FRONT COVER

Created by author and educator G. Art Gibson
and
technically edited by Jack Carter

Lab 1 Manual

| STEM | Automotive | HVAC | Electronics |

Mr Circuit Technology

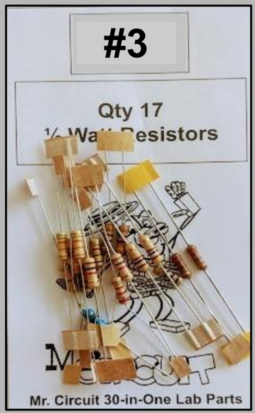
Mr Circuit Lab 1

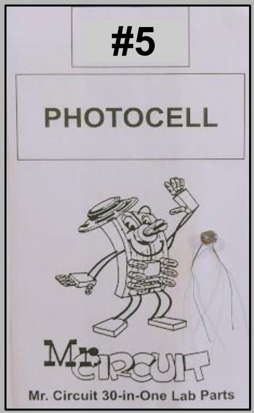
ELECTRONICS LAB #1101

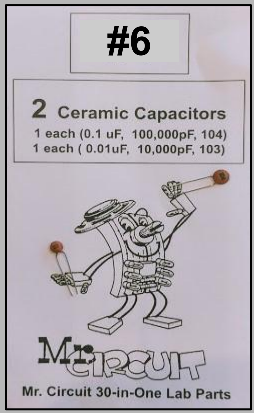
www.mrcircuittechnology.com

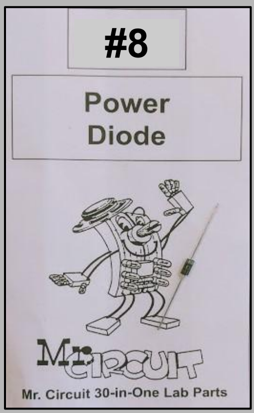
Mr Circuit Basic Electronics Lab 1 "Concepts & Components"

BOX for Lab 1 (Part# 1101-LAB)







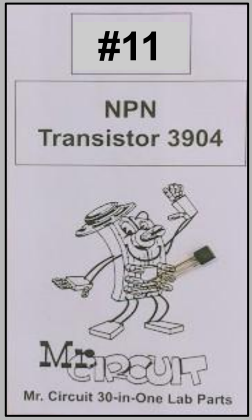


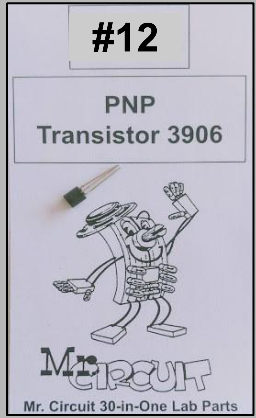
THIS BOX CONTAINS:

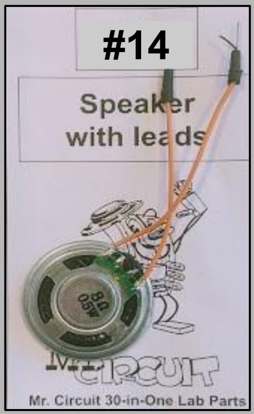
A printed lab manual of all lessons and experiments, and all experiment parts shown here.

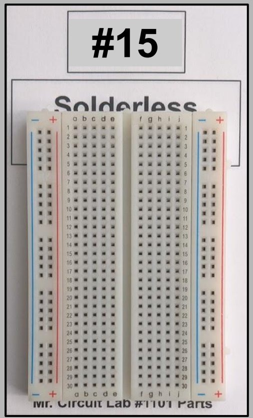
Online Student Resources Link

https://bit.ly/3wioVYk









Mr Circuit Basic Electronics Lab 1 #1101

Introduction to Lab 1

This Mr Circuit lab was designed to meet the needs of students who really want to be part of the world of science, math, or technology. The teacher does not need a background in electronics to teach with this lab. The teacher will learn right along with the students.

.***THIS LAB 1 CAN BE INSERTED INTO ANY SCIENCE, TECHNOLOGY, OR MATH CLASS.

It will stimulate the mind by using easy to understand experiments. It is very important to use "Hands-to-Mind" concepts like this lab uses to add to the knowledge and experience of the student.

Many Science projects have been spawned from the ideas in this lab. This lab was prepared for students from 10 years old and up.

Objectives of this Lab 1

The objectives of this lab are the following:
- learn to recognize basic components used in electronics
- learn the name and schematic symbols of electronic components in use today
- learn to follow electronic schematic diagrams
- learn the name and use of the basic electronic components
- learn to construct electronic devices on a solderless circuit board following the pictorial and schematic diagram

How to use this Lab 1

This lab was designed in a progressive order of complexity. Therefore, we recommend that the beginner follow the order of the 4 Lessons and 30 experiments.

Important note from the author:

Many schools have installed expensive labs that have furniture, expensive test equipment, and plug-in modules to try to teach the concepts we cover in this lab. We call those expensive labs, "Photo-Op" labs because they look good in a picture but, in the end, they do not excite the student who needs and wants real, hands-on, transferable knowledge. This lab works with real electronic parts and the student can do the same experiments at home and not just at school with expensive trainers. Our lab experiment parts are inexpensive enough so the student can afford to buy their own set. Do not make the mistake of buying those expensive "Photo-Op" labs.

Mr Circuit Basic Electronics Lab 1 "Concepts and Components" #1101

TABLE OF CONTENTS

- Introduction.
- Inventory Sheet

LESSONS:

- Lesson 1: Basic Electronic Theory.
- Lesson 2: Electronic Component Identification.
- Lesson 3: Resistor Color Code.
- Lesson 4: Using the Solderless Circuit Board.

COMPONENT FUNCTION EXPERIMENTS:

1. LED CURRENT INDICATOR (RESISTORS)
2. LED BRIGHTNESS CONTROL (POTENTIOMETER)
3. LIGHT ACTIVATED LED (PHOTOCELL)
4. STORAGE OF ELECTRONS (CAPACITOR)
5. SPEAKER ACTION (SPEAKER)
6. DIODE TESTER (SILICON DIODE)
7. SCR CHECKER
8. NPN TRANSISTOR CHECKER
9. PNP TRANSISTOR CHECKER
10. TRANSISTOR OSCILLATOR
11. BLINKING LIGHT (IC TIMER)

EXPERIMENT PROJECTS

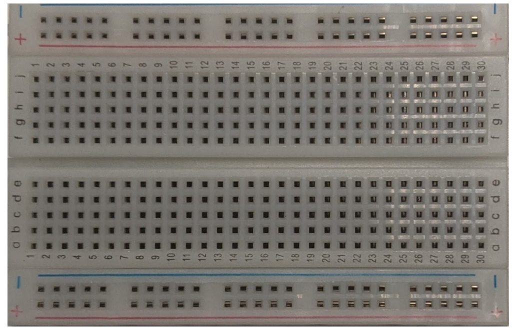
12. BURGLAR ALARM.
13. AUTOMATIC NIGHT LIGHT.
14. DC TO DC POWER SUPPLY.
15. ELECTRONIC METRONOME.
16. ELECTRONIC MOTORCYCLE.
17. RAILROAD LIGHTS.
18. VARIABLE SPEED LIGHTS.
19. CONTINUITY TESTER.
20. AUDIO GENERATOR.
21. ELECTRONIC POLICE SIREN.
22. WAKE-UP ALARM.
23. VARIABLE TIMER.
24. MOISTURE DETECTOR.
25. CODE OSCILLATOR.
26. AUDIBLE WATER DETECTOR.
27. ENGLISH POLICE SIREN.
28. ELECTRONIC CANARY.
29. SPACE MACHINE GUN.
30. ULTRASONIC PEST REPELLER.

PARTS INVENTORY SHEET

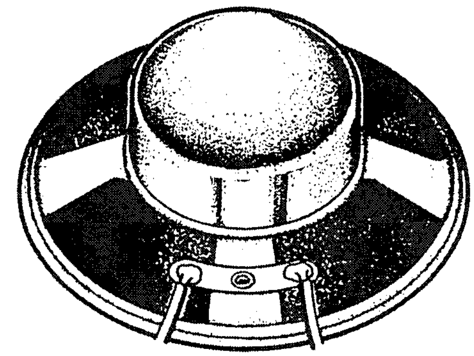
RESISTORS (Resistors have no polarity)

- 10 ohm (Brown, Black, Black, Gold)
- 47 ohm (Yellow, Violet, Black, Gold)
- 47 ohm (Yellow, Violet, Black, Gold)
- 100 ohm (Brown, Black, Brown, Gold)
- 100 ohm (Brown, Black, Brown, Gold)
- 220 ohm (Red, Red, Brown, Gold)
- 220 ohm (Red, Red, Brown, Gold)
- 1K (Brown, Black, Red, Gold)
- 1K (Brown, Black, Red, Gold)
- 2.2K (Red, Red, Red, Gold)
- 3.3K (Orange, Orange, Red, Gold)
- 6.8K (Blue, Gray, Red, Gold)
- 16K (Brown, Blue, Orange, Gold)
- 33K (Orange, Orange, Orange, Gold)
- 33K (Orange, Orange, Orange, Gold)
- 120K (Brown, Red, Yellow, Gold)
- 470K (Yellow, Violet, Yellow, Gold)

Solderless Circuit Board

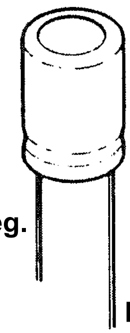


Speaker



RADIAL ELECTROLYTIC CAPACITORS

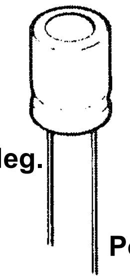
1000 µF



Neg.

Pos.

100µF



Neg.

Pos.

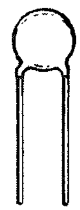
10µF

Neg.

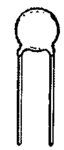
Pos.

CERAMIC CAPACITORS

.1µF (104)

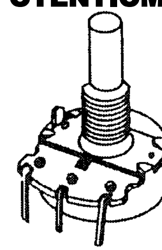


.01µF (103)

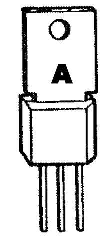


No polarity on disc capacitors

POTENTIOMETER

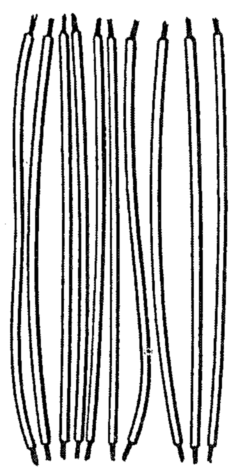


SCR



C A G

JUMPER Wires

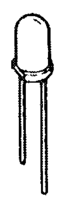


POWER DIODE

Cathode

Anode

LED



PHOTOCELL

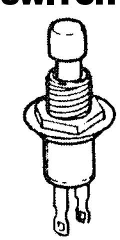
No polarity

BATTERY SNAP

\+ -

Pos. Neg.

N/O PUSHBUTTON SWITCH

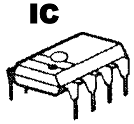


LED

Cathode

Anode

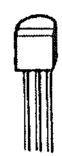
555 TIMER IC



Pin 4

Pin 1

Transistor NPN 2N3904



E B C

Transistor PNP 2N3906

E B C

LESSON 1

BASIC ELECTRON THEORY

MATTER
Everything you see around you is made of matter; the desk, the pen, the paper, water and even yourself. Matter is something that has mass and takes up space. It can be found in three states: solid, liquid or gas.

ELEMENTS
At this point you might ask, what is matter made of? ELEMENTS. Matter is made of elements which are substances found naturally in the universe such as carbon oxygen silver gold etc. There are around 104 naturally occurring elements in the universe.

ATOMS
Now, the next question is, what are elements made of? Well, each element is made up of atoms. Atoms have a central core called a nucleus filled with positively charged particles known as protons and neutrons that have no charge, positive or negative.

AN ATOM

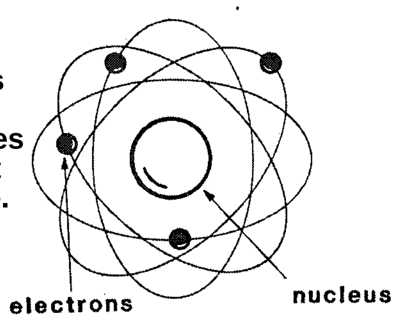


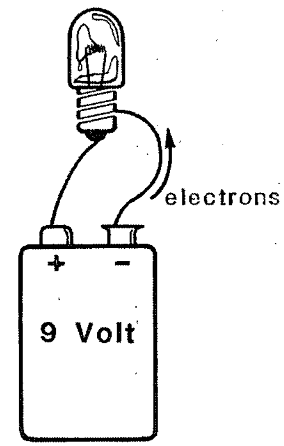
Fig. 1

Surrounding the nucleus, in several different orbits, are negatively charged particles called electrons. All atoms are so constructed regardless of whether they constitute an element of hydrogen or gold.

The only difference between one atom and another, is the number of protons, neutrons, and electrons that each atom has. For example, hydrogen has one proton and one electron and no neutrons while gold has 79 protons, 79 electrons and 118 neutrons.

ELECTRONS AND ELECTRON CURRENT
Now you can say, OK I understand everything is made up of atoms and that atoms have protons inside the nucleus with electrons in orbits running around it. But, …, what does this have to do with electronics?

The answer to that question is, by definition, electronics is the part of physics that studies the movement of electrons called electron current. Electron current is the movement of millions and millions of electrons through a conductor, or wire.



When we connect an incandescent light bulb to a battery such as shown here, the light bulb turns on because the electrons that circulate through the filament of the bulb cause the metal filament to heat up and emit light..

This Pencil exercise is to draw a diagram of an atom and label its parts. Copy Figure #1 in the space below.

Now that you know that electronics is the part of physics that studies the movement of electrons and that electric current is the movement of millions and millions of electrons from the negative to the positive, let's go to the lesson #2 and learn about electronic components.

LESSON 2 (Page 1 of 3)

ELECTRONIC COMPONENT IDENTIFICATION

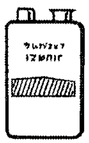
OBJECTIVE: In this experiment you will learn the physical appearance, schematic symbol, and basic function of the following electronic components:

- **-Batteries.**
- **-Switches.**
- **-Resistors.**
- **-Potentiometers.**
- **-Photocell.**
- **-Ceramic Capacitors.**
- **-Electrolytic Capacitors.**
- **-Diodes.**
- **-LED's.**
- **-SCR's.**
- **-Transistors.**
- **-Integrated Circuits.**
- **-Speakers.**

BATTERIES There are several types.

Physical Appearance | Schematic Symbol | Draw Schem. Symbol

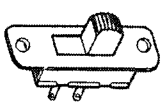
#1

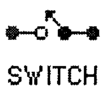


FUNCTION: A battery stores electric energy.

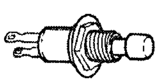
SWITCHES

Physical Appearance | Schematic Symbols | Draw Schem. Symbol





#2



FUNCTION: A switch or a pushbutton is a device that opens or closes an electric circuit.
Switches or pushbuttons may have any number of terminals. They need to have at least two.
Identify the switch in your Lab and observe it.

RESISTORS

Physical Appearance | Schematic Symbol | Draw Schem. Symbol

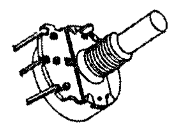
#3

FUNCTION: A resistor limits or controls the amount of current flowing through a circuit by presenting an opposition or **resistance** to the current flow.
Identify the resistors in your Lab and observe them.

POTENTIOMETERS

Physical Appearance | Schematic Symbol | Draw Schem. Symbol

#4

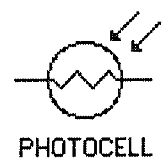


FUNCTION: A potentiometer is a variable resistor.
Identify the potentiometer in your Lab .

PHOTOCELL

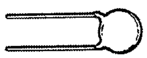
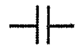
Physical Appearance | Schematic Symbol | Draw Schem. Symbol

#5



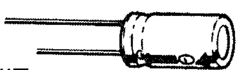
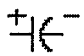
FUNCTION: A photocell is a special kind of resistor that varies its resistance according to the intensity of the light that hits its surface.
Identify the photocell in your Lab.

CERAMIC CAPACITORS

Physical Appearance	Schematic Symbol	Draw Schem. Symbol
#6 	 CERAMIC CAPACITOR	

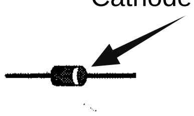
FUNCTION: A capacitor acts as a temporary battery by storing electricity. Ceramic capacitors store small amounts of electricity.
Identify the ceramic capacitors in your Lab .

ELECTROLYTIC CAPACITORS

Physical Appearance	Schematic Symbol	Draw Schem. Symbol
 #7	 ELECTROLYTIC CAPACITOR	

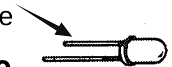
FUNCTION: Electrolytic capacitors store relatively large amounts of electricity. They have polarity, which means that they have a positive and a negative terminal and therefore care must be taken when connecting them to a circuit. They must be installed in the right direction.
Identify the electrolytic capacitors in your Lab , observe them and note the indicated polarity of their leads.

DIODES

Physical Appearance	Schematic Symbol	Draw Schem. Symbol
Cathode #8 	ANODE  CATHODE DIODE	

FUNCTION: A diode is a device that allows current to flow through it in one direction only. You can compare the diode to a "one way street".
Diodes have two leads, one is the anode and the other is the cathode. The cathode is indicated by a band around the body of the diode.
Identify and observe the diode in your Lab .

LIGHT EMITTING DIODES (LED's)

Physical Appearance	Schematic Symbol	Draw Schem. Symbol
Cathode #9 	A  C LED	

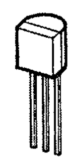
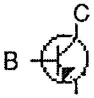
FUNCTION: LED's are a special kind of diode that emit light when current flows through them. They have two terminals called anode and cathode. The cathode is indicated by a flat side on the case of the LED or by the shorter lead.
Identify the two LED's in your Lab and try to recognize the anode and the cathode leads.

SCR's.

Physical Appearance	Schematic Symbol	Draw Schem. Symbol
#10  Gate	A  C SCR G	

FUNCTION: The SCR allows current to flow through it only after a momentary positive voltage is applied to the gate. SCR's have three leads which are called: **anode, cathode,** and **gate.**
Identify and observe the SCR in your Lab .

TRANSISTORS

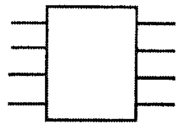
Physical Appearance	Schematic Symbol	Draw Schem. Symbol
 **E B C**	B  C E #11 NPN; B  C E PNP #12	

FUNCTION: The transistor is a component used to amplify electricity. It has three terminals called **Emitter, Base,** and **Collector.**
According to how transistors are manufactured they become an NPN or PNP type. Observe the difference in the schematic symbol between these two types.
Identify and observe the two transistors in your Lab .

INTEGRATED CIRCUIT

Physical Appearance | Schematic Symbol | Draw Schem. Symbol

#13



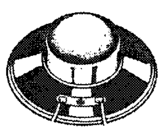
INTEGRATED CIRCUIT

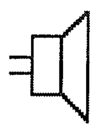
FUNCTION: Integrated Circuits (IC's) have several components (transistors, diodes, resistors, capacitors, etc), condensed into a very small package. Each type of IC performs a different function according to the different components it has inside.
Identify and observe the IC in your Lab.

SPEAKERS

Physical Appearance | Schematic Symbol | Draw Schem. Symbol

#14

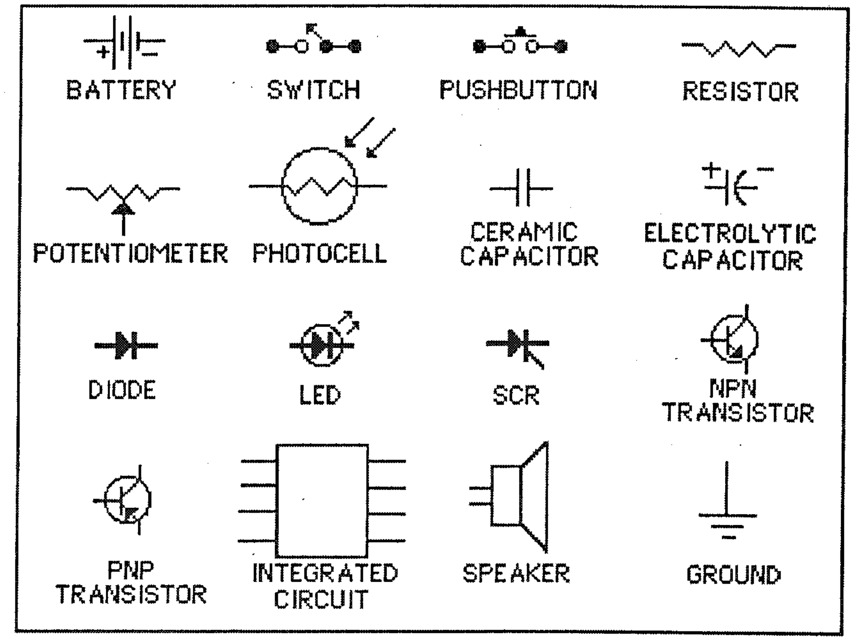




SPEAKER

FUNCTION: The purpose of the speaker is to produce sound waves from the electric current that flows through it.
Identify and observe the speaker.

SCHEMATIC DIAGRAM CHART



#15 Solderless Circuit Board

#16 10 Jumper Wires

LESSON 3 (Page 1 of 2)

RESISTOR COLOR CODE

RESISTORS, RESISTANCE & OHMS. (Ω : Ohms)

Resistors are one of the most popular and fundamental electronic components. You will always find them in electronic circuits.
Resistance is the opposition to current flow. We often need resistance to control current flow and in order to get it we use components known as resistors.
Each resistor contains a certain amount of resistance. Resistance is measured in ohms. For example, a resistor of 10,000 ohms would provide much more opposition to current flow than a resistor of 1000 ohms.

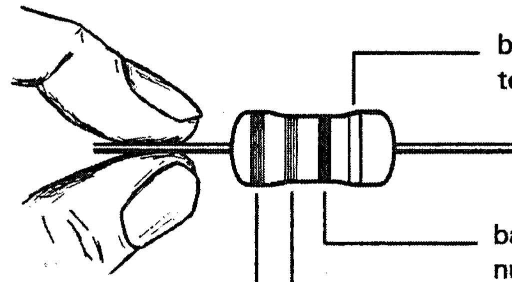
Pencil Exercise.
1. Resistance is the ____________ to current flow.
2. Each resistor contains a certain amount of ___________.
3. Resistance is measured in________.
4. A resistor of 20,000 ohms will provide_________ opposition to the current flow than a resistor of 5,000 ohms.

THE RESISTOR COLOR CODE?

The resistor color code is a method of indicating the resistance value in ohms and the tolerance range. It is not a secret code designed by sinister cryptographers to confuse and frustrate us. On the contrary, it was made as easy as possible to facilitate its wide usage. Anyone can learn it in just a few minutes, including you.

WHY THE COLOR CODE

With the color code we use colored bands in order to overcome two basic problems:
One: It would be very difficult to print and see large numbers on a small resistor.
Two: Even if we could see the number, placement of the resistor in the project might entirely obscure it.
The color coded bands that go entirely around the resistor seem to solve these two problems.
When reading the color code, the resistor should be held with the gold (or silver) band on the right, as shown in the next picture.



THIS IS THE RESISTOR COLOR CODE

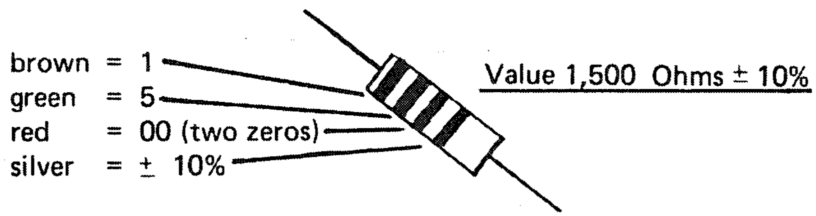
black	0
brown	1
red	2
orange	3
yellow	4
green	5
blue	6
violet	7
gray	8
white	9

Each color stands for a particular number. For example, red equals two.
When reading the color code remember:
- -The **first band** always represents **a number.**
- -The **second band** always represents **a number.**
- -The **third band** always represents the **number of zeros** to be added to the numbers.(If the third band is black, no zeros are added).
- -The **fourth band** represents the **tolerance** value. This band is usually **gold, 5%;** or **silver 10%.**

Tolerance means the precision or exactness in the value of the resistor.

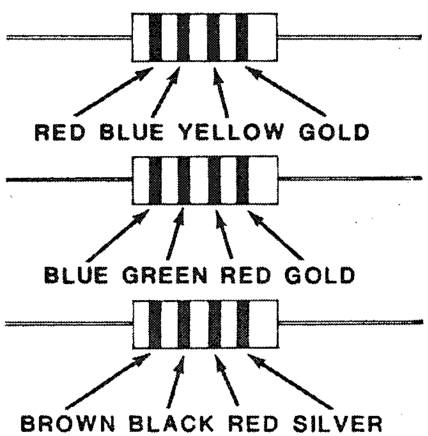
EXAMPLE

What is the value in ohms, and the tolerance of the following resistor?



PENCIL EXERCISE

Give the value in ohms and the tolerance, of these resistors.



Value ____________

Value ____________

Value ____________

ABBREVIATING NUMBERS

Usually the values of resistors are abbreviated by using the letter K to represent 1,000 ohms and the letter M to represent 1,000,000 ohms. For example, a 1K resistor is a resistor of 1000 ohms. A 3.3 K resistor is a resistor of 3300 ohms. A 2M resistor is a 2,000,000 ohm resistor.

LESSON 4 (Page 1 of 2)

USING THE SOLDERLESS CIRCUIT BOARD

The Solderless Circuit Board is a device that allows you to assemble electronic circuits without the use of solder. It makes for quick and easy costruction and is thus ideal for experimentation.
A Solderless Circuit Board comes supplied with your Science Electronic Lab.
Lay the board in front of you, as shown in Fig 1.

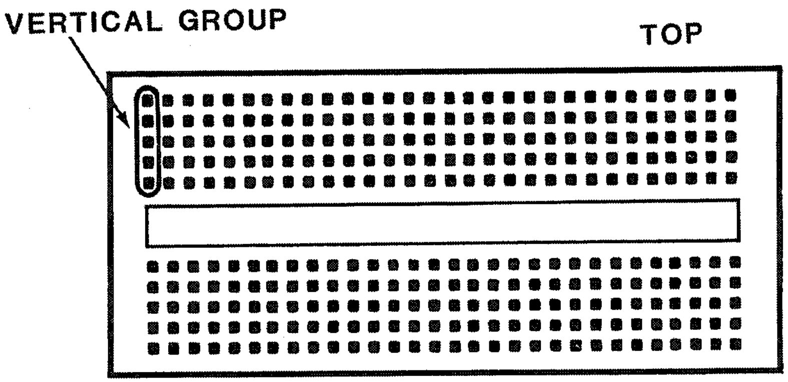
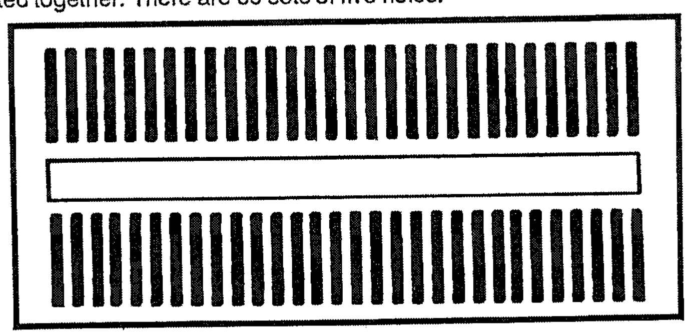


FIG. 1

Notice that there are many tiny holes in each board. Each hole will accept a component lead or wire. **All five holes in each vertical group or set are connected together.** Thus each vertical group is "shorted" together. Two or more wires or leads plugged into anyone of the five holes will be connected together. There are 60 sets of five holes.



UNDER SIDE OF SOLDERLESS CIRCUIT BOARD SHOWING METAL STRIPS WHICH CONNECT EACH SET OF FIVE HOLES. FIG. 2

A center channel separates or divides the board in half. Integrated Circuits are straddled across this channel as shown in Fig 3.
Also note that numbers and letters were printed on the board to help to identify each hole during the contruction process.

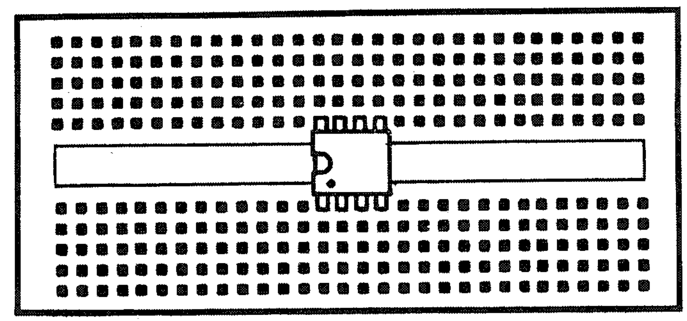


FIG. 3

In order to learn how to use the Solderless Circuit Board let us do the following experiment.
Let us say that we want to build a simple circuit to light up an LED, like the one shown in Fig 4.

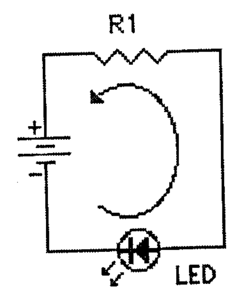


FIG. 4

In this circuit an electric current flows from the negative terminal of the battery to the positive terminal, passing through the LED and the resistor. As current flows through the LED, it illuminates.

LESSON 4: USING THE SOLDERLESS CIRCUIT BOARD (Page 2 of 2)

One way to build this circuit is by soldering the leads of the components to one another, as shown in Fig 5.

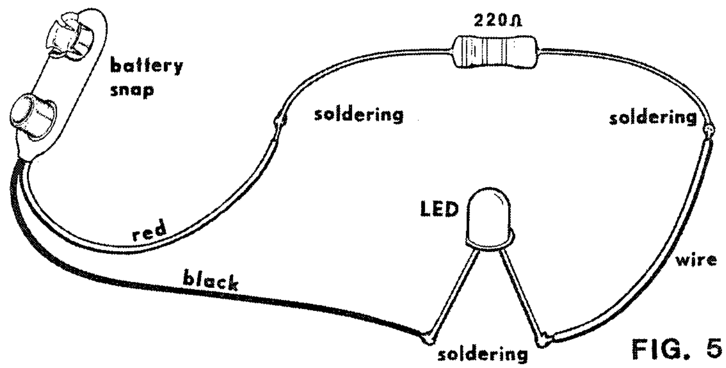


FIG. 5

Or, the same circuit can be constructed, easily and neatly, by using a solderless circuit board, as shown in Fig 6.

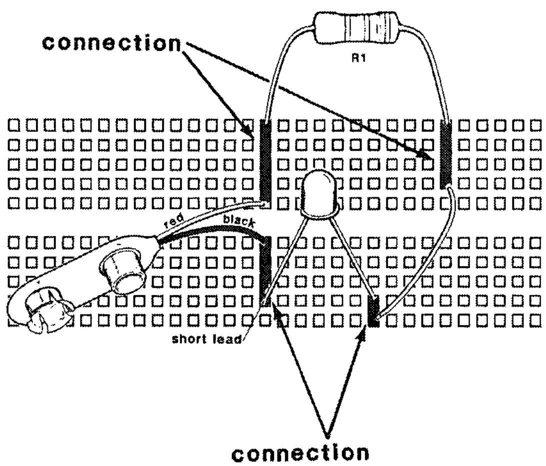


FIG. 6

In this case, the leads of the components are connected to one another by the metal strips of the solderless circuit board, as shown in Fig 6.

Remember, wires that must be connected together must be inserted in holes of the same vertical column.

Now, using the solderless circuit board and the parts, build the circuit of Fig 6. Take special care while installing the LED to put the short lead in the right direction.

Once you have the circuit assembled, connect the battery to the battery snap and the LED should light.

Now, make a little change in the circuit. Pull out the red wire of the battery snap from its original position and insert it in the hole shown in Fig 7.

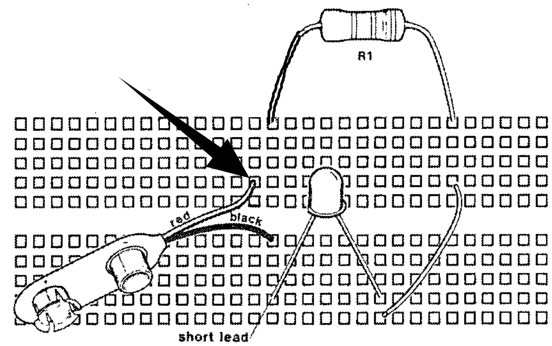


FIG. 7

What happened to the LED when you made that change?________________
Explain why.________________________________

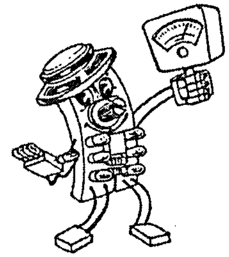
The LED went off because in the circuit shown in Fig 7 there is no connection between the red wire of the battery snap and the resistor R1. **Therefore, again, always remember, "wires that need to be connected together must be inserted into the same vertical column of holes".**

Now you are ready to go on to the experiments.

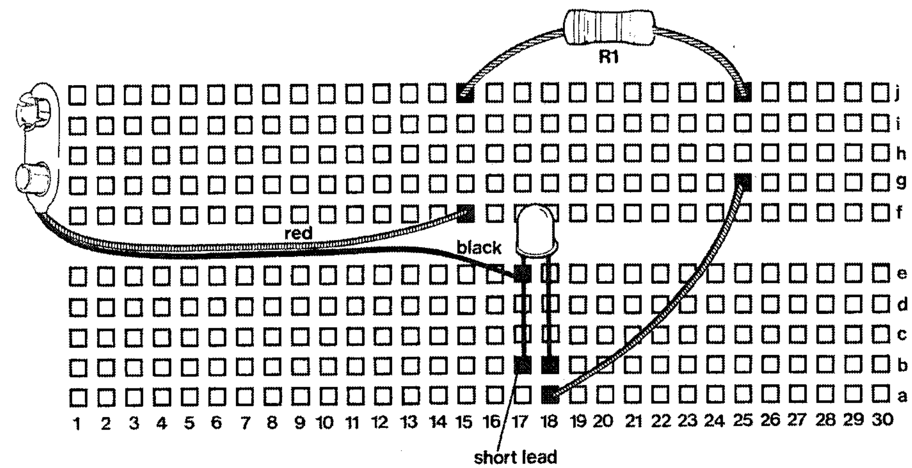
EXPERIMENT 1

LED CURRENT INDICATOR

HOW A RESISTOR WORKS



PICTORIAL DIAGRAM



PURPOSE: To observe the effect of a resistor controlling current flow.

PROCEDURE:

1) Build the circuit shown in the pictorial diagram. Observe the brightness of the LED.
2) Replace, one at a time, the following resistors for R1 (100 ohm resistor) and observe in each case the brightness of the LED.
   Resistors: 220 ohm, 1K, 6.8K.

RESULTS:

By performing this experiment you found that the brightness of the LED depends upon the value of the resistor in the circuit. The higher the resistance value, the less the brightness of the LED.

EXPLANATION OF EXPERIMENT 1.

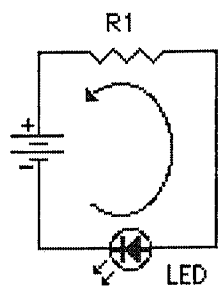


Fig. 1 shows the basic circuit of the LED Current Indicator. This circuit is made up of three components: the **battery**, the **LED,** and the **resistor**, which are connected in series, one following the other.

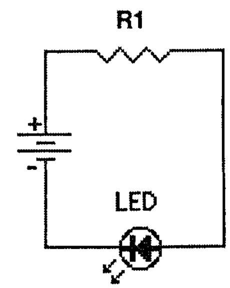
In this circuit the current flows from the negative of the battery to the positive of the battery, passing through the LED and the resistor, as indicated in the schematic.

As current passes through the LED, it illuminates. **The more the current, the greater the brightness.**

The element that controls the amount of current flowing through the circuit is the resistor. The smaller the resistance value, the smaller the opposition to the current flow and the higher the current. The higher the current, the brighter the LED.

On the other hand, the higher the resistance value, the greater the opposition to current flow and the lower the current. The lower the current, the dimmer the LED.

Now you understand why, as you insert in the circuit progressively higher values of resistance, the brightness of the LED decreases. The higher the resistance, the lower the amount of current that flows through the circuit.



R1:

100 ohms (Brown,Black, Brown, Gold).
220 ohms (Red, Red, Brown, Gold).
1K ohm (Brown, Black, Red, Gold).
6.8K ohm (Blue, Gray, Red, Gold).

EXPERIMENT 2

LED BRIGHTNESS CONTROL

HOW A POTENTIOMETER WORKS

PURPOSE: To observe how a potentiometer works as a variable resistor.

PROCEDURE:
1) Build the circuit shown in the pictorial diagram.
2) Adjust the potentiometer from one end to the other while observing the brightness of the LED.

RESULTS: By performing this experiment you found that by adjusting the potentiometer from one end to the other you can control the brightness of the LED.

EXPLANATION OF EXPERIMENT 2:
Fig. 1A shows the schematic diagram of a potentiometer. It has three leads labeled A, B, and C. C is the cursor that moves between A and B.

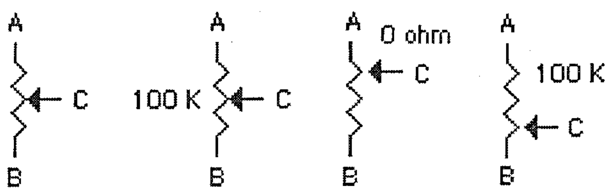
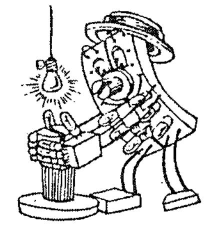
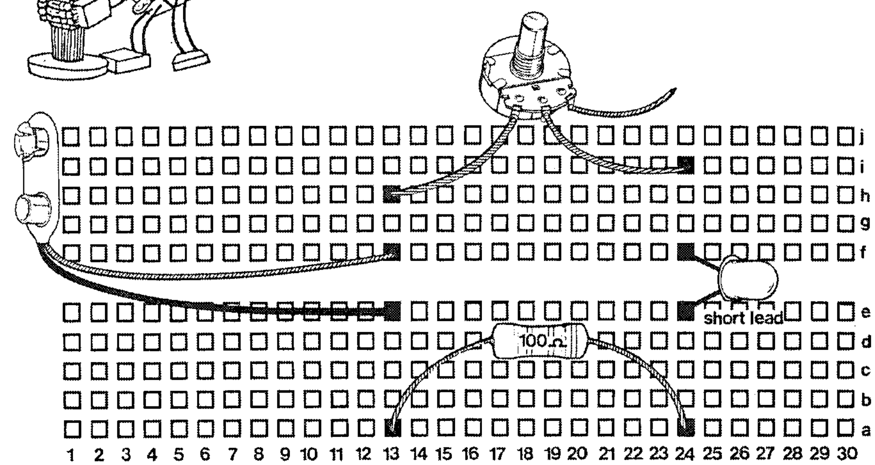


FIG 1A FIG 1B FIG 1C FIG 1D

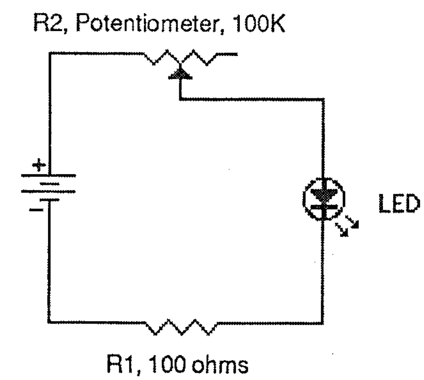
If the value of the potentiometer is, for example, 100K ohms, between A and B there will be a resistance of 100K ohms(FIG 1B). The resistance between A and C depends upon the position of the cursor. If the cursor is touching the end A, the resistance will be zero (Fig. 1C). If the cursor is touching the end B the resistance between A and C will be 100K ohms(Fig. 1D). If the cursor is in any position between A and B, the value of the resistance between A and C will be somewhere between 0 and 100K ohms.
Now, observe the circuit of the LED Brightness Control. The current flows from the negative of the battery to the positive of the battery, passing through resistor R1, the LED, and the potentiometer. As you adjust the potentiometer from one end to the other, the resistance changes, producing a change in the amount of the current flowing through the circuit. This change in the amount of the current is observed by the change in the brightness of the LED.
NOTE: The 100 ohm resistor R1 is placed in the circuit to limit the current so the LED does not burn out when the potentiometer is at its minimum value of resistance (zero ohms).



PICTORIAL DIAGRAM



SCHEMATIC DIAGRAM



Resistor R1: 100 ohms (Brown, Black, Brown, Gold).
Resistor R2: 100K Potentiometer.

EXPERIMENT 3

LIGHT ACTIVATED LED

HOW A PHOTOCELL WORKS

PURPOSE: To observe how a photocell works as a light sensitive resistor.

PROCEDURE:
1) Build the circuit shown in the pictorial diagram.
2) Using your hand, partially cover the surface of the photocell to vary the intensity of the light striking the photocell. Observe how this affects the brightness of the LED.

RESULTS: By performing this experiment, you found that the brightness of the LED depends upon the light striking the surface of the photocell. The more light striking the surface of the photocell, the brighter the LED.

EXPLANATION OF EXPERIMENT 3:

The circuit of the Light Activated LED is made up of three components: the battery, the LED, and the photocell, which are connected in series, one following the other.

In this circuit, the current flows from the negative terminal of the battery to the positive terminal of the battery, passing through the LED and the photocell, as indicated in the schematic.

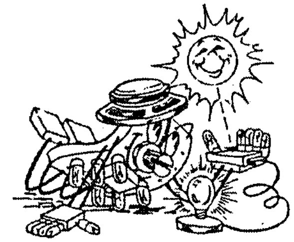
As current passes through the LED, it illuminates. The more current, the greater the brightness.

The element that controls the amount of current flowing through the circuit is the photocell.

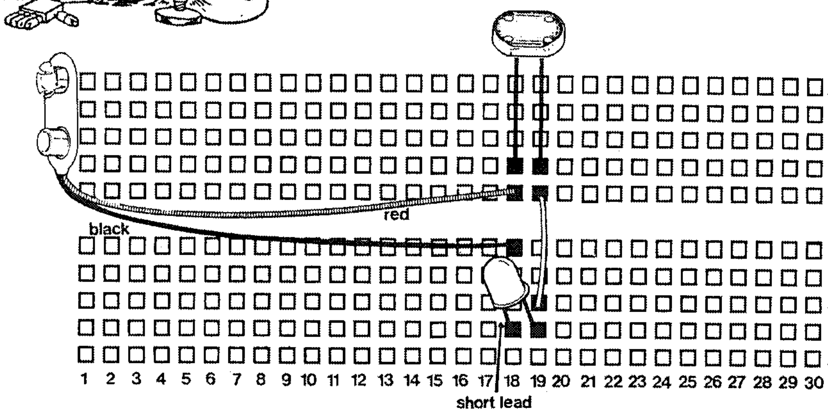
The photocell is a light sensitive resistor that changes its resistance according to the light that hits its surface. The more light hitting its surface, the lower its internal resistance. The less light hitting its surface, the greater its resistance.

The element that controls the amount of current flowing in the circuit of the Light Activated LED is the photocell. The greater the light hitting its surface, the smaller its resistance and therefore, the greater the current and the brighter the LED. On the other hand, the lesser the light hitting the photocell surface, the higher its resistance and, therefore, the smaller the current and the dimmer the LED.

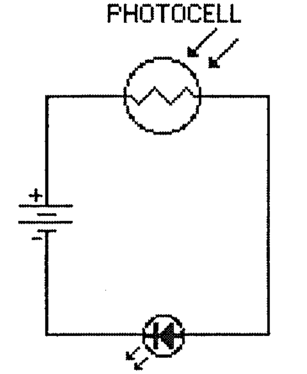
Now you understand why, as you shadow the surface of the photocell, the brightness of the LED decreases, and as you illuminate the surface of the photocell the brightness of the LED increases.



PICTORIAL DIAGRAM



SCHEMATIC DIAGRAM

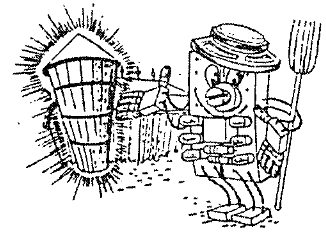


NOTE: Using your hand as a shield around the LED, you will be able to notice the difference better.

EXPERIMENT 4

STORAGE OF ELECTRONS

HOW A CAPACITOR WORKS



PURPOSE: To observe the effect of a capacitor storing electrical energy.

PROCEDURE:

1) Build the circuit shown in the pictorial diagram.
2) Connect the battery to the battery snap. After 10 seconds, disconnect the battery and observe the LED.

RESULTS: By performing this experiment you found that after disconnecting the battery from the circuit, the LED continues to be illuminated for a while. The light decreases until it completely turns off. After the battery was disconnected from the circuit the LED got the energy from the capacitor.

EXPLANATION OF EXPERIMENT 4:

When the battery is connected, the current flows in the circuit as shown in fig. 1. The current goes from the negative terminal of the battery to point A, where it divides. A part of it goes through the LED and R2, causing the LED to turn on, and the other part goes to capacitor C2, which starts to charge. Once C2 is charged, current stops flowing to it.

Then, the current path in the circuit, is as shown in Fig. 2. The current passing through the LED causes it to illuminate.

When the battery is disconnected, the electrical energy stored in the capacitor flows in the current path shown in Fig. 3, which keeps the LED illuminated until the capacitor completely discharges.

Now you can understand why, when the battery is disconnected, the LED still remains illuminated for a while.

Now, experiment by replacing the 1000 uF capacitor C2, with a 100 uF and then with a 10uF capacitor, and observe the results.

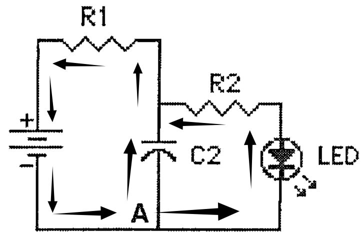


FIG 1

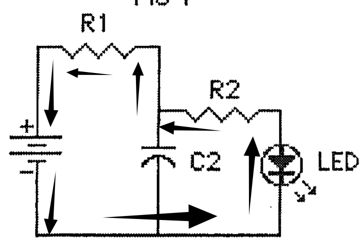


FIG 2

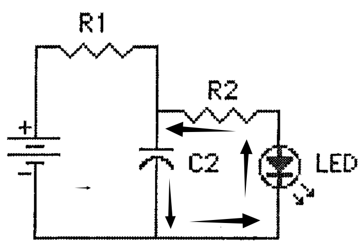
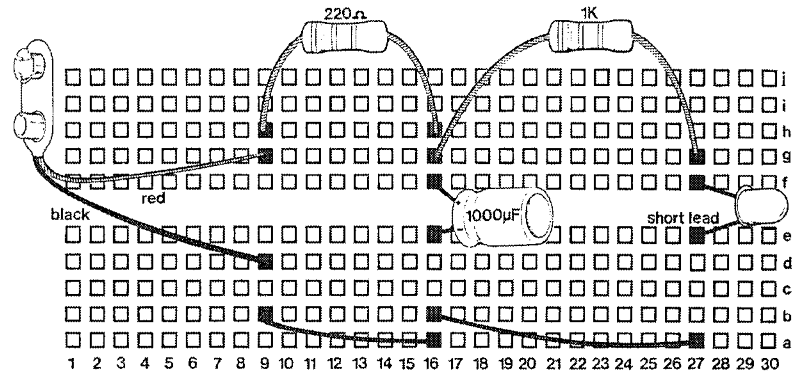
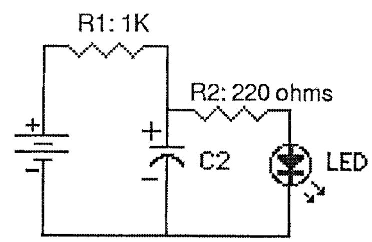


FIG 3

PICTORIAL DIAGRAM



SCHEMATIC DIAGRAM



R1 : 220 ohms (Red, Red, Brown, Gold).
R2 : 1K ohm (Brown, Black, Red, Gold).
C2 : 1000 uF capacitor,100 uF , or 10 uF.

EXPERIMENT 5

SPEAKER ACTION

HOW A SPEAKER WORKS

PURPOSE: To observe how a speaker transforms electrical energy (current flowing through it) into sound waves.

PROCEDURE:

1) Build the circuit shown in the pictorial diagram.
2) Touch the wire connected to the speaker to the resistor, as shown in the pictorial diagram. As you do this, observe the direction of the movement of the speaker cone. Repeat this step if necessary.
3) Reverse the polarity of the battery wires connected to the solderless circuit board (Connect the red wire in the place of the black wire and the black wire in the place of the red wire).
   Again observe the movement of the speaker cone.

RESULTS:

By performing this experiment you have learned the following:

1) Every time you touch the speaker wire to the resistor, the cone moves and produces a sound.
2) At step 2 of the PROCEDURE , the cone moves from the normal position **away** from the magnet.
3) At step 3 of the PROCEDURE, the cone moves from the normal position toward the magnet.

EXPLANATION OF EXPERIMENT 5:

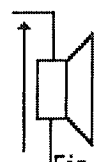


Fig 1a

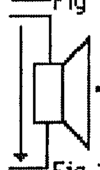
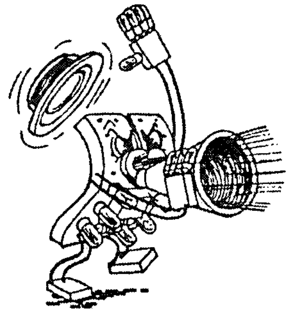
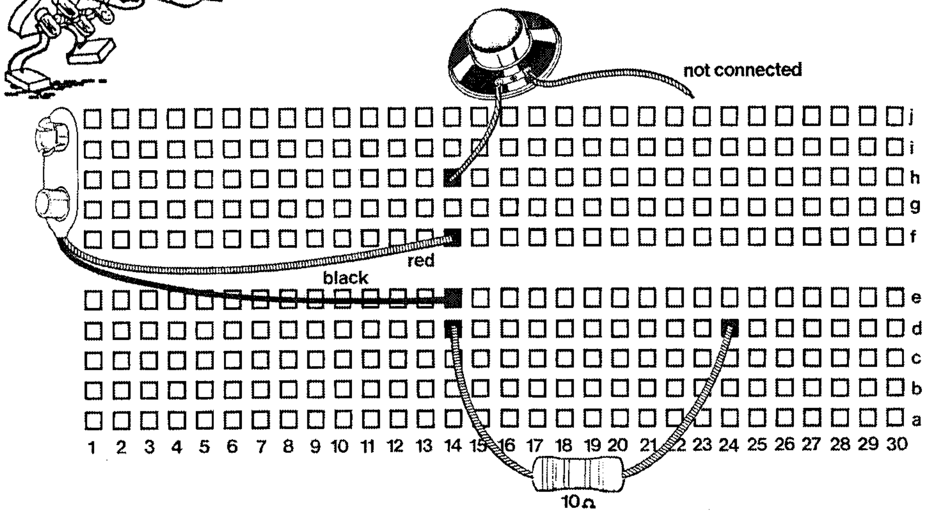


Fig 1b

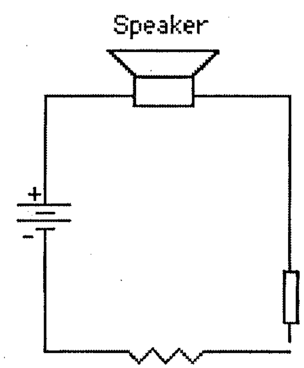
A speaker is an electromechanical device that produces a movement of its cone when current is flowing through it. If the current flows in one direction through the speaker, the cone moves in a certain direction. If current flows in the opposite direction, the cone moves in the opposite direction . See Fig. 1a and 1b.
As the cone of the speaker moves, it generates sound waves. The sound waves generated by the speaker are proportional to the variations of the current that flows through it.
In step 2 of the PROCEDURE, the current flowed through the speaker in one direction, causing the cone of the speaker to move toward the magnet.
In step 3 of the PROCEDURE, the current flowed through the speaker in the opposite direction, causing the cone to move away from the magnet.
When an alternating current (generated by a microphone, oscillator, or phono cartridge) is amplified and then sent to the speaker, it will cause the cone to follow the variations of that current producing sound waves (words or music).



PICTORIAL DIAGRAM



SCHEMATIC DIAGRAM



R1, 10 ohms

R1: 10 ohms (Brown, Black, Black, Gold)

Can you explain why a sound comes from the speaker only when the connection is made or broken and not while the connection is complete?.

EXPERIMENT 6

DIODE TESTER

HOW A DIODE WORKS

PURPOSE:

-To observe how a diode allows current to flow through it in one direction only.
-Build a useful diode checker.

PROCEDURE:

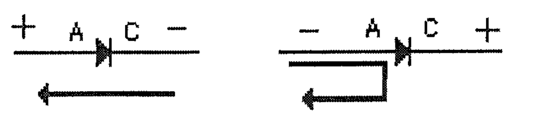
1) Build the circuit shown in the pictorial diagram.
2) Touch the anode of the diode on point A and its cathode on point C. The LED will turn on, indicating that current is flowing through the diode.
3) Touch the cathode of the diode on point A and its anode on point C. . No current will flow through the diode and the LED will remain off.

RESULTS: By performing this experiment, you have found that a diode works as a one-way gate in that it allows current to flow through it in one direction only. Also, if steps 2 and 3 of the procedure can be completed successfully, you can conclude that the diode under test is OK.

EXPLANATION OF EXPERIMENT 6:

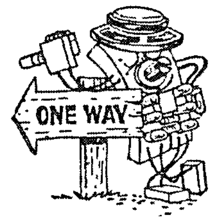
A diode is a one-way gate. It allows current to flow through it only when its anode is positive and its cathode is negative, as shown in the next picture.

A: Anode **C: Cathode**

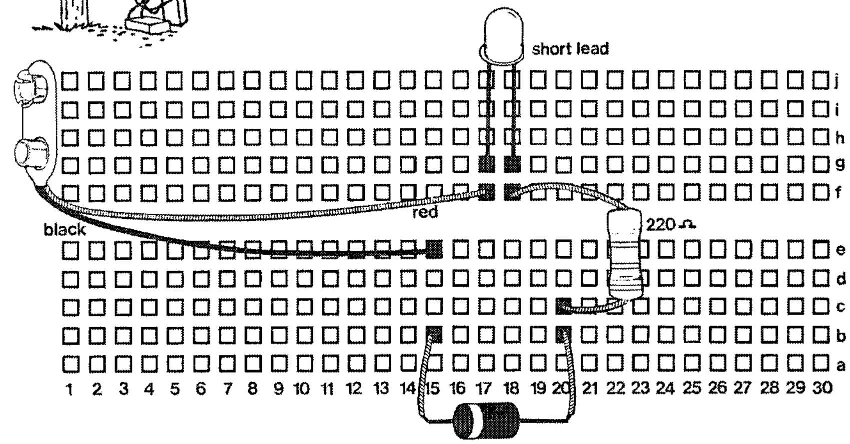


CURRENT FLOWS CURRENT DOES NOT FLOW

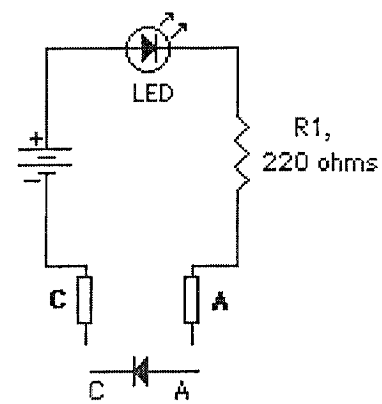
When the diode is connected in the Diode Tester Circuit with its anode on point A (positive point) and its cathode on point C (negative point), it allows current to flow through it , and therefore, the LED turns on.
When the diode is connected in the Diode Tester Circuit with its cathode on point A and its anode on point C, current will not flow through the diode and the LED will remain off.
Now you can understand why the LED turns on when the diode is connected in one direction and remains off when it is connected in the other.



PICTORIAL DIAGRAM



SCHEMATIC DIAGRAM



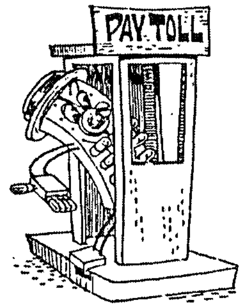
(DIODE UNDER TEST)

R1: 220 ohms (Red, Red, Brown, Gold)

EXPERIMENT 7

SCR CHECKER

HOW AN SCR WORKS



PURPOSE:

-To observe how an SCR works.
-Build a useful SCR checker.

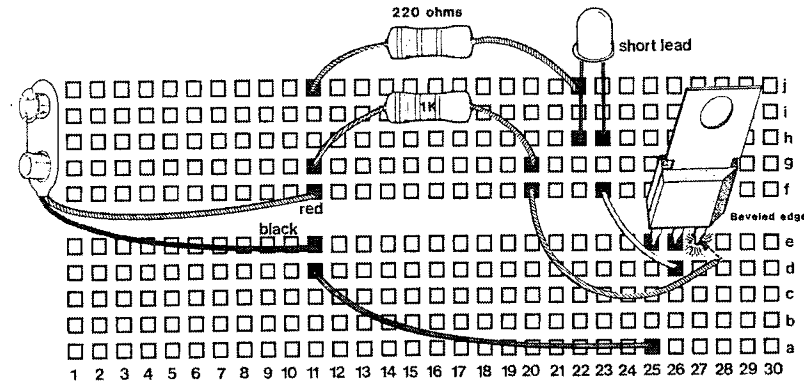
PROCEDURE:

1) Build the circuit shown in the pictorial diagram.
2) Touch, **briefly,** the wire from the 1K resistor to the gate of the SCR. The LED should turn on and remain on, indicating that current is flowing through the circuit.
3) Disconnect the battery briefly and connect it again. The LED will turn off when the battery is disconnected, and remain off after it is reconnected.

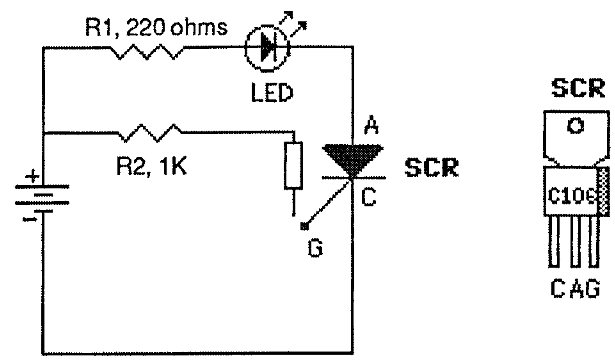
RESULTS: By performing this experiment you have found that the SCR conducts (LED on) when a positive voltage is applied to its gate. Also, you found that the SCR continues conducting even if the positive voltage has been removed from its gate. You learned that the only way to turn the SCR off is by removing the positive voltage from its anode by disconnecting the battery. Also, if steps 2 and 3 of the procedure can be completed successfully, you can conclude that the SCR is OK.

EXPLANATION OF THE EXPERIMENT:
An SCR is a " diode with a difference". Like a diode, it has a cathode and anode, and allows current to flow through it in one direction only. Yet, unlike an ordinary diode, it has a gate electrode as well. The gate is used to "trigger" the SCR into conduction. Only when the gate receives a positive voltage will the SCR conduct. Even if the positive voltage is then removed from the gate, the SCR will continue to conduct. The only way to turn off the SCR is to remove the positive voltage on its anode by, for example, disconnecting the battery.
In this experiment, by touching the gate of the SCR with the wire, you apply a positive voltage to it, and, therefore, the SCR starts to conduct causing current to flow from the negative terminal of the battery to the positive terminal, passing through the SCR, the LED, and the resistor. When the battery is disconnected, current stops flowing and the SCR turns off. When the battery is reconnected the SCR will be off until a positive voltage is again applied to its gate .

PICTORIAL DIAGRAM



SCHEMATIC DIAGRAM

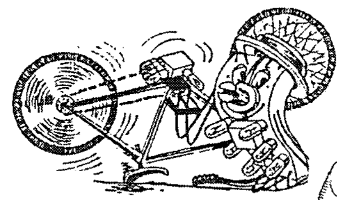


R1: 220 ohms (Red, Red, Brown, Gold).
R2: 1K (Brown, Black, Red, Gold).

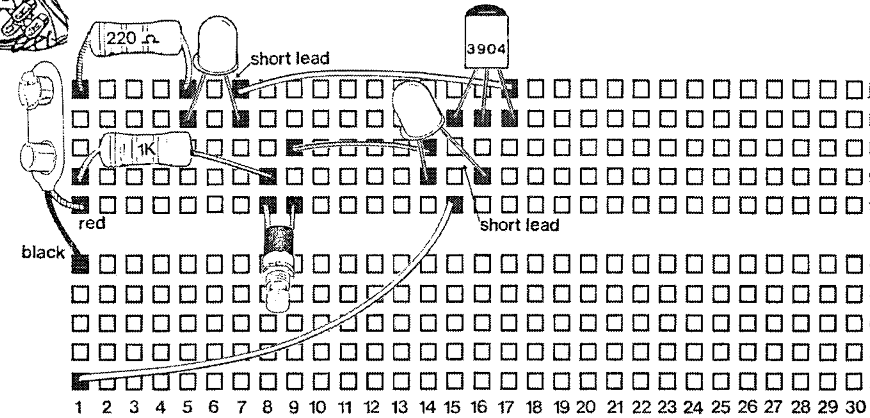
EXPERIMENT 8

NPN TRANSISTOR CHECKER

HOW AN NPN TRANSISTOR WORKS



PICTORIAL DIAGRAM



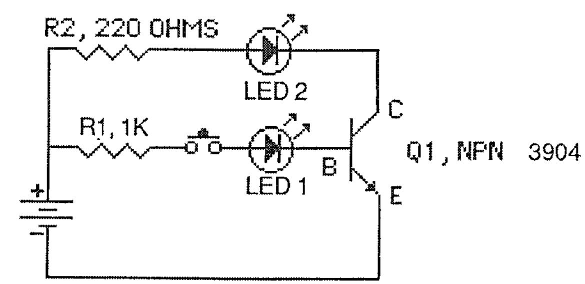
PURPOSE:

To observe how an NPN Bipolar Transistor works in a circuit as a current amplifier. This circuit will also serve as a Transistor Checker for NPN transistors.

PROCEDURE

Using the parts from your Mr Circuit Lab, build the circuit on your Solderless Circuit Board as shown in the pictorial diagram. Compare the pictorial to the Schematic Diagram. Does the pictorial follow the Schematic Diagram?

SCHEMATIC DIAGRAM



RESULTS

When you connect a 9-volt battery to the assembled circuit, the LEDs in the circuit should NOT light up. But, when you press the pushbutton switch, allowing current to flow in the Base circuit, current will also flow in the Collector circuit. So, what you will see is both LEDs will light up.

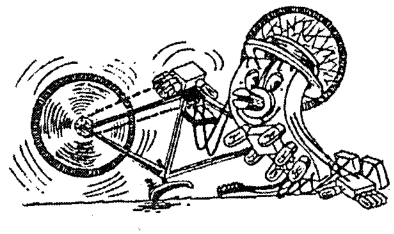
But you will notice that LED 1 in the Base circuit is a little less bright than LED 2 in the Collector circuit. What this demonstrates is that a smaller current in the Base circuit is causing a larger current to flow in the Collector circuit. We refer to this as AMPLIFICATION.

In an Audio Amplifier, a small current flowing from the microphone into the Base of a transistor will control the larger current that will come out of the Collector circuit which is what drives the speaker so everyone can hear.

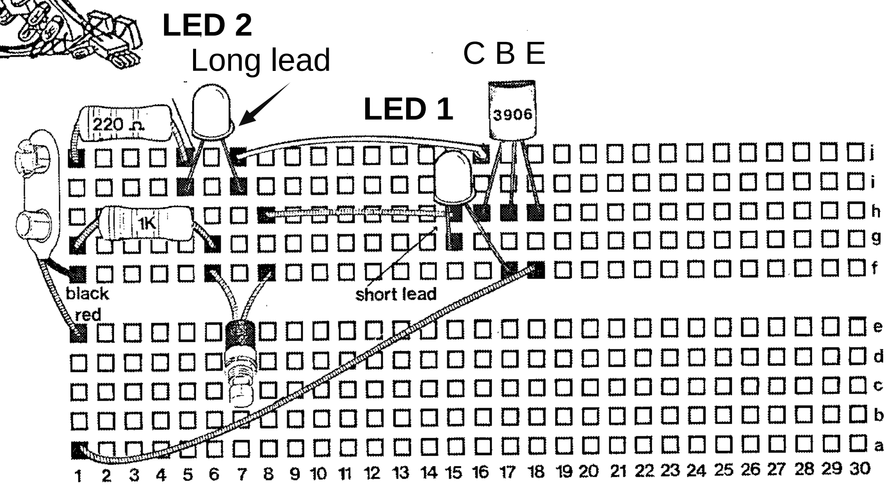
EXPERIMENT 9

PNP TRANSISTOR CHECKER

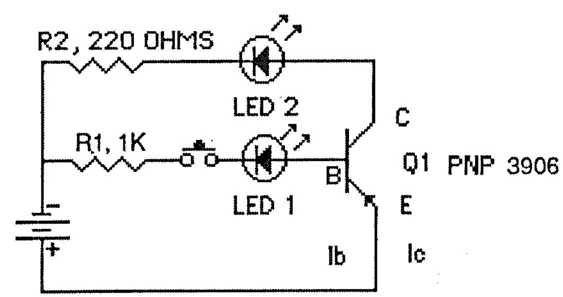
HOW A PNP TRANSISTOR WORKS



PICTORIAL DIAGRAM



SCHEMATIC DIAGRAM



Jumper Wire connections

1a to 18f
8h to 15h
7j - 16j

PURPOSE:

To observe how an PNP Bipolar Transistor works in a circuit as a current amplifier. This circuit will also serve as a Transistor Checker for PNP transistors.

Note: This experiment is similar to the experiment with the NPN transistor. The only difference is the direction of the current flow. In this experiment, the current enters the Collector and comes out of the Base and Emitter leads.

PROCEDURE:

Using the parts from your Mr Circuit Lab, build the circuit on your Solderless Circuit Board as shown in the pictorial diagram. Compare the pictorial to the Schematic Diagram. Does the pictorial follow the Schematic Diagram?

RESULTS:

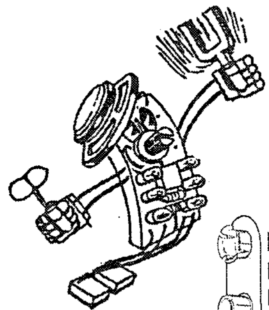
When you connect a 9-volt battery to the assembled circuit, the LEDs in the circuit should NOT light up. But, when you press the pushbutton switch, allowing current to flow in the Base circuit, current will also flow in the Collector circuit. So, what you will see is both LEDs will light up.

But you will notice that LED 1 in the Base circuit is a little less bright than LED 2 in the Collector circuit. What this demonstrates is that a smaller current in the Base circuit is causing a larger current to flow in the Collector circuit. We refer to this as AMPLIFICATION.

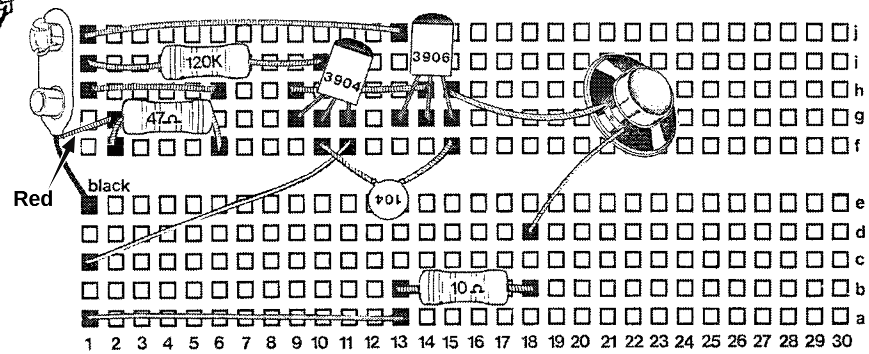
In an Audio Amplifier, a small current flowing from the microphone into the Base of a transistor will control the larger current that will come out of the Collector circuit which is what drives the speaker so everyone can hear.

EXPERIMENT 10

TWO-TRANSISTOR OSCILLATOR



PICTORIAL DIAGRAM

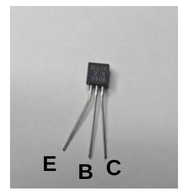


PURPOSE:

To learn about audio oscillators and then build and observe a two-transistor oscillator in action using NPN and PNP Bipolar transistors.

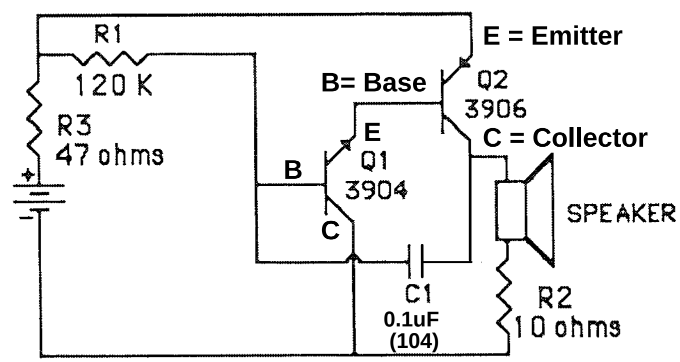
PROCEDURE:

Using the parts from your Mr Circuit Lab, build the circuit on your Solderless Circuit Board as shown in the pictorial diagram. Compare the pictorial to the Schematic Diagram. Does the pictorial follow the Schematic Diagram?



SCHEMATIC DIAGRAM

E = Emitter B = Base C = Collector



R1: 120 K (Brown, Red, Yellow, Gold)
R2: 10 ohms (Brown, Black, Black, Gold)
R3: 47 ohms (Yellow, Violet, Black, Gold)

RESULTS:

An audio oscillator is a device that generates a frequency in the audio range. An electronic oscillator does this by using electronic components like transistors, etc.

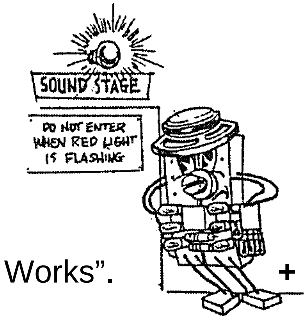
The frequency of an oscillator is how many times per second that a complete cycle of change occurs. A speaker is used to turn these oscillations into sound waves in the audio range. Audio oscillations are those that the ear can hear. The human ear can usually hear oscillations from as few as 10 cycles per second up to 16 thousand cycles per second.

This oscillator has two transistors that are connected together with resistors and capacitors that make the transistors turn on and off at a frequency that you can hear out of the speaker.

The frequency of this oscillator is controlled by the values of resistor R1 and capacitor C1. By Increasing the value of either one or both, you will lower the frequency of the oscillator and vice versa.

EXPERIMENT 11

BLINKING LIGHT - 555 TIMER IC



PURPOSE:

This experiment will demonstrate “How a 555 Timer IC Works”.

PROCEDURE

Using the parts from your Mr Circuit Lab, build the circuit on your Solderless Circuit Board as shown in the pictorial diagram. Compare the pictorial to the Schematic Diagram. Does the pictorial follow the Schematic Diagram?

RESULTS:

The 555 timer was invented by engineers who needed circuits that would generate many different pulse rates and duty cycles.

A 555 timer is called an Integrated Circuit because it has many different circuits inside of it.

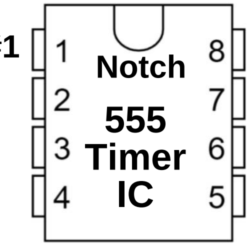
To use a 555, an engineer has to see the Spec Sheet to see what electronic components are needed to be connected to the 555 timer IC leads to make it output a variety of timing pulses.

A 555 timer has 8 pins. They are numbered 1 through 8. There is a mark or indentation on the top of the 555 which helps you find Pin #1. If you hold the 555 timer looking from the top with the mark to your left, Pin #1 is the pin on the lower left. You count pins in a counter-clockwise direction.

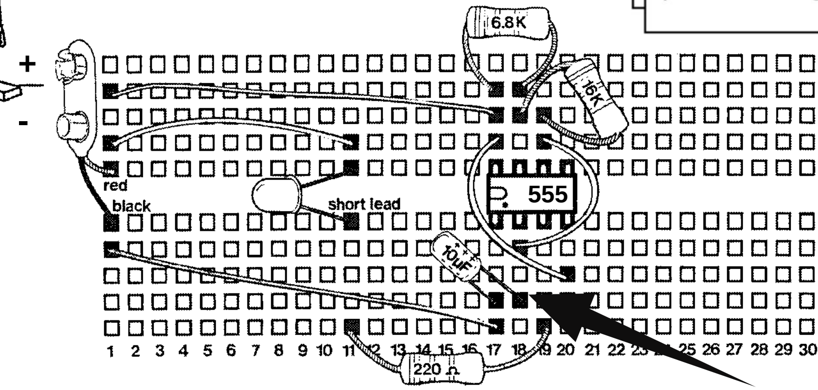
Our LED blinking circuit has five components connected to the pins of the 555. There are 3 resistors, a capacitor, and an LED. The values of these components determine the pulse rate of the LED. Our circuit is designed to give us a pulse rate out of Pin 3 of about 1 per second with the 10uF capacitor as shown.

If we increase the value of the capacitor to 100uF from 10uF, the pulse rate will slow down considerably. If you want to know the exact calculations, you have to refer to the Spec Sheet for the 555 timer.

Pin #1

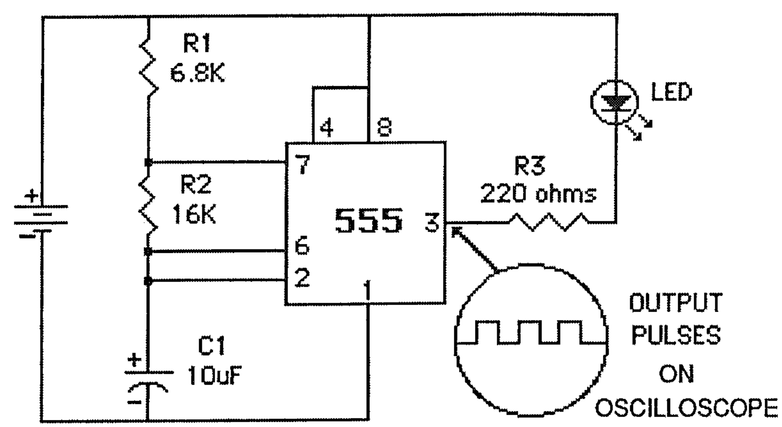


PICTORIAL DIAGRAM



Long Lead of capacitor

SCHEMATIC DIAGRAM



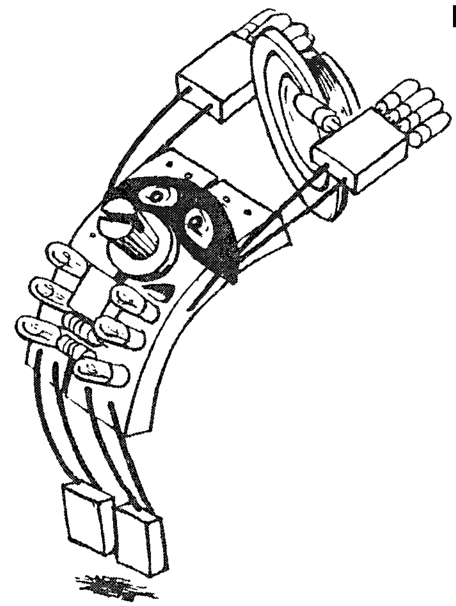
R1: 6.8K (Blue, Gray, Red, Gold)
R2: 16K (Brown, Blue, Orange, gold)
R3: 220 ohms (Red, Red, Brown, Gold)

EXPERIMENT PROJECT 12

DESCRIPTION

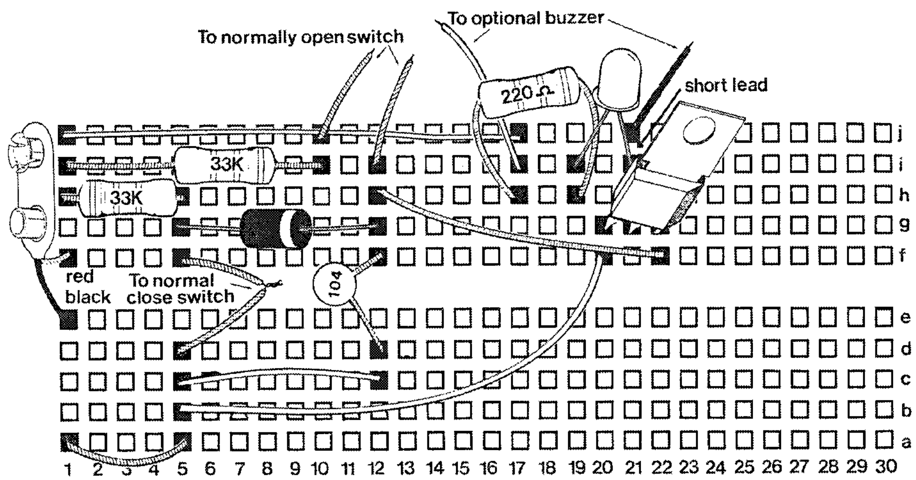
This burglar alarm is designed to be used with normally open (S1) or normally closed (S2) switches. If, after the alarm is armed (connecting the battery), the normally closed switch (S2) is opened, or the normally open switch (S1) is closed, a positive voltage will be applied to the gate of the SCR causing it to conduct. The LED will turn on and the 9-volt buzzer or siren connected to points 1 and 2 will be activated. The only way to stop it is by disconnecting the battery from the circuit.

Before connecting the battery, be sure that the two wires labeled S2 are connected together and the two labeled S1 are not touching one another.

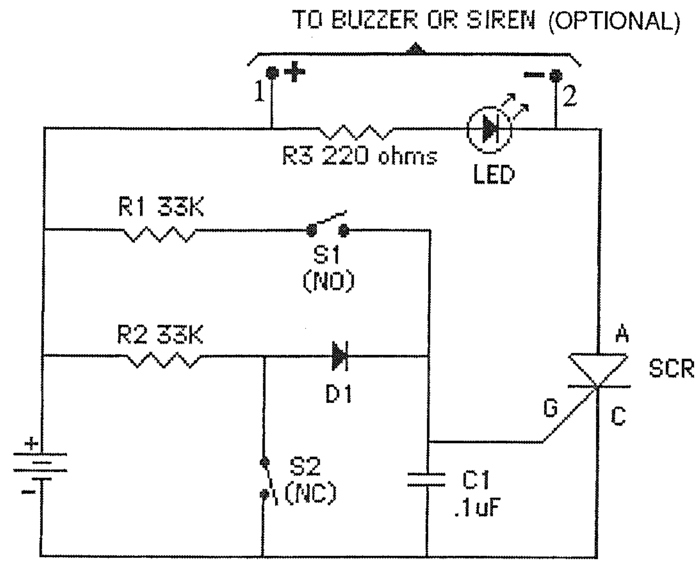


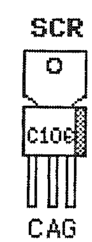
BURGLAR ALARM

PICTORIAL DIAGRAM



SCHEMATIC DIAGRAM





R1 : 33K (Orange, Orange, Orange, Gold)
R2 : 33K (Orange, Orange, Orange, Gold)
R3 : 220 ohms (Red, Red, Brown, Gold)

EXPERIMENT PROJECT 13

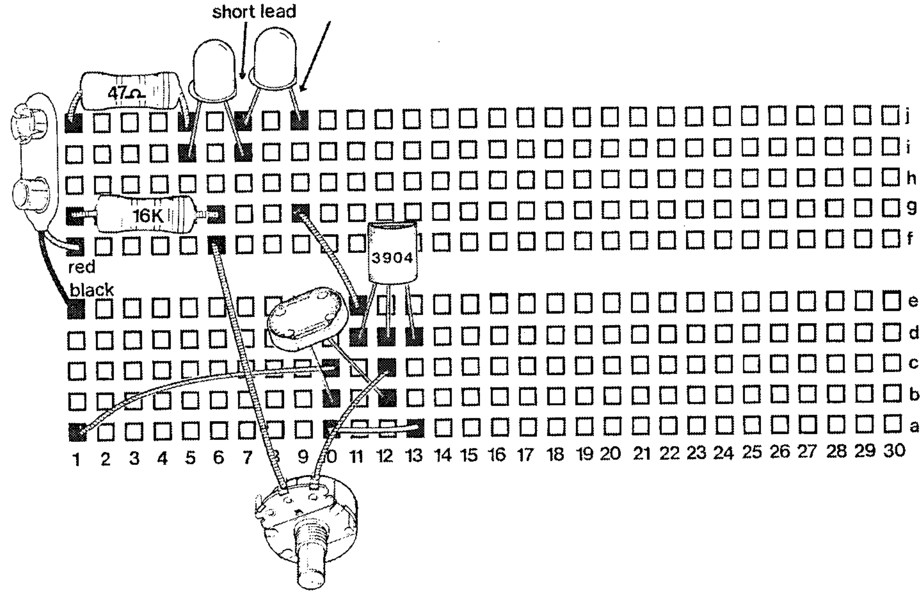
DESCRIPTION

In the Automatic Night Light circuit, the two LED's turn on at night and go off during the day. The brightness of the two LED's is inversely proportional to the intensity of the light received by the photocell. The more light received by the photocell, the less the brightness of the LED's and viceversa. With potentiometer R3 you can adjust the sensitivity of the device in order to keep the LED's off under any level of light and then automatically turn on when the light disappears.

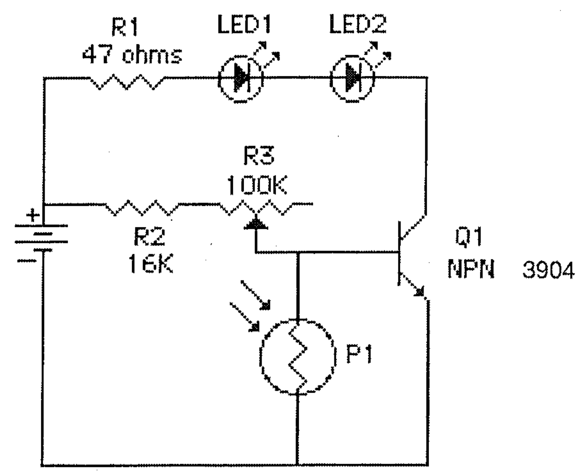
In order to test this device, first connect the battery and then adjust R3 until the LED's go off. Then shadow, with your hand, the face of the photocell and the LED should illuminate.

AUTOMATIC NIGHT LIGHT

PICTORIAL DIAGRAM



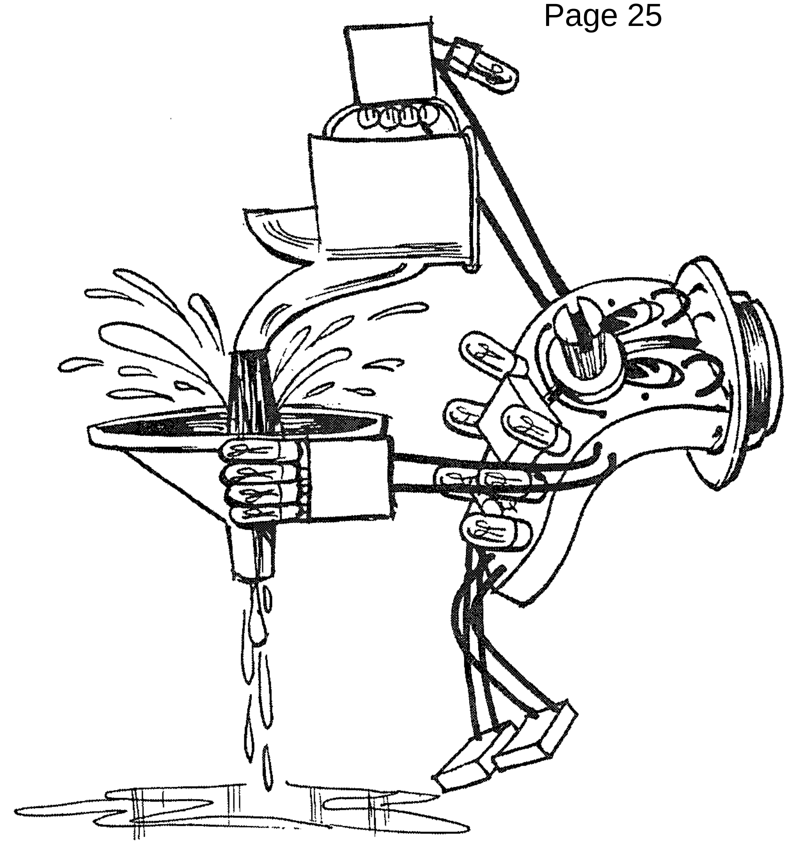
SCHEMATIC DIAGRAM



R1 : 47 ohms (Yellow, Violet, Black, Gold)
R2 : 16K (Brown, Blue, Orange, Gold)
R3 : 100K Potentiometer
P1 : Photocell

Mr Circuit Basic Electronics Lab 1

EXPERIMENT PROJECT 14



DESCRIPTION

In this experiment, you will construct a useful DC to DC adjustable power supply, which, when connected to a 9-volt battery, provides an adjustable output voltage between 0 and 9 volts.

This device is able to supply an output current of up to 50 mA, and, therefore, it is ideal to supply DC to a host of electronic projects from portable radios to burglar alarms.

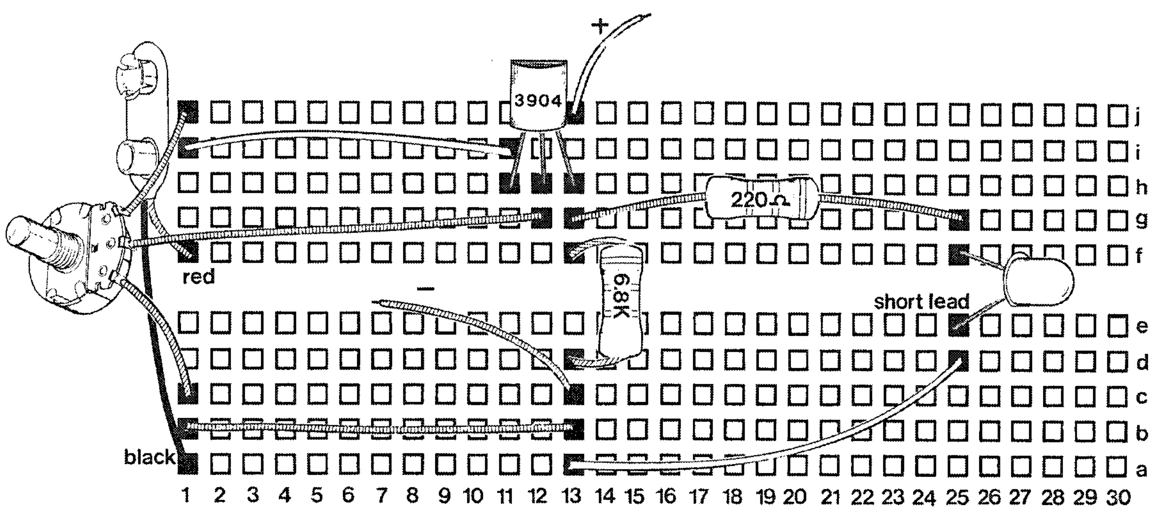
In order to use this power supply, connect a fresh 9-volt battery to the battery snap, then, using a voltmeter (multimeter), adjust potentiometer P1 until you get the desired output voltage.

In the circuit of the DC to DC Power Supply, transistor Q1 works as an adjustable resistor which changes its internal resistance, between collector and emitter, according to the voltage applied to its base, by potentiometer R3. When the internal resistance of Q1 is close to 0 ohms, the output voltage of the power supply will be 9 volts. On the other hand, when the internal resistance of Q1 is very high (Q1 not conducting) the output voltage will be 0 volts.

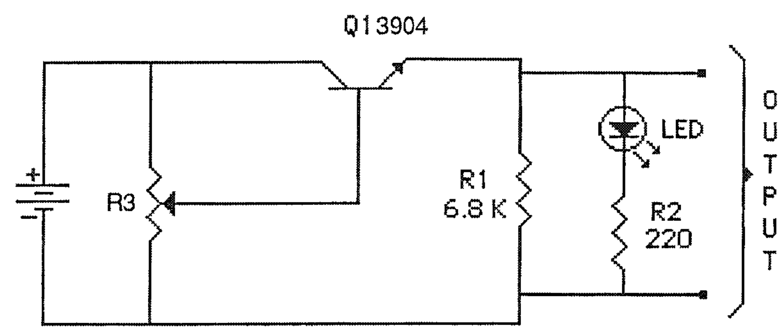
An LED in series with a 220 ohm resistor (R2) was connected to the output of the Power Supply. The brightness of this LED is proportional to the output voltage. The maximum brightness corresponds to 9 Volts.

DC TO DC POWER SUPPLY

PICTORIAL DIAGRAM



SCHEMATIC DIAGRAM



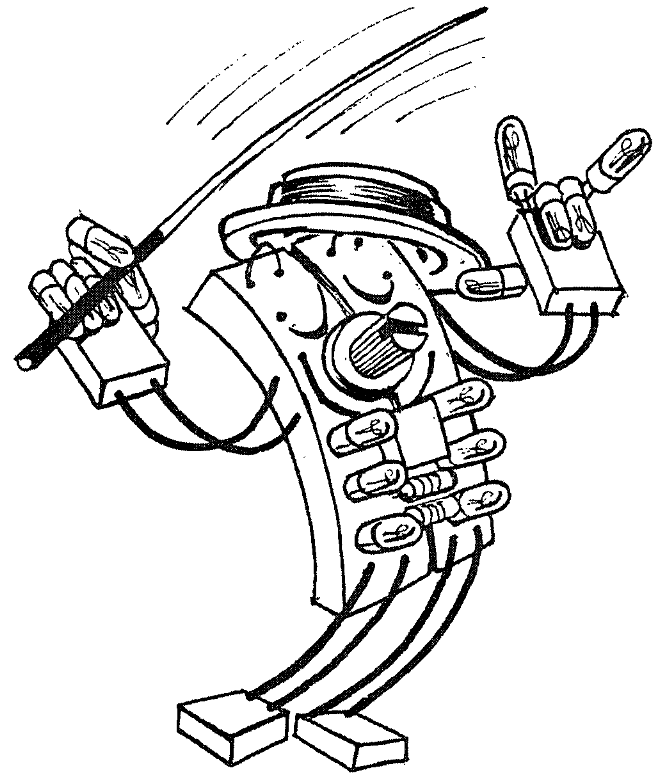
R1: 6.8 K (Blue, Gray, Red, Gold).
R2: 220 ohm (Red, Red, Brown, Gold).
R3: 100K Potentiometer.
Q1: 2N3904 (NPN)

EXPERIMENT PROJECT 15

DESCRIPTION

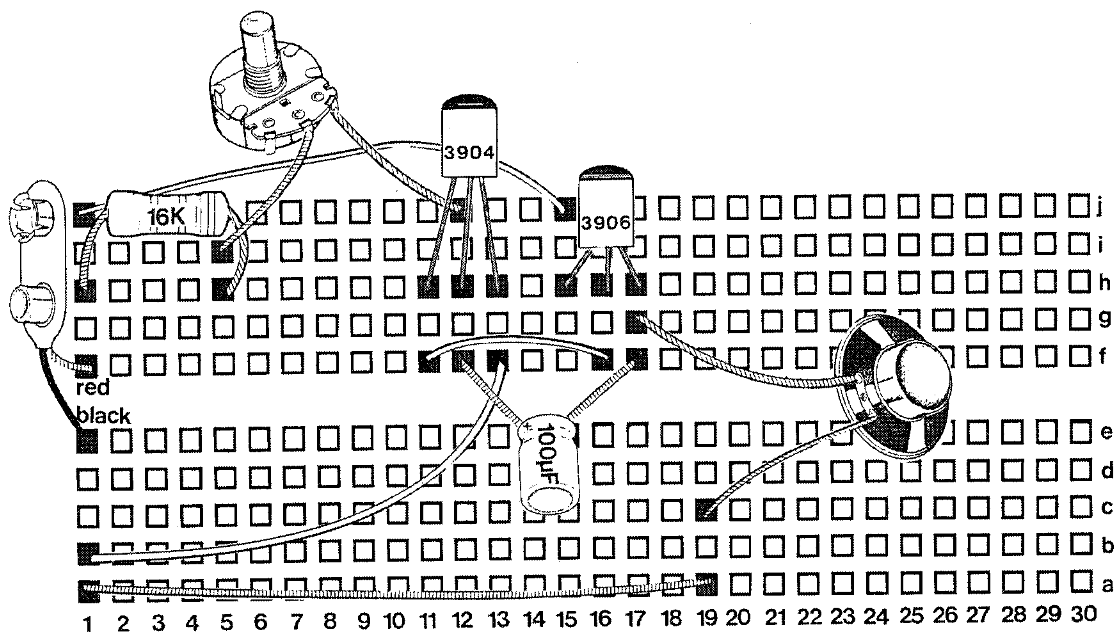
A metronome is a device used to aid in setting and keeping the tempo of music. Traditional metronomes are mechanical and employ a swinging arm that causes a clicking sound at the end of each swing. On those metronomes you adjust the tempo by adjusting the speed of the oscillating arm.
In this project you build an electronic metronome which allows you to adjust the tempo by rotating the control (potentiometer R2).

The circuit of the metronome is made of a low frequency two-transistor oscillator, similar to the one explained in Experiment 10. The frequency of this oscillator is controlled by potentiometer R2 and by adjusting it, you speed up or slow down the tempo.

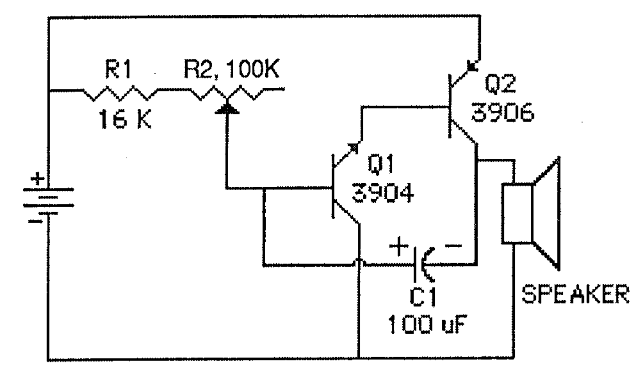


ELECTRONIC METRONOME

PICTORIAL DIAGRAM



SCHEMATIC DIAGRAM



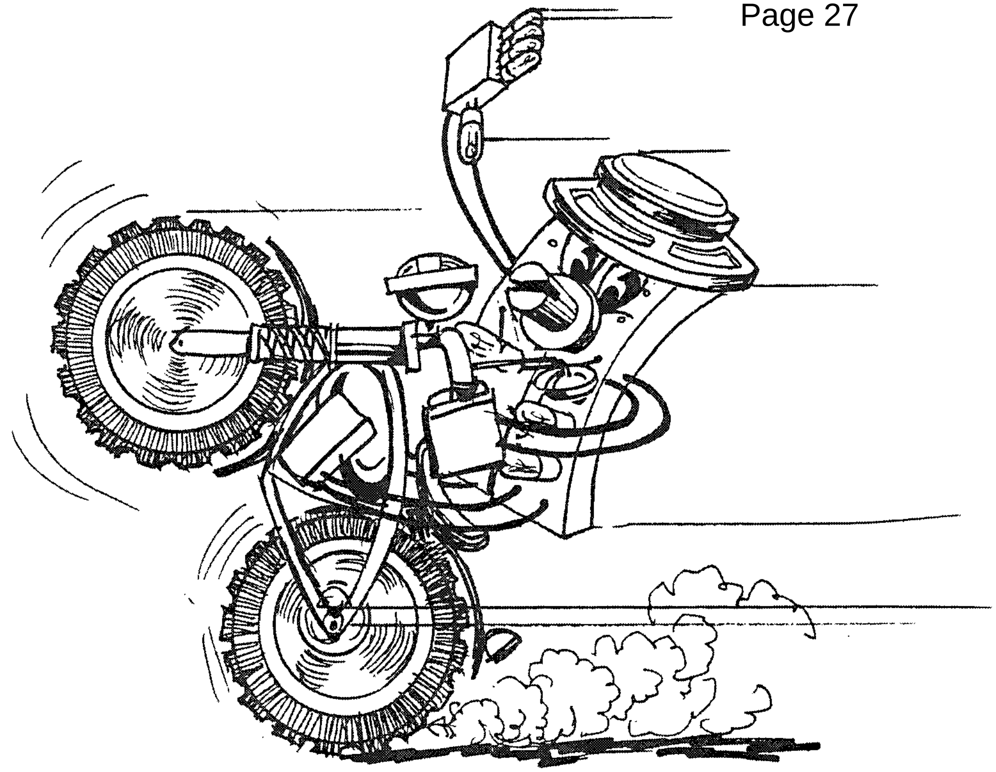
R1: 16K (Brown, Blue, Orange, Gold).
R2: 100K (Potentiometer).

EXPERIMENT PROJECT 16

DESCRIPTION

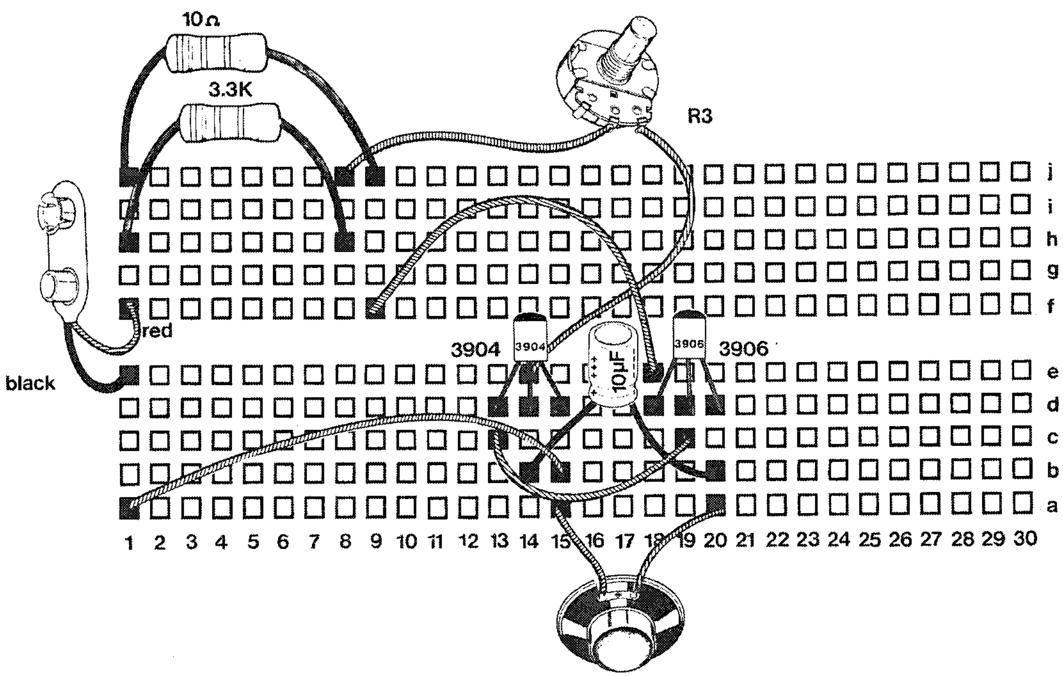
With this project you can generate the sound of a motorcycle starting and speeding up.
You can accelerate or slow down your electronic motorcycle by rotating potentiometer R3.
To operate this project, just plug the battery in the battery snap and then rotate R3.

The circuit of the electronic motorcycle consists of a low frequency two-transistor oscillator similar to the one explained in Experiment 10.
The frequency of this oscillator (speed of the motorcycle) is controlled by potentiometer R3- by adjusting it you accelerate or slow down the motorcycle.

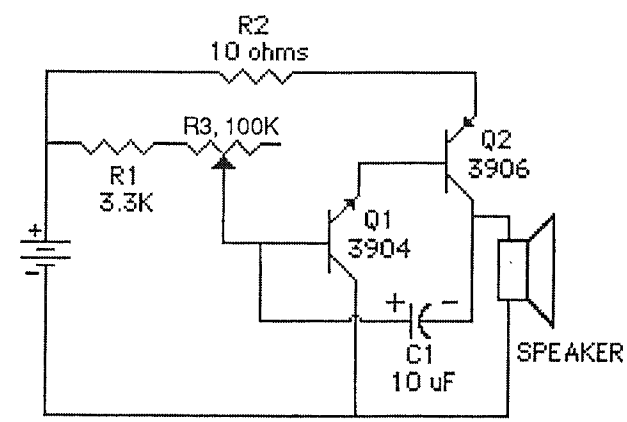


ELECTRONIC MOTORCYCLE

PICTORIAL DIAGRAM



SCHEMATIC DIAGRAM



R1: 3.3 K (Orange, Orange, Red, Gold).
R2: 10 ohms (Brown, Black, Black, Gold).
R3: 100K Potentiometer.

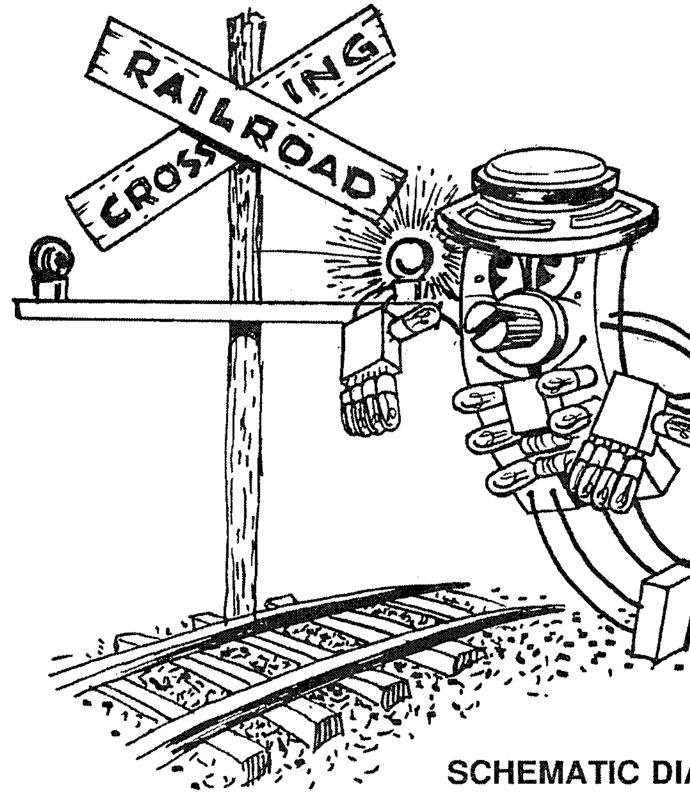
Mr Circuit Basic Electronics Lab 1

EXPERIMENT PROJECT 17

DESCRIPTION

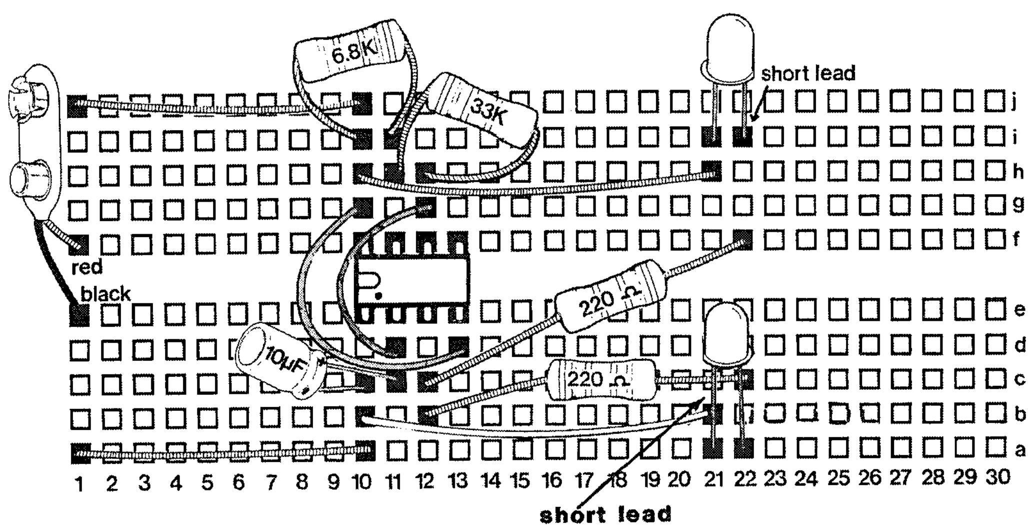
The Railroad Lights project alternately flashes a pair of LED's at a rate of about two blinks per second, producing the same effect as railroad signals.
To operate this device, just connect the battery to the battery snap.

The circuit of the Railroad Lights is basically made of a 555 timer working as a clock, similar to the one explained in Experiment 11. Two LED's, in opposite polarity, are connected to the output of the clock (pin 3) through two 220 ohms resistors. When pin 3 is positive, LED 2 will be forward biased (anode positive, cathode negative) and LED 1 reverse biased, and, therefore, LED 2 will light and LED 1 will remain off. The opposite situation occurs when pin 3 is negative.

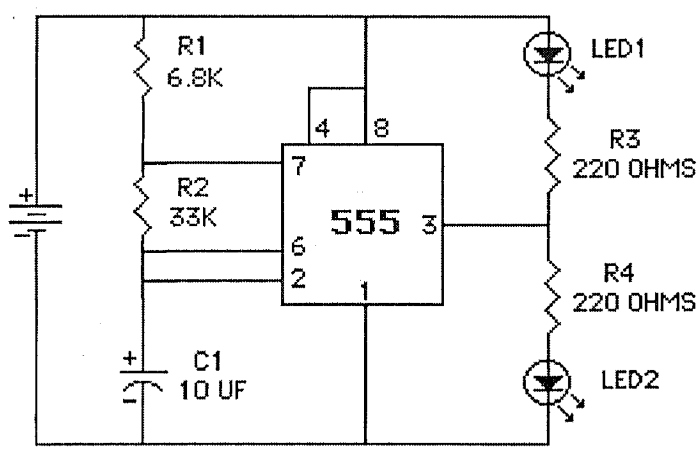


RAILROAD LIGHTS

PICTORIAL DIAGRAM



SCHEMATIC DIAGRAM



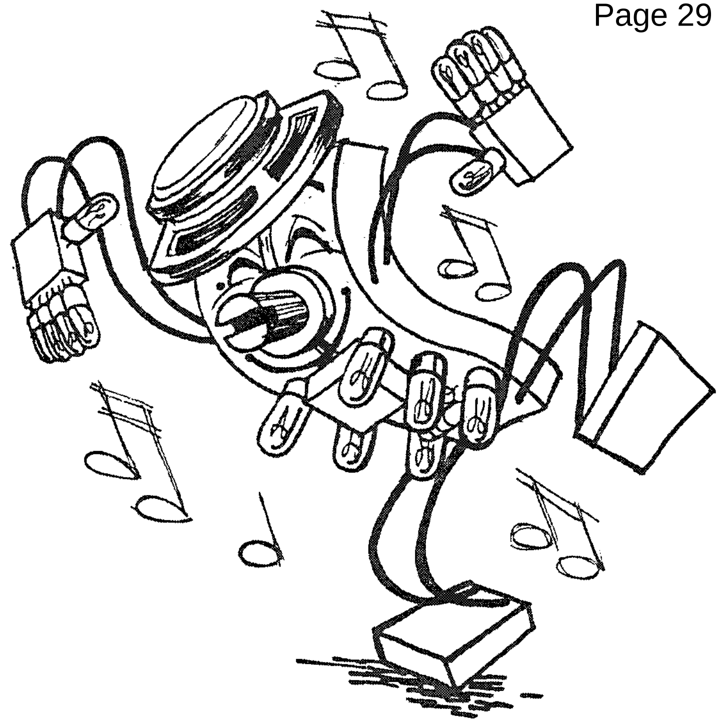
R1: 6.8K (Blue, Gray, Red, Gold).
R2: 33K (Orange, Orange, Orange, Gold).
R3, R4: 220 ohms (Red, Red, Brown, Gold).

Mr Circuit Basic Electronics Lab 1

EXPERIMENT PROJECT 18

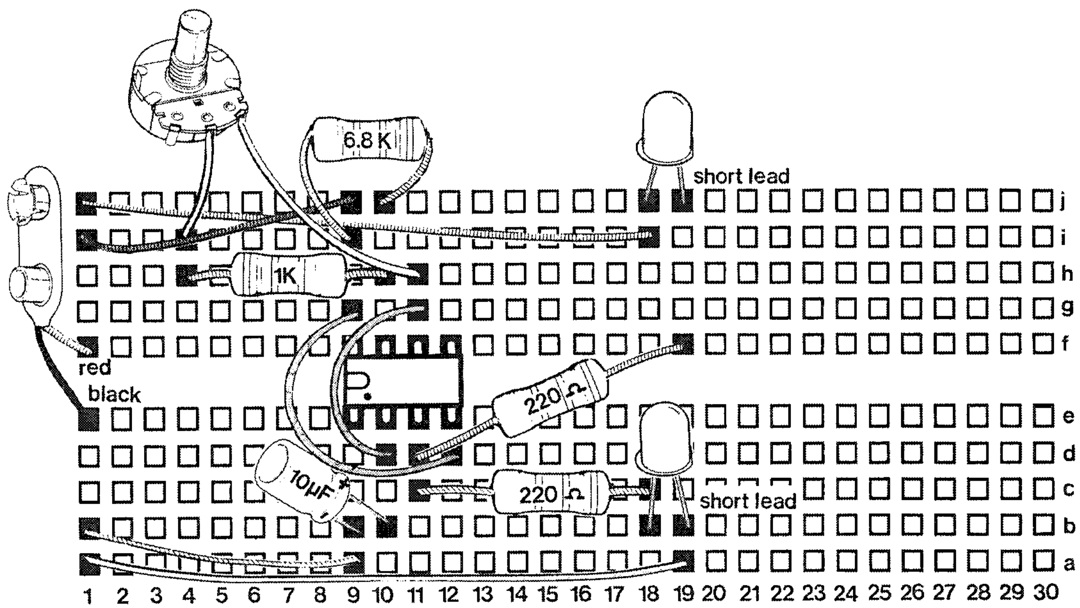
DESCRIPTION

The Variable Speed Lights alternately flashes a pair of LED's at a rate that can be adjusted through a potentiometer, producing an interesting light display.
To operate this project, just connect the battery to the battery snap and adjust the speed of the flashing lights by rotating potentiometer R5.
The circuit of the Variable Speed Lights Project is basically made of a 555 timer operating as a clock, similar to the one explained in Experiment 11. The frequency of the pulses produced by the clock may be adjusted by potentiometer R5. Two LED's in opposite polarity, which alternately illuminate, are connected to the output of the clock, as explained in experiment 17.

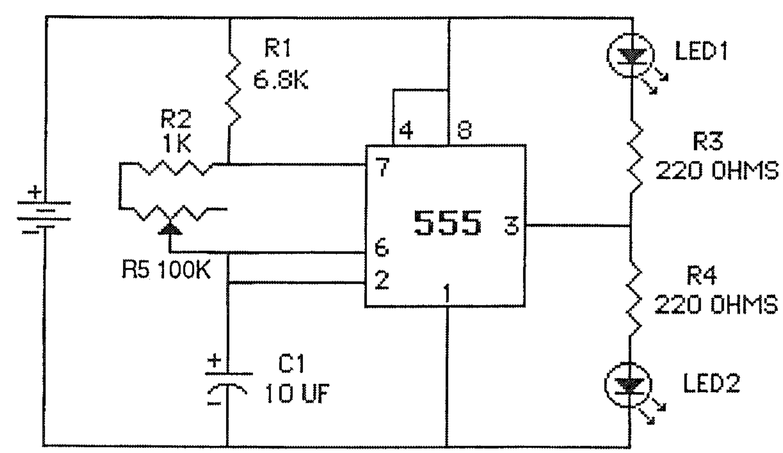


VARIABLE SPEED LIGHTS

PICTORIAL DIAGRAM



SCHEMATIC DIAGRAM



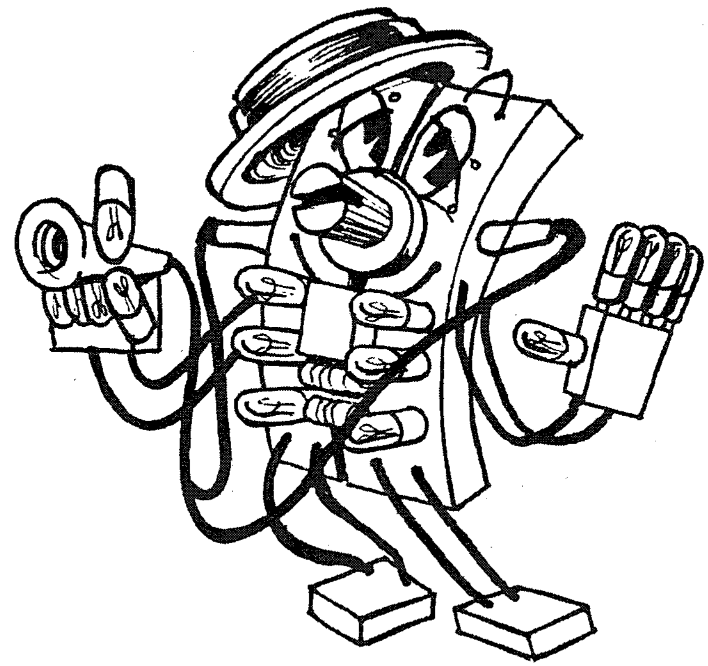
R1: 6.8K (Blue, Gray, Red, Gold).
R2: 1K (Brown, Black, Red, gold).
R3, R4: 220 ohms (Red, Red, Brown, Gold).
R5: 100K Potentiometer.

EXPERIMENT PROJECT 19

DESCRIPTION

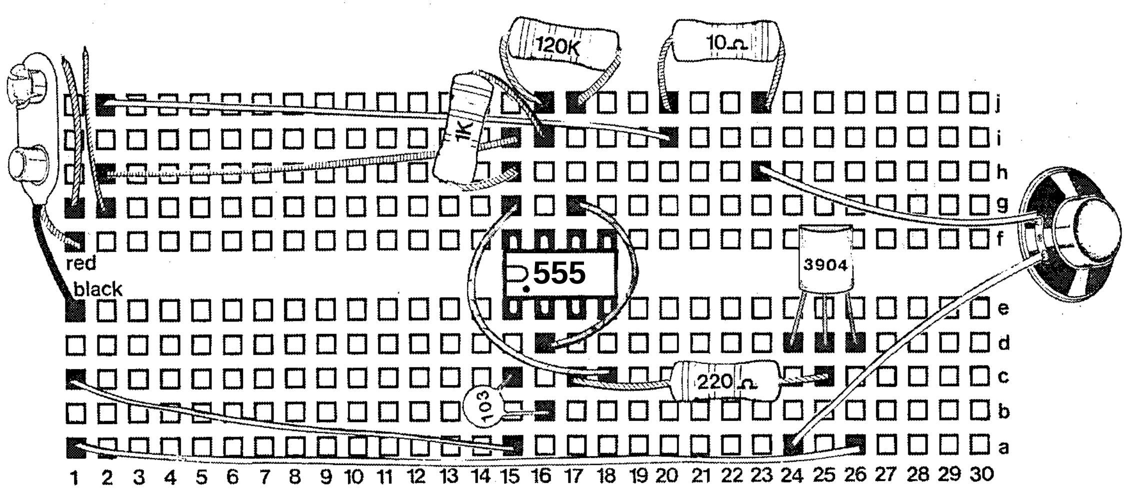
The audible Continuity Tester provides a convenient way to check for open circuits, broken wires, bad connections or to test light bulbs or fuses.
To operate it, just connect the battery to the battery snap and touch the two probes (wires) of the device to the two leads of the circuit under test (fuse, lamp, wire ,etc). If there is electrical continuity in the tested circuit, the Continuity Tester will emit a loud sound . If the circuit is open, no sound will be emitted.

The circuit of the Continuity Tester is basically made of a 555 timer working as a clock, similar to the one explained in Experiment 11. When there is electrical continuity between the two probes, the 555 generates an audio signal which is amplified by transistor Q1 and then reproduced by the speaker.

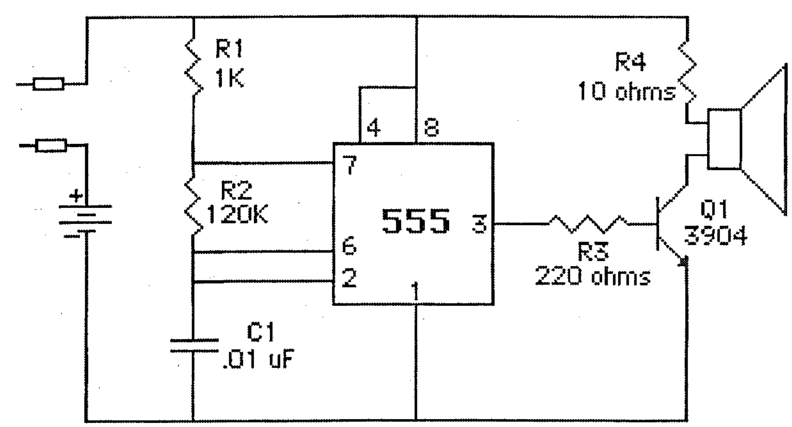


CONTINUITY TESTER

PICTORIAL DIAGRAM

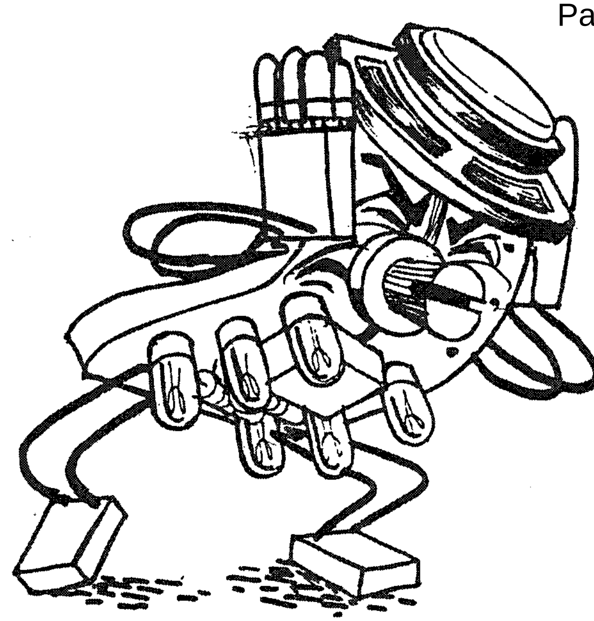


SCHEMATIC DIAGRAM



R1 : 1K (Brown, Black, Red, Gold)
R2 : 120K (Brown, Red, Yellow, Gold).
R3 : 220 ohms (Red, Red, Brown, Gold).
R4 : 10 ohms (Brown, Black, Black, Red)

EXPERIMENT PROJECT 20



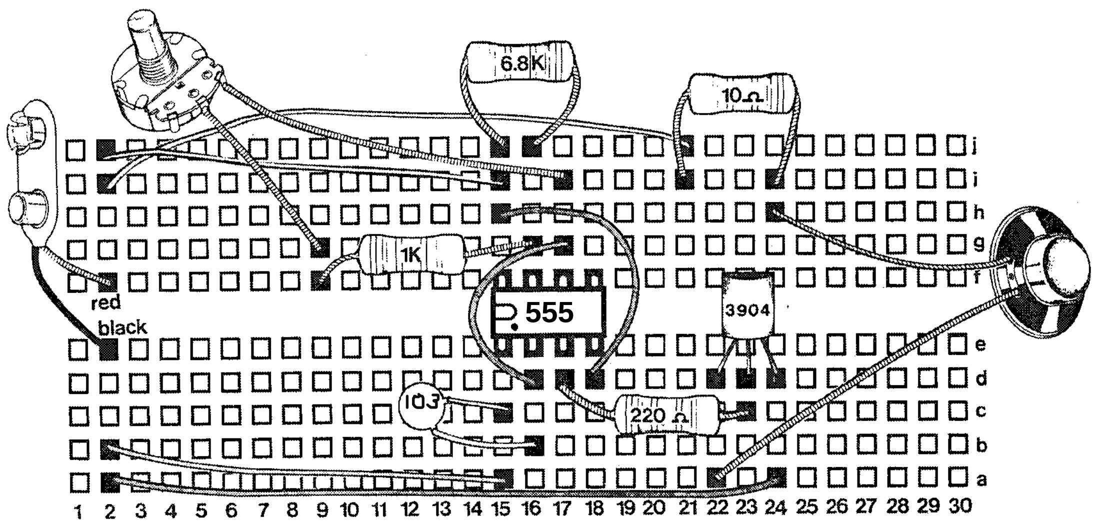
DESCRIPTION

As its name says, this project generates an audio signal (an electrical signal that is able to be heard through a speaker) of adjustable pitch (tone).
To operate this circuit, just connect the battery to the battery snap and then rotate potentiometer R5 to vary the pitch of the audio signal.

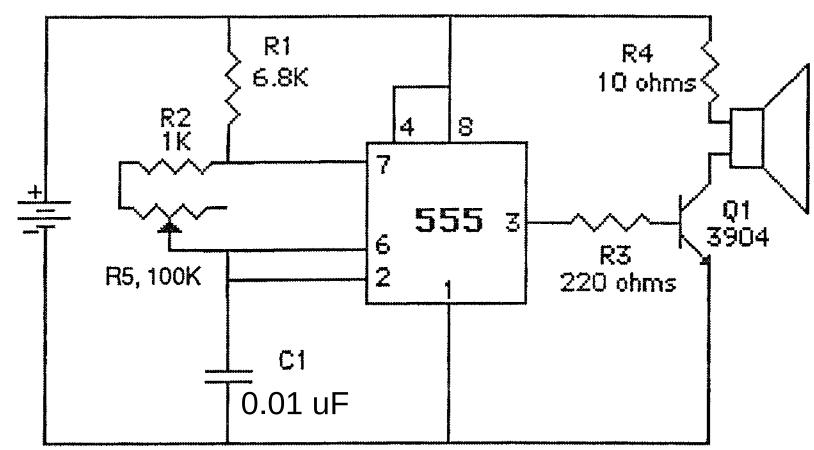
The circuit of the Audio Generator is basically made of a 555 timer working as a clock, similar to the one explained in Experiment 11. Potentiometer R5 controls the frequency of the audio signal generated by the clock. Transistor Q1 amplifies the audio signal which is then reproduced by the speaker.

AUDIO GENERATOR

PICTORIAL DIAGRAM



SCHEMATIC DIAGRAM



R1: 6.8K (Blue, Gray, Red, Gold).
R2: 1K (Brown, Black, Red, Gold).
R3: 220 ohms (Red, Red, Brown, Gold).
R4: 10 ohms (Brown, Black, Black, Gold).
R5: 100K Potentiometer.

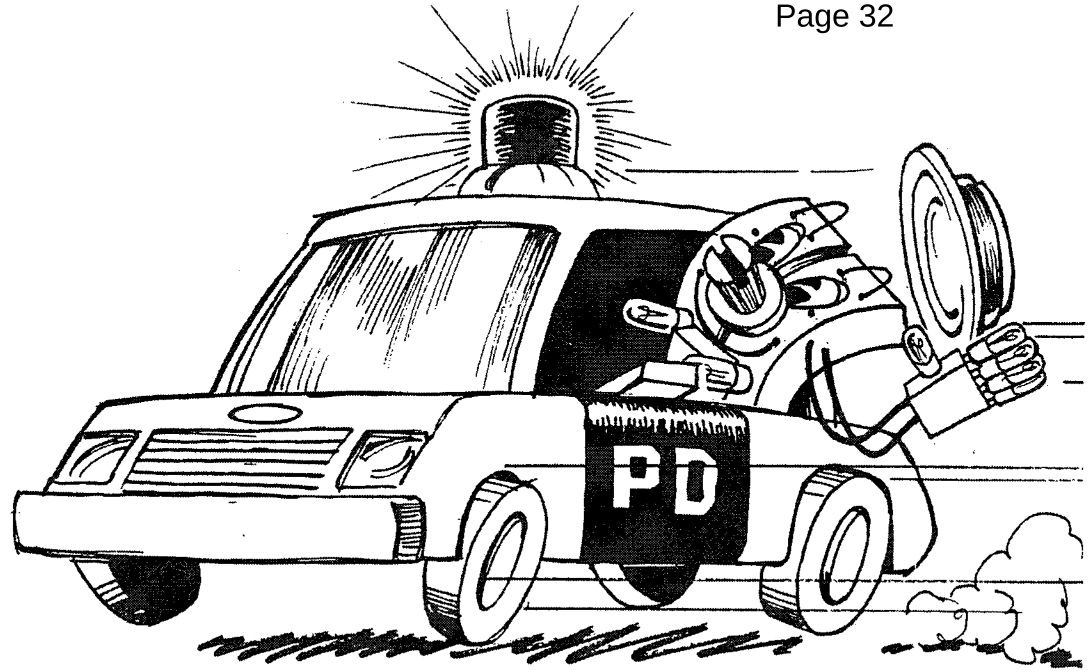
EXPERIMENT PROJECT 21

DESCRIPTION

Here it is!. This exciting little project will give you and your friends lots of fun. It produces a siren sound of rising and falling pitch.

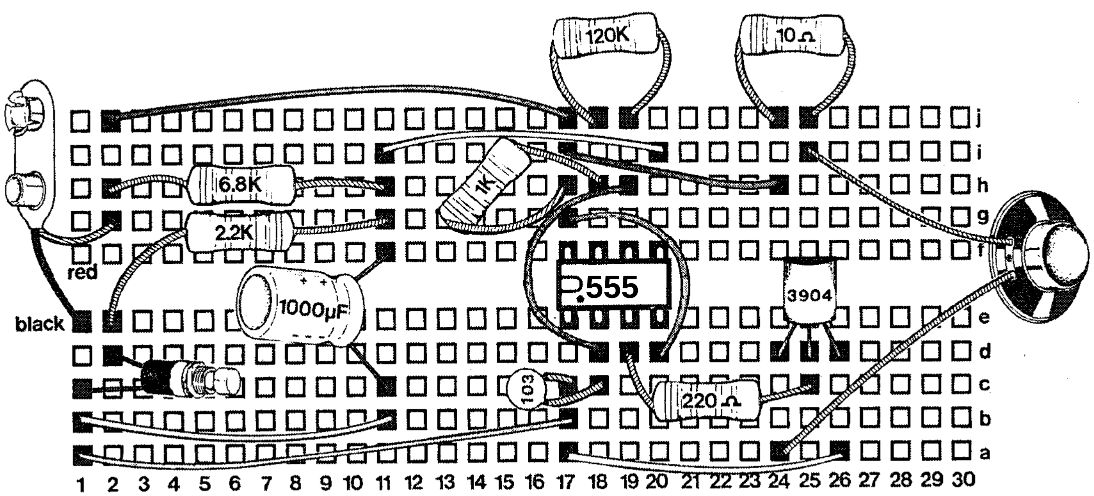
To operate it, just connect the battery to the battery snap. Press the pushbutton S1 to produce a steadily rising tone from the speaker. Release the pushbutton and the tone descends in pitch. Thus you control the overall rising and falling pitch of the siren with the closing and opening of pushbutton S1.

The circuit of the Electronic Police Siren is basically made of a 555 timer working as a clock, similar to the one explained in Experiment 11. It has an audio amplifier section consisting of transistor Q1 and the speaker. The frequency of the 555 clock is controlled by the voltage applied on pin 5 which is generated by the charge and discharge of capacitor C2. C2 discharges when the pushbutton is pressed and charges when it is open, producing the rising and falling of the pitch of the siren.

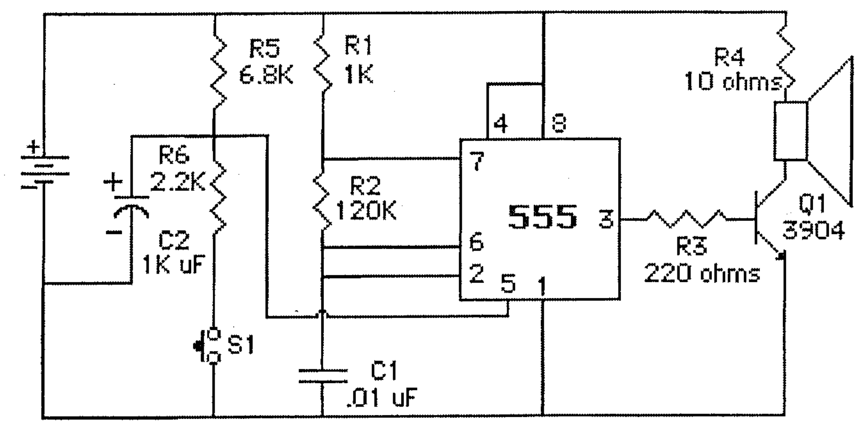


ELECTRONIC POLICE SIREN

PICTORIAL DIAGRAM



SCHEMATIC DIAGRAM



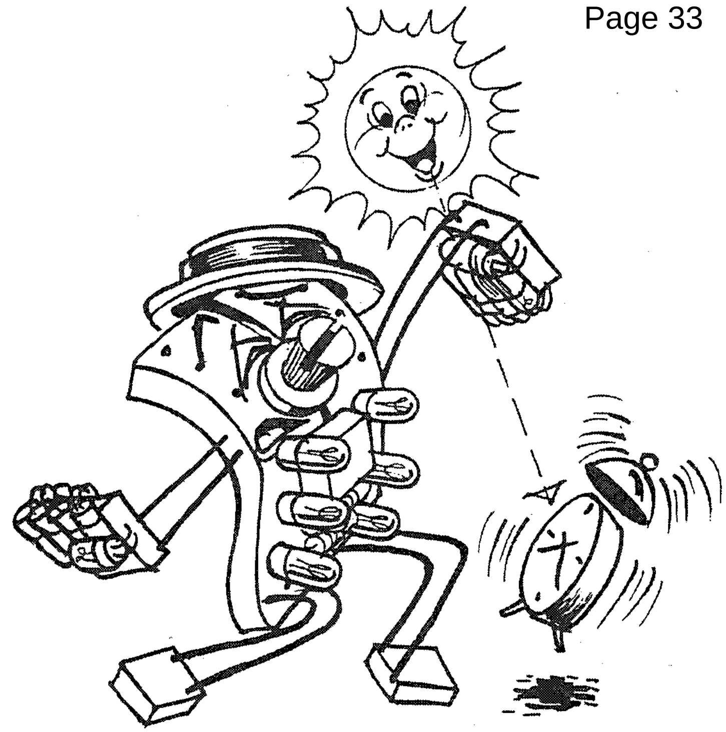
R1 : 1K (Brown, Black, Red, Gold)
R2 : 120K (Brown, Red, Yellow, Gold).
R3 : 220 ohms (Red, Red, Brown, Gold).
R4 : 10 ohms (Brown, Black, Black, Red)
R5 : 6.8K (Blue, Gray, Red, Gold)
R6 : 2.2K (Red, Red, Red, Gold)

Mr Circuit Basic Electronics Lab 1

EXPERIMENT PROJECT 22

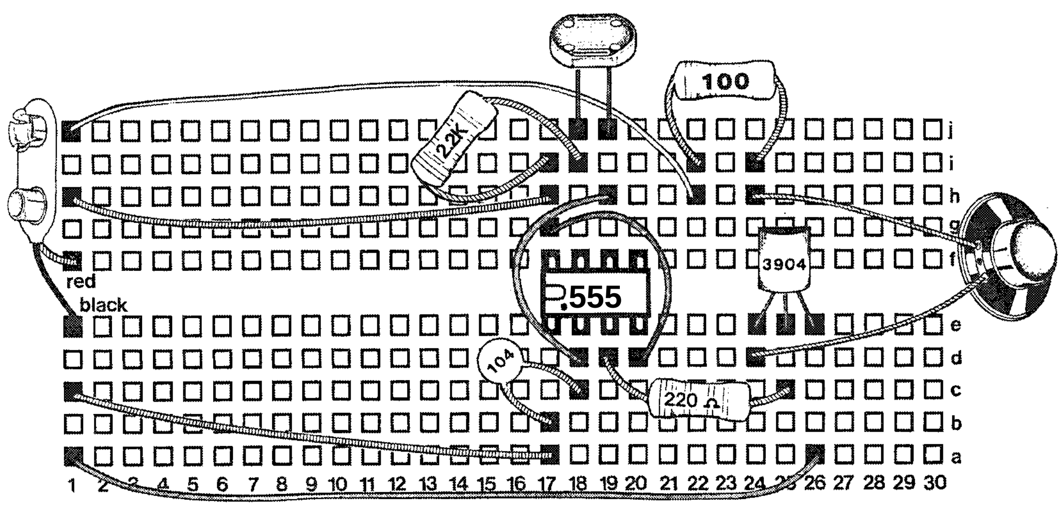
DESCRIPTION

This little amazing device will give you lots of fun in your office, school or camp. The Wake-up Alarm generates a loud sound **only** when light hits its photocell. In the darkness it remains silent. Therefore, you can use it to wake you up or to scare your friends by hiding it in a drawer (drawer closed, no sound; drawer open, sound).
The pitch of the sound also depends on the intensity of the light hitting the photocell. Therefore, you can produce interesting sound effects by shadowing with your hand the surface of the photocell.
To operate the Wake-Up Alarm, just connect the battery to the battery snap.
The circuit of this device consists of a 555 timer working as a clock, similar to the one explained in Experiment 11. It generates an audio signal having a frequency which is dependent upon the intensity of the light on the photocell. The audio signal generated by the 555 is amplified by transistor Q1 and then reproduced by the speaker.

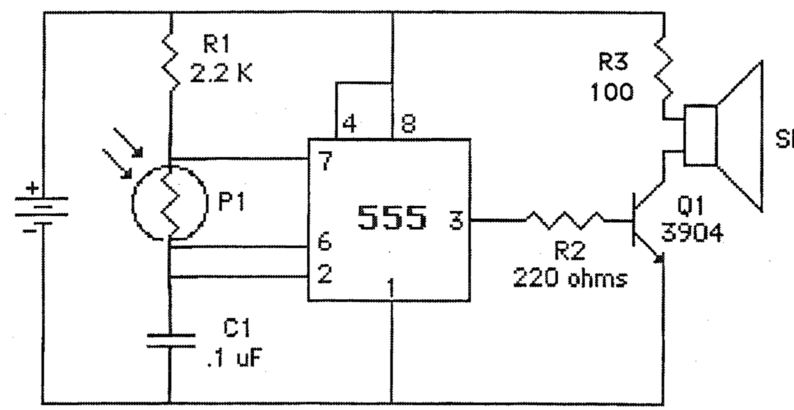


WAKE-UP ALARM

PICTORIAL DIAGRAM



SCHEMATIC DIAGRAM



R1 : 2.2K (Red, Red, Red, Gold).
R2 : 220 ohms (Red, Red, Brown, Gold).
R3 : 100 ohms (Brown, Black, Brown, Gold).
P1 : Photocell.
SP : Speaker.

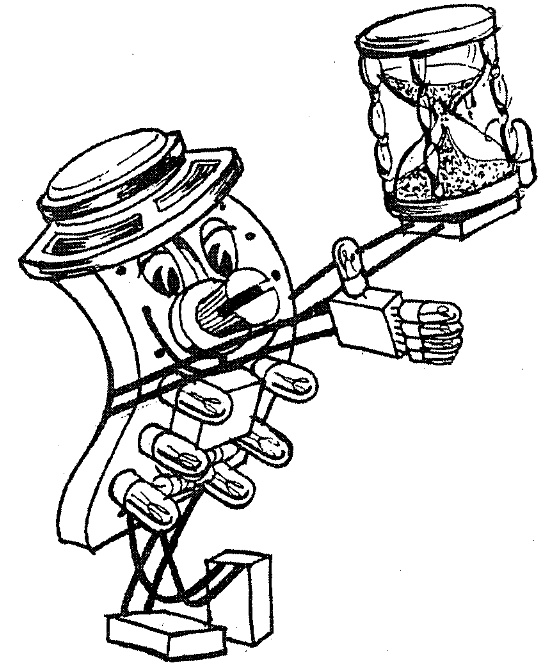
EXPERIMENT PROJECT 23

DESCRIPTION

A timer, as the term is used in digital electronics, is an electronic circuit that once triggered, produces an output pulse for a predetermined period and then shuts down. A simple timer, for example, would involve momentarily pressing a button to turn on a light for a minute or so. After that time interval, the light is extinguished and the circuit is ready to be reactivated by a new press of the button. This is exactly what the Variable Timer does. With potentiometer R4 you can adjust the interval the LED remains ON.

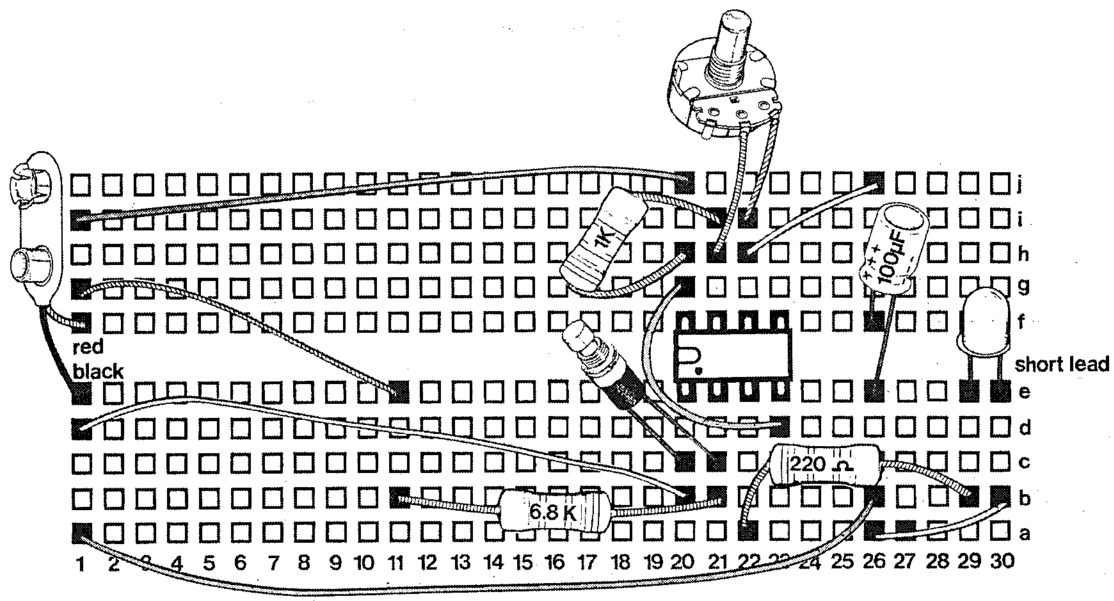
To operate this project just connect the battery to the battery snap , adjust R4 to its middle position and press pushbutton S1 and observe the LED. Then, observe what happens when you readjust R4.

The circuit of the Variable Timer is made by a 555 working as a timer. The trigger of the timer occurs when a negative voltage is applied to pin 2 of the 555 and the period of time the timer is ON depends upon the values of R2, R4 and C1. To get longer periods of time, replace C1 with a 1000 uF capacitor.

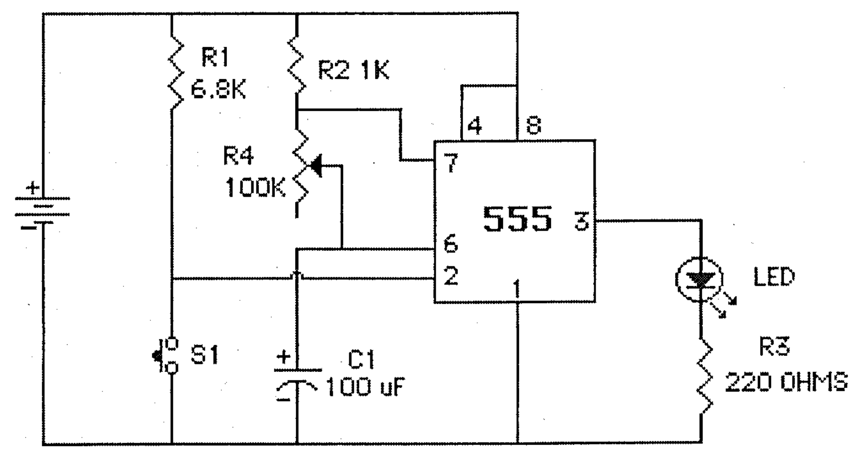


VARIABLE TIMER

PICTORIAL DIAGRAM



SCHEMATIC DIAGRAM



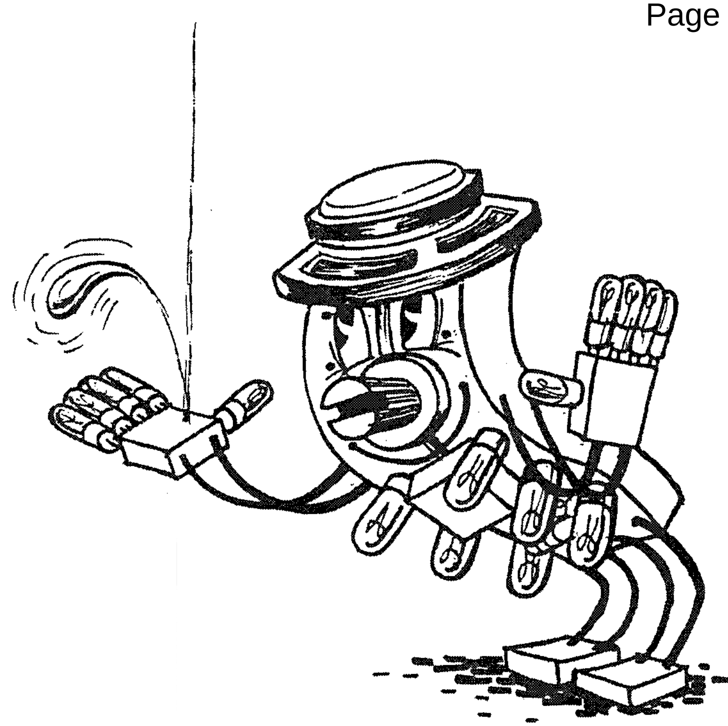
R1 : 6.8K (Blue, Gray, Red, Gold).
R2 : 1K (Brown, Black, Red, Gold).
R3 : 220 ohms (Red, Red, Brown, Gold).
R4 : 100 K Potentiometer.

EXPERIMENT PROJECT 24

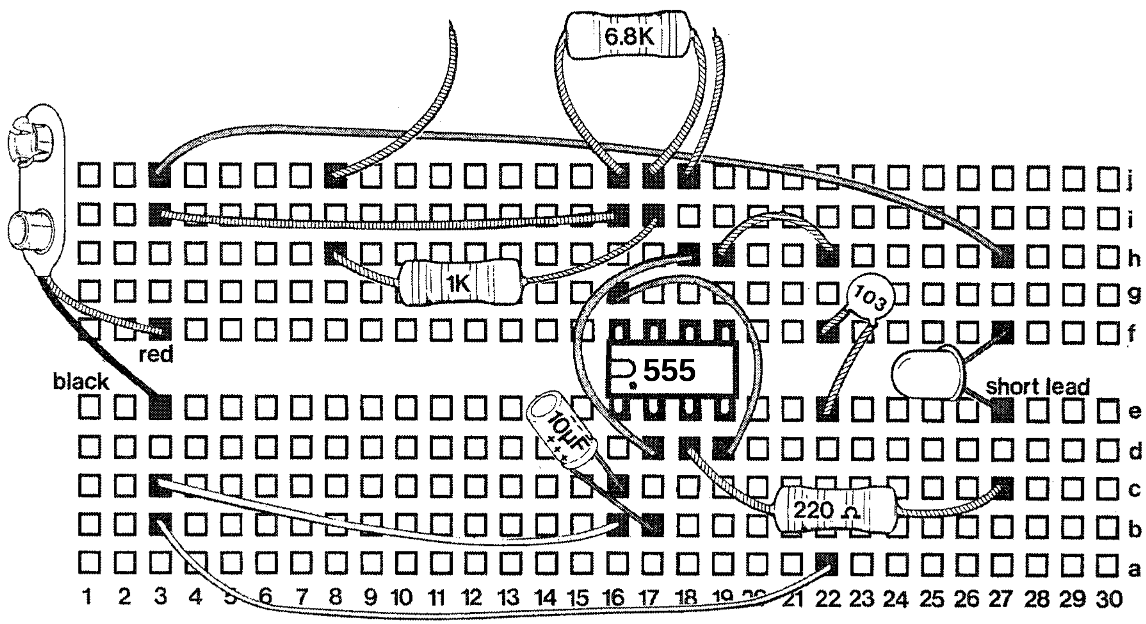
DESCRIPTION

The moisture detector is a practical device that can be used to test the moisture in the earth around a plant, to be sure that it has the necessary water.
To operate it just connect the battery to the battery snap and then inject the probes (wires) into the earth around the plant. As you do that, the LED should start to blink at a rate proportional to the humidity of the soil. The more moisture, the faster the blinking, and vice-versa. If there is no moisture at all, the LED will not blink, remaining ON or OFF.

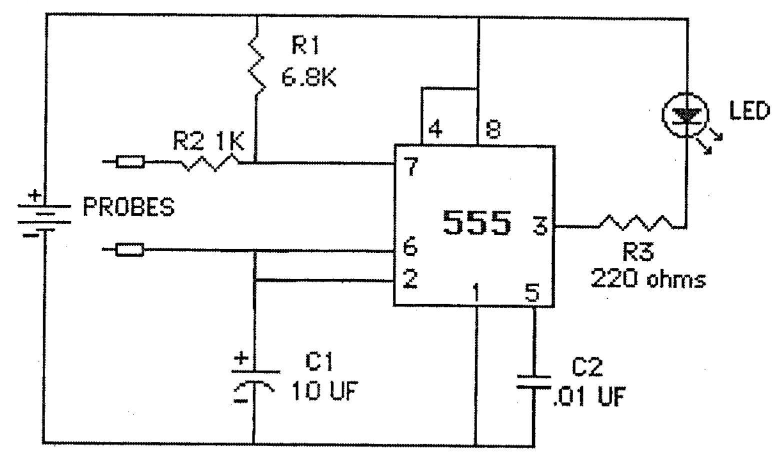
The circuit of the Moisture Detector is basically made of a 555 timer working as a clock, similar to the one explained in Experiment 11. The frequency of the pulses produced by the 555 is controlled by the resistance between the probes. The resistance between the probes depends upon the moisture that they detect. The more moisture, the lower the resistance and viceversa.



MOISTURE DETECTOR



SCHEMATIC DIAGRAM



R1 : 6.8K (Blue, Gray, Red, Gold).
R2 : 1K (Brown, Black, Red, Gold)
R3 : 220 ohms (Red, Red, Brown, Gold)

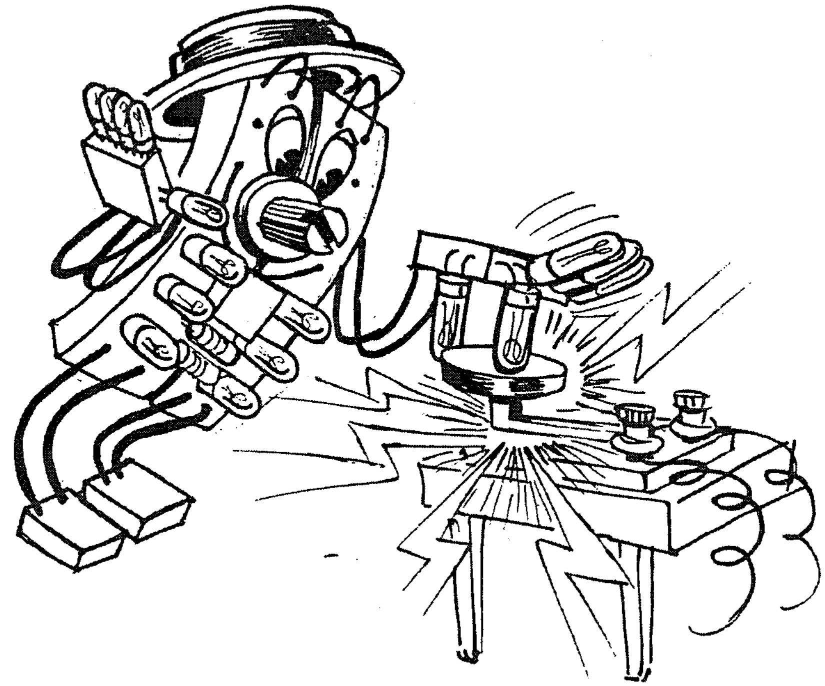
EXPERIMENT PROJECT 25

DESCRIPTION

In this project you will build a Code Practice Oscillator that you can use to learn and practice the Morse Code.
To operate this circuit, just connect the battery to the battery snap and use pushbutton S1 as the code key.
The circuit of the Code Oscillator is basically made by a 555 timer working as a clock, similar to the one explained in Experiment 11, which generates an audio signal each time pushbutton S1 is closed.

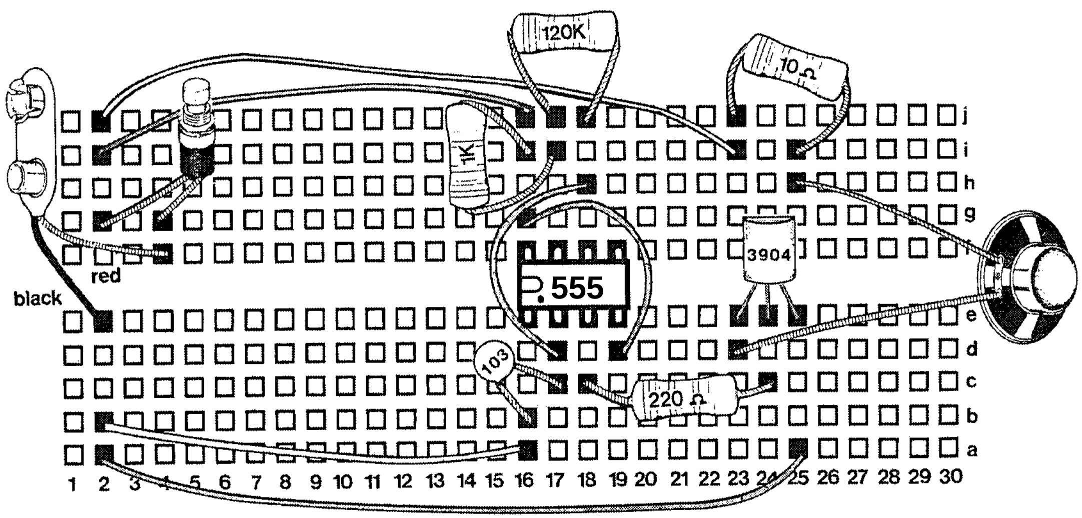
MORSE CODE

A ·—	I ··	O ———	Y —·——	Z ——··
B —···	J ·———	R ·—·		
C —·—·	K —·—	S ···	**NUMBERS**	
D —··	L ·—··	T —	1 ·————	6 —····
E ·	M ——	U ··—	2 ··———	7 ——···
F ··—·	N —·	V ···—	3 ···——	8 ———··
G ——·	O ———	W ·——	4 ····—	9 ————·
H ····	P ·——·	X —··—	5 ·····	0 —————

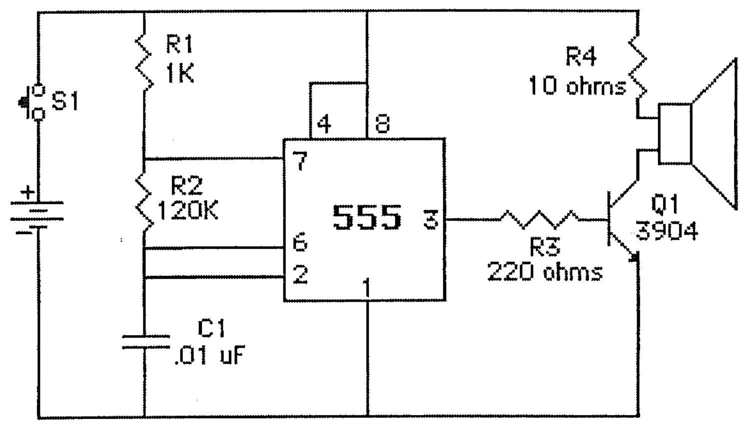


CODE OSCILLATOR

PICTORIAL DIAGRAM



SCHEMATIC DIAGRAM



R1: 1k (Brown, Black, Red, Gold)
R2: 120k (Brown, Red, Yellow, Gold)
R3: 220 ohms (Red, Red, Brown, Gold)
R4: 10 ohms (Brown, Black, Black, Gold)

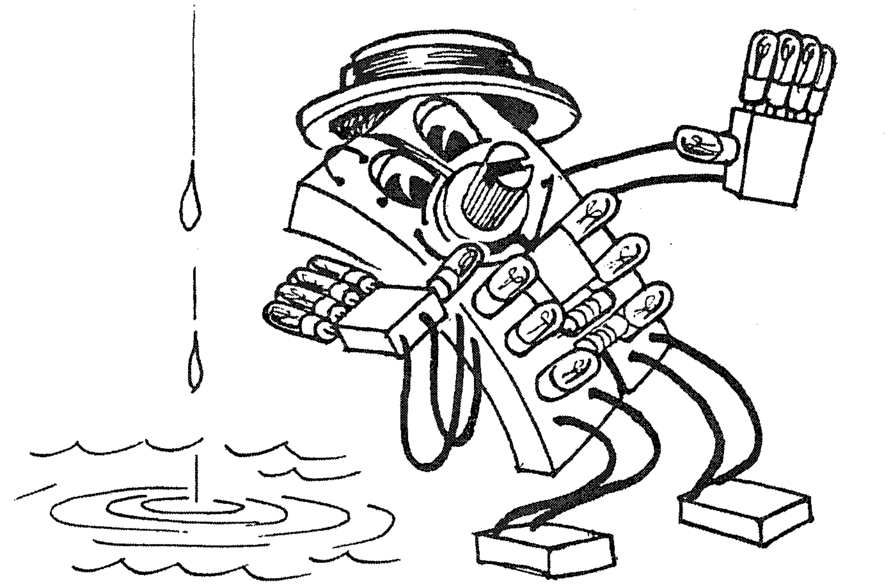
Mr Circuit Basic Electronics Lab 1

EXPERIMENT PROJECT 26

DESCRIPTION

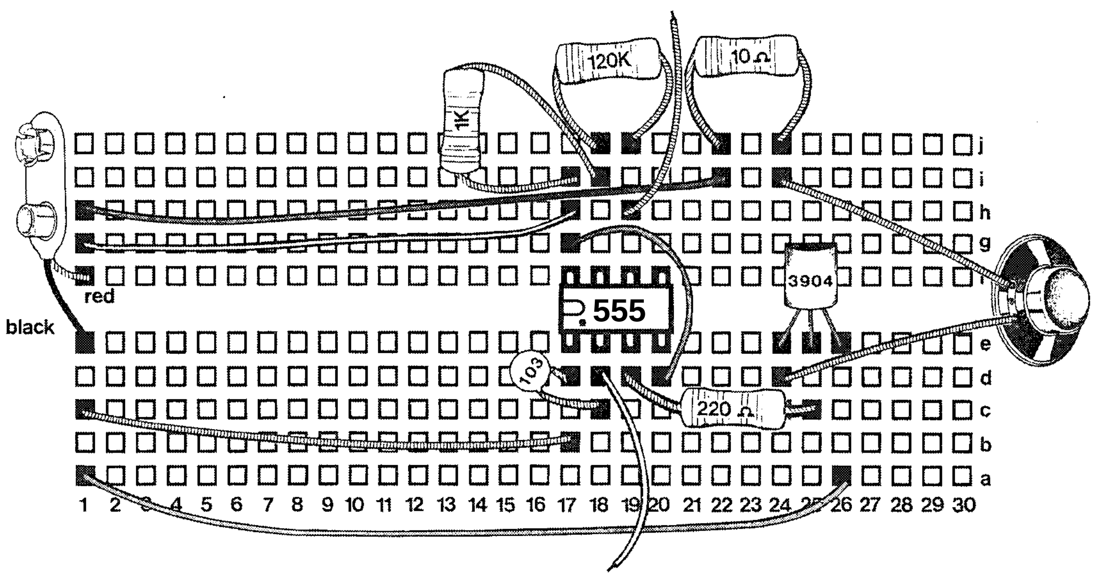
This useful project may be used to monitor water containers, such as a bathtub, sink, swimming pool, etc, during filling , to avoid overflow. When the water reaches the probes, this device will emit a loud sound.

To operate it, just connect the battery to the battery snap and install the probes in the water container. You can test your Audible Water Detector in a glass of water by touching the probes to the water.
The circuit of the Audible Water Detector is basically made of the 555 IC working as a clock, similar to the one explained in Experiment 11.
When there is electrical continuity between the two probes (caused by the water) the 555 generates an audio signal which is amplified by transistor Q1 and then reproduced by the speaker.

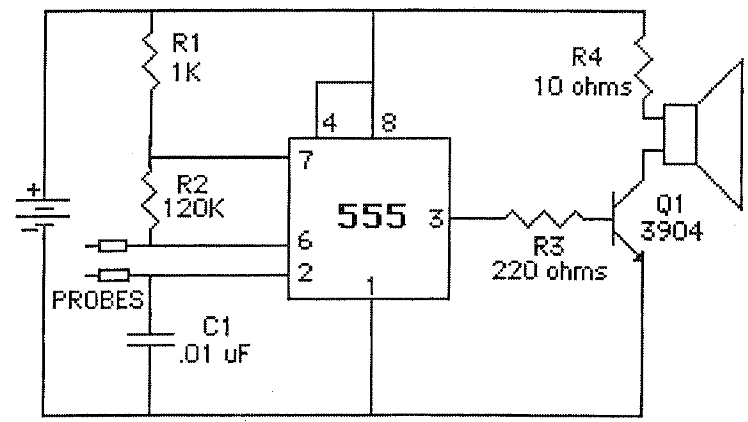


AUDIBLE WATER DETECTOR

PICTORIAL DIAGRAM



SCHEMATIC DIAGRAM



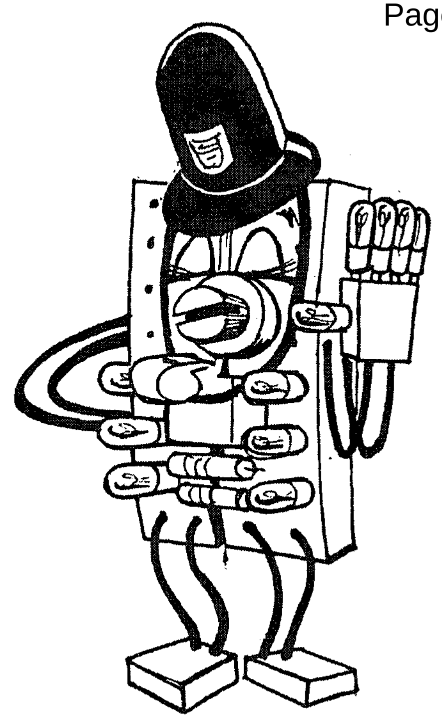
R1 : 1K (Brown, Black, Red, Gold)
R2: 120K (Brown, Red, Yellow, Gold).
R3: 220 ohms (Red, Red, Brown, Gold).
R4: 10 ohms (Brown, Black, Black, Red)

EXPERIMENT PROJECT 27

DESCRIPTION

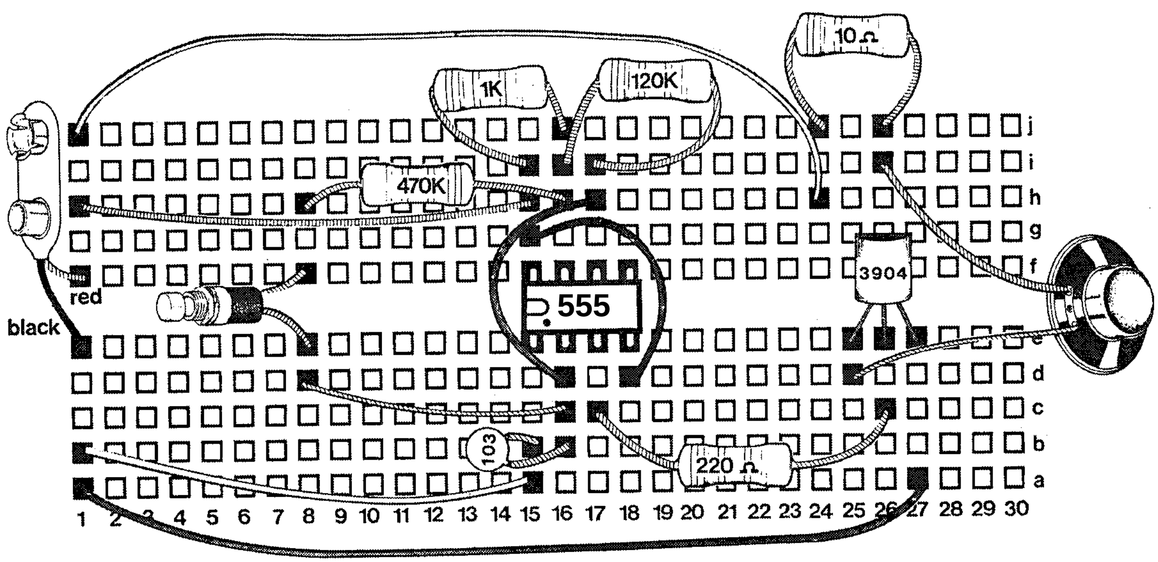
Here we go! This amazing project will generate the typical sound of the two-tone siren used by the British Police.
To operate it, just connect the battery to the battery snap and then alternately press and release pushbutton S1.

The circuit of the English Police Siren is basically made by a 555 IC working as a clock, as explained in Experiment 11. When switch S1 is open, the frequency of the audio signal generated by the IC depends upon the values of R1, R2, and C1. Under these circumstances a tone is generated. When pushbutton S1 is pressed, R5 is set in parallel with R2. The parallel R2-R5 will have a different resistance value than the one of R2, and, therefore, the frequency of the audio signal changes and the second tone is generated.

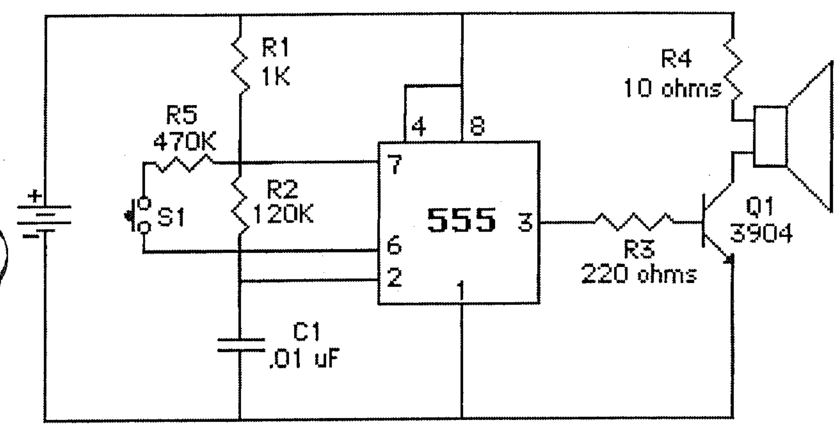


ENGLISH POLICE SIREN

PICTORIAL DIAGRAM



SCHEMATIC DIAGRAM



R1 : 1K (Brown, Black, Red, Gold)
R2 : 120K (Brown, Red, Yellow, Gold).
R3 : 220 ohms (Red, Red, Brown, Gold).
R4 : 10 ohms (Brown, Black, Black, Gold)
R5 : 470K (Yellow, Violet, Yellow, Gold)

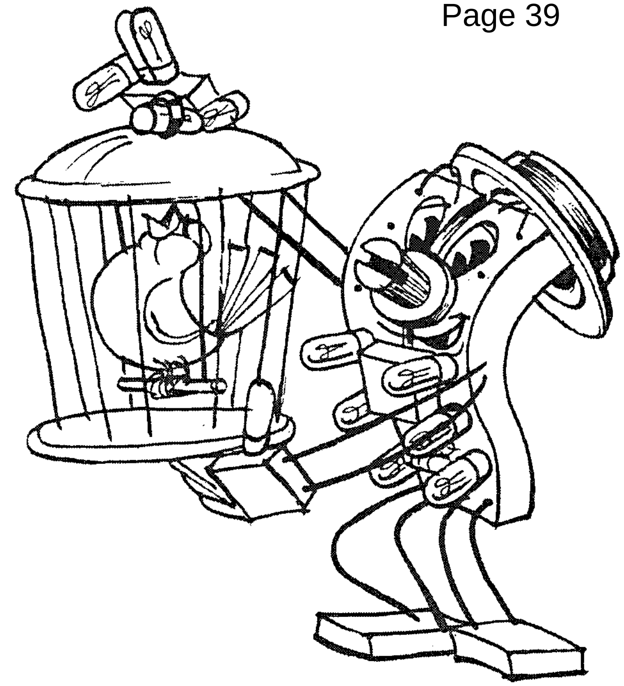
EXPERIMENT PROJECT 28

DESCRIPTION

Do you have a canary at home? If you don't, here is the solution. This amazing Electronic Canary does not consume any food, just a few electrons, and sings like a real one.

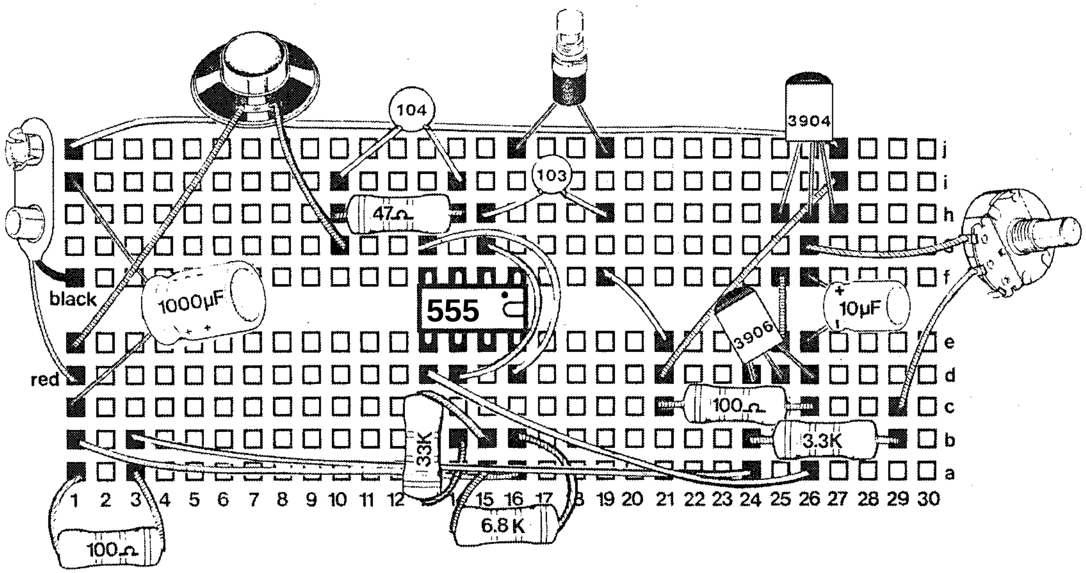
To operate it, just connect the battery to the battery snap, press pushbutton S1, and adjust potentiometer R7 until you get the desired canary sound. To get more real bird sound effects, press and release S1 intermittently while adjusting R7.

The circuit of the electronic canary is made of two oscillators in series. The first is a two-transistor audio oscillator consisting of Q1 and Q2, as the one explained in Experiment 10. The audio signal generated by the first oscillator is " injected" in pin 5 of the 555 IC, to control the frequency of its audio signal. The result of this process is an audio signal present on pin 3 of the 555 which is constantly changing its frequency. When this signal is reproduced by the speaker the result is a sound similar to a bird singing.

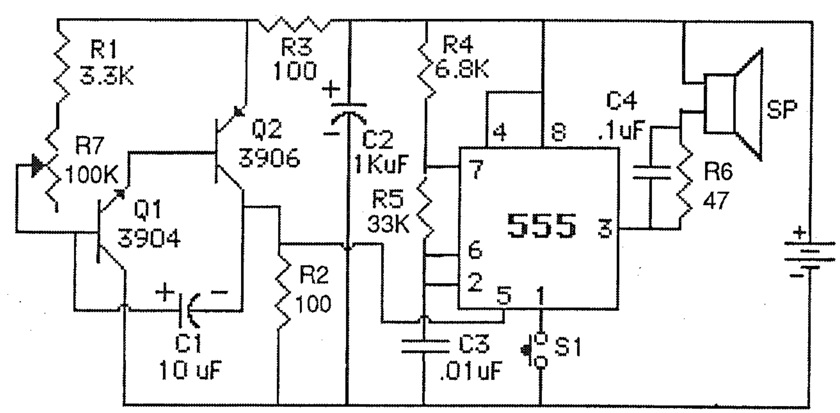


ELECTRONIC CANARY

PICTORIAL DIAGRAM



SCHEMATIC DIAGRAM



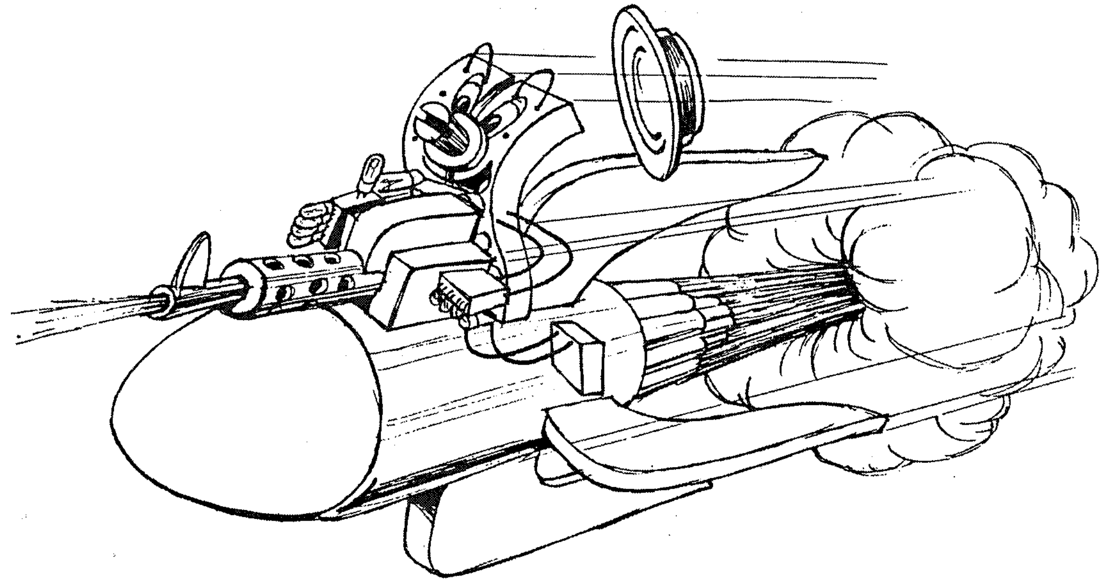
R1: 3.3K (Orange, Orange, Red, Gold).
R2: 100 ohms (Brown, Black, Brown, Gold).
R3: 100 ohms (Brown, Black, Brown, Gold).
R4: 6.8K (Blue, Gray, Red, Gold).
R5: 33K (Orange, Orange, Orange, Gold).
R6: 47 ohms (Yellow, Violet, Black, Gold).
R7: 100K Potentiometer.

EXPERIMENT PROJECT 29

DESCRIPTION

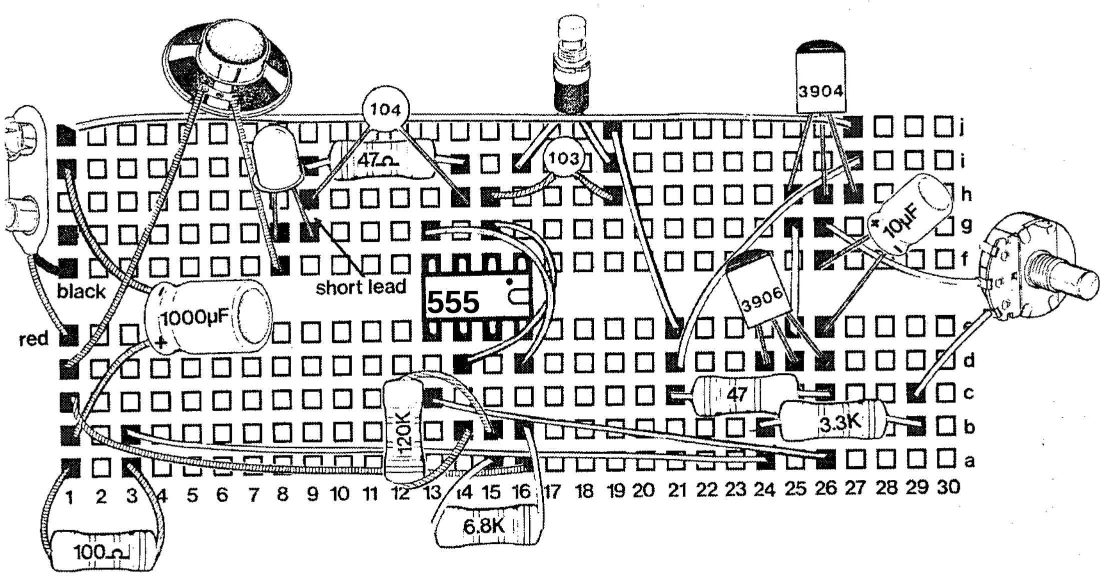
The Space Machine Gun is a fun project that generates the sound of a Phaser Gun, like those produced in Space Arcade Games. It also produces a light effect which follows the firing. The firing rate of the "machine gun" can be adjusted with potentiometer R7.

To operate it, just connect the battery to the battery snap and press the "gun trigger" which is pushbutton S1. Adjust R7 to control the firing rate.
The circuit of the Space Machine Gun has two oscillators, one controling the frequency of the other like that as explained in Experiment 28.

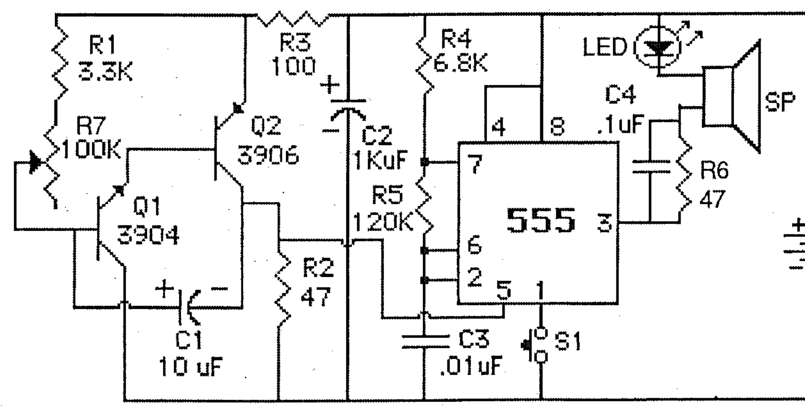


SPACE MACHINE GUN

PICTORIAL DIAGRAM



SCHEMATIC DIAGRAM



R1 : 3.3K (Orange, Orange, Red, Gold)
R2 : 47 ohmd (Yellow, Violet, Black, Gold)
R3 :100 ohms (Brown, Black, Black, Gold)
R4 : 6.8K (Blue, Gray Red, Gold)
R5 : 120K (Brown, Red, Yellow, Gold)
R6 : 47 ohms (Yellow, Violet, Black, Gold)
R7 : 100K Potentiometer.

EXPERIMENT PROJECT 30

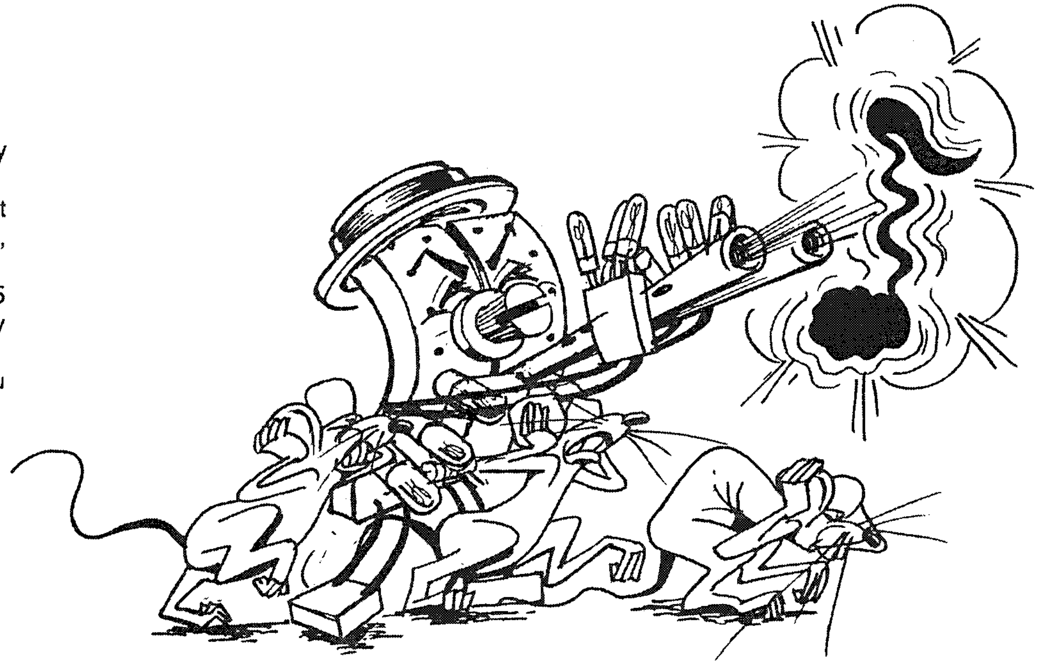
DESCRIPTION

Do you have pests in your home?...like roaches, crickets, etc. If you do, try this Ultrasonic Pest Repeller.

It has been proven that certain frequencies of ultrasonic sounds (sounds not perceived by humans) irritate certain kinds of bugs like roaches, crickets, etc, causing them to flee.

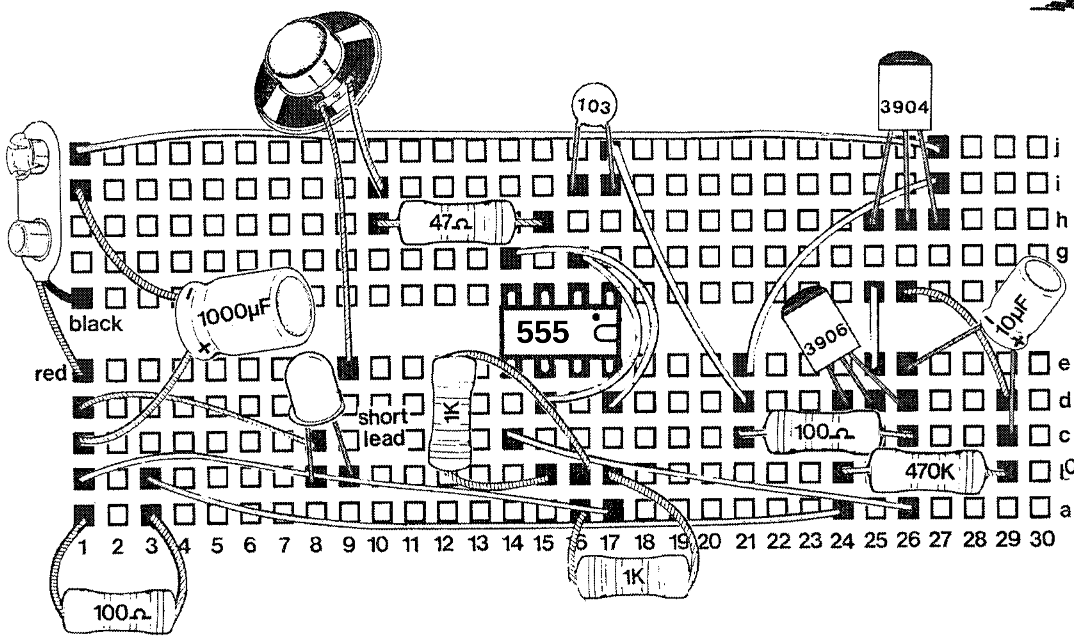
This project constantly generates a series of ultrasonic sounds from 13.5 KHz to 80 KHz. Because of this, it has a wide spectrum of action which may cause pests to flee away.

To operate this project, just connect the battery to the battery snap and you are in business.

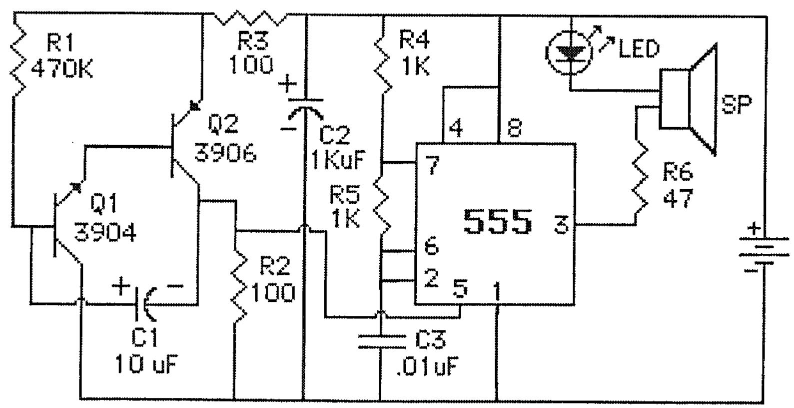


ULTRASONIC PEST REPELLER

PICTORIAL DIAGRAM



SCHEMATIC DIAGRAM



R1: 470K (Yellow, Violet, Yellow, Gold).
R2: 100 ohms (Brown, Black, Brown, Gold).
R3: 100 ohms (Brown, Black, Brown, Gold).
R4, R5: 1K (Brown, Black, Red, Gold).
R6: 47 ohms (Yellow, Violet, Black, Gold).

Mr Circuit Technology

Certificate of Training

To Certify That

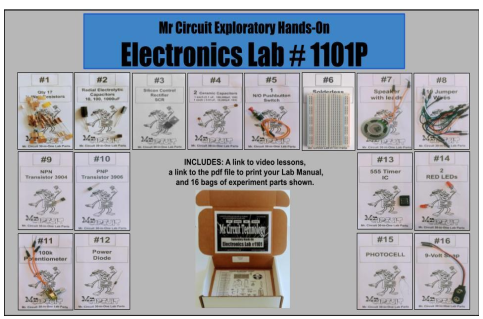
**** ______________________________ ****

Name of Student

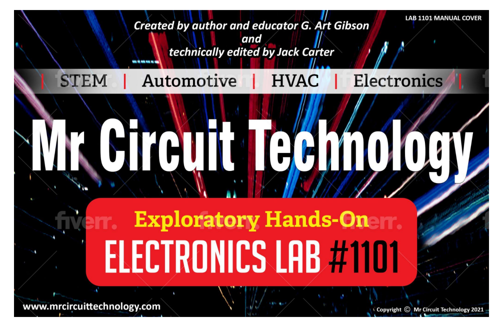
Has Completed The Training For The

Mr Circuit Basic Electronics Level I Lab

And Is Awarded This Certificate By



Mr. Circuit®



____

Month Day Year

______________________________ at ______________________________

Name of Teacher or Proctor Name of School

Mr Circuit Technology

Mr Circuit Technology

Mr Circuit Technology

Mr Circuit Technology

Mr Circuit Technology

Mr Circuit Technology

The recipient of this Certificate of Training has this Skill Set

- Describe electron flow in a simple circuit.
- Draw a simple circuit schematic and identify the elements required for current to flow.
- Know the 11 most common electronics components in use in electronics and their functions.
- Draw and identify basic electronics symbols.
- Read the Resistor Color Code and determine the values of resistors.
- Construct circuits on a solderless circuit board.
- Correctly read the values of ceramic disc and electrolytic capacitors.
- Build a basic circuit using a potentiometer.
- Understand and use a photocell in an electronic circuit.
- Construct a circuit using a schematic diagram.
- Understand how and when to use a capacitor in an electronic circuit.
- Use a transducer like a speaker to make sounds from electron flow in a circuit.
- Know why you hear a clicking sound in a speaker when you connect and disconnect a circuit.
- Understand how the Gate in an SCR works and how to use it in an electronic circuit.
- Build a two-transistor oscillator with a PNP and an NPN transistor.
- Know the function of a resistor and recognize its schematic symbol.
- Know the function of a capacitor and recognize its schematic symbol.
- Know the function of a power diode and recognize its schematic symbol.
- Know the function of bipolar transistors and recognize its schematic symbols.
- Know the function of a switch and recognize its schematic symbol.
- Understand the uses of a 555 Timer Integrated Circuit and how to use it to make an oscillator.
- Build an SCR Checker on a solderless circuit board.
- Build an NPN and PNP bipolar Transistor Checker.
- Build a Diode checker on a solderless circuit board.
- Build a DC to DC Power Supply, Variable Timer, Moisture Detector, Audio Generator, Metronome and more.
- Troubleshoot electronic circuits by comparing the schematic to the physical circuit.

Mr CIRCUIT®

Mr Circuit Technology

BACK COVER

Created by author and educator G. Art Gibson
and
technically edited by Jack Carter

Lab 1 Manual

| STEM | Automotive | HVAC | Electronics |

Mr Circuit Technology

Mr Circuit Lab 1

ELECTRONICS LAB #1101

9 780971 234024

www.mrcircuittechnology.com