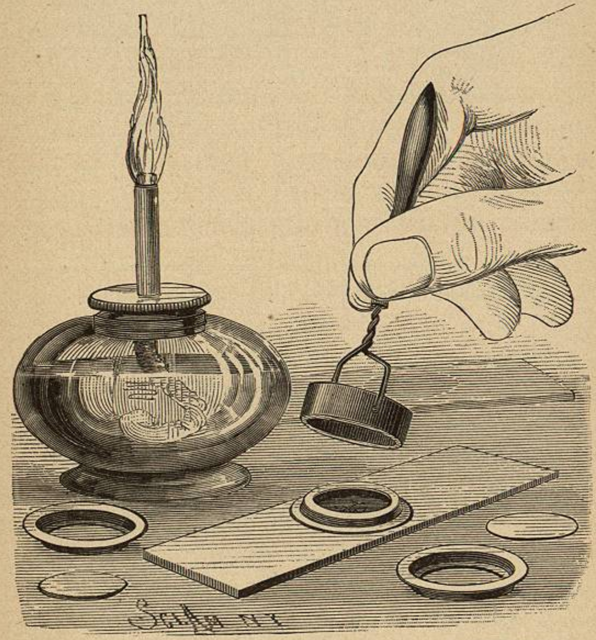
mounting. For such objects the method shown in the annexed engraving (Fig. 307) is of great utility, as it permits of inclosing the object quickly, completely, permanently, and in a presentable form, and while it seems especially adapted to such objects as are common and liable to remain unmounted, it is, of course, applicable to almost any dry object.

To carry out this method, only two articles, in addition

FIG. 307.



Quick Method of mounting Microscopic Objects.

to those usually possessed by microscopists, are required; one being the ring with an internal flange at the top and an external flange at the bottom, the other a heating tool, consisting of a ring of brass attached to a suitable handle.

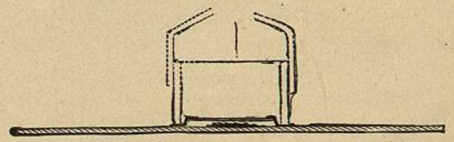
The rings, of which the walls of the cells are formed, are spun or stamped from disks of Britannia metal, sheet brass, or other sheet metal, with a narrow internal flange or fillet at the top for receiving the cover glass, and a wider external

flange at the bottom, for attachment to the slide. The rings vary in depth according to the depth of cell required. The under surface of each ring is coated with thick shellac varnish and allowed to dry thoroughly. When the varnish is dry and hard, a clean cover glass is dropped into each ring, and the ring is placed bottom upward on the warming stand and heated until the shellac melts and thoroughly covers the edge of the cover glass. The ring is now allowed to cool, when the cover will be ready for use. It will, of course, be understood that a quantity of rings and covers are thus prepared and held in reserve. In fact, it is to be hoped that the manufacturers of microscopists' supplies will furnish the rings and covers thus prepared, ready for instant use.

The object to be protected is attached to the slide by means of cement, in the usual way.

A ring containing a glass cover is arranged over the

FIG. 308.



Sectional View of the Slide and Heating Tool.

object, and the heating tool is warmed and placed upon the outer flange of the ring, as shown in the sectional view, Fig. 308. By this means sufficient heat is imparted to the ring to melt the shellac upon that portion touched by the heating tool, and cause it to attach itself to the glass slide. It is the work of an instant to cover an object in this way, and the slide needs no further finish; but the operator may, if he choose, lacquer the rings to prevent them from tarnishing.

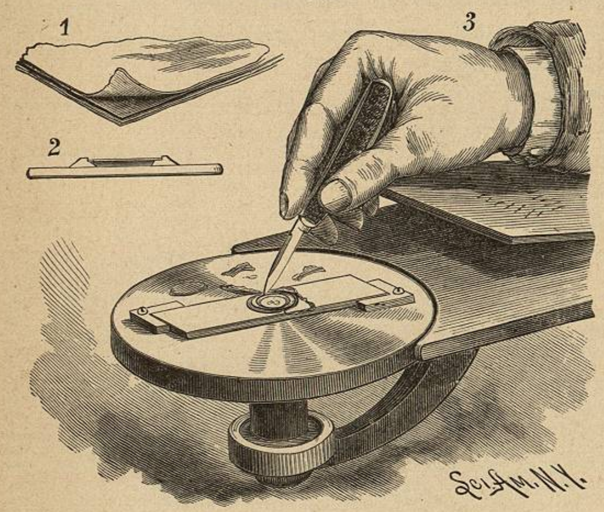
A thin ring provided with the coating of shellac may be applied to an ordinary balsam mount to increase its security.

By applying to the ring a suitable cement, a liquid cell may be made. The object to be mounted in the liquid cell is wet with the liquid and placed on the slide. The ring is then secured in the manner above described, and the liquid is afterward introduced into the cell through an aperture previously made in the side of the ring. This aperture is stopped with cement, applied with a hot wire or needle.

Dr. Stiles' wax cell is simple in construction, beautiful in appearance, and very effective for dry objects.

Sheet wax, such as is used by the makers of artificial flowers, is the material employed in the construction of this cell. Three or four sheets of different colors are pressed together by the thumb and finger to cause them to adhere, and a square of the combined sheet thus formed of sufficient size for a cell is cut out and pressed upon a glass slide. The

FIG. 309.



Making the Wax Cell.

slide is then placed upon a turn table, as shown at 3, Fig. 309, when, by the dextrous manipulation of an ordinary penknife, the wax is cut into a circular form, and the center is cut out to the required depth. If the cell is to contain a transparent or translucent object, the entire central portion of the wax is removed, as shown at 2; but if a ground is required for the object, one or more layers of wax are allowed to remain. A portion of the upper layer of wax is removed to form a rim for the reception of the cover glass. Where a black ground is required, a small

disk of black paper is pressed upon the lower layer of wax. The final finish is given to the cell by a coating of shellac varnish, applied while the slide is on the turn table. These cells are very quickly made and have the finished appearance of a cell formed of different colored cements.

MICROSCOPICAL EXAMINATION OF THE PHENOMENON O. COLORS OF THIN PLATES.

As all works on light and on general physics treat of the phenomenon of the interference of light as exhibited in thin transparent plates or films, it will be unnecessary to go into an examination of this subject in detail; but it will doubtless prove both interesting and profitable to those interested in microscopy to take up the study of this subject with the aid of the microscope.

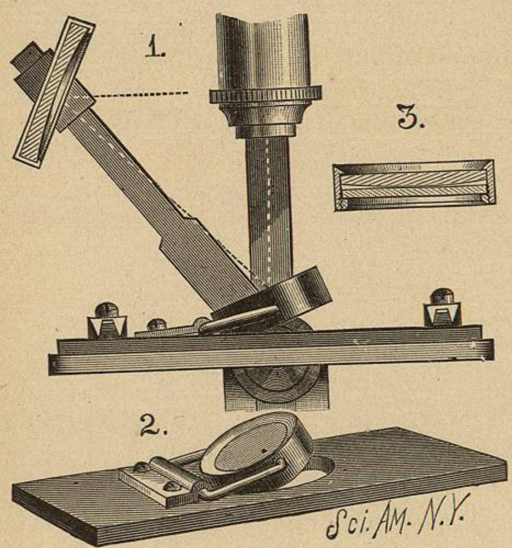
There is nothing more beautiful than Newton's rings, or a soap film, or extremely thin plates of mica when viewed in a microscope by properly directed light. Even the gorgeous colors of polarized light cannot be excluded in this comparison; but it is difficult with ordinary appliances to see these exquisite tints.

The writer, after some experiment, devised mounts for the ready exhibition of Newton's rings and interference phenomena, as shown by the soap film.

The device for the exhibition of Newton's rings is shown in Fig. 310, 1 showing the position of the mount on the microscope stage, 2 being a perspective view of the slide, and 3 a diametrical section of the rubber cell containing the plane and convex glasses. The plane glass is a disk cut from one of the finer kind of glass slips, commonly used in mounting objects. The convex disk is cut from an ordinary biconvex spectacle lens, having a focal length of 24 inches. The cell is screw-threaded internally, and provided with a screw-threaded ring, which clamps the two glasses together. It has, in diametrically opposite sides, cavities for receiving the ends of the wire frame, which is clamped to the face of the slide by a clip and two screws. The cell containing the glasses is in this way supported adjustably so that it can be raised or lowered, or tilted at any required angle.

The position of the cell relative to the source of light is shown at 1. The cell and the source of light or the mirror should be arranged so that the image of the flame used for illumination or the broad light of the sky will be reflected up the tube. The objective (a 2 inch, with 2 inch eyepiece) may now be focused, when the rings, which about fill the field, will appear with great brilliancy. The effect may be

FIG. 310.



Mount of Newton's Rings for the Microscope.

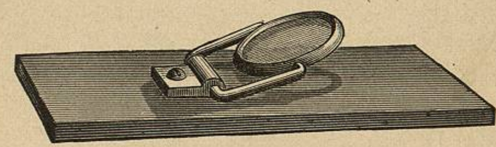
somewhat varied by turning the cell at different angles, and moving the source of light accordingly. The concave mirror is used to concentrate the light; but, of course, a condenser may be used instead, or, if the light is strong enough, the beam may be received directly on the glass of the cell, and thrown up the tube.

With the unaided eye the rings appear as a very small disk, with no very noticeable beauty; but in the microscope it is not only greatly magnified, but properly illuminated.

An interesting experiment, showing the difference between the effect of pure sunlight and artificial light, consists in adjusting the mirror so as to simultaneously receive light from the sky and from a lamp or gas light. The portion of the disk illuminated by the lamp light shows the predominance of yellow, a greenish hue taking the place of the blue; the red being also modified.

Monochromatic light, such as is secured by passing light

FIG. 311.

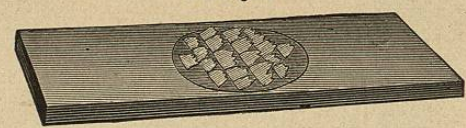


Holder for Soap Film.

through a deep red glass, for example, shows the rings as alternately red and black.

The device for exhibiting the soap film, which is shown in Fig. 311, will now need little explanation. A ring is pivoted in the same manner as the cell already described. By dipping the finger in soapy water, and passing it over the ring, a film will remain in the ring, which may be viewed

FIG. 312



Mount of Mica Plates.

in the same manner as Newton's rings. The bands of iridescent color are very brilliant.

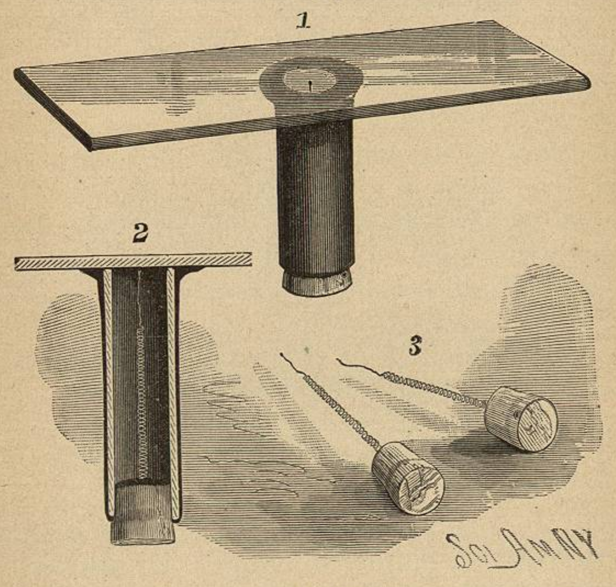
Thin plates of mica exhibit the same phenomenon. By tearing a very thin plate of mica, so as to leave a ragged edge, many extremely thin points will remain projecting from the torn edges; these may be cut off, and cemented in a suitable position for observation. These little points are quite difficult to handle. Probably the easiest way to manage them is to cut the piece of mica down quite small, and then take the bright point in a pair of clean forceps, and cut the larger part off, then touch the edge of the bright piece with Canada balsam, and put it in position on the slide. These little plates of mica are viewed in the same manner as the Newton's rings.

It is perhaps hardly necessary to say that having prepared a good mount of the mica plates, it is advisable to inclose it under a cover, as soon as convenient, to exclude dust.

MICROSCOPIC OBSERVATION OF VIBRATING RODS.

A metal rod fixed in a vise at one end, with a silvered glass bead attached to the other end, constitutes Sir Charles

FIG. 313.



Vibrating Rod mounted for Microscopic Observation.

Wheatstone's apparatus for the study of the transverse vibrations of rods.

By vibrating a rod arranged in this way, Wheatstone was enabled to obtain an almost infinite variety of symmetrical and beautiful luminous scrolls.

It is a simple matter to repeat Wheatstone's experiment

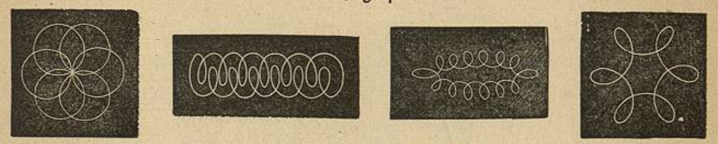
with the apparatus alluded to, but it is not always convenient to do it.

A vibrating rod permanently mounted in a cell and arranged for observation with a microscope is shown in Fig. 313, 1 representing the mount in perspective, 2 showing it in section, 3 showing the rods detached from the mount.

To an ordinary 3×1 inch glass slip is connected a paper tube $\frac{5}{16}$ inch internal diameter and 1¼ inches long, well blackened on the inside.

The cement is applied carefully, so as to have the glass clean and clear with the tube. To a cork fitted to the open end of the tube is cemented a wire spiral formed of about 4 in. of No. 40 spring brass wire. The diameter of the spiral is $\frac{3}{32}$ inch. The end of the spiral next the glass slip terminates in a straight arm $\frac{1}{4}$ in. long, upon the end of which there is

FIG. 314.



Curves traced by Vibrating Rod.

a minute bead of black glass. A smooth bead is secured by first fusing borax on the end of the wire, then touching the borax while in a fused state with a thin thread of black glass, then breaking the thread a short distance from the end of the wire, and finally fusing it by gradually pushing it forward into the flame until a perfect bead of the required size is formed.

The cork with the spiral is inserted in the paper tube with the bead arranged centrally with reference to the tube, and only a very short distance below the glass.

By placing the mount thus prepared under a 1 in. or 2 in. objective, and allowing light to fall on the bead from one direction, it will be noticed that the black glass bead is rarely at rest, the bright pencil of light reflected from it continually describing curves of various forms. Stepping on the floor of the room in which the microscope is located is generally sufficient to set the spiral into active vibration. Rapping on the table on which the microscope rests will cause the bead to describe intricate curves.

By striking the side of the paper tube with more or less force, different figures will be produced.

Illuminating the bead from two points produces parallel curves.

While this mount is perhaps not strictly a microscopic object, it may nevertheless be viewed to advantage by the microscope.

SIMPLE POLARISCOPE FOR THE MICROSCOPE.

To the draw tube of the microscope is fitted a paper tube, which is readily made by gumming writing paper and winding it around a cylindrical stick of the proper size. To the paper tube is fitted a second tube, and this last tube is cut diagonally through the center at an angle of 35° 25′. One of these pieces is inserted in the first tube, and sixteen or eighteen elliptical glass covers, such as are used for covering mounted microscopic objects, are placed on the diagonally cut end of the inner tube.

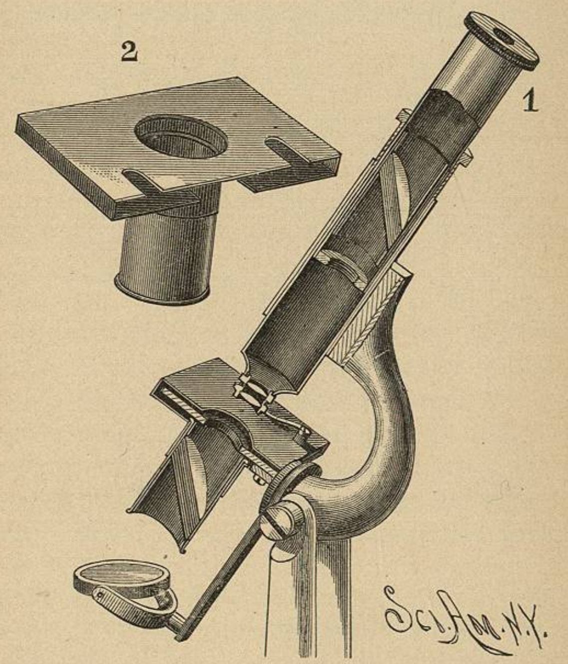
The glasses should be thoroughly cleaned, and when in position in the tube they are held by the remainder of the diagonally cut tube. The sectional view of the instrument clearly shows the position of these glasses in the draw tube.

The tube which goes under the stage is made in precisely the same way, and is supported in position for use by a short paper tube secured to a cardboard casing adapted to slide over the stage of the microscope, as shown in the engraving. Notches are formed in the rear edge of the upper part of the casing to allow it to slip by the slide-holding clips. The lower tube must be capable of turning in the short fixed tube, and it may be prevented from falling out by gluing a cardboard band or a piece of small cord around its upper end, forming a sort of flange. The hole in the upper part of the casing is made larger than the movable tube, to admit of inserting the tube from the top of the casing. The part of the attachment below the stage is the polarizer. The part in the draw tube is the analyzer.

By turning the polarizer, the light being thrown directly up the tube by the mirror, the field of the microscope will appear alternately light and dark, showing the partial extinguishment of the polarized beam twice during each revolution of the polarizer.

When the field is darkest, a piece of mica of the proper thickness inserted between the stage and objective renders

Fig. 315.



Simple Polariscope for the Microscope.

the field light, and it may, in addition to this, produce a color effect. The colors depend on the thickness of the film and upon its position in the instrument.

There are various chemical salts and animal and vegetable substances which produce brilliant color effects in the polarized beam. Salicine is a favorite. Santonine is good. Tartaric acid, boracic acid, and cane sugar are easily prepared by allowing their solutions to crystallize on the glass slip. Some of these substances, salicine for example, may be fused upon the slip and recrystallized.

The colors may be heightened by placing a film of mica behind the object during examination. Different colors will be produced by different thicknesses of mica.

Among animal substances to be examined in this way are fish scales, parings of the finger nails and of horses' hoofs, parings of corns and of horn.

Among vegetable substances, the sections of some woods, the cuticle of plants, the rush for example, form good polariscopic objects.

Many minerals show well in polarized light, but they are generally difficult of preparation. Selenite is an exception. It may be readily reduced to the proper thickness to secure brilliant effects.

The polariscope above described, although not as desirable as one provided with a pair of Nicol prisms, is nevertheless worth having, and will give its possessor a great deal of satisfaction.

CHAPTER XIV.

THE TELESCOPE.

Some hints are here given as to the construction of a cheap and efficient telescope which will give its possessor a great deal of enjoyment, and will serve to stimulate astronomical observation and research.

Plate IV. represents the telescope, its standard, and the various parts in section and in detail. The object glass, A, shown in the engraving, is a meniscus lens $2\frac{1}{2}$ inches in diameter and 36 to 38 inch focus. It is mounted in a wooden cell, B, having an internal flange or fillet about $\frac{1}{16}$ inch wide, forming a true support for the lens and bearing against the end of the paper tube, D, which forms the body of the telescope. The lens is retained in its cell by a flat strip, E, of brass which is sprung into the cell and pushed down against the lens. The cell is fastened to the tube by common wood-screws, which pass through the collar into the paper forming the tube. It is perhaps needless to say that the cell should be made of some thoroughly seasoned hard wood, which is not liable to change under atmospheric influences. Hard maple answers a good purpose, but mahogany is preferable.

To protect the objective when not in use, a cap, F, of tin or pasteboard, neatly covered with morocco or velvet, is fitted to the cell.

The paper tube, of which the telescope body is formed, is such as is commonly used for rolling engravings for mailing. It is 3 inches external diameter and 32 inches long (about 4 inches shorter than the focal length of the objective). The exterior of the tube is covered with Java canvas attached by means of bookbinder's paste (flour paste with glue added), and varnished when dry with two or three thin coats of shellac varnish. This gives the tube an elegant and durable finish.