Electronics
Radio
Television
Radar

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IDENTIFYING ELECTRONICS PARTS

ASSIGNMENT 2

IDENTIFYING ELECTRONICS PARTS

Industrial electronics equipment and radio and television receivers have much in common. Although they may be doing a different job—the industrial electronics equipment may be controlling a production process, whereas a radio receiver is merely reproducing entertainment—these units operate on the same basic principles. They also use the same basic parts—coils, capacitors, resistors, tubes or transistors. At this time we are going to look at some of the parts, to become familiar with them and how they are used in actual equipment.

In Assignment 1 we looked at the basic principles of the transmitter and receiver of the radio and television broadcasting system. Let us now continue our study of electronics in a practical way, by using a small, table-model receiver—such as can be found in nearly every home, or can be borrowed from friends—as our first practical project.

It is suggested that you read through this entire Assignment at least once, to get a mental picture of just what the Assignment covers. Then, go through it paragraph by paragraph, with the actual radio before you. For the present, we will **look** at the various component parts and examine the connections. This will give us a world of knowledge about the parts used in all types of electronics equipment. If we understand the directions and follow them carefully—if we do not make any changes or adjustments—the radio will remain in good condition. In fact, the radio will be in better operating condition when we finish than it was when we started.

The choice of a radio to use in this assignment is not at all critical—almost any will do, from the smallest to the largest. However, a small table radio somewhat similar to that in Figure 1 is easier to handle, and you will have less chance to become confused by connections to a phonograph, extra loudspeakers, etc. We **do not** recommend that you use a transistor radio for this project.

A Word of Caution

A word of caution is in order before we begin. On some of the parts in the radio—for example. on the tuning capacitor and the I-F transformers with which we will become familiar presently—there may be a number of screws or nuts, which may seem to need tightening. However, none of these should be turned or tightened under any circumstances. These screws or nuts may be for the purpose of adjusting critical circuits in the receiver, rather than to just "hold things in place." If you were to move any one of these as much as a quarter of a turn, one way or the other, it might make the radio completely inoperative.

Rough-Testing the Receiver

Having selected our radio, we should first of all "rough-test" it. This simply means to check to see if the radio is in proper operating condition. If it is an a-c radio, check to see if the line cord is in good condition, the insulation is not frayed or worn through, the plug is not broken, and of course, the plug must be securely plugged into an outlet of the proper voltage and current. If it is a battery model, we should see that the batteries are good and that they are connected properly. Next, check to see that the antenna and ground wires—if used—are in good condition and properly connected. Most small table-model radios have a built-in antenna with provisions for adding an outside antenna, if necessary. Few modern table-model radios use an outside ground wire and unless there is a connection clearly marked "ground" on the radio, never use one. If a ground wire is connected to this newer type receiver, or if the metal chassis or base of the receiver comes in contact with some metal such as a waterpipe, the house fuses may be blown and the radio damaged.

The next step in our rough-test examination should be to turn the radio on and by operating the various knobs or controls, see what effect they have on the operation of the radio. Having assured ourselves that the radio is operating satisfactorily and that we know what each of the knobs does to the operation of the radio, let us turn it off again and disconnect the antenna and ground wires (if used) and remove the a-c plug from its socket. Begin at once to practice the correct way for doing each job. For example, to remove the plug from the socket, pull on the plug itself and not on the wire. In removing the antenna and ground wires, tag them or write down their color scheme to insure being able to reconnect them properly, with the least amount of trouble and effort. An expert electronics technician plans his every step and goes through the operation first in his mind. Then, he follows through with the actual operation.

Removing the Knobs

Now let us carefully examine the radio we are using in this Assignment and see what we can learn about it. For example, it probably has several knobs which must be removed if we want to take the radio chassis out of the cabinet. These knobs fit over a metal shaft which is a part of some component in the radio. Often the knob is held in place by a small metal "set screw". Looking at the side of the knob rather than the front, and rotating it, we may see a small opening and inside of this opening, the head of the screw. To remove this type of knob, loosen this screw with a small screwdriver and pull lightly on the knob. Of course, standard screws may be loosened by turning the screw to the left or counter-clockwise and tightened by turning the screw clockwise. Later on, when the knobs are replaced, the set screws should be tightened just enough to keep the knob from slipping on the shaft.

If the examination of the sides of the knob discloses no set screws, try pulling on the knob. On a great many modern radios the knobs are held in place on the shaft by a flat spring and may be removed by pulling on the knob. It may be necessary to pry it off with a small screw-driver if it fits very tightly, but care must be taken not to scratch the cabinet or break the knob. After you have removed the knob, notice how it fits on the shaft and plan to replace it in exactly the same way.

Removing the Chassis

Now we shall examine the entire radio cabinet, paying particular attention to the bottom and back in order to see how the chassis, or radio proper, is held in place. Probably several screws or bolts hold it in place and these will have their heads coming out the **bottom** of the cabinet. When all the necessary bolts have been removed, the chassis should slide out easily from the cabinet. Be careful not to damage the speaker and the dial assembly. If the speaker is not a part of the chassis and does not come out with the chassis be careful not to break or damage the wires leading to it. Sometimes these wires terminate in a plug which may be pulled out; sometimes they are connected by screws, which, when loosened, enable them to be removed. When removing them, be sure you are able to connect the proper wire to the proper point when you wish to replace it. Also, in removing the chassis from the cabinet, notice how everything fits together so that you can reassemble it quickly and easily.

Figure 2 shows a typical table model receiver chassis after it has been removed from its cabinet.

If the receiver uses a speaker which is mounted on the cabinet rather than on the chassis, let us remove it from the cabinet. We will notice that it is fastened to the cabinet by several bolts and nuts, the bolts most likely having ornamental heads without screwdriver slots.

A pair of pliers or a small wrench will enable us to remove the nuts from the back, but be careful not to allow the tool to slip and punch a hole through the paper speaker cone, thus ruining it. Notice how the bolts are made so that they do not slip or turn, even though we cannot hold them in place with a screwdriver.

If the radio chassis has not been removed from its cabinet for some time, the chances are it will be quite dusty. The next thing that should be done is to clean it up. This will serve two purposes. First, it will make the radio play better when we have finished, since dust and dirt are two major enemies of electronic circuits. Second, by cleaning it thoroughly, we will notice more things about the radio. If this radio were one we were attempting to repair, we would be likely to notice things like burned resistors, capacitors with the wax melting and dropping out of them, broken wires and poorly soldered joints, worn or chaffed insulation, etc.

In cleaning the radio we should be careful not to disturb any of the adjustments or the wiring. The best way to clean it is with a small, soft brush and pipe cleaners and by blowing occasionally to remove dust deposits. A soft cloth also may be some help. We can remove the tubes **one at a time** being sure to replace them in their original sockets. Since the a-c plug is pulled out of the socket we need not worry about touching any of the parts and getting a shock. However, any time the radio is turned on, common sense should tell us to be careful where we place our hands and fingers. All radios (except the smallest battery sets) employ voltages of 100 volts or more and under the proper conditions contact with this voltage could be very unpleasant. Even if this voltage is too low to be injurious, contact with it might cause us to jerk our hand away and break something or cut a finger.

After the radio has been cleaned the control knobs should be replaced on their shafts. This is a precautionary operation, since the circuit wiring of some radio receivers is so arranged that it is possible for a person to be shocked if he touches the chassis or the control shafts at the same time he touches some grounded object, such as a radiator, if the power cord is plugged into a receptacle. If the speaker of the set has been disconnected from the chassis, let us now reconnect it in the original manner. Then connect the antenna and ground wires (if these were disconnected) and plug in the power cord. Now we may turn the radio on again. Notice that the radio will play without the cabinet but that the tone will not be as good. After this second operating test, pull the power cord out of its socket again.

What the Knobs Do

Now, let us see to what each knob connects and what this part does. First, notice that the knob which is used to tune in the desired radio station is connected, probably by a cord or cable, to both the dial mechanism and to a part made up of a number of fixed and movable plates. Notice that as we turn the knob the dial pointer moves and the movable plates are more or less enmeshed with the fixed plates. These two sets of plates should never touch each other or short together so we must be careful not to bend them. This part is known as a **variable capacitor**, or **tuning capacitor.** This capacitor usually consists of two or three variable sections and we say that they are "ganged" together. Each section of the ganged tuning capacitor consists of two parts, (1) a rotor and (2) a stator. The rotor of each section consists of the plates which rotate while the stator consists of those plates which remain stationary.

The stator and rotor plates of the ganged tuning capacitor of a typical table model receiver are shown in Figure 3. It is the purpose of this tuning capacitor, in conjunction with some coils, to select the desired station from the thousands which are on the air at any hour of the day or night.

Mounted on the top of the side of the ganged tuning capacitor are small semi-variable capacitors, called trimmer capacitors. These capacitors may be seen in Figure 3. These capacitors usually consist of two small plates of metal separated by a sheet of mica. A slotted screw is used to adjust these capacitors. At the present time, these adjusting screws should **not** be moved.

Examine carefully the dial cord assembly with its springs and pulleys. Quite frequently these dial cords break and the serviceman often has nothing more to go on than his experience and common sense in determining how to string a replacement cord. Figure 4 is a drawing of the dial cord arrangement of the receiver shown in Figure 2.

Also notice that the dial pointer will read "55" or beyond when the variable capacitor is completely in mesh and somewhere between "150" and "170" when the variable capacitor is completely out of mesh. The manufacturer's service instructions for this particular receiver more than likely tell exactly where to set the pointer when the capacitor is completely out of mesh.

If the radio which is being examined has push-buttons for rapid tuning, try pressing them one at a time, and notice what happens in the receiver. There are two types of push-buttons in general use in modern receivers. One type of push-button rotates the tuning capacitor when it is depressed. The other type of push-button operates a small switch when it is depressed.

The remainder of the knobs on the front of the receiver probably control parts which are mounted under the chassis, so let us turn the chassis over. Most receivers may be turned upside down without damage, when out of their cabinet, if we are careful with the loudspeaker and dial mechanism.

The knob which controls the volume of the radio rotates the shaft of a variable resistor known as a **potentiometer.** This unit will be discussed in detail later and a typical potentiometer is illustrated in Figure 5.

If the radio has a tone control, it probably consists of another potentiometer although in some sets it may be connected to a 2 or 3 position switch.

In most radios the on-off switch is a part of the volume control. This also will be discussed with potentiometers.

If the radio has one or more short-wave bands on it, the knob used to select the proper band will be fastened to the shaft of a switch similar to the one illustrated in Figure 6. Examine this switch carefully noting the number of sections or "decks" and the number of contacts on each deck. The one contact which is moved around and always connected to one of the other contacts is usually referred to as the "wipe". Watching it as you operate the switch, see if you can discover why.

Connected by wires to this switch are a number of coils. Even if the radio you are using does not have a short-wave band you will be able to see at least one coil mounted somewhere on the chassis, either above or below. This coil will consist of many turns of very fine wire wound around a cardboard or wood form. If your radio has a short-wave band, you will notice that some coils have fewer turns and larger wire on them than others. Some short wave coils may have only 6 or 8 turns of much heavier wire on the form. In some receivers, both the broadcast and the short-wave coils may be wound on the same form.

Parts Above the Chassis

Now let us return to the top of the chassis and observe the following parts with which we will now become familiar: Vacuum tubes and sockets, filter capacitors, cans containing coils, and the power transformer.

The vacuum tubes may be of various types and they may have either glass or metal envelopes. Examine them closely, being careful not to break the glass loose from the bakelite or metal base. Let us remove them one at a time. They may be removed most easily with an upward motion while slightly rocking them from side to side. Notice how the tubes plug into the socket, paying particular attention to the spacing and arrangement of the prongs. The earlier types of tubes have from 4 to 7 prongs. These tubes have two prongs which are larger than the others so that they may be plugged in their sockets only one way. Later types of tubes have 8 equally spaced prongs and in the center have a keyed guide to prevent them from being plugged in incorrectly. Many newer receivers use new style, miniature tubes which are about the size of your finger and about 1½ inches tall. These tubes have unequal spacing of the prongs to prevent them being inserted in their sockets incorrectly. Notice the type numbers stamped on the tubes. Some tubes have 2 numbers only (such as 27 or 45), while still others have 1 or 2 numbers followed by a letter or two and then another number (such as 12SK7 or 6V6). Older radios may contain tubes numbered with three numbers (such as 224 or 484). Tube numbers followed by G or GT are glass versions of tubes also made in metal types, and are usually interchangeable with the metal versions. On a piece of paper, jot down the type number of each tube, and the number of prongs on each, in the radio you are examining.

Later on we will learn about the tube numbering system for vacuum tubes and will study in considerable detail just how tubes work. Turn the chassis over and notice how the tube sockets make contact with the tube prongs. Also notice how the wires leading to other parts of the radio are fastened to the sockets.

Every radio has one or more filter capacitors which may be in any one of several forms or shapes. Sometimes they are enclosed in metal cans or containers and are located on top of the chassis. In other receivers they may be in cardboard boxes or tubes and located under the chassis. The filter capacitors can always be identified by the markings on the container which will usually read something like "50-30 MFD, 150 VDC, 200 VSP", or "16 MFD, 450 V". If your radio has a filter capacitor marked as our first example, it means that there are actually two capacitors in the container. One of them has an electrical size of 50 MFD (50 microfarads) and the other 30 MFD. Both capacitors are rated for maximum steady d-c voltage of 150 volts and they will withstand voltages as high as 200 volts for very short periods of time without breaking down. If the container has just a single capacitor in it, it will probably have two wires coming out of it. If there is just one wire, and it is in a metal container, the can itself is the other connection to the capacitor. If there are three wires coming out of a cardboard container, the chances are that there are two sections and one of the wires is common to both sections. When the two capacitors in a single container are of a different size, the markings will usually give the color of the wires leading to each section. The filter capacitors are one of the things that most often "wear out" in a radio receiver, or other electronic equipment.

A number of different types of filter capacitors are shown in Figure 7. The capacitors shown in Figure 7(A) are the metal cased capacitors and are usually mounted in an upright position on the top of the chassis with leads coming out below the chassis. Figure 7(B) shows two types of cardboard cased filter capacitors. These types will be located below the chassis.

You will probably find several **square aluminum cans** mounted in an upright position above the chassis. Keeping the location of these cans in mind, turn the chassis upside down and notice that there is a small round opening directly beneath each can. There will be connecting wires coming through this opening, and if we look through the opening we should be able to see a radio coil or transformer mounted inside the can. There will probably be small holes in the top of these cans and through these holes can be seen the heads of screws. Under no conditions, at this time, should these screws be turned. The metal cans are called shields. Figure 8 shows what is inside one of these shield cans. The component inside of the shield can is called an "I.F. transformer". Later in the training program we will learn just what this component does in the circuit.

If the radio you are using will work on a-c (alternating current) **only**, you will usually find that it contains a power transformer.* The power transformer can be identified by its large size and the fact that it contains a number of thin sheets of iron stacked together. Around this iron core are wound many turns of fine wire. The winding may or may not be seen on the transformer in your set (if it has one) depending upon the type of case on the transformer. Figure 9 shows three styles of power transformers. Figure 9(A) is called a universal mounting, Figure 9(B) is called a vertical shielded transformer, and Figure 9(C) is called a flush mounting transformer.

If your radio works on both a-c and d-c, it will not have a power transformer. Sometimes these sets have a third wire in the supply cord. This wire is made of a special material and is quite similar to the heater element of an electric toaster. If the radio uses this, you will notice that the line cord becomes warm when the set is in operation. Should this type of cord become worn or frayed, it must never be cut and shortened, but must be removed and replaced by a similar complete cord.

Although not very common among the table model radios, some of them use a smoothing or filter choke. In appearance, this is quite similar to the power transformer, but can be distinguished from it by being smaller and having only two wires coming out of it. This filter choke consists of a stack of iron laminations or plates around which which are wound many turns of wire.

Let us look at the speaker carefully. Notice that it has a paper cone or diaphragm. Carefully touch this and notice that it moves in and out slightly. Turn the radio on and tune in a program. Now touch the speaker lightly and notice that it is vibrating. If we wait for a pause in the program we will notice that when there is no sound coming from the radio, this paper cone will not be vibrating. Let us turn the radio off again and disconnect the line cord. Perhaps our radio has mounted on the speaker a small trans-

*This may not be the case if it is a clock-radio, or a radio-phono combination.

former with two wires going down into the speaker and two wires going back into the radio chassis. This is the output transformer. If this is not the case, we will always see two wires coming out of the speaker. Follow these until you find the output transformer. Figure 10 shows a loudspeaker with its output transformer mounted on it.

Parts Under the Chassis

We will now return to the parts underneath the chassis. In addition to the sockets for the tubes and the potentiometers, switches and coils already mentioned, we will find resistors of all types and sizes, small fixed capacitors and a maze of interconnecting wires. The resistors look like small round rods varying from a half an inch to an inch or more in length, having wires coming out of each end of the rod, and have several colors painted on the body of the resistor. Older resistors may have stamped on them their electrical size such as "50,000 ohms" whereas the newer ones have their electrical size marked by means of these colors. We will learn to read this code when we study resistors in greater detail.

The fixed capacitors in the radio are probably of several types. A common type consists of round rods, larger in diameter, and longer than resistors and these usually have cardboard or plastic on the outside with their electrical size and voltage rating printed on this wrapper. See if there are any in your radio marked ".05 MFD, 400 VDC". Like resistors, these capacitors have a wire coming out of each end. This type of capacitor is often called a "paper capacitor". Another type of capacitor most likely found in the radio is the "mica or postage stamp" type. These are about the size of a postage stamp and have a flat bakelite case with a wire coming out each end. Sometimes they have their electrical size stamped on them, such as .0001 MFD, and sometimes this is coded by means of 3 or 4 colored dots painted on them. We will learn this color code when we study fixed capacitors in greater detail.

Other capacitors are flat discs, about the size of a dime, and have two or three leads coming out of the edge of them. These usually have the electrical size stamped on them.

Look carefully at all the parts on your radio, top and bottom, and be sure that you can name them. This is what we have tried to accomplish so far, for we must know the names and the main points of appearance of every part before we can go on. Also, the workmanship under the chassis will tell you a great deal about the quality of the receiver you have. The better sets have the parts neatly wired in and the parts sturdily mounted. When you do electronics maintenance work, you should plan to replace the defective parts neatly and securely.

Tools

The repair, construction and testing of electronics equipment will require the use of a number of hand tools, quite a few of which you no doubt already have. Before discussing some of the tools which you will be using, let us discuss briefly the care and use of our tools. All tools should be kept free of dirt, grease, rust and any foreign matter. It is difficult to clean a tool after excessive dirt or rust has been allowed to accumulate; therefore its accumulation should be prevented. A good technician always wipes his tools regularly with a clean or slightly oily cloth. Tools should be used only for the purpose for which they are intended. This would seem to be an obvious statement, but the fact is that far more tools are **ruined** by improper use than are ever **worn out** through proper use. As the various tools are discussed their proper and improper use will be mentioned.

Of the tools used in electronics work, pliers are the most widely used. There are many types and sizes of pliers, each intended for some specific purpose. All types of pliers can be obtained in various sizes. The size of a pair of pliers is determined by the overall length. The most common fault of the untrained workman is to use a pair of pliers as an all purpose tool. Several types of pliers, and their uses are listed below:

1. Side-cutting pliers have square gripping surfaces on the end of the jaws; behind these gripping surfaces are cutting blades. See Figure 11(A). These pliers are used for gripping, splicing, wire cutting, removing insulation, etc. They are not intended to be used as a substitute for a wrench. The most useful sizes of these pliers are the six and eight inch; the larger size being used for cutting and handling larger wire.

2. Diagonal pliers have two cutting edges set at an angle of fifteen to twenty degrees with the length of the tool. See Figure 11(B). They are intended for wire cutting only and also can be obtained in different sizes. Their advantage over side cutting pliers is that, due to their construction, they can cut off a wire closer to its point of attachment than the side cutting pliers. The chief **misuse of diagonal pliers** is forcing them to cut **heavier wire** than that for which they are intended. The most common sizes are the five and six inch types which will cut a number 16 hard steel wire. For cutting heavier wire the side-cutting pliers must be used.

3. Long-nose pliers are primarily for light gripping and holding operations and for use in small places. They consist of a pair of long tapering jaws, half round on the outside and flat on the inside. The long-nose pliers may or may not have cutting edges behind the gripping surfaces. See Figure 11(C). If they are forced to do heavier work than that for which they are intended, the jaws will either break or they will bend out of shape and refuse to close firmly on small objects. Five and six inches are the common sizes of long-nose pliers.

4. Needle-nose and chain-nose pliers are similar in appearance and construction to long-nose pliers except that the jaws are circular in cross section instead of semi-circular. See Figure 11(D). They should be used only for forming small loops on the end of wires and for work on instruments.

5. Slip joint pliers have square nose gripping jaws with serrated gripping jaws behind them, close to the hinge. The method of hinging permits

the jaws to operate in either of two positions, thereby increasing the gripping range of the pliers. See Figure 11(E). Slip joint pliers are used for gripping fairly large stock and are primarily a make-shift tool to be used when the proper tool is not among the technician's equipment. They are a possible cause of damage to any surface on which they are used and their use should be strictly limited.

The screwdriver is a tool for turning bolts and screws that are slotted to receive the screwdriver blade. It comes in several styles, the most common being, straight screwdriver, off-set screwdriver and ratchet screwdriver. Figure 12(A) shows an assortment of straight screwdrivers and Figure 12(B) shows an off-set screwdriver. The blade point is designed to fill the slot in the head of the screw. Turning the screwdriver then tightens or loosens the screw. The screwdriver is often wrongly used for prying, opening boxes, or as a chisel.

Two faults can be found with the average man's use of screwdrivers, assuming that he uses them for no other purpose than turning screws. First, is the failure to use a proper assortment of screwdrivers. When a screwdriver too small for a job is used, the blade of the screwdriver does not fit the slot in the screw-head properly. The force necessary to turn the screw is exerted upon too small a surface, and the result is that the head of the screw is damaged.

The other fault in the use of the screwdriver is the improper sharpening of the blade. The two faces of the screwdriver blade should be nearly parallel and the end square. The point of the blade should not be sharpened to an edge like a chisel but should form a rectangle. The blade of the screwdriver should be the same width at the point as the length of the slot of the screw-head for which it is intended, and it should be ground with sufficient thickness to be a snug fit in the slot and yet reach the bottom of the slot. The ideal screwdriver should completely fill the slot for its depth, width and length. The further this ideal is departed from, the greater is the likelihood of damage to the screwdriver and the screw-head. Sharpening is best done upon a small bench grinder.

Electronics men are frequent users of drills; such as the hand drill and portable electric drill.

The hand drill is operated by a hand crank driving bevel gears. The feed is obtained from pressure from the body or hand. A 3-jawed chuck is attached to the spindle and it will usually take up to ⅜ inch straight shank drills.

The portable electric drills come in a variety of sizes and power ratings and the smaller sizes are popular in all shop work. They are made as small as possible and are rated in horsepower (or fraction thereof) or the maximum size twist drill to be used with each machine. A switch is usually so located as to give the operator complete control of the starting and stopping of the motor. Care should be exercised in operating these machines as the motor will overheat if overloaded and soon burn-out if stalled.

The most generally used drill for boring small holes in metals is the straight shank "twist drill". Twist drills are usually made with two flutes, or grooves, running around the body. This furnishes cutting edges, and the cuttings follow the flutes out of the hole being drilled. The point or cutting end of a drill should be properly shaped at all times, and this can be achieved by grinding carefully on a grinding wheel. A drill grinding tool is available to be used in conjunction with a bench grinder. The size of small twist drills is designated by numbers, and by diameter in fractions of an inch.

Drills are made of high carbon steel especially heat treated to make the cutting edges hard, and are suitable for most all classes of work if properly used and never allowed to become heated. Excessive temperatures cause the cutting edges to lose their hardness and are thus rendered useless by working them too fast (depending on substance being drilled), so that the heat cannot be dissipated. Brass and copper are good conductors of heat so may be drilled faster than iron. Bakelite is a poor heat conductor and requires slow drilling or high speed drills. Monel metal, stainless steel, and other extremely tough materials produce so much heat when drilled that the use of high speed drills is absolutely necessary. A drill should be lubricated as should any other metal cutting tool.

Drills made of a special alloy containing tungsten, chromium, and cobalt, are referred to as "high speed" drills. They cost more than ordinary carbon drills, but may be operated at quite high temperatures and still retain their hardness.

Screws, Bolts and Nuts

The term "machine screws" is the general commercial term for screws to be driven into drilled and tapped holes in the assembly of metal parts. When furnished with a nut the combination is referred to as a "bolt". Machine screws are regularly made of steel or brass, with a variety of styles of heads and finishes. Figure 13(A) shows an assortment of round head machine screws.

The Hoover National Screw Commission established standards for machine screws, and these standard sizes are now used by all electronics manufacturers. The standards so established were subdivided into two main divisions; that is, (1) The American (National) Fine thread series, and (2) The American (National) Coarse thread series. The name "American" instead of "National" is coming into universal use throughout this country.

Screw size refers to the number of the stock of material from which the screw is made; that is, a 6/32 screw means that the screw is made from number 6 stock. (The size is always the first number). This size is different from any other gauge, and has nothing to do with the Brown & Sharpe wire gauge. The 32 indicates that there are 32 threads to the inch.

The length of a screw includes that part of the screw and its head which remains below the surface when properly driven, thus, the length of a round head screw includes none of the head while a flat head screw includes all of the head.

All screw manufacturers list flat, round and oval heads as standard stock items, and some also include fillister, binding, or other types. There are many special heads in use such as ornamental-head screws used to hold loud-speakers, and types with heads designed for special driving devices, etc.

The most common method of driving machine screws is by means of a slot milled into the head of the screw. Such screws are referred to as "slotted head" screws. Some machine screws are made with a hexagonal head (see Figure 13B). With such screws it is possible to use a hexagonal wrench for tightening; thus eliminating the possibility of slipping. Another type of screw head which is becoming increasingly popular is the Phillips head. This screw head is milled with an X-shaped slot which is deeper in the center than at the edges. This type of head requires the use of a special "Phillips" screwdriver, but can be tightened much more securely without the danger of the screw-driver slipping.

Sheet metal screws are made of hard steel, have sharp threads, and are available in the same lengths, diameters, and head styles as are machine screws. An assortment of these screws is shown in Figure 13(B). They are sometimes referred to as self-tapping screws although this is not strictly the case inasmuch as the threads are formed by embossing the work rather than actually removing chips of metals as is done when using a regular tap. It is much better to refer to these screws as "sheet metal" screws. They are driven into punched or drilled pilot holes in sheet metal, fibre, hard rubber, plastics, etc., by means of a screwdriver or hex wrench.

Set-screws are used to fasten the hub of pulleys, wheels, gears, knobs, and tuning dials, etc., to shafts, either permanently or semi-permanently as required. Most set screws are of the "headless" type and are obtained in such lengths that they fit flush with the face of the hub. Figure 13(C) shows an assortment of set screws. Headless set screws may be slotted so that they may be tightened with a screwdriver, they may have the Phillip's recess feature or may be of the "hollow" type with Allen sockets.

Nuts for machine screws are made of steel or brass and are usually hexagon in shape.

Wing nuts to be tightened without aid of tools, are available in all standard threads.

A thumb nut is a cylindrical nut with the outside knurled.

Wood screws are available with the same type of standard heads as machine screws, and are also made from the same metals, and in the same lengths, finishes, drives, etc. The threads of all wood screws are uniform, making it neither necessary nor desirable to state the number of threads per inch when ordering or describing the screws. They are ordered by diameter, which is specified in gauge numbers of the American Screw Gauge, and length. Wood screws have a so-called "gimlet" point which is more or less self starting in wood; however, a pilot hole reduces splitting.

How Radio Parts are Mounted

With the radio in front of us let us examine how the various radio parts are mounted. The smaller parts such as resistors and capacitors are usually supported with their own leads. The tube sockets may be riveted to the chassis or small bolts may be used to hold them in place. Large capacitors of the metal cased type such as the filter capacitors are mounted with bolts, or with a nut over a threaded portion of the container. Power transformers and filter chokes are bolted in place, usually using the screws which hold the frame to the laminations. Potentiometers and switches used for volume and tone controls are mounted behind the front of the metal chassis with the shaft coming through a threaded section which is held securely in place with a nut.

Notice the manner of interconnecting the various components in your receiver. Radio parts are interconnected with hook-up wire, the wire electrically joining the various terminals. The hook-up wire should be insulated along its path, but is made bare and clean where it comes in contact with the terminals. Push-back insulated wire in sizes 16 to 20, B & S gauge, is easiest to handle. To make a connection with this wire, the insulation is pushed back as shown in Figure 14(A). When the insulation cannot be pushed back far enough with the fingers, it will be easier to grasp the bare end of the wire with a pair of long-nosed pliers. Then, holding the wire in this manner, it is a simple matter to push the insulation back with the fingers as far as required. This is illustrated in Figure 14(B). After the connection has been made, the insulation should be pushed back over the bare wire right up to the terminal.

Hook-up wire having plastic insulation is often used to interconnect parts, and rubber insulated wire is sometimes used as the leads of parts such as transformers and filter capacitors. To make connections to these leads the insulation is crushed with pliers and then removed with diagonal cutting pliers or a knife. Care should be taken so that the wire is not nicked or cut in removing the insulation.

Notice that when the connecting wires are connected to tube socket terminals they are not just held against the terminal and then soldered, but are "crimped" to the terminal before they are soldered. The purpose of crimping wires to a terminal is to insure a strong mechanical connection, as solder alone should never be depended upon to keep the connection secure. If the terminal has a hole in it, the hook-up wire can be bent into a half-loop with long-nose pliers, and the tip of this loop inserted through the hole. Then the wire is squeezed or crimped against the terminal and the unused portion of the wire cut off before the solder is applied. In case the terminal is of the lug type and does not have a hole, the wire is also made into a half-loop and crimped against the terminal. It is even better to wrap the wire around the terminal a time or two and then crimp it from both sides. This is illustrated in Figure 15.

Electrical connections should be soldered in order to insure a good low-resistance path under all conditions. For best results, make it a rule to solder every connection you make, even if you intend it to be a temporary one. Solder is made up of tin and lead and melts readily when heated with a hot soldering iron. Solder cannot make a permanent connection with any metal when the metal is dirty or has a layer of oxidation on it. A soldering paste or **flux** has been developed which, when heated, removes all dirt, grease and oxidation and allows the solder to adhere to the metal. Rosin flux rather than acid flux should be used in electronics wiring, and solder is available which contains a core of rosin flux. Since the rosin has a lower melting point than the solder, the rosin melts first and flows out and cleans the metal before the solder begins to flow.

To provide the necessary heat to melt the solder, electronics technicians use an electrically heated soldering iron. These irons are rated in the electrical energy they consume, with irons ranging from 60 to 100 watts being the most popular. The heating element of the iron is located inside a metal barrel and the heat travels down to the copper tip which does the actual soldering.

Your first Laboratory Experiment will provide you with the necessary equipment and complete instructions for soldering electronics equipment. Examine the soldered connections in the receiver before you. Notice that the solder is not "stacked up" on the terminals but that there is just enough to hold the connections firmly. After you have finished the soldering practice provided in your first Laboratory Experiment, you should be able to make solder joints comparable in quality to those in your receiver.

If you have examined your receiver thoroughly and are satisfied that you can identify all of the parts, re-install the chassis in the cabinet. Be sure to re-connect everything just as it was before removal of the chassis. Plug the power cord plug into the receptacle and again "rough check" the receiver to see that it operates as well as it did before you started working on it.

Summary

This assignment has enabled you to take a real step forward toward your goal of becoming an electronics technician. You have learned to identify the parts in a radio receiver which, as pointed out previously, are the same as those used in industrial electronics equipment. You have also learned the proper use of the various tools employed in electronics work.

The radio which you have examined in this assignment contains a wide variety of electronics parts. Quite obviously, however, it does not contain all of the different types of parts which are employed in the many thousands of kinds of electronics equipment in use. Just as the information you have gained in this assignment will be of great value to you as you proceed with your training, so will any additional information you can gain regarding the appearance of various electronics components be of value to you. Thus it is advisable for you to become familiar with the appearance of as many different electronics components as possible. One very practical way of obtaining this knowledge is to look over—in fact, study—one or more electronics parts catalogs. These catalogs are issued by many electronics mail-order supply houses. If you will send a postcard to one or more of the following firms, you will receive their catalog showing pictures, descriptions and prices of many types of electronics equipment and parts:

Allied Radio Corporation
100 N. Western Avenue
Chicago, Illinois 60680

Burstein-Applebee Company
1012 McGee Street
Kansas City, Missouri 64106

Olson Electronics
260 South Forge Street
Akron, Ohio 44308

Walter Ashe Radio Company
1125 Pine Street
St. Louis, Missouri 63101

Another suggestion which we feel may be of great value to you is that, from time to time, you obtain one or more of the electronics magazines on the newsstand. Look over the various electronics magazines, and decide which "suits you best." Then subscribe to this magazine, and read it regularly. You will find that the general information you obtain from technical magazines will aid you greatly in your advancement in the electronics field. Two magazines which are recommended for general reading are **Electronics World** and **Radio-Electronics.**

In the next assignment you will use the information you have learned here in a very interesting way. Various symbols which can be easily drawn by hand and easily printed are used to represent electronics parts in circuit diagrams. In the next assignment you will learn to identify these various symbols, so that you will be able to "read" and draw electronics circuit diagrams.

"HOW TO PRONOUNCE . . ."

(Note: the accent falls on the part shown in CAPITAL letters.)

chassis	(SHAH-see)
lamination	(lamm-ih-NAY-shun)
mica	(MY-kuh)
potentiometer	(pah-tenn-she-OMM-ett-urr)
solder	(SODD-urr)
stator	(STAY-turr)

TEST QUESTIONS

Be sure to number your Answer Sheet Assignment 2.
Place your Name and Associate Number on **every** Answer Sheet.
Send in your answers for this assignment immediately after you finish them. This will give you the greatest possible benefit from our personal grading service.

1. If an 8/32 (or 8-32) machine screw is specified for holding an electronics part, what does the **8** part of the number mean, and what does the **32** part of the number mean?
2. What is the proper name of the component that controls the volume (and sometimes the tone) of a radio receiver? POTENTIOMETER
3. How can it be determined which of the components in a receiver are the filter capacitors? BY MARKINGS ON THEM
4. What do the colors painted on a resistor indicate?
5. If there is no set screw in a knob, how should the knob be removed?
6. What are the tube type numbers in the set which you have examined? How many base pins does each tube have? 50C5
7. In electronics work what are long-nose pliers used for?
8. If you wanted to cut a **large** wire, should you use a pair of diagonal pliers, or a pair of side-cutting pliers?
9. If you found a tubular shaped part under the chassis of a radio receiver labeled .01 MFD-600V DC, what would be the proper name for this radio part?
10. If you found a part on the top of the chassis of your radio which was in a square aluminum shield can, what would be the proper name for this component be?

[redacted]

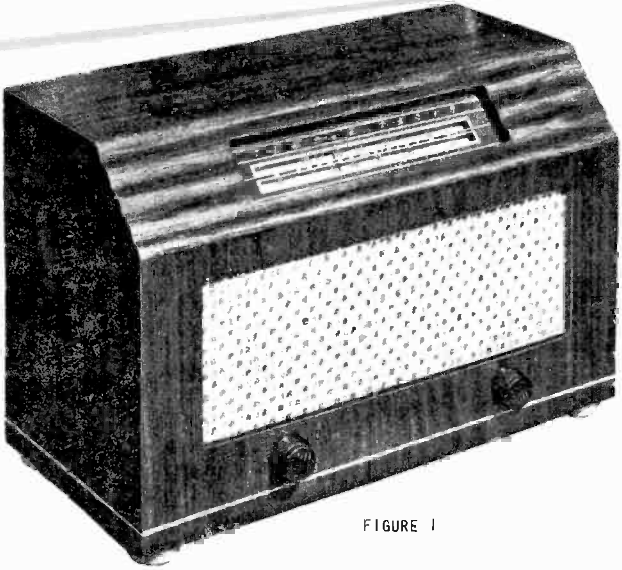


FIGURE 1

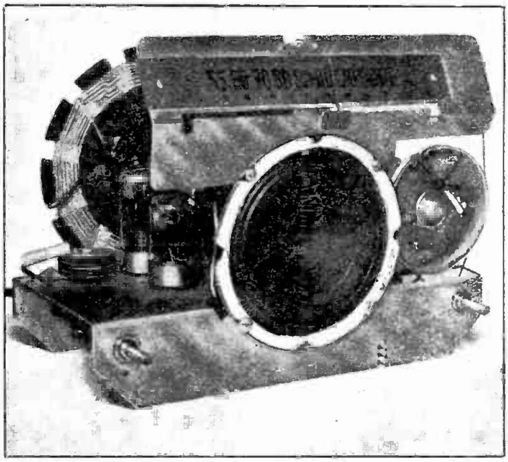


FIGURE 2

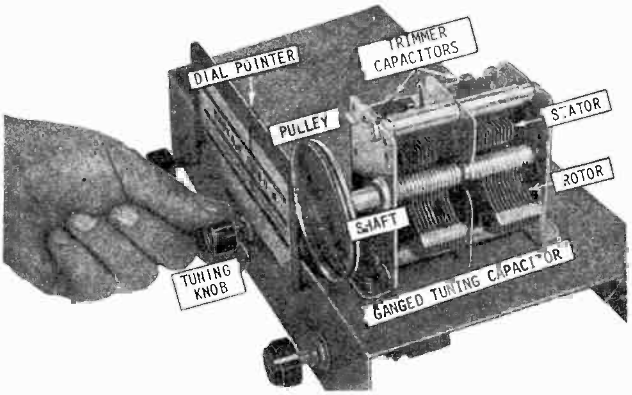


FIGURE 3

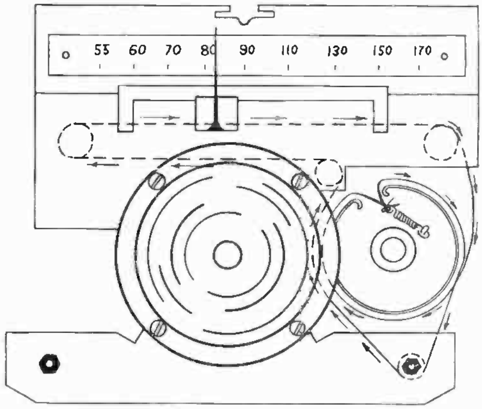


FIGURE 4

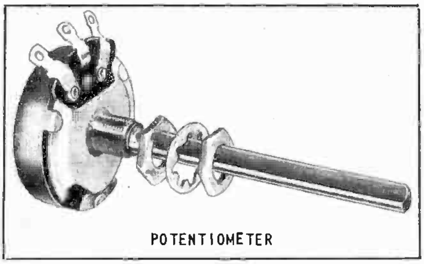


FIGURE 5

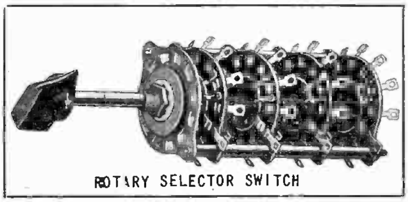
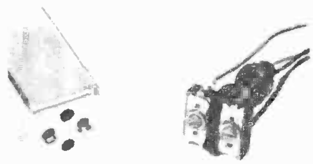


FIGURE 6



SHIELD CAN I-F TRANSFORMER

FIGURE 8

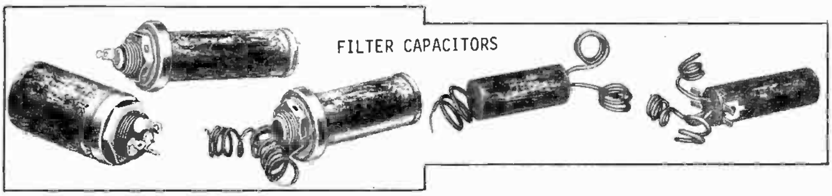


FIGURE 7-A FIGURE 7-B