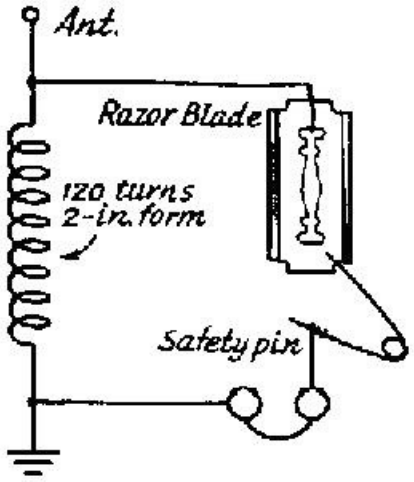
Name _____ Date _____ Period _____

Lab: Making a Foxhole Radio

UNIT 4: ELECTRICITY AND MAGNETISM

Introduction: When Allied troops were halted near Anzio, Italy during the spring of 1944, personal portable radios were strictly prohibited, as the Germans had radio detecting equipment that could detect the local oscillator signal of superheterodyne receivers. Crystal sets lack local oscillators, so they cannot be detected in this way. Some resourceful GIs found that a crude crystal set could be made from a coil made of salvaged wire, a rusty razor blade and a pencil lead for a diode. By lightly touching the pencil lead to spots of blue on the blade, or to spots of rust, they formed what is called a point contact diode and the rectified signal could be heard on headphones or crystal ear pieces. The idea spread across the beachhead, to other parts of the war, and to popular civilian culture. The sets were dubbed "foxhole receivers" by the popular press, and they became part of the folklore of World War II.



Fox Hole Radio

In some Nazi occupied countries there were widespread confiscations of radio sets from the civilian population. This led to particularly determined listeners building their own "clandestine receivers" which frequently amounted to little more than a basic crystal set. However anyone doing so risked imprisonment or even death if caught and in most parts of Europe the signals from the BBC (or other allied stations) were not strong enough to be received on such a set.[citation needed] However there were places such as the Channel Islands and Netherlands where it was possible.

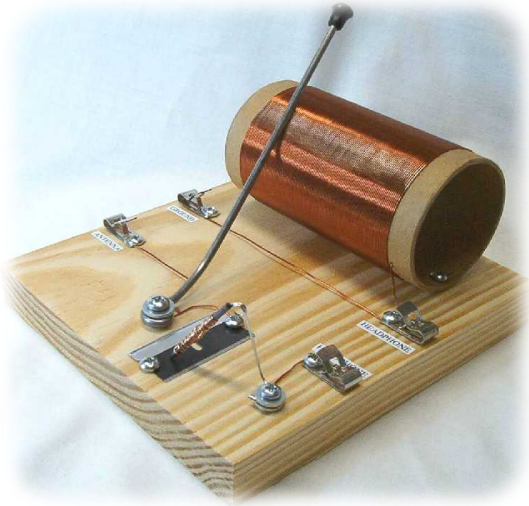
How it Works:

A crystal radio can be thought of as a radio receiver reduced to its essentials. It consists at a minimum of these components:

- An ***antenna*** to pick up the radio waves and convert them to electric currents.
- A ***tuned circuit*** to select the signal of the radio station to be received, out of all the signals received by the antenna. This consists of an inductor or tuning coil and a capacitor connected together, one of which is adjustable and used to tune in different stations. The tuned circuit has a natural resonant frequency, and allows radio signals at this frequency to pass while rejecting signals at all other frequencies.
- A ***semiconductor*** crystal detector which extracts the audio signal (modulation) from the radio frequency carrier wave. It does this by only allowing current to pass through it in one direction, blocking half of the oscillations of the radio wave. This rectifies the alternating current radio wave to a pulsing direct current, whose strength varies with the audio signal. This current can be converted to sound by the earphone. It was this component that gave crystal sets their name.
- An ***earphone*** to convert the audio signal to sound waves so they can be heard. The low power produced by crystal radios is insufficient to power a loudspeaker so earphones are used.

Materials:

- Vintage- style fahnestock clips or paper clips
- 10 wood screws or thumb tacks
- 10 washers for the screws
- Needle- nose pliers
- Wire hanger
- Wooden board (a 1⁄2- inch- thick pine board is best)
- Coil form (you can use a cardboard toilet paper roll that's at least
- 13⁄4 inches in diameter—2 inches is best)
- Number 2 lead pencil
- Single- edge safety razor (preferably "blued"; see step 13)
- Geranium diode—1N34A (from Radio Shack), optional
- 40 feet of #22 AWG coil or magnet wire
- 1 foot of #26 wire
- 100 feet of antenna wire or an antenna kit
- Sand paper
- Crystal earphone
- Safety pin
- Screw driver
- Spray lacquer



Procedure:

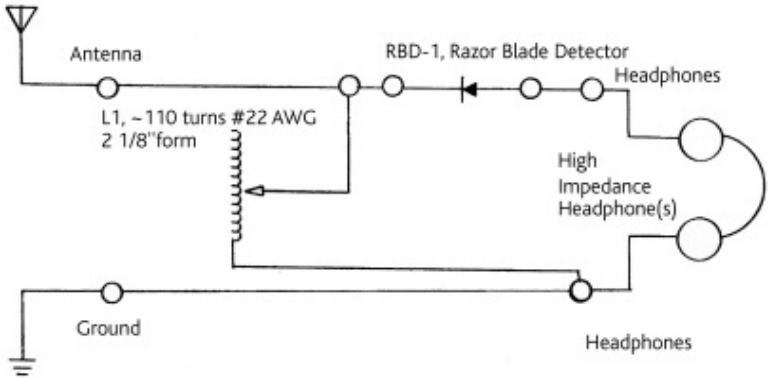
STEP 1: Cut the wooden board to which your radio will be attached. The exact size is irrelevant, but it should be at least 6 × 6 inches to accommodate all the parts.

STEP 2: Create coil form. This is the tube around which you are going to wrap about 40 feet of copper wire. A toilet paper role will do, but it might be a bit flimsy. If you can get your hands on thicker tubing, such as the type used for gift wrapping paper, it will be more solid. You can use two toilet paper tubes, cutting out a section of one tube and then gluing it inside of the outer tube. Once the glue has dried it will be fairly rigid and work quite well.

STEP 3: Punch four tiny holes in the tube. The two holes at each end should be about 1⁄2 inch from the end and about 1⁄4 inch apart. The two holes on each end should run width- wise to the ends. (See illustration on page 65.)

STEP 4: Wind the wire tightly around the coil form. This may be accomplished in many ways, but ultimately wrapping it by hand is best. It is very important that the coils be wrapped neatly next to each other.

Allow for about 6 inches of excess wire on the right side of the tube. I used magnet wire, which is a copper or aluminum wire covered with thin insulation. If you go to a place like Radio Shack, ask for #22 AWG (American Wire Gauge). It should be between 100 and



SCHEMATIC

125 turns.

STEP 5: Tighten the coil manually by gripping it between both hands and rotating your hands in opposite directions.

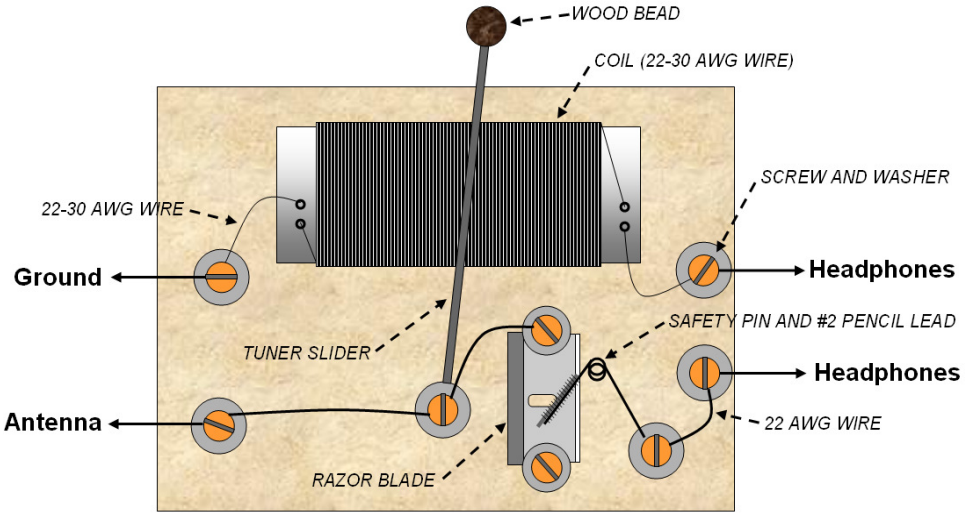
STEP 6: Spray the coil with lacquer to help keep the form wrapped tight. Allow it to dry.

STEP 7: Attach the coil to the board. Use either two thumb tacks or two small screws. The excess coil wire should protrude from the front side of the tube, closer to the board, rather than from the top of the tube (see illustration).

COILING THE TUBE

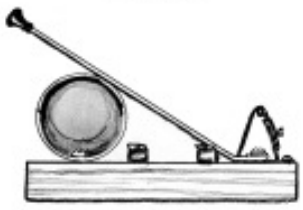
STEP 8: Attach four wire clips to the board—two on each side of the board below the coil. They should be about 41⁄2 inches apart from each other width- wise along the coil and about 11⁄2 inches apart from each other on each side of the board (see illustration). The top clips should be about an inch below the coil.

TIP: You can substitute paper clips for the clips and thumb tacks for the screws. The idea is to be as innovative as the GIs in the field!



STEP 9: Make the tuner slider by cutting 7 or 8 inches of wire from a wire coat hanger. If the hanger has any type of coating on it such as paint, lightly sand it to improve contact points and reception.

STEP 10: Using needle- nose pliers, bend a loop around the bottom end of the tuner slider. This loop will be wrapped around a screw and washer, so bend it accordingly. You may want to attach a knob or ball of tape at the top end of the slider as this is where your fingers will move the slide later for tuning. About 3 inches below the coil, in the middle of the board, attach the slider to the board by placing it on top of two washers. Then screw it to the board firmly but not so tight that it inhibits the movement of the slider. The hook- up wires should go under the washers for all contact points. (See illustration.)


SIDE VIEW

STEP 11: Attach the safety pin, which will be the detector contact, to a 2- inch piece of bare lead by bending the pin open about 90 degrees (on the clasp side—see illustration) and wrapping the pin side with #26 wire. Sharpen the end of the lead with a razor.

STEP 12: Attach the safety pin to the board, using a washer and screw, in the lower right- hand corner. Attach a wire between the safety pin head and board with a washer and screw and wrap wire to the lower right clip, which will ultimately be one of the headphone attachments clips. The tip of the lead will ultimately come in contact with the side of the razor. (See illustration.)

STEP 13: Attach the razor blade, which will act as the radio's crystal. If you use a standard single-edged razor, it will need to be "blued" or heat treated. To do this, attach it to some pliers in a vise and heat it with a torch. (If you don't have a torch, you can purchase one that's ready to go from a hobby shop.) Bend the safety pin so that the tip touches the razor's surface.
FYI ***During World War II, standard- issue razors were blued because they remained sharper longer.***

The crystal is the trickiest and most important part of this set. If you want better reception, you might consider purchasing a Germanium crystal detector from Radio Shack or from a radio hobby store like Borden's (Borden Radio Company, 138911 Kensington Place, Houston, TX, 77034, www.xtalman.com) . I found that it was easier to work out the kinks in my set by using the crystal detector before trying out the razor blade crystal.

STEP 14: Attach the rest of the wires according to the illustration. If any of the connections or contact surfaces are lacquered or painted, sand them lightly.

STEP 15: Attach a long wire to use as an antenna to the lower- left clip. The longer and higher, the better—use between 50 and 100 feet of wire of any type. Radio Shack sells some really great antenna kits for very little money. I have found that it works fairly well to attach the antenna high up on a tree.

TIP: If you want it really high, attach a weight and toss one end as high up in the tree as possible. Your radio must have a ground wire. Plumbing pipes work as do fl ag poles. Experiment with different metal contacts. Attach the ground wire to upper- left clip. You are now ready to operate your foxhole radio! Don't be frustrated if it does not immediately work. I found that I had to experiment a lot with gently moving the tuning slider back and forth along the coil. The antenna and grounding wires made a big difference in how they were placed and how well they were connected. I remember the fi rst time I actually heard an AM station being tuned in. It was a bit of a mind- blowing experience listening to a radio on a device with no electrical parts. I felt like I was listening to the propaganda DJs Tokyo Rose or Axis Sally as the GIs did during World War II. It was the most fun I have ever had with a radio. Enjoy listening to your new set.

AM Broadcast Band Coil Winding Data:

* Use Standard "Off-The-Shelf" Magnet Wire.
* All Coils Are "Cylindrical" and "Single Layer".
* Use All Coils with 365 pf. Variable Capacitor.
* All Coils Are 240 uhy., + or - 2%
* Coils Indicated In Heavy Outline Are:
"Ideally Square Coils" and Most Recommended

Wire Gauge	Form Diameter	Number of Turns	Coil Length
20	2-1/8"	96	3-5/16"
20	2-1/4"	88	3-1/16"
20	2-3/8"	82	2-7/8"
20	2-1/2"	76	2-5/8"
20	2-5/8"	72	2-1/2"
20	2-3/4"	68	2-3/8"
20	2-7/8"	64	2-1/4"
20	3"	61	2-1/8"
20	3-1/8"	58	2"

Wire Gauge	Form Diameter	Number of Turns	Coil Length
22	1-3/4"	113	3-1/4"
22	1-7/8"	103	3"
22	2"	92	2-5/8"
22	2-1/8"	85	2-7/16"
22	2-1/4"	80	2-5/16"
22	2-3/8"	74	2-1/8"
22	2-1/2"	69	2"
22	2-5/8"	65	1-7/8"
22	2-3/4"	62	1-13/16"

Wire Gauge	Form Diameter	Number of Turns	Coil Length
24	1-1/2"	120	2-11/16"
24	1-5/8"	107	2-3/8"
24	1-3/4"	97	2-3/16"
24	1-7/8"	89	2"
24	2"	82	1-7/8"
24	2-1/8"	75	1-11/16"
24	2-1/4"	71	1-5/8"
24	2-3/8"	66	1-1/2"
24	2-1/2"	63	1-7/16"

Wire Gauge	Form Diameter	Number of Turns	Coil Length
26	1-1/8"	160	2-7/8"
26	1-1/4"	136	2-7/16"
26	1-3/8"	118	2-1/8"
26	1-1/2"	105	1-7/8"
26	1-5/8"	94	1-11/16"
26	1-3/4"	86	1-9/16"
26	1-7/8"	79	1-7/16"
26	2"	73	1-5/16"
26	2-1/8"	69	1-1/4"

Wire Gauge	Form Diameter	Number of Turns	Coil Length
28	7/8"	207	3"
28	1"	165	2-3/8"
28	1-1/8"	137	2"
28	1-1/4"	120	1-3/4"
28	1-3/8"	104	1-1/2"
28	1-1/2"	92	1-5/16"
28	1-5/8"	85	1-1/4"
28	1-3/4"	78	1-1/8"
28	1-7/8"	72	1-1/16"

Wire Gauge	Form Diameter	Number of Turns	Coil Length
30	5/8"	285	3"
30	3/4"	207	2-3/16"
30	7/8"	164	1-3/4"
30	1"	135	1-7/16"
30	1-1/8"	114	1-3/16"
30	1-1/4"	100	1-1/16"
30	1-3/8"	89	15/16"
30	1-1/2"	82	7/8"
30	1-5/8"	75	13/16"

Conclusion Questions:

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Much of this lab was “borrowed” from the internet and included “Build a World War II Foxhole Radio”, www.wnyc.org/files/foxhole_radio.pdf