of heat, if the heat is judiciously applied; a gradual heating of the side to be elongated by a heat that can be controlled, and the simultaneous persuasion of weight, lever, or screw, will do wonders on such a material as the cast iron that is usually considered to be of too friable, untenacious, and brittle a nature to be much beyond stone in resistance to tension; but even stone will bend.

Purifying Air by Washing.

M. Windhausen has designed an apparatus for the purifying of air from dust, germs, and other impurities which is well spoken of by French technical writers. The principle of the appliance is to impart a rotatory movement to the air to be purified; the air being at the same time surrounded by a surface of water in movement. The idea is that in this way the solid impurities which may happen to be in the air will be thrown, by centrifugal force, against the water surface; and they will consequently be taken up and carried away by it. The actual apparatus consists of two horizontal concentric cylinders placed in connection with a fan. The fan and cylinders are fixed upon and turn with the same spindle, and the whole is inclosed in a casing. The cylinders are closed at the ends, except for a hole permitting the passage of air drawn by the fan. As the air passes through the concentric space between the drums, it is caused to rotate with them by the presence of feathers running longitudinally on the inside of the outer cylinder.

The spindle which carries the whole arrangement is hollow; and it thus serves to bring the water, which is allowed to escape therefrom inside the drum by means of fine holes, which project it in the form of fine rain against the inside of the inner cylinder. This cylinder is also perforated, and the water again escapes from it and is projected against the inside of the outer cylinder, over which it spreads as a thin coating. The motions of the air and water are as nearly as possible in opposite directions. The water after it has been sufficiently exposed to the air is allowed to escape, and is drawn off by means of a siphon. It is impossible for any air to pass through the apparatus without being washed, and its solid impurities removed by centrifugal action; and the proportion of water required may be varied as found necessary with reference to the condition of the air. The apparatus may be combined with any device for warming or cooling the air; or the same arrangement may be modified for treating smoke or gases.

MICROSCOPICAL EXAMINATION OF THE PHENOMENON OF COLORS OF THIN PLATES

BY GEO. M. HOPKINS.

As all works on light and on general physics treat on 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 Figs. 1, 2, and 3; Fig. 1 showing the position of the mount on the microscope stage; Fig. 2 being a perspective view of the slide; and Fig. 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 kinds of glass slips, commonly used in mounting objects. The convex disk is cut from an ordinary 24 inch biconvex spectacle lens. The cell is screw-threaded internally, and provided with a screw-threaded ring, which clamps the two glasses together. The cell so formed has, in diametrically opposite sides, cavities for receiving the ends of the wire frame, and the wire frame is clamped to the face of the slide by a clip and two screws. The cell containing the glasses is in this way supported 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 in Fig. 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 an A eyepiece) may now be focused, when the rings, which about fill the field, will appear with great brilliancy. The effect may be 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 through a deep red glass, for example, shows the rings as alternately red and black.

The device for exhibiting the soap film, which is

MOUNT OF NEWTON'S RINGS FOR THE MICROSCOPE.

shown in Fig. 4, 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 in the same manner as Newton's rings. The bands of iridescent color are very brilliant, and the eddies and swirls of gorgeous colors are something beyond description.

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

HOLDER FOR SOAP FILM.

MOUNT OF MICA PLATES.

larger part off, then touch the edge of the bright piece to 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.

Removing Microbes from Water.

Professor Frankland has recently made a series of experiments on the relative efficiency of filtration, agitation with solid particles, and precipitation as a means of removing micro-organisms from water. His method was to determine the number of organisms present in a given volume of the water, before and after filtration. The filtering materials were greensand, silver sand, powdered glass, brick dust, coke, animal charcoal, and spongy iron. These materials were all used in the same state of division, being made to pass through a sieve of forty meshes to the inch. Columns 6 inches in height were used. It was found that only greensand, coke, animal charcoal, and spongy iron wholly removed the micro-organisms from the water filtered through them, and that this power was lost in every case after the filters had been in operation a month. With the exception of the animal charcoal, however, all these substances, even after being in operation for a month, continued to remove a very considerable proportion of the organisms present in the unfiltered water; and in this respect coke and spongy iron occupied the first place. Water con-

taining micro-organisms was also agitated with various substances in the same state of division as above mentioned, and after subsidence of the suspended particles, the number of organisms remaining was determined. A gramme of substance was in general agitated with 50 c. c. of water for a period of about fifteen minutes. It was found that a great reduction in the number of organisms could be produced in this way; and the complete removal of all organisms by agitation with coke is especially to be remarked. Precipitation by "Clark's process" also showed that it affords a means of greatly reducing the number of these organisms in water. Dr. Frankland concludes from his experiments that, although the production in large quantities of sterilized potable water is a matter of great difficulty, involving the continual renewal of filtering materials, there are numerous and simple methods of treatment which secure a large reduction in the number of organisms present in water.—*Journal of the Society of Arts.*

Trying a Dynamite Gun.

The pneumatic dynamite gun, tested last week at Fort Lafayette, is the development on a large scale of the system of throwing high explosives from guns by means of compressed air. Experiments with this system have been in progress for several years past with small guns with from two to four inch bore, throwing from 10 to 20 pounds of explosive gelatine about a mile, using a pressure of 500 pounds to the square inch.

The system, in brief, consists in the use of a reservoir for compressed air connected to a gun-barrel by a suitable firing valve, this reservoir having a cubic capacity six times greater than the bore of the gun, measured from breech to muzzle. A shot loaded with explosive gelatine is placed in position through a breech-closing mechanism, when, by means of a firing lever, the valve is made to deliver a quantity of air from the reservoir into the barrel just sufficient to fill it, and shut off the supply just at the point when the shot passes out of the muzzle, thus subjecting the shot during its passage through the barrel to a pressure equal to an average of the initial and terminal pressures in the reservoir. A space is left between the base of the shot and the face of the firing valve, which acts as an air cushion, starting the shot without shock or jar, thus avoiding explosion. Each shot is fitted with fulminate primers, which explode the charge on impact.

In the small guns referred to above, full air pressure was never obtained on the base of the projectiles, on account of faulty valve action, and numerous minor points of construction were impracticable; but the absolute surety with which high explosives could be handled, proved by a large number of shots said to have been made under all sorts of conditions, favorable and unfavorable, if the private tests have not been exaggerated in their description, did much to prove the correctness of the principle involved.

The dynamite gun is large enough to carry 100 pounds of explosive gelatine two miles, and its projectors expect it to supersede all kinds of self-propelling torpedoes, except in special cases. It will, they think, if successful, introduce into warfare an aerial and explosive shell.

This gun was constructed from plans furnished by Mr. Nat. W. Pratt, a practical and ingenious mechanic. It has a bore of $7\frac{3}{4}$ inches with a barrel 60 feet long, hung on trunnions at the breech and in a pair of heavy cast supports, which in turn are bolted to a carriage running on a track for side training. The elevation is obtained by swinging the gun on its trunnions. Both motions are performed by the compressed air in the reservoirs, which rest on the carriage and turn with it.

The handling of the gun is controlled by the man who does the firing. The gun's crew consists of the gunner and two men to load. The valve which regulates the flow of the air into the barrel is eight inches in diameter, and works under a total load of over 75,000 lb. without shock or jar, and the amount of air to be discharged at any one shot can be regulated at will; the valve always giving a full opening, delivering the full pressure on the base of the shot, but remaining open a longer or a shorter time, according to the amount to be delivered.

Unlike the smaller guns, there are no movable joints under pressure, and it is said no leaks are found when working under a full pressure of 1,000 lb. per square inch. On account of the greater pressure at which this gun is worked, and the certainty that full pressure is delivered on the base of the shot, the experiments of firing dynamite have been very carefully conducted.

At the exhibition last week a projectile weighing 200 lb., one hundred pounds of which was explosive gelatine, was fired with 1,000 lb. pressure at an elevation of barrel of 30°. At this writing the exact range has not been received from those operating the plane-tables at Fort Hamilton, but it was thought to be about a mile and a half.

Unfortunately, the electric battery which should explode the charge upon contact with the water did not do its work.