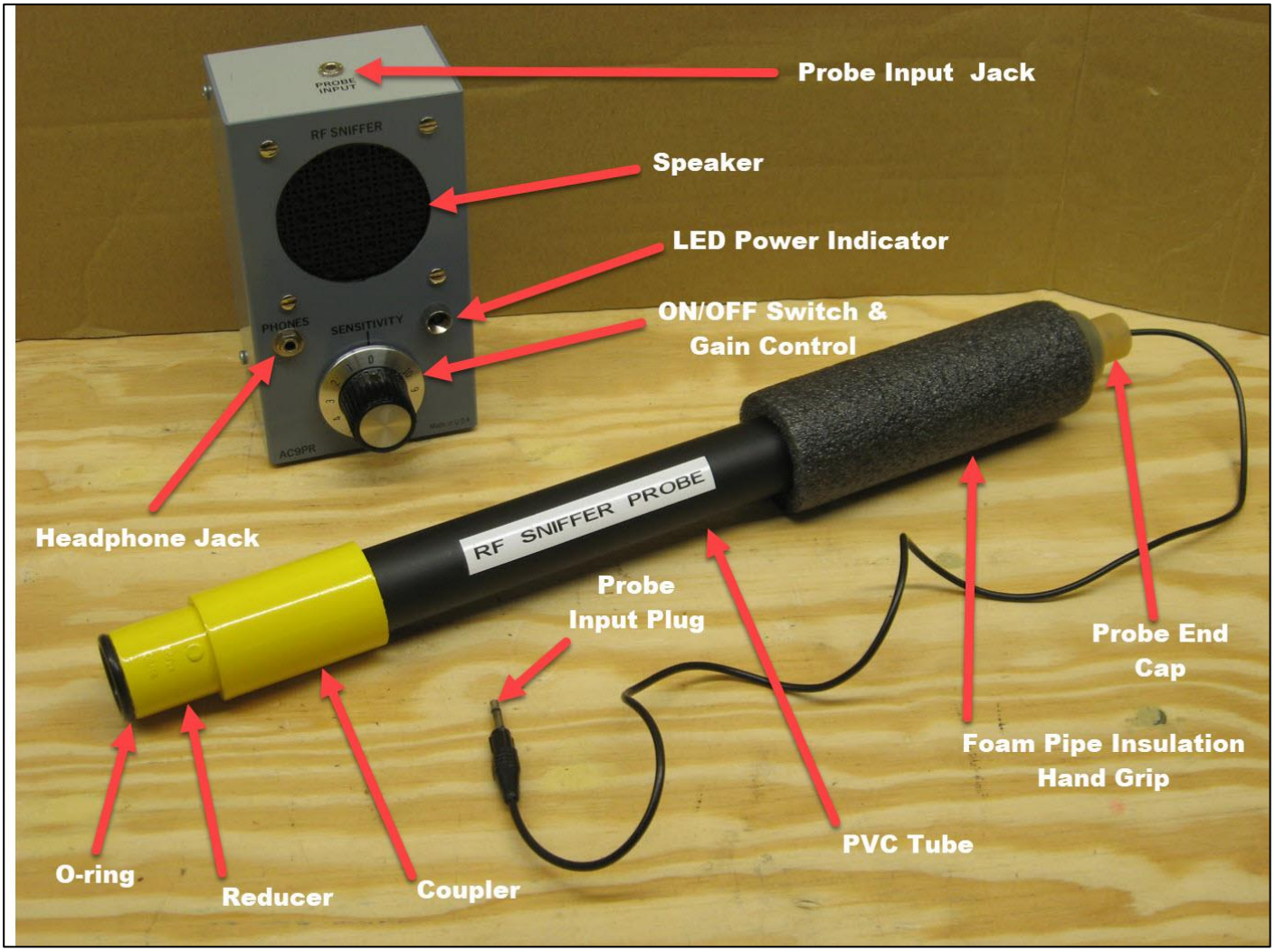
RF Sniffer Construction Notes

By Mark Kupferschmid, AC9PR



The completed units.

This article is a guide to the construction of the RF Sniffer project in the *ARRL Handbook* chapter on RF Interference (RFI). It covers both the electronics unit and the probe used to pick up RF. Several parts were ordered from Cable & Connectors (**www.cablesandconnectors.com/index.html**) and other parts are available from numerous electronics vendors.

To help insure the electronics are assembled completely put a check mark on or by each component and each connection on the schematic (or on a copy of the schematic) as each component or connection is completed.

RF Sniffer Electronics

Front view of the main unit.

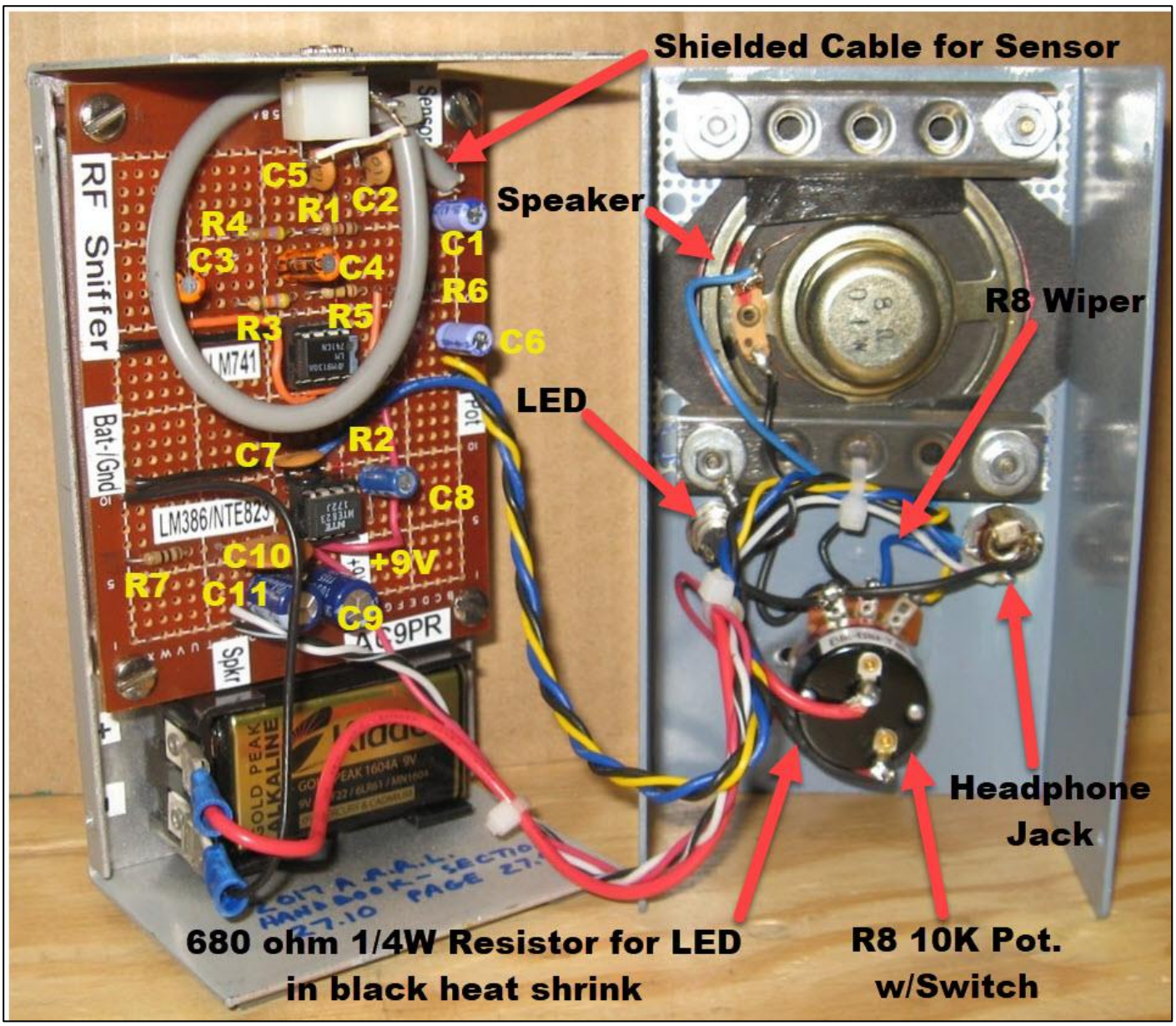
1. Enclosure shown is a 3” W × 5” H × 2” D aluminum box. The size is not critical, but the box needs to be metallic for shielding and suitable for hand-held operation.
2. There is metallic (aluminum) grill material covering the speaker. Although it is painted black and has a layer of cloth material behind it, the grill itself is bonded to the aluminum case. The grill cloth material is Pellon non-fusible sew-in interfacing fabric. Double-back tape was used to secure it in place.
3. The speaker is secured by compression – the four hex stand-off screw posts and their screws, flat washers, and two short pieces of metal strip. Between the metal strips and the speaker’s frame is a piece of self-stick rubberized padding material.
4. I recommend using IC sockets for both ICs. Sockets with gold-plated *machined pins* are more expensive but easier to insert and replace the ICs if needed and much better quality.
5. An ECG941M is a direct substitute for the LM741CN and the NTE823 will replace the LM386.
6. Be sure to install the ICs after all of the other components and wiring is done (except for testing purposes). When laying out where/how to install the components on the board, be sure to allow adequate room to install/remove the ICs. It is also recommended to put a mark on the perf board that corresponds to Pin 1 of each IC.
7. During the component layout phase, be sure there is no interference between board components, the grounded chassis, the speaker, potentiometer, and other components that may have protruding leads or a wiring harness, no pinched wires, etc. Also be sure to allow enough room to remove and install the 9V battery.
8. Add four rubber feet to the bottom of the chassis.
9. The perf board I was RadioShack 276-158A. RadioShack part number 276-154A is similar but larger and could be made to work. The perf board should have rows of individual or paired solder pads on

the reverse side. If you use perf board with solid copper traces running back and forth and in long runs, you will have to cut a lot of traces to install/connect the various parts.

10. Miscellaneous mechanical hardware and supplies include:
    - 1/8" cable clamp
    - 6-32 × 1/2" pan head screw, hex nut, external tooth lock washer
    - Black tape and painter's or masking tape
    - Spray paint
    - 91% rubbing alcohol
    - PVC end cap for ¾" PVC tube
    - PVC cleaner and cement for white

    Additional items and supplies are included in the instructions.
11. Press-on lettering should be coated with clear acrylic spray to prevent damage. Be sure to apply the spray *before* mounting the components on the chassis and allow it to dry completely.
12. If the metallic enclosure that you use is painted on the inside, be sure to remove the paint <u>for all</u> ground connections! Use a file, rasp, sandpaper, steel wool, etc., as necessary to ensure a good ground connection is made. Be sure to remove all filings, dust, etc.
13. I added a green super-bright LED power indicator (long lead is anode [+]) with a 680-Ω ¼-W series resistor to limit current to approx. 10 mA. This item is not shown on the schematic.
14. I also added a 3.5-mm (1/8") shorting jack for using a pair of headphones *with an inline volume control*. The shorting feature will mute the loud speaker on the unit when the headphone plug is inserted into the jack. You will want to use a pair of mono headphones or insert a stereo-to-mono converter jack in series with the headphone jack. Another option is to modify a stereo jack by installing a wire jumper between the left side and the right side. The added jack is not shown on the schematic.
15. On the schematic along the top of the illustration, I ran a jumper wire from "9V via S1" shown on the left to "9V via S1" shown on the right. Doing this eliminates running a second power wire to/from the power switch which is incorporated on R8, the 10 kΩ pot.

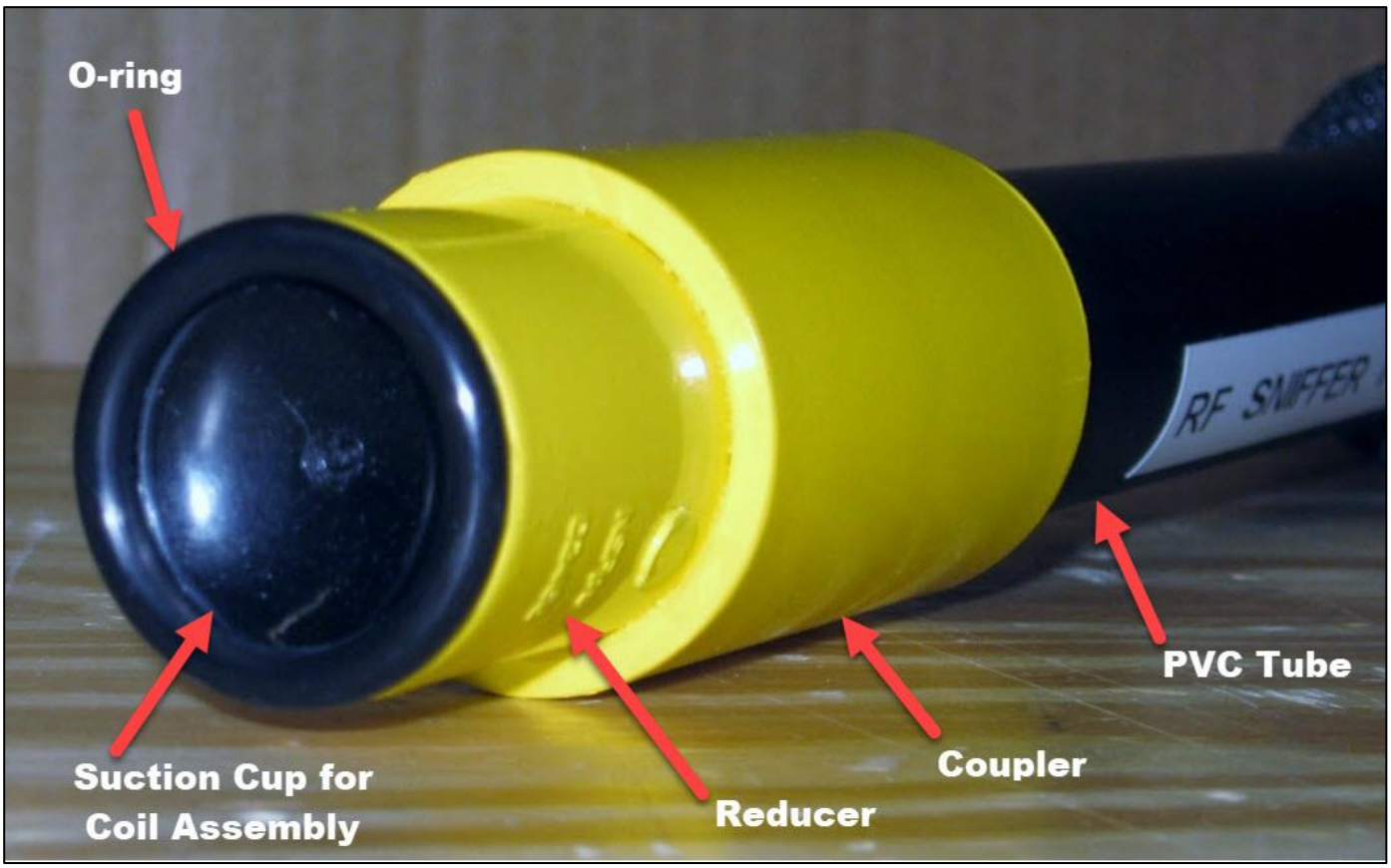
    NOTE: Editions of the *ARRL Handbook* prior to 2021 contained two errors in Figure 27.32: (1) there should be a connection between pin 6 of U1 and the left side of R6, and (2) the right side of C9 should be connected to the ground bus around the outside of the board.



Inside view of the main unit.

RF Sniffer Probe Assembly

The following instructions are for the assembly of the PVC probe parts. All PVC parts were obtained from the local home repair and hardware store. Do **NOT** cement any of the parts together until after you read all of the probe assembly notes! Follow the manufacturer's warnings, cautions, notes, and instructions before following the PVC and painting steps. Be sure to have adequate ventilation and wear safety glasses/goggles and appropriate safety garments for the various machining and assembly procedures listed below.



Close-up of the business end of the probe.

Parts list for the probe assembly (one each of the following). Part numbers are Menard's stock numbers.

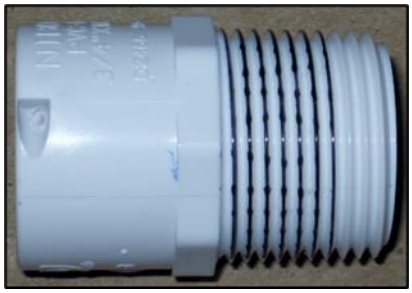
- ¾" × 5' PVC Schedule 40 pipe (PVC Tube), #689-8517
- ¾" Pipe Insulation, #679-2723
- ¾" to ¾" Female Adapter (Coupler), #689-6810
- ¾" to ½" Adapter (Reducer), # 689-6580
- 6-32 × ½" Pan head machine screw
- 6-32 hex nut
- #6 External tooth lock washer
- 1/8" Plastic cable clamp
- 13/16" I.D. × 1–1/16" O.D. O-ring with a 1/8" cross section
- Rubber or plastic end cap for bottom end of probe

NOTE: Since stock may be from multiple suppliers, the appearance of a given part may be different than what is shown. However, they do not change stock numbers between the various suppliers. For example, the adapter that I used was smooth but the current parts stocked have a molded hex configuration rather than a smooth surface. Although I provide part numbers for certain items shown above, I am also including additional descriptions of each of those items for reference, as other hardware stores may have identical items in stock, but under their part number system.

1. The main body of the probe shown is approx. 12” of ¾” Schedule 40 PVC, a ¾” coupler from NIBCO with the following markings on the end: PVC-1 ¾” SCH 40 D-2466 NSF UPC. Inserted into the coupler is a reducer that is threaded on the end that is inserted into the coupler. It contains the following markings: ¾ × ½” LASCO PVC1 MHT-101 NSFpw? 02466.

In order for the reducer to fit well into the coupler, file down the threads until you can twist the reducer into the coupler snugly. To assemble all three parts, I used the appropriate cleaner and adhesive for white PVC fittings.

2. First, carefully file down the threads on the reducer to allow assembly of the reducer into the coupler. Since they are pipe threads, the diameter of the threads increases with depth. The first several turns will be easy, but will become tighter with insertion depth of the mating part. File the threads only enough to allow complete assembly. Remove the reducer from the coupler.



File down the threaded area marked in black until you are able to fully insert the reducer into the coupler. The mating parts should fit snugly prior to the cementing process.

3. The telephone pick-up coil typically has about a 36” long cable terminated by a 1/8” 2-conductor plug. Carefully feed the cable into the end of the reducer with the smooth bore, using caution so as not to cause damage to the cable where it exits the coil assembly. For the coil used, a Dremel tool was used to remove some of the PVC material near the center of the reducer to allow enough clearance for the cable where it exits the coil. Grind out just enough PVC material so as not to kink or damage the cable when the coil assembly is inserted into the end of the reducer. The coil should be positioned so that the suction cup of the coil assembly is flush with the edge of the reducer.

If necessary, grind the area marked in red to provide adequate clearance for the coil’s cable assembly.

4. Once you are satisfied with the fit of the coil, remove the coil assembly. Prep the PVC tube and fittings for painting them, if desired. Remove all sharp edges, and clean both the insides and the outsides to remove all debris and coatings. Use the rubbing alcohol for this task. Use masking or painters' tape to cover the areas that will end up being cemented together when the unit is assembled. Place a cotton ball just inside the tube and just inside the fittings to help keep paint out of the bores, but still allow the ends of the fittings to be painted. Paint as desired.
5. After the paint has dried completely, carefully remove the cotton balls and the tape applied in the previous step.
6. Insert the coil's cable into the reducer and as you insert the coil assembly itself, be sure to position the cable so that it passes through the area that you provided clearance for in Step 3. Insert the coil assembly into the reducer until the outer edge of the suction cup is flush with the edge of the reducer. Make sure there is no damage to the cable where it exits the coil assembly. Set the reducer on a flat surface so the suction cup end is facing down on the flat surface. Very carefully, pull some cotton off of a cotton ball, and pack it around the coil assembly so that it is wrapped around the back side of the suction cup. Carefully pack more cotton down and around the back side of the suction cup area and around the lower portion of the coil assembly. This will help prevent damage to the suction cup in the next step.
7. During this step, *do NOT apply any hot glue to the coil's cable, nor allow any hot glue to drip down onto the suction cup of the coil assembly. Doing so may cause damage to the cable, or damage or disfigurement to the suction cup*. Carefully hot glue the coil assembly in several places, taking care not to apply too much. Consider that at some future time, you may need to replace the coil assembly. Allow the glue to completely cool.
8. Obtain a plastic straw and slit it down its length. Slip the slit straw over the cable and slide it until it is against the back of the coil assembly. Secure the straw in place with a short piece of masking or painters' tape. This will prevent the cable from being damaged during the PVC cementing process.
9. Measure and mark with a pencil where the tube will be cemented inside of the coupler. *Use painters' tape to cover the painted surface of the tube, and prevent damage from the cleaner and the cement*. You will need to work fast, and *CAREFULLY*, as the cleaner is watery and will run and drip, immediately beginning to damage the paint! Remember that PVC cement sets up FAST!

   NOTE: Be sure to follow the manufacturer's warnings and instructions prior to the PVC cleaning and cementing steps that follow.

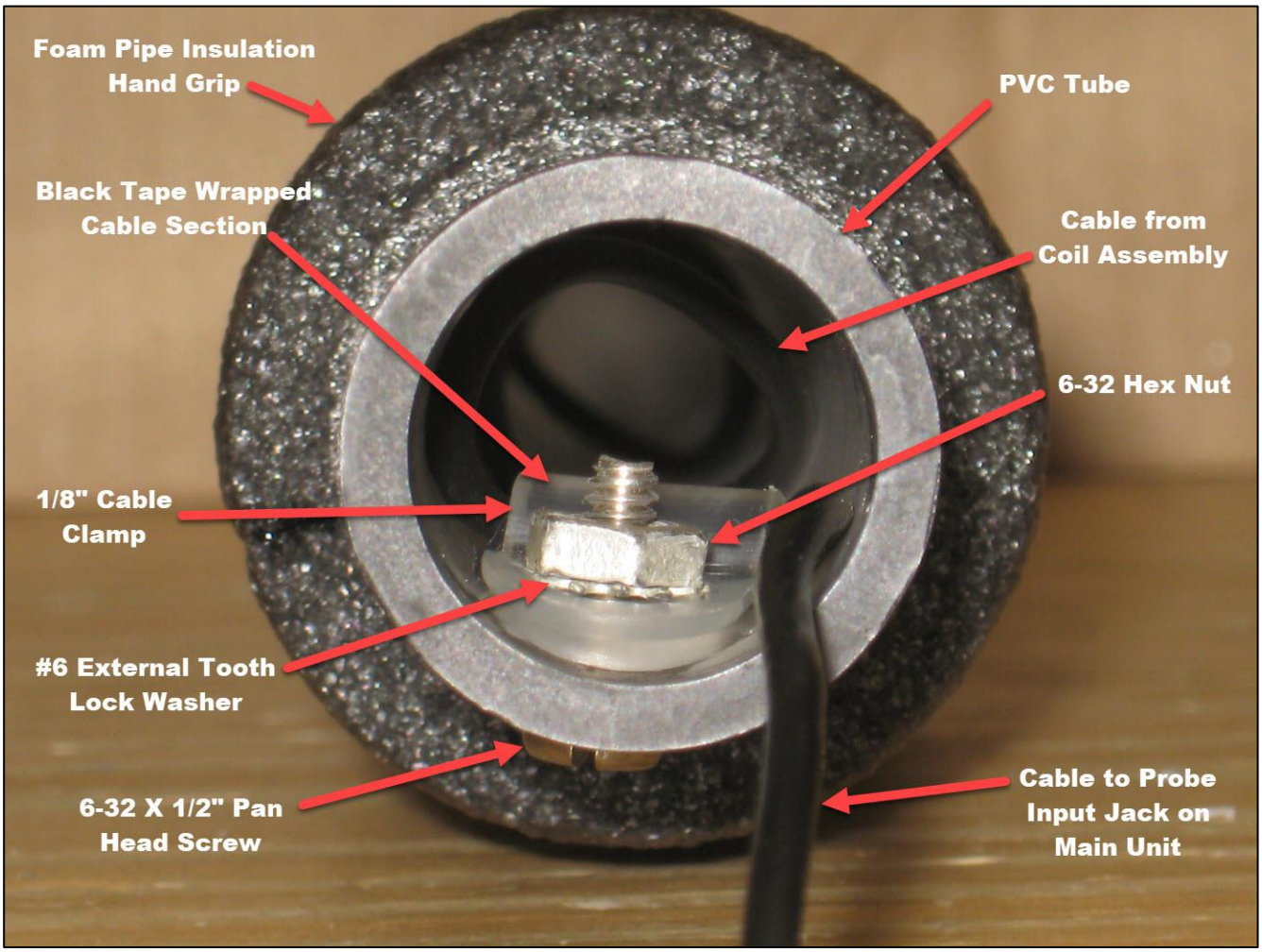
10. Apply the PVC cleaner SPARINGLY to the threads of the reducer and the bore of the coupler.

    NOTE: Due to the fluid consistency and short curing time of the PVC cement, timing of the cementing/assembly process is ***CRITICAL*** during the following two steps.

11. Apply the cement sparingly to the threads of the reducer and the bore of the coupler. Quickly but carefully, slip the cable into the coupling, making sure the straw protects the cable from damage, and using a slight twisting motion, insert the reducer into the coupler until fully assembled. Immediately clean excess cement while allowing the cement to cure.
12. Remove the straw and tape from the cable then feed the cable into the length of tubing until the end of the cable is hanging out of the tube. Repeat the cleaning and cementing process for assembling the tube into the bore of the coupling, and avoid getting either cleaner or cement on the cable. Be sure to use a twisting motion as you insert the tube into the coupling until the tubing is fully seated into the

coupling. When the cement is cured, *carefully* remove the painters' tape from the tubing that you installed in Step 9.

Strain relief for the cable:



Close-up of the cable strain relief inside of the tube.

13. Measure 5/8" from the end of the tube end where the cable exits and drill a 9/64" diameter hole through one side of the tube. Where the cable exits the end of the tube, wrap a short piece of black tape around the cable several times so that when you slip the cable into a 1/8" plastic cable clamp and secure the clamp closed, the cable will not slip through the tightened clamp. Be sure to put just enough black tape around the cable to do the job.
14. Install the 1/8" cable clamp around the cable where the tape is wrapped around the cable. Rotate the clamp 90 degrees so the clamp is perpendicular to the exiting cable. Secure the clamp in place with the 6-32 × 1/2" pan head screw, #6 external lock washer, and a 6-32 hex nut. Tighten securely. Install a cap over the cable and the end of the tube assembly.
15. Cut and install a 5" length of foam pipe insulation over the end of the tube assembly for a handle grip. You may need then to apply additional glue along the lengthwise slit of the foam pipe insulation and use rubber bands to hold the insulation together until the glue sets. I used black E6000 adhesive from Hobby Lobby for this purpose.

16. Glue the rubber O-ring onto the end of the probe with the E6000 adhesive to prevent damage to the probe and the suction cup portion of the coil assembly.

Operational Testing

1. If you haven't done so already, install both ICs. Be sure they are installed in their correct socket, and are correctly oriented in the socket. Pin #1 on each IC is typically indicated with a small dot on the top of the IC. Use caution when inserting the pins of the ICs into their socket … *they bend easily*.
2. Make sure the power switch on the potentiometer is in the OFF position. Install a new 9 V alkaline battery.
3. Insert the plug for the probe into the probe's jack.
4. If you installed the optional headphone jack, do not plug in the headphones at this time. Turn the unit ON. If you installed the optional LED power indicator, check to see if it is illuminated. With the Sensitivity/Gain control in its lowest setting, you should hear a faint hiss emanating from the speaker.
5. If successful, assemble and secure the housing closed.
6. Rotate the potentiometer clockwise to increase the amount of Sensitivity/Gain to the mid-range. Holding the main unit in one hand, and the probe in the other hand, move the tip of the probe to some sort of working electrical device. Examples may include a fluorescent or LED lighting fixture, a digital telephone, computer, router, TV, etc. You should hear an assortment of buzzing, hissing, squeaks, squawks, thumping, ticks, noise pulses, humming, etc., depending on where you point the tip of the probe on a particular item. If you experience feedback, rotate the potentiometer counterclockwise to reduce the Sensitivity/Gain.
7. If the headphone option was installed, plug the headphones into the headphone jack on the main unit and make sure the external speaker mutes when the headphones are plugged in. Move the probe around to ensure the sounds can be heard through the headphones alright. Adjust the inline volume control on the headphones to an acceptable level.
8. If the unit is not to be used for an extended period of time, be sure to remove the battery to prevent potential damage to the unit from battery leakage.