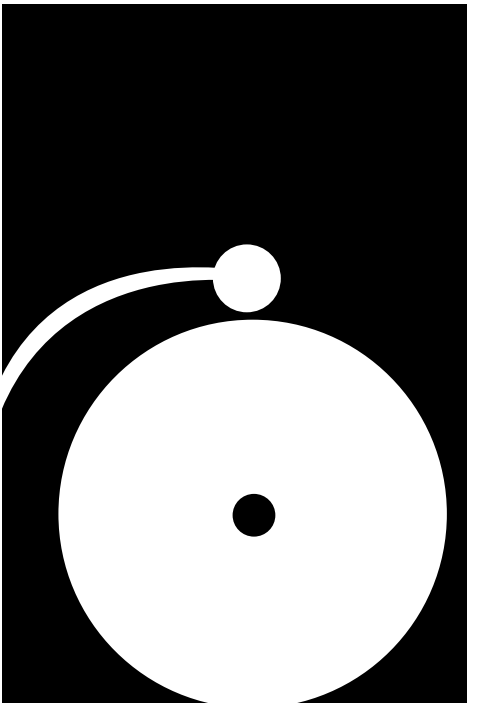
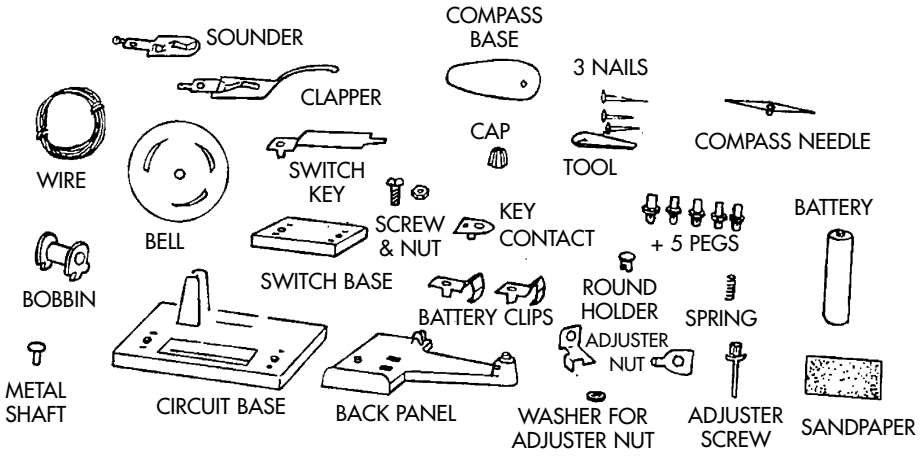


BELL, BUZZER & SWITCH

65168-05

STUDENT'S WORKBOOK

By Lawrence F. Lowery



MATERIALS INCLUDED IN THIS KIT

1 Bell
1 Bobbin
1 Switch Base
1 Circuit Base
1 Back Panel

5 Pegs + Round Holder +
1 Cap (on plastic bar)
1 Clapper
1 Sounder
1 Battery

You will find all items in the following groupings packaged together in small plastic bags within your kit.

1 Compass Base
1 Compass Needle
3 Nails
1 Metal Tool
1 Metal shaft for bobbin

1 Piece Sandpaper
1 Wire Coil
1 Key Contact
1 Bobbin Bracket
1 Switch Key

1 Adjuster Screw
1 Adjuster Nut
1 Washer for Adjuster Nut
1 Spring
2 Battery Clips
1 Small Screw + Nut
1 Medium Screw + Nut

STUDENT'S WORKBOOK
BELL, BUZZER & SWITCH KIT

INTRODUCTION

What would happen if suddenly there was no electricity? Radios, television, telephones and stereos would be silent and blank Homes would be dark. Cars wouldn't run. Airplanes wouldn't fly. In short, your life would be very different if you had no electricity in your home.

One of the most important properties of electricity is that it produces a magnetic force. This force can be harnessed to power thousands of devices that we have come to rely on in our daily lives.

The materials in this Bell, Buzzer, and Switch Kit can be used to build several small devices that are run by electricity and magnetism. These devices will show you how many other machines and tools work. Before you begin the four Explorations on electricity and magnetism, check the list of materials on the preceding page to make sure your Discovery Kit is complete.

CIRCUIT ASSEMBLY

In this exercise you will build an electrical circuit to use in all of the Explorations in this kit. Assembling the circuit is done in three parts: Preparing the Bobbin, Building the Switch, and Completing the Circuit.

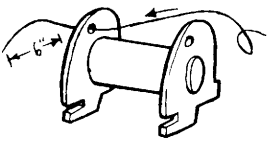
LIST A

Wire Coil
Bobbin
Sandpaper

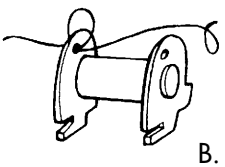
PREPARING THE BOBBIN:

To start, find all the pieces noted in List A and prepare the bobbin and wires as follows:

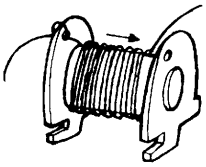
1. Use scissors to cut about one foot of wire from the wire coil. Set the piece of wire aside to use when Building The Switch.
2. Starting from the center of the bobbin, thread about 6 inches of wire from the end of the remaining coil through the small hole on one side of the bobbin. Put the end of the wire through the hole again to form a loop (see pictures A & B). Pull the loop tight to hold the end of the wire firmly in place.
3. Begin to unwind the rest of the coil and start wrapping the wire evenly around the bobbin (pictures C & D). To keep the wire



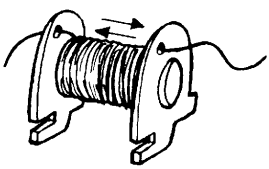
A.



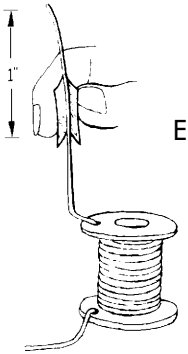
B.



C.



C.



E.

from tangling, you might want to hold the loop of coil over your thumb or finger, straightening it out as you use it. When you reach one edge of the bobbin, begin wrapping the wire towards the other edge. Keep the wire tight on the bobbin and free of kinks. When winding, make sure that the wires do not cross one another, and that the loops are close together and parallel to one another. Keep winding until there is about 6 inches of wire left. **TAKE YOUR TIME ON THIS STEP. A PROPERLY PREPARED COIL IS THE MOST IMPORTANT ELEMENT OF THIS KIT.**

4. Starting from inside the bobbin, thread the last 6 inches of wire through the small hole on the other side of the bobbin. Loop it through the hole, taking care not to kink the wire.
5. Use the sandpaper to rub away 1 inch of the coating from both ends of the bobbin wire (picture E). The ends of the wire should be a bright copper color when you finish.
6. Set the prepared bobbin aside, to use when **completing the circuit**.

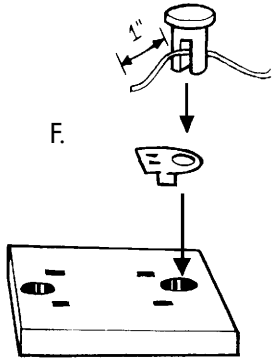
BUILDING THE SWITCH:

Next, find the pieces noted in List B, and build the switch as follows:

LIST B

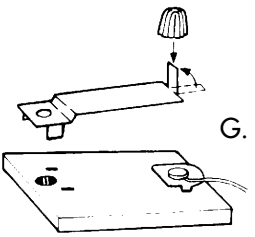
Switch Base
Key Contact
Metal Tool
Switch Key
Sandpaper
Round Holder
Cap
(the Round Holder and Cap are on the plastic bar)

1. Slip the key contact into one side of the base. Make sure that the hole on the key contact matches up with the hole on the switch base. Using the metal tool (or a small slot head screwdriver), bend the locking tabs underneath the base to hold the key contact in place.
2. Cut the piece of wire you set aside earlier (Step 1: Building The Switch) in half. Use sandpaper to rub away 1 inch of the coating from both ends of both pieces of wire. Set one piece of wire aside. You will use it later in Exploration 3.
3. Remove the round holder from the plastic bar. Place the remaining wire into the notch on the holder, leaving about one inch sticking out on one side. With the wire in place, push the round holder firmly into the hole on the key contact. The wire should now be held securely in place (see picture F).



F.

4. Find the switch key and the cap. Use the metal tool to bend the tab at the end of the key up. Put the cap on the tab. (You might want to place a drop of glue on the inside of the cap before you put it on the tab).
5. Insert the switch key into the remaining slots of the switch base, so that when you press the tab at the end of the key, it touches the top of the round holder. Use the metal tool to bend the locking tabs underneath the base to hold the key in place. When you press the switch key down, make sure that it touches the raised metal circle of the key contact (see picture G).



G.

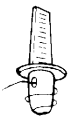
COMPLETING THE CIRCUIT:

Now, find the pieces noted in List C, and complete the circuit as follows:

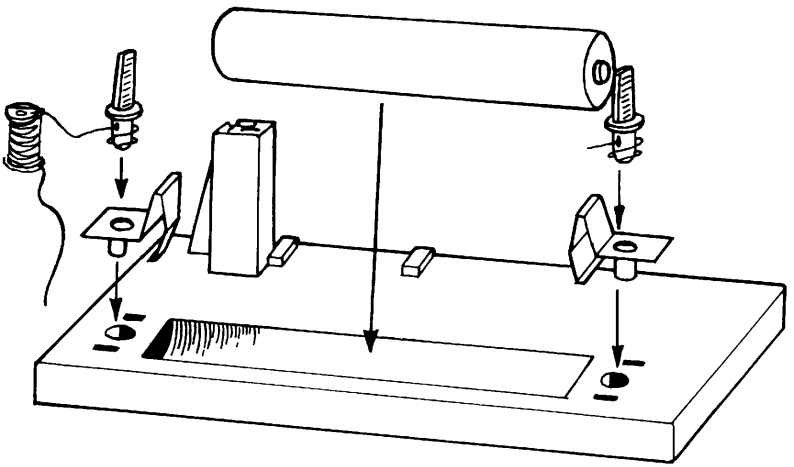
LIST C

Circuit Base
Battery Clips
Pegs
Metal Tool
Prepared Bobbin
6" Piece of Wire
Assembled Switch
(see picture G)
AA Battery

1. Put the battery clips into the slots in the circuit base. Bend back each set of locking tabs underneath the base to hold the clips in place.
2. Remove two pegs from the plastic bar. Each peg has a small hole in it. Thread about 1 inch of a free end of the bobbin wire through the hole in one peg (see picture H). Wrap the free end of the wire around the base of the peg, and insert the peg into the hole in the battery clip (see picture I).

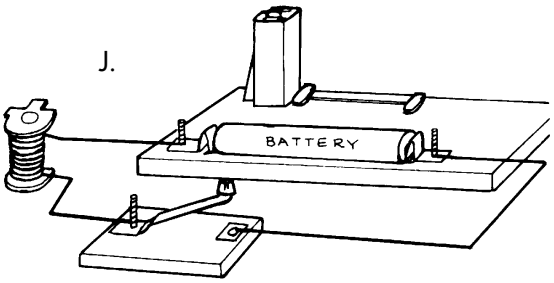


H.

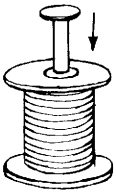


3. Thread about 1 inch of the remaining free end of the bobbin wire through the hole in another peg. Again, wrap the wire around the base of the peg. Insert this peg into the hole on the switch (see picture J).

J.



4. Thread the wire extending from the round holder on the switch through another peg. Wrap about 1 inch of the wire around the base of the peg. Insert this peg into the remaining battery clip on the circuit base.
5. Place the battery in the slot between the battery clips.
6. Insert the metal bobbin shaft into the bobbin (see picture K).



K.

You should now have an open circuit like the one shown in picture J. Trace the circuit with you finger. Where is the break in circuit? How would you close it?

LIST D

Open Circuit
(see picture J)
Nail
Compass Needle
Compass Base

EXPLORATION 1: TESTING THE ELECTROMAGNET

Assemble the materials noted in List D for this Exploration.

The battery in the circuit you have created provides the electricity for the circuit. That electricity, however, will not travel through the coil of wire until the circuit is closed.

Close the circuit by pressing down the switch key. Hold the nail against the metal bobbin shaft. What happens? Lift you finger from the switch key to break the circuit. What happens to the nail now?

Closing the circuit carries the current from the battery to the coil around the bobbin. This current carrying coil acts like a magnet, and is called an electromagnet. The magnetic force carried by the electromagnet holds the nail against the shaft when the circuit is complete.

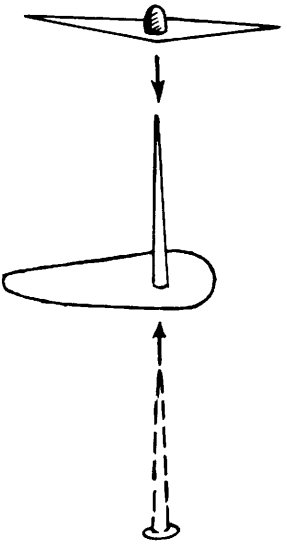
You can test the strength of your electromagnet several different ways. First, hold some paper clips near the circuit's coil. How many paper clips does the electromagnet attract? How close do paper clips need to be from the coil before they are attracted to it?

You can also test your electromagnet with a compass. To build your compass, insert a nail through the indentation in the compass base. Set the base on a flat surface. Place the compass needle on the end of the nail. Watch the compass needle. Which direction does the red tip of the compass point?

Now press the switch and slowly bring the electromagnet near the compass. What happens to the compass needle? Release the switch. What happens to the compass needle now?

Remove the battery from the circuit base and turn it around, so that the terminals are reversed. Put the battery back in the base.

Press the switch again. Now what happens to the compass needle? Can you make any observations about the way an electrical current flows through the circuit from this?



LIST E

Open Circuit
(see picture J)
Bobbin Bracket
Back Panel
Screw and Nut
Sounder

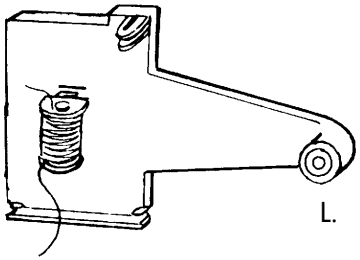
EXPLORATION 2: MAKING A SOUNDER

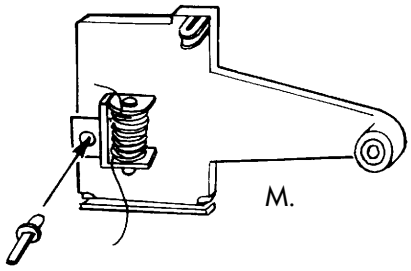
Assemble the materials noted in List E for this Exploration.

Using your electromagnet, you can make a device that is similar to a telegraph.

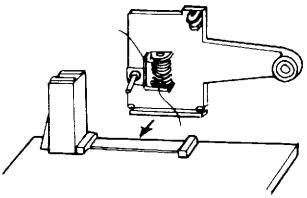
Construct the sounder as follows:

1. Make sure that the metal bobbin shaft is inside the bobbin. Insert the two tabs on the bobbin into the slots on the back panel. You may need to squeeze both ends of the bobbin between your thumb and finger to fit it into the tabs. Make sure that the top of the shaft is towards the top of the panel (see picture L).
2. Attach the bobbin bracket to the bobbin. The bottom of the bobbin shaft should fit into the hole in the bobbin bracket. Match the smaller hole on the bracket to the small hole in the back panel. Fasten the bracket onto the panel with a screw and nut (picture M).

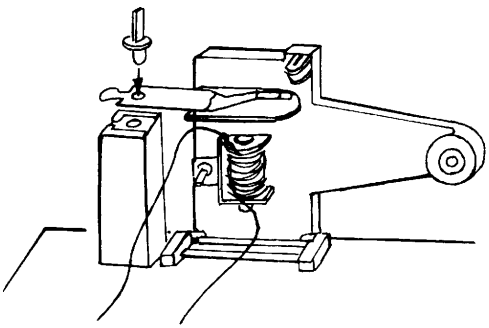

L.


M.

3. Slide the entire back panel unit into the appropriate slot on the circuit base (picture N).
4. Place the sounder on the base (picture O). The sounder should go in between the top of the bobbin and the top of the back panel; it should not, however, touch the top of the bobbin shaft. If it does, bend the copper base of the sounder. If it still touches the top of the bobbin shaft, try pushing the shaft further into the bobbin. Also try bending down the tab at the end of the sounder (by the peg hole). Once it is properly positioned, fasten the sounder in place with a peg.



N.



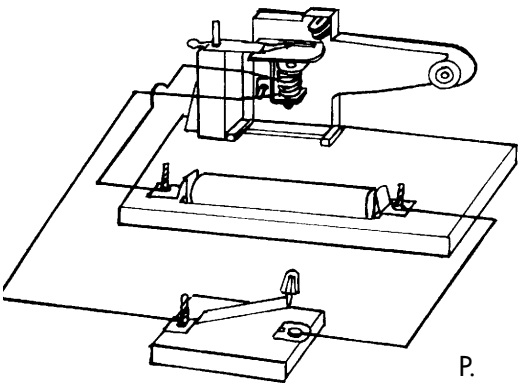
O.

Now you have created an extended circuit like the one in picture P. Trace the circuit with your finger.

In Exploration 1, you learned that your electromagnet is a temporary magnet: that is, it can be turned on and off by pressing or releasing a switch to open or close a circuit.

Press the switch cap in the circuit you have created. What happens to the sounder? Now release the switch. What happens?

Rapidly press and release the switch cap. You should hear a rapid clicking sound as the sounder is pulled to and from the top of the bobbin shaft.



P.

The electric device you have just created is much like a telegraph key and sounder. It is possible to send messages with this device, through a code of short and long clicks, known as dots and dashes, which translate into letters of the alphabet.

A dot is made by quickly pressing and releasing the switch key. A dash is made by pressing and releasing the key more slowly. A dash should be as long as three dots. This code, which has been used to send messages around the world, is known as the International Morse Code.

The letter translations of the International Morse Code are as follows:

A	B	C	D	E	F	G	H	I
.-	-...	-.-.	-..	.	..-.	--.	....	..
J	K	L	M	N	O	P	Q	R
.---	-.-	.-..	--	-.	---	.--.	--.-	.-.
S	T	U	V	W	X	Y	Z	
...	-	..-	...-	.--	-..-	-.--	--..	
1	2	3	4	5	6	7	8	
.----	..---	...--	....-	.....	-....	--...	---..	
9	10							
----.	-----							

Practice sending code messages with your device. You and a friend can send messages to each other this way.

EXPLORATION 3: MAKING A BUZZER

Assemble the materials noted in List F for this Exploration.

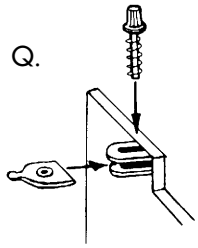
Using your electromagnet, you can also make an electric-powered buzzer.

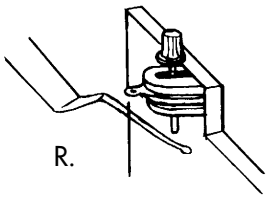
Construct the buzzer as follows:

1. Slip the adjuster nut between the clips at the top of the back panel (picture Q). Place the small spring on the adjuster screw and turn the screw into the adjuster nut. Turn the screw until it barely touches the round metal disk on the coppersounder (picture R). As in Exploration 2, it may be necessary to adjust the position of the sounder to complete this connection.

LIST F

Sounder Circuit
(see picture P)
Adjuster Nut
Adjuster Screw
Spring
Reserved Wire
(from Step 2, Building the Switch)


Q.


R.

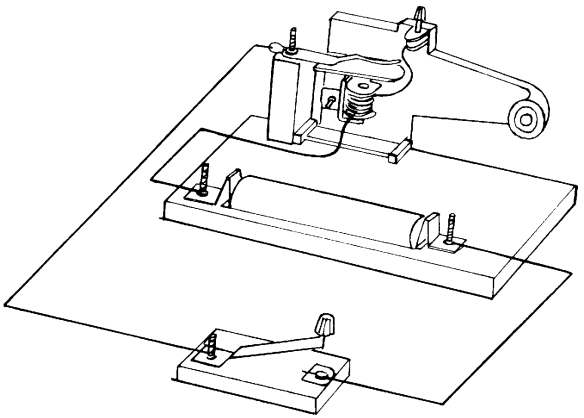
2. Change the wire connections in the circuit as follows:

Currently	**Change**
Wire extending from top of bobbin connects to peg in battery holder.	Remove peg from battery holder; unloop wire from peg and set peg aside. Loop and knot wire through small hole on extending tab of adjuster nut.
Wire extending from bottom of bobbin connects to peg in base of switch.	Remove peg and wire from base of switch; insert into open battery holder.

3. Loop one end of the wire you prepared earlier through the small hole in one of the pegs; wrap the wire around the base of the peg. Place the peg into the hole on the switch. Loop and knot the other end of the wire through the tab at the end of the sounder (by the peg hole).

By now, your circuit should look like the one in picture S. Trace this extended circuit with your finger.

Now, press the switch and hold it down. Does the sounder buzz? If not, turn the adjuster screw up or down until the sounder buzzes. Be sure the lower part of the sounder does not touch the metal shaft when the switch is off.



S.

Watch the sounder as it buzzes. How is magnetism used to make it work? Why doesn't the sounder stick to the magnet all this time? Can you send code signals with your buzzer?

EXPLORATION 4:
MAKING AN ELECTRIC BELL

Assemble the materials noted in List G for this Exploration.

Using your electromagnet, you can also make an electric-powered bell, similar to the doorbell in your home.

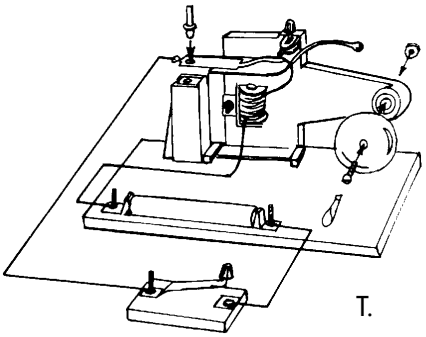
Construct the electric bell as follows:

1. Remove the sounder arm from its base and replace it with the bell clapper. Fasten the clapper in place with the peg from the sounder arm. Make sure that the bottom of the bell clapper does not touch the top of the bobbin shaft. If necessary, adjust the position of the clapper as you did with the sounder in Exploration2.
2. Remove the wire from the sounder arm; loop and knot it around the tab extending from the clapper arm.
3. Mount the bell on the back panel with the screw and a nut. Insert your finger in the opening in the back panel to hold the nut in place while tightening the screw. Tighten the screw with either the metal tool or a small screwdriver.

LIST G

Sounder Circuit
(see picture S)
Bell Clapper
Bell
Screw and Nut
Metal Tool

The circuit for your electric bell should look like the one in picture T. Trace this extended circuit with your finger to double check that all connections are secure. How do you think magnetism will be used this time?



T.

Press the switch key: The bell should ring. If it doesn't:

a) Check your connections. Make sure they are tight.
b) Make sure the metal clapper isn't touching the bobbin when the switch is open.
c) Turn the adjuster screw up or down against the clapper arm.
d) Check your battery to see if it is still good.
e) Bend the metal clapper closer to or further away from the bell.

Using longer wires, how could you and a friend set up your bells so your switch would ring your friend's bell, and his switch would ring yours? Do you think it is possible to send messages by ringing the bells?

Turn the battery around so that the position of the positive and negative terminals are reversed. Now try the switch. Does the bell still sound? It should, since the current flows in both directions.

Dr. Lawrence F. Lowery is a professor of science education at the University of California, Berkeley. He has had extensive elementary and junior high school teaching experience, has written numerous films and books on science and has written many articles for teachers on science instruction.

THIS DISCOVERY KIT IS ONE IN A SERIES COVERING BASIC SCIENCE CURRICULUM OTHER KITS ARE AVAILABLE FOR TEACHING SOUND, MAGNETISM, LIGHT, FRICTION, ELECTROLYSIS, WEIGHTS AND MEASURING, AND SIMPLE MACHINES AND BALANCE.

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