Journal of the Royal Microscopical Society

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS

AND

A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia)

MICROSCOPY, &c.

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Minimis partibus, per totum Naturæ campum, certitudo omnis innititur quas qui fugit pariter Naturam fugit.—*Linnæus.*

FOR THE YEAR

1915

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MICROSCOPY.

A. Instruments, Accessories, etc.*

(1) Stands.

Small Comparator.†—This instrument (fig. 2), made by the Cambridge Scientific Instrument Co., consists of a cylindrical steel tube about 500 mm. long which is supported in geometric bearings on a rigid frame, and can be fed backwards and forwards by means of a micrometer screw of 1 mm. pitch. The micrometer head is divided in 100 parts and readings can be estimated to 0·001 mm. The screw has a pitch of

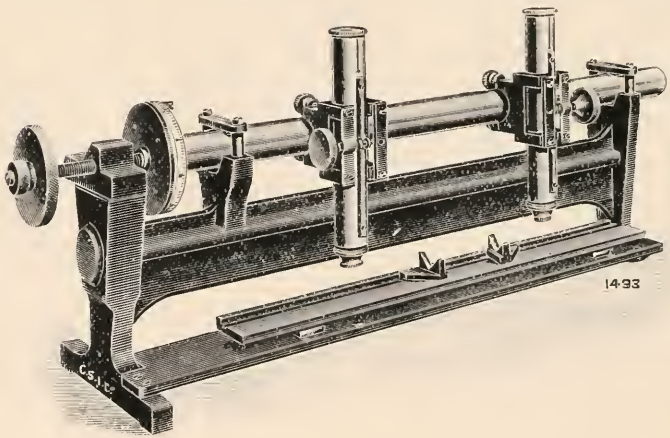


Fig. 2.

1 mm. and is free from backlash. Two Microscopes with achromatic objectives are clamped to the steel tube. They are fitted with the Lucas slow motion focusing mechanism which gives a very smooth movement and is also free from backlash. The scale under observation is supported on the base of the instruments and scales of any length may be checked.

* This subdivision contains (1) Stands: (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† Cambridge Scientific Instrument Co., Ltd.

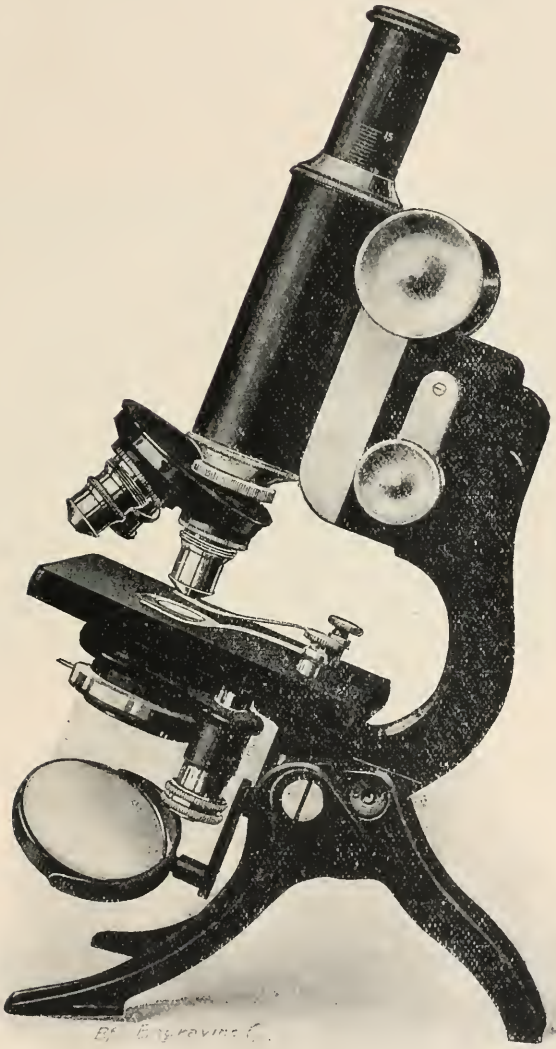


Fig. 3.

The method of working is as follows. Assuming that it is desired to check a scale at intervals of 100 mm., the Microscopes are focused on a standard scale and the interval between them is adjusted by hand to be as nearly as possible 100 mm. Experience shows that this interval can be adjusted correctly to within 0·1 mm. To determine the exact interval, the cross wires in the left-hand Microscope are brought into coincidence with one of the marks defining the standard scale and the reading of the micrometer head noted. The head is then turned till the cross wires of the right-hand Microscope are on the other mark, and the reading again taken. The exact distance between the points on which the Microscopes are focused is thus known. The calibration of a scale may be tested by a series of observations made in a similar manner.

If desired a micrometer eye-piece with head divided to 0·01 mm. can be fitted to one of the Microscopes. It will be found that this very much facilitates quick adjustment of the instrument.

New Spencer Portable Microscope.*—This instrument, which is listed as No. 60 in the maker's catalogue, is shown in fig. 3. It is

Fig. 4.

enclosed in a metal case (fig. 4), the two halves of which are hinged together. Each half is a single thin casting of magnalium, a light alloy of aluminium which is resistant to weather conditions. The wall is strengthened around the edge by a narrow band of increased thickness which is sufficient for holding a felt buffer to make the case dust-tight. This buffer is burnished into the metal. No glue is used to fasten any of the pads. The outside is finished in an imitation leather enamel, which is baked on and is permanent. This, together with the rounded

* Spencer Microscopes and Accessories, 1914, p. 54. Buffalo, New York, and 83 Wigmore Street, London, W.

edges and corners, makes an exceptionally neat case, $8\frac{3}{4}$ in. by $6\frac{1}{2}$ in. by $3\frac{3}{4}$ in. in its extreme over-all dimensions. The Microscope is rigidly held in place in the case by two strong pins, which fit into depressions in the arm. To prepare for using, it is only necessary to lift the instrument from the case, turn the legs to position and pull the draw-tube. The instrument goes into the case with the objectives in position on the nose-piece. Caps are furnished for protecting the objectives if desired. The instrument, a simple side fine adjustment, each division of the

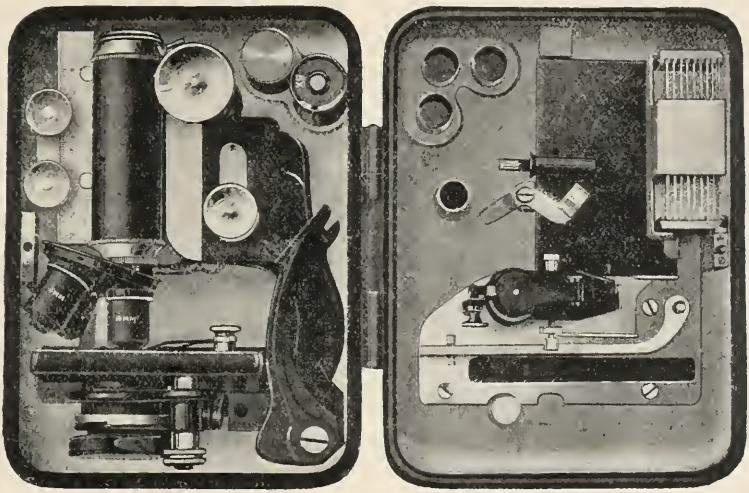


FIG. 5.

graduated button of which represents a movement of one micron in the body tube. Fig. 5 shows the open case, the mechanical stage and camera-lucida being in position.

(4) Photomicrography.

Freedom from Vibration for Photomicrography.*—The apparatus described below has been in use in the Office of Soil Bacteriology Investigations for many years, and has made it possible, says K. F. Kellerman, to prepare photomicrographs of unusually high character, requiring sometimes as much as six minutes exposure, even though tram cars and heavy wagons pass the doorway of our building at frequent intervals. The stand consists essentially of a heavy stone slab A, upon which is mounted the photomicrographic equipment and the electric lighting apparatus. Immediately below this stone and supporting it is

* Dep. Agric. U.S.A., Bureau of Plant Industry.

a layer of felt B, approximately 2 in. in thickness. This felt layer is in effect a shock absorber. The felt in turn is supported by the flat top of the movable table C. This table may be equipped with cupboards and drawers giving the necessary space for the special equipment for the various kinds of photomicrography which may be attempted. At the corners of the table near the wheels, where castors are placed, there are also placed spring checks D, which can be adjusted to press against the floor and thus prevent any undue freedom of movement of the table while it is in use. Examples of six-minute exposures, at 1000 magnification, are extremely fine.

(5) Microscopical Optics and Manipulation.

Optic Projection by S. H. and H. P. Gage.*—This book is a very complete and up to date exposition of its subject. The authors' intention is not only to give an explanation of the principles underlying the art, but to give such simple and explicit directions that any intelligent person can succeed in all the fields of projection. At the same time attention is devoted to the physiological principles of vision, so that the investigator in novel or special applications of projection may have a clear idea of the methods which must be adopted to obtain success. While impressed with the general excellence of the apparatus supplied by many different makers, the authors point out certain general defects, among them being an uncertainty as to the right and the wrong way of using the auxiliary parts of an apparatus. The authors think that manufacturers should give attention to this point, and should construct their apparatus so that it can be used in only one, and that the right way. Thus, to take a simple example, the condenser is usually so mounted that it may be used with either end facing the arc lamp: this ought to be impossible, and could be easily obviated. This idea of rendering the apparatus as far as possible "fool-proof" is a strong feature of the book. Every chapter is followed by a summary of useful instructions, entitled "Do" and "Do not," with the intention of reducing the difficulties of operators.

The work is divided into fifteen chapters, the first six of which deal with the magic-lantern as operated with different kinds of light (direct current, alternating current, house electric light, lime-light, ordinary lamps, and sunlight). Other chapters deal with projection of opaque objects, lantern slides, the projection Microscope, drawing and photography with projection apparatus, moving pictures. Chapter XII is a useful discussion of projection rooms and screens. Chapters XIII and XIV treat of electric currents and their measurements, and optics of projection; and Chapter XV discusses normal and defective vision. An appendix gives a brief historical statement on the origin and development of projection apparatus. There are modern and historical bibliographies and a list of manufacturers of projection apparatus.

* Comstock Publishing Co., Ithaca, New York (1914) 731 pp. (413 figs.).

(6) Miscellaneous.

Batsch's "Testacea Arenulæ," 1791.*—E. Heron-Allen informs us that by the courtesy of F. W. Millet, F.R.M.S., he has been informed of yet another copy of this ultrà-rare work, which is in that gentleman's possession. As this newly recorded copy is said to contain both the Latin and German versions of the text, it would also appear to be unique, for no such edition has ever been recorded before.

Apparatus and Practical Methods for the Microscopical Examination of Crystalline Bodies.†—This work is divided into five parts and is published as a supplement to Mikrokosmos. Its object is to deal exhaustively with the subject of micro-crystallography in such a manner as to meet the needs of amateurs and of all classes of investigators. The first three parts are due to C. Leiss, and deal with petrological Microscopes and the various instruments and methods in general use for preparing objects. The last part contains two sub-parts and is by H. Schneiderhöhn: it sets forth the methods of investigation in systematic order. The titles of the parts are:—

1. Structure and manipulation of the mineralogical Microscope and its auxiliary apparatus (32 pp.).
2. Management of rock-preparations and their sections (5 pp.)
3. Apparatus for determination of optical constants of crystalline bodies (4 pp).
4. Determination of physical constants of crystalline bodies by means of the polarizing Microscope: —(*a*) transparent objects (46 pp.); (*b*) opaque objects (5 pp.). The work also contains a bibliography of modern authorities.

B. Technique.‡

(1) Collecting Objects, including Culture Processes.

Pipette Method in the Isolation of Single Micro-organisms.§ In this communication, M. A. Barber has collected together the various descriptions which have appeared from time to time regarding the technique and methods of application of the pipette method of isolating single micro-organisms under microscopical control. He has also

* See this Journal, 1914, p. 526.

† Apparate und Arbeitsmethoden zur mikroskopischen Untersuchung Kristallisierter-Körper. C. Leiss and H. Schneiderhöhn. Stuttgart: "Mikrokosmos" (1914) 94 pp. (115 figs.).

‡ This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Embedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, etc.; (6) Miscellaneous.

§ Philippine Journ. Sci., ix. (1914) pp. 307-60 (19 figs. and 2 pls.).

appended considerable information not before published regarding the various applications of the method. The technique has a very wide application, not only in bacteriology but also in all departments of microscopy. Single bacteria, yeast-cells, spores of fungi, algæ, protozoa, blood-corpuscles, and other histological elements may be isolated with comparative ease. Isolated organisms may be cultivated *in situ*, transferred to any medium, or inoculated into animals Injections may be made into the vacuoles or protoplasm of living cells. Microscopical

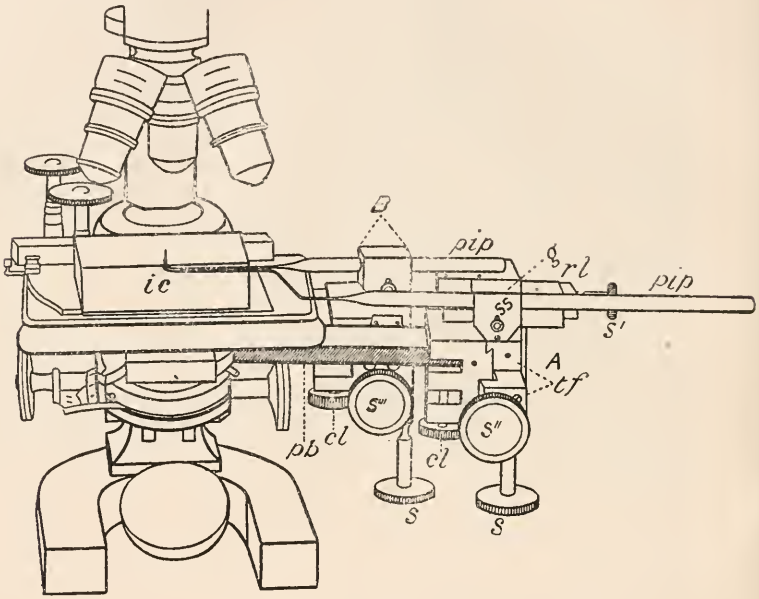


FIG. 6.—Microscope with two pipette-holders, each containing a pipette attached to the stage by means of metal plates. Seen from the back: A a three-movement, and B a two-movement holder; *tf*, adjustment governed by screen *s''* for moving the pipette to and from the observer.

objects may be dissected or stained under the highest powers of the Microscope.

The principle of the method consists in the separation of a single organism by means of a very finely-pointed capillary glass pipette. The isolation is carried out in hanging drops on the under-side of a large cover-glass, which is placed over a moist chamber. The organism to be isolated is touched with the tip of the pipette, into which it enters by capillarity; a sterile portion of the cover-glass is brought over the tip and the organism is discharged on to it by pressure through a rubber tube held in the mouth of the operator. The whole process is carried out under the Microscope, with the highest powers, if desired.

Various methods of procedure are applicable. The most convenient is that in which the pipette is manipulated by means of a special holder, clamped directly on to the Microscope stage, or to a metal plate fastened beneath. The best form of pipette-holder possesses movements in three directions of space as shown in fig. 6. The figure also shows the other portions of the apparatus in position. The pipette is held in a groove *g* in the side of the adjustment *rl* and is fixed by the set screw *ss*.

The moist chamber (fig. 7) is made by fastening strips of glass to a slide with Canada balsam or any convenient cement, an additional strip being cemented to the slide at the open end *s*, which serves to strengthen the apparatus and makes it capable of holding water. A convenient size for the moist chamber is 70 mm. long, 35 wide, and 28 high. The moist chamber is lined on the sides and end with filter paper, *p*, in order to furnish a large moist surface. The cover glass, which should be of a sufficient size to seal well over the sides of the chamber, needs special care in its preparation. After careful cleaning, a little vaseline is applied, the excess of vaseline is removed with soap and water, and the

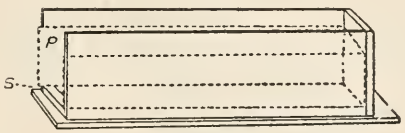


Fig. 7.—Isolating chamber. *p*, lining of blotting-paper; *s*, glass strip for retaining water in bottom.

cover-glass, after warming, is rubbed with a dry clean cloth. The trace of vaseline left behind is sufficient to prevent the hanging drops from running together. Before use the cover-glass is sterilized, and a series of drops of sterile broth are placed on the under side.

The making of the capillary pipette presents some difficulties, and experience is needed to obtain the best results. An ordinary capillary pipette (0·5 mm. external diameter) is first drawn out in the Bunsen flame. The shank of the pipette is held in the right hand, and with a pair of fine forceps held in the left hand, the capillary is grasped at about 5 cm. from the shank, both hands resting on the table. The point of the capillary next to the forceps is then held over the flame of a micro-burner (fig. 8). When the glass begins to soften it is lifted slowly from the flame and pulled so as to draw the capillary out into a very fine point. The end of the capillary is then turned at right angles. The pipette is placed in position in the pipette holder, and the tip brought into view, and into the centre of the field of the Microscope by means of the adjustments. The tip is then lowered. One of the drops of sterile broth is then brought into the field, the objective is lowered until the tip comes into view and the objective and tip are then raised together until the tip comes into contact with the cover-glass just outside the drop. The point of the capillary is then broken against the cover-glass,

and a little broth taken up by suction on the rubber tube held in the mouth. If the point is sufficiently patent, a little drop should be easily blown out on to the cover-glass. The size of the opening will vary with the nature of the work in contemplation. If too large, say over 15 micrometers, the difficulty of isolation will increase ; if too small, say less than a micrometer, it will be difficult to blow out broth or introduce the larger bacteria. Bacteria can be isolated by means of the high powers. The tip is brought into the drop near the bacterium and is then lowered, the bacterium usually entering the pipette by capillarity. It can be isolated on a sterile part of the cover-glass. In using cover-glass

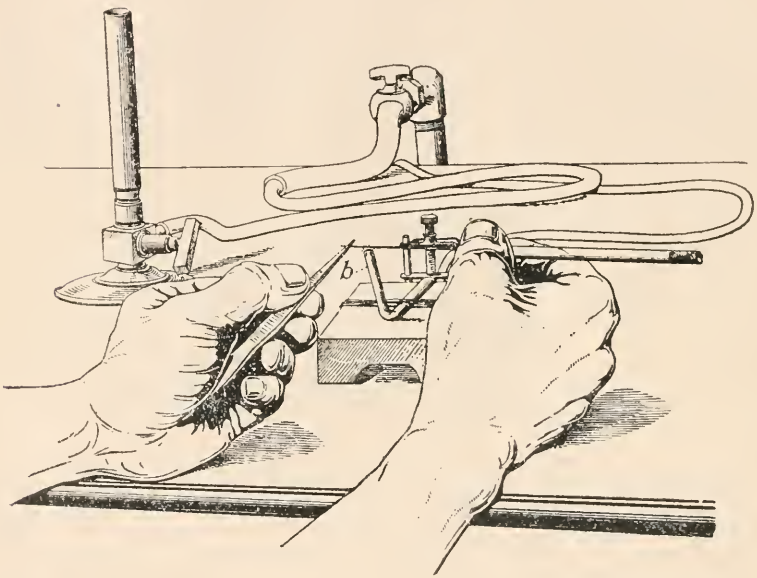


Fig. 8.—Method of making the capillary pipette.
b, microburner.

cultivations, broth, liquefied gelatin, or any fluid or semi-fluid, may be employed. The media may be placed in readiness on the slide previous to isolation.

The isolated organisms may be inoculated into animals, subcutaneously, intravenously, or intraperitoneally. The organism is washed well back into the pipette with broth or salt solution. The end of the pipette (which should be obliquely fractured) is inserted into the tissue of the animal and the organism blown out. Large animals may be inoculated through the mucous membrane of the mouth.

In the latter portion of his paper Barber gives full details of the various special applications of the pipette method that he has employed

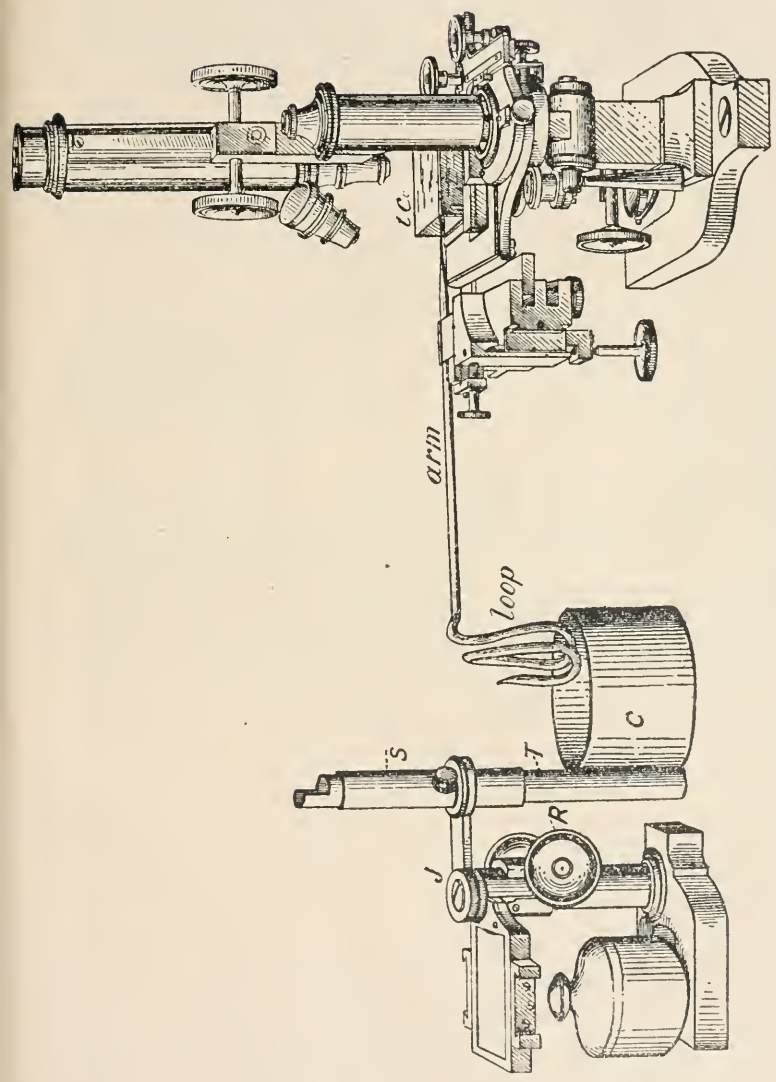


FIG. 9.—The inoculation pipette in position, with the apparatus for regulating the temperature of the loop. R, ratchet and pinion of a simple Microscope; S, sleeve of metal fastened to the lens-holder, which is joined to the Microscope at J; T, hollow metal tube inserted in the sleeve, and bearing at its base the cup C.

from time to time. These include the carrying out of serological tests, experiments on chemiotaxis, dissections and inoculations into living cells. A special form of pipette is needed for the latter purpose. Either hard or soft glass may be used. A piece of tubing about 35 cm. long is bent at one end into the form shown in fig. 9. The tip of the convoluted portion is drawn out into a coarse capillary, inserted into a cup of mercury, and filled by exhausting the tube at the straight end, the tube being heated before filling ; the aperture is then sealed off. The end of the arm is next drawn out into a straight capillary about 8 cm. long and 0·5 to 0·8 mm. external diameter. The pipette is then filled with mercury to the tip of the capillary, the loop being gently heated and the tip immersed in mercury. The mercury in the capillary is then retracted by immersing the loop in ice water, and the pipette point made in the micro-burner in the usual way. A special form of apparatus is needed for the regulation of the temperature of the loop (see fig. 9). The cup *c*. containing ice and water, can be raised or lowered by means of ratchet and pinion, or swung aside. The inoculating substance is introduced into the capillary tip by raising the cup and thus lowering the temperature of the mercury. The tip is then inserted into the cell selected for inoculation, and the mercury in the loop expanded by lowering the cup containing the ice-water ; the inoculating substance being driven out by pressure into the substance of the cell body.

Diagnosis of Asiatic Cholera.*—B. C. Cromwell has investigated a series of cases post mortem, with the view of ascertaining how far cholera can be diagnosed from the gross pathological lesions without having recourse to bacteriological examination. Ninety-two cases were examined in all, and while it was ascertained that no anatomical feature was in constant evidence, a diagnosis of cholera might be based on the following features :—Acute catarrhal enteritis associated with (1) cyanotic finger nails ; (2) dry tissues ; (3) oligæmia ; (4) dry and sticky peritoneum, with pink serosa of the ileum ; (5) contracted and empty urinary bladder ; (6) shrunken, dry spleen and liver ; (7) acute degeneration of parenchymatous organs ; (8) poorly coagulated blood ; (9) absence of formed fæces ; (10) presence of " rice water stools" ; and (11) prominence of lymphoid tissue in the ileum. Comparison of anatomical and bacteriological findings led to an identity of diagnosis in eighty-seven cases. Five cases anatomically negative were proved to be positive on bacteriological examination.

(3) Cutting, including Embedding and Microtomes.

New Spencer Rotary Microtome.†—The Spencer Lens Co. have set themselves to remedy the defect usually found in rotary microtomes, viz., want of accuracy in cutting, one after another, sections of definite uniform thickness. They claim to have accomplished this by making

* Philippine Journ. Sci., ix. (1914) pp. 361–5.
† Special Pamphlet, Spencer Lens Co., Buffalo, New York.

the sliding part S P (fig. 10), into which the object-clamp fits, move freely backward and forward in B, its polished inclined surface being firmly held by a spring against the point P which, in turn, is firmly supsupported on the slideway forming a part of the feed-mechanism, which again, in turn, is independent of the up-and-down movement. This is contrary to most microtomes, as in the majority of them the feed-mechanism is dependent on the up-and-down movement, with the result that sooner or later inequality of section-cutting results. In the Spencer

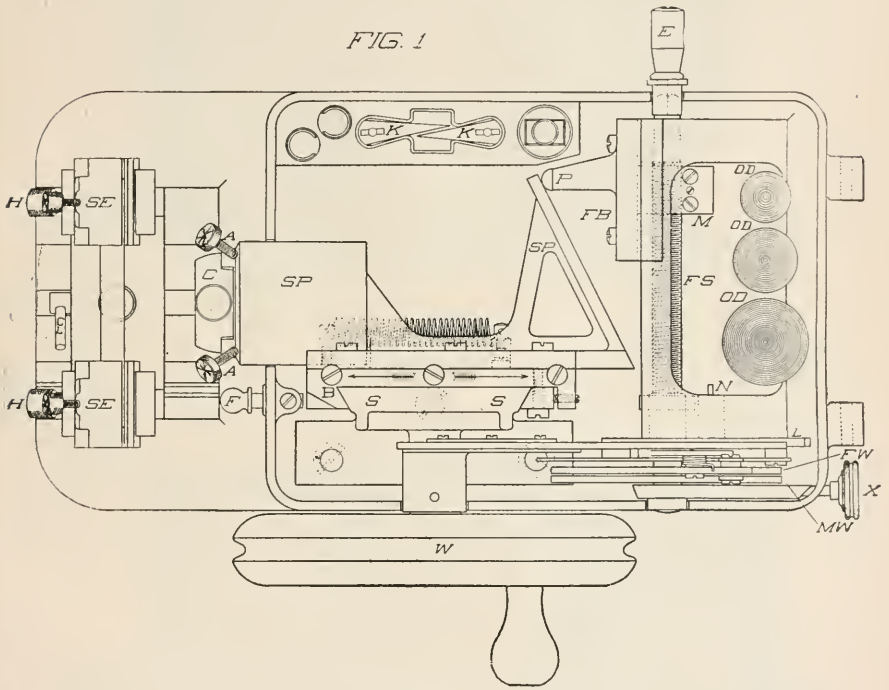


Fig. 10.

machine the feed-mechanism is composed of a rigid bearing on which the feed-block F B, of which the point P is a part, is moved by the feed-screw F S. As this block is moved towards the side on which the balance wheel W is located, the sliding part S P is forced forward towards the knife one half as much, because the polished surface resting against the point P is set at the proper angle to accomplished this purpose. Thus any imperfection in the screw is reduced by one half. As the screw is cut with two threads to the millimetre and as it is revolved by a ratchet feed-wheel with 250 teeth, each tooth represents a feeding of the object forward one micron. The feed is so arranged that it can be set for

sections of any thickness, from one micron to sixty microns, by turning the knurled button at the back of the case, just below the hinge, until the number representing the desired thickness appears opposite the indicator I (fig. 11) at the small opening in the side of the case near the balance-wheel. The total excursion of the feed is 37 mm., allowing a sufficient range for cutting a complete series of a very large object without the necessity of a break in the series, due to resetting the knife and the feeding-mechanism. The pawl F P (fig. 11), which works into the teeth of the feed ratchet-wheel F W (fig. 10) is located at the end of an arm F A (fig. 11), which swings on an axis identical with that of the screw. This arm is actuated by a connecting arm C A (fig. 11) running from

FIG. 2

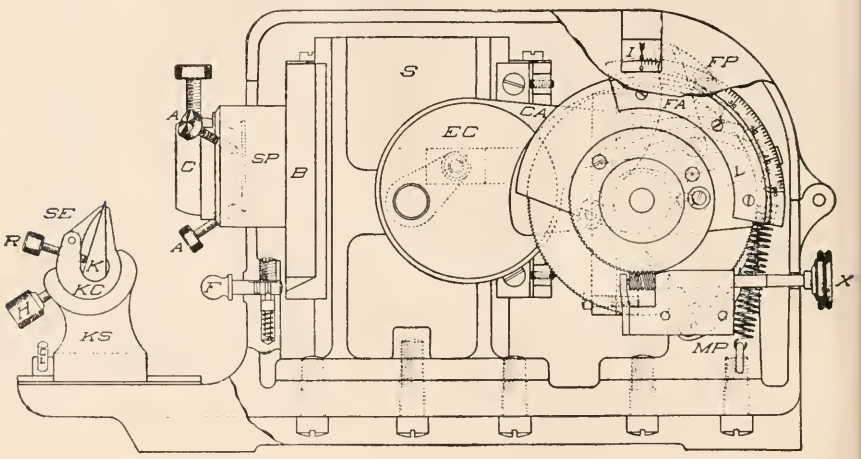


FIG. 11.

it to an excentric E C (fig. 11), which revolves with the balance-wheel W. This excentric is so located on the axis that the feeding is done when the object is at its upper limit and thus above the knife, thereby avoiding the danger of forcing the face of the paraffin against the knife on the upward stroke.

By the side of the feeding ratchet-wheel there is another ratchet-wheel M W (fig. 10) like it, but placed with the teeth running in the opposite direction. Working into the teeth of this wheel is a pawl M P (fig. 11) fastened to the upright support of the sliding bearing of the feed block F B. This pawl is kept away from the teeth of its rachet-wheel by a cam fastened to the arm carrying the feed pawl, and is allowed to engage the teeth only for an instant at the extreme end of the feeding stroke. This brings the wheels and feed screw to a definite

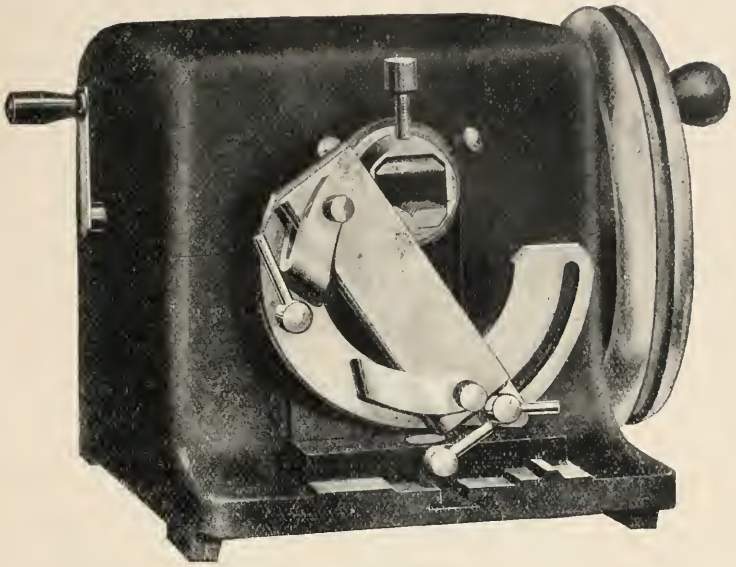


FIG. 12.

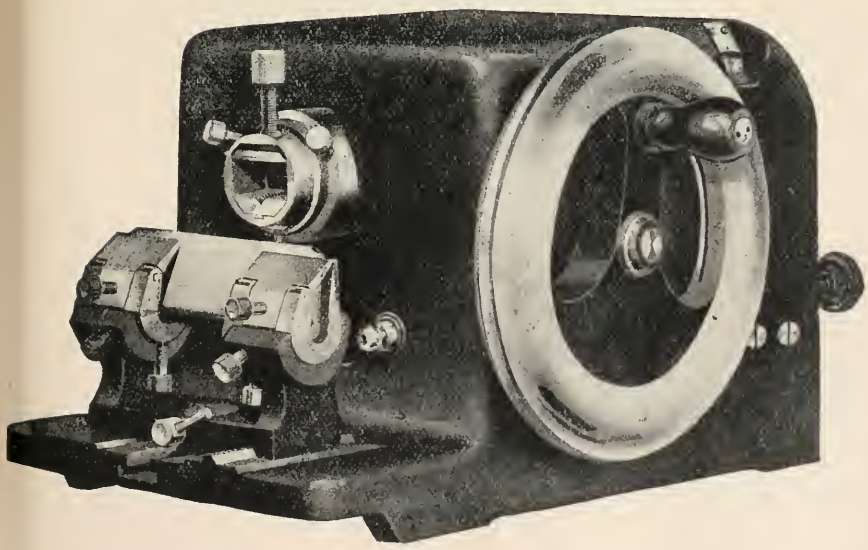


FIG. 13.

stop overcoming momentum and always ensuring sections of exactly the thickness called for; which is, of course, a very essential feature. The feed pawl is automatically lifted free from the teeth of its ratchet-wheel on the return stroke, thus avoiding wear and the accompanying noise. There are special arrangements for avoiding injury to thread of feed when the nut has reached its limit and for resumption of cutting. The up-and-down stroke of the object clamp is 2 in. The whole of the feeding mechanism is covered thus protecting the wearing parts from dust, and presenting a much neater apparatus (figs. 12, 13).

New Spencer Cylindrical Ribbon-carrier.*—This apparatus, which is shown in fig. 14, has been made after C. E. McClung. The

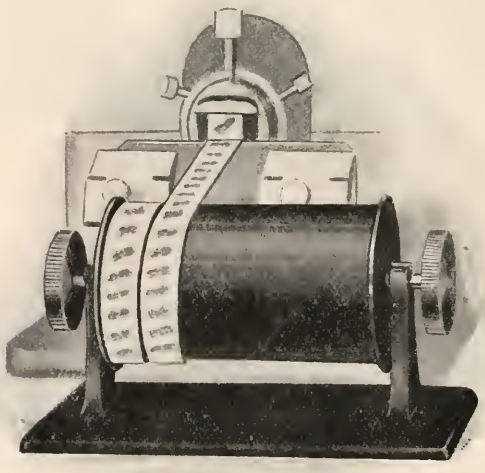


Fig. 14.

aluminium cylinder is mounted in an aluminium framework, under the base of which are little rollers rotating in the direction of the long dimension of the frame. The end of the ribbon adheres to the cylinder, which is slowly turned by the little buttons at the end as the ribbon lengthens. At the same time the cylinder and frame are gently pushed forward on the recess so as to place the ribbon on the cylinder in a long spiral. The cylinder is $4\frac{1}{2}$ in. long and $2\frac{5}{8}$ in. in diameter.

* Spencer Microscopes and Accessories, 1914. Buffalo, New York, and 83 Wigmore Street, London, W.

(4) Staining and Injecting.

Method of Staining Parasitic Amœbæ.*—The difficulty of satisfactorily staining the amœbæ of dysentery and allied forms is in practice considerable, so that any method which can be relied on to give good results is of interest. The following directions are given in a recent communication by Alexander Marshall, of the Wellcome Tropical Research Laboratories at Khartoum. Smears are made from dysenteric stools and transferred rapidly, while still wet, to Schaudinn's fluid. They are then washed in alcohol of different strengths and finally in distilled water, after which they are stained in Delafield's hæmatoxylin for twenty minutes. They are next washed in tap water and stained with carbol-fuchsin, as for tubercle bacilli ; after which they are again washed with water and finally differentiated with Sprengel's solution of picric acid, consisting of equal parts of absolute alcohol and of saturated watery solution of the acid. This is applied for three to five minutes, during which time the reagent is changed three or four times. The stained films are then dehydrated in absolute alcohol, cleared in xylol, and mounted in Canada balsam. Thus treated, the nuclei of the parasites are stained a purplish black, while the cytoplasm is a pale translucent yellow colour. Red blood corpuscles are also stained yellow. The method is described as easy, rapid, and certain in its results, and is certainly well worth trial by those called upon to make this investigation.

Cytology of the Stamens of Smilax herbacea.† — Lilian E. Humphrey carried out an investigation, the primary purpose of which was to observe the reduction division in the microsporocytes of *Smilax herbacea*. The buds were killed in Schaffner's weaker chrom-acetic acid and with a trace of osmic acid added, being left in this for twenty-four hours. After being thoroughly washed in water, the material was dehydrated by passing it through the various grades of alcohol to 70 p.c., where it was left for about three months, when it was passed through the higher grades into chloroform, from which it was gradually passed into pure paraffin and embedded. Sections 10μ to 13μ thick were cut.

Several methods of staining were used. The first tried was anilin-safranin, which was a fairly good stain, but it did not make enough differentiation between the chromatin material and the cytoplasm to be easily studied. Next Heidenhain's iron-alum-hæmatoxylin was used and found to be very good, staining the chromatin material black and the surrounding tissues brownish. In using this stain the slides were passed through turpentine, xylol, the different grades of alcohol to water, then passed through iron-alum, where they were left for two hours ; after being well washed in water, they were left four hours or longer in

* Lancet (1915) i. p. 145.
† Ohio Naturalist, xv. (1914) pp. 357-67 (2 pls.).

Heidenhain's hæmatoxylin, after which they were washed and placed in iron-alum to clear, and after dehydration they were mounted in Canada balsam. The most satisfactory stain was Delafield's hæmatoxylin. The slides were passed through alcohols to 25 p.c., then into Delafield, where they were left for two hours, after which they were washed in water and passed up through the alcohols and mounted.

Metallography, etc.

Metallography of German Silver.*—F. C. Thompson has studied the microstructure of commercial specimens of German silver, consisting of the α solid solution of the copper-zinc-nickel system. In one series of experiments four melts of identical composition were made. To one was added 0·25 p.c. manganese, to another 0·5 p.c. aluminium ; while no addition was made to the remaining two. The alloys after casting were rolled into sheets and annealed. The mean area of the crystals of the two alloys which had not been deoxidized was 0·3 sq. cm., while the mean crystal-area of the alloys deoxidized respectively with manganese and with aluminium was 0·0005 sq. cm. The manganese had passed almost wholly into the slag, hardly a trace remaining in the alloy. A specimen of high nickel content, after annealing at an excessively high temperature, was found to have a very definite "casting" structure. It was then annealed at 750° C. for four hours. The structure after this treatment was normal, and all traces of the dendritic markings had disappeared. The specimen was next reheated to about 1000° C. for one hour : this caused the reappearance of the casting pattern. Th author believes that the casting pattern, reproduced by overheating previously annealed alloys,, is a remnant of the structure of the original ingot, but so faintly preserved that in ordinary circumstances it is not seen. Its reappearance may be due to incipient volatilization of zinc occurring at high temperatures. An overheated specimen showed almost complete absence of twin crystals. A series of seven alloys ranging in nickel content from 7 to 22 p.c. were submitted to ordinary commercial treatment. The size of the crystals diminished notably with increasing nickel content, the mean crystal-area being 0·015 sq. cm. in the alloy containing 12 p.c. nickel, and 0·0005 sq. cm. in the alloy containing 22 p.c. nickel. The sections were etched with 5 p.c. ferric chloride solution.

Artificial Twin-crystals in Tin.†—The crystals of a block of tin affected by stresses may contain twinned lamellæ ; these become apparent in an artificially-polished surface etched with hydrochloric acid. P. Ganbert has studied the formation of the twin-crystals in the following manner. A few grammes of tin were melted between clean plane glass surfaces. By pressing the upper glass plate, the layer of tin could be brought to the desired thickness. On solidification a plate of tin was obtained with plane surfaces having a perfect polish. By controlling the rate of cooling during solidification, the crystals could be obtained

* Journ. Chem. Soc., cv. (1914) pp. 2342–9 (7 figs.).
† Comptes Rendus, clix. (1914) pp. 680–2.

of any desired size, up to the whole area of the specimen, which then consisted of one crystal. Striking such a plate of tin with the point of a needle produced: (1) on the face opposite to the face penetrated, a cross in relief, with broad arms; (2) two or three series of bright bands, parallel, of width up to 0·5 mm., and reaching from the impression made by the needle, to the boundary of the crystal. These twinned lamellæ passed right through the crystal. Their faces, originally in the same plane as the general surface of the plate, now formed an angle of several degrees with it. Further phenomena observed are described. The "cry" of tin appears to be caused by the formation of twinned crystals.

Dilute Solutions of Aluminium in Gold.* — C. T. Heycock and F. H. Neville have determined the equilibrium diagram of the aluminium-gold system for the range 0 to 5 p.c. aluminium, and describe the microstructure of the numerous alloys examined. From 0 to 2 p.c. aluminium the α solid solution only was found. From 2 to 3 p.c. the alloys consisted of α and β, β being stable only above 424° C. A substance D may be the compound Al_3Au_8. Polished and etched surfaces of β that have been chilled at a high temperature show, under high magnification, groups of fine parallel lines, the direction of the lines changing from grain to grain so as to give the effect of shading. This is due to a laminated structure in the β, perhaps to an incipient decomposition. When β is slowly cooled it breaks up at 424° C. (the eutectoid temperature) into a complex of α and of D. The etching reagents used were bromine water and aqua regia; the two gave practically the same pattern.

Nitrogen in Steel.†—A peculiar structure found in the welded portions of electrically-welded iron plates led B. Strauss to undertake an investigation upon nitrogen in steel. These welded portions contained up to 0·12 p.c. nitrogen, while plates welded by means of acetylene contained 0·02 p.c. nitrogen. The nitrification of iron specimens in a current of ammonia gas begins below 300° C., and proceeds most rapidly between 600° and 800° C. In this way are obtained layers differing in nitrogen content and in structure. The outermost layer of a nitrified specimen of pure iron consisted of the nitride Fe_4N_2. Below this was a layer, having a pearlite-like structure, in which both carbon and nitrogen were present, the carbon being obtained from pyridine, an impurity in the ammonia used. The next layer had an acicular structure, which was also present in the electrically-welded plates. The needles, formerly regarded as consisting of an iron-nitride, were found to be twinned lamellæ in the nitrogen-containing ferrite crystals. When carbon steels were nitrified, another constituent, appearing as light brown specks in the etched specimens, was formed. The iron nitride was readily decomposed by heating: when elements such as silicon

* Phil. Trans., Series A, ccxiv. (1914) pp. 267–76 (26 figs.).
† Stahl und Eisen, xxxiv. (1914) pp. 1055-6.

and chromium were also present, nitrification at higher temperatures caused the formation of the nitrides of these elements, these nitrides being more stable than iron-nitride. Heat-tinting was employed to distinguish the constituents, since the nitrogen-containing constituents oxidized more rapidly than the carbide or the ferrite. Lumière autochrome photomicrographs preserved a record of the heat-tinted specimens in their actual colours.

Decarburization of Steels in Salt Baths.*—A. M. Portevin describes experiments indicating the considerable extent of the decarburization of surface layers which may occur in steel objects during heating in salt baths previous to hardening. When cyanides are present in the salt bath, the carbon-content of a low-carbon steel may be increased, that of a high-carbon steel diminished, by immersion. In iron, originally carbon-free, which had become superficially carburized through heating in a salt bath containing cyanides, there were observed microscopically, in the ferrite below the carburized layer, needles resembling those seen in specimens of steel suspected to contain much nitrogen.

Heat-treatment of Steel Wire.†—In the course of manufacture, steel wire undergoes heat-treatments which vary according to the composition of the steel and the purpose for which the wire is intended. J. F. Tinsley describes and explains the effect of such treatments on microstructure. The principal heat-treatments are: (1) annealing; (2) "patenting"; and (3) hardening and tempering. Annealing is employed to effect one or more of three results: (*a*) to remove cold-work effects; (*b*) to refine the crystalline structure; (*c*) to produce some desired structure such as granular pearlite. To remove cold-work effects it is not necessary to heat above the critical range: 600° C. is a sufficiently high temperature. "Patenting" consists in heating above the critical range and cooling rapidly to a temperature below the critical range, as by immersion in molten lead. The structure produced is sorbitic. Hardening and tempering are usually conducted as a continuous operation, the wire passing from the furnace, through a quenching bath of oil or water, and then through a tempering bath such as molten lead.

Theory of Hardening and Constitution of Steel.‡—In some remarks introductory to a discussion of the constitution of steel, E. D. Campbell states that in a steel containing 0·32 p.c. carbon, cooled from 1060° to 700° C. in seven hours, the carbide areas were sharply separated, and were 0·2 to 0·3 mm. in size, embedded in nearly pure ferrite, the

* Journ. Iron and Steel. Inst., xc. (1914, 2) pp. 196–203 (2 figs.).
† Iron and Coal Trades Review, lxxxviii. (1914) pp. 948–50 (8 figs.).
‡ Journ. Iron and Steel Inst., xc. (1914, 2) pp. 1–16.

distance between individual carbide areas being somewhat greater than their diameters. The author's experience suggests that, in steel annealed in this way, at least an hour at 1000° C. is required for precipitated carbides to redissolve and diffuse so that a strictly homogeneous solid solution in chemical equilibrium is obtained.

MICROSCOPY.

A. Instruments, Accessories, etc.*

(1) Stands.

Swift's Sideros Metallurgical Microscope.† — This instrument (fig. 16), which was built according to the suggestion of J. E. Stead, F.R.S., is well suited for use in the laboratories attached to steel and iron works. The stage, which measures 4 in. by $3\frac{3}{4}$ in., is focused by means of a rack-and-pinion. In order to allow of the use of very low powers, such as a 4-in. objective, additional coarse focusing is obtained by sliding the optical tube in its cloth-lined fitting, and this fitting is provided with a clamp-screw so that no movement shall take place after having been set. There is also a fine-adjustment capable of focusing the highest power immersion objectives.

This stand is well adapted for use with the Swift attachable Cone Camera, and has at the upper end of the optical tube a fitting to carry it.

Nelson, E. M.—**Binocular Microscopes.**

[The author gives a very interesting review of the types and principles of the best known instruments.]

Journ. Quekett Micr. Club, xii. (Nov. 1914) pp. 369–80.

(2) Eye-pieces and Objectives.

Zeiss' New Object-glass, and a New Method of Illumination.‡ E. M. Nelson describes this short-tube oil-immersion auxiliary, which is made upon an entirely new plan, being nickelled all over, with the front lens set in a push-tube, and not screwed up as usual. It is a $\frac{1}{4}$th of 0·9 N.A. In the performance of this lens the corrections are very perfect. Although no fluorite is used in its construction it is very nearly apochromatic, and shows a considerable advance over semi-apochromatism, for only a slight trace of outstanding blue can be seen. Its defining power is quite remarkable, surpassing all object-glasses of similar aperture known to the author. On a Möller's probe-platte of sixty diatoms all are resolved except the two specimens of *Amphipleura pellucida*. The lens is sufficiently powerful to do all that is wanted in practical study, and, owing to its great working distance, it does not pick up by capillary attraction an unfixed cover-glass.

The lens is peculiarly suitable for the author's new method of resolving diatoms, for which he gives the following directions:—1. Place the diatom so that the striæ to be resolved are vertical in the field. 2. Set

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† James Swift and Son's Catalogue, 1914, pp. 36–7.

‡ Journ. Quekett Micr. Club, xii. (Nov. 1914) pp. 363–6.

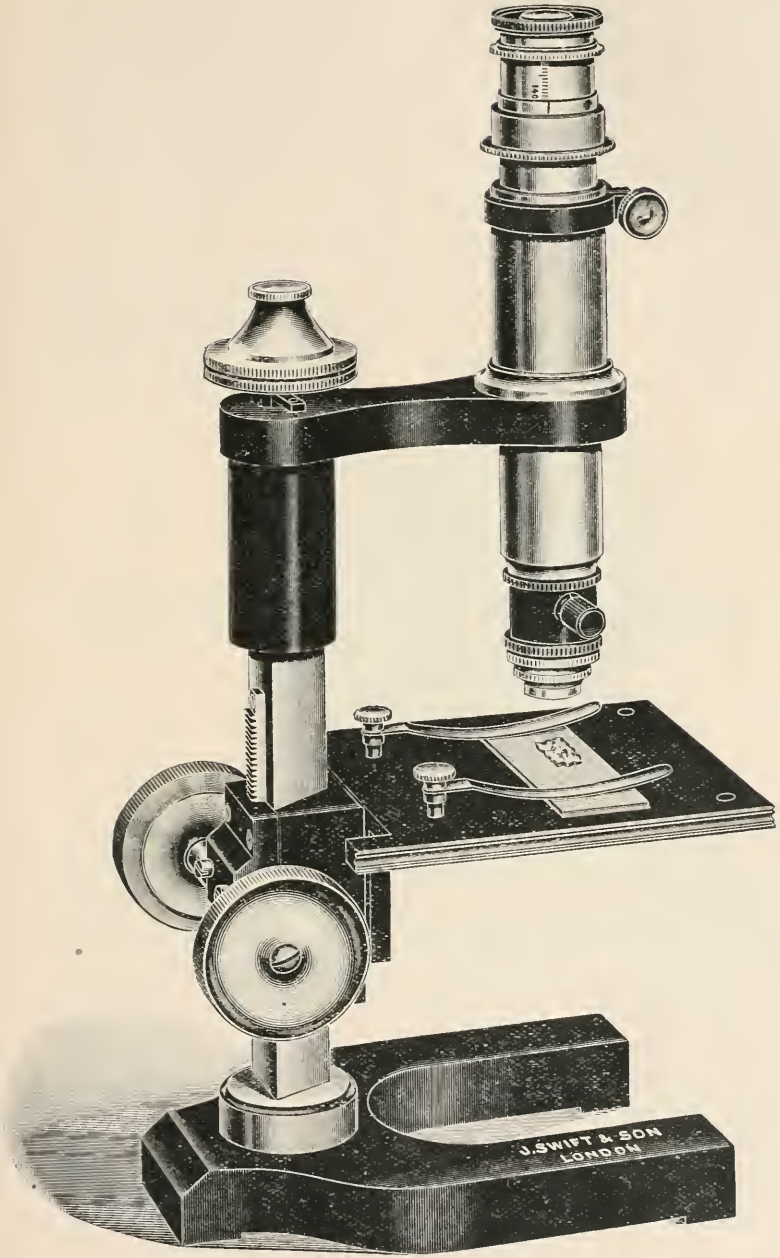


Fig. 16.

up a critical image with the edge of the flame in focus and central to the field, and open the diaphragm to its full extent. 3. By means of the substage centring screws move the condenser so that the image of the flame lies just outside the field of a high-power eye-piece. If the striæ are within the grip of the object-glass they will be resolved. This kind of illumination will be of service, for it will enable an observer to obtain high resolution, with a dry condenser, in an instant, without the troublesome manipulations usually necessary.

(3) Illuminating and other Apparatus.

Hutchinson Co-ordinate Micrometer.*—This instrument (fig. 17), made by J. Swift and Son, is a modified form of the ordinary ocular used with petrological Microscopes. In place of the cross-wires usually fitted, is mounted a glass plate, on which two systems of lines are ruled at right angles. In the illustration only the centre of the micrometer is

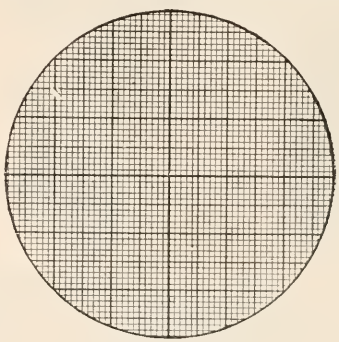


Fig. 17.

shown. These lines are 0·1 mm. apart, every fifth line being slightly thicker than the others, and every tenth line stronger still, while the two which intersect at right angles in the centre, and which correspond with the cross-wires, are given particular prominence. As the image of the object is projected on the network of lines, the ocular will be found useful for recording observations, as an enlarged drawing of any object can be readily sketched on paper similarly ruled, and its dimensions can be ascertained. By its aid the relative proportions of the various constituents of a rock can be estimated, and it is useful for recording the position of emergence of optic axes, and for finding the magnitude of the optic axial angle in bi-axial crystals. It may also be applied to the determination of this constant by Becke's method (measurement of the position and shape of the black hyberbolic brushes seen in convergent light), being an efficient substitute both for the revolving table used by Becke, and for the double-screw micrometer recommended by F. E. Wright.†

* James Swift and Son's Catalogue, 1914, p. 20.
† Amer. Journ. Sci., iv. (1907) pp. 24–331.

Water-heated Stage.*—This apparatus (fig. 18) is for the study of preparations at temperatures between 0° and 100° C. As may be seen from the illustration, it consists of a central chamber mounted in a metal plate, and communicating immediately with two thermometer chambers, through which the water from any convenient circulating apparatus enters and leaves. The thermometer chambers are so arranged that they can be lagged, and all metal surfaces are nickel-plated to check loss of heat. The central chamber is closed above and below by stout 1-in. cover-glasses, its lower side being $\frac{3}{32}$ in. away from the surface of the Microscope-stage on which the apparatus rests. Metal plates with any special form of cell, and of any depth up to $\frac{3}{8}$ in., can be readily fitted and are interchangeable. The three joints are made water-tight by rubber washers.

The special advantages of the apparatus are :—1. The interchange-

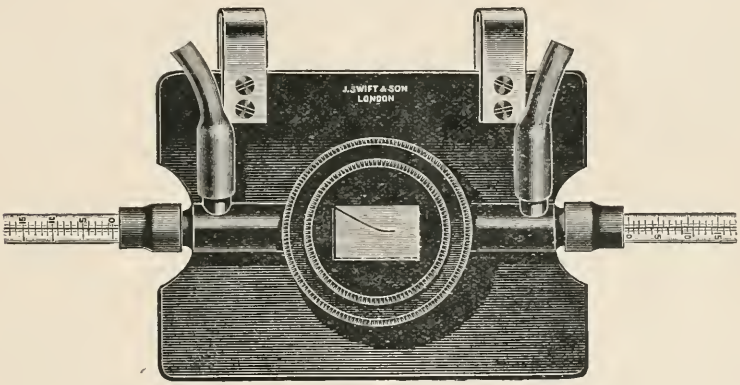


Fig. 18.

ability of washers and cover-glasses in case of breakage. 2. The adaptability at small cost to any form of cell desired. 3. The small distance between the chamber and the stage of the Microscope, permitting the use of a condenser. The apparatus is specially adapted to the study of extinction angles and other properties in crystal sections, but small-scaled preparations of any nature can be examined with equal facility.

(5) Microscopical Optics and Manipulation.

Optical Character of the Faint Interference-figure observed in High-power Objectives between Crossed Nicols.†— F. E. Wright points out that to the petrologist the appearance under crossed nicols of a faint, apparently uniaxial interference-figure in an objective of short focal length is a matter of common observation. It was at first considered to be the result of strain in the objective lenses, but Rinne,

* James Swift and Son's Catalogue, 1914, p. 25.

† Journ. Washington Acad. Sci., iv. No. 12 (June 19, 1914) 9 pp. (2 figs.).

in 1900, gave the correct explanation of the phenomenon, and ascribed it to the rotation of the vibration plane of the transmitted plane-polarized waves at the steeply inclined lens surfaces. It will be readily understood that a spherical surface may be considered to consist of a series of minute planes inclined at all angles with the vertical and in all azimuths. The rotatory effect of such a surface on transmitted plane-polarized light waves is, therefore, different in different directions, the result being a distinct uniaxial cross, with quadrants whose intensity of illumination increases with the distance from the centre. This is, in brief, the explanation of the faint uniaxial cross which appears in all high-power objectives between cross nicols. The plane-polarized light waves whose normals are parallel to the principal planes of the nicols suffer no rotation, while all others are rotated to an increasing extent as their azimuth increases, until the maximum rotation at 45° is reached. The reasons why these phenomena are so much more distinct in high-power than in low-power objectives are (1) the larger numerical aperture of high-power objectives, and (2) the fact that in such objectives the front lens of the system is a small uncorrected glass hemisphere, at whose steeply inclined sides the transmitted light waves are rotated through relatively large angles. The author gives a full account of experiments and observations which confirm his explanation.

New Half-shade Apparatus with Variable Sensibility.*—F. E. Wright describes the following apparatus, which he has used for working with Fresnel's equation, $\cot B = \cos^2(i-r) \cot A$. He mounts a plane-parallel glass plate so that it can be rotated about a horizontal axis in the first (N.E.) quadrant midway between the principal nicol planes. The azimuth angle A for incident waves from the polarizer becomes, therefore, 45° for all angles of incidence i, and the angle of rotation of the transmitted waves can be calculated from the simplified Fresnel equation, $\cot B = \cos^2(i-r)$. If, now, a second glass plate be taken and rotated about an axis in the second (N.W.) quadrant, the azimuth angle of the incident light waves from the polarizer is −45°, and the Fresnel equation reduces to $\cot B = -\cos^2(i-r)$. For a given angle of incidence the angle of rotation produced by the glass plate in the second quadrant is accordingly equal in value to that in the first quadrant, but opposite in sign. If, now, two glass plates be so mounted that they meet in a fine line, they form a half-shade apparatus of a definite angle of rotation. The author describes his method of mounting these plates, and gives a table of his results.

Determination of the Relative Refringence of Mineral Grains under the Petrographic Microscope.†—F. E. Wright points out that in many instances, especially in the measurement of the refractive indices of fine grains immersed in refractive liquids, it is extremely difficult to detect the faint differences in light intensity which appear at the margins of the grains, and by means of which the differences in refractivity are recognized. Under such conditions the eye of the observer is subjected

* Journ. Washington Acad. Sci., iv. No. 12 (June 19, 1914) 5 pp. (2 figs.).
† Journ. Washington Acad. Sci., iv. No. 14 (Aug. 19, 1914) 4 pp. (1 fig.).

to severe strain and tires quickly. Fortunately, however, it is possible, by modifying the conditions of observation slightly, to render the phenomena more easily visible, and thus to relieve the eye-strain to a large extent, and at the same time to increase the accuracy of the determinations. These modifications involve both the sources of light and a new method of two-fold oblique illumination.

Sources of Light.— In place of the sodium-flame ordinarily used as source of monochromatic light, the following light sources have been substituted : Mercury light, helium light, and either a calcium-flame or a molybdenum- or tin-spark. With this array of lights set up side by side on the dark-room table, and in conjunction with a monochromatic illuminator, or a dispersion prism or suitable ray filters (Wratten mercury-line filters), the following spectral line sources are available : $\lambda = 546{\cdot}1$, 558 to 561 (average about 560), 577 and 579 (average 578), and 588 $\mu\mu$. With these lights it is not difficult to determine between which two of the four available lines (546, 560, 578, 588 $\mu\mu$) the refractive indices of mineral and liquid coincide, the liquid having the higher refractive index for the shorter wave-length, and the mineral the higher index for the longer wave-length. Now, the refractive index of solids increases about $0{\cdot}001$ for a decrease in wave-length of 10–20 $\mu\mu$, while for liquids the change is approximately twice as great. If, therefore, the refractive index of a mineral be accurately measured for any wave-length between 546 and 588, its index for the wave-length 589 $\mu\mu$ (D line) can be estimated with an error not exceeding $\pm\ 0{\cdot}001$, and a liquid then prepared of exactly this index, whereupon the estimated refractive index of the mineral grain can be checked by immersion in the new liquid. By use of this arrangement a considerable amount of time has been saved in the routine measurement of the refractive indices of fine crystal grains. Occasionally the monochromatic illuminator (Hilger type, with Nernst light filament and ground-glass diffusing screen) has been found useful for ascertaining approximately the wave-length for which the refractive index of the grain coincides with that of the enveloping liquid.

New Method involving Two-fold Oblique Illumination. — Oblique illumination is obtained ordinarily by means of a sliding stop below the condenser of the Microscope. This stop is purposely not sharply imaged in the object-field, but appears as a shadow with a hazy edge, which passes gradually into the brightly illuminated part of the field. The mineral grains are placed in this transition shadow-edge between light and dark, and the illumination of their edges both in white and in monochromatic light is observed. Because of the prismatic refraction of the inclined edges of such grains, the intensity of illumination of edges adjacent to the shadow is different from that of the opposite edges, when the refractive index of the grains is different from the refractive index of the liquid in which they are immersed. These differences become less distinct as the refractive index of the liquid approaches that of the mineral ; and, if the refractive indices differ by only $\pm\ 0{\cdot}001$, the intensity differences in illumination are difficult to see, because of the relatively large amount of light in the field. To reduce the field illumination, and thus to increase the differences in

relative intensity of illumination, and to render them more clearly visible, a double-stop device has been found useful.

This device consists essentially of two safety-razor blades mounted in a horizontal position to a vertical connecting-bar, which in turn is attached to the side of the stage-support of the Microscope. These blades are so adjusted that as the lower blade swings into position below

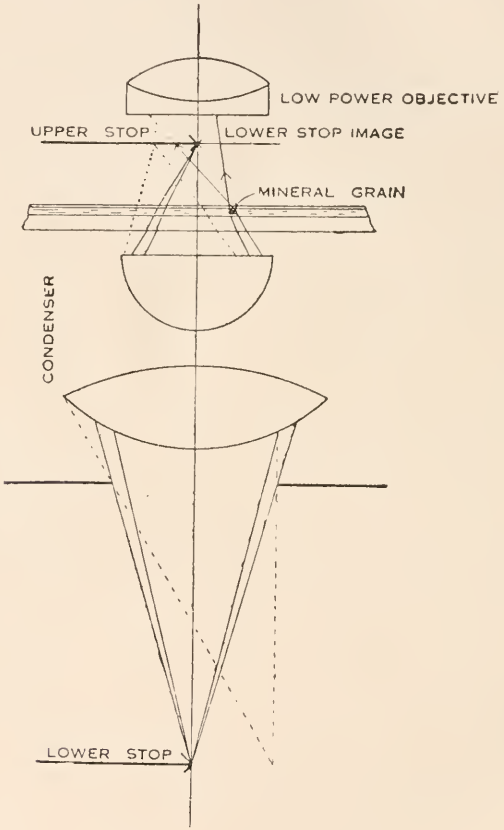


Fig. 19.

the condenser, the upper blade is brought to rest in the conjugate image-plane above the condenser and between the objective and slide. The upper stop is so adjusted that its knife-edge faces the knife-edge of the image of the lower blade. In case these two edges just meet, the entire field of view appears very weakly illuminated and is almost dark. The path of the rays is indicated in fig. 19. The effect of the refracting mineral grain is to disturb the path of the transmitted rays, so that

instead of focusing sharply in the image-plane they are deflected (as indicated with the two rays with arrows in fig. 19), and are thus able to enter the low-power objective (E.F. 16 mm.), and finally to reach the eye of the observer. If a mineral grain immersed in a liquid of slightly different refractive index be examined under these conditions of illumination, its edges appear in part brighter, and in part darker than the field. The intensity of illumination of the field is so weak that the illumination of the edges is clearly marked even for differences in refractive index of only $\pm$ 0·001, and the eye suffers no appreciable strain in making the observation. If now the upper blade be moved away from the edge of the image, a small amount of direct light from the condenser enters the field, and the phenomena produced by oblique illumination from the lower stop are observed under reduced field illumination. As the upper blade recedes, the field illumination increases, until finally the conditions of ordinary oblique illumination are reached. The phenomena observed under the first set of conditions are, moreover, the reverse of those produced on withdrawing the upper stop: the edges which appeared bright in the first case are dark in the second, and *vice versa*. This reversal, caused by the shift of the upper stop, is an additional factor which adds to the sensitiveness of the method. The movable upper stop not only increases the distinctness of the ordinary phenomena of oblique illumination by reducing the field illumination, but it also enables the observer to reverse the phenomena, and to study the slight differences in illumination against a dark field, for which the eye is more sensitive.

(6) Miscellaneous.

Merlin, A. A. C. E.—**On the Minimum Visible.**

[The author reviews many examples of measurements of very minute magnitudes.]

Journ. Quekett Micr. Club, xii. (Nov. 1914) pp. 385–92.

B. Technique.*

(1) Collecting Objects, including Culture Processes.

Studies in Amœbic Dysentery.†—In the course of an abstract by Schill (Dresden) of "Studien über Amöbendysenterie," by K. Ujihara,‡ the following method is given for the examination, by means of enrichment, of encysted amœbæ.

The fæcal matter, containing cysts, is first filtered through gauze, and 60 c.cm. of the filtrate is then mixed with 30 c.cm. of glycerin, the specific gravity of the resulting mixture amounting to about 1070. The

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, etc.; (6) Miscellaneous.

† Centralbl. Bakt. Ref., lxii. (1914) pp. 316–18.

‡ Zeitschr. f. Hyg. u. Infectionskrankh. Bd. 77, 1914, p. 329 *et. seq.*; and Mitt. d. Med. Gesellsch. zu Tokio, Bd. 28, 1914.

filtrate is then centrifuged and water is added till the specific gravity is reduced to 1060. After repeated centrifugalization, the sediment is washed several times with salt solution, shaken up with 20 p.c. antiformin solution and again centrifuged and washed. The precipitate is then mixed with 10 c.cm. water containing five to ten drops of hydrochloric acid, centrifuged and again washed. On microscopical examination of the resulting precipitate, numerous cysts can now be found, which may be stained readily with neutral red solution.

Simple Cultural Method of Distinguishing Diphtheria from Pseudo-diphtheria Bacilli.*—G. Schmidt has reviewed a paper by M. af Heurlin, which appeared recently in the Münch. Med. Wochenschr., in which the author has employed a new medium for the differential cultivation of diphtheria and pseudo-diphtheria bacilli. This medium consists of a 1 p.c. agar medium with a 1·5 glucose content, and an addition of 100 c.cm. normal sodium carbonate solution to each litre. Fifty-three strains of true diphtheria were employed, and after fifteen to forty-eight hours, anaerophil or true anaerobic colonies developed. On the other hand, with most strains of pseudo-diphtheria the growth was unequivocally aerobic ; principally on the surface of the medium, or as little points up to 8 mm. below the surface. The remainder of the pseudo-diphtheria strains employed did not produce any growth on this medium.

New Medium for the Cultivation of Chick Tissues in Vitro.† H. F. Smyth has devised a method of growing chick tissues in vitro, in which the use of chicken plasma is done away with and an agar medium substituted therefore. After trying various combinations of egg albumen and agar, it was found that the following preparation gave the best results. Egg albumen was removed to a sterile Erlenmeyer flask, to which was added an equal amount of trypsinized pepton solution, prepared by dissolving 10 c.cm. Witte's pepton and 0·5 c.cm. trypsin in 200 c.cm. of Ringer's solution, and digesting for three hours at 40° C. The solution was then made up to 1 litre with Ringer's solution, boiled for twenty minutes, filtered and sterilized. A second solution (clarified with egg-white and stored in small flasks) was made by dissolving 15 grm. of agar in one litre of Ringer's solution. The mixture, when combined, was in the following proportions : egg albumen 25, trypsinized pepton 0·25, agar 0·75, and Ringer's solution 74. It gives a soft agar, rich in egg albumen, reinforced by partially digested pepton. It is easy to prepare, is very efficacious, does not solidify if kept above 42° C., and the contained albumen will not coagulate if kept below 60° C.

Preparation of Hæmatin.‡—J. A. Menzies describes the following method of preparing hæmatin, which appears to be an improvement on the potassium carbonate method usually employed.

Add to blood one-fourth of its volume of syrupy solution of potassium carbonate, place in a porcelain capsule and heat on a water bath till it

* Centralbl. Bakt. Ref., lxii. (1914) pp. 389–90.
† Journ. Med. Research, xxxi. (1914) pp. 255–9.
‡ Proc. Phys. Soc., xlix. (1914) pp. iv–v.

sets to a dark brown coagulum. The coagulum is then broken up with a glass rod and added to twice its volume of absolute alcohol or methylated spirit. A dilute solution of alkaline hæmatin is readily obtained by this method in a few minutes. For complete extraction, the mixture is allowed to stand overnight, when, on filtering off the solution, a dark, tarry fluid, consisting of alkali hæmatin with some alkali and lipoid substances, is obtained. The residue may be rubbed up with 66 p.c. alcohol to extract the remainder of the hæmatin. The solution may be neutralized with hydrochloric acid, when the hæmatin is precipitated. The precipitate is purified by successive washings with distilled water, alcohol and ether. The hæmatin may also be precipitated by adding twice its volume of ether to the solution, or by the use of calcium chloride and ammonia, or with baryta mixture. These precipitates may be washed with dilute hydrochloric acid, to remove the precipitated carbonate, then with distilled water, alcohol and ether.

Cultivation of Tubercle Bacilli from Sputum and Fæces. * S. A. Petroff has elaborated a new and rapid method for the isolation and cultivation of tubercle bacilli directly from sputum and fæces. In each case the material is digested in a solution of sodium hydrate, and cultures made subsequently on special media. The medium employed consists of egg, beef or veal juice and gentian violet, and is prepared as follows. Sterilize the shells of the eggs by immersion for ten minutes in 70 p.c. alcohol, or by pouring hot water upon them; break the eggs into a sterile beaker, and after mixing well, filter through sterile gauze. The meat juice is prepared by infusing 500 grm. of beef or veal in 500 c.cm. of a 15 p.c. solution of glycerin in water. Twenty-four hours later the meat is squeezed in a sterile meat-press and collected in a sterile beaker. One part by volume of meat juice is added to the eggs and a sufficiency of 1 p.c. alcoholic gentian violet to make a dilution of 1 in 10,000. The medium is tubed in sterile test-tubes and inspissated for three successive days; on the first day at 85° C., on the second and third at 75° C. For cultivations of the bovine type of bacillus omit the glycerin and infuse the meat for 24 hours in water.

For isolating the bacilli from sputum, equal parts of fresh sputum (about 5 c.cm.) and 3 p.c. sodium hydrate are well shaken and left in the incubator for twenty minutes, or till the sputum is fairly well digested. The sputum is then neutralized to litmus, centrifugalized, and the sediment inoculated into the above-described medium. By employing this method 69 positive cultures were obtained from 69 specimens of sputum from practically all stages of tuberculosis, six being negative by direct microscopical examination. In many cases the growths were in pure culture, the inhibitory effect of the gentian violet killing out all extraneous organisms.

The method advocated for isolating the bacilli from fæces consists in collection in wide-mouthed jars, diluting with three volumes of water and filtering to remove solid particles. The filtrate is then saturated with sodium chloride, and the floating film resulting is mixed with an equal volume of sodium hydrate. After digestion and neutralization

* Journ. Exper. Med., xxi. (1915) pp. 38-42.

the sediment is inoculated into tubes of the special medium. Of 32 specimens examined, 9 were positive, 6 contaminated, and 7 were negative. Two of the positive cultures were inoculated into guinea-pigs, both of which contracted tuberculosis.

Immunization of Rodents against Naturally Pathogenic Paratyphoid Organisms.*—J. Danysz and Z. Skrzynski have attempted to protect mice and rats against infection with *Bacillus typhi murium, type B* (which is a paratyphoid organism naturally infective for these rodents) with entire lack of success. They employed the following techniques in these attempts—(*a*) vaccination with heated cultures or emulsions (Method of Chantemesse) in one, two or three injections; (*b*) vaccination with ether-killed cultures (Method of Vincent); (*c*) vaccination with cultures killed by dry heat at 75° C. (Method of Lœffler); and (*d*) vaccination with sensitized cultures killed by dry heat at 75° C. (Modification of Besredka's Method).

As stated, it was found to be impossible to vaccinate the mouse by any of these methods or to obtain from it a specific serum. From this fact the authors infer that the mouse does not possess any natural defensive mechanism against infection by the organism. The rat, however, is almost as difficult to vaccinate, though much less sensitive to the disease, and consequently one is driven to conclude that this is due to an inherent peculiarity in the nature of the microbe. Guinea-pigs and rabbits, on the other hand, are very easy to vaccinate against *B. typhi murium, type B.* These animals are refractory to infection per os or by subcutaneous inoculation, but readily succumb to peritoneal infection. The authors therefore conclude that the possibility of immunizing animals naturally resistant to a disease, against an infection artificially provoked, does not permit one to conclude that it is possible to immunize by the same methods animals naturally sensitive to the same disease.

Adaptation of Lactose Fermenting Organisms to the Medium in which they are grown.†—C. Richet has published a memoir on the above subject in which he demonstrates that an organism that has lived on a medium A grows more easily on the medium A than an organism of the same origin which has grown upon a medium different from A. The organism thus becomes accustomed to the medium A and transmits this peculiarity to its descendants. In estimating the measure of acidity produced by lactose-producing organisms in mixtures containing various quantities of toxic substances the technique employed was as follows:—

To cow's milk was added an equal quantity of distilled water, followed by a few drops of phthaline; potassium hydrate being introduced until a suspicion of a pink colouration appears. No more potash than necessary should be added, as during the subsequent sterilization, caramalization of the lactose is apt to occur and thus obscure the end reaction. Ten c.cm. of the solution, accurately measured, is delivered

* Ann. Inst. Pasteur, xxix. (1915) pp. 55–70.
† Ann. Inst. Pasteur, xxix. (1915) pp. 22–54.

into a series of U-tubes, which are then plugged and sterilized for three minutes at 110° C. The toxic substances are added to the media in definite proportions. When toxic substances are added in the place of distilled water they are added in double strength to the content required in the mixture; thus if the toxic content needed is A per litre, a solution containing 2A per litre is added, and so on. The inoculation and the growth of the lactic organism in the tubes containing various chemicals in solution and in the control-tubes containing distilled water is arranged to take place as far as possible under identical conditions of temperature, and so forth.

The following table, which is a summary of the results obtained with three different concentrations of the toxic substances (A) used, compared in each case with similar experiments conducted with controls containing distilled water (N), shows quantitatively the amount of lactic acid produced by a ferment A (the action of a similar ferment N being in each case 100) when it is allowed to actuate solutions free from or containing varying quantities of the substance which produced the strain A :—

——	0·00	A/2	A	2A
Selinate of Potash	85	115	138	164
Phosphate of Potash	89	118	199	206
Azotate of Potash	75	100	138	183
Sulphate of Potash	104	122	136	138
Chloride of Soda	107	111	120	138
Bromide of Potash	79	108	126	153
Arsenate of Soda	81	119	138	174
Nitrate of Thallium	78	104	120	153
Saccharose	99	115	132	123
Mean	88	112	138	159

These figures prove the adaptation of the organism to the toxic substances, and also show that a diminution of ferment activity takes place when the organisms which have been accustomed to grow in the presence of such toxic substances are again allowed to grow in normal milk. The only exceptions to this are to be found in the cases of sulphate of copper and sodium chloride.

Testing Antiseptics.*—W. W. Cheyne, in a lecture before the Royal College of Surgeons, stated that in co-operation with A. May, Bassett-Smith and A. Edmunds, experiments had been made to test the value of certain antiseptics with reference to the treatment of wounds in war. The technique, in their own words, is as follows :—

"Speaking generally, the plan which we have ultimately adopted as regards agar, is to place the antiseptic paste to be tested on the bottom of a Petri dish underneath a slab of nutrient agar, and to paint the upper surface of the agar with an emulsion of bacteria of various kinds,

* Lancet, clxxxviii. (1914) i. pp. 419-30 (1 pl.).

according to circumstances. We were then able to judge of the diffusibility and activity of the antiseptic by observing the growth or absence of growth of the bacteria which we had planted. Now, a comparative test is only of value if all the conditions are exactly the same, and I think we have ultimately worked out a satisfactory method. We always use the same quantity of the paste by weight, either $\frac{1}{2}$ grm. or 1 grm. as we wish. This is placed on an ordinary microscopical cover-glass, either $\frac{3}{4}$ or 1 in. in diameter, which is applied to the centre of the under-surface of the slab of agar. In this way the antiseptic is applied to the same definite area ($\frac{3}{4}$ or 1 in.) of the agar in all cases. Where fluids have been tested they have been put into a small paraffin cell containing pieces of filter-paper, and always in definite quantities.

"The slabs of agar must also always be of exactly the same thickness, and here we had our greatest difficulty. We began by pouring the agar into a Petri dish, till, as far as we could judge, we had got the proper depth of agar, and then allowed it to solidify and turned it out into another Petri dish, in the centre of which the paste was laid. After all, however, this was only guesswork; the table might not be level, and one side of the agar might be thicker than another, and besides we could not always be certain that we had put the same amount of agar into each dish. This difficulty has been overcome in a very ingenious manner, and though when two or more men work together it is not usual to refer to any one man's share in particular, still in this instance the arrangement is likely to be very useful in similar experiments in future, and therefore I think I ought to say that it was devised by Edmunds, and I shall speak of it as Edmunds's cell.

"To make an Edmunds's cell you take two square pieces of glass, a brass ring of known thickness (we generally have used one $\frac{1}{4}$ inch thick), the ring being incomplete in one part, and two or three broad paper-clips. First sterilize a glass plate in the flame and then lay it down on a dish, then similarly flame the interior of the brass ring and lay it down on the glass, then flame the other piece of glass and lay it over the brass. Bind these together by the paper-clips and you have a cell with an opening at one part through which the melted agar can be poured and left to solidify. When the agar has solidified the cell is laid down flat, the clips removed, the upper glass plate and the brass ring lifted off, and then we have the slab of agar lying on the lower glass plate. The cover-glass with the paste is now placed on the centre of this slab, with the paste next the agar, and then the lower part of a Petri dish is inverted over it, the whole turned upside down, and with a little manipulation the slab is transferred to the dish. A thin emulsion of the bacteria to be employed is previously made and is now brushed over the whole surface with a camel's-hair brush. Finally, a little fluid agar is run round the edge of the slab, partly to fix it to the dish and partly to prevent the escape of vapour should the antiseptic to be tested be volatile.

"As regards bacteria, we have chiefly employed the ordinary pus organisms, the *Staphylococcus pyogenes aureus*, but we have used *Micrococcus prodigiosus* and also *Bacillus subtilis* so as to study the effect on spores. It will be very interesting, when we have time, to study

other organisms. The Petri dish thus prepared is placed in an incubator at the body temperature, and observations made from time to time."

The most effective disinfectants appear to have been carbolic acid and tricresol.

Purification of Silk Pepton for Bacteriological Purposes.* J. Walker Hall says† that the tetra-peptid sold as silk pepton has certain advantages for bacteriological purposes over complex mixtures like Witte's pepton. Methods are described for purifying the crude product; the pigment may be removed by filtration through *Argilla alba*. The product has the same optical rotation and amino-acid content as that obtained by phosphotungstic acid precipitation.

Cultivation of Plasmodia of Bodhamia Utricularis.†—A. E. Hilton has found that the growth of a plasmodium of *B. utricularis* can be stimulated by the occasional application of a mixture of ammonium phosphate and cane sugar, half an ounce of the phosphate and the same weight of sugar being dissolved in a quart of water.

In the second place, he finds that the plasmodium will feed and grow

Fig. 20.

on bread kept moistened with water, especially if some of the mixture described be added to it from time to time.

The effect of the mixture seems to be both direct and indirect. It appears to impart greater vigour to the plasmodium, so increasing its feeding capacity; and it also benefits the plasmodium indirectly by promoting the growth of filamentous moulds, such as *Aspergillus* or *Penicillium*, which soon appear on fungus or bread after the mixture has been applied to it. The hyphæ of these moulds are dissolved and absorbed by the protoplasm as food.

The author then describes his method of exhibiting the reversing currents of streaming plasmodia.‡ The very simple arrangement is shown in fig. 20.

A tube of this size is sufficient, and a ring of blotting-paper, with sclerotium upon it, is placed inside; the sclerotium being between the paper and the glass. A few drops of water are added, the cork is inserted, and the tube is then tilted and revolved until the water has soaked the paper and moistened the whole of the interior surface of the tube. A small hole is bored through the cork to admit air without allowing too much evaporation; or the cork may occasionally be

* Journ. Pathol. and Bact., xix. (1914) pp. 286–304; through Journ. Chem. Soc., cvii. and cviii. (1915) i. p. 46.

† Journ. Quekett Micr. Club, xii. (1914) pp. 381-4 (1 fig.).

‡ See this Journal, 1909, p. 196.

removed. If necessary, a drop or two of water can be added now and then, to keep the air moist. Only plain water should be used. When the sclerotium revives, the plasmodium creeps on to the glass on either side of the ring of paper, and the reversing currents can then be seen by placing the tube on the stage of the Microscope and throwing the light up through it from the mirror beneath. A 1-inch objective, focused on the veins of the spreading plasmodium, shows the streaming movements quite plainly. The sclerotium should be placed in the tube the day before the plasmodium is required for exhibition.

New Collecting Tube.*—A. M. Banta states that the pipette described below (fig. 21) is very useful for pond-life purposes, and will collect any small or delicate object up to 6 or 8 mm. in diameter. It is made from a calcium-chloride tube about 200 mm. long and the ordinary 50 c.cm rubber bulb. The calcium-chloride tube used in the pipette figured consists of a glass bulb about 35 mm. in diameter blown in a glass tube of 16 mm. in diameter and about 120 mm. long. One end of the tube is heated in the flame and drawn out to the desired

Fig. 21.

diameter for the pipette-mouth. From the opposite end of the glass bulb there extends a tube about 6 mm. in diameter suitable for attachment of the rubber bulb.

(2) Preparing Objects.

Demonstrating the Development of Trypanosoma lewisi in the Rat-flea.†—E. A. Minchin and J. D. Thomson first extracted the viscera of the fleas and then examined them under the Microscope. If infected the cover-glass was removed and then dropped into a fixative, while the slide is exposed to the vapour of osmic acid for 10 to 15 seconds, and then removed to absolute alcohol for about 15 minutes, and then stained with Giemsa in the usual manner. For fixation of cover-slip films Schaudinn's fluid or sublimate-acetic were used, but though the results were good, Maier's modification of Schaudinn's fluid was afterwards adopted (H_2O 200 c.cm., C_2H_6O 100 c.cm., sodium-chloride 1·2 grm., $HgCl_2$ 10 grm.). The cover-slips are immersed in this fluid for 10 to 30 minutes or longer, and then passed through upgraded alcohols to 90 p.c., wherein they can be kept until it is convenient to stain them. The cover-slip films were stained with Heidenhain's iron-hæmatoxylin. When this process was completed the cover-slips were rapidly passed through Lichtgrün-picric-acid solution (Lichtgrün 1 grm., picric acid

* Science, xl. (1914) pp. 98–9 (1 fig.).

† Quart. Journ. Micr. Sci., lx. (1915) pp. 463–692 (10 pls. and 24 text figs.).

½ grm., absolute alcohol 100 c.c.), then washed in absolute alcohol, passed through xylol and mounted in balsam. Sometimes the preparations were unmounted by dissolving the balsam in xylol and after removing the hæmatoxylin by means of iron-alum were restained by means of Twort's stain.

Sections of stomachs of infected fleas were also made. The viscera were fixed in the strong Flemming fluid or in Maier's modification of Schaudinn's fluid. The fixatives were allowed to act for about one hour, and the Flemming's solution was found to give the better results. The fixed stomachs were placed, three at a time, on thin slices of amyloid liver and stuck on with a tiny drop of glycerin-albumin. After fixing the stomachs to the liver in 90 p.c. alcohol, they were imbedded in paraffin. Celloidin imbedding did not give good results. The most suitable thickness for the sections was found to be 6μ. Though numerous methods for staining were tried, only two gave satisfactory results, viz., iron-hæmatoxylin followed by Lichtgrün-picric in absolute alcohol, and Giemsa's method.

(5) Mounting, including Slides, Preservative Fluids, etc.

Mounting Diatoms in Oil of Cassia.*—H. Miles-Carter states that this is an excellent, cheap, easily obtained medium, and with it the image obtained is far stronger than with balsam. He proceeds as follows:—Cement to a clean glass slip, a thin glass or tin cell, using isinglass cement or hard paraffin wax. Have ready the cover with the diatoms dried upon it, fill the cell with oil of cassia, slightly warm the cover, and lower it on to the cell, being careful to avoid air-bubbles. Remove with blotting-paper the superfluous oil from the outside of the cell and cover, taking care not to allow any of it to get on the upper surface of the cover, and, having ready a pot of melted hard wax, run this (with the aid of a hot wire and small brush) into the space between the outer edge of the cover and the slip; do not allow any air-bubbles to remain, get them out with a hot needle. When the wax is solid, the superfluity can be cleaned off with a penknife to within ⅛ in. of the edge of the cover, and the glass cleaned up with a piece of rag. Then run a hot wire round the edge of the wax on the slip, so as to ensure a sound junction with the glass, then trim up as before. Give two coats of thick collodion, and an hour later a good coat of seccotine. Put the slide aside for 24 hours, then finish with shellac varnish.

(6) Miscellaneous.

Elements of Microscopical Technique and Vegetable Histology.† J. Ochoterena, who is the Director-general of Primary Education of San Luis, Potesi, has compiled a tract dealing with the elements of microscopical technique and vegetable histology. It contains 50 pages and 17 illustrations. The contents are common to all elementary works on microscopical technique, and the printing of the illustrations is very imperfect.

* Journ. Micrology, 1914, pp. 95–6.
† San Luis, Potosi, Mexico, 1914, Fasciculo i.

Metallography, etc.

Polymorphism of Zinc.*—G. I. Petrenko states that the polished surface of zinc cooled slowly from above its melting-point to 180° C. exhibited large polyhedra upon which comparatively few small ones were disposed promiscuously ; the small polyhedra were more abundant when the metal was quenched at 360–330° C., but completely covered the surfaces of the large crystals when the metal was cooled to just below 300° C. The phenomenon was reversible, and is considered to indicate the occurrence of an allotropic transformation between 290° and 300° C.

Tensile Properties of Copper at High Temperatures.†—G. D. Bengough and D. Hanson have made tensile tests on copper at temperatures up to 1000° C., in oxidising, neutral, and reducing atmospheres, and have recorded the microstructure of the broken specimens. In order to preserve the actual edge of the fractures during polishing, the specimens were electroplated with a thin coating of nickel, on which a thick coating of copper was deposited, and were then cut through at the desired position and polished in the usual way. Satisfactory etching was obtained, with some difficulty, by using a 10 p.c. solution of ammonium persulphate containing excess of ammonia. In pure copper two types of fracture are distinguished, the low-temperature type which passes through the crystals, and the high-temperature type, observed in specimens broken at temperatures between 720° C. and the melting-point, which is intercrystalline. In the high-temperature intercrystalline fracture there is no distortion of the crystals. The results are considered to support the hypothesis of the existence in pure metals of an intercrystalline cement, highly elastic at relatively low temperatures, which loses its strength with rise of temperature much more rapidly than do the crystals themselves.

Annealing of Brass.‡—Commercial castings of the alloy copper 70, zinc 29, tin 1 p.c., contain a complex eutectoid, in which the light-coloured brittle tin-rich constituent appears to be the δ-phase of the copper-tin system. On heating, this eutectoid is transformed to homogeneous β at about 600° C., and at higher temperatures the β diffuses into the α solid solution. F. Johnson has examined a 70–29–1 tube-casting which cracked badly during the drawing process. The casting contained intercrystalline eutectoid, through which the cracks frequently ran. The presence of the brittle eutectoid, the cause of the cracking, indicated that the casting had not been sufficiently annealed.

* Journ. Russ. Phys. Chem. Soc., xlvi. (1914) pp. 176–78, through Journ. Soc. Chem. Ind., xxxiii. (1914) p. 1212.

† Journ. Inst. Metals, xii. (1914, 2) pp. 56–88 (21 figs.).

‡ Journ Inst. Metals, xii. (1914, 2) pp. 111–15 (9 figs.).

Embrittling of Brass.* — D. Meneghini examined worked brass (parts of incandescent gas-burners) which had become brittle in use, in some cases fracturing spontaneously. No change in composition was detected; the brass contained 35 p.c. zinc, 0·3 to 0·4 p.c. lead, and consisted almost wholly of the α solid solution. The softening resulting upon annealing at 700° C. indicated that the brass had been hardened by cold-work. The brittleness is ascribed to the effect of sulphur dioxide and moisture acting on brass in which internal stresses, caused by cold-work, existed.

Removal of Sulphur from Silver.†—C. C. Bissett has investigated the possibility of removing sulphur from silver by additions of copper or iron, and records some observations of structure of the melts prepared. When copper was added in increasing amounts to molten silver containing 13·5 p.c. of silver sulphide, the amount of sulphide remained fairly constant until 2 p.c. copper had been added. Further additions reduced the amount of sulphide, and the addition of more than 3·5 p.c. copper removed all the sulphide from the silver. When iron was added to molten silver containing 11·6 p.c. of silver sulphide, two liquid layers were formed, as in the case of copper additions, the upper rich in sulphur, the lower rich in silver. When a considerable excess of iron beyond that required to saturate the whole of the sulphur present was added, the upper layer contained all the sulphur, and the lower layer all the silver.

Copper-zinc-lead Alloys.‡—N. Parravano has studied the equilibrium of the copper-zinc system and the copper-zinc-lead system. Lead does not dissolve, in the solid state, in the α or γ copper-zinc solid solutions, and in lead brasses is found admixed mechanically with the copper-zinc alloy.

Widmanstätten Structure in Alloys.§—N. T. Belaiew points out that the Widmanstätten figures found in steel prepared under certain conditions are formed by the distribution of the structural elements between the cleavage planes during recrystallization, and are characteristic of the primary octahedral crystallization of the iron. Similar structures should occur in other alloys which crystallize in the regular system and undergo recrystallization after solidification; the primary octahedral crystals of the solid solution should throw out secondary deposits on their cleavage planes during recrystallization. A number of examples (brasses, bronzes, platinum-aluminium alloys, etc.) are illustrated by photomicrographs.

Coating Metals with Aluminium Alloy.‖— H. B. C. Allison and L. A. Hawkins describe a process in which articles of copper, iron or

* Annali. Chim. Appl. ii. (1914) pp. 154-8, through Journ. Chem. Soc., cvi. (1914) p. 849.

† Journ. Chem. Soc., cv. (1914) pp. 2829-36 (2 figs.).

‡ Gaz. Chim. Ital., xliv. (1914) ii. pp. 475-502, through Journ. Soc. Chem. Ind. xxxiv. (1915) p. 86.

§ Journ. Inst. Metals, xii. (1914, 2) pp. 46-55 (14 figs.).

‖ Met. and Chem. Eng., xii. (1914) p. 730.

some other metal are heated in a mixture containing finely ground aluminium. The effect is to form a coating of an aluminium-rich alloy on the article treated. This coating possesses remarkable resistance to oxidation on heating to high temperatures, and it is because of this property that the process is known as "calorizing." The microstructure of the coatings obtained on copper and other metals is described. There is a clear line of division between the unchanged copper and the alloy; the alloy is richest in aluminium at the surface.

Manganese Steel.*—J. H. Hall deals with the metallography as well as the manufacture, properties and uses of manganese steel, which commonly contains 9 to 14 p.c. manganese and 1 to 1·5 p.c. carbon. In the cast condition manganese steel consists of a ground-mass of austenite, containing manganiferous cementite in the form of a network, needles, and small masses. The cementite is bordered by austenite more or less transformed to troostite or sorbite. When the steel is heated to a sufficiently high temperature (1000 to 1100° C.), the cementite is dissolved in the austenite. If the cooling is rapid, the cementite is not liberated, but if the steel is cooled slowly, the cementite is liberated in a structure resembling that of the cast material. When the tough, quenched steel is reheated it becomes brittle owing to the separation of cementite as a fine network, and needles at about 500° C. If heating at 500° to 600° C. is prolonged for 24 hours, the austenite is transformed to sorbite and the steel becomes strongly magnetic.

Boron Steels.†—G. Hannesen has examined iron-boron alloys containing up to 8·5 p.c. boron. The compound Fe_5B_2 was found as needle-shaped crystals of rhombic section, and is magnetic. By quenching alloys containing 0·4 to 2·0 p.c. boron a martensitic structure was obtained, but in no case was an austenitic structure produced.

Honeycombing in Steel.‡—E. Crowe describes the structure of a crust of solid steel which had formed to a thickness of 4 to 6 inches on the top of the steel contained in a casting ladle, as a result of accidental long delay in casting. The underside of this top crust was honeycombed in a remarkable way. J. E. Stead puts forward the explanation that the gases given off in solidification had collected underneath the crust as bubbles, and the steel continued to crystallize round these bubbles.

Structure of Steel Castings.§—J. H. Whiteley found two distinct structures in a steel casting. On one side, large dendrites had formed, while on the other side the structure was not dendritic but granular. Examination of a number of castings, and experiments in which portions of molten steel were cooled quickly or slowly, indicated that slow cooling

* Journ. Soc. Chem. Ind., xxxiv. (1915) pp. 57–60 (1 fig.).

† Zeitschr. Anorg. Chem., lxxxix. (1914) pp. 257–78, through Journ. Soc. Chem. Ind., xxxiv. (1915) p. 84.

‡ Iron and Coal Trades Rev., xc. (1915) p. 327 (2 figs.).

§ Iron and Coal Trades Rev., lxxxix. (1914) p. 763 (Clev. Inst. Engineers, Dec. 14, 1914).

favoured the formation of a dendritic structure, and more rapid cooling produced a granular structure. In rolled material such as plates, the sulphide and silicate of manganese are often present in fine broken threads, as well as in the usual ellipsoidal form. The author suggests that the threads were originally cellular films in the ingot, while the ellipsoidal masses were globules.

Slag Inclusions in Steel.*—F. Giolitti and S. Zublena give the results of heat-treatment experiments on an acid open-hearth steel containing 0·38 p.c. carbon, and 2 p.c. nickel, intended to ascertain the effect of the slag inclusions present. The extent to which separation of ferrite round the inclusions occurred was influenced by the conditions of heating, whether carburizing or decarburizing. By appropriate heat-treatment, the injurious effects of slag inclusions may be diminished or even eliminated.

Annealing of Tyres.†—A. L. Babochine points out that the desirable structure in a steel tyre is a fine-grained sorbitic structure, and indicates the theoretical conditions for the production of such a structure by annealing. The tyre should be heated above A3 for a length of time sufficient to destroy the original structure, and to produce a uniform solid solution. Cooling to a temperature below A1 should be moderately rapid, and the subsequent cooling slow. In practice the annealing temperature should not be below 800°–840° C. The microstructures of tyres correctly annealed, and of tyres the annealing of which had been faulty in different ways, are illustrated by photomicrographs. Common faults in structure are coarsely lamellar pearlite, granular pearlite, and a coarse cellular structure.

Microscopical Investigation of Opaque Minerals.‡—O. Stutzer discusses the application in petrography of the microscopical examination of minerals by means of reflected light. Chalcopyrite, iron pyrites, pyrrhotite, and other coloured minerals can be detected in a polished section of the ore, while etching may be required to distinguish between minerals of similar colour. In nickeliferous pyrrhotite, the nickel is seen to be associated mechanically with the pyrrhotite in the form of pentlandite, whereas formerly it was considered to be in chemical combination in the pyrrhotite. In titaniferous magnetite the titanium occurs partly in mechanical association with the magnetite as ilmenite, and in part replaces the iron chemically in the magnetite molecules. Such specimens of titaniferous magnetite may be etched with hydrochloric acid, which dissolves the magnetite and leaves the ilmenite unaffected. In copper-iron pyrites, bornite $3\,Cu_2S$, Fe_2S_3, copper glance Cu_2S, chalcopyrite $CuFeS_2$, enargite Cu_3AsS_4, and iron pyrites FeS_2 may all be identified by their microscopical characteristics.

* Annali Chim. Appl. ii. (1914) pp. 218–245, through Journ. Soc. Chem. Ind., xxxiii. (1914) p. 1210.

† Rev. Soc. Russ. Met., i. (1913) pp. 387–705, through Rev. Métallurgie, xi. (1914), Extraits, pp. 594–599 (9 figs.).

‡ Metall. und Erz., xi. (1914) pp. 450–455, through Journ. Soc. Chem. Ind., xxxiii. (1914) p. 1160.

Microstructure of Coal.*—J. Lomax describes and illustrates by photomicrographs the structure of the different layers forming a typical coal seam. Most coal seams were originated by a regular deposition from the growth of vegetation on the spot where they were now found. The lower part of the seam consisted of a bed of very fine humus. Higher up the seam were remains of Cordaitiæ, a type of plant belonging to the Gymnosperms. Above these were Lycopods, which in the upper layers became predominant. Higher still in the seam the plant-life deteriorated, and the top layer resembled the bottom. It has been shown that the alternating dull bands and bright bands in coal differ in that the dull bands are more resinous. When coal is freed from the normal pressure in a seam, the more resinous bands expand, while the less resinous bands are cracked and pulled asunder by the unequal expansion. This appears to be the chief cause of the disintegration of coal into slack and dust.

* Iron and Coal Trades Rev., xc. (1915) pp. 46–48 (11 figs.).

MICROSCOPY.

A. Instruments, Accessories, etc.*

(1) Stands.

Swift and Son's "Improved Dick" Petrological Microscope (Khartum Model).†—The first Microscope of this type (fig. 30) was built to the specification of G. W. Grabham, Senior Geologist to the Sudan Government, Khartum. Possessing all the features of previous "Dicks," it provides also additional adjustments, and permits the use of further apparatus of the greatest practical utility to mineralogists. It is provided with a rack-and-pinion focusing substage with centering movements, which carries a triple nose-piece for the different condensers, an iris-diaphragm, and a rotating swing-out cell for stops. Any condenser with the R.M.S. standard screw can be used. The iris-diaphragm fitted below the condenser serves not only to regulate the illumination of the object, but also to cut down the cone of light in order to test the refractive indices of minerals and mounting media. The rotating swing-out cell carries stops for giving oblique and dark-ground illumination.

(3) Illuminating and other Apparatus.

Hutchinson's Universal Goniometer.‡—This instrument (fig. 31) is a goniometer of the suspended type. It is intended for the examination of small crystals, and by its aid all the usual crystallographic and optical determinations can be carried out. It is specially adapted for the following purposes:—(1) as an ordinary goniometer: (2) as an axial-angle apparatus; (3) as a Hohlrausch total reflectometer; (4) for determining refractive indices by the prism method.

A circle D, 5 in. in diameter, graduated to half degrees and reading by a vernier to minutes, is supported by a stout bracket S, at a height of 10 in. above a base plate P, 11 in. square. The circle is provided with a slow-motion attachment, and can be clamped by the screw E. A steel rod, which can be clamped at any convenient position by the screw F, passes through the centre of the circle and carries at its lower end the centering and adjusting head shown at G. A loose collar, which can be clamped to the rod by the screw R, gives the means of raising the adjusting head and of again lowering it to its former position.

A telescope A and a collimator C are securely clamped to the base-

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† J. Swift and Son's Catalogue, 1914, pp. 17–8.

‡ J. Swift and Son's Catalogue, 1914, pp. 28–9.

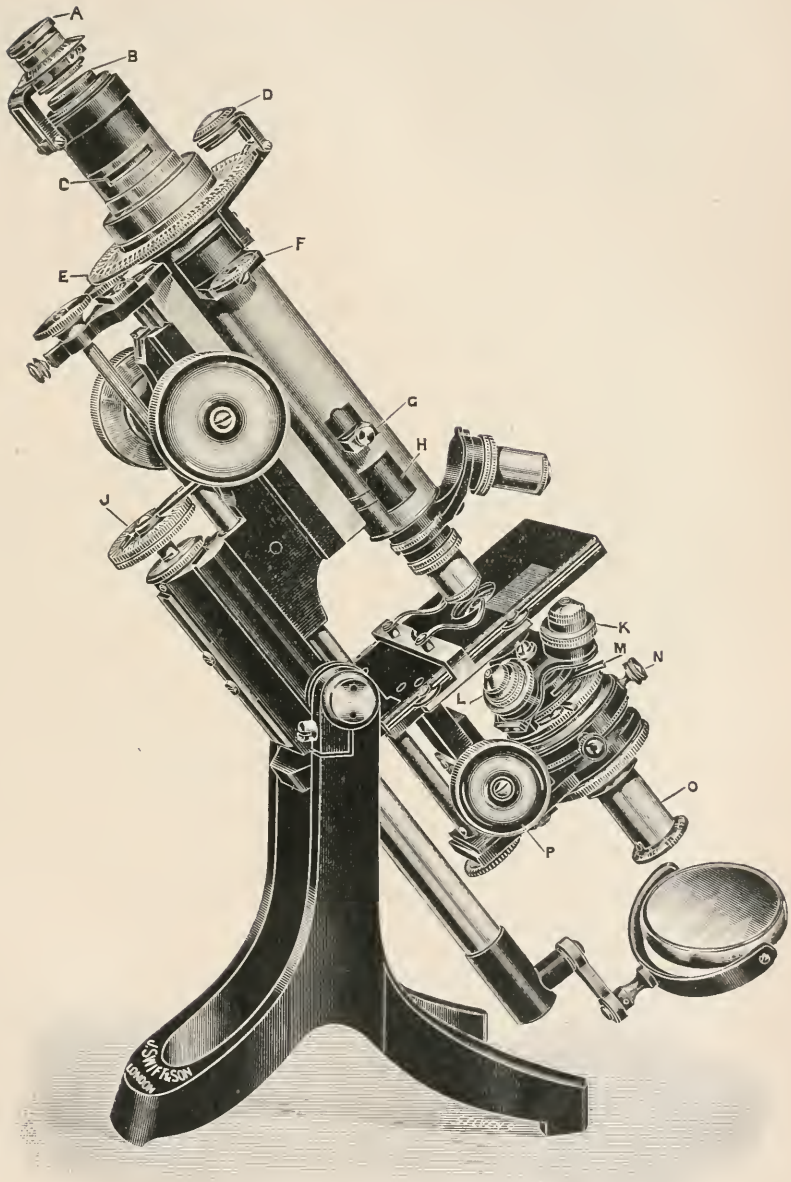


Fig. 30.

plate in the manner shown at K, a number of holes being provided for this purpose at convenient positions. The object-glasses of the telescope and collimator are $\frac{3}{4}$ in. in diameter and about 4 in. focal length. Their tubes are carried by collars provided with adjusting screws. An additional lens of $2\frac{1}{2}$-in. focus is hinged over the object-glass of the telescope to convert it into a Microscope of low power, with which the crystal can be directly examined. The telescope and collimator can be placed at any convenient angle to one another, and the Microscope B is

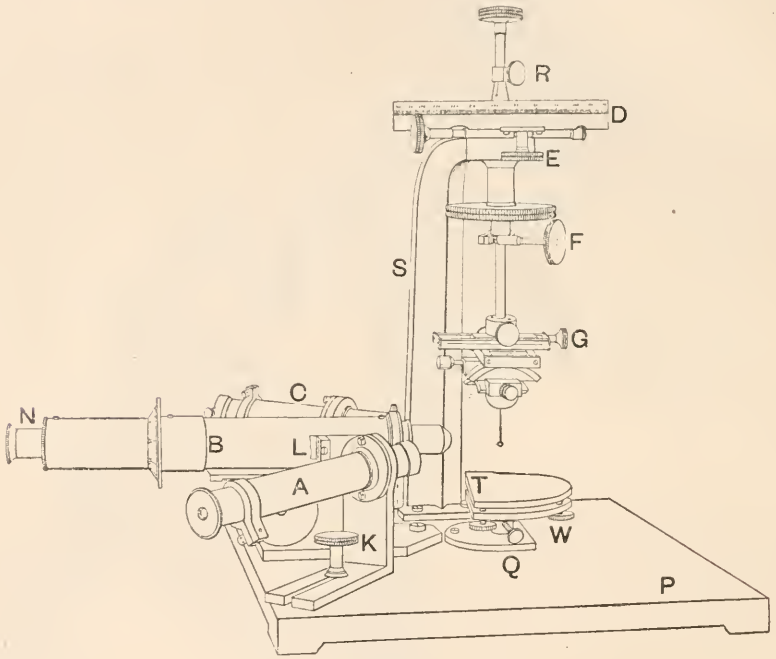


Fig. 31.

arranged so that its optic axis bisects the angle between them. The Microscope tube, which is 8 in. long, is moved by a rack-and-pinion coarse-adjustment. At the nose-piece end it carries the tube-fitting of a centering objective-changer, which enables different objectives to be rapidly slipped into position. At the other end of the Microscope a rotating analyzer N slips over the cross-webbed ocular; this latter and the prism-holder are slotted to admit of the insertion of a quartz wedge, mica plate, or other compensator. A Bertrand lens L slides in the body of the Microscope.

An adjustable table T, which can be levelled by the screw W, is carried by a steel rod, which can be clamped by the screw Q; a loose collar, clamped to the rod by a screw, enables the table to be rotated when supported at any convenient height. On this table can be placed

a tank when it is desired to observe the crystal immersed in a liquid. There are some other supplementary fittings.

When the instrument is being used as a total reflectometer, and fairly large crystal plates are available, the Microscope can, by means of a special objective and ocular, be converted into a telescope.

(4) Photomicrography.

Colour Screens.*—J. E. Barnard has used the following methods in the preparation of colour screens for photomicrographic use. Permanent screens may be made by staining either gelatin or collodion films. A 7½ p.c. solution of gelatin in distilled water is melted down over a water-bath and then filtered through glass or cotton wool. The indicated dye is then added to the solution, and a suitable proportion of gelatin then poured on to the plate and allowed to dry in a perfectly horizontal position where dust is not likely to settle on it. Another, and perhaps more preferable, method is to immerse a gelatin plate in a solution of the dye until a sufficient depth of colour has been taken up by the film. The solution of aniline dyes used should be of a strength of 1 in 1000, with the exception of yellow dyes (e.g. acradine yellow, auramine, or tartrazine), which may be used as strong as 1 in 250. Enamel collodion may be used instead of gelatin, the dye being in this case dissolved in absolute alcohol and added to the collodion before the plate is coated. The best quality of enamel collodion must be used in order to insure a perfectly clear film.

The use of a fluid screen has the advantage of simplicity and the easy control of absorbing power. For use with such fluid filters a simple type of cell may be formed of a rubber band, from which a segment has been cut, fixed between two thin glass plates by a pair of spring clips, the depth of the cells being varied by the employment of bands of different thicknesses. The dyes used are kept in stock solution, and a fluid screen can be improvised at any time in a few moments.

The use of a mercury vapour lamp as a source of light is of particular advantage in dealing with objects that are faintly stained with methylene blue, and which often give only very faint images in photomicrographic work. By using a screen that transmits the yellow mercury vapour line, one can be perfectly sure that no blue is transmitted, and thus the utmost contrast is secured.

Directions are given for the preparation of the various fluid filters that have given good results in the lecturer's hands :—Gifford's screen (methyl or malachite green dissolved in warm glycerin), Zettnow's green filter (cupric nitrate and chromic acid dissolved in water), yellow screen (10 p.c. solution of acradine yellow in absolute alcohol ; one part being added to four parts of enamel collodion), and blue screen (ammonio-sulphate of copper).

* Journ. Photomicrograph. Soc., 1915, iv. pp. 1–8.

(6) Miscellaneous.

An Amateur's Introduction to Crystallography.*—Under this title W. P. Beale has produced a very useful and serviceable treatise. He states that it is his intention to help other amateurs to find in the problems of Crystal Morphology occupation of practical interest in itself leading to the more fascinating study of the optical and other special properties of crystalline structures, and pointing to further fields of study in molecular physics, which he (the writer) can only see faintly and beyond his reach. At the same time the book does not shirk difficulties. It commences with the study of an actual specimen, and shows how the crystalline faces and edges can be connected with a system of axes and co-ordinates, and so gradually leads up to an explanation of the thirty-two systems. Methods of measurement and calculation, are introduced, and special difficulties are reserved for two appendices. The book is very clearly printed, and the illustrations are unusually well done.

B. Technique.†

(1) Collecting Objects, including Culture Processes.

Detection of Trypanosomes in Animals.‡—Mühlens draws attention to the following method devised by A. Lundie § for the investigation of trypanosomes. The suspected blood is allowed to run into a test-tube, which contains a solution of 5 c.cm. of sodium citrate in 5 c.cm. of sterile water, until the tube is three-quarters full. The contents are then mixed by rolling in the hands. After about half an hour it will be observed that a small quantity of clear fluid has separated out over the blood layer. If trypanosomes are present they will be found in this clear fluid layer. The author is of opinion that the development of trypanosomes may be followed by this method, and that by the addition of hydrochloric acid, the developmental cycle in the *Glossina* may be simulated.

Detection and Identification of Bacillus typhosus and B. paratyphosus.‖—G. Dreyer, E. W. Ainley Walker, and A. G. Gibson point out that, in view of the importance at the present time of retaining convalescent soldiers under observation and control until they cease to act as carriers, it is essential that the method used in making examinations should be one in which a negative finding represents as nearly as possible a true negative. The method of direct plating on so-called selective media has often proved to be misleading.

An extensive series of experiments was carried out with the media

* Longmans, Green and Co., London, 1915, 220 pp., many figs.

† This division contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Embedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including Slides, preservative fluids, etc.; (6) Miscellaneous.

‡ Centralbl. Bakt., Ref. lxii (1913), p. 522.

§ Journal of Tropical Medicine and Hygiene, xvii (1914), p. 22.

‖ Lancet, 1915, pp. 643–7.

of Drigalski and Conradi, MacConkey and Endo, and the outstanding conclusion derived from these researches was that all these media eliminate a very large proportion of typhoid (and even paratyphoid bacilli), and do not to any very notable degree inhibit the growth of *B. coli*. The following table shows the kind of results that were obtained :—

Medium	Number of Colonies on Plates Inoculated with *B. typhosus* 20 c.cm.			Number of Colonies on Plates Inoculated with *B. coli* 20 c.cm.		
	Experiments			Experiments		
	(1)	(2)	(3)	(1)	(2)	(3)
Ordinary agar	265	150	90	1100	550	86
Endo's medium	245	135	85	1000	500	60
MacConkey's medium ..	2	1	0	950	450	70
Drigalski-Conradi medium	2	0	0	1050	500	64

The good result here shown with Endo's medium was only obtained when the medium was very fresh. The colonies of *B. coli* on Endo's medium are well developed, of a deep red colour, and gradually acquire an intense metallic sheen, while those of *B. typhosus* are at first only faintly rosy in colour, and though they eventually become red they never acquire any metallic lustre.

It is suggested that this medium might well be used instead of MacConkey's medium in the technique of the brilliant green enhancement method of Browning, Gilmour and Mackie.

The authors have devised a technique for the rapid isolation of *B. typhosus* or *B. paratyphosus A.* or *B.* in twelve or twenty-four hours by means of a single plate. The method consists of the subjection of an ordinary agar plate, liberally spread with the bacterial emulsion, to a graduated exposure to the rays of an arc light, silver electrodes giving the best results.

The lamp consists of two small metal pillars bracketed on an insulating slate base. The pillars carry the horizontal arms upon which electrodes, water-cooled after the manner devised by Bang, are screwed. These arms can be approximated to each other by means of thumb-screws. They consist of an outer tube within which runs a smaller inner tube, serving as inflow for the cooling water, which returns by the outer tube. The arc is made by an electric current of 5 to 7 amperes, with a voltage of 30 to 35 volts. In exposing an inoculated plate, the lid is removed and the agar surface is directly exposed to the arc at a distance of about 6 cm. Upon the Perti dish is placed a sheet of blackened metal in which an oblong window has been cut. By means of another sheet of blackened metal, the window, at first fully opened, is gradually closed, the different exposures along the strip varying from 30 to 240 seconds. In making a plate, from 0·5 to 1 c.cm. of fæces are broken down in 2·5 c.cm. broth and allowed to stand for about two hours. Two or three drops are then taken from the upper part of the fluid and

spread on the surface of the plate to be subjected to the action of the electric arc.

Whereas with the selective media in present use, typhoid bacilli when mixed with large proportions of *B. coli* are only recovered with extreme uncertainty, by the new technique, in cases where the proportion of coli to typhosus was as 500 to 1, a few isolated colonies of the latter were recovered. On applying the method to the examination of the fæces of convalescents and suspected carriers, seven have already yielded positive results by this method at the first examination, though the ordinary methods failed to afford any evidence of the presence of *B. typhosus* or *B. paratyphosus*. In five of the cases *B. typhosus* was isolated, and in the remaining two, *B. paratyphosus B.* Although it would not be wise to make broad generalizations from the results of these few cases, it must be admitted that so far as they go they are very encouraging.

Some Simple Anaerobic Methods.*—P. P. Laidlaw has employed three new methods for the cultivation of anaerobic organisms, with the idea of simplifying the attainment of anaerobic conditions. The point which he has set out to obtain is the avoidance of costly and bulky apparatus, and to devise a technique for use in a travelling laboratory which might be of service to those working with anaerobic bacteria in the field, for those whose space is limited, and who cannot take a large equipment with them.

Method 1. *Porous Platinum.*—This method is the simplest, and is applicable to solid or liquid media, and for these reasons is probably the best.

Short pieces of platinum wire are fixed into glass holders at the blow-pipe, and the free ends are wrapped tightly round small pieces of gas carbon and secured by twisting round the main piece of wire. The carbons are then heated in the flame to expel the air, and are dipped, while still hot, into a strong solution of platinic chloride. After soaking they are removed and dried in the flame. They are then heated red hot and re-dipped, and the process repeated several times. On removal from the flame the reduced platinum on the surface of the carbon will absorb sufficient oxygen from the air to keep the mass at a dull red until all the carbon has been burned away.

The glass holder is cut short and pushed into the centre of a cork. With this and a Kipp's hydrogen apparatus the atmosphere above a medium can be rendered anaerobic in a few minutes. With solid media (e.g. a blood-agar slope) the tube is inoculated in the usual way, the plug removed, and the tube turned upside down. A sterile capillary tube is connected with the hydrogen apparatus, introduced with a cotton-wool plug from below, and a stream of hydrogen run into the test-tube. The capillary is removed and the sterilized platinum-armed cork is pushed home, the joint being secured with melted paraffin-wax. The platinum will glow dull red when introduced, and continue to do so until all residual oxygen has been used up in forming water. If insufficient hydrogen has been introduced, the platinum will become

* Brit. Med. Journ., 1915, i., pp. 497–8.

white-hot and an explosion will result. The haemoglobin in the superficial layers of the medium becomes reduced as the oxygen is given up, and the surface is rendered suitable for anaerobic growth in a few minutes.

By this method the organisms of tetanus, botulismus, and malignant œdema grow with great freedom, and nearly the whole surface of the medium is covered with growth in forty-eight hours. Plating methods may be adapted by use of the Roux bottle, or similar contrivance, using larger pieces of platinum and plenty of hydrogen, as explosions in such bottles might be dangerous. When taking samples with a warm platinum loop several minutes should be allowed to elapse after opening the bottle, in order to avoid risk of explosion.

The method can be applied to broth. As the tube cannot be held upside-down, a very brisk stream of hydrogen is bubbled through the medium and the tube corked up as soon as possible after the capillary has been withdrawn. The method is rapid and simple in theory and practice, and is quite cheap, as the pieces of platinum can be used again and again. A tube or bottle can be inoculated, rendered anaerobic, and put in the incubator in a few minutes.

Method 2. *Colloidal Platinum.*—In this method, test-tubes which have been cut short are introduced upside-down into the lumen of somewhat larger tubes. These tubes are filled with broth to which a trace of methylene-blue has been added. The tubes are then plugged and sterilized; 2 c.cm. of platinum sol are added to each tube, the tube inoculated, and a stream of hydrogen passed through the upper layers of the medium by means of a fine capillary. The methylene-blue is gradually bleached, the colloidal platinum acting as a catalyst, and the hydrogen gradually destroying all the oxygen present in the medium. The capillary is then passed down to the bottom of the tube, and the inner tube filled with hydrogen. The capillary is then withdrawn, and the tube plugged and subsequently incubated. The hydrogen in the inner tube acts as a reducing agent which destroys oxygen from the surface of the medium. The method gives good results with the organisms of botulismus and malignant œdema, but with tetanus the growth is slow and poor.

Method 3. *Colloidal Platinum and Sodium Formate.*—An attempt to dispense with hydrogen was made by adding to broth excess of sodium formate and colloidal platinum, the idea being that the free oxygen would be used up in oxidizing the formate owing to the vigorous catalytic action of the colloidal platinum. In broth, however, some constituent interferes with the reaction. Bouillon made with Witte's pepton (Douglas) did not give good results, but broth made with a tryptic digest proved to be more suitable. To the latter medium was added a trace of methylene-blue, sodium formate up to 1 or 2 p.c., and, just before inoculating, 2 c.cm. of colloidal platinum, or platinum-black suspension. The tubes were plugged with cotton-wool, and the contained media thus given free access to the air. The tubes remained anaerobic for twenty-four or forty-eight hours. *B. Botulinus* grew extremely well and regularly, the bacillus or malignant œdema less regularly, while the *Bacillus tetani* either grew badly or not at all.

Although by Methods 2 and 3 the platinum used is not recovered, the weight of metal thrown away is extremely small and the cost is not great. The last two methods require further work to endeavour to get over the uncertainty and poor growth with the tetanus bacillus.

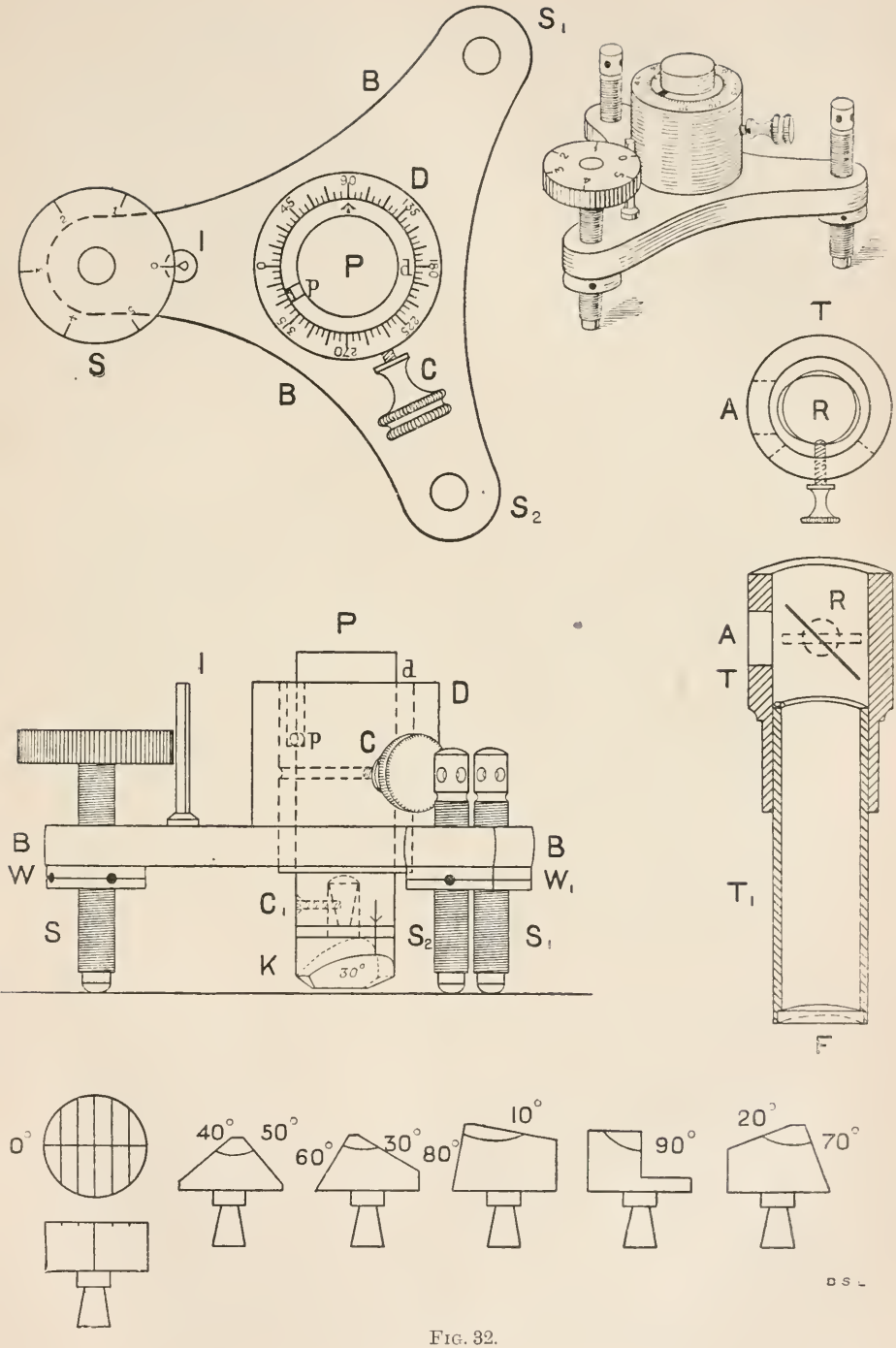
Studying the Mitotic Spindle in the Spermatocytes of Forficula auricularia.*—C. F. V. Meek preserved the material, obtained in July and August, in Flemming's strong chromo-aceto-osmic acid fluid. The testes remained in the fixative for twenty-four hours, and after washing in running water and passing through upgraded alcohol, were cleaned in xylol and embedded in paraffin. Sections were cut 8 μ thick with a Cambridge rocking microtome.

All sections were stained on the slide; the slides were placed for four to six hours in an aqueous solution of ferric alum, and were then stained for twelve to fifteen hours in Heidenhain's iron-hæmatoxylin. In certain cases they were first stained for ten minutes in eosin. The preparations were studied with an apochromatic oil-immersion objective of 2 mm. focus and N.A. 1·30 and compensating oculars. The light was obtained from an inverted incandescent gas-burner, and was passed through a Watson holoscopic oil-immersion substage condenser. The photo-micrographs were made with a Zeiss camera, the apochromatic objective mentioned above, and compensating ocular No. 4. The camera extension was 50 cm. in the case of photographs of individual cells, and 25 cm. in the case of photographs of cysts. The magnification was estimated with a stage micrometer graduated to read one-hundredth part of a millimetre.

(2) Preparing Objects.

Crystal-grinding Apparatus.†—This instrument (fig. 32) was designed by H. H. Thomas and W. C. Smith to facilitate the cutting and polishing of optically orientated parallel plates and prisms of mineral substances. It consists of a triangular metal plate B, traversed by three steel screws, one of which, S, carries a graduated head. The pitch of the graduated screw is such that one revolution imparts a tilt of half a degree to the axis of the instrument. This axis is occupied by a solid metal cylinder P, capable of vertical movement and of rotation within the graduated collar D. After rotation it may be clamped in any desired position by the screw C, but still retains its power to move vertically. The lower end of the cylinder is drilled to receive a series of chucks or crystal-holders which are bevelled off at angles different by 10° from each other, so that by the use of chucks and the graduated screw S a face at any desired angle from 0° to 90° may be cut and polished upon a crystal. For the cutting of parallel plates and other sections it is essential that the axis of the instrument should be first set accurately normal to the grinding surface; an optical method has been found most suitable for this purpose, and the usual levelling system has been dispensed with. A tube, carrying an optical flat F at its lower end and a vertical illuminator R at its upper end, is inserted down the

* Quart. Journ. Microscop. Sci. lxi. (1915), pp. 1–14 (2 pls.)
† J. Swift and Son's Catalogue (1914), pp. 26–7.


S1
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S2
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W1
C1
S
S2
S1
K
30°
R
A
T
T1
F
0°
40°
50°
60°
30°
80°
10°
90°
20°
70°

Fig. 32.

axis of the instrument in place of the solid cylinder P. If the apparatus stand on a blackened glass plate and the image of a signal be reflected down the tube, two images may be seen when the eye is placed over the vertical illuminator, one from the optical flat and the other from the blackened glass plate; by turning the screw S these images may be brought into coincidence, and it is found that this method of adjustment is sensitive to 2′ of arc. Plates may thus be cut the surfaces of which do not depart more than 2′ from parallelism. The principle underlying the application of the instrument is that a crystal suitably mounted on any of the holders may be rotated in two directions at right angles to each other, one of the axis of rotation being that of the cylinder P. By means of these two movements it is possible to bring any desired direction in the crystal normal to the grinding surface.

Investigating the Life-history of the Sporozoa of Spatangoids.* Helen L. M. Pixell-Goodrich obtained *Echinocardium cordatum* from Naples, Plymouth, and Port Erin. A little hole is made in each side of the test. The cœlomic fluid can then be poured out into a suitable vessel and examined with a binocular Microscope. Afterwards the inside of the test is carefully washed out with sea-water introduced by a pipette through one of the holes and the washing collected and examined in a similar way. The cysts containing early stages are generally free in the cavity and readily distinguished by their opacity. The cyst walls of those ripe with spores, where not covered with amœbocytes, are so translucent that the spherical mass of crystals shows up with great clearness in the interior. Nearly all the work was done on living parasites, though films and sections were also made. Hot corrosive sublimate and acetic acid mixture fixed the sporozoite nuclei of the ripe spore satisfactorily. In studying differences in the shapes of the tails it was found best to overstain with iron-hæmatoxylin or haematein, which are fairly readily taken up by the epispore, but readily lost again on differentiating with iron alum. Orange G and nigrosin also stain the epispore, but not very easily. Unless well stained the tails are practically invisible in Canada balsam. For rough comparison, Stephen's ink was found very convenient for staining the tails of fresh spores.

(4) Staining and Injecting.

Vital Staining of the Nucleus.†—A. M. Przesmycky used neutral red for staining intra vitam the nuclei of protozoa and metazoa. The nucleus behaved differently. It might stain uniformly; the staining might be irregular, some parts being dark, others light. In a third class, the staining clearly differentiated between the chromatin and the achromatin. It was noticed that all the organisms which stained well during life decolorized directly they died. The results were, that the stained and living nucleus was able to divide, and that after death it decolorized though it remained in the staining fluid. The different substances in the living nucleus stain quite distinctly, e.g. chromatin and achromatin. The living nucleus has a greater affinity for neutral red than the protoplasm, as it stains more strongly and decolorizes more slowly.

* Quart. Journ. Microscop. Sci. lxi., 1915, pp. 81–104 (1 pl.)
† C.R. Soc. Biol. lxxviii. (1915), pp. 83–6.

Metallography, etc.

Alloys of Copper and Zinc.*—L. Guillet reviews recent progress in the knowledge of the copper-zinc alloys, and gives the results of his own investigations upon fifteen alloys in the range 0 to 44 p.c. zinc. The influence upon microstructure, of hot-rolling, of cold-rolling, of annealing, and of quenching from various temperatures, is described.

Deformation of Copper at High Temperatures.†—A. K. Huntington gives results additional to those he has previously published upon the effect of temperatures higher than atmospheric on tensile tests of copper and its alloys. A number of photomicrographs of specimens strained at various temperatures illustrate the author's conclusions.

Coalescence in Steel and in Alloys.‡—A. M. Portevin and V. Bernard discuss the coalescence of constituents of alloys brought about by heat-treatment, and describe the microstructure of specimens of bronze and of steel which had undergone heat-treatments intended to induce the aggregation, into larger masses, of particular constituents. Two copper-tin alloys containing respectively 16 and 25 p.c. tin were heated in a salt-bath to 525° C., cooled (through the eutectoid temperature) in 5 hours to 475° C., rapidly reheated to 525° C., and again very slowly cooled. The δ constituent, originally finely divided, had coalesced into large masses. Steels of eutectoid composition slowly cooled from 800° C. consisted of lamellar pearlite; annealing for 30 hours at 700° C. caused the formation of very perfect granular pearlite, a photomicrograph of which, at 1200 diameters, shows globules of cementite embedded in ferrite. A steel containing 0·5 p.c. carbon, very slowly cooled from 800° to 700° C., and more rapidly below that temperature, contained no granular pearlite. Coalescence had begun in a specimen slowly cooled from 800° to 700° C., maintained at 700° C. for 10 hours and then air-cooled, while complete coalescence had occurred in a specimen annealed for 30 hours at 700° C. and air-cooled, the steel then consisting of free ferrite and granular pearlite. Re-solution of the cementite does not occur in granular pearlite immediately on passing the critical point on heating, but requires a certain duration of heating above the critical point.

Electrolytic Iron.§—L. Guillet deals with the manufacture, properties, and uses of very pure electrolytic iron, and describes its microstructure. On removal from the electrolyte bath the material is hard and brittle, and consists microscopically of innumerable fine needles, much resembling martensite. This structure does not disappear at 300° C., but it fades as the temperature rises, and disappears entirely

* Rev. Métallurgie, xi. (1914) pp. 1094–1132 (26 figs.).
† Journ. Inst. Metals, xii. (1914, 2) pp. 234–253 (20 figs.).
‡ Journ. Iron and Steel Inst., xc. (1914, 2) pp. 204–212 (17 figs.).
§ Journ. Iron and Steel Inst., xc. (1914, 2) pp. 66–81 (12 figs.).

at about 800° to 900° C. After annealing at 900° C. the structure is normal for pure iron, and the metal is soft and ductile. During the heating, hydrogen and smaller quantities of other gases are evolved.

Slag Inclusions in Steel.*—Specimens of acid steel and of basic steel were rapidly cooled from the liquid state, and microscopically examined by F. Giolitti and G. Tavanti. The same specimens were again examined after annealings followed by rapid cooling, and by slow cooling. The various treatments had no appreciable influence upon the form and distribution of the inclusions of reaction slag, and the authors conclude that such slag inclusions are not dissolved in the molten steel. The behaviour of reaction slag appears to be different from that of inclusions consisting mainly of sulphides of manganese and iron.

Mechanical Anisotropy of Metals.†—A. Portevin discusses the irregularity of form of the impression made by the ball in Brinell tests upon metallic specimens in which the crystals and the impression are of the same order of magnitude. Each crystal is anisotropic, and its mechanical properties are a function of direction relative to the crystal structure. When the area affected by the test contains a very large number of crystals, each independent in its orientation, as is commonly the case, the various crystals neutralize each other as regards their anisotropic properties, and approximately circular impressions are obtained. An impression wholly contained within one crystal tends to be square with rounded corners. The form of impressions covering a small number of adjacent crystals, of similar or different orientation, is described.

Some Metal Failures in Plant.‡—S. Evans describes a number of failures occurring in an engineering works, the causes of which were ascertained by microscopic examination of the faulty metal. A steel crosshead of a gas-engine, containing 0·37 p.c. carbon, was considered to have failed owing to its coarse structure, of the Widmanstätten type, which might have been removed by suitable heat-treatment.

* Ann. Chim. Appl. ii. (1914) pp. 360–366, through Journ. Soc. Chem. Ind. xxxiv. (1915), p. 179.

† Comptes Rendus, clx. (1915) pp. 344–6.

‡ Journ. Soc. Chem. Ind. xxxiv. (1915) pp. 204–207 (8 figs.).

MICROSCOPY.

A. Instruments, Accessories, etc.*

(1) Stands.

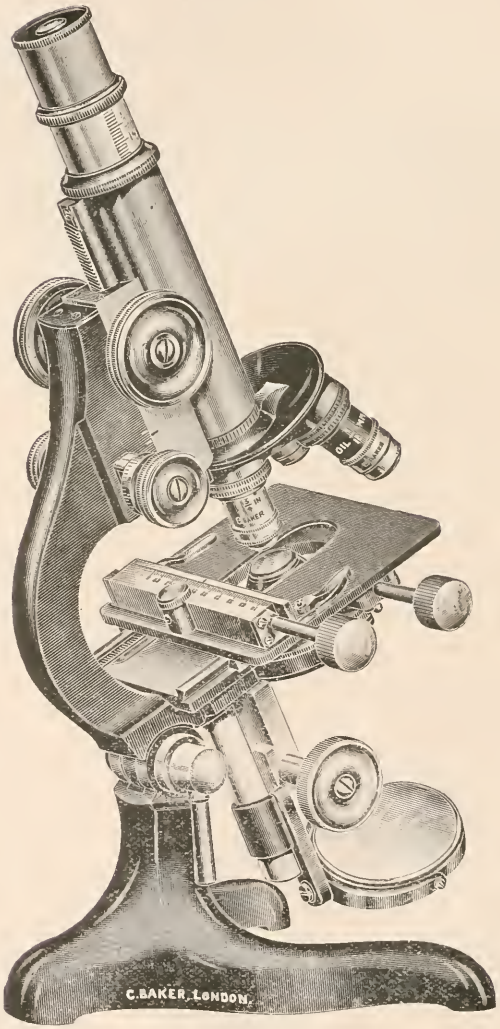

Fig. 49.

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

C. Baker's Stands D A and D.*—These stands (figs. 49 and 50) are copies of well-known Continental models; the former, however, has a

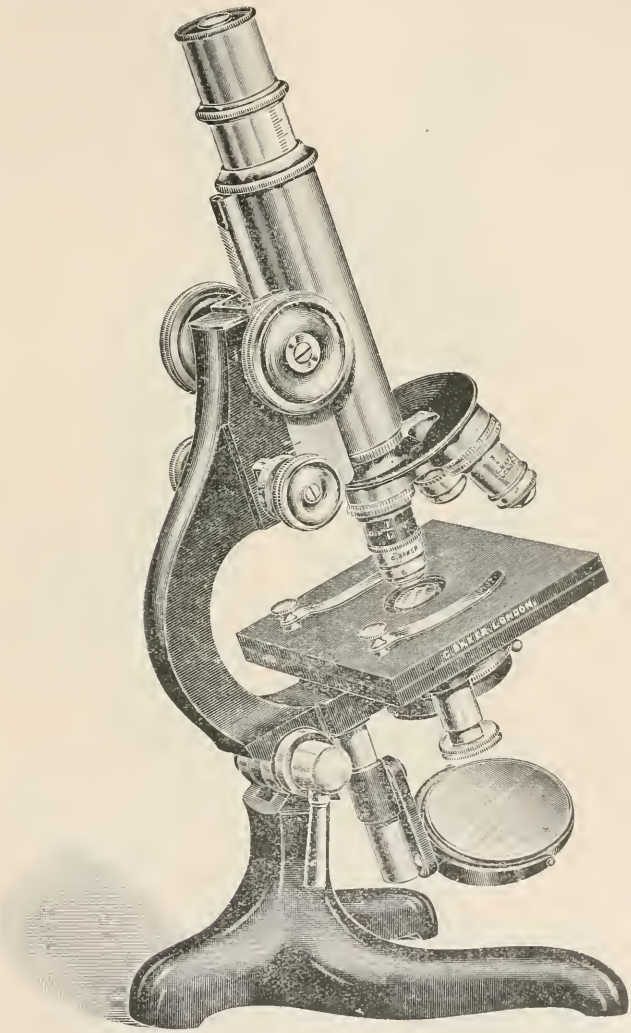

FIG. 50.

built-on mechanical stage, and centring screws to the substage can be provided if required.

* C. Baker's Catalogue, 1915, pp. 12–15.

C. Baker's D.P.H. No. 1a Microscope * (fig. 51) is designed for bacteriological and hæmatological work; it is provided with the usual spiral rack-work coarse-movement and micrometer-screw fine-adjust-

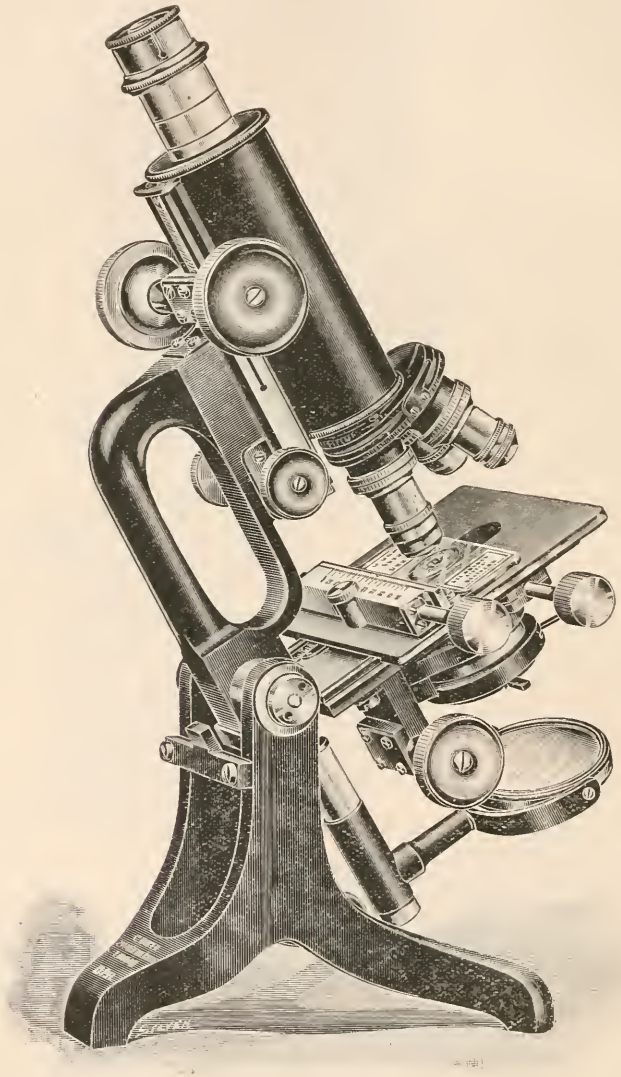

Fig. 51.

* C. Baker's Catalogue, 1915, pp. 10-11.

ment, with milled heads situated either side of the limb. The body is $1\frac{1}{2}$ in. diam., a most useful size when photomicrographs are being made

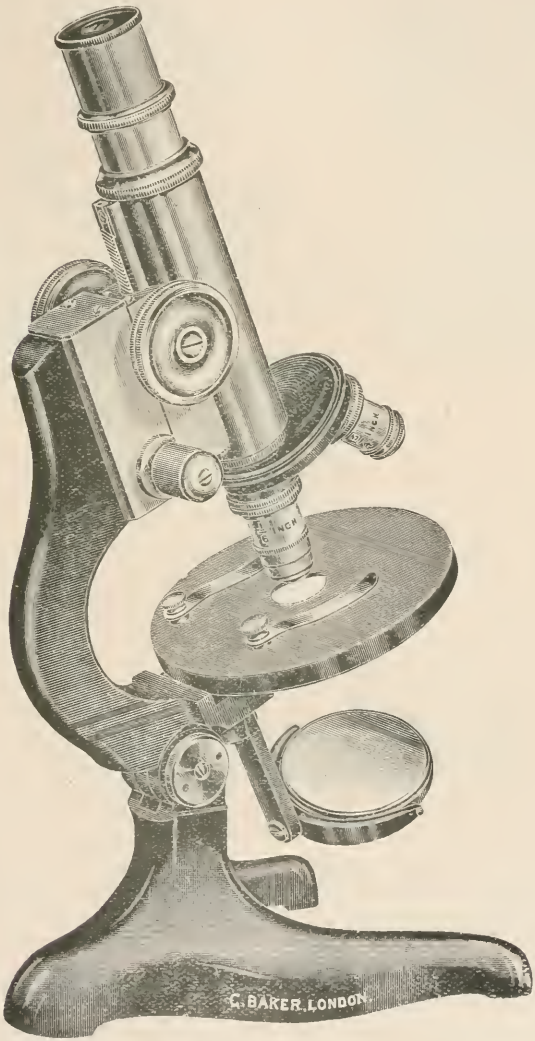

Fig. 52.

with a low-power objective without employing an eye-piece. The draw-tube is arranged to carry eye-pieces of the R.M.S. No. 1 size (23·2 mm.). A built-on mechanical stage, with movements of 30 mm. in a vertical

and 60 mm. in a horizontal direction, is fitted, also rack-work substage, and large plane and concave mirrors.

C. Baker's Student's Microscope * (fig. 52), also on the Continental design, can be provided with either a round or square stage, a sliding substage tube, or a screw-focusing substage capable of being turned aside when not required. This instrument has spiral, rack, coarse, and micrometer-screw fine-adjustments, and is mounted on a steady tripod foot; it is usually supplied with one eye-piece, two objectives, $\frac{2}{3}$ in. and $\frac{1}{6}$ in., and dust-proof double nose-piece. In case, with handle, lock, and key.

(3) Illuminating and other Apparatus.

C. Baker's Electric Lamp† (fig. 53) consists of an incandescent bulb, silvered on the outside except a small window, which is frosted; it is black enamelled, and the brilliant light obtained only proceeds from the

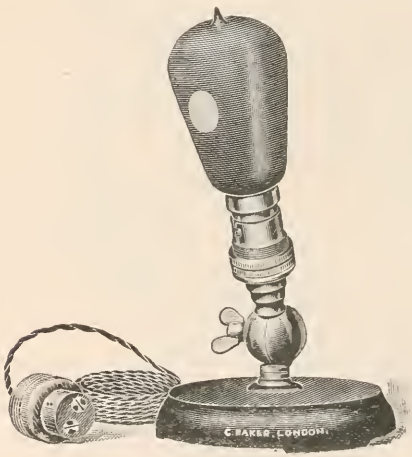

FIG. 53.

frosted window. This forms a very comfortable illuminant to work with, as no stray light affects the user's vision. It is mounted on a heavy stand, with adjustment for inclination.

C. Baker's Portable Battery Lamp ‡ (fig. 54) consists of a small 4-volt bulb in metal cover, with bull's-eye condenser mounted on arm with universal movements, and an upright on circular base, and a two-cell battery. This lamp will burn for twenty hours continuously, and can be readily re-charged without sending to an electrician, at a small cost of sixpence. The light is powerful enough to illuminate a $1\frac{1}{2}$-in.

* C. Baker's Catalogue, 1915, pp. 24–5.
† C. Baker's Catalogue, 1915, p. 52.
‡ C. Baker's Catalogue, 1915, p. 53.

oil-immersion objective, and is specially recommended for use in the tropics, or where the ordinary electric current is not available.

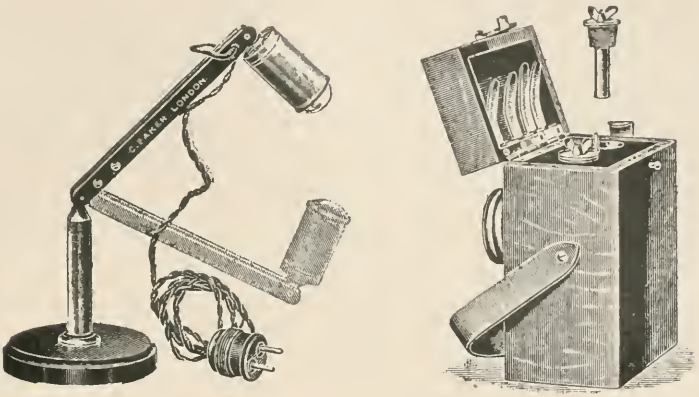

Fig. 54.

B. Technique.*

(1) Collecting Objects, including Culture Processes.

New Method of Sterilizing Bacterial Cultures.† — H. Stassano points out that in sterilizing a broth culture or an emulsion of a bacterium in physiological salt solution, the fluid is subjected to unequal heating, and that in order for the whole of the fluid to attain the indicated lethal temperature the heating must be unnecessarily prolonged. The length of time to ensure sterilization at the given temperature will depend upon (1) the volume of fluid to be sterilized, and (2) the concentration of organisms in suspension. The author has devised a rapid method of sterilization in which the culture or the emulsion traverses, under the constant and regular pressure of an inert gas (e.g. nitrogen), an extremely narrow rectangular cell, formed by the approximation of two flat bronze plates, which are separated by a frame of Japanese paper $\frac{1}{100}$ mm. in thickness, the frame and opposed plates being held together by screws. The apparatus is immersed in a double-boiler at the required temperature, and the fluid, the sterilization of which is desired, is slowly forced through the cell by the pressure of the inert gas. By this means a constantly changing film of the liquid, $\frac{1}{100}$ mm. in thickness, is brought into contact with the bronze plates, which remain constantly at the required temperature.

This method of sterilization is particularly recommended in the preparation of vaccines, as the least amount of injury to the contained antigen, consistent with sterilization, is claimed to be obtained. The

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Embedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, etc.; (6) Miscellaneous.

† Comptes Rendus, clx. (1915) pp. 820–2.

method is also of use in the sterilization or pasteurization of different organic liquids (e.g. milk), as no appreciable modification in their characters and constituents is brought about.

Thyroid and Supra-renal Glands as Bacterial Culture Media.* C. J. Parhon and E. Savini have attempted to grow various organisms, *Bacillus anthracis*, *B. tuberculosis*, etc., on sterile thyroid gland substance. The organ is cut in half-cylindrical pieces, which are placed in the kind of test-tubes that are used for potato cultures. In growing the tubercle bacillus it is necessary to impregnate the piece of tissue for some hours with glycerinated (6 p.c.) physiological salt solution.

On thyroid medium the anthrax bacillus grows quickly, but does not form tangled filaments, as upon ordinary media. It shows a manifest tendency to isolated growth, such growth appearing in L-, V-, U-, or O-shaped forms. The medium has a pronounced bactericidal action, numbers of the bacilli soon dying off, the number of survivors being extremely reduced. Sporulation is delayed.

The tubercle bacillus (human, bovine, or avian) cannot grow on glycerinated thyroid gland, even after a stay of three or four weeks in the incubator. The conclusion is arrived at that the thyroid gland exerts an obvious action on the growth and vitality of the anthrax and tubercle bacillus, and plays an important part in the complex mechanism of immunity.

Anthrax also grows well on supra-renal gland tissue, giving a shining thick growth of a *café-au-lait* colour, which soon changes to chestnut. Sometimes the colour of the culture is grey-violet. The bacilli exhibit marked pleomorphism on this medium, and many dead individuals can be discerned. The tubercle bacillus grows slowly and with difficulty on glycerinated supra-renal gland. After several weeks a scanty growth appears, the best development being with the avian type of the bacillus. Microscopically, the bacilli are much altered, the interior of the organisms containing one or many strongly-staining granules, which sometimes show a bi-polar arrangement.

(4) Staining and Injecting.

Vital-staining with the Free Base of Neutral Red.†—A. M. Przesmycki has employed the free base of neutral red in the vital-staining of the nucleus of certain Infusorian parasites, such as *Opalina ranarum*, *Balantidium entozoon*, and *Nyctotherus cordiformis*, and finds that this stain is much more rapid in its action than neutral red itself. The free base is prepared as follows: to an aqueous solution of neutral red (monochlorhydrate) is added ammonium hydrate until the commencement of the formation of an orange-yellow flocculent precipitate. The chloride of ammonia and ammonia in excess are eliminated by filtration and washing in distilled water. The free base is left behind on the filter-paper in orange-yellow crystals, which are then dried at 80–100° C. On drying, the crystals assume a deeper colour, which is described as being between orange-red and blood-red.

* C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 161–3 and 163–5.
† C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 169–71.

Metallography, etc.

Structure of Electrolytically-deposited Copper.*—A. Sieverts and W. Wippelmann describe the microstructure of copper deposited on iron cathodes, in sheets 0·1–0·3 mm. thick, under different conditions of concentration, acidity, and current density. The deposited sheets, which usually separated readily from the cathode, were clamped between pieces of pure copper, sawn through, and deeply etched on the transverse section, without polishing. A finely-crystalline deposit is first obtained from an acid solution of copper-sulphate. V-shaped crystallites then grow outwards; their size at first diminishes with increasing current density, but increases after a certain limit is exceeded. Deposits obtained from neutral sulphate solutions contain cuprous-oxide particles enclosed between the crystallites. Deposits from alkaline solutions of complex copper salts adhere firmly to the cathode, and are apparently structureless.

Critical Point at 460° C. in Zinc-copper Alloys.†—O. F. Hudson has made a number of experiments to determine whether the thermal change occurring at 460° C. in copper-zinc alloys containing 63 to 40 p.c. of copper is, as Carpenter holds, a eutectoid inversion of β into $\alpha + \gamma$, or is a polymorphic change of β into β_1. The effects of long annealings (for periods up to eleven weeks) at temperatures below the critical point, were that (1) in alloys slightly on the α side of pure β a very decided increase in the amount of α was observed, after a few hours' annealing: subsequently no further increase in the amount of α was noted; (2) pure β showed no sign whatever of breaking down; (3) in alloys slightly on the γ side of pure β there appeared to be a small increase, which soon ceased, in the amount of γ. An inhomogeneous alloy was made by pouring a molten alloy (γ), containing 40 p.c. copper and 60 p.c. zinc, on to copper which had just solidified in a crucible. When cold, the specimen was cut through, and was found to consist of copper at the bottom and γ at the top, with layers of intermediate composition between. The layer of pure β, with some $\beta + \gamma$ on one side, and some $\alpha + \beta$ on the other side, was cut out and annealed at 435° C. The β layer gradually grew at the expense of the α and γ, and in thirty-two days increased in width from 0·05–0·075 in. During this experiment recrystallization of the β, by the division of large crystals and the subsequent growth of the small ones formed, was observed. A small piece of copper was immersed in molten zinc at a temperature below 450° C. for thirty-six hours. The whole was allowed to cool, and a section was cut and examined. The copper core was surrounded by a layer of yellow alloy, which in turn was surrounded by a layer of γ. It appeared that the yellow alloy, which was sharply separated from the copper, was β. To test this, the experiment was re-

* Zeitschr. Anorg. Chem., xci. (1915) pp. 1–45.
† Journ. Inst. Metals, xii. (1914, 2) pp. 89–110 (27 figs.).

peated, using α-brass (70–30) in zinc, instead of copper in zinc. After fifty-six hours' annealing, at a temperature not exceeding 450° C., a layer of β was found to have been formed between and sharply divided from the α and γ. Further repetitions of the experiment, using annealing temperatures from 400° C. upwards, gave a layer of β in every case.

The failure to obtain any evidence of the breaking down of β into α and γ, and the clear proofs that stable β (or β_1) may be formed from copper and zinc or from other phases, at temperatures well below the critical point at 460° C., demonstrate that the 460° C. change is not a eutectoid point, but is a polymorphic change occurring in the β-phase, and that β_1 is a stable phase below 460° C.

Bismuth-cadmium Alloys.*— G. J. Petrenko and A. S. Fedorow find that bismuth and cadmium form a simple eutectiferous series of alloys, the solid solubility of bismuth in cadmium, and of cadmium in bismuth, being very slight, probably less than 0·1 p.c. The microscopic examination of the alloys at each end of the series may give misleading results, owing to the effects of segregation. The eutectic segregates to the upper part of the ingot in the bismuth-rich alloys, and to the lower part in the cadmium-rich alloys ; in each case regions free from eutectic may be found, consisting of homogeneous crystals, which may be mistaken for homogeneous solid solutions.

Bismuth-arsenic Alloys.†—W. Heike describes the microstructure of alloys containing 5 to 80 p.c. arsenic. Bismuth and arsenic are mutually miscible in the liquid state. Arsenic separates primarily on cooling, and approximately pure bismuth crystallizes last. The sections were etched with dilute copper-ammonium-chloride solution, which coloured the bismuth a reddish brown, the arsenic remaining bright.

Manganese-carbon, Nickel-carbon, Iron-carbon, and Cobalt-carbon Systems.‡—O. Ruff, W. Bormann, and F. Keilig have studied the equilibrium diagrams of these binary systems at temperatures up to 2700° C., and incidentally describe the structure of some of the alloys obtained. The cobalt-carbon alloys, containing up to 11·5 p.c. carbon, showed graphite lamellæ embedded in cobalt. The cobalt-carbide, stable at high temperatures, decomposed into cobalt and graphite on cooling.

Malleable Castings.§ – W. H. Hatfield discusses the modifications in structure brought about by the annealing process in the manufacture of malleable cast iron, and describes the microstructure of foundry cast iron, Swedish white iron, and malleable cast iron made by the Reamur and by the black-heart processes.

Reduced Metals in Crystallized Form.‖—J. H. Bowman describes a method of reducing metals in crystallized form on glass slips as per-

* Int. Zeitschr. Metallog., vi. (1914) pp. 212–16 (1 fig.).
† Int. Zeitschr. Metallog., vi. (1914) pp. 209–11 (3 figs.).
‡ Zeitschr. Anorg. Chem., lxxxviii. (1914) pp. 365–423 (13 figs.).
§ Foundry Trade Journal, xvii. (1915) pp. 248–52 (7 figs.).
‖ Journ. Amer. Chem. Soc., xxxvii. (1915) pp. 1468–71 (6 figs.).

manent Microscope mounts. The process is applicable to such metals as are reducible from solution by some other metal. For the preparation of silver crystals, a small drop of a mixture of equal parts of a 10 p.c. solution of silver nitrate, and a concentrated solution of zinc nitrate, is placed on a glass slip and spread into a thin film. A piece of zinc is filed in such manner that the filings fall thinly over the moist surface. Reduction begins at once, and each zinc particle becomes a centre of crystallization of silver. The preparation is kept in a moist atmosphere until crystallization is complete, then allowed to become nearly dry in the air, coated with balsam in xylol, dried in a dust-free atmosphere, and covered in the usual way. With variations in manipulation, the general process may be used for gold, copper, lead, bismuth, tin, cadmium, and antimony.

Photomicrographs indicate the appearance of the radiating, fern-like crystals produced.

Artificial Sillimanite.* — W. Eitel has examined, microscopically and otherwise, the slags obtained by the ignition of a mixture of iron-thermit and silica. Such slags, which are crystalline, not vitreous, consist essentially of silica and alumina, and contain crystals of the silicate of alumina, sillimanite, strongly resembling the natural mineral. The fibrous structure of the slag was due to the presence of long, very thin, fibre-shaped crystals of sillimanite, but other forms occurred also. Crystals of corundum were abundant in the slags.

Metal-microscopy with Polarized Light.†—H. Hanemann has introduced into the apparatus, previously described, modifications which greatly facilitate the observations. The examination of metallic surfaces by means of reflected polarized light yields information upon the optical properties of the various constituents. The examination of the constituents of numerous iron-carbon alloys indicated that ferrite and austenite were isotropic, martensite was feebly anisotropic, and cementite was anisotropic. Austenite and martensite were thus shown to be distinct phases.

* Zeitschr. Anorg. Chem., lxxxviii. (1914) pp. 173–84 (8 figs.).
† Zeitschr. Anorg. Chem., lxxxviii. (1914) pp. 265–8.

MICROSCOPY.

A. Instruments, Accessories, etc.*

(3) Illuminating and other Apparatus.

Chromoscopic Filter.†—This simple apparatus, J. Salkind says, presents transparent and colourless objects coloured on a white background. Ordinary microscopic observation of such objects (living cells, etc.) fatigues the eyesight in consequence of the necessity of detecting the minutest refractive differences, many a detail eluding notice in the uniform greyish-white of the preparation; moreover, the necessity of a high diaphragm power deprives the objective of the marginal rays so important for the resolution of fine structures.

The chromoscopic filter, intended to remedy these inconveniences, essentially consists of a glass or celluloid disk of dimensions suitable for its introduction into the Abbe apparatus. This disk is uniformly coloured and is centrally perforated by a circular aperture. Theoretically, observation with the chromoscopic filter holds the mean between vision by transmitted light and that with the ultramicroscope. Thanks to the filter, the most oblique rays of the condenser are coloured rays; they are reflected and refracted by the object and penetrate the objective. At the same time the background of the preparation is colourless, for the centre of the mount—optically homogeneous and of minimum refraction—transmits to the objective only the white rays of the central bundle. Moreover, according to the specific refractive index of the different parts constituting the object, these parts appear either coloured or white.

It being granted that the conditions necessary for the realization of the chromoscope vary with—(1) the numerical aperture of the objective; (2) the refractive index of the immersion medium placed between a given condenser and an object-slide of given thickness; (3) with the refractive index of the object and of its mount-medium—it would seem that the observer should possess a large number of filters with central apertures of varying diameters (or a transparent and coloured iris-diaphragm). But in practice, if a condenser of numerical aperture 1·40 be used, with cedar-oil as the immersion liquid, it will suffice to have a single filter with central aperture of about 5 mm. diameter (the aperture varying a few millimetres according to the colour intensity of a given disk). Correction is performed by means of two star diaphragms superposable on the filter; the first, with a dull centre, serves to diminish the brightness of the background, thereby intensifying the colour of the

* This subdivision contains (1) Stands: (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† Soc. de Biologie, lxxviii. (1915) pp. 382–3.

object; the second, with a black ring, intercepts the rays of medium obliquity, which cause a coloured veil in strong objectives and in immersions. It is possible also to use a star diaphragm with a centre tinted complementarily to the filter, the result being double colorations. The other conditions for producing chromoscopic images are: (1) use of daylight or of a light-source of large extent; (2) use, by preference, of a condenser of large aperture, and, in all cases, joining the object-slide to the condenser by a drop of liquid.

As illumination by the short waves affords the maximum of resolution, it is advantageous to employ the violet filter for direct observation: the red, inactinic, chromoscopic filter is favourable for photography. To appreciate the services which chromoscopy can render, the author recommends the observer to try the effect on fresh blood (leucocytes with their nuclei coloured in contrast with the red corpuscles), infusoria, and vegetable sections.

Adaptable Eye-shade for Microscopic Use.*—S. G. Shattock draws attention to the advantage which is derived from cutting off the access

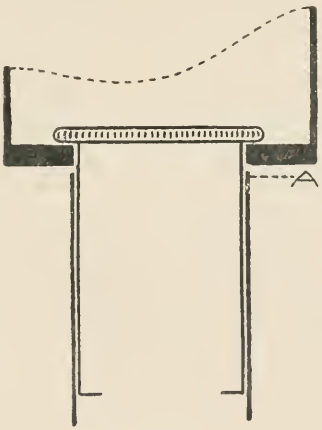

Fig. 65.

of direct light to the eye above the ocular. In working in a darkened room with a hooded lamp this drawback does not of course arise. But when daylight is used the admission of light to the eye above the ocular is a distinct hindrance to the study of fine detail. The difference can be at once brought home by temporarily shading the eye with the hand so as to improvise a dark chamber above the ocular. The ability to see more minute details with an eye-shade and a consciousness of diminished strain will become so apparent, that once used, it is certain the device will be afterward invariably resorted to for any prolonged microscopic study. Mansell J. Swift, who makes the device, told the inventor that binocular Microscopes were occasionally fitted with shades, but these (as in the

* Brit. Med. Journ., ii. (1915) p. 504 (1 fig.).

case of field-glasses), were fixed adjuncts. As the use of binoculars for histological purposes became obsolete, the advantage of the shade appears to have been lost sight of.

The drawtube of all Microscopes at the present time is made of a standard inside diameter known as No. 1, namely 23·3 mm., and this is the size adopted for the aperture in the floor of the shade through which the ocular drops; but the aperture is made also of a larger size to correspond with Standard No. 2, namely 26 mm., and it can of course be cut so as to take an ocular of any other dimension. It is hardly necessary to add that the shade can be used for either eye by rotating it so that the higher part corresponds with the outer receding margin of the orbit. The diagrammatic section, fig. 65 (natural size), shows the shade in situ, as kept in position between the flat upper edge of the draw-tube A and the rim at the top of the ocular. The form of the upper opening of the shade is indicated by the dotted line.

(6) Miscellaneous.

Microscopical Characters of Volcanic Tuffs: a Study for Students.*—L. V. Pirsson aims at the systematic treatment of the characteristics of tuffs, which he classifies into (1) vitric, (2) crystal, and (3) lithic tuffs. The subject is microscopically treated with the view of elucidating the type features. But it must not be supposed that all tuffs will clearly fall into one or other of these three classes. While many will doubtless do so, the majority of these rocks will be found to be intermediate in character; for all gradations between the three will be found in nature, with the exception that tuffs composed of glass dust with stony ash particles, but devoid of individual mineral crystals, must be extremely rare, if indeed they occur. The most common kinds are those containing in variable proportions all three ingredients. Tuffs may also be fresh, altered, or metamorphosed, and the author deals further with his subject from this point of view.

B. Technique.†

(1) Collecting Objects, including Culture Processes.

Bacterial Test for Plant Food Accessories (Auximones).‡—W. B. Bottomley has elaborated a bacterial test for plant food accessories ("auximones"). These auximones are obtained from an alcoholic extract of bacterized peat, the fractions of such extracts obtained by means of phosphotungstic acid and by silver and baryta giving good results with wheat plants. Cultures were obtained by placing 10 grm. of garden soil in a flask containing 100 ccm. tap-water, 0·1 grm. $(NH_4)_2SO_4$, 0·1 grm., K_2HPO_4, and 0·2 grm., $MgCO_3$ (Winogradsky's

* Amer. Journ. Sci., xl. (Aug. 1915) pp. 191–211 (6 figs.).

† This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Embedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, etc.; (6) Miscellaneous.

‡ Proc. Roy. Soc., Series B, lxxxix. (1915) pp. 102–8.

medium) and incubated for seven days at 26° C., at the end of which period the liquid showed a strong reaction for nitrates. The effect of the auximones was tried on subcultures from these growths. At the end of forty-eight hours all the flasks to which auximone had been added showed a thick scum on the surface of the liquid, and at the end of six days were found to contain no trace of nitrate, while in the control flasks, without auximones, no scum had developed and nitrification had proceeded normally. These scum organisms, which were present in the original soil cultures, showed two predominant types of organisms: a thin beaded form and a spindle-shaped form. It was found that the presence of both these forms was necessary for scum formation, as when either organism in pure culture was grown in nitrifying solution plus auximone, characteristic scum never developed. The best results were obtained from new loam from a virgin field, though loams, clay, and gravels also gave positive results. A stock for experimental purposes can be obtained by sterilizing soil, putting aside for a week, and then saturating with a suspension of scum-forming organisms. The stock is then allowed to dry down at room temperature under sterile conditions, and stored in a bottle. This stock can be depended on to yield a good growth of scum in from two to three days in the presence of auximones.

Methyl-violet as a Means of Differentiating the Coli-typhoid Group.*—A. Botez has elaborated a new technique, based on the reduction of methyl-violet as a means of differentiating members of the coli-typhoid group of organisms. A stock solution of methyl-violet (5B) is made up to the strength of 5 parts per 100, and 0·2 ccm. of this solution is added to each 10 ccm. tube of broth. In this medium *Bacillus typhosus* gives no change even after fifteen days, *B. paratyphosus A* gives partial change, the colour of the medium becoming pale violet, while *B. paratyphus B* and *B. coli* destroy the colour completely in forty-eight hours; the original colour of the broth re-appearing. Similar results are obtained on agar plates if methyl-violet in the same proportions is added to the agar before pouring the plates. The reduction of methyl-violet by certain organisms, and the non-reduction by others, is said to be a new distinctive characteristic, the reduction processes involved being as yet uninvestigated.

Method of Collecting Diatoms from Surface of Mud.†—O. Kendall states that the following method will be found to be of great help in gathering material free from excess of sand and foreign particles, especially on the shores of tide-water. The method requires that the surface of the mud be uncovered by the tide. The spot for working is found by the presence of a brownish coloured film, generally in streaks or patches, on the sand surface. It has been found that by removing the film of diatoms with a spoon large quantities of sand and mud are taken up at the same time, making its removal difficult in the cleansing process.

* C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 489–90.
† Trans. Amer. Micr. Soc., xxxiv. (1915) pp. 53–4.

The collector is to provide himself with several squares of well-washed cotton cloth, about the size of a handkerchief, and be at the ground at low tide. Take a square of cloth and carefully lay it down on the mud surface in a way not to include air-bells. The cloth will in a few moments become wet, and may then be raised by one corner first and folded up with the side that was next the mud on the inside. After folding wrap in waxed paper and label for future reference. When ready to clean, place the cloth in a porcelain evaporating dish, and cover with strong sulphuric acid and enough bichromate of soda to make the mass a deep reddish colour. Place the dish in a sand-bath over a gas-stove or other source of heat, boil the mass till crystals of chromic acid appear as scum on the surface of the liquid. Remove and let cool, and pour into a preserve-jar partly filled with water. Let settle for at least half an hour undisturbed, then siphon off the water with a rubber tube to within 1 in. of the bottom of the jar, being careful not to disturb the sediment. Repeat the washing till clear from all colour. The sediment may now be removed to a small bottle and examined, and if a small quantity of sand be present it may be removed by whirling it with some water in the evaporation dish by means of a glass rod, and the sand will be found to pile up in the centre as a dark spot. Carefully pour off the water with the diatoms suspended in it, leaving the sand in the dish. It is surprising how the diatoms will stick to the cloth, and how little foreign matter will be collected by this method.

Useful Medium for the Bacteriological Examination of Fæces.* C. G. Delta recommends the following medium. To 100 c.cm. of 3 p.c. agar, slightly alkalin to litmus, are added (1) $1\frac{1}{2}$ grm. of lactose, or any sugar, dissolved in 4 c.cm. of distilled boiling water, and further boiled half a minute; (2) 10 c.cm. of $\frac{1}{2}$ p.c. aqueous solution of acid fuchsin, brought to boiling point and discolourized by adding four drops of a normal solution of sodium carbonate, and by boiling again until it assumes a port-wine colour. The agar thus prepared presents all the advantages and disadvantages of Endo's medium, but also has its own special advantages, namely, it is very easily prepared from staple solutions and is not affected by light. Furthermore (should one wish to make this medium more differentiating), there may be added nutrose or caffein, or malachite green or crystal violet (10 drops of 1 p.c. in 1000 solution). In the last two combinations the background is green or blue, and the *Bacillus coli* colonies are violet or red.

New Medium for the Culture of the Meningococcus.†—G. Faroy and Chavaillon recommend the following medium for the cultivation of the meningococcus, as a substitute for the usual ascitic agar medium. It is easily prepared, and, provided a stock of agar is kept on hand, is eminently suitable for travelling or field laboratories. 100 c.cm. of sterile horse serum is poured into a sterile flask containing glass beads, and to this 20 c.cm. of white of egg are added. (The large extremities of the eggs are sterilized in the flame and pierced with a sterile forceps, the

* Lancet (1915) ii. p. 1053.
† C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 455–6.

egg-white being drawn up into a sterile Pasteur pipette.) The resulting mixture is then shaken vigorously for five or ten minutes, until the liquid is homogeneous and free from lumps of albumin. One then prepares a sufficient quantity of 2·5 p.c. neutral agar, to which 0·2 c.cm. of a solution of caustic soda (10 parts per 100) has been added per litre. One part of the serum-egg mixture is then added to three parts of the agar mixture (heated to 100° C. and then cooled to 50° C.), the resulting medium being then sloped in the usual way.

The new medium has given excellent results in the author's hands, both with cerebro-spinal fluid and with naso-pharyngeal exudates containing the meningococcus.

(2) Preparing Objects.

Preparation of Crystals.* — R. Pettigrew gives the following method of preparing crystals referred to in "Melting Crystals," which appeared in vol. ii. of the "Micrologist."

Camphor monobromide crystals are added to natural Canada balsam, the mixture being gently heated in a test-tube, and crystals added successively until, on cooling, the mass solidifies ; about three times as much of the camphor as of balsam will be found necessary. When required for preparing slides, melt the mass by gently warming over a spirit-lamp, take a drop out with a warm glass rod, put a drop about a quarter of an inch on a warm slip, and cover and press down with a warm cover-glass. When cool scrape away the excess and ring with gold-size. When warmed to about 70° C.—by holding a lighted match underneath the reversed slide—the material will melt and, on cooling, gradually crystallize. If the match used for heating be held so that all but just a little at one edge is melted, the growth of crystals will start from the unmelted portion more quickly than if all be melted. By arranging the amount of camphor monobromide, the time of growth may be shortened or lengthened at will, but, generally, best results are obtained from a very thin layer, and which takes about one minute to start growth. If some tiny air-bubbles be left in on mounting, they are of value, as the growth, on touching the air-bubble, will go off with a rush, pushing the air-bubble in front of it in a zig-zag line. It is not necessary to make different tubes of material. If quick growth be required, choose a medium growing sample, and add some crystals of monobromide to a drop on a slide ; if a slow growing sample, a little balsam.

Preparation of Chick Embryos.†—A. Flatters gives the following method of preparing, staining, and mounting chick embryos. The eggs are taken out of the incubator one at a time, the pointed ends cracked, and the shell picked off sufficiently to allow a clear view of the embryo. The bottom half of the shell, containing the embryo, is now placed in a dish of water kept at 105° Fahr., and allowed to rest on the bottom of the dish, the broken edge of shell and exposed embryo standing above the water line. The tissues of attachment are now severed and the

* Micrologist, iii. (1915) p. 22.
† Micrologist, iii. (1915) pp. 17–21.

embryos are removed from this solution and are transferred to a solution of formalin in water. After thirty to forty-five minutes the embryo floated on to the water, and then transferred, by means of a broad lifter, to the killing and fixing solution, consisting of a 5 p.c. third dish, containing 25 p.c. alcohol; after another two hours they are graded through an ascending series of alcohols up to 92 p.c., in which they are allowed to remain. Formalin fixation is serviceable when the embryos are to be mounted whole, but where sections are required a more precise fixative solution should be employed, such as Fleming's fluid or picro-formo-acetic solution. The latter solution is formed by mixing standard aqueous solution of picric acid 75 parts, formalin 25 parts, and acetic acid 5 parts. After three hours the fixative is washed out with 25 p.c. alcohol, and graded up to 92 p.c. alcohol.

Staining and Mounting.—Mayer's formula for hæmacalcium gives specially good results, and prevents the danger of swelling which is enconntered with the use of hæmatoxylin in aqueous solution. Before staining, the specimens should be placed in 70 p.c. alcohol from fifteen to thirty minutes, to neutralize and prevent precipitation of the hæmatin. For staining entire embryos, 2 oz. of the stain is added to 6 oz. of 70 p.c. alcohol. The embryos are left in the stain for several hours, and, if necessary, the colour may be reduced by washing out with weak hydrochloric acid. The embryos are then left in 92 p.c. alcohol for two or three hours, then transferred to absolute alcohol for one hour, from which they are cleared in oil of terpineol, and mounted in benzol balsam.

For histological purposes special treatment of the embryos is necessary, i.e. infiltrating the specimens with paraffin, or permeating them with celloidine for sectionizing purposes. By the paraffin method the specimens fixed with picro-formo-acetic solution are dehydrated, and transferred successively to absolute alcohol and chloroform (six hours), chloroform (one hour), saturated solution of paraffin (130° Fahr.) in chloroform (three to six hours), and then to pure paraffin in a water-oven. After several changes of paraffin the specimens are moulded and cooled, and sections cut in the usual way. Sections may be stained with hæmacalcium. Xylol may be substituted for chloroform in the clearing process, cedar-wood oil being used between the alcohols and the xylol. Possibly terpineol might be used as a cheap substitute for the xylol.

The writer recommends the use of the celloidin method of embedding embryos, as the tissues are less liable to be injured than by the paraffin method. He only resorts to the latter method when it is impossible to obtain sufficiently thin sections without the aid of celloidin.

Collection and Preparation of Fresh-water Nematodes.*—Margaret V. Cobb collected fresh-water Nematodes by taking samples of the sand or mud and water of the pool or stream bottom and of the aquatic vegetation. These were washed through a series of graded sieves from coarse to fine which removed the coarser debris, until examination with a lens showed that Nematodes also were caught on the sieve. The collection was then allowed to settle for five minutes or more and the

* Trans. Amer. Micr. Soc., xxxiv. (1915) pp. 22–3.

superfluous water poured off. The Nematodes were killed and fixed by adding to this watery mud an equal quantity of boiling hot saturated solution of corrosive sublimate. For staining and mounting each sample was treated as follows : The sediment was examined, a little at a time, in a Syracuse watch-glass under a dissecting-lens ; the Nematodes were picked out one at a time with a bamboo splinter and placed in water in the object-box of a differentiator, in which they were gradually passed up through upgraded alcohols to 80 p.c. At this point they were treated with acid-alcohol to dissolve out impurities (10 drops concentrated HCl to 100 c.cm. 80 p.c. alcohol), and overstained with acid carmine according to following formula : Carmine 4 grm., H_2O 15 c.cm., HCl 30 drops. Add 95 c.cm. of 85 p.c. alcohol, boil until the carmine is dissolved, neutralize with ammonia until carmine begins to precipitate, filter through glass wool. For differentiation of the tissues acid-alcohol was used (4 drops concentrated HCl to 100 c.cm. 90 p.c. alcohol). The specimens still in the object-box were passed up to and through absolute alcohol and turpentine to thin balsam. This was done without removing the object-box from the differentiator except to remove it to another type of differentiator when the change to heavier fluids began. The object-box was now opened in thin balsam in a Syracuse watch-glass and the Nematodes mounted in balsam. From ten to 100, according to size, can be arranged in one drop of balsam without much crossing of specimens. This is also best done under magnification ; it is convenient to have two dissecting Microscopes, keeping the watch-glass of specimens under one and the slide which is being prepared under the other.

New Method of Examining Stools for Eggs.* — Vida Annette Latham reports that C. M. Fauntleroy and R. Hayden suggest the following method. 1. Mix thoroughly about 2 grms. of fæcal matter with 5 c.cm. of a 2 p.c. aqueous solution of lysol in a centrifuge tube. 2. Centrifuge at high speed for one minute, decant the supernatant fluid, and mix a fresh quantity of the lysol solution with the sediment in the tubes. Repeat this step three times. 3. Remove small portions of the centrifuged deposit with a pipette, place on slide, mix a small drop of anilin-gentian violet with the sediment, cover and examine. All eggs, hookworms, etc., stand out very clearly. Everything is stained except the eggs.

(5) Mounting, including Slides, Preservative Fluids, etc.

Euparal.†—Euparal, says H. L. Wieman, is a mounting medium composed of a mixture of camsal, sandarac, eucalyptol, and paraldehyde, and having a refractive index of 1·483.‡ It is put up in two forms, the colourless and the green, the latter containing a copper salt which intensifies hæmatoxylin stains. The colourless is preferable when stains other than hæmatoxylin are used. The primary advantage of this medium is that it spares delicate objects the usual treatment with absolute

* Trans. Amer. Micr. Soc., xxxiv. (1915) pp. 54–5.
† Trans. Amer. Micr. Soc., xxxiv. (1915) pp. 52–3.
‡ See also this Journal, 1907, p. 501.

alcohol, since objects may be mounted in it directly from 95 p.c. alcohol. It dries rapidly, so that preparations may be studied with safety at the end of twenty-four hours. Cover-slips may be removed from old preparations by immersion in 95 p.c. alcohol for several hours. Another useful property of euparal is its low index of refraction, which is well-adapted to cytological study, giving a much-desired increase of visibility to delicate elements. Another important feature is that it does not bleach the stain.

(6) Miscellaneous.

Development of Botanical Microtechnique.* — G. M. Smith describes the development of botanical microtechnique under the following captions. 1. The methods of the early microscopists (from the time of Hooke's discovery of the cell to 1800). 2. The technique of the English microscopists (1800–1875). 3. The methods of the German botanists (1800–1875). 4. The development of modern methods of microtechnique (1875 to the present). There is much useful information in the article which deserves the perusal of those interested in the historical aspects of microscopy. A copious bibliography is appended.

Metallography, etc.

Copper-tin Alloys.†—J. L. Haughton has studied the constitution of the copper-tin alloys in the range 55 to 65 p.c. tin, which is the range containing the ϵ constituent. The alloys were cast in a wedge-shaped mould made of thin sheet copper, surrounded by a freezing mixture. The very rapid solidification and cooling produced a fine structure which on subsequent annealing attained equilibrium in much less time than that required for alloys which had been cooled less rapidly. Specimens were annealed for 20 to 300 hours at 210°, 310°, and 390° C., quenched, and examined microscopically. At 59 p.c. tin the alloy annealed at 390° C. consisted of pure ϵ. With less tin η was also present, and with more tin the annealed alloy consisted of ϵ + eutectic. After annealing at 310° C. pure ϵ contained 59·5 p.c. tin. At 210° C. the composition of pure ϵ is between 59·8 and 61 p.c. tin. In all specimens containing any quantity of eutectic the ϵ was not coloured by the etching reagent used (ferric chloride in hydrochloric acid), while in the absence of the eutectic it etched dark, leaving the η as pale blue crystals. This formed a sensitive test for the presence of eutectic. Heating curves were taken. The author's conclusions are embodied in an equilibrium diagram for the range studied.

Microstructure of Base-metal Thermocouples.‡—O. L. Kowalke has microscopically examined transverse sections of thermocouple wires, annealed at various temperatures. Pure metals, or alloys consisting of

* Trans. Amer. Micr. Soc., xxxiv. (1915) pp. 71–129 (3 pls. and 12 text figs.).

† Journ. Inst. Metals., xiii. (1915, 1) pp. 222–48 (30 figs.).

‡ Trans. Amer. Electrochem. Soc., xxvi. (1914) pp. 199–214, through Science Abstracts, xviii. (1915) pp. 372–3.

one solid solution, were found to be the most constant in their thermo-electric behaviour.

Micro-chemistry of Corrosion : α-β Copper-zinc Alloys.*—S. Whyte has applied the methods previously described to an α-β alloy containing 60·8 p.c. copper and 39·2 p.c. zinc, to three alloys of similar composition but having 1 p.c. zinc replaced by 1 p.c. of iron, 1 p.c. of lead, and 1 p.c. of tin respectively, and to a pure α and a pure β alloy. Corrosion in sodium chloride solution was stimulated by an electric current, and the effects were determined by microscopical and chemical methods. β corroded more rapidly than α, and corrosion proceeded in all cases by dezincification. In alloys containing both α and β, the layer of copper formed was thicker over the β constituent than over α.

Appliances for Metallographic Research.† — W. Rosenhain describes a levelling device for metallographic specimens. A small, low-power telescope is rigidly fixed in a vertical position, with the eye-piece uppermost. A plane glass reflector, set at 45° to the axis, is fixed in the tube a little below the eye-piece. This reflects downwards the light admitted horizontally through a small hole in a plate at the end of a short side tube. A few inches below the objective a glass plate, silvered on its lower face, is adjusted accurately at right angles to the axis of the telescope, by bringing the image of the small hole on to the cross wires of the eye-piece. The specimen, mounted on a slip by means of plasticine, is placed on the glass plate and acts as the reflector ; its level is adjusted until the image of the small hole again falls on the cross wires. The polished face of the specimen is then parallel to the lower surface of the slip on which it is mounted. The adjustment can be made in a few seconds. Some appliances for use in taking thermal curves are also described.

Etching Reagents.‡— O. F. Hudson discusses etching reagents generally, and gives a detailed description of the action of all the reagents in common use, and of many which have been used for special purposes. In an etched surface of a pure metal the appearance of the crystal boundaries as black lines may be due in part to the more rapid solution of the metal at the boundaries. Etching usually produces some roughening of the surface of each crystal, and staining due to a film of oxide. When two or more constituents are present, they are commonly stained to a markedly different extent, and such differences are employed to distinguish the constituents. The amorphous surface film produced by the polishing of a specimen does not as a rule seriously interfere with the effects produced by etching, but its presence should not be overlooked.

Electrolytic etching, polish attack—a method which the author believes is not adopted as widely as it should be—and heat-tinting are described. A list of metals and alloys, with the etching reagents suitable for each, is given.

* Journ. Inst. Metals, xiii. (1915, 1) pp. 80–99 (11 figs.).
† Journ. Inst. Metals, xiii. (1915, 1) pp. 160–92 (13 figs.).
‡ Journ. Inst. Metals, xiii. (1915, 1) pp. 193–221 (2 figs.).

National Physical Laboratory.*—Metallographical research work has been carried out upon the constitution of the aluminium-zinc-copper alloys, the effects of strain at high temperatures, and the intercrystalline cohesion of metals. The new copper-depositing reagent for etching steel has been in constant use, and has given important results. An annealed steel, showing phosphoric banding when etched with the new reagent, was heated to 800° C. and quenched. It then consisted mainly of martensite-troostite, but certain regions consisting of ferrite were identified with the phosphoric bands of the original annealed steel. Their relatively high phosphorus-content had prevented the diffusion of iron carbide into the bands.

* National Physical Laboratory, Report for year 1914–15.