

ION PROPULSION IS A REALITY!

On October 24, 1998, NASA launched the spacecraft Deep Space 1 with a remarkable new ion drive. The Deep Space 1 mission was the first launch of NASA's New Millennium program. This is the first time that ion propulsion has been used as the primary means of propelling a spacecraft.



In a spacecraft, ion propulsion has advantages over conventional chemical propulsion systems. It can operate on a small amount of fuel for extended periods of time.

The limitations of ion propulsion are that it produces very low thrust and uses a lot of electricity. The engine on Deep Space 1 consumes 2,500 watts of electrical power at full throttle, but only exerts 1/50th of a pound of thrust. However, given extremely long periods of time, an ion thruster can allow a spacecraft to achieve theoretical velocities over 60,000 miles per hour.

Since NASA's ion engine works in the vacuum of space, it uses xenon gas as a fuel. Solar panels on the spacecraft generate the electricity needed to ionize the gas and to charge a grid in the engine's chamber to a 1,200 volt potential. The charged grid exerts a strong electrostatic pull on the xenon ions. The electrostatic force is powerful enough to cause the xenon ions to reach an exhaust velocity over 30 kilometers per second.

BUILD YOUR OWN ION PROPULSION MOTOR

Now you can build your own ion propulsion motor that works

on the same basic principles as NASA's Deep Space 1 craft. This project uses a high-voltage potential that generates four streams of "ion wind." The ion streams exert enough force to spin a rotor at a remarkable speed. This high-tech device makes a great science project or an interesting desktop toy. The ion motor also generates negative ions, which can reduce pollen and pollution in the air to produce a healthier environment.

The ion motor in this project doesn't need exotic gases for fuel, because it ionizes regular air. Figure 1 is a block diagram that demonstrates the motor's principles.

A wall transformer provides nine volts DC to a step-up voltage converter. The DC-to-DC converter boosts the nine volts to a negative potential of over 10KV. The output current of the converter is limited to a safe level of less than 0.5 milliamps. The high-voltage is connected to a metal pivot pin and a PC board rotor is balanced on the point of the pin. The rotor has four ion discharge points made from four bent pieces of solid wire.

During operation, the four wire tips on the rotor get charged to 10,000 volts and the strong negative potential affects the surrounding air. Any air molecules that come near the wire tips become negatively charged "ions."

Since opposite charges attract

and similar charges repel each other, the negative air molecules are repelled from the negative wire tips. As the air moves quickly away, it creates an "ion wind." It also generates a reactive force on the wire tips that causes the rotor to spin on the pivot pin.

The neutral side of the DC-to-DC converter is connected to an aluminum plate on the bottom of the ion motor's enclosure. This metal plate is at a higher voltage potential than the negatively charged air ions. Therefore, it attracts some of the ions and gives the rotor additional speed.

CONSTRUCTION

All the parts for the ion motor are shown in the Parts List. The rotor is made from a small printed

circuit board. The foil layout for the PC board is shown in Figure 2.

Begin by inserting one of the pin sockets in the center of the PC board rotor as shown in Figure 3. Solder the socket in place and then insert and solder the four jumper wires on the rotor. Trim any excess wire from the bottom side of the rotor, and then bend the four wire tips as shown in Figure 4.

Next, take the wall transformer and cut off any connector from the end of the wires. Then separate the two wires for a distance of 1 inch and strip back about 1/2 inch of the insulation from each wire. Identify the positive (+) wire and twist it together with the red wire on the high voltage power supply. Use a plastic wire nut to hold the two wires together. Take the nega-

tive (or ground) wire from the transformer and twist it together with the black wire on the high voltage power supply. Solder the two wires to the metal ring lug as shown in Figure 5.

Place the high voltage power supply on the aluminum base plate and attach it to the plate with a #4-40 screw and hex nut. Make sure to place the ring lug under the nut as shown.

Now insert the remaining pin socket in the plastic case. Turn the case over and solder the high voltage output wire to the pin socket as shown in

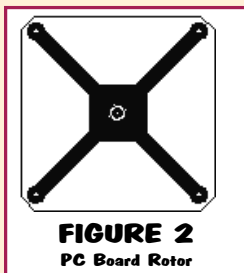


FIGURE 2
PC Board Rotor

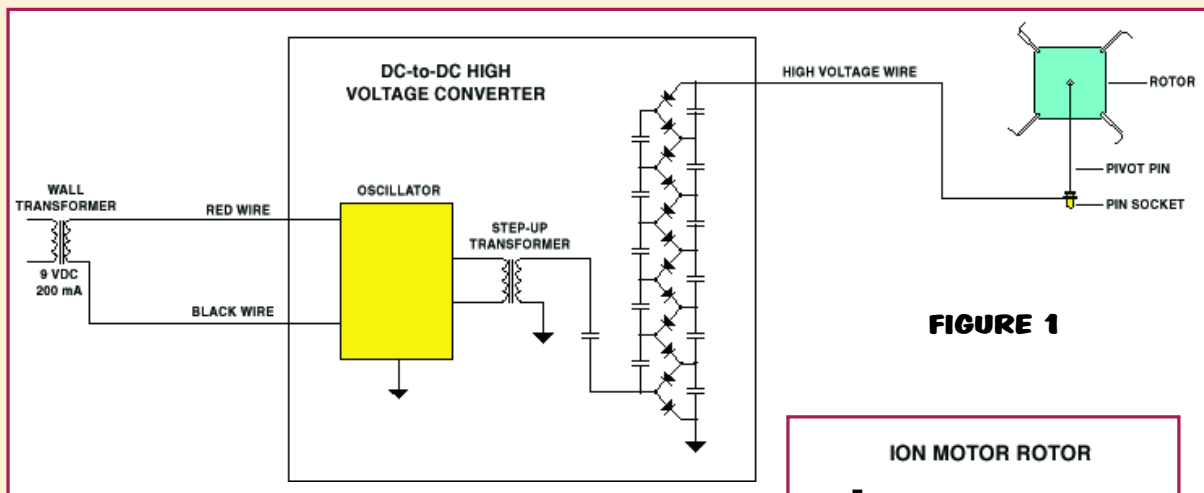


FIGURE 1

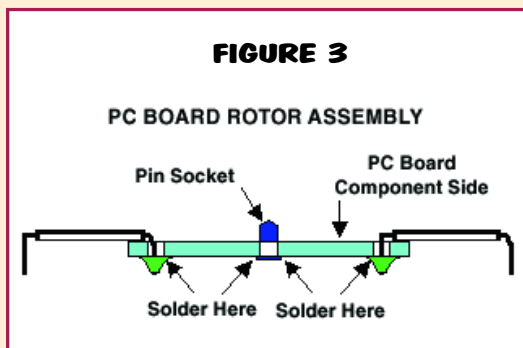


FIGURE 3

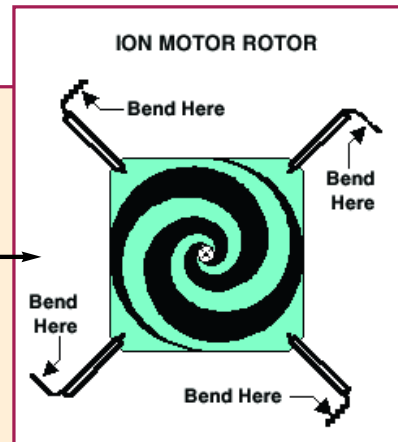


FIGURE 4

Figure 6. Carefully place the plastic case over the assembled baseplate and guide the transformer wire through the slot in the plastic case.

When everything is fit together

properly, refer to Figure 7 and attach the aluminum baseplate to the case with four screws. Locate the four rubber adhesive feet and apply them to the corners of the aluminum plate.

Locate the metal pivot pin. This is a quilter's "T" pin with the "T" section cut off. Insert the pivot pin into the pin socket on top of the plastic case. Then place the rotor onto the point of the pivot

pin. It should be balanced and should spin freely.

Read the safety precautions below before you plug in the wall transformer. As soon as the wall transformer is plugged into a wall

SAFETY PRECAUTIONS

This project contains high-voltages and a sharp pivot pin. The current has been limited to a safe level, but the unit can deliver small "static electricity" shocks. Keep the Ion Motor away from children at all times.

Never leave the point of the pivot pin exposed. Always remove the pivot pin from the pin socket whenever the unit is not in use or whenever the rotor is removed.

Do not touch any metal surfaces on the ion motor while power is on. The Ion Motor can generate "static electricity" sparks, so do not operate the unit near combustible materials or gases.

Do not run the Ion Motor near electronic equipment including computers. The Ion Motor can cause an electrical charge build-up inside nearby equipment that could damage electronic circuits. Do not use any electronic equipment to make measurements on the Ion Motor.

Never use the Ion Motor to charge a capacitor or Leyden jar. Fatal voltage and current levels can result.

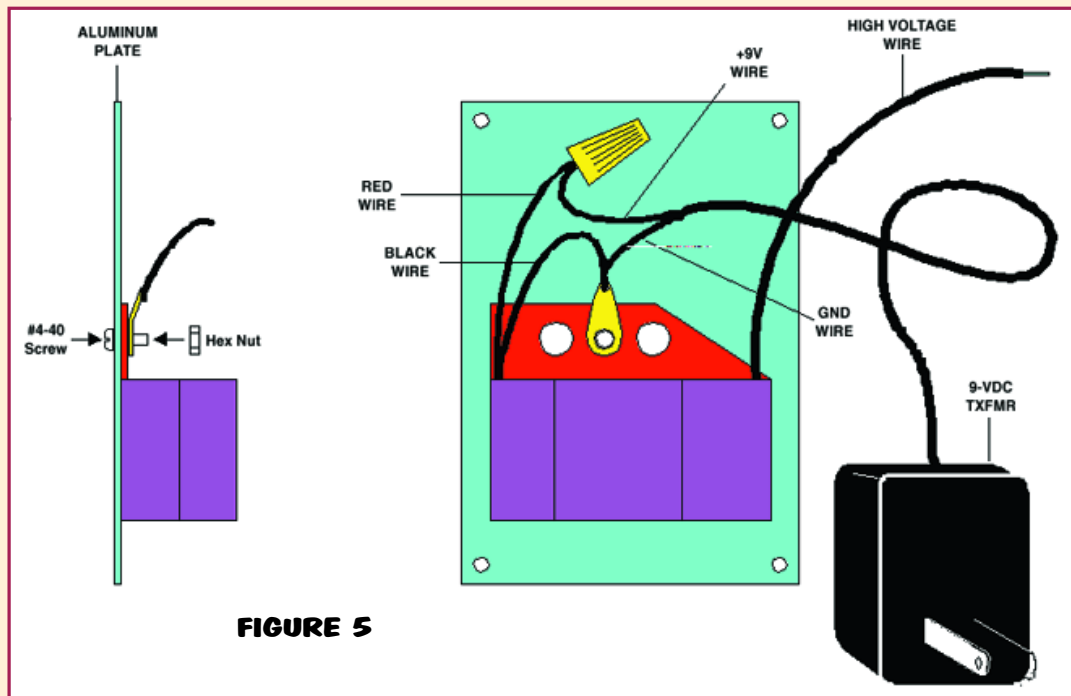
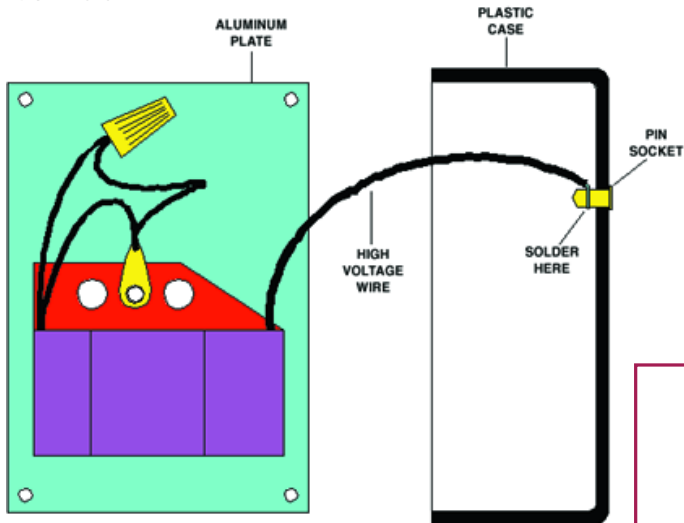


FIGURE 5

FIGURE 6

outlet, the rotor should begin to turn and then gradually pick-up speed.

You can leave the Ion Motor running continuously, and it will add negative ions to the room. There have been many studies of the effect of negative ions on people. The results indicate several positive effects including: mood enhancement, reduced airborne contaminants, and improved physical performance. The FDA limits health claims on negative ion generators, but you can experiment and determine the benefits for yourself.

ADDITIONAL EXPERIMENTS

It was mentioned earlier that the aluminum plate on the bottom of the enclosure attracts the ions and increases the speed of the rotor.

You can investigate this phenomenon further by getting another metal panel and connecting a wire from it to the aluminum plate on the bottom of the ion motor. Place the new movable metal panel near the rotor and watch the rotor speed increase. Be careful to not get the metal so close to the rotor that sparks occur.

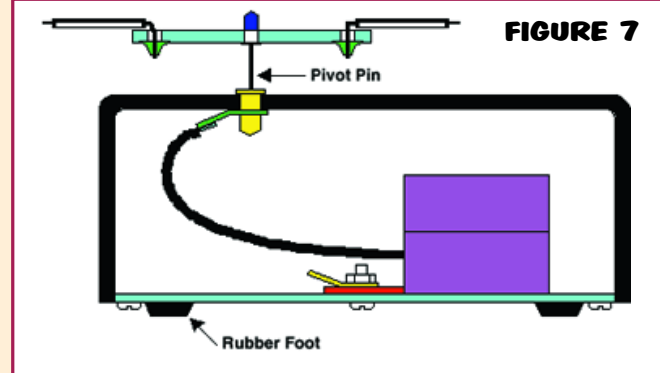
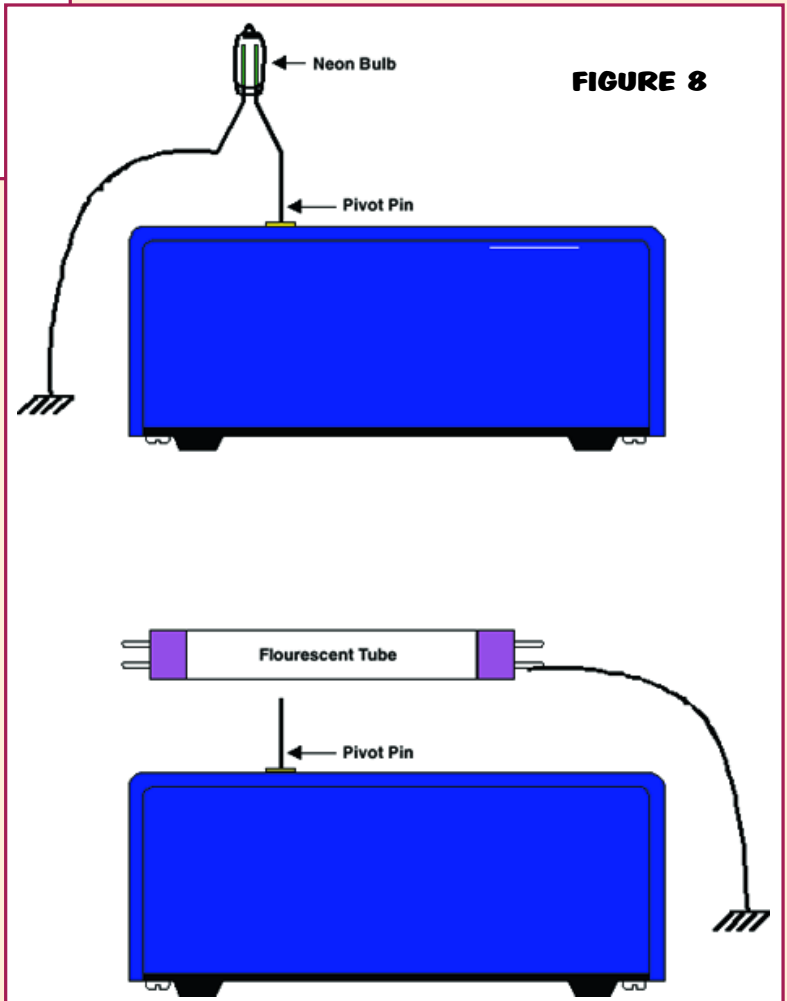
How does this work? Well, the attractive force between two different voltage potentials varies inversely as the square of the distance between them. This means



the forces are much stronger as the surfaces get closer together. In fact, that is why you get a spark if the plate is too close to the rotor. With 10KV and a small gap, the attraction is so incredibly strong that the air ionizes to a plasma and the voltage jumps across the plasma in the gap.

Refer to Figure 8 for other ways the unit can be used for high voltage experiments. A neon bulb will glow when one leg is grounded and the other leg is brought near the pivot pin. A fluorescent bulb will generate an even more interesting glow in a similar configuration. In both cases, you are seeing the ionization of the gases in the tubes.

Note that using neon or fluorescent bulbs for high voltage experiments may leave the bulbs unusable. **NV**

FIGURE 7**FIGURE 8**

PARTS LIST FOR THE ION MOTOR

TXFMR Nine-volt DC, 200mA Wall Transformer.
 PS 10KV DC Step-up Power Supply.
 ENCL Phenolic Plastic Enclosure.
 PCB PC Board for Rotor (ION0399).
 JP1-4 Solid Wire Jumpers (four each).
 SOK1-2 Metal Pin Sockets (two each).
 PIVOTPIN Quilter's "T" Pin used as Rotor Pivot.
 BASEPANEL Aluminum Panel Enclosure Bottom.
 FEET Adhesive Rubber Feet (four each).

MISC. PARTS
 - #4 Screws (5 each) - #4 Nut - Wire Nut - Metal Solder Tab

The following items are available from:
LNS Technologies, P.O. Box 67243, Scotts Valley, CA 95067;
 Phone: 831-768-9155; www.techkits.com
ION MOTOR-KIT: Complete kit of parts for the Ion Motor including printed circuit board rotor, drilled plastic case, high-voltage power supply, transformer, and all other components listed above \$29.00. Please add \$5.00 shipping/handling. California residents add 8% sales tax. MC/VISA orders accepted. No COD orders.