



THE CONSTRUCTION OF AN IMPROVED SILICON DETECTOR.

BY GEORGE F. WORTS.

The detector described here is one that can easily take the name "Improved," being a radical departure from the coarsely-adjusted detectors generally used. If properly constructed and connected, it will easily pick up wireless messages sent from very distant points. The component parts are shown in Fig. 1.

The base of the instrument is fashioned from hard rubber, 3 x 2 x 1/2 inches; 1/8-inch holes are bored in it one inch from either end. A support for the crystal cup is made from annealed brass, 4 inches in length, 3/8 inch in width, and 3/16 inch in thickness. It is bent to an L shape, as can be seen in Fig. 2.

The crystal cup is turned from brass rod 1/2 inch in diameter. It is threaded, as seen in Figs. 1 and 2, to fit a thumb nut. The crystal is fastened in the cup by means of lead. This insures a good contact. The ad-

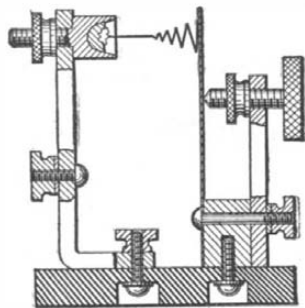
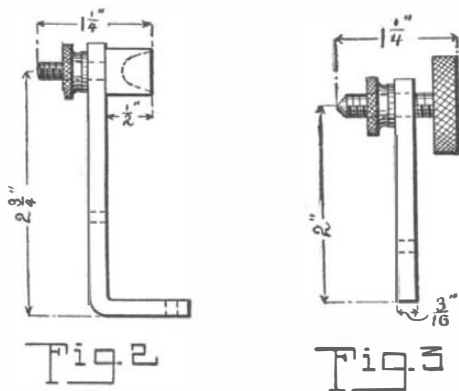


Fig. 1

SECTIONAL VIEW OF THE ASSEMBLED DETECTOR.

justing mechanism can be made to move a steel hair spiral, the point of which makes contact on the silicon, to the thousandth part of an inch. The phosphor-bronze strip upon which the spiral contact is fastened is 3 inches in length, 1/2 inch in width, of No. 28 B. & S. gage sheet. It is bolted to a cube of brass which in turn is fastened by means of a machine screw to the base. This screw serves also as a binding post. The brass post supporting the adjusting screw is of 3/16 inch brass of the same stock as the L-shaped post. It is 2 1/4 inches in length, 3/8 inch in width, and 3/16 inch in thickness. A 1/8-inch hole is bored 1/2 inch from



SUPPORTS FOR THE CRYSTAL AND THE ADJUSTING DEVICE.

one end to admit the machine screw that binds it to the brass cube. Another hole is bored 1/4 inch from the other end and tapped to fit the adjusting screw. The adjusting screw has a large knurled rubber handle for adjusting purposes, also a lock nut to be tightened when the detector is at its most sensitive point.

This detector is comparatively easy to construct and is inexpensive. The one undesirable quality in silicon detectors—their ability to get out of adjustment—is almost entirely eliminated in this detector, due to the use of the spiral instead of the solid contact.

INCREASING THE EFFICIENCY OF WIMSHURST ELECTRIC MACHINES.

BY GEORGE J. MURDOCK.

The Wimshurst static electric machine, as is well known, consists of two glass circles revolving on a compound axis in opposite directions. As usually made, this machine is inferior to the Toepler-Holtz type, although somewhat cheaper to make, and superior in simplicity. The latter quality has been without doubt one of the chief reasons why it is in general use wher-

ever the small electric discharge this machine will give as commonly made, will answer the purpose.

In building both kinds of these interesting machines, it is the practice to varnish the revolving glass circles with white shellac dissolved in alcohol. In the higher grade machines the best quality of shellac and grain alcohol are used for this varnish, but for the toy variety wood alcohol and the cheapest grades of shellac are used. Some years ago the writer was building both Wimshurst and Toepler-Holtz statics, but was unable to obtain a discharge from the Wimshurst type that could compare with the other kind, even when the glass circles were of the same diameter.

The development of the machines in both cases had extended over a series of years, and it was supposed the limit was reached. At this time the Toepler-Holtz machines were giving with 26-inch circles, sparks (using the Leyden jars) equal to the radius of the circles or 13 inches long, thick as the thumb, and when discharging detonating like the sound of a rifle.

The Wimshurst machines with an equally large circle would not give sparks over 4 inches long, and about as thick as a knitting needle. Finally, in building a lot of six machines it was found some were much better than others. Strenuous efforts were made to ascertain what caused the increase in efficiency, but without discovering anything different in the construction of those that showed the improvement from the others. In the next lot after this, however, all of the machines were capable of giving sparks 6 inches long, although the diameter of the glass circles was but 14 inches. The thickness of the spark had also increased to the size of a pipe stem, and this wonderful increase of efficiency was attributed to some quality inherent in the glass of which the circles were made, but inquiries made of the manufacturers of the glass failed to disclose any different methods of making the glass than had been followed for many years.

About this time the writer in varnishing some circles held one of them up to the light, and was struck by its light green appearance, and although giving it little attention at the time, gained the impression that this change in color might have something to do with the increased efficiency still unaccounted for. Shortly after this a new lot of machines were built, and every one of them had reverted to first principles so far as the spark was concerned, it being short, weak, and spindling. In the effort to find out what had caused the reversion, the writer called to mind that just before varnishing the last lot a new brush had been used in a new batch of varnish.

It is customary in making the varnish to dissolve the shellac gum in a glass jar with a mouth just large enough to get the brush in conveniently, and the brush is left in the jar between the construction of the different lots of machines. It was found that the old brush had been shedding its bristles, and to prevent this it had been bound around with some fine copper wire. The action of the varnish had been to corrode the copper, and the salt had given the varnish the faint green color noticed some time before on the glass circles, although there had been nothing different in the color of the body of varnish in the jar apparent.

The suspicion dawned on the mind of the writer that this had been the cause of the increase of efficiency, and the lack of it in the last lot of machines. Another batch of varnish was accordingly made, and in it was put about a quarter of a pound of fine bare copper wire. A new brush was procured, and placed in the jar, and the varnish allowed to stand in a warm, dark room about a week, when it had assumed a light green color, and was used to coat the circles of a new machine.

This machine was found on trial to be even more efficient than the best of the others.

In experimenting with the newly-discovered varnish, it was found that if it was allowed to become a dark green the voltage of the machine was interfered with, and while the spark would be thicker it would not jump as far. The best results were obtained when the color was a very light green. The reason for the increased efficiency was thought to be due to a decrease of the resistance of the shellac between the sectors on which the equalizing brushes bear.

This varnish was tried on Toepler-Holtz machines without their showing any marked increase, perhaps due to their being already capable of delivering sparks equal to the radius of the glass circles.

The use of varnish made in this way will be found by amateurs and others to add greatly to the capabilities of the Wimshurst machine, and besides the light green color on the glass adds to the beauty of the instrument.

Many builders of Wimshurst machines as well as those experimentally inclined have trouble in making the brass sectors stick to the shellac. As tinfoil soon wears through from contact with the equalizer brushes, thin sheet brass is used by many on the better grades of machines to secure durability. Brass sectors can be made to stick permanently in the following manner:

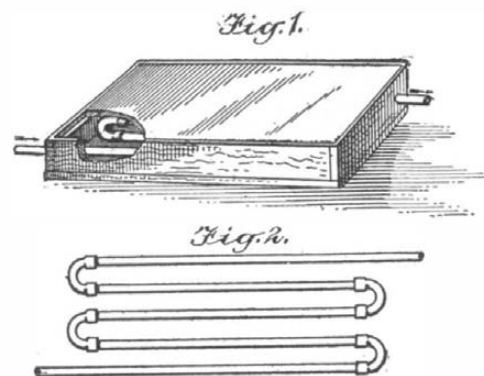
In varnishing the circles, about three coats is generally applied with a large flat camel's hair brush.

Each coat is allowed to become moderately hard before applying the next. After the last coat is applied, and has stood about fifteen minutes, mark the locations where the sectors are to go (they should be evenly spaced), and after applying some varnish to the under side of the sector, press it down into the soft varnish until a slight ring swells up around the margin of the sector. After the varnish is hard, an examination will show the sector dovetailed into the varnish, from which it will never separate, as it will if cemented in any other way on account of the expansion and contractions of the brass being so much greater than the glass, and causing the sector to become loose.

SILVERING GLASS AT HOME.

BY A. J. JARMAN.

A good glass mirror, made with one's own hands, is a thing to be proud of. Mirrors are now seldom made by the tinfoil and mercury process, because of the dangerous character of the work, but pure silver is used instead. The silver process is not in the least dangerous to the workman. The formula here given is one that has been in use in several looking glass and art mirror factories in the city of London. The



APPARATUS REQUIRED FOR SILVERING GLASS.

chemicals used must be of absolute purity (chemically pure) and all operations in preparing the glass must be carried out with care and scrupulous cleanliness. The surface to be silvered must not be pressed upon by the fingers or thumbs, they would leave an indelible impression.

The first thing to be done is to make a small table out of a piece of slate about 3/8 or 1/2 inch thick, 10 or 12 inches wide and 18 inches long. These measurements are not binding, any piece of slate about the above size will do. A wooden trough must be made with grooves at the top edges for the slate slab to rest in. There must be a space of 2 inches between the slate slab to the wooden bottom, as indicated in Fig. 1. In this space is a coil of pipe arranged as shown in Fig. 2. The pipe is of about 3/8 inch bore, and through it steam is passed to raise the temperature of the slate slab to about 120 deg. F., in fact just hot enough for the hand to bear. The steam can be supplied from an ordinary tea kettle placed near the depositing table with a rubber tube connecting the coil to the spout of the kettle. Uniform heating of the slate slab is essential. The coil can be easily made of 1/4-inch iron gas piping, screwed into U-shaped cast-iron connectors, as shown in Fig. 2. The slate slab can be covered with black oilcloth and made perfectly level. The following stock solutions must be made up and carefully filtered through absorbent cotton, ready for use:

Stock Solution A.—Nitrate of silver, 3 ounces; distilled water, 10 ounces; strong water ammonia, 12 1/2 ounces. This solution must be stirred well and allowed to stand five or six hours, then add 10 ounces more of distilled water and filter.

Stock Solution B.—Rochelle salts, 4 ounces; distilled water, 20 ounces.

Stock Solution C.—Distilled water, 40 ounces, protochloride of tin, 5 grains.

Clean the glass plate or plates with very fine rouge and water, taking care that no trace of grease whatsoever comes into contact with the glass or the cloths or chamois leather used for polishing. When cleaned, the plate must be flooded all over with the tin solution. Pour this solution off and wash the plate well with distilled water. Lay the plate wet side up upon the table, with four clean wood wedges at each corner. Let the glass rest on the wedges, so as to allow a slight adjustment, if required, for leveling. The mixture for silvering is made up as follows:

Distilled water, 20 ounces; stock solution B, 1 drachm by measure; stock solution A, 1 ounce by measure. The glass plate being quite level, and still wet, pour this mixture carefully and slowly upon the center. It will flow evenly all over until it stands about one-eighth of an inch deep all over the plate. Any tendency to run to one end must be rectified by the wedges. The plate now being completely covered with the silvering mixture must be left to itself for about two hours, the heat being kept up during this time, and when it is found that the whole of the silver has been deposited, the liquid must be poured off by tilting and allowed to run into a stoneware crock and saved

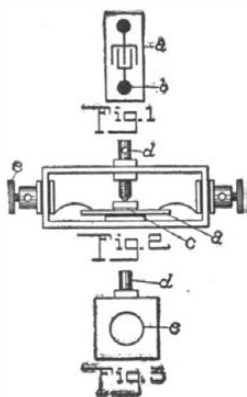
for the waste silver it contains. If it is desired to increase the thickness of the deposit of silver, the operation must be repeated as soon as the silvering is complete; wash the plate well in a soft stream of running water, stand it cornerwise to drain and dry. When dry the following protective varnish must be used as a coating to protect the deposited silver: Shellac, $\frac{1}{2}$ pound; wood alcohol, 6 pints. As soon as this coating has dried it must be painted over again with the following paint: Red lead, $\frac{1}{2}$ pound; white lead, $\frac{1}{2}$ pound; mixed with enough boiled oil and a small quantity of turpentine to make a good covering with a single coating. A small quantity of gold size must also be added to insure quick drying and a tough adhering quality. The mirror is now ready for framing. If much work has to be done, it will be advisable to cover the slate all over with a piece of felt, and keep the felt wet during the operation for two reasons: First, no pieces of woollen fiber can settle upon the plate, and secondly, the heat from the slate slab is communicated to the glass better than from a dry surface.

For a regular workshop a very good size is 4 by 7 feet, with a gutter cut around the slab, so that the spent silvering liquid can run from the tilted plate, around the table, and be collected by running through a hole at one corner. In this case the liquid will be sure to come in contact with the felt. This will prove of no consequence, because in time it will become saturated with silver, which will realize twenty times its first cost when sent to the silver refiner, and not only pay for a new felt covering, but increase the size of the pocket book at the same time. The quantity of nitrate of silver required to coat a square foot of glass with a moderate coating of silver is 18 grains. An estimate as to cost can be made from this amount.

SELENIUM CELL WITH CONTACT BY PRESSURE.

BY W. S. GRIPENBERG.

The usual method of making a selenium cell consists in pressing the electrodes against a piece of crystallized selenium, which decreases its resistance to an electric current, when submitted to the action of light. The quality of selenium can be perfectly controlled, as it needs not come in contact with metal when fluid in which state it dissolves nearly all metals (i. e., the electrodes). This is of importance, because small quantities of other elements sometimes have considerable influence on its sensitiveness. Moreover a piece of selenium, that for some reason has lost its efficiency, can be easily replaced by another piece, at low cost. The most important point, however, is that the contraction or decrease in volume (5 to 8 per cent), which is inseparable from the process of crystallization, has no influence whatever upon the contact with the electrodes, as the piece of selenium is



SELENIUM CELL WITH CONTACT BY PRESSURE.

given its definite form after the contraction has taken place. Strong currents of short duration do not lead to the destruction of the cell, as there is full scope for expansion.

Despite these important facts, this method has not been hitherto used, because very thin plates of selenium are necessary, as the action of light is limited to an extremely thin layer of the exposed surface (calculated by Marc to be about 1/500,000 inch thick). Moreover, selenium is rather fragile and being of high resistance, heavy pressure must be used in order to realize good contact.

The author discovered that selenium, when molten between a cold and a very hot glass plate, strongly adheres to the latter, after the crystallization. It is thus possible to cover a thin (1/250 inch) flexible glass plate with an exceedingly thin coating of selenium (1/1,000 to 1/30,000 inch) which has a highly polished surface that gives very good contact with the electrodes. These consist of gilt stripes on a glass plate (Fig. 1). There are from 250 to 2,500 electrodes on every inch.

Cells constructed after this method are very reliable and show remarkable constancy. They are of small specific working surface. The following is a description of a cell actually made:

Working surface = $\frac{1}{4}$ by $\frac{1}{4}$ inch.

Resistance in the dark = 20,000 ohms.

Resistance in ordinary daylight = 10,000 ohms.

Resistance in strong light = 3,000 ohms.

Maximum intensity of current = 0.0018 ampere.

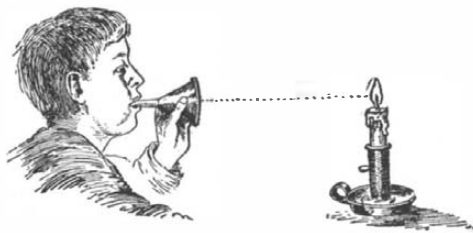
Fig. 2 gives a diagram of the cell.

Fig. 3 is an end view of same.

Glass plates with a thin coating of metal (silver) have before now been used as electrodes for substances sensitive to light. This combination or at least the results attained are new.

SOME SCIENTIFIC AMUSEMENTS.

The Candle and the Funnel.—Ask a person to extinguish a lighted candle, two feet distant from his mouth, by blowing through a common tin funnel with his lips applied to the stem. Almost invariably, he will fail to accomplish the feat, although he could easily have blown out the candle without using the funnel. Now put your own mouth to the stem of the funnel and blow out the candle. If you have any skill in performing tricks you can repeat this one many times without betraying its secret to the average spectator. The secret is this: When you blow into the small end of a funnel, your breath follows the inner surface of the cone, and not only shuns the axis, but produces eddies of such a character that there is actually a slight back draft or inward current at the center of the wide mouth of the funnel. You, therefore, hold the



RIGHT AND WRONG WAY OF BLOWING OUT A CANDLE.

funnel so that some part of its conical surface would, if extended, strike the candle flame. An inexperienced person naturally directs the axis of the funnel toward the candle and consequently fails to extinguish the flame. If he stands quite near the candle and blows gently the flame will even be drawn toward the funnel by the inward current. The whirling motion of the air may be made visible by using a glass funnel and filling it with tobacco smoke.

Paradoxes of Ebullition.—Everybody knows that water boils at the temperature of 212 deg. Fahr. But if an uncorked bottle partly filled with water is set in a saucepan containing water in which a good deal of salt has been dissolved, and the pan is heated over a spirit lamp or otherwise, the water in the bottle will begin to boil while the water outside still remains perfectly quiet. Yet the water outside must be at least as hot as the water inside (212 deg. Fahr.), for the latter is heated by the former. Hence we see that water which contains salt in solution does not boil at 212 deg. Fahr. The same effect is produced by dissolving any other solid substance in the water.

Now, if the bottle is taken from the hot brine and corked, the water in the bottle stops boiling, but it will boil again, even after it has cooled many degrees, if cold water is poured on the upper part of the bottle. The explanation is that the boiling point of water is affected by pressure. It is about 212 deg. Fahr. under the ordinary pressure of the atmosphere (exactly 212 deg. when the barometer stands at 30 inches), but if the pressure is reduced, water boils at a lower temperature. When the water bottle was corked and taken from the fire, its upper part was filled with steam at atmospheric pressure, which had expelled the air originally present. As the bottle cooled, this steam partly condensed and its pressure was diminished, but not sufficiently to permit the water to boil, because the water cooled also and its gradually diminishing temperature was always a little below the boiling point corresponding to the actual pressure. But the application of the cold water caused a rapid condensation of steam and a sudden lowering of the pressure without having much cooling effect on the water, which consequently began to boil.

Distillation.—The same apparatus may be employed to illustrate the process of distillation. The brine in the pan is replaced by fresh water, a hole is bored in the cork and a glass tube is fitted to the hole. To the water in the bottle is added one-tenth its volume of alcohol, or less. The bottle and pan are placed over the lamp, as before, and heated gently. Before the water in the pan has reached the boiling point the vapor of the more volatile alcohol (mixed with a lit-

tle water vapor) issues from the end of the glass tube, where its presence can be detected by its odor or by the application of a lighted match, which will result in the production of a tall blue flame. The jet should not be lighted until the mixture has been heated long enough to expel the air from the bottle, as the ignition of a mixture of air and alcohol would produce a violent explosion. For this reason the cork, though it should be air-tight, should not be inserted too tightly. With this precaution an explosion will drive out the cork, instead of shattering the bottle. This experiment, and the others performed with this apparatus, should not be attempted by children or careless persons.

Hero's Fountain.—If the jet of flame issuing from the tube is extinguished and the tube pushed down until it dips into the water, a fine liquid stream will

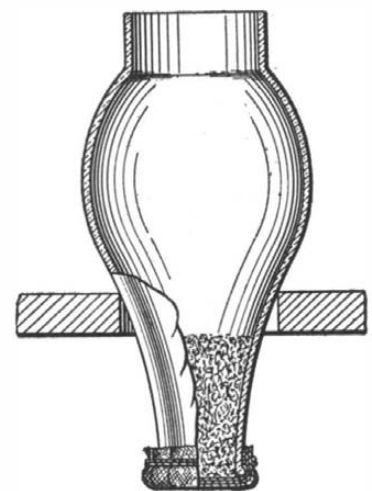


MODIFIED FORM OF HERO'S FOUNTAIN.

be thrown high in the air by the pressure of the mixed vapors of alcohol and water in the upper part of the bottle.—Kosmos.

A SIMPLE EFFECTIVE FILTER.

The filter here described was first made by the writer in 1878, and used originally for filtering gelatine emulsions. As a water filter it is both simple and effective. Procure an ordinary kerosene lamp chimney. Fit over the end of it two or three thicknesses of washed cheese-cloth. Press a tuft of absorbent cotton into the small part of the neck for about three inches in depth, insert



HOME-MADE FILTER.

the chimney, and place it in a hole cut in a wooden shelf as a support. Pour the water in until the filter is filled, when it will be observed that any organic matter, chips of iron rust, etc., will be retained by the cotton. The fine organic matter may penetrate the cotton for about one inch, but no farther. The resultant filtered water will be bright, clean, and pure.

A paper dealing with "Research on Metallic Filament Lamps," by Mr. F. H. Reakes Lavender, was recently presented at a meeting of the Birmingham Institution of Electrical Engineers. The research was undertaken in order to investigate the conditions of working as regards voltage, and efficiency and percentage drop in candle-power, giving the most economical life in the case of metallic filament glow lamps, and to determine as far as possible the cost of illumination with this source of light. The author stated that the useful life of a lamp, and the drop in candle-power which it was advisable to allow for a given voltage, depended on the cost of current and the price of the lamp. The cheaper the current, the longer the life, and the greater the admissible drop. Taking the current at 5d. per unit as an average price, and the lamp run at rated voltage, then it paid in the case of the tantalum class of lamp to throw it away as soon as the candle-power had fallen to 3 per cent below its original value. This result appeared startling at first, considering the large initial cost of the lamp. However, by the time that point was reached the lamp had been burning for 1,500 hours at the best possible efficiency, so that the cost of the lamp per candle-power had become small.