Radio Construction

For the Amateur

SIXTH EDITION

By Merle Duston

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FOREWORD

THE Sixth Edition of this booklet has been devoted to constructional details on building several new type circuits as well as giving some new designs for older circuits which have stood the test of time. We believe that the drawings shown in this edition are much clearer and easier to work from than those shown in previous editions, and we believe also that the veteran radio fan, as well as the man who is just becoming interested in radio, will find the instructions superior to most of those published.

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Antenna and Loops

Erecting a good antenna is a comparatively simple job, but because most any kind of a poor installation will work, after a fashion, this most important part of an installation is sometimes neglected. Putting up an antenna depends upon the surroundings and the particular conditions present. A good thing to remember is that inefficiency in an antenna must be made up in efficiency in the set, if proper reception is to be had. It is generally much easier to put up a good, well insulated antenna than to add a number of extra bulbs to your set.

Some of the most commonly used methods of putting up antennae is shown in Figures 1, 2, 3, and 4. For the ordinary receiving set a single stand from 75 to 100 feet long and well insulated is all that is necessary. It has also been demonstrated that better results will be obtained by running the wire in a general direction of the broadcasting station it is most desired to hear. For this reason an east or west antenna works better on most stations than one running north and south. If the antennae cannot be placed out of doors, very good results have been obtained with aerials in the attic, etc., especially with sets of the radio frequency type. No matter what type of aerial is employed it is absolutely necessary to have a good connection between the aerial and lead-in or wire which goes to the receiving set. All connections should be soldered. Lead-in should be a covered wire and kept free from eve troughs and other obstructions on the sides of the building.

The lead-in wire should run as directly from the aerial to the set as possible. Sharp bends and curves are to be avoided. The efficiency of an antenna also depends on the type and kind of wire used. In rural districts a solid copper, copper clad, or tinned copper conductor will generally give high efficiency for a long time. In a city, however, with its smoky acid filled atmosphere, corrosion of copper wire is very rapid. For this reason it is generally best to use some type of wire which will not become corroded under these conditions. The following is quoted from the Bureau of Standards Radio Communications pamphlet No. 40:

> Solid copper or other conductor in sizes such as No. 14 is often used. Stranded conductor, however, has advantages, including flexibility and lower resistance at high frequencies than solid conductor because of skin effect. In the stranded conductor for a given weight of copper there is much more cross sectional area available for carrying the current than there is in the solid conductor. The individual strands should, however, always be enameled in stranded wire used for radio frequency currents, or the stranded conductor may have a higher resistance than solid conductor of the same weight.

Ribbon antenna are being used considerably and the efficiency is high until they become corroded. Another type of antenna recently placed on the market is the spring aerial for use inside of buildings. These are easy to install and give the requisite amount of wire in a given space and are as good as any, where a long stretch cannot be put up.

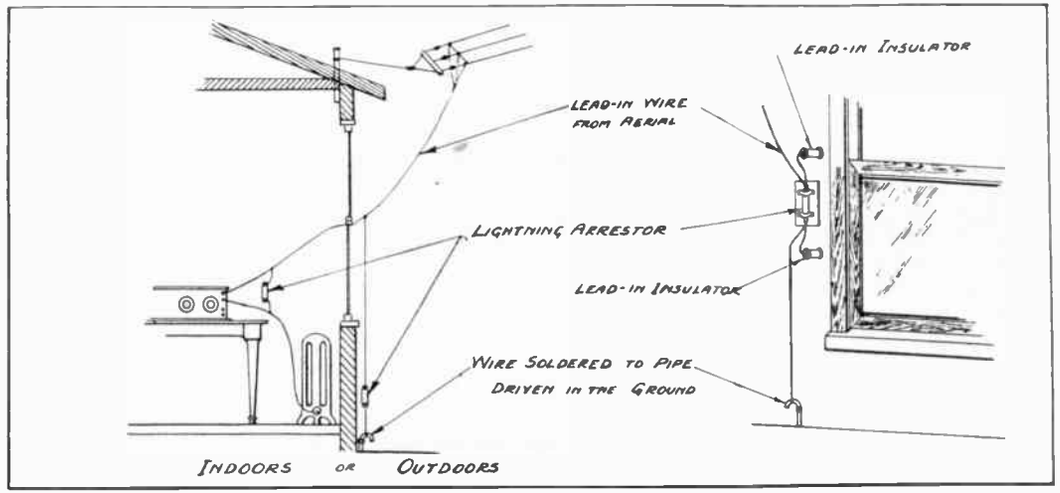


Fig. No. 1—Installation of Lightning Arrestor

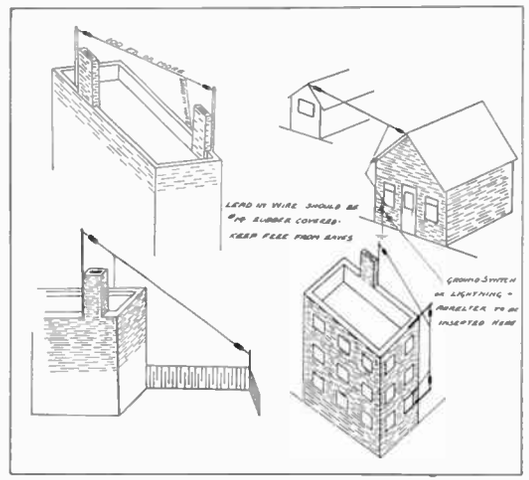


Fig. No. 2—Antenna Installations

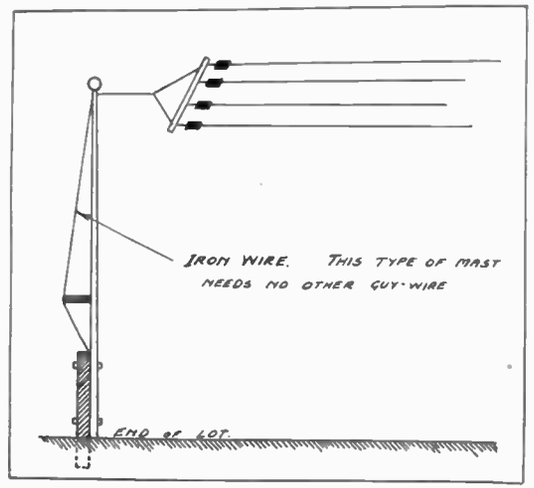


Fig. No. 3—Construction of Mast

LIGHTNING ARRESTORS

Lightning Arrestors should be installed on all outside antenna. They should also be installed so as to apply to the rules of the National Board of Fire Underwriters. For the person unfamiliar with these rules we reprint Article 37, as applied to radio receiving stations only, from the National Electric Code for 1923.

a. Antenna and counterpoise outside buildings shall be kept well away from all electric lights or power wires of any circuit of more than 600 volts, and from railway, trolley or feeder wires, so as to avoid the possibility of contact between the antenna or counterpoise and such wires under accidental conditions.

b. Antenna and counterpoise where placed in proximity to electric light or power wires of less than 600 volts, or signal wires, shall be constructed and installed in a strong and durable manner, and shall be so located and provided with suitable clearances as to prevent accidental contact with such wires by sagging or swinging.

c. Splices and joints in the antenna span shall be soldered unless made with approved splicing devices.

d. The preceding paragraphs a, b, and c, shall not apply to light and power circuits used as receiving antenna, but the devices used to connect the light and power wires to radio receiving sets shall be of approved type.

e. Lead-in conductors shall be of copper, approved copper clad steel or other metal which will not corrode excessively, and in no case shall they be smaller than No. 14, except that bronze or copper-clad steel not less than No. 17 may be used.

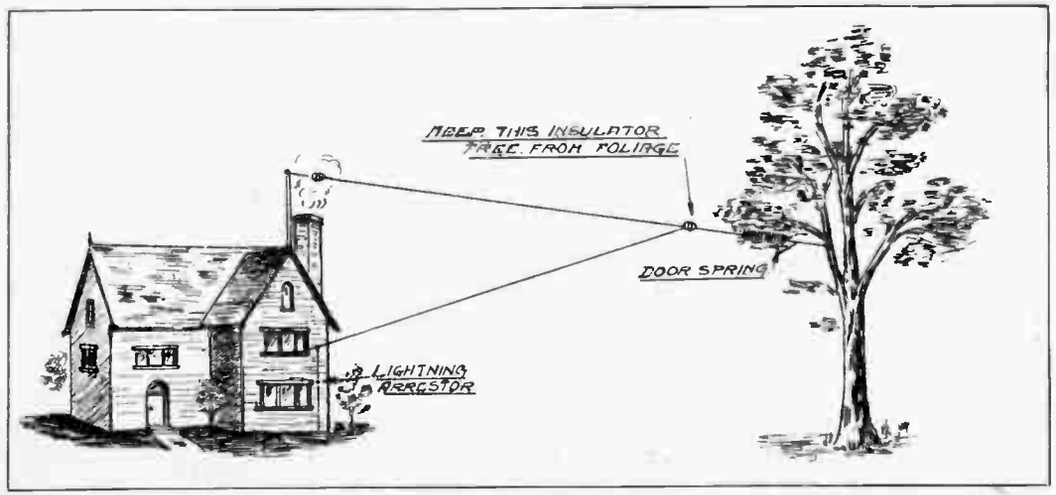


Fig. No. 4—Single Wire "V" Type Antenna

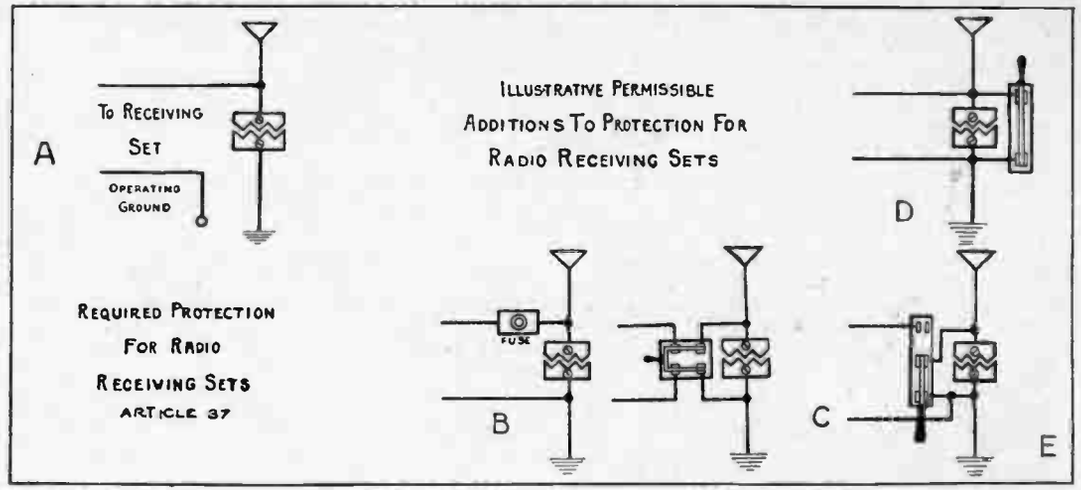


Fig. No. 5—Proper Ways to Install Lightning Arrestor

f. Lead-in conductors on the outside of buildings shall not come nearer than four inches to electric light and power wires unless separated therefrom by a continuous and firmly fixed non-conductor which will maintain permanent separation. The non-conductor shall be in addition to any insulating covering on the wire.

g. Lead-in conductors shall enter the building through a non-combustible, non-absorptive insulating bushing slanting upward toward the inside.

h. Each lead-in conductor shall be provided with an approved protective device (lightning arrestor) which will operate at a voltage of 500 volts or less, properly connected and located either inside the building at some point between the entrance and the set which is convenient to a ground, or outside the building as near as practical to the point of interest. The protector shall not be placed in the immediate vicinity of easily ignitible stuff, or where exposed to inflammable gasses or flying dust or flying combustible materials.

i. If an antenna grounding switch is employed, it shall in its closed position form a shunt around the protective device. Such a switch shall not be used as a substitute for the protective device.

j. If fuses are used they shall not be placed in the cirucit from the antenna through the protective device to the ground.

k. The protective grounding conductor may be bare and shall be of copper, bronze or approved copper-clad steel. The grounding conductor shall not be smaller than the lead-in conductor and in no case shall it be smaller than No. 14 if copper nor smaller than No. 17 if of bronze or copper clad steel. The grounding conductor shall be run in as straight a line

as possible from the protective device to a good permanent ground. Preference shall be given to water piping. Other permissible grounds are grounded steel frames of buildings or other grounded metal work in the building, and artificial grounds such as driven pipes, rods, plates, cones, etc. Gas piping shall not be used for the ground.

l. The protective grounding conductor shall be guarded where exposed to mechanical injury. An approved ground clamp shall be used where the grounding conductor is connected to pipes or piping.

m. The grounding conductor may be run either inside or outside the building. The protective grounding conductor and ground installed as prescribed in the preceding paragraphs k and l may be used as the operating ground.

n. Wires inside buildings shall be securely fastened in a workmanlike manner and shall not come nearer than two inches to any electric light or power wire not in conduit unless separated therefrom by some continuous and firmly fixed non-conductor, such as porcelain tubes or approved flexible tubing, making a permanent separation. This non-conductor shall be in addition to any regular insulative covering on the wire. Storage battery leads may consist of conductors having approved rubber insulation.

Figure 5 will show the proper way to install arrestors as recommended by the Board.

Much could be said concerning the efficiency of different types of insulators, but it is believed to be unnecessary. If the amateur constructor will provide himself with any of the commercial high grade insulators, no trouble will be experienced. If in doubt as to their quality, use more than one at each end of the antenna.

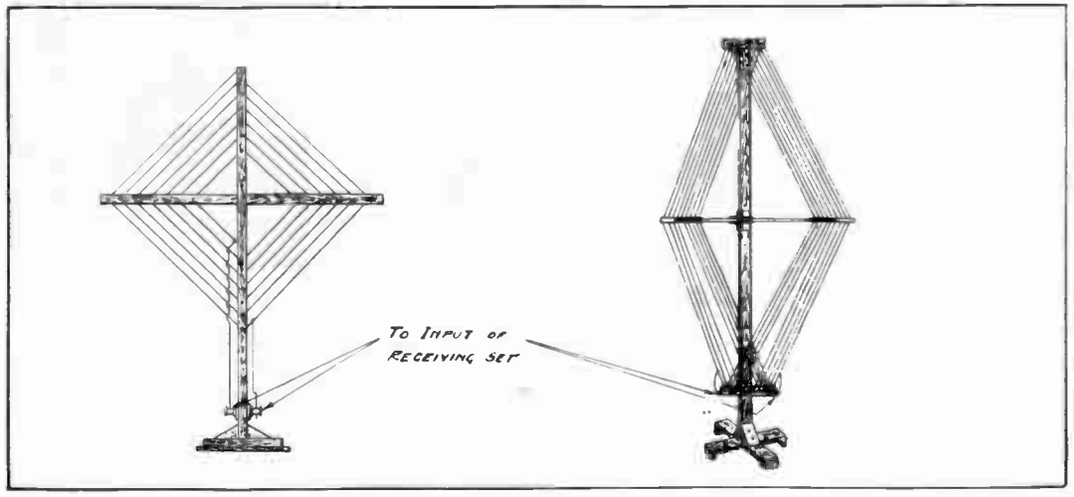


Fig. No. 6—Two types of antennae

LOOPS

Figure 6 shows two different types of loop antenna. Figuring out the proper number of turns of wires and sizes is a very long and complicated process, so we are showing two tables which if followed will be close enough for ordinary use. These tables were figured for use with No. 20 or 22 B and S gage solid wire but a stranded wire, such as lamp cord, can be used without changing the characteristics of the loop to any considerable extent.

Table Showing Proper Number of Turns for Various Sized Loops

Length of Side of a Square Loop (Feet)	Number of Turns	Spacing of Wire (Inches)	Wave Length of Range When Used With .001 M. F. D. Var. Cond.
2	10	1/8	175-710
3	8	1/8	183-850
4	6	1/4	174-775

Length of Side of a Flat Loop (Feet)	Number of Turns	Spacing of Wire (Inches)	Wave Length of Range When Shunted With a .001 M. F. D. Var. Cond.
2	12	1/2	260-810
4	10	1/2	250-805
6	8	1/2	240-796

Constructional Details

There are a great many things that the experimenter can learn about constructing a set. In previous editions of this book, we gave short explanations of how to solder and how to drill panels. In this, the Sixth Edition, constructional details will be treated in a more comprehensive manner.

The first operation is that of drilling the panel. This is a comparatively simple operation if templates similar to those in the back of this book are used. Templates are furnished for all sets described on the following pages. If you wish to change the layout somewhat or drill a panel for a particular type of set not described in this book, the following hints may be helpful.

The first thing to do is to provide a panel of the correct dimensions. Lay it flat on the table and arrange the apparatus to be mounted thereon in a symmetrical manner so that the set will look right from the front of the panel when it is finished. If a sub-base is used, lay it parallel to the panel, and arrange the parts to be mounted thereon in their respective positions. Plate No. 1 illustrates how this is done. The next operation is the measuring of distances between the separate parts and either drawing a layout on a separate sheet of paper using it for a template, or scribing the lines on the panel, using a sharp instrument. An adjustable square is a great help in doing this work. Plate No. 2 shows the proper way to scribe the panel. Next, use a center punch for marking the center of the holes at the crossovers.

To drill a panel using the Templates, which are in this book, proceed as follows: Cut off the template at border, and paste to the front of the panel, using just enough paste on the four corners to hold the template in place.

After the template is in place, take a center punch or a nail that has been filed to a sharp point and mark the center of all the holes that are to be drilled. Plate No. 3 will give you a good idea of how this is to be done. Also mark graduations shown at the place where the top of the dials will be, by making a little punch-mark at both the top and bottom of this this line. Remove the template before drilling. The hole made by the center punch will start the drill in the right place. Next, select a drill from the size shown on the template. Countersink all holes as shown. For this, the drill used for the largest hole in the panel will do. Be careful not to countersink too deeply.

A small hand drill or even a common carpenter's brace can be used for holding a drill if a drill press is not available. Most all bolts and screws used in radio work are either of 6/32 or 8/32 thread, meaning the bolt is made from No. 6 or No. 8 stock with 32 threads to the inch. The proper size of drill to use for 6/32 is 9/64″ or No. 27 and for 8/32 is 11/64″ or No. 19.

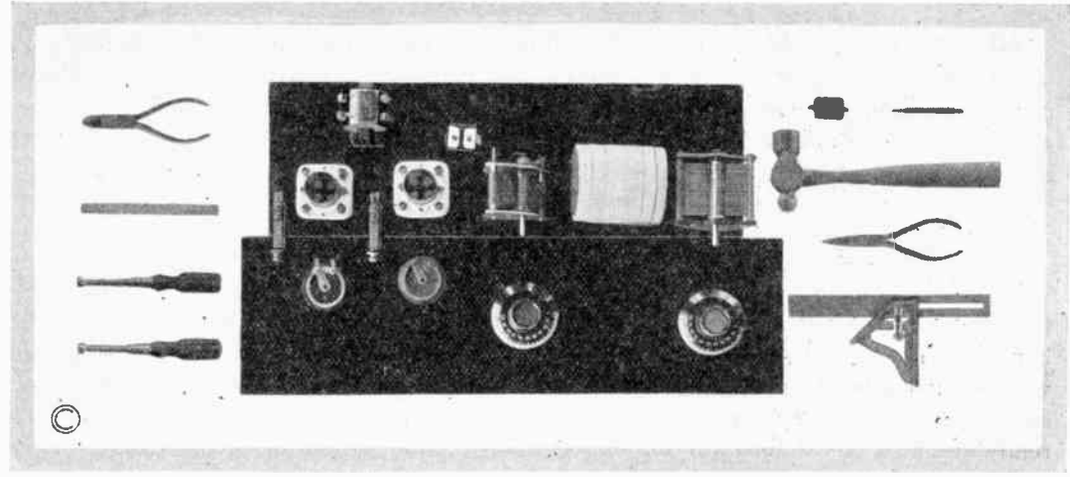


Plate No. 1—Laying Out Panel When Template Cannot Be Had

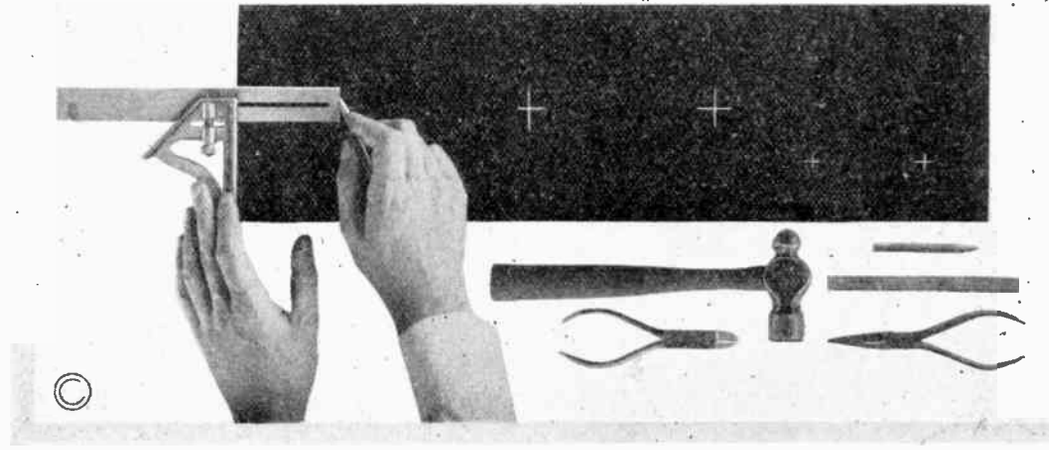


Plate No. 2—Proper Way to Scribe "A" Panel

ASSEMBLING

After the panel is drilled, the next operation is the mounting of the different parts on the panel and sub-base, providing one is used. Of course, if the panel is to be machine engraved, this should be done before anything is mounted, but if using Decalcomania, panel markers, this operation should be left to the very last. Plate No. 5 shows a set completely assembled ready for wiring and soldering.

SOLDERING

Recently connectors have been placed on the market for use in connecting wires without the use of solder. For a permanent job, however, it is best to solder all connections. There has been much agitation against the use of acid or any kind of acid soldering paste in radio work. Experience has taught, that many times noises in a receiver were caused by a poor connection due to the corrosion of a joint or terminal where acid flux had been used, which really amounts to the introduction of a variable contact resistance to the circuit. Oftentimes where two terminals are close together on the panel, the acid will run between them, thus causing trouble. The worst practice of all, is to use acid soldering flux for soldering leaves or terminals of a fixed condenser. When used in this way, the flux is bound to run between the leaves of the condenser, thus forming a high resistance leak which will cause trouble in any radio set. All of these troubles can be practically eliminated through the use of rosin flux or rosin core solder. If acid paste flux is used be very careful to use as small an amount as possible and thoroughly clean off all excess paste left on the joint.

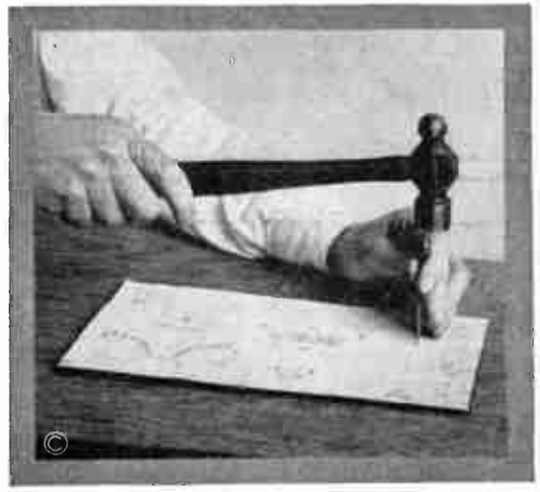


Plate No. 3—Marking panel from Template

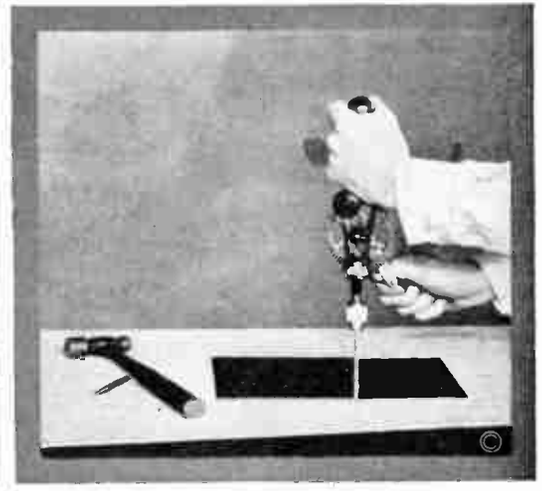


Plate No. 4—Drilling panels

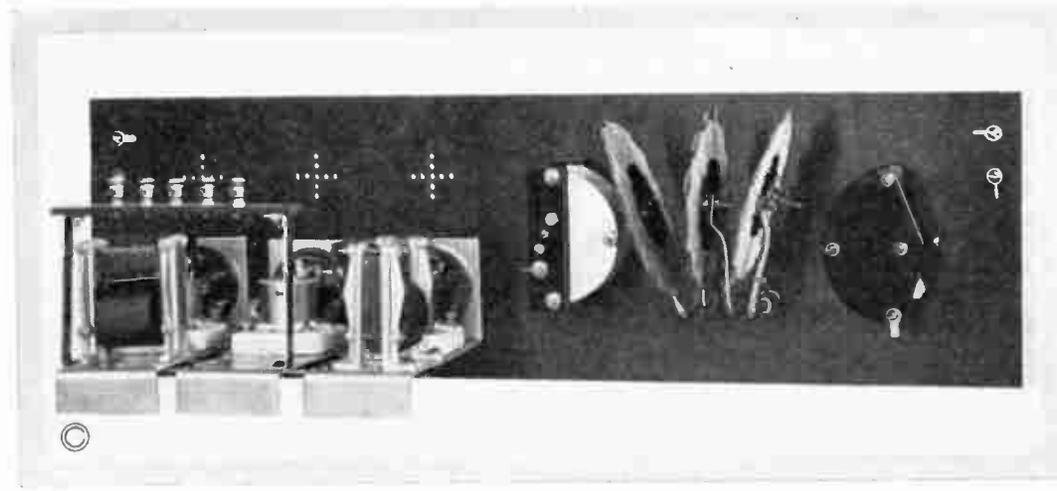


Plate No. 5—Set Assembled Ready to Wire

The best tool that can be used for soldering is an electric soldering iron. Not everyone will have access to an iron of this type, however, so we will tell you how to do soldering using other types of tools.

One very cheap way is to buy a small soldering iron, such as is used by tinners and electricians and to heat this iron over a gas burner or in the stove. Do not try to use your iron too hot; just have it hot enough to heat up the parts you are going to solder so as to allow the solder to run freely.

Another simple type of soldering device is a little alcohol torch. These can be purchased for a very small sum and work very well where care is exercised. Always see that the parts to be soldered are scraped clean. Leave your soldering iron or the flame from your alcohol torch on the terminal long enough to have the solder run freely. Do not use too much solder.

Inspection and Testing

If the builder has not had much experience in building sets it would be best for him to thoroughly test and inspect the set before placing it into actual operation. This will oftentimes save a tube. One good and safe way to test a set is to leave the "B" battery disconnected and to connect the "A" battery to the "B" battery terminals. If the tubes do not light up it shows that this part of the circuit is clear. If they do light, look for trouble and under no circumstances, connect the "B" battery to the circuit as it will burn out the tubes. If everything is clear, connect the "A" and "B" battery in their proper places, put the bulbs in the sockets, being sure that the rheostats are in the off position. If a loud click is heard when the phones are then connected with the bulbs turned off this will show that there is something wrong. The "A" or "B" batteries may be directly connected across the phones. Look for a broken-down condenser. When this test is made a very slight barely audible click should be heard. Next light the filaments of the bulbs. Then by connecting and disconnecting one phone terminal a very pronounced click should be heard. If this does not occur the "B" battery terminals are probably reversed or open.

Another test can be made by placing a moistened finger on the grid terminal of the detector bulb. When this is done a pronounced noise should be heard. Next connect the aerial and ground. A slight click should also be heard when the aerial is connected.

If you are not sure of the polarity of the "A" battery the leads may be reversed to find out which way gives the better results.

If, after the set is connected, a great deal of noise is heard in the phones or loud speaker, try disconnecting the aerial and ground to see if this noise disappears. If it does, then you can be sure it is being caused by outside sources. If it does not cease, there is something wrong with either the set, bulbs or batteries.

Some of the most common causes of a noisy set are, poor fixed condensers, inefficient "B" batteries, loose or corroded connections, or noises caused by the bulbs being in an oscillating condition.

Batteries

"A" BATTERIES

"A" Batteries are of two types. The six volt three cell storage battery or one or more dry cells which are sometimes used with tubes consuming low filament current. The storage battery used in radio work is generally as much neglected as the battery that is for starting and lighting an automobile. As long as they will operate at all the user generally believes in letting them alone. This is not conducive to long life. Plates should at all times be covered with liquid and distilled water only should be added. The owner should provide himself with a hydrometer for testing purposes as this is the only accurate method of determining the condition of the battery. The cell tops and connections should be kept free from corrosion and the terminals or battery clips should be thoroughly cleaned occasionally. Oftentimes a poor connection caused by corrosion between the wires going to the set and battery will give a fluctuating current to the bulbs in the radio set, thus causing variation in sound produced by the set. The leads running from the set to the battery should be as short as possible and not smaller than No. 18 B and S Gage copper. If it is desired to place the battery in the basement or some place distant from the set a No. 14 or

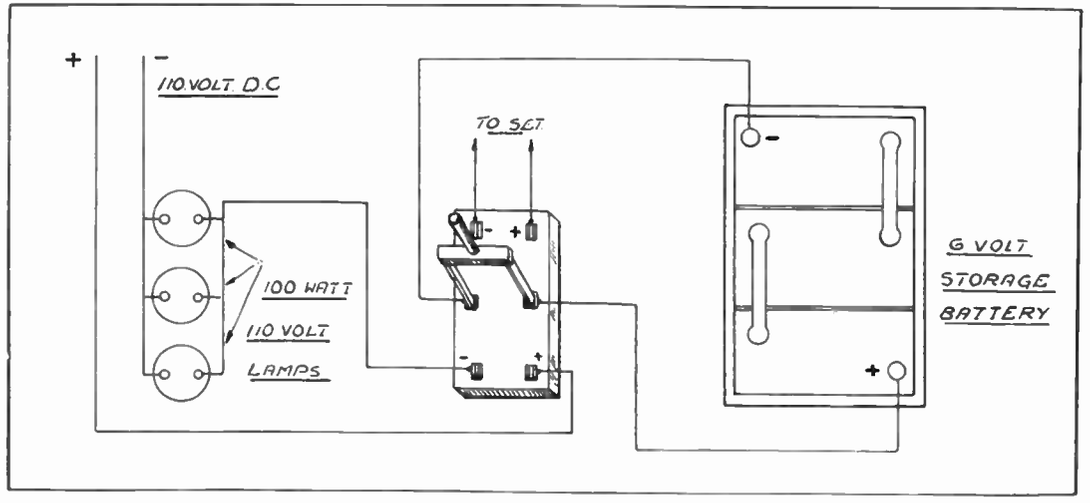


Fig. No. 7—Charging "A" Battery from Direct Current Line

larger wire should be used and a 0.5 to 1.0 MFD condenser should be connected across the battery leads. This will act as a by-pass condenser for radio frequency waves and keep the battery leads from acting as a second antenna. The battery should never be allowed to become completely discharged. Keeping the battery charged is an easy matter if a battery charger is part of the equipment. A neat and handy charging panel can be made by the use of a double pole double through (DPDT) switch so that all that is necessary when it is desired to charge the battery is to throw the switch over and turn on the battery charger.

If direct current is available a battery charger is unnecessary as the "A" Battery can be charged by placing one or two 100 Watt Bulbs in series with the DC line. Figure 7 gives the proper hook-up for this. When using DC lines for charging the battery care must be taken to connect the positive side of line to positive side of battery and negative to negative. If the polarity of the line is unknown place a lamp in series with one side of line and immerse the two wires in a weak solution of salt water keeping the wires separated about a quarter of an inch. Bubbles will rise freely from the negative wire. A few will be present around the positive also but not nearly so many. Figure 9 shows how to make this experiment. This test can also be used for finding the polarity of the "A" battery in case the markings become obscure or the polarity is unknown.

When using dry cells as in "A" battery on a one and one-half volt tube, such as a WD-11 or WD-12 it is generally more economical to connect two or more cells in parallel. When using a bulb of the UV-199 type three cells should be connected in series.

Parallel connection means hooking all positive terminals together and running a wire to the set and hooking all negative terminals together and running a wire to the set. Series connection means hooking the positive side of one cell to the negative side of another. The two end terminals being used to run to positive and negative posts on set respectively.

When hooking cells in series the total voltage is the voltage of one cell multiplied by the number of cells used, and when they are in parallel the voltage of the complete sets of cells is the same as that of any one cell but a heavier current in amperes can be had. Figure 10 shows these connections. In using dry cells for an "A" battery, a battery tester should be used to determine their condition.

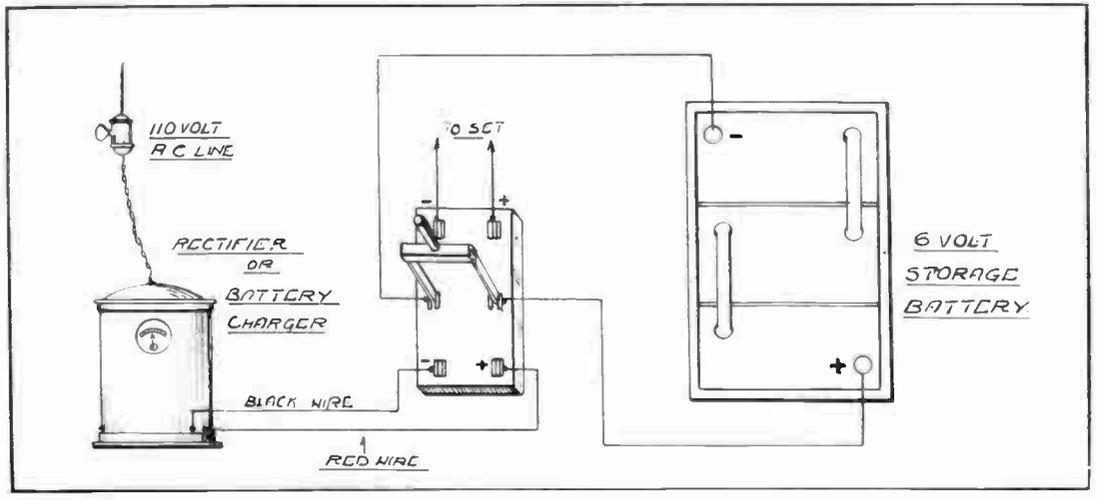


Fig. No. 8—Charging "A" Battery from Alternating Current Line

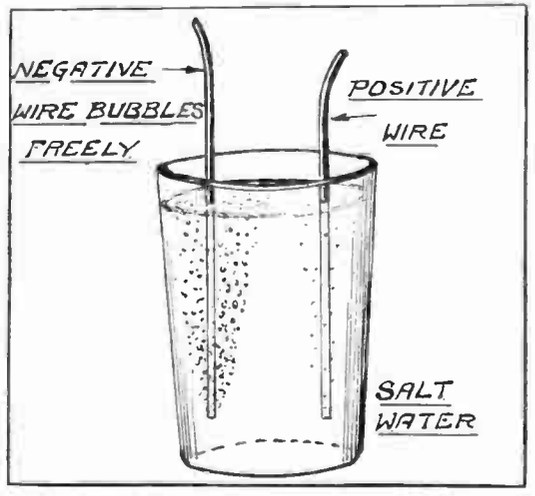


Fig. No. 9—
Testing for Polarity of Direct Current Line

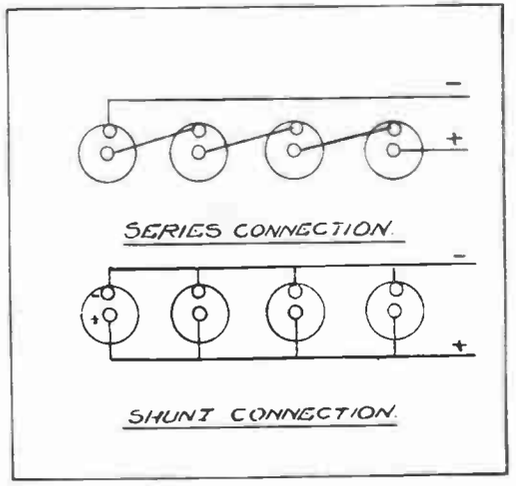


Fig. No. 10—
Series and Shunt Connections of Dry Cells

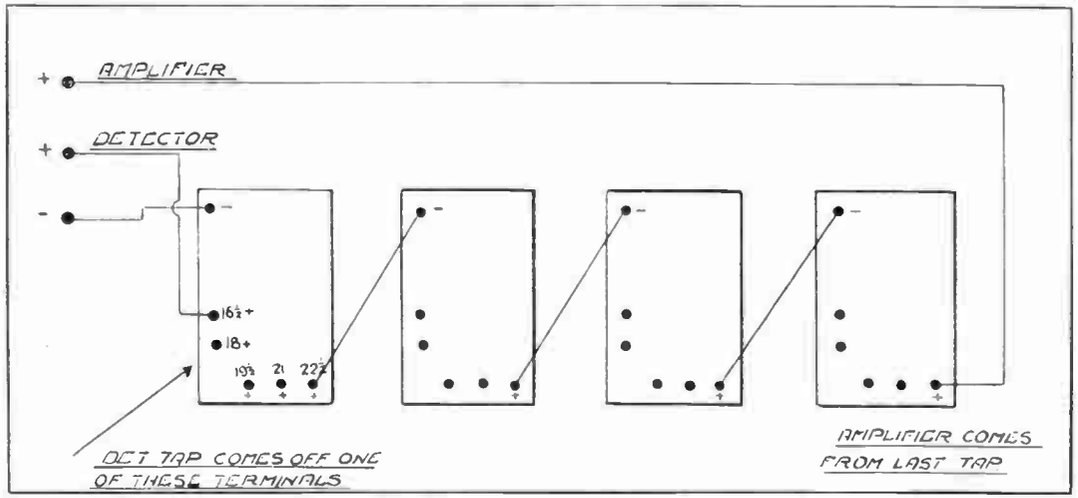


Fig. No. 11—Proper Way to Connect "B" Battery Blocks in Series

DRY "B" BATTERIES

"B" batteries can be had in three different sizes. Blocks of 4½ volts which can be connected in series to make up the required voltage, blocks of 22½, and 45 volts each. Ordinarily the detector bulbs operate best at from 16 to 22½ volts, (this for 200 type or soft tube and these are seldom sold now). The 201-A type or hard tube, when used as a detector should have around 45 volts. The ordinary amplifier bulb operates best at from 45 to 90 volts preferably the latter. Most times the detector and amplifier batteries are connected together and then a tap must be taken off at from 16 to 22½ volts from the negative end for the detector bulb. Figure 11 shows the proper way to hook batteries together when using this system. Another type of chargeable "B" battery is made up of small Edison elements. These elements can be purchased for a very nominal sum and when assembled make the longest lived battery that it is possible to make. The efficiency per cell is lower than the ordinary chargeable cell but they will stand a great deal of use and abuse. This battery can be re-charged by the use of an electrolytic rectifier or with any battery charger which has provisions for charging "B" batteries. Directions for assembling and care of this battery is usually furnished with the purchase of the elements.

"C" BATTERIES

Oftentimes the amateur constructor wishes to use a "C" battery in connection with the amplifying bulbs. This is generally advisable when using a high voltage on the plates of the amplifier tubes. Proper voltage of the "C" battery is determined by the voltage of the "B" or plate battery in use. Directions which come with most bulbs gives this data. Figure No. 12 shows the proper way to connect the "C" battery in the grid return lead for 1 and 2 tubes.

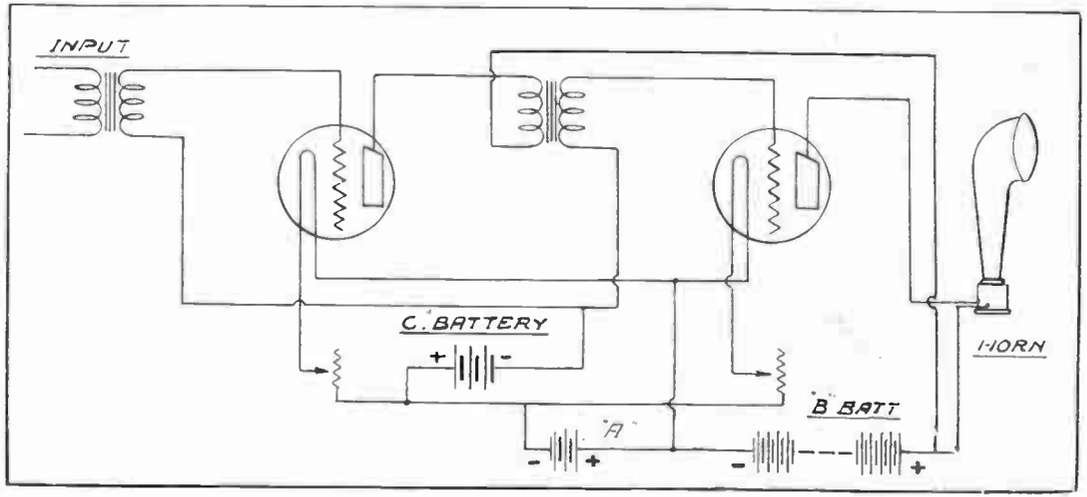


Fig. No. 12—Proper Way to Connect "C" Battery in Amplifier Circuit

CHARGEABLE "B" BATTERIES

THE chargeable "B" battery is becoming more and more popular as interest in Radio increases. For this reason we are devoting space in this edition to a short explanation on how these should be assembled and charged.

When buying these batteries knocked-down you will find that each unit consists of a positive and negative plate, a lead connecting bar, a glass jar and composition top for same.

Before starting to assemble, be sure that the jar and top are clean. Insert the post of the positive (brown color) plate through the hole in the rubber cover marked plus (+) and the post of the negative (gray color) plate through the hole marked minus (—), so that the posts extend 5/8" above the top of the cover. Turn the plates to a parallel position, leaving about 1/8" between them. Next place the wood separator between the plate with the flat side against the negative (gray color) plate.

The assembled element can then be put into the glass jar with the cover screwed on until it just seats itself. The cells can then be placed in the wood container which is furnished with the assembly. Place them so that the positive side of one cell is next to the negative side of the next cell and place the connectors on the plate posts and solder or lead burn the connectors and the posts together. Fig. 13 shows this assembly. If soldering these, tin the top of the posts by applying soldering paste (never use acid) and add a drop of solder to the top posts with the soldering iron. Connectors should then be placed on the posts and soldered to them with the addition of more paste and solder. Next fill the cell with electrolyte. This should be 1.250 specific gravity storage battery acid (H_2SO_4). This should come to a level of 1/4" below the edge of the rubber cover. Be sure to use acid of 1.250 specific gravity only. It will require approximately three pints for twelve cells.

This electrolyte can be secured from any storage battery service station or from the place where you purchase the battery.

After the acid is placed in the cells, these should be allowed to stand for at least an hour and then you can start the developing charge.

To charge a battery, connect the positive terminal of the battery to the plus (+) or positive terminal of the charging device and the negative terminal of the battery marked minus (—) to the negative terminal of the charging device.

The charging rate should be .15 ampere. A new battery should be charged for at least fifty-two hours. The charging rate should never exceed .20 ampere. When re-charging a battery, it will probably not take more than eight to twelve hours and with ordinary use this will not have to be done more than every thirty to sixty days. The battery can be tested with an ordinary hydrometer and when it is fully charged it will read 1.250. When fully charged, the voltage will be 2.2 to 2.5 volts per cell.

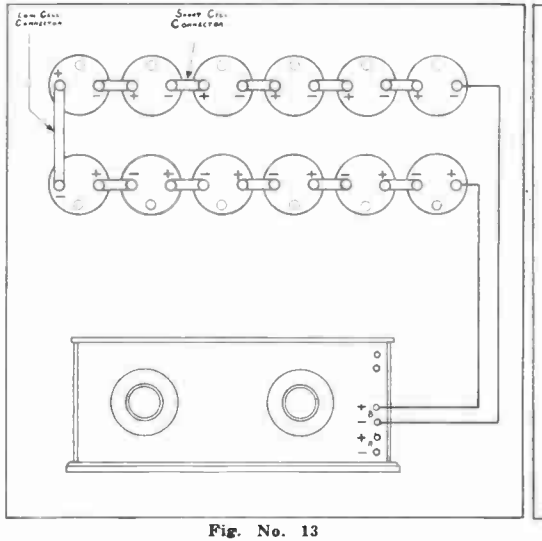


Fig. No. 13

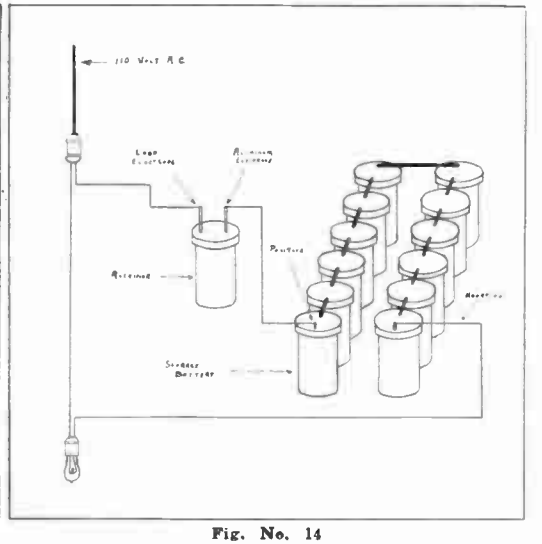


Fig. No. 14

INSTRUCTIONS ON ASSEMBLING AND USE OF CHEMICAL RECTIFIER

THE chemical rectifier is also becoming popular with users of chargeable "B" batteries. These can be purchased for a very nominal sum and when once assembled and hooked-up, make it easy to keep the battery charged.

These rectifiers can be purchased complete with glass jar, top, electrodes, and chemical. When assembling these, the aluminum rod should be placed through the hole of the rubber cover marked plus (+) or positive and the lead rod or electrode should be placed through the hole marked minus (—) or negative. The chemical which is furnished with the charger should then be placed in the glass jar and the jar filled to within one inch of the top with pure water. This should be stirred until the chemical is dissolved. Then screw the rubber cover with the electrodes on the jar. The vent plug must be removed while the rectifier is being used.

Connect the rectifier in series with a 25 watt lamp and with the "B" storage battery. Attach to a 110 volt alternating current line as shown in Fig. 14. Be sure to always connect the aluminum electrode of the rectifier to the positive or plus (+) plate of the battery. Six to twelve cells may be charged at one time but never attempt to charge more than this number.

When the "B" battery is thoroughly charged it will be gassing freely or be full of small bubbles. A few hours after the rectifier is placed in use the solution should change in color, finally becoming dark brown or black.

The lamp used should at first be as bright as usual but gradually grow dim if the rectifier is used properly. Pure water should be placed in the rectifier to replace that which evaporates with use. Chemicals do not evaporate and need not be replaced unless spoiled. Do not add the water while the rectifier is in use.

One Bulb Low Loss Set

CERTAIN types of regenerating receiving sets are still popular regardless of the number of so-called *new circuits* being brought out daily. Many radio fans are finding that a well designed regenerative set, using a detector and one or more stages of audio frequency amplification will get stations thousands of miles away with as much volume as many of the four, five and six bulb radio frequency sets.

Before building a set of this type, however, it is best to know its advantages and disadvantages and compare these with the advantages and disadvantages of other sets described in this book. You can then decide which type of receivers will best fill your requirements.

Following are shown several different hook-ups, using the same three circuit low loss coil. These hook-ups can also be used with other types of three circuit tuning couplers. The one bulb set described on this page was designed for the man who wished to construct a one bulb set for use with one or more sets of phones and which will get him a number of distant stations. If, at a later date, he then wishes to add more bulbs, he can do so by building the two-stage amplifying unit described on page 13. The one bulb set has been so designed that it could be assembled complete without the use of a soldering iron. If you can buy a drilled panel from the store where you buy your parts, the only tools necessary to assemble the set will be a pair of pliers and a screw-driver.

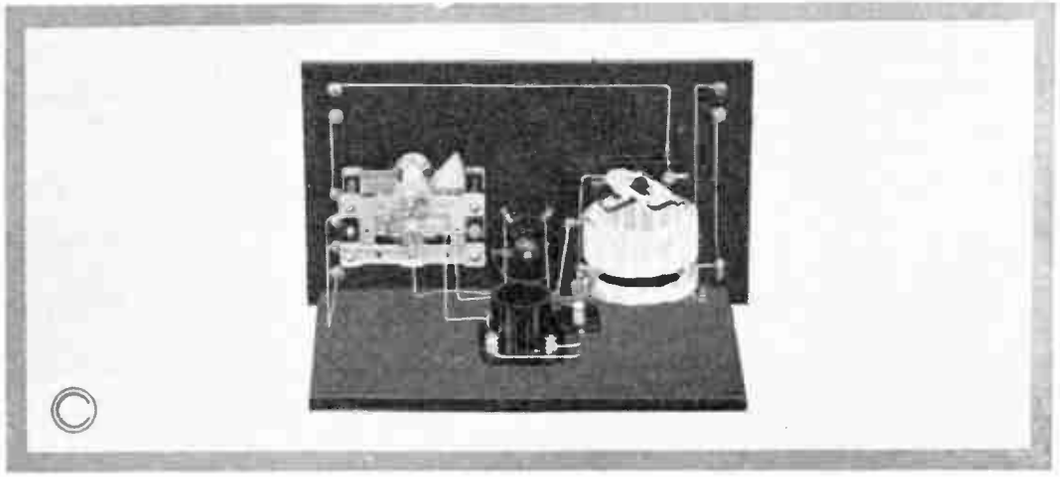


Plate No. 6—Rear View Low Loss One Bulb Set

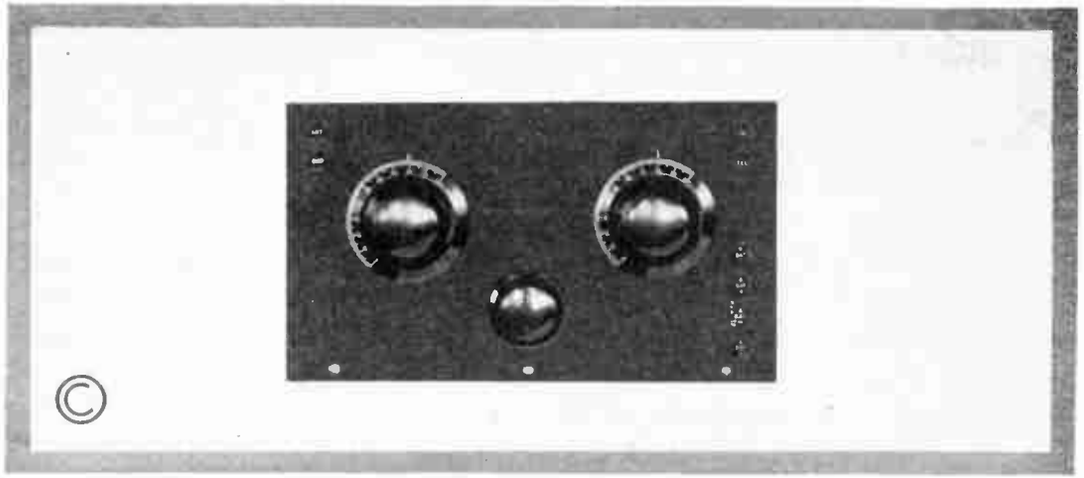


Plate No. 7—Front View Low Loss One Bulb Set

Some of the advantages of this set are as follows: Simplicity of construction and operation—long distance reception at a very low cost for parts (parts for a one bulb set should not cost over $12.00, including equipment)—allows the builder to start with one bulb and later add one or two stages of amplification in a separate unit.

Disadvantages of the set in comparison with those of the radio frequency type are as follows: Set oscillates and re-radiates every easily. If care is not exercised in the operation of this set, it will cause all manner of disagreeable noises not only in your own receivers, but in the receivers of all of your neighbors who are using their sets and listening to the same stations or those close in wave lengths to the ones which you are trying to tune in. The set is not extremely selective and if it is used in a city where there are two or more local broad-casting stations, which are operating simultaneously, it will be next to impossible to tune these local stations out and receive signals from outside cities.

If you wish an inexpensive set which will give loud speaker reception on local and other high-powered stations, but do not care for extremely long distance, we would advise you to build a set of the reflex type described on page 30 to 33 of this book.

The single circuit can be used with either 201-A or 199 Type bulb.

List of parts and hook-up are given on next page. Panel layout is given in the back of this book, use Template No. 1.

Hook-Up of One Bulb Low Loss Set

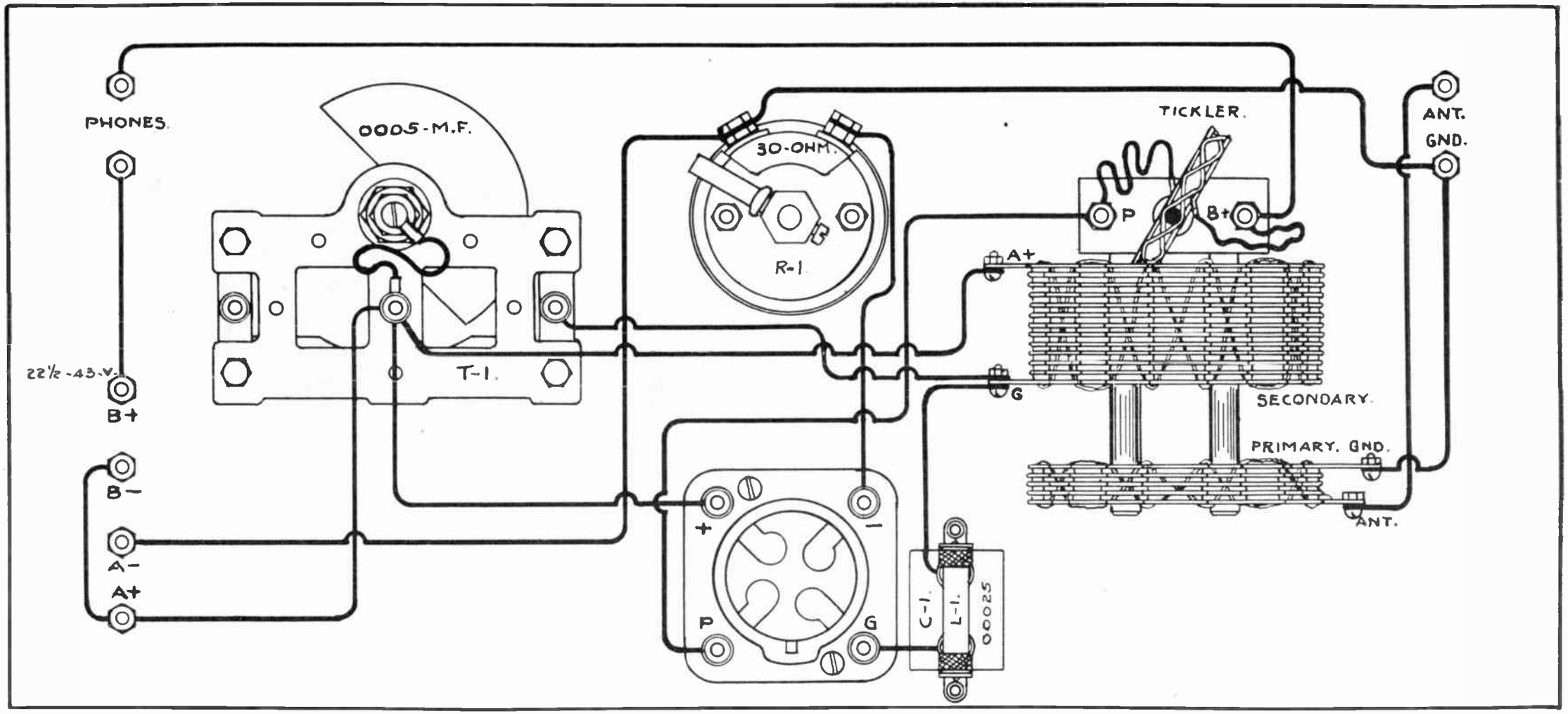


Fig. No. 15

LIST OF PARTS AND KEY TO SYMBOLS USED IN DRAWING FOLLOW:

1 7"x12" cabinet
1 7"x12"x$\frac{3}{16}$" panel
1 11"x6½" baseboard
1 low loss three circuit tuner
1 tube socket
1 20 or 30 ohm rheostat
7 marked binding posts
Note: These should be marked as follows: 1 Ant., 1 Gnd. 2 Tel., 1 A+ and 1 A—, 1 B+ and 1 B—
2 3" dials

T-1 1 .0005 variable condenser 23 plate
C-1 1 .00025 grid condenser with mountings
L-1 1 grid leak suitable for tube

Misc. Parts Hook-up wire, spaghetti, lugs, screws, etc

Two-Stage Audio-Frequency Amplifying Unit

THIS amplifying unit was designed primarily to be used with the three circuit one bulb set described on the foregoing pages. It can, however, be used with any type of detector set which does not have audio frequency amplification embodied in the set.

If one stage only is wanted, the same hook-up can be used by leaving out the last bulb, transformer and jack. The first two jacks should be used, but wires will not have to be fastened to the inside terminals of the second jack.

When using this unit with a one bulb three circuit receiver, the only connection necessary between the two sets will be two short wires going from the phone terminals of the first set to the input terminals of the amplifying units. The same "A" and "B" batteries can be used. If a strong signal is wanted a higher "B" voltage battery will be necessary, so more "B" batteries will have to be added with those used on the detector set. These should be connected as shown in Fig. 11, page 9. Run a wire from the 90 volt positive or plus terminal on the battery to the positive terminal on the amplifying unit.

If using the same "A" battery, the negative side of the "B" battery will then not have to be connected to the amplifying unit, as the "A" and "B" batteries are connected together in the detector set. so by running a battery wire to this detector set, you have already connected the "A" and "B" batteries together. The negative or minus side of the "B" battery should be connected to the detector unit. Be sure and get the right post, which will be the fourth one from the top or the third one from the bottom. Next, connect the tap from the first positive terminal of the first battery, counting from the negative end of the battery. This tap should be changed around on different posts of the battery to find out what detector voltage is best suited to the particular tube you may be using. It can be as low as 16½ volts for soft two hundred type detector bulb and as high as 45 volts for a hard 201-A type of tube. Three jacks have been provided in this unit, so that it will be possible to use either one, two or three bulbs. When using a pair of phones with a phone plug in the first jack, the two bulbs in the amplifying unit may be turned out.

LIST OF PARTS FOR AUDIO FREQUENCY UNIT.

	1 7"x9" panel.	J-3	1 single circuit jack
	1 6½"x8" baseboard.	AT-1-2	2 audio frequency transformers. These may be two low ratio transformers or one high ratio in first stage and low ratio in second stage.
	2 tube sockets to fit tubes used.		
	6 binding posts marked as follows: 2 input 1 A and 1 A, 1 B and 1 B.		
R-1-2	2 30 ohm rheostats		1 phone plug
J-1-2	2 two circuit jacks	Misc Parts:	wire, spaghetti, lugs, screws, etc.

Panel layout is given in the back of this book. Use template No. 2.

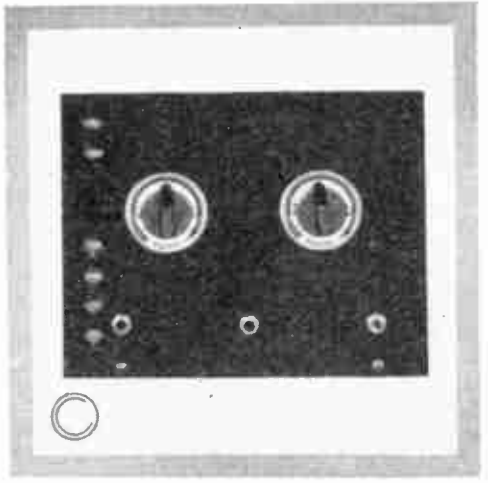


Plate No. 8—Front View of Two Stage

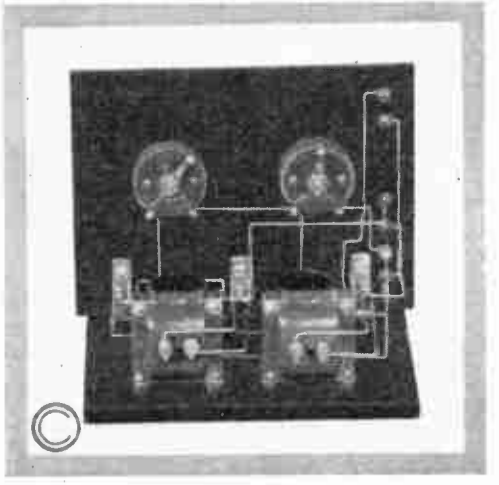


Plate No. 9—Rear View of Two Stage

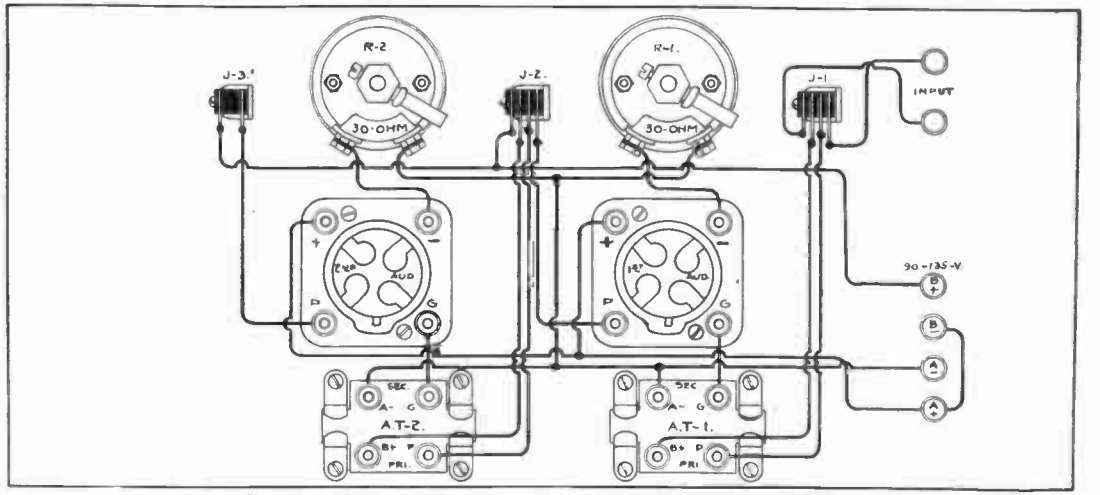
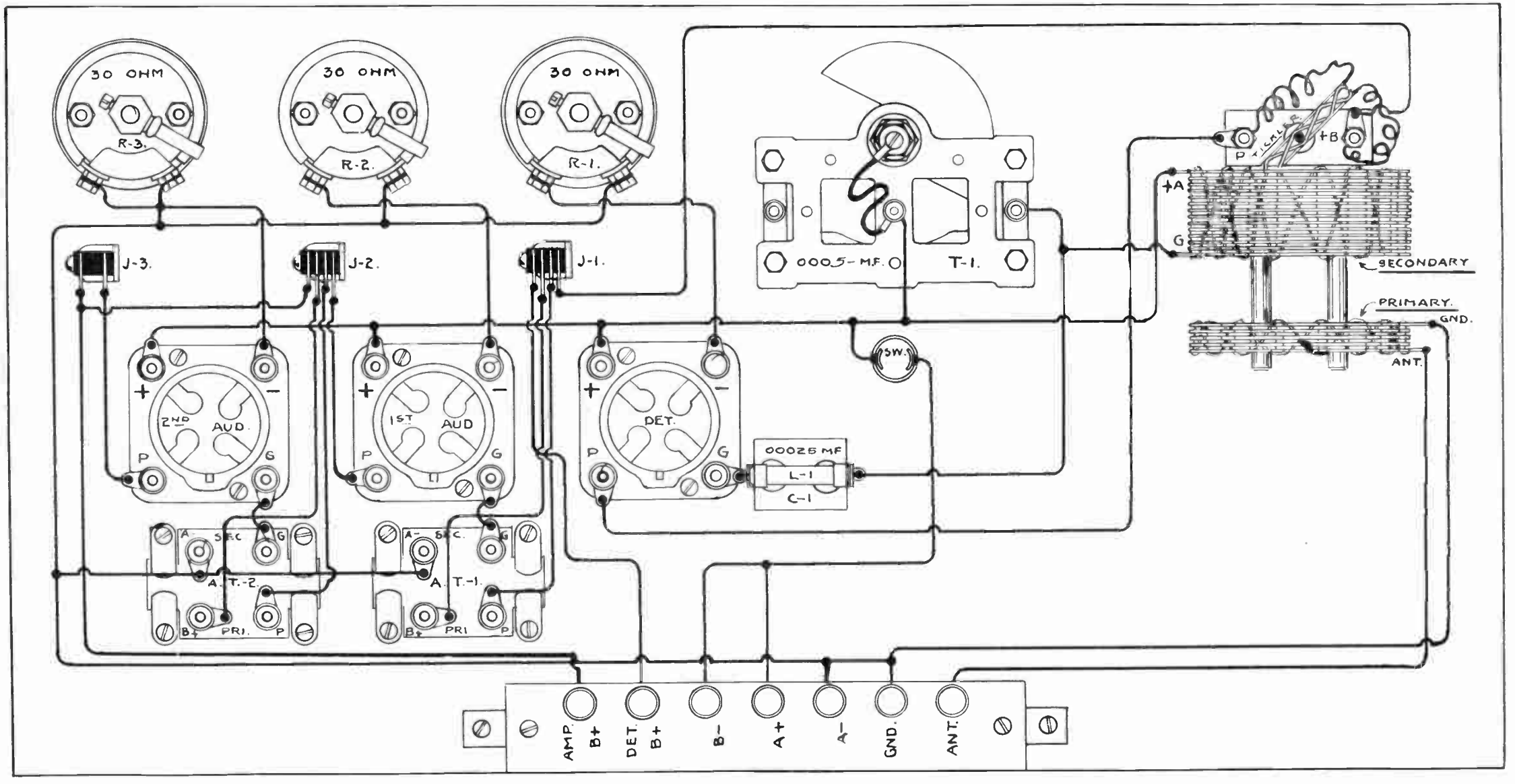


Fig. No. 16—Drawing of Two Stage Audio-Frequency Amplifying Unit



No. 17—Drawing of Three Bulb, Three Circuit Set—Transformer Coupled

Three Circuit Low Loss Receivers

SOME of the advantages and disadvantages of three circuit receivers have been given before. We do not think it necessary to enumerate these again, but do wish to add that when a person builds a four bulb set, using one stage of transformer coupled amplification with two stages of resistance coupled amplification, the quality of signals received is hard to beat. Of course, adding the extra bulbs does not make the set any more selective or keep it from re-radiating, but it does help the quality of reception.

We have been asked many times if good results could be obtained by adding one stage of radio frequency amplification to a three circuit regenerative receiver. It can be done but it is not a practice we would advise the amateur builder to undertake, unless he wishes to experiment and see what he can do. We have always found that it is hard enough to keep the radio frequency bulbs from oscillating when not using regeneration, so a radio frequency bulb is added to a set using the regenerative principle, it is nearly impossible to get good reception. In the few cases where it has been done successfully, extremely long distance stations were heard with good volume. Don't write and ask us for a hook-up showing the way to do this, as only a great deal of experimenting will enable you to get a proper value in coils and condensers.

The three circuit tuner used to make this set is one of the low loss type and is so constructed that a variation in the coupling between the primary and secondary coil can be had. The set will be much more selective if this coupling is kept loose and the primary

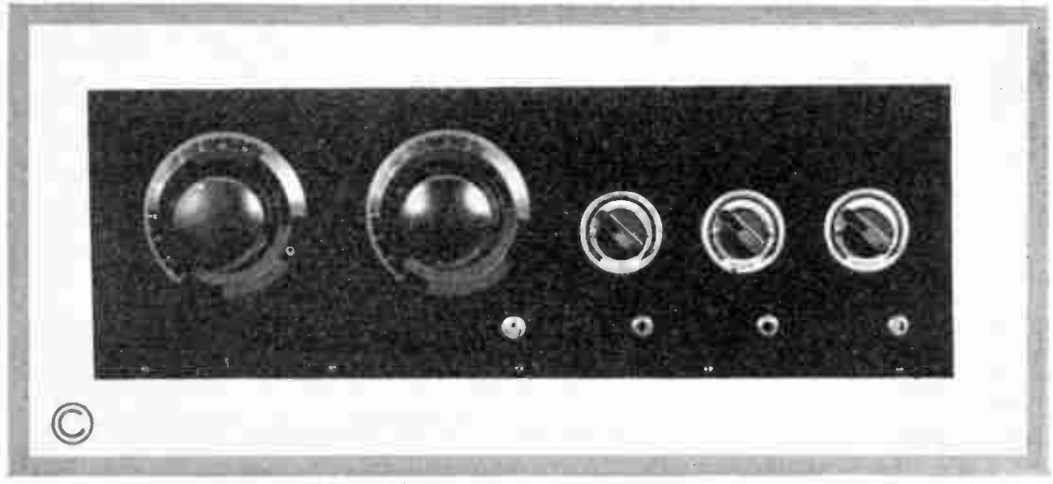


Plate No. 10—Front View of Three Circuit Receiver
Note Front of Panel is the same for the Three and Four Bulb Sets

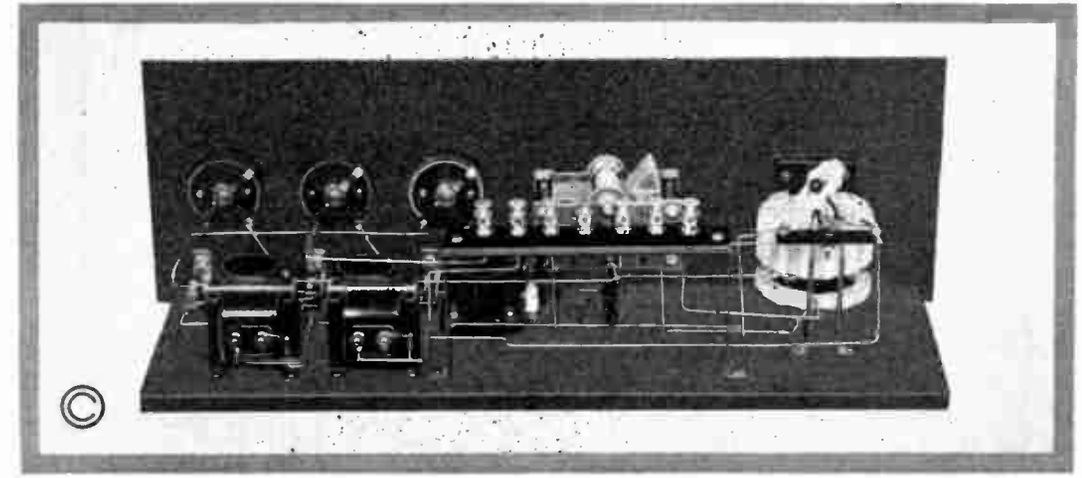


Plate No. 11—Rear View Transformer Coupled Low Loss Three Circuit Receiver

PARTS NEEDED FOR SET SHOWN IN FIG. 17

	1 7"x21"x[illegible]" panel
	1 6½"x20" baseboard
	1 7"x21" cabinet
	1 terminal strip with brackets
	2 binding posts
	1 low loss three circuit tuner
	2 4"dials
	3 sockets to fit tubes used
(T-1)	1 .0005 variable condenser 23 plate
(R-1-2-3)	3 30 ohm rheostats—use these for 201-A or 199 type tube. If 200 detector bulb is used in first socket, R-1 should be a 6 ohm rheostat.
(J-1-2)	2 two circuit jacks
(J-3)	1 single circuit jack
(C-1)	1 .00025 grid leak condenser with grid leak mountings
(L-1	1 Grid leak suitable for tube used. Try varying from one-half to five megohms and get one that works best with tube used.
(S-W)	1 filament switch
(Misc. parts)	Hook-up wire, spaghetti, lugs, screws, etc.

A phone condenser of .001 or .002 capacity may be placed across the primary or P and B terminals of the first transformer. If the set will not oscillate, try a .0005 fixed condenser between the plate of the first tube and the positive side of the "B" battery detector terminal.

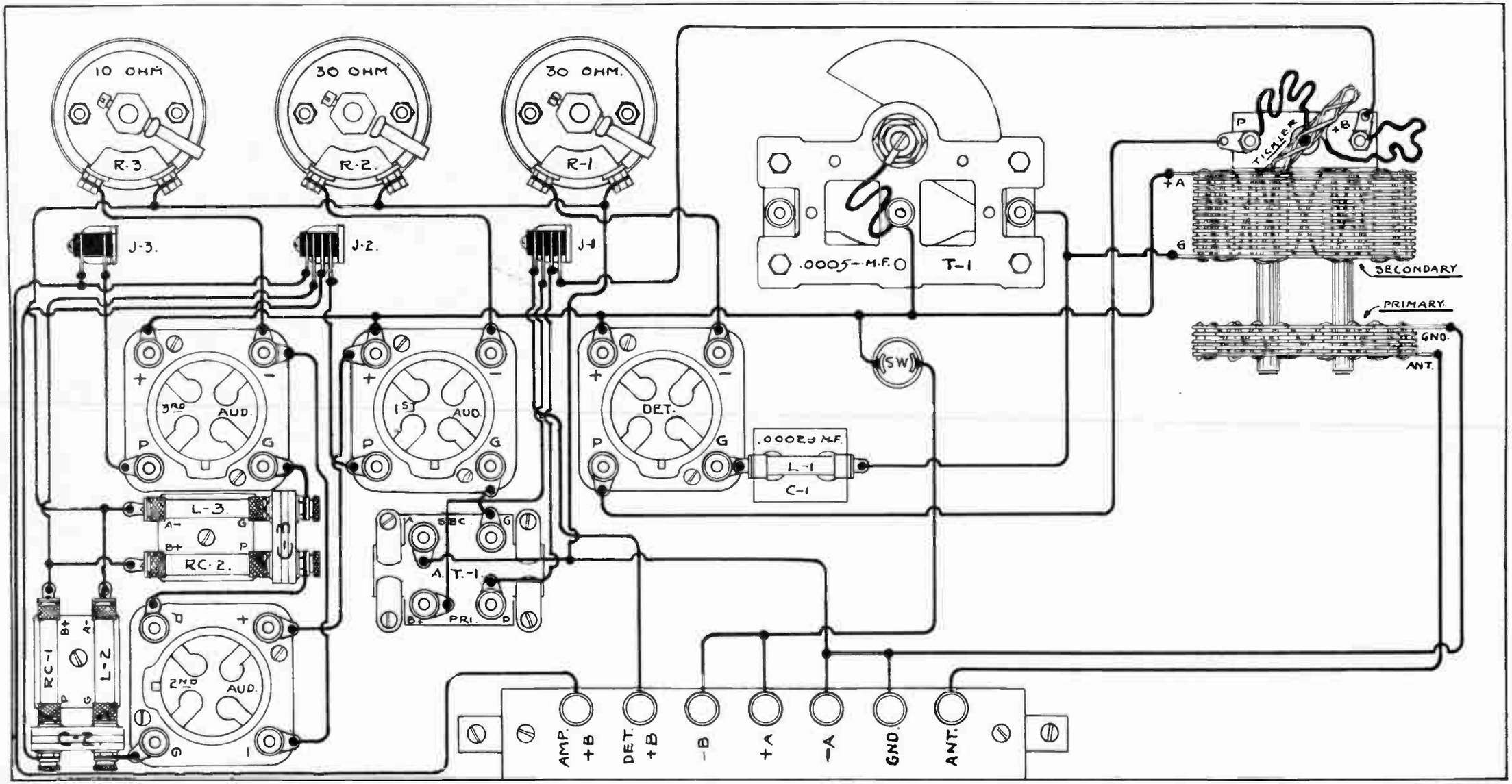


Fig. No. 18—Drawing of Four Bulb Three Circuit Set Using One Stage Transformer Coupled and Two Stages Resistance Coupled Amplification

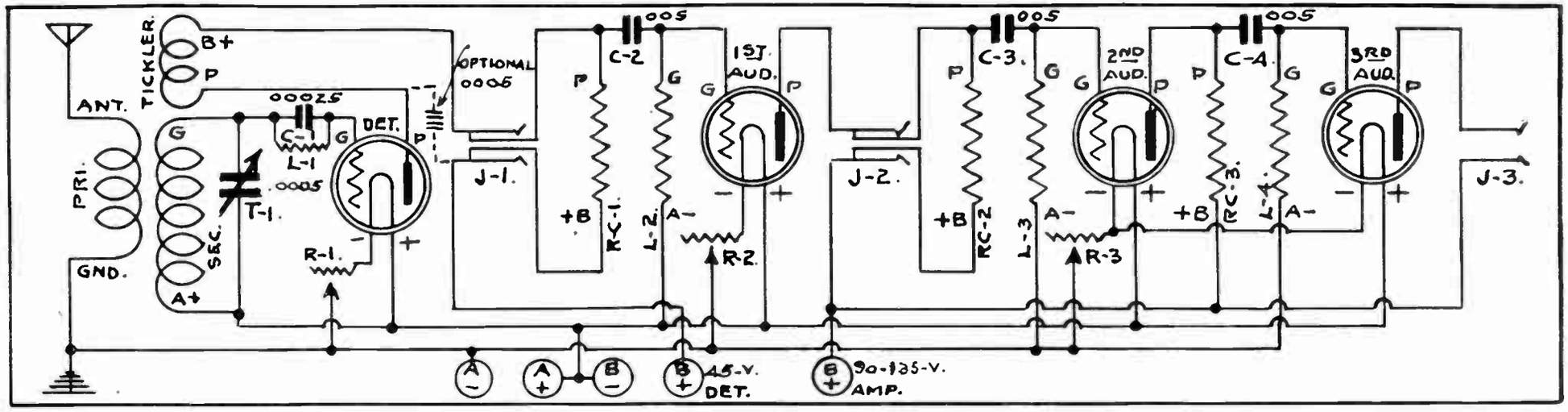


Fig. No. 19—Hook-up Three Circuit Set Using Three Stages Resistance Coupled Amplification

placed one-half inch or more away from the secondary. If you do not get volume enough with this loose coupling, these coils can be moved close together.

More selectivity can sometimes be had by taking a few turns of wire off the primary coil. Care must be used in doing this, or the coil will fall apart.

When building the set shown in Fig. 17, the transformers should be low ratio about 2½ or 3½ to 1. If more volume is wanted, use one high ratio (about 5 to 1) in the first stage and a low ratio in the last stage.

Resistance coupled amplification is becoming more and more popular as people are demanding quality rather than quantity. Ordinarily we advise the builder to use one stage of audio and two stages of resistance coupled. We think this will give him the best all round results and combine fair volume with clear reception. Hook-up for this is shown in Fig. 18.

There will be some experimenters who will want to try using three stages of resistance coupled amplification in place of transformers. We have added a schematic drawing showing how this type of set should be wired.

Key to the symbols used in the drawing are given in the list of parts for the various sets.

Either one of the three hook-ups shown in Figs. 17-18-19 can be built on a 7x21 panel and the same panel layout used. The baseboard should be one inch shorter than the panel and 6½" wide. A full size drilling templet showing the panel layout is given in the back of this book. Use templet No. 5.

PARTS NEEDED FOR SET SHOWN IN FIG. 18

	1 7"x21"x$\frac{3}{16}$" panel
	1 7"x21" cabinet
	1 6½"x20" baseboard
	1 terminal strip and brackets
	7 binding posts
	1 three circuit low loss tuner
	2 4" dials
	4 sockets to fit tubes
T1	1 .0005 MF or 500MMF variable condenser—23 plate
R-1-2	2 30 ohm rheostat
R-3	1 10 ohm rheostat
J-1-2	2 Double circuit jacks
J-3	1 single circuit jack
C-1	1 grid condenser .00025 MF with mounting for grid leak
L-1	1 grid leak to fit tube. (try from ½ to 5 megohms)
RC-1-2	2 resistance units from 100,000 to 150,000 ohms
	2 double resistance units mountings
L-2-3	2 grid leaks to fit tubes. (try ½ to 1/10 megohms)
	Note: We have found that in most cases the 1½ megohm leak could be used in the first stage L-2, and a 1/10 megohm in the last stage L-3. It is best to provide yourself with a series of grid leaks and use the one best fitted to your tubes
C-2-3	2 .005 MF fixed condensers
AT-1	1 3½ to 1 or 2 to 1 audio frequency transformer
SW	1 filament switch
Misc. Parts	wire, spaghetti, lugs, screws, bolts, etc.

PART REQUIRED FOR FIG. 19

	1 7"x21"x$\frac{3}{16}$" panel
	1 7"x21" cabinet
	1 6½"x20" baseboard
	1 terminal strip and brackets
	7 binding posts
	1 three circuit low loss tuner
	2 4" dials
	4 sockets to fit tubes
T-1	1 .0005 MF or 500 MMF variable condenser —23 plate
R-1-2	2 30 ohm rheostats
R-3	1 10 ohm rheostat
J-1-2	2 double circuit jack
J-3	1 single circuit jack
C-1	1 grid condenser .00025 MF with mounting for grid leak
L-1	1 grid leak to fit tube. (try from ½ to 5 megohms).
RC-1-2-3	3 resistance units from 100,000 to 150,000 ohms
C-2-3-4	3 .005 Fixed Condensers
	2 double resistance mountings
L-2-3-4	grid leaks to fit tubes. Suggested L-2 1½ megohms. L-3 ½ megohms and L-4 1/10 megohms. Always try other values to see which give the best results with your tubes
Misc. parts	Wire, spaghetti lugs, screws, bolts etc.

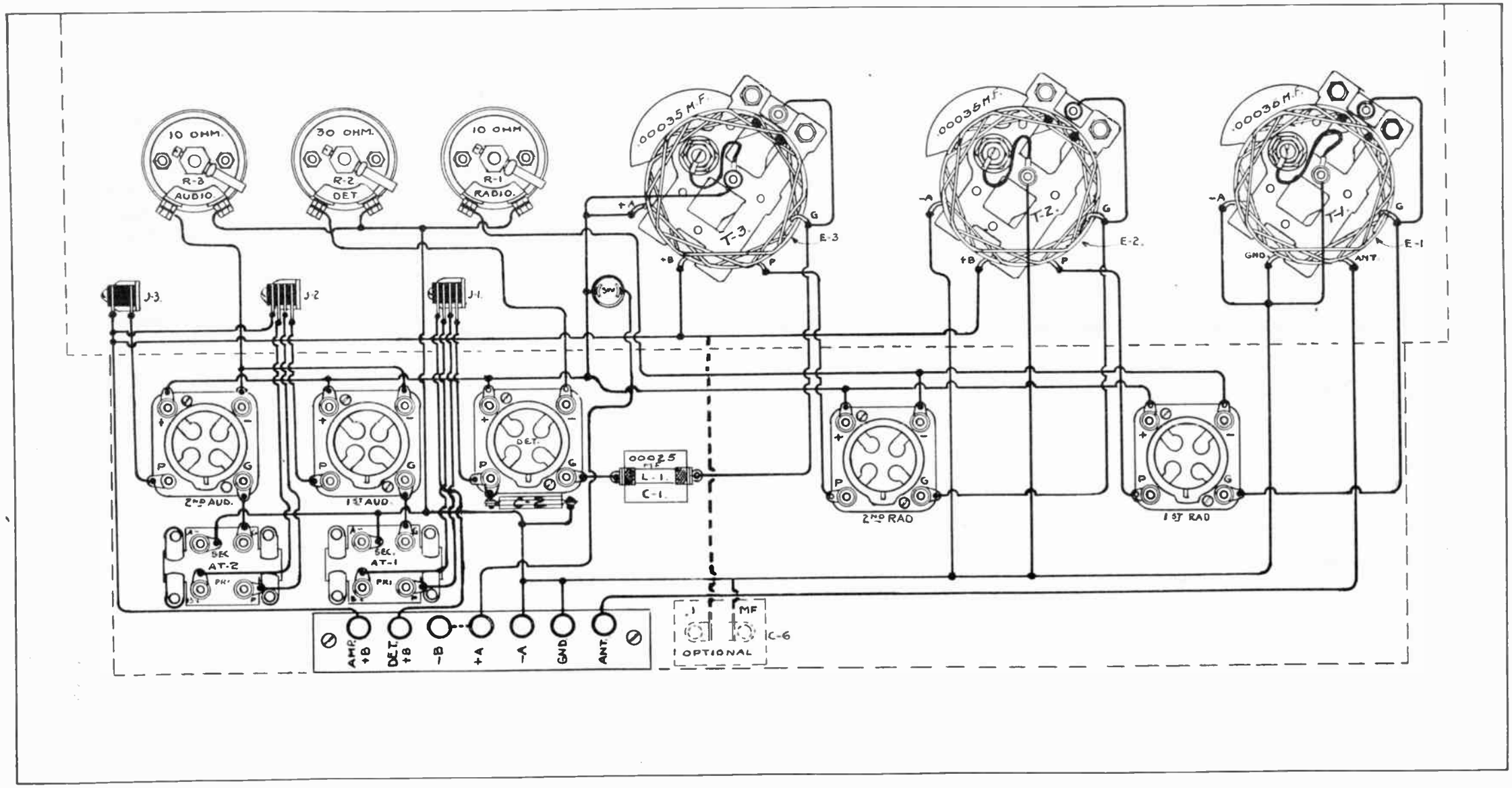


Fig. No. 20—Drawing of Low Loss Radio Frequency Set Using Transformer Coupled Amplification

Low Loss Radio Frequency Receivers

ON THE preceding pages a good deal has been said about the three circuit regenerative set in comparison with a set using radio frequency amplification in place of regeneration. Under many conditions it will be found necessary to use the set of the kind described on this page. In the congested districts of cities where there are a great many receiving sets as well as a number of broad-casting stations, the experimenter will find it best to construct a set which will give him selectivity and will not interfere with the reception of his neighbors.

The low loss radio frequency set described in this and the following page is similar to the set made famous by the Freshman Company. It is also similar to the neutrodyne type set described on the following pages and, in fact, similar to all types of radio frequency sets which use the tuned radio frequency principle. Most of the five and six bulb sets being sold today use the same general principle of radio frequency amplication. They only differ in the way the coils are constructed, mounted and tuned.

The ideal operating condition in any of these sets is found when the set will give a maximum signal strength on all of the broad-cast range from 200 to 600 meters. It should do this without it being necessary to force the bulbs into oscillation. More will be said about overcoming this oscillation on the pages devoted to a description of the Duston Special.

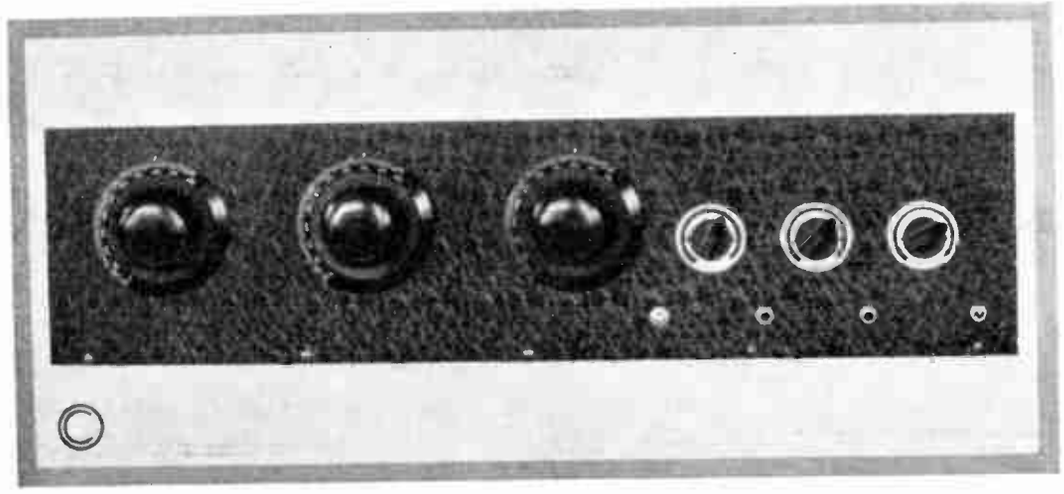


Plate No. 12—Front View of Low Loss Radio Frequency Receivers

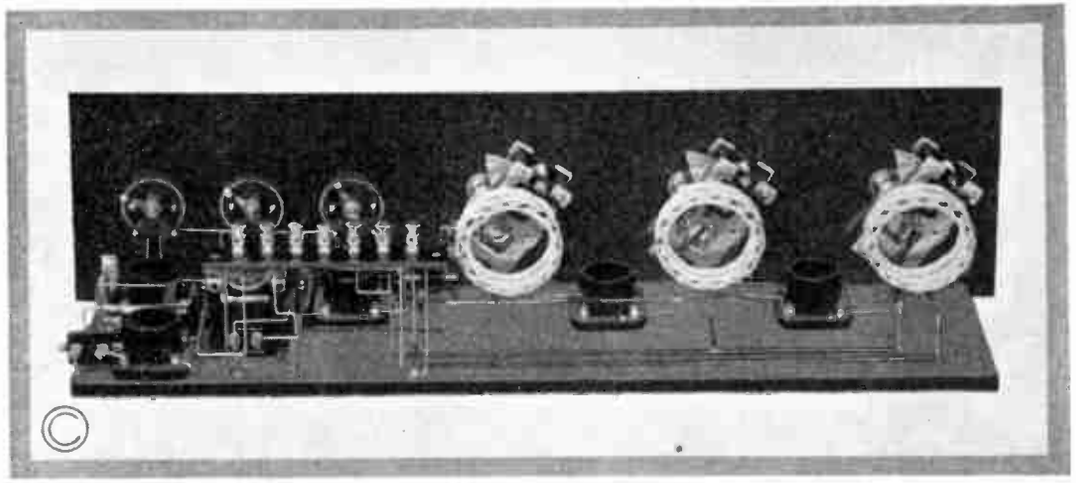


Plate No. 13—Rear View of Set Showing One Stage Transformer and Two Stages Resistance Coupled Amplification

When wiring the set, the wires can practically be run as shown in the two outline drawings. The parts have been so arranged so that the grid leads will be short and to eliminate as far as is possible capacity effect between wires.

LIST OF PARTS NEEDED FOR SET IN FIG. 20

	1 7"x28"x$\frac{3}{16}$" panel	R-1-3	10 ohm Rheostats
	1 7"x28" cabinet	R-2	1 30 ohm rhheostat
	1 6½"x26" base board		Note: For 199 type tubes, use 20 ohm rheostat for R-1-3 and 30 ohm rheostat for R-2
	1 terminal strip and brackets		
	7 binding posts		
	6 sockets to fit tubes, preferably 301 A	J-1-2	2 double circuit jacks
	3 4" dials	J-3	1 single circuit jack
T-1-2-3	3 .00035 MF or 350 MMF variable condensers —17 plate Note: 13 plate .0003 M F may be used, but in most cases they will not tune the coils to the higher wave lengths	SW-1	1 filament switch
		C-1	1 .00025 grid condenser with mountings for grid leak
		L-1	1 grid leak to fit tube (try ½ to 5 megohms)
E-1-2-3	3 low loss radio frequency coils	C-2	1 .001 MF or .002 MF fixed condensers
AT-1-2	2 low ratio transformers 3½ to 1 or AT-1 may be a 5 to 1, and AT-2 a 2½ or 2 to 1	C-6	1 1MF by-pass condenser (optional)
		Misc. Parts	Wire spaghetti, lugs, screws, bolts, etc.

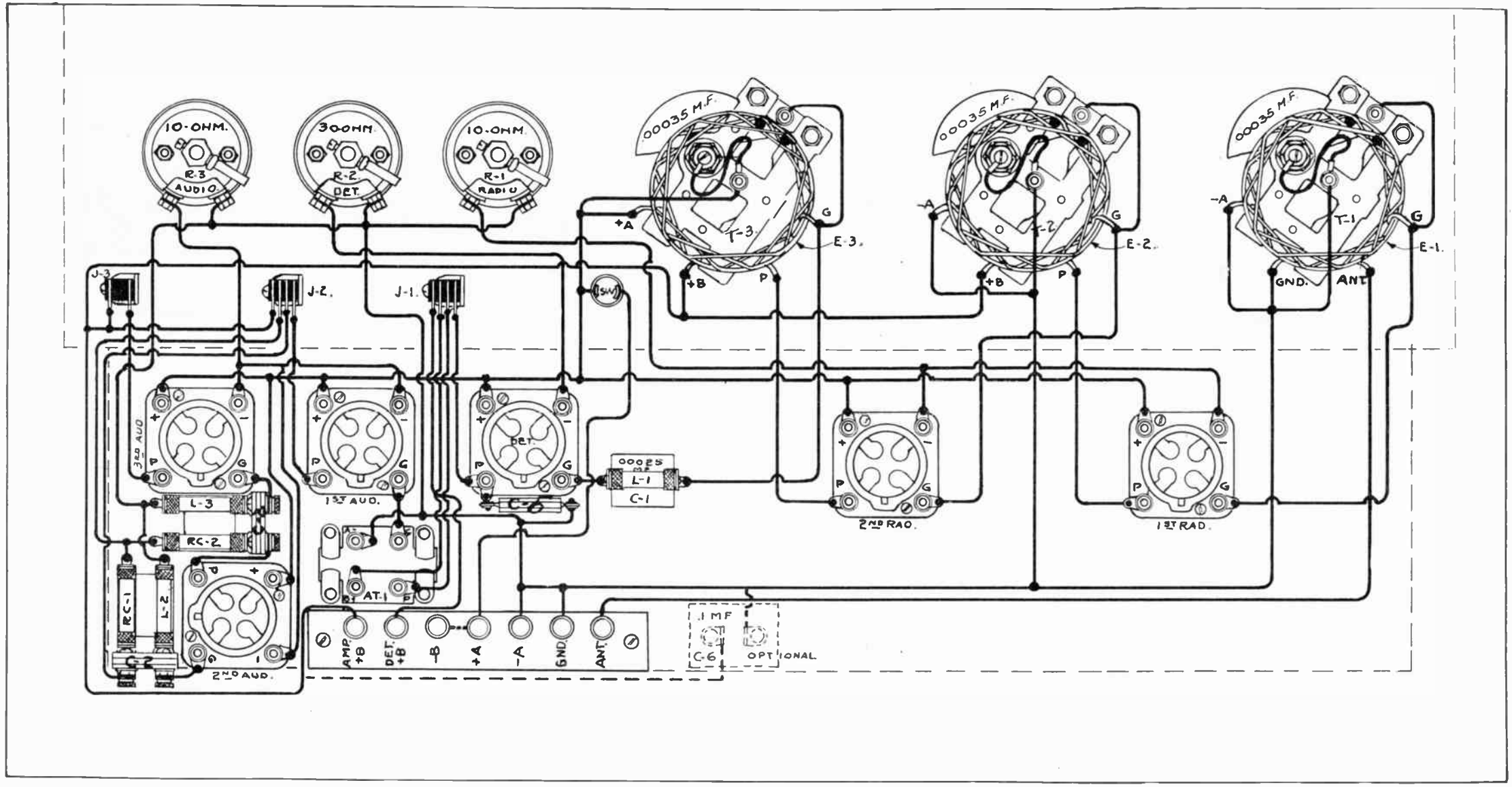


Fig. No. 21—Drawing of Low Loss Set Using One Stage Transformer Coupled and Two Stages of Resistance Coupled Amplification

The most common trouble experienced in this type of set is that of oscillation of the first two bulbs. If you construct a set and you find it doing this, try changing around the bulbs until you have those in the first two or radio frequency sockets nearly matched, then these can be turned down with the rheostat so that they will operate right under the oscillating point.

If these bulbs are not matched and one oscillates at a lower temperature than the other by the time the high bulb is turned down low enough to stop oscillating, the low bulb will not be in condition to pass a strong signal.

There are several other ways to stop the set from oscillating. These are only enumerated so that the builder can try them in case he is experiencing extreme trouble along this line. One thing to try is to change the position of the coils, as shown in the drawing, these are mounted directly on the back of the variable condensers. This method of mounting is satisfactory in most cases and oscillation can be controlled by adjusting the rheostat. If it has not proved a proper method of construction, try mounting the middle coil on the baseboard at right angles to the two other coils. When mounting this coil on the baseboard, use the same fibre mounting as is used to fasten the coils to the variable condenser, but add a small brass angle bracket to hold this mounting.

(Continued on Page 22)

PARTS NEEDED FOR SET SHOWN IN FIG. 21.

	1 7"x28"x$\frac{3}{16}$"panel	J-3	1 single circuit jack
	1 7"x28" cabinet	SW-1	1 filament switch
	1 6½"x26½ baseboard	C-1	1 .00025 grid condenser with mountings for grid leak
	1 terminal strip and brackets		
	7 binding posts	L-1	1 grid leak to fit tube
	6 Sockets to fit tubes, preferably 201-A	C-2-3	2 .005 fixed condensers
	3 4" dials	C-5	1 .001MF or .002MF fixed condensor
T-1-2-3	3 .00035 variable condensers 17 plate	C-6	1 MF by-pass condenser (optional)
E-1-2-3	3 low loss radio frequency coils	L-2-3	2 grid leaks to fit tubes
AT-1	1 low ratio transformer, preferably 3½ to 1	R-C-1-2	2 resistance units from 100,000 to 150,000 ohms
R-1-3	2 10 ohm rheostats		
R-2	1 30 ohm rheostat		2 double resistance mountings
J-1-2	2 double circuit jacks	Misc. Parts	wires, spaghetti, logs, screws, bolts, etc.

PARTS NEEDED FOR SET SHOWN IN FIG. 22

	1 7"x28"x$\frac{3}{16}$"panel	J-3	1 single circuit jack
	1 7"x28" cabinet	SW-1	1 filament switch
	1 6½"x26½" baseboard	C-1	1 .00025 grid condenser with mountings for grid leak
	1 terminal strip and brackets		
	7 binding posts	L-1	1 grid leak to fit tube
	6 sockets to fit tubes	C-6	1 MF by-pass condenser (optional)
	3 4" dials	L-2-3-4	3 grid leaks to fit tubes.
T-1-2-3	3 .00035 MF variable condensers 17 plate	RC-1-2-3	3 resistance units from 100,000 to 150,000 ohms
E-1-2-3	3 Low loss radio frequency transformers		
R-1-3	2 10 ohm rheostats		3 double resistance and leak mountings.
R-2	1 30 ohm rheostat	Miscl. Parts	Wires, spaghetti, lugs, screws, bolts, etc.
J-1-2	2 double circuit jacks		

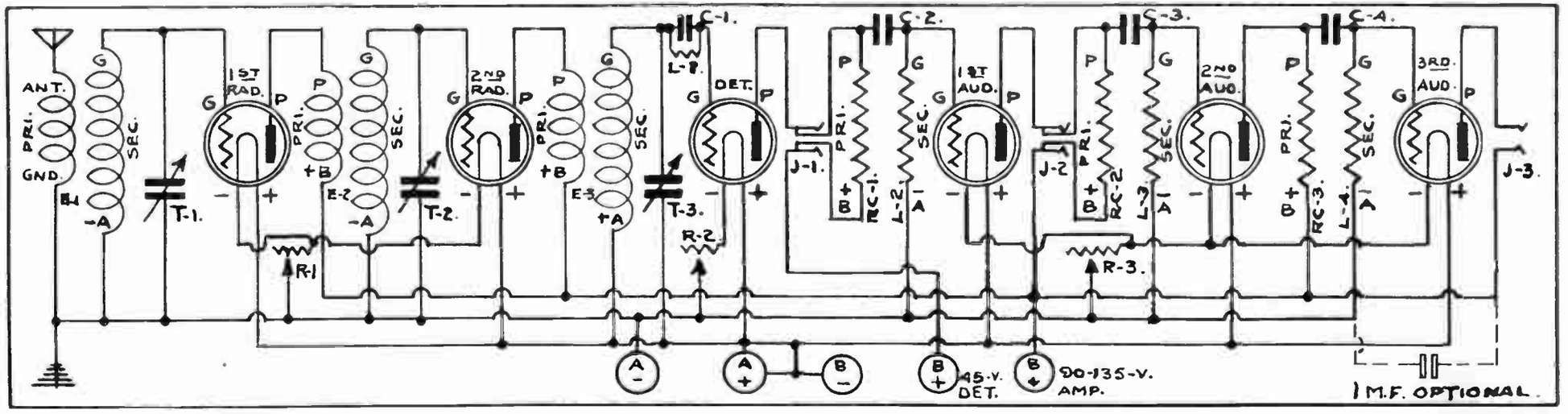


Fig. No. 22—Hook-up Showing Low Loss Set with Three Stages of Resistance Coupled Amplification

(Continued from Page 21)

Another way to stop oscillation is to place a 200 ohm potentiatometer in the "A" battery lead of the secondary of the middle coil. This potentiatometer can be mounted on the baseboard so that additional holes will not have to be drilled in the panel.

Another method sometimes used is to change around or reverse the leads of the primary of the second or middle coil. These latter suggestions to be tried only if it is found impossible to stop oscillation by matching the tubes and keeping the rheostats turned down low.

All of the foregoing explanations may make the prospective builder afraid to try to construct one of these sets. Don't get the wrong impression. This set is one of the easiest radio sets to build, and we can safely say that people who build a set of this kind, just as shown in the hook-up get better results, than they would if they had built other types of radio frequency receivers.

For ease in wiring, mount the coils exactly as shown in the hook-up. It will then be a simple matter to determine the proper way to connect the different wires to these coils. If using coils where the leads do not conform with the ones shown in the drawing, it might be well to remember that the part of the coil having the greatest number of turns will be the secondary and the part of the coil having a few turns, the primary "P" and "B+" terminals are primary and "A" and "G" terminals are secondary. The grid wires on the secondary coil should be connected from the same side of the coil as the plate lead on the primary. Always wire this way first and then if trouble is experienced the primary leads of the second coil may be reversed, as stated before.

The set can be built on a 7 x 28 panel and the same panel layout used for all three drawings of the low loss set as well as for the neutrodyne set. Use templet No. 6 which will be found in the back of the book.

The mounting holes for the variable condensers are drilled at an angle so that they will be right for neutrodyne coils. Having the condensers at this angle also works out right for the low loss set.

Neutrodyne Type Radio Frequency Receivers

SET described on the next two pages is similar to that made famous by Professor Hazeltine, and was called by him the "Neutrodyne." The set is one of the first successful tuned radio frequency receivers used for broad-cast reception, and when the set is properly constructed and operated, will give very satisfactory results, having selectivity with good volume on distant stations.

Two small capacity neutralizing condensers have been provided to enable the operator to neutralize the grid to plate capacity effect of the tubes, and in that way, keep them from oscillating. Before it is possible to do this, the balance of the set must be so

LIST OF PARTS FOR SET SHOWN IN FIG. 23

	1 7"x28" panel	R-1-3	2 10 ohm rheostats
	1 6½"x26½" baseboard	R-2	1 30 ohm rheostat
	1 7"x28" cabinet	J-1-2	2 double circuit jacks
	8 4" dials	J-3	1 single circuit jack
	5 tube sockets	SW	1 filament switch
	7 binding posts	C-1	1 grid condenser with mountings
	1 terminal strip and brackets	L-1	Grid leaks to fit tube
T-1-2-3	3 .00035MF variable condenser, 17 plate	N-1-2	2 neutralizers
NC-1-2-3	3 neutrodyne coils	C-2	1 .001 or .002 MF fixed condenser
AT-1-2	2 3½ to 1 audio frequency transformers	Misc. Parts	—Hook-up wire, lugs, screws spaghetti, etc.

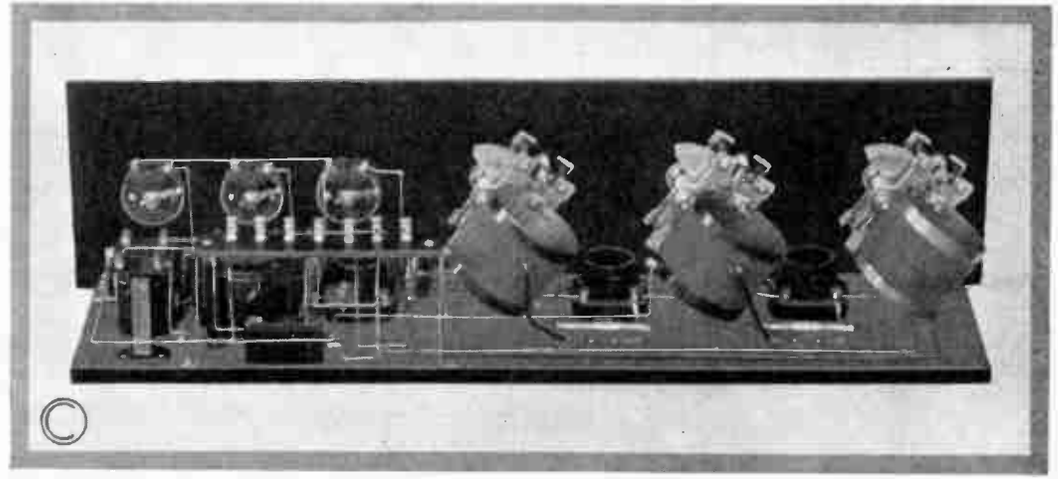


Plate No. 14—Rear View of Neutrodyne Type Receiver—Front View Is the Same as Shown in Plate No. 12

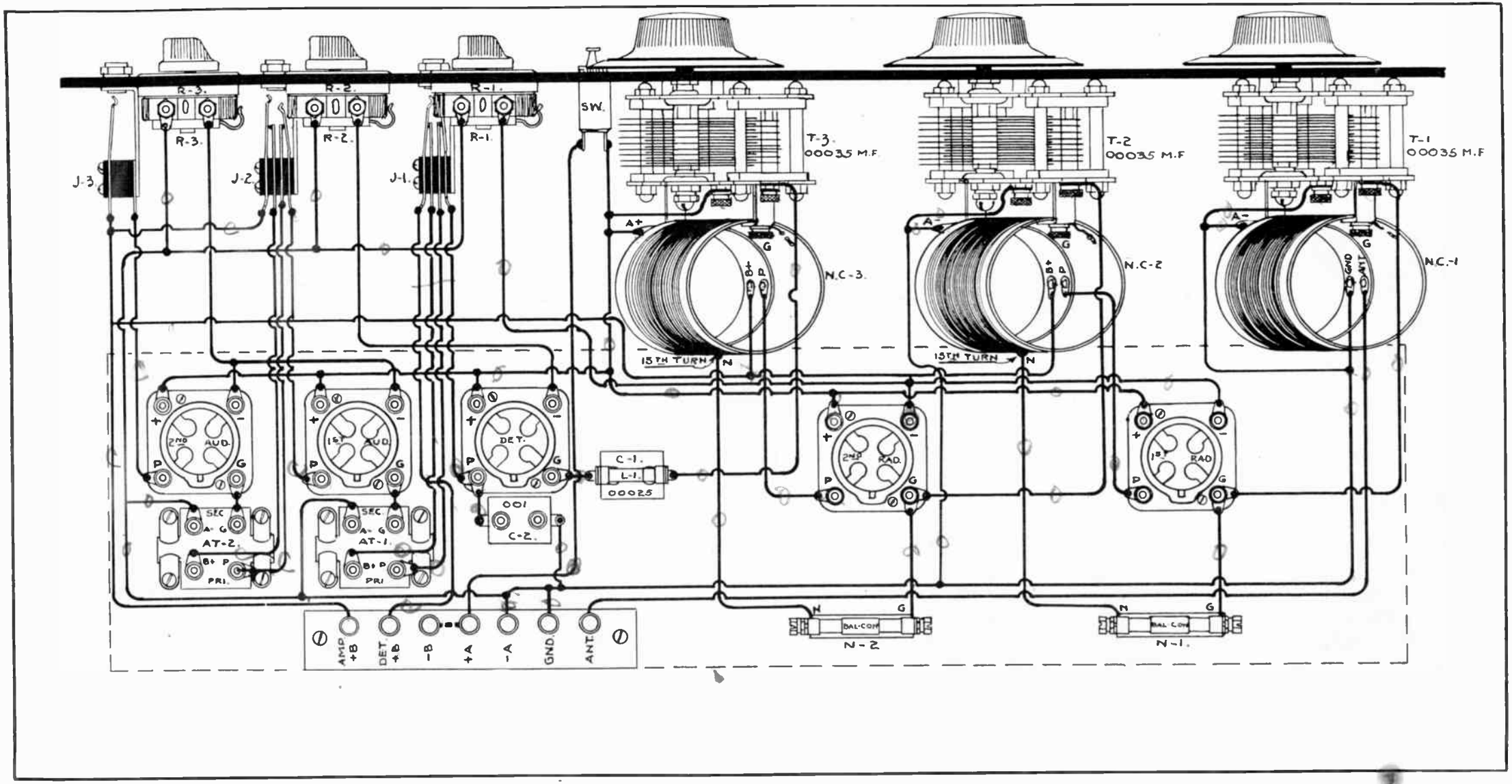


Fig. No. 23—Neutrodyne Type Using Two Audio-Frequency Transformers

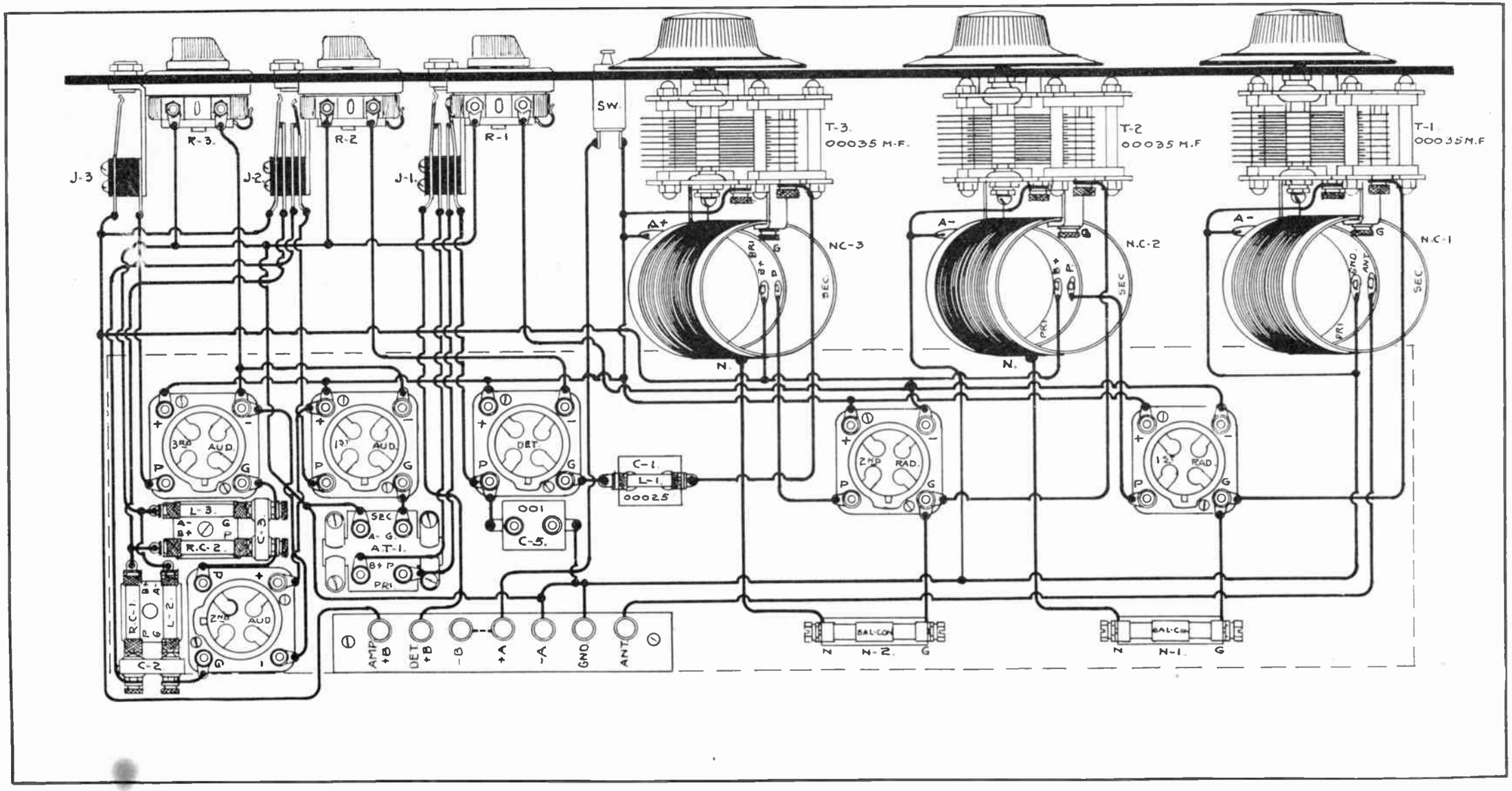


Fig. No. 24—Neutrodyne Type Receiver Using One Stage Transformer Coupled and Two Stages Resistance Coupled A. F. Amplification

constructed that there is not a great deal of feed back between the coils of the R F transformers. This is the reason that these are mounted at an angle of 57-7/10 degrees.

Many times the amateur, and even the professional set builder, so constructs this set that it is nearly impossible to keep the set from oscillating and moving the small capacity condenser does not seem to do any good. If experiencing this trouble, it can be overcome in most cases by using matched tubes in the first two radio frequency sockets and then controlling oscillation by keeping these tubes turned down low.

If winding your own coils or if the coils you buy are not tapped, the tap should be taken off at the fifteenth turn from the "A" battery end of the secondary coil. This tap can best be connected by scraping the insulation from two wires and soldering the small wire to the coil. This will short circuit two wires in the coil, but will not do any great harm if care is taken not to get the solder on more than these two turns. This is not good engineering principle, but is the easiest way to tap a ready wound coil and will likely make neutralization easier. A better method is to lift one turn with a sharp instrument such as a knife blade, slip a small strip of paper under it, scrape off the insulation, then solder on the tap.

The same panel layout can be used for all of the hook-ups shown. This is the same layout as is used for the low loss radio frequency set. Template is given in the back of the book. Use template No. 6.

PARTS NEEDED FOR SET SHOWN IN FIG. 24

	1 7"x28" panel	J-1-2	2 double circuit jacks
	1 6½"x26½" baseboard	J-3	1 single circuit jack
	1 7"x28" cabinet	SW	1 filament switch
	3 4" dials	C-1	1 .00025 MF grid condenser with mounting
	6 tube sockets	L-1	grid leaks to fit tube
	7 binding posts	N-1-2	2 neutralizers
	1 terminal strip and brackets	C-5	1 .001 or .002 fixed condenser
T-1-2-3	3 .00035 MF variable condensers—17 plate		2 double resistance unit mountings
NC-1-2-3	3 neutrodyne coils	RC-1-2	2 100,000 to 150,000 ohm resistance units
AT-1	1 3½ or 4½ to 1 audio frequency transformer	L-2-3	2 grid leaks 1½ to ½ megohm
R-1-3	2 10 ohm rheostats	C-2-3	2 .005 fixed condensers
R-2	1 30 ohm rheostat	Misc. Parts	Hook-up wire, screws, lugs, spaghetti etc.

A list of parts for set shown in Fig. 25 will be the same except that no audio frequency transformer is used and one extra double mounting with necessary resistances and leaks will have to be provided. The resistance should all be from 100,000 to 150,000 ohms, and the leaks the same as is given for the low loss set, list of parts for which are shown on page 21.

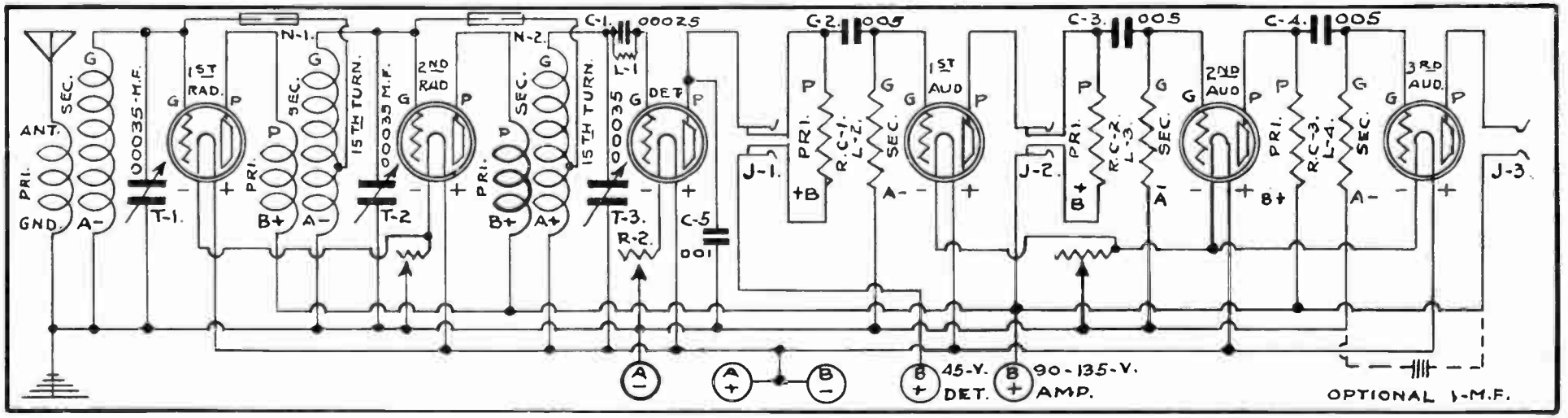


Fig. No. 25—Hook-up Showing Three Stages Resistance Coupled

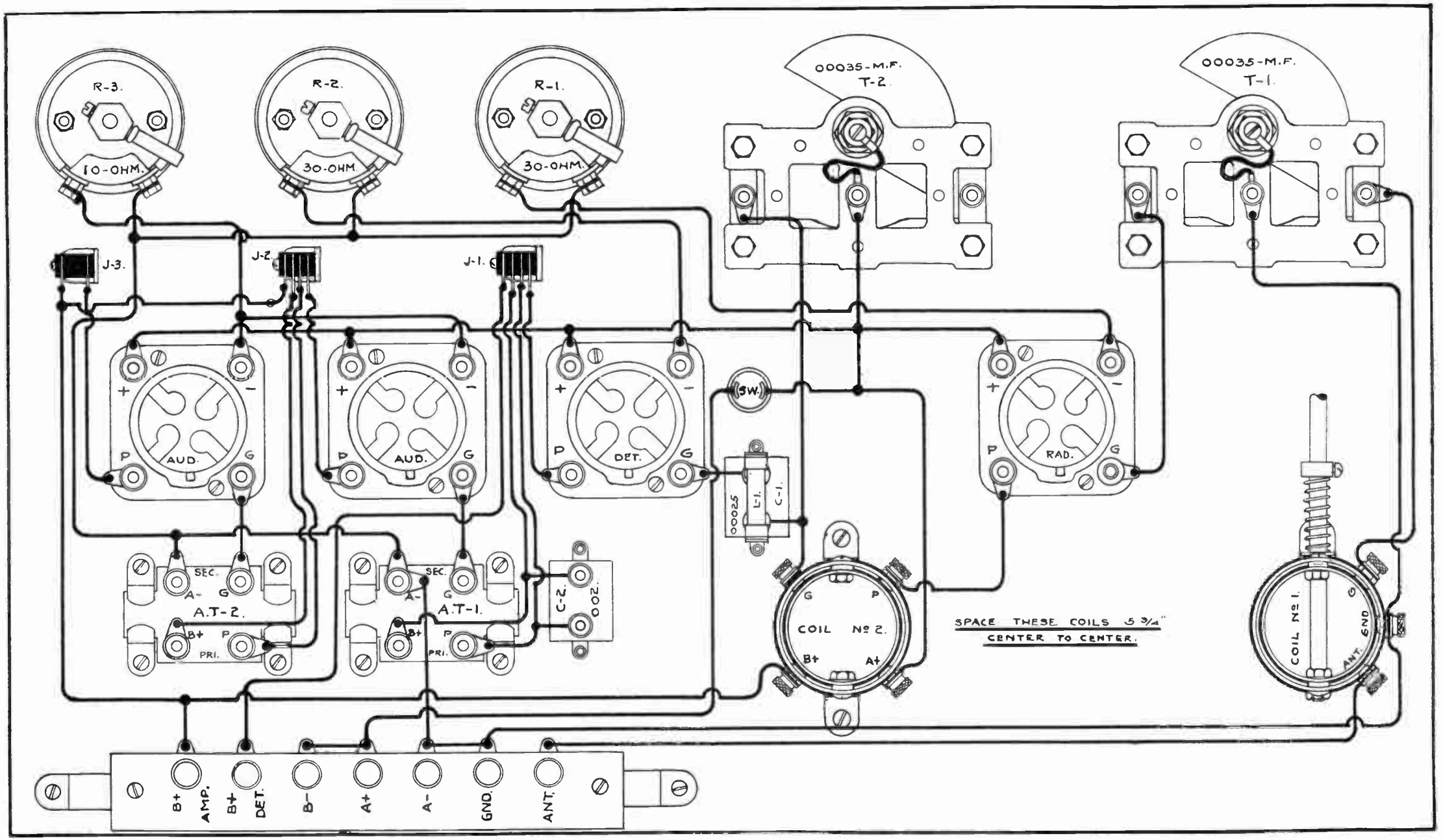


Fig. No. 26—Drawing of Duston Special Transformer Coupled

Duston Special Radio Frequency Set

THE set described on this page was designed by the author of this book. It has been thru the process of experimentation for more than a year, and we believe it is worth the time that has been expended on it. Since the set is a special pet of the author's, it may be well to discount some of the good things said about it; but we know that it has a place in the radio field. It has only two tuning dials, and will give as much volume on stations up to 1000 miles as most sets which use two stages of radio frequency amplification.

A large number of radio fans live in cities where there are several broad-casting stations operating at the same time, and they find it necessary to have a selective set in order to tune out local stations and pick up concerts from out of town. This class of radio fans, as well as others who want a selective receiver, will appreciate the Duston Special.

Before taking up construction details of the set, we would like to tell you about the principle of its operation. Most R. F. sets of this type do not get the most out of the radio frequency bulbs, due to the fact that these sets do not give a maximum efficiency on the complete band of wave lengths allotted to broad-casting stations.

PARTS NEEDS FOR SET SHOWN IN FIG. 26

1 7x21x3/16 panel
1 6"x20" baseboard
1 7"x21" cabinet
4 tube sockets to fit tubes
1 terminal strip and brackets
7 binding posts
2 4" dials
1 No. 1 coil assembly bracket

Note: If one of these cannot be purchased completely assembled, buy a movable spider web arm bracket and then use a short piece of brass rod which will have to be threaded on both ends. Dimensions of this can be obtained from the drawing.

Coil 1 and Coil 2. 2 Special coils.

NOTE: Parts needed to make up special coils are shown in the drawing. Each coil will take about 75 feet of Litz wire and 10 feet of soild wire. Tube for secondary should be approximately 5 inches long, and tube for primary need not be more than 2 inches long.

T-1 and T-2	2 variable condensers, 13 plate approximately .0003 MF
R-1 and R-2	2 30 ohm rheostats
R-3	1 10 ohm rheostat

NOTE: If No. 199 tubes are used, this last rheostat should be a 20 ohm

J-1 and J-2	2 double circuit jacks
J-3	1 single circuit jack
C-1	1 grid condenser with mounting
L-1	1 grid leak to suit tube
C-2	1 .001 or .002 MF fixed condenser
AT-1-2	2 low ratio audio frequency transformer 3½ to 1 or 2 to 1

Misc. Parts—Bus wire, spaghetti, screws, lugs, bolts, etc.

LIST OF PARTS FOR SET SHOWN IN FIG. 29

1 7"x21"x3/16" panel
1 6½"x20" baseboard
1 7"x21" cabinet
5 tube sockets to fit tubes
1 terminal strip and brackets
7 binding posts
1 coil assembly bracket

Coil 1 and Coil 2 2 special coils.

NOTE: Information on material needed is shown in the list of parts given for Fig. 26

T-1-2	2 variable condensers .0003 MF 13 plate
R-1-2	2 30 ohm rheostats
R-3	1 10 ohm rheostat
J-1-2	2 double circuit jacks
J-3	1 single circuit jack
C-1	1 .00025 MF grid condenser with mountings
L-1	1 grid leak to suit tube
C-2	1 .001 MF fixed condenser
C-3 and C-4	2 .005 fixed condensers
AT-1	1 3½ to 1 audio frequency transformer
	2 double resistance mountings
RC-1-2	2 100,000 to 150,000 resistance units
L-2-3	2 grid leaks 1½ and ½ megohm
	2 4" dials

Misc. Parts—Hook-up wire, screws, lugs, spaghetti, etc.

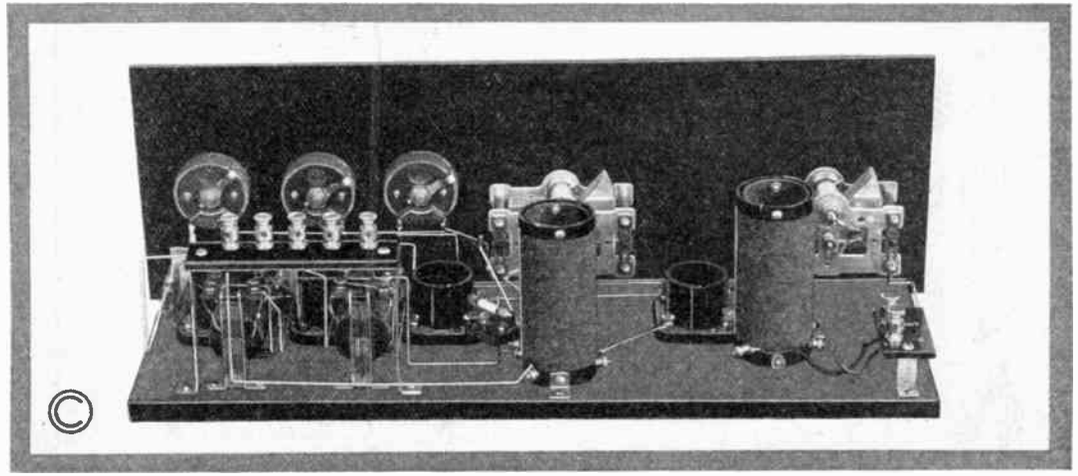


Plate No. 15—Rear View of Duston Special R. F. Set

A great many R. F. Sets have a tendency to oscillate on certain wave lengths, and it is necessary to put losses in the set in the form of small condensers or resistances to keep sets under the oscillating point. This will mean that this set does not give the highest efficiency because the bulbs cannot be operated at the highest point of their characteristic curve, which is generally right under the oscillating point. Certain of the better set manufacturers have recognized this fact and designed their sets so that the bulbs were always doing their best regardless of the wave length of the station being received. The Super-Zenith is an example of this. They get the right effect by having a small variometer in the primary of the radio frequency transformer, and this is controlled as the secondary is being tuned to stations on different wave lengths. As stated by manufacturers of the Zenith sets, this type of receiver is very difficult for an amateur constructor to build. In designing the Duston Special, the author kept in mind the necessity of having a set that provided enough variation to make up for the different methods of construction of the amateur builder.

Space does not permit us to tell you just why we have constructed the radio frequency transformer in the way we have, but we will state that if these coils are constructed carefully, enough variation can be had to keep the bulbs under the oscillating point on the whole broad-cast range, and when so operated, gives surprising results using only one stage of radio frequency amplification.

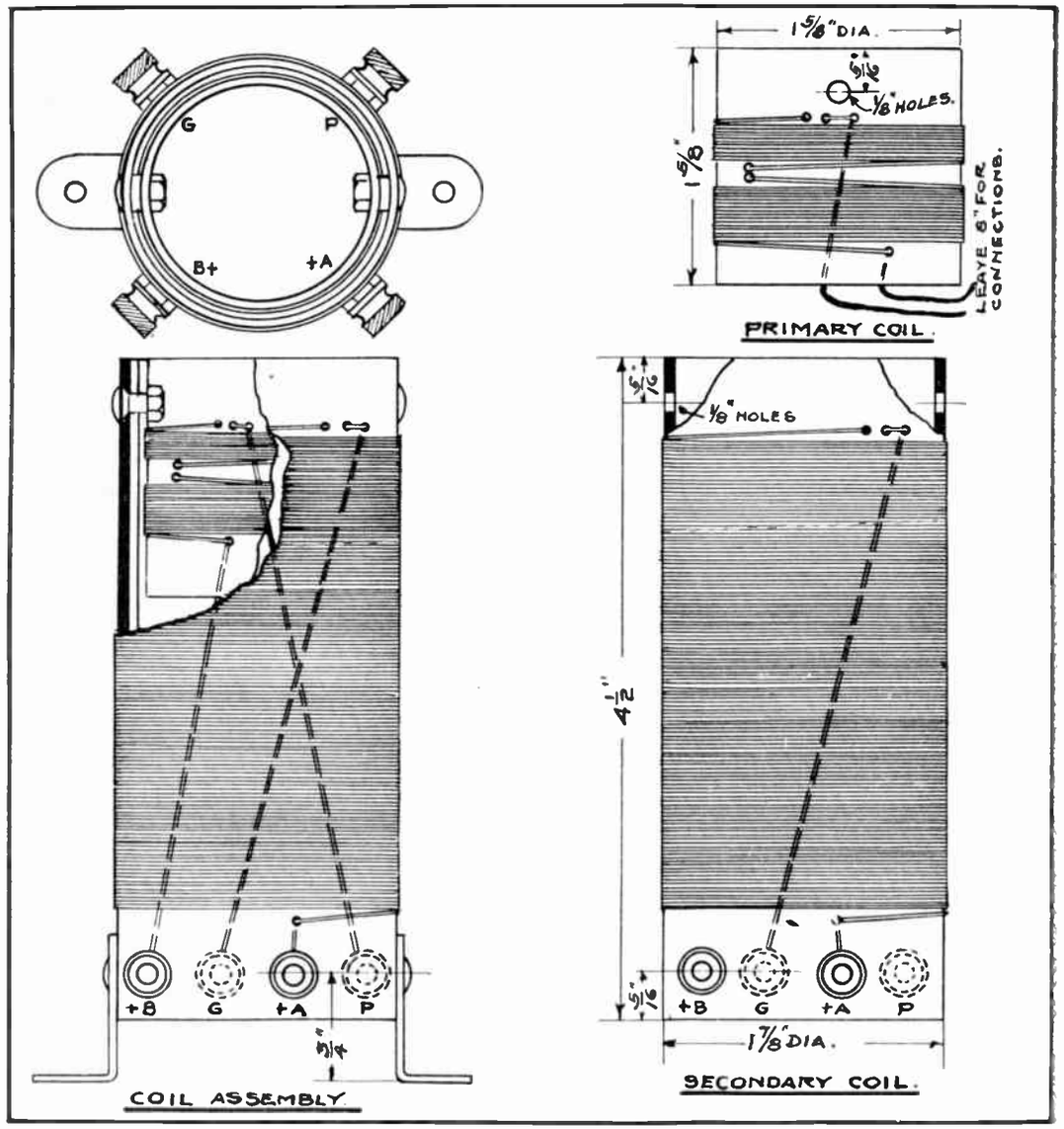


Fig. No. 27—Detailed Drawing Showing How to Construct Coil No. 2 for Duston Special

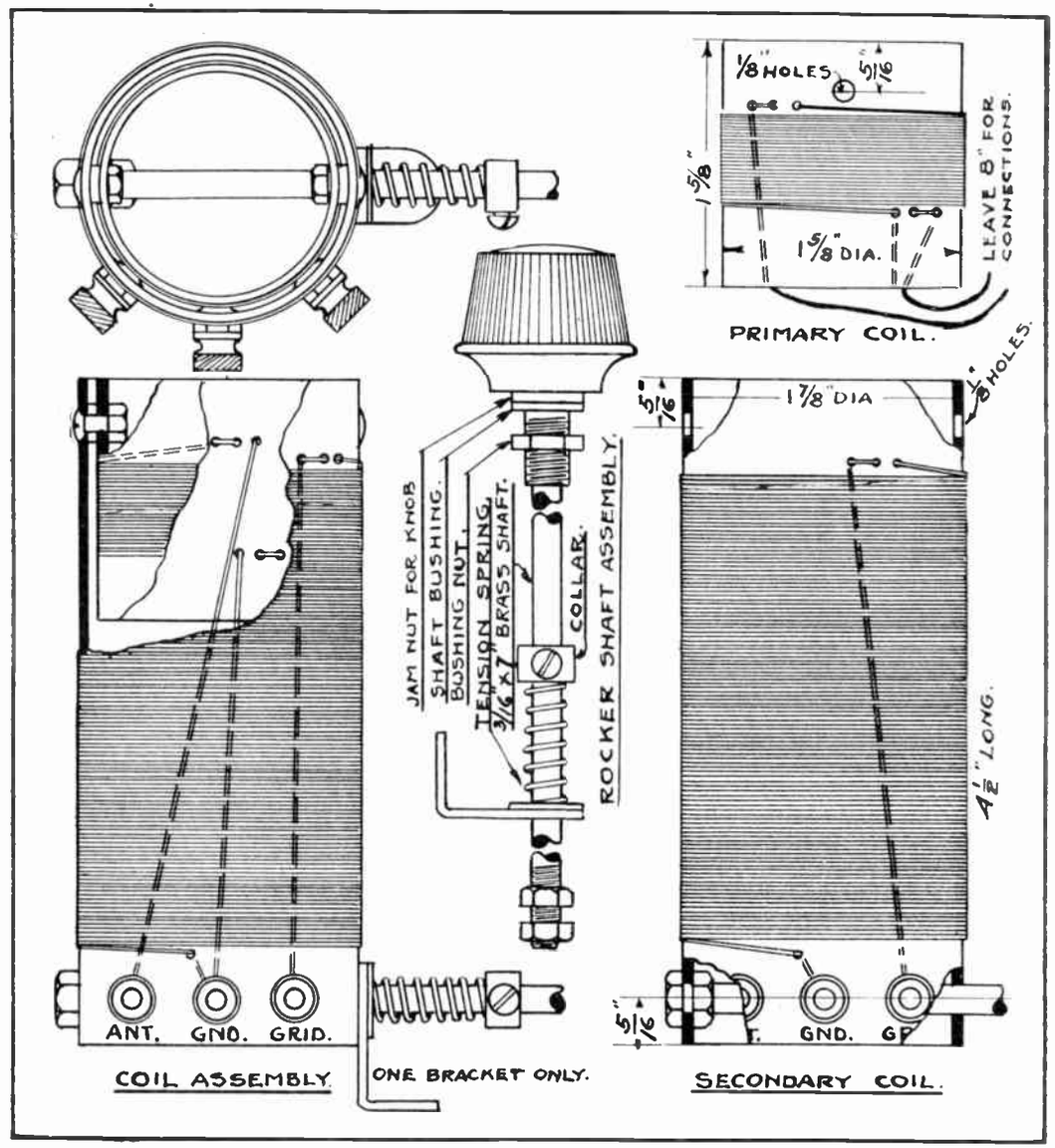


Fig. No. 28—Detailed Drawing of Coil No. 1 for Duston Special

Now, in regard to tuning. As this set is exceptionally selective, some time will have to be spent in learning to operate it for the best results to be obtained. Varying the coupling between the first two coils will not change the dial readings to any great extent. These two coils want to be just close enough together so that the set will not squeal or howl when the condensers are moved back and forth when tuning in a station. The rheostat connected to the first bulb should also be turned down low enough to help control oscillation. When you get the rheostat and coil set at the right place, these can generally remain stationary for station over a band of 200 meters,—and how stations will come in! On a good night a person will be able to tune a different station every degree or two on the dial, and sometimes only one-half of a degree will tune out one station and tune in another. They come in clear without a bit of distortion and with good volume, although, volume also depends on the type of audio frequency transformers used and also on how high a "B" battery voltage is used on the amplifier bulbs. The detector "B" battery voltage should be varied to find out where it works the best on the bulb used in the set. Sometimes this should be as low as 16½ volts.

Always try changing the size of the grid leak until you get the right one for your tube. We do not advise a variable leak unless an extremely good one is to be had. It is best to get several sizes of the cartridge type and use these with a grid condenser provided with clips.

The set gives very satisfactory results with dry cell tubes of the No. 199 type, although 201-A type tubes are always best. The same type of tube can be used for all sockets. Amplifier "B" battery voltage need not be higher than 90 when using either of the two hook-ups shown. A set using one stage of transformer coupled and two stages of resistance amplification will give better quality, but will be somewhat harder to construct than the straight transformer coupled set.

The panel layout for this set is the same as for the low loss three circuit receiver, except that there is one more hole to be drilled for the Duston Special. Drilling template will be found in the back of the book. Use template No. 5.

Instructions For Winding Coils

As these coils must be constructed right to make the set operate successfully, follow the instructions given here and study the drawings of these coils carefully. The Primary of No. 1 Coil should be wound with 25 turns of No. 22 Double Cotton Covered Wire and should be wound anti-clockwise and in the same direction as the Secondary of this coil. If Litz wire is obtainable, it should be used on the Secondary of both Coils. We generally use Litz wire which has twenty-eight strands of No. 38, although other sizes will do. If you cannot get Litz wire, the Secondaries may be wound with No. 22 D. C. C. or No. 22 D. S. C.

Secondary of No. 1 Coil should be wound anti-clockwise and in the opposite direction to the Secondary of the No. 2 Coil. Both secondaries should be wound with approximately 150 turns of wire when using 1⅞" diameter tube. The ends of these coils should go to the terminals as shown in the drawings in Figures 27 and 28.

The Primary of the second Coil should be wound with No. 22 Double Covered Wire and have 10 turns wound in the same direction as the Secondary of this Coil and then the wire should be reversed and 15 turns wound in the opposite direction. If you do not want to run the wire through the coil as shown on the drawing, this can be avoided by drilling a small hole in the tube, making a loop of the wire, running it through the hole and hold same in place by placing a toothpick or match through the loop inside the tube. This can then be drawn up tight and the wire wound in the opposite direction. If unable to get tubes just the right size shown, larger tubes may be used, but do not have them larger than 2⅛" outside diameter.

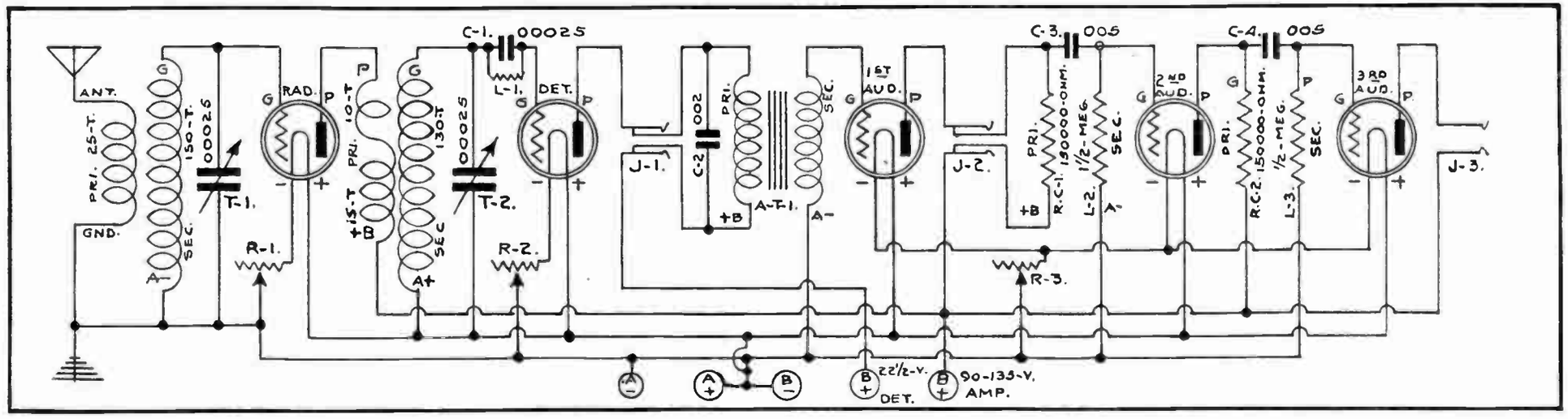


Fig. No. 29—Hook-up Showing Duston Special Using One Stage transformer Coupled and Two Stages Resistance Coupled Amplification

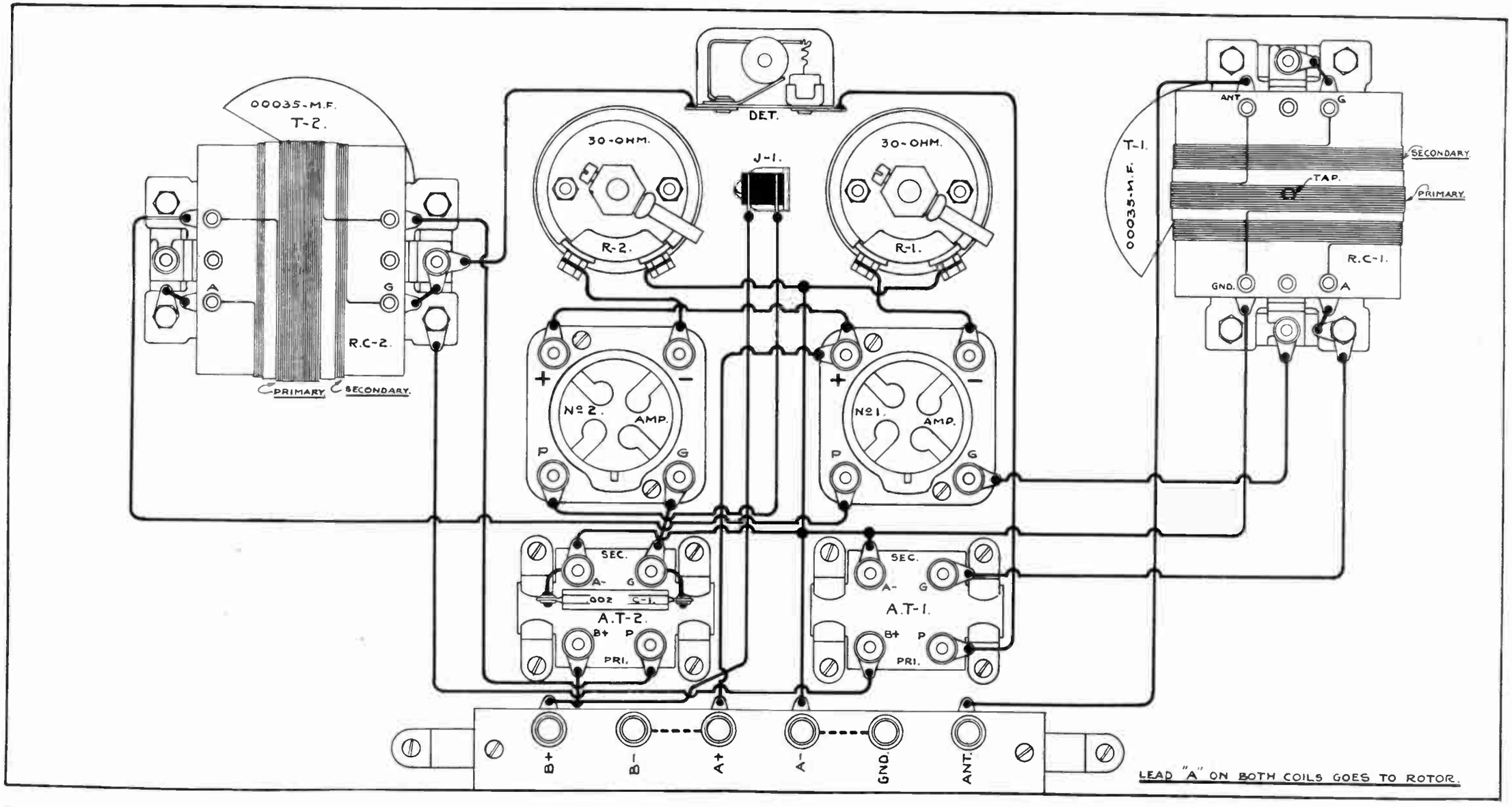


Fig. No. 30—Hook-up T wo Bulb Reflex Set

Two Bulb Reflex Set

THE set herewith described is generally known as the Harkness Reflex. It is one of the first receivers of this type to be designed by Kenneth Harkness, and we believe it is one of the best. The set is exceptionally well adapted for local reception, and will give a clear, loud speaker signal on local stations, and can sometimes be used for loud speaker reception on stations up to 500 miles distant.

Many radio fans want a set which could be built cheaply, but which would allow them to use a loud speaker on local stations. To this type of fan we can recommend highly the Harkness two bulb receiver. Tone quality is remarkably clear, due to the fact that a crystal detector is used for rectification. The audio frequency transformers in the set should be good ones and ordinarily transformers of the same ratio are used, although we have seen sets which used a low ratio for the first transformer and a high ratio for the second. If you are buying transformers especially for this set, we would recommend those of fairly low ratio, about 3½ to 1.

Volume of this set also depends a great deal upon having a good crystal. We do not recommend a fixed crystal for this purpose, as the reflex set passes a considerable amount of current thru the crystal, and the contact of a fixed crystal soon becomes corroded and the efficiency of the set is lessened.

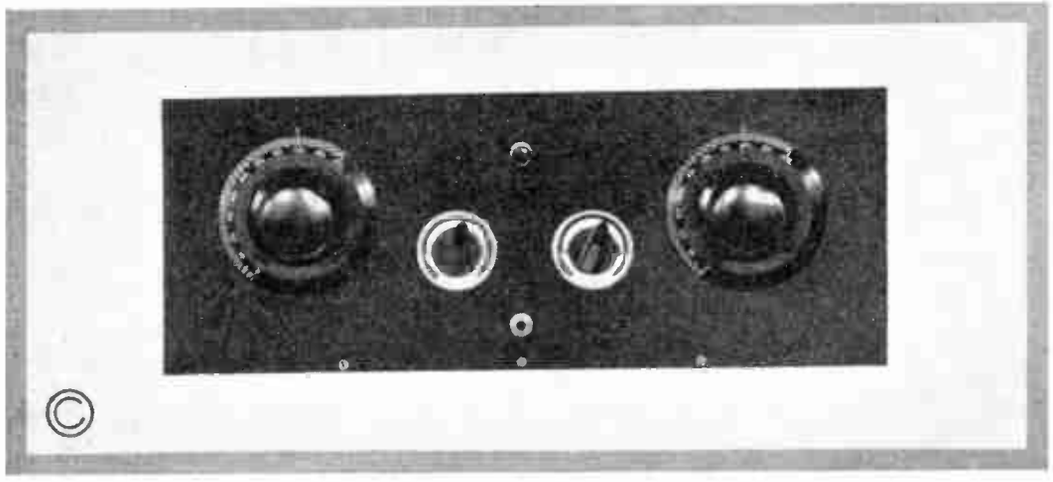


Plate No. 16—Front View of Two Bulb Reflex Set

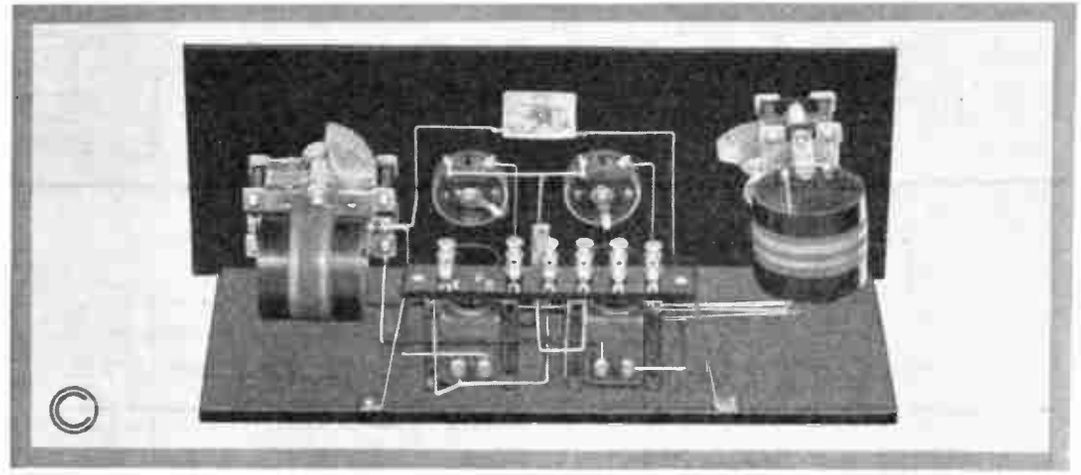


Plate No. 17—Rear View of Two Bulb Reflex

The first or tuning coil has a smaller amount of wire on the primary than is used on the primary of the second coil. This primary is also provided with a tap and if an extremely long aerial is used, the aerial connection should be run to this tap rather than to the end of the coil. Reflex sets are not generally as selective as sets of the tuned radio frequency type, so that a great deal of selectivity cannot be had with this receiver. Local stations 100 meters or more apart can be received and outside stations 20 meters or more apart can be separated without interference.

The set will work with No. 199 tubes, so that a storage battery can be eliminated. This keeps the original cost and operating cost of one of these receivers very low, the 201-A type tubes are to be recommended, however.

LIST OF PARTS FOR SET SHOWN IN FIG. 30

	1 7"x18" panel	RC-1-2	2 reflex coils
	1 6½"x17" baseboard	AT-1-2	2 3½ to 1 or 5 to 1 audio frequency transformers
	1 7"x18" cabinet		
	2 4" dials	R-1-2	2 30 ohm rheostats
	2 tube sockets	J-1	1 single circuit jack
	1 terminal strip and bracket	DET	1 adjustable crystal detector mounting
	1 crystal	C-1	1 .002 MF fixed condenser
T-1-2	2 .00035 MF variable condensers 17 plate	Misc. Parts	hook-up wire, screws, lugs, spaghetti, etc.

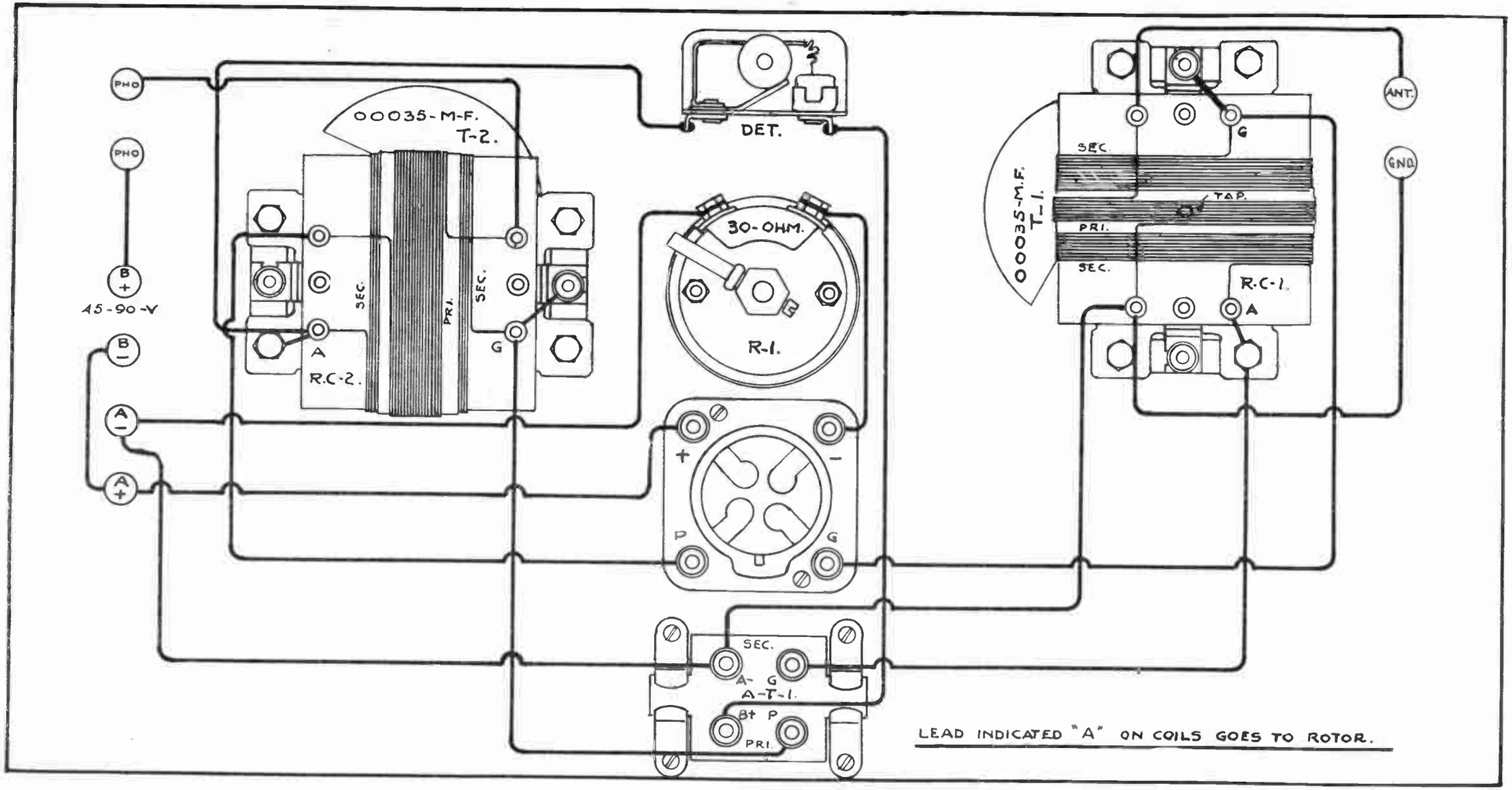


Fig. No. 31—Hook-up of One Bulb Reflex Set

One Bulb Reflex Set

THIS set is similar to the two bulb reflex set shown on the previous two pages. It makes an extremely good receiver for anyone who does not wish to spend a great deal of money for parts, but who wishes a receiver which will not re-radiate, squeal or howl, and which will give him loud signals from broadcasting stations close by.

If this set is constructed properly, loud speaker reception can be had on strong local stations and distant stations can be heard when using head phones.

Volume of the set depends upon having a good tube and a good crystal detector. It is better to buy several crystal detectors and then pick out the best one.

The set will work with a No. 199 tube, although a trifle better volume can be had when used with a No. 201-A type bulb. With either type of bulb use 90 volts of "B" battery.

If the set is not selective, due to the fact that it is used on a long aerial, try connecting the wire from the antennae post to the middle tap on the primary of the reflex coil, RC-1, rather than to the end of this primary.

As shown in the drawing, the wire from one end of the secondary of both coils marked "A" should go to the movable plates of the variable condenser. The drawing shows this fastened to the frame of the condenser which would also be connected to the movable plates on most low loss type condensers. Regardless of what type condenser is used, be sure to fasten this terminal to the movable plates of the variable condenser and the other end of the secondary to the stationary plates.

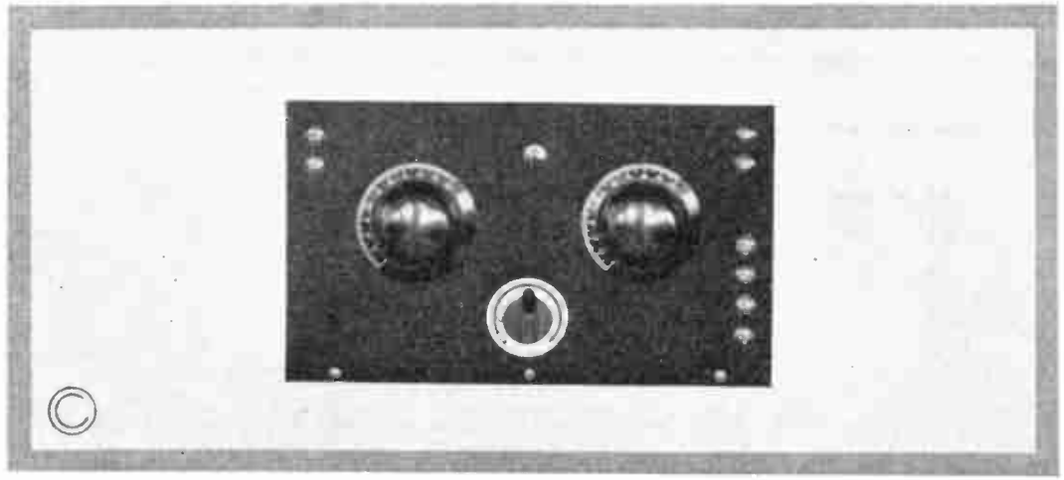


Plate No. 18—Front View of One Bulb Reflex Set

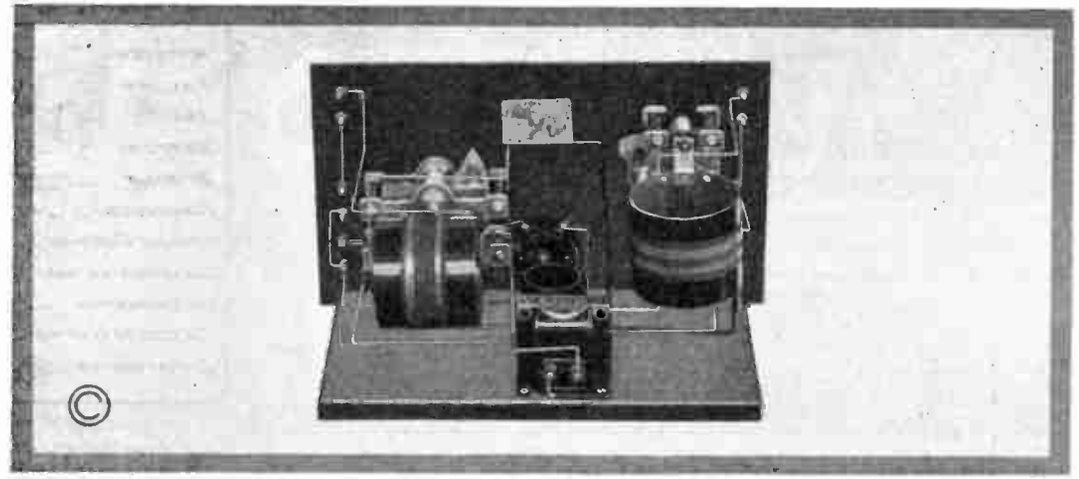


Plate No. 20—Rear View of One Bulb Reflex Set

The drawing shows the coil connections made on the back of the coils. These terminals are generally on the side of the coil close to the condenser and are shown this way in the drawing to make clear how the coil connection should be fastened.

If screw terminals are provided on the coils rather than lugs to which wires must be soldered, this set can be wired up complete, without a soldered joint, thus doing away with the necessity of having a soldering iron.

This set can also be used with the two-stage, audio frequency amplifying unit described on page. 13.

LIST OF PARTS NEEDED FOR SET SHOWN IN FIG. 31

1 7"x12"x$\frac{3}{16}$" panel	AT-1-2	2 .00035 MF variable condenser 17 plate
1 6"x11" baseboard	RC-1-2	2 reflex coils
1 7"x12" cabinet	AT-1	1 3½ to 1 or 4½ to 1 audio frequency transformer
2 3" dials		
1 tube socket to fit tube	R-1	1 30 ohm rheostat
8 marked binding posts (These should be marked as follows:) Ant., Gnd., 2 phones, "B" battery+, "B" battery—, "A" +, and "A"—.	DET	1 crystal detector with crystal

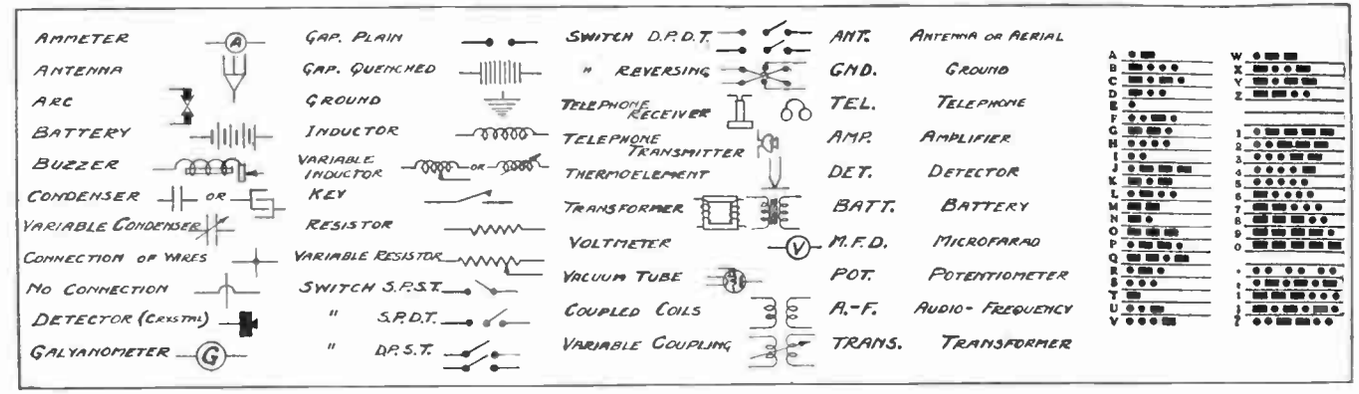
Form 772 a.

DEPARTMENT OF COMMERCE
BUREAU OF NAVIGATION
RADIO SERVICE

INTERNATIONAL RADIOTELEGRAPHIC CONVENTION
LIST OF ABBREVIATIONS TO BE USED IN RADIO COMMUNICATION

ABBREVIATION	QUESTION	ANSWER OR NOTICE
PRB	Do you wish to communicate by means of the International Signal Code?	I wish to communicate by means of the International Signal Code.
QRA	What ship or coast station is that?	This is.....
QRB	What is your distance?	My distance is.....
QRC	What is your true bearing?	My true bearing is.....degrees.
QRD	Where are you bound for?	I am bound for.....
QRF	Where are you bound from?	I am bound from.....
QRG	What line do you belong to?	I belong to the.....Line.
QRH	What is your wave length in meters?	My wave length is.....meters.
QRJ	How many words have you to send?	I have.....words to send.
QRK	How do you receive me?	I am receiving well.
QRL	Are you receiving badly? Shall I send 20? . . . — . for adjustment?	I am receiving badly. Please send 20. . . . — . for adjustment.
QRM	Are you being interfered with?	I am being interfered with.
QRN	Are the atmospherics strong?	Atmospherics are very strong.
QRO	Shall I increase power?	Increase power.
QRP	Shall I decrease power?	Decrease power.
QRQ	Shall I send faster?	Send faster.
QRS	Shall I send slower?	Send slower.
QRT	Shall I stop sending?	Stop sending.
QRU	Have you anything for me?	I have nothing for you.
QRV	Are you ready?	I am ready. All right now.
QRW	Are you busy?	I am busy (or: I am busy with.....). Please do not interfere.
QRX	Shall I stand by?	Stand by. I will call you when required.
QRY	What will be my turn?	Your turn will be No.....
QRZ	Are my signals weak?	Your signals are weak.
QSA	Are my signals strong?	Your signals are strong.
QSB	Is my tone bad?	The tone is bad.
	Is my spark bad?	The spark is bad.
QSC	Is my spacing bad?	Your spacing is bad.
QSD	What is your time?	My time is .....
QSF	Is transmission to be in alternate order or in series?	Transmission will be in alternate order.
QSG	.....	Transmission will be in series of 5 messages.
QSH	.....	Transmission will be in series of 10 messages.
QSJ	What rate shall I collect for ..... ?	Collect.....
QSK	Is the last radiogram canceled	The last radiogram is canceled.
QSL	Did you get my receipt?	Please acknowledge.
QSM	What is your true course?	My true course is.....degrees.
QSN	Are you in communication with land?	I am not in communication with land.
QSO	Are you in communication with any ship or station (or: with.....)?	I am in communication with..... (through.....).
QSP	Shall I inform.....that you are calling him?	Inform.....that I am calling him.
QSQ	Is.....calling me?	You are being called by.....
QSR	Will you forward the radiogram?	I will forward the radiogram.
QST	Have you received the general call?	General call to all stations.
QSU	Please call me when you have finished (or: at.....o'clock)?	Will call when I have finished.
QSV	Is public correspondence being handled?	Public correspondence is being handled. Please do not interfere.
QSW	Shall I increase my spark frequency?	Increase your spark frequency.
QSX	Shall I decrease my spark frequency?	Decrease your spark frequency.
QSY	Shall I send on a wave length of..... meters?	Let us change to the wave length of..... meters.
QSZ	.....	Send each word twice. I have difficulty in receiving you.
QTA	.....	Repeat the last radiogram.
QTE	What is my true bearing?	Your true bearing is ..... degrees from .....
QTF	What is my position?	Your position is.... latitude .... longitude.

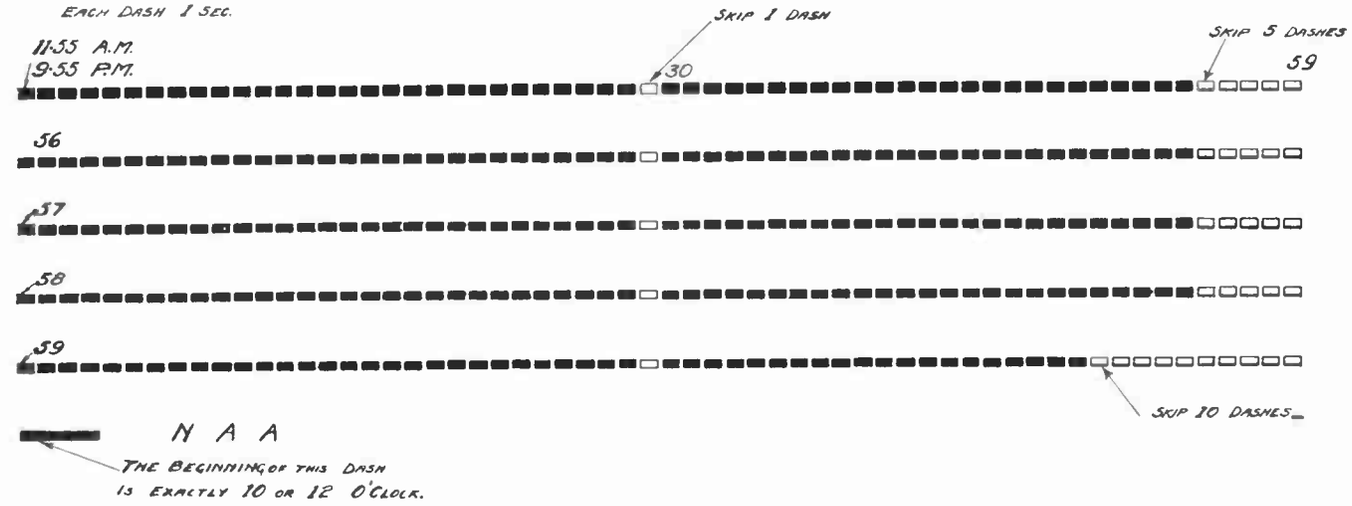
RADIO SYMBOLS



ABBREVIATIONS

ANT.	ANTENNA OR AERIAL
GND.	GROUND
TEL.	TELEPHONE
AMP.	AMPLIFIER
DET.	DETECTOR
BATT.	BATTERY
M.F.D.	MICROFARAD
POT.	POTENTIOMETER
A.-F.	AUDIO-FREQUENCY
TRANS.	TRANSFORMER

CODE



SINCE many of the Broadcasting Stations are relaying the Arlington time-signals on other wave lengths, it is of interest to a number of amateur radio fans to understand what the time-signals mean.

The diagram given above should enable you to follow these time-signals, and set your watch or clock in synchronism with the signals, and enable you to adjust it within a second of the right time. These time-signals start at 11:55 A. M. and 9:55 P. M. every day, Eastern Standard time. The final signals are at exactly 12:00 noon, and 10:00 P. M. Every tick of the Naval Observatory clock is transmitted as a dot, omitting the 29th second of each minute, and the last 5 seconds of the first 4 minutes, and the last 10 seconds of the last minute. The beginning of the last long dash is exactly 12:00 noon, and 10:00 P. M.

NOTES–

A – DRILL ON THESE CENTERS FOR PILOT RHEOSTATS.

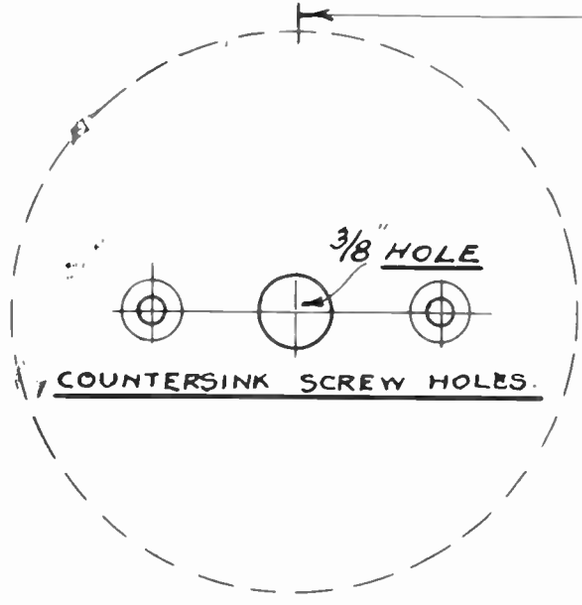
B – DRILL ON THESE CENTERS FOR PACENT RHEOSTATS.
COUNTERSINK SCREW HOLES FOR PACENT DIALS.
USE #18 DRILL FOR ALL HOLES WHERE SIZE NOT SHOWN.
BROKEN CIRCLES INDICATE DIAL OUTLINES.

ANT.

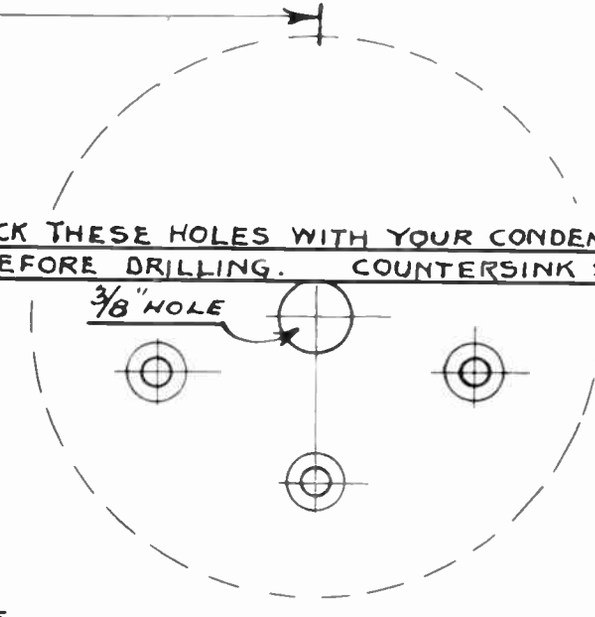
GND.

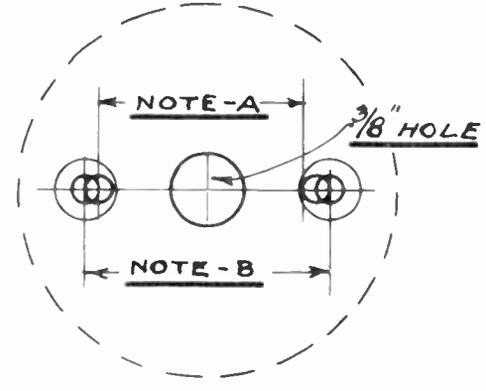
PHONES.

WHITE MARKS OR POINTERS



CHECK THESE HOLES WITH YOUR CONDENSER TEMPLATE BEFORE DRILLING. COUNTERSINK SCREW HOLES.





B +

B –

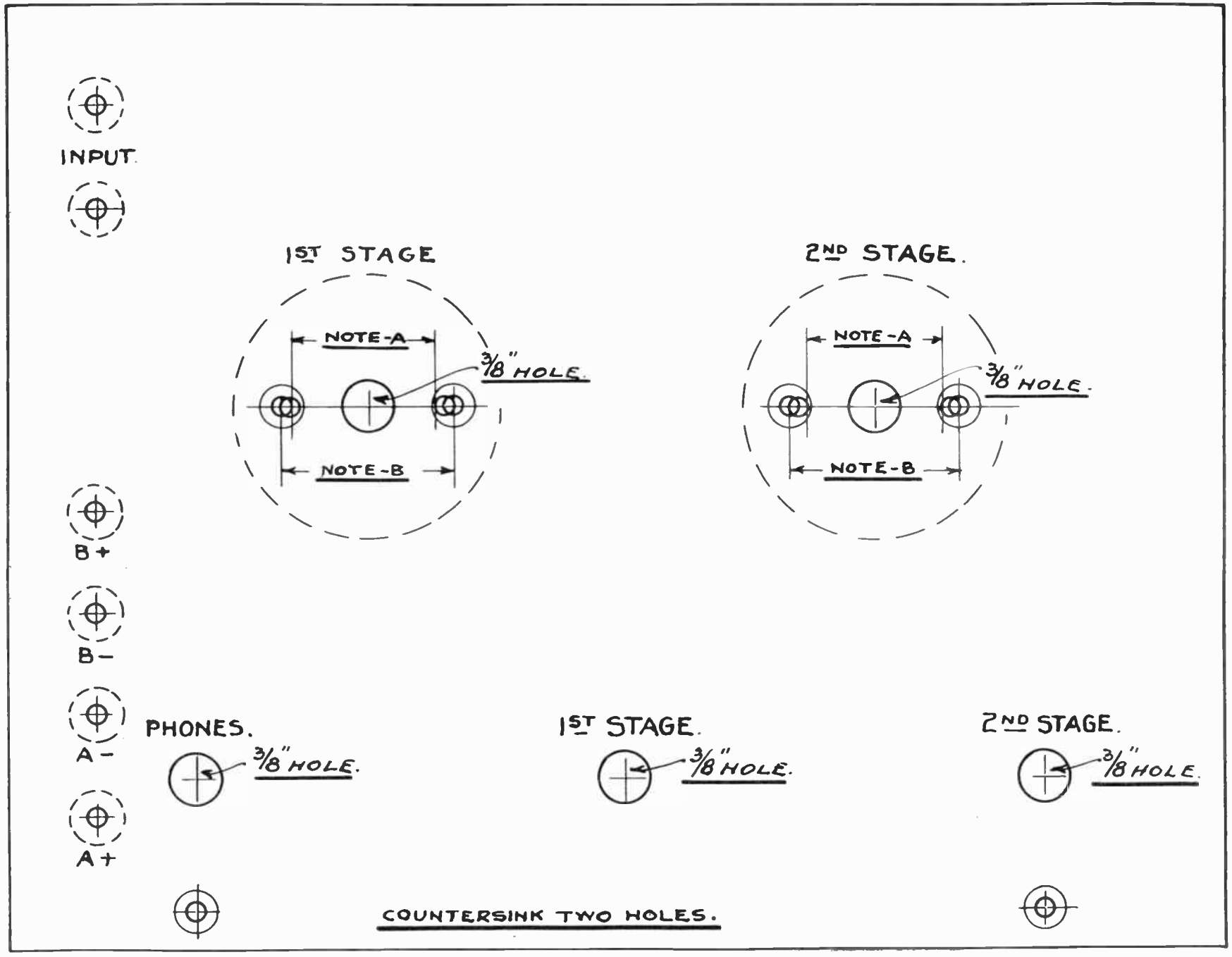
A –

A +

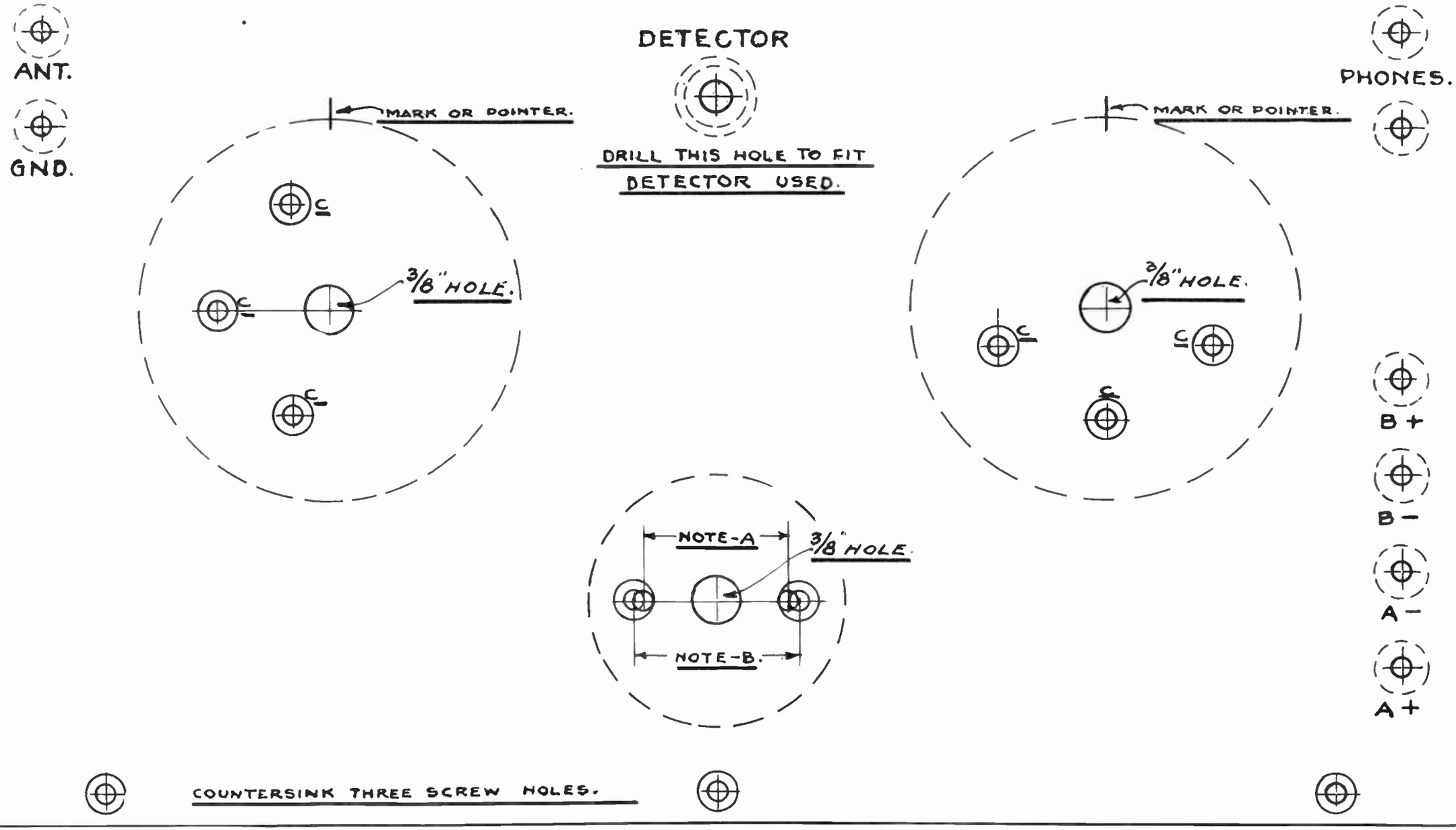
Template No. 1—
One Bulb Low Loss Set

COUNTERSINK THESE THREE HOLES.

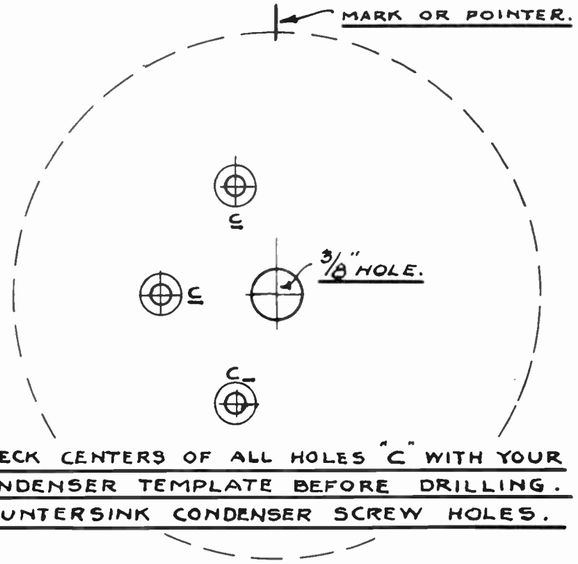
Template No. 2—
Two-Stage
Audio-Frequency
Amplifying Unit



Template No. 3—One Bulb Reflex Set



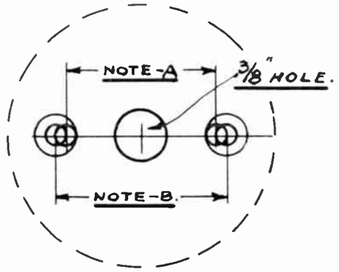
Template No. 4—Two Bulb Reflex Set

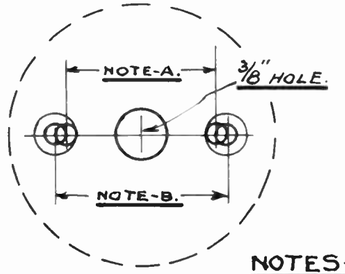


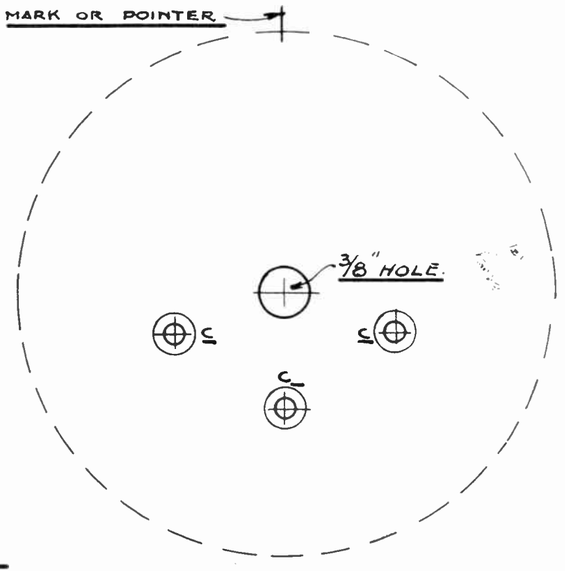
CHECK CENTERS OF ALL HOLES "C" WITH YOUR CONDENSER TEMPLATE BEFORE DRILLING. COUNTERSINK CONDENSER SCREW HOLES.

DETECTOR.

DRILL THIS HOLE TO FIT DETECTOR USED.



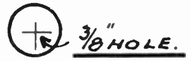




NOTES-

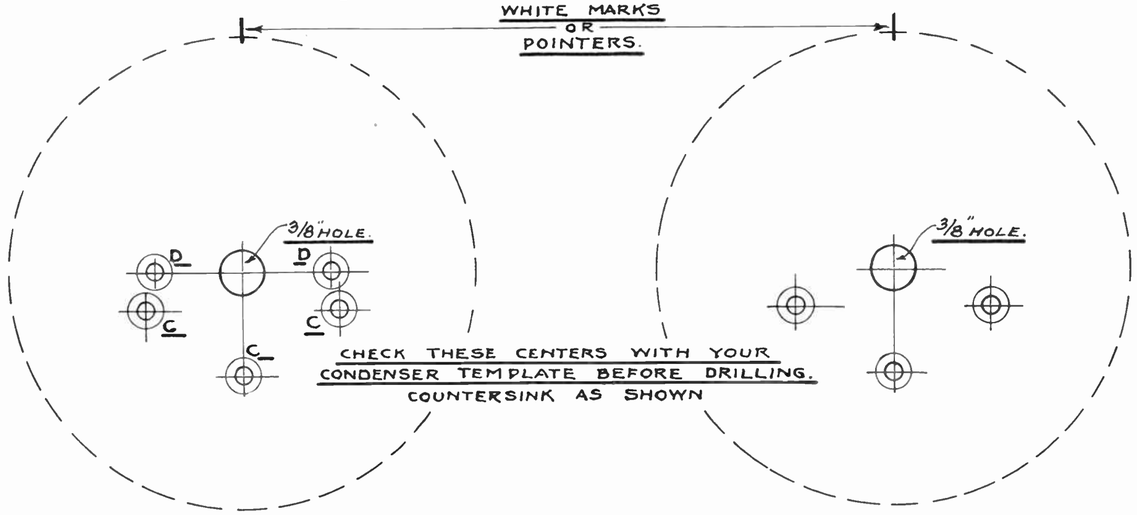
A - DRILL ON THESE CENTERS FOR PILOT RHEOSTATS.

B - DRILL ON THESE CENTERS FOR PACENT RHEOSTATS.
COUNTERSINK HOLES FOR PACENT DIALS.
USE # 18 DRILL FOR ALL HOLES WHERE SIZE NOT NOTED.
BROKEN CIRCLES DENOTE DIAL OUTLINES.



COUNTERSINK THREE SCREW HOLES.

Template No. 5—Three Circuit Low Loss Receivers and Duston Special



NOTES-

A - DRILL ON THESE CENTERS FOR PILOT RHEOSTATS.

B - DRILL ON THESE CENTERS FOR PACENT RHEOSTATS.

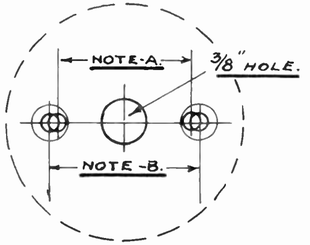
COUNTERSINK SCREW HOLES FOR PACENT DIALS.

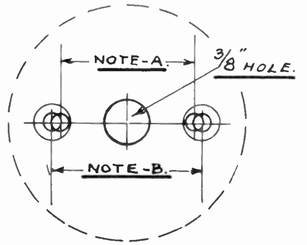
DRILL CONDENSER SCREW HOLES **C** FOR DUSTON SPECIAL ONLY.

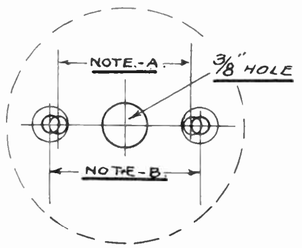
DRILL COIL MOUNTING SCREW HOLES **D** FOR THREE CIRCUIT SET ONLY.

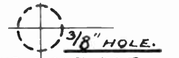
USE # 18 DRILL FOR ALL HOLES WHERE SIZE IS NOT NOTED.

BROKEN CIRCLES INDICATE DIAL OUTLINES.

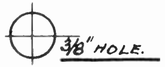


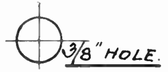


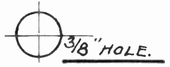


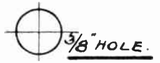


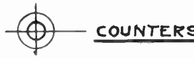
DRILL THIS HOLE FOR
DUSTON SPECIAL ONLY.











Radio Construction

For the Amateur