SOLAR ENERGY

BOOKLET EXPLAINING THE WHYS AND HOWS OF SOLAR ENERGY

HARNESS
THE
POWER
OF
THE SUN

POWERED BY THE SUN ....

Congratulations, you have just purchased a very unique solar powered model. In the age of rising energy costs, the idea of a free and virtually limitless energy source seems too good to be true. For years scientists have experimented with various methods of capturing the abundant energy radiated from our sun. Today, although far from perfected, solar technology has been advanced to a point where we have learned how to harness and utilize the sun's power. Time, research and money will bring to the market place new products that will be energy savers needed by the entire world. Your Solar model is designed to demonstrate the potential of solar energy. We hope that you will enjoy and educate others regarding this energy source of the future.

SPACE AGE TECHNOLOGY

Your Solar model is powered by means of a tiny disc which actually converts light into electricity. This disc, more commonly referred to as a photovoltaic (photo meaning light and voltaic meaning producing electricity) or solar cell, is the result of the extensive research and development which went into the space program. Scientists originally developed photovoltaic cells as a means of recharging batteries and powering various systems contained in spacecraft. These tiny cells have contributed greatly to the success of the space program.

Research and development of solar cells increased on a fairly large scale. Cost was not the big factor ..... weight was the big factor, even the critical factor. Every additional ounce put into orbit had to be carefully considered. The efficiency of solar cells increased and manufacturing techniques improved. Solar cells become lighter and less expensive. In many cases, batteries could be eliminated completely and solar cells used to supply all the electrical power required to operate the quipment aboard satellites. This research has helped to open the door to the unlimited potential for applying solar technology to industry and to our private lives.

CARE AND MAINTENANCE OF SOLAR CELLS

Though it may be hard to believe, these lightweight solar cells never wear out or require any maintenance. Do not drop or abuse the solar cell or solar cell module, as the material it is made from is similar to glass and will break. We are not responsible for solar cells which are damaged due to mishandling. The motor provided with your Solar model requires no maintenance and its operation should exceed the models lifetime.

To clean, a simple blowing with your breath removes dust and most foreign objects. We recommend wiping with a soft cloth and glass cleaner.

HOW DO SOLAR CELLS WORK?

Most of the solar cells in volume production today are made with silicon. This plentiful natural resource makes up more than one fourth of the earth's crust and is the chief component of ordinary sand. The silicon used in the production of solar cells must be purified to a very high degree. A large part of the cost of solar cell production results from the painstaking task of removing all but the slightest traces of impurities in order to produce the highest quality silicon.

To make the solar cell which powers your Solar model, we start with a thin disc of almost pure silicon crystal. When the silicon crystal is being formed, a small amount of boron is added. The boron gives the crystal structure a unique characteristic. It actually has a positive electrical charge. Since this part of the solar cell has a positive charge it is referred to as "P" type silicon and it forms the base of the cell.

Next, a very thin layer of silicon crystal is formed over the disc of "P" type silicon. However, instead of adding boron, this time a small amount of phosphorous is added to the mixture. The phosphorous provides a negative charge and thus is referred to as "N" type silicon.

The two halves of the solar cell, one "P" type silicon and the other "N" type silicon, cancel each other out to produce a neutral cell.

When sunshine penetrates to the junction of the "N" type and "P" type silicon cell layers it creates a flow of electrons throughout the crystal structure. The crystal structure of silicon contains empty areas which will accept electrons. As one electron moves to fill a hole, it creates another hole. It is this flow of electrons which produces electricity.

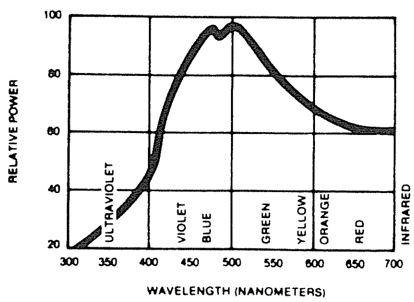


FIGURE 1

Sunlight contains many colors of light. Color and the relative power in each color of light is determined by the measure of the wavelength. Figure 1 plots the relationship between wavelengths and color along the spectral distribution of ordinary daylight.

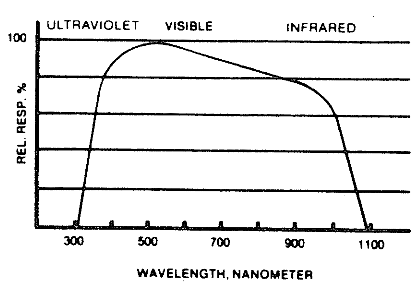


FIGURE 2

The relative response of a typical silicon solar cell across the light spectrum is represented in figure 2. As we can see from this chart, silicon solar cells have a high response over a broad range of wavelengths.

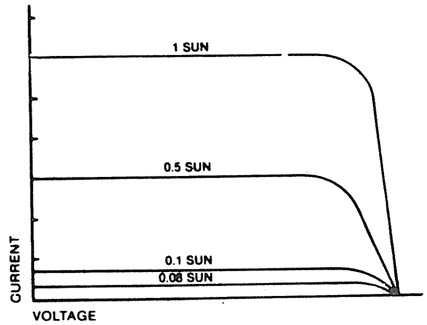


FIGURE 3

In most circumstances, solar cells are not exposed to maximum levels of sunlight. Figure 3 shows the resulting output of a solar cell when exposed to maximum and lesser amounts of sunlight. Notice that the terminal voltage is not significantly effected by the amount of light.

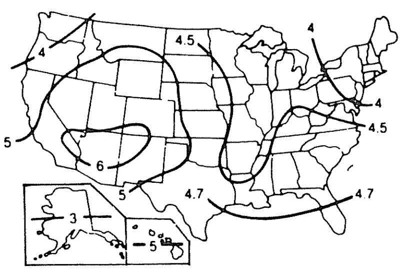


FIGURE 4

The average number of peak sun hours per day varies from one area of the country to another. Figure 4 shows the yearly average peak sun hours and in turn the potential for solar energy applications for different parts of the country.

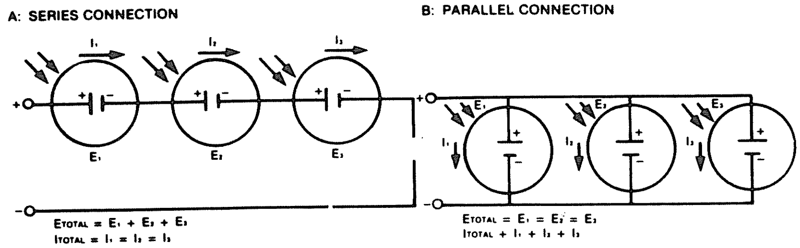


FIGURE 5

In order to transmit the electricity provided by sunlight activating the "N-P" junction of the solar cell, simply attach a conductor (copper wire) to each half of the cell. The resulting electrical current is determined by the square area of the cell being used at about one-half volt. To vary the amount of current or voltage produced, cells can be connected in series and/or parallel. Figure 5 illustrates that when multiple solar cells are connected in series the voltage (E) is increased, but the current (I) remains constant. Conversely, when multiple solar cells are connected in parallel the result is increased current without altering voltage output.

OPERATION OF THE SOLAR MODEL

Your model will function best when the solar cell or solar cell module is placed in direct sunlight. For best performance, place in an east, south or west window. In the event you don't have a window facing the sun or you prefer unlimited operation, an artificial light source can be utilized to power your model. The distance from the artificial light source to your model will depend on the wattage of your light source. We recommend using a 150 watt floodlight PAR 38 G.E. outdoor approximately 8 to 18 inches above your model to obtain maximum performance.

SOLAR CELL MODULE

If your model comes supplied with an encapsulated solar cell module for remote light pick up, place the solar cell module in a window (with supplied clear suction cup) or inside a table lamp. As you can see you can operate your Solar model day or night. The solar cell is encapsulated in a protective collector lens to prevent damage and comes complete with miniature wire.

Do not subject the solar cell module to an excessive heat location, as it will warp the plastic lens. Remember, it is not heat that makes your model function, it is light. A little experimentation will tell you what setting makes your model work best!

Please handle all models with care.

WHAT DOES THE FUTURE HOLD?

Although the solar cell described in the previous section will provide enough power to operate your Solar model, a more efficient system must be developed in order to produce enough electricity to satisfy average consumer needs. Some of the concepts currently under study include: solar cell arrays on individual buildings which will be designed to supply all of that building's electrical requirements; massive central systems erected in selected locations which receive abundant sunlight capable of serving an entire distribution system and even central orbiting systems in space which will beam power back to earth and then on to individual users.

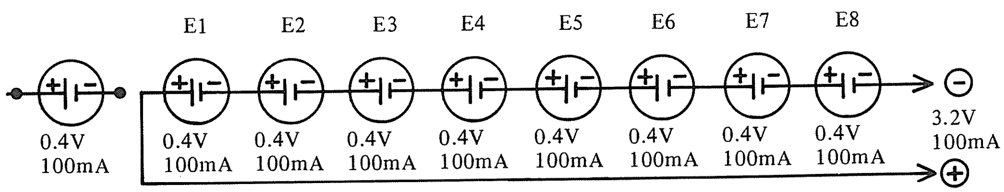
Practical applications of solar energy will be plentiful in the years to come. Some uses in the not too distant future include: electrical power for remote areas; battery recharging for appliances, radios and TV's.

The technology of solar energy is still in the formative stages, however much of what is known today can and is being applied by innovative individuals. Our company, is one company dedicated to advancing the use of solar power and we are leaders in our own particular specialty. Our products are designed to be both educational and entertaining. We feel that with the development of this free, non-polluting energy source ..... the future looks bright.

HOW MUCH POWER CAN YOU GET FROM SUN BATTERIES.

There is no limit to the amount of electricity you can produce from sunlight. The more cells you use, the more power you get. Just remember that you increase the voltage by connecting the cells in series, as shown in figs. 6 and 7. If you make the connection in parallel, you increase the current (amperage). Cells may be connected in parallel or in series to get more voltage and more current.

To increase the voltage connect the cells in series but the current (I) remains constant (negative point connect to positive point)



E Total = E1 + E2 + E3 + E4 + E5 + E6 + E7 + E8
I Total = I(1) = I(2) = I(3) = I(4) = I(5) = I(6) = I(7) = I(8)

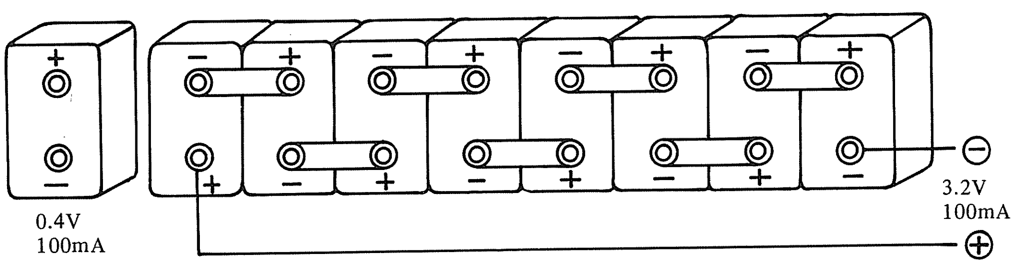
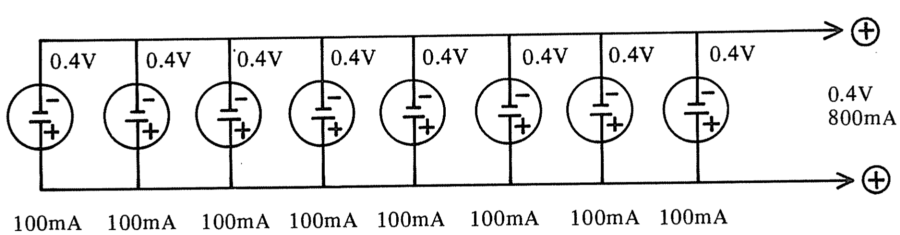


Figure 6. Each cell output is 0.4V x 8 pcs = 3.2V
but the current (I) remains constant = 80mA

To increase the current (amperage) connect the cells in parallel. (Negative point connect to negative point, positive point connect to positive point). Each cell output is 100mA x 8 pcs = 800mA but the voltage (E) remains constant = 0.4V



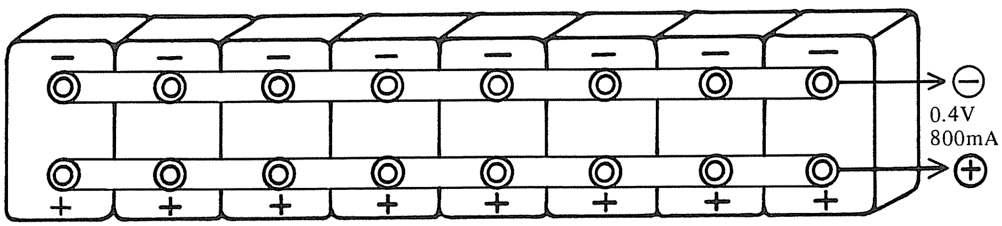
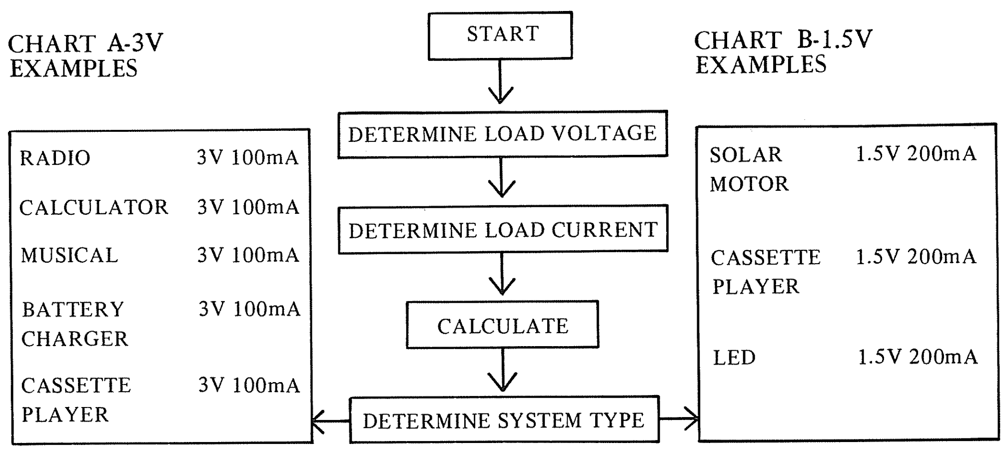


Figure 7. I total I(1) + I(2) + I(3) + I(4) + I(5) + I(6) + I(7) + I(8)
E total E(1) = E(2) = E(3) = E(4) = E(5) = E(6) = E(7) = E(8)

HOW TO MAKE A SOLAR PANEL FOR YOUR APPLIANCE



Calculation
Each solar cell output is Voc 0.4V = 0.5V
Isc 80mA – 100mA

We use the figure of 0.4V 100mA for simple calculation

eg. Fig A-3V
How many pieces of solar cells are needed to make a solar panel for a radio consumption of 3V 100mA?

$$\text{Pieces} = \frac{\text{Radio consumption 3.2V}}{\text{Each cell 0.4V}}$$
$$= \text{8 Pieces}$$

8 pcs of cells x 0.4V = 3.2V

e.g. Fig B-1.5V
How many pieces of solar cells are needed to make a solar panel for a solar motor kit consumption of 1.5V 200mA?

$$\text{Pieces} = \frac{\text{Solar motor kit 1.6V}}{\text{Solar cell 0.4V}}$$
$$= \text{4 Parts cells}$$

4 parts cells x 0.4V = .1.6V

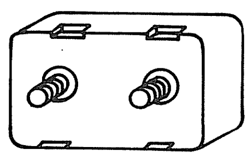
Use 8 pcs of cells to connect in series to increase the voltage, but the current (I) remains constant = 100mA. The solar panel output is Voc 3.2V, Isc 100mA see Fig. 11

Use 2 pcs of cells to connect in parallel to increase the current (I) 2 pcs x 100mA = 200mA of each part. Then use 4 parts of 200mA to connect in series to increase the voltage, 4 parts x 0.4V = 1.6V Now the solar panel output is 1.6V 200mA see Fig. 12

There are many uses of a solar panel, just use your imagination. If your appliance requires 3V 300mA consumption then you need two more solar panel kits to connect in parallel 100mA x 3 pcs solar panel = 300mA

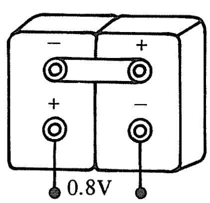
Below are some connecting methods of making solar panels for your reference. Use your imagination to design the connections, remember to increase the voltage – use in series connections, to increase the current – use in parallel connections.

Each solar cell output
is Voc : 0.4V – 0.5V
Isc : 80mA – 100mA
Size : 26x46x7mm



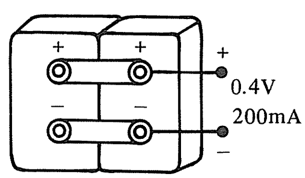
use the Figure of 4V 100mA for simple calculation

Fig 8



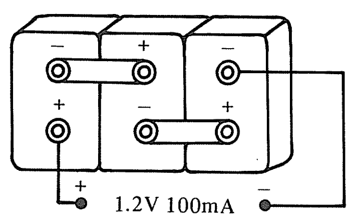
Make in series connection

Fig 9



Make in parallel connection circuit

Fig 10



Make in series system

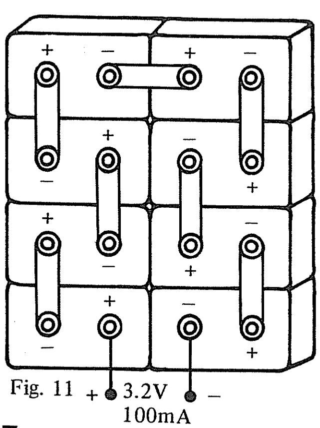


Fig. 11

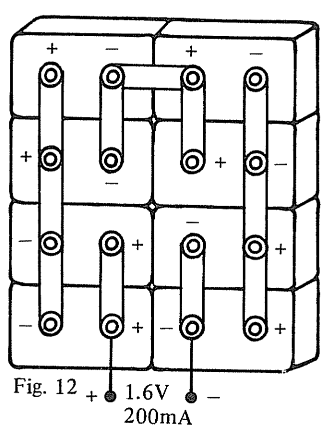


Fig. 12

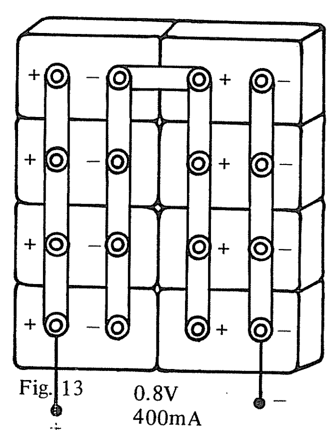


Fig. 13

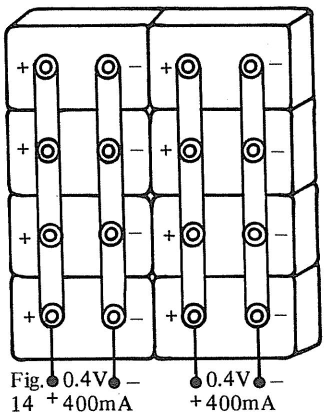


Fig. 14

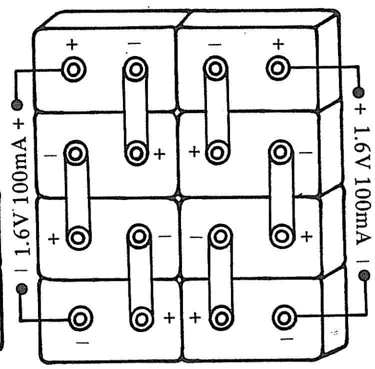


Fig. 15

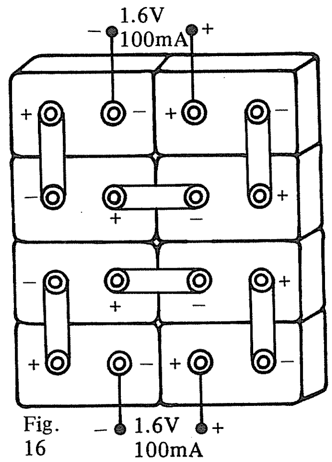


Fig. 16

HOW TO MOUNT THE SOLAR CELLS AND SOLAR MOTOR FAN

1. Use the plastic spanner to undo the screw's nut and move the copper link and washer from the back of the solar cells. See fig. A

2. Place all the copper links, washers and nuts in the poly bag or a match box for safe keeping as they will be used again for reconnection.

3. Insert the solar cells in the plastic tray to make the solar panel. See fig. B

4. Make sure that the polarity (Negative and Positive) of the solar panel is correct as set out in your circuit format i.e. fig. 12

5. On the back of each solar cell the positive and negative are shown. These show through the holes in the back of the tray to enable you to check that your solar cells have been placed in the correct order as per your circuit format. See fig. 12 and fig. D

6. Connect the solar cells using the copper links and washers, tighten the screw nuts with the plastic spanner. See fig. C

7. To make a solar panel for the solar motor fan. The output of the solar panel required is 1.6V 200mA. Therefore, use 2 pcs cells to connect in parallel to increase the current (I) 2 pcs x 100mA = 200mA for each part, then use 4 parts of 200mA to connect in series to increase the voltage for the output 1.6V and 200mA. See fig. 12 and Chart B-1.5V.

8. To make a solar panel for a radio consumption of 3V 100mA, the output of the solar panel required is 3.2V 100mA, therefore, use 8 pcs of cells to connect in series in order to increase the voltage. That means 8 pcs x 0.4V = 3.2V but the current remains constant 100mA. Now the solar panel output is 3.2V and 100mA. See fig. 11 and Chart A-3V.

9. Connect the wires, washers and nuts to the solar panel. See fig. D

10. Insert the motor into the plastic motor holder. See fig. E

11. Join the plastic motor holder and stand together with a screw and nut and tighten. See fig. F

12. Put the fan on the motor spindle. See fig. F

13. Connect the wire clips to the motor's conductor. See fig. G

14. Insert the stand into the plastic base keyhole or the solar panel's keyhole by twisting tightly. See figs. H & I

15. The solar motor fan can be adjusted to any angle.

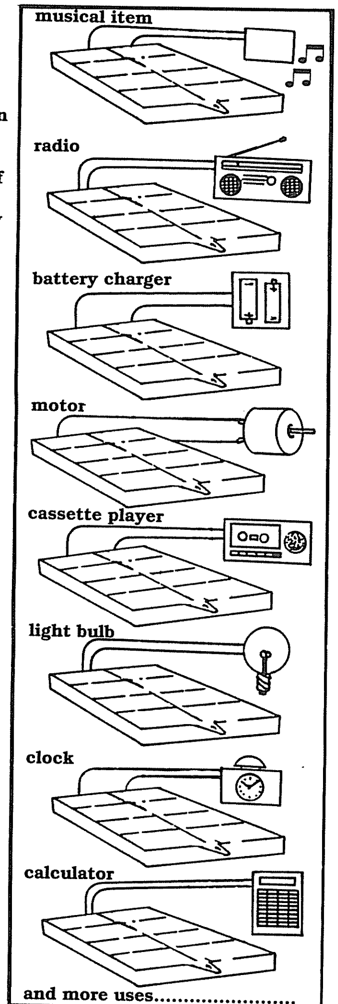
16. Place the solar panel to directly face the sunlight for the best performance.

17. If there is no sunlight, and you prefer unlimited operation, an artificial light source can be utilized to power your model. The distance from the artifical light (100W) should be 5 inches approximately

NOTE: WHEN USING PLASTIC SPANNER, DO NOT OVERTIGHTEN SOLAR PANEL'S SCREWS.

EDUCATIONAL SOLAR ENERGY KIT

USES



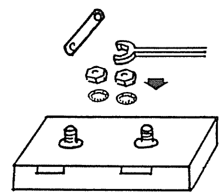


Fig. A undo the screws

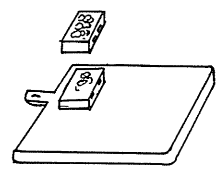


Fig. B insert the solar cells in the correct circuit format in the plastic tray

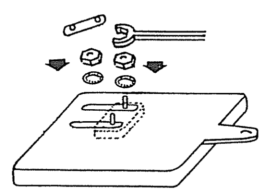


Fig. C position the copper links in the correct circuit format and tighten screws

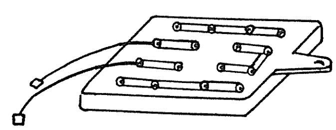


Fig. D connect the wires

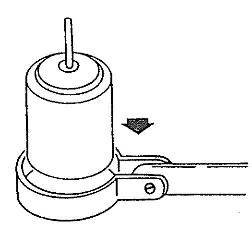


Fig. E insert the motor into the plastic holder

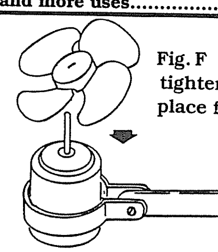


Fig. F tighten screw and place fan on spindle

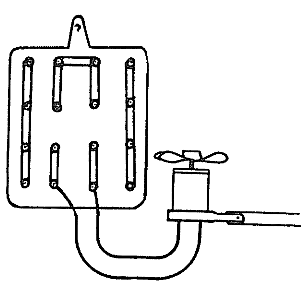


Fig. G connect the wires to the motor

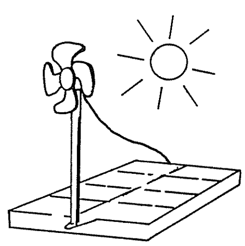


Fig. H

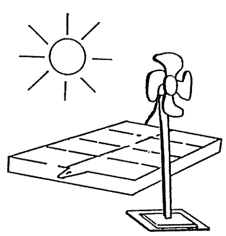
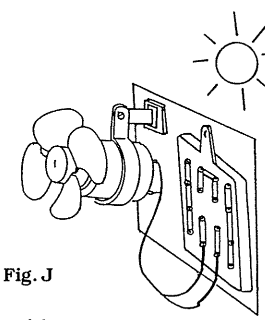


Fig. I



you can hang on the glass of the window

Fig. J

position fan as per figs. H , I and J