

due to a communication of electricity, and not to be an effect of induction, for on introducing a thin glass disc at different heights over the smoke surface, the figures were formed only round about the glass disc, not under it. "Perhaps," he says, "the whole phenomenon may be attributed to very soft impulses of long cylindrical electric air-waves, propagated in extremely short time from the Leyden jar to the smoke surface, and causing in the cloudlets themselves a momentary separation of electricity. In this way the phenomena may be explained, yet its cause is not yet given with certainty. The production of the concentric circles may be attributed to the smoke waves arising in the streaming out from the paper funnel, the cohesion of which waves seems to persist, though at a short distance from the funnel they flow into each other. The individual smoke-waves separate from each other, and in this state go farther if the charged jar be cautiously brought nearer to the funnel. The radial division (more difficult to explain than the concentric circles) have probably their cause in the regular arrangement of the cloudlets, which flow into each other polarly."

The figures may be maintained longer if the jar be nearer to the smoke-surface slowly, but they are always more and more blended.

A second phenomenon is that, if the somewhat weakened jar be brought nearer the smoke-surface, the cloudlets at a certain limit assume, instead of the roundish and elliptic forms, a ruffled (*gekräuselter*) appearance (like hat-maker's wool). Individual cloudlets rise, whirling slowly, but mostly fall back again. The ruffled cloudlets may subsist some time, especially if they occur near the edge of the smoke, where at the same time traces of the radial divisions are perceptible. M. Antolik considers them a result of electric induction.

If, now, the jar be brought quite close to the smoke layer, so that a small spark leaps to the table, the entire smoke layer is quickly driven outwards in form of a concave circular surface. But, before this stage, the smoke commonly disappears on the table, while the small carbon particles in it adhere to the table, and cannot now free themselves from it.

A third phenomenon, when it once occurs, subsists till the last moment of the experiment. There appear, namely, on the smoke layer, winding and sharply defined furrows, which swim round, shadowlike, in the layer, and follow the movements of the Leyden jar. At first there are only a few furrows, often only one; but they afterwards multiply greatly.

This phenomenon seems to point to the fact that on the head of the Leyden jar are small particles of dust, from which, as from points, the electric wind streams out in infinite fine cone-like bundles, which must be very smooth and uncommonly delicate at their surface, since the borders of the furrows they produce seem to be sharply cut. A furrow often sinks only to the half of the by no means thick smoke layer, and in it the cloudlets of the first phenomenon occur and fill it up. If we hold the jar quite still on production of the furrows, there appear only shady larger and smaller points in the smoke surface, which continuously maintain their positions, even when the smoke waves stream more quickly out of the paper funnel. If the jar be moved, however, and only two or three cone-like rays occur near each other, they wind parallel to each other. The outlines of the furrows remain visible several seconds, especially at the border of the smoke surface, where this is less movable. Once they occur, they are broader the farther the jar is from the smoke surface.

Good conductors and glass tables under the smoke layer seem to have no influence on all these phenomena. If the Leyden jar be charged with negative electricity the same phenomena occur, only the jar must be brought much nearer to the smoke.

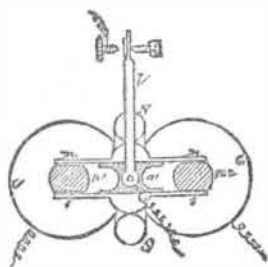
All these phenomena seem to render it probable that the lamb's-wool clouds visible in the sky have their cause in the air currents saturated with electricity. Whether these are positively or negatively electrified they must certainly act on the cooled water vapors of the atmosphere, even at a great height, either communicatively or inductively. The rarefied air must highly favor the action at a distance of the electricity, and accordingly the clouds in question may continue at rest a long time in the place of their origination.

THEILER'S RELAY.

The peculiarity of this relay consists in the novel construction of its magnetic armature and its combination with an electro-magnet, whereby the power is thoroughly utilized.

The figure gives in plan an outline drawing of the relay. It consists of an ordinary electro-magnet, *c c*, of which *p*, *p*₂, are the poles. Two light tongues or bars, *n n* and *s s*, of soft iron are mounted on a pivoted axle at *a*, their flat sides facing each other, and kept a certain distance apart by a short piece of brass, shown in the figure by the dark shading. The armature, in fact, somewhat resembles a double tuning fork.

This armature is magnetized by a horseshoe permanent steel magnet, whose poles, *N* and *S*, are shown in the figure.



These poles are in close proximity to the portions of the tongues, *n n* and *s s*, which, at the middle of their length, are made to project.

The magnet poles impart similar polarity to the ends of the tongues, to which they are respectively in close proximity; consequently, when the electro-magnet becomes magnetized by a current, the whole armature tends to turn on the axis at *a*.

Fixed to the armature is a brass tongue, *l*, which is furnished at its extremity with the usual platinum contact point playing between an insulated and a contact screw.

This relay is found to give very good results, especially for fast speed working.

ZIRCONIA FOR THE OXY-HYDROGEN LIGHT.*

By JOHN CHRISTOPHER DRAPER, M.D., LL.D., Professor of Natural History in the College of the City of New York.

Success in the use of the microscope for the purpose of projecting magnified representations of microscopic objects on a screen depends primarily upon the light employed, especially when high powers are used, as for example, a quarter-inch objective. To answer the purpose in question in light must possess: 1st, intrinsic brilliancy; 2d, the brilliancy must be as nearly as possible invariable; 3d, it must retain its fixity of position in the optical axis of the apparatus.

If the experimenter has a good heliostat, the light from the sun fulfills these conditions better than any artificial light; but, experience teaches the unwelcome lesson that, though sunlight is preferable to any other, it scarcely ever happens that it is available at the time it is wanted. The weather is almost certain to be either cloudy or hazy just at the hour when it is desired to make an important demonstration, and the lecturer is obliged to postpone it, thereby lessening its value, and often entirely losing its effect. The selection of the best artificial light therefore becomes a matter of importance to those who desire to secure the advantages to be derived from the successful demonstration of such microscopic objects as preparations of animal and vegetable tissues, animalcules, the circulation of the blood, etc.

The artificial lights possessed of sufficient intrinsic brilliancy are: 1st, the electric arc or light; 2d, the magnesium ribbon light; 3d, the oxy-calcium light; 4th, the oxy-magnesium light; and 5th, the oxy-zirconium light. The first has greater brilliancy than any other in the list, but in addition to fifty or one hundred cups of a nitric acid or bichromate battery a good regulator is also necessary; this involves a very considerable expenditure of money, and even when this is made, the labor and trouble required to manage the battery, and the continued change in the parts of the carbon electrodes between which the arc of light passes, render its use unsatisfactory.

The magnesium ribbon light has the great disadvantage of the emission of fumes of oxide, which coat the surface of the condensing lenses in spite of all attempts to dispose of it otherwise. The light also is not concentrated on a small fixed surface; but is emitted from a varying length of ribbon.

The oxy-calcium light produced by projecting the flame of mixed oxygen and hydrogen gases upon a cylinder or pencil of calcium oxide is the one generally employed. It is fixed in its position in the optical axis of the apparatus, it is thrown into operation with comparative facility when cylinders containing the compressed gases are available, and it has sufficient intrinsic brilliancy for the majority of experiments. The difficulties in this way of its use are however serious, and it is very desirable that they should be lessened. They arise chiefly from the volatility of the calcium oxide at the intensely high temperature employed. The volatilized material depositing on the condensing lenses prevents the passage of the luminous rays, and the cavity formed in the cylinder of lime at the spot where the flame impinges soon interferes with the brilliancy of the light; this necessitates a change in the position of the lime cylinder to present a new surface to the action of the flame, and this in its turn implies a distraction of the attention of the experimenter, which interferes seriously with the satisfactory management of his subject. Though the attempt is made to avoid this difficulty by clockwork, or other mechanical contrivances, they are still unsatisfactory in their action. Another serious objection is the necessity of placing the cylinders in a closed vessel when not in use, to protect them from the action of the air.

The oxy-magnesium light is similar to the preceding, differing only in the substitution of a cylinder or pencil of magnesium oxide for calcium oxide, and the light emitted is of equal brilliancy. Following the instructions given for the preparation of these cylinders, I have taken the greatest pains to procure samples of magnesium oxide of the utmost purity. I have also tried various methods for its preparation, among which the combustion of the metal in oxygen may be mentioned, but failure has thus far attended all efforts to make pencils or cylinders which could withstand the intense heat of the flame of the mixed oxygen and hydrogen gases without undergoing volatilization. The pencils obtained were fully equal in this respect to those of calcium oxide; but I did not find any superiority that repaid the trouble of their preparation.

The oxy-zirconium light produced by the action of the flame of mixed oxygen and hydrogen gases on a cylinder of zirconium oxide meets all the requirements of the case in question. It has the intrinsic brilliancy, the invariable brilliancy, the fixity of position in the optical axis of the apparatus, and it does not volatilize under the heat employed. The condensing lenses remain free from deposit, and after the light is once adjusted the experimenter can carry on his demonstrations without the distraction of his attention that attends the use of the other lights. All that is necessary is, according to the size of the reservoirs of compressed gas, to open the cocks a little as the pressure diminishes. There is also no necessity to remove the zirconium oxide pencil from its position, as in the case with the calcium oxide; it may on the contrary remain *in situ* for any length of time, and the apparatus is always ready for use whenever it is wanted.

Though the standard works on chemistry generally mention the light-emitting power of zirconium oxide under a high temperature, the only successful attempt that has been made to apply it practically that I am aware of was that of Tessié du Motay. Unsatisfactory references to his process for preparing zirconia cylinders are to be found in various chemical works and journals, the best that I have seen being that given on page 47 of "Crookes' Select Methods in Chemical Analysis." The careful reader of this and other articles on zirconia will be prepared to expect difficulties in the way of its preparation, and it is to the removal or lessening of these difficulties that I now propose to address myself by the minute relation of the process I have adopted after many weeks of experiment.

The subject naturally divides itself: 1st, into the preparation of zirconium oxide; and 2d, the preparation of the cylinders or pencils.

PREPARATION OF ZIRCONIUM OXIDE.

The compound zirconium used is that known as the zircon of North Carolina. It is essentially zirconium silicate, and the composition of this and other specimens of zircon will be found in Dana's Mineralogy. The difficulty in the operation consists in the complete removal of the silica and

of the sodium compounds used in the disintegration of the mineral.

1st. Select the zircon crystals or fragments thereof of as light a color as possible, and carefully remove all attached foreign matter; provide about ten grams in weight.

2d. Reduce five or six grams to powder in a steel mortar; or, by first heating to bright redness and chilling in water while very hot, the same may be done in a porcelain mortar. Remove any mica or other foreign matter that may appear.

3d. Complete the pulverization in an agate mortar, introducing small quantities at a time, and reduce to an impalpable powder. The final yield of zirconia depends on the thoroughness with which this was done.

4th. Weigh out two grams of the fine zircon powder and mix it intimately in a mortar with ten grams of dry sodium carbonate, place the mixture in a covered platinum crucible of twenty cubic centimeters capacity.

5th. Place the crucible over a strong Bunsen flame; the burner should be at least fifteen millimeters in diameter; in about twenty minutes the mass in the crucible will have shrunk to one-third of its original volume if the heat is sufficient. To secure uniformity in temperature of the crucible I have employed the following device. The platinum crucible being placed in a triangle of platinum wire supported on the ring of a retort stand, a graphite crucible having a diameter of five centimeters was taken and an opening fifteen to twenty millimeters in diameter made in its bottom. It was then placed mouth downwards over the platinum crucible, with its mouth at the level of the bottom of the latter, and resting on the same support. A brass or iron tube two and a half centimeters in diameter and six to eight decimeters in length was placed vertically over the bottom of the graphite crucible, resting on it and enclosing the opening previously made therein. A furnace was thus constructed, the long tube being the chimney, giving a good draught, and the graphite crucible the body which confined the flame to the surface of the enclosed platinum crucible and heated it equally.

6th. The shrinkage of the mass having been satisfactorily accomplished, it is to be fused; for this purpose a powerful gas blowpipe flame urged by a foot bellows answers very well. In place of the ordinary blowpipe flame I have used a modification contrived by my assistant, Mr. Ivin Sickels. It consists of a large Bunsen burner two centimeters in diameter; the upper opening is closed by a cap through which seven small tubes pass, each having a diameter of two and a half millimeters. The lower openings of the burners are also closed except one through which a tube passes and communicates with a foot bellows. Coal gas being turned into the burner, ignited, and the bellows thrown into action, seven clean sharp pointed blowpipe flames are produced which give a very intense heat.

The mass in the platinum crucible having been fused and the fusion continued until it begins to assume a pasty state, it is again liquified according to the plan of Berzelius, by the addition of caustic soda about equal in weight to that of zircon. The heat being again applied, the disintegration of the silicate continues, and if necessary a second addition of caustic soda may be made.

7th. The contents of the platinum crucible having cooled, separate them therefrom, and place in a beaker, add two hundred cubic centimeters of distilled water; any portions of the fused material that adhere to the walls or cover of the crucible are also to be removed by a jet of distilled water and added to the contents of the beaker. An occasional stirring will promote the disintegration of the mass, which is completed in the course of a couple of hours, silicate of sodium, the excess of sodium carbonate and soda, dissolving and leaving a white powder, which, according to Dr. Melliss, is composed of zirconium oxide, silicium anhydride, and sodium oxide, together with any zircon that may have escaped disintegration.

The contents of the beaker are thoroughly stirred and set aside for twenty-four hours to settle. The clear supernatant fluid is decanted, another two hundred cubic centimeters of distilled water added, the mixture stirred and set aside for twenty-four hours or longer, and when the precipitate has settled the liquid is decanted and the beaker with its contents set on the water bath to dry.

8th. Pulverize the dried material in the beaker with a glass rod, add twenty cubic centimeters of pure hydrochloric acid (Merck's), cover the beaker with a large watch glass and set on the water bath; when the acid has dissolved as much as it will take up, it is to be decanted while hot into a shallow evaporating dish of about five hundred cubic centimeters capacity. A second dose of twenty cubic centimeters of hydrochloric acid is added to the contents of the beaker, and when all lumps are broken down the mixture is transferred to the evaporating dish, a little hydrochloric acid being used to complete the transference.

9th. For the final separation of the silica the contents of the dish are evaporated to dryness on the water bath, and the heat continued until they cease to emit acid fumes; a little distilled water is then added and thoroughly incorporated with the residue by stirring. The mixture is again evaporated to dryness at 212° F. The second drying being completed, about two hundred cubic centimeters of distilled water are added, and when all the soluble material is taken up the mixture is transferred to a filter. On the filter there remain silica and undecomposed zircon. In the filtrate there are zirconium chloride, sodium chloride and iron chloride.

10th. The next step is the separation of the zirconium chloride from the iron chloride, and as completely as possible from the sodium chloride. This I have accomplished as follows. The filtrate being made up to five hundred cubic centimeters with distilled water, washed sulphurous acid gas is passed through the fluid as long as a precipitate forms, or until the contents of the flask smell strongly of sulphurous acid. The mixture is then boiled as long as it emits any odor of sulphurous acid, the loss of liquid being made up from time to time by the addition of distilled water. The precipitate of zirconium sulphite is allowed to settle for a day or two and is then collected on a filter, where it must drain for a day, the funnel being covered with a sheet of paper. As it is impossible to wash the precipitate properly on the filter, it must be carefully transferred therefrom to a beaker while it is still moist, by means of a glass rod and jet of distilled water from a washing bottle. The lumps being completely broken up, the contents of the beaker are again made up to five hundred cubic centimeters with distilled water well stirred, and when the precipitate has settled it is collected on a filter as before and allowed to drain as long as it will yield any fluid.

11th. The precipitate obtained above is dissolved in as little pure hydrochloric acid as possible, the solution diluted with distilled water to five hundred cubic centimeters and heated to boiling for some time. Ammonia is added to the

*American Journal of Science.

hot solution, when the zirconium oxide is thrown down and is to be collected on a filter, washed with hot water and allowed to dry at the temperature of the air, the yellowish or whitish lumps resulting are pulverized in an agate mortar, when a white powder is obtained. The quantities I have given in the various operations detailed above apply to two grams of the powdered zircon. For the preparation of a zirconia cylinder of sufficient size the preparation from four grams of zircon is required; the quantities may be doubled throughout; but it is better to make two fusions of two grams each and double the quantities given in the latter part of the description.

I have also tried the separation of zirconium chloride from iron chloride by hydrochloric acid; but, though I worked at a temperature of 32° F., the yield was very small and therefore unsatisfactory. In the process by hyposulphite of soda I found it very difficult to get rid of the soda. The process of disintegrating the zircon by chlorine at a high temperature also failed to give satisfactory results in my hands, and I find that Dr. Melliss records the same experience.

PREPARATION OF THE CYLINDER.

The zirconium oxide powder obtained in the manner described above is to be heated in a platinum crucible and kept at a bright red for five or six hours; it will under these circumstances shrink considerably in volume. I have sometimes in addition submitted the powder to a heat of the oxy-hydrogen flame with advantage, spreading it out for this purpose on a piece of platinum foil supported on a slab of iron, and directing the flame on the powder. The operator should wear smoked spectacles. The powdered oxide thus condensed by heat is then moistened with just enough water to give it a tendency to form small lumps. In this condition is placed in a cylindrical mould and submitted to severe pressure by a piston fitting closely to the cavity of the cylinder, both of which should be properly oiled. The size of the pencils I have prepared is about six millimeters in diameter and one centimeter in length. When in use they are mounted so as to present one end to the action of the oxy-hydrogen flame, when a brilliant circular spot of light is formed, admirably adapted for all kinds of optical experiments.

The cylinder in which the pencils have been compressed is about two centimeters in diameter and four centimeters in length; the cavity running centrally through it is six millimeters in diameter, the piston rod fits closely, and both it and the cylinder are of hardened steel; the source of compression is a small hydraulic press, and the pressure employed is about two tons. The pencil is forced from the cylinder after compression by the press itself, and is very hard. It is allowed to dry slowly and then ready for use. When first heated the temperature is gradually increased until at last the full force of the oxy-hydrogen jet is employed. In case the pencil chips or loses any part of its substance the portions are to be preserved and ground up with old pencils in an agate mortar mingled with a little fresh zirconia powder and compressed in the cylinder. The pencils thus obtained from portions of older ones are generally superior to those made entirely from fresh oxide.

In the process of Tessié du Motay certain agglutinant materials are employed in preparing the pencils; but these reduce the brilliancy of the light considerably. With care in the management of the pencils the use of agglutinants may be avoided; and though they may be necessary in case of pencils to be handled by an ordinary peripatetic calcium light manipulator, they are not only unnecessary in the hands of a lecturer, but are also detrimental exactly in the proportion in which they reduce the brilliancy of the light.

If the zirconium oxide is free from silica there is no evidence of fusion on the extremity of the pencil, though it may have been submitted to the action of the flame for a full hour. If on the contrary silica is present the spot on which the flame impinges becomes glazed, giving evidence of fusion, and the brilliancy of the light decreases greatly. The pencils made from the zirconia prepared in the manner related above have been tested alongside of those made from zirconia prepared by Merck, which is stated to be pure, and is sold at the rate of one dollar per gram. Whatever the process may be that is used in its preparation, it does not give a product as free from iron and silica as the one which I have described, nor does it possess the same illuminating power.

A NEW MORDANT.

It is well known that coloring matters soluble in water absorb certain matters in the condition of powder with an avidity apparently equal to that with which they absorb colors known as substantive. It is known that starch takes up and holds the substantive colors of aniline with considerable force, so that by treating the dressing in powder with cold solutions of aniline colors colored powders are produced which are used in various ways in the production of paper-hangings. It is known that the colorless precipitates forming in solution containing coloring matters absorb considerable quantities, although they themselves become but slightly colored. Thus are produced very elegant results with sulphate of barytes in solutions containing aniline colors. These precipitates have heretofore had but a secondary interest in the art of dyeing. And there is not yet a single pulverulent or porous substance known which will act like filamentary matters in substantive as well as adjective colors.

By experiments and experience in the dyeing of cotton with aniline colors and other processes, M. Reimann has demonstrated the enormous power of silica and amorphous substances in absorbing coloring matters. A combination of silicic acid had already been colored by substantive matters, and attempts had been made, with more or less success, to color mica in powder with the brilliant aniline pigments, but the experiments had not been extended to the compounds of silica.

The silicic acid precipitated from a solution of soluble glass by means of acid in the form of jelly, and which, transforming itself into an impalpable white powder by drying, shows in a most convincing manner the property it possesses, when brought into contact with solutions of substantive colors, of taking up the coloring matters they contain, and with adjective colors after mordantage to act in precisely the same manner as textile fibres, the colors being as fixed as on cotton.

The aniline colors are these which the most readily combine with silica, which they seem to color in a permanent manner. When solutions of fuchsine, aniline blue, violet, etc., are agitated with silicic acid precipitate, as above described, and carefully washed, the acid soon assumes a decided color, which it retains after washing, though hot water

on alcohol will cause it to disappear. But the same occurs in the case of fibre dyes, such as cotton, from which the color is discharged by the same means. The tinted amorphous silicic acid yields pretty colored powders, which may be useful in the manufacture of paper-hangings.

It would, however, be very much more important if these phenomena could be turned to account in dyeing. It is easy to fix on fibrous substances, such as cotton, which do not take substantive colors directly and without preparation, aniline dyes by means of silicic acid. When the fibre of cotton, which is exceedingly rebellious against coloring matters, is simply impregnated with a compound of silicic acid easily decomposed, it absorbs colors, especially those of aniline, which possess in themselves all the properties of substantive colors.

A simple passing through a solution of soluble glass gives cotton the property of absorbing colors; but it is better to decompose the soluble glass upon the cotton by impregnating it with an alkaline solution of silica, and afterwards plunging it into diluted acid. By this plan the cotton, which is then washed and afterwards dyed in a solution of the color, when it takes a bright and fresh tint, which, moreover, is more permanent than any that can be obtained by the numerous mordants in use.

It is well known that the mordanting of cotton for aniline dyes consists in the use of an acid with which roseaniline, trimethylroseeaniline, etc., form soluble salts with difficulty, if at all. Tannic acid, on account of the insolubility of its salts, is generally preferred for this purpose. But the combinations with tannic acid do not give color so fresh as those obtained with other means, and their effect is always rather dull. This fault is entirely prevented by the use of silicic acid. It has been found in practice that aniline colors produced with its aid on cotton are more pure and resist soap and alkalis better than those obtained with other mordants.

The powerful attraction and fixation of silicic acid for coloring matter is still better understood when it is seen that wool, in direct opposition to its action with analogous colors, will not take aniline green; whereas, if passed through the solution of soluble glass, then dyed in a tepid solution of green, and finally passed through acid, it dyes perfectly. The methods above described have been applied to cotton on a large scale with highly satisfactory results.

M. Reimann has also experimented on the use of silicic acid in dyeing with adjective colors, and has found that it takes up acetate of alumina, acetate of iron, etc., from the various mordants precisely in the same manner as cotton; and consequently, the dyeing of black, etc., succeeds very well.

It was thought necessary to ascertain whether silicic acid, like mica, was not united to the coloring matter by a superficial attraction, or whether the affinity might not be attributed to a small proportion of alkali in the precipitate. This latter supposition obtained all the more attention from the fact that, for about a year, it had not been noticed that aniline colors could be fixed on cotton by an alkaline mordant. M. Reimann had, in consequence, sought to obtain all the colors got with silicic acid on glass itself, with fluoric acid as a mordant. If the affinity for the coloring matters only depended on the presence of an alkali, the experiment on the glass would give a negative result, as it could not be conjectured that the glass contained any soluble alkali. If, on the other hand, the affinity rose from a physical quality of its surface, the glass must give the same or similar results. And so it turned out; the glass mordanted on the surface with fluoric acid took the aniline colors as well as the amorphous silicic acid, and it was found that, with an iron mordant and logwood, the glass could be dyed black, rusty yellow, potash, etc. In consequence of the shallow action of the fluoric acid on the glass, the tints, which approach those of the silicic acid, are rather light, but wherever the acid has taken, the color is as perfectly fixed as with silicic acid. — *Polytech. Journal.*

SILK PRODUCTION.

ENGLAND alone consumes 4,000,000 lbs. of silk annually, and, at most, every pound requires 3,500 worms. China has consumed fifty times the quantity for 3,000 years, silk being the universal item of clothing there. It is produced mostly between the 30th and 40th degrees of latitude. The East India Company used to import vast quantities of silk from China, and the quality was always the same. It requires 14,000,000 of silkworms to produce the silk consumed in the United Kingdom. Lyons has 22,000 silk looms, and France manufactures nearly 3,000,000 lbs of silk. Italy produces 4,000,000 lbs.; Turkey produces 2,000,000 lbs. Russia manufactures silks at Novgorod. In 1838-9 France manufactured 22,000 bales of silk, or about 60,000,000 lbs., and America nearly as much. The silkworms prefer the white to the red mulberry, and the red to the black. The trees are raised by cuttings, layers, or by seed and transplanting. No other insect eats the leaves. When eight days old the worm is already three days in its first moulting; in five days its second moulting takes place; in five days more, a third; and, in another five days, a fourth. In three or four days it encloses itself in its cocoon, and becomes a chrysalis, all in about 29 or 30 days. Then it required a temperature of 65° to 70°; eggs require 45°. It remains in the chrysalis form from two to four weeks, and escapes from the cocoon (by dissolving the gum which holds the threads, and not by their ruptures) as a large moth. Every female lays about 350 eggs, of which 391,680 weigh one pound troy. But, when full grown, 50 weigh a pound, having increased 9,000 times. In 1,000 ounces of cocoons the pure silk is only 15 ounces, and in reeling 100, and sometimes even 80 only; an ounce of eggs yields about 1,200 ounces of cocoons. Five pounds of reeled silk have been produced in England from 1,200 worms; 97.5 lbs. avoidupois of mulberry leaves yield 10 ounces of reeled silk, or 156 to 1. Cocoons from lettuce leaves are one-seventh less, and the worms die. The coarse floss is a twentieth of the pure cocoons. The length of the fibers in each cocoon varies from 300 to 600 yards; 12 lbs. of cocoons yield on the average one pound of reeled silk, from which is made 15 yards of Gros de Naples. Every fiber of silk will sustain a weight of 50 grains. One third of the silk manufactured in England is exported to the United States, and a sixth to Canada and the West Indies. Spitalfields manufactures three sevenths of the broad silks, and Manchester two sevenths. Coventry and Macclesfield are the chief manufactories of ribbons, worth £1,750,000, and equal to one fifth of the whole consumption. Nearly two shillings a pound is paid for silk, and the national returns depend for repayment on the exports of one fifth to all parts of the world. Not less than 4,000 lbs. of raw silk are used weekly for making sewing silks, which employs above 2,000 hands at 5 and 6 shillings a week. The reduction of duties on raw silk in 1852 greatly

increased the manufactures, which, subject to oppressive duties, could not compete with the French fabric. The annual consumption is estimated at about 4,000,000 lbs., of which nearly two-thirds is in piece goods, a fourth ribbons and handkerchiefs, and a twentieth in sewing silks at a cost of 17s. a pound, exclusive of 2s. for throwing. The cost of labor in all branches—winding, weaving, dyeing, etc., is about £3,250,000, divided among 180,000 persons, at an average wage of only 8s. per week. The total returns are about £10,500,000, leaving £2,750,000 for machinery, profits, etc. — *Himalaya Chronicle.*

DETECTION OF ORGANIC COMPOUNDS IN VEGETABLE TISSUES.

By DR. OTTOMAR HERRMANN.

FOR the micro-chemical detection of datscin the author recommends the application of lime or baryta-water, which gives an intense yellow color to the cells containing the glucoside. On the addition of acetic acid or dilute hydrochloric acid this color at once disappears. In order to detect berberin we may use nitric acid. On merely examining plants containing this alkaloid we find in certain parts cells filled with a gold-yellow liquid or intense yellow membranes. On the addition of alcohol and very dilute nitric acid this color disappears in a short time, and numerous gold-colored crystals are formed, which chiefly occupy the interior of the cells in stellar groups. Sulphide of ammonium occasions a brown coloration. Colchicin takes an intense yellow coloration in contact with alkalis. To detect chloridazin we may utilize its deep brown-red solution in ferric chloride, and its brown-yellow precipitate with ferrous sulphate. The presence of a small quantity of tannic acid renders the color deeper, but does not effectually mask the reaction. Larger quantities of tannin interfere. Curcumin is dissolved by mineral acids with a carmine red color, but not without decomposition. Its solutions give red-brown precipitates with the salts of lime and barium, and fiery-red precipitates with the salts of lead. Nucin may be recognized by the purple-red color which it assumes with alkalis, preferably with the fumes of ammonia. The color is not permanent, and soon passes into various shades of brown. The author detects rutin by the intense yellow solutions which it forms with carbonated and caustic alkalis, lime and baryta-water, and which on exposure to the air take up oxygen and turn brown. Plumbagin dissolves in alkalis with a red color, which passes into yellow on the addition of an acid. Chrysophanic acid is recognized by the splendid purple-red color with which it dissolves in aqueous alkalis. Frangulin takes a carmine-red with dilute potassa.

HARDENED GLASS FOR LABORATORY PURPOSES.*

By J. W. SWAN.

"To supply me with flasks and beakers, almost as resistant of the destructive agencies of fire and hard knocks as cast-iron." This was the attractive proposal made to me a few days since by the representative of a company now working M. de la Bastie's process for hardening or tempering glass. Samples were provided, not of flasks and beakers, but of other vessels that would sufficiently illustrate their properties. I immediately, and with great eagerness, gave myself up to experiments with some of the vessels. Some of them are here to-night, and are at the service of the members for the purpose of experiment. The results of my experiments are at least interesting. I found that even in a very thick basin water might be boiled, by means of a naked flame strongly playing upon it, without fracture; that the hot vessel might, without harm, be lifted off the stand with cold tongs and set upon a cold plate of iron; that altogether it bore an amount of ill usage that was extraordinary. Then I thought I would subject it to a severer test; I therefore only partly filled the basin, and allowed the flame to play upon a larger surface of the glass than was covered by the liquid, so that the margin of the basin might be heated above the boiling point. I did this with the idea that probably under those conditions the temper of the glass might alter or be destroyed where the glass was more strongly heated, and if it was destroyed, that fracture would almost certainly result. The agent of the company said no, but the fragments—the result of two experiments of exactly the same kind—say yes. The character of the fracture is worthy of attention; you will observe that the bottom, which was covered by the water, is broken in small pieces like hardened glass, and that the rim has broken in larger pieces with sharp-cutting angles—in fact like ordinary untempered glass. Possibly tempered glass may in some instances prove useful in the laboratory—for the much-abused water bottle for example—but for general purposes of the analyst, in place of flasks and breakers of thin glass, the experience which I have so far had of it makes me very doubtful of its utility.

WASHING OUT FLASKS BY INVERSION.†

By DR. P. TOWNSEND AUSTEN, New York School of Mines.

TO WASH a precipitate out of a flask would seem to be an easy manipulation, but yet the extraction of the last particles is often a tedious operation. This is particularly true in the case of small grains of sand or mica in the analysis of silicates, as well as with heavy gelatinous precipitates.

By using the following simple method a flask may be washed out at a single operation.

1. The flask contains a hot liquid.—The flask, which ought for the sake of convenience to be half full, is suddenly inverted† in a dish, the larger the better, containing about as much liquid as in the flask. This operation requires a little skill. It is most easily performed by holding the flask over the rim of the dish, then gradually inverting the flask, and, as soon as the liquid begins to flow out, suddenly inserting it, putting the mouth of the flask entirely under the surface of the liquid, and at the same instant bringing it by a swift movement to the middle of the dish. After a few seconds the cooling of the air in the flask occasions a partial vacuum, and the liquid rises in the flask. If the liquid has been at a boiling temperature the flask will be almost filled. After allowing the liquid to ascend, the flask is firmly held by the neck with one hand, while the other grasps the

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† This method is not very applicable, however, to liquids holding light powders in suspension. By standing as in the silver assay and allowing the substance to settle, agitating occasionally to prevent its deposition on the bulge of the flask, even suspended powders may be removed.

‡ I much prefer this to corking the flask, inverting, and then removing the cork.

§ Protected by a felt pad if necessary.