondary, because
ce. The total electro-
in the secondary does
the circuit is closed.
the P. D. when the
When the circuit is
the amount of work done in carrying a unit of electric quantity around the entire circuit against the electric force.

There is also a difference of potential across the terminals of a battery even when no current is flowing. And as in the case of the transformer, the P. D. is greater when the cell is open than when the circuit is closed. The difference is the fall of potential in the internal resistance of the cell.

If a battery be connected across the terminals of a condenser there will be a current flowing into the condenser for a very short time. It will flow until the potential difference across the condenser is equal to the potential of the battery. When current has ceased to flow, the battery is charged to a potential equal to that of the battery and that charged remains in the condenser when the battery is removed, unless there is a leak in the condenser which lets it escape gradually.

Why Click Is Heard

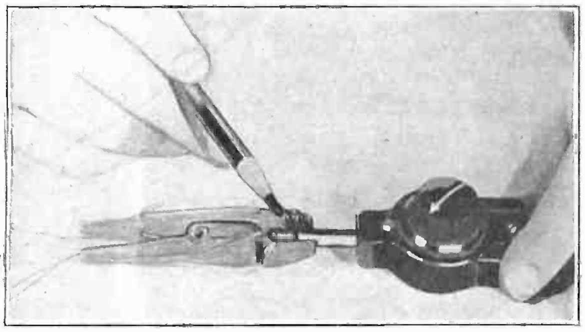
A certain amount of work has been done by the battery in charging the condenser, and this work may be regained in discharging the condenser. If the condenser is discharged through a head set, a click will be heard, and this click is produced by the work which was originally done in charging the condenser. The amount of work required to charge a condenser is measured by one half the product of the square of the voltage multiplied by the capacity of the condenser, that is, $W = \frac{1}{2}V^2C$. Thus if the condenser is charged to 100 volts and the capacity is 4 microfarads, the work or energy stored in the condenser is .02 joules. A joule is a watt-second of energy or work. The energy stored in this condenser is about eleven one millionths of the energy required to operate a 50 watt light for one hour.

The charging of a condenser may be compared with the inflation of an air tank. The pump used is the battery. The pressure of the air is the voltage, or potential difference of the condenser, the size of the tank is the capacity of the condenser. Work is done in charging the gas tank with air up to a certain pressure. This work may be regained if the compressed air is released. There are two methods which may be used to measure the pressure.

Use of Pressure Gauge

In the first place a pressure gauge may be used. In this case the air pressure against a spring which has been calibrated against a known force or weight. In the place it may be measured by measuring the rate at which air escapes through a very tiny hole in the tank. The first method compares with the use of an electrostatic voltmeter and is the more accurate since it does not change the pressure. The second method compares with the use of an ordinary voltmeter, which depends for its operation on a small current, a stream of air in the one case and a current of electricity in the other. The second method is not very accurate.

WOODEN CLIP HANDY FOR TESTING



(Hayden)

A WOODEN CLIP can be used for tests as per photo. Place wire on the upper and bottom portions of the clip, so that when a plug is inserted a complete circuit is made. These wires may be connected to speaker plus and minus, etc., and used to determine complete circuits, etc. The Centralab modulator plug is shown.

Bill Orders Station Aerials Outside City

MINNEAPOLIS, Minn.

A movement has been started in the City Council of Minneapolis to formulate an ordinance forcing all broadcasters to move their transmitting stations outside of the city limits. The matter has been referred to the City Attorney's Office to determine its legality.

The Federal Government, it is said, is interested in the outcome. As far as can be ascertained, such an ordinance would be the first of its kind in history. Its passage might be a means of assisting Congress in formulating national legislation governing radio broadcasting.

While the City Attorney's Office of Minneapolis is considering the matter, the Northwest Radio Trade Association is printing ballots in the newspapers asking listeners of the Northwest to vote on whether or not they believe it advisable for broadcasting stations to move their transmitters outside of the city limits. In fact, this ballot specifically suggests removal of transmitters to a distance of 10 miles from the Twin Cities. WCCO has employed this suggested method for a long while, having its transmitting station 18 miles away from the Twin Cities.

Broadcast Locates Dead Man's Brother

How the radio enabled the police of Carteret, N. J., to get in touch with the relatives of a man who was killed was told recently by Hollywood McCosker of WOR, Newark, N. J. The station was requested by Henry J. Harrington, Chief of Police of Carteret, to broadcast the announcement of the death of George Armstrong, a watchman, who had been killed in an accident.

Nothing was known of the relatives of Armstrong other than that he was said to have a brother living in Philadelphia. An announcement of the watchman's death was broadcast from WOR, Newark. Charles Armstrong of Philadelphia, brother of the dead man, happened to be listening in at the home of a friend in Philadelphia and heard the account of his brother's death and description of him. The brother caught a train for Careteret at once and arrived very shortly after the announcement.

SELECTIVITY ON LOWER WAVES

Selectivity is greater on the higher wavelengths than on the lower ones, because the same frequency difference between two stations in adjoining channels represents a smaller proportion of the total in the case of the higher frequencies (shorter waves) and the RF resistance is higher. Hence complaints of poor selectivity usually concern low wavelength stations.

A THOUGHT FOR THE WEEK

1927 will bring many blessings to millions in our own country and all over the world. Not least of these, let us hope, will be the better education of those few station announcers who seem to think that aspirates are vegetables and that vowels and consonants are members of the dinosaur family.

RADIO WORLD
REG. U.S. PAT. OFF.
The First and Only National Radio Weekly

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

TELEPHONE BRYANT 0558, 0559
PUBLISHED EVERY WEDNESDAY
(Dated Saturday of same week)
FROM PUBLICATION OFFICE
HENNESSY RADIO PUBLICATION CORPORATION
145 WEST 45th STREET, NEW YORK, N. Y.
(Just East of Broadway)
ROLAND BURKE HENNESSY, President
M. B. HENNESSY, Vice-President
FRED S. CLARK, Secretary and Manager
European Representatives: The International News Co.
Breams Bldgs., Chancery Lane, London, Eng.
Paris, France: Brentano's, 8 Avenue de l'Opera
Chicago: William A. Diehl, 30 North Dearborn St.
Los Angeles: Lloyd B. Chappell, 611 S. Coronado St.

EDITOR, Roland Burke Hennessy
MANAGING EDITOR, Herman Bernard
TECHNICAL EDITOR, Lewis Winner
ART DIRECTOR, J. Gerard Sheedy
CONTRIBUTING EDITORS, James H. Carroll and J. E. Anderson

SUBSCRIPTION RATES

Fifteen cents a copy. $6.00 a year. $3.00 for six months. $1.50 for three months Add $1.00 a year extra for foreign postage. Canada, 50 cents.

Receipt by new subscribers of the first copy of RADIO WORLD mailed to them after sending in their order is automatic acknowledgment of their subscription order. Changes of address should be received at this office two weeks before date of publication. Always give old address; also state whether subscription is new or a renewal.

ADVERTISING RATES

General Advertising

1 Page, 7¼"x11"	462 lines	$300.00
½ Page, 7¼"x5½"	231 lines	150.00
½ Page, 8¼" D. C.	231 lines	150.00
¼ Page, 4½" D. C.	115 lines	75.00
1 Column, 2¼"x11"	154 lines	100.00
1 Inch		10.00
Per Agate Line		.75

Time Discount

52 consecutive issues	20%
26 times consecutively or E. O. W. one year	15%
4 consecutive issues	10%

WEEKLY, dated each Saturday, published Wednesday. Advertising forms close Tuesday, eleven days in advance of date of issue.

CLASSIFIED ADVERTISEMENTS

Ten cents per word. Minimum 10 words. Cash with order. Business Opportunities ten cents per word, $1.00 minimum.

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

INTERESTING FACTS

A hissing noise in the loud speaker is due often to a defective conductor or contact. Carbon resistors are most frequently to blame. The trouble may be traced to the transmitting microphone, to a grid leak, or to a plate coupling resistor. Sometimes the cause is a corroded contact and most frequently occurs at the positive terminal of the storage battery.

If the A battery has been accidently reversed it will produce a very noisy signal, characterized by scratches and hisses.

A run down dry cell will cause a similar noise, but it will be more severe.

All sets radiate unless they have been completely shielded.

Most of the whistles heard at this time in a radio set are not due to faults in the set. The true cause is double in nature.

Do not worry about the quality of a tuning condenser.

LIFE OF A C BATTERY

If the grid is correctly biased no current flows in the grid circuit, and the C battery will last as long in the set as it will on the shelf.

Damrosch Finds Radio Saving British Music

Former Subsidizers of Classical Renditions Now Land Poor, So Broadcasting Keeps New School Alive, He Adds

While men like Sir Thomas Beecham, English composer, and William Boosey, English music publisher are telling the world that broadcasting and radio are killing music in Great Britain, there is growing up in England a new school of composers that is doing very interesting work, according to Walter Damrosch, director of the New York Symphony Orchestra, and the Balkite Hour. This school, because of the lack of interest in music in the United Kingdom, is forced to earn its living doing other things besides creating music, but this does not prevent its producing music of a most interesting sort.

"I am 3,000 miles away from England and I can not judge conditions there as well as I might were I in the position of Sir Thomas or Mr. Boosey," Mr. Damrosch said, "but I do know several things are true about England and music.

Nobility Withdrew Support

"First, the nobility, the blue-blooded class, hasn't the money to support music any longer; in fact it has been withdrawing its support of music for the last twenty years, not because it has been losing its interest but because it has been becoming land-poor. Coal and many other strikes have been hitting at the class that has controlled the destinies of all the British arts for some time and they are unable, in a pocketbook way, to afford the underwriting of fine music. Fine music must be underwritten; it is here in America. All our Symphony orchestras have been money-losing enterprises and it is expected that they should be. Art should be and must be subsidized.

"The moneyed class in England, that is the class that has the money right now, is not yet interested in music. They have but a short time ago acquired money and their patronage of the arts, both music and others, is a step they have to take. Broadcasting, in my mind, will persuade them to take the step.

Familiarity Breeds Joy

"Love of music comes through association. Many of the most ardent supporters of the New York Symphony Orchestra first came to the concerts by force of their wives' persuasion. They came the first few times through this force but gradually they came because they began to love music. Love of classic music is inborn in a very few of us; the great majority of people learn to love and appreciate it.

"When this love is cultivated, I know England will discover that many young composers of more than usual ability and these will suddenly blossom out as finely matured musicians. England's and the world's renaissance of music will be brought about by radio, I am sure."

Mr. Damrosch will quit the New York Symphony Orchestra at the end of the season.

The Analogy Between a Radio Set and a Cat

There is a great deal of similarity between our radio set and our old tabby cat. Sometimes she was playful, sometimes silent, sometimes grouchy. Her playfulness was a sort of hang-over from her kittenish days. Her silent periods were indicative of contentment. Her grouchiness was the sign of advancing age.

Her favorite place for practising her silence was on a rug where she was in everybody's way. Quite frequently some one would step on her paws, not always accidently, we admit. Every time that happened the cat would insist on emitting an unearthly yowl. For a time that presented quite a problem. Getting a new cat was suggested as a solution to the problem, but that was turned down by the elders, who preferred the old model. Various schemes were suggested by those who were expert in the ways of cats and kids without success. Finally the trouble was remedied by moving the rug out of the main thoroughfare. In other words, by-passing solved the problem.

When your set howls, by-pass.

Outdoor Direction Finder Developed by Bureau

WASHINGTON.

A direction finder of the familiar rotating coil type which is suitable for use outdoors and is a valuable aid in studying the behavior of radio waves has been designed by the Bureau of Standards. The direction finder is also valuable for the location of man-made interference.

The new finder is convenient in operation, as automatic features are provided so that only two controls have to be adjusted. The receiving set is a superheterodyne which employs a standard amplifier arranged for operation by a single control. The wide frequency range, 90 to 7700 kilocycles (3300 to 39 meters) is made possible by a set of interchangeable plug-in direction finding coils, each with a corresponding interchangeable heterdyne generator coil and a cam for operating an auxiliary tuning condenser. A small telescoping brass rod through the center of each direction finder coil serves as an antenna for the purpose of sharpening the point of minimum signal when taking a bearing. The complete apparatus except the direction finding coils is housed in a shielding aluminum box.

The direction finder is recognized as an effective means of locating radio signals from any source. With the rapid increase in the range of frequencies used for radio transmission, need had arisen for a direction finder which would function over a wide range of frequencies and yet be portable and quite simple to operate.

Gershwin Plays Piano For His Biggest Audience


GEORGE GERSHWIN

George Gershwin, the man who has taken the wild and woolly "jazz" music and made of it a civilized, polished and classic work of art, played for the greatest audience of his career thus far, when he appeared as the guest artist of the Eveready Hour in the broadcasting studio of station WEAF, in New York, December 14.

George Gershwin, prominent figure though he is today in the realm of modern music, is almost as new to that prominence as radio is new to its glory. Both are babes in swaddling clothes, in point of years. Gershwin is actually twenty-seven years old, but he was almost unknown until six or seven years ago. He sprang into great prominence with his "Rhapsody in Blue." It is common gossip that Paul Whiteman was so moved when he heard that masterpiece of native music for the first time, that tears streamed down his face.

The Eveready Hour in which Gershwin was the stellar figure, was truly a Gershwin hour. The composer himself was at the piano and the radio audience of the WEAF network of stations throughout the East and Middle West heard the Gershwin music played by Gershwin himself, Gershwin songs with Gershwin accompanying the regulars of the Eveready Group and Gershwin music by the Eveready Orchestra.

His appearance in the Eveready Hour was George Gershwin's first broadcasting effort of note. About two years ago, he played at station WEAF on a program which was broadcast several hours after midnight. But this time virtually half the population of the United States was within loud-speaker range of his program.

Among the best known of the numbers which Gershwin rendered in piano solo were "Suanee," which has been played and whistled and hummed from coast to coast. Several numbers which he wrote for "Oh Kay" and George White's "Scandals," were sung by members of the Eveready Group. "I Was So Young and You Were So Beautiful," from "Good Morning, Judge"; "Nobody But You," from "La La Lucille" and several numbers from "Tip Toes" and "Lady Be Good," were among the most popular numbers. Gershwin also did in piano solo, a part of his striking "Concerto in F," which was written especially for Walter Damrosch.

Coolidge Favors White Bill And Hopes for Legislaiton

WASHINGTON

President Coolidge is heartily in sympathy with radio legislation and hopes a bill can be enacted which will check confusion and interference. At a White House conference, Representative Frank D. Scott, of Michigan, Chairman of the House Merchant Marine and Fisheries Committee, and Representative Wallace White, author of the White Bill, the President is said to have endorsed the White bill and expressed the view that it should be enacted into law as early as possible.

It is understood the President has expressed a similar desire to a number of Senators. The White bill, which places regulation in the Department of Commerce with a Commission to which appeal can be made, is favored by Coolidge.

HAPPY VOICES INAUGURATE NEW STATION

(Fotograms)

AS A part of the inaugural program of the new station WABC, which supplants the old station WAHG, New York City, the artists shown in the above photograph appeared. Left to right, Paul Althouse, tenor; Helen Stanley, soprano; Nevada Van Der Veer, contralto, and Arthur Middleton, basso.

Davis Elected Head of N. B. C. Directors

"Father of Broadcasting" Lauded By Aylesworth—House of Morgan Represented on that Body

By Dwight W. Morrow

H. P. Davis, vice president of the Westinghouse Electric and Manufacturing Company, under whose encouragement and direction the first regular broadcasting service in the United States was established six years ago, has been elected chairman of the board of directors of the National Broadcasting Company, which now owns and operates WEAF and manages WJZ in New York and WRC in Washington. Under Mr. Davis' regime KDKA at Pittsburgh first "took the air," with election returns, and finally with musical programs broadcast regularly every night.

Mr. Davis, long known as one of the pioneers in the radio broadcasting field, took a leading part in the organization of the National Broadcasting Company. He had always been strong in the belief that broadcasting would become a permanent institution in the United States and that a service could be developed which would rest upon a secure and economic foundation.

"His election as chairman of the Board of Directors of the National Broadcasting Company," said Merlin Hall Aylesworth, president of the company, "is perhaps the best earnest symbol of the fact that no effort will be spared to develop a broadcasting service which will permanently establish the primacy of the United States in the broadcasting art as pronounced as its leadership in the radio industry and international wireless communications."

The list of directors includes the leading figures in the electrical and radio industries of the United States:

Chairman, Mr. Davis; Mr. Aylesworth; Owen D. Young, chairman of the Board, General Electric Company; Gen. Guy E. Tripp, chairman of the board, Westinghouse Electric and Manufacturing Company; Gerard Swope, president, General Electric Company; E. M. Herr, president, Westinghouse Electric and Manufacturing Company; Gen. J. G. Harbord, president, Radio Corporation of America; David Sarnoff, vice president and general manager, Radio Corporation of America; William Brown, vice president and general attorney, Radio Corporation of America; E. W. Harden, James Colgate and Company; Dwight W. Morrow, J. P. Morgan Company.

One of the first official acts of the new board of directors was to establish a board of consulting engineers to assist the National Broadcasting Company in problems of transmission and mechanical development. This board consists of Dr. Alfred N. Goldsmith, chief broadcast engineer, Radio Corporation of America, chairman; E. F. W. Alexanderson, chief consulting engineer, General Electric Company, and Frank Conrad, chief consulting engineer, Westinghouse Electric and Manufacturing Company.

All these are noted men.

Complete List of Stations

Corrected up to December 21, 1926

Station — Location — Owner — Meters

KDGR—San Antonio, Tex., Radio Engineers 240
KDKA—East Pittsburgh, Pa., Westinghouse, house E. & M. Co. 309.1
KDLR—Devils Lake, N. D., Radio Elec. Co. 231
KDYL—Salt Lake City, Ia., Inter. Bdcstg. Corp. 245.8
KFAB—Lincoln, Neb., Neb. Buick Auto Co. 340.7
KFAD—Phoenix, Ariz., Elec. Equip. Co. 273
KFAF—San Jose, Cal., A. E. Fowler 217.3
KFAU—Boise, Idaho, Indep. Sch. Dist. of Boise 280.2
KFBB—Havre, Mont., F. A. Buttrey & Co. 275
KFBC—San Diego, Calif., W. K. Azbill 380
KFBK—Sacramento, Calif., Kinball Upson Co. 535.4
KFBL—Everett, Wash., Leese Bros. 224
KFBS—Trinidad, Cal., School District No. 1 238
KFBU—Laramie, Wyo., St. Matthews Cathedral 374.8
KFCB—Phoenix, Ariz., Nielson Radio Supply Co. 238
KFDD—Boise, Idaho, St. Michael Cathedral 275.1
KFDM—Beaumont, Tex., Magnolia Petroleum Co. 315.6
KFDX—Shreveport, La., First Baptist Church 236.1
KFDY—Brookings, S. D., S. D. State College 299.8
KFDZ—Minneapolis, Minn., H. O. Iverson 231
KFEC—Portland, Ore., Meier & Frank 252
KFEL—Denver, Colo., E. P. O'Fallon, Inc. 254.1
KFEQ—Oak, Neb., Scroggin & Co. 268
KFEY—Kellog, Idaho, Bunker Hill & Sullivan 233
KFFP—Moberly, Mo., First Baptist Church 242
KFGQ—Boone, Ia., Crary Hardware Co. 226
KFH—Witchita, Kans., Hotel Lassen 267.7
KFHA—Gunnison, Colo., Western State College 252
KFHL—Oskaloosa, Ia., Penn College 240
KFI—Los Angeles, Cal., Earl C. Anthony, Inc. 467
KFIF—Portland, Ore., Benson Poly. Inst. 247.8
KFIO—Spokane, Wash., North Central High School 272.6
KFIQ—Yakima, Wash., First Methodist Church 256
KFIU—Juneau, Alaska, Alaska Elec. Light & Power Co. 226
KFIZ—Fond Du Lac, Wisc., Fond Du Lac Commonwealth Reporter 273
KFJB—Marshalltown, Ia., Marshall Electric Co. 248
KFJF—Oklahoma City, Okla., Nat'l. Radio Mfg. Co. 260.7
KFJI—Astoria, Ore., E. E. Marsh 245.8
KFJM—Grand Forks, N. D., Univ. of N. D. 278
KFJR—Portland, Ore., A. C. Dixon & Son 263
KFJY—Fort Dodge, Ia., Tunwall Radio Co. 246
KFJZ—Fort Worth, Tex., W. E. Branch 254.1
KFKA—Greeley, Colo., Colo. State Teachers Col. 273
KFKB—Mieford, Kans., J. R. Brinkley, M.D. 431.4
KFKU—Lawrence, Kans. Univ. of Kans. 275
KFKX—Hastings, Neb., Westinghouse, E. & M. Co. 288.3
KFKZ—Kirksville, Mo., Cham. of Com. 225.4
KFLR—Albuquerque, N. M., Univ. of N. M. 254
KFLU—San Benito, Tex., San Benito Radio Club 236
KFLV—Rockford, Ill., Swedish Evan. Church 229
KFLX—Galveston, Tex., Geo. Roy Clough 240
KFMR—Sioux City, Ia., Morningside College 261
KFMX—Northfield, Minn., Carlton College 336.9
KFNF—Shenandoah, Ia., Henry Field Seed Co. 461.3
KFOA—Seattle, Wash., Rhodes Dept. Store 454.3
KFOB—Burlingame, Cal., K. F. O. B., Inc. 225.4
KFON—Long Beach, Calif., Nichols & Warimer, Inc. 232.4
KFOO—Salt Lake City, Utah, Latter Day Saints Union 236
KFOR—David City, Neb., Tire & Electric Co. 226
KFOT—Wichita, Kans., College Hill Radio Club 231
KFOX—Omaha, Neb., Technical H. S. 248
KFOY—St. Paul, Minn., Beacon Radio Service 252
KFPL—Dublin, Tex., C. C. Baxter 252
KFPM—Greenville, Tex., New Furniture Co. 242
KFPR—Los Angeles, Cal., L. A. County Forestry Department 231
KFPW—Carterville, Mo., St. John's Methodist Episcopal Church 258
KFPY—Spokane, Wash., Symons Investment Co. 272.6
KFOA—St. Louis, Mo., The Principa 261
KFQB—Fort Worth, Tex., Searchlight Publishing Co. 508.2
KFQD—Anchorage, Alaska, Anchorage Radio Club 300
KFQP—Iowa City, Ia., G. S. Carson, Jr. 224
KFQU—Holy City, Cal., W. E. Riker 230.6
KFQW—North Bend, Wash., C. F. Knierim 215.7
KFOX—Seattle, Wash., A. M. Hubbard 210
KFQZ—Hollywood, Cal., Taft Products Co. 226
KFRB—Beeville, Tex., Hall Brothers 248
KFRC—San Francisco, Calif., Don Lee, Inc. 267.7
KFRU—Columbia, Mo., Stephens College 499.7
KFRW—Olympia, Wash., Western Bdcstg Co. 218.8
KFSD—San Diego, Cal., Airfan Radio Corp. 245.8
KFSG—Los Angeles, Calif., Echo Park Evan. Assn. 275.1
KFUL—Galveston, Tex., T. Goggan & Bros. 258
KFUM—Colorado Springs, Colo., W. D. Corley 239.9
KFUO—St. Louis, Mo., Concordia Seminary 545.1
KFUP—Denver, Col., Fitzsimmons Gen. Hosp. 234
KFUR—Salt Lake City, Utah, L. L. Sherman 256.2
KFUS—Oakland, Cal., L. L. Sherman 256
KFUT—Salt Lake City, Utah, Univ. of Utah 263
KFUU—Oakland, Calif., Colburn Radio Lab. 220.4
KFVD—San Pedro, Calif., C. & W. J. McWhinnie 208
KFVE—St. Louis, Mo., Benson Bdcstg. Corp. 239.9
KFVG—Independence, Kans., First M. E. Church 236.1
KFVI—Houston, Tex., Headquarters Troop, 56th Calvary 240
KFVN—Fairmont, Minn., C. E. Bagley 227
KFVR—Denver, Col., Moonlight Ranch 244
KFVS—Cape Girardeau, Mo., Cape Girardeau Battery Station 224
KFVY—Albuquerque, N. M., Radio Supply Co. 250
KFWB—Hollywood, Cal., Warner Bros. Pic. 252
KFWC—San Bernardino, Calif., L. E. Wall 291.9
KFWF—St. Louis, Mo., St. Louis Truth Center 214.2
KFWH—Eureka, Calif., F. W. Morse, Jr. 254
KFWI—San Francisco, Calif., Radio Enter. 249.9
KFWM—Oakland, Calif., Oakland Educa. Soc. 325
KFWO—Avalon, Cal., Lawrence Mott 211.1
KFWU—Pineville, La., Louisiana College 238
KFWV—Portland, Ore., KFWV Bdcst. Studios 212.6
KFXB—Big Bear Lake, Cal., B. C. Heller 202.6
KFXD—Logan, Utah, Service Radio Company 205.4
KFXF—Denver, Col., Pikes Peak Broadcasting Company 430.1
KFXH—El Paso, Tex., Bledsoe Radio Co. 242
KFXJ—Near Edgewater, Col., R. G. Howell 215.7
KFXR—Oklahoma City, Okla., Classen Film Finishing Co. 214.2
KFXY—Flag Staff, Ariz., M. N. Costigan 205.4
KFYF—Oxnard, Cal., Carl's Radio Den 214.2
KFYJ—Portable, Tex., Houston Chronicle Publishing Company 238
KFYO—Texarkana, Tex., Buchanan-Vaughan Co. 209.7
KFYR—Bismark, N. D., Hoskins-Meyer, Inc. 248
KGAR—Tucson, Ariz., Tucson Citizen 243.8
KGBS—Tucson, Ariz., A. C. Dailey 227
KGBU—Ketchikan, Alaska, Alaska Radio and Service Company 228.9
KGBX—St. Joseph, Mo., Forster Hall Co. 347.8
KGBY—Shelby, Neb., Albert C. Dunning 202.6
KGBZ—York, Neb., Federal Live Stock Remedy Company 333.1
KGCA—Decorah, Ia., C. W. Greenle 280.2
KGCB—Wayne, Neb., Wayne Hospital 434.5
KGCG—Newark, Ark., Moore Motor Co. 239.9
KGCH—Wayne, Neb., Wayne Hospital 434.5
KGCI—San Antonio, Tex., S. M. Rhodes 239.9
KGCL—Seattle, Wash., Louis Wasmer 238
KGCM—San Antonio, Tex., R. B. Bridge 263
KGCN—Concordia, Kans., Alva E. Smith 210
KGCR—Brookings, S. D., Cutlers Broadcasting Service 252
KGCU—Mandan, N. D., Mandan Radio Assn. 285
KGCX—Vida, Mont., First State Bank 240
KGDA—Dell Rapids, S. D., Home Auto Co. 254.1
KGDE—Barrette, Minn., Jaren Drug Co. 232.4
KGDJ—Cresco, Ia., R. Rothert 405.2
KGDI—Seattle, Wash., N. W. Radio Service Co. 416.4
KGDJ—Cresco, Ia., R. Rathert 202.6
KGDM—Stockton, Calif., Victor G. Koping 217.3
KGDO—Dallas, Tex., C. H. & Henry Garrett 285
KGDP—Boy Scouts Pueblo, Colo., Boy Scouts 260
KGEA—Seattle, Wash., Puget Sound Bdcst. Co. 345
KGO—Oakland, Cal., General Electric Co. 361.2
KGRS—Amarillo, Tex., Gish Radio Service 234
KGTT—San Francisco, Cal., Glad Tidings Temple & Bible Inst. 206.8
KGU—Honolulu, T. H., Marion A. Mulrony 270
KGW—Portland, Ore., Oregonian Pub. Co. 491.5
KGY—Lacey, Wash., St. Martins College 277.6
KHJ—Los Angeles, Cal., Times Mirror Co. 405.2
KHQ—Spokane, Wash., Louis Wasmer 394.5
KICK—Anita, Ia., Atlantic Auto Co. 272.6
KJBS—San Francisco, Cal., J. Brunton & Sons Co. 234.2
KJR—Seattle, Wash., Northwest Radio Serv. Co. 384.4
KLDS—Independence, Mo., Reorganized Church of Jesus Christ 440.9
KLS—Oakland, Cal., Warner Brothers 250
KLX—Oakland, Cal., Tribune Publishing Co. 508.2
KLZ—Denver, Col., Reynolds Radio Co. 265.3
KMA—Shenandoah, Ia., May Seed & Nursery 461.3
KMJ—Fresno, Cal., The Fresno Bee 234.2
KMMJ—Clay Center, Neb., M. M. Johnson Co. 228.9
KMO—Kokomo, Wash., KMO, Inc. 249.9
KMOX—St. Louis, Mo., Voice of St. Louis 280.2
KMTR—Los Angeles, Cal., Echophone Co. 370.2
KNRC—Santa Monica, Calif., C. B. Juneau 238
KNX—Los Angeles, Cal., Los Angeles Express 336.9
KOA—Denver, Col., General Electric Co. 322.4
KOAC—Corvallis, Ore., Oregon Agriculture Col. 280.2
KOB—State College, N. M., New Mexico College of Agriculture 348.6
KOCH—Omaha, Neb., Omaha Central H. S. 258
KOCW—Chickashia, Okla., Oklahoma College for Women 252
KOIL—Council Bluffs, Ia., Mona Motor Co. 305.9
KOIN—Portland, Ore., KOIN, Inc. 319
KOMO—Seattle, Wash., Birt F. Fisher 305.9
KOWW—Walla Walla, Wash., F. A. Moore 285
KPO—San Francisco, Cal., Hale Bros., Inc. 428.3
KPJM—Prescott, Ariz., Wilburn Radio Service 215
KPPC—Pasadena, Cal., Pasadena Presbyterian Church 229
KPRC—Houston, Tex., Houston Priting Co. 296.9
KPSN—Pasadena Star-News, Pasadena, Ca. 315.6
KQW—San Jose, Cal., First Baptist Church 333.1
KQV—Pittsburgh, Pa., Doubleday Hill Electric Company 275
KRAC—Shreveport, La., Caddo Radio Club 220
KRLD—Dallas, Tex., Dallas Radio Lab. 353
KRSC—Seattle, Wash., Radio Sales Corp. 499.7
KRE—Berkeley, Cal., Berkeley Daily Gazette 256
KSAC—Manhattan, Kans., Kansas State Agricultural College 340.7
KSBA—Shreveport, La., W. G. Patterson 260.7
KSD—St. Louis, Mo., Pulitzer Publishing Co. 545.1
KSEI—Pocatello, Idaho., KSEI Bdsctg. Co. 260.7
KSL—Salt Lake City, Utah, Radio Service Corp. 299.8
KSMR—Santa Maria, Cal., Santa Maria Valley R. R. 282.8
KSO—Clarinda, Ia., A. A. Berry Seed Co. 405.2
KSOO—Sioux Falls, S. D., Sioux Falls Bdcst. Ass. 360
KTAB—Oakland, Cal., Ass. Broadcasters 302.8
KTAP—San Antonio, Tex., R. B. Bridge 263
KTBI—Los Angeles, Cal., Bible Institute 293.9
KTBR—Portland, Ore., M. E. Brown 263
KTHS—Hot Springs, Ark., New Arlington Hotel 374.8
KTNT—Muscatine, Ia., Norman Baker 333.1
KTUE—Houston, Tex., Uhalt Electric 263
KTW—Seattle, Wash., First Presbyterian Church 454.3
KUOA—Fayetteville, Ark., University of Ark. 299.8
KUOM—Missoula, Mont., University of Mont. 243.8
KUSD—Vermillion, S. D., University of S. D. 278
KUT—Austin, Tex., University of Tex. 231
KVI—Tacoma, Wash., Puget Sound Bdcstg. Co. 242.5
KVOO—Bristow, Okla., SW Sales Corp. 374.8
KVOS—Seattle, Wash., L. L. Jackson 333
KWCR—Cedar Rapids, Ia., H. F. Parr 296
KWG—Stockton, Cal., Portable Wireless Telegraph Co. 248
KWKC—Kansas City, Mo., Wilson Duncan Studios 236
KWKH—Shreveport, La., The W. K. Henderson Iron Works and Supply Co. 312.3
KWSC—Pullman, Wash., State College of Wash. 348.6
KWTC—Santa Ana, Cal., Dr. J. W. Hancock 263
KWUC—Lemars, Ia., Western Union College 252
KWWG—Brownsville, Tex., City of Brownsville 278
KYW—Chicago, Ill., Westinghouse E. & M. Co. 535.4
KXL—Portland, Ore., KXL Bdcstg. 400
KXRO—Seattle, Wash., Brott Lab. 240
KZKZ—Manila, P. I., Electric Supply 270
KZM—Oakland, Cal., Freston D. Allen 240
KZRG—Manila, P. I., Far Eastern Radio, Inc. 222
NAA—Arlington, Va., U. S. Navy 435
WAAD—Cincinnati, O., Ohio Mechanical Inst. 258
WAAF—Chicago, Ill., Daily Drovers Journal 277.6
WAAM—Newark, N. J., Isaiah R. Nelson 263
WAAT—Jersey City, N. J., F. B. Bremer 235
WAAW—Omaha, Neb., Omaha Grain Exchange 384.4
WABB—Harrisburg, Pa., Harrisburg Radio Co. 204
WABC—Asheville, N. C., Asheville Battery Co. 254
WABF—Pringleboro, Pa., Markle Bdcst. Corp. 410.7
WABI—Bangor, Me., First Universalist Church 240
WABO—Rochester, N. Y., Hickson Elec. Co. Inc. Club 278 261
WABQ—Haverford, Pa., Haverford College Radio Club 261
WABR—Toledo, O., Scott High School 263
WABW—Wooster, O., The College of Wooster 206.8
WABX—Mount Clemens, Mich., H. B. Joy 246
WABY—Philadelphia, Pa., J. Magaldi, Jr. 242
WABZ—New Orleans, La., Colis Place Baptist Church 275.1
WADC—Akron, O., Allen T. Simmons 258
WAFD—Port Huron, Mich., A. P. Parfet 275
WAGM—Royal Oak, Mich., R. L. Miller 225.4
WAHG—Richmond Hill, N. Y., A. H. Grebe 315.6
WAGS—Somerville, Mass., Willow Garages, Inc. 250
WAIT—Tauton, Mass., A. H. Waite & Co. 229
WAIU—Columbus, O., American Ins. Union 293.9
WAMD—Minneapolis, Minn., Raddison Radio Corp. 243.8
WAPI—Auburn, Ala., Alabama Polytechnic Inst. 461.3
WARC—Medford, Mass., American Radio & Research 261
WARS—Brooklyn, N. Y., Amateur Radio Specialty Co. 295
WASH—Grand Rapids, Mich., Baxter Launderers & Cleaners 256.3
WATT—Portable-First District, Edison Electric, Ill. 243.8
WBAA—W. Lafayette, Ind., Purdue Univ. 273
WBAK—Harrisburg, Pa., Pa. State Police 275
WBAL—Baltimore, Md., Consolidated Gas & Power Co. 245.8
WBAO—Decatur, Ill., James Miliken Univ. 270.1
WBAP—Fort Worth, Tex., Carter Pub., Inc. 475.9
WBAW—Nashville, Tenn., Ray Elec. Co. and Waldrum Drug Co. 236
WBAX—Wilkes Barre, Pa., J. H. Stenger, Jr. 256
WBBC—Brooklyn, N. Y., P. J. Testan 249.9
WBBL—Richmond, Va., Grace Covenant Presbyterian Church 228.9
WBBM—Chicago, Ill., Atlass Investment 226
WBBP—Petosky, Mich., Petosky High School 238
WBBR—Rossville, N. Y., Peoples Pulpit Ass'n 416.4
WBBW—Norfolk, Va., Ruffner Junior H. S. 222
WBBY—Charlestown, S. C., Washington Light Infantry 268
WBBZ—Portable, Ill., C. L. Carrell 215
WBCN—Chicago, Ill., Foster & McDonnell 266
WBES—Takoma Park, Md., Bliss Electrical School 222
WBKN—Brooklyn, N. Y., A. Faske 291.1
WBMS—North Bergen, N. J., G. J. Schwerer 223.7
WBNY—New York, N. Y., Baruchrome Corp. 322.4
WBOQ—Richmond Hill, N. Y., A. H. Grebe & Company, Inc. 236
WBRC—Birmingham, Ala., Birmingham Bdcstg. Corp. 247.8
WBRE—Wilkes Barre, Pa., Baltimore Radio Exchange 231
WBRL—Tilton, N. H., Booth Radio Labs. 365
WBRS—Brooklyn, N. Y., Universal Radio Mfg. Company 394
WBT—Charlotte, N. C., C. Cham. of Com. 275
WBZ—Springfield, Mass., Westinghouse E. & M. Company 333.1
WBZA—Boston, Mass., Westinghouse E. & M. Company 333.1
WCAC—Mansfield, Conn., Conn. Agri. College 275
WCAD—Canton, N. Y., St. Lawrence University 263
WCAE—Pittsburgh, Pa., Kaufman & Baer Co. 461.3
WCAH—Columbus, Ohio, Entrekin Elec. Co. 265.3
WCAJ—University Place, Neb., Neb. Wesleyan University 254
WCAL—Northfield, Minn., St. Olaf College 336.9
WCAM—Camden, N. J., City of Camden 336.9
WCAO—Baltimore, Md., Monumental Radio Co., Inc. 275
WCAR—San Antonio, Tex., Southern Radio Corporation 263
WCAT—Rapid City, S. D., School of Mines 240
WCAU—Philadelphia, Pa., Universal Bdcstg Co. 278
WCAX—Burlington, Vt., University of Vermont 250
WCAZ—Carthage, Ill., Carthage College 245.8
WCBA—Allentown, Pa., C. W. Heimbach 254
WCBD—Zion, Ill., Wilber Glenn Voliva 344.6
WCBE—New Orleans, La., Uhalt Radio Co. 263
WCBH—Oxford, Miss., University of Miss. 242
WCBM—Baltimore, Md., Hotel Chateau 229
WCBR—Portable, R. I., C. H. Messter 234.2
WCBS—Portable, H. L. Dewing 242
WCCO—Anoka, Minn., Washburn Crosby Co. 416.4
WCFL—Chicago, Ill., Chicago Fed. of Labor 491.5
WCFT—Tullahoma, Tenn., Knights Pyth. Home 252
WCGU—Lakewood, N. J., C. G. Ungar 350.6
WCLO—Camp Lake, Wis., C. E. Whitmore 231
WCLS—Joliet, Ill., WCLS, Inc. 214.2
WCMA—Culver, Ind., Culver Military Academy 258.5
WCOA—Pensacola, Fla., City of Pensacola 252
WCRW—Chicago, Ill., C. R. White 416.4
WCSH—Portland, Me., H. R. Rines 499.7
WCSO—Springfield, O., Wittonberg College 248
WCWK—Fort Wayne, Ind., C. W. Keen 234.2
WCWS—Portable Comm., C. Wm. Selen 232.4
WCX—Pontiac, Mich., Detroit Free Press 516.9
WJR—Pontiac, Mich., Jewett Radio & Phonograph Co. 516.9
WDAD & WLAC—Nashville, Tenn., Dad's Auto Access., Inc., & Life & Casualty Ins. Co. 226

Station Location Owner Meters

WDAE—Tampa, Fla., Tampa Daily Times.... 273
WDAF—Kansas City, Mo., Kansas City Star... 365.6
WDAG—Amarillo, Tex., J. L. Martin.......... 263
WDAH—El Paso, Tex., Trinity Methodist Ch... 267.7
WDAY—Fargo, N. D., Radio Equipment Corp... 260.7
WDBE—Atlanta, Ga., Gilham Electric Co........ 270
WDBJ—Roanoke, Va., Richardson, Wayland Elec. Corp.................... 228.9
WDBK—Cleveland, O., M. F. Broz.............. 227
WDBO—Winter Park, Fla., Rollins College..... 240
WDBZ—Kingston, N. Y., Kingston Radio Club.233
WDEL—Welmington, Del., Wilmington Elec. Spec. Co............................266
WDGY—Minneapolis, Minn., Dr. G. W. Young... 263
WDOD—Chattanooga, Tenn., Chattanooga Radio Co., Inc.......................... 256
WDRC—New Haven, Conn., Doolittle Radio Corporation 268
WDXL—Detroit, Mich., DXL Radio Corp....... 296.9
WDWF—Cranston, R. I., D. W. Flint, Inc...... 440.9
WDWM—Newark, N. J., Radio Industries Bdsct. Co.............................280.2
WDZ—Tuscola, Ill., James L. Bush............. 278
WEAF—N. Y. City, National Bd'g Co. of Am.. 491.5
WEAI—Ithaca, N. Y., Cornell University........ 254
WEAM—North Plainfield, N. J., Borough of North Plainfield 261
WEAN—Providence, R. I., The Shepard Co........ 367
WEAO—Columbus, O., Ohio State University.. 293.9
WEAR—Cleveland, O., Willard Storage Battery Company 389.4
WEAU—Sioux City, Ia., Davidson Bros. Co...... 275
WEBC—Superior, Wisc., W. C. Bridges........ 242
WEBH—Chicago, Ill., Edgewater Beach Hotel. 370.2
WEBJ—New York, N. Y., Third Ave. R. R. Co. 273
WEBL—Portable, R. C. A. Show................ 226
WEBQ—Harrisburgh, Ill., Tate Radio Co........ 226
WEBR—Buffalo, N. Y., H. H. Howell............ 244
WEBW—Beloit, Wisc., Beloit College........... 258
WEBZ—Savannah, Ga., Savannah Radio Corp.. 263
WEDC—Chicago, Ill., Emil Denemark Bdcstg. Station 249.9
WEEI—Boston, Mass., Edison Electric Ill. Co.. 348.6
WEHS—Chicago, Ill., O. G. Fordham........... 202.6
WEMC—Berrien Springs, Mich., Emanuel Miss. College 315.6
WENR—Chicago, Ill., All-American Radio Corp. 266
WEPS—Gloucester, Mass., R. G. Matheson.......295
WEW—St. Louis, Mo., St. Louis University.... 360
WFAA—Dallas, Tex., Dallas News & Dallas Journal 475.9
WFAM—St. Cloud, Minn., Times Publishing Co. 273
WFAV—Lincoln, Neb., University of Neb....... 275
WFBC—Knoxville, Tenn., First Baptist Church 250
WFBE—Cinc., O., Garfield Place Hotel......... 232.4
WFBG—Altoona, Pa., W. F. Gable Co........... 278
WFBJ—Collegeville, Minn., St. John's University 236
WFBL—Syracuse, N. Y., Onondaga, Conn........252
WFBM—Indianapolis, Ind., Merchant H. L. Co. 268
WFBR—Baltimore, Md., Fifth Infantry, National Guard 254
WFBZ—Galesburg, Ill., Knox College........... 254
WFCI—Pawtucket, R. I., Frank Crook, Inc...... 229
WFDF—Flint, Mich., Frank D. allain............. 234
WFI—Phila., Pa., Strawbridge & Clothier......394.5
WFKB—Chicago, Ill., F. K. Bridgman...........217.3
WFKD—Philadelphia, Pa., Foulkord Radio Engineering Co. 249.9
WFRL—Brooklyn, N. Y., Flatbush Radio Labs..329.5
WGAL—Lancaster, Pa., Lancaster Electric Supply and Construction Co.................. 248
WGBB—Freeport, N. Y., H. H. Carman......... 243.8
WGBC—Memphis, Tenn., First Baptist Church.278
WGBI—Scranton, Pa., Scranton Bdcstg. Inc.....252
WGBS—Astoria, L. I., N. Y., Gimbel Bros....... 315.6
WGBR—Marshfield, Wis., G. S. Ives............228.9
WGBU—Fulford-by-the-Sea, Fla., Florida Cities Finance Company 278
WGBX—Oreno, Maine, Univ. of Maine.........234.2
WGCP—Newark, N. J., May Radio Bdcstg. Corp. 252
WGES—Chicago, Ill., Oak Leaves Broadcasting Corporation 315.6
WGHB—Clearwater, Fla., Ft. Harrison Hotel...266
WGHP—Detroit, Mich., G. H. Phelps, Inc....... 270
WGM—Jeanette, Pa., Verne & Elton Spencer...269
WGMU—Portable, N. Y., A. H. Grebe & Co..... 236
WGN—Chicago, Ill., Chicago Tribune........... 302.8
WGR—Buffalo, N. Y., Federal Tel. & Tel. Co... 319
WGST—Atlanta, Ga., School of Tech........... 270
WGWB—Milwaukee, Wis., Radiocast Corp. of Wisc. 384.4
WGY—Schenectady, N. Y., G. E. Co............ 379.5
WHA—Madison, Wisc., University of Wisc..... 535.4
WHAD—Milwaukee, Wisc., Marquette Univ.... 275
WHAM—Rochester, N. Y., Eastman School of Music 278
WHAP—New York, N. Y., W. H. Taylor Finance Corporation 431
WHAR—Atlantic City, N. J., F. D. Cooks Sons. 275
WHAS—Louisville, Ky., Courier Journal & Louisville Times 399.8
WHAZ—Troy, N. Y., Rensselaer Polytechnic Inst. 379.5
WHB—Kansas City, Mo., Sweeney School Co... 365.6
WHBA—Oil City, Pa., C. C. Shaffer.............. 250
WHBC—Canton, O., Rev. E. P. Graham.......... 254
WHBD—Bellefontaine, O., Chamber of Com..... 222.1
WHBF—Rock Island, Ill., Beardsley Spc. Co.... 222
WHBL—Portable, Ninth District, C. L. Carrell.215.7
WHBM—Portable, Ninth District, C. L. Carrell 215.7
WHBN—St. Petersburg, Fla., First Avenue M. E. Church 238
WHBP—Johnston, Pa., Johnston Auto Co........256
WHBQ—Memphis, Tenn., St. Johns M. E. Ch. 233
WHBS—Rock Island, Ill., Beardsley Spec. Co...221.1
WHBU—Anderson, Ind., Riviera Theatre.........218.8
WHBW—Philadelphia, Pa., D. R. Kienzle........ 215.7
WHBY—West De Pere, Wisc., St. Norberts College 249.9
WHDI—Minneapolis, Minn., W. H. Dunwoody Institute 278
WHEC—Rochester, N. Y., Hickson Electric Co., Inc. 258
WHFC—Chicago, Ill., Triangle Bdcstrs..........258.5
WHK—Cleveland, O., Radio Air Service Corp.. 272.6
WHN—New York, N. Y., Geo. Schubel.......... 361.2
WHO—Des Moines, Ia., Bankers Life Co...... 526
WHOG—Huntington, Ind., Huntington Bdcstrs. Association 241.8
WHT—Deerfield, Ill., Radiophone Bdcstg. Corp.238.8
WIAD—Philadelphia, Pa., Howard R. Miller.... 250.
WIAS—Burlington, Ia., Home Elec............254
WIBA—Madison, Wisc., Strand Theatre.........236.1
WIBG—Elkins Park, Pa., St. Paul's Protestant Episcopal Church 222
WIBH—New Bedford, Mass., Elite Radio Stores 209.7
WIBI—Flushing, L. I., N. Y., F. B. Zittel, Jr. 218.8
WIBJ—Portable, Ill., C. L. Carrell............ 215.7
WIBM—Portable, Ill., B. Maine................ 215.7
WIBO—Chicago, Ill., Nelson Brothers.......... 226
WIBR—Weirton, W. Va., Thurman A. Owings 246
WIBS—Elizabeth, N. J., Thos. F. Hunter...... 202.6
WIBU—Poynette, Wisc., The Electric Farm.... 222
WIBW—Logansport, Ind., Dr. L. L. Dill...... 220
WIBX—Utica, N. Y., WIBX, Inc................234.2
WIBZ—Montgomery, Ala., A. D. Trum.........230.6
WICC—Bridgeport, Conn., Bridgep't Bdsctg. Sta. 285
WIL—St. Louis, Mo., St. Louis Star............258
WIOD—Miami, Fla., Carl G. Fisher Co......... 247.8
WIP—Philadelphia, Pa., Gimbel Bros........... 508.2
WJAD—Waco, Tex., Jackson's Radio Engineering Laboratories 352.7
WJAF—Ferndale, Mich., J. S. Fernberg Radio Co. 407
WJAG—Norfolk, Neb., Norfolk Daily News.....270
WJAK—Kokomo, Ind., Kokomo Tribune........ 254.1
WJAM—Cedar Rapids, Ia., D. M. Perham...... 268
WJAR—Providence, R. I., The Outlet Co..... 305.9
WJAS—Pittsburg, Pa., Pittsburgh Radio Supply House 275
WJAX—Jacksonville, Fla., City of Jacksonville 336.9
WJAZ—Mount Prospect, Ill., Zenith Radio Corp. 329.5
WJBA—Joliet, Ill., D. H. Lentz, Jr............ 206.8
WJBB—St. Petersburg, Fla., Financial Journal. 254.1
WJBC—La Salle, Ill., Hummer Furniture Co.. 234
WJBI—Red Bank, N. J., R. S. Johnson........ 218.8
WJBK—Ypsilanti, Mich., E. F. Goodwin......... 233
WJBL—Decatur, Ill., Wm. Gushard Dry Goods Co. 270
WJBO—New Orleans, La., V. Jenson.......... 267.7
WJBR—Omro, Wisc., Omro Drug Stores...... 227.1
WJBT—Chicago, Ill., John S. Boyd............ 468.5
WJBU—Lewisburg, Pa., Bucknell University.. 211.1
WJBV—Woodhaven, N. Y., Union Course Club 288.3
WJBW—New Orleans, La., C. Carlson, Jr.... 270.1
WJBY—Gadsen, Ala., Elec. Construction Co.... 260
WJBZ—Chicago Heights, Ill., R. G. Palmer.....419.3
WJJD—Moosehart, Ill., Loyal Order of Moose.. 370.2
WJR—Pontiac, Mich., Jewett Radio & Phonograph Co., and The Detroit Free Press 516.9
WJUG—New York City, U. B. Ross............ 516.9
WJY—New York, N. Y., Nat. Bdcstg. Co. of Amer. 405.2
WJZ—Bound Brook, N. J., Nat. Bdcstg Co. of Amer. 454.3
WKAF—Milwaukee, Wisc., WKAF Broadcasting Corp. 261
WKAQ—San Juan, P. R., Radio Corporation of Porto Rico 340.7
WKAR—East Lansing, Mich., Michigan State College 285.8
WKAV—Laconia, New Haven, Laconia Radio Club 224
WKBA—Chicago, Ill., Arrow Battery Co....... 209.7
WKBB—Joliet, Ill., Sanders Brothers.......... 282.8
WKBC—Birmingham, Ala., H. L. Ansley 225
WKBE—Webster, Mass., K. & B. Electric Co.. 270.1
WKBF—Indianapolis, Ind., N. D. Watson....... 244
WKBH—La Crosse, Wisc., Callaway Music......249.9
WKBG—Portable, Ill., C. L. Carrell........... 215.7
WKBI—Chicago, Ill., F. L. Schoenwolf 220.4
WKBJ—St. Petersburg, Fla., Gospel Tabernacle, Inc. 280
WKBL—Monroe, Mich., Monrona Radio Mfg. Co. 252
WKBM—Newburgh, N. Y., J. W. Jones.........285.5
WKBN—Youngstown, O., Radio Elec. Serv. Co...360
WKBO—Jersey City, N. J., Camith Corp........303.9
WKBP—Battle Creek, Mich., Enquirer & News 265
WKBO—Jersey City, N. J., Camith Corp.........303.39
WKBR—Auburn, N. Y., Chas. J. Hesiser....... 256.3
WKBS—Galesburg, Ill., P. N. Nelson.......... 361.2
WKBT—New Orleans, La., First Baptist Church..252
WKBU—New Castle, Pa., H. K. Armstrong.....238
WKBV—Brookville, Ind., Knox Battery & Electric Co. 236.1
WKBY—Danville, Pa., (Portable) F. Quick.... 220
WKBW—Buffalo, N. Y. Churchill Evan. Assn... 362.5
WKBZ—Ludington, Mich., K. L. Ashbacker.. 256.3
WKDR—Kenosha, Wisc., E. A. Dato........... 428.3
WKJC—Lancaster, Pa., Kirk Johnson & Co..... 258.5
WKRC—Cincinnati, O., Kodel Radio Corp.......422.3
WKY—Oklahoma City, Okla., R. C. Hull & N. S. Richards 275
WLAL—Tulsa, Okla., First Christian Church.. 250
WLAP—Louisville, Ky., W. V. Jordan.......... 275
WLB—Minneapolis, Minn., University of Minnesota 278
WLBC—Muncie, Ind., D. A. Burton............ 223.7
WLBE—Bklyn, N. Y., J. H. Fruitman.......... 230.6
WLBF—Kansas City, Mo., E. L. Dellard........211.1
WLBH—Farmingdale, N. Y., J. J. Lombardi....230
WLBI—East Weonona, Ill., A. Yarc...........296.9
WLBL—Stevens Point, Wisc., Wisc. Department of Markets........................ 278
WLCI—Ithaca, N. Y., Lutheran Assn. of Ithaca.266
WLIB—Elgin, Ill., Liberty Weekly, Inc........ 302.8
WLIT—Philadelphia, Pa., Lit Brothers........ 394.5
WLS—Crete, Ill., Sears Roebuck Co........... 344.5
WLSL—Cranston, R. I., The Lincoln Studios, Inc. 440.9
WLTS—Chicago, Ill., Lane Technical High School 258
WLW—Harrison, O., The Crosley Radio Corp. 422.3
WLWL—N. Y. C., Paulist Fathers............. 384.4
WMAC—Cazenovia, N. Y., C. B. Meredith.... 275
WMAF—Dartmouth, Mass., Round Hills Radio Corp. 440.9
WMAK—Lockport, N. Y., Norton Laboratories 266
WMAL—Washington, D. C., M. A. Leese Optical Co. 293.9
WMAN—Columbus, O., Haskett Radio Station 278
WMAQ—Chicago, Ill., Chicago Daily News.... 447.5
WMAY—St. Louis, Mo., Kings Highway Preb. Church 248
WMAZ—Macon, Ga., Mercer University...... 261
WMBB—Chicago, Ill., American Bond & Mortgage Co. 250
WMBC—Detroit, Mich., Michigan Broadcasting Co., Inc. 256
WMBF—Miami Beach, Fla., Fleetwood Hotel Corp. 384.4
WMBI—Chicago, Ill., Moody Bible Inst.........288.3
WMC—Memphis, Tenn., Commercial Pub. Co...499.7
WMCA—Hoboken, N. J., Greely Square Hotel 340.7
WMRJ—Jamaica, N. Y., P. J. Prinz............227.1
WMSG—N. Y. C., N. Y., Radio Eng. Corp.....302.8
WMVM—Newark, N. J., E. J. Malone, Jr.......475.9
WNAB—Boston, Mass., Shepard Stores........ 280.2
WNAC—Boston, Mass, Shepard Stores.......... 430.1
WNAD—Norman, Okla., University of Okla.... 254
WNAL—Omaha, Neb., Omaha Central High School 258
WNAT—Philadelphia, Pa., Lennig Brothers Co. 250
WNAX—Yankton, S. D., Dakota Radio Apparatus Co. 244
WNBH—New Bedford, Mass., New Bedford Hotel 247.8
WNJ—Newark, N. J., H. Lubinsky.............350
WNOX—Knoxville, Tenn., Peoples Tel. & Tel. Co. 267.7
WNRC—Greenboro, N. C., W. M. Nelson........224
WNYC—New York, N. Y., Department of Plants & Structures 526
WOAI—San Antonio, Tex., Sou. Equip. Co..... 394.5
WOAN—Lawrenceburg, Tenn., Vaughan Con. of Music 356.4
WOAW—Omaha, Neb., Woodmen of the World 526
WOAX—Trenton, N. J., F. J. Wolff............240
WOBB—Chicago, Ill., Longacre Engrg. Const'n. Co. 555.2
WOC—Davenport, Ia., Palmer School of Chiropractic 483.6
WOCB—Orlando Bdcstg. Co., Orlando, Fla.... 293.7
WOCL—Jamestown, N. Y., A. B. Newton...... 275.1
WODA—Patterson, N. J., O'Dea Temple of Music 390.9
WOI—Ames, Ia., Iowa State College............ 270
WOK—Homewood, Ill., Neutrowound Radio Mfg. Co. 217.3
WOKO—Peekskill, N. Y., H. E. Smith......... 232.4
WOKO—Peekskill, N. Y., O. Bauer.............233
WOO—Philadelphia, Pa., J. Wanamaker 508.2
WOOD—Grand Rapids, Mich., Grand Radio Co. 241.8
WOQ—Kansas City, Mo., Unity School......... 278
WOR—Newark, N. J., L. Bamberger & Co..... 405.2
WORD—Batavia, Ill., Peoples Pulpit Association 275
WOS—Jefferson City, Mo., State Marketing Bureau 440.9
WOWO—Fort Wayne, Ind., Main Automobile Supply Co. 227
WPAB—Norfolk, Va., Radio Corp. of Va.........319
WPAK—Agricultural College, N. D., N. D. Agricultural College 275
WPAP—Cliffside, N. J., (See WQAO) 361.2
WPCC—Chicago, Ill., North Shore Congregational Church 258
WPCH—N. Y. C., N. Y., Concourse Radio Corp. 273
WPDQ—Buffalo, N. Y., Hiram L. Turner...... 205.4
WPEP—Waugegan, Ill., M. Mayer..............212.6
WPG—Alantic City, N. J., Municipality of Atlantic City 299.8
WPRC—Harrisburg, Pa., Wilson Printing & Radio Co. 215.7
WPSC—State College, Pa., Pa. State College... 261
WQAA—Parkensburg, Pa., H. A. Beale, Jr..... 220
WQAE—Springfield, Vt., Moore Radio News Station 246
WQAM—Miami, Fla., Electrical Equipment Co. 285.5
WQAN—Scranton, Pa., Scranton Times........ 250
WQAO—Cliffside, N. J., Calvary Baptist Church (WPAP used when Palisade Amusement Park Program is on) 361.2
WQJ—Chicago, Ill., Calumet Co.............. 447.5
WRAB—Yellow Springs, O., Antioch College....263
WRAF—Laporte, Ind., Radio Club, Inc.......... 224
WRAH—Providence, R. I., Stanley N. Read....235
WRAK—Escanoba, Mich., Economy Light Co.. 256
WRAM—Galesburg, Ill., Lombard College 244
WRAW—Reading, Pa., Avenue Radio & Electric Shop 238
WRAX—Gloucester City, N. J., Fexon's Garage..268
WRBC—Valparaiso, Ind., Immanuel Lutheran Church 278
WRC—Washington, D. C., Nat. Bdcstg. Co. of Amer. 468.5
WRCO—Raleigh, N. C., Wayne Radio Co...... 252
WREC—Coldwater, Miss., Wooten's Radio Shop. 254
WREO—Lansing, Mich., Reo Motor Car Co.....285.5
WRES—Wollaston, Mass., H. L. Sawyer...... 300
WRHF—Washington, D. C., Washington Radio Hospital Fund 256
WRHM—Minneapolis, Minn., Rosedale Hospital 252
WRK—Hamilton, O., Doron Brothers Electric Co. 270
WRM—Urbana, Ill., Univ. of Ill................273
WRMU—Motor Yacht "MU-1", A. H. Grebe & Co. 236
WRNY—Coytesville, N. J., Experimenter Pub. Co. ....373..8
WRR—Dallas, Tex., City of Dallas........... 246
WRRS—Racine, Wisc., Racine Radio Co.........360
WRST—Bay Shore, N. Y., Radiotel Manufacturing Co., Inc. 215.7
WRVA—Richmond, Va., Larus & Bro. Co., Inc. 256
WSAI—Cincinnati, O., United States Playing Card Co. 325.9
WSAJ—Grove City, Pa., Grove City College.... 229
WSAN—Allentown Pa., Allentown Call Publishing Co., Inc. 229
WSAR—Fall River, Mass., Doughty & Welch Elec. Co. 322
WSAV—Houston, Tex., Clifford W. Vick.. 247.8
WSAX—Chicago, Ill., Zenith Radio Corporation. 268
WSAZ—Pomeroy, O., Chas. Electric Shop 244
WSB—Atlanta, Ga., Atlanta Journal Co....... 428.3
WSBC—Chicago, Ill., World Battery Co. 288.3
WSBF—St. Louis, Mo., Stix Baer & Fuller......273

(Concluded on page 23)

THE RADIO TRADE

Northwest Trade Circuit Unites Show Activities

PORTLAND, Ore.

Formation of a radio circuit, coupling the Portland, Seattle and Spokane radio shows under one management, has just been announced by George J. Thompson Jr., secretary of the Oregon Radio Trades Association and director of the recent Portland Radio show.

The local exhibit will be held shortly after the San Francisco show, then Seattle will hold theirs and Spokane will follow shortly after with the final Northwest exhibit. There is some possibility that Salt Lake and Denver might be linked into the chain to provide a bigger and better show for all cities in the circuit, which for the present will be called the S. P. and S. Radio show circuit.

The triple Northwest exhibit will attract many Eastern exhibitors who took their displays to Los Angeles and other Southern shows this year, instead of coming north to the Portland show, according to Thompson, who will direct the Northwest chain.

Some of the features in store for radio fans at next year's exhibit are already being planned. One of these will be a new type of studio entirely different than anything ever shown radio fans and one which Thompson says will be second to none in the United States. He also says that by holding the three shows under one management he can attract many of the high class artists from both Eastern and Western broadcasting stations to perform for the fans at the show.

The good done by the radio show is proved by the popularity of the B battery eliminators, which Thompson attributes as a direct result of the local show, held in September. Many other popular improvements are brought before the eyes of the public as no other means could accomplish.

New Speaker Designed; Manufacture Is Begun

ASBURY PARK, N. J.

Hobart A. Simpson of 69 Broadway, Ocean Grove, N. J., who has been working on radio devices, has announced that he has invented a new type of loud speaker.

He said the speaker is built on a new and revolutionary principle, being neither a horn nor a cone and claims for it remarkable tonal quality.

The Asparad Radio corporation has been organized to manufacture the instrument, and has laboratories at 711 Sewall Avenue, this city. Simpson has assigned his patent rights to this company, the officers of which are: President, Hobart A. Simpson; vice president, W. T. Jackson of West Allenhurst; treasurer, J. A. Straussman, Asbury Park, connected with the comptroller's office of the Standard Oil company; secretary and assistant treasurer, Robert McMichael, attorney.

The Florey Piano company of Washington, N. J. is associated with the local corporation in the manufacture of the loud speaker. Florey was associated with the Victor Talking Machine company as an acoustical engineer and has performed special work in this field for Thomas Edison.

Tobe Has New Condenser for Repair of R. C. A. Speaker

The R. C. A. Radiola No. 104 speaker employs an electro-magnet instead of a permanent magnet, in the operating unit, and a moving-coil attachment to the cone. Owing to the very large currents and high voltages sometimes employed, surges are set up which blow the large 9 mfd. condenser, which is used in these speakers. To meet the necessity for replacements of these condensers, Tobe Deutschmann Company has brought out its No. 104 Condenser, made expressly for use in the No. 104 Radiola speaker. It is exactly the same size as the condenser which comes with the speaker and may be installed in a very short time.

R. C. A. dealers and jobbers will find the Tobe 104 condenser a valuable line to carry, for assistance in servicing the speakers.

TRADE NOTES

DALLAS, Tex.

Southwestern headquarters have been established in the Santa Fe Building here by the Radio Cabinet Company of Indianapolis, Ind. This company manufactures and distributes three types of radio sets and loud speakers.

James J. Ryan is manager of the Southwestern headquarters. The company is preparing a display of its various lines.

* * *

LITTLE ROCK, Ark.

Formation of a new radio supply company, the Central Radio Company, with offices at 1003 West Seventh street, has been completed. The firm will handle radios. It also will specialize in repair work on any service.

R. E. Hohenschutz, formerly with O. D. Tucker IV. Company, and H. G. Clok, formerly with the Southern Radio Company, compose the firm.

* * *

SAN FRANCISCO, Cal.

The committee in charge of San Francisco's 1927 radio exposition is busy on the big feature following the appointment of A. A. Tremp as manager and Leo J. Meyberg as chairman of the committee in charge of the coming event, by Ernest Ingold, president of the Pacific Radio Trades Association, sponsor of the exposition. The radio show will be held in Exposition Auditorium from August 20 to 27.

* * *

SEATTLE, Wash.

Appointment of H. R. Fletcher as director of sales and distribution of Thermiodyne radio receiving sets is announced by the Algonquin Electric Company with general offices at 120 Broadway, New York. The company recently acquired the trade name "Thermiodyne" and is manufacturing the set in the factory at Poughkeepsie, New York.

* * *

According to the many dealers handling the famous Victoreen Kit, it is most popular of all the kits they handle. This, they say is due to the simplicity of the wiring up of the receiver, combined with the excellent efficiency obtained. For every kit sold, they sell another kit, via the purchaser, due to the aforementioned reasons. The superb tonal quality has been stressed upon, by all the fans. This is due to the use of the Karas Harmonik All-Stage audio frequency transformers. The remarkable selectivity factor in this set is laid to the use of the excellently constructed, both mechanically and electrically, Victoreen antenna, oscillator and intermediate frequency coils. Both these remarkable features are causing the fans to flock to this kit with extreme enthusiasm.

Court Fines WGY $250 For Broadcasting a Song

Copyright Piece Played in Hotel, Without Authority and Picked Up By Remote Control—Court Explains Liability Arises From the Supplying of Electricity to Send Out the Program

Jerome H. Remick & Co., music publishers, received an award of $250 damages, counsel fees of $1,000, and an injunction against further infringement of copyrights in a suit against the General Electric Company (WGY at Schenectady, N. Y.), by a decision of Federal Judge Thomas D. Thacher. The publishers charged in their suit that WGY had broadcast the song "Somebody's Wrong" from the New Kenmore Hotel at Albany, and also charged that the hotel orchestra used the song without authorization of the copyright owner.

This is the first time that a broadcasting station has been sued for transmission of music from a source outside of the studio and not under control of the station. Stations have been sued for music broadcast from their own studios without authorization of the copyright owners.

Judge Thacher ruled that although the "defendant did not participate in the rendition of the musical production except by affording others the opportunity to hear it," this constituted a "contributory infringement."

Judge Thacher made the comparison of a person leaving a window open so that those passing in the street might hear music within to the action of the broadcaster.

"Such is not the case of the broadcaster," he said, "equipped with instruments animated by electricity constantly furnished, who throughout the performance of the orchestra, picks up each note, translates it into electrical energy, and transmits it to persons within a radius of several hundred miles so that they may hear the original sound."

The Court added that the acts of the broadcaster are found in the reactions of his instruments, constantly animated and controlled by himself, and those acts are quite as continuous and infinitely more complex than the playing of the selection by the orchestra.

The $250 damage is the amount fixed by statute.

Literature Wanted

THE names of readers of RADIO WORLD who desire literature from radio jobbers and dealers are published in RADIO WORLD on request of the reader. The blank below may be used, or a post card or letter will do instead.

RADIO WORLD,
145 West 45th St., N. Y. City.
I desire to receive radio literature

Name ....

Address ....

City or town ....

State ....

R. H. Wilkerson, 915 Farley Boulevard, Birmingham, Ala.
H. H. Hanchey, Hendricks-Laws Son, El Paso, Texas.
Lloyd C. Reese, 513½ North Pennsylvania St., Allentown, Pa.
W. R. Delong, Shoreham, Vt.
C. J. Haines, 58 Tonawanda St., Dorchester, Mass.
Carlton Talmadge, 3 Gregory Boulevard, East Norwalk, Conn.
C. E. Davis, P. O. Box 2767 Miami, Fla.
George S. Oakford, George's Radio Service, 24 Greenwich St., Hemstead, L. Is., N. Y.
E. H. Rush, 4678 Mayberry, Omaha, Neb.
Floyd Wickenkemp, Box 1546, Casper, Wyo.
Atlas Radio Co., 7765 75th St., Glendale, R. Is., N. Y.
Gus Burdick, 181 South Pennsylvania Ave., Wilkes Barre, Pa.
K. Flammand, 308 East King St., Lancaster, Pa.
George C. Wells, 363 Lake St., Newark, N. J.
W. E. Collins, 907 Shattuck Ave., Berkeley, Cal.
Harry H. Kuhn, 602 South 5th St., Marshall, Ill.
F. A. Fabuercker, 372 Kerrigan Ave., Union City, N. J.
Luther Lewis, Prospect, Oneida County, N. Y.
Arthur Leach, 12 Sanborn St., Exeter, N. H.
W. E. Bryant, 206 West Jean St., Tampa, Fla.
Fred Sullivan, 12016 Hawthorne Ave., Highland Park, Detroit, Mich.
J. W. Richards, Route 3, Sylacauga, Ala.

GALVANOMETER USEFUL

A current of one micromicroampere may be measured with a sensitive galvanometer. If this current be multipled by one million one million times, there would be just enough to heat the filaments of four 201-A type tubes.

STATIONS

(Concluded from page 21)

WSBT—South Bend, Ind., South Bend Tribune. 315
WSDA—N. Y. C., Seventh Day Adventist Ch. .. 263
WSKC—Bay City, Mich., World's Star Knitting Co. 261
WSM—Nashville, Tenn., National Life & Accident Insurance Co. 282.8
WSMZ—New Orleans, La., Saenger Amusement Co., & Maison Blanche.... 319
WSMH—Owosso, Mich., Shattuck Music House. 240
WSMK—Dayton, O., S. M. K. Radio Corp.... 275
WSOE—Milwaukee, Wisc., School of Engineering of Milwaukee 246
WSRO—Hamilton, O., H. W. Fahlander 252
WSSH—Boston, Mass., Tremont Temple Baptist Church 260.7
WSUI—Iowa City, Iowa, State University of Ia. 483.6
WSVS—Buffalo, N. Y., Seneca Vocational Sch. 218.8
WSWS—Batavia, Ill., S. W. Straus & Co.... 275.1
WSYR—Syracuse, N. Y., Clive B. Meredith.... 352.7
WTAB—Fall River, Mass., Fall River Herald-News 266
WTAD—Carthage, Ill., E. Compton 236
WTAG—Worcester, Mass., Worcester Telegram 545.1
WTAL—Toledo, O., Toledo Radio & Electric Co. 252
WTAM—Cleveland, O., Willard Storage Battery Co. 389.4
WTAQ—Osseo, Wisc., C. S. Van Gordon.... 254.1
WTAR—Norfolk, Va., Reliance Electric Co. 261
WTAW—College Station, Tex., Agricultural & Mechanical College of Texas 270
WTAX—Streator, Ill., Williams Hardware Co. 231
WTAZ—Lambertville, N. J., Thomas J. McGuire 261
WTHO—Ferndale, Mich., Fernberg Radio Co.... 407
WTIC—Hartford, Conn., Travelers Insurance Co. 475.9
WTRC—Brooklyn, N. Y., 20th Dist. Repub. Club.. 239.9
WWAE—Plainfield, Ill., Electric Park.... 384.4
WWJ—Detroit, Mich., Evening News Association (Detroit News) 352.7
WWNC—Asheville, N. C., Asheville Bat. Co., Inc. 254
WWPR—Detroit, Mich., Detroit Police Dept..... 300
WWL—New Orleans, La., Loyola University.. 275
WWRL—Woodside, N. Y., Woodside Radio Laboratories 258.5
WWVA—Wheeling, W. Va., J. C. Stroebel.... 348.6

NEW CORPORATIONS

Tomalyn Electric and Radio Corp., N. Y. City, $10,000; T. J. and O. J. and R. V. Falciglisa. (Atty., N. Cimbalo, 1451 Broadway, N. Y. City).

Minute-Men of Melody, N. Y. City, orchestras for radio, $20,000; N. Sanders, P. Goldfarb, B. M. Smith. (Atty., Cohen, Goldfarb & Salpeter, 302 Broadway, N. Y. City).

International Authors and Composers Organization, N. Y. City, radio broadcasting station, 1,000 common, no par; J. Hoeflich, J. Kahn, N. Saron. (Atty., W. Klein, 1440 Broadway, N. Y. City).

Masta Radio, N. Y. City, radio instruments, $15,000; T. W. Richie, I. Rosenblatt. (Atty., J. Leiman, 276 5th Ave., N. Y. City).

Radio Industries Broadcast Co., Newark, N. J., Conduct broadcasting stations, 100 shares, no par value; D. W. May, Samuel Green, Irving Venokur, Newark, N. J. (Atty., Green & Green, Newark, N. J.

750 Stations in Sight As Crowded List Swells

White Resolution, Prohibiting Any New Licenses Unless Otherwise Directed by Congress, Is Called Only Remedy in Sight—108 New Stations in Five Months

WASHINGTON.

The total number of broadcasting stations in the United States will be increased to around 750 within the next two months unless the emergency resolution introduced by Representative Wallace White Jr., of Maine, is enacted. The White resolution instructs the Secretary of Commerce to issue no new broadcasting licenses until otherwise directed by Congress.

The increase in stations is clearly indicated by the most recent report of radio supervisors to the Department of Commerce. The report shows 102 new stations actually under construction, while plans are more or less indefinite for the construction of 168 more.

The report shows that 108 new stations were licensed since July 1, 126 stations increased their power, 93 stations changed their wavelength, 102 stations were under constructions, 63 stations were preparing to increase their power, and plans were indefinite for the construction of 168 stations. Of the new stations licensed, 24 were of 500 watts power or more.

The report by districts follows:

First district, Boston: 9 new stations, 5 with increased power, 14 have changed waves, 8 are under construction, while plans are indefinite for the construction of 8 stations.

Second district, New York: 17 new stations, 10 with increased power, 10 have changed waves, 2 are under construction, 15 are preparing to increase power, while plans are indefinite for the construction of 29 stations.

Third district, Baltimore: 4 have increased their power, 2 have changed waves, 1 is under construction, 5 are planning to increase power, while plans are indefinite for 4 stations.

Fourth district, Atlanta: 1 new station, 14 have increased power, 4 have changed waves, 8 are under construction, while 8 are preparing to increase power.

Fifth district, New Orleans: 11 new stations, 6 with increased power, 5 have changed waves, 12 are under construction, 12 are preparing to increase power while plans are indefinite for 17.

Sixth district, San Francisco: 4 new stations, 8 have increased power, 17 have changed waves, 8 are under construction while plans are indefinite for 17.

Seventh district, Seattle: 15 new stations, 11 have increased power, 9 have changed waves, 16 are under construction, 4 are preparing to increase power, while plans are indefinite for 15.

Eighth district, Detroit: 16 new stations, 20 have increased power, 4 have changed waves, 7 are under construction, 2 are preparing to increase power and plans are indefinite for 53.

Ninth district, Chicago: 35 new stations, 48 have increased power, 27 have changed waves, 40 are under construction, 17 are preparing to increase power, and plans are indefinite for 25.

DC IS EASIER TO MEASURE

AC cannot be measured as accurately as DC. The most sensitive AC meters will not do better than one microampere. The reason is that they have to be measured by the heat they generate in a resistance, and small currents do not generate much.

AT YOUR SERVICE

[Questions pertaining to servicing of radio receivers will be answered by Robert L. Eichberg, Director of the Extension Division of the Federated Radio Trade School, 4464 Cass Avenue, Detroit, Michigan, and all inquiries should be sent direct to him at that address. Also questions on radio merchandising, advertising, sales methods, etc., may be asked. Mr. Eichberg is familiar with radio from all of these various angles, having been engaged in radio selling and advertising for some of the country's foremost radio concerns for several years.]

By Robert L. Eichberg

Director, Extension Division, Federated Radio Trade School, Detroit, Mich.

WE find some problems occur quite frequently in service, work, and so, perhaps, it will be well to discuss some general topic each week, in addition to answering such queries as may be asked. In the classes at School there are men who have built over three hundred sets, and men, who until they came, had never attempted to build any. In these articles, as in the school, we will try to benefit those who are quite new to radio as well as those to whom radio is a familiar subject. There will occasionally be articles of a far more technical character than that appearing in this issue, but remember that it is the simpler, most commonly known happenings that most frequently occur and articles such as this may serve to remind you of some fact that has slipped your mind even though they may not tell you anything that strikes you as radically new.

RF Amplifier and Detector Grid Returns

Quite frequently, the service man is called in to give his views on the failure of a home-built tuned radio frequency set to afford volume and selectivity. Often this can be traced to the grid returns of one or more of the RF coils or the detector coil secondary being run to the wrong filament lead. There is a quick way to check up on the former, if the set is the usual type, using 90 volts of B battery potential on the plates of all amplifier tubes and 45 volts on the detector tube, with a 4½ volt negative bias on the audio amplifier grids. It is to insert a 0-50 scale milliammeter in the wire running from the negative terminal of the B battery to the common A and B battery connection. If all is well, the deflection of the needle on the meter will indicate that a current of 17 mils or less is flowing. When a greater amount of current is being consumed, first see that the polarity of the C battery is correct, and that its positive terminal is connected to the negative A lead. Next, inspect the set and make sure that the RF amplifier grid returns are connected to the negative side of the filament circuit and that those of the audio tubes are run to the negative B battery terminal. If a 201-A type tube is being used as detector, it should have a positive grid return, and if the detector is of the 200 or 200-A type, the grid return should be negative.

The milliammeter reading of about 17 mils, as mentioned above, will hold good for storage battery operated sets that do not use power tubes, as these tubes will require higher B and C voltages and draw a greater amount of plate current. Sets using various types of dry-cell tubes will draw slightly less.

Many owners of factory-made sets are replacing their type 201-A tubes with the type 200-A in the detector stage—and are neglecting to change the grid return. This is a point that must be watched, if the new tubes are to function properly. If ever you hear a set owner complaining that a special detector is not performing as it should, check up on the grid return before going to any further trouble.

QUESTIONS AND ANSWERS

I HAVE constructed an eight tube Super-Heterodyne, using a kit, with two stages of resistance coupled audio frequency amplification. Tubes, batteries and speaker are O.K., and I have checked over the circuit four times and still the set does not work as it should. Are there any suggestions you can offer?—J. Reilly.

The output of the second detector of a properly designed and constructed Super is so great that a resistance coupler will not usually allow enough plate current to flow to handle it. Try a transformer.

(*Continued on page 26*)

(*Continued from page 25*)

I HAVE BEEN GIVEN a five tube tuned radio frequency set, and been told to stop it from squealing when tuned. I don't know where to tap the coils to neutralize it. Can you tell me of any other way that will work?—John R. Stritt.

You can connect a 50,000 ohm-maximum variable resistance in the B battery lead to the primaries of the RF transformers (not the antenna coupler), and use this to cut down their plate potential to the proper value. Also, you can connect the grid returns of the first two tubes to the arm of a non-inductive potentiometer, and connect its outside terminals across the A battery leads in the set, to give a control of RF grid bias. If you decide to use the latter method, be sure that the filament switch is between the potentiometer and the A battery, to avoid a constant current drain. Use a potentiometer that has a resistance of 400 ohms, and the current passed through it will be only .015 ampere.

* * *

I WISH to install a set in a hotel room, where I have no facilities for erecting an aerial. I have tried to make the set work on a loop, but without succeeding. It is a regenerative set, using three tubes. How can I get along without an aerial, or if this cannot be done, how can I change the set?—W. Hall.

There are several acceptable antenna substitutes on the market. Some attach in an electric light socket. Examples are the "Antenella" and the "Ducon." There is also a metal plate which may be placed under a telephone. Its name, I believe, is the "Antennaphone." Another way that usually works well is to use the steam pipe or gas-pipe as an aerial. In all cases use the cold water pipe as the ground.

* * *

MY SET has a rather raspy tone, that I would like to overcome. Tubes and batteries are new, so I assume that they are all right and the loud speaker sounded fine when the dealer demonstrated it to me. Do you think that if I added a stage of resistance coupled amplification it might help?—Irving Hendon.

No. If you were to remove the second audio transformer and replace it with a better one or with two stages of resistance coupling, the tone would probably be improved. Before doing this, try connecting a 1/4 to 5 megohm variable resistance across the primary of the first transformer. Then try it across the primary of the second transformer. It is likely that you will find that this will remove the rasp without necessitating rebuilding.

* * *

CAN YOU TELL me an easy way to determine the primary to secondary ratio of an audio transformer?—Ira Hoff.

An approximate idea can be had by connecting first the primary and then the secondary in series with a 0-50 milliammeter and a 22½ volt B battery. Suppose that the reading shows a current of 2 mils through the secondary and 10 mils through the primary. Then the transformer has a 5-1 ratio, as 10 divided by 2 equals 5. This test holds good only if the primary and secondary are wound with the same size wire, as is almost always the case.

KEEP FILAMENTS NORMAL

Do not burn the filaments in the radio set brighter than normal. Nothing is gained and the life is unduly shortened. If more power is required, use a larger tube.

CIVIL SERVICE

The United States Civil Service Commission announces the following open competitive examination:

ASSISTANT PHYSICIST

Applications for assistant physicist must be on file at Washington, D. C., not later than January 11, 1927.

The examination is to fill vacancies in the Bureau of Standards and the Bureau of Mines, Washington, D. C., and vacancies in positions requiring similar qualifications.

The entrance salary in the Departmental Service is $2,400 a year. A probationary period of six months is required; advancement after that depends upon individual efficiency, increased usefulness, and the occurrence of vacancies in higher positions. For appointment to the field service the entrance salary will be approximately the same.

Competitors will be rated on the optional subjects of heat, electricity, mechanics, optics, radio, physical metallurgy, or any specialized work in the field of physics not included in any of the above.

Competitors will not be required to report for examination at any place, but will be rated on their education and experience, and writings to be filed with the application.

The work of the Bureau of Standards includes many branches of physics, chemistry, engineering, and technology, such as mechanics, heat, optics, electricity, sound, metrology, metallurgy, radio, electronics, engineering (gas, electrical) mechanical, etc.), and offers valuable experience in these professions, combining as it does theoretical, experimental, and practical work.

Full information and application blanks may be obtained from the United States Civil Service Commission, Washington, D. C., or the secretary of the board of U. S. Civil Service Examiners at the post office or customhouse in any city.

HIGH RECORD BY THE R. C. A.

A new high record in gross business of the Radio Corporation of America for 1926 is expected to be announced, at approximately $60,000,000.

USE FOR DISTORTION

Modulation and detection are two points of view of the same phenomenon, distortion. Sometimes distortion is very useful.

The Twin-Choke Amplifier

(*Continued from page* 11)

on the lower side of the panel in the positions indicated in Fig. 4. Note that only three bolts are used to hold the output choke to the panel.

Then mount the binding-posts, tube sockets, Amperites and twin-choke couplers on top of the panel as shown in the photograph and in Fig. 3. This completes the assembly.

For wiring, use either flexible hook-up wire throughout or, as shown in the amplifier illustrated, use bus-bar for some connections.

The wiring is very clearly illustrated in Figs. 3 and 4. No special instructions are necessary. Fig. 3 shows the wiring to be performed on top of the sub-panel together with some wires which run through holes in the panel to the binding post terminals underneath. Fig. 4 shows the completion of the wiring on the lower side of the unit.

How to Install the Amplifier

To use the amplifier as a separate unit, apart from the receiving set itself, attach a seven-conductor battery cable to the amplifier and connect to your receiving set as illustrated in Fig. 3. Connect the seven wires as follows:

1. From first input terminal of amplifier to detector B plus binding post of receiver.

2. From second input terminal of amplifier to plate terminal of detector tube in receiving set through a RF choke coil.

3. From amplifier A plus binding post to receiver A plus binding post.

4. From amplifier A minus post to filament switch of receiving set, as shown. (If your set is wired with the filament switch in the positive side of the filament circuit, connect the amplifier A minus post directly to the receiver A minus and amplifier A plus to the filament switch).

5. Amplifier 90 volts post to receiver 90 volts post.

6. Amplifier B plus binding post to receiver 135 volts binding post. If there is no such binding post on your receiver, connect directly to 135 volts plus on the B battery itself.

7. Amplifier C minus to negative of 22½ volt C battery and, with a separate wire, connect positive of C battery to A minus binding post of receiver. This C battery is only necessary when a 171 tube is used in the last stage of the audio amplifier. If a —01A type or 112 tube is used, connect amplifier C minus post directly to A minus on receiver.

With regard to the input connections, note that the input of the twin-choke amplifier must take the place of the input to the audio amplifier in your receiver, which is not used. That is, remove the connecting wires from the primary of the first audio transformer in your set and substitute the input of the new amplifier. Terminal P of the amplifier input (second binding post) goes to the plate of your detector tube through a RF choke coil. Terminal B (the first binding post) goes to the detector B battery binding post. The connections to the input must not be reversed. If the radio frequency choke coil and .001 mfd. fixed condenser are not already included in your set they must be added. Connect them in the receiving set itself, near the detector tube. This filter keeps radio frequency currents from entering the audio amplifier.

Operating the Amplifier

If your set is of the regenerative type, with a tickler coil, the tickler, of course, comes between the plate of the detector tube and the RF choke coil and .001 condenser.

When the connections described above have been completed, attach your loudspeaker (which should be a good cone speaker) to the "loudspeaker" posts or jacks on the amplifier.

Then take the tubes out of the audio stages in your receiver. Insert two —01As in the first two stages of the new audio amplifier and a type 71, 12 or —01A in the last stage, preferably a type 71. If you use a —01A in the last stage, be sure to change the Amperite to a type 1A instead of the type 112 specified.

Finally connect your 16 volt A battery, 135 volt B battery, aerial and ground to the receiving set in the usual way. As noted above, if there is no 135 volt binding post on your set, connect the B plus binding post on the amplifier directly to the positive of the 135 volt B battery itself. Do not use less than 135 volts.

You will avoid all possibility of microphonic howling if you place the loudspeaker on some surface other than that on which the receiver and amplifier are placed.

If you incorporate this amplifier directly in your receiving set, mounting it on the front panel of the set, the connections between the amplifier and the receiver are exactly the same as described above. In this case, however, it is not necessary to use a separate battery cable to connect the amplifier to the receiver. The connections can be made with short pieces of wire.

LIST OF PARTS

- **One bakelite or hard rubber panel, 7 x 8½"**
- **Three KH Twinchoke Audio Couplers**
- **One KH Output Filter Choke Coil**
- **Three Benjamin tube sockets**
- **Two Amperites, type 112**
- **One 2 Mfd. Tobe filter condenser**
- **Seven binding posts**
- **Two phone tip jacks (or loudspeaker binding posts)**
- **One pair I. C. A. Bakelite mounting brackets**

[*Next week Fig. 6, the subpanel template, will be published.*]

The Advance Toward Television Told by Alexanderson in Absorbing Brief

By E. F. W. Alexanderson

Consulting Engineer, General Electric Co.

IN the well known play by George Bernard Shaw, "Back To Methuselah," is described a scene which is supposed to take place in the year 2170. The head of the British Government holds conferences with his various cabinet ministers several hundred miles away. He has at his desk a switchboard and in the background of the room is a silver screen. When he selects the right key at the switchboard a life sized image is flashed on the screen of the person with whom he is speaking at the same time as he hears his voice. The fact that one of his ministers is a lady lends some dramatic color to the incident but this is beside the point.

A passage of this sort by a great writer is significant. The new things that civilization brings into our lives are not created or invented by anybody in particular; it seems to be predestined by a combination of circumstances that certain things are going to happen at certain times. It is the great writers and the great statesmen who have the first presentiment of what is coming next. Then the inventors and engineers take hold of the same ideas and dress them up in practical form.

Young's Sound Hope

It is now several years since Mr. Owen D. Young at a banquet expressed his hope that radio would soon give us visual means of communication. The idea seemed at the time absurd to many of the technical men present but work was promptly started and we have at least gotten so far that a commercial radio picture service across the Atlantic ocean is in operation. It takes at present twenty minutes to send one of these pictures, whereas the imagination of Bernard Shaw forecasts a direct vision of moving objects.

From moving picture practice we know that for this to be realized would require the transmission of a series of pictures at the rate of sixteen per second. It is a long way from twenty minutes to one-sixteenth of a second. It means that we must work twenty thousand times faster than we do now. However, we have tackled this problem and I shall attempt to show what prospects we have of realizing practical television. In doing so we shall think of the scene described by Bernard Shaw as the ultimate goal.

Progress In Telephotography

The principle for picture transmission over wires or radio was worked out about fifty years ago and all work done at the present time is based on this same principle. The work of fifty years ago, though described in many books and patents, fell into neglect, but the development of radio has renewed interest in the subject. We have also some new tools to work with, such as the vacuum tube amplifier and the photoelectric cell. Radio photography has thus become an established fact. A practical realization of television, or the art of seeing moving objects by radio, involves some difficulties which have heretofore seemed almost insurmountable.

However, before dealing with the problems of the future I shall give a brief picture of the contemporary art of

(*Continued on page 30*)

4, 5 OR 6 TUBE KIT FREE

THE NEW, IMPROVED
DIAMOND OF THE AIR

Mfd by the Clapp-Eastham Co. Licensed under Armstrong Patent No. 1,113,149 for Bruno Radio Corp.
Complete Kit of Parts, with Blueprint, ready to wire, as Specified by HERMAN BERNARD. **$37.50**

B. C. L. RADIO SERVICE,

ANY POPULAR KIT YOU WANT
Write for Particulars

4-Tube DIAMOND Kit	$30.00
Filtrex Intermediate Power Pack	$42.50
Bruno Regenatrol	$60.00
Hammerlund-Roberts Hi-Q	$63.05
New Karas Equamatic	$88.70
S-M Shielded Six	$95.00
Powertone 2 Control, 4-Tube	$25.00
Powertone 2 Control, 5-Tube	27.50
Powertone 2 Control, 6-Tube	30.00

Bernard KIT
6-Tube Wonder Circuit. Complete Kit of Parts with Blueprint, ready to wire. **$40.**

221 Fulton St., New York City

PERFECT FILAMENT CONTROL
in the
"DIAMOND OF THE AIR"
Is Assured with AMPERITE
Eliminates hand rheostats. Simplifies set wiring. Accepted as the only perfect filament control in every popular construction set.

Radiall Company
Dept. R.W.25, 50 Franklin St., N. Y. City

Write for "RADIALL BOOK"

AMPERITE
REG. U.S. PAT. OFF.
The "SELF-ADJUSTING" *Rheostat*

BLUE PRINT and Book, DIAMOND OF THE AIR sent on receipt of 50c. Guaranty Radio Goods Co., 145 West 45th Street, New York City.

How to Build
THE DIAMOND
FIVE TUBE MODEL

Herman Bernard, designer of this wonder circuit, has written an illustrated booklet on "How to Build Radio World's Improved Diamond of the Air." Send 50c and get this booklet, including a full-sized wiring blueprint

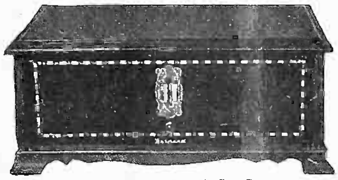
Send $6 for year's subscription and get booklet, and blueprint FREE.

[Newsdealers or radio dealers, order the booklets with blueprints included, in quantity, direct from American News Co. or branches.]

RADIO WORLD
145 WEST 45th ST. NEW YORK CITY

THE BROWNING-DRAKE CIRCUIT—Text and illustrations covering this famous circuit starting with our issue of Aug. 14. The 3 numbers sent on receipt of 45c. RADIO WORLD, 145 W. 45th St., N. Y. C.

A 6-TUBE CIRCUIT BEAUTIFUL TO EAR AND EYE



How to Build the
Bernard
This Nameplate Free to All!

Fully described in the October 16 issue of Radio World by Herman Bernard. Schematic and picture diagrams of the wiring, textual wiring directions, step by step; striking photographs of the completed receiver, all treated so that the veriest novice in radio can build the Bernard.

THE SET YOU TUNE WITH YOUR THUMB!

Send 15c for October 16 issue

Blueprint of panel, subpanel and wiring (complete), with Bernard's constructional article $1.00

Or send $6 NOW for one year's subscription to Radio World (52 numbers) and get the blueprint FREE; also the October 16 issue FREE, and panel nameplate FREE! Keep informed on this fine circuit by reading Radio World.

RADIO WORLD
145 West 45th St. N. Y. City

DEMAND **AEROVOX**
for Fixed Condensers and Resistances. Approved by M. I. T. and Yale. Used as standard equipment by over 200 manufacturers of Radio Receivers and "B" Eliminators.
AEROVOX WIRELESS CORP.
489-491-493 Broome St. New York

ANY SET DESCRIBED IN
RADIO WORLD
BUILT TO YOUR ORDER. WRITE
M. LERNER
1498 Remsen Ave. Brooklyn, N. Y.

HOW TO BUILD THE BERNARD, the beautiful 6-tube thumb-tuning set, fully described and illustrated in the Oct. 16 issue. Send 15c for a copy. Namepieces for affixing to front panel free to all on special request. Radio World, 145 W. 45th St., N. Y. City.

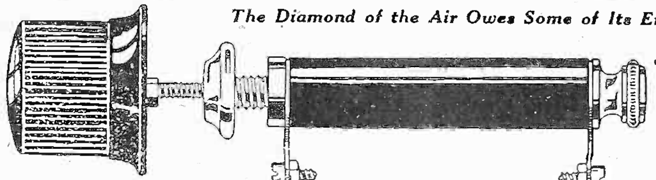
DIAMOND NAMEPLATES OUT

Our supply of nameplates for the Diamond of the Air has been exhausted. We can, however, continue to send a booklet and blue print for the 5-tube Diamond of the Air on receipt of 50c, and a booklet and blue print for the 4-tube Diamond of the Air on receipt of $1.00. Radio World, 145 W. 45th St., N. Y. C.

INSTALL THE BRETWOOD GRID LEAK and have absolute control of your volume. Sent on receipt of $1.50. North American Bretwood Co., 145 W. 45th St., N. Y. C.

The Diamond of the Air Owes Some of Its Efficiency to This Leak

THE BRETWOOD
Variable Grid Leak Certified for The Diamond



THE BRETWOOD
Improves Any Set!
Price, $1.50

SPECIAL PREMIUM SUBSCRIPTION OFFER
For NEW RADIO WORLD Subscribers Ordering NOW

Radio World has made arrangements
—To offer a year's subscription FREE for any one of the following publications with one year's subscription for RADIO WORLD
—RADIO NEWS or
—POPULAR RADIO or
—SCIENCE AND INVENTION or
—BOYS' LIFE or
—RADIO DEALER or
—RADIO (San Francisco) or
—RADIO AGE.

This is the way to get two publications
—for the price of one:
—Send $6.00 today for RADIO WORLD
—for one year (regular price
—for 52 numbers)
—and select any one of the other
—nine publications for twelve months.
—Add $1.00 a year extra for
—Canadian or Foreign Postage.
—Present RADIO WORLD subscribers
—can take advantage of this offer by
—extending subscriptions one year
—if they send renewals NOW!

RADIO WORLD'S SPECIAL TWO-FOR-PRICE-OF-ONE SUBSCRIPTION BLANK
RADIO WORLD, 145 West 45th Street, New York City.
Enclosed find $6.00 for which send me RADIO WORLD for twelve months (52 numbers, beginning... and also without additional cost, Popular Radio, or Radio News, or Science and Invention, or Radio Dealer, or Radio (San Francisco), or Radio Age, or Boys' Life (or $10.00 for two yearly subscriptions). (No other premium with this offer.)

Indicate if renewal.
Offer Good Until January 22, 1927.

Name ....
Street Address ....
City and State ....

(*Continued from page 28*)

telephotography. So much has already been published on this subject that I need only give a few references. Since the interest in telephotography was revived the work was taken up simultaneously in America, France, England and Germany and the names of a number of engineers have become familiar such as Korn, Belin, Jenkins, Ranger, Ives, Karolus, Petersen and Baird. I hesitate to give names because there are surely some equally important ones that I have left out.

Some telephotographs were made in Schenectady. The originals were made at a rate of sixteen square inches per minute and these pictures were produced in two minutes. They were made as a preliminary study of commercial transmission of pictures and fascimile messages over long distances.

The recording instrument used in making these originals is a standard General Electric oscillograph with some adaptations. The availability of this highly developed instrument made it possible for us to make rapid progress in the development of a practical technique in telephotography so that our energies can be devoted largely to the main problem which is the adaptation of the radio art to this new use and particularly to devise ways of dealing with our old enemies—static and fading—when we wish to transmit pictures over long distances.

The radio art has up to the present developed two distinct methods of signalling; by modulation and by interruption. The first is usually associated with broadcasting and the second with telegraphy. Both of these methods of signalling may be adapted to radio photography and each will have its distinct field. The effective range of a broadcast station is very much shorter than a telegraph station of the same power but within this range it gives a service of excellent quality. We made pictures with a modulation frequency of 3000 cycles, which can easily be transmitted by the ordinary broadcast stations. It is therefore possible that a picture service may be given by these same stations which will be of the same standard of quality as the musical entertainments.

The Brute Force Method

Freedom from disturbances is insured by having a large number of stations, interlinked by a wire system so that a good selection of entertainment is available in all parts of the country. This method of dealing with static and fading may be characterized as brute force but after all it is this mode of operation that has developed radio into the great industry that it is now. This whole broadcasting machinery is now available, should the public become interested in radio photography for entertainment or otherwise.

For long distance communication we have fortunately another method of using the radio wave which is much more sensitive and economical. The most striking illustrations of this are the feats of the amateurs of communicating with their friends on the other side of the earth with a small home made set. So far this method of signalling has been limited to dots and dashes but the possibilities are ahead of us of using this wonderful medium of communication to transmit pictures, fascimile of letters or printed pages, moving picture films and ultimately to see by radio. It is these fascinating possibilities that have induced so many investigators to work on this problem.

Independent of Strength

In our research work on the development of radio photography and television we have looked upon the adaptation of the telegraphic method of communication to picture transmission as one of the essential problems and a system has been worked out for transmitting half tone pictures in a way which takes advantage of the more efficient methods used in radio telegraphy.

The underlying principle which makes this possible is the use of a system of signalling in which the results are independent of the signal strength. Thus if the signal is strong enough to be recorded at all it gives the same kind of records at the maximum as at the minimum signal intensity. This makes the recording independent of fading. If furthermore the signals are stronger than the prevailing static, it is possible to eliminate the effects of static by introducing a threshold value of signal strength in the receiver so that nothing is received unless the signal exceeds this value.

Half tone effects are produced by dividing up the picture in five or more separate shades such as, white, light gray, medium gray, dark gray and black. The transmitting and receiving machines analyze and reassemble these shades automatically. Various methods may be worked out for transmitting light intensities into radio signals. One method would be to use five wavelengths, one for each shade.

The transmitting machine is made in such a way that it automatically at every moment selects the shade that comes nearest to one of the five shades, and sends out a telegraphic signal which selects the corresponding shade in the receiving machine.

How Tones Register

This sounds perhaps more complicated than it really is because the telegraphic code by which different shades are selected depends upon the synchronization of the two machines which is necessary under all circumstances. Thus black in the picture is produced by exposure of the sensitive paper to the recording light spot during four successive revolutions, whereas, light gray is produced by a single exposure during one of the four revolutions and no exposure for the three succeeding revolutions. The overlapping exposure is progressive and the whole works as a continuous process.

When we embark on such an ambitious program as television, it behooves us to reason out, so far as it is possible, whether the results we expect to get are going to be worth while even if our most sanguine hopes are fulfilled. We have before us a struggle with imperfections of our technique, with problems which are difficult but which may be solved. In every branch of engineering, there are, however, limitations which are not within our control. There is the question whether the medium with which we are dealing is capable of functioiing in accordance with our expectations and desires. We are dealing with the photoelectric cell, the amplifier, the antenna and the radio wave. The photoelectric cell and the amplifier employ the medium of the electron which is extremely fast, but the use of the radio wave itself imposes certain speed limitations on account of the limited scale of available wavelengths. The question, therefore remains, what quality of reproduction may we ultimately expect in a television system if we succeed to take full advantage of the ultimate working speed of the radio wave? An experimental study of the problem and the conclusions may be illustrated by the comparison of some pictures made at different speeds.

Use of Short Waves

If we wish to draw conclusions regarding the practicability of television we may say that if we are speaking with a friend across the ocean and if we can see his features as clearly as we do in a two minute picture, we will be satisfied, and probably quite pleased. This kind of picture has been produced as accurately as we can determine by laboratory equivalents with a wave of 25,000 cycles wave frequency. Now, if we let our imaginations loose we will use a wavelength of twelve meters instead of 12,000 meters and a wave frequency of 25 million cycles instead of 25,000 cycles. If now the photoelectric cell and the amplifier and the light control can keep up with this pace, the radio wave will do its part and transmit a picture such as seen here in 1/1000th part of two minutes, i. e., in one-eighth of a second. We are thus able to predict that it will be possible to transmit a good pictere in a space of time which is of the order of magnitude of the time required for moving picture operation, the exact figure being one-sixteenth of a second.

But Bernard Shaw's specification has one more requirement. He wants the television picture shown life size on a large screen. In this lies one of the fundamental difficulties.

A photograph published last week (page 20) shows a model of a television projector, consisting of a source of light, a lens and a drum carrying a number of mirrors. When the drum is stationary, a spot of light is focused on the screen. This spot of light is the brush that paints the picture. When the drum revolves, the spot of light passes across the screen.

10,000 Stroke Minimum

Then as a new mirror which is set at a slightly different angle comes into line, the light spot passes over the screen again on a track adjacent to the first and so on until the whole screen is covered. If we expect to paint a light picture of fair quality, the least that we can be satisfied with is ten thousand separate strokes of the brush. This may mean that the spot of light should pass over the screen in one hundred parallel paths and that it should be capable of making one hundred separate impressions of light and darkness in each path. If we now repeat this process of painting the picture over and over again sixteen times in a second it means that we require 160,000 independent strokes of the brush of light in one second. To work at such a speed seems at first inconceivable; moreover, a good picture requires really a scanning process with more than 100 lines. This brings the speed requirements up to something like 300,000 picture-units per second.

Besides having the theoretical possibility of employing waves capable of high speed of signalling, we must have a light of such brilliancy that it will illuminate the screen effectively, although it stays in one spot only one-three hundred thousandths of a second. This was one of the serious difficulties because even if we take the most brilliant arc light we know of, and no matter how we design the optical system we cannot figure out sufficient brilliancy to illuminate a large screen with a single spot of light. The model television projector was built in order to study this problem and to demonstrate the practicability of a new system which promises to give a solution to this difficulty.

How to Get More Light

The result of this study is briefly that, if we employ seven spots of light instead of one, we will get 49 times as much useful illumination. Offhand, it is not so easy to see why we gain in light by the square of the number of light spots used, but this can be explained with reference to the model. The drum has twenty-four mirrors and, in one revolution of the drum, one light spot passes over the screen twenty-four times; and when we use seven sources of light and seven light spots we have a total of 170 light spot passages over the screen during one revolution of the drum.

The gain in using seven beams of light in multiple is twofold. In the first place we get the direct increase of illumination of 7:1 but we have the further advantage that the speed at which each light beam must travel on the screen has been reduced at a rate of 7 to 1, because each light spot has only 24 tracks to cover instead of 170. While the light itself may travel at any conceivable speed there are limitations of the speed at which we can operate a mirror drum or any other optical device and the drum with 24 mirorrs has already been designed for the maximum permissible speed. A higher speed of the light spot can therefore be attained only by making the mirrors correspondingly smaller and mirror one-seventh as large will reflect only one-seventh as much light. The brilliancy of the light spot would therefore be only one-seventh of what we realize by the multiple beam system, which gives seven light spots seven times as bright or 49 times as much total light.

(More complete details on this remarkable new system of television transmission, which has been invented by one of the foremost of electrical and radio engineers in this country, Dr. E. F. W. Alexanderson, will be given in next week's issue of January 8. How the light beams, are intercepted by the rapidly revolving drum, will be told.)