GILBERT
Fun With Electricity

pp 20-33

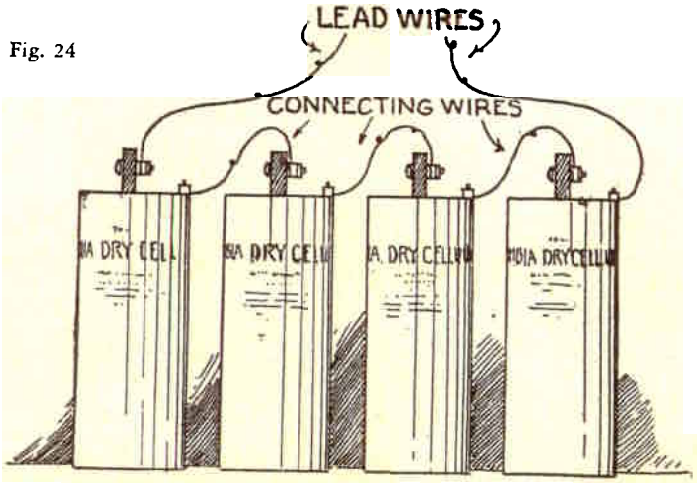
THE OHM

The wire along which a current flows offers a certain amount of resistance depending on its size, length, and material from which it is made. This resistance is measured by the unit *Ohm*. The Wheatstone Bridge or Ohmmeter is used to measure the amount of resistance.

WAYS TO CONNECT UP YOUR BATTERY

Electricity is very much like water, in that it has quantity, and you can drive it along a wire under pressure. The quantity of electricity flowing along a wire is measured in Amperes and the pressure that drives it in Volts. By connecting up the cells of your battery in *Series;* that is, the carbon of one cell to the zinc of the next cell as shown in Fig. 24, you will get more voltage (pressure) but not so many Amperes (quantity). By connecting the cells in *Parallel;* that is, all the carbons of all the cells together, and all of the zincs of all the cells together, as in Fig. 25, you will get more Amperes (quantity) and less Volts (pressure).

Fig. 24



HOW TO MAKE A SOLENOID

You have already learned that an electric current flowing through a wire causes a magnetic effect around the wire. If we wind insulated wire around a pencil and then slip it off, we have a so-called *Solenoid.* (Fig. 26.) Place this solenoid upon the table and lay the compass about two inches from one end of it. Connect the ends of the solenoid to the terminals of your battery. The compass needle will be either repelled

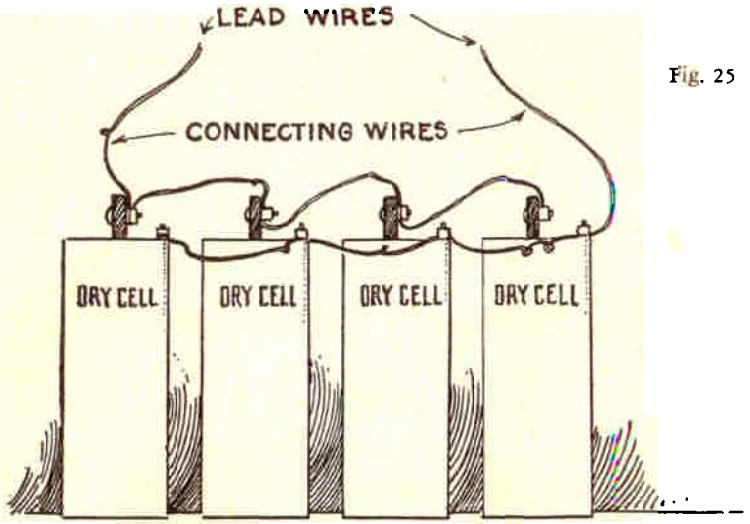


Fig. 25

or attracted. The lines of force which pass around every turn of the wire will cause the solenoid to become a magnet having a North pole at one end of the wire and a South pole at the other end.

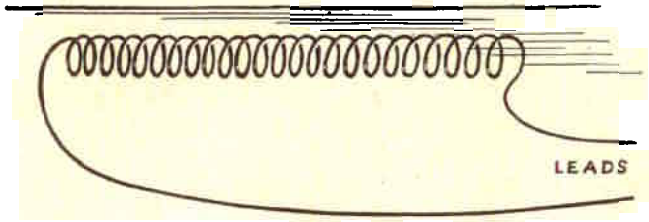


Fig. 26

MAGNETIZING WITH A SOLENOID

In your set you will find two very efficient solenoids. After connecting one with your battery, lay a smooth card on it and on top of this sprinkle some iron filings. (Fig. 27.) You will see that the center of the solenoid is very strongly magnetic. This can be used to your advantage by using it to magnetize steel needles and watch springs. Just place them in the hole of the solenoid and turn on the current for half a minute

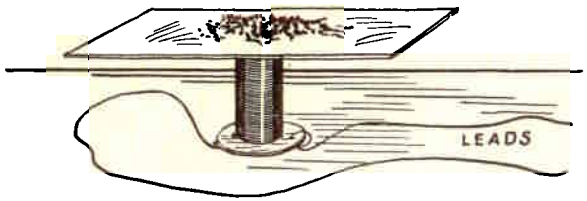


Fig. 27

THE ELECTROMAGNETIC GUN

An electromagnetic gun is one that shoots a projectile from it by means of the magnetic force set up. To make a toy gun of this kind slip the brass sleeve into the solenoid. Then lay it at a slight angle and connect one wire to one terminal of your battery. In your part box is a 1⅛" screw which you can use for a core. Insert it in the solenoid, so that about half of its length sticks out. (Fig. 28.) Now drop a dried pea in the open end of the gun and then close the circuit by bringing the free end of the wire from the solenoid into contact with the other battery terminal. The iron core will be driven forward and the shot in front of it propelled forward with some little force.

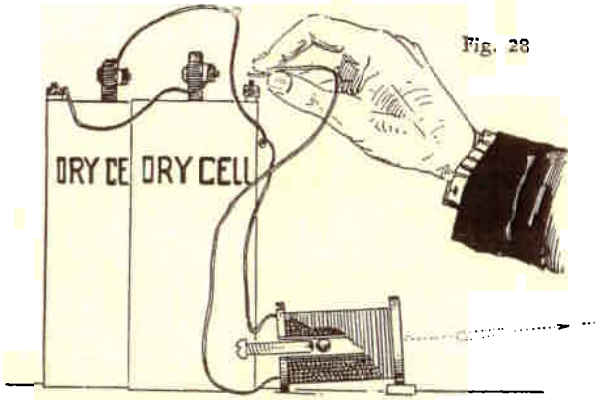


Fig. 28

THE ELECTROMAGNET

By placing a soft iron bar through the hole in your solenoid you have what is called an electromagnet. When connected to your battery this will give you a magnet that is more powerful than the solenoid. The reason for this is that the iron bar stops the lines of force from leaking out around the sides of the coil. In other words, the iron attracts them and they act through it.

THE HORSESHOE ELECTROMAGNET

The most common of electromagnets is the horseshoe type. Fasten the two solenoids to the angle yoke by means of the 1⅛" screws, placing a washer between each coil and the yoke. Join the inside wires of each solenoid. (Fig. 29.) This causes the current to flow through one solenoid in a clockwise direction and through the other in a counter-clockwise direction, giving the horseshoe magnet a North and South pole. Connect one lead from your battery to one of the binding posts on the base of the key.

Connect the other binding post to one wire of your coil. The other wire of your coil goes to the remaining battery terminal. You can now easily turn your magnet on and off. As long as the current flows through the coil it causes the yoke to become very strongly magnetized, its strength depending on the strength of the current. It will lose its magnetism or become demagnetized as soon as the current is turned off.

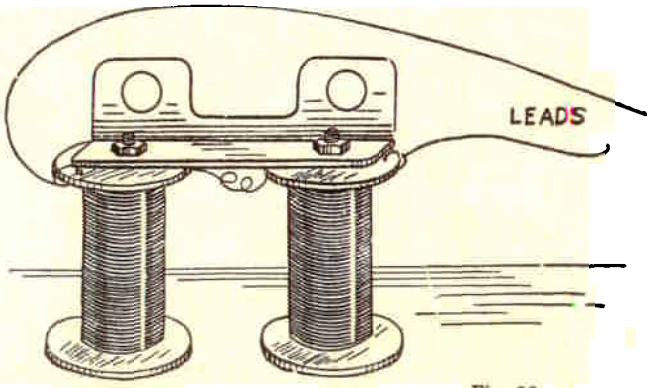


Fig. 29

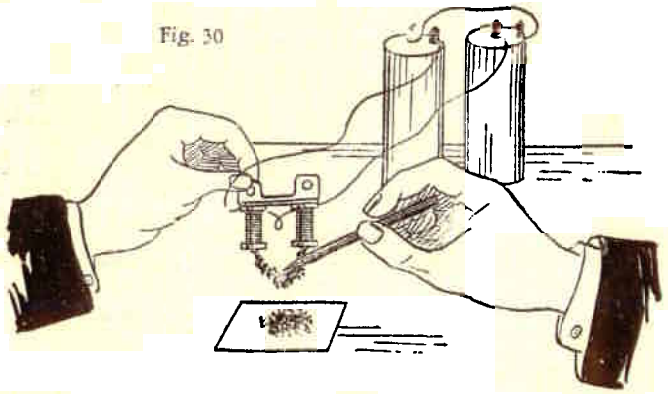
THE SUSPENSION BRIDGE

Pour some iron filings onto a sheet of paper and place the poles of the electromagnet which you have connected to your battery on them. Then lift the magnet and the filings will bridge the gap between the poles. With a pencil push down on the filings between the poles and you will have an iron suspension bridge. Cut off the current and the bridge will fall. (Shown in Fig. 30.)

MAGIC CORK

Conceal a large nail or needle in a cork and place in a shallow dish of water under which you have concealed the horseshoe electromagnet. Connect the wires of the magnet to a battery using your key in the circuit. Arrange the key under the table so you can press it with your foot. Now tell your friends that you can make the cork

Fig. 30



sink or swim at your command. If you fix a head and arms on the cork to resemble a diver, this trick will be much more amusing. When you want him to go down, close the circuit by pressing the key with your foot and the magnet will pull the needle in the man to the bottom of the dish and it will go up again when the circuit is opened.

THE BUZZER

A very common use for the electromagnet is found in the buzzer, illustrated in Fig. 31. When the button A is pushed the current flows from the battery to the

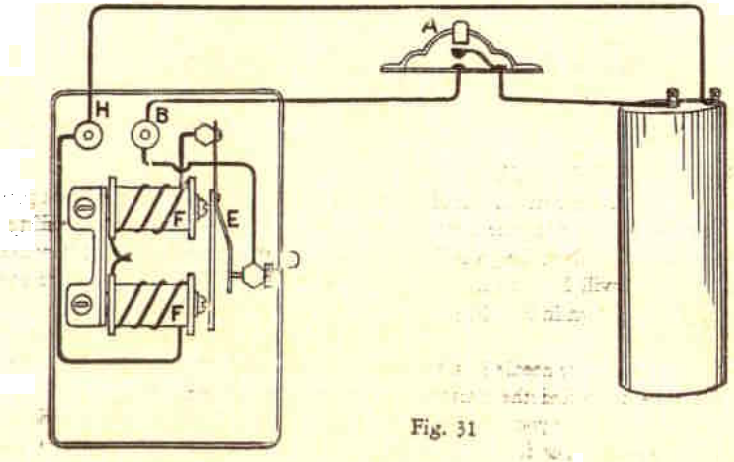


Fig. 31

terminal B, to the thumb screw D. It then goes through the spring E and coils F F to the terminal H and so back to the battery completing the circuit. The coils form an electromagnet and attract the armature. The armature in moving towards the magnet breaks the circuit between the spring E and thumb screw D. The armature then returns to its original position as the coils are no longer magnetized. This causes the current to again flow and the movement is repeated. This continues at a rapid rate until the button is released.

CONSTRUCTING A BUZZER

You can build a very efficient buzzer with the parts in your set. The brass binding posts with a washer under the heads are first put into holes 1 and 2 on the Universal Base and secured by nuts, followed by the terminal nuts. The horseshoe electromagnet which you have already constructed is then fastened to the base by two short screws through holes 3 and 4, washers and nuts going on the under side of the base. The armature support is held down by a screw put through hole 5. Using a small screw fasten the armature to the flat of the support, which is then turned so that the armature is in front of the poles of the electromagnet.

In hole 6 mount the contact support into which insert the contact screw and knurled set nut. The contact should press lightly against the armature spring and the set nut tightened so as to hold it firmly in place.

The buzzer is now complete except for the wiring, which is done on the underside of the base. The two free wires from the electromagnet are passed down through holes 7 and 8 and connections are made as shown in Fig. 32.

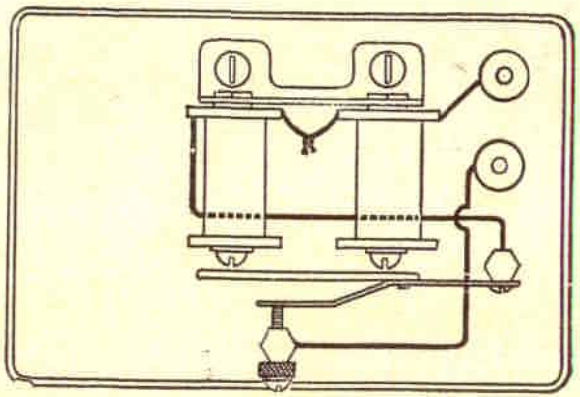


Fig. 32

THE POWER PACK

Your power pack is a device for holding two flashlight cells which are used to provide necessary electrical power for your motor, bell, light and buzzer. Figure 33 shows how the power pack is filled with batteries. It is necessary to have the spring located between the end cap and flat end of battery to insure good contact. Do not connect any wires to the end caps under the clips until you are ready to use the units.

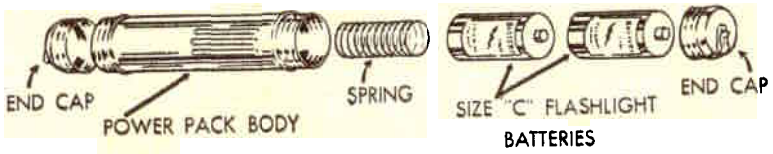


Fig. 33

Note: To turn on — tighten caps.
To turn off — remove end caps.

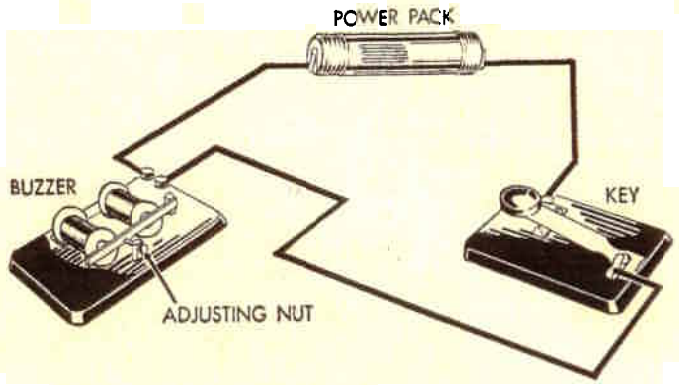


Fig. 34

THE BUZZER TELEGRAPH

Connect up your buzzer, key, and power pack as shown in Figure 34. The tone may be changed by loosening the adjustment nut and slightly turning the adjusting screw, being sure to tighten the nut.

LEARNING TO SIGNAL

Figure 35 shows the International Morse Code. The dots and dashes are determined by the length of time the sender's key is held down. The dash is equal to three dots. You can learn the code very quickly if you practice and gradually build up speed. It will help if some one else practices with you taking turns sending and receiving messages.

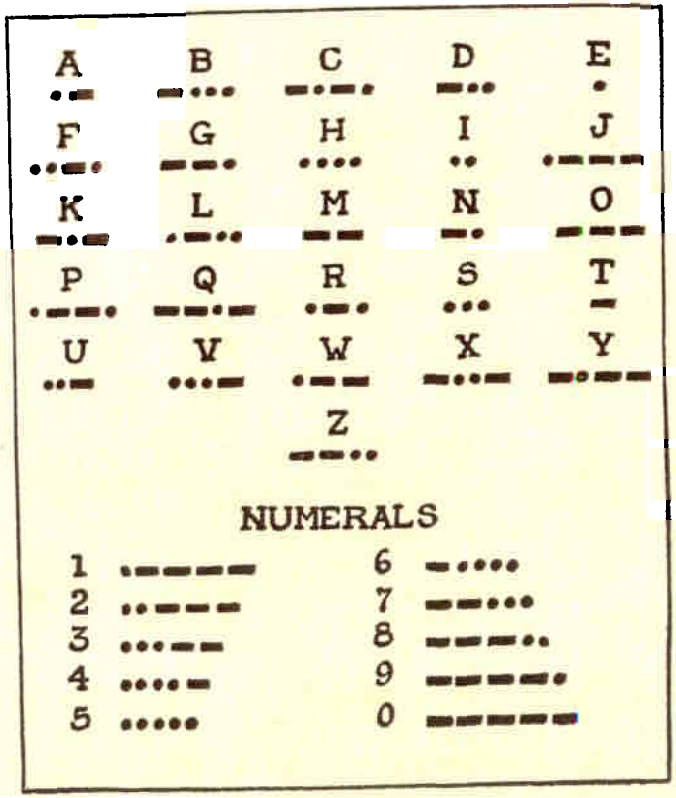


Fig. 35

You can have your own private communicating system with your friends if they have a Gilbert Electrical Set by connecting your buzzers as shown in Figure 36. With this system you can use bells or lights for signaling. When wires are run from one house to another, be certain to support the wires with plastic, glass or porcelain insulators. It must be remembered that the person on the receiving end must keep his key closed so as to complete the circuit.

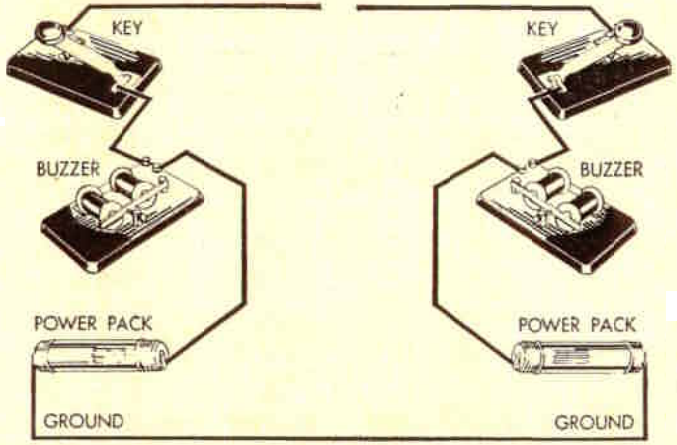


Fig. 36

You can have fun by changing your signaling device from the buzzer to a bell sounder as shown in Figure 37. You will find the bell already mounted on a base in your set. It is necessary to mount a clip under screw holding bell to base. A second clip is fastened to base with nut and bolt. The wire from coil on bell is to be fastened to clip. Remove coating from end of wire with knife.

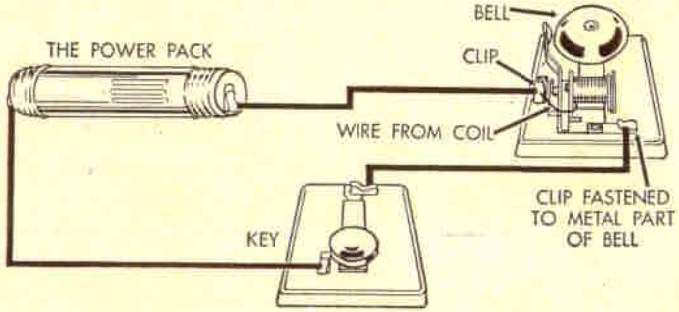


Fig. 37

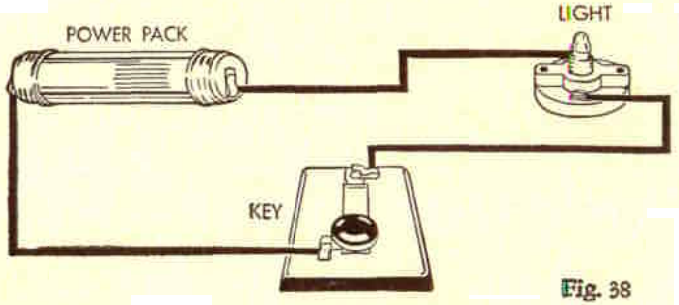


Fig. 38

Figure 38 shows another signaling hook-up.

THE TINY ATOM ELECTRIC MOTOR

You are probably anxious to assemble and run your motor but first a word about the motor.

"Tiny Atom" is a high speed direct-current motor that runs at 6000 R.P.M. (Revolutions per Minute) on one or two flashlight batteries or doorbell batteries. The field is an Alnico permanent magnet. The armature is wire-wound on a laminated steel core — the same type of construction that is used on large-size motors. The bearings are brass sleeves. The brushes are phosphor bronze for long life.

It operates on 1½ to 3 volts. Each dry cell is equivalent to 1½ volts.

Wires from the battery are connected to the two bronze straps that protrude on one side of the motor frame. When connecting the wires, simply put the wire through the hole in the strap and twist over. One caution, be certain the wires do not touch one another or the battery will be short circuited.

A tiny drop of oil applied with a match stem should be placed on each motor bearing occasionally.

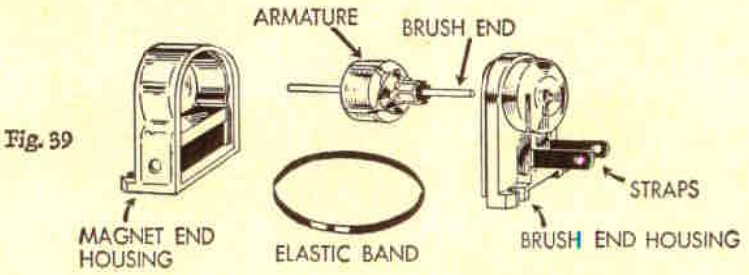


Fig. 39

MOTOR ASSEMBLY

After carefully removing the three basic parts from your set, assemble the motor as shown in Figure 39. The brush end of armature is placed in the Brush End Housing first. Inside this housing you will see the two brushes. Insert the shaft of armature in bearing hole of housing and then by turning the armature, feed the commutator between the brushes. Use extreme care because this is the most important part of the assembly.

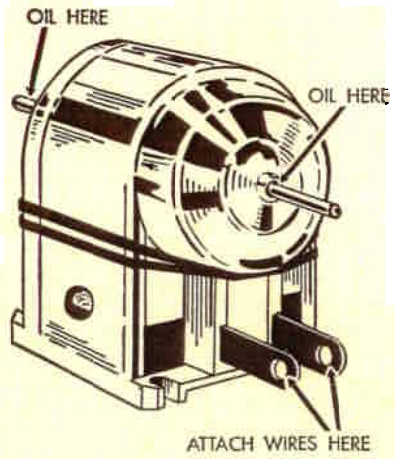


Fig. 40

Now while holding these two parts, insert the opposite end of armature shaft into magnet end housing. Bring both plastic housings together until they lock in place and secure by placing the elastic band around case as shown in Figure 40. The armature should spin free and will run by connecting leads from each end of power pack to straps on motor.

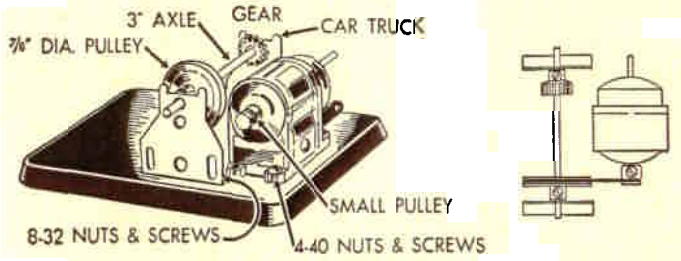


Fig. 41

RUNNING GEARS AND PULLEYS WITH MOTOR

Figures 41 and 42 show suggested hook-ups with pulleys and gears. The motor is fastened to the base using (2) 4-40 screws and nuts through holes 8 and 9. The red car trucks are fastened to base with (4) 8-32 screws and nuts in holes 3, 4, 10 and 13. The small split brushing is placed on shaft of motor and the small pulley fastened to it with set screw. The large pulley and gear are placed on 3" axle. These two parts are fastened to the axle so there is a little end play between car trucks. This shaft must be free turning. When a piece of string or elastic band is placed over the two pulleys, you will see the driving action of this little "Atom" motor. The pulleys may be reversed with the larger pulley being put on the motor shaft.

In Figure 42 you can see the motor running a gear set-up. The set-up as shown is a 3:1 reduction. With the motor shaft (driver) running 6000 rpm, the other shaft (driven) is running at 2000 rpm. This is due to the combination of the 12 tooth pinion gear and the 36 tooth large gear.

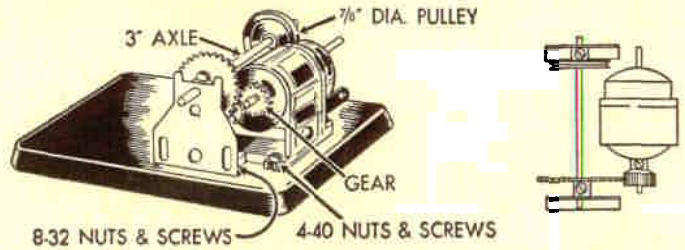


Fig. 42

We are certain that you will derive a great deal of fun in making your own combinations of gears and pulleys.

OTHER APPLICATIONS

There are many applications for this motor in small toys or models. Figures 43 and 44 show two typical applications. As you become familiar with your motor you will find countless other applications for it.

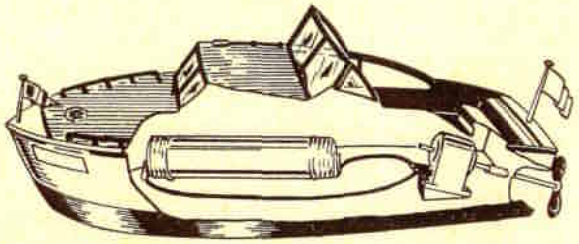


Fig. 43

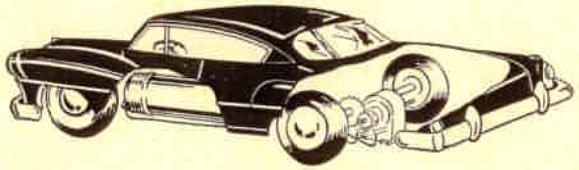


Fig. 44