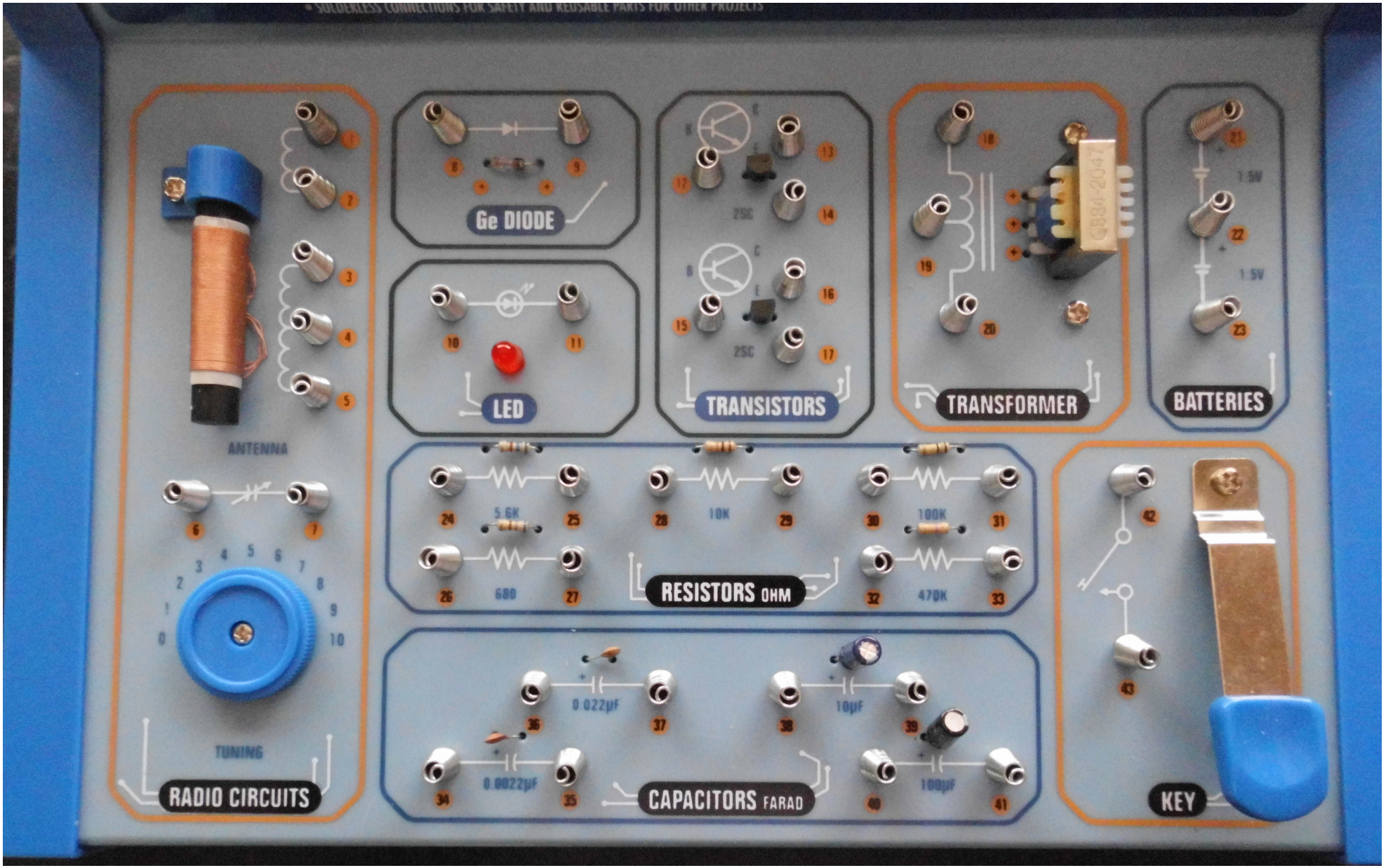
ELECTRONICS SCIENCE™

35 INSTANT ELECTRONIC ACTIVITY

35 IN ONE

OPEN YOUR EYES TO THE Y2K WORLD OF ELECTRICITY FOR MILLENNIUM KIDS!

- LEARN TO BUILD YOUR VERY OWN AM/FM RADIO, BURGLAS ALARM, WATER DETECTOR, MORSE CODE PRATICE CIRCUIT, SAMPLE COMPUTER CIRCUIT, AND MORE
- SOLDERLESS CONNECTIONS FOR SAFETY AND REUSABLE PARTS FOR OTHER PROJECTS
- ELECTRONICS EXPERIENCE IS NOT REQUIRED
- INSTRUCTION MANUAL INCLUDED


SOLDERLESS CONNECTIONS FOR SAFETY AND REUSABLE PARTS FOR OTHER PROJECTS
ANTENNA
TUNING
RADIO CIRCUITS
Ge DIODE
LED
2SC
2SC
TRANSISTORS
TRANSFORMER
BATTERIES
1.5V
1.5V
5.6K
10K
100K
680
470K
RESISTORS OHM
0.022μF
10μF
0.0022μF
100μF
CAPACITORS FARAD
KEY

35 INSTANT ELECTRONIC ACTIVITY

ELECTRONIC SCIENCE

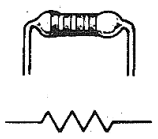
35 IN ONE

This kit is a"Instant Electronics" because it enables you to build your first project straight away, whether you have knowledge of electronics or not. Once you complete all experiments, you will not only gain knowledge about the way electricity operates but also want to try designing some circuits of your own.

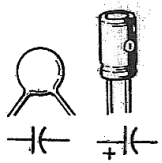
REQUIRED BATTERIES: 2 "AA" batteries, that is not included.

SYMBOLS ON THE CIRCUIT BOARD

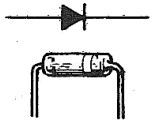
•RESISTORS



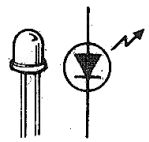
•CAPACITORS



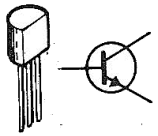
•DIODE



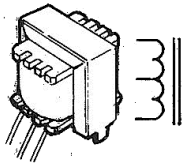
•LED



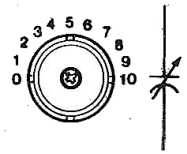
•TRANSISTORS



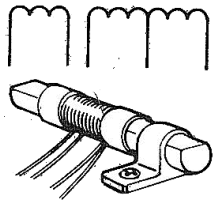
•TRANSFORMER



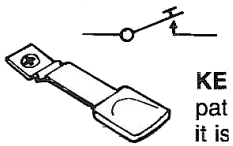
•TUNING KNOB



•ANTENNA COIL



•KEY



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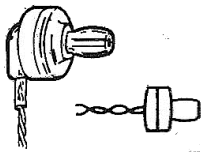
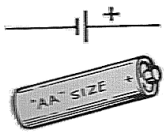
•EARPHONE



•BATTERIES



ITEM NO. SE535

DIFFERENT TYPES OF EXPERIMENTS TO CARRY OUT:

Circuit 1:	High-Pitched Sound
Circuit 2:	The Electronic Storage Tank
Circuit 3:	The One-Way Street
Circuit 4:	The "Invisible Power" Radio
Circuit 5:	The Transitor, An Electronic "Trigger"
Circuit 6:	The Transistor and Amplication
Circuit 7:	The Sunrise-Sunset Light
Circuit 8:	The Slow Motion Sunrise-Sunset Light
Circuit 9:	The "Secret Code" Key
Circuit 10:	The Highs And Lows of Oscillation
Circuit 11:	The Beacon Light
Circuit 12:	Music From A Pencil
Circuit 13:	The Leaky Faucet
Circuit 14:	The Bee
Circuit 15:	The Electronic Canary
Circuit 16:	The Burglar Alarm
Circuit 17:	The Touching Light
Circuit 18:	The Rain Detector
Circuit 19:	The Radio Station
Circuit 20:	The "Wireless" Rain Detector
Circuit 21:	The Metal Dectector
Circuit 22:	TWO WAY EFFECTS
Circuit 23:	The Blinker
Circuit 24:	The Two-Transistor Oscillator
Circuit 25:	The Timer
Circuit 26:	The Memory
Circuit 27:	The "AND" Gate
Circuit 28:	The "OR" Gate
Circuit 29:	The NAND" Gate
Circuit 30:	The "NOR" Gate
Circuit 31:	Resistors in Series & Parallel
Circuit 32:	Capacitor in Series & Parallel
Circuit 33:	Two-Tone
Circuit 34:	Electronic Siren
Circuit 35:	Clock Sound

The 30 in 1 set consists of a board covered with electronic parts, and an assortment of wires to connect those parts. There are several different colours and lengths of wire. As well, the parts on the board, there are some shiny, silver springs with number next to them. These springs and numbers are the keys to starting right now.

CIRCUIT 1: THE HIGH-PITCHED SOUND

The first connection for your first project will be from 23 to 17. Locate these springs and choose a wire long enough to reach between them. To attach the wire, bend the spring to one side with your finger and stick the wire into one of the gaps that you see. Now let the spring go and it will clamp the wire firmly in place.

After connecting 23 & 17, make sure the spring is touching the metal part of the wire and not the plastic insulation. The experiment won't work if the metal part of the wire isn't touching the spring.

Next connection is from 17 to 39. When you have two connections at the same spring, like at 17, it is easier if you make them on opposite side of the spring.

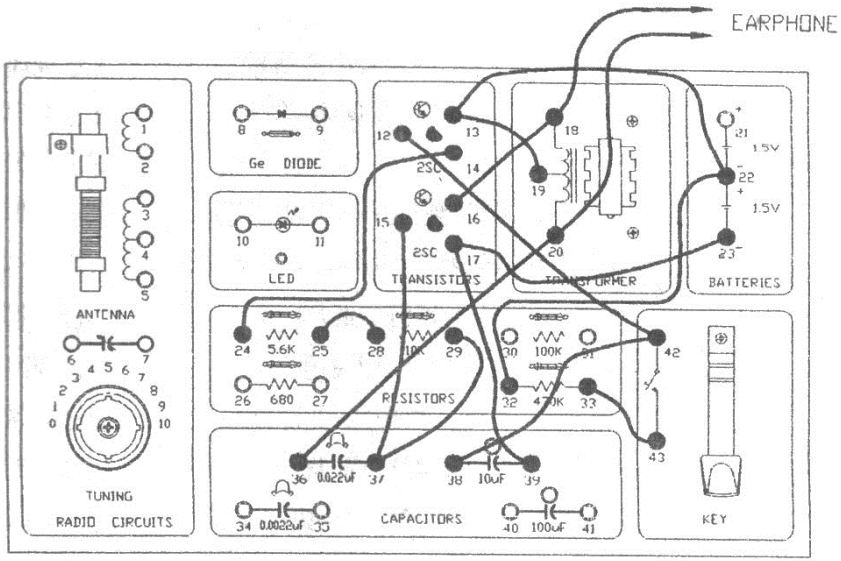
Connect 24 to14, 25 to 28, 29 to 37, 37 to 15, 32 to 22, 22 to 13, 13 to 19, 33 to 43, 12 to 42, 42 to 38, 16 to 18, and 36 to 20. The final connection will be for the EARPHONE. One wire of the EARPHONE goes to 18 and the other to 20.

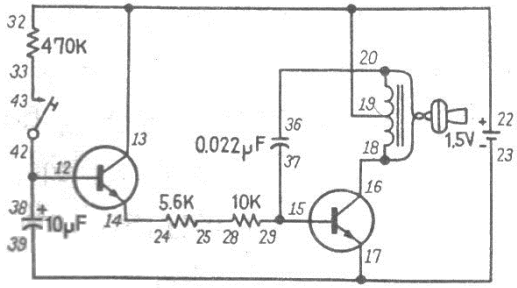
Put the EARPHONE in your ear and press the KEY on the CIRCUIT BOARD. Hold down for about 5 seconds, and you should hear a high-pitched sound. If you do not hear sound, then check your connections.

When you hear the sound, begin to press and release the KEY about once a second. Did you hear a siren or one of those electronic games you like to play?

WIRING SEQUENCE

23-17-39,24-14,25-28,29-37-15,32-22-13-19, 33-43,12-42-38,16-18-EARPHONE,36-20-EARPHONE





CIRCUIT 2: THE ELECTRONIC STORAGE TANK

To have a better understanding, refer to the illustrated diagram. This is known as SCHEMATIC, and it is the kind of drawing professionals use to build circuits.

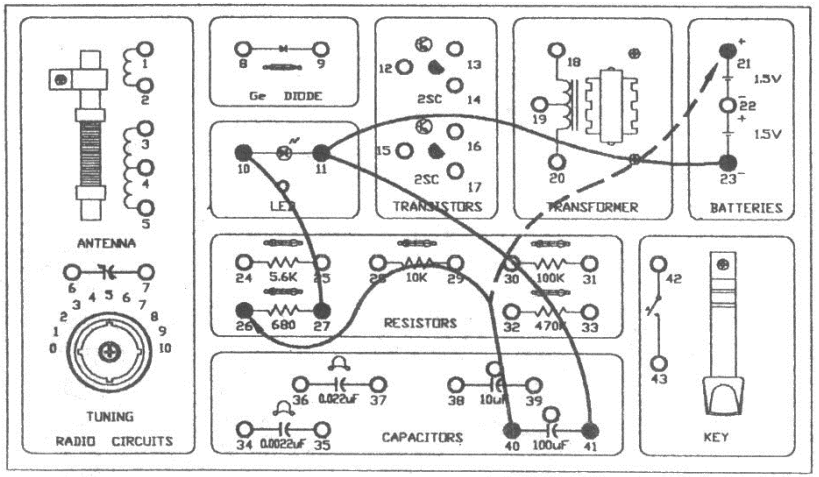
In this experiment, when you touch the free end of the LONG WIRE to 21 and then to 26, the LED lights up.

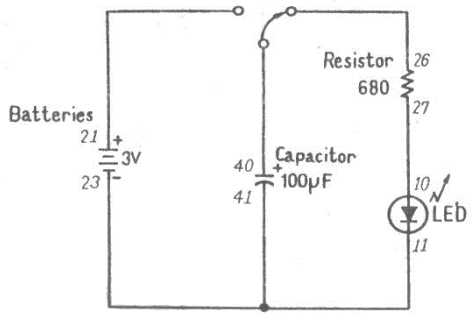
Touching the wire to 21 completes a path for electricity to flow from the terminal of the Batteries to the Capacitor and then from the other side of the Capacitor to the (+) terminal of the Batteries. This experiment lets the Capacitor "fill up" with electricity.

Touching the wire to 26, you complete the path for the Capacitor to release electricity through the LED. The LED lights just long enough for the Capacitor to "empty"

WIRING SEQUENCE

23-11-41, 10-27, 40-LONG WIRE (BLUE)





CIRCUIT 3: THE ONE-WAY STREET

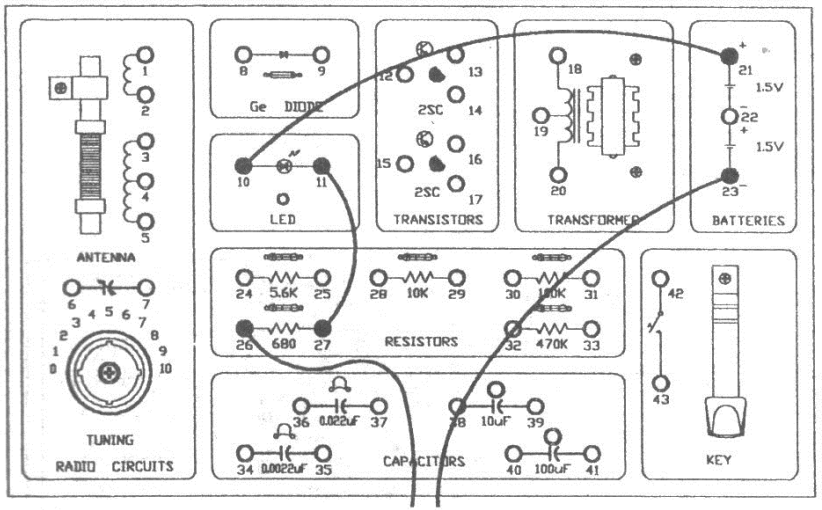
Complete the wiring, and then touch the two free ends of the LONG WIRES together. This enables the LED to light up. Now, reverse the connections to the Batteries (21 & 23), and touch the LONG WIRES again. Nothing happens, because the flow of electricity is going in the opposite direction and the Diode won't let it through.

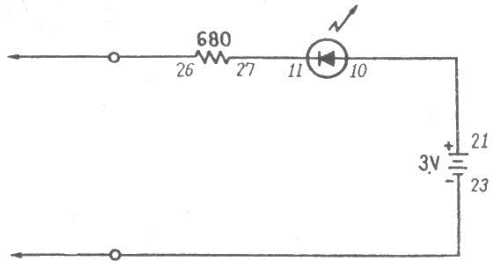
Referring to the Schematic, Diode must be connected to the light. The (+) side of the Batteries goes to the arrow-head and the (-) side of the Batteries goes to the line.

This experiment is like a continuity tester to see whether electricity flows through a particular circuit or component. It helps to find where to problems are if a circuit isn't working correctly.

WIRING SEQUENCE

21-10, 11-27, 26-LONG WIRE, 23-LONG WIRE





CIRCUIT 4: THE "INVISIBLE POWER" RADIO

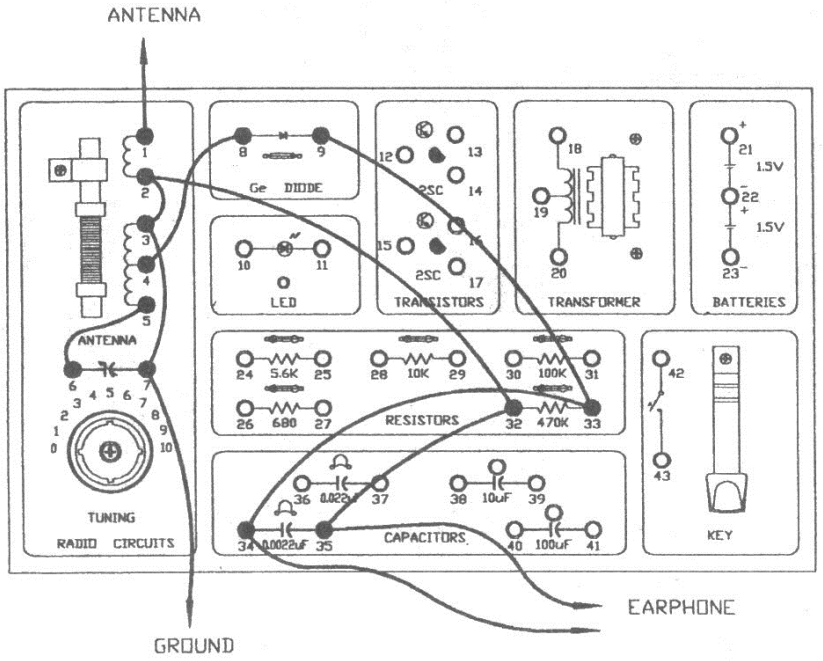
When the wiring is completed as illustrated, put the EARPHONE in your ear and turn the TURNING Knob (variable capacitor) until you hear a radio station. This is a weak radio, and you will have to listen carefully.

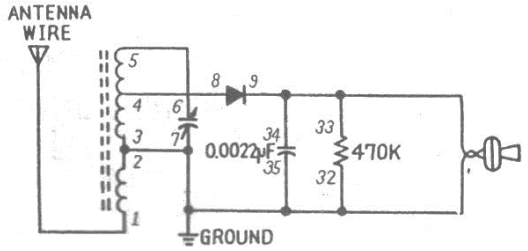
After you've listened to the radio for a while, take a look at the name of this circuit. We are not using the Batteries, but there is power. Actually, the power is coming from the invisible radio waves that are moving through air. The radio waves are intercepted by the green wire and are sent to the ANTENNA where they "stir up" the atoms in the coil of wire. This stirring up causes small pulses of electricity to follow out of the ANTENNA.

Therefore, the reason as to the weak sound is power for the radio comes "out of the air."

WIRING SEQUENCE

5-6,4-8, 1-ANTENNA (green), 7-3-2-32-35-Earphone, 9-33-34-EARPHONE, 7-GROUND





CIRCUIT 5: THE TRANSISTOR, AN ELECTRONIC "TRIGGER"

The three connections are the BASE, EMITTER, and COLLECTOR.

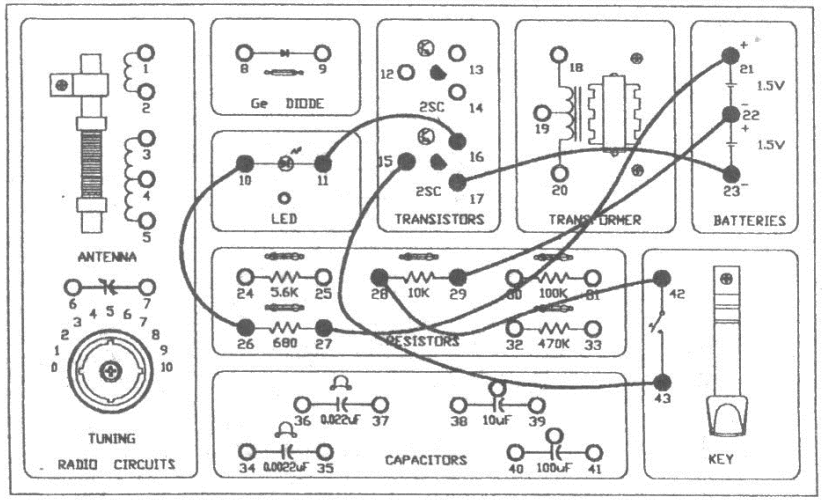
Complete the wiring sequence, press the KEY, and the LED will light up.

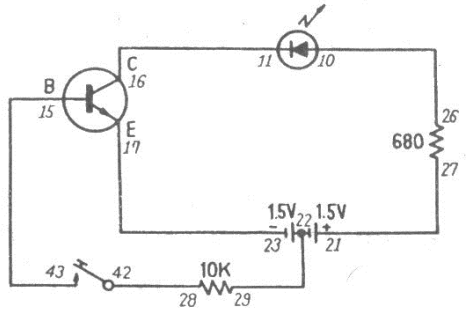
There are actually two paths for electricity in this diagram. One from the emitter (E) to collector (C), and one from the emitter (E) to base (B). From now on, we will call the "emitter to collector" path the OUTPUT, and the "emitter to base" path the INPUT in all circuit using transistors.

The output circuit looks complete, but the LED doesn't light up until you press the KEY and complete the input circuit, too. The small amount of electricity in the input circuit (one Battery), triggers the larger amount of electricity in the output circuit (both Batteries), and the LED lights up.

WIRING SEQUENCE

10-26,11-16,15-43,17-23,21-27,22-29,28-42





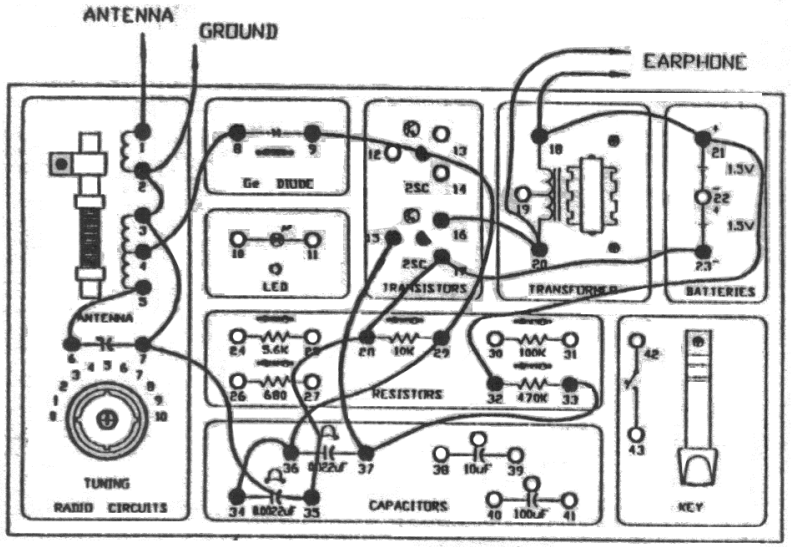
CIRCUIT 6: THE TRANSISTOR AND AMPLIFICATION

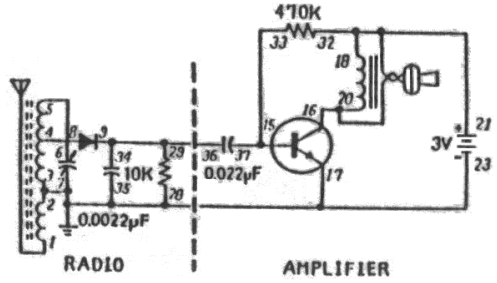
This experiment combines a radio like the one in the Circuit 4 with a "one transistor amplifier." Connect the GROUND and ANTENNA as previously accomplished and tune in a station. Louder sound should be heard from the EARPHONE this time.

In this circuit those same pulses of electricity are connected to the INPUT of the Transistor. As the pulses turn the INPUT on and off they create a "mirror image" of the pulses in the OUTPUT. OUTPUT is controlled by the INPUT. Pulses from OUTPUT are connected to the EARPHONE and are much stronger than the INPUT signal, because Batteries are connected to the OUTPUT of the transistor. Getting a high power signal from a low power signal in this way is called AMPLIFICATION.

WIRING SEQUENCE

2-3-7-35-28-17-23, 4-8, 5-6, 9-29-36-34, 15-37-33, 16-20-EARPHONE, 32-21-18-EARPHONE, 1-ANTENNA, 2 GROUND





CIRCUIT 7: THE SUNRISE-SUNSET LIGHT

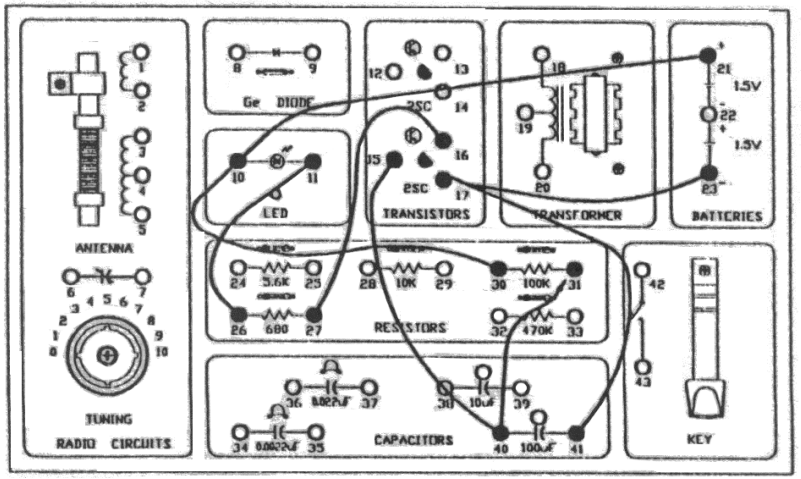
After connecting circuit in this experiment, hold the WIRE to 31 and watch the LED. It will slowly light up.....like a sunrise.

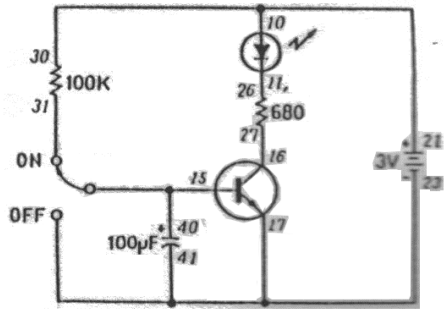
When the LED reaches its brightest point, remove the WIRE from 31 and the LED will dim and go off.....like a sunset.

If you touch the WIRE to 41 the LED will go off very quickly. In this circuit the Transistor is used as a switch. Touching 41 makes the Capacitor discharge very quickly, because it makes a "short circuit" (a path with little or no resistance) for the Capacitor to empty through.

WIRING SEQUENCE

21-10-30,23-17-41,11-26,16-27,15-40-WIRE





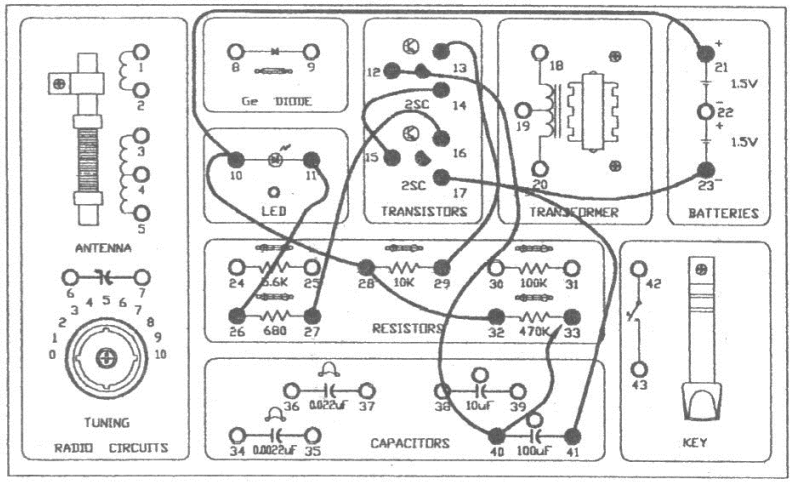
CIRCUIT 8: THE SLOW MOTION SUNRISE-SUNSET LIGHT

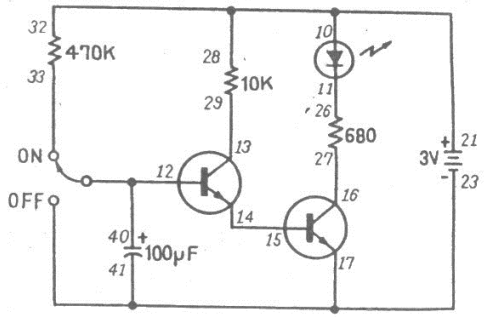
Light from the LED comes on extremely slowly in this circuit. Complete the wiring and hold the LONG WIRE to 33. In about 20-30 seconds the LED will begin to light up. Remove the LONG WIRE and the LED will slowly go off. It may take 5 minutes. If you touch the LONG WIRE to 42 the LED will go off quickly.

The LED comes on more slowly because of the increased resistance in the input, and both transistors must be switched on before the LED (connected to the output) can light up.

WIRING SEQUENCE

21-10-28-32,23-17-41,11-26,27-16,29-13,12-40-WIRE,14-15





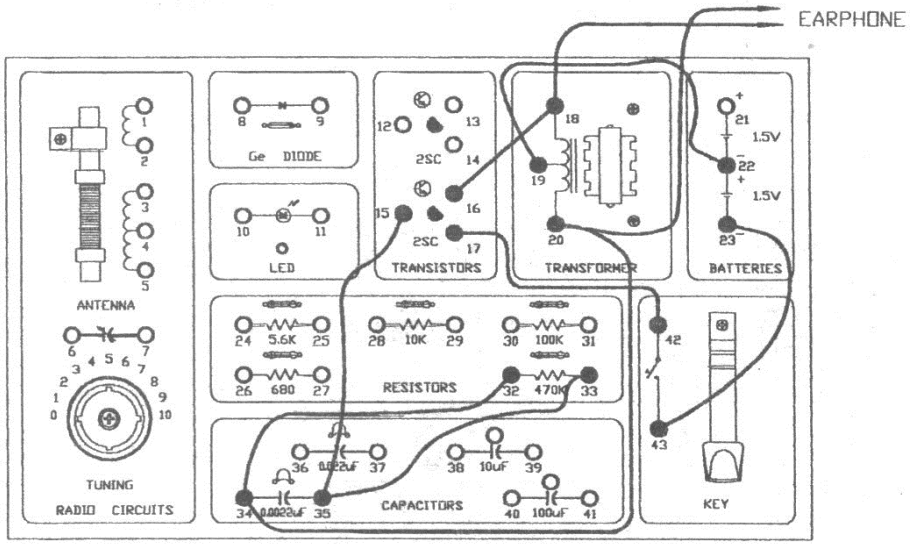
CIRCUIT 9: THE "SECRET CODE" KEY

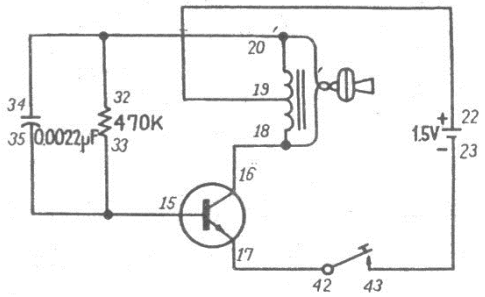
When all the connections have been made, press the KEY and you will hear a sound in the EARPHONE. By following the MORSE CODE chart you will be able to send messages with a series of dots (short sounds) and dashes (longer sounds). Morse code refers to a means of electronic communication by telegraph and then radio.

The type of circuit used here is called an OSCILLATOR. The sound in the EARPHONE is caused from pulses of electricity, like the radios built. The difference is that pulses come from the circuit turning itself on and off instead of from the radio waves. The oscillator turns on and off because of something called "feedback".

WIRING SEQUENCE

22-19,23-43,32-34-20-EARPHONE,33-35-15, 16-18-EARPHONE,17-42





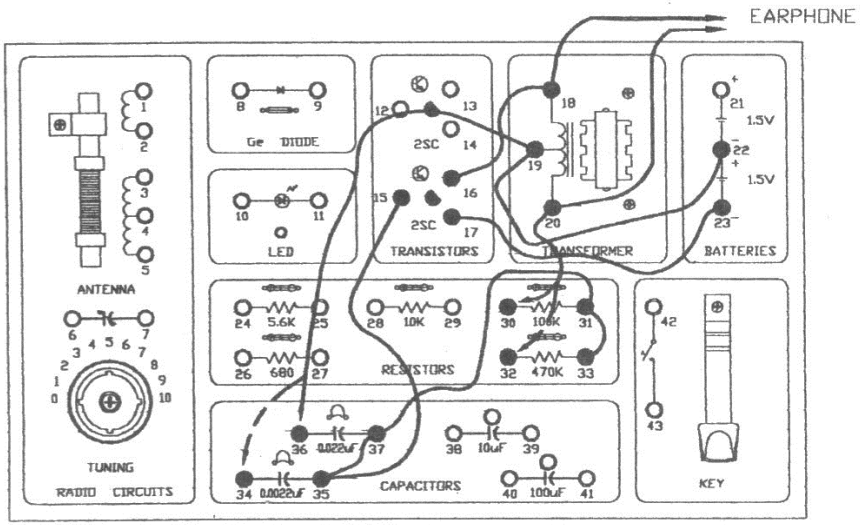
CIRCUIT 10: THE HIGHS AND LOWS OF OSCILLATION

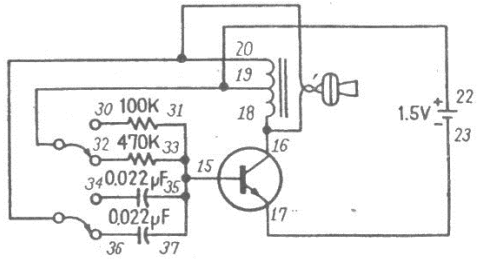
This experiment from the circuit will give you a chance to see how the frequency or tone of an oscillator can be changed.

When you have completed the wiring sequence, touch the LONG WIRE from 19 to either 30 or 32, and at the same time touch the LONG WIRE from 20 to either 34 or 36. Now you should be hearing a sound in the EARPHONE.

Looking at the Schematic you can see that touching 30 connects the 100K ohm resistor, and 32 connects the 470K ohm resistor. 34 connects the 0.0022 µF capacitor and 36 the 0.022 µF capacitor.

WIRING SEQUENCE
22-19-LONG WIRE,23-17,33-31-37-35-15,
16-18-EARPHONE,LONG WIRE-20-EARPHONE





CIRCUIT 11: THE BEACON LIGHT

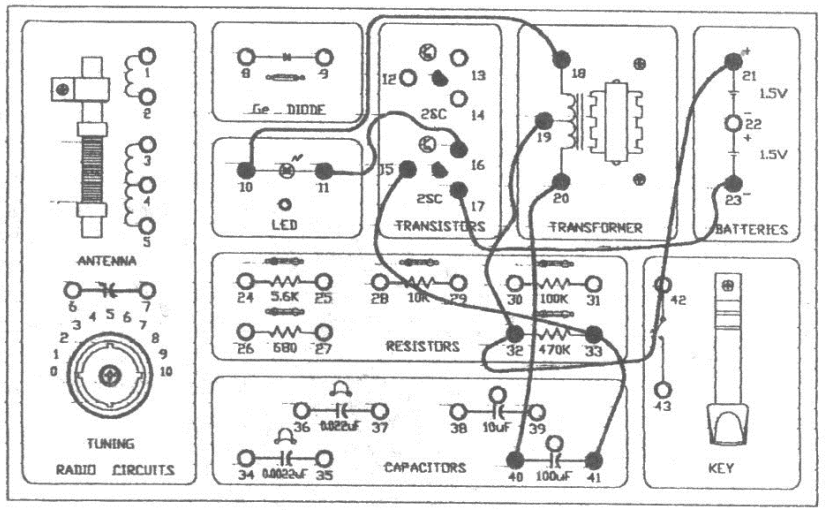
After you have finished the wiring, the LED will begin to flash on and off slowly, like a beacon lights on top of tall buildings or towers.

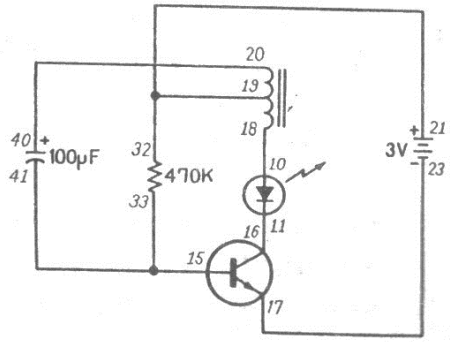
If you look at the Schematic, it should be familiar because it is an oscillator very much like the last two circuits you have built. The difference is that it has a much lower frequency than the others.

As you might suspect, changing the resistor or capacitor will alter the frequency of this oscillator too, so try it.

WIRING SEQUENCE

21-32-19,23-17,10-18,11-16,15-33-41,40-20





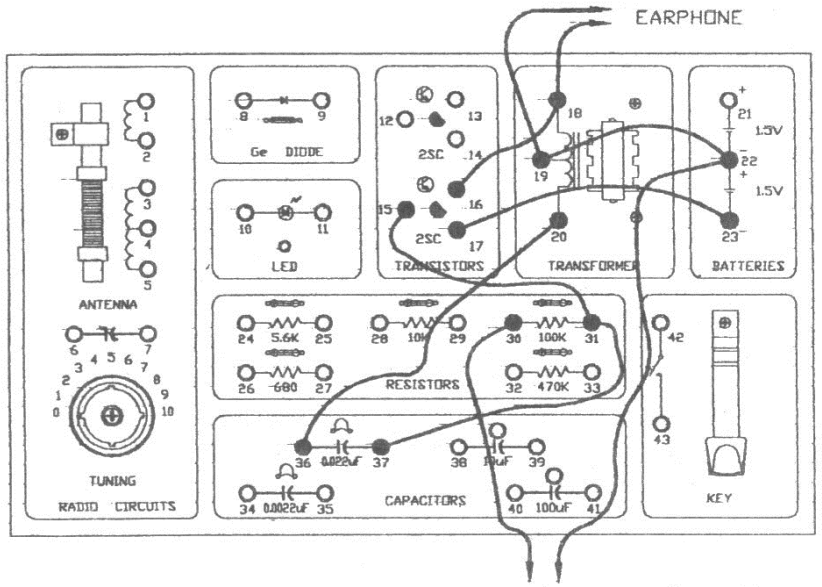
CIRCUIT 12: MUSIC FROM A PENCIL

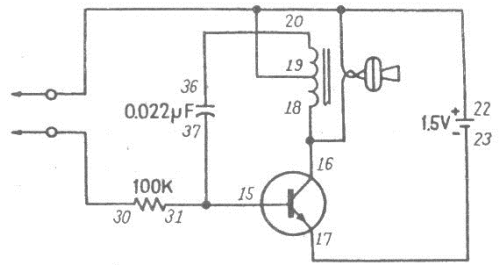
An oscillator is used in this circuit to produce sound, but you will control the frequency with a pencil mark. You may even be able to play a song with this "electronic organ." In this circuit the pencil mark acts as a variable resistor.

Complete the wiring and draw a rectangle the full length of a piece of notebook paper, and about 2 or 3 cm wide. Fill in the entire rectangle with heavy pencil marks (a very soft pencil will be best). Next tape one of the LONG WIRES to one end of the pencil mark. Touch the other LONG WIRE to the middle of the pencil mark and listen to the EARPHONE. You should hear a sound now, and if you move the free wire up and down the pencil mark the tone will get higher and lower.

When the two wires are closer together the resistance is less and the frequency and tone get higher. When the two wires are farther apart, the resistance is more and the frequency and tone get lower.

WIRING SEQUENCE
22-19-EARPHONE,22-LONG WIRE,23-17,30-LONG WIRE,
16-18-EARPHONE,15-31-37,36-20



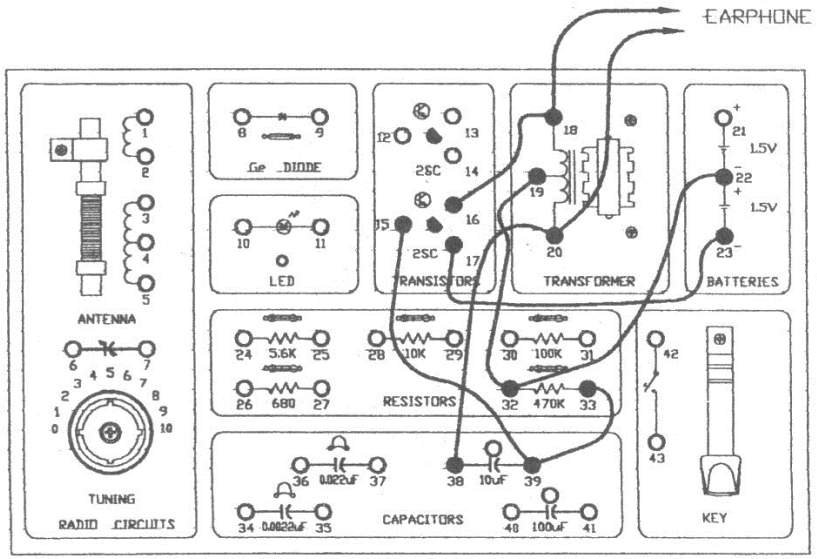


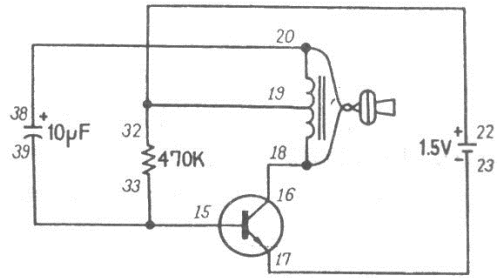
CIRCUIT 13: THE LEAKY FAUCET

In this circuit and the next 3 circuits, you are going to experiment with "sound effects."

When you complete the wiring you will begin to hear a slow clicking sound, something like dripping faucet.

WIRING SEQUENCE
22-32-19,23-17,16-18-EARPHONE,15-39-33,
38-20-earphone





CIRCUIT 14: THE BEE

Do the wiring and then press the KEY and hold it. You will hear a buzzing sound through the EARPHONE. Now release the KEY and see what happens. The sound fades away.

By experimenting with different rates of pressing and releasing the KEY you will be able to get a sound very much like a bee.

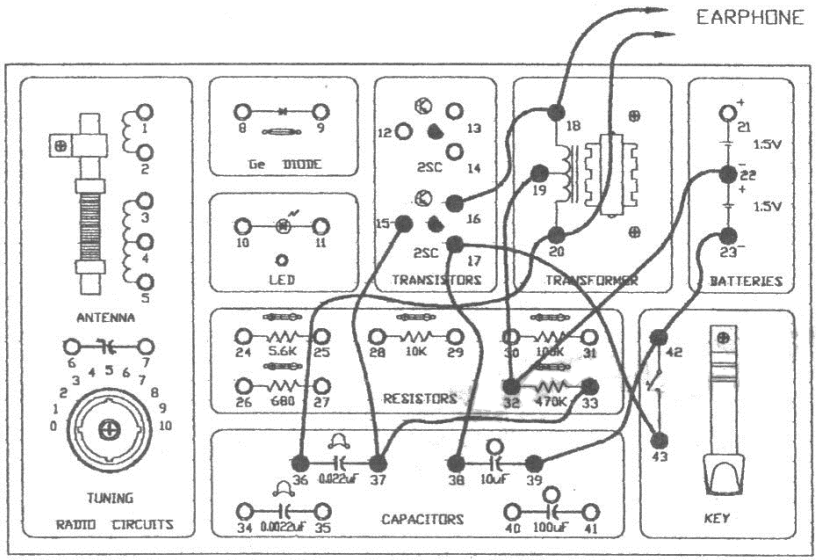
This is an oscillator, but it has two capacitors instead of one like all the others. To see what you can do with the two capacitors, first replace the 10 μF capacitor with the 100 μF and press the KEY. When you release the KEY the sound fades away more slowly. This tells us the large capacitors store electricity while the KEY is pressed and release it when you release the KEY. Since the 100 μF capacitor is much larger, it takes longer for it to discharge, and the "bee" sound fades away more slowly.

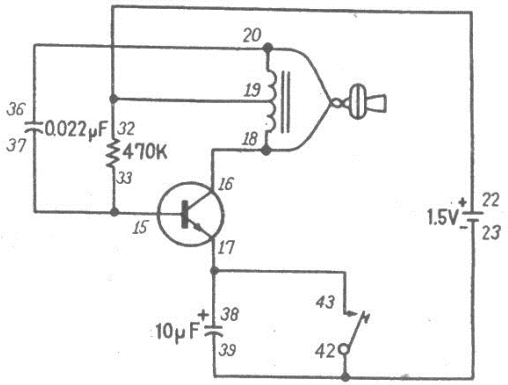
Now change the 0.022 μF capacitor to the 0.0022 μF. The tone will be higher, so we can assume that these capacitors control the frequency of the oscillator.

As for the resistor, changing the resistance will change the frequency of oscillation, and the rate of discharge of the large capacitor.

WIRING SEQUENCE

22-32-19,23-42-39,33-37-15,16-18-EARPHONE, 36-20-EARPHONE,38-17-43



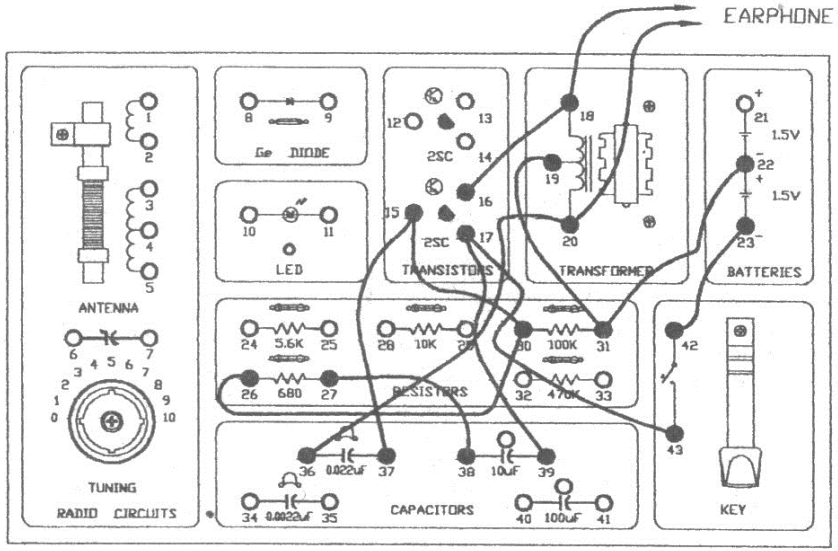


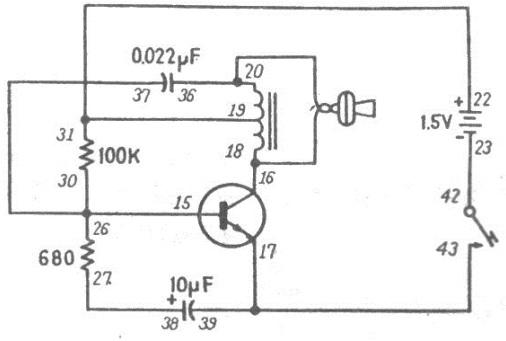
CIRCUIT 15: THE ELECTRONIC CANARY

The name of this circuit gives things away, but go ahead and get the wiring done and see what you think.

WIRING SEQUENCE

22-31-19,23-42,43-17-39,26-30-15-37,27-38,
16-18-EARPHONE,36-20-EARPHONE



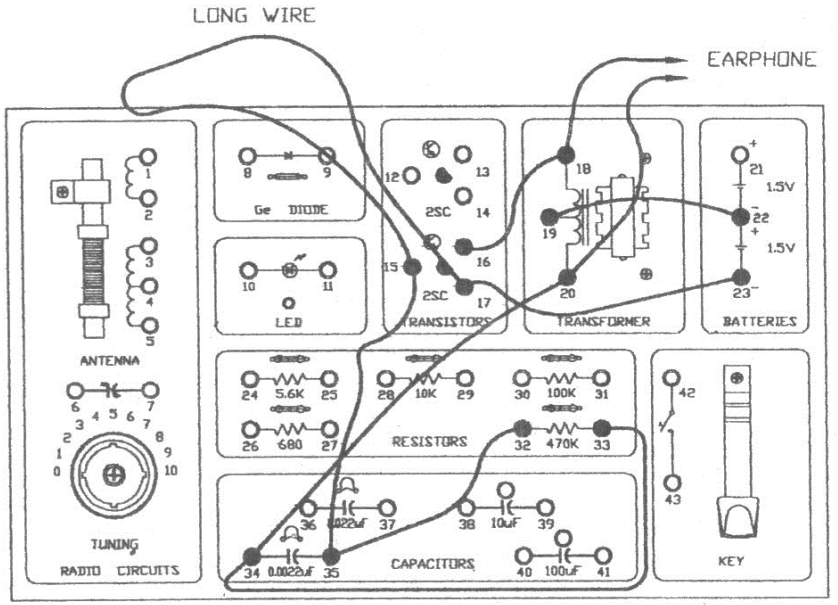


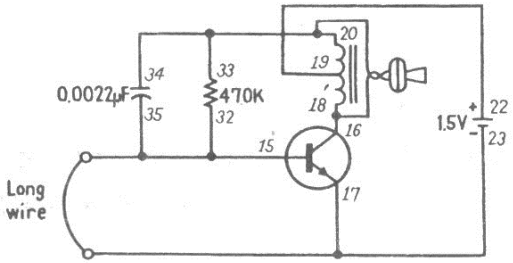
CIRCUIT 16: THE BURGLAR ALARM

This circuit is turned on by disconnecting a wire, instead of by connecting. Any time the LONG WIRE between 15 and 17 is disconnected, the "alarm" goes off.

The "trip wire" keeps the alarm from going off when it is connected because it makes a "short circuit" around the base and emitter of the Transistor (the input). A short circuit is a path for electricity that has little or no resistance, and electricity will always flow through the path with least resistance. When the electricity flows through the trip wire instead of the oscillator input circuit, no sound is produced, but when the trip wire is disconnected the electricity flows through the oscillator input and the alarm sounds.

WIRING SEQUENCE
22-19,23-17-LONG WIRE(green)-15-35-32, 33-34-20-EARPHONE,16-18-EARPHONE





CIRCUIT 17: THE TOUCHING LIGHT

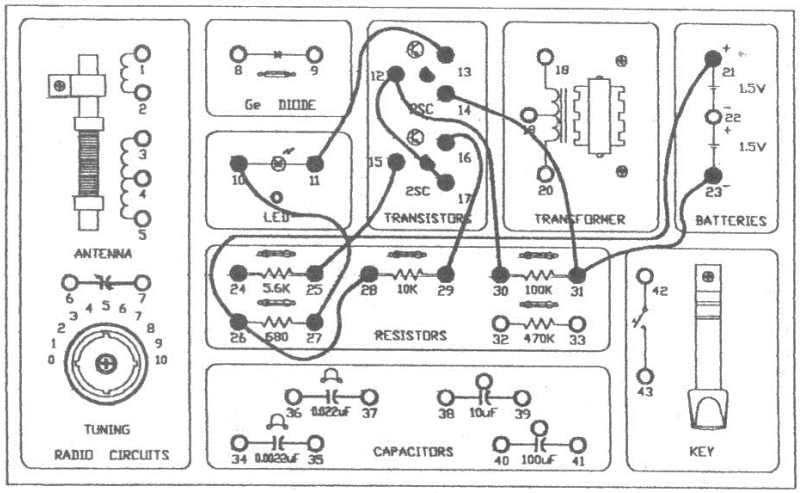
Up until now, all of the circuits have used wire to carry or "conduct" electricity and make them work. However, in this circuit, you will discover one you probably haven't thought of - in the TOUCHING LIGHT.

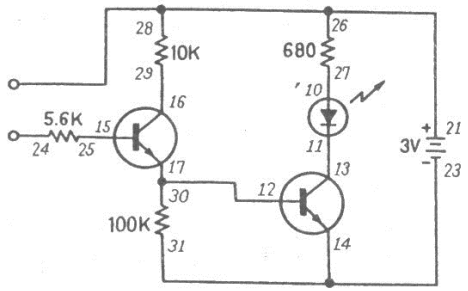
After you have finished the wiring, the final step is to touch 24 and 26 with fingers of the same hand. The LED lights up, and YOU are the conductor for the electricity. Don't worry about getting a shock from this, because the amount of electricity being used is very low.

Before you go on to the next circuit, try touching 24 and 26 with fingers from different hands. Does the LED still light? Wetting your fingers will make better contact with the terminals.

WIRING SEQUENCE

21-26-28,23-31-14,10-27,11-13,25-15,29-16,30-12-17





CIRCUIT 18: THE RAIN DETECTOR

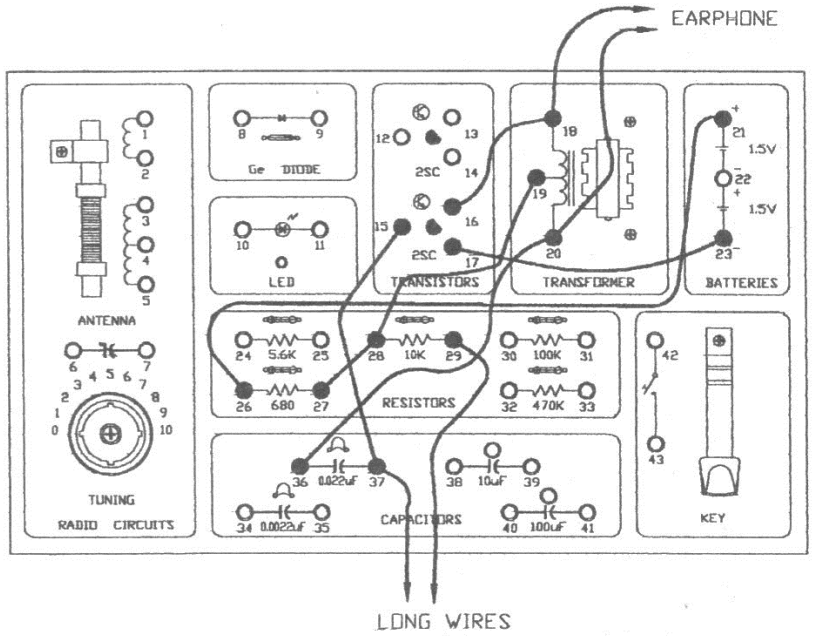
This circuit shows you another thing that conducts electricity....water!

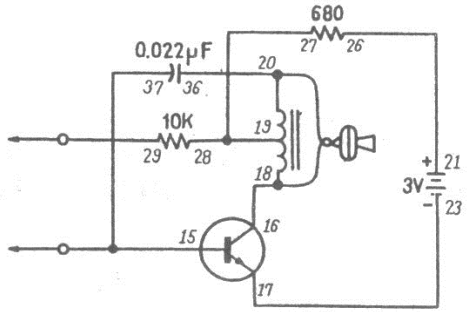
When the wiring is complete, put the free ends of the two LONG WIRES in a glass of water. Hold them as close together as you can without letting them touch (you may find it easier to tape the wires to a pencil and then put them in the water. The water will conduct the electricity and you will hear a sound in the EARPHONE. This "alarm" will go off any time there is enough water present to connect the two wires.

This type of circuit could be used to tell you if the water level in an aquarium is getting too high.

To use this as a rain detector, you will need to get extra wire, and run two wires outside. Tape them close together on a board or piece of plastic, so that a few drops of rain will complete the circuit and set the alarm off.

WIRING SEQUENCE
21-26,23-17,27-28-19,29-LONG WIRE,
16-18-EARPHONE,15-37-LONG WIRE, 36-20-EARPHONE





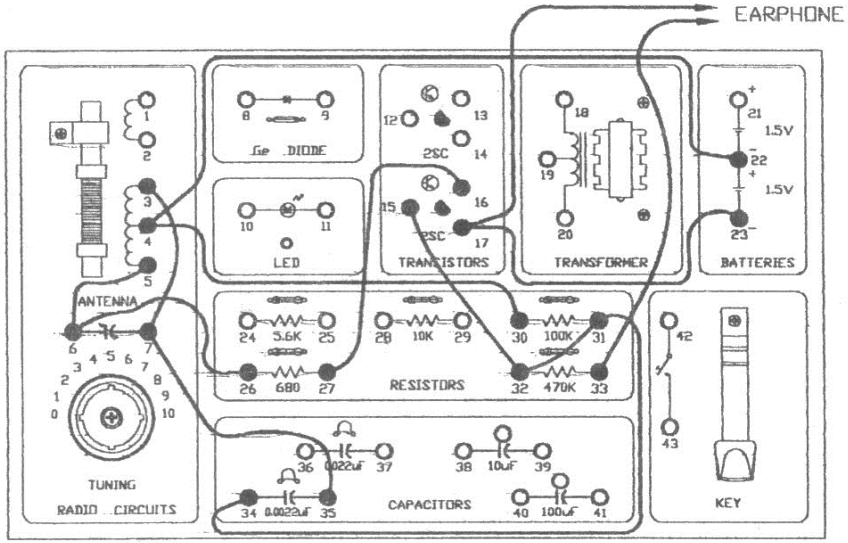
CIRCUIT 19: THE RADIO STATION

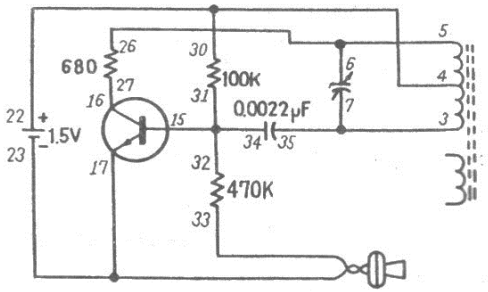
After you finish the wiring, you need an AM radio to receive your "broadcast." The radio should be about one foot away from the RADIO STATION, to begin with, and should be tuned to a place on the dial where there is no other station.

Now adjust the TUNING KNOB on the RADIO STATION, while speaking into the EARPHONE, until you hear your voice on the radio.

WIRING SEQUENCE

22-4-30,23-17-EARPHONE,5-6-26,27-16,
33-EARPHONE,15-32-31-34,3-7-35





CIRCUIT 20: THE "WIRELESS" RAIN DETECTOR

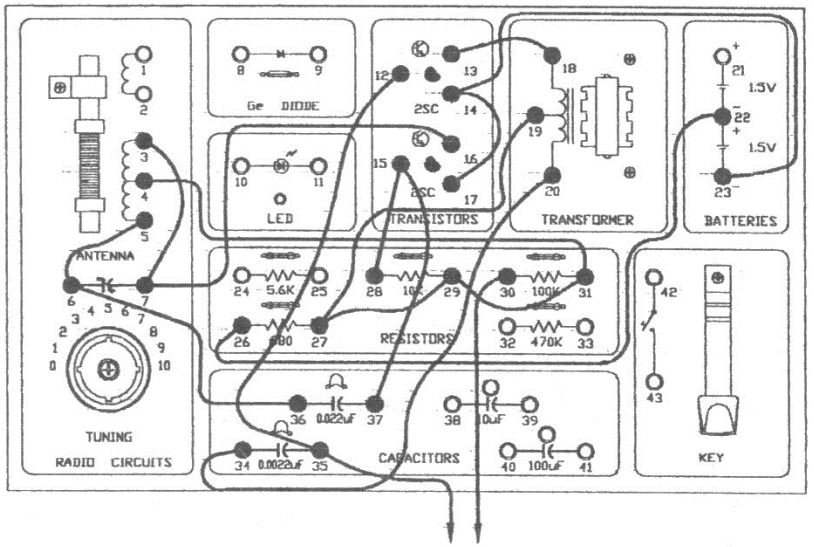
This circuit is another example of combining two simple circuits to make a more advanced one. Here we have combined the RAIN DETECTOR and the RADIO STATION. They work the same way, but small changes had to be made so that the two parts would get along better.

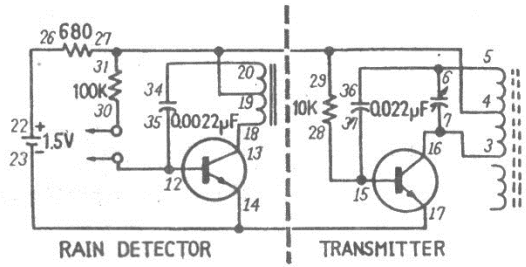
You will put the two LONG WIRES in water, as you did before, but this time you will use the AM radio to receive the "alarm" signal. As well, you have to adjust the TUNING KNOB until you can hear the signal coming from the WIRELESS RAIN DETECTOR.

In the schematic, output that went to the EARPHONE in the other rain detector is now going to the RADIO STATION or "transmitter" section of the circuit. The TUNING KNOB adjusts the transmitter's frequency to match the setting on the radio dial. And the ANTENNA COIL sends the signal out into the air where the AM radio picks it up and turns the radio wave signal into sound.

WIRING SEQUENCE

22-26,23-14-17,5-6-36,4-31-29-27-19,3-7-16,28-15-37, 30-LONG WIRE, 12-35-LONG WIRE, 13-18,34-20





CIRCUIT 21: METAL DETECTOR

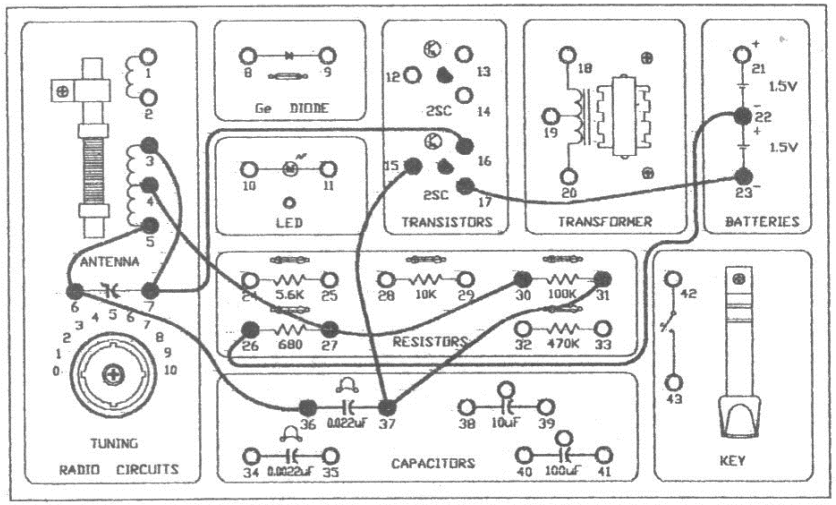
When the circuit is complete, you will again need an AM radio to act as the "voice" of the circuit, but this time the radio will be tuned in a different way. Set the dial to a station that is weak and does not come in very clearly. Then adjust the TUNING KNOB until the radio station is blocked out by a "squeal". Next, fine-tune the TUNING KNOB until you get the lowest tone "squeal" you can. Now you're ready to test the METAL DETECTOR.

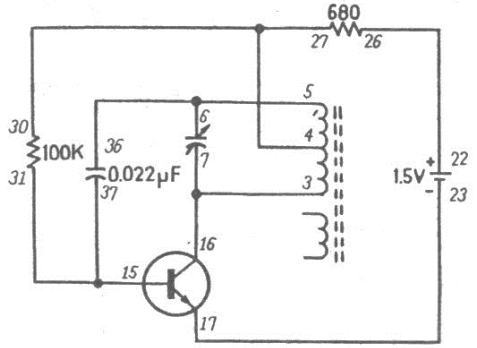
Take a piece of metal (try a coin) and touch it to the end of the ANTENNA COIL core. The squeal tone will go away to indicate the presence of metal.

When metal is touched to the core of the ANTENNA COIL the frequency of the blocking signal is changed enough to stop its interference with the weak radio station, and that is your signal that metal is present.

WIRING SEQUENCE

22-26,23-17,5-6-36,3-7-16,4-27-30,31-37-15





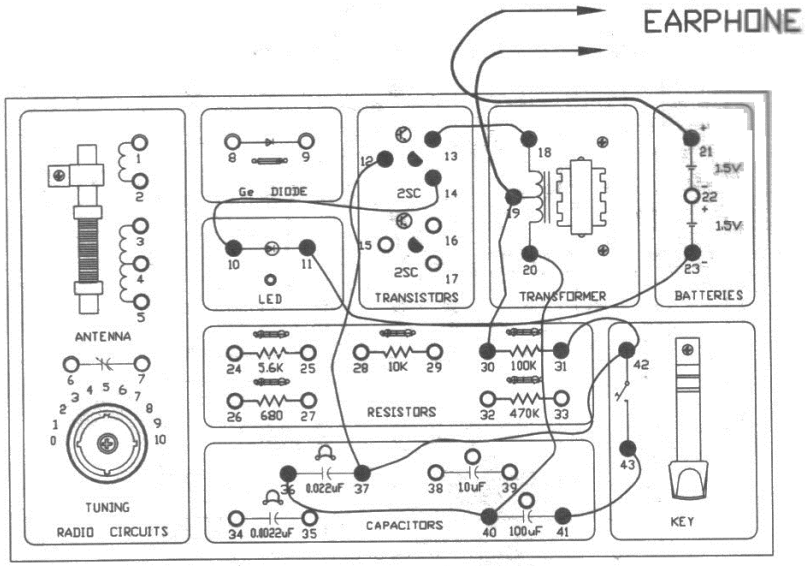
CIRCUIT 22: TWO WAY EFFECTS

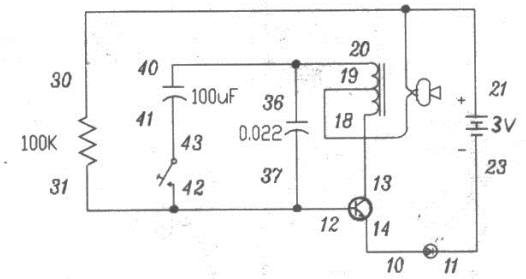
In this project, connect the wiring sequence according to the diagram shown. If you think this looks familiar, you are right. This is another oscillation circuit.

Now put the earphone to your ear, you will hear an alarm sound. By pressing the key, you will find that the LED turns on and off with the same frequency of the sound. Output of the osillation is sent to both the LED and the earphone.

WIRING SEQUENCE

21-30-EARPHONE, 31-42-37-12, 43-41, 40-36-20, 13-18, 14-10, 11-23, 19-EARPHONE





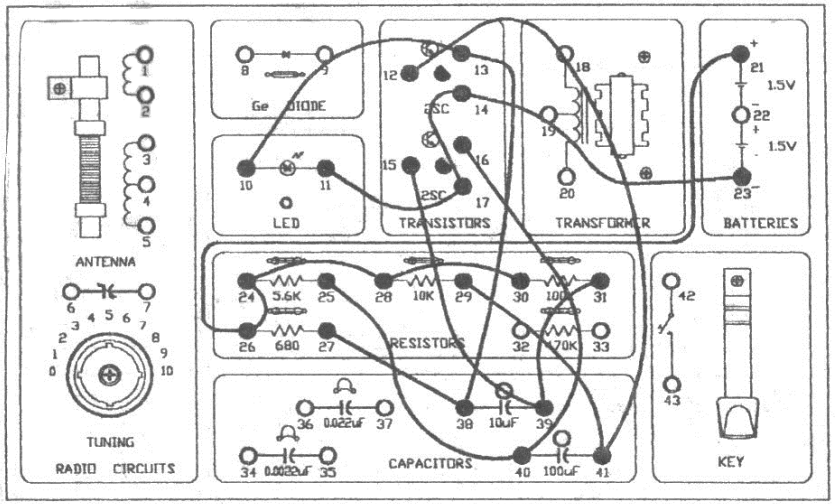
CIRCUIT 23: THE BLINKER

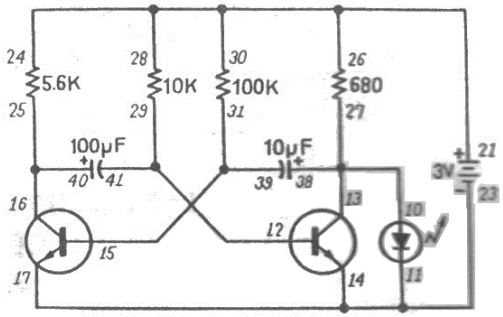
A circuit like this one might be controlling the blinker in your parent's car. It's a type of oscillator called an "astable multivibrator." It is designed so that, when one transistor is on the other is off, and they continually switch back and forth, or vibrate, from "on" to "off".

Just like the one transistor oscillator, the frequency of the multivibrator is controlled by the combination of resistors and capacitors. Try replacing the 100K ohm resistor with the 470K ohm resistor and see what happens.

WIRING SEQUENCE

21-26-24-28-30,23-14-17-11,27-38-13-10,
25-40-16,29-41-12,31-39-15





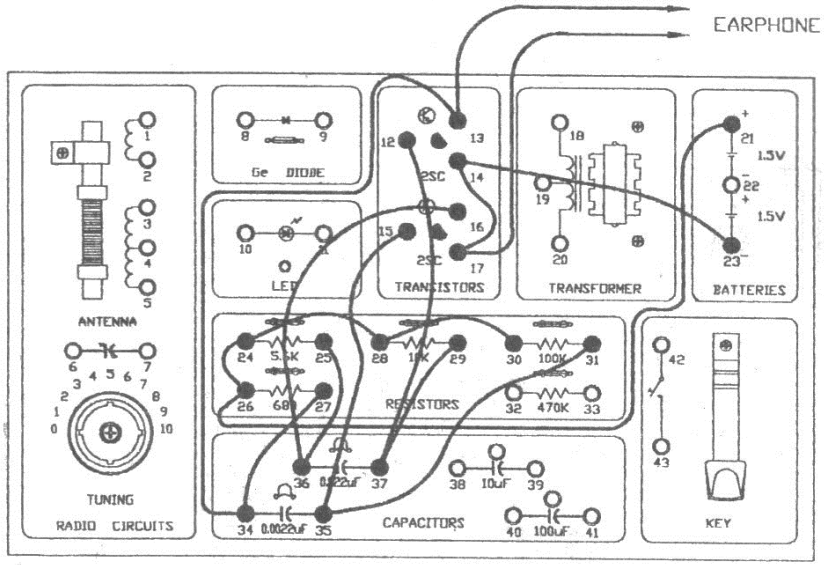
CIRCUIT 24: THE TWO-TRANSISTOR OSCILLATOR

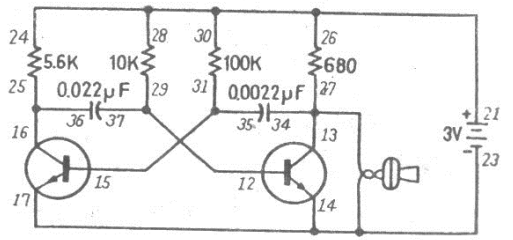
From the wiring sequence and the Schematic, you can see that this circuit is almost like the Blinker. The difference is that we have changed the frequency of the oscillation and changed the form of the output from lighting the LED to making a sound in the EARPHONE.

As in the BLINKER you can change the frequency by replacing the 100K ohm resistor with the 470K ohm resistor.

WIRING SEQUENCE

21-26-24-28-30,23-14-17-EARPHONE,
27-34-13-EARPHONE,25-36-16,29-37-12,31-35-15





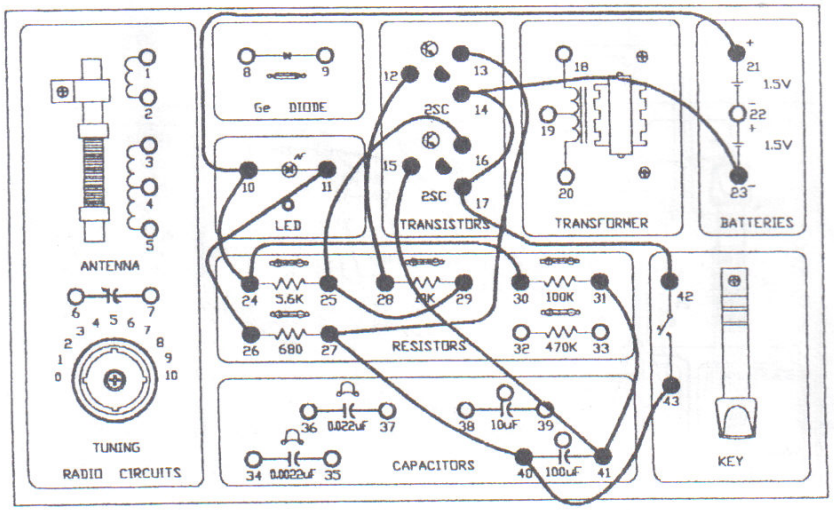
CIRCUIT 25: THE TIMER

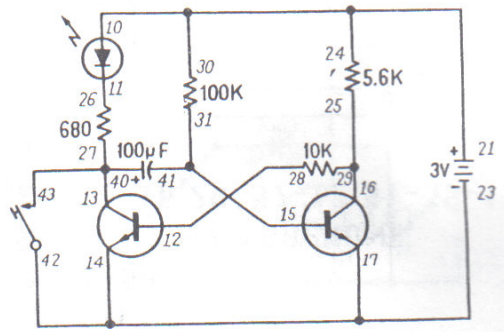
This circuit is also a multivibrator, but it is a special kind called a "one-shot multivibrator." Press the KEY and release it immediately. The LED will light and stay on for a few seconds and then go off. It will stay on for the same amount of time every time you press the KEY, even if you hold the KEY down longer sometimes.

The time the LED stays on is controlled by the 100 µF capacitor, so you could change the time by changing the capacitor - or the resistor that controls its discharge (the 100K ohm).

WIRING SEQUENCE

21-10-24-30,23-14-17-42,11-26,28-12,
29-25-16,31-41-15,13-27-40-43





CIRCUIT 26: THE MEMORY

This type of circuit is used in computers, because it has the ability to remember to stay on even after the original input has been removed.

After wiring, touch the LONG WIRE to 15 and the LED will light up. Now remove the wire from 15 and the LED stays on. It remembers the "order" you gave it to be "on."

Next touch the LONG WIRE to 12 and the LED goes off. It will remember to stay off until you tell it to be on again by touching 15.

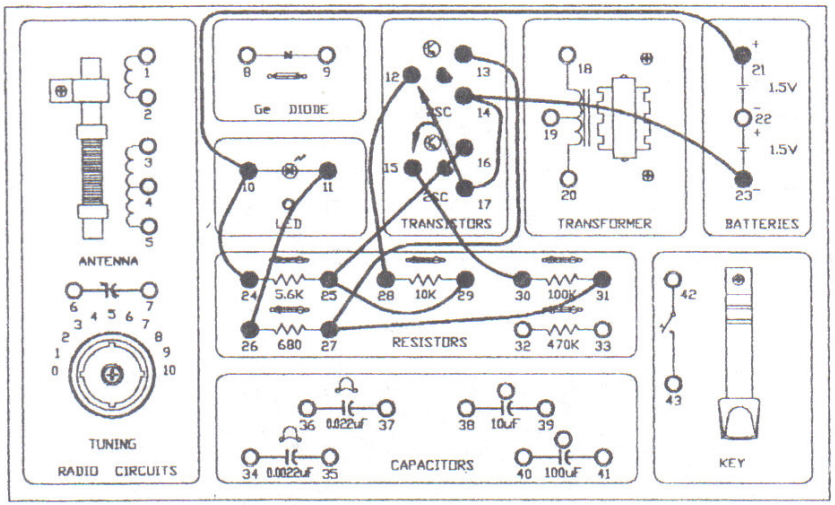
Another name for this circuit is the bistable switch or "flip flop." It works the way it does because the two transistors are connected.

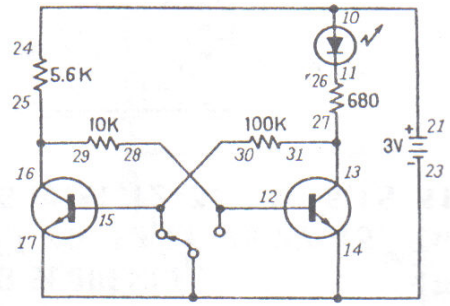
Before you touch the LONG WIRE to 15 or 12, the left transistor is on, but when you touch 15 you make a short circuit around the input of that transistor and turn it off. When that happens, the electricity that was going through the left output begins to flow through the 10K ohm resistor and to the input of the right transistor. This turns on the right transistor's output and the LED. The LED stays on when the LONG WIRE is removed from 15, because the electricity that was flowing to the base of the left transistor through the 100K ohm resistor will continue to go through the output of the right transistor.

When the LONG WIRE is touched to 12, the input to the right transistor is short-circuited and the output on the right is turned off. This allows the flow of electricity to return as it was before you did anything with the circuit.

WIRING SEQUENCE

21-10-24,23-14-17-LONG WIRE,11-26,28-12,30-15,29-25-16,31-27-13





CIRCUIT 27: THE "AND" GATE

The AND gate is another type of circuit that is used in computers and calculators.

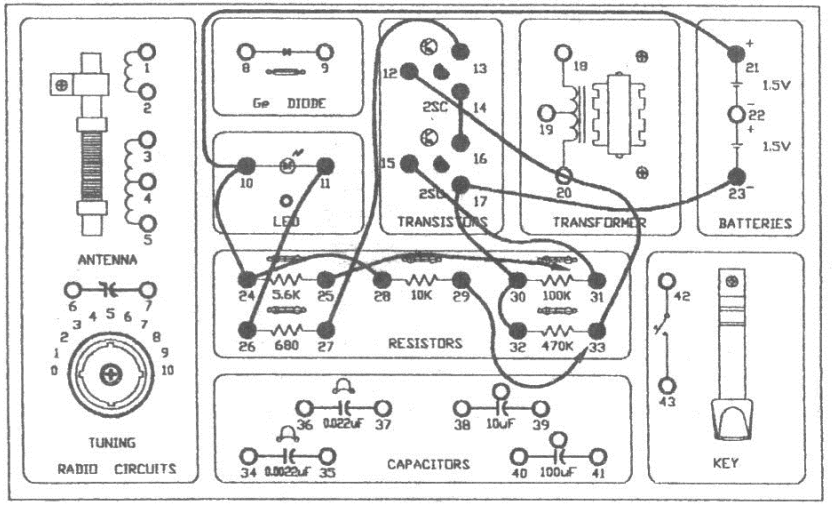
When you finish wiring, touch the LONG WIRE from 25 to 31. Nothing happens. Now remove that wire and touch the LONG WIRE from 29 to 33. Again nothing happens, but if you touch both wires at the same time the LED will light. It's like having two wall switches in your room and having to trun them both on beofre the light comes on.

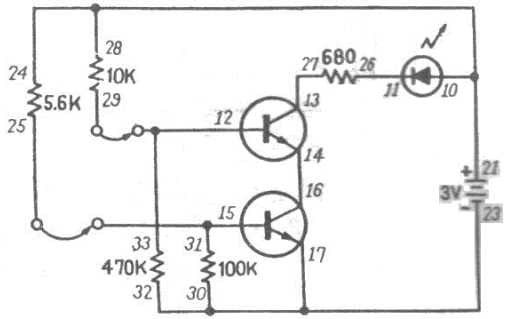
The AND gate works as it does because both transistors have to be on before there is a complete path for electricity to flow through, the LED. Look at the Schematic and trace the output circuit's path.

When transistors are connected in this way the outputs are said to be in "series."

WIRING SEQUENCE

21-10-24-28,23-17-30-32,11-26,27-13,
25-LONG WIRE,29-LONG WIRE,12-33,14-16,15-31





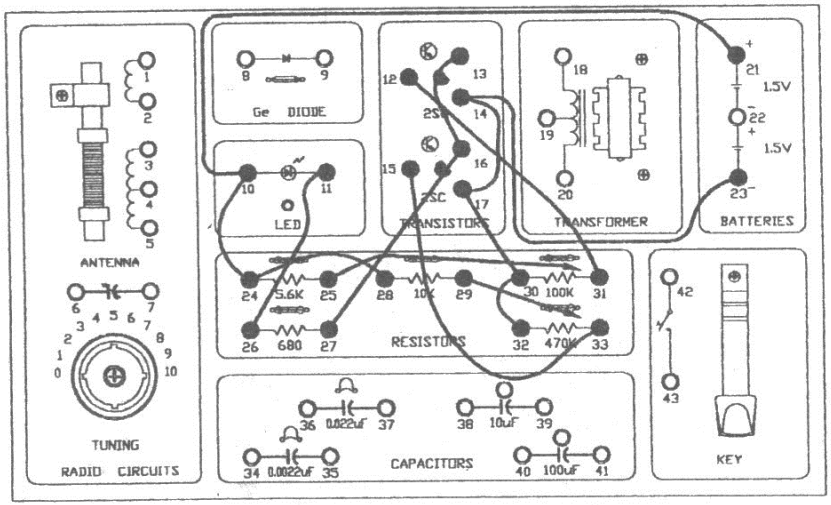
CIRCUIT 28: THE "OR" GATE

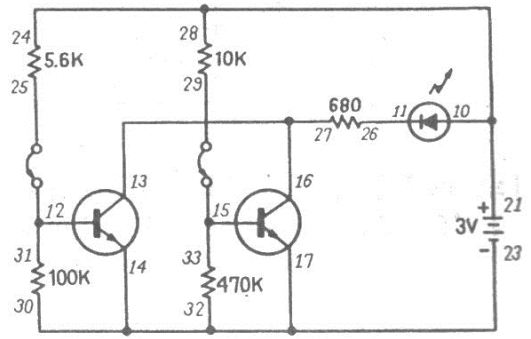
The OR gate is a computer circuit. Another name for the types of circuit used in computers is "logic" or "digital" circuits. Complete the wiring sequence and touch the LONG WIRE from 29 to 33. Again, the LED should light. Instead of needing both transistors to be on before the LED lights, like the AND gate, this circuit works if either one transistor OR the other is on.

This circuit works as it does because touching either one of the LONG WIRES turns on a transistor, and there is a complete path for the electricity to flow through the LED if either transistor is on. Trace the path of the electricity on the Schematic and you will see a path through either transistor output.

WIRING SEQUENCE

21-10-24-28,23-14-17-30-32,11-26,27-16-13, 25-LONG WIRE, 29-LONG WIRE,12-31,15-33





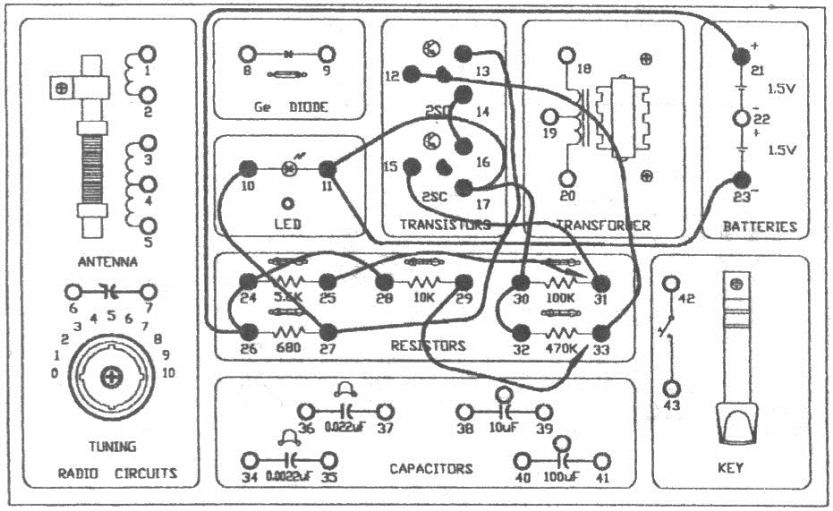
CIRCUIT 29: THE "NAND" GATE

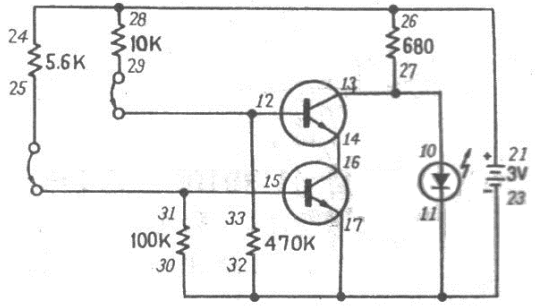
As you might suspect the NAND gate is the opposite of the AND gate. In this circuit you must connect both LONG WIRES (25 to 31 and 29 to 33) to turn the LED (the output) off. One use for a NAND gate, besides in a computer, might be for the door buzzer in your parent's car. They have to close both doors (two inputs) to turn off the buzzer (the output).

In the Schematic you will see that when both connections are made, both transistors are on, and that makes a short circuit around the LED, through the output circuits of the transistors. The LED then has to go off.

WIRING SEQUENCE

21-26-24-28,23-11-17-30-32,10-27-13,
25-LONG WIRE,29-LONG WIRE,12-33,14-16,15-31





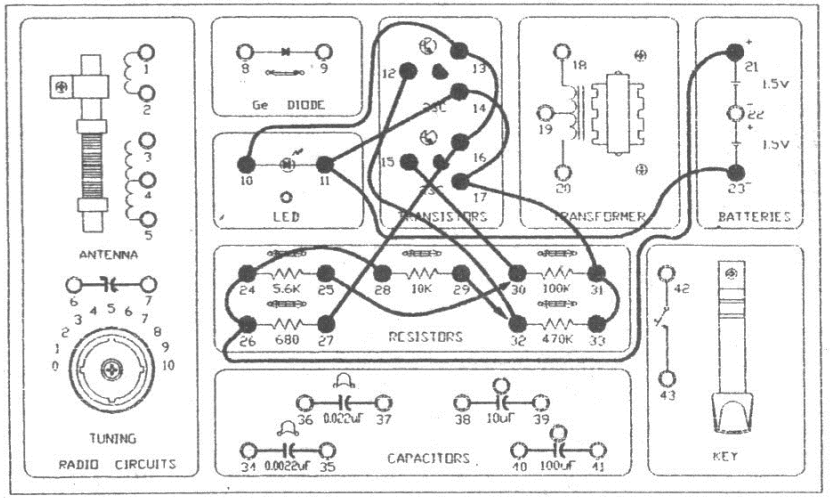
CIRCUIT 30: THE "NOR" GATE

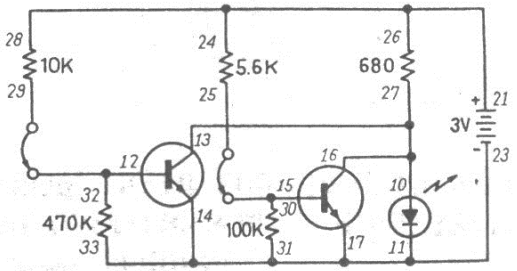
The NOR gate is another "logic" circuit and is the opposite of the OR gate. Here, connecting either one input OR the other (25 to 30 or 29 to 32) will turn off the LED (output).

By following the path of electricity in the Schematic you will see that connecting either input (and turning on that transistor) will make a short circuit around the LED through the output of that transistor.

WIRING SEQUENCE

21-26-24-28,23-11-14-17-31-33,10-13-16-27, 25-LONG WIRE, 29-LONG WIRE, 12-32,15-30





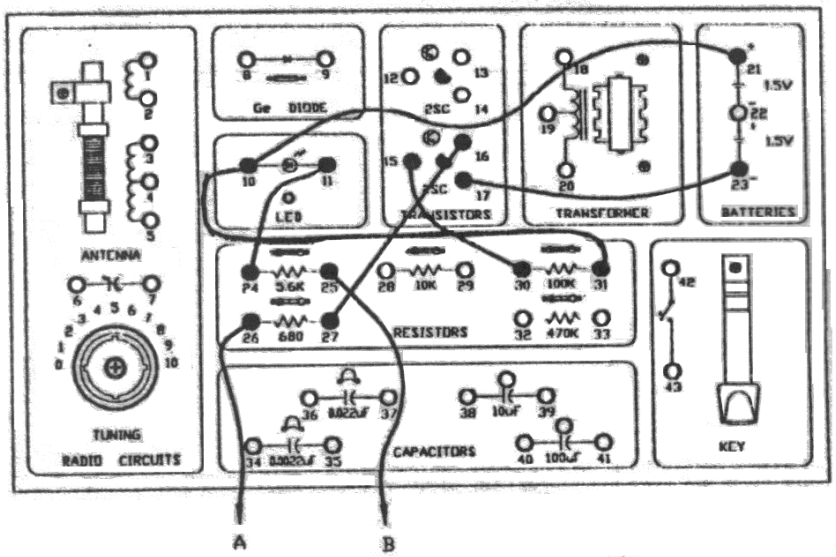
CIRCUIT 31: RESISTORS IN SERIES & PARALLEL

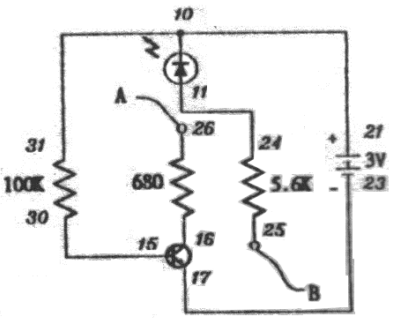
Resistors do exactly what their name implies - they resist the flow of electricity within a circuit.

To start off, connect the wires. Be sure to follow the wiring sequence exactly, then connect the LONG WIRE to terminal 24 and connect the LONG WIRE B to terminal 27. This is called a parallel connection.

Note what happens when you make the last connection A & B - LED lights. Next, see what happens when you change the LONG WIRE from terminal 24 to 25. The LED grows brighter. This is called a series connection.

WIRING SEQUENCE
21-10-31,30-15,11-24,25-LONG WIRE B, 26-LONG WIRE A, 27-16,17-23





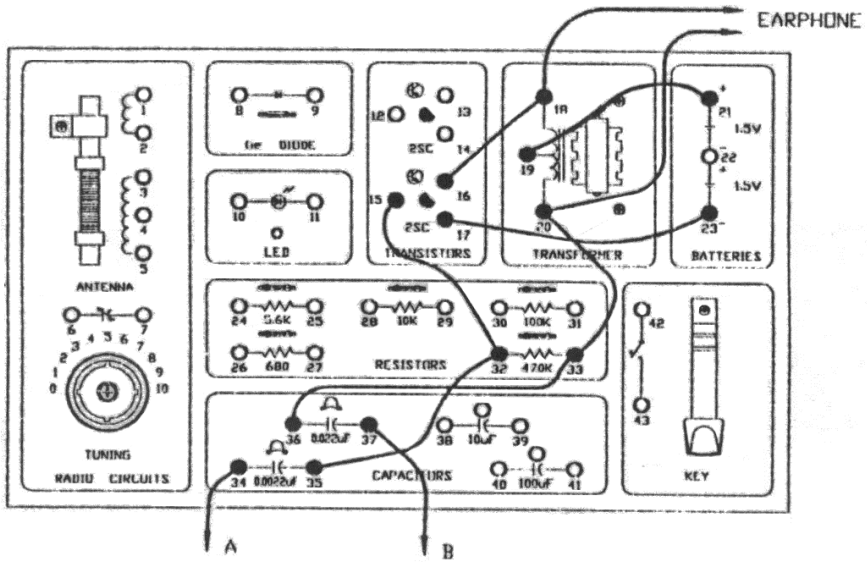
CIRCUIT 32: CAPACITOR IN SERIES & PARALLEL

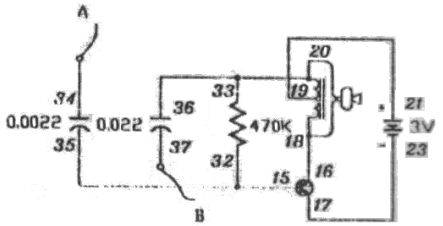
The capacitors might be a handy item in your kit. It can store current, smooth out a pulsing current flow, and allow alternating current (AC) flow while blocking direct current (DC) flow. This experiment lets you hear the effect of capacitor connected in series and parallel.

Connect the wires according to the wiring sequence. When you are done, you can hear sound coming from the earphone. Change the LONG WIRE from terminal 34-36, and move the LONG WIRE B from 37 to 35, this is called parallel connection. Now you can hear different sounds. Next move the LONG WIRE A from 36 to 37. This is called series connection. As well you can evidence the changed of sound.

WIRING SEQUENCE

21-19,34-LONG WIRE A,37-LONG WIRE B,35-32-15, 36-33-20-EARPHONE, 16-18-EARPHONE,17-23



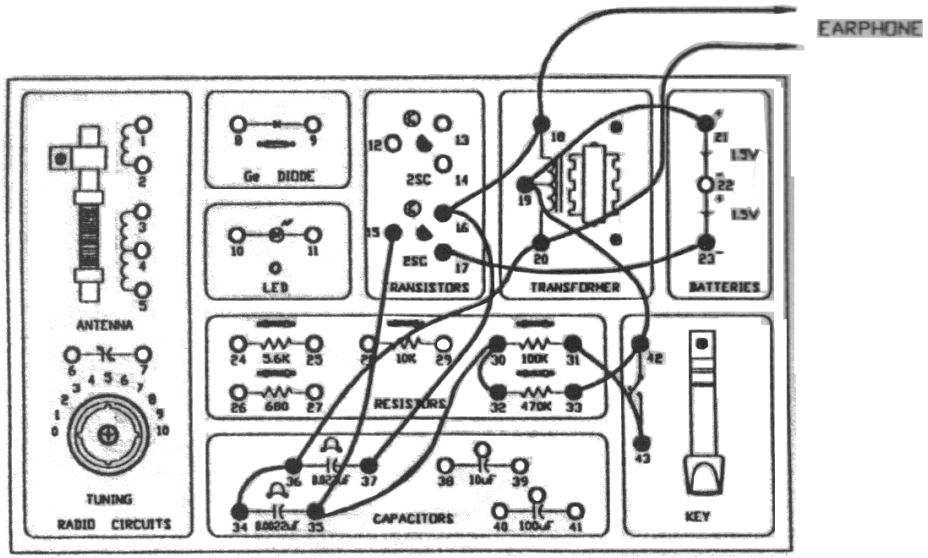


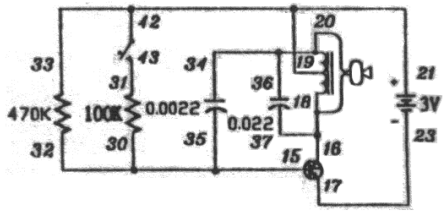
CIRCUIT 33: TWO-TONE

In this project, you can build a two-tone using a low frequency oscillator. Connect the wires according to the wiring sequence. When you connect the last wire, you can hear beeping in the earphone. By pressing the key, the sound changes to another tone.

WIRING SEQUENCE

21-19-42-33,32-30-35-15,34-36-20-EARPHONE, 37-16-18-EARPHONE,31-43,17-23





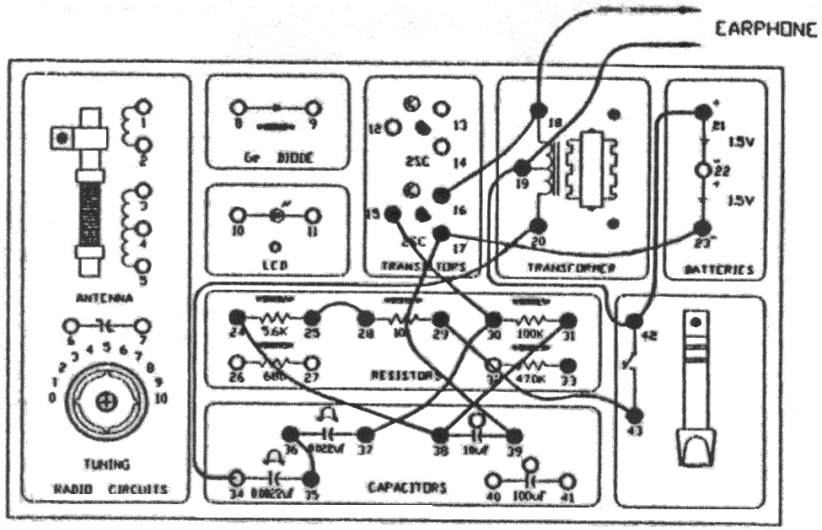
CIRCUIT 34: ELECTRONIC SIREN

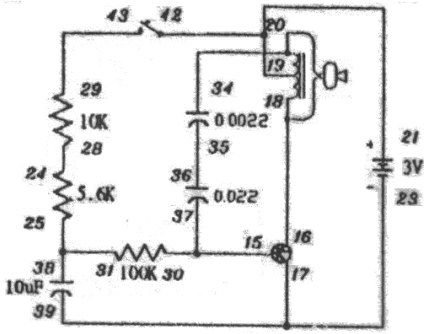
In this circuit, you can build an electronic siren using a low-frequency oscillator made up of Q3 and the transformer.

Connect the circuit as shown in the wiring sequence. Press the key, the capacitor changes and the charging current decreases, a bias current runs through the 100K ohm resistor to Q3, and the siren sounds.

WIRING SEQUENCE

21-42-19-EARPHONE,23-17-39,15-30-37,
16-18-EARPHONE,20-34,24-38-31,25-28,29-43,35-36

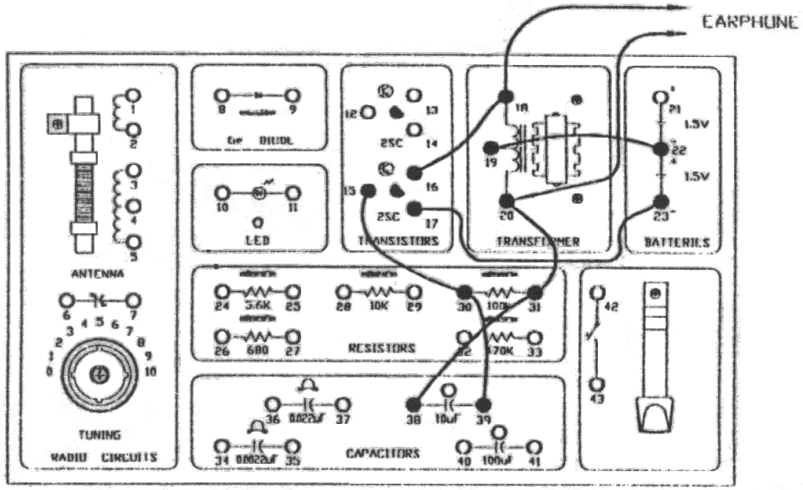


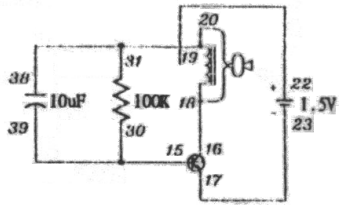


CIRCUIT 35: CLOCK SOUND

The "clock sound" uses a low frequency oscillator similar to the electronic siren in the last experiment. Connect the wires accordingly and you can hear clock sound coming from the earphone.

WIRING SEQUENCE
22-19,39-30-15,38-31-20-EARPHONE,
16-18-EARPHONE,17-23





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