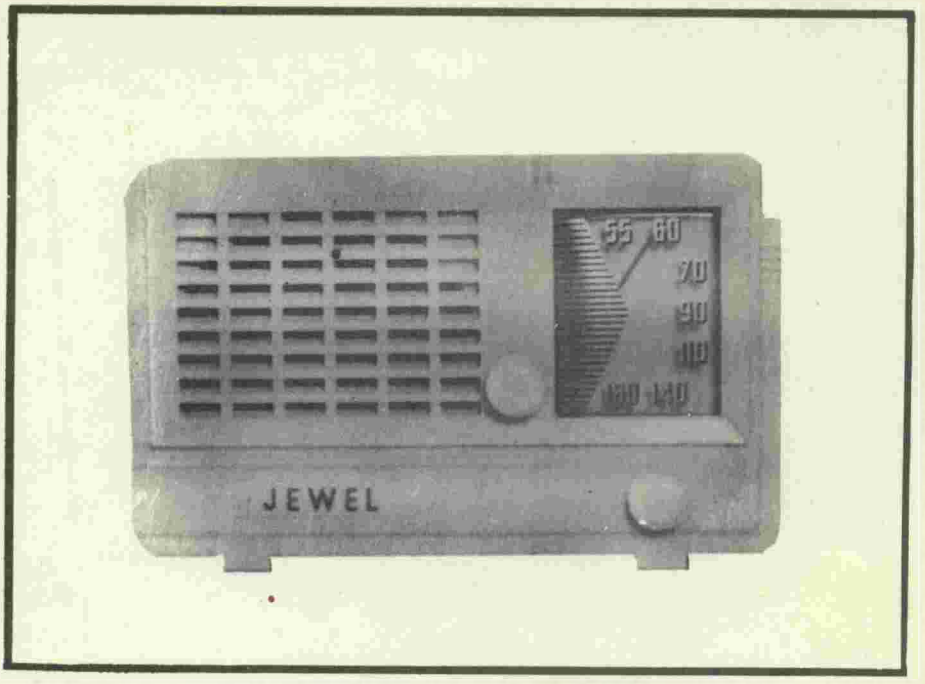


LESSON
1 RA

INTRODUCING YOU TO A-M RADIO

RADIO-TELEVISION TRAINING SCHOOL, INC.
ESTABLISHED 1922
LOS ANGELES

RADIO-TELEVISION TRAINING SCHOOL, INC.

5100 SOUTH VERMONT AVENUE • LOS ANGELES 37, CALIFORNIA, U. S. A.

INTRODUCING YOU TO A-M RADIO

Introduction

In the early days of radio, which were not so very long ago, it was relatively easy to master the basic fundamentals required at that time to service radio receiving sets. That is, the information regarding the theoretical operation of the radio receiving sets was easy to learn in order to handle all of the service problems involved in maintaining this equipment in proper operation. Today, with the introduction of television receiving sets employing many more parts, there are many more problems involved in receiving satisfactory reproduction of both sound and sight portions of the televised program. Although there is a great similarity between radio and television receiving set requirements, there is a tremendous difference in the type of service equipment used by the radio receiving set serviceman and the type of service equipment used by the television serviceman. It is, however, not difficult to learn about these problems but it does take a little longer to master the theory and also longer to do the actual service work.

Since you are going to not only service radio receiving sets but television receiving sets as well, we shall introduce you first to radio receiving sets and then to the more advanced theory about the parts in these sets and eventually tell you about the maintainance problems in keeping radio receiving sets operating. Then, later, we shall follow just about the same procedure with television receiving sets. In both instances we shall first cover the theory about the operation of the equipment and then, later, the problems encountered in maintaining the respective receiving sets in proper operation.

We shall present to you the necessary information that applies in particular to the field of radio-television in which you will specialize and become proficient. Information will be presented in a manner whereby you will be introduced to those items which relate to the particular subject as you progress.

YOUR RADIO

Let us assume, for example, that you are an average American, and that you have in your possession a small radio receiving set. With this set you may listen to any one of several radio programs. Let us assume that this small radio receiving set is in a plastic case. This case has been especially moulded from material that may have been baked at a high temperature and formed to be used as a cover for the set. This plastic material is neither wood nor metal, but very hard and durable. It may be any shade or color, such as brown, red, ivory, or gray. Let your imagination visualize the condition shown in Fig. 1 where you are reading and, at the same time, sitting in front of your radio receiving set.

There are certain things which you now already know about your radio. There are many other interesting things you should know and will learn about your radio. You will learn about those phases of radio which will enable you to eventually service your

customers' sets when you have acquired the knowledge to do this fascinating work.

Although your radio receiving set may be only 9 inches long, about 5 inches high and 6 inches deep, it is one part of a great industry. In nearly every home in the United States of America there is either a radio receiving set or a television receiving set. This is according to the Radio Manufacturers' Association. They have made a survey and found that there are over 70,463,000 home radio receiving sets in operation. Then there are 14,764,000 automobile radio receiving sets and about as many television sets owned by American citizens. To this list we can add several million portable radio receiving sets capable of operating from their own batteries. Thousands of trained and qualified men will be required to maintain them. You will soon become one of the few who know about the names of the different pieces or parts of equipment required to make a receiving set and eventually other important details such as their adjustment for proper performance.

Your own radio receiving set is capable of giving valuable information relating to your welfare as a citizen of the U.S.A. You can receive weather reports, election reports, campaign speeches and general news items. You may also receive the best entertainment made available through radio broadcasting companies from the nation's best and largest studios located in New York and Los Angeles. This information is brought to you through space by the use of magnetic lines of force or radio waves. These lines of force are not visible but, nevertheless, present and mysteriously convey the signal of intelligence (the program) to you for reproduction by your radio receiving set.

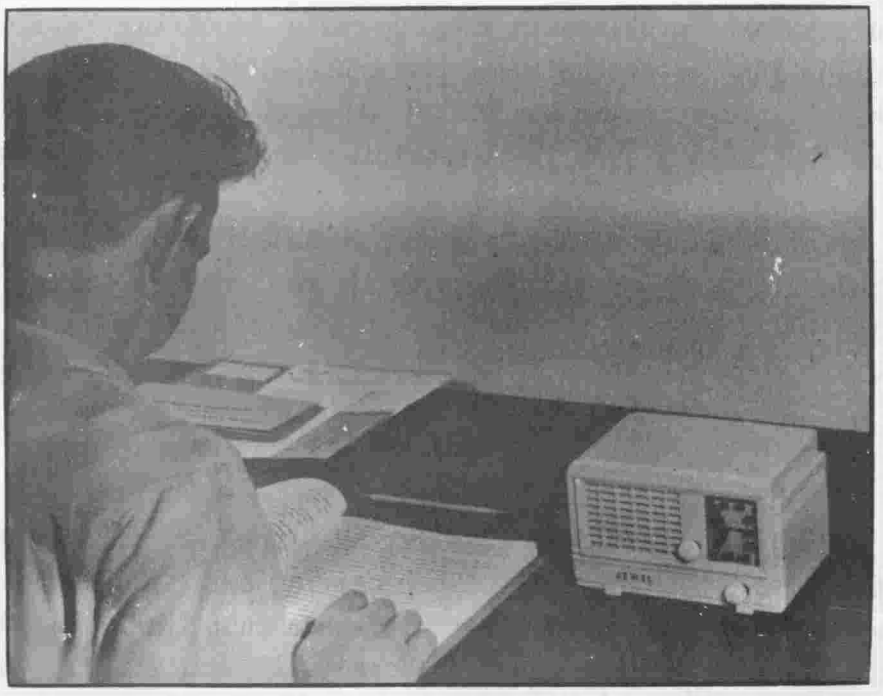


Fig. 1. This may well be a photograph of you studying this lesson in learning about the A-1 radio set.

A few new phrases or expressions have now been presented to you. For example, the phrase "magnetic lines of force" means the application of a force in the form of lines, and these lines are magnetic. They are invisible but yet have an effect of sufficient strength to cause the results we desire. Then the phrase "radio receiving set" has been introduced. This is to distinguish the difference between a radio transmitting and a receiving set. The phrase "radio" is used by many in different ways. Many people merely imply that radio is the entire process of transmission and reception of messages through space by a mysterious means. To these phrases or expressions we can add the "signal of intelligence". This is the actual result or effect the radio entertainer wishes to convey to you. In the transmission of an

oral radio program, it is the sounds, the music, the talking, and sound effects you hear from your radio receiving set.

As these new phrases, terms, and expressions are added, try to obtain the association between the meanings, the ideas we are introducing to you. We know that it is impossible to remember all of them, but by association and constant use you will become familiar with them. We also know that it is impossible to present in one lesson all of the theory regarding a certain phase of radio, so in teaching we use proven methods and apply them to enable you to make the greatest progress. Learning radio is just like building a house of small bricks. It takes a large number of bricks arranged in a systematic manner to give us the type of house we want.

SOUND WAVES

Whenever someone talks to you in person or over the telephone they must produce sound waves. These sound waves, like radio waves, cannot be seen but the presence of them is heard clearly. The strength of these sound waves is known as their volume, or more technically, volume level.

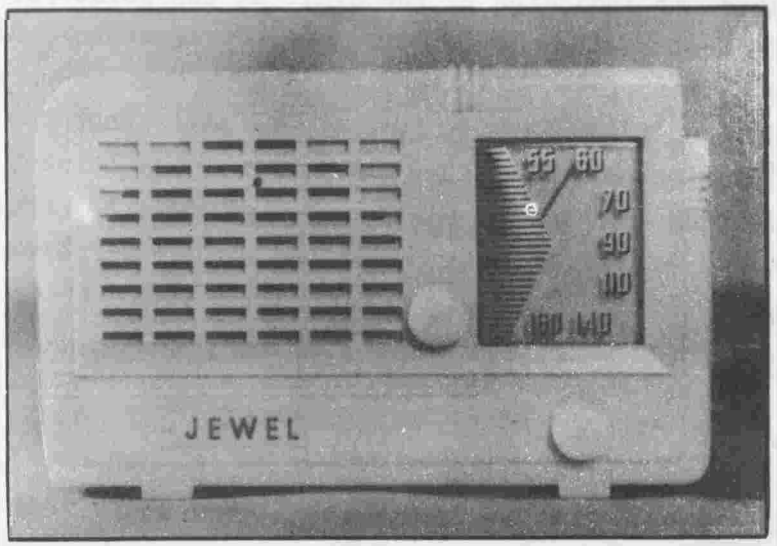


Fig. 2. Close-up view of the radio set. Clearly shown are the numbers 55, 60, 70, 90, 110, 140 and 160 as the dial calibrations.

The sound waves produced by individuals in broadcasting station studios are first converted into varying electrical signals by microphones and conveyed by regular telephone lines, just like a regular telephone conversation, to the various radio broadcasting stations located throughout U.S.A. Then these individual broadcasting stations convert these lines of force and send them by (past) your radio receiving set. You may, if you wish, pick up some of these magnetic lines of force or radio waves and convert them to a satisfactory sound level for your own comfort in your room. Although your radio receiving set is small, it is capable of giving you satisfactory service. By this service we mean a signal that is clear and pleasant to hear.

It may be of interest to you to know that in the early days of radio it was necessary to wear headphones, sometimes called phones, in order to hear a radio program. Today a very compact set will give you comfortable volume level with a degree of fidelity of reproduction which has been unobtainable in the past.

Again let's refer to Fig. 1. Let us look a little bit more closely at the radio receiving set and observe many other details as shown in Fig. 2. This is an enlarged photograph which has been taken of the radio receiving set shown in Fig. 1. Note in

particular that there are two round knobs, one near the center of the set and one in the lower right hand corner. The word "JEWEL" indicates that the set is manufactured by an organization known as the Jewel Radio Corporation located in Long Island, New York, USA.

A closer observation of the front panel of this typical radio receiving set will disclose the fact that there is a grill consisting of vertical and horizontal strips of plastic material. Between these strips there are small openings through which the sound waves pass on their way to your ears.

To the right of the left knob can be seen the numbers 55, 60, 70, 90, 110, 140 and 160. Between the numbers 55 and 60 can be seen the pointer of the dial. This pointer will move when we turn the left knob. The pointer may move to the number 60 and allow us to select a radio program which may be transmitted by a station operating on that dial setting. Then we may turn the left knob a little more and in the clockwise direction and select another radio program transmitted by a radio broadcasting station operated, as indicated by the dial, at the point 70. In other words, the dial is calibrated in numbers from 55 through 160. These numbers allow us to select certain radio channels and, naturally, different radio programs by merely turning the left knob to the desired dial setting. As you rotate the left knob you may hear two programs at the same time. This means that the pointer is half way between the magnetic lines of force sent out by two radio stations. Clear reception will be obtained when the pointer is adjusted to the exact dial setting used by the particular broadcasting station you wish to hear. We shall call this setting the transmitting frequency of the radio broadcasting station.

FREQUENCIES

What do we mean by the word frequency? Now there are various ways of describing this word, however, let's take a very practical one. Let's assume that you are in the left front seat of a passenger car, and that you are driving at the rate of 30 miles per hour. Then to the left of your car you hear a friend say "hello". He is in a car and is also driving at the same rate of 30 miles per hour. Both of you are, therefore, driving at the same speed or frequency. The same thing is true in a general way when we talk about the transmitting frequency of a radio broadcasting station being of a given value. This is another way of saying that the dial of your radio set is adjusted to the transmitting frequency of the radio broadcasting station to which you are listening. In other words, the dial of the radio set is the device which is used as an indicator to aid you in selecting the desired stations.

You will recall that the numbers on the dial of your radio set started with the number 55 and ended with the number 160. These numbers are technical abbreviations for the frequency range through which stations may be received. If we go back to our very practical problem where you were driving an automobile at 30 miles per hour and you heard a friend say "hello", we may let the number 55 mean 55 miles per hour and we may let the number 160 mean 160 miles per hour. Now actually these numbers between 55 and 160 are not miles per hour, but actually a rate of speed referred to as "cycles".

Here we have introduced another new word. The word cycle refers to a repetition or a recurring condition. The wheel of an automobile revolves at a very high rate of speed when the automobile is driven at a high rate of speed. The number of complete revolutions may be referred to as the number of complete cycles. The wheel keeps on repeating its rotation. In a radio set we have parts that keep on repeating their operation. These parts operate at a very high rate of speed.

Let us go back to the dial of the radio set once more, and from a more technical view point, learn what the number 55 means. It is an abbreviation for a frequency of 550,000 cycles. Since a cycle in a radio set is referred to as a complete repetition of a change in a part within a time period of one second, then we can say that we have the set adjusted to a frequency of 550,000 cycles per second.

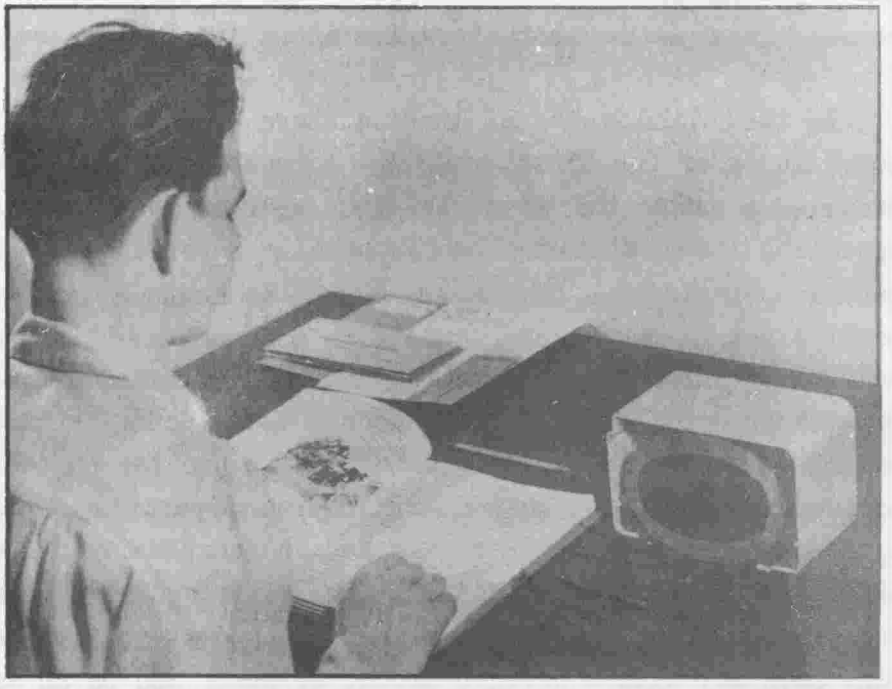


Fig. 3. Rear view of the radio set showing the loop antenna, power cord and plug.

The dial of the radio set was calibrated from the number 55 through 160. This means that we have the ability to tune in radio broadcasting stations operating on radio frequencies between 550,000 cycles and 1,600,000 cycles. This frequency range is known as the "standard broadcast band", and the stations that operate in this band are known as the "standard broadcast stations."

STANDARD BROADCAST BAND

The term "standard broadcast station" means a radio station licensed by the Federal Communications Commission of the United States of America for the transmission of radiotelephone programs primarily intended to be received by the "general public". The station is operated on a channel in the band of frequencies which are limited between 550,000 and 1,600,000 cycles inclusive. Radio men do not like to use large numbers so they divide the numbers by 1,000 and then say that this band of frequencies extends from 550 to 1,600 kilocycles inclusive. A standard broadcast station always sends out a magnetic wave regardless of whether or not sound waves strike the microphone. This wave is known as the "carrier wave" and it is transmitted in the center of the standard broadcast channel. The "standard broadcast channel" means the band of frequencies occupied by the carrier wave, which is really the magnetic lines of force and often known as the radio

wave carrying the program and the excursions taken by the broadcast signal as the radiotelephone program is transmitted. These excursions extend above and below the assigned broadcast channels. This is why the broadcast channels are separated 10,000 cycles or 10 kilocycles. For example, a standard broadcast station operating on a frequency of 600 kilocycles will have excursions which extend above and below this assigned frequency. This means that the channel for a standard broadcast station operating on 600 kilocycles will extend from 595 to 605 kilocycles in its normal process of operation.

Standard broadcast stations operate on frequencies separated in steps of 10 kilocycles. For example, a station may be operating on 550 kilocycles, another 560 kilocycles and another on 570 kilocycles, and so forth on up through the band to 1,600 kilocycles. This means that there are about 104 broadcast channels in the broadcast band.

In the United States of America there are over 2,000 broadcasting stations in operation. In order for these stations to operate in the broadcast band which has only 104 channels, a number of stations must operate on channels used by other stations. By separating these stations geographically several hundred miles, interference from one station operating on the same channel as another station is not too serious. A very specific set of rules and regulations are enforced in order to maintain the minimum amount of interference between the various standard broadcast stations. This is done to give the greatest number of listeners satisfactory broadcast station service in their respective sections. This is also done to provide the best service for listeners using receivers having a low degree of station separating ability. This is known as a "low degree of selectivity". For example, an inexpensive receiver with but a few parts may not receive distant broadcast stations satisfactorily because of interference from other more powerful broadcasting stations. Broadcast stations are licensed to operate certain hours each day with a certain amount of power and on an assigned frequency.

A-M RADIO RECEIVING SETS

All of the standard broadcast stations operating in the broadcast band, extending from 550 to 1,600 kilocycles inclusive, are licensed to use certain specific amounts of power. This power is known as the carrier power. This carrier power is developed by a radio transmitting set. This carrier power is then conveyed to a vertical steel tower called an antenna. From this antenna the magnetic waves radiate in all directions. The carrier power is, therefore, the amount of power which is conveyed by the radio transmitting set to the antenna of the entire gathering of equipment known as a "broadcasting station". Since this power is varied in intensity in accordance with the sound levels produced in front of the microphone in the broadcast stations studio, we say that the carrier of the broadcasting station is amplitude modulated. The word "amplitude" indicates the relative intensity of a given signal and that signal may be the signal transmitted by the broadcasting station. Here the word "modulated" means a variation of the carrier power (signal) by the sound signal. Since the carrier wave of the standard broadcast station is varied in accordance with the sound pressure in front of the microphone at the studio, and this variation is impressed upon the carrier wave when the wave

is modulated in intensity in direct proportion to the pressure of the sound wave, we obtain "amplitude modulation." This is the type of signal received on your radio receiving set. Your set is, therefore, an "a-m radio receiving set."

THE ON-OFF VOLUME CONTROL

The lower right hand knob serves two distinctive purposes. When this knob is first turned in the clockwise direction, then we will hear a snap. This snap is the operation of a switch that completes the power circuit. Yes, we must apply power to the radio receiving set in order to hear the program. This power is usually supplied to the set in order to hear the program. This power is usually supplied to the set through a six-foot long single cord having two flexible wires within it. This cord is usually permanently attached to the rear of the set and has at its other end a "double-prong plug". This plug is similar to the plugs used on portable desk and floor lamps as well as other electrical appliances found in the American home.

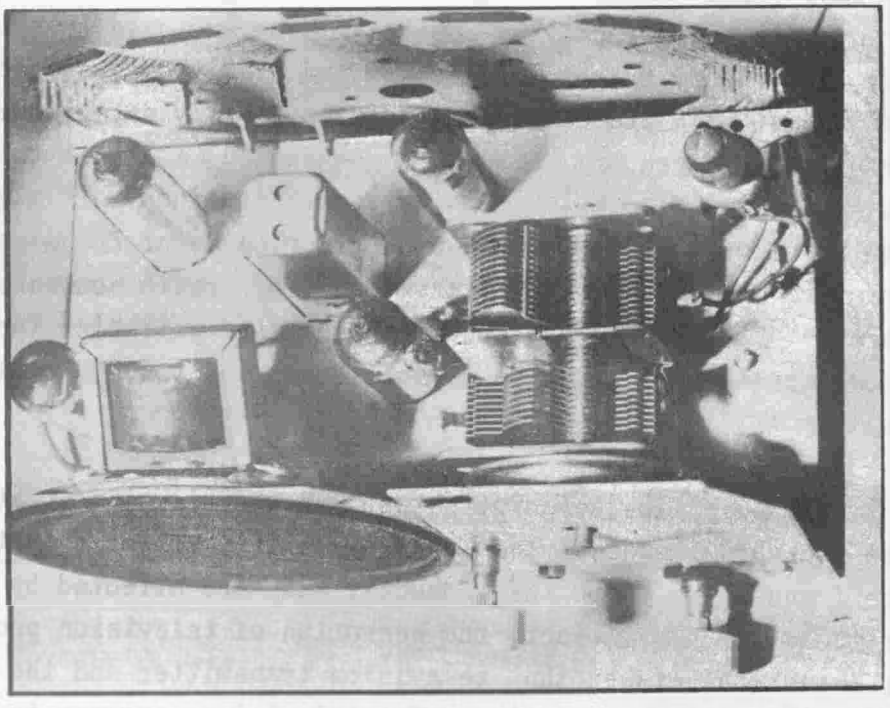


Fig. 4. This is the way the chassis of the radio set looks after removing the cabinet. Note the loop antenna at the rear, the variable capacitor which is above the two knobs, and the 4 tubes as well as the loudspeaker at the left.

As the right hand knob is first rotated in the clockwise direction, we first hear this snap and after waiting a few seconds, about thirty seconds, the set is ready to operate. During this time power has been applied to small vacuum tubes of special characteristics designed especially for use in radio sets. When these tubes have reached their operating temperature, then the various parts in the set begin to operate and as a result we may hear sound waves coming from the opening in the grill to the left of the left knob. This sound signal will be heard from a part in the receiving set called a loudspeaker. The loudness of the sound can be adjusted by setting of the right hand knob. This right hand knob is, therefore, properly referred to as a volume control. Since this control also turns the power on and off, we refer to it as the on-off switch and volume control. Now the setting of this volume control for a comfortable loudspeaker volume will also depend upon the intensity of the magnetic waves passing your radio set from a broadcasting station located in your section of the country. If you listen to a station located nearby, then we may refer to this station as a local signal or local station. When you listen to a station located many miles away, you may refer to this station as a distant signal or distant station. Since the various broadcasting stations use different amounts of power for the transmission of their programs,

it is sometimes possible to receive a distant signal with greater volume and clarity than a local signal.

THE RADIO SPECTRUM

You now know that the standard broadcast band extends from 550 to 1,600 kilocycles. This band of frequencies is but a very small section of the entire band or range of frequencies used for radio transmitting and receiving. The entire band is referred to by radiomen as the "radio spectrum". This useful band extends from about 10 kilocycles through and above 30,000,000 kilocycles. It is customary to express a large number of kilocycles in megacycles. For example, 30,000,000 kilocycles is known as 30,000 megacycles. This means that there are a large number of other bands and types of radio transmitting and receiving units. These are used by not only private companies set up for the primary purpose of sending and receiving messages by radio, but also the Federal Government with its channels (bands) primarily established for the guidance of ships and airplanes. There are bands of frequencies assigned to amateur radio stations, police stations, and also television broadcast stations. It might be of interest to point out at this time that certainfrequenciesor bands of frequencies are best suited for certain specific types of radio transmission or radio communication. For example, those frequencies near and above 10 kilocycles are suitable for point to point communication. Those frequencies above 50 megacycles to above 1,000 megacycles have proven to be satisfactory for television broadcasting purposes.

We would like to point out to you at this time that the bands of frequencies below the standard broadcast band are very little affected by the presence of mountain ranges. The frequencies above the broadcast band are affected by the presence of mountain ranges in their paths. In fact, the reception of television programs require a direct line of transmission between the television transmitter and the television receiver. That is, the successful transmission of a television program to its receiving point must be a straight line as if the radio signal were a beam of light. Any objects in between the television transmitter and the television receiver will stop and reflect the magnetic lines of force.

ELECTRO-MAGNETIC WAVES

Earlier in this lesson we told you about magnetic waves going past the radio receiving set. These magnetic waves are really known as electro-magnetic waves. An antenna is a metal object such as a wire heldinspace above the earth. These waves travel through space just like the magnetic lines of force act upon a magnetic compass. When they pass through the walls of a house by the antenna in a receiving set, some of the lines of force cut the pickup device (the loop antenna) on the radio receiving set.

Now let us turn the radio set around and look at the rear of the cabinet. The rear of the set is shown in Fig. 3. Here we see an oval-shaped part that looks somewhat like a circular spider web. Actually we have about 100 turns of fine copper wire woven in a

zigzag manner between the small projections and around a cardboard-like form.

Copper wire is used in radio sets to convey the signals from one part to another. Since copper wire is a good conductor of electrical signals, it must be covered by a non-conducting material. This material may be cotton, silk or rubber. Whenever a wire is covered with this non-conducting material, we generally describe the wire as being insulated. If the wire is made of copper, then we can say that insulated copper wire is used in making the loop antenna.

Only a certain number of turns of insulated copper wire may be used for the reception of broadcast signals. This is true because the number of turns determines the number of waves on which the broadcast is sent.

POWER PRESSURE

You will also observe in Fig. 3. the power cord and plug. Generally the plug of this cord is inserted into a wall outlet which has been designed for it. From the wall outlet, we receive power and the amount of power available is expressed in electrical pressure measured in units known as volts. In the U.S.A. most of the convenient wall outlets provide a pressure between 110 to 120 volts. Since this pressure is expressed in volts, we may say that the wall outlet provides a voltage from 110 to 120 volts. The usual power line voltage is 115 volts. A radio receiving set or a TV set will operate satisfactorily for any voltage between 110 and 120 volts.

THE CHASSIS OF YOUR RADIO

It will now be interesting to remove the knobs from the front panel of the radio set shown in Fig. 2. Remove the screws from the bottom of the cabinet and carefully pull out the chassis, that is, the works from the cabinet of your radio. Of course you must remove the knobs. Most knobs are easily removed, and generally by merely pulling them off. A straightaway pull will generally cause the knobs to slip off the shafts of the controls on which they are used. Sometimes a small screwdriver is necessary to loosen the small set screw in the side of a knob.

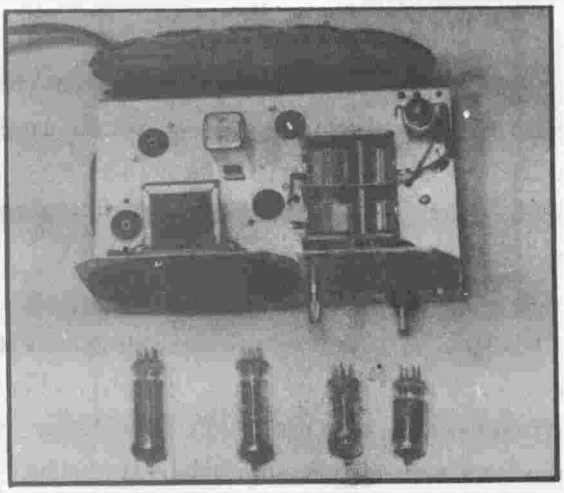


Fig. 5. This photograph shows the four miniature glass tubes after they have been removed from the chassis.

After you have removed the chassis from the cabinet, you may then again place the knobs on the shafts. Then turn the set around and view it from the top as shown in Fig. 4. This view gives you another inside glimpse of the equipment on the chassis and within the cabinet of a radio set. Note how it is possible to see the dial pointer. The circular black object to the left of the center knob is the "diaphragm of the loudspeaker," the sound-producing device.

Just to the right of the center knob can be seen a device with thin plates which have been pressed into a round shaft to which the dial pointer has been attached. This device is known as a "variable capacitor". It has the ability to store a certain amount of electrical energy, and at the same time make it possible to store various amounts of electrical energy because it is variable.

Just to the rear of the loudspeaker and, in fact, mounted on the loudspeaker supports, we find a rectangular unit. This device is known as a "transformer". It is capable of forming the signals that have been amplified so that they can go from one circuit to another. It has many small sheets of iron held in a rectangular form about which are wound many turns of insulated copper wire.

The top view of the chassis, as shown in Fig. 4, indicates that there are four small radio tubes. These tubes have been removed from the chassis and are shown in Fig. 5. Some radio sets use four tubes, others use 5, 6, 7 and more. The greater the number of tubes generally indicates the relative value or cost of a set. The larger the loudspeaker, the larger the chassis, and the greater the number of tubes, the better will be the sound quality or the more natural will be the reproduction. This is known as the "degree of fidelity" and also the better will be the sensitivity of the set. The sensitivity is the ability of a set to pick up a signal that is not very strong and amplify it to the proper level for satisfactory reception or reproduction.

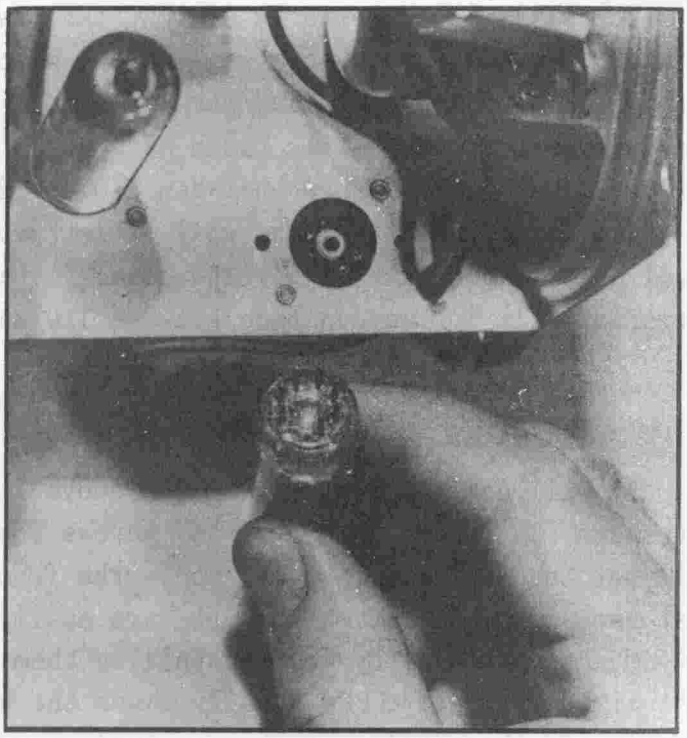


Fig. 6. This photograph shows the relative size of a miniature glass tube having a 7 pin base. The 7 pins go into the 7 openings in the socket in the chassis. Note that the 8th pin has been removed.

Radio tubes are designed in various ways. The particular tubes shown in Fig.5 are known as the miniature glass type. Although they are small they are, nevertheless, very efficient.

In Fig. 6 you may obtain a better impression of the relative size of a miniature glass tube. Here we photographically show you how the pins project out of the base of a miniature glass tube. It has been removed from the socket. Note in particular that there are seven pins visible and that one has been removed. These pins are often called "prongs". The removal of this prong enables us to insert the tube in the socket in the proper way so that the various parts below the chassis will always be connected to certain prongs of the tube. This means that each and every pin on a tube is connected by wires to certain electrodes within the tube for a specific reason. This also means that certain parts below the chassis are connected by wires to certain pins on a tube socket.

A BLOCK DIAGRAM

The tubes used in radio sets have different shaped electrodes in them for the purpose of obtaining certain types of performance in different sections of a radio receiving set. These tubes, therefore, are assigned numbers and we refer to these numbers as the "type number" of a tube. A tube type number is usually preceeded by a number which indicates the electrical pressure which is applied to the heater within the tube used for the purpose of heating it to the operating temperature. This first number is then followed by two letters which further classify the tube. These letters are assigned by tube manufacturers. Following these two letters appears a number indicating the total number of electrodes in the tube. For example, a tube in the set may have the type number 6AB5. The number 6 indicates the number of volts applied to the heater. The heater voltage, therefore, may be 6 volts. The letter A may indicate that the tube is to be used as an amplifier. The letter B may indicate a certain class of amplifier. Then the number 5 will indicate the total number of electrodes within the tube.

Whenever tubes are removed from a radio chassis, the trained serviceman will draw a block diagram. A typical block diagram is shown in Fig. 7. Here we find a rectangular image with four circles and within the circles appear the type numbers of the respective tubes taken from the radio set shown in Fig. 2. With the aid of this block diagram it is possible for the radio serviceman to replace the tubes in their respective sockets and obtain satisfactory operation. In other words, it is very important to insert the tube in the proper section of a radio receiving set.

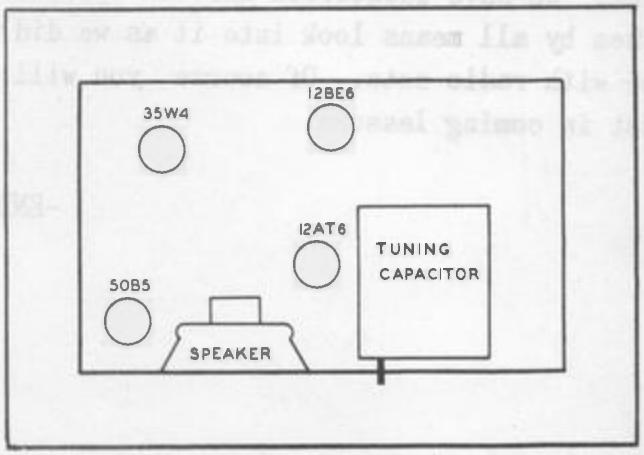


Fig. 7. This block diagram shows the location of the different types of tubes used on the chassis of this radio set.

TERMS

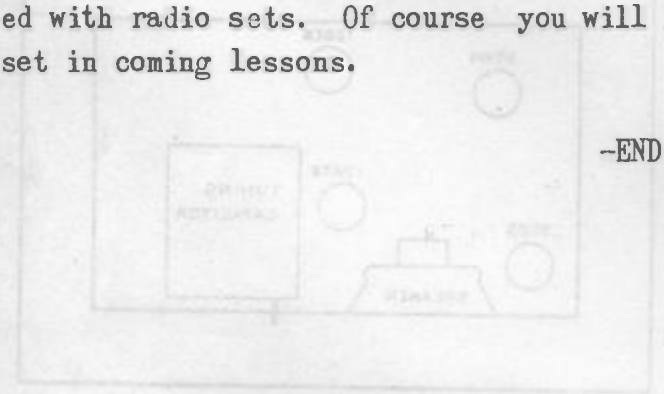
In this lesson we have introduced you to certain specific radio terms. You will hear them again and again. Let us review many of these terms in order that we become better acquainted with their application. By knowing their application we can remember their meaning.

Earlier in this lesson we referred to the plastic cabinet on which the tuning dial knob and the on-off switch volume control knob were located. The knobs may or may not have set screws to hold them on. Within the cabinet we found the chassis on which the variable capacitor, the loud speaker and the transformer as well as the different tubes and the non-conducting material used with the loop antenna usedforintercepting electromagnetic waves in the radio spectrum. Then the power line voltage is carried through the flexible power cord with its double-prong plug was referred to in supplying power to the set. We, therefore, have now assembled a complete group of specific radio terms and identified nearly every part on the radio receiving set.

The face of the dial, sometimes known as the "station selector", of the radio receiving set introduced you to its calibration indicating its relation to the standard broadcast band in which standard broadcast stations operate with their carrier power which is amplitude modulated. Then when listening to the signal of intelligence with a low degree of fidelity from a local signal or a local station, and on the other hand, from a distant signal or a distant station, you now know the relative difference between these technical terms. Each of these terms associated with the radio receiving set and the standard broadcasting station operatinginthe standard broadcast band were explained in detail in the lesson. Later you were told about the procedure followed in removing radio tubes from a chassis and how the radio serviceman used a block diagram to aid him when replacing tubes in their proper sockets because they have a specific number of electrodes. You were given information on tube type numbers and their significance.

CONCLUSION

In this lesson we have introduced you to many interesting facts about a small radio set. We have identified certain specific parts used in a set. If you have a radio set then by all means look into it as we did in this particular instance and become acquainted with radio sets. Of course you will learn many more facts about the parts in your set in coming lessons.



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