The Laboratory

Some Suggestions for Home Experiment

Microscopic Photography

By Norman Borden

IT is the purpose of this article to give a definite idea of how photomicrographs are made and at the same time to give the possessor of a microscope precise and accurate directions for obtaining photographs of microscopic objects.

The entire apparatus consists of a microscope and accessories, camera shutter and body, rack for carrying the camera and if necessary a source of artificial light. Fig. 1 shows most of the pieces of apparatus which are to be considered separately in the following paragraphs:

First, the quality of the objectives must be taken into consideration. A chromatic objective is entirely out of the question for making high amplifications. An achromatic objective, free from scratches, must be used in securing high power negatives. Objectives

media while making long exposures. Fig. 2 shows how such a cell may be made. There are times, too, when dark ground illumination will be wanted. This is effected by stopping out the light immediately behind the object with some opaque substance put on the front lens of the condenser. When done properly, a cone of oblique rays illuminates the object and gives it more relief so that it has a natural appearance.

The appearance of the object in the negative has to do with the plate used. Isochromatic plates give truer color values than the ordinary plates. Fast plates can be used to an advantage over the slower ones.

Working Directions.

We will begin by picking out an object that is suited for photography, namely, a diatom "Triceratium Favus," which is generally the first one of prepared diatom plates. The diatom is placed in the

of which are (a) the salivary corpuscles, which are about the size of the white corpuscles of the blood (8 to 10 μ); (b) the pavement epithelial cells; (c) living organisms from the cavities of the teeth; (d) leptothrix buccalis, which are large rod-shaped bacteria. All these objects are well suited for photography when deeply stained with fuchine and mounted in balsam. Fig. 3 shows an epithelial cell with bacteria.

In Fig. 4 is seen a group of micrococci, which were cultured on a slice of potato. They are easily stained mythel-violet and mounted in Canada balsam. The spores of the fungus, Aspergillus Glaucus, magnified 500 diameters are seen in Fig. 5. Fungus spores do not need be stained and are best photographed dry. Among other objects are pollen grains, sections of plant stems and plant hairs. The stagnant water in frog ponds contains innumerable specimens.

A Heat-storing Water Bag

THE bag described in the following paragraphs is a great improvement over the ordinary hot water bag. Besides its property of retaining heat longer, it can be prepared so that it will store heat, be set aside and then used at a future time. It is then ready for any emergency. Fill an ordinary hot water bag with either sodium sulphate crystals or hypo crystals. The crystals cost about ten cents per pound at the drug store. Sodium sulphate is preferable. To use, place the bag, which should be tightly corked, into a vessel of boiling water, and boil for about fifteen minutes. The crystals in the bag are now in a liquid state, i. e., a super-saturated solution has been formed. The bag is now ready for immediate use. It will now impart its heat steadily about four times as long as the same weight of water. If the bag becomes cold in too short a time, it is a sign that it has been boiled too long.

To prepare the bag for future use, boil twice as long as you did for immediate use. You can if you wish, use the bag while it is giving off its temporary heat in cooling, and then later utilize its latent heat. The storing qualities of the bag depend upon the heat of crystallization. The solution in the bag has become super-saturated by long boiling of the bag. Upon cooling it remains a liquid, but if it is touched by the cold fingers or suddenly jarred, or if one of its crystals is inserted in the solution, the whole mass crystallizes, and the heat of crystallization is given off. Sometimes the solution on solidifying forms in one hard lump. This does no particular harm, but it may be prevented by kneading the bag at intervals while in use.

Ball Clamp for Holding a Camera

By J. H. Bentley

A BALL clamp for holding a camera to any suitable support may be made very simply as follows: Two clamp plates should be fashioned out of a 1 $\frac{1}{4}$ -inch by 5/16-inch stick of wood, one being 4 $\frac{3}{4}$ inches long and the other 4 $\frac{1}{4}$ inches. A $\frac{3}{4}$ -inch hole is drilled at one end and countersunk on the inside, the other end

A camera-supporting clamp.

of the short one being cut away as shown to give the clamp a good grip on angles. Very often a wooden ball can be found on the end of broom handles or a discarded child's ten-pin set, knobs, etc. The stud in the ball is $\frac{1}{4}$ -inch-24 thread, for standard cameras, and is pressed tight into a hole drilled for it.

The cup-head bolt is also $\frac{1}{4}$ -inch-24 and the inside of the head should be filed a very obtuse V as shown to prevent turning and to form a rocking fulcrum when on an angle. The spring on it keeps the clamps apart.

Fig. 1.—General arrangement of the microscope and camera.

Fig. 2.—Cell for ammonio-sulphate solution.

Fig. 3.—Epithelial cell with bacteria.

Fig. 4.—Micrococci cultured on potato.

Fig. 5.—Fungus spores, 500 diameters.

of 3, 4, and 16 millimeters focal lengths will be found to suffice for amplifications up to 1,000 diameters. Also if the eyepiece is to be used in connection with the objective, both lenses must be perfectly clean. One method of cleaning lenses is to wash them in a solution of tincture of green soap and distilled water, using absorbent cotton, and, then, as a final, to rinse them in pure grain alcohol.

One form of a frame work for carrying the camera is shown in Fig. 1. The base B is large enough to accommodate a stereopticon or other source of light. The uprights A, of which there are two, should be made of metal rods or tubes. They must be fastened rigidly to the base and if necessary, strongly braced. It is of great importance to have the apparatus as rigid as possible so that it will not vibrate. Four feet is a suitable length for the uprights. In constructing the camera and bellows, the main object is to get them light tight. For the bellows rubberized cloth will be sufficient. The plate-holder is made to slide upon the uprights and is provided with thumb set-screws so that it may be fastened at any position. If a regular camera shutter is not at hand the exposing can be done by using a cardboard before the mirror of the microscope.

Perfectly white light gives the best results. Sun light may be used if the photographer is provided with a heliostat. The student had better resort to an artificial light such as gas or electric light. The tungsten light is the best of the convenient incandescent lamps. If this lamp be used as shown in Fig. 1, its light will be found sufficient for all magnifications up to 1,000 diameters. If the gas mantle is used, the stereopticon should be provided with a number of light trapped ventilators. Mono-chromatic light can also be used to advantage with certain objects. This kind of light is obtained by the use of ray filters which absorb all the light except the color wanted. A substitute for true mono-chromatic light is the light which passes through a cell containing ammonio-sulphate solution. This last named light is also free from heat waves, so that there is no danger of softening the mounting

center of the field and then the microscope is put in connection with the camera by means of a small rubberized tube. The magnification will be about 200 diameters, so the camera is fastened in its position and a rough focus is made. The finer details cannot be seen on the ordinary ground glass, so a focusing glass is used and a piece of plain glass is substituted for the ground glass. In this last named method of focusing, the aerial image is used to focus upon and it must be in the same plane that the sensitive surface of the plate will be. The light is adjusted while focusing, by means of the iris diaphragm.

Rules for exposing cannot be given in precise statements. With a heliostat, 5 millimeters objective and 400 diameters amplification, the exposure would have to be about 2 or 3 seconds. Using light from the clear blue sky, an exposure of 30 to 90 seconds would be made for an amplification of 50 to 75 diameters. The time of exposure depends upon the light used, the color of the object, the plates used and the magnification. The one aim in making photomicrographs is to produce a dense negative with contrast.

Developing and Fixing.

As there are a great number of reliable developers on the market it is not advisable for the beginner to mix his own. Develop the plate until the details show from the back of the plate and then rinse in plenty of water and transfer to the fixing bath. Here it should remain long enough to clear the last traces of silver. The negative is then washed and intensified if necessary. To intensify, immerse the plate in a saturated solution of mercury bichloride until it is bleached white and wash thoroughly. Next immerse in a solution of ammonium hydroxide (about 10 per cent) until the film turns black again. This method produces intensification to a moderate degree.

Preparation of Specimens.

Epithelial cells are good objects for practising mounting and staining. They are found in a free condition in the saliva, the microscopic constituents