(see photos). Today's bench-sized demonstration units typically have 12-inch diameter plates. During the heyday of electrostatics, larger Wimshurst machines (used for research or powering early X-ray machines) had multiple pairs of plates several feet in diameter.

Each Wimshurst machine develops a maximum electrostatic potential based on the number of plates used, their diameter, and the spacing between them. Interestingly enough, increasing the rotating speed of the plates does not increase the maximum discharge voltage. Only increasing the number of pairs of plates increases the discharge voltage.

The plates can be any sturdy, nonconducting material, such as glass or plastic (see Fig. 2). The plates are mounted in pairs, separated by a quarter-inch gap, on a horizontal shaft. The closer the plates are mounted to each other, the better the machine will operate. The plates are turned by belts and pulleys from a common crankshaft, but they rotate in opposite directions. A difference in pulley diameters causes the plates to spin several times faster than the handcrank.

Metal-foil strips called "sectors" are evenly spaced along the outer surface of each plate. Those help extract excess charges from the non-conductive plates.

The charges that accumulate on the sectors are removed by pairs of collecting combs made of tinsel threads. Each pair of combs is mounted on a U-shaped bracket, with one brush touching the front plate and the other brush touching the rear plate. The two U-shaped brackets are mounted opposite one another. They carry the accumulated charges to the machine's discharge balls.

There are two "neutralizing rods" that span the diameter of each plate and also have metal tinsel combs on each end. The front and rear rods are perpendicular to each other and are positioned at an angle of 45° to 60° from the machine's base.

In addition to the three basic parts of a Wimshurst machine, they typically have two built-in Leyden jars, which are very simple glass and foil capacitors. Each Leyden jar can be electrically connected to a collecting comb by means of a hinged rod. If the Leyden jars are not connected to the collecting combs, then a continuous arc jumps between the discharge balls when the handcrank is turned. If the connecting rods are lifted to touch the collecting combs, then a sharp (and intense) snap of electricity jumps between the discharge balls every few seconds.

It is important to notice that all the metal parts of a Wimshurst machine are built with rounded edges. A fundamental rule of electrostatics is that charges find it much easier to "jump" from a pointed surface than from a rounded one. Any sharp points on the machine would allow the charges to dissipate quickly.

How it Works. Remember that the Wimshurst machine is an induction device. It doesn't depend on friction to make an electrostatic charge. As you'll see, quadrants of negative and positive charge are created across the plates by induction between the front and rear plates. As the plates rotate, these positive and negative charges are syphoned off through the metal sectors by the collecting combs.

As you may recall, the principle of induction requires that an object be initially charged before you can use it to induce a charge in something else. That holds true for the plates on the Wimshurst machine. Even before you crank the handle the plates have some static charges on their surface. The charge is created from the incidental rubbing and handling of the machine, and the machine actually amplifies this initial imbalance of charge.

Resources.

Wimshurst electrostatic generators are available from Edmund Scientific Company (Cat. No. B70,070), 101 E. Gloucester Pike, Barrington, NJ 08007-1380; Tel. 609-573-6250, and from The Chem Shop, 1151 South Redwood Road, Salt Lake City, UT 84104; Tel. 801-973-7966.

See the following books for more information:

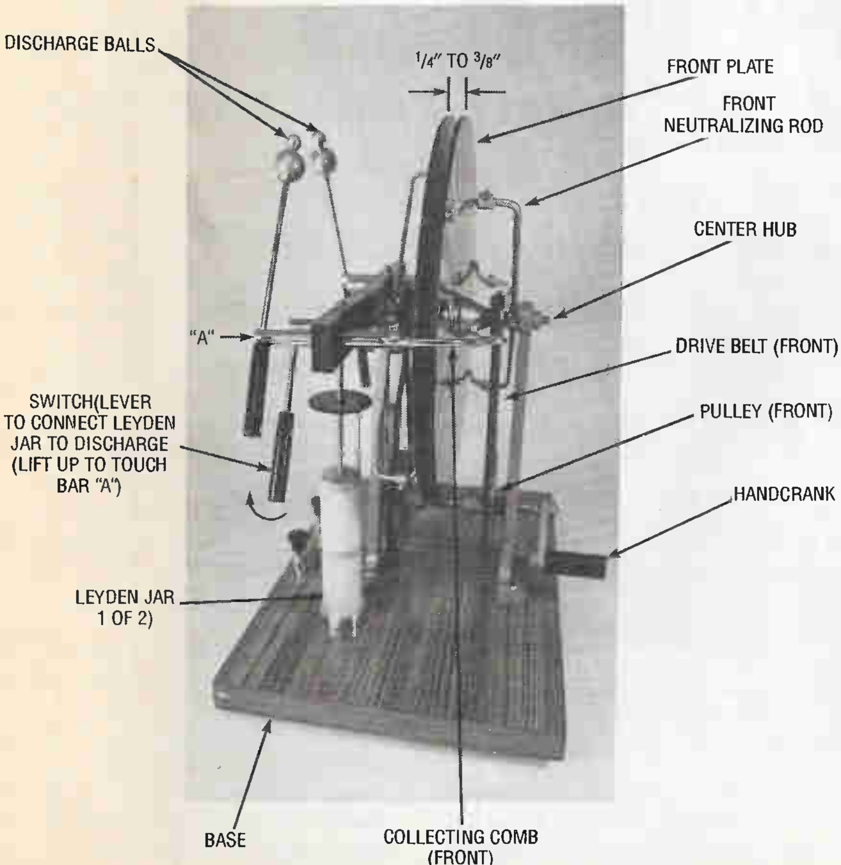
The Wimshurst Machine: How to Make and Use It, by Alfred W. Marshall; Lindsay Publications, Inc., P.O. Box 12, Bradley, IL 60915-0012.

Electrostatics: Exploring, Controlling and Using Static Electricity, by A.D. Moore; Anchor Books, 1968.

Handbook of Electrostatic Discharge Controls, By Bernard S. Matisoff; Van Nostrand Reinhold Company, 1986.

Electrostatics: Principles, Problems and Applications., By Jean Cross; Adam Hilger, 1987.

Homemade Lightning, By R.A. Ford, Book #3576, TAB Books, Blue Ridge Summit, PA 17294; Tel. 800-233-1128 or 717-794-2191.



The Wimshurst machine is composed of many parts. However, not all Wimshurst machines have Leyden jars although this one does.