

## IMPORTANT WARRANTY INFORMATION! PLEASE READ

**Return Policy on Kits When *Not* Purchased Directly From Vectronics:** Before continuing any further with your VEC kit check with your Dealer about their return policy. If your Dealer allows returns, your kit must be returned *before* you begin construction.

**Return Policy on Kits When Purchased Directly From Vectronics:** Your VEC kit may be returned to the factory *in its pre-assembled condition only*. The reason for this stipulation is, once you begin installing and soldering parts, you essentially take over the role of the device's manufacturer. From this point on, neither Vectronics nor its dealers can reasonably be held accountable for the quality or the outcome of your work. Because of this, Vectronics cannot accept return of any kit-in-progress or completed work as a warranty item for any reason whatsoever. If you are a new or inexperienced kit builder, we urge you to read the manual carefully and determine whether or not you're ready to take on the job. If you wish to change your mind and return your kit, you may--but you must do it *before* you begin construction, and within ten (10) working days of the time it arrives.

**Vectronics Warrants:** Your kit contains each item specified in the parts list.

**Missing Parts:** If you determine, during your pre-construction inventory, that any part is missing, please contact Vectronics and we'll send the missing item to you free of charge. However, *before* you contact Vectronics, *please look carefully* to confirm you haven't misread the marking on one of the other items provided with the kit. Also, make certain an alternative part hasn't been substituted for the item you're missing. If a specific part is no longer available, or if Engineering has determined that an alternative component is more suitable, Vectronics reserves the right to make substitutions at any time. In most cases, these changes will be clearly noted in an addendum to the manual.

**Defective Parts:** Today's electronic parts are physically and electrically resilient, and defective components are rare. However, if you discover an item during your pre-construction inventory that's obviously broken or unserviceable, we'll replace it. Just return the part to Vectronics at the address below accompanied with an explanation. Upon receipt, we'll test it. If it's defective and appears unused, we'll ship you a new one right away at no charge.

**Missing or Defective Parts After You Begin Assembly:** Parts and materials lost or damaged *after construction begins* are not covered under the terms of this warranty. However, most parts supplied with VEC kits are relatively inexpensive and Vectronics can replace them for a reasonable charge. Simply contact the factory with a complete description. We'll process your order quickly and get you back on track.

**Factory Repair After You Begin Assembly:** *Kits-in progress and completed kits are specifically excluded from coverage by the Vectronics warranty.* However, as a service to customers, technicians are available to evaluate and repair malfunctioning kits for a minimum service fee of \$18.00 (½ hour rate) plus \$7.00 shipping and handling (prices subject to change). To qualify for repair service, your kit must be fully completed, unmodified, and the printed circuit board assembled using rosin-core solder. In the event your repair will require more than an hour to fix (or \$36.00, subject to change), our technicians will contact you in advance by telephone before performing the work. Defective units should be shipped prepaid to:

Vectronics  
1007 HWY 25 South  
Starkville, MS 39759

When shipping, pack your kit well and include the minimum payment plus shipping and handling charges (\$25.00 total). No work can be performed without pre-payment. Also, provide a valid UPS return address and a day time phone number where you may be reached.

## **INTRODUCTION**

Relive those bygone days of radio--a time almost 90 years ago, when early radio pioneers experimented with crystal radio receivers! Wind your own “inductor” coil, wire up the earliest radio circuit; and, there’s no soldering needed! Everything is assembled on a pine “breadboard”, just like great, great granddad did when he was a youngster. Learn about basic radio theory. Put up an antenna (wire included), connect a ground, and experience the magic of a radio that needs no power. A special high-sensitivity earphone allows you to hear AM Broadcast signals from many miles away; this little baby really performs. The VEC-121K is a fascinating project for youngsters of all ages!

The VEC-121K features a modern “fixed detector”, eliminating the need for frequent and frustrating catwhisker adjustments. A large, Hi-Q antenna coil, and a modern miniature Hi-Q tuning capacitor, are used for best sensitivity and selectivity. The high-impedance parallel-resonant tuning circuit allows a short receiving antenna to deliver maximum signal to the set.

## **TOOLS AND SUPPLIES**

Having the right tool to do a job always makes things go better. There is no soldering required, and only a few basic hand tools are needed to assemble your VEC-121K crystal radio set.

This is a list of the tools you will need:

**SAFETY EYEGLASSES or GOGGLES!** Working with wires, tools and radio parts is a lot of fun, but please, *safety first!* Your local hardware store carries inexpensive safety goggles. Before you are going to be cutting or working with wires, hammering, handling any chemicals, or using any tools, put on your safety eye wear first!

1. **Phillips screwdriver.** There are eight Phillips head screws included in the kit, and we will use this tool when it is time to mount parts on the wood board. Try to find a screwdriver with a *shaft* (the distance between the tip and start of the handle) that is at least 3” long.
2. **Long-nose pliers.** These pliers have a long and tapered nose and are used by electricians. The long slender nose makes it easy to hold or bend a wire that is being worked on.
3. **Wire cutters.** These special pliers have sharp cutters to cut wires. Some long-nose pliers styles feature built-in wire cutters. Wire cutters are sometimes called “nippy cutters” or “diagonal wire cutters”—depending on how they’re made.

4. **Ruler or tape measure.** A small 12” ruler or flexible tape measure will do.
5. **Small penknife.** A penknife, or small Exacto™ knife, is needed to scrape off wire insulation. If you aren't old enough to use a knife, a small section of sandpaper will do.
6. **Small Hammer.** It will be used with a finishing nail to mark where the screw holes are placed on the pine board.
7. **Small-Screwdriver or Hex-Tool.** Size to fit the set screw in the tuning knob--depending on which type of knob is supplied with your kit.

Radio Shack carries many inexpensive small hand tools for electronics work.

Here are some items that will come handy:

1. **Masking tape.**
2. **Cyanoacrylate adhesive.** This is the fancy name for contact cement, which is sold as “Super Glue™” or “Crazy Glue™”. You'll use the contact cement to hold the coil windings in place. These adhesives are very strong, and can instantly glue your fingers together if you are not careful! If you are not old enough to work with contact cements, have someone who is older help you when gluing is directed in the instructions. The glues used to assemble plastic model airplanes are safer to work with and may also be used instead of super glue. However, they will require a longer time to dry. Always have an adult advise and supervise your use of any chemicals!

## **WOODWORKING AND FINISHING (OPTIONAL)**

Perhaps this is your first kit building experience, or your first homemade receiver project. If so, your VEC-121K crystal receiver will be a source of pride for many years to come. Before assembling this kit, you might wish to consider sanding and staining the pine board—this will bring out the beauty of the wood, and make your project look as if it was done by an “*old pro*”. Many early radios were built in what was called “breadboard” fashion. The radio parts were laid out on a small section of wood board.

Early radio parts were very expensive, even a simple crystal radio set could cost a week's pay! Most experimenters had to improvise. Often an old breadboard (used to roll out bread dough) was used as a base to mount radio parts. If you were well-to-do, your “breadboard” was probably a fine piece of mahogany or walnut board!

**Sanding:** Before applying a stain finish, carefully sand the pine board using 200 grit sandpaper. When sanding the surfaces, always sand in the direction of the grain to avoid scratching the wood. The two board edges that expose the end

grains of the wood will be rather rough to the touch, and will require some extra sanding to produce a smooth even surface. You may have to use a 150 grit in the beginning on the end grains. Sanding is best done outdoors. Wear a disposable paper dust mask while sanding.

**Finishing:** Your local hardware store stocks small cans of woodworker stains. Either a walnut or mahogany wood stain finish is a good choice. Both oil-based and water-based stains are available. We suggest using a water-based stain for this project—it is easier to work with and easier to clean up afterwards. You will need a clean cloth, or *staining cloth*, to apply the stain. Follow the manufacturer's directions very carefully, and read the safety information on the label. Use disposable latex gloves when handling stain. If you're too young to safely work with wood stains, ask an adult for assistance with this portion of the project. *Always handle any chemicals with great care!*

**Important Note:** Once the stain is dry to the touch, the assembly work may begin. Before attaching the tuning capacitor with the double-sided adhesive tape, the board should be allowed to dry for a few days. This will allow the stain to fully *cure*, or dry, so it does not interfere with the tape adhesive.

## **BEFORE YOU START BUILDING**

**Your work area:** Use a good workbench with good lighting so you can see what you are doing. At times we will need to set items aside to allow glue to dry; or you will need to stop working on your project for other activities. Your work area should be in a place where your project does not interfere with others.

Keep your work area clean and free of clutter. Kit parts should be kept in the box until you need to use them. When you are finished for the day, return the tools to their proper place. Put unused kit parts back in the box so you will not lose them. If you are old enough to use glues and wood stains, you may have younger brothers and sisters who aren't! Keep chemicals out of the reach of younger children.

**Following directions:** Kits are built in "steps". These steps follow a logical order, that means following the instructions will make your kit building experience easier and ensures that your project will work *first time* when finished.

You will notice a check box  as each instruction gives you a simple task, or direction, to follow. When the task is finished, make a small check mark in the box to show that part has been completed. This will allow you to keep track of where you left off when returning from a break.

For example, a direction may read:

- Tighten the screw until snug, this will make a good electrical connection between the Fahnstock clip and wire.

When finished following the directions, “check off” that the step has been done.

- Tighten the screw until snug, this will make a good electrical connection between the Fahnstock clip and wire.

### **Don't rush!**

Have you ever noticed that when you try to rush doing something, it never turns out right? Don't try to build the crystal set receiver in one day! The time spent building a kit is most of the fun. We will be “breaking down” the kit assembly into several phases. For example, the first phase is preparing the “breadboard”. The next kit phase involves winding the coil.

### **Working with wire:**

**Unspooling:** Your kit includes a 100-foot roll of 18 AWG enamel-coated wire. This wire is used to wind the tuning coil, for your receiver's antenna, and is also to be used for making connections between the radio components. Do not remove the wire tie from the roll of wire until you are ready to use it. There is a right and wrong way to remove wire from the spool! Never allow the wire to uncoil, like a Slinky™ toy! Doing so will cause the wire to twist and make kinks when you try to use it. Instead, hold the spool of wire in both hands, and carefully unroll the wire from the spool. Re-tape the unused portion when finished.

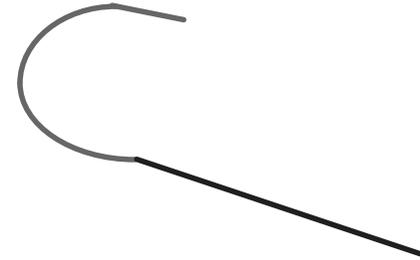
**Removing insulation:** Electrical connections are made by removing the insulation from the enamel wire. When you need to make an electrical connection, you will be instructed to remove the wire insulation. We will tell you where the insulation should be removed, and how much to remove. This can be done by using a small piece of 150 grit sandpaper. Fold the sandpaper in half so the “sandy” sides face together. Place the wire into the sandpaper fold, and slide the sandpaper back-and-forth over the wire while applying a gentle pressure. Turn the sandpaper every so often to fully remove all of the insulation. Gently scraping the insulation with a small penknife will also work. Lay the wire on a piece of scrap board, and draw the knife blade over the insulation to scrape it away. *Always scrape in a direction away from your body!*

All of the insulation must be removed to make a good electrical connection. The bare area of the copper wire should be bright and shiny when you are finished.

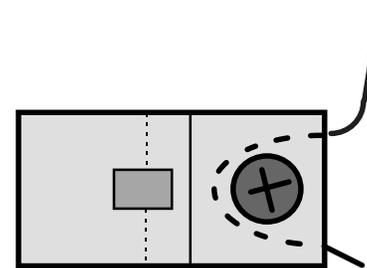
### **Making connections:**

The directions will tell you to make one of two types of connections: “End” connections or “through” connections.

**End Connections:** End connections are made when the end of a wire is connected. To make an end connection, you will have to remove about 1" of insulation from the wire and form the end into a "fishhook" shape, as shown below.



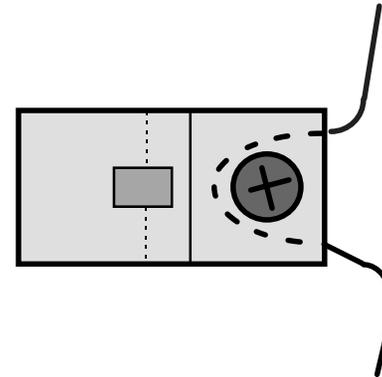
In the following drawing, a wire end connection is used to make an electrical connection to one of the Fahnstock clips mounted on the pine board. Note we show the wire as a "dotted line" where it passes *under* the Fahnstock clip. When the Phillips screw is tightened, a good electrical connection is made. The drawing shows how the wire hook is placed between the Fahnstock clip and board.



Through connections are used when the wire goes to an electrical connection at a Fahnstock clip, and then continues on to make one or more connections to other points. The directions will tell where to make a through connection on a wire, and how much insulation needs to be removed.



The wire insulation is removed where shown in the directions, and made into a half loop as shown above.



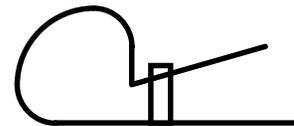
The above drawing shows a through connection being made to a Fahnstock clip. The dotted line shows where the wire runs under the clip body.

**PARTS LIST**

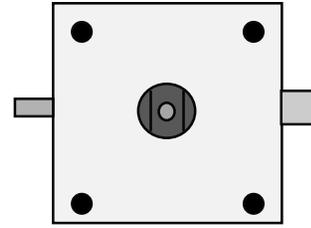
You are just about ready to begin your kit building adventure! But first, let's take a few minutes to make sure everything needed is present and accounted for. If any parts are missing or damaged, you'll need to refer to the directions given in the Vectronics kit warranty section of the manual.

<input checked="" type="checkbox"/>	Qty	Part Description
<input type="checkbox"/>	8	Phillips head screws
<input type="checkbox"/>	1	5 inch length of white 2-1/2" diameter PVC plastic pipe
<input type="checkbox"/>	1	100 foot spool of 18 AWG enamel coated wire.
<input type="checkbox"/>	6	Fahnstock clips.
<input type="checkbox"/>	1	Tuning capacitor shaft extension
<input type="checkbox"/>	1	Tuning capacitor
<input type="checkbox"/>	1	Tuning knob
<input type="checkbox"/>	1	Double-sided foam tape
<input type="checkbox"/>	1	Earphone
<input type="checkbox"/>	1	Pine board , 3/4" high by 5-1/4" deep by 6" wide
<input type="checkbox"/>	1	Insulated stranded wire, 7 feet long
<input type="checkbox"/>	1	27K resistor (red-violet-orange-gold)
<input type="checkbox"/>	1	1N34A germanium diode

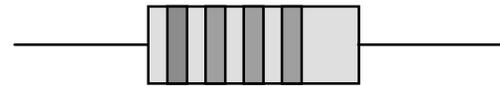
Fahnstock clips



Tuning capacitor.



Resistor:



Germanium diode:

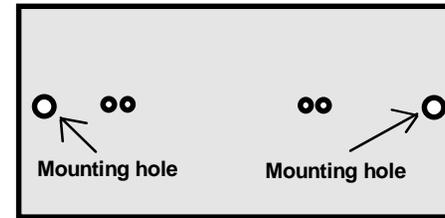


## **STEP-BY-STEP CONSTRUCTION**

Before starting any construction, please read the Vectronics warranty. Kits that have been started *cannot* be returned for credit. Make sure this kit is within your skill level before starting assembly!

### **Phase 1: Breadboard preparation**

- Find the pine board. Look it over carefully, and select which side you wish to use for mounting the parts. Chose the side that has the fewest imperfections, and has the nicest looking grain pattern.
- Locate the drawing that shows the screw hole pattern for the pine board.
- Place the screw hole pattern guide over the board, be sure the board edges line up with the outline on the drawing. Use masking tape to hold the pattern to the board.
- Using a finishing nail and small hammer, make a small punch mark at each of the eight screw hole locations. These marks will show you where the screw holes are located on the board. *Don't drive the nail into wood!* We need only make small indentations, about 1/8", to mark the screw locations, and to provide pilot holes for the wood screws.
- Remove the paper pattern guide.
- Find one of the eight Phillips head screws and a Phillips head screwdriver.
- At each of the eight screw hole locations marked by the finishing nail, screw the Phillips head screw fully into the board, stopping when its head reaches the board surface. Make sure the screw remains perfectly straight, and not tilted, when doing each of the eight holes.
- Return the screw to the parts bag.
- Find the 5-inch length of PVC pipe. The tuning coil will be wound on this section of plastic pipe. It is called a *coil form*.
- There are six holes drilled through the pipe, look for the two outer, and larger sized, mounting holes.



- Now, make sure that the two screw pilot holes on the pine board for mounting the coil form are correct. Refer to the drawings in the manual that show the placement for the Fahnstock clips and coil form. Temporarily mount the coil in its proper location using two Phillips head screws. You do not need to fully tighten the screws, we are just checking to see that things fit properly.

**Important Note:** You will need to use a screwdriver with a long shaft (about three inches) for these two screws because of the large diameter of the coil form.

- If the coil form mounting holes align properly with the breadboard's mounting holes, you may remove the coil and return the screws to the parts bag. If things don't match up just right, you will have to mark the correct position for the breadboard pilot hole with a pencil, and remove the coil. Make a new pilot hole by using the hammer and finishing nail to make a small indentation to start the screw. Run a screw into the pilot hole until the head reaches the board surface. Remove the screw and return it to the parts bag.

This completes Phase 1. There should be eight screw holes in the pine breadboard at this point. If so, the mounting holes have been properly located, marked, and the screw holes are ready for parts installation!

If you haven't already done so, this is an excellent time to stain the board (if you are planning to do so).

We are ready to begin Phase 2.

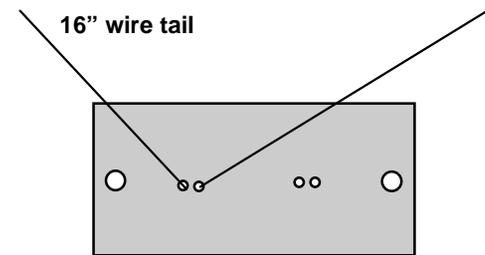
**Phase 2: Winding the tuning coil**

This portion of the assembly involves winding about 66 turns of 18 AWG enamel coated copper wire over a 2½" area of the PVC plastic coil form. This will take time, patience, planning and practice! Here are a few suggestions to help you along.

You will be directed to unwind a length of wire from the 100-foot coil of enamel wire in several of the following steps. Always unspool the wire, never allow it to uncoil in Slinky™ toy fashion. The unspooled length of wire should be laid out in a straight line—*do not* allow it to simply pile onto the floor, or you will end up with a hopeless tangle of wire. After unwinding a length of wire, use two strips of masking tape to secure the remaining wire on the coil.

The winding on the coil should be smooth and even—with no gaps or kinks. If the copper wire kinks during handling, smooth it out as best you can before trying to wind it. We are going to wind a single-layer coil, this is called a *solenoid* winding. The winding is done in several steps. You will be instructed to stop winding after a certain amount of wire is wound. If you have a friend who is willing to help, ask him to give you a hand winding the coil. Four hands can be very helpful!

- Remove several 5-inch lengths of masking tape from the roll of tape. Keep them within arm's reach while winding the coil.
- Find the PVC coil form and the 100-foot hank of coil wire.
- Unspool about 15' of wire from the 100-foot coil of wire. Leave wire attached to the spool—*do not cut it!* Tape the remaining wire so it will not unwind and become tangled.
- First, secure the wire at the starting point of the winding. Insert about 16" of wire into the starting hole, and loop it back out of the adjacent wire hole and pull tightly. Either end of the form may be used as the starting point. This will secure the wire. The illustration below shows how to do this:



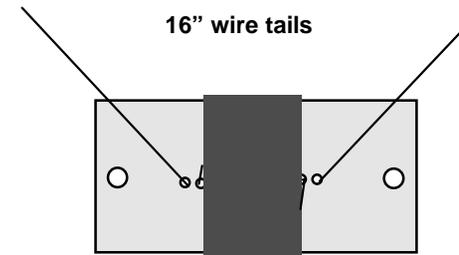
- Tuck the 16" wire tail back inside of the coil form, so it will be out of the way during winding.
- Hold the coil form in your left hand. The wire coming from the 100-foot coil should be between you and the form. Insert the middle and index finger of your left hand into the coil form. Place your left thumb over the wire at the starting hole.
- Use your right hand to help turn the PVC coil form while winding the coil. This takes a little practice, but you will quickly master the technique once you start.
- Wind several turns of wire by turning the form. Use your left hand thumb to guide the wire, and keep enough pressure on the wire with your thumb so that the windings are tight, even, and spaced together.
- After several turns are completed, examine your work. (Keep your thumb in place so the wire doesn't loosen on the coil form!) The wire windings should be even and spaced so the wire of each turn is firmly pressed against the next. The windings should be tight. There should be no gaps between the wire turns. You can squeeze the windings together to remove small gaps.
- The first several turns of the winding form the foundation for the rest of the windings. If you didn't quite get it right the first time, unwind the coil and try again.
- Once you are satisfied with your work, grab a piece of masking tape with your right hand, and tape across the windings to hold them securely. *Note:* Tape across and over the windings—the tape should follow the 5" width of the coil.
- Using its dispenser tip, put a small drop of contact adhesive on the winding at its beginning and end point. Smear any excess back over adjacent

windings using the dispenser tip. Draw a very light bead of adhesive across the full width of the winding. Very little adhesive is needed for these tasks! Let the coil sit until the contact cement has fully cured! (You may use the glue sold for assembling plastic models for these tasks. Remember, it will take several hours for the glue to harden.)

- Now, finish winding the tuning coil. It takes about 3 feet of wire to do four full turns. It takes about 66 turns of wire to fully wind the coil over the 2.5" coil span; so you will use about 52 feet of wire for the entire winding. Don't bother trying to count turns as you go. A few extra or missing turns will not affect the performance of the crystal set. What is important is to have the winding cover the full 2.5" inch span, without gaps.
- Unspool another 20 feet of 18 AWG enamel coated wire. Remove the masking tape from the coil form. Continue winding until the 20 feet of wire is used. Tape the new windings to hold them in place.
- Again, inspect the new windings you have just completed. Are they tightly wound, and free of gaps between adjacent windings? Squeeze the newer windings towards the starting windings to close up any gaps. When you're satisfied, use masking tape to secure the turns, and then fix the windings in place using contact cement or model glue.

**Important Note:** As you continue adding windings, you will reach a point where your left hand fingers will no longer reach inside of the PVC coil form. At this point, you will need both hands on the form as you work, and you will be using both thumbs to guide the wire and keep the proper tension.

- Continue by unspooling 20 foot lengths of wire at a time, winding the coil until you reach the "finish" point on the coil form. Securely tape the coil windings, and glue the new windings in place.
- At the end of the winding, mark off an additional 16" of wire, and cut the wire at this point.
- Insert the 16" inch wire tail into the "finish" wire hole in the PVC coil form. Bring the wire back out through the adjacent hole and pull with enough force so the wire is snug. Secure the end point of the winding with a very small drop of contact cement.
- Fish the wire end for the starting point of the winding out of the form. Your coil should now resemble the illustration below:

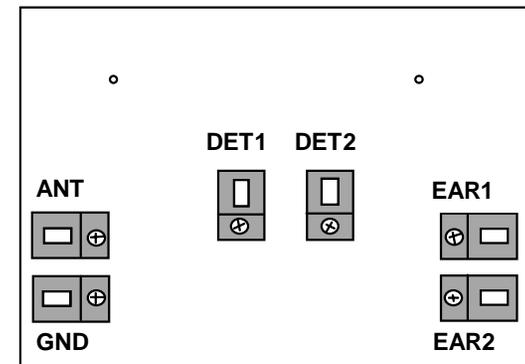


- Rewind any excess wire back onto the supply spool.

Congratulations! You have just wound an inductor that has about 217-uH of inductance! Put the coil aside for now, you'll be mounting it on the breadboard soon.

### Phase 3: Mounting the parts

- Locate the six Fahnstock clips, and six of the eight Phillips screws supplied with the kit.
- Refer to the positioning guide below for the following steps.



In the following several steps, we will mount the six Fahnstock clips.

- Place a Fahnstock clip at the point shown as *GND* in the drawing. Align the clip so its rounded over edge faces the board edge.
- Secure the clip to the board using one of the Phillips head screws. Tighten the screw until snug, so it holds the clip firmly. *Do not over tighten.*

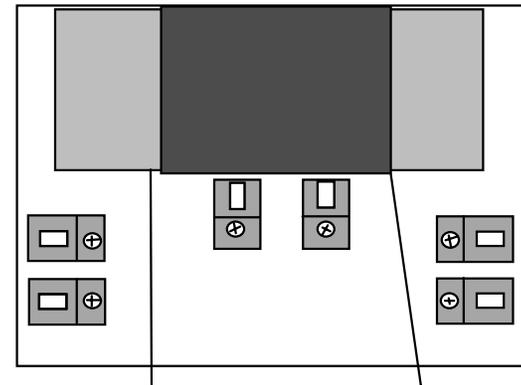
For the remaining steps, align the Fahstock clips as shown in the drawing.

- Mount a second clip at the *ANT* position on the breadboard using a Phillips screw.
- Mount a clip using a Phillips screw at the *DET1* position on the breadboard.
- Mount a clip using a Phillips screw at the *DET2* position on the breadboard.
- Mount a clip using a Phillips screw at the *EAR2* position on the breadboard.
- Mount a clip using a Phillips screw at the *EAR1* position on the breadboard.

The six Fahstock clips should all be mounted at this point.

- Find the coil and the remaining two Phillips head screws.
- Mount the coil to the board using the two Phillips head mounting screws. Before tightening the screws, make sure the two 16" coil lead wires are oriented towards the front of the breadboard. You may now tighten the screws so the coil is mounted snugly against the board. *NOTE: Overtightening the screws may damage the coil form, or cause the screws to strip the pine board.*

Your crystal receiver should resemble the following drawing:

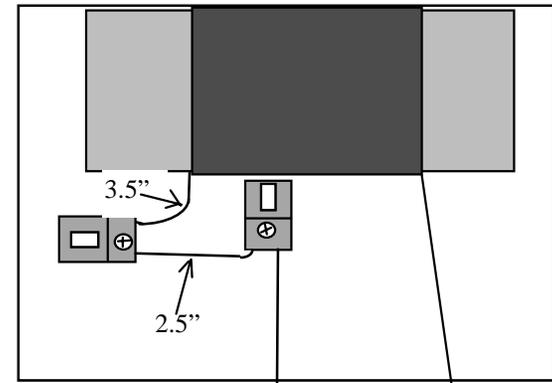


You have finished Phase 3 of your crystal set receiver project. In Phase 4, we'll be doing the wiring between the crystal set's components.

#### Phase 4: Wiring the crystal set

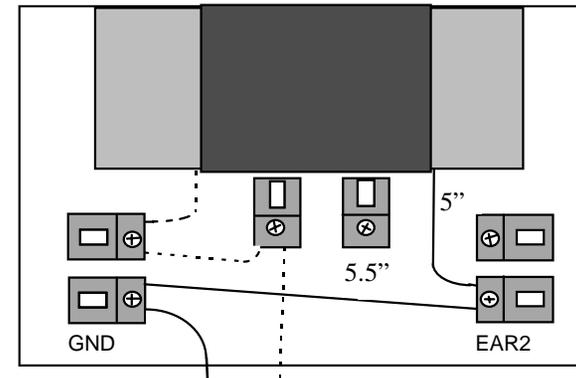
In phase 4, most of the wiring will involve using the two 16" coil wires. For clarity, we are only showing the components we are going to be working with.

You need to know where the wire leads need to be sanded to make connections. Route the coil wire, as shown in the following diagram, by loosening the Phillips screws mounting the two Fahnestock clips labeled ANT and DET1 (as shown):



- Measure and mark the coil wire lead at the left-hand side of the crystal set at 3.5 inches. The measurement is taken from the point where the wire exits the form.
- Remove about 1" of insulation at the 3.5" mark.
- Form the wire so the area stripped of insulation forms a *through connection*.
- Loosen the Phillips head screw for the *ANT* Fahnestock clip.
- Route the *through-connection* loop so it passes between the *ANT* Fahnestock clip and breadboard.
- Tighten the *ANT* clip mounting screw so it is snug.
- Measure and mark the wire lead emerging from the antenna clip at 2.5".
- At the 2.5" point, remove 1" of wire insulation, and form a second *through-connection* half loop.
- Loosen the Phillips screw mounting the *DET1* Fahnestock clip.
- Route the second through connection so it passes under the *DET1* Fahnestock, loops around the screw shank, and exits as shown in the drawings.
- Tighten the Phillips screw for the *DET1* clip so it is snug.
- Several inches of wire should remain from the *DET1* clip connection, this will be used later. **Do not cut the wire until told to do so!**

In the next few steps you will be working with the right-hand coil wire. Refer to the drawing below for the following steps:



**Important Note:** The “dotted” lines show wiring done in previous steps.

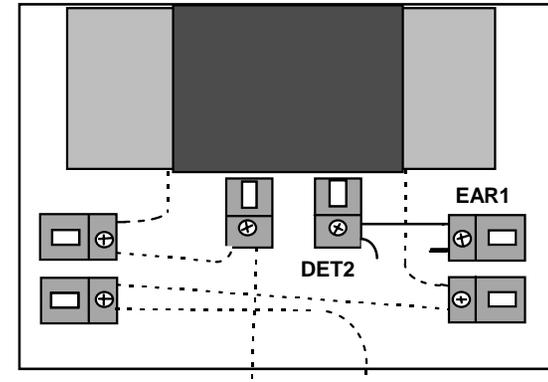
- Mark the left-hand coil wire at 5” from where it exits the coil.
- At the 5” point, remove 1” of insulation from the wire.
- Form the area stripped of insulation into a *through-connection* half loop.
- Loosen the Fahnstock clip mounting screw for the *EAR2* clip.
- Pass the *through-connection* between the *EAR2* clip and breadboard, with loop going around the Phillips screw shank, as shown above.
- Tighten the mounting screw for the *EAR2* clip until snug.
- Measure the wire exiting from the *EAR2* connection, and at the 5.5” point remove 1” of insulation from the wire.
- Form the area of wire stripped of insulation into a second *through-connection* half loop.
- Loosen the Phillips screw that mounts the Fahnstock clip used for the *GND* connection.
- Pass the *through-connection* between the *GND* clip and breadboard, with the loop going around the Phillips screw shank, as shown above.
- Tighten the *GND* Phillips mounting screw until snug.
- Several inches of wire should remain from the *GND* connection. ***Do not cut this wire until instructed to do so!***

This completes Phase 4. You’ve come a long way since first opening the kit. Your little crystal receiving set is really starting to look like something.

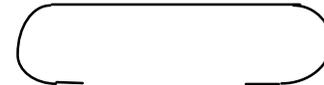
#### Phase 5: Final wiring

Only a few more steps remain, and the set will be finished.

Refer to the drawing below for the last wiring steps.



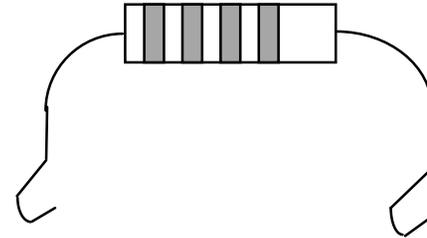
- Cut a 4½" length of 18 AWG enamel wire from the wire spool in the kit.
- Remove 1" of insulation from each end.
- Form each end of the wire into an *end* connection.



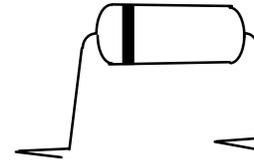
- Loosen the screws mounting the Fahnstock clips *DET2* and *EAR1*.
- Take one of the wire *end* connections and place between the *DET2* clip and breadboard.
- Tighten the mounting screw for the *DET2* clip until snug.
- The remaining *end* connection is placed between the *EAR1* clip and breadboard.
- Tighten the mounting screw for clip *EAR1* until snug.

- The wire should be routed so it crosses over the wire from the right end of the coil without the wires touching each other.
- Find the 27K ohm resistor (it has the Red-Violet-Orange-Gold colored bands) and form the leads as shown below:

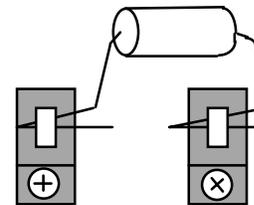
**Important Note:** It makes no difference which lead is used for either connection.



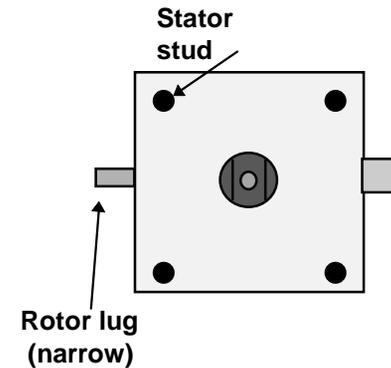
- The ends of the resistor leads are formed into little half loop hooks.
- Loosen the two Phillips screws for *EAR1* and *EAR2* clips.
- Put one of the half loop connections between the *top* of the clip body, and the *bottom* of the screw head for the *EAR1* clip. Adjust the size of the loop so it fits snugly around the shank of the screw.
- Tighten the mounting screw for clip *EAR1* until snug. The resistor lead should remain firmly attached.
- Place the remaining loop between the screw head and body of the clip *EAR2*. Re-form the loop so it fits snugly around the screw body.
- Tighten the screw for clip *EAR2* until snug. The resistor lead should remain firmly attached.
- Find the germanium detector diode. Form the leads as shown below.



- A 3/8" length of each of the diode's lead ends is sharply folded back on itself. This is done because the diode will be mounted in the *DET1* and *DET2* Fahnstock clips. The diode lead wires are a very small diameter, and may not be held tightly enough by the clip unless the leads are made a bit thicker.
- Follow the diagram below, and clip the diode's anode lead into the *DET1* Fahnstock clip, and the cathode lead (the lead with the band close to it) into the *DET2* Fahnstock clip. Gently pressing down on the clip opens the jaw, permitting the wire lead to be inserted.



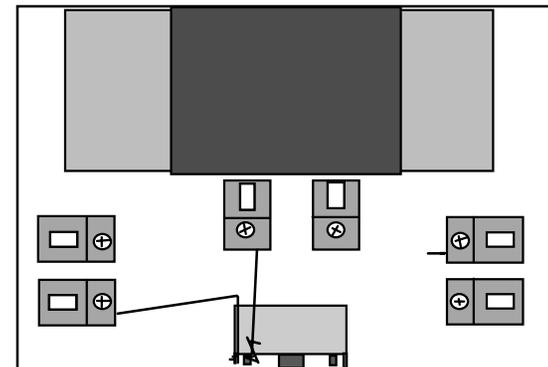
Find the tuning capacitor. Refer to the drawing below for the following steps.



*This is the correct orientation for installing the capacitor. Note that the narrower rotor lug must be at the left hand side!*

Variable capacitors have two sets of plates. One set of plates remain stationary, and are called the “*stator*” plates. The tuning shaft is attached to another set of plates that rotate as the shaft is turned. They are called the “*rotor*” plates. As the shaft is turned, the plates are either meshed or unmeshed, changing the capacitance value. This is how the tuning capacitor works.

The tuning capacitor will be mounted at the front center of the breadboard using the double-sided foam tape. The remaining enamel wire lead coming from the *GND* Fahnstock clip will be connected to the narrow *rotor lug* terminal on the tuning capacitor. The remaining enamel wire lead from the *DET1* Fahnstock clip will be connected to the round *stator stud* on the front of the capacitor.



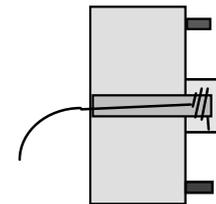
The above drawing shows how the wires will be routed to the tuning capacitor connections.

#### Connecting the stator lead

- Temporarily place the tuning capacitor as shown in the drawing. **Be sure the narrowest stator lug is at the left hand side!**
- Cut the free enamel wire lead from the *GND* clip to a length of five inches.
- At the end of the wire, remove 2" of insulation.
- Route the enamel wire from the *GND* clip so it reaches to the capacitor body. At that point, the wire goes up to the middle of the capacitor, and then makes another sharp bend towards the front of the board.

Study how the capacitor is made. If you look into the capacitor through its clear plastic housing, you can see how the narrow rotor lug continues to the rear of the capacitor. At that point, there is a tiny opening in the plastic capacitor housing.

- Take the wire from the *GND* clip and insert it into this capacitor opening. Carefully feed the wire so it passes through the capacitor body (it will be between the plastic housing and narrow metal strap) and finally emerges at the front end of the capacitor.
- Continue feeding the wire until 1" of bare enamel wire clears the front opening in the capacitor.
- Using your long nose pliers, carefully wrap the enamel wire around the narrow rotor lug until two or three full turns are made. Trim off the excess wire.

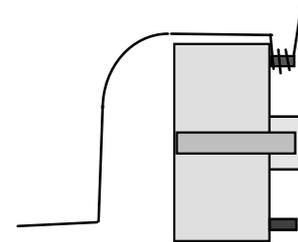


- Gently, but firmly, squeeze the turns wrapped around the rotor lug, using the long nose pliers, until they are compressed tightly--making a good, tight electrical connection.

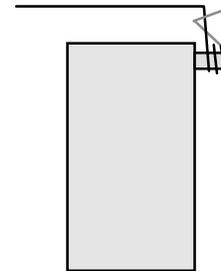
**Important Note:** If for some reason the narrow rotor lug is damaged while trying to attach the lead, use the wider rotor lug as an alternate connection point.

### Making the stator connection

- Temporarily place the capacitor at its mounting location.
- Route the free enamel wire coming from the *DET1* Fahnstock clip so it follows the breadboard, and comes up and over the top of the capacitor until it reaches the stator stud. (Refer to the drawings to identify the proper stud.)
- Trim the wire coming from the DET1 clip to a length of 4½”.
- Remove 1½” of insulation from the wire end.
- Wind the wire over the stud to form three *tightly* wound turns. See the following drawing. Use enough wire so when finished you have a small ½” pigtail remaining.



- You need a good, tight electrical connection. Slide the turns off of the stud—note how they make a little coil. Gently tighten the coil by twisting the coil so it is smaller.
- The coil should slide back on with some difficulty—otherwise the turns are too loose.
- To make an even tighter connection, take the pigtail, and wrap it back over the wire in a half-loop.



- Using the long nose pliers, gently twist the half loop to take up wire slack and tighten the wire wraps made over the stud.

**Important Note:** If the stator stud is damaged beyond use, the stud located directly beneath it may be used as a backup. The two right hand studs may not be used.

- Place the capacitor at its mounting location at the center front of the board. The body of the capacitor should sit about 1/8" back from the board edge. Use a ruler to center the capacitor body at 3" from either outside board edge.
- Mark the capacitor body outline by tracing its outline onto the breadboard with a pencil.
- Find the double-sided foam tape.
- Remove one of the protective covers from one side of the tape. Place the sticky side over the capacitor outline on the breadboard. Firmly press the tape to set the adhesive.
- Remove the protective cover over the top of the tape.
- While being careful to keep the capacitor centered on the board, and parallel to the front edge of the board, press it to the foam tape. Apply gentle, but firm, pressure to set the adhesive.
- Find the 1/4" diameter aluminum tuning shaft extension. Align the threaded screw end with the opening in the capacitor tuning shaft. Screw the extension into the tuning capacitor.
- Unscrew the tuning shaft about 1 or 2 turns, to open a gap between the two shafts.

- Using the dispenser, allow a small drop of contact adhesive to flow into the gap and onto the threaded portion of the extension. *Quickly* screw the extension back into the tuning capacitor to close the gap. If you are using model airplane cement, unscrew the shaft extension, and lightly smear a small amount of glue over the threads. Quickly screw the extension back into the capacitor shaft.
- Allow time for the glue to harden.
- Using a small screwdriver or hex tool, install the tuning knob on the shaft extension.

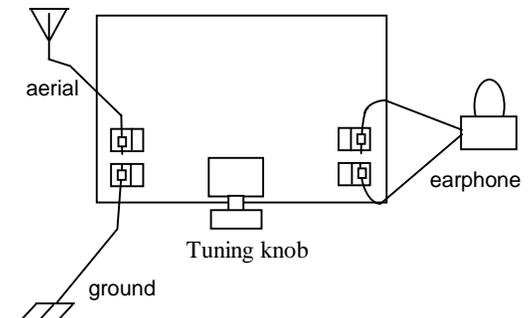
This completes the construction of the VEC-121K crystal set receiver.

## **TESTING AND ALIGNMENT**

1. Turn the capacitor shaft in a counter clockwise direction until the stop is reached.
2. Loosen the tuning knob set screw, and align the tuning indicator on the knob so it corresponds to the 9 o'clock position.
3. Tighten the set screw.
4. Verify that the knob indicator properly corresponds to the capacitor stops at the 9 and 3 o'clock positions.

## **OPERATING INSTRUCTIONS**

1. Use the hookup shown in the following diagram to make the antenna (aerial), ground, and earphone connections.



2. Connect the earphone wires to the Fahnstock clips at the right hand side of the radio.

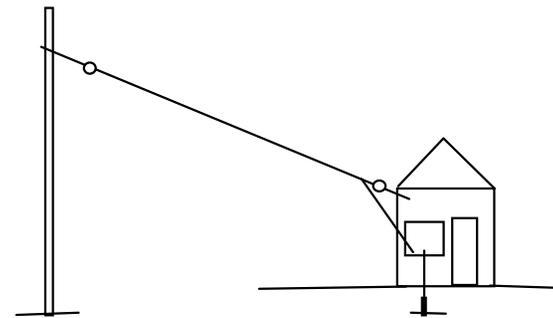
3. Connect a good ground connection to the crystal receiver. Use the 7 foot length of stranded hookup wire supplied with the kit to make the ground connection between a good earth ground and the Fahnstock clip on the receiver.
4. Connect a long wire antenna to the Fahnstock clip on the receiver.
5. Carefully tune the tuning knob while listening for signals in the earphone. You should be able to copy at least one, and maybe several, stations without difficulty.

**What can I hear?** You should be able to hear local stations without much difficulty. The crystal set tunes the entire broadcast band from 530 kHz to 1700 kHz. The antenna and ground system are the keys to success when using crystal sets. Where you live affects how well you receive signals. If you live in a salt marsh, or along the shore, you may experience exceptional reception. The fellow living in an arid area with poor soil moisture may have much poorer reception.

**When to listen?** You should hear local stations at any time of the day. At dusk, radio signals propagate over greater distances. Listening just before the sun goes down may yield some pleasant surprises! Also, as the seasons change, you may find you can hear different distant stations at sundown. Keep a simple log of new stations when you receive them. Note the time, call letters and frequency. It's always fun to add a "new one" to the list.

### Erecting a good antenna

Your radio will work only as good as the antenna and ground it is connected to do. The best antenna for a crystal set is located outdoors, it is between 100 and 30 feet long, and is mounted high and in the clear. Your kit includes enough wire to make an outdoor 40 foot wire antenna and short lead-in wire to the crystal set receiver.



This diagram shows an aerial going between a pole (or tall tree trunk) and location where the receiver is located. A small length of lead-wire connects the antenna to the crystal set inside of the house. (Make sure the lead-in wire makes good electrical connection to the antenna wire!) Note the insulators between the antenna wire and the supporting structures. A good earth ground is provided by a short ground rod driven into the earth outside of the window where the crystal set is located. You may make your own insulators from scraps of 1" plastic pipe, or small sections of 1" by 6" Lexan™ or Plexiglas™. Drill holes at the ends of the insulators for tie-points for the antenna wire and support rope. Clothesline is a good way to tie the insulator to the supporting structures.

The antenna wire should not be allowed to touch leaves or rub against branches. Doing so will affect your reception. Keep your antenna wire away from power lines.

### **Finding the elusive ground**

Several feet of insulated stranded hookup wire is included in your kit. This is provided to connect a *ground* to the crystal set. But, what is a good *ground* and how can you make or find one?

**Ground rods.** Many times a crystal set will work quite well without a ground connection, especially if a very good antenna is being used. The most effective ground is a 10 foot ground rod driven into the earth. If you have a TV antenna on your home, it should be connected to a ground rod for lightning protection. If it is near your operating position, you may be able to tie a wire between your crystal set and the TV antenna ground rod. Even four or five feet length of old copper pipe driven into the earth will do in a pinch! But, be sure you use some sandpaper to remove any corrosion on the pipe that would prevent making a good electrical connection to your ground wire lead in.

**Water pipe grounds.** If you live in an older home that uses metal instead of plastic plumbing, you have a good ground point at the nearest water pipe or radiator. Connect a short wire between the crystal set ground and the water pipe. Remember that the pipe must be free of corrosion or paint to make a good electrical connection.

**Counterpoise grounds.** The reason the crystal set needs a ground is because a single wire antenna is really only one-half of a complete antenna! The ground makes up for the missing half of the antenna, and gives the wire antenna something to "work against". If you have 50 or 60 feet of scrap wire laying about, you can make what is called a "counterpoise" to serve as a ground for the crystal set. Simply run the wire out on the ground in a straight line. The wire needn't be buried, it will "couple" to the earth due to "stray capacitance". Connect one end of the counterpoise wire to the ground Fahnstock on the crystal set, and you're in business!

## **IN CASE OF DIFFICULTY**

This crystal set almost *has* to work, if it was built according to the directions. If you can not hear any stations at all, go back over the assembly instructions and try to find any errors that you might have made during construction. Perhaps you missed removing the insulation from the wire at a connection. Or, a wire is in the wrong place. Have a friend check your work. It's very easy to look over a mistake, and a fresh pair of eyes will often quickly find mistakes that elude your detection. Factory repair is available for assembled kits that do not work. Consult the warranty for information regarding factory service.

Here's a quick check list of common problems.

**The set receives several signals at once.** This is normal for crystal sets. They don't have the ability to separate signals that very are strong or close in frequency.

**The tuning control has no effect.** Check that the connections to the tuning capacitor are tight, and that the proper connection points to the tuning capacitor were used.

**Signals are very weak, or I can only hear one station.** Again, this may be normal, if there are no strong signals in your area. Check your ground and antenna connections. A longer antenna or better ground may improve things.

**Set works intermittently.** This sounds like a poor connection. Check that the Fahnstock clips are making good connections to the antenna, ground and earphone wires. If a clip won't grip the wire properly, remove the wire and bend the clip upwards slightly. This should restore the clasping action of the clip's jaw.

**There is a local station at the high or low end of the dial that I can't hear.** The VEC-121K is designed to tune the entire broadcast band. However, there will be certain antenna lengths that will behave in unexpected manners at certain frequencies. Also, because of the way the antenna and ground are coupled to the receiver tuned circuits, they will also have some effect on the tuning range limits.

## **THEORY OF OPERATION AND SPECIFICATIONS**

The tuning capacitor and coil form a parallel resonant circuit that tunes from about 530-kHz to over 1.6 MHz. The antenna and ground are directly applied across the resonant circuit. Thus, the set is optimized for use with short, high-

## THEORY OF OPERATION AND SPECIFICATIONS

The tuning capacitor and coil form a parallel resonant circuit that tunes from about 530-kHz to over 1.6 MHz. The antenna and ground are directly applied across the resonant circuit. Thus, the set is optimized for use with short, high-impedance antennas under 100' long. The parallel resonant circuit acts like a very low impedance path to signals off resonance. (Signals that are not tuned in see a "short circuit".) At resonance, the parallel circuit becomes a very high impedance (offers little resistance to a signal it is tuned too).

Signals that are "tuned in" are "rectified" by the germanium detector diode. The radio signal is simply a high-frequency AC voltage. During rectification, better called detection, the signal is broken down into two components: a DC voltage and a AC signal that corresponds to the information being carried by the Amplitude Modulated signal. The AC signal maybe voice, music, or whatever program material the radio station is broadcasting.

Because the audio recovered from the radio station AM carrier is a very, very, small voltage, the ear piece must be very sensitive. The high-impedance crystal earpiece supplied with the VEC-121K meets those requirements. Because the crystal earpiece has almost no resistance, a 27K ohm resistor is placed across the earphone clips to provide a path for the detector diode current.

Tuning Range.....	530-1700 KHz (typical)
Detector diode .....	Fixed germanium, 1N34A or equiv.
Headphone impedance.....	2000-ohms or higher
Mode.....	AM receiver

## SCHEMATIC

