Radio Questions Answered

By

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Radio Questions Answered

WHAT IS RADIO?

QUESTION No. 1. WHAT DOES THE TERM RADIO MEAN?

Answer. The term radio is used to designate the transmission and reception of voice, sounds or signals between two points at a distance from each other, yet with no connection between them other than the earth below and the ether around them.

QUESTION No. 2. IS THERE ANY DIFFERENCE BETWEEN RADIO AND WIRELESS?

Answer. There is no difference between them.

QUESTION No. 3. HOW DOES SPEECH TRAVEL THROUGH SPACE?

Answer. This is a very popular misconception. Speech does not travel through space in radio work. At the transmitting station, a current is generated, and on this, another current, which varies in accordance to the voice vibrations, is impressed. The resulting current goes to the antenna or aerial and there sets up waves in the ether.

The accepted theory at the present day, of the propagation of wireless waves, is that they are transmitted through the ether. One of the leading scientists has attmpted to change this theory, but as yet no authentic information has been issued which would indicate that the waves were transmitted through any other medium.

The term ether is used to designate an intangible substance which is supposed to permeate all objects on this earth. It is supposed to be present in wood, iron, stone, the air and even in the human body. It has no relation whatsoever to the anesthetic of the same name. It is through this medium and not through the atmosphere that radio waves are transmitted. This fact can be very easily proven in the laboratory by showing that radio waves sent out by a miniature station placed within a vacuum can be received by a receiving set outside of the enclosed vacuum.

The waves sent out by the transmitting station affect the receiving aerial and set up a like current therein. This current is then detected or rectified so as to render it audible in the receivers. In this way, it will be seen that the speech does not travel but merely affect certain instruments which perform the work desired.

QUESTION No. 4 IS A LICENSE NECESSARY IN THE U. S. TO RECEIVE RADIO MESSAGES?

Answer. No, only to transmit.

QUESTION No. 5. WHAT IS MEANT BY TUNING?

Answer. To illustrate this, an analogy is quite necessary. If two tuning forks with the same pitch are placed near each other, and one is sounded, the other will also vibrate, even though it has not been touched. This is because the first one sets up air waves which vibrate the second. If the untouched fork is not of the same pitch as the one which is sounded, it will not respond.

In the same way in radio, we find that vibrations of a certain frequency are sent out in the ether by the transmitter. The number per second, or frequency of these vibrations or waves are constant for a given wave length. If the antenna circuit of the receiver is not "tuned" to respond to the particular frequency being sent out, no sound will be heard. However, by adding more or less turns of wire to the circuit, it can be made to respond. The same effect can be obtained with a combination of coils and condensers.

QUESTION No. 6.—WHAT IS WAVE-LENGTH?

Answer. From the answer to the preceding question, we understand that vibrations are sent out by the transmitter. These might be similar to the waves in the ocean. There is, however, always a certain distance between their peaks. This distance is measured in meters and the wave-length is so expressed. There is a movement on foot to do away with this method of distinction and rate the wave of the transmitter in the number of vibrations or cycles per second. However, nothing definite has as yet been decided along these lines.

QUESTION No. 7. WHAT IS A METER?

Answer. A meter is a definite measurement of length slightly longer than a yard; to be exact, it is 39.37 inches.

QUESTION No. 8. WHAT IS STATIC?

Answer. At all times, there is a certain amount of electricity present in the air. This is known as static electricity. During hot weather it is usually most noticeable, due to the presence of lightning storms. This electricity affects a radio receiving set in much the same way as signals. Its presence is made noticeable by crashing sounds and other noises in the phones.

QUESTION No. 9. CAN STATIC BE ELIMINATED?

Answer. There is no way of eliminating static, but it may be reduced by the use of a loop aerial and radio-frequency amplification as explained later in this book.

QUESTION No. 10 WHAT IS MEANT BY FADING AND WHAT CAUSES IT?

Answer. When signals or music come in quite loud and then get weaker, only to return to the original intensity, the action is known as fading, or swinging of signals.

The exact cause of this phenonmenon is not known. It is assumed, however, that it is caused by variable weather conditions at points between the transmitter and receiver.

HOW DOES THE RADIO APPARATUS WORK?

QUESTION No. 11. WHAT IS A PANEL?

Answer. When a radio set is to be constructed the builder usually prefers to have the various instruments mounted in the most convenient form. He first selects a base board, and then at right-angles to this, mounts a piece of good electrical insulating material, usually bakelite, which is a material similar in appearance to hard rubber. In this panel the various holes for mounting the instruments are drilled. Wood may be used for this purpose, but is not as satisfactory as bakelite.

QUESTION No. 12. WHAT IS A TAP?

Answer. When a coil of wire is wound and it is desired to use various sections of the coil, provision is made so that wires can be attached to certain parts of the coil in order that one or more sections may be used as desired. This process of tapping is shown in the illustration.

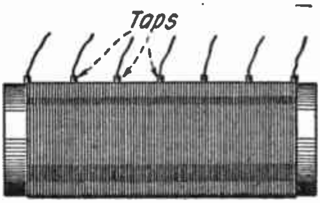


Fig. Q. No. 12

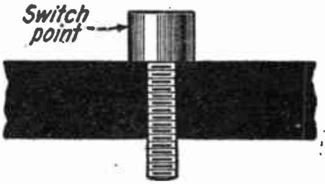


Fig. Q. No. 13

QUESTION No. 13. WHAT IS A SWITCH POINT?

Answer. A switch point is somewhat similar to an ordinary machine screw, but has no slot in the head, and the heads are

Fig. Q. No. 14

Fig. Q. No. 15

usually cylindrical in shape. They are used for connecting taps such as mentioned in the preceding question, so as to make the easiest possible method of varying the number of turns.

QUESTION No. 14. WHAT IS A SWITCH ARM?

Answer. A standard form of switch arm is illustrated herewith. The switch points mentioned above are placed in a circle or semicircle and the arm illustrated mounted in the center so that the end of it will make contact with one or another of the switch points as desired.

QUESTION No. 15. What is a tuning coil, and how is it used?

Answer. The usual type of tuning coil consists of many turns of insulated copper wire, wound in an even layer on an insulating

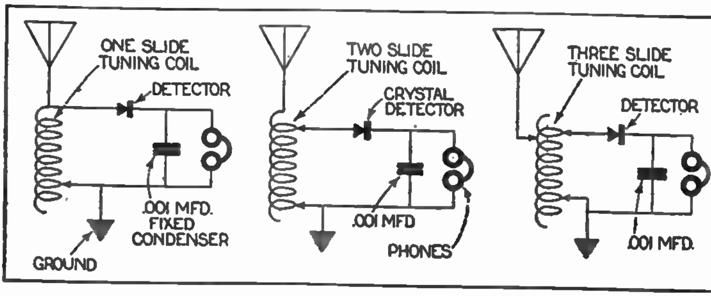


Fig. Q. No. 15

core or tube. A connection is made at one end of the wire, and another to a slider which is so arranged as to slide over a path on the coil from which path the insulation has been removed, in order that the slider may make metallic contact with any particular turn

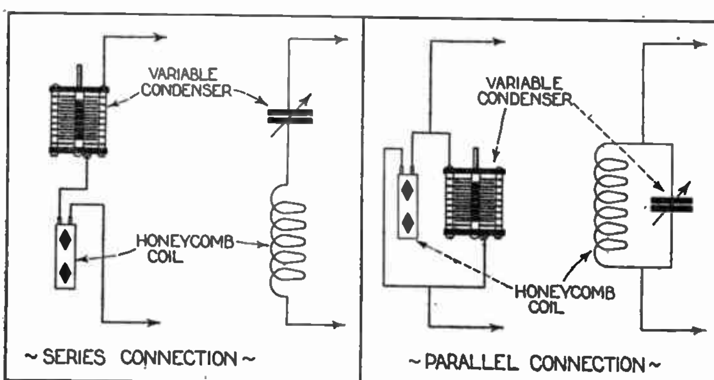


Fig. Q. No. 16

desired. The best type of slider touches only one wire at a time and does not injure it by scraping it. Sometimes two or three sliders are used in order to obtain greater selectivity in tuning.

The methods of connecting these different tuning coils to a crystal detector are shown in the illustrations.

QUESTION No. 16. WHAT IS AN INDUCTANCE COIL?

Answer. The answer to the tuning coil query above will apply here also as a tuning coil is also an inductance coil. **Honeycomb coils** and other coils with many layers of wire wound on them would also come under this head.

All such coils are said to have a certain amount of inductance which is dependent on the size of wire and the number of turns, as well as the insulation between the turns. The greater the inductance of a tuning coil, the higher the wave-length to which it will tune.

An inductance coil in which the number of turns of wire are not variable, is usually tuned by connecting a variable condenser either in series with it, or in parallel. These connections are shown in the sketch. When a variable condenser is placed in series with a coil, the natural wave-length of the coil is lowered. When they are connected in parallel, the resulting wave-length is higher than the natural wave-length to which the coil will respond without the use of any condenser.

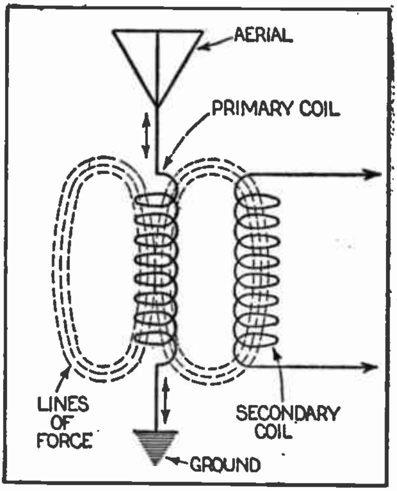


Fig. Q. No. 18

QUESTION No. 17. WHAT IS A CONDENSER?

Answer. A **condenser** consists of two or more metallic plates, separated from each other by an insulating material, which in some cases is air. The metallic plates may have a fixed relation between them, in which case they are termed **fixed condensers**, or they may be so arranged that their relation to each other may be changed at will. The latter type is known as a **variable condenser.**

These instruments are usually used in conjunction with inductance coils as mentioned above, or in other parts of radio circuits where their use is found advantageous. The unit of measurements of the capacity or value of a condenser is the farad.

The capacity of the condensers used in radio work is usually expressed in **microfarads**, or millionth of a farad.

The theory of the action of the condenser will not be dealt with here, as it is very complicated and a knowledge of it is not necessary for the successful operation of a radio set.

QUESTION No. 18. WHAT IS MEANT BY THE TERM COUPLING?

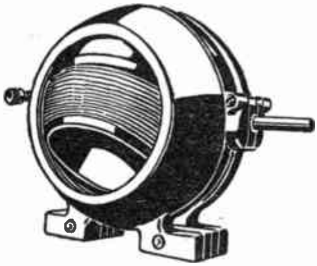


Fig. Q. No. 19

Answer. When an alternating current is flowing through an inductance coil, there is a magnetic field set up around that coil. Any other conductor which happens to be within this field will then have a like current induced into it. This is one of the fundamental laws of electricity. Now in radio work, if we have two coils placed one within the other and an alternating current flowing through one, we will find that a current will be flowing through the other, even though there is no electrical connection between the two. This is known as **inductive coupling.** If, however, two circuits are joined together by an electrical connection they are

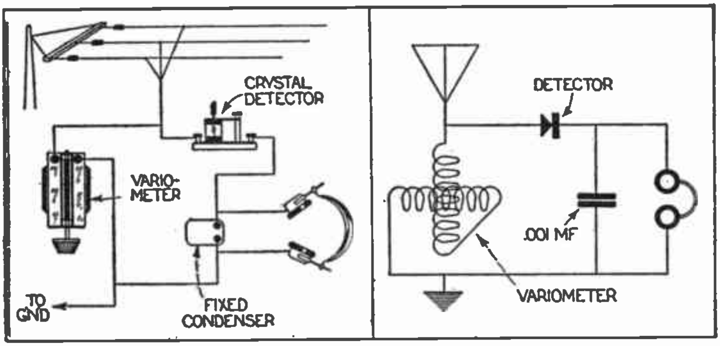


Fig. Q. No. 19

said to be **conductively coupled.** This is the case in the single circuit tuner as described in the latter part of this book.

QUESTION No. 19. WHAT IS A VARIOMETER AND HOW IT IS USED?

Answer. A variometer consists of two coils of wire wound on insulating tubes, and arranged one within the other. The center coil is arranged so that it can be rotated within the other. Their windings are connected in series with one another. When the coils are parallel with each other and the windings running in the same direction, the entire instrument has its greatest inductive value, and will tune to the highest possible wave-length with the particular size of coils used. Now, however, when the coils are rotated through 180 degrees and the windings are running in opposite directions they are said to be "bucking" each other and their inductive value is at its lowest point. Therefore, the wave-length is at its lowest point.

A circuit diagram is given with this answer which shows a variometer connected with a crystal detector. This is probably one of the simplest forms of radio receiving sets, but will not give very sharp tuning.

QUESTION No. 20. WHAT IS A VARIO-COUPLER, HOW DOES IT DIFFER FROM A VARIOMETER, AND HOW IS IT USED?

Answer. A vario-coupler may have practically the same external appearance as a variometer, but the two coils are not electrically connected together. The outside or stationary coil is usually

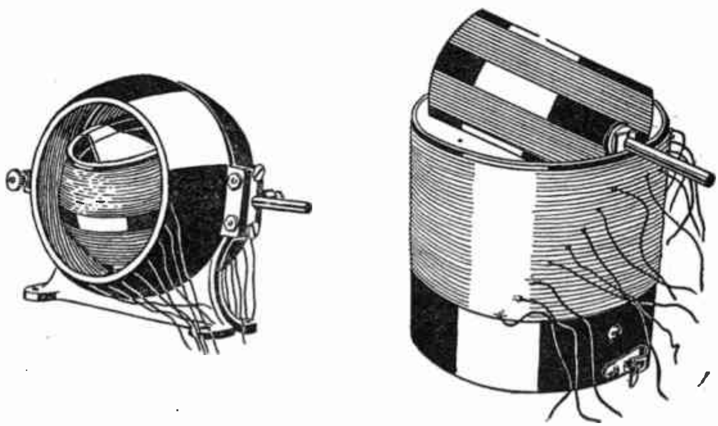


Fig. Q. No. 20

tapped so that various numbers of turns of wire may be used as desired. These taps are usually brought out to switch points so that correct adjustment may be obtained. The inside or rotor coil is not tapped in any way, but a current is induced into it by the stator or outside coil, when current is flowing through the latter.

A circuit showing a vario-coupler connected with a crystal detector is shown in the accompanying diagram. The greatest difference between a variometer and a vario-coupler is that in the latter there is no elecrical connection between the two coils. A variometer and vario-coupler may be used interchangeably in practically all cases, but the vario-coupler will give much greater selectivity in tuning; that is, it will allow the operator to eliminate one station and listen to another when both are transmitting on practically the

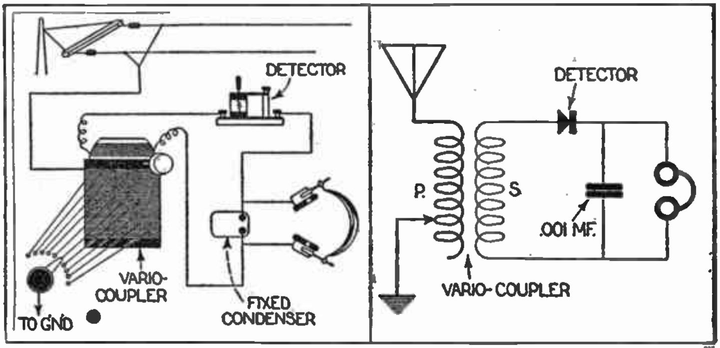


Fig. Q. No. 20

same wave-lengths. After years of experiment these two instruments have been assigned to their various uses in radio, several examples of which will be found in the diagrams throughout this book.

QUESTION No. 21. Shall I use a loose coupler or a vario-coupler for receiving?

Answer. In theory, there is no difference between the use of a loose coupler and a vario-coupler, but in actual practice a vario-coupler is usually found to be the handiest form. This is for the simple reason that it can be readily mounted on a panel and the controls so arranged that they are accessible and instantly adjusted. A loose coupler will always give excellent results, in fact, exactly the same results as a vario-coupler, but it is not practical for panel mounting, an obvious disadvantage in the type of sets most generally in use today.

QUESTION No. 22. What is a vernier?

Answer. A vernier is any device which allows very close or accurate adjustment of any particular instrument. This is its meaning as applied in radio work. Verniers are usually used on variable condensers only, but in some cases they are used on rheostats as will be described later.

As will be seen there are illustrated three separate and distinct types of verniers for use on condensers. One type is designed to be placed on the outside of a panel and has a rubber ring which engages frictionally with the condenser dial. By turning the small knob to which the rubber ring is attached, very critical adjustment can be obtained as there is a greater reduction in the radio of speed between the rubber ring and the edge of the dial than could be accomplished by turning the dial alone.

Fig. Q. No. 22

Sometimes it is desirable to use a second variable condenser placed in parallel with the main condenser, the former usually having a very small capacity. This small condenser is then known as the vernier. One of these types is illustrated and usually consists of two or three plates. Since the total capacity of this vernier condenser is so very small, even a great degree of rotation of the single movable plate will give only a very slight variation in capacity.

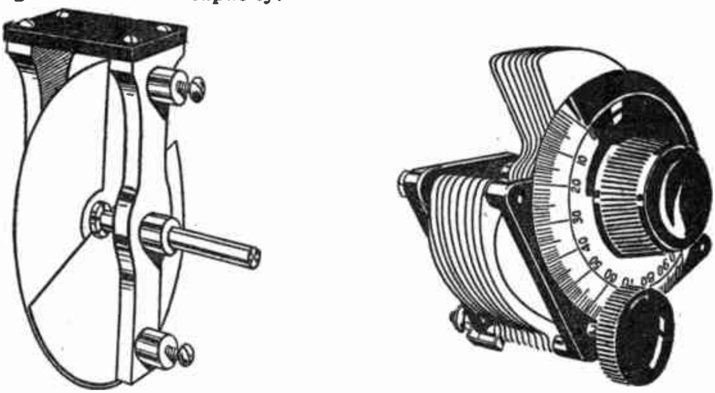
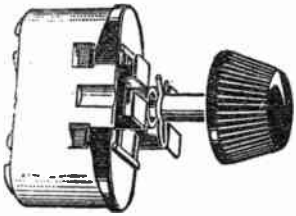


Fig. Q. No. 22

The third type shown makes use of a separate plate which is built as part of the condenser itself. The single rotary plate is turned by means of a knob on the side of the dial which passes through to the outside of the panel where it can be easliy operated. In another type shown the vernier or single plate is operated by means of a small knob in the center of the larger one which rotates the plates of the main condenser.

One of these attachments is quite necessary in radio reception in order to be able to tune in a certain station sharply without having any interference from other sections which happen to be transmitting at the same time.



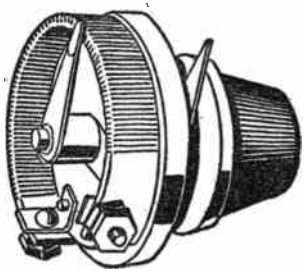
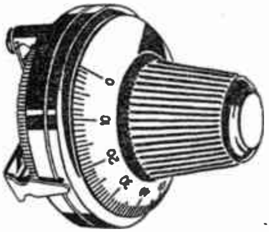


Fig. Q. No. 23

QUESTION No. 23. WHAT IS A RHEOSTAT, AND A POTENTIOMETER?

Answer. Due to the way in which vacuum tubes are constructed, it is necessary that only a certain voltage be supplied to the filament. In order to regulate the voltage delivered by the batteries, it is necessary to have some sort of a resistance in the circuit. By resistance is meant some hindrance to the electric potential, or voltage which does not allow it to force through as many amperes as it is capable of doing. In effect, it is the same as using a small pipe to transmit water rather than a large



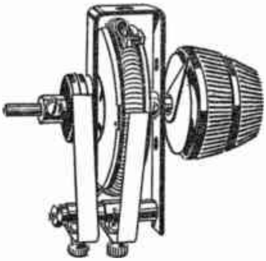
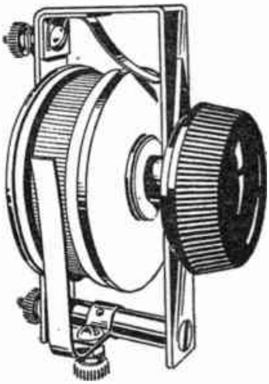


Fig. Q. No. 23

pipe. The larger pipe will allow more water to flow through it than a smaller pipe at the same pressure. The smaller pipe may be thought of as having the most resistance.

The resistance required in the filament circuit is supplied by the instrument known as the rheostat. Three types are shown in the illustrations. One type makes use of carbon discs which are compressed or released in order to vary the electrical resistance and another consists of many convolutions of wire wound on a fibre or composition strip which is then bent in the form of a circle. A switch arm is so arranged as to make contact with successive turns which process varies the amount of wire placed in the circuit.

With detector tubes it is practically essential to have minute regulation of the filament voltage. Such regulation is afforded by a vernier rheostat such as illustrated. In this case an arm is revolved around the base of the rheostat which makes contact with a single turn of wire set in a groove around the edge of the base. Very close regulation of the amount of resistance in the circuit can be obtained with this type of rheostat. Also when the carbon pile rheostat as forementioned is used, very close adjustment is possible as the resistance does not vary greatly when the pressure is increased slightly. Thus, the effect makes the rheostat a vernier.



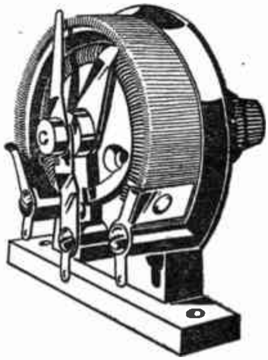


Fig. Q. No. 23

A potentiometer has somewhat the general appearance of a rheostat, but is supplied with a connection to each end of the wire wound thereon as well as one to the switch arm. The resistance of potentiometers in use today is usually between 200 and 400 ohms, the ohm being the unit of electrical resistance. (To be exact the ohm is the amount of electrical resistance through which one volt will force one ampere of current).

A potentiometer is usually used in various circuits in order to supply a certain voltage to different instruments. It is particularly useful in radio frequency circuits as shown in the diagrams in this book.

QUESTION No. 24. WHAT IS A GRID LEAK?

Answer. A grid leak is a very high resistance, usually having a value of from 500,000 to 3,000,000 ohms which terms are expressed as one-half megohm to three megohms. It is connected either across the grid condenser or from the grid to the filament of a vacuum tube.

WHY IS AN AERIAL AND GROUND USED?

QUESTION No. 25. WHAT IS AN AERIAL?

Answer. An **aerial** is any form of conductor which is used to pick up radio waves. It may consist of a single wire as shown in the illustration. This is a splendid receiving aerial especially when a crystal set or only a single tube is being used. Another type which is very good when an inside aerial is required is that consisting of a wire running around the moulding of a room. It is preferable to use insulated wire for this purpose, although it is not absolutely necessary.

When one or two stages of radio frequency amplification, such as will be explained later, are used, a loop **antenna** on the order shown may be employed. Either the spiral or solenoid type will give good results and in size need not be larger than two feet square. Even smaller sizes will give good results.

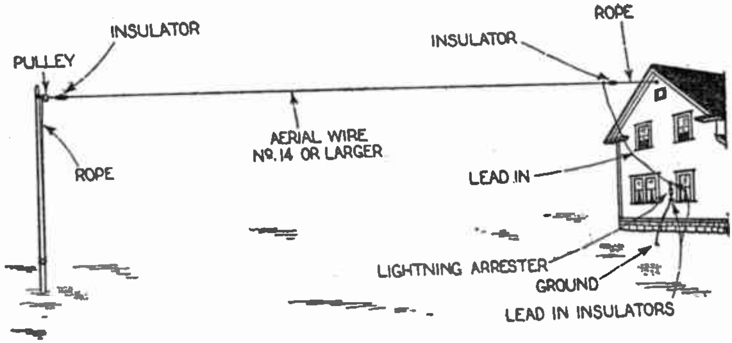


Fig. Q. No. 25

When using an outdoor antenna, it should always be very well insulated from all surrounding objects and should have insulators at each end. It should not pass through the branches of trees and should never be brought close to telephone, electric light or high tension lines. The wire used should preferably consist of stranded phosphor bronze, although solid copper wire will give good results. The size should be no smaller than No. 14 gauge and where the aerial is subject to severe weather conditions, No. 12 gauge should preferably be used.

QUESTION No. 26. WHY IS A GROUND USED?

Answer. Every electrical circuit, in order to operate efficiently, must make a complete circuit, that is, it must have one way of getting to a place and one way of returning. In radio, the ether is used for one path and the energy returns through the ground. Therefore, it is quite essential that a good ground connection be made in order to oppose as little resistance as possible to the flow of the current.

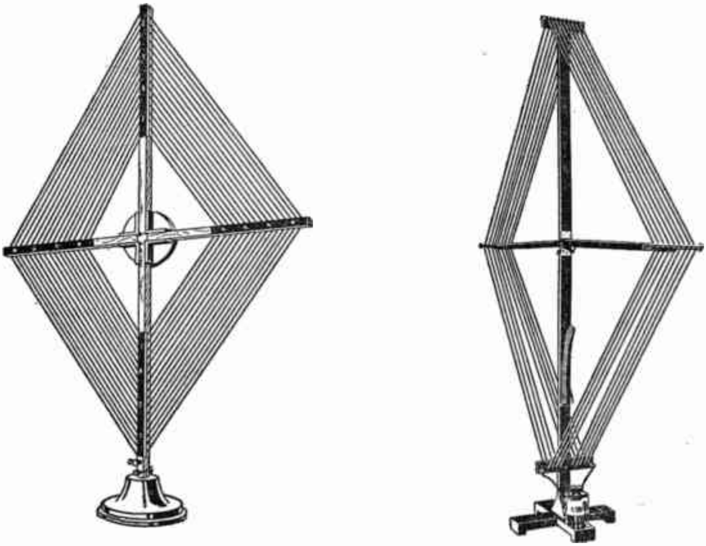


Fig. Q. No. 25

A ground connection fastened to a water, steam radiator or drain pipe with a ground clamp will give good results. If it is impossible to make a connection to any of these pipes, a length of iron pipe about 1 inch in diameter by 7 feet long driven in the ground, or metallic bodies such as illustrated will serve as excellent grounds. In any case they should, if possible, be placed in a moist part of the earth.

QUESTION No. 27. HOW SHOULD A LIGHTNING SWITCH BE INSTALLED?

Answer. The diagram shows the method of mounting a lightning switch. It should be placed on the outside of the house and the lead brought in through an insulator to the set. A separate outside ground should preferably be used for a lightning protection, although the Board of Fire Underwriters now permit the use of an inside lightning ground. If desired the same ground may be used both as a lightning ground and also for the ground used in connection with the set.

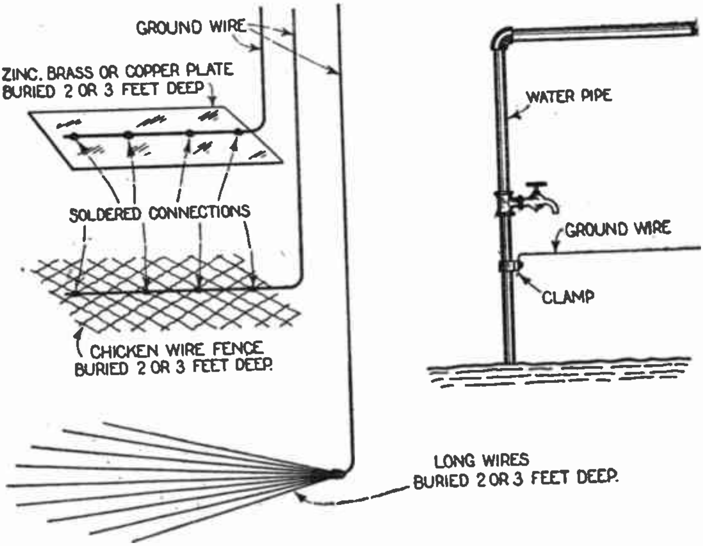


Fig. Q. No. 26

QUESTION No. 28. How should a lightning arrester be connected?

Answer. The connections for lightning arrester are given in the accompanying diagram. Only such a type of arrester as is approved by the Board of Fire Underwriters should be used. A lightning arrester usually consists of two pointed rods enclosed in a glass bulb from which all the air has been exhausted. It may take on other forms, however, and may consist of two plates placed edge to edge and about 1/16th of an inch apart. Various types are made by different manufacturers. However, the purpose of all of them is the same. They are designed to form a pathway for any abnormal charges of electricity which may accumulate on the aerial during a thunder storm and allow these charges to pass to the ground without injuring the receiving instruments or entering the house where they might cause damage.

QUESTION No. 29. Are both a lightning switch and an arrester necessary?

Answer. Both are not required, but it is a very good idea to use both. In such a case you have double protection from lightning and even if you do forget to close the switch when through using the set, the protective gap or arrester will provide sufficient protection. They should be connected up as shown in the diagram.

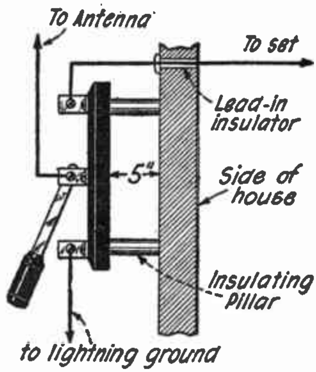


Fig. Q. No. 27

QUESTION No. 30. Is there any advantage in having two, three, or four wires in the aerial?

Answer. In transmission it is desirable to have a multi-wire aerial, but for reception it will be found that a single wire will give almost as good results. In fact, the installation of a multi-wire aerial would make very little noticeable difference in signal strength. Taken all in all, it is hardly worth the expense and trouble to erect a multi-wire antenna for reception purposes.

QUESTION No. 31. What is a counterpoise and when should it be used?

Answer. As stated under Question 25, it is necessary for every electrical current to have a return circuit. This can be furnished

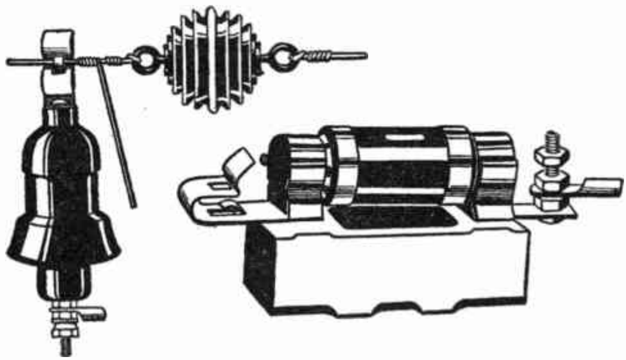


Fig. Q. No. 28

by means of what is known as a counterpoise and which may consist of an arrangement similar to the aerial, but suspended only a few feet above the ground. This is used where only a poor ground connection can be had and provides the necessary surface so that it may act, together with the ground, as a condenser.

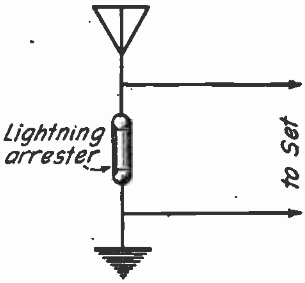


Fig. Q. No. 28

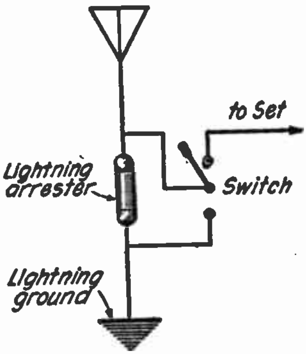


Fig. Q. No. 29

The condenser action found here, replaces the necessity of using a ground connection.

THE HOW AND WHY OF VACUUM TUBES

QUESTION No. 32. WHAT IS A VACUUM TUBE?

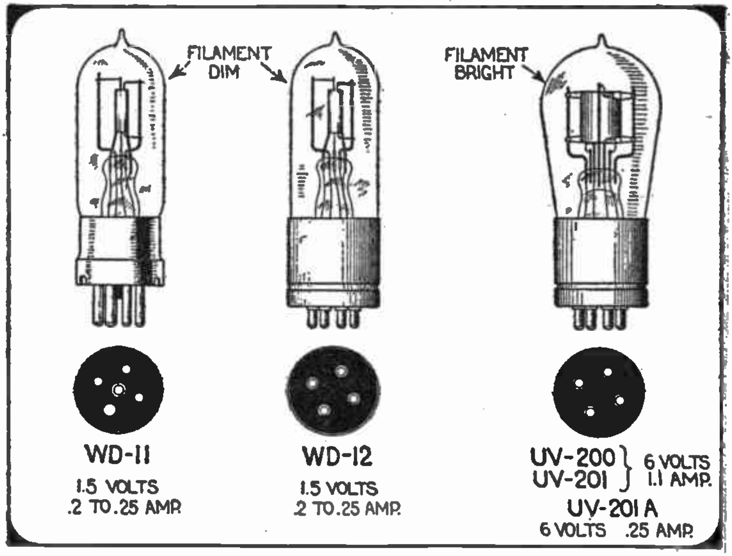
Answer. A vacuum tube is very similar to the ordinary electric light bulb in that it is a glass bulb from which the air has been exhausted, a vacuum in other words. The bulb has a filament inside it which is to be lit by electricity. Batteries are used for this latter purpose. The points where the vacuum tube differs from the ordinary electric light bulb is that it contains two other members aside from the filament. They are what is known as the grid and plate and can be plainly seen in the accompanying illustration. The grid usually consists of a lattice work of wires and the plate is a strip of metal; although in some cases it is corrugated.

QUESTION No. 33. WHY IS A VACUUM TUBE EVACUATED?

Answer. The main reason for evacuating an audion or vacuum tube is so that the filament may remain heated. If it were rendered incandescent in the open air it would soon oxidize and burn away. By keeping it in a vacuum this does not happen.

QUESTION No. 34. HOW DOES A VACUUM TUBE OPERATE?

Answer. When any metal is heated, it gives forth what is known as electrons. When these electrons fly through an evacuated space they make a conductive path for electricity. This path, of course, has a very high resistance. By referring to the illustration,


FILAMENT DIM
FILAMENT BRIGHT
WD-11
1.5 VOLTS
.2 TO .25 AMP.
WD-12
1.5 VOLTS
.2 TO .25 AMP.
UV-200
UV-201
6 VOLTS
1.1 AMP.
UV-201 A
6 VOLTS .25 AMP.

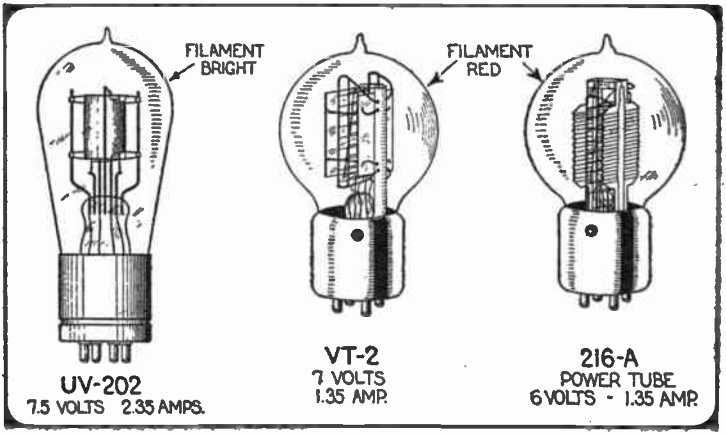

FILAMENT BRIGHT
FILAMENT RED
UV-202
7.5 VOLTS 2.35 AMPS.
VT-2
7 VOLTS
1.35 AMP.
216-A
POWER TUBE
6 VOLTS - 1.35 AMP.

Fig. Q. No. 32

the electrons will be seen flying off from the filament as represented by small dots and going in the direction indicated by the small arrows. The filament is made incandescent by means of what is known at the "A" battery. The positive side of the "B" or high voltage battery is connected to the plate and the phones are placed in the circuit as shown.

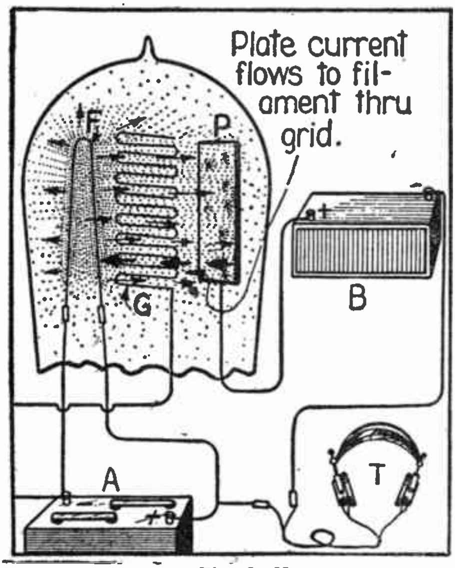


Fig. Q. No. 34

It is an established fact that a positively charged object will attract these electrons, while a negative charged object will repel them. Now when an incoming signal charges the grid postitively, we find a strong flow of electrons from the filament to the plate and a corresponding flow of electricity from the plate to the filament and back to the "B" battery through the phones. When the grid becomes negatively charged it deflects the electrons from the plate and a much weaker current flows. The incoming radio waves alternately charge the grid positively and negatively so that sounds are made audible in the phones according to the fluctuations of current. It will be seen that the whole action of the tube is very similar to a valve, with the grid as the stop-cock.

QUESTION No. 35. WHAT IS A SOFT TUBE AND WHAT IS IT ADAPTED FOR?

Answer. A soft tube is one which does not have a very high degree of vacuum in it. It requires a much lower plate voltage and a more critical adjustment of the filament for proper operation. It is adapted very well to use as a detector tube.

QUESTION 36. WHAT IS A HARD TUBE AND WHAT THE BEST USE FOR IT?

Answer. A hard tube is one with a high degree of evacuation and it requires a comparatively high "B" battery voltage. Also the filament voltage is not critical. These tubes are used as amplifiers.

Of the tubes illustrated the W. D.-11, W. D.-12, U. V.-200, and U. V. 201-A will give good results as detectors. The others are designed to be used as amplifiers although the U. V.-202, V. T.-2 and the 216-A require an extremely high plate potential; in the neighborhood of 150 to 350 volts. The U. V.-201 will give good results as an amplifier with 45 volts on the plate as will also the W. D.-11 and W. D.-12.

QUESTION No. 37. How MAY A NEGATIVE POTENTIAL BE IMPRESSED ON THE GRID OF A VACUUM TUBE AND WHEN SHOULD SUCH A POTENTIAL BE USED?

Answer. A negative potential may be impressed upon the grid of a tube by inserting in series with the grid, a small dry battery of from 1⅛ to 9 volts, with the negative side connected to the grid. Another way to obtain this same effect is to have a potentiometer with a resistance of about 200 to 400 ohms connected

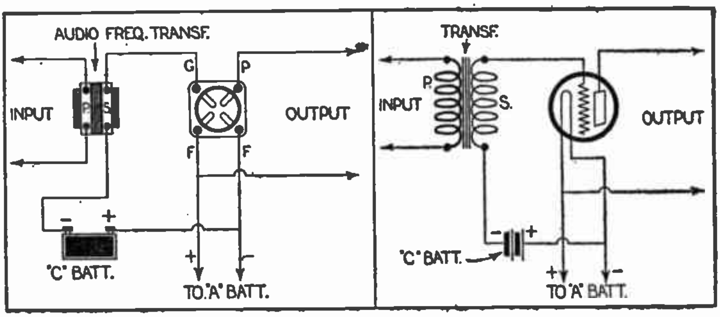


Fig. Q. No. 37

across the "A" battery, with the center point connected to the grid. This is particularly useful in radio frequency amplifying circuits and the exact connections are illustrated in the chapter on circuits.

QUESTION No. 38. How SHOULD THE GRID CIRCUIT OF A DETECTOR TUBE BE CONNECTED TO THE "A" BATTERY?

Answer. The grid circuit of a detector tube should be connected to the positive side of "A" battery.

QUESTION No. 39. WHERE SHOULD THE GRID CIRCUIT OF AN AMPLIFYING TUBE BE CONNECTED?

Answer. The grid circuit of an amplifying tube should be connected to the negative side of the "A" battery, in audio frequency amplifying circuits. In radio frequency circuits, the grid circuit should be connected to the potentiometer, except in the Neutrodyne circuit, where the grid circuits are connected as in audio frequency amplifying circuits.

QUESTION No. 40. WHAT IS REGENERATION?

Answer. A vacuum tube is one of the few instruments used in radio work which can do more than one thing at a time. This is particularly noticeable in the phenomenon of regeneration. The vacuum tube, not being a perfect rectifier or detector, allows a certain amount of radio frequency current to pass by it without changing it to audio frequency current. These two kinds of current are explained in Question No. 45. When this radio frequency current is fed back, as in a single circuit tuner, to the grid circuit of the tube, it, in effect, reduces the resistance of the grid circuit toward zero, thereby allowing greater amplification through the vacuum tube as a greater amount of current can flow in the grid circuit. In the standard vario-coupler and two variometer regenerative circuit, the fed-back action is acomplished by means of the capacity found between the grid and plate of the vacuum tube.

ALL ABOUT PHONES

QUESTION No. 41. WHAT IS THE PRINCIPLE OF THE PHONE OR RECEIVER?

Answer. The illustrations show several different kinds of receivers, but they all work on the principle of electro-magnetism. We will consider Fig. 1 as an example. A coil of wire is wound around the soft iron pole piece and when a current goes through this wire it magnetizes the pole piece to a greater or lesser extent, thereby causing the diaphragm to vibrate. The force with which the pole piece attracts the diaphragm is directly dependent upon

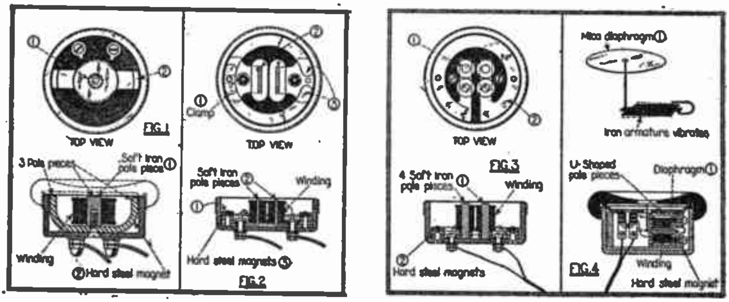


Fig. Q. No. 41

the amount of current flowing through the coil. It will, therefore, be seen that the sound produced by the diaphragm will vary according to the amount of current passing through the coil. The permanent steel magnet in Fig. 1, provides a return path for the magnetic flux. This is a feature not found in other types of receivers which gives very good results as the magnetic pull may be placed directly in the center of the diaghragm. The principle of the other types of receivers can very readily be seen from the illustrations.

QUESTION No. 42. CAN YOU COMPARE SEVERAL TYPES OF PHONES AS TO AUDIBILITY AND CLARITY?

Answer. The diagram shows four different makes of phones. Probably the very best of any, due to its amplifying feature, is that shown in Fig. 4. This is the well-known Baldwin receiver which owing to the lever arrangement connecting its diaphragm with a light iron armature, suspended in the center of the coil, has a decided amplifying effect. The phone shown in Fig. 1 gives a very clear tone and very exact reproduction. Figs. 2 and 3 show standard types of phones which will give very good results. In general, we would advise the prospective buyer of phones to purchase only a standard make which is backed by the reputation of a reliable concern. By doing so he will know that he has the very best that his money can buy.

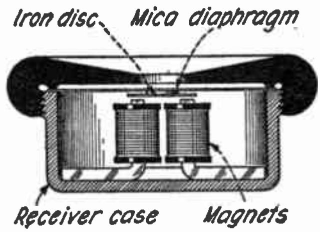


Fig. Q. No. 44

QUESTION No. 43. IS A MICA DIAPHRAGM BETTER THAN A STEEL DIAPHRAGM?

Answer. A mica diaphragm will give much better reproduction when it is made of good quality ruby mica. It will not usually rattle when certain frequencies are reproduced as will a metal diaphragm. It is less subject to expansion and contraction under changes of weather conditions and will not rust. All in all, a mica daphragm will, when properly fitted to a receiver, give much better results than a sheet metal diaphragm.

QUESTION No. 44. CAN A MICA DIAPHRAGM BE ATTACHED TO AN ORDINARY SINGLE OR DOUBLE POLE RECEIVER?

Answer. There are now on the market mica diaphragms which are designed to be attached to an ordinary receiver. To do this, all that is necessary is to remove the sheet metal diaphragm and place the mica one in its place. The appearance of the mica diaphragm as used in this case is shown in the illustration. In the center of it is a round soft iron disc which just covers the pole pieces of the receivers without touching them. This disc is acted upon by the magnets and the entire pull of the magnets is directed on the center of the diaphragm, a decidely advantageous feature as was mentioned before.

THE DIFFERENT TYPES OF AMPLIFIERS EXPLAINED

QUESTION No. 45. WHAT IS THE DIFFERENCE BETWEEN AUDIO FREQUENCY AND RADIO FREQUENCY AMPLIFICATIONS?

Answer. In radio work, there are two different kinds of currents. One is radio frequency current, and is that which is received on the antenna. In order to make the signals audible, this radio frequency current is rectified or changed to a pulsating direct current, the radio frequency current being alternating. This rectified current, known as the audio frequency current, is then made audible by the receivers. Now in **radio frequency amplification,** vacuum tubes are used to raise the value of the current, before it is detected. **Audio frequency amplification** amplifies the signals after they are rectified.

QUESTION No. 46. WHAT ARE THE TWO DIFFERENT KINDS OF AMPLIFICATION BEST ADAPTED FOR?

Answer. **Radio frequency amplification** is used when extreme distance reception is desired as it builds up very weak signals to an extent where they can be rectified by the detector. It is very useful in this manner because very weak signals will not affect the detector.

Audio frequency amplification is used where volume is desired. It is particularly useful when a loud speaker is to be used.

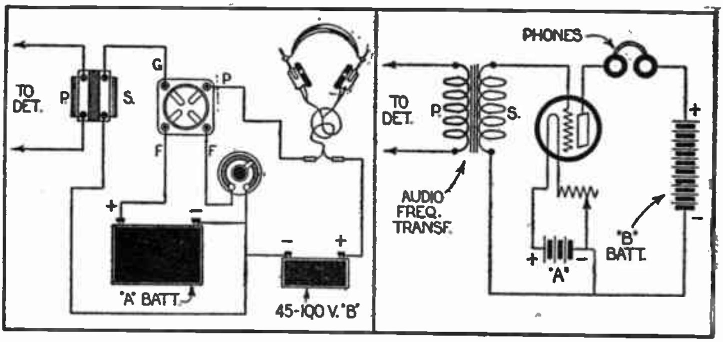


Fig. Q. No. 48

In fact, unless you are within a mile or two of a broadcasting station, it is absolutely necessary to use at least one and probably two or three stages of audio frequency amplification, in order to use a **loud speaker.**

QUESTION No. 47. Should different transformers be used in connection with the additional stages of audio frequency amplification?

Answer. It is wise to use the same make of transformers in the first, second and third stages of audio frequency amplification, but

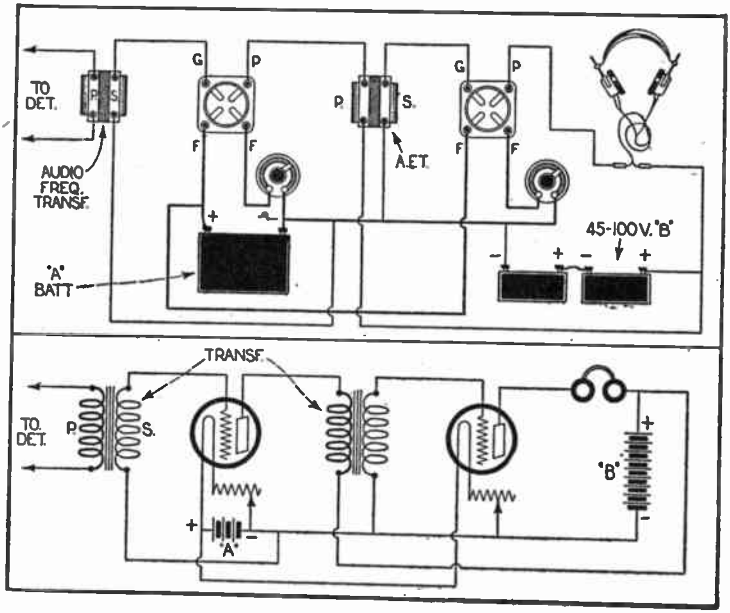


Fig. Q. No. 49

they should have different ratios between their primary and secondary windings. That of the first transformer should be rather high, either 5 to 1 or 9 to 1. The second and third stages, if a third stage is used, should employ transformers with a step-up ratio between the windings of 3 to 1.

QUESTION No. 48. Give a circuit diagram for one stage of audio frequency amplification?

Answer. The circuit is given herewith.

QUESTION No. 49. How may two stages of audio frequency amplification be connected?

Answer. A circuit diagram showing all the connections for two stages of audio frequency amplification is given herewith.

QUESTION No. 50. What are filament control jacks used for and how can I hook them up in a circuit using a vario coupler, two variometers and an audion detector and two stages of audio frequency amplification?

Answer. Filament control jacks are used so that when a plug is inserted in the detector plate circuit, the filament of that tube alone

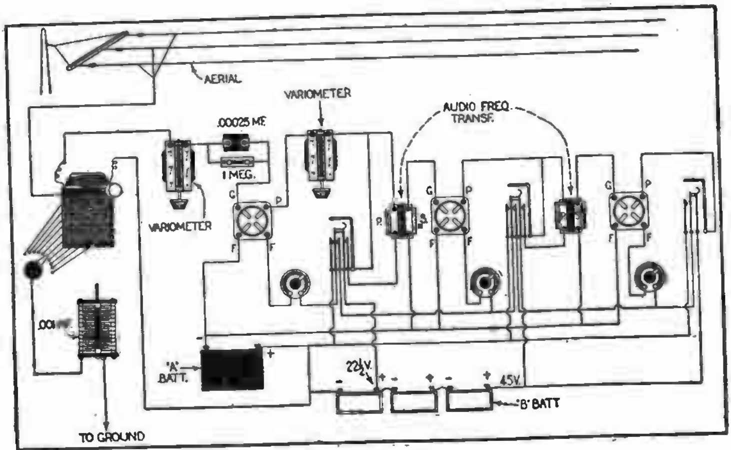


Fig. Q. No. 50

will light. When the plug is removed and inserted in the first stage the filaments of the detector and the first stage will be lit. The same happens when the plug is inserted in the second stage, as all three of the filaments light. The circuit diagram given herewith shows all the necessary connections for such jacks.

QUESTION No. 51. Give a circuit diagram for one stage of power amplification to be used in connection with a detector and two stage amplifier?

Answer. The circuit diagram given herewith shows all the necessary connections. The "C" Battery of 4½ volts is quite necessary in order to impress upon the grid of the amplifying tube, a negative potential. The transformer used should be one designed especially for this work.

QUESTION No. 52. What is tuned radio frequency amplificating and what is the circuit diagram for one stage of the same?

Answer. Turned radio frequency amplifications, as may be seen from the circuit diagram given herewith, employs an inductance coil and a condenser to furnish the coupling or connection between the two tubes and at the same time provides a means of supplying the correct "B" battery voltage to the plate of the amplifying tube. The characteristics of vacuum tubes make necessary the use of either this apparatus or a transformer in order to secure the proper results.

QUESTION No. 53. WHAT IS MEANT BY RADIO FREQUENCY AMPLIFICATION USING A TRANSFORMER FOR COUPLING AND WHAT IS THE CIRCUIT DIAGRAM OF ONE STAGE OF SUCH AMPLIFICATION?

Answer. As explained in the first part of this book under coupling, two coils placed in inductive relation with each other will have a current induced into one when a current is passed through the other. This is made use of in a radio frequency transformer, so that the current from the plate circuit of the first tube will be sent through a transformer and from there into the second tube. The circuit diagram which we give herewith will show the action very clearly upon being studied carefully.

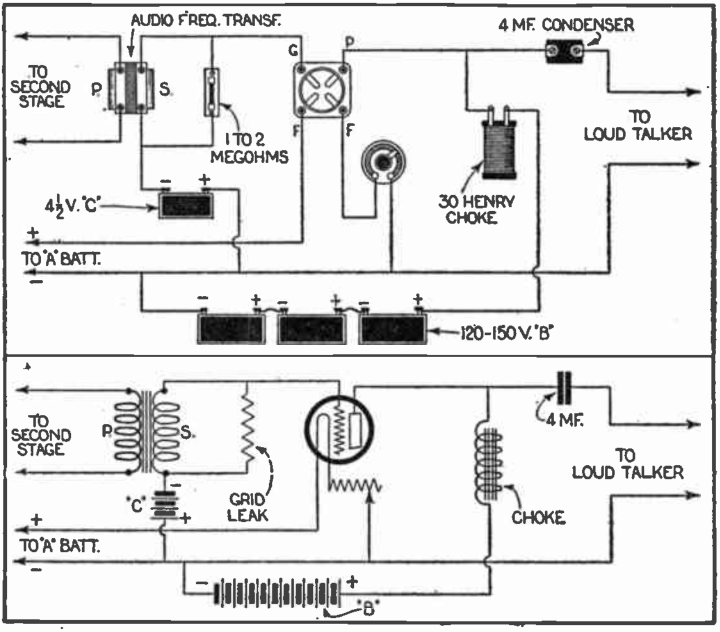


Fig. Q. No. 51

QUESTION No. 54. WOULD ONE STAGE OF RADIO FREQUENCY AMPLIFICATION EMPLOYING A TRANSFORMER AND ONE STAGE OF TUNED RADIO FREQUENCY AMPLIFICATION GIVE GOOD RESULTS AND HOW SHOULD THE SAME BE CONNECTED?

Answer. This is one of the most efficient methods of using two stages of radio frequency amplification and the circuit diagram herewith shows all the necessary connections. The impedence coil used in the second stage is the same as that employed in the circuit diagram given

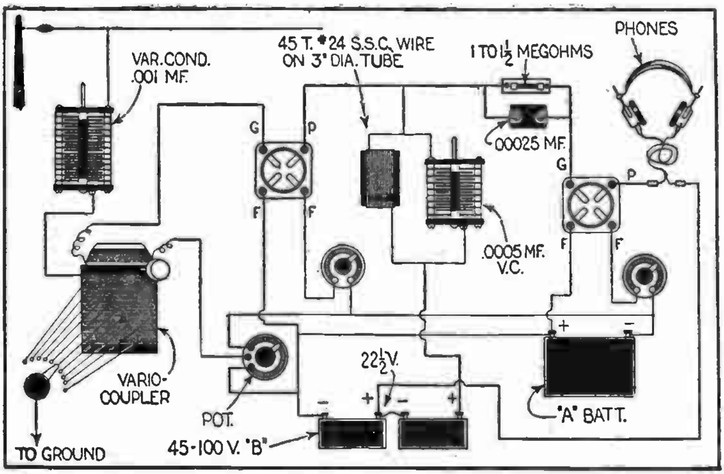


Fig. Q. No. 52

in connection with the preceding question. This circuit was developed recently by Mr. W. L. Pearce of the staff of *Radio News*, and to him the author is indebted for the accurate data on the tuned impedence coil.

CIRCUITS ELUCIDATED

QUESTION No. 55. WHAT IS MEANT BY THE TERM SINGLE CIRCUIT TUNER, AND IS THE CIRCUIT DIAGRAM OF SUCH A RECEIVING SET?

Answer. A single circuit tuner is one in which the antenna circuit and the grid circuit of the vacuum tube are conductively coupled, and a feed back coil, connected in the plate circuit, is placed in inductive relation to the primary. An ordinary vario-coupler can be used as a single circuit tuner as shown in the accompanying diagram. The grid leak may be connected as in the diagram or in parallel with the grid condenser, which can be found best by experiment. The "B" battery should have a voltage of approximately 22½, if a soft tube is used, or higher if a hard tube is used. The former will, however, give best results as a detector. The voltage of the "A" battery will depend upon the type of tube used. The variable condenser in series with the antenna provides more selective tuning, so that one station at a time may be listened to without interference from others. It is, however, not absolutely necessary, if the primary of the coupler is tapped in two sections, giving what is commonly known as units and tens taps. This tuner is regenerative.

QUESTION No. 56. WHAT IS A TWO-CIRCUIT TUNER?

Answer. The two-circuit tuner shown herewith is non-regenerative and consists of an inductively coupled primary and secondary circuit, such as shown in the diagram. A vario-coupler or loose coupler may be used as the tuner and the variable condenser serves the same function as it does in the single circuit tuner.

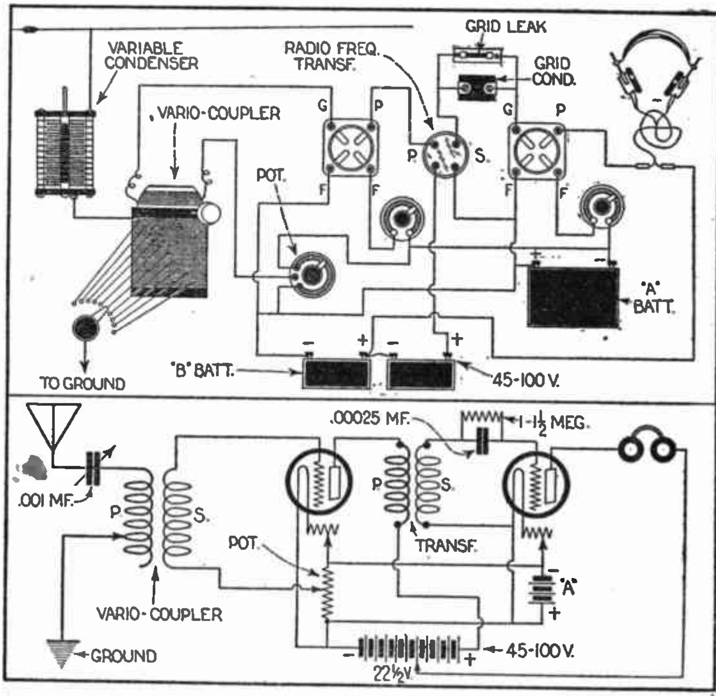


Fig. Q. No. 53

The variable condenser in parallel with the secondary is used to tune that circuit so that it will have the same value as the primary circuit, an important item in "balancing up" this particular set. All other remarks pertaining to the single circuit tuner apply here as well.

QUESTION No. 57. WHAT IS A THREE-CIRCUIT TUNER?

Answer. A three-circuit tuner is one in which the primary, secondary or grid circuit, and the plate circuit are capable of being tuned so that they will be in resonance with each other. Being in resonance means that the circuits are all tuned to respond to the

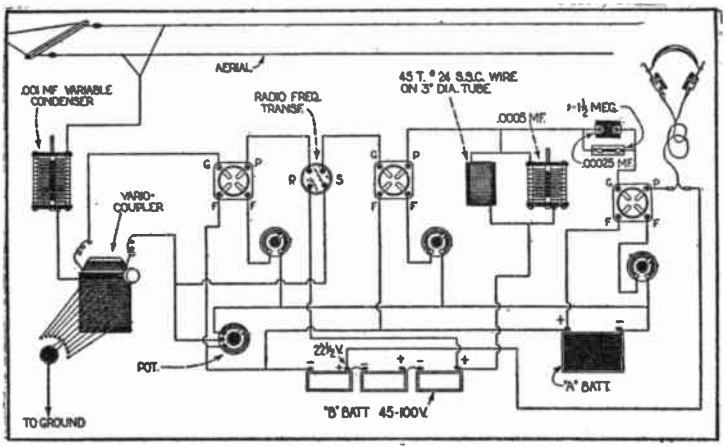


Fig. Q. No. 54

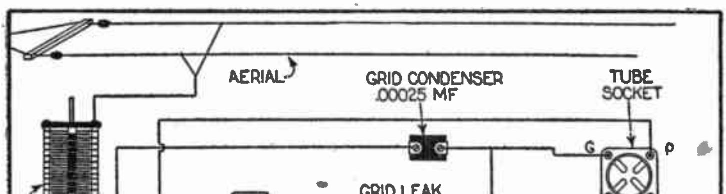


Fig. Q. No. 55

same wave-length. This tuning, together with the capacity of the tube, furnishes a capacity or tuned feed back so that the circuit regenerates. The standard form of a three-circuit tuner is that employing a vario-coupler and two variometers such as shown in our circuit diagram herewith. In some cases, the grid variometer is omitted and the side of the vario-coupler to which it was connected is led directly to the grid leak and condenser. A variable condenser is then placed in parallel with the secondary of the vario-coupler. This gives the same effect as if two variometers

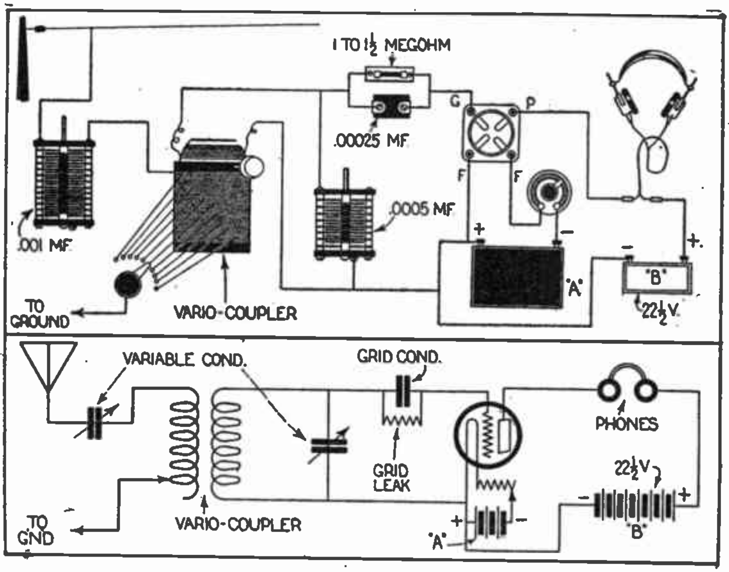


Fig. Q. No. 56

were used, and sometimes gives better results as far as selective tuning is concerned. This is a standard circuit and is very widely used throughout the country as it is comparatively simple to tune, and combined with this, it gives great selectivity.

QUESTION No. 58. WHAT IS THE CIRCUIT OF THE REINARTZ TUNER AND HOW ARE THE COILS WOUND?

Answer. The original Reinartz tuner was wound on a single tube, with both grid and plate windings placed side by side. The core for these windings should consist of a three-inch bakelite tube and the coil should be wound, follow the directions given below. Beginning one-quarter of an inch from the end of the tube wind 45 turns of No. 20 D. C. C. wire, or better still "Litz" wire. The latter will give the greatest efficiency. This winding is tapped at the first, fifteenth, thirtieth and forty-fifth turns and constitutes the plate or feed-back coil. Three-eighths to one-quarter of an inch from the end of this winding should begin the grid coil. This is to be wound with 36 turns of the same size wire as it was used in the plate coil, tapped at the first, second, third, fourth, fifth, sixth, seventh, eighth, ninth, tenth, twenty-fourth, thirtieth and thirty-sixth turns. These taps are brought out to two switches one for the unit taps to be connected to the aerial, and the other for the rest of the turns, to be connected to the grid. It is important that all connections on this turner be soldered in order to obtain best results.

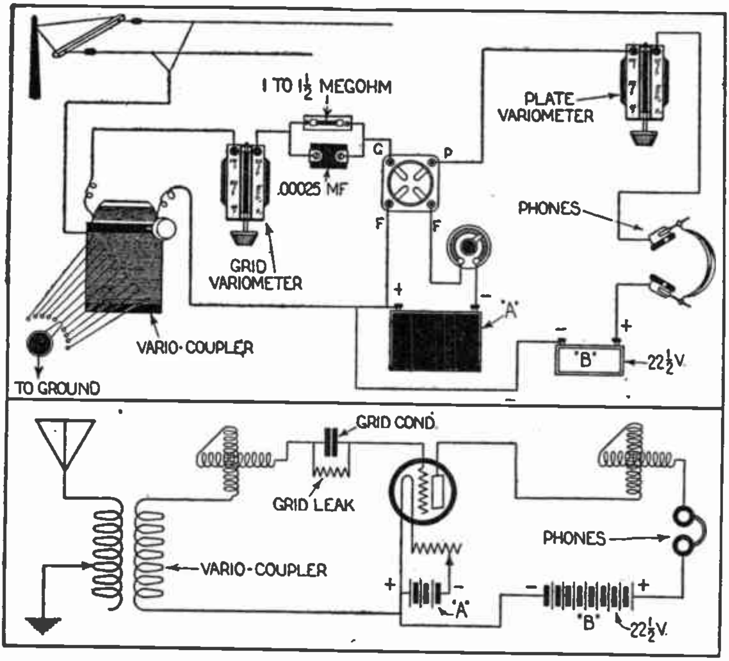


Fig. Q. No. 57

One of the important points in connection with this circuit is the feed-back condenser, connected in series with the plate coil, which may consist of a standard variable condenser having a capacity of .0005 mf. This capacity controls the oscillation and regeneration of this receiver which is capable of extraordinary work in the reception of continuous wave signals. The condenser which is shunted across the grid circuit of the vacuum tube is very essential to the operation of this tuner and the finer tuning depends entirely upon it. This condenser should be equipped with a vernier in order to make fine adjustment possible, which becomes quite necessary when receiving from certain stations through severe Q R M, which means interference in the government code.

QUESTION No. 59. WHAT IS THE IMPROVED REINARTZ CIRCUIT AND HOW ARE THE COILS CONSTRUCTED?

Answer. The circuit for this tuner is shown herewith and its construction is extremely simple. On a 3½" tube are wound 30 turns of No. 20 D. C. C. or "Litz" wire tapped every turn for the first ten turns. Within this tube is placed a rotor, upon which

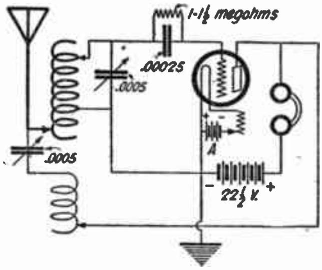


Fig. Q. No. 58

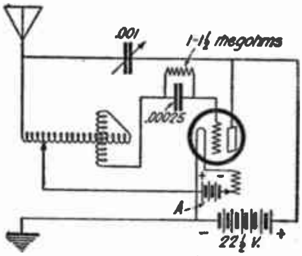


Fig. Q. No. 59

are wound 30 turns of the same size wire. These two elements are connected together and to a vacuum tube as shown. The number of switches used are reduced by two when this circuit is employed and its control is much simpler; besides, this circuit will yield louder signals due to the conductive coupling which is not found in the first circuit described. If the builder desired to employ a spider web type of tuner he may proceed with the winding using practically the same constants as were given for the inductively coupled tuner. Some changes more or less will be necessary in the number of turns although those given will work. The spider web form for this work should be approximately six inches in outside diameter and the slots should be cut two inches deep. The circuit for this coil is the same as for the set described in the preceding question and answer.

An experimental set along still different lines was built by the writer which employed the constants given in connection with set number one, with the exception that the grid coil was wound on a stationary tube and the plate feed-back on a rotating tube. This however, necessitated the bringing out of taps from the rotor which entailed considerable work which the builder will not find necessary. The reader, however, might obtain results by attempting this form of construction and at any rate experimental work along these lines will be extremely interesting.

QUESTION No. 60. Is the Cockaday circuit very selective and how should it be constructed and connected?

Answer. The Cockaday four-circuit tuner is extremely selective and will give excellent results for all around reception. The circuit diagram is shown herewith and the necessary coils should be wound as follows. On a tube 3½ inches in diameter is wound 34 turns of No. 18 S. C. C. wire. This is the stabilizer coil which furnishes coupling between the single turn and the secondary. Right next to this winding on the same tube and running in the same direction, but separated from the first by about one-sixteenth of an inch, is wound 65 turns of the same size of wire. This is the secondary coil. On another tube 3½ inches in diameter, wind 43 turns, tapped at the first, third, seventh, thirteenth, twenty-first, thirty-first and last turns. This is the primary loading inductance and should be situated at right angles to the other coils, when placed in the circuit. On the stabilizer coil, and about one-fourth of an inch from the beginning of the same is wound a single turn of bus wire or No. 14 bare copper wire. This is connected in series with the primary loading inductance as shown.

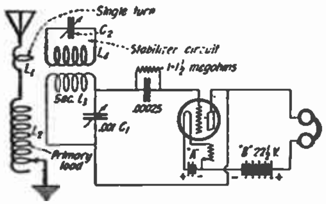


Fig. Q. No. 60

QUESTION No. 61. How is the Cockaday circuit tuned?

Answer. In the first place, it must be remembered that the antenna tuning is accomplished by means of the aerial switch. To tune the secondary circuit, the variable condenser C-1 is used. The control of regeneration is accomplished by means of the variable condenser C-2, located in the stabilizer circuit. The dial is first set at approximately 90 degrees. The filament control is then increased to a point just below that which would set the circuit into oscillation. With the antenna tuning switch and the secondary condenser, a signal is tuned in.

Now it will be necessary to use only C-1 and C-2 to tune the signals in so as to secure the loudest response. To increase the strength of the signal, it is necessary to increase the the feed-back from the plate circuit, and this is done by setting the control C-2 at a lower value and adjusting the stabilizer circuit accurately. If necessary, a readjustment of the control C-1 may be made with a further adjustment of C-2 to increase or decrease regeneration. In this way a louder signal will be obtained, and tuning will be extremely sharp.

Thus it will be noticed that the lower the value at which C-2 is placed, the more freely the circuit will oscillate. Then it is only a matter of finding the correct setting for C-2 and adjusting C-1 for the correct wave-length. A high value for condenser C-2 will be used for tuning in voice or spark signals on the higher waves, while a comparatively small value is necessary for amateur CW signals.

With the enforcement and the putting into action of the new federal regulations with respect to wave-length allotments to broadcasting stations, in which each district will be given a certain wave-length, between 222 and 545 meters, the range of this set (150-550 meters) will be thoroughly appreciated. And because of the fact that in the future, broadcasting stations will operate with a difference of but 2 to 3 meters in wave-lengths, this type of tuner will be all the more valuable because of its unusual selectivity.

It is found that it is easy to tune out interference even from a local source, once the operator familiarizes himself with the circuit, and provided also that the stations are not transmitting simultaneously on the exact same wave-length.

QUESTION No. 62. WHAT IS MEANT BY THE REFLEX CIRCUITS AND HOW ARE THEY CONNECTED UP AND USED?

Answer. Within the last few years another possibility of the vacuum tube has been developed and recently brought to the attention of the radio public. This is what is known as the reflex method of receiving radio telephone and telegraph messages. This method in the main, causes the vacuum tube to perform two distinct functions at virtually the same time, which is accomplished by feeding back the impulses from the last tube to the first one, whereupon they are amplified again. This process must not be confused with the regenerative feed-back, as the latter is entirely different. The term is used in connection with the reflex in lieu of a better one. In the ordinary familiar regenerative feed back circuit the plate current is fed back through a coil inductively coupled to the grid circuit, thereby inducing a larger current in the latter.

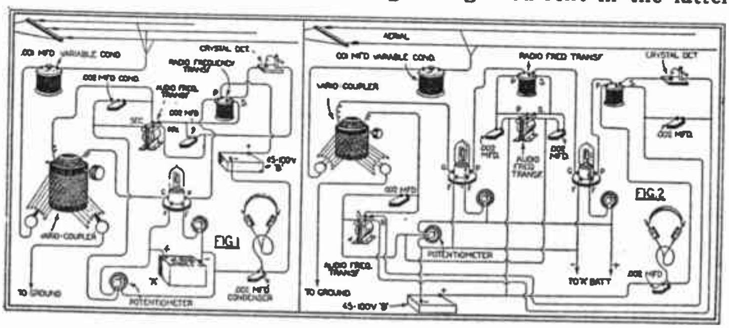


Fig. Q. No. 62

This, in effect, reduces the resistance of the grid circuit as the coupling is varied, to such an extent that the tube starts to oscillate and produce sustained oscillations. Just before the oscillating point is reached a current greater than normal flows in the grid circuit and the result is a correspondingly larger flow in the plate, and consequently in the phone circuit. If the tube is allowed to break into oscillation, the set will not function properly.

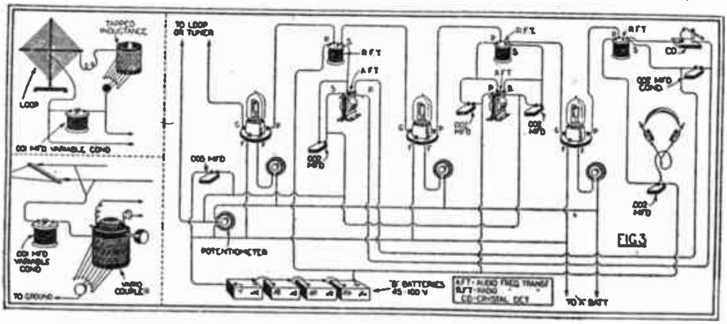


Fig. Q. No. 62

This phenomena, however, is not present in the reflex circuit as the action taking place is on an entirely different principle. Here the current, considering the one tube circuit illustrated in Fig. 1, is first amplified at radio frequency by the tube, is rectified by the crystal detector and then led back through the audio frequency transformer to the grid circuit of the tube. Here it is now amplified at audio frequency, by the same tube, and rendered audible by the telephone receivers.

Glancing at Fig. 1, the first question that arises, is, how is it that the current does not effect the phones after it is amplified at radio frequency, and before it reaches the detector? This is easily understood when it is realized that radio frequency current will not pass through a high impedance coil with an iron core such as the windings of the phones. It is, therefore, provided with a path through the by-pass condenser across the phones.

The potentiometers shown in all the circuits are absolutely necessary to keep the tube or tubes as the case may be, in a stable state and not oscillating. They serve to regulate the potential on the grid or grids of the tubes. This allows the tubes to work at their normal efficiency and reduces the tube noises to a minimum.

A word regarding the tubes suitable for use in these circuits would not be amiss at this point. The W. D. 11 or its successor, the W. D. 12, 1½ volt, dry cell tube could very well be used, and a plate potential of 45 volts should be applied. The potentiometer for use with this tube may be of any standard make and resistance. Since a crystal detector is to be used for rectification, no soft tubes will be necessary, as hard tubes are by far the better amplifiers. U. V. 201, V. T. 1, and V. T. 2 tubes will all give good results. The author assembled a set such as shown in Fig. 2, and with V. T. 2's obtained great satisfaction. 120 volts on the plates gave the best signals, but the adjustment of the potentiometer was found to be quite critical; one point bringing in the signals with great volume and clarity, while at all other points, the music and voice was distorted and by no means as loud.

Crystal detectors are shown in all the circuits herewith, but if the user desires he may employ a detector tube for the purpose of rectification. The use of the crystal, however, simplifies the operation of the set to a great extent and eliminates the distortion which is liable to be encountered when a tube is used. An excellent detector for use in these circuits is that known as the "Gold-Grain," as it is easy to adjust and holds its adjustment very well. It has also the added advantage that it is entirely dust-proof. Of course, any ordinary crystal detector can be used with good results. Silicon and carborundum should give very good results in this circuit as they are very stable under all conditions, and since great sensitiveness is not required, but rather capability of handling comparatively large currents, either of these crystals will give very satisfactory results. The transformers used may be of any standard make.

In Figs. 1 and 2 the tuning unit is shown to be composed of a vario-coupler and a variable condenser. This, of course, may be varied to suit the material that the maker may have on hand. Honeycomb coils could very well be used, in which case two of them should be employed, one for the primary and the other as the secondary, both of them to be shunted by a variable condenser with a capacity of .001 mfd.

In Fig. 3 is shown practically the same circuit as used in the de Forest reflex set, employing three tubes and a crystal detector and giving the effect of three stages of radio frequency, detector and two stages of audio frequency amplification. This may be used either with a loop or an outdoor antenna, and will give very good results with either. The connections for both are shown in the diagram.

The tapped inductance shown in series with the loop is only necessary when a very small loop is used; it need not be included if the loop wound with from eight to ten turns of wire exceeds three feet square.

The various fixed condensers shown in the accompanying diagram play an important part in the action of these sets. It is known that a high impedance coil with an iron core will not allow radio frequency currents to pass through it. Therefore, condensers are shunted across all of the windings containing iron cores to supply a path for these currents. The sizes of these condensers are not critical; they may vary from .001 to .002 mfd. without affecting the operation of the set to any appreciable extent. They should be of the best grade obtainable, for if they are of cheap construction, their capacity will tend to vary and cause trouble in the set. Mica dielectric will be found best in all cases.

In conclusion the author advises the experimenter to start with the one tube set; then as his knowledge of the operation of the set expands, he can increase the size first to the two tube set and finally to the one shown in Fig. 3.

QUESTION No. 63. WHAT IS THE INVERSE DUPLEX?

Answer. The inverse duplex is a refinement of the reflex which does away with potentiometers and relieves the strain on the various vacuum tubes. Here instead of having the second tube act as the second stage of radio frequency as well as the second stage of audio frequency amplification, the second tube acts as the second stage of radio frequency and the first stage of audio frequency amplification. The first tube then acts as the first stage of radio frequency and the second stage of audio frequency amplification.

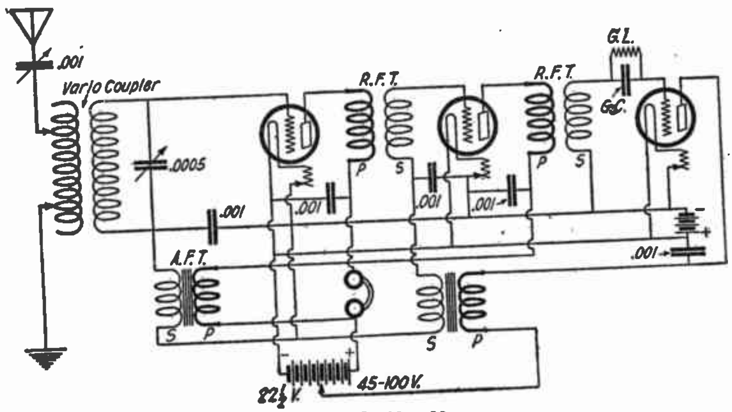


Fig. Q. No. 63

Therefore, in the three tube circuit which is illustrated, there will be less trouble caused by the tubes "blocking out" or becoming overloaded. This circuit is very good and when properly manipulated will give even better results than the reflex circuits mentioned before. All remarks relative to the reflex circuits will apply to the inverse duplex.

QUESTION No. 64. WHAT IS MEANT BY SUPER-REGENERATION?

Answer. Super-regeneration, a recent development of Major Edwin Armstrong's, is caused by providing oscillations in a vacuum tube circuit at a very high frequency. These oscillations tend to reduce the resistance of the grid circuit, even further than is accomplished in an ordinary regenerative circuit. This, of course, allows greater amplification in the vacuum tube and is known as super-regeneration.

A very practical circuit for a one-tube super-regenerative tuner is given herewith. When these instruments are first set up, the builder will find a very shrill high pitched whistle noticeable. This is, however, common with all "supers" and when the listener once gets used to the whistle it will not be noticeable. It is advisable to use a loop with this circuit as an aerial and ground will not work satisfactorily.

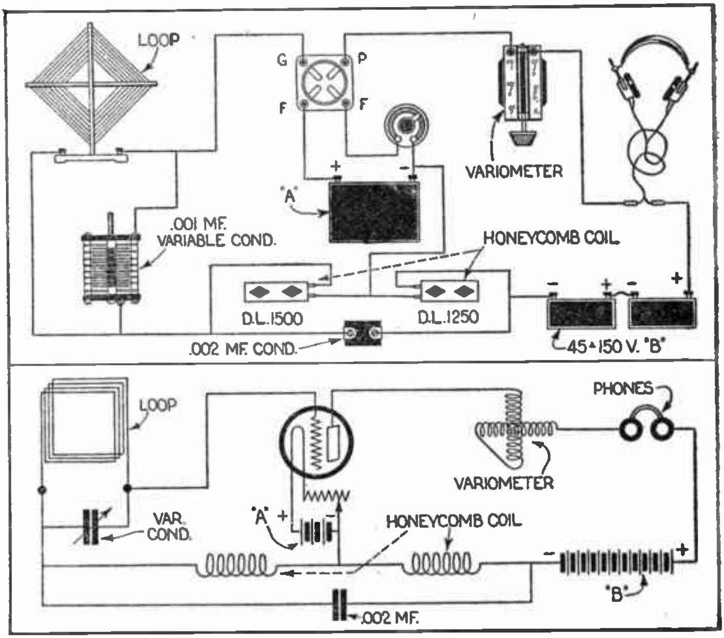


Fig. Q. No. 64

QUESTION No. 65. WHAT IS THE FLEWELLING CIRCUIT? GIVE FULL DATA ON THE SAME.

Answer. The Flewelling circuit has been said by various authorities to be nothing more or less than a modification of the Armstrong super-regenerative tuner. However, whether or not this is the case will have to be decided by the United States Patent Office officials, as Mr. Flewelling has filed an application for patents covering his circuits. Edward T. Flewelling, the inventor of the circuit, is an electrical engineer, and has conducted a series of some 200 tests with his newly developed circuit, in an endeavor to improve the same, and correct faults which it originally had.

One of the greatest advantages for this circuit is that it does not require an aerial, a simple loop or only a ground connection being necessary, although in some cases with certain instruments and under certain conditions the use of an antenna, but no ground will be found advantageous. This is a point which the amateur must determine for himself by experimentation.

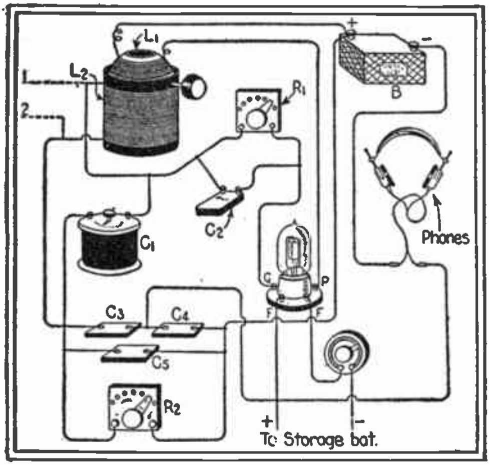


Fig. Q. No. 65

The diagram herewith shows the Flewelling circuit in its simplest form. As will be seen, the only difference between this circuit and a standard single circuit regenerative tuner is the addition of three fixed condensers, and a variable resistance. The condensers C3, C4, and C5 have a fixed capacity of approximately .006 M. F. although the exact value is not a fixed resistance of critical. R2 may be a fixed resistance of ½ megohm, although in some cases it will be found to advantage to have this resistance variable from ¼ to 1 megohm. The resistance R1 is critical and must be variable from 1 to 1½ megohms.

C2 should be a standard mica grid condenser with a capacity of .00025 mf. In all cases the condensers should preferably have mica dielectric, and all the apparatus should be constructed as efficiently as possible in order to avoid losses, and also to keep the set from becoming critical.

In this circuit only one tube is used, that tube functioning as an oscillator, regenerator and detector. This tube should preferably be an amplifier, in which case the "B" battery voltage should be from 60 to 150 volts, although in some cases it will be found possible to use a detector tube applying as high a potential as possible to the plate. Any type and make of tube may be used in this circuit, including the dry cell tubes. Five watt power tubes give excellent results.

The inductance coils L1 and L2 may be of various types. Honeycomb coils give good results, L1 being a 75 or 100 turn coil, and L2 a 50 or 75 turn coil. The correct values may be found by experiment. A vario-coupler may be used in place of the honeycomb coils, but the rotor should be re-wound so that it contains at least 75 turns of wire. A standard vario-coupler with about

50 turns on the rotor has been found to work in this circuit, but the results are not the same as would be obtained when the correct values for the coils were used. The variable condenser C1 should have a maximum capacity of .0005 M. F., and in order to secure proper results should be equipped with a vernier. Shielding of this apparatus, as well as of the filament rheostat, is quite desirable in order to reduce the capacity effect caused by the body of the operator.

The coupling of the two inductance coils will be found to be critical, loose coupling being generally employed for best results. After the circuit is once connected, and the proper values for the inductance and condensers determined, the adjustment of the same is comparatively simple. When connecting up the apparatus, it will be found necessary to try reversing the tickler coil in order to secure proper results. In most cases, when using a vario-coupler for the inductance coils, it will be found that the total inductance of the stator may be left in the circuit, and controlled by the variable condenser C1.

When everything is ready, turn on the current to the filament of the tube, place the resistance R1 at 1½ megohms, and adjust the coupling until a shrill note is heard in the phones. Now, if the tickler is adjusted further, it will be found that the frequency of that note will change. Vary the coupling and the capacity of C1 continuously until a signal is heard. During this process of tuning, squeaks, howls and noises similar to those heard in the ordinary regenerative tuner will be produced. After the signal is heard, balance all the instrument for best results, paying particular attention to the adjustments of the two resistances R1 and R2. After these latter are obtained correctly, they may be left at these positions, and all further tuning done with the coupling and the condenser.

The amateur will find it an advantage to have a switching arrangment so that the aerial, ground or loop may be used at will, or any combination of the three. This will aid materially in experimenting with this circuit. In all cases when only an aerial is used alone, it will be found necessary to connect the same to the grid side of L2.

QUESTION No. 66. WHAT IS THE FUNCTION OF A NEUTRODYNE CIRCUIT?

Answer. In using two stages of radio frequency amplification, great trouble is often experienced in keeping the tubes from oscillating without the use of a potentiometer. This is due to the capacity existing between the elements of the vacuum tube. In order to overcome this, Professor L. A. Hazeltine, M. E., has evolved a method whereby the capacities of the vacuum tubes are neutralized by connecting small variable condensers between the grids of the tubes as shown in the illustration. These condensers consist of two pieces of No. 14 wire placed end to end within an insulating, sleeve, with their ends about ¾ of an inch apart, the insulating sleeve to be about 2½ inches long. Over this sleeve is placed a copper tube slightly larger in inside diameter than the outside diameter of the insulating sleeve.

When the set is placed in operation, the filament of the first tube is turned out. It will usually be found that the signals can still be heard although somewhat fainter. The copper tube of the

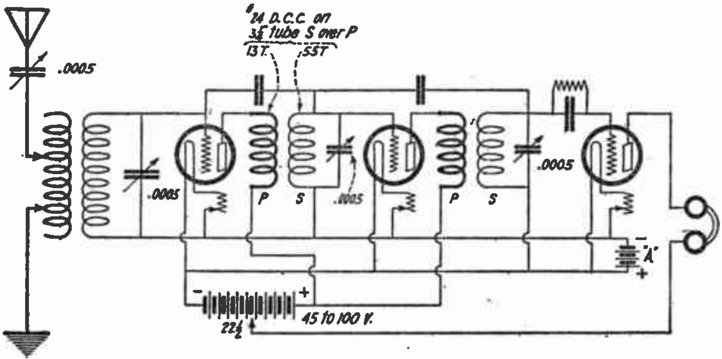


Fig. Q. No. 66

small condenser connected between the first and second tubes is now moved backward and forward until the signal disappears entirely. The tube is then turned on and the same process gone through with the second tube and second condenser. When the condensers are once adjusted for a particular set of tubes they need never be touched until the tubes are changed.

QUESTION No. 67. WHAT IS A WAVE TRAP AND WHAT FORMS OF THE SAME ARE BEST?

Answer. Wave traps could very well be called interference preventers as they provide a means for tuning out undesired signals and bringing in those to which the operator wishes to listen. They are particularly valuable when a receiving set is being used which is not very selective. Probably the best known types of wave traps are those illustrated in Fig. 1 and Fig. 2. In both of these cases it has been found that the very best results may be obtained when the inductance coil has as low a resistance as possible, and the condenser as low a capacity as can be used. The author advises the builder to construct the coil used in these two circuits with taps for coarse adjustments, while the condenser is used for fine tuning. The best wire for winding these coils is Litz, but, if it is impossible to obtain this, No. 18 bell wire may be used with very good results. Many amateurs using these circuits, employ the ordinary honeycomb coils for the inductance, but it has been found that they are not as good as coils wound with the above mentioned wire. The inductance should have approximately the following dimensions. The form may be a cardboard or bakelite tube 3½ inches in diameter, and on it should be wound 50 turns of either Litz or other comparatively heavy wire, tapped at the 30th, 35th, 40th, 45th, and 50th turns. The condenser should preferably be of the straight line type for the very best results, and may be shunted with a vernier to afford close adjustments. However, very accurate adjustment of this condenser may be made, without a vernier, by attaching a long wooden or other insulating rod to the knob, at right angles to the shaft. By turning the condenser with the further end of the rod, the capacity may be very carefully and accurately adjusted.

The tuning of Fig. 1 is accomplished somewhat as follows: The switch should be closed, short circuiting the wave-trap and the set tuned as usual to the desired signal. When interference is encountered, the switch is opened, and the wave-trap circuit balanced to eliminate the interfering signal. It will generally be found necessary to retune the receiving set slightly for best results. The theory is that the oscillating circuit formed by the variable condenser and inductance will present a circuit of infinite impedance to the frequencies to which the circuit is tuned, but will pass all frequencies to which it is not tuned. Fig. 1 shows this wave-trap in connection with a standard short wave regenerative tuner consisting of a vario-coupler and two variometers, but of course it may be used with any type of receiving set, merely by connecting it in series with the antenna.

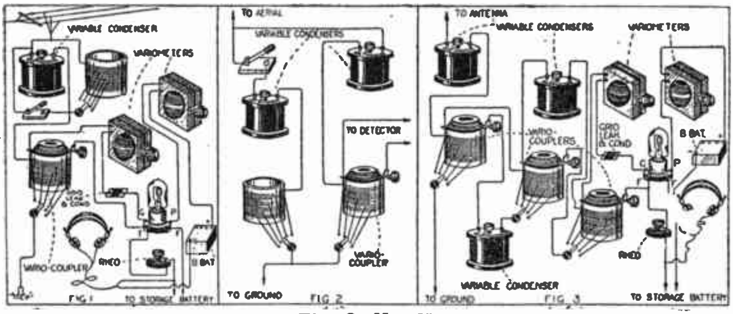


Fig. Q. No. 67

In Fig. 2, the same coil and condenser are used as in Fig. 1, but they are connected in shunt with the primary of the receiving transformer. The same detector circuit as in Fig. 1 may also be used. Here the same tuning procedure is used as given above. The theory of this circuit is that the primary of the vario-coupler or receiving transformer is tuned to the desired wave-length, while that of the wave-trap, is tuned to the undesired wave.

A general rule may be stated for both of the above wave-traps, and this rule is that they should be thoroughly shielded from the receiving set. The best way to do this would be to mount the inductance coil, the condenser and the switch in a small cabinet, the inside of which is lined with tin foil, and the tin foil grounded. In lining the box with the foil, be sure that the latter does not touch any metallic part of the instruments. For experimental purposes, the coil, switch and condenser may be placed on a table separated by several feet from the receiving instruments. These precautions are necessary so that the electro-magnetic field set up around the inductance coil of the wave-trap will not affect the secondary circuit of the receiving set.

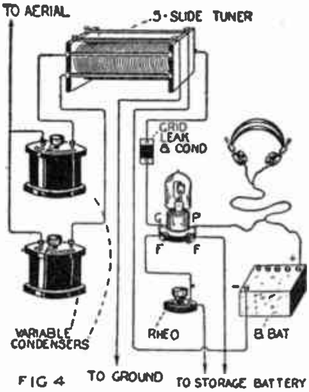


Fig. Q. No. 67

A very selective tuner, know as the wave filter, is shown in Fig. 3. The only additions to a vario-coupler and vario-meter tuner necessary to construct this filter, are two vario-couplers and two variable condensers. The former may be any standard make capable of tuning to the same wave as the coupler used in the receiving set, and the variable condensers should have a capacity of .001 M. F.

In practice, the three coupler and the three variable condensers are all tuned to the desired wave. The variometers are then balanced to secure regeneration. This set will be rather hard to tune, but the selectivity it affords will make up for any trouble in learning to operate it. If a three coil honey-comb tuner is being used, the four coils represented by the primaries and secondaries of the first two vario-couplers, may consist of four honeycomb coils, the primary ones of the same size as the primary of the tuner, and the secondaries of the same size as the secondary coil in the tuner. This circuit, when tuned properly, should be able to select one of two transmitting stations operating on close wave-lengths, such lengths being within 3 meters of each others.

An ultra-selective, yet easily made tuner is illustrated in Fig. 4. The tuning coil which is equipped with 5 sliding contacts, may be made by winding about 100 turns of No. 20 or No. 22 D. C. C. wire on a cardboard or bakelite tube 3½ inches in diameter. The two variable condensers used should have a capacity of .001 M. F. When the two sliders connected to the aerial are symetrically arranged in relation to the sliders connecting to the detector, and the slider connected to the ground, the detector will not be affected by any incoming signals. To receive the desired signals, the slider connected to the ground, should be shifted to the right or left as the case may be, until the station is heard loudest. Various arrangements of the sliders will give different results, and tests should be made to determine just what setting is best for receiving a particular wave. This circuit will function equally well with either a crystal or audion detector.

MISCELLANEOUS QUERIES

QUESTION No. 68. ARE SETS USING RADIO FREQUENCY VERY DIFFICULT TO TUNE?

Answer. Radio frequency will make the set tune sharper, but if the radio frequency unit is constructed correctly, it should not prove more difficult to tune that the average regenerative set.

QUESTION No. 69. HOW MAY I ELIMINATE SOME OF THE NOISES FROM THREE STAGES OF AUDIO FREQUENCY?

Answer. The third stage should be entirely shielded on all sides, if possible, and grounded. If the cores of all the A. F. transformers are grounded it will help to a great extent. It is possible that the "B" battery is the cause of a good deal of trouble. Fluctuating voltage from the "B" battery, although not noticeable in the detector, will be very much in evidence on three stages. A radio frequency choke coil, consisting of 75 turns of wire on a 2" tube, placed in the grid circuit of the third amplifying tube will be beneficial. In such an amplifier the turns ratio of the second and third transformers should not exceed 3 to 1.

QUESTION No. 70. I HAVE HAD GREAT TROUBLE TRYING TO STOP A SQUEALING SOUND WHEN RECEIVING BROADCASTING. HOW CAN I PREVENT THIS?

Answer. This is, no doubt, due to the carrier wave of two or more broadcasting stations heterodyning each other. This carrier wave would not be heard if only one station were transmitting, but when two are on, the two carrier waves overlap each other and produce an audible "beat" note in the receivers. This could also be caused by a receiving set in the vicinity, tuned to the same wavelength as the transmitting station and receiving with the detector tube in a state of oscillation.

QUESTION No. 71. WHAT MUST I DO TO MAKE MY REGENERATIVE SET OSCILLATE WITHOUT FORCING THE FILAMENT?

Answer. If the resistances of all circuits and contacts are reduced to a minimum, the receiver will operate correctly with lowered filament current. It would be advisable to go over the wiring carefully; use at least No. 18 wire for connections. Soldering all contacts will be of great benefit. Make certain that the vacuum tube makes positive contact with the socket prong. It may be that a cell in your "B" battery is dead; try a new battery. Shunt a condenser of .001 M. F. across the phones and "B" battery to allow a bypass for the radio frequency oscillations. Your ground may be of high resistance, try improving it or use a counterpoise in conjunction with it. Perhaps closer coupling between tickler and secondary would help. Keep the secondary condenser as near zero as possible, using the inductance to increase the wave-length. Make a grid leak from the grid to the positive side of the filament.

QUESTION No. 72. Is THE INSULATION IN THE RECEIVING AERIAL VERY IMPORTANT?

Answer. The best possible insulation should be employed in any aerial if maximum results are desired.

QUESTION No. 73. GIVE SOME CONSTRUCTIONAL DATA ON A SHORT WAVE WAVEMETER.

Answer. Wind a coil of 25 turns No. 18 D. C. C. wire on a well-seasoned and shellacked wooden form or bakelite tube 3" in diameter. Shunt this coil with a good make of 43 plate variable condenser; the condenser is the determining factor in the wavemeter and great care should be exercised in its purchase. Mount the coil and condenser in a box with an insulating panel; make connections direct (avoid all bends). The dial should be riveted or otherwise firmly attached to the shaft and should be set so that when zero is registered on the scale, the capacity is lowest. Write the Bureau of Standards at Washington for shipping instructions and if you follow them out carefully they will calibrate your wavemeter. The range of this meter will be rather large but use only the portion of the 180° scale between 20° and 160°. In this manner the curves at the maximum and minimum setting are avoided. In asking the Bureau to calibrate the meter, request that one point be taken at 200 meters so that there will be no discrepancy in the finished curve. If you desire, a D. L. 25 honeycomb coil could be used instead of the inductance mentioned.

QUESTION No. 74. WHAT SIZE WIRE SHOULD BE USED IN THE DIFFERENT PARTS OF A RADIO RECEIVING SET?

Answer. No. 14 copper or copper-clad may be used for the aerial, ground and connections. No. 24 double cotton-covered can be used for coils and couplers. No. 16 is a safe size to carry the filament current although a heavier wire will be better when using more than one tube. Square bus wire is best for all other connections.

QUESTION No. 75. I HAVE OFTEN SEEN THE TERMS D. C. C., S. C. C., S. S. C. AND AT TIMES, E. C.—WHAT DO THEY MEAN?

Answer. D. C. C. means double cotton-covered; S. C. C. means single cotton-covered; S. S. C. means single silk covered; E. C. means enamel covered.

QUESTION No. 76. WHAT DETERMINES THE KIND OF COVERING ON WIRE TO BE USED IN MAKING TUNING COILS?

Answer. If distributed capacity is to be kept low for efficiency in operation, D. C. C. is generally used. If small size is required S. C. C. or E. C. may be used with a slight loss in efficiency.

QUESTION No. 77. Give instructions for building a loose coupler to tune up to 2500 meters.

Answer. Use No. 24 D. C. C. on both primary and secondary; wind 400 turns on a 4" tube for the primary with taps every 25 turns. The secondary tube should slip inside the primary and is wound with 300 turns tapped every 25th turn. A series condenser of .001 M. F. is used in the primary and a similar condenser in parallel with the secondary.

QUESTION No. 78. I would greatly like to find a crystal which will give the best results in my set; is there any special one superior to all others?

Answer. Many types of crystals will operate equally well, though occasionally an especially good piece may lead one to believe that type is best. The design of the detector stand will greatly influence the results. Galena is the favorite but silicon will be found to be almost as good and retains a good spot for long periods at a time. A graphite contact instead of the usual copper cat-whisker will sometimes give surprising results when used in conjunction with galena. Carborundum has the advantage of eliminating fine adjustments and is very rugged. Molybdenite, or zincite in combination with bornite, iron pyrites and others have been successfully used. A block of galena may be purchased and broken into small pieces. Some good crystals will most likely be found.

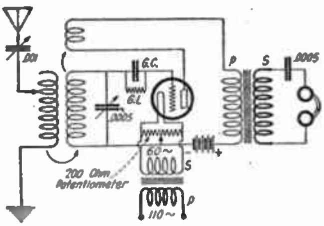


Fig. Q. No 79

QUESTION No. 79. Please give me an efficient hook-up for a one-tube receiver employing A. C. on the filament?

Answer. The circuit requested appears on this page.

QUESTION No. 80. Is it possible to secure good results with such a circuit? Are there any precautions to be observed in making same a success?

Answer. It is possible to secure fair operation, with this circuit, although patience and perseverance will be required. This circuit will not function well with a soft detector tube. A hard tube is required for best results. The potentiometer is of about 200 ohms and is shunted across the filament terminals. Connection from the set to the filament is made at the slider. The growl and roar in the receiver is at a minimum when the slider is located near the center of the resistance. The potentiometer draws very little current from the line. Although this method does not entirely eliminate the alternator hum, it reduces same to a very low value.

QUESTION No. 81. Is it true that with a higher antenna the static becomes worse?

Answer. It is true to a certain extent that the higher the antenna the greater the static, but the increase is so little that it would hardly be noticeable when compared with the increase in signal strength which would be obtained from a high aerial.

QUESTION No. 82. Why is it that my vario-coupler gives no coupling? I can only hear signals when the rotor is horizontal, and when I turn it they gradually die out.

Answer. If you hear signals when the rotor of your vario-coupler is horizontal and they gradually die out until, when the rotor is perpendicular to the stator, you hear nothing, this shows that you are getting coupling. The reason that the rotor is arranged so that it may rotate within the stator is to provide a variation in the inductive relation between the two.