

are formed by cutting half from each plate, a very simple matter as compared with cutting the three holes from an entire disk. The lateral holes are two and three-quarter inches long, and one and three quarter inches wide at the larger end, and their sides are nearly on radial lines extending from the center of the disk. The central opening through which the sleeve, C, extends is approximately circular, but is slightly elongated at *ee*, to facilitate the removal of the portion cut out. Of course the simplest way to get the glass into the desired shape is to have a glazier cut it with his diamond, but any one may do it with one of the twenty-five cent steel roller glass cutters sold everywhere. The disks of the machine represented were cut in this way, and the notches in the semicircles of the fixed disk were cut with one of these inexpensive yet useful tools. The only precaution necessary in cutting the notches is to make them rather flaring to permit of the removal of the piece after it is cut.

The two halves of the fixed disk are fastened together by two elliptical pieces of glass cemented to the two halves, between the central and lateral openings. The cement used is the same as that above described, and it is applied in a similar manner. The cement known as "stratena" answers very well for this purpose, but it must have several days to dry before the machine can be used.

The edges of the glass around the apertures and along the seams should be varnished with the best quality of alcoholic shellac varnish to prevent the accumulation of moisture.

Paper inductors, *c*, are attached to opposite sides of the apertured glass by means of starch paste made by cooking starch until it begins to thicken, and cooling it before it becomes clear, i. e., while it is still of milky whiteness. These inductors are made of filter paper or of single thick drawing paper, and extend from the lateral openings or windows about one third the distance between the two windows in a circular direction. The outer edges of the inductors are arranged on a circle a little smaller than the revolving disk. At the end of each inductor and upon the opposite sides of the glass are pasted pieces, *d*, of gilt paper, which project into the window, and when dry are serrated, the points of the teeth being on the center line of the windows.

In front of the revolving plate, B, two combs or collectors, E, are supported upon glass columns having wooden bases and tops. These combs are made of three-eighths inch brass tubing, the pieces being fitted together and fastened with soft solder. The points, which are simply bank pins, are driven into holes in the brass tubes three-eighths inch apart. The inner ends of the tubes forming the combs are soldered to brass ball buttons; the outer ends are inserted in wooden balls, from which wooden screws extend backward to receive the deeply grooved wooden nuts, F, which hold the edges of the apertured disk, A. The points of the combs each cover a space $2\frac{1}{2}$ inches long, or about equal to the width of the paper inductors. Care should be taken to avoid bringing the inner ends of the combs nearer together than is absolutely necessary, and the outer point should be at least one-eighth inch from the periphery of the revolving plate. The points should be as near the face of the revolving glass as possible without touching. The combs are clamped in place by wooden screws in the wooden tops of the glass standards.

The outer ends of the tubes supporting the combs are fitted to tubes soldered in the large hollow balls. Through these balls the discharging rods slide with a gentle friction. The inner ends of the discharging rods are provided with spherical knobs, and their outer ends are fitted with wooden handles well varnished.

The cross arm, G, instead of being supported from the center, as usual with the apertured revolving plate, is elongated and bent so as to enter the rear end of the tube which forms the bearing for the sleeve, C. It is split to create friction in the tubes to retain it in position, and in addition to this the screw which holds the tube in the post, D, passes through a hole in the tube and bears against the extension of the cross arm.

The free end of the cross arm is carefully rounded, and the pins correspond in number and position to those of the comb, E. The cross arm when the machine is in use, is placed opposite the ends of the paper inductors, as shown in the illustration.

The lower edge of the apertured plate, A, rests in an adjustable support on the table.

The base of the machine is 13 inches wide by 14 inches long, with an extension 9 inches long for receiving the standard of the driving pulley, which is made adjustable on the table to tighten the belt, the table being slotted to receive the screw projecting from the standard, and the foot of the table answering as a nut to clamp the standard in any desired position. The pulley on the sleeve is $1\frac{1}{2}$ inch in diameter, and the driving pulley is 6 inches in diameter. Almost any kind of belting will answer, but a gut string is preferable.

To complete the machine two condensers or small Leyden jars are required. These may vary in size; in the machine shown they are $2\frac{1}{2}$ inches in diameter and 6 inches high, and are covered on the inner and outer side with tin foil to within 3 inches of the top, the starch paste before mentioned being used to fasten the foil. The uncovered portion of the jar is varnished with shellac. If jars of the desired form and proportion are not obtainable, bottles may be readily cut by means of a hot curved rod of iron about one quarter inch in diameter.

The condensers are placed outside the glass columns under the tubes that support the combs, and a small chain hanging on each tube touches the tin foil lining of the jar.

The outer coatings of the jars are connected by a small brass chain lying on the table. The plate, A, should be placed about three-sixteenths of an inch from the plate, B, and it must be turned so that the edge of the windows to which the gilt paper is attached is exactly opposite the teeth of the combs, E.

To charge the machine the ends of the discharge rods are brought into actual contact, and a piece of vulcanite, a quarter of an inch thick, 4 inches wide, and 10 or 12 inches long, is rubbed with a catskin, a piece of flannel, or a piece of silk, and applied to one of the paper inductors. At the same moment the machine is turned toward the gilt paper points. A strong smell of ozone and an increased resistance to turning are the first indications of the successful charging of the machine. Now, by slowly separating the discharge rods the spark will pass over an increased distance until it is fully 6 inches long. To produce the silent discharge all that is required is to remove the chain on the table from one of the jars. No special directions are required as to the management of the machine. A dry atmosphere is favorable to its action, and it must be kept free from dust. Air currents interfere with its operation; therefore it should be used in a room with the doors and windows shut.

I have so far described only one form of apertured plate. In Fig. 3 is shown a form in which the disk has a central portion, $1\frac{1}{2}$ inches wide, removed and the two parts are connected by glass strips *a a* and *b b*, cemented in the manner already described. When this form of plate is used the combs must be inclined to correspond to the direction of the edges to which the gilt paper is attached. Fig. 5 shows the usual form of plate which requires the aid of the glass cutter, as the holes cannot be readily made by one unused to operations of this kind.

THE EFFECT OF FREEZING ON PLANTS.

When frost attacks plants to such an extent that ice is formed in their tissues, says the *Gardiner's Chronicle*, it has been observed that the ice does not occur within the bags or cells of which the plant is made up, but outside or between them. The reason of this is probably because the contents of the cells are thicker and denser, and do not freeze so readily as do the thinner and more watery juices in the spaces between the cells. In this manner the essential part of the cell—so far as its life actions are concerned—the thick protoplasm, is less liable to injury. Moreover, as a consequence of the low temperature, the watery part of the cell-contents exudes from the interior through the cell-walls and there freezes. The expansion which takes place when water freezes, therefore, does not, at least in slight cases, take place within the cell, where it would do mischief by bursting the cell-walls, but outside them, where there is more room to expand and less risk of tearing the tissues. When the frost is more severe the tissues do become torn, cracks and fissures occur, the protoplasm is killed, branches fall, leaves wither or rot, and death ensues. But where the injury is less, and especially where the protoplasm is uninjured, when the thaw comes the ice outside the cells becomes melted, and the water, by the power of diffusion, passes once more through the cell-wall into its cavity, there to mix again with the more dense protoplasm. It is clear, then, that the danger to plants from frost is proportionate to the water they contain. If they are in an unripe, sappy condition the danger is far greater than if they are comparatively dry and at rest. Tubers and seeds, for instance, are specially adapted to resist cold; and how well they do so has been shown in the case of wheat which germinated at home after having remained throughout the winter in the Arctic regions.—*Mining and Scientific Press*.

THE correspondence between the distinguished astronomers, Bessel and Gauss, has been issued under the auspices of the Prussian Academy of Sciences. All but a few of the letters on scientific subjects which passed between the two astronomers during a period of forty years are included.