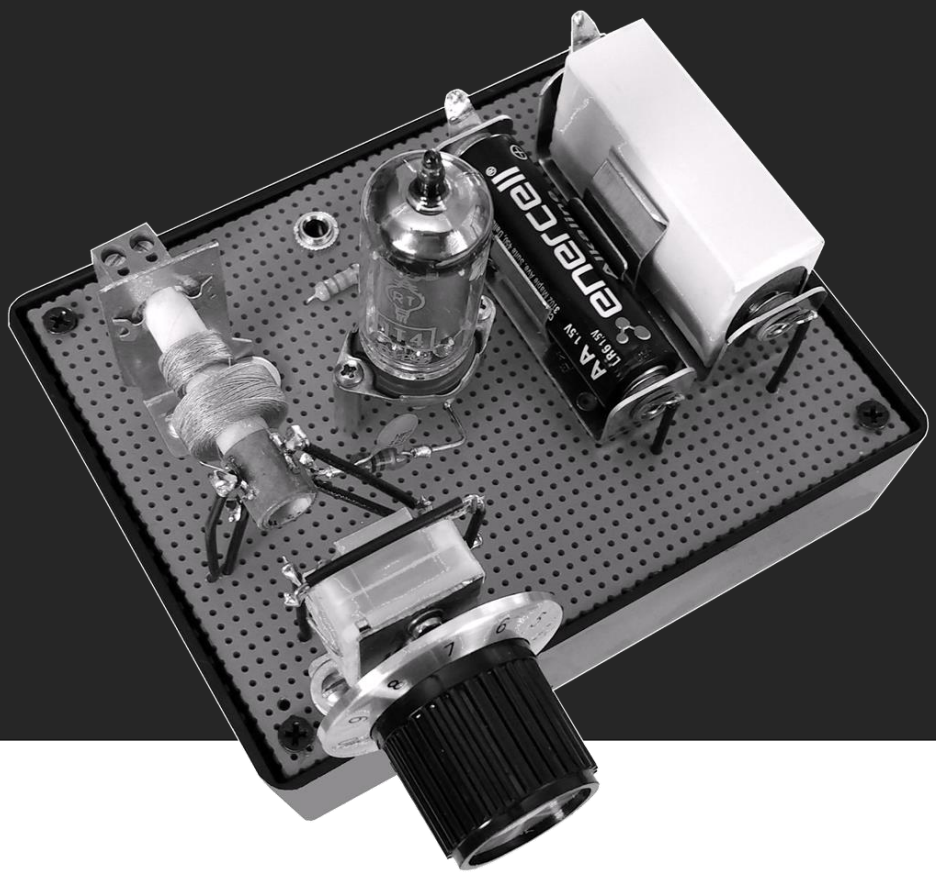
Science Fair™

INSTRUCTION MANUAL PRICE: 50¢



ONE TUBE AM RADIO

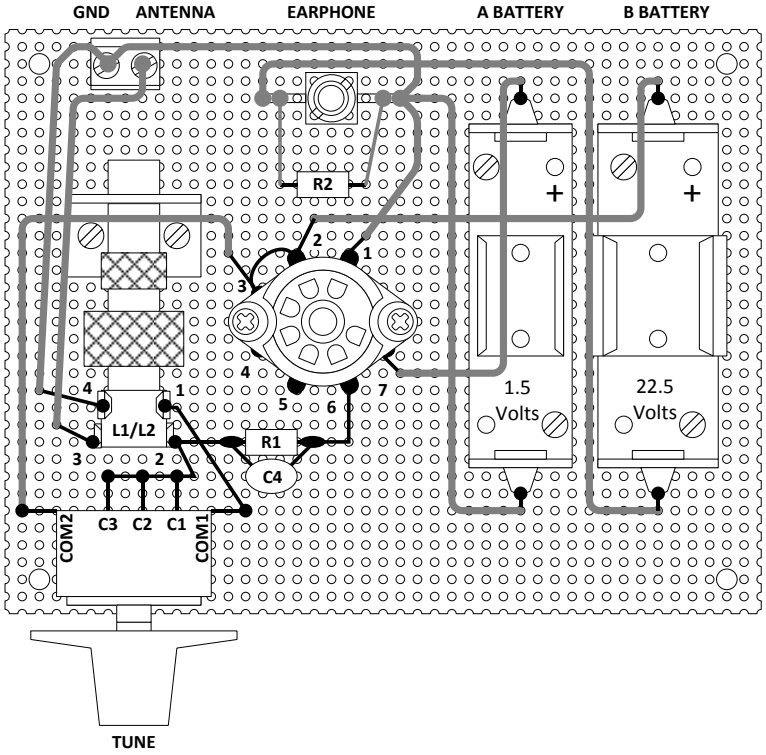
Catalog Number 28-100

This tunable AM radio, similar to the very early receivers, is simple in design and easy to build. You can enjoy hours of listening pleasure and, at the same time, learn about the fascinating world of electronics.

The broadcast band signal is picked up by the antenna. The antenna coil and capacitor serve to filter out all of the radio signals but the one that you wish to hear. The tube removes the sound signal from the radio signal and then amplifies it so that it can be heard in the earphone.

CUSTOM MANUFACTURED IN U.S.A. BY RADIO SHACK A DIVISION OF TANDY CORPORATION

FIG. 1 – PICTORIAL DIAGRAM TOP VIEW



PARTS LIST

Quantity	Identification	Symbol	Vendor	Vendor Part	Price
1	Variable Capacitor	C1/C2/C3	amazon.com	B00GYRKLGQ	$ 3.00 (2 min)
1	120pF Disc Capacitor COG/NP0	C4	newark.com	91K7402	$ 0.23
1	10M 1/2W Resistor	R1	newark.com	24R8885	$ 0.25
1	270K 1/2W Resistor	R2	newark.com	38K5195	$ 0.21
1	Small Battery Holder		newark.com	59K0297	$ 3.01
1	Large Battery Holder		newark.com	59K0313	$ 3.69
1	1T4 Radio Tube	V1	amplifiedparts.com	T-1T4_DF91	$ 4.45
1	Antenna Coil	L1/L2	amplifiedparts.com	P-C70-A	$ 8.95
1	7-pin Tube Socket		amplifiedparts.com	P-ST7-201MXB	$ 0.85
1	Crystal Earphone		amplifiedparts.com	P-A480	$ 3.25
1	Earphone Jack		amazon.com	B017CBOEGA	$ 0.35 (20 min)
2	Aluminum Spacer 5/8”		amazon.com	B00DIHVKQ0	$ 0.46 (25 min)
2	#2-56 x 1” Machine Screw		amazon.com	B000FN5THG	$ 0.05 (100 min)
2	#2-56 Hex Nut		amazon.com	B00DGB34YE	$ 0.11 (100 min)
8	#4-40 x 3/8” Machine Screw		amazon.com	3SSMPP04C006	$ 0.08 (100 min)
8	#4-40 Hex Nut		amazon.com	B001B2QP3C	$ 0.06 (100 min)
2	M2 x 4mm Machine Screw		amazon.com	B012TBN4V4	$ 0.10 (60 min)
1	M2 x 8mm Standoff		amazon.com	B00BWLQEHE	$ 0.11 (50 min)
1	Tuning Knob		amazon.com	B018JKG650	$ 4.00 (2 min)
1	2 Position Screw Terminal Block		amazon.com	B011QFLS0S	$ 0.26 (30 min)
1	Project Box		amazon.com	B0002BENLY	$ 8.00
1	4” x 5” Perfboard		amazon.com	B00DDD7TOQ	$ 7.69

NOTES ON COMPONENTS

Careful research was done to redesign the One Tube AM Radio using readily available parts from as few suppliers as possible. Component parts were chosen to preserve the original appearance of the radio kit without requiring the purchase of rare vintage parts that are better saved for the restoration of vintage radio equipment. Many people prefer to use Amazon.com to purchase component parts, however Amazon does not always have the best prices on its retail platform. Significant cost can be saved by using parts available in the junk box, substituting lower cost parts that look different than the original, buying in bulk from JoeKnowsElectronics.com or Sparkfun.com, and purchasing directly from suppliers like AmplifiedParts.com, Uxcell.com, or Mouser.com. With careful selection the One Tube AM Radio can be built for around $30 to $50 (excluding shipping and sales tax not included).

STEP-BY-STEP WIRING AND ASSEMBLY DIRECTIONS

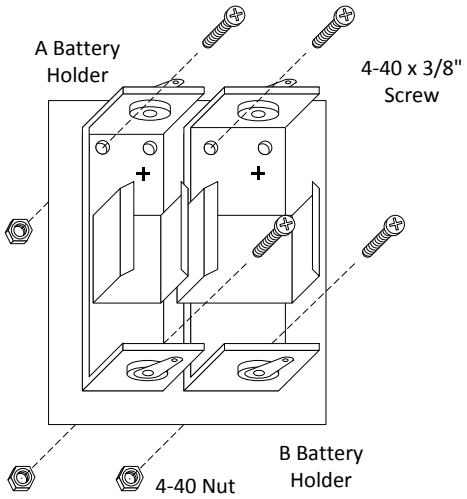
Be sure to carefully follow all the directions. Do one step at a time and then check off the step in the box provided. Before beginning, read over the enclosed page labeled "Construction Hints".

The step by step instructions indicate a soldering requirement; however, if no soldering iron is available, temporary connections can be made by firmly twisting wires together. Keep in mind, however, that improved circuit reliability can be expected if the connections are soldered. Before soldering, read the instructions in "Construction Hints". When mounting a part that does not require soldering, bend the leads to hold the part in place.

( ) Check the parts list to see that everything listed is included. Check each step as you progress (✓).

( ) Place the pictorial diagram (Figure 1) near the perfboard so that it can be used as a guide for exact placement of parts. The gray lines in the pictorial diagram indicate components and wires which are mounted under the perfboard. The solid lines indicate components and wires mounted on top of the perfboard.

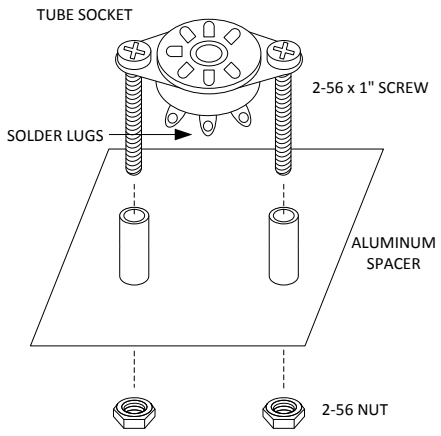
( ) Place the A and B battery holders in the location indicated on the pictorial diagram (Figure 1) and mark the perfboard hole centered in the upper left and lower right mounting holes. Enlarge the marked holes to accommodate a 4-40 x 3/8" screw. Mount the two battery holders. Use four 4-40 nuts and four 4-40 x 3/8" screws (refer to Detail A). Be sure to position the plus (+) signs as shown in Figure 1.



DETAIL A

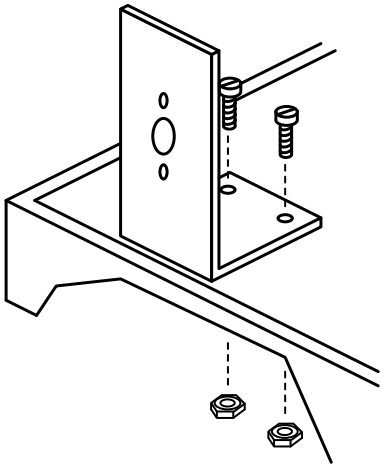
( ) Before you mount the tube socket, carefully bend the solder lugs to a 45° angle as shown in Detail B.
NOTE: On the underside of the tube socket, notice that the solder lugs are numbered 1 to 7. These numbers must line up with the numbers that are shown in Figure 1.

( ) Mount the socket in the location indicated on the pictorial diagram (Figure 1) using two 2-56 x 1" screws, two 5/8" aluminum spacers and two 2-56 nuts (refer to Detail B).



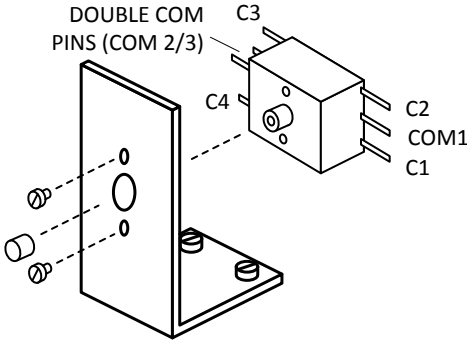
DETAIL B

( ) Place the tuning capacitor mounting bracket in the location indicated on the pictorial diagram (Figure 1) and mark the perfboard holes centered over the bracket mounting holes. Enlarge the marked holes to accommodate a 4-40 x 3/8" screw. Mount the tuning capacitor bracket as shown in Detail C using the two screws and two 4-40 nuts.



DETAIL C

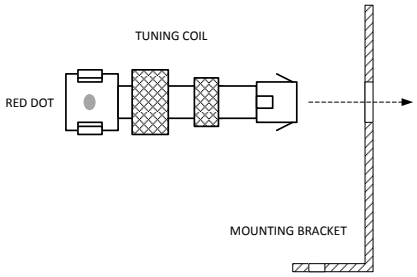
( ) Mount the variable capacitor C1-C3 as shown in Detail D using two M2 x 4mm screws. Thread the shaft extension M2 x 8mm standoff on the variable capacitor and tighten.



DETAIL D

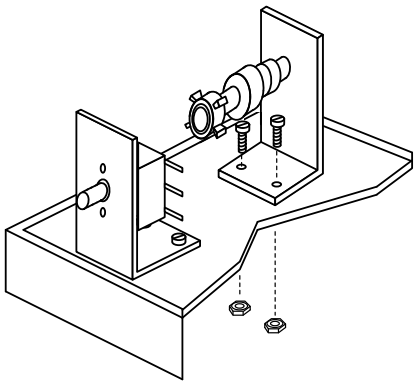
( ) Place the tuning coil mounting bracket in the location indicated on the pictorial diagram (Figure 1) and mark the perfboard holes centered over the bracket mounting holes. Enlarge the marked holes to accommodate a 4-40 x 3/8" screw.

( ) Mount the antenna coil L1/L2 by carefully pushing it through the large hole in the bracket until it clicks into place (refer to Detail E).



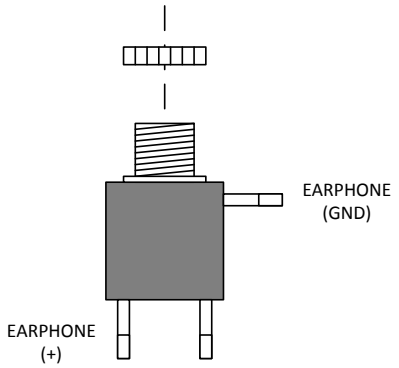
DETAIL E

( ) Mount the antenna coil and bracket as shown in Detail F using two 4-40 x 3/8" screws and two 4-40 nuts.

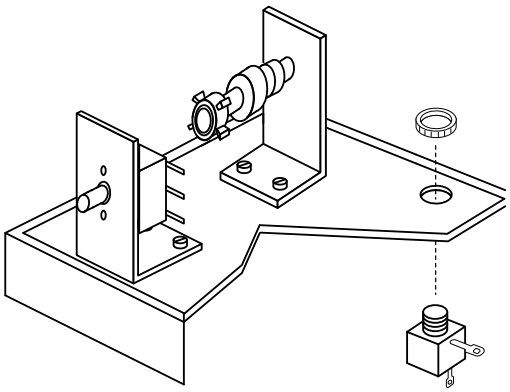


DETAIL F

( ) Place the headphone jack in the location indicated on the pictorial diagram (Figure 1) and mark the perfboard hole centered over the jack. Carefully cut a hole in the perfboard large enough for the jack threads to pass through.

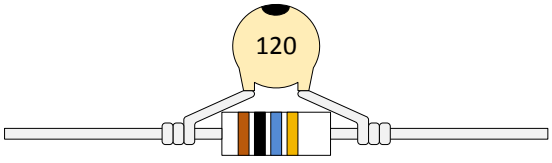


( ) Mount the earphone jack as shown in the pictorial diagram (Figure 1) and tighten the mounting ring firmly. Make sure the Earphone (GND) pin is facing the battery holders and Earphone (+) pin is facing the antenna coil as shown in Detail G.



DETAIL G

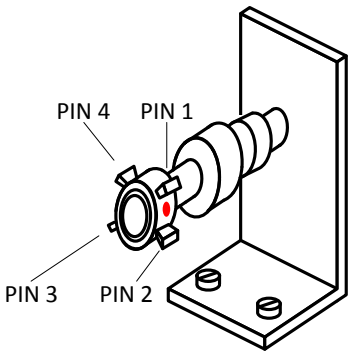
( ) Connect the two leads of the 120pF capacitor C4 to the two leads of the 10 meg ohm resistor R1 (brown, black, blue) and solder (refer to Detail H).



DETAIL H

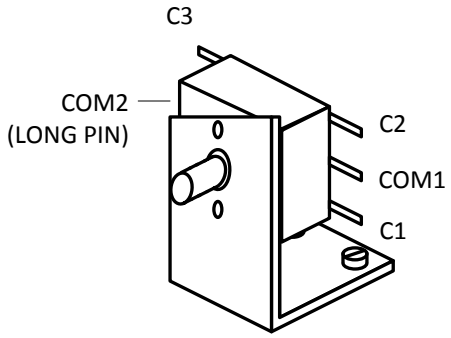
( ) Bend the leads of 10 meg ohm resistor R1 as shown in the pictorial diagram (Figure 1).

( ) Solder one end of R1 to tube socket Pin 6. Attach the other end to antenna coil Pin 2 (see Detail I). Do not solder yet.



DETAIL I

( ) Remove ¼" insulation from each end of 1-1/2" piece of wire. Connect one end to variable capacitor pin C3 (Refer to Detail J) and solder. Connect the other end to variable capacitor pin C2 but do not solder yet.



DETAIL J

( ) Remove ¼" insulation from each end of a 1-1/2" piece of wire. Connect one end to variable capacitor pin C2 (Refer to Detail J) and solder. Connect the other end to variable capacitor pin C1 but do not solder yet.

( ) Remove ¼" insulation from each end of a 1-1/2" piece of wire. Connect one end to variable capacitor Pin C1 (Refer to Detail J) and solder. Connect the other end to tuning coil Pin 2 and solder.

( ) Remove ¼" insulation from each end of a 2" piece of wire. Connect one end to tuning coil Pin 1 (Refer to Detail I) and solder. Connect the other end to variable capacitor Pin COM1 (Refer to Detail J) and solder.

( ) Remove ¼" insulation from each end of a 4" piece of wire. Connect one end to B battery positive (+) terminal and solder. Connect the other end to tube socket Pin 2 but do not solder yet. Enlarge perfboard holes as necessary to permit wire to pass through.

( ) Remove all insulation from a ½" piece of wire. Connect one end to tube socket Pin 2 and solder. Connect the other end to tube socket Pin 3 but do not solder yet.

( ) Strip ¼" insulation from each end of a 4" piece of wire. Attach one end to tube socket Pin 3 and solder. Connect the other end to variable capacitor COM2 pin (Refer to Detail J) and solder. Enlarge perfboard holes as necessary to permit wire to pass through.

( ) Strip ¼" insulation from each end of a 4-1/2" piece of wire. Attach one end to tuning coil Pin 4 and solder. Attach the other end to the GND pin of the antenna connector but do not solder yet.

( ) Strip ¼" insulation from each end of a 2-3/4" piece of wire. Attach one end to antenna coil Pin 3 and solder. Attach the other end to the Antenna pin of the antenna connector and solder.

( ) Install 270K ohm resistor R2 (red, violet, yellow) in the position as shown on the pictorial diagram (Figure 1). Attach one end of the resistor to earphone jack (+) pin and the other end to earphone jack GND pin. Do not solder yet.

( ) Strip ¼" insulation from each end of a 2-1/2" piece of wire. Attach one end to the GND pin of the antenna connector and solder. Attach the other end to earphone GND pin but do not solder yet.

( ) Strip ¼" insulation from each end of a 2" piece of wire. Attach one end to tube socket Pin 1 and solder. Attach the other end to earphone jack GND pin (Refer to Detail G) but do not solder yet. Enlarge perfboard holes as necessary to permit wire to pass through.

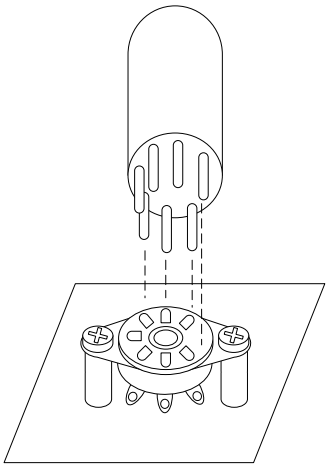
( ) Strip ¼" insulation from each end of a 4" piece of wire. Attach one end to A battery (-) terminal and solder. Attach the other end to the earphone jack GND pin and solder. Enlarge perfboard holes as necessary to permit wire to pass through.

( ) Strip ¼" insulation from each end of a 3-1/2" piece of wire. Attach one end A battery (+) terminal and solder. Attach other end to tube socket Pin 7 and solder.

( ) Strip ¼" insulation from each end of a 6" piece of wire. Attach one end to B battery (-) terminal and solder. Attach the other end to earphone jack (+) pin and solder.

NOTE: Clip all excess wire at the soldered joints. You have completed all connections, both wiring and soldering. Carefully double check your work against Figure 1.

Plug the radio tube into the socket. Line up the pins with the socket pin holes as shown in Detail F.



DETAIL F

OPERATION

This radio depends upon a good ground to work properly. Connect one end of a length of wire to the Antenna GND pin and the other end to a cold water pipe; however a metal rod driven two to four feet into the earth works best.

The radio is also dependent upon a good antenna for best reception. If there is plenty of space available, you should use a long antenna; the longer the antenna the better the results. A 50 foot (15 meter) antenna of the type illustrated in Figure 2 (Radio Shack Catalog Number 278-1373, or equivalent) is recommended. If this is impractical, you may use a long wire strung around the room. If you have a dial telephone you can connect the antenna to the metal dial stop. Insert the earphone into the earphone jack.

Insert a 1-1/2 volt AA penlite battery (Radio Shack Catalog Number 23-468, or equivalent) in the A battery holder. Insert a 22 ½ colt Burgess U15 battery (Radio Shack Catalog Number 23-097, or equivalent) in the B battery holder. Be sure to observe polarity (+ and -). If the batteries are inserted incorrectly, the radio will not work.

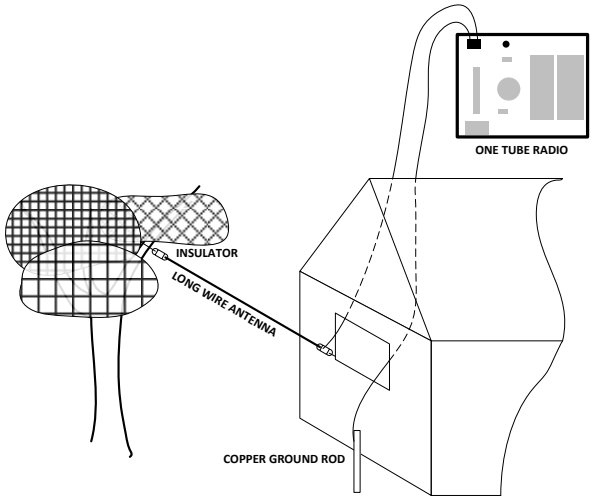


FIGURE 2

HOW IT WORKS

Every circuit carrying alternating current radiates a small amount of electromagnetic energy. If the circuit is matched to an antenna of the proper length for the frequency at which it is alternating then this energy will be radiated into space very efficiently. The lower the frequency of alternation, or oscillation, the longer the antenna needed. For instance, to efficiently radiate energy at 60 cycles per second, as in your house wiring, you would need an antenna 3,000 miles long! AM radios operate between 500,000 cycles, or 500 kHz, and a maximum frequency of 1,710,000 cycles, or 1710 kHz!

Alternating current is electrical energy that is constantly swinging from a plus value to a minus value at some constant rate. A pictorial representation of this swinging, or oscillating current, is illustrated in Figure 3. The number of times that the current swings from a plus value to a minus value and back again in one second represents the frequency of oscillation. A typical radio signal that this radio will receive, oscillates back and forth 1,000 times a second, which is a frequency of 1 kHz. Radio signals of this frequency, when induced into an antenna of the proper length and of sufficient strength, will travel virtually around the world.

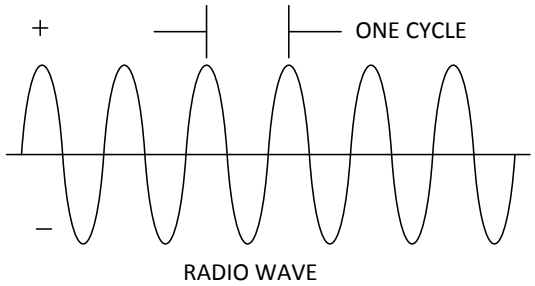


FIGURE 3

A radio wave is simply a carrier of information. If no information is added to the carrier, then nothing is picked up by the radio. Only when some music or speech (audio signal) is superimposed on the carrier do you hear anything. This addition of audio information to the carrier is called modulation. On the broadcast band in which your radio works, the information is added to the carrier by increasing or decreasing the strength of the carrier in relation to the audio signal. This is called Amplitude Modulation because the amplitude of the carrier changes with the changes in the audio signal. Figure 4 shows how the audio signal is added to the carrier for Amplitude Modulation.

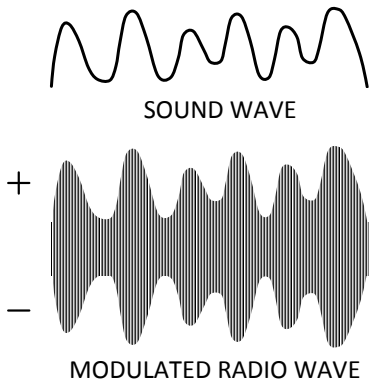


FIGURE 4

A radio has three basic functions. One is to select the proper signal out of the thousands of radio signals in the air. This job is done by the antenna coil L1/L2 and capacitor C1/C2/C3. They form a tuned circuit that accepts the signal you wish to hear and rejects all others. The second function is that of removing the audio signal from the radio wave – this task is called detection. It is accomplished by rectifying the signal; that is, cutting the signal in half by allowing the signal to swing in one direction but not in the other. The tube has the responsibility for this function, and in this radio the method is that of a grid detector. The signal is applied to the grid of the tube (pin 6); however, the tube is allowed to conduct only when there is a signal present, and then only in one direction. Figure 5 shows the signal after detection.

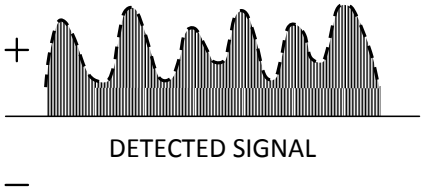
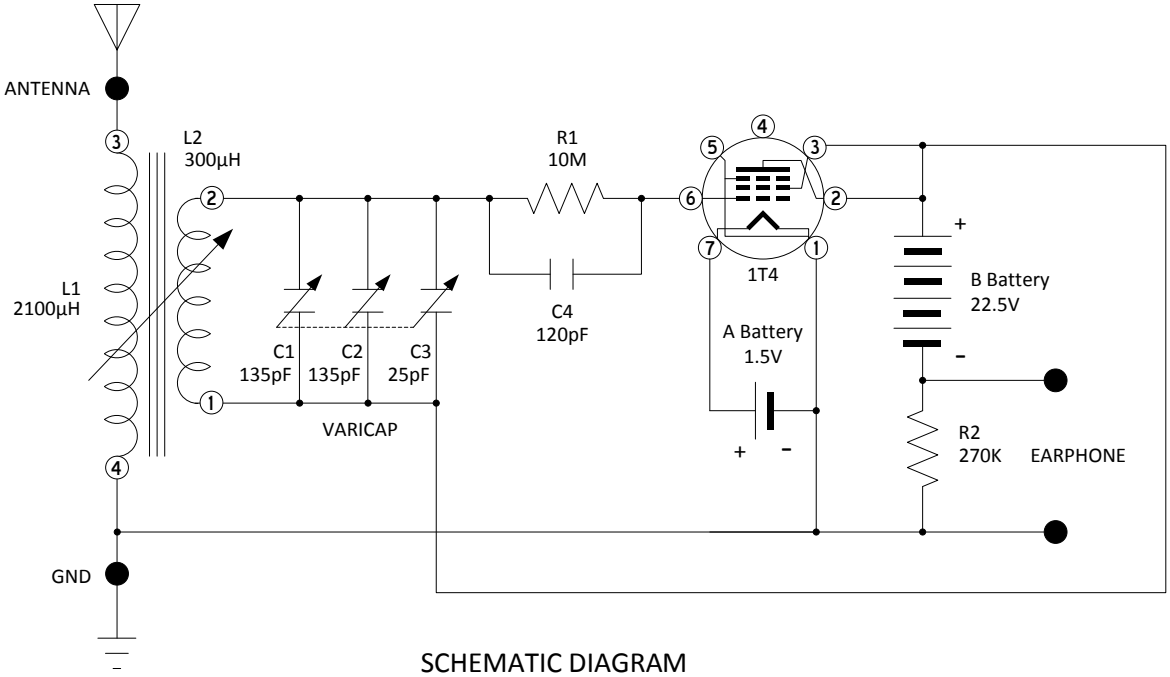


FIGURE 5

The third function of the radio is that of amplification. The signals from the air are seldom strong enough to be heard without some assistance from the electronic circuit. The tube not only detects the audio signal but it also provides additional signal strength so that it can be heard in the earphone. The tube is an electronic switch or, as it is called in England, a valve which can control a large number of electrons going out of the tube with only a small number of electrons controlling the action of the tube. Hence, the small variations of the incoming signal become larger variations in the earphone.



SCHEMATIC DIAGRAM

FIGURE 6