FUN WITH ELECTRONICS
ASSEMBLY INSTRUCTIONS

Before you do the projects on the CD-ROM, you need to prepare your "Electronic Workbench." You do this by installing the electronic parts in the plastic container onto the cardboard box with the holes punched in it. Once all of the components (electronic parts) are installed, you will make projects by hooking the components together with pieces of wire. Each project is a different circuit, a term that means "a bunch of electronic components that does something when you send electricity through it." The following setup will let you build 25 different circuits!

WARNING #1: Do not use any other source of electricity with your projects. The current from wall sockets or appliances is very, very strong and can cause you great injury. There is no risk from the current in your battery, but anything more powerful will, at the very least, damage the circuits in your Electronic Workbench. Or it could damage *your* circuits. Treat electricity extremely carefully.

WARNING #2: Do not just connect the two terminals of the battery directly together with a piece of wire or other metal. The battery and wire will heat up enough to burn you!

PUTTING TOGETHER THE BASIC ELECTRONIC WORKBENCH

Step One: The Springs

The first step in setting up your Electronic Workbench is to install the springs (you will find in the plastic case) into the holes in the cardboard box. (fig. 2)

The springs fit into the large holes punched in the top of the cardboard box. Some holes may not be punched all the way through, so take a pen or pencil and push the extra cardboard through the hole. While you're at it, push out all the small holes, too. Then push a spring about halfway into each of the 52 bigger holes (they have a number next to them) (figs. 2, 3). There should be enough springs to fill all 52 holes. After you have filled all the holes with springs, open the bottom of the box so you can put the rest of the parts together.

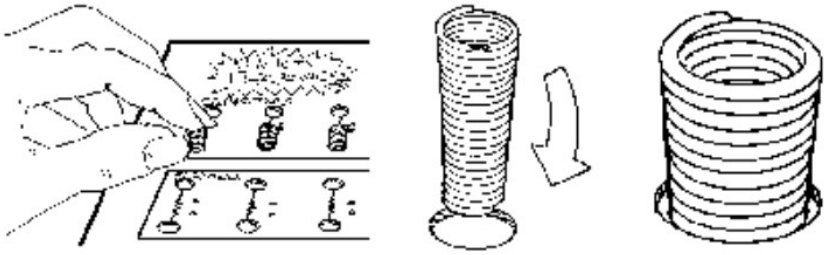

fig.1 fig. 2 fig. 3

You are now ready to begin installing your components, but first these **Words of Warning:** ***Many of these parts will not work if they are not put in the right way, and some will get permanently zapped if they are put in wrong.*** Pay close attention to the directions, or you'll be trotting down to your local electronic-supply store for replacement parts!

Step Two: The Capacitors

The first electronic parts that you are going to install are called capacitors. These guys act as little electricity storage tanks. You have five different capacitors for your workbench. Three of them look like little brown disks (almost like tiny M&Ms) with two leads (small wires attached to the component sticking out. These are called ceramic capacitors. If you look closely, you will see that there is a number printed on the side. (fig. 4) The numbers indicate how much electricity the capacitor will hold. They're measured in units called "farads," which are named after a man named Faraday. Find the smallest capacitor -- it should say "102" on it. This is going to be the first component that you install. Follow these steps!

1) Put the leads from the bottom of the capacitor through the small holes next to springs 1 and 2. It doesn't make any difference which lead goes in which hole. (figs. 5, 6)
2) Turn the box over and bend spring 1 until you can insert the closest lead into one of the gaps. Once you have the wire lead in spring 1, let go of the spring.
3) Put the other lead into spring 2. (fig. 7)
4) Take the capacitor numbered "103" or "01" and install it into holes and springs numbered 3 and 4. (fig. 8)
5) Put the capacitor numbered "503" or ".05" into holes and springs 5 and 6.

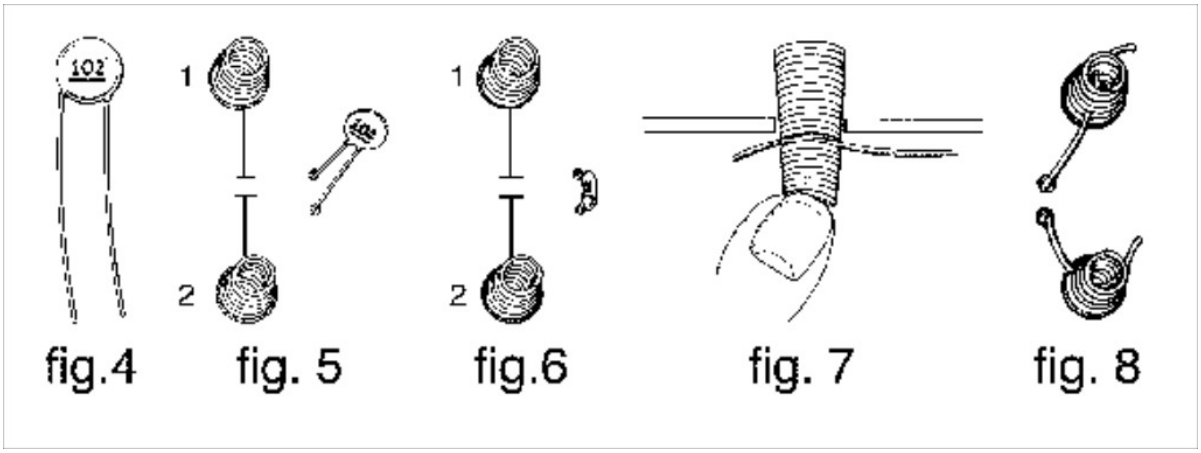

fig.4 fig. 5 fig.6 fig. 7 fig. 8

The other two capacitors look like small, blue cans with two leads on the bottom. These are electrolytic capacitors. (fig. 9) They store more electricity than ceramic capacitors. Another important difference is that these capacitors don't work if you put them in backwards. Find the capacitor that says "47uF" on the side. Look carefully, and you should be able to find one side that has a minus (-) sign on it. Put the lead under the minus sign through the small hole next to spring 8 and the other lead through the small hole next to spring 7. (fig. 10) Attach them to the springs underneath. Now double-check and make sure that the minus side of the capacitor is next to spring 8.

Now take the last capacitor (which should say "470uF" on the side) and put it into holes 9 and 10, with the lead from the minus side attaching to spring 10.

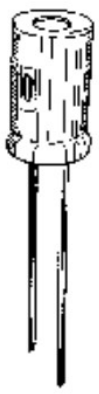

fig.9

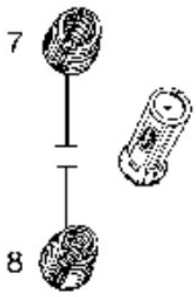

fig. 10

Step Three: The Resistors

RESISTORS are used to control how much electricity is traveling in a circuit. If you look carefully, you'll see that each resistor has colored stripes. (fig.11) The stripes indicate how strong the resistor is, and each color indicates a different number (except for a gold or silver one on the end). You should have six resistors, and they should be installed as follows.

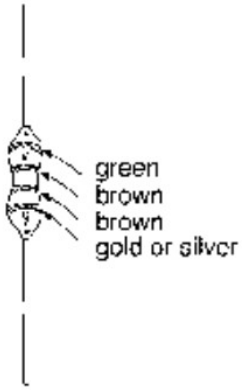

fig. 11

1) Find the resistor with green, brown, and brown stripes. (The last brown stripe should be closest to the gold or silver stripe.) Install it in springs 11 and 12. It doesn't matter which way you put it in.
2) Install the resistor with brown, black, and red stripes in springs 13 and 14.
3) Install the resistor with green, brown, and red stripes in springs 15 and 16.
4) Install the resistor with brown, black, and orange stripes in springs 17 and 18.
5) Install the resistor with brown, black, and yellow stripes in springs 19 and 20.
6) Install the resistor with yellow, purple, and yellow stripes in springs 21 and 22.

Step Four: Transistors

There should be two small black components with three leads sticking out of the bottom. These are transistors. (fig. 12) There are only two in your Electronic Workbench, but they are very important. **They**

are also very easy to break, so be very careful!

1) The leads from the first transistor go into springs 23, 24, and 25. (fig. 13) Hold the transistor so the curved side faces spring 23. Put the center lead into hole next to spring 23, the lead closest to the top of the Electronic Workbench in the hole next to spring 24, and the lead closest to the bottom in the hole next to spring 25. Connect the leads to the springs. (fig. 14)

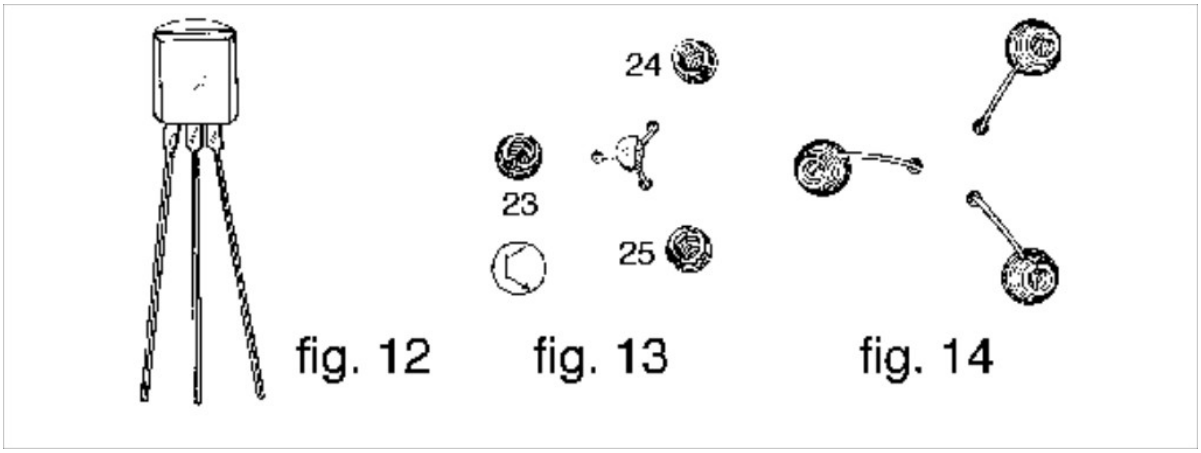

fig. 12 fig. 13 fig. 14

2) Install the leads from the second transistor in springs 26, 27, and 28. Face the curved side toward spring 26, and put the center lead into hole 26. Put the top lead into hole 27, and the bottom lead into hole 28. Connect to the springs.

Step Five: Diodes

The diode is a little glass tube with leads coming out of both ends. (fig. 15) A diode is a "one-way" component like a valve-- it lets electricity go through in one direction, but not the other. Attach the diode to springs 44 and 45, with the black stripe pointing at spring 45. (fig. 16)

fig. 15

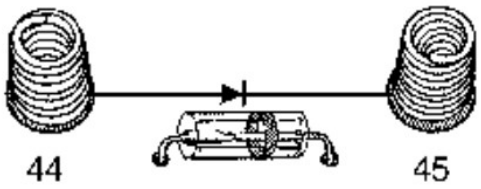

fig. 16

The bright red and green "lights" are called **L**ight **E**mitting **D**iodes, or LEDs for short. (fig. 17) Just like the plain vanilla diode you just installed, these only allow electricity to go in only one direction. However, they also light up, which of course makes them way cooler.

If you look at the LED's carefully, you will notice that one side of the little edge around the bottom is flat . Put the red LED into springs 29 and 30, with the flat edge next to spring 29. (fig. 18) Put the green LED into springs 31 and 32, with the flat side toward 31. Double check the LEDs and the diode -- if they're in backwards, they'll plug everything up!

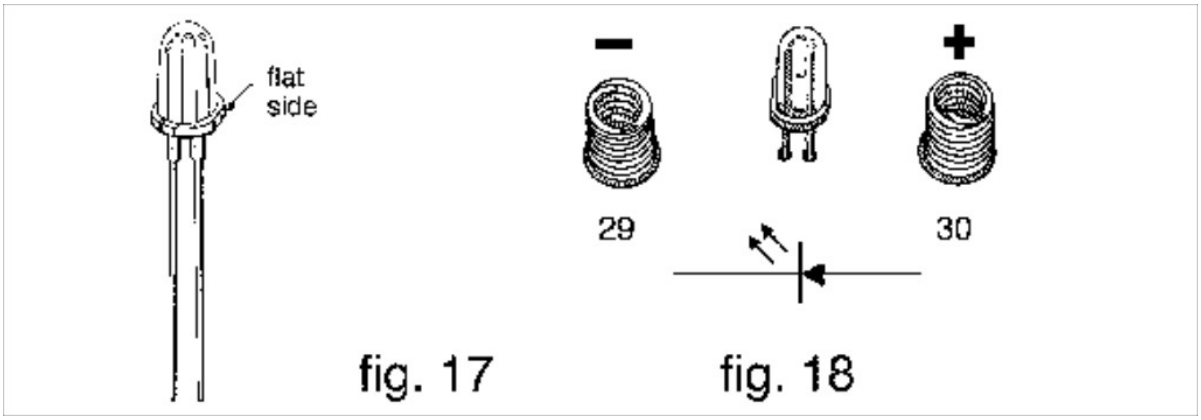

fig. 17 fig. 18

Step Six: The Photocell

The photocell is an orange disk with tiny stripes. (fig. 19) This is actually a special kind of resistor that varies how much it resists depending on how much light is shining on it. The darker it gets in the room where you're working, the less electricity it lets through. To install the photocell attach it to springs 46 and 47. It doesn't matter which lead goes on which spring.

fig. 19

Step Seven: The Transformer

The funny-looking thing with five leads coming out of it is the transformer. (fig. 20) (No, it doesn't turn into a robot. Be kinda cool if it did, though.) A transformer is a device that changes the voltage of the electricity passing through it.

Put the transformer in the holes indicated on the drawing (fig. 21) (the leads will match up exactly with the small holes), and attach the leads to springs 35, 36, 37, 51, and 52 as shown. (fig. 22)

fig. 20

fig. 21

fig. 22

Step Eight: The Piezo Transducer

The big round metal disk is the piezo transducer. (fig. 23) It makes noise when electricity goes through it.

Place the two leads on the piezo transducer through the two holes next to springs 38 and 39, (fig. 24) then attach the leads to springs 38 and 39, making sure the leads don't touch. (fig. 25)

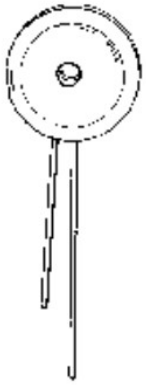

fig. 23

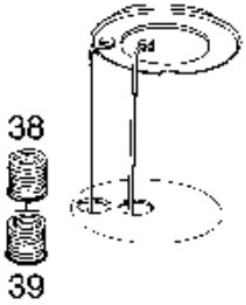

fig. 24

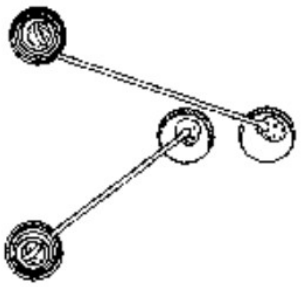

fig. 25

Step Nine: The Variable Capacitor

The square, clear box is the variable capacitor. (fig. 26) As the name implies, it is a capacitor that can be changed, which can be a very handy thing. On top of the box is a short metal tube with screw threads on the inside. There is also a flat black disc and a special screw that are part of the variable capacitor.

From underneath the Electronic Workbench, push the metal tube up through the hole to the right of springs 42 and 43 and hold it in place. (fig. 27) Then place the round plastic knob on top of the tube, so that it notches into place. Use the special screw to attach the knob firmly to the metal tube. When you have the knob attached, carefully connect the wires on the bottom of the variable capacitor onto springs 42 and 43. (fig. 28)

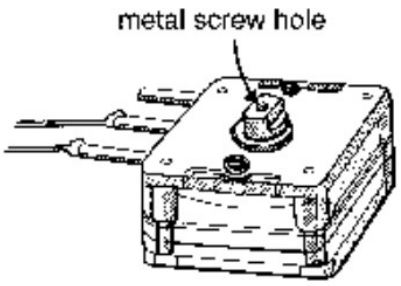

fig. 26

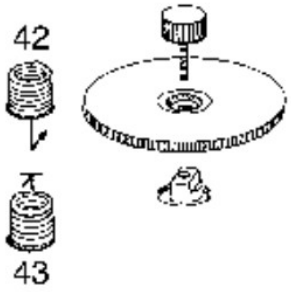

fig. 27

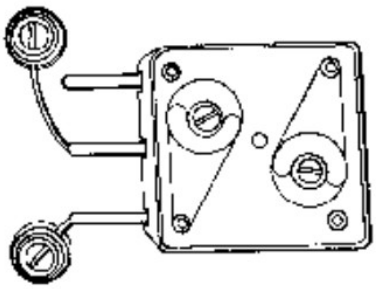

fig. 28

Step Ten: The Antenna

The black metal rod and coil of copper wire are the two parts of the antenna. (fig. 29) The antenna picks up faint radio signals that you will actually be able to hear!

To assemble the antenna, slide the coil of wire over the metal rod as shown. (fig. 30) You may have to bend the coil into the shape of the metal rod. To put it in the Electronic Workbench, look carefully at the workbench next to springs number 48, 49, and 50, and you will see two tabs that can be folded up. These tabs hold the antenna in place (look at the drawing, because it's a lot easier to show than explain). Once you have the antenna in place, put the three wires through the hole between springs 48 and 49. Then, from the bottom, attach the red wire in spring 48, the uncolored wire in spring 49, and the green wire to spring 50. (fig. 32) Only the very ends of the wire are bare metal, so make sure the metal ends are touching the springs!

fig. 29

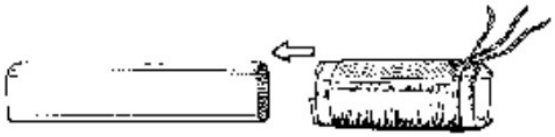

fig. 30

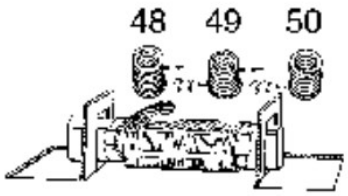

fig. 31

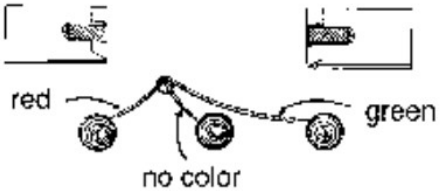

fig. 32

Step Eleven: The Earphone

The earphone has a small speaker inside it, and can translate electricity into sound. (fig. 33)

To attach (or install) the earphone to the workbench, put the wire through the small hole between springs 40 and 41 (fig. 34) and attach the bare metal ends of the wire to those two springs, in no particular order. (fig. 35)

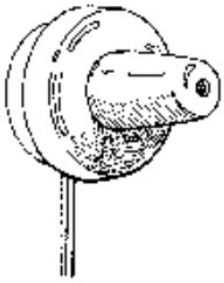

fig. 33

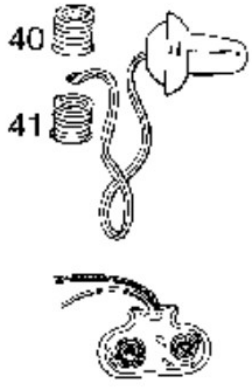

fig. 34

fig. 35

Step Twelve: The Battery Holder

And last, but certainly not least, is the battery holder.

Feed the red and black leads through the small hole next to springs 33 and 34. The red wire goes to spring 33, and the black wire to spring 34. (fig. 36)

Definitely double-check this, because if you did this backwards, nothing will work. Place a 9-volt battery into the punched-out rectangle. (fig. 37) When you build a circuit, you will connect the battery clips to the battery.

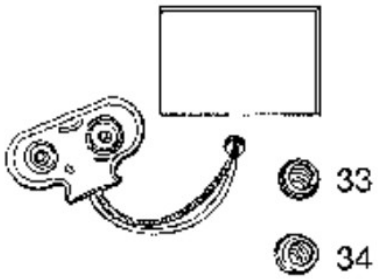

fig. 36

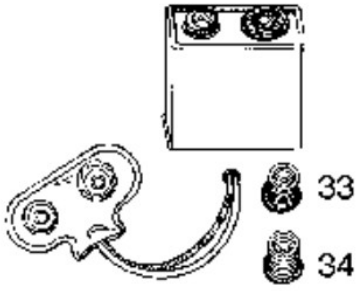

fig. 37

Whew! Congratulations! Your "Electronic Workbench" is done!

There will be a bunch of hookup wires left over, which you should keep in the plastic box. You will use them to build your projects. However, there is one more step that we must take, and that is…

TESTING YOUR ELECTRONIC WORKBENCH

Before you get too far, it's a good idea to test your Electronic Workbench and its components to make sure there are no problems. It's a lot less frustrating to find problems and fix them now. Let's put together a couple of test circuits that, when hooked up, will make sure everything is doing what it is supposed to do.
You will test your Electronic Workbench by connecting wires to some of the springs. Connecting springs builds a circuit that connects the components. Some "Basic Rules of Wiring":

- Connect metal to metal. Make sure the wire (not the plastic wrap) is hooked in the spring.
- Gently pull the wires to make sure they are connected.
- Try not to bend the wires more than you have to. They will eventually break.
- Use the shortest wire possible. You might need the longer one somewhere else, and besides, it looks tidier.
- Always clear your workbench between tests.
- Last, but certainly very important, **never hook up the battery until you have the whole circuit completed.** Hooking it up too early can fry your components.

Test Circuit #1: Red LED

Take your wires and hook up the following pairs of springs:
11 to 33; 12 to 30; 29 to 34.
Attach the battery clip, and the red LED should light up. If it doesn't, make sure that the flat side of the LED is facing spring 29.

Test Circuit #2: Green LED

Hook up the following pairs of springs: 11 to 33, 12 to 32, and 31 to 34. Attach the battery clip and the green LED should light up. If it doesn't, double check that the flat side of the LED is facing spring 31.

Test Circuit #3: Transistor 1

To test transistor 1 (springs 23,24, 25) connect the following pairs of springs:
11-33, 12-30, 17-23, 24-29, 25-34. Attach a long wire to spring 18, hook up the battery clip and touch the other end of the long wire to spring 33. The red LED should light up. If it doesn't , then transistor 1 was not installed properly. Make sure the leads are in the right holes.

Test Circuit #4: Transistor 2

To test the other transistor, connect the following pairs of springs:
11-33, 12-30 ,17-26, 27-29, 28-34. Again attach a wire to spring 18, hook up the battery clip, and then touch the other end of the wire to spring 33. If the red LED lights up, all systems are go! If not, double check that all the leads are attached to the right springs.

GENERAL TROUBLE-SHOOTING

Sometimes you will find that a circuit won't work, even after you double-check all of the connections. If this is the case, first check your battery, especially if you left it in your circuit over the weekend by mistake. If the battery is OK, take all of the wires off and start again from scratch, paying close attention to the directions. I know it's frustrating, but it can be easier than tracking the problem down any other way.

If the circuit still doesn't work, you may have burnt out a transistor. (They are fragile little guys, I'm afraid.) Disconnect all the wires, and try the transistor checking circuits previously outlined. If the transistor is not working, try your local Radio Shack or other electronic parts store and ask for a "general purpose NPN transistor, such as 2N2222 or 2N3904". No, they don't cost very much!

NOTE TO PARENTS

These hints cover most of the problems your child might encounter. The transistors and the LEDs are the components voted "most likely to cause trouble", but the test circuits previously completed will allow easy testing of them. If they break, they are available inexpensively at any electronics supply store.

As you help (or watch) your child assembling the circuits, keep in mind that 1) something is bound to go wrong eventually; 2) your child will become frustrated; 3) this is perfectly normal and happens to NASA engineers, too; 4) with a little support from you, he or she should be able to find the problem and fix it.

If a circuit just won't cooperate, and you've done everything imaginable, then pack it in. Move on to another circuit, and come back to the problem circuit another day. There's a very good chance it will work perfectly. After all, as Scarlet O'Hara said (famous electrician that she was), "Tomorrow is another day!"