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

1913

TO BE OBTAINED AT THE SOCIETY'S ROOMS

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MICROSCOPY.

A. Instruments, Accessories, etc.*

(1) Stands.

John Cuthbert's Reflecting Microscope (1827–8): presented by the Committee of the Quekett Microscopical Club.—The earliest record of a "reflecting" Microscope, that is, one in which the image is formed by reflecting surfaces of speculum metal or mirrors, instead of by object-glasses, is one that was suggested by Isaac Newton to the Royal Society in 1672. It is based on his well-known reflecting telescope, and in the note to the Royal Society Newton wrote as follows: "For these instruments (Microscopes) seem as capable of improvement as Telescopes, and perhaps more, because but one reflective piece of metal is requisite in them."

The idea, however, was apparently not taken up, and there is no record that Newton ever had this Microscope constructed.

The next attempt at a reflecting Microscope was sixty-four years later. In 1736 Barker described his "Catoptric" Microscope in the Philosophical Transactions (xxxix. pp. 259–61), which was based on the Gregorian telescope with two mirrors. The design, however, was bad, because the small mirror is in the direct way of the object (see the figure in Mayall's Cantor Lectures, Society of Arts, 1886, p. 39). In 1738 Dr. Smith conceived and described a much more efficient reflecting Microscope, constructed after the Cassegrainian telescope, with a hole pierced through the centre of both mirrors.

After this date we hear nothing more of reflecting Microscopes for nearly a century, due no doubt to the greater convenience and improvements in the construction of the dioptric Microscopes by Culpeper, Benjamin Martin, Cuff, Adams, and Jones.

But early in the eighteenth century, when all the attempts at producing serviceable achromatic object-glasses had failed, Frauenhofer in Germany, Amici in Italy, and John Cuthbert in this country, took up again the subject of reflecting Microscopes in order to get rid of the troublesome spherical aberration, which at that time seemed to have stopped all further improvements.

Amici was most successful in his designs in this direction, and a beautiful specimen of his work is in the Society's collection.

John Cuthbert, acting upon Dr. Goring's advice, produced 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.

present instrument (fig. 5) in 1827, which was said to be very excellent and superior in workmanship and definition to those made by Amici.

In Cuthbert's reflecting Microscope the reflectors were supplied in separate tubes, ranging from 2 in. to $\frac{3}{10}$ in. focus, and are screwed on to the nose-piece like other object-glasses. For the illumination of opaque objects Lieberkuhns were supplied sprung on the tubes of the lower powers. The triangular stem or bar carrying the stage is clamped on the nose-piece at right angles to the optic axis, and has a rack, cut in the angle of the bar, which gives coarse movement to the stage for focusing. The stage carries a spring super-stage for holding object-sliders and the live-box, but has no mechanical movement. The

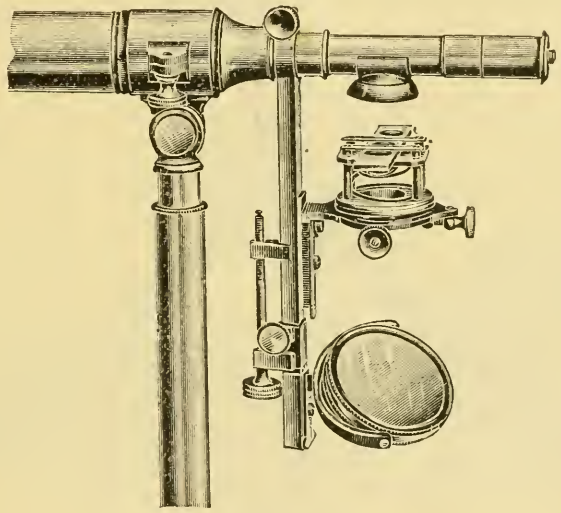


Fig. 5.

double mirror and also a plano-convex condensing lens slide on the triangular bar. A small bullseye, sprung on to the nose-piece for illuminating opaque objects, is also provided.

In another specimen in the Society's collection (fig. 6), the triangular stem has no rack, but there is a fine-adjustment screw, which, after being clamped on to the stem, moves the stage in the manner of Cuff's fine-adjustment ; the coarse-adjustment is effected by sliding the stage up and down the stem. The stage itself has mechanical movements in two directions. A jointed arm carrying a spring forceps is provided, which takes the place of the stage when in use.

The present instrument has three reflector-objectives, three eye-pieces, Lieberkühns and various other apparatus common to the Microscopes of the period.

From 1830 onwards, led by Charles Chevalier and Oberhaeuser in Paris, and followed by Andrew Ross, Hugh Powell, and James Smith in

this country, the rapid improvements made in the achromatic object-glass left the reflecting Microscopes out of the race, and they have long since entirely disappeared.

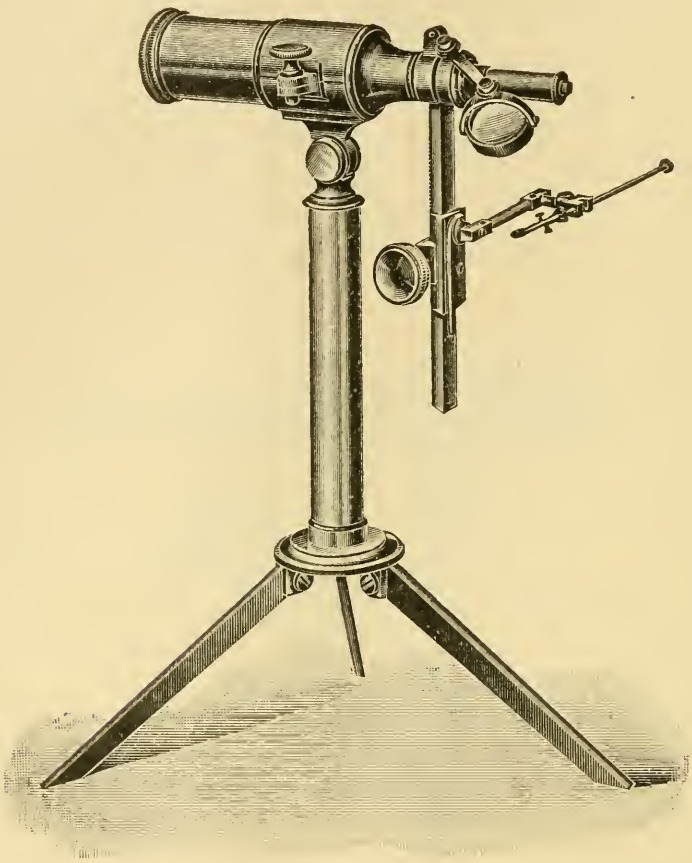


Fig. 6.

Old Microscope by Andrew Pritchard.—The old Microscope here figured (fig. 7) is signed Andrew Pritchard, 263 Strand, London, both on the tripod and on the body-tube. Pritchard, it is known, sold Microscopes made by Andrew Ross and Hugh Powell, who at that time (1830–45) worked for the trade. The present stand shows by details of its style and workmanship that it was probably made by Andrew Ross. It is similar to the two Microscopes figured and described in this Journal in 1902 (pp. 251–2) and 1906 (pp. 596–7), and yet is different in various particulars, showing it to be a somewhat earlier model of Pritchard's "Solid Tripod-stand Achromatic Microscope and Engiscope," as described by him in his Microscopic Illustrations of 1838 (p. 92).

The earliest form of this Microscope must have been made for Pritchard in or just before 1834, and is figured in the plate facing the title-page of the first edition of his Natural History of Animalcules, 1834. No description of the instrument is given, and only in one sentence (p. 23) he speaks of his Achromatic Engiscope "recently constructed." The present model shows several modifications and im-

provements, such as a clamp to the tubular pillar, a turret mechanical stage, and a curved arm to carry the body. The date to be assigned to it must therefore be between 1834 and 1838.

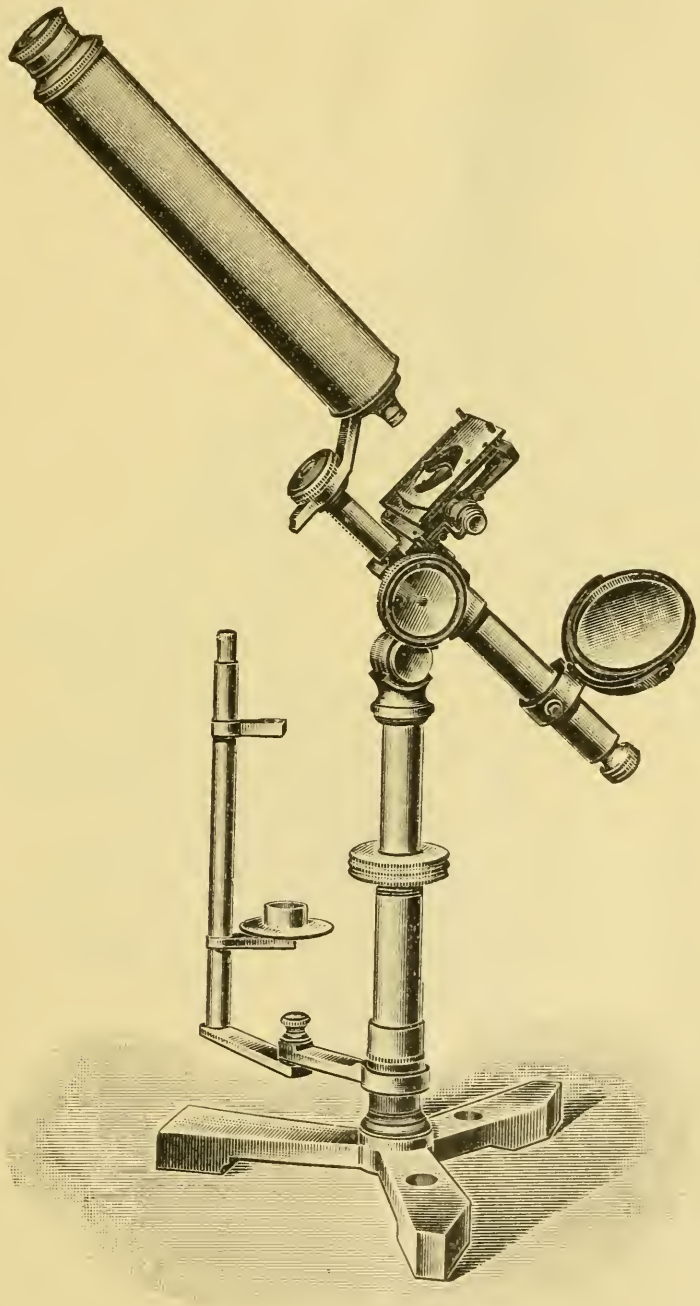


Fig. 7.

The massive, flat tripod foot, of peculiar shape, is surmounted by a tubular pillar holding an extension-rod, which can be clamped by a screw-ring ; the rod is surmounted by a compass joint, to which the

limb of the Microscope is fixed by means of a screw-clamp. The limb is round and hollow, and contains a triangular bar, upon the posterior edge of which the coarse-rack is cut; on the top of this bar a short curved arm is fixed by means of a screw, about which the arm can be rotated

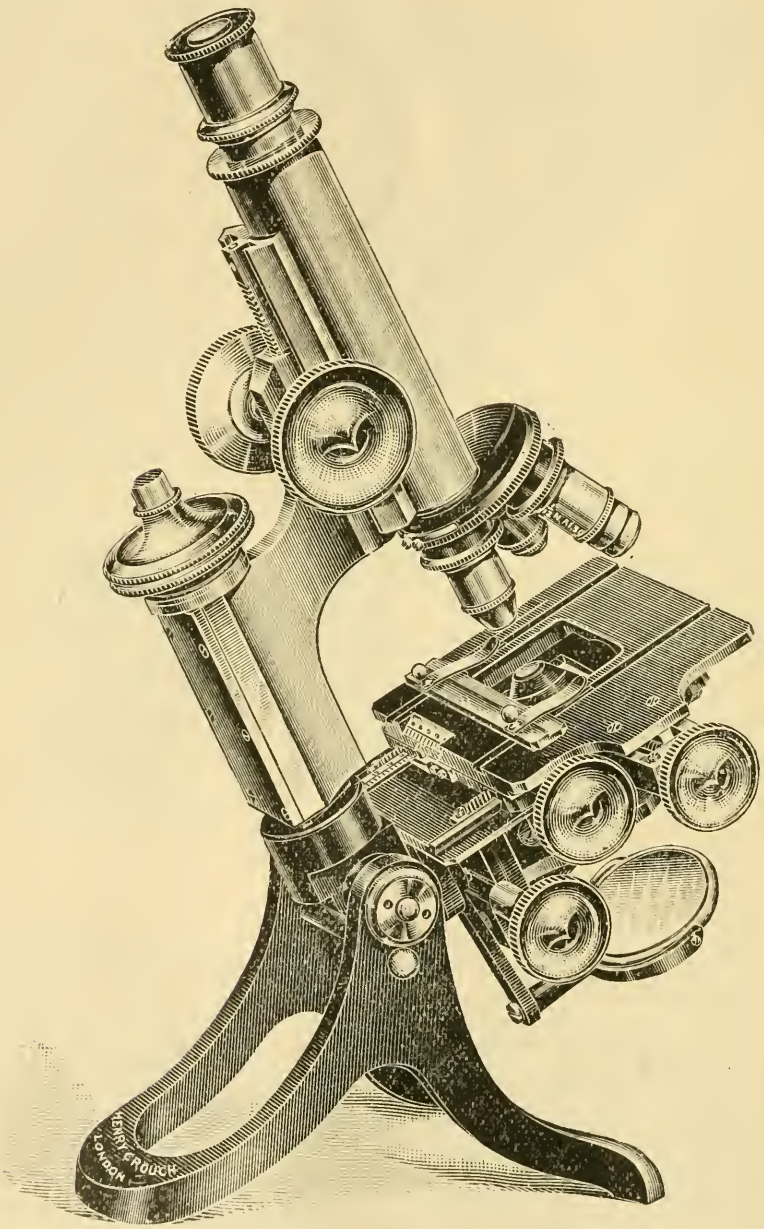


Fig. 8.

and screwed in any position. The body screws on to this arm; it is 8 in. long, and carries a Huyghenian eye-piece with two plano-convex lenses. A fine-adjustment is not provided (it is present in the later model of 1838). The limb carries the concave mirror and also a

mechanical stage of the Turrel pattern. The pillar of the Microscope also carries a jointed arm, which can be fixed at any height, with holder for a candle and stage-condenser. There are four objectives—single, non-achromatic bi-convex lenses. The name "Engiscope" was given by C. R. Goring to designate a "Compound Microscope," his intention being to retain the expressions "Microscope" or "Simple Microscope," to denominate what was then called a "Single Microscope." The suggestion was, however, not adopted, and the name was soon dropped.

This interesting old Microscope has been presented to the Society by A. F. G. Warrington, who discovered it in India, where it had evidently been for a great many years.

Crouch's "D.P.H." Microscope.*—This Microscope (fig. 8) has been constructed for research and other work of the highest class in Bacteriology. The coarse focusing adjustment is by diagonal rack-and-pinion, the bearings of which are much wider than ordinarily made and consequently much more solid and durable. The fine-adjustment is executed by the direct action of a left-handed micrometer screw, operated by a triangular bar and working on a polished hardened steel plate. The large stage has rectangular adjustments by means of a diagonal rack-and-pinion and quick screw, with a range in each direction of 25 mm., each adjustment having a graduated millimetre scale. The substage has a swing-out movement and is focused by means of a diagonal rack-and-pinion; but, by special request of several eminent bacteriologists, centring adjustments are not included.

This model is also made with a specially constructed stage and a larger body tube. It is then listed as the "Army Medical."

It can also be supplied with a horse-shoe foot. This adds 3 lb. to its weight. ("Tropical" Model.)

(3) Illuminating and other Apparatus.

Ultra-violet Monochrometer.†—C. Leiss describes the above apparatus, which has been made by the firm of Fuess to his designs. Its object is to obtain readily ultra-violet light of any required wave-length. The apparatus is shown in figs. 9 and 10. The dispersion system is a quartz double prism with constant deviation of 90°, as proposed by Straubel. The advantages of such a prism are that it is practically free from double refraction, and that every part of the light incident in the field of view of the fluorescing ocular is in the position of minimum deviation. Rotation of the system is attained by a screw, whose division drum is graduated according to wave-lengths corresponding to a range between 500 $\mu\mu$ and 200 $\mu\mu$.

In the figures, E is the entrance slit and A the exit slit; both are symmetrical. A tube L is connected with A and carries an adjustable projection lens O_3 which, as desired, either parallelizes the light or throws an image of the exit slit at double the focal distance on any required

* Catalogue, Crouch's Microscopes and Accessories, S. Maw, Son & Sons, London.

† Zeitschr. f. Instrumentenk., xxxii. (1912) pp. 292–4 (2 figs.).

object, e.g. on a spectrometer slit. The tube is engraved with the mark $\propto$ and 1 : 1 in order to denote the necessary positions of O_3. The quartz double prism can be removed from its compartment P_1 ; it

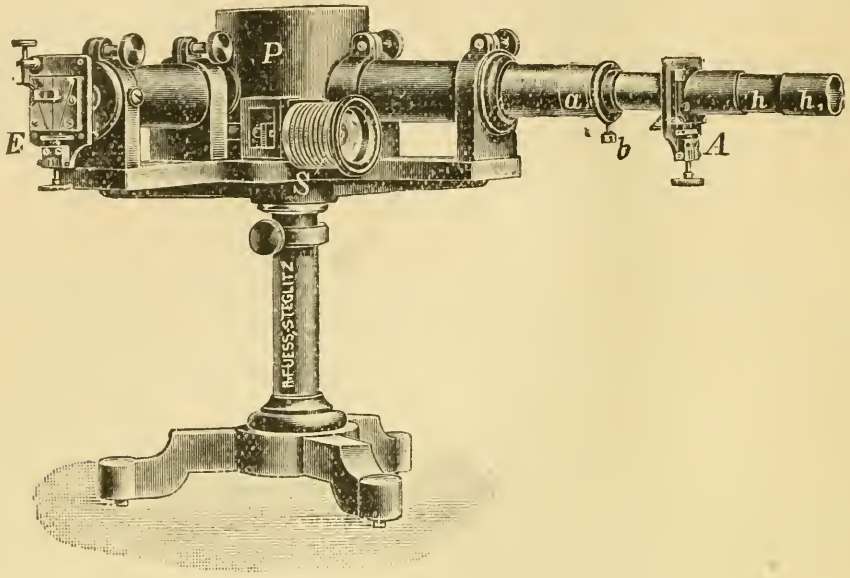


Fig. 9.

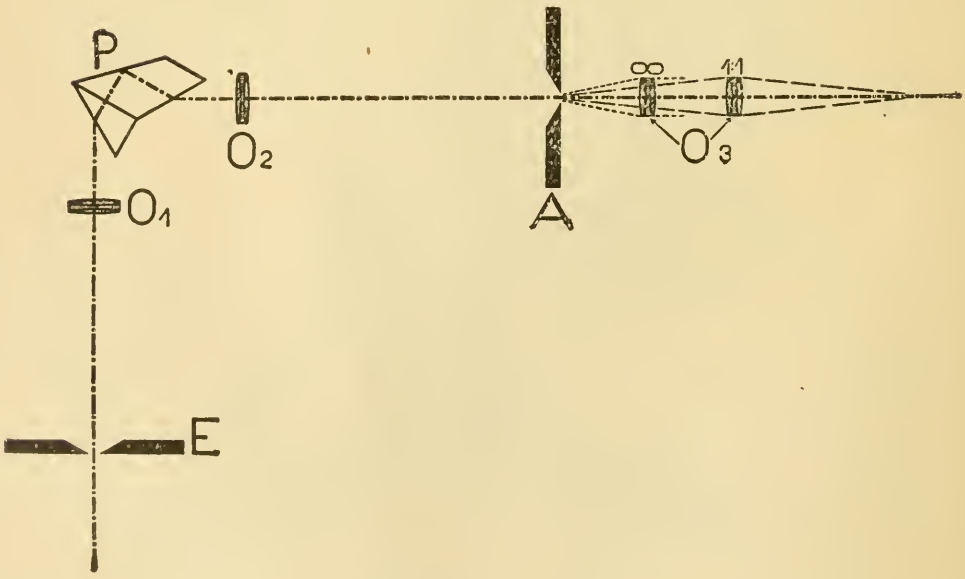


Fig. 10.

has a dispersion of 394 $\mu\mu$ to 185 $\mu\mu$, about 10° 40′. The lens O_3 is an air-tight achromat of quartz rock-salt quartz.

The objectives O_1 and O_2 are also adjustable and have focal lengths proportional to F : 4 and F : 6 respectively. The free distance of both objectives is 30 mm.

The adjustment of the apparatus is very simple, If, for example, one wishes to use light of 280 $\mu\,\mu$ it is only necessary to set the drum indicator at 280 and then to make the corresponding corrections on the adjustable objectives O_1 and O_2.

(4) Photomicrography.

EDER, J. M. — **Separat-Abdruck aus Jahrbuch für Photographie und Reproduktionstechnik für das Jahr 1912.**

[The author summarizes with his usual thoroughness the more important advances in microphotography and projection.]

Halle : W. Knapp, 12 pp. (1 fig.).

(5) Microscopical Optics and Manipulation.

Photolysis of various Complex Sugars (Bioses and Trioses) by the Ultra-violet Rays.*—MM. Daniel, Berthelot and H. Gaudechon have systematically investigated the action of ultra-violet light upon polyose sugars. They find that the effect is to decompose the complex molecules into simpler ones. Thus, for example, maltose becomes glucose + glucose ; and saccharose becomes glucose + levulose. In short, while the decomposition by hydrolysis, necessary to render the sugars assimilable by the animal organism, is naturally performed by the action of ferments, the authors have obtained it by the ultra-violet rays. This suggests that the efficacy of ferments is not of a material, but of a dynamic, order ; and that the key of their action must be sought not in their formula of constitution, but in their vibratory rhythm.

(6) Miscellaneous.

Hayem-Sahli Hæmatocytometer.†—This apparatus consists of the following parts :—1. A pipette, calibrated to hold 1–5 c.mm. for the purpose of counting the red cells. 2. For counting leucocytes a similar pipette calibrated to take from 5–25 c.mm. 3. A pair of diluting pipettes for measuring quantities of the diluent ranging from 250–500 c.mm. 4. Two glass cells, marked red and white, for preparing the mixture of blood and diluent. 5. A glass spatulum for stirring the mixtures. 6. Two chambers, with plane-parallel cover-glasses respectively 0·2 and 0·1 mm. deep. Unlike other patterns of the counting chamber, these are not provided with a grating, as this is contained in the eyepiece. On the floor of the chamber, however, there are concentric markings for controlling the position of the Microscope. 7. An eyepiece, provided with screw-in grating, consisting of a large square divided into sixteen small squares. The small squares provide a means of orientation ; the large square serves exclusively as the counting unit of reference. 8. Tables which supply for a given dilution and depth of chamber the number of corpuscles per cubic millimetre, corresponding to the mean number counted in a square. 9. A mechanical stage, with travel check ; the action of the limit catch is felt distinctly as the milled heads are turned, each space corresponding to a microscopic field.

* Comptes Rendus, clv. (1912) pp. 1506–9. † Leitz Circular.

Two main advantages of this apparatus are that the dilutions prepared at the bedside may be transported conveniently in the diluting cells to the laboratory, and may there be examined at leisure. Secondly, the eyepiece grating shows dead black lines on a white ground, and thus less eye-strain is caused by the use of this apparatus.

The Beginner's Guide to the Microscope, by C. E. Heath.* This little book is one of the useful manuals published by Messrs. Percival, Marshall and Co. Its aim is to be thoroughly practical and helpful, and it admirably succeeds in carrying out its purpose. The author studiously adopts a simple style of language, and writes in a manner intended to popularize the instrument. In addition to sections describing the Microscope itself, there are others devoted to the simpler methods of slide-mounting.

Wright, F. E.—**Microscopical Petrography from the Quantitative View-point.** [Gives a valuable survey of the present condition of this branch of science.] *Journ. Geology*, Sept. to Oct., 1912, pp. 481-501.

B. Technique.†

(1) Collecting Objects, including Culture Processes.

Cultivation of Mosses on Sterilized Media.‡—Servettaz records that he has obtained successful cultivations of twelve species of mosses in liquid and solid media. The cultivations were made from spores which were sown directly on the medium, though it was found better to employ a moist substratum, both for convenience of observation or to ensure a better aeration of the cultures. In Erlenmeyer's flasks or in Petri dishes was placed a layer of absorbent cotton-wool, and this was covered with a layer of thick blotting-paper. When test-tubes were used, slips of filter-paper dipped into the medium gave successful results.

Plates of porous porcelain were also employed, but the results were not altogether satisfactory.

The success of the experiments was found to depend principally on careful regulation of temperature and light. The optimum temperature lay between 16°–25°, while the amount of light had to be regulated according to the species, good results being obtained only by constant and careful supervision.

Cultivation of the Mammalian Blastoderm.§—A. Brachet set out to investigate whether an egg or a young blastocyst is capable of living and of developing outside the maternal organism, and if so, does

* Published by Percival, Marshall and Co., London.

† 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, preservation fluids, etc.; (6) Miscellaneous.

‡ Comptes Rendus, clv. (1912) pp. 1160–2.

§ Comptes Rendus, clv. (1912) pp. 1191–3.

it in any way develop its special parts and organs. He followed previous investigators in this line of research, but somewhat modified the technique. He used rabbits which were pregnant five to seven days, and, after removing the blastocysts, immersed them in maternal blood-plasma, previously obtained by bleeding the animal. After an incubation at 39°·5 for 24 hours development was found to have occurred as shown by the increased size of the embryo, and by the presence of numerous mitoses. The author regards his results with complaisance, and states that he is pursuing the subject still further, and is endeavouring to ascertain if the plasma of the unfertilized female or of the male exercises any inhibitory influence on the development of the blastocyst.

(3) Cutting, including Embedding and Microtomes.

Modification of the Burri Indian Ink Method.*—L. W. Harrison finds that collargol forms an effective substitute for Indian ink. A suspension is made by adding 1 part of the powder to 19 parts of distilled water in a black glass bottle, or a bottle covered with carbon paper. After a few shakings the suspension is ready for use. It keeps well for months. The films are made in the usual way, and the spirochætes appear as delicate spirals on a reddish-brown perfectly homogeneous field.

(4) Staining and Injecting.

Staining Nerve-fibres with Neutral Red.†—J. Kublik demonstrates the vitreous and fine nerve-fibres by means of neutral red, a method discovered by S. Mayer. He uses a saturated solution of neutral red in normal saline, and then dilutes from 10 to 15 times with saline. The preparations when stained are washed in saline and then treated with picrate of ammonium, after which they are mounted in glycerin or in glycerin-ammonium picrate.

Hæmalum and Picrocarmin Staining Solutions.‡—T. G. de Groot gives the following directions :—1. Watery hæmalum : Dissolve 0·1 grm. potassium ferricyanide in 20 c.cm. distilled water, add 0·2 grm. Grübler's hæmatoxylin, and, when this is dissolved, 40 c.cm. of distilled water. Add 5 grm. alum, heat gently and make up with 50 c.cm. of water. Cool and filter. 2. Alcoholic hæmalum : In a 300 c.cm. flask, place 2 c.cm. of hydrogen peroxide and 4 c.cm. of a 12 : 2 mixture of 70 p.c. alcohol and glycerin. Warm and add 0·5 grm. hæmatoxylin. When dissolved add 60 c.cm. alcohol-glycerin, and, after shaking, 4 grm. calcium chloride and 2 grm. sodium bromide. When this is dissolved add 3 grm. alum and 100 c.cm. alcohol-glycerin. Warm to promote solution. Then add 0·2 grm. potassium ferricyanide, 76 c.cm. of alcohol-glycerin, and 3 grm. of alum. Cool and filter. 3. Alcoholic hæmalum solution, 30 c.cm. ; alum, 4 grm. ; distilled water, 85 c.cm. 4. Picrocarmin : Place 0·5 grm. carmin in 4 c.cm. distilled water warm.

* Brit. Med. Journ., 1912, ii. pp. 1547.
† Arch. Mikr. Anat., lxxxi. (1912) pp. 74–81 (2 pls.).
‡ Zeitschr. wiss. Mikrosk., xxix. (1912) pp. 181–5.

Add 0·04 grm. heavy magnesia and 2 c.cm. of solution of ammonia. Heat to dryness. Add 4 c.cm. distilled water to re-dissolve carmin, 0·05 grm. magnesia and 4 c.cm. ammonia. Mix and add 0·5 grm. picric acid. Heat almost to dryness. Add 15 c.cm. of distilled water and warm until boiling begins. Add 95 c.cm. of distilled water, warm the mixture, then cool and filter. Add one crystal of thymol.

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

Mounting Celloidin Sections.*—A. Weber recommends the following method. Slides are coated with albumin-glycerin. Sections cut with a razor, moistened with 50 p.c. alcohol, are laid out flat on a spatula and placed on slides. A few drops of 50 p.c. alcohol are added. Berzelius paper is then applied to the slides in order to soak up the excessive alcohol. A single fine layer of collodion is applied to the slide, which is then plunged, without waiting for the collodion to dry, into 50 p.c. alcohol and from this transferred to a bath containing equal parts of alcohol and chloroform. After a sojourn in this fluid of length depending upon the nature of the tissue, the slide is transferred to carbol-xylol, and the preparation is finally mounted in Canada balsam.

Metallography, etc.

Recent Micrographical Investigations of Copper.†—H. Baucke has measured the length and the breadth of the grains in specimens of copper, including trolly wire annealed at different temperatures, and gives the values obtained. Heating cast copper containing copper-cuprous oxide eutectic has no effect on the distribution of the oxide if the temperature does not exceed 700° C. Long heating at 800° C., or shorter heating at higher temperatures, causes a coalescence of the particles of oxide into larger globules.

Control of Work put on Copper and Brass.‡—C. Grard shows that in copper, 90/10 brass and 67/33 brass, the microscopic structure is very definitely related to the amount of cold work and subsequent annealing undergone by the specimen, and that accordingly each kind of structure is associated with definite mechanical properties. The methods by which microscopical examination may be used to control manufacturing operations are indicated.

Nickel-cobalt System.§—R. Ruer and K. Kaneko have studied this system by thermal and magnetic methods, and describe the structure of the alloys examined. The sections were etched with a mixture of 1 part of a 10 p.c. ferric chloride solution with 2 parts of alcohol. Each

* Zeitschr. wiss. Mikrosk., xxix. (1912) pp. 186–7.
† Proc. Int. Assoc. Testing Materials, ii. (1912) No. 11, 14 pp. (10 figs.).
‡ Proc. Int. Assoc. Testing Materials, ii. (1912) No. 11, 13 pp. (79 figs.).
§ Metallurgie, ix. (1912) pp. 419–22 (14 figs.).

alloy consisted of a single solid solution and had the usual polygonal structure. Twinning was evident in the alloys rich in cobalt but was not observed in the nickel-rich alloys. Nickel oxide is soluble in molten nickel and the eutectic formed on solidification has a well defined structure.

Lead-tin-antimony Alloys.*—W. Campbell discusses the equilibrium of this ternary system, and gives a number of photomicrographs. In many cases the observed structure is not in full agreement with the equilibrium diagram, owing to the failure of the alloy to attain equilibrium during solidification and cooling.

Porous Metals.†—If an alloy, which consists of primary crystals together with a eutectic, be heated just above the melting-point of the eutectic, the liquid eutectic may be extracted by means of a centrifuge, or by forcing another liquid in under pressure. The specimen thus obtained possesses its original form, but consists of the primary crystals with microscopic spaces between. H. I. Hannover describes the process, giving details of the precautions necessary. Porous lead and porous antimony may be obtained from lead-antimony alloys containing excess of lead in one case, excess of antimony in the other case. Porous lead finds an application as accumulator plates ; porous bearings may receive a constant supply of lubricating oil through the pores.

Coalescence in Lead.‡—Coalescence, the growth of certain crystals by absorption of surrounding crystals, occurs in rolled lead at ordinary temperatures. H. Baucke shows that this growth is accelerated during immersion in a suitable electrolyte. Dilute etching reagents, such as 5 p.c. acetic acid, and 5 p.c. nitric acid in alcohol, have been found to act in this manner on lead. The growth is rapid in lead foil, but less evident in plates. Local coalescence in a specimen of lead has been observed to be followed by rapid corrosion of the same region. It has not been found possible to control the rate and degree of coalescence caused by immersion in an electrolyte.

Growth of Crystals in the Annealing of Cold-worked Metals.§ By annealing cold-rolled sheets of tin, lead, zinc, aluminium, copper, and iron at different temperatures, F. Robin has shown that, though the size of the resulting crystals depends upon the temperature and length of time of annealing, the size of crystal is not directly proportional to the temperature for a given duration of annealing. Experiments on the same metals have shown that when locally deformed specimens are annealed, the crystals in the most strongly deformed parts do not show abnormal growth, but the distorted crystals at the edge of the region of deformation grow enormously at the expense of the contiguous undeformed crystals.

* Metallurgie, ix. (1912) pp. 422–5 (15 figs.).
† Rev. Métallurgie, ix. (1912) pp. 641–6 (7 figs.).
‡ Int. Zeitschr. Metallographie, ii. (1912) pp. 243–57 (15 figs.).
§ Comptes Rendus, clv. (1912) pp. 585–7, 716–8.

Structure of Hypo-eutectoid Steel.*—H. M. Howe and A. G. Levy describe experiments which indicate that, though the precipitation of ferrite, in or below the transformation range, in hypo-eutectoid steel cooling from a higher temperature, is rapid at any given temperature, the coalescence of this ferrite into visible masses is slow if 0·4 p.c. carbon, or more, is present. The masking of the early formed ferrite network is due more to the slowness of coalescence which results in the formation of masses of ferrite within the mesh, than to the balling-up of the network itself.

Japanese Meteorite.†—M. Chikashige and T. Hiki describe the structure of a meteorite observed to fall at Okano in 1904. Its composition was iron 94·85, nickel 4·44, cobalt 0·48 and phosphorus 0·23 p.c. A section deeply etched with nitric acid, showed Neumann lines. Crystals of rhabdite (phosphorus-nickel-iron), sometimes several millimetres in length, were embedded in a ground mass of hexahedric nickel-iron. The structure was completely changed by heating to a high temperature.

Eutectic Crystallization.‡—R. Vogel discusses the various forms of eutectic structure, and shows that the controlling factors in the crystallization of eutectics are the same as in one-component systems, viz. linear velocity of crystallization, spontaneous crystallization capacity, and flow of heat. Two possible modes of formation of the familiar banded structure are: 1. The successive crystallization of alternate layers of the two constituents, the lamellæ formed being at right angles to the direction of flow of heat. 2. The simultaneous crystallization of the two constituents in the form of rods, parallel to the direction of flow of heat. Experimental investigation appears to indicate that banded eutectic structures are, in fact, formed by the second of these two possible modes of crystallization.

Standard Magnification for Photomicrographs.§—M. T. Lothrop and C. R. Bulley point out the confusion caused by the great variety of magnifications to be found in published photomicrographs. The authors do not recommend any particular set of standard magnifications, but suggest that such standards be drawn up by a competent committee.

National Physical Laboratory.‖—The etching of steel at high temperatures by Baykoff's method, with gaseous reagents such as hydrochloric acid, was found to be satisfactory at temperatures above 1000° C., but at lower temperatures the products of the reaction remained as a film upon the polished surface, completely masking the structure. The production of " heat reliefs " by heating steel in a vacuum is being tried

* Int. Zeitschr. Metallographie, iii. (1912) pp. 4–14 (14 figs.).
† Zeitschr. Anorg. Chem., lxxvii. (1912) pp. 197–9 (8 figs.).
‡ Zeitschr. Anorg. Chem., lxxvi. (1912) pp. 425–36 (12 figs.).
§ Proc. Int. Assoc. Testing Materials, ii. (1912) No. 11, 4 pp.
‖ Nat. Phys. Lab. Ann. Report, 1911.

as an alternative method of developing the structure existing at high temperatures. A steel containing 1 p.c. carbon appeared to be very slightly decarburized by prolonged heating in a vacuum; a very thin decarburized skin was formed at temperatures below Ac1, but not at temperatures above that critical point. Probably at the higher temperatures the carbide of iron on the surface, losing carbon by volatilization, is replaced by carbide diffusing from the deeper layers; no such diffusion takes place at lower temperatures.

MICROSCOPY.

A. Instruments. Accessories, etc.*

(1) Stands.

Fuess' New Petrographic Microscope for the Theodolite Method.† E. von Fedorow's discovery that the principle of the theodolite could be advantageously applied to crystallographic and petrographic instruments, has resulted in a somewhat extensive use of the method. C. Leiss now describes its application to the above Microscope (fig. 11), which embodies certain improvements which have been suggested by Nikitin and Wright.

The stage is constructed for the reception of object-glasses 28 by 48 mm. In this instrument it is not necessary to use thin sections uncovered and with the polished face upwards, but the preparation is placed in the ordinary way on the stage and kept steady with spring-clamps. The stand is non-inclinable and is strongly built. The upright arm *t* supports the (so-called immobile) axis of the vertically divided circle *I*, rotatory by means of the spoke-wheel *r*, and capable of being clamped by a screw (not shown in the figure). Firmly connected with *I* is the projecting piece *l*, for carrying the combined circular systems, viz. the circle *II*, the auxiliary circle *III*, and the two removable divided arcs *IV*. The circle *II* has a (so-called mobile) rotation axis in *l* and is clamped by the screw *s*. The rotation or inclination of the auxiliary circle *III*, which carries the preparation, takes place with reference to the sockets *z z'* ; *z z'* cannot be clamped. In order that the polished face of the preparation lying on *III* can be brought accurately into the prolonged imaginary axis of circles *I* and *III*, the position-plate (which is independent of the circle *III*) for receiving the preparation can be screwed up and down within necessary limits ; the nut which governs this movement is therefore in circle *III*. All three circles and the two arcs are divided into degrees. Verniers reading to 5′ are fitted to the two main circles *I* and *II* ; in the other cases the reading is taken by a pointer. The usual rotation of the whole Microscope about a vertical diameter is, in this instrument, replaced by a more convenient arrangement for the rotation of the two nicols (polarizer P, analyzer A). The rotation-value is given by the circle N, graduated to degrees, and two verniers reading to 5′, the combined nicol-rotation being effected by the rod *n*. For certain purposes the analysing prism A can be rotated alone, the rotation being read off on the small half-circle A_1. In such a case the rod *n* is separated from the connecting-arm *a*, in order that the tube may be

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

† Zeitschr. f. Instrumentenk., xxxii. (1912) pp. 377–9 (1 fig.).

racked-up until the arm *a* stands over the rod *n*, which is then turned aside to permit of the rotation of the analysing prism. For better observation of the axis-exit in the case of strong inclination-angles, two hemispherical lenses accompany each Microscope. The larger of these can be centrally cemented on (with thick cedar-oil, or such-like) in a

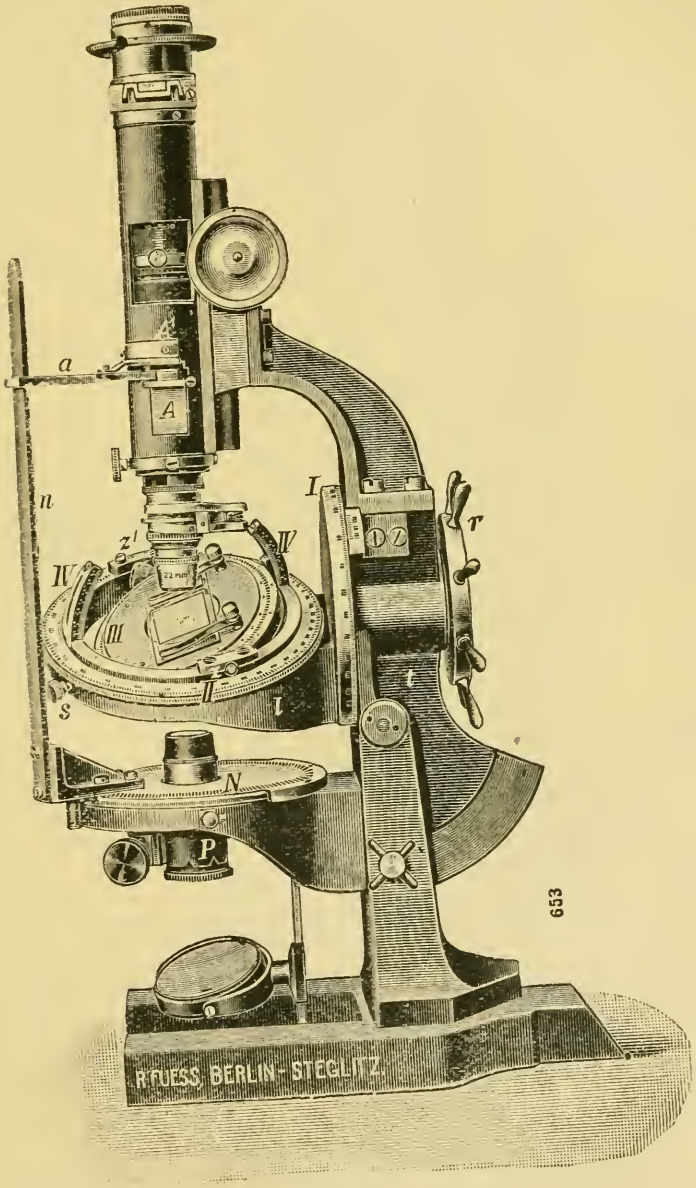


FIG. 11.

special mount, under the glass stage of the auxiliary circle *III*. The smaller lens, of about 12–14 mm. diameter, is inserted in a narrow mount, and by means of cedar-wood oil rests, easily removable, on the upper surface of the preparation, after the manner of a cover-glass. The polarizer-nicol can be raised and lowered by rack-and-pinion in the usual

way. Illumination of the preparation is effected by a weakly convex lens screwed on above the polarizer : a lens system for convergent light can also be applied if desired. The tube has the well-known arrangement of modern mineralogical Microscopes. As with the theodolite method, strong magnifications are unnecessary ; a well cut rack-and-pinion serves for both coarse- and fine-adjustments. The ocular end is, at Wright's suggestion, equipped with an arrangement for inserting micrometers, co-ordinate nets, gypsum plates, and so forth.

Home-made Water Microscope.*—A. Tchikin describes how a really efficient and powerful Microscope can be made in which the lenses are constituted by drops of water. A thin ($\frac{1}{2}$ mm.) zinc sector is pierced with small accurately round holes, from 3 mm. to 1 mm. (fig. 12). In

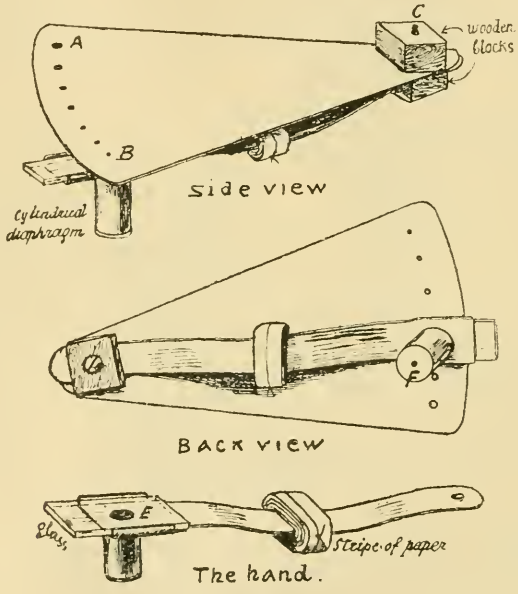


Fig. 12.

the centre C of the arch AB, on which is placed the holes, there is joined a movable hand, or strip of hard tin-plate, about 2 cm. wide. The sector and the hand are screwed together between two wooden blocks. A $\frac{1}{2}$-cm. hole E is drilled on the movable end of the hand, the $1\frac{1}{2}$-mm. wider margins of the hand being bent to form a groove, or faucet, in which may be placed a square piece of glass for a micro-object. Against the hole is soldered to the hand a cylindrical diaphragm, i.e. a small brass tube (about 1 in.), with zinc bottom, through which a small hole F, about 2 mm. diameter, is drilled. Adjustment for focusing is by a strip of thick paper, or carbon, rolled on the hand, which is slightly curved. This strip of paper rolls along the hand, and, therefore, moves the hand to and from the sector. The author states that a fine truly spherical drop of water on a 1-mm. hole forms an ideal lens, with a sharply distinct and colourless image, the power being near 100.

* English Mechanic, xcvii. (1913) p. 109 (3 figs.).

(3) Illuminating and other Apparatus.

Bausch and Lomb's Projection Lanterns.*—Messrs. Bausch and Lomb manufacture several forms of the projection lantern, and apply

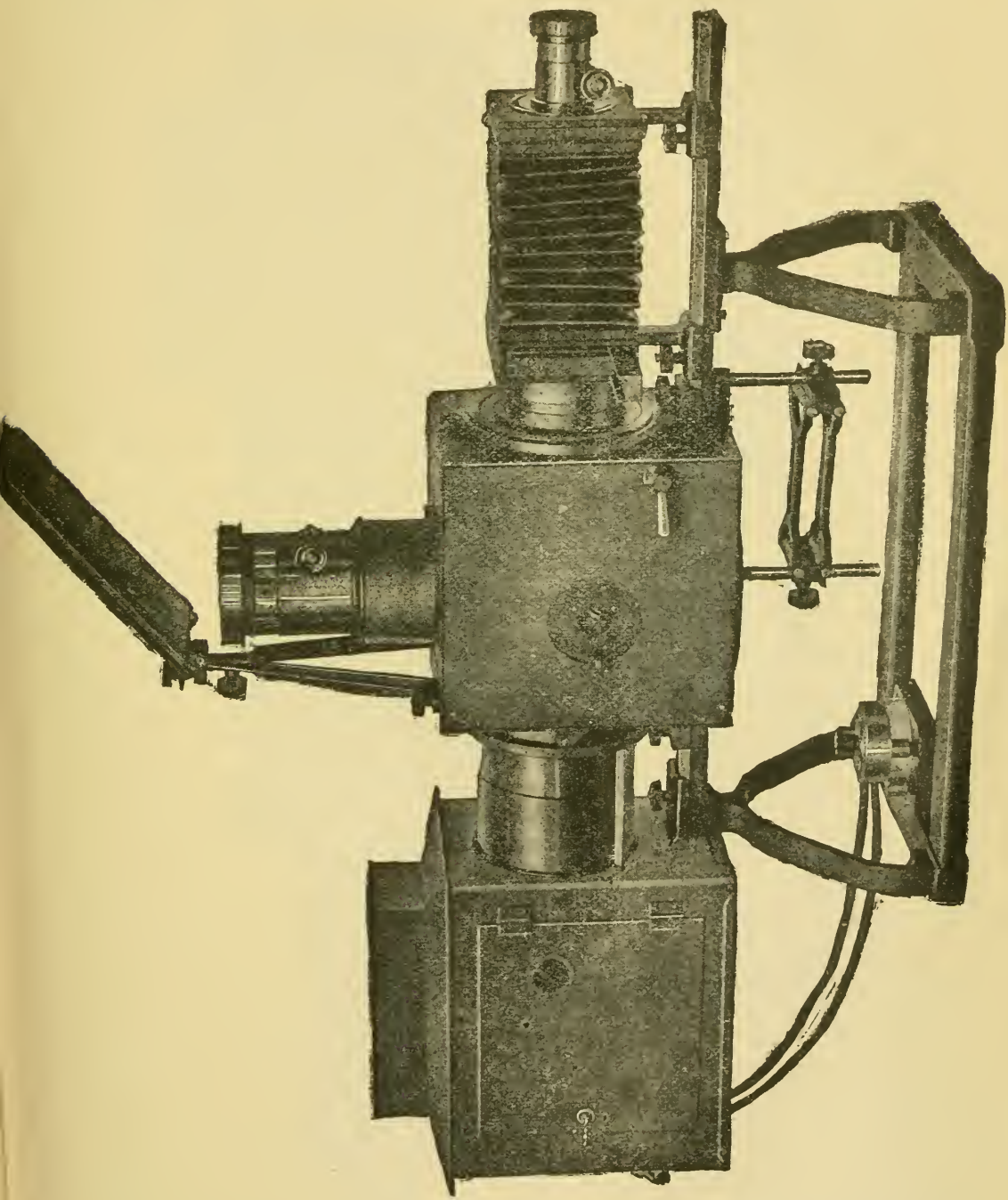


Fig. 13.

to them the trade name of "balopticon." The model represented in figs. 13–18 is listed as their "Convertible" balopticon, and is their highest

* Special Illustrated Catalogue, Projection Apparatus, Rochester, N.Y. (1911 66 pp.

development of projection apparatus. It can be adapted to every form of optical projection (lantern slide, opaque, microscopic, vertical, polariscopic and spectroscopic). Fig. 13 shows the simplest form of this balopticon set up in its normal position, and fig. 14 is a cross-section

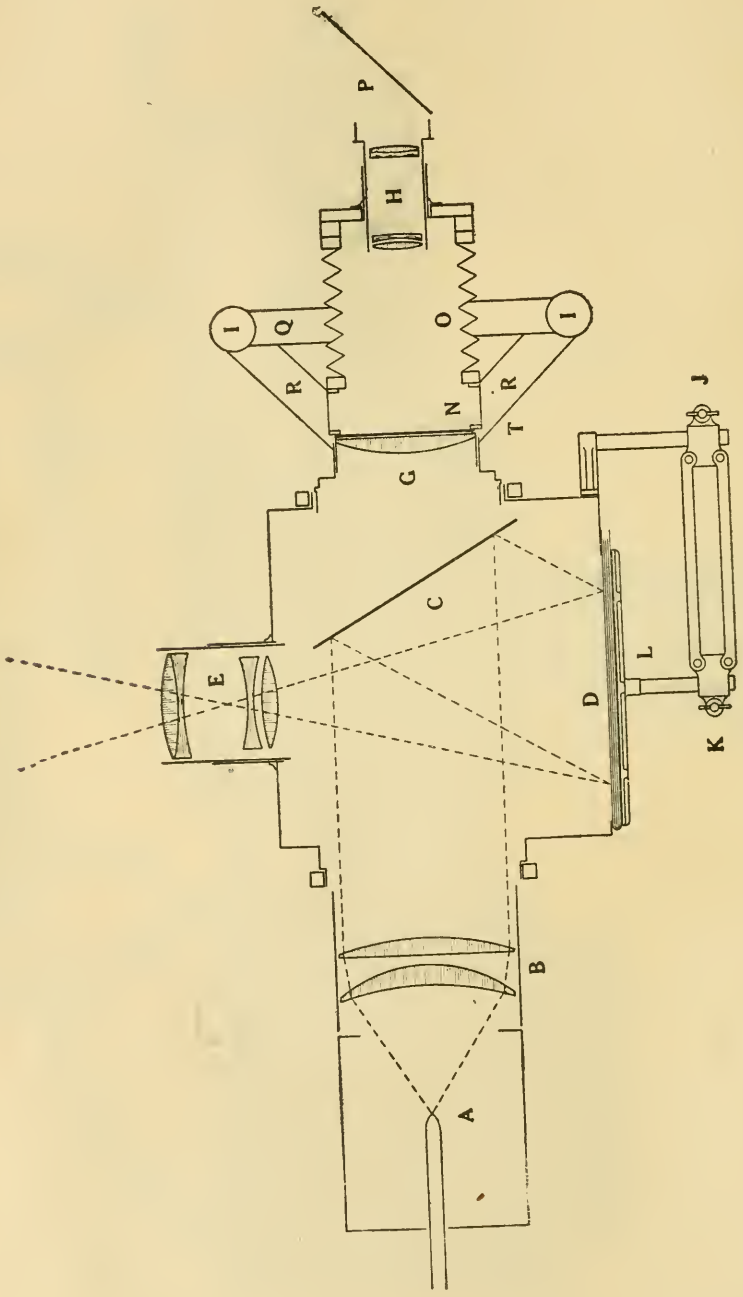


FIG. 14.

showing the path of the light-rays the external projecting mirror being not shown. When used for lantern projection, the position of the adjustable mirror C is altered so that the rays, by means of the lens G, are converged in the projection lens H after passing through the slide placed in the carrier at N. For opaque projection, the adjustable mirror is raised

to the position C ; the parallel rays, after having been reflected on to the opaque object at D, then converge in the projection lens E, whence they

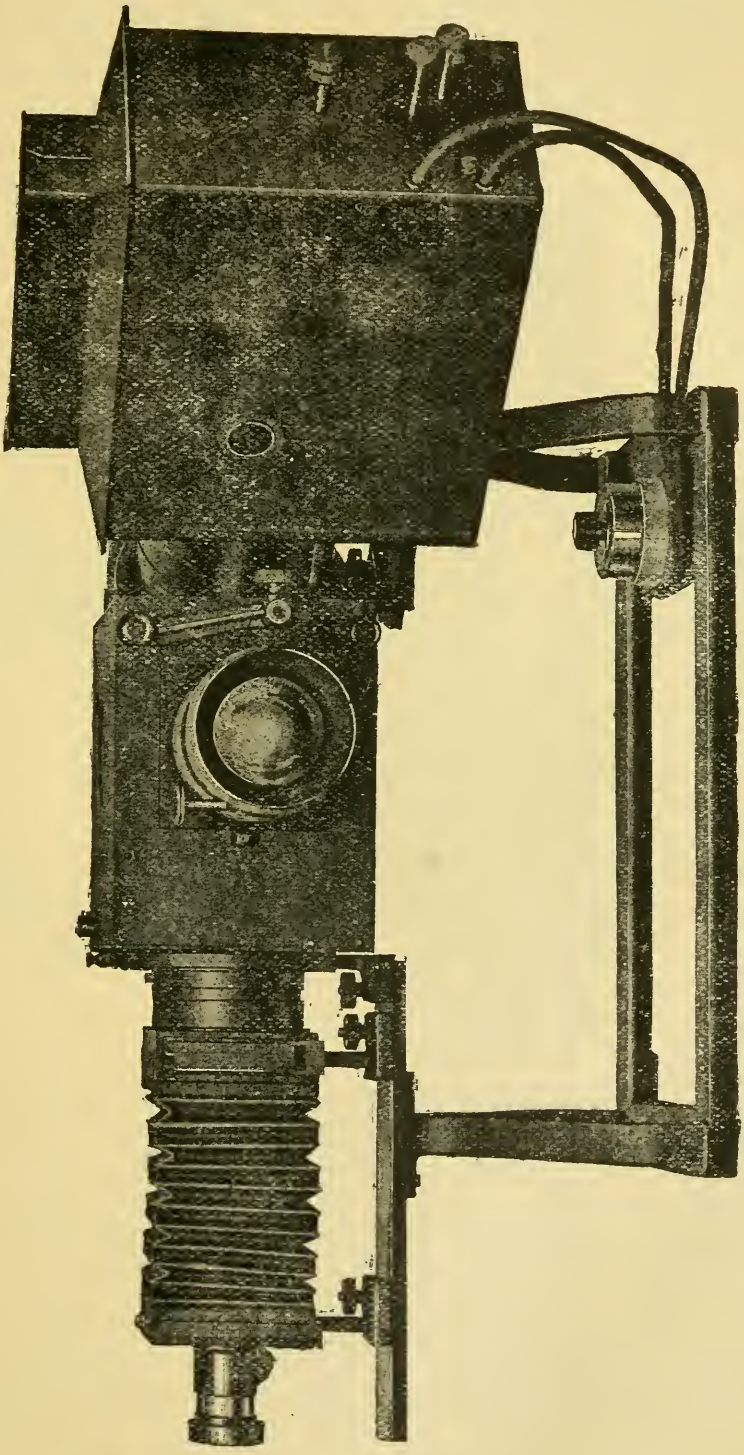


Fig. 15.

are reflected from the reversing mirror F on to the screen. Figs. 15 and 16 show how the apparatus can be used for projecting an opaque

object placed vertically. For this purpose the release of a catch enables the dark chamber to be easily rotated until the projection lens occupies a horizontal position ; the lamp-house is then rotated to the suitable angle, and the effect is obtained by *direct* reflection from the opaque object. This gives a great gain in brilliance. The illuminant recommended is a hand-feed arc lamp for direct or alternating current, connected by two feed wires to a switch attached to rear of base.

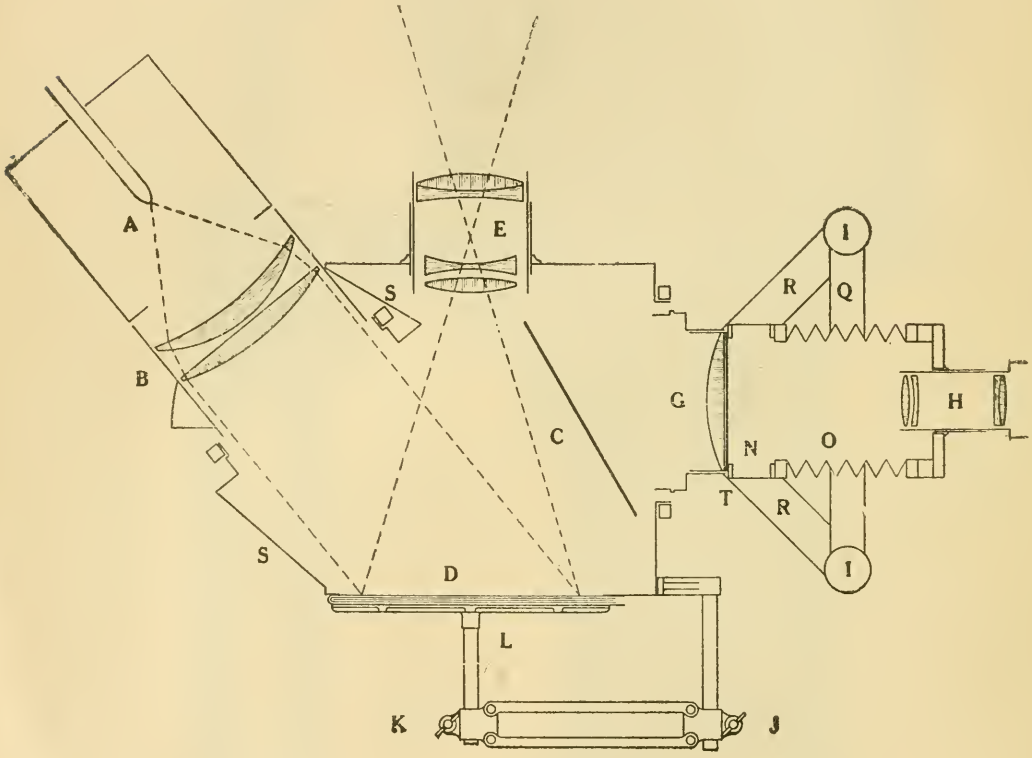


Fig. 16.

Fig. 17 shows the apparatus fitted up so as to be available for microscopic or for polariscopic (horizontal or vertical) projection.

Spectroscopic projection is attained by adapting an adjustable slit and an equilateral prism to the normal lantern. The slit narrows the beam of light as much as desired before it passes through the projection lens. The prism, placed in front of the projection lens, breaks up the beam into its prismatic components before it is projected on to the screen.

Fig. 18 shows the balopticon fitted with Edison moving picture (type B) attachment, the whole being mounted on a special table. The attachment furnished has an automatic shutter and two film-reels in fire-proof magazines. A lens is also supplied of suitable relative focus to produce images from the films of the same size as those from the slides or opaque objects.

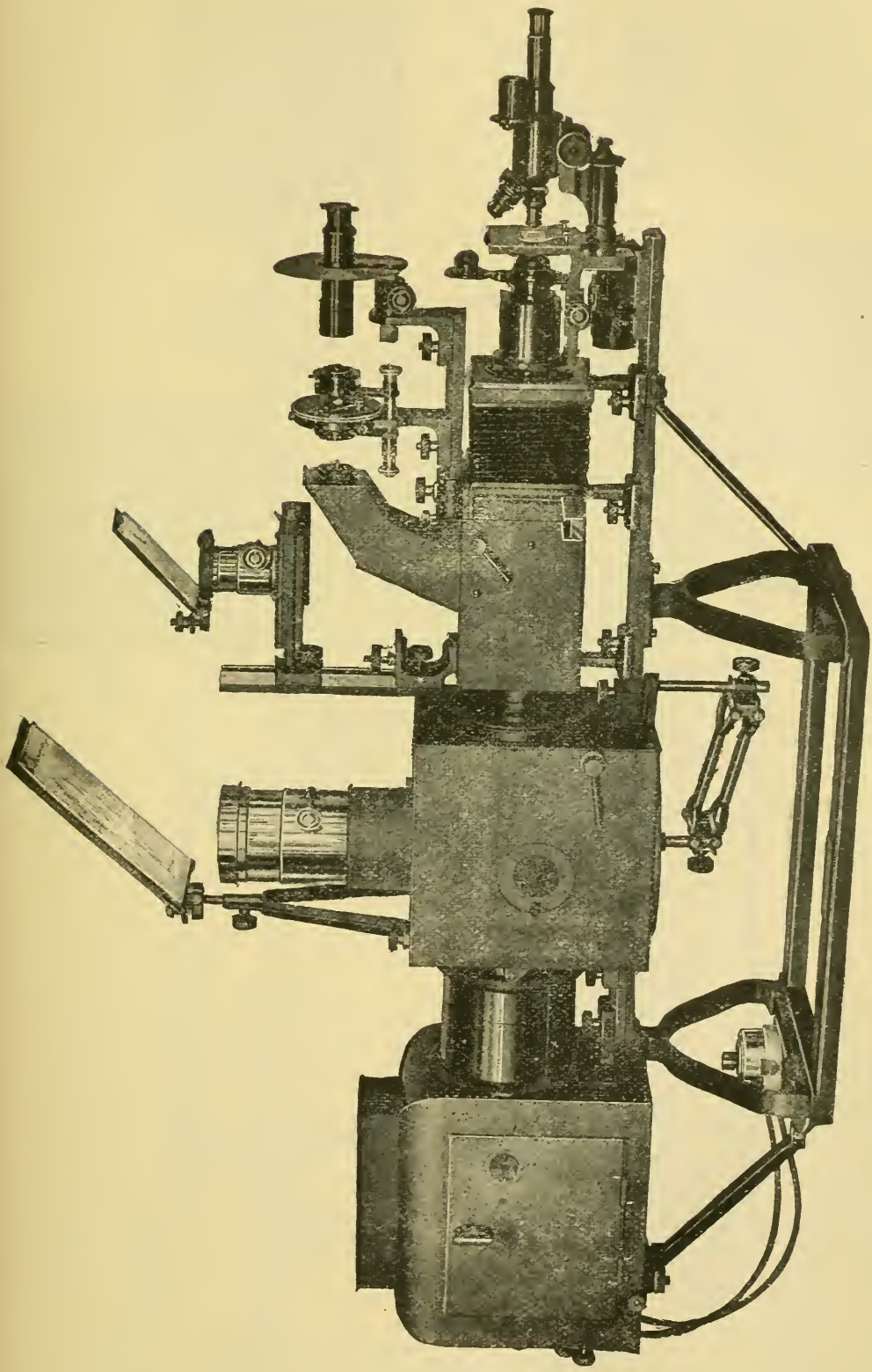


Fig. 17.

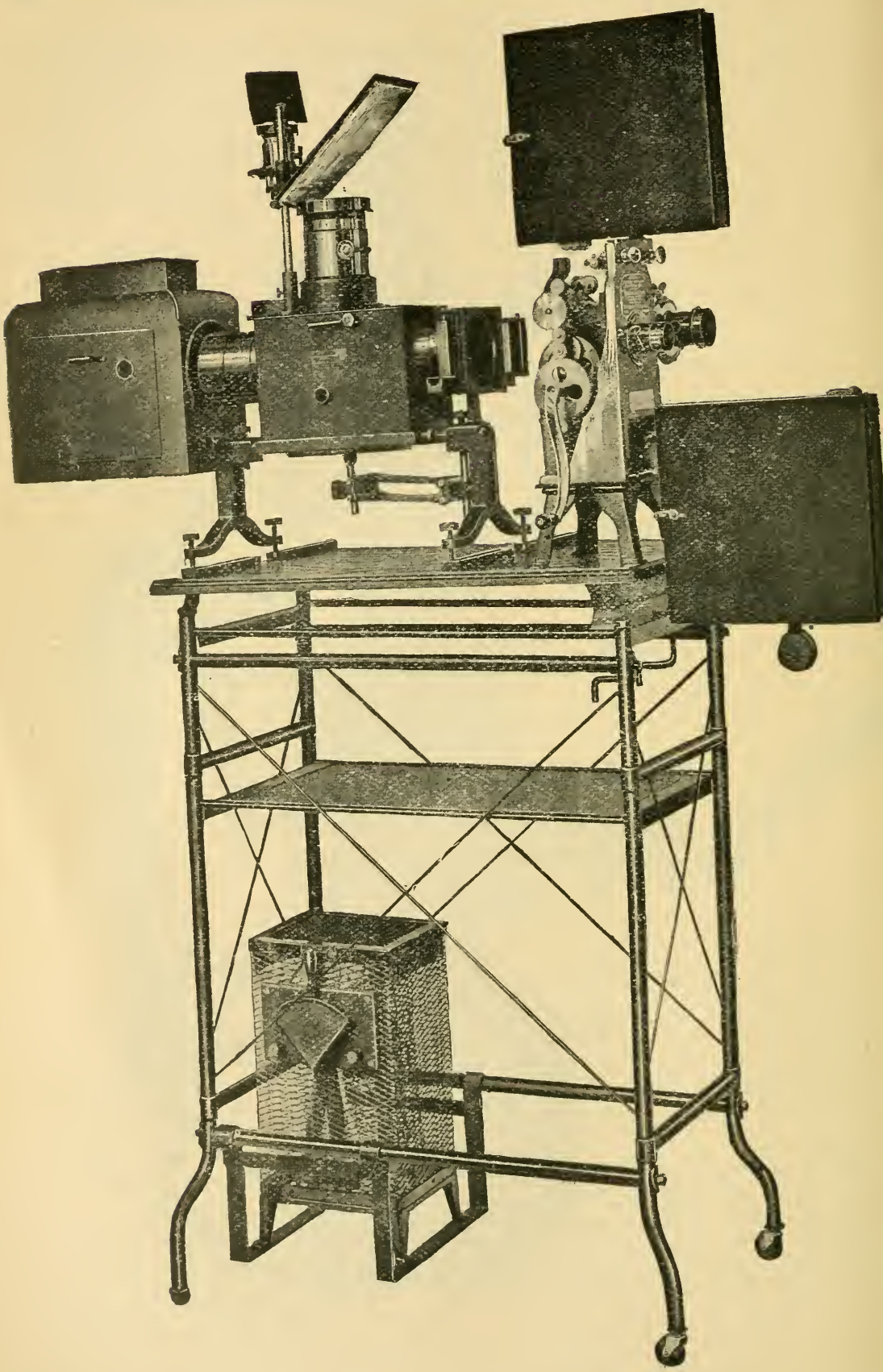


FIG. 18.

Krüss Apparatus for Optical Demonstrations.* — The firm of A. Krüss, Hamburg, have devised a set of apparatus by which all the usual optical phenomena can be easily and clearly demonstrated to a class of students. A Lilliput arc-lamp is used as a light-source, and is so adjusted on an iron pillar as to emit horizontal rays through iron plates pierced in various ways. The effect in a dark room is like miniature search-lights, which by passing through lenses—by reflection at surfaces, and so forth—facilitate a lecturer's explanations.

Apparatus for Micro-operations.†—S. Tschachotin, who has lately described a photo-chemical cell-operation method suitable for micro-

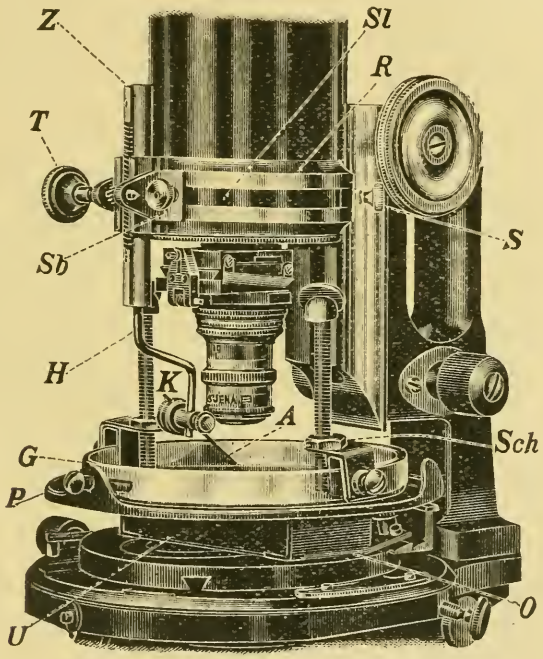


Fig. 19.

scopically dealing with the smallest cells,‡ now describes a mechanical method applicable to fairly large cells, e.g. those of Amphibians. His method facilitates such operations under the Microscope as sectionizing, juxtaposing, extirpation, resection, localizing electrical or thermal agencies —especially with small objects.

Fig. 19 shows the apparatus. It consists of a metal ring R fitted to the lower part of the Microscope tube and fixed by a screw S. The ring has a horizontal slit Sl in which works a small pin Sb, which by application of a screw can be clamped in any position on the circumference of the ring. A toothed bar Z is attached to the pin Sb and operated by a rack

* Deutsch. Mech.-Zeit., 1913, pp. 1–6 and 13–15 (22 figs.).

† Zeitschr. wiss. Mikrosk., xxix. (1912) pp. 188–90 (1 fig.).

‡ Die Mikroskopische Schahlenstichmethode,eine Zelloperationsmethode (Biol. Zentralbl., 1912).

for up-and-down movements. The toothed bar Z carries at its lower end a holder H with a universal clamp K, for receiving and setting in suitable positions such pieces of apparatus as very fine lancet points, couching needles, stimulation-electrodes, and so on. The examination of some objects would be suitably carried out in a small circular trough to whose rim the object has been secured by a special clamp Scb. Very small objects could be secured by white of egg, or by a gelatin layer on an object-slide. In all cases the application points of the instruments must be first focused and brought into the centre of the field. The tube is then racked down and the object also brought into the centre of the field. If, for example, it is desired to sever an object, the point of the lancet is brought into the necessary lateral position and the operator rotates the whole apparatus, the result being a microscopical section of required length. By means of the milled head T the depth of the section can be regulated. The simultaneous use of an eye-micrometer is of advantage.

(5) Microscopical Optics and Manipulation.

Relation of Aperture to Power in the Microscope Objective.* E. A. Hutton, in discussing this subject, keeps steadily in view the considerations which should guide a microscopist in the selection of a lens, and whether a purchaser would, for example, make a "better bargain" in acquiring a $\frac{1}{6}$-in. objective of N.A. 0·88, or of N.A. 0·74. The complete answer partly depends on eye-piece magnifying power, and partly on the average power of resolution for ordinary eyesight. These he respectively takes as 10, which all modern high-power objectives will stand, and 125 lines to the inch. Again, an objective of 0·13 N.A. will, according to the R.M.S. tables, resolve 12,500 lines to the inch. To accomplish this the objective must have an initial power of 10, which. multiplied by 10 (the eye-piece power), and then by 125 (the limit of resolution of ordinary eyesight), gives the above result. In this way the author constructs the following table, which gives the minimum N.A. required (tube-length 160 mm.).

Magnification	N.A.	Focal Length of Objective mm.
100	0·13	16·0
200	0·26	8·0
300	0·39	5·33
400	0·52	4·0
500	0·65	3·2
600	0·78	2·67
700	0·91	2·3

It is quite true that owing to optical difficulties the first five in the table cannot be constructed, but those objectives will be preferable which approximate the most closely to these figures. Excess of aperture is useless, and moreover it involves sacrifice of depth of focus. Application of these figures to the disk of confusion gives, for example, by the

* Knowledge, xxxvi. (1913) pp. 63–65.

usual formula $100 \div 95000 \times 0{\cdot}13 = 1/123{\cdot}5$ in., which is at any rate a safe limit above the conventional $\frac{1}{100}$ in.

The author also treats of the limit of useful magnification in connexion with numerical aperture, of which he takes the highest attained value, 1·50. Starting from this some authorities have thought that the highest useful power will be 750, and that anything beyond that value would reveal no further structure. Other authorities have even quoted 577 as the limit. The author, however, considers that the limit of useful magnification is given by the calculation $1{\cdot}50 \times 100 \div 0{\cdot}13 = 1154$, or even perhaps by $1{\cdot}50 \times 100 \div 0{\cdot}10 = 1500$, and he quotes the evidence of the photographs of *Amphipleura pellucida*, given in Spitta's Microscopy, as practical confirmations of his theoretical values.

The author is of opinion that the $\frac{1}{12}$-in. homogeneous immersion objective usually sold cannot be improved upon, either in aperture or in power. He concludes by advising a student to equip himself with a low aperture for the usual $\frac{2}{3}$ in. (16 mm.) objectives, one of N.A. 0·65 to 0·75 for the $\frac{1}{6}$-in. (4·2 mm.), and one of as high as he can afford for the $\frac{1}{12}$ in. (2 mm. oil-immersion. From the last alone he will expect the utmost resolution. The others will show him all that the eyes can see without unduly forcing them by high oculars, and altogether he will have a battery that will save his eyesight, his patience and his pocket, and that will, above all, never disappoint him, or fail to show him all that can be shown. The specialist may go a step farther and obtain a $\frac{1}{16}$-in. oil-immersion for the very highest power, not in place of the $\frac{1}{12}$-in., but to supplement it, and to prevent the use of too high an eye-piece.

Relation of Aperture to Power.*—E. A. Hutton's contribution on this subject seems to have initiated a controversy. T. F. Smith, while assenting to many of Hutton's remarks, takes exception to his advice to restrict N.A. to the barely necessary limit. He thinks that there is an advantage in an excess of N.A., and that it is a mistake to limit eye-piece power to 10. A micro-objective with reserve of aperture is a whole battery of lenses in itself, the progress from lower to higher magnification being made by changing the eye-pieces instead of the objectives. Five eye-pieces, ranging from four to twenty-seven powers will give with a $\frac{2}{3}$-in. objective on a 7-in. tube magnifications of from 40 to 270 diameters. As regards a $\frac{1}{12}$-in. oil-immersion Smith has never been able to work advantageously with anything higher than a twelve-power eye-piece calculated upon a 10-in. tube. Hutton's remark that even with a ten-power eye-piece many low-power objectives only give a "foggy glare" unless the illumination is carefully attended to is contrary to Smith's experience, who finds that his low-power objectives only begin to do their work when under a twenty-seven eye-piece.

As regards the increased resolution apparently obtained by micro-photography, it will always be found that details in the photograph can be seen visually in the image when looked for.

Smith supports his views by micro-photographs, and considers that Hutton has overlooked an important property due to reserve of N.A.,

* Knowledge, xxxvi. (1913) pp. 102–5 (4 figs.).

viz. the power of optically separating two structures superimposed upon one another. In the words of Dr. Abbe, a wide aperture then becomes an optical microtome.

Power of a Microscope.*—The English Mechanic quotes the following simple method of finding the magnifying power of a lens, as given by C. W. Nieman in the Scientific American. Take a good watch and measure the exact length of the hour-hand, that is, from the tip to the centre of the pivot. Suppose this is found to be 0·57 in Then the path of the point in twelve hours will be $2\pi\ 0{\cdot}57 = 3{\cdot}58$ in. Therefore the point will move $\frac{1}{100}$ in every 2 min. 1 sec. To the side of the barrel of the Microscope fasten a piece of sheet metal, with a small hole in one end, and bent as shown (fig. 20). The distance between the hole and the centre of the eye-piece must be the same as the distance between the experimenter's eyes. On the table below the hole, fasten a ruler exactly 10 in. below the line joining hole and centre

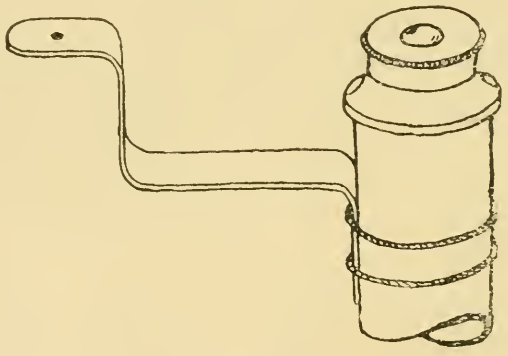


Fig. 20.

of eye-piece. The Microscope is now focused down on to the watch-face, the crystal cover having been removed. If the experimenter looks in the Microscope with one eye and through the hole with the other, the watch-hand and the ruler will appear superposed. Note the exact point on the ruler where the hand is at any instant. Then let 2 min 1 sec. pass, and again note the positions. If the distance moved is 2·5 in. it will mean a magnification of 2·5 in. ÷ 0·01 in. = 250 diameter. A scale may now be constructed on a slip of cardboard, in which every $\frac{1}{4}$ in. will represent $\frac{1}{1000}$ in. in the object. The scale would have to be brought into the field of view and superposed on the object in the same way as the ruler was used.

Dark-ground Illumination.†—A. E. Conrady, as the results of theory and experiment, enumerates the following principles concerning dark-ground resolution. 1. In order to obtain the utmost resolving

* English Mechanic, xcvi. (1913) p. 564 (1 fig.).
† Journ. Quekett Micr. Club, xi. (1912) pp.. 475–80 (2 figs.).

power with dark-ground illumination, the condenser must have not less than three times the N.A. of the objective. As condensers are limited to, say, 1·40 N.A. this means that it is impossible to obtain their fullest resolving power with dark-ground illumination with any objectives over 0·47 N.A. 2. If a dark-ground illumination has an aperture less than that of the objective, then the limit of resolving power of the combination is measured by one quarter of the sum of the numerical apertures of illumination and objective. 3. With dark-ground illumination it is important that the wheel-diaphragm should be only just large enough to secure a dark background, otherwise there may be certain ranges of structure which cannot be resolved, although both finer and coarser ones are visible.

Oblique Illumination in Petrographic Microscope Work.*—F. E. Wright summarizes the methods of obtaining oblique illumination in petrographic work, as follows :—1. By swinging the substage mirror to one side and allowing the light to enter the section under a large angle (condenser and polarizer having been previously removed). 2. By a sliding stop in the lower focal-plane of the condenser. 3. By placing the index finger below the condenser and observing the edge of the shadow which it casts. 4. By means of an opaque strip immediately above the upper lens of the condenser. 5. By use of a sliding stop in the Microscope draw-tube. 6. By a sliding stop in the eye-circle of the ocular.

The author describes in detail the above methods, and discusses their relative merits. He concludes that the methods are not all equally good, either from a theoretical or from a practical standpoint. Theoretically the first three methods are superior to the others ; methods 2 and 3 are also simplest to apply in actual work, and, therefore, are to be adopted in preference to the others.

In discussing the application of oblique illumination to petrography, the author describes the following simple field method for distinguishing calcite and dolomite. The ordinary refractive index, W, of calcite is 1·658 ; that of dolomite 1·682. Grains of calcite immersed in α-monobrom-naphthalene (W = 1·658) show distinct colour fringes ; such colour fringes do not appear along the margins of dolomite grains. To apply the method in the field, two object slides and a small bottle of α-monobrom-naphthalene are necessary. The material to be tested is finely powdered with the hammer, and a small portion immersed in a drop of the α-monobrom-naphthalene on the object-slide. The drop and the immersed powder are then covered with the second object-slide and the whole tilted and examined through a pocket lens pointed towards the sky. Oblique illumination is procured by placing the finger in front of the object-slides (between the glass and the sky). The edge of the finger then appears out of focus and indistinct ; grains of calcite within this semi-dark zone of indistinct focus show the characteristic blue and orange marginal colours, while grains of dolomite appear simply white and dark. Here and there a suggestion of colour is to be ob-

* Amer. Journ. Sci., xxxv. (1913) pp. 63–82.

served, even with the dolomite, but with a little practice the eye becomes accustomed to these differences, and the two substances can be readily distinguished by this method.

Index Ellipsoid (Optical Indicatrix) in Petrographic Microscope Work.*—In considering this matter, F. E. Wright emphasizes the importance of presenting the subject of microscopical petrography consistently from the view-point of the index ellipsoid (optical indicatrix), as applied to wave-front normals. The various optical properties employed in practical petrographic microscopic work can be best described and explained systematically by means of the index ellipsoid. The use of the so-called "axes of elasticity," a, b, c, or X, Y, Z, in this connexion is confusing, and only adds to the difficulties encountered by the observer in mastering the subject. They should accordingly be abandoned, and the French usage of naming the principal axes of the index ellipsoid (α, β, γ, or n_p, n_m, n_g) adopted. This applies in particular to the different modes now in vogue for expressing extinction angles. For a given crystal face an extinction angle is simply the angle between a definite crystallographic direction on the face and one of the axes, α' or γ', of its optic ellipse, and this fact should be indicated in the expression for the extinction angle. To introduce "axes of elasticity" (a, c', or X', Z') in this connexion is not only needless but less direct, as it introduces entirely new conceptions which experience has shown only tend to bewilder the student. Clear concise modes of expression and simple methods of attack are as essential in petrology as in other sciences, whose development is often directly dependent on the care and attention given by its workers to these features.

Media of High Refraction for Refractive Index Determinations with the Microscope; also a set of Permanent Standard Media of Lower Refraction.†—H. E. Merwin has made a number of experimental studies for the purpose of extending the conditions under which determinations of refractive index by means of the Microscope can be made. Such determinations require immersion media of standard refractive index. Various immersion liquids have been in use for the determination of refractive indices over the interval 1·33 to 1·80; mixtures of amorphous sulphur and selenium have been found useful over the range (for sodium light) 2·1 to 2·4. The author's efforts have been devoted to filling the gap 1·80 to 2·10, and to extending the series beyond 2·4 N.A., or, in special cases, particularly when a refractometer is not at hand for standardizing the liquids, to replacing media hitherto used. Although the refractive indices can be determined to three places of decimals, it is seldom that in determinative mineralogical work results closer than 0·01 are of practical use, owing to the complex character of most minerals. For full information the author's directions and statistical tables must be consulted, but the following outline of results may be of service.

* Amer. Journ. Sci. xxxv. (1913) pp. 133–8.
† Journ. Washington Acad. Sci., iii. (1913) pp. 35–40.

Liquids, $n = 1{\cdot}74$ *to* $1{\cdot}87$.—Sulphur and the iodides of tin, arsenic and antimony are dissolved in methylen iodide.

Liquids, $n = 1{\cdot}74$ *to* $2{\cdot}28$.—Arsenic trisulphide is dissolved in methylen iodide, and the solution standardized by means of a goniometer or a spectrometer and a prism.

Resin-like Substances, $n = 1{\cdot}68$ *to* $2{\cdot}10$.—The triodides of arsenic and antimony are dissolved in piperin.

Mixtures of Amorphous Sulphur and Arsenic Trisulphide, $n = 2{\cdot}1$ *to* $2{\cdot}6$.—These mixtures are much lighter-coloured than corresponding ones of sulphur and selenium, but they are less easily standardized and manipulated. They should be used only in cases requiring greater transparency than the sulphur-selenium mixtures.

Permanent Standard Resinous Media, $n = 1{\cdot}546$ *to* $1{\cdot}682$.—Any proportions of piperine and resin form a homogeneous fusion, which cools to a transparent resinous mass.

Permanent Standard Resinous Media, $n = 1{\cdot}510$ *to* $1{\cdot}546$.—This series is prepared from resin and camphor.

Permanent Standard Fluids, $n = 1{\cdot}487$ *to* $1{\cdot}683$.—These are formed from certain organic solids, which form eutectic mixtures melting much below ordinary temperature.

Resolving Power of the Microscope.*—A discussion on the above subject between A. S. Percival and E. Leitz, extending over several numbers of the Lancet, resulted in reaching the following points of agreement. 1. That the smallest distance between two adjacent bars of a grating which can be resolved is given by $d = \frac{\lambda}{a}$. 2. That the formula $d = 0{\cdot}61\,\frac{\lambda}{a}$ is correct when a telescope is employed to resolve the distance between two stars, as in the case of doubles.

(6) Miscellaneous.

Quekett Microscopical Club.—The 486th Ordinary Meeting was held on January 28, 1913, the President, Prof. A. Dendy, F.R.S., in the Chair. W. M. Bale, F.R.M.S. : "Notes on some of the Discoid Diatoms." H. Whitehead, B.Sc. : A paper on "British Fresh-water Rhabdocœlida (Planarians)." E. M. Nelson, F.R.M.S., in a "Note on *Pleurosigma angulatum*," using a Leitz $\frac{1}{12}$ apochromatic of N.A. 1·4, has unmistakably seen in this and allied forms that the apertures in the lower membrane are below the intercostals of the upper and are not "eye-spotted," that is, that the aperture in the lower membrane is directly below the aperture in the upper membrane, as was formerly held to be the case. C. F. Rousselet, F.R.M.S., read a note on "Some Rotifers from Devil's Lake, North Dakota, U.S.A."

The 47th Annual General Meeting was held on February 25, 1913. Prof. A. Dendy, F.R.S., delivered the annual address, and dealt with "By-Products of Organic Evolution." March 25. Messrs. Heron-Allen and Earland on "Some Foraminifera from the southern area of the North Sea." The investigation of six dredgings—three from near the Great

* Lancet, 1911, pp. 253, 1212, 1455.

Fisher Bank, and three from near the Northumberland coast—was undertaken with a view to ascertaining the distribution of *Saccammina sphærica* Sars and *Psammosphæra fusca* Schulze. Mr. D. Bryce, on "Five new species of Bdelloid Rotifers." Of these, four are assigned to the genus *Habrotrocha*, and the fifth to *Callidina*.

B. Technique.*

(1) Collecting Objects, including Culture Processes.

Field Incubator.†—O. Mayer describes a portable incubator, of a total weight of 8540 grm. and external measurements of 46 × 31 × 12 cm., which has been employed in army manœuvres and typhoid investigations, and found to be of service in investigations carried out at a distance from a laboratory base. It consists essentially of two tin boxes, one of which fits inside the other, the intervening space being filled with dry sand heated to 37° C., a thermometer and thermometer-case, an asbestos covering, and a petroleum lamp. The figures show the apparatus ready for use, and before being put together.

Cultivation of the Malarial Parasite.‡—Thomson and McLellan recommend the following procedure. After careful sterilization of the skin, 8 c.cm. of blood are drawn from the median basilic vein, and transferred rapidly to a sterile tube containing 0·1 c.cm. of 50 p.c. dextrose solution. The blood is defibrinated by stirring with a sterile glass rod, and is then incubated at 38° C. The corpuscles settle, leaving clear serum at the top of the fluid. The junction zone containing white and a few red cells, is described as the culture layer, as multiplication of the parasite is found to take place in this situation.

Modification of the Novy-McNeal Medium for Cultivating Trypanosomes.§—A Ponselle records that he has had much success in cultivating *Trypanosoma granulosum* in the following medium: agar 20 grm., tap-water, 1000 c.cm. The melted agar is filtered and is distributed into test-tubes (2 to 3 c.cm. each), and then sterilized. After cooling to about 50° C. it is mixed in the usual way with an equal quantity of defibrinated rabbit's blood and then solidified in slopes. The condensation water was inoculated with the pure (non-citrated) blood of the eel.

(2) Preparing Objects.

Washing Apparatus.‖—For the removal of certain fixing reagents from tissues, W. Yezierski makes use of the apparatus shown in fig. 21.

* 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.

† Centralbl. Bakt., 1te Abt., Orig., lxvii. (1912) pp. 398–400.

‡ Brit. Med. Journ., 1913, i. pp. 130.

§ C.R. Soc. Biol. Paris, lxxiv. (1913) pp. 339–41.

‖ Zeitschr. wiss. Mikrosk., xxix. (1912) pp. 319–20.

The rubber tube *c* connects the water reservoir *d* with the main supply. The reservoir communicates below with glass tubes, to contain the tissues to be treated, closed at the lower ends with gauze. The force of water can thus be easily regulated.

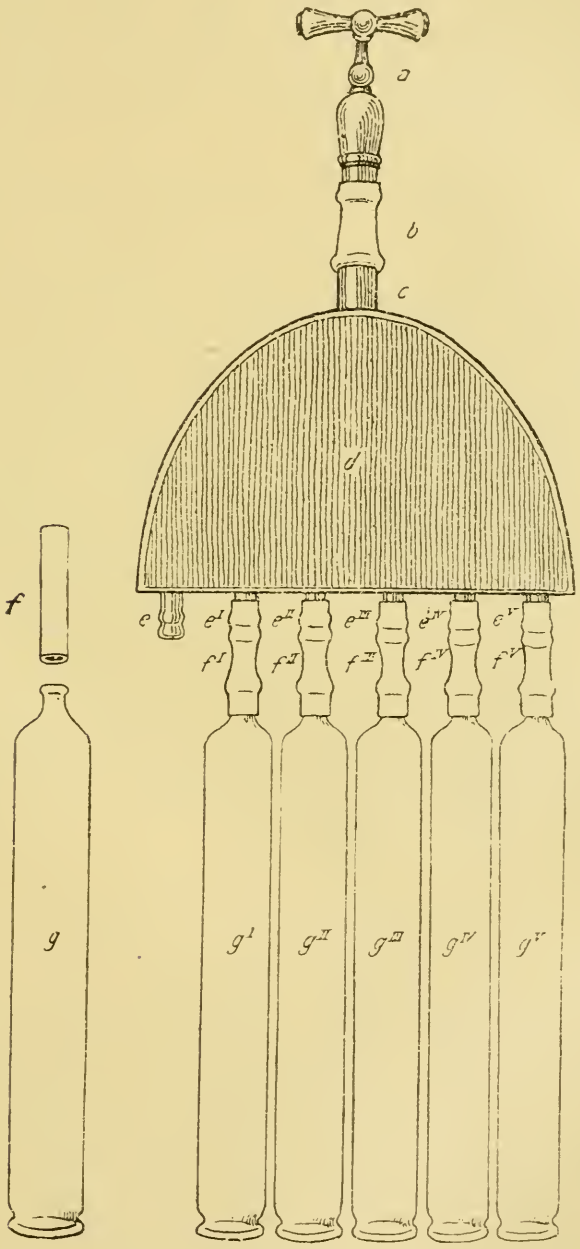


FIG. 21.

Value of Some Histological Methods for Fixing Fatty Bodies.* A. Mayer and colleagues report results of tests applied to fatty tissues

* C.R. Soc. Biol. Paris, lxxiv. (1913) pp. 241-3.

when treated with certain fixatives. They find that Van Gehuchten's fluid (alcohol 60, chloroform 30, acetic acid 10) fixes less than a tenth of the compounds of fatty acids; Lindsay's fluid (bichromate of potassium 2·5 p.c. 70, osmic acid 1 p.c. 10, bichloride of platinum 1 p.c. 15, acetic acid 5) fixes a fifth; the fluids of Laguesse (osmic acid 2 p.c. 4 parts chromic, acid 1 p.c. 8 parts, acetic acid 1 drop) and Regaud (bichromate of potassium 3 p.c., 24 formalin 40 p.c., 6 parts) fix about third, and Müller's fluid a half. The authors infer that the ordinary methods of fixing compounds of fatty acid are inadequate when tissues are treated with alcohol and xylol.

Preparation of Ascaris Ova.*—P. Cerfontaine gives an account of his methods of dealing with the eggs of *Ascaris*, in the preparation of the material for section. After preliminary remarks upon the collection of the material and artificial incubation, by means of which eggs may be obtained at any desired stage of development, he describes the fixing and clearing processes. The eggs are killed by immersion for several hours in a liquid composed of absolute alcohol and glacial acetic acid in equal proportions, to which is added a small quantity of picric acid. They are then transferred to 94 p.c. alcohol. This is changed several times until the yellow colour is lost. Then, after treatment with absolute alcohol, the material is placed in a bath containing 5 c.cm. of essence of cloves and 500 c.cm. of absolute alcohol. This is loosely covered so that the alcohol evaporates slowly. When the fluid reaches a bulk of one-tenth of the original volume, a mixture of 10 c.cm. essence of cloves and 200 c.cm. of absolute alcohol is added, and the same slow concentration is allowed to proceed until one-tenth of the original bulk of fluid is reacted. Then a third mixture (essence of cloves 20 c.cm., collodion 20 c.cm., absolute alcohol 200 c.cm.) is added, and the concentration process repeated. Then the eggs are transferred to cedar wood oil and then embedded in paraffin.

(4) Staining and Injecting.

New Fixing and Staining Methods.†—A. v. Szüts describes improved methods for dealing with certain classes of tissue. For plasma staining he recommends a fixing fluid containing 1 p.c. platinum chloride solution 15 c.cm., formalin 15 c.cm., concentrated sublimate solution 30 c.cm. After 16 to 24 hours fixation, the tissue is well washed in running water and then passed through mounting alcohols. The sublimate is removed by iodine alcohol. The paraffin sections, mounted on albumenized slides, are treated with chloroform and chloroform-alcohol, passed down through alcohols to distilled water and stained with Heidenhain's iron-hæmatoxylin. Then, after washing with distilled water, they are treated with 5 p.c. aluminium acetate for

* Zeitschr. wiss. Mikrosk., xxix. (1912) pp. 305–9.
† Zeitschr. wiss. Mikrosk., xxix. (1912) pp. 289–301.

five hours, again washed, treated for five hours with sodium sulphalizarinate, washed, dehydrated, and mounted.

For reduction of silver, in silver-impregnation processes, formol-glycerin is recommended.

The author discusses Apáthy's gold chloride method of staining nerve-fibril preparations. After prolonged immersion in a gold chloride solution, the sections are placed in a 1 p.c. formic acid solution and exposed to bright sunlight. In view of the uncertainty caused by possible failure of sunlight, it is recommended that the whole process should be repeated twice. Good results have thus been obtained.

In conclusion, the author gives a detailed discussion of Cajal's silver methods and of certain modifications.

Methods for Demonstrating Nuclear Structure.*—H. Raabe has carried out a research upon the nuclear division of *Amœbidium parasiticum*, and has found certain fixing and staining methods of service. For fixing the preparations he recommends the use of Schaudinn's fluid; for staining, Delafield's or Böhmer's hæmatoxylin, picrocarmin, Unna, Pappenheim, and Romanowsky stains were employed. The most useful was hæmatoxylin, applied according to the method of Siedlecki. After staining for 24 hours, the preparation was decolorized in 50 p.c. acid alcohol and then immersed in 50 p.c. alcohol containing ammonia. Good results were also obtained when the acid was not neutralized by subsequent alkaline treatment.

Staining Plasma-cells.†—By the use of a staining-fluid containing acridin red (Grübler), L. Stropeni has obtained good results. The tissue is fixed in alcohol, sublimate or Zenker's fluid, and thoroughly washed in running water. After embedding and cutting, the sections are fixed to slides, and the paraffin is removed in the usual manner. They are then treated for thirty to forty-five minutes with the stain (methyl-green 0·05, acridin-red 0·25, methyl-alcohol 30, glycerin 20, 1–2 p.c. phenol solution to 100), decolorized rapidly with absolute alcohol, treated with xylol, and mounted in balsam.

New Method of Staining the Tubercle Bacillus.‡—T. Ishiwara stains with petrol-ether-carbol-fuchsin, decolorizes with 25 p.c. nitric acid, and afterwards with 70 p.c. alcohol, and subsequently stains with aqueous saturated solution of methylen-blue.

The petrol-ether is shaken up with distilled water (1 to 3), and then filtered. To the filtrate one-fourth of its volume of carbol-fuchsin is added.

It is claimed that the granular appearance of the tubercle bacillus is well demonstrated by this method.

In an addendum the author gives the following modification of the

* Arch. Zool. Expér., x. (1912) pp. 371–98.
† Zeitschr. wiss. Mikrosk., xxix. (1912) pp. 302–5.
‡ Centralbl. Bakt., lxviii. (1913) p. 113.

foregoing precedure. Stain with the aid of heat by means of the petrol-ether-carbol-fuchsin solution. Then treat for 5 minutes with iodo-potassic iodide solution. Decolorize for 10 seconds in 3 p.c. hydrochloric acid, wash in aceton-alcohol (equal parts) until no more colour comes away. Contrast stain with 2 p.c. safranin solution.

(6) Miscellaneous.

Biochromo-reaction for Diagnosis of Typhoid Bacilli.*—In order to facilitate the recognition of typhoid bacilli in fæces, water, etc., Botelho has devised an application of the principles of vital staining and agglutination. A dilution of the material to be examined is treated with a blue stain ; a suspension of known typhoid bacilli is treated with a red stain. Serial dilutions of a standard typhoid agglutinating serum in a gum solution are prepared. By means of a platinum needle portions of the known and the unknown suspensions are added to drops of the dilutions of the agglutinating serum, the blue and the red bacilli are side by side in this fluid. If agglutination of red and blue bacilli together be observed, the reaction is said to be positive. Separate agglutinations of the known typhoid and of the unknown organisms is interpreted as negative, the blue agglutination being regarded as non-specific clumping. Only when organisms from the two sources, distinguished by their staining, appear together in a clump, may the presence of typhoid bacilli in the material under investigation be inferred.

Metallography, etc.

Iron-carbon Alloys.†—Wittorf's investigations upon the iron-carbon equilibrium in the hypereutectic region are summarized by Belaiew. By observations of the phenomena occurring when iron is heated with excess of carbon at temperatures up to 2600° C., and by microscopic examination of melts quenched from different temperatures, the existence of three phases which are probably compounds having the formulæ FeC_2, FeC, Fe_4C, has been established. FeC_2 in the form of primary crystals is silvery grey in colour, is attacked slowly by 20 p.c. nitric acid in water, and deposits copper from a dilute solution of copper sulphate.

System Iron-iron sulphide.‡—R. Loebe and E. Becker have investigated the Fe-FeS system thermally, and describe the structure of numerous alloys prepared. Alloys containing 64 and 74 p.c. FeS, after

* C.R. Soc. Biol. Paris, lxxiii. (1912) pp. 692–4.

† Rev. Métallurgie, ix. (1912) pp. 600–17 (26 figs.) See also Vorläufige Versuche über primäre Kristallisation und nachfolgende physikalisch-chemische Umwandlungen im Systeme: Eisen-Kohlenstoff mit über 4% Kohlenstoff, N. M. Wittorf, Zeitschr. Anorg. Chem., lxxix. (1912) pp. 1–70 (42 figs.).

‡ Zeitschr. Anorg. Chem., lxxvii. (1912) pp. 301–19 (24 figs.).

heating in an oxidizing atmosphere, were observed to contain, in addition to the two constituents normally present, a third which formed a network upon the Fe-FeS eutectic. This appearance is due to the entry of oxygen into the binary eutectic, and it is suggested that the red-shortness in iron containing sulphur is due to oxidation of the Fe-FeS eutectic.

Chemical Method for Investigation of Alloys.* —A. Portevin points out two possible sources of error, in addition to those which have been indicated previously, in the determination of the composition of compounds by analysis of the residues obtained when alloys are chemically acted upon by reagents. A single crystal, of a definite compound, may in its growth completely enclose within itself a portion of the still liquid alloy, differing considerably in composition from the crystal. Photomicrographs of a crystal of Cu_3Sn in a bearing metal, and a crystal of antimony in a copper-antimony alloy, are given: in each case the crystal contains a kernel of eutectic. If, during the solidification of an alloy, primary crystals A react with the liquid L giving a compound C, the compound C may form a complete envelope round A, preventing further reaction of A with L. Thus in the solid alloy, the C crystals contain a kernel of A.

Copper-zinc Alloys: the β Constituent.†—H. C. H. Carpenter has made further attempts to cause a visible separation of the β structure of the pure α and γ eutectoid alloy, into α and γ. No annealing, however prolonged, will effect this separation. A section of pure apparent β alloy was heated at 420° C., with its polished face in contact with the polished face of a section of a eutectoid alloy containing 0·95 p.c. vanadium, which contained its α and γ in a coarse crystalline form. Incipient resolution of the pure eutectoid resulted from this inoculation, and a further prolonged annealing of the pure eutectoid alone caused the formation of coarse segregations of α and γ. A lamellar resolution of pure β was never observed.

The structure of alloys of β composition, to which different percentages of various common metals had been added, was investigated. The effect upon the structural stability of the apparent β constituent was slight when the added metal was bismuth, lead, chromium, manganese, or iron, while aluminium, antimony, tin, silicon, and vanadium aid the precipitation of visible α and γ from apparent β. In general, the structural stability of apparent β is at a maximum when no impurities are present.

Annealing of Quenched Aluminium Bronze.‡—An alloy of 90 p.c. copper and 10 p.c. aluminium consists of a eutectoid, together with excess of the α constituent. Quenching from a temperature above the critical point causes the replacement of the eutectoid by a "martensitic"

* Rev. Métallurgie, ix. (1912) pp. 884–90 (6 figs.).
† Journ. Inst. Metals, viii. (1912, 2) pp. 51–85 (24 figs.).
‡ Comptes Rendus, cliv. (1912) pp. 510–14(2 figs.).

constituent with an acicular structure. Raising the quenching temperature results in the diminution and ultimate disappearance of the α constituent, the alloy quenched from a sufficiently high temperature consisting wholly of the acicular constituent. A. Portevin and G. Arnou find that when such homogeneous quenched specimens are re-heated to temperatures below the critical point, the α constituent separates out along the planes which appear as needles in etched sections. In this behaviour the copper-aluminium alloys differ from the iron-carbon alloys (steel) with which they have many points of resemblance.

Structure of Hardened Steel.*—H. Hanemann gives a detailed description of the mode of formation and the structure of the various constituents of hardened and re-heated steels. A series of excellent photomicrographs illustrates the descriptions. Austenite is a solid solution of carbide in γ-iron. In etched sections it appears as uniform areas with a roughened texture, white to black, showing twinning, and having rectilinear grain boundaries. Martensite is a solid solution of carbide in β-iron, and has an acicular structure, containing deep-lying needles appearing dark or raised needles appearing light. Strictly speaking, the term martensite should be restricted to the needles, but it is convenient and usual to describe an acicular area, including the ground mass as well as the needles, as martensite. Definitions of hardenite, osmondite, troostite, sorbite, and ledeburite are also given.

Structure of Alloy Steels.†—F. Fettweis describes the microstructure of a number of steels containing large percentages of chromium and tungsten, separately or together. Alcoholic solutions of acids were useless as etching reagents; copper-ammonium chloride solution was good, and sulphurous acid was better still. The carbide in the so-called carbide steels originates in a eutectic corresponding to the ledeburite of iron-carbon alloys. High contents of chromium, or of chromium and tungsten together, reduce the carbon content of the solid solution which first separates from the melt to such an extent that the "ledeburite" eutectic is formed even when the total percentage of carbon in the steel is low.

Slag Inclusions in Steel.‡—G. Mars gives photomicrographs showing the inclusions found in small sample ingots of steel, made by the acid and basic open hearth, basic Bessemer, crucible, and electric furnace processes. The samples were taken from the bath at different stages before the end of the process.

F. Pacher§ discusses this subject at some length, and gives photomicrographs, some of which are of fractures which show the effects of the presence of slag inclusions.

* Stahl und Eisen, xxxii. (1912) pp. 1397–1404, 1490–4 (36 figs.).
† Stahl und Eisen, xxxii. (1912) pp. 1866-9 (36 figs.).
‡ Stahl und Eisen, xxxii. (1912) pp. 1557–63 (24 figs.).
§ Stahl und Eisen, xxxii. (1912) pp. 1647–53 (17 figs.).

VII.—*Convection-Current Circulation in Laboratory Aquaria: an Aid to the Rearing of Pelagic Larvæ.*

By James F. Gemmill, M.A. M.D., D.Sc.

Lecturer in Embryology, Glasgow University, and in Zoology, Glasgow Provincial Training College.

(*Read February* 19, 1913.)

Plate XI.

The following arrangement provides a simple and effective method of ensuring gentle circulation and aeration, as well as cooling, either in a single small laboratory aquarium, or in a series of such aquaria. It can be applied wherever the temperature of the ordinary tap water is some degrees lower than that of the interior of the laboratory, a condition which practically always exists.

What follows will be made clear by a reference to Plate XI. Cool tap water circulates through one or more U tubes of glass and then either runs to waste, or can be employed, if necessary, to work a low pressure intermittent aerating apparatus.* The U tubes dip down from above for some distance into the middle of the aquaria, and cool the water in immediate contact with their surfaces. A downward convection-current from top to bottom is thereby caused in the middle of each aquarium. A compensating upward convection-current occurs everywhere in the layer of water close to the aquarium wall, this wall being exposed to the higher temperature of the laboratory. So much surface water is carried down in the descending stream, that adequate oxygenation of the whole volume is ensured.

For the most part I employed, as aquaria, tall beakers of flint-glass, holding rather more than half a gallon when filled up to about 9 in. from the bottom. These make very good convection-current aquaria, since the thin glass readily conducts heat from the outside to the contained water. The U tubes were of ordinary glass tubing $\frac{1}{2}$ in. in external diameter, and they dipped down $4\frac{1}{2}$ in. into the water, leaving the same distance between their lower ends and the bottom of the vessels. So far, I have only been working with salt water aquaria, but the same results should be produced in fresh water as well.

* See this Journal, 1910, p. 11.

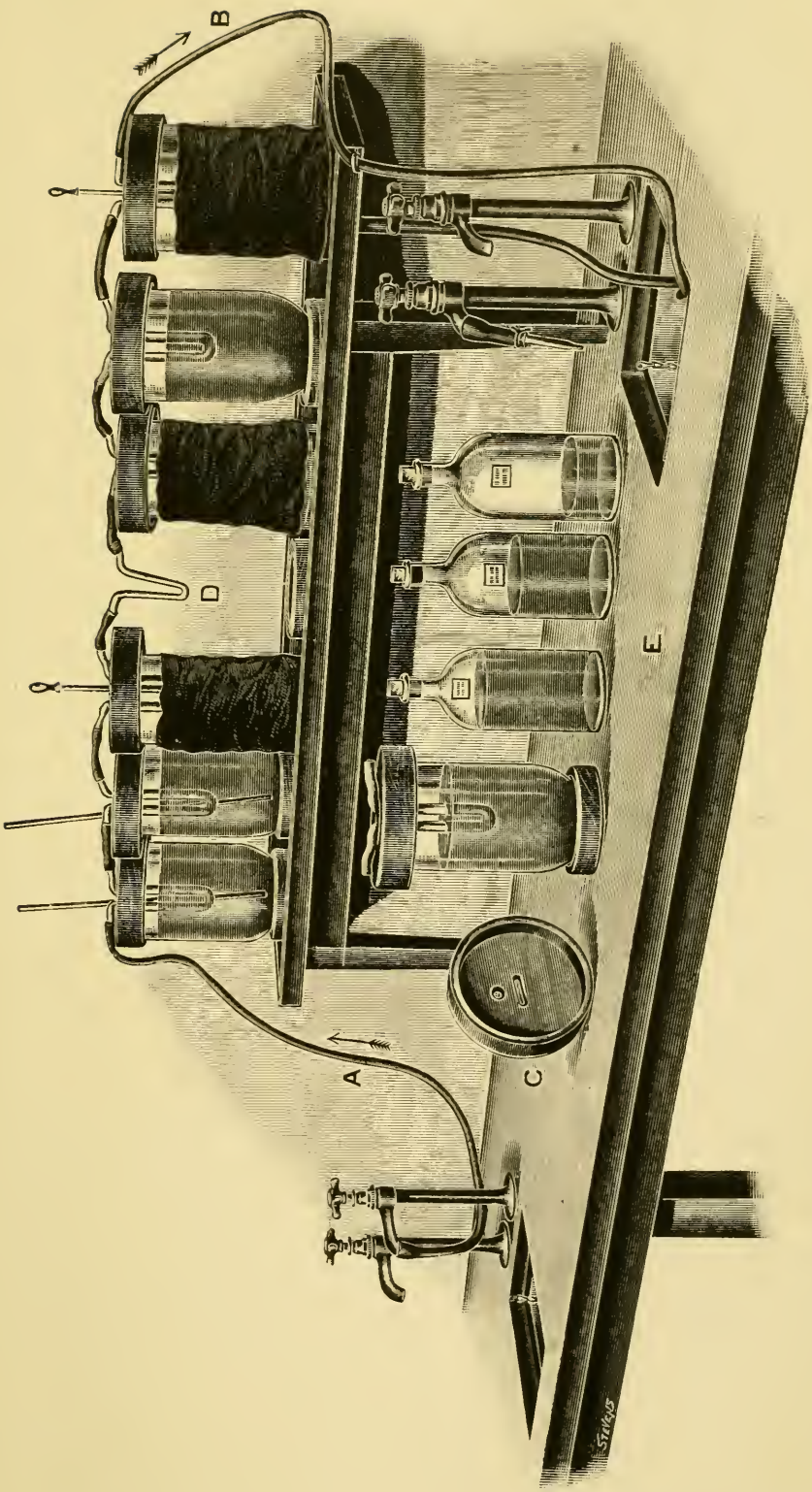
On an average the temperature of the water running to waste was only $1\frac{1}{2}$° F. higher than when it left the tap.

Date	Temperature of Laboratory	Temperature of Tap Water	Temperature of Water in Aquaria
1911			
May 3	50° F.	42° F.	46° F.
May 7	56°	44°	50°
May 18	58°	46°	52°

Various things may serve to demonstrate the currents, for example small larvæ or fine suspended particles. Perhaps the best is a strong solution of some colouring matter, e.g. fuchsin dissolved in salt water. If a drop or two of such a solution is brought gently from a pipette close to the U-tube, one can watch the colouring matter being drawn slowly downwards in a long streak following the tube and then leaving the tube at the middle of the bend to strike rapidly straight down to the bottom. The method will also show the gradual spreading out of the tinctured water over the bottom of the vessel, and the tendency to slow upward return on the inner side of the vessel walls. Again, the concentrated stain introduced gently into any part of the aquarium will be found, within a comparatively short time, to have become evenly distributed throughout the water, while the same stain thus introduced into a similar aquarium without the convection arrangement may take a day or more to reach an equal state of diffusion.

From a practical point of view the following data regarding the effect of these currents in moving small floating larvæ may be of interest. The larvæ referred to were healthy swarming starfish gastrulæ. The time taken to carry down larvæ from near the surface close to the U-tube was approximately 24 seconds for the first 2 in. The next 2 in. were done in 18 seconds, the next 2 in 12, the next 2 in about 7, while the last inch of the downward course was hurried over in little more than 2 seconds. The total time from top to bottom was thus something like 63 seconds. At the top the current is slow and indefinite; lower down it becomes quicker and more restricted in area, while near the bottom it is a narrow and relatively rapid central stream.

It will readily be understood that the currents are unable in the end to keep débris or dead larvæ, or larvæ that have lost vitality, from settling on the bottom. Although these objects might all be set a-going at places where the currents are strongest, still they soon find opportunity of sinking down in intermediate areas where the currents are too weak to keep them on the move.



[*To face p.* 248.

Large beakers of flint glass are somewhat easily broken, and accordingly, in fitting up my present permanent arrangement, I employed the knobless bell jars known as wreath-covers. The glass is comparatively thin, and the rounded bottom facilitates equal dispersion of the downward central current, no stagnant corners being left. These bell jars were about 10 in. high, held a little more than half a gallon of sea-water, and were set on soles of compressed cork. As they have rather thicker walls than the flint glass beakers, the convection currents are not quite so strong, but they sufficed for the health of my cultures.

The particular advantage of the arrangement described above is that delicate floating larvæ are protected from possible mechanical injury such as is entailed by the use of a stream of air-bubbles or sometimes even of a Brown's plunger. At the same time the method lends itself well to isolation of the aquaria from infections, even those carried by the air. The method can be used for larger or smaller vessels, and a great many of these can be linked on in the same series.

The amount of tap water employed is not great. I estimated it at 90–100 gallons per day, at the time when the previously given data regarding currents and temperatures were recorded.

The apparatus has already proved useful along various lines, but perhaps the best testimony to its efficiency is that it enabled me last summer at Glasgow University to rear *Asterias rubens* from an artificial fertilization right through metamorphosis in one or two single aquaria of the size described above, without changing the water in each more than three times during the whole six or seven weeks that elapsed from the time when the larvæ were put in as swarming blastulæ, until metamorphosis was complete. Of course, great pains were taken in other directions, in order to secure healthy cultures to begin with, and to feed the larvæ properly, but the account of these will better be included in a paper I hope to publish on the development of the species in question.

The convection-current method cannot be expected to take the place of air-bubble aeration for aquaria containing larger sessile animals, or the larger and hardier free-swimming animals or larvæ. But wherever small animals are being kept with a view to their spawning if their eggs and larvæ are minute and pelagic, or wherever broods of small floating larvæ have to be reared, or delicate plankton objects to be kept alive, I think that the method in question, suitably applied to meet particular needs, is likely to prove of use.

MICROSCOPY.

A. Instruments, Accessories, etc.*

(1) Stands.

Watson's Philatelic Microscope.†—This Microscope (fig. 38) has been specially designed by W. Harold S. Cheavin, F.R.M.S., for the purposes of investigations connected with postage stamps. The instrument

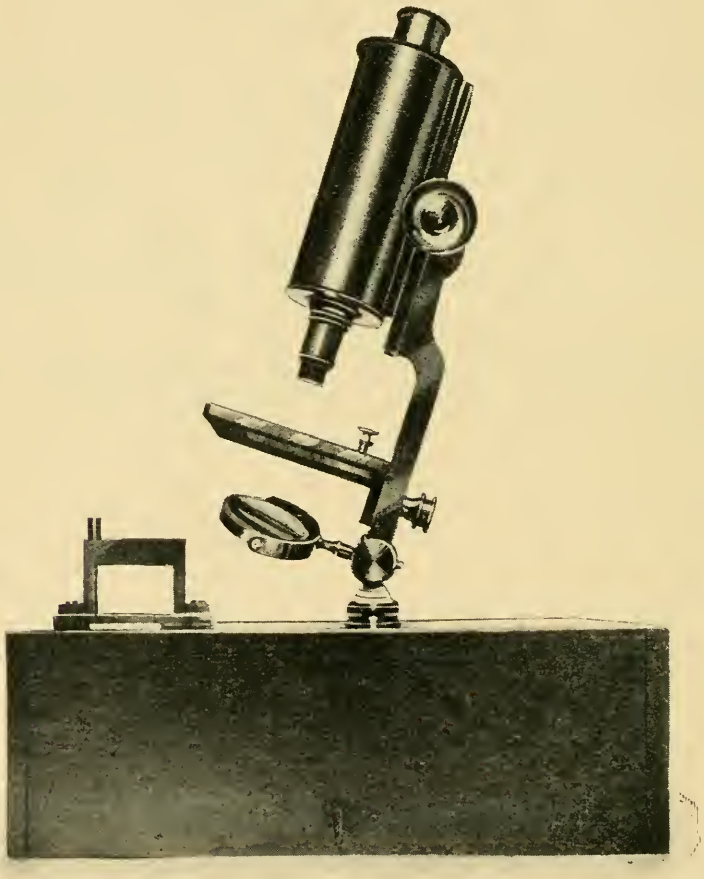


Fig. 38.—Philatelic Microscope mounted in socket on side of case.

was exhibited and a communication on its various uses, along with results, was read before a meeting ‡ of the Society on Nov. 20th, 1912. Various reasons were put forward to show why the special design was

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

† Watson's Special Circular, 1912, 4 pp. (2 figs.).

‡ See this Journal, 1912, p. 671.

necessary, and these were compared with the features of the more elaborate types of Microscopes. By simple photomicrography methods, the philatelist can photograph any surface feature found in the various dies used, and, of more importance still, can produce photomicrographs of watermarks in postage-stamps. For the investigations of papers used for making postage-stamps and in numerous other ways, the instrument will be found useful. The Philatelic Microscope will be found to give a range of 7 to 150 diameters for both visual and photographic work. Primarily the Philatelic Microscope has been produced specially for Philatelic work, but it can be used in many other branches of microscopy with great success, especially in the examination of large sec-

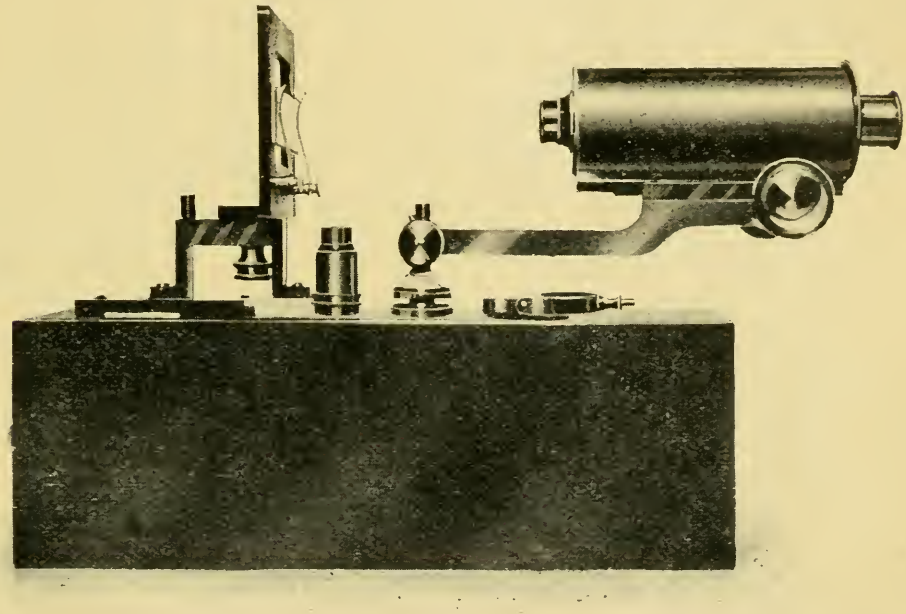


FIG. 39.—Philatelic Microscope, with Mirror removed, in position for examination of water-marks or for photographic purposes.

tions and specimens. The height, when the body tube is racked down to its lowest point, measures 9 in., and when fully extended measures $12\frac{1}{2}$ in. from the base of the box. The containing case measures $10\frac{3}{4} \times 4\frac{1}{8} \times 3\frac{1}{4}$ in. internally, and $11 \times 5\frac{1}{2} \times 4\frac{7}{8}$ in. externally. The body-tube measures 6 in. long and in diameter just over 2 in., a wide body-tube being more suitable for Philatelic work. The limb or arm has been made specially long to allow for a long rackwork extension when low power objectives are used. The foot comprises a conical peg which fits into a cone-shaped slot, fixed on the side of the box; the base of the limb is inclinable, which allows the instrument to be used in almost any position, especially when used for photomicrography. The mirror is of double form and can be removed out of its socket. The coarse-adjustment is controlled by two large milled-head screws as found in ordinary instruments, along with diagonal rackwork and pinion. The stage, of large size, 4 in. square and plain type, fits into the limb of the Microscope, and is held in position by means of a large screw.

The opening in the stage measures 2 in. square, to allow for the examination of large specimens. Holes are provided to receive the peg of the mirror when the latter is required for use in super-illumination. A sliding bar fits at the top end of the containing case in a special groove for the purpose, and can be removed when not required ; this is a new feature, and is of great service when extremely low power objectives are used in photomicrographical work, especially the 4-in. The stage can be removed from the limb of the Microscope, and fitted into this bar and screwed into position (fig. 39).

*Methods of Working.**—The postage stamps can be examined visually by placing them on the ordinary 3 × 1 glass slips, and in photomicrography by using a very thin square cover-glass placed over the specimen on the glass slip. For surface features reflected light is used, both for visual and photographic purposes, but for watermarks transmitted light is used, and the specimen is photographed with the gum side turned towards the sensitive plate. An eyepiece × 5 is the one recommended for this kind of work. Objectives of all kinds can be fitted to the instrument, and for surface features the 2-in. and 3-in. parachromatic form are recommended ; for watermarks, cancellations, overprints, the 4-in. parachromatic is used. The Philatelic Microscope has been fitted with the standard threads of the R.M.S. gauge.

John Cuthbert's Reflecting Microscope : Correction.—The figures illustrating this instrument are transposed. *For* fig. 5, p. 99, *read* fig. 6 ; and *for* fig. 6, p. 100, *read* fig. 5.

Old Microscope by Andrew Pritchard : Correction.—On p. 101, line 1, *for* turret *read* Turrell.

(3) Illuminating and other Apparatus.

Leitz' Aplanatic and Achromatic Condenser : also its use as an Apertometer.†—C. Metz describes this auxiliary, which is intended to be applicable either to bright-ground or dark-ground illumination. As fig. 40 shows, the condenser consists of a pair of double lenses cemented together and separated by a meniscus, with a hemisphere as a front lens. In its construction it resembles an oil-immersion objective. It is, in fact, an immersion system, but it can be used as a dry condenser, in which case, however, the numerical aperture does not exceed 1·0, because rays of higher aperture are totally reflected at the air-layer separating condenser and object. In addition to possessing spherical and achromatic correction, the condenser also satisfies the sine condition. The focal lengths of the two systems are respectively 14·5 mm. and 9·6 mm., and the available lens aperture is 26 mm. The brightness is in no wise inferior to that of a simple lens condenser of equal lens diameter. The loss of light suffered by absorption at the six lenses is made good by the intense concentration of the light-rays belonging to the various zones. The image attained in the object-plane is sharp and colour-clean.

The manifold requirements which modern dark-ground illumination

* Watson's Catalogue, 1912–13, pp. 20–1.

† Zeitschr. wiss. Mikrosk., xxix. (1913) pp. 553–62 (7 figs.).

imposes on condensers have been carefully borne in mind. Fig. 42 shows the path of the light-beams issuing from the condensers into a fluorescent uranium glass. The good spherical and chromatic correction

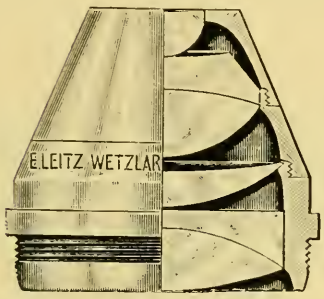


Fig. 40.

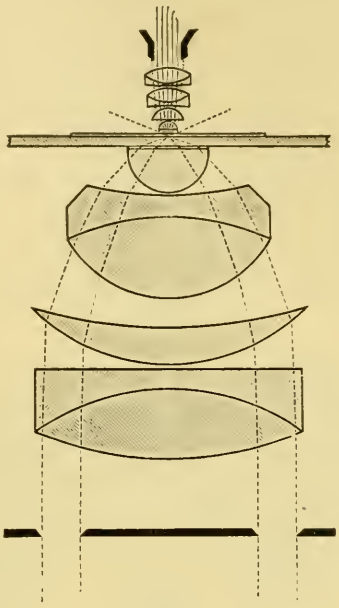


Fig. 41.

and the satisfaction of the sine-condition furnish such an illumination of the object in the dark ground that the images appear undistorted,

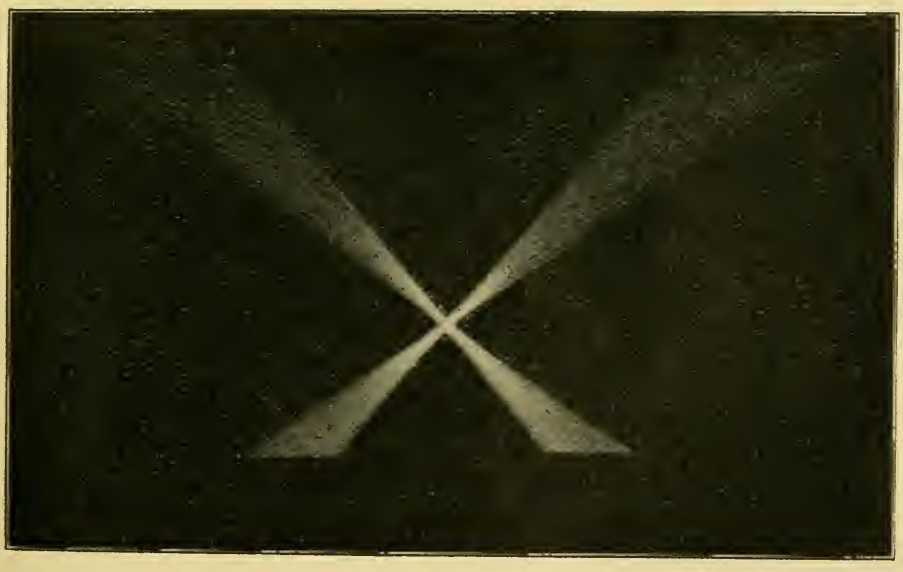


Fig. 42.

colour-clean, and free from disturbing reflexions and refractions. The dark ground is obtained by placing a central diaphragm in the usual way on the carrier of the iris. Fig. 41 shows the ray-paths through the

condenser and oil-immersion. It will be noticed that the first diaphragm in fig. 43 bears the figures 0·85 and 1·33 on its central and peripheral portions respectively. These figures denote the range of apertures for which the condenser is serviceable. With this particular diaphragm, therefore, an objective must be used whose aperture does not exceed 0·85. With stronger objectives the central area of the diaphragm must be enlarged, and this is done by superposing one of the other three stops on the first one, the little hole in the disk fitting on to the pin shown in the centre of the left-hand one. The figures on each denote the aperture of the corresponding objective.

The best light source for dark ground illumination is a specially constructed small arc-lamp, with carbons mutually perpendicular. It requires a current strength of 4 amperes and can be obtained by plug-contact from a domestic installation. The light from this lamp is

Fig. 43.

parallelized by a lens, and then directed on the plane mirror of the Microscope (fig. 44). A hinge on the vertical lamp pillar makes it possible to slope the lamp so that the Microscope mirror is completely filled with light. In the use of dry systems a ground-glass disk should be inserted between lamp and mirror. This has the effect of deepening the contrast between dark ground and bright object. With weak objectives, i.e. up to about aperture 0·4, the condenser should be used dry; but with stronger objectives it should be used as an immersion condenser, and water will usually be found to be a satisfactory medium.

In order to effect quickly a change from dark-ground to light-ground illumination, or vice versa, a special central stop arrangement can be inserted under the iris-carrier of the condenser, and can be quickly slid into and out of action.

The above described condenser can also be used as an apertometer, as will be understood from the following. The effect of the proximity of the iris to the lower focal plane of the condenser is to throw back the image of the iris projected by the condenser almost to infinity. Of this image the objective projects an image close to its lower focal point approximately near to the extreme lens surface facing the ocular. The rays of a beam entering the condenser parallel to the optic axis combine at the front focal point of the condenser; inasmuch as this point practically coincides with the lower focus of the objective, the light-cone

issuing from the objective-focus quits the rear focal plane as an almost parallel beam. The basis of this light-cone appears on the rear objective-plane as a bright circular spot ; thus the iris and the light-circle appear in the same plane. The magnitude of the light-circle is dependent on

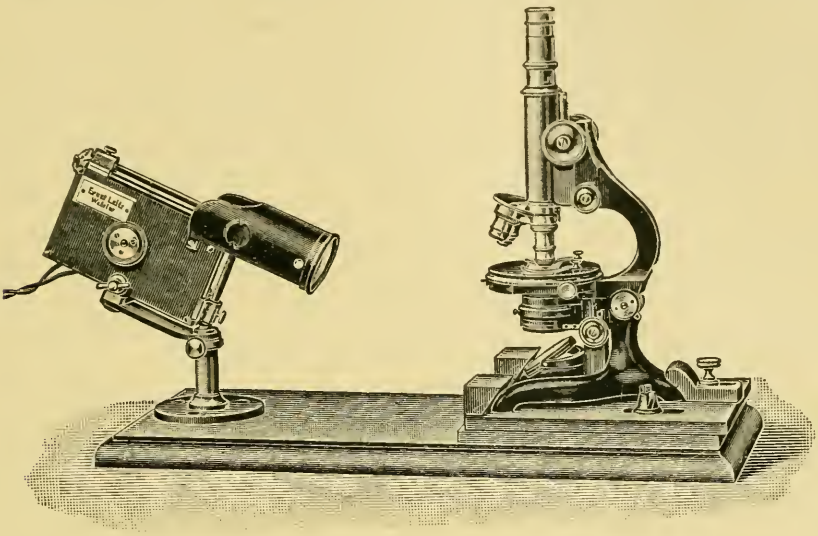


Fig. 44.

the aperture of the objective, and the aperture angle of the objective corresponds to an equal aperture angle of the condenser ; but the aperture angle of the condenser is, again, dependent on the opening of the iris diaphragm. The corresponding aperture of the condenser is

Fig. 45.

calculated according to the opening of the iris, and the aperture of the objective is determined by this known magnitude. The property which especially adapts the condenser as an apertometer is not only the correction of spherical and chromatic aberration, but the attainment of

the sine condition, viz. $h/\sin\phi$ = a constant. With parallel light-incidence this constant is the actual focal length of the condenser ; h is the half-aperture of the iris and $\sin\phi$ is the aperture of the condenser for dry systems, $n\sin\phi$ for immersion systems. The opening of the condenser is, therefore, proportional to the numerical aperture of the condenser and, therefore, also of the objective. On this proportionality of the magnitudes depends the convenient arrangement that marks indicating numerical apertures ; 0·1, 0·2 up to 1·3 are engraved on the rim of the iris at equal intervals (fig. 45). The calculation and attainment of the said range of apertures is therefore, on account of this property, very much facilitated. If a preparation is placed between the condenser and the objective, the emergency angle ϕ of the condenser still becomes the incidence angle of the objective, because object-slide, cover-glass, and intervening space being plane-parallel do not affect the angles, and their materials are unimportant so long as the surrounding media (air, water, oil) remain unchanged.

In determining the aperture the objective is first directed, in the usual way, with plane mirror and diffused light, on to a preparation : the ocular is then removed and the operator, looking directly down the tube, observes the light circle in the rear plane of the objective and opens the iris until the image of the iris-opening coincides with the light circle. The values obtained by this method differ but very little from those attainable by very precise apparatus. The convenience of always having at hand a ready means of noting the conditions of aperture under which a preparation yields its best results, needs no commendation.

Simple Screw-micrometer.*—C. Barus has designed a simple screw-micrometer in which the lugs are made of indurated fibre instead of metal. A mirror-attachment fastened to the end of the screw is an important part of the construction. The author considers that there is no doubt that a screw satisfying the requirements of the interferometer, and trustworthy to about 0·0001 cm. and a length of even 1 ft. or more, could be constructed by the above method. It is necessary to begin with a straight rod for this purpose (or preferably with a tube) of a larger diameter, say 1 or 2 cm. The adjustable mirror at the end should be light. The adjustment screw with orthogonal axes must be of very fine pitch, if the image is to be stationary. Such a screw of low pitch, carefully cut in brass and running in sockets of indurated fibre, can be made in almost any laboratory. The final advantage of this type of micrometer is the fact that the normal of the mirror is necessarily a prolongation of the axis of the screw, and also coincides very nearly with the incident and reflected ray. There are thus no unknown angles between screw-axis and mirror-normal, and exchange of screws is no longer necessary. When a mere comparison of screws is in question, it is sufficient to reduce the play of image in the telescope to a small circle, and this may be done in a few minutes.

Auxiliary Apparatus for facilitating Adjustment of the Microscope.†—The purpose of this apparatus is to reduce the familiar

* Amer. Journ. Sci., xxxv. (1913) pp. 267–9 (2 figs.).
† Zeitschr. wiss. Mikrosk., xxix. (1912) pp. 193–4 (1 fig.).

difficulties experienced in focusing a high-power objective. A small universally adjustable mirror in a circular frame is clamped on to the object-stage, and so orientated that it reflects object and objective to the eye in just such a manner as the eye would see them if it were itself in the plane of the object-stage, and at a suitable distance. The operator can therefore apply himself with confidence to the work of focusing, with occasional glances at the mirror. The distance between objective and object is made much more distinct if a slip of celluloid is inserted behind the objective. The separating air-space then appears as a fine white line.

Dark-ground Illumination.*—"Queketter" states that an effective dark-ground illuminator may be made by placing between the top and next lens of the Abbe illuminator, an opaque disk of such a diameter as will cut off all the rays that directly enter the objective. The simplest way is to take some tinfoil and make a disk within a fraction of the diameter of the upper side of the second lens—that is, the lens immediately behind the front lens—of the condenser. The disk is then rested on the upper side of the second lens and made to stay in position by means of a little immersion oil or similar material. The top lens is then screwed on and placed in immersion contact with the underside of the slide. Now if a $\frac{1}{6}$ or $\frac{1}{8}$ objective be used on the object (which must be mounted in a medium other than air), it will soon be seen whether the object or particles are lit up on a black background. If no light passes, reduce the size of the tinfoil disk and repeat the experiment until the desired effect is obtained. This device gives a result equal to that obtainable with the expensive immersion dark-ground illuminators.

(5) Microscopical Optics and Manipulation.

Application of Optical Methods to Technical Problems of Stress Distribution.† — E. G. Coker describes the advantages as regards cheapness and transparency of nitro-cellulose compounds for the manufacture of models of machinery and mechanical structures. When subjected to loads, strains are set up in the material which, under crossed nicols, reveal themselves as colour fringes. Fig. 46 shows such an example, the coloured parts appearing black in the photograph. The difficulty and expense of procuring large-size nicols, has, however, led to a method of obtaining polarized light on a large scale, and this is applicable to the examination of models of objects such as girders, ships, and bridge-structure. Fig. 47 shows an apparatus of this kind due to Silvanus P. Thompson. Light from a bank of lamps A, is diffused by tissue paper screens B, and afterwards reflected from a black glass plate C set at the polarizing angle. Quarter-wave plates D and E are arranged to produce a circularly polarized field in the object-space F, and for demonstration purposes the analyser is constructed of thin glass plates G, while a small nicol prism is used for quantitative work. This apparatus is capable of affording a clear field of view through quarter-

* Knowledge, xxxvi. (1913) p. 148.

† Nature, No. 2249 (Dec. 5, 1912, pp. 383-6 (6 figs.).

wave plates of nearly a yard in length and a foot in depth, but so far no models of this size have been found necessary. The observations lend themselves to quantitative measurement and graphic illustration, and the lines of strain can be accurately plotted out.

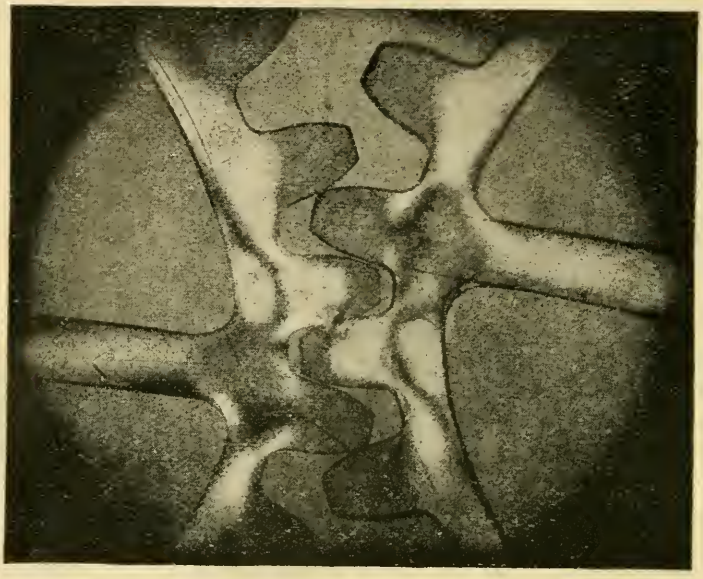


FIG. 46.

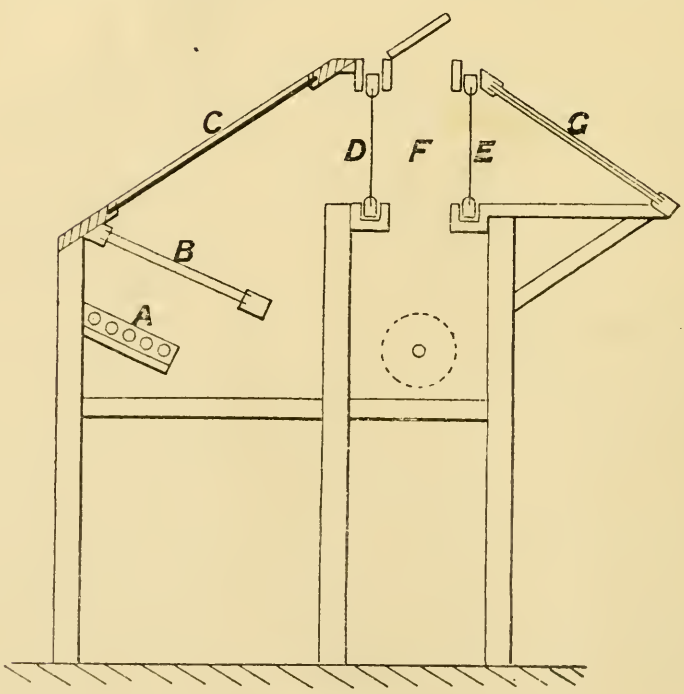


FIG. 47.

Joly's Method of Microscopic Measurement.* — J. Joly suggests the following method of making microscopic measurements by means of the camera-lucida. Two fine lines (fig. 48) are drawn with a drawing-pen in indian ink on a piece of white paper. The camera-lucida is placed in position, and the image of the object under the Microscope referred in the usual manner to the sheet of white paper, which is then shifted till the object appears to fit exactly between the lines. While the object is still in view, a mark is made with a pencil across the lines just where the object is referred. An engraved scale, divided to 0·01 mm., is now substituted for the object, and a few, say n, of the subdivisions brought by the camera-lucida to fit, as before, be-

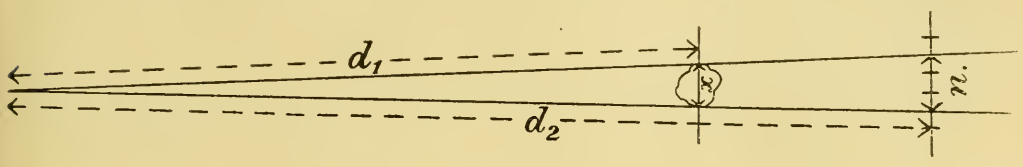


Fig. 48.

tween the lines. This point is also marked on the paper. The distances d_1 d_2 of the two marks from the intersection point of the two lines are then measured, and the diameter x of the object is found from the proportion $x : n :: d_1 : d_2$.

(6) Miscellaneous.

Quekett Microscopical Club.—The 489th Ordinary Meeting was held on April 22. Mr. E. J. Spitta, F.R.A.S., Vice-President, in the Chair.

Mr. C. D. Soar, F.R.M.S., described two new species of water-mites. These were *Arrhenurus scourfieldi* sp. n., from Cornwall, and *Acercus longitarsus* sp. n., from South Devon.

Mr. G. T. Harris, "The Collection and Preservation of the Hydroida."

B. Technique.†

(1) Collecting Objects, including Culture Processes.

Direct Cultivation of Tubercle Bacilli.‡ — K. K. Wedensky describes a method by which tubercle bacilli may be cultivated directly from animal tissues. The apparatus required consists of a number of Erlenmeyer flasks containing 5 p.c. glycerin-broth, short silk threads fastened at one end to small clamps, and sterilized dissecting instruments. The threads are placed in test-tubes and sterilized in dry air. The tuberculous material is removed under the most rigid aseptic or antiseptic conditions, fastened into a sterilized clamp, threaded as above, and suspended in a glycerin-broth flask in such a way that about half the tissue projects above the surface of the liquid. The pieces of tissue so

* Sci. Proc. Roy. Dublin Soc., xiii. (1913) pp. 441–2 (1 fig.).

† 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, preservation fluids, etc.; (6) Miscellaneous.

‡ Centralbl. Bakt., 1te Abt. Orig., lxviii. (1913) pp. 429–31.

treated should be about 0·5 to 1 c.cm. in size. If casual contamination has crept in, the broth becomes turbid within three days. Visible growth of tubercle bacilli usually starts after one or two weeks.

New Medium for Cultivating the Tubercle Bacillus.*—G. Valletti has devised the following medium on which he has obtained a growth of tubercle bacilli in 24–36 hours. It is composed of ordinary agar with bouillon and sodium chloride, but without glycerin. To this are added 2 c.cm. of cow's milk serum, obtained by acidulating milk with a few drops of acetic acid and then boiling it.

New Cultivation Medium.†—A. Rochaix reports most excellent results from the use of the following medium. The juice of carrots (*Daucus carota*) is obtained by pressure. To 800 c.cm. of the juice 200 c.cm. of water are added. To agar prepared in the usual way, the juice is added in the proportion of 30–35 grm. to 1000 c.cm. of the diluted juice. The mixture is heated in the autoclave at 115° for 20–25 minutes. Next it is cleared with white of egg, alkalinized and filtered. After distribution in tubes it is re-sterilized at 108–110°.

The author mentions a number of organisms cultivated in this medium most successfully. It does not favour the growth of staphylococci, Loeffler's bacillus, and pneumococcus.

The addition of 10 p.c. neutral glycerin at 30° to the foregoing medium favours the growth of fungi. The luxuriant growth of the bacillus of tubercle on the glycerinated medium is noted. This medium also serves to distinguish members of the coli-typhoid group and allied bacteria. Thus the coli group forms gas while the typhoid does not. The other non gas-forming bacteria are *B. enteritidis* and *B. fæcalis alkaligenes*.

Deep Sea Bacteriological Water-bottle.‡—D. J. Matthews describes a water-bottle which has been used down to 800 fathoms with complete success. For the details of construction and working, the original should be consulted.

Tests for Human and Bovine Tubercle.§—J. Fraser remarks that there are three tests which give trustworthy evidence of the type of bacilli. 1. Theobald Smith's test. This is glycerin bouillon, to which 0·05 acid is added. In the case of the human bacillus, the degree of acidity progressively increases, while the bovine bacillus diminishes the acidity, and the medium may even become alkaline. 2. Cobbet's test. In this 4 p.c. glycerin is added to Dorset's egg medium. On this the bovine bacillus grows scantily if at all, while the human bacillus spreads rapidly and profusely. 3. The most reliable test is that termed the animal test. It is found that the bovine bacillus is extremely virulent for the rabbit and the calf. If the animal be inoculated with the human bacillus, the disease is limited to a few chronic lesions in the internal organs. If inoculated with bovine tubercle the animal rapidly emaciates, and usually dies in six weeks from acute miliary tuberculosis.

* Centralbl. Bakt., 1te Abt. Orig., lxviii. (1913) pp. 239–41.
† C.R. Soc. Biol. Paris, lxxiv. (1913) pp. 604–7.
‡ Journ. Marine Biol. Assoc., ix. (1913) pp. 525–9 (4 figs.).
§ Brit. Med. Journ. (1913) i. pp. 760–2.

Differentiation of Streptococci.*—H. W. Crowe finds valuable assistance in differentiating certain streptococci by means of Dorset's egg medium, to which neutral-red in the proportion of 0·005 p.c. is added as indicator. The chief points are the colour and shape of the colony, and the effect (if any) on the surrounding medium.

(2) Preparing Objects.

Demonstrating Presence of Protozoa in Soils.†—C. H. Martin mixes a small quantity of the soil with an equal volume of picric acid. The mixture is then placed in a wide dish, carefully stirred and allowed to stand. This allows bacteria, diatoms, and protozoa to come to the surface. Coverslips are then floated on the surface, and afterwards placed in corrosive. The slips are then handled as ordinary smears, and afterwards stained for some time with strong acid-hæmalum, followed by eosin. Clean preparations, showing large numbers of amœbæ and flagellata, are obtained.

(3) Cutting, including Embedding and Microtomes.

Berlin-blue Injection Mass.‡—B. Možejko finds that the presence of sugar prevents clotting or precipitate in injection masses of Berlin-blue gelatin. The author leaves 5 grm. gelatin in 20 grm. distilled water to macerate, and afterwards dissolves it on a water-bath. Meanwhile 5 grm. of ordinary sugar are dissolved in 10 grm. of saturated Berlin-blue solution. This is immediately added to the gelatin ; a perfectly homogeneous solution results. To this are added 100 grm. of saturated Berlin-blue solution. The mass is then filtered.

The author then advises that in order to prevent the decolorization of the pigment, the injected preparation should be fixed in the following solution. Formalin (40 p.c.) 10, alcohol (70 p.c.) 90, nitric acid 5.

After fixation the preparations are to be removed to alcohol, which should be twice changed.

Recent Histological Methods.§—S. v. Apáthy gives an account of the methods of embedding, section-cutting, and mounting employed in his laboratory. The paper consists mainly of a recapitulation of processes previously described, but contain much valuable information upon a large number of minor points. In a short abstract it is only possible to deal with one of the many aspects of the subjects discussed, and possibly the most suitable for reference is the new oil-gelatin method of embedding, by means of which undistorted preparations of intercellular matrix may be obtained. The tissue is placed in glycerin-water (1 : 1) and to this is added an equal volume of gelatin solution. This is left for at least 24 hours in a thermostat at 40° to allow the gelatin to permeate. The subsequent procedures consist of thickening of the gelatin, passing through upgraded alcohols, drying over calcium chloride, hardening in absolute alcohol, and replacing the alcohol by terpinol. The gelatin block may then be treated as celloidin.

* Proc. Roy. Soc. Med. (Path. Sect.) vi. (1913) pp. 117–25 (1 col. pl.).
† Nature, xci. (1913) pp. 111.
‡ Zeitschr. wiss. Mikrosk., xxix. (1913) pp. 516–22.
§ Zeitschr. wiss. Mikrosk., xxix. (1913) pp. 449–515.

Simple Cooler for Use with the Microtome.*—C. Grave and O. C. Glaser describe the above apparatus which they have found of great service. It consists essentially of a hollow truncated pyramid, open at both ends and suspended in an inverted position from a standard, so adjusted that the lower end of the shoot is at a convenient distance above the knife of the microtome. At the upper end of the inverted pyramid, and surrounded by it, is a tray, whose dimensions are less than those of the base of the shoot. This tray is filled with crushed ice, and from one corner of it a drain leads the water to the escape from the lower end of the air-channel. At that point a rubber tube connects the pipe with a suitable receptacle. When the air of the room strikes the melting ice in the tray it is chilled and immediately falls between the tray and the walls of the pyramid. In this a constant stream of cold air pours from the lower end of the shoot, and as this may be placed directly above the paraffin-block and knife-edge, both of these latter are cooled, and so make it possible to cut sections very much thinner than the unmodified temperature of the room would allow. The extent to which it is desirable to cool the paraffin and knife varies with each specific case, but the cooler is adjustable in at least two ways. In the first place, the distance of the block from the end of the shoot can be changed within comparatively wide limits; in the second place, the temperature of the air delivered may be further lowered by the addition of common salt to the ice. The authors record a case in which the material could not be embedded in paraffin of a high melting-point, and it was impossible in the ordinary way to cut sections even as thin as 12 micra. With the aid of the cooler, however, a perfect series 3 micra in thickness was easily prepared from the same block of 45° to 48° paraffin. The dimensions of apparatus are: base, 12·5 × 8·7 in.; truncated apex, 6·1 × 2·1 in.; ice-tray, 8·8 × 3·3 in.

(4) Staining and Injecting.

Demonstrating the Presence of Capsules in Bacteria.†—L. Gózony shows that the capsules of the bacteria of hæmorrhagic septicæmia are readily demonstrated by the indian ink method. Reproductions of photographs of films of *Bacillus avisepticus* and *B. suisepticus* are given.

Differentiation of Cells in the Cerebrospinal Fluid by Alzheimer's Method.‡ — D. K. Henderson and Winifred Muirhead say that the technique of this procedure is not difficult. It consists in centrifuging 3 or 4 c.cm. of the cerebrospinal fluid with double the quantity of 96 p.c. alcohol for from one-half to one hour, depending on speed of the centrifuge. By this means the proteid is coagulated into a hardened plug. It is then still further dehydrated and hardened by means of pouring on absolute alcohol and then equal quantities of absolute alcohol and ether, each for a variable number of hours depending on the thickness of the plug. The plug is then loosened by means of a fine flattened platinum needle embedded in celloidin and cut in sections of 15 μ in thickness.

* Biol. Bull., xix. (1910) pp. 240–2 (1 fig.).
† Centralbl. Bakt. 1te Abt. Orig., lxviii. (1913) pp. 549–7 (3 figs.).
‡ Rev. Neurology and Psychiatry, April 1913.

The section may be stained by Pappenheim's pyronin-methyl-green method or with Unna's polychrome methylen-blue.

The authors modified the foregoing technique by using dextrin as a medium for freezing the celloidin-block and cutting the sections with a freezing microtome. The procedure then was as follows. The plug of cerebrospinal fluid was prepared as above and embedded in 8 p.c. celloidin. When dry the block was immersed in dextrin, made up as follows: dissolve 1 part of dextrin in 2 parts of boiling water, filter through white cotton wool and add 1 p.c. of carbolic acid. The block is left in the dextrin until the following day or until required: this prevents the celloidin from becoming too hard. The block is then sectioned on an ether-freezing microtome. The sections are placed in warm water to remove the dextrin, and then mounted on slides.

The celloidin is then dissolved out, first by methyl-alcohol, then by absolute alcohol, lastly by 75 p.c. alcohol, and stained with pyronin-methyl-green. The sections should not be too thin, as the stain is easily washed out, and the cell differentiation then becomes poor.

New Method of Staining Diphtheria Bacilli.*— Marie Raskin recommends the following stain. Glacial acetic acid 5 c.cm., distilled water 95 c.cm., alcohol (95 p.c.) 100 c.cm., saturated solution methylen-blue 4 c.cm. Ziehl's carbol-fuchsin solution 4 c.cm.

Drop mixture in a thin layer over the smear or film on the cover-glass: heat over flame. The alcohol ignites and is permitted to burn off, after which the specimen is washed in water and dried. The entire process takes 20–25 seconds. The polar bodies are stained blue and the bacilli bright red. Even in smears with a preponderance of other bacteria, individual diphtheria bacilli may be readily identified.

(6) Miscellaneous.

Modified Centrifuge Fitting.†—For the investigation of certain problems in cytological analysis, for studying the viscosity of cytoplasm and the relative density of cytoplasmic inclusions, E. Fauré-Fremiet has applied to the centrifuge a modification which permits of the centrifugalizing of a preparation mounted between slide and cover-slip. In place of the movable ring, which carries the centrifuge tube-holder, there is fitted to the apparatus a rectangular structure, capable of holding a slide of the usual dimensions, and provided with solid stays to prevent lateral movement.

Dilution of Stock Solutions.‡—E. Löwe gives a simple rule for the preparation of dilute solutions of stains and other reagents from a stock solution. Into a measuring cylinder pour of the stock solution a number of cubic centimetres corresponding to the percentage strength of the required dilute solution, and then add of the diluent enough to bring up the total bulk of fluid to a quantity corresponding to the percentage strength of the stock solution. For example: from a 10 p.c. solution to prepare a 3 p.c. solution, put 3 c.cm. of the stock solution into a measuring-glass, and make up with the diluent to 10 c.cm.

* Trans. American Micr. Soc., xxxii. (1913) pp. 74-5.
† C.R. Soc. Biol. Paris, lxxiii. (1913) p. 616.
‡ Zeitschr. wiss. Mikrosk., xxix. (1913) pp. 545–7.

Metallography, etc.

The Silver-zinc Equilibrium.*—H. C. H. Carpenter and W. Whiteley, accepting the accuracy of the liquidus of the silver-zinc system as determined by Heycock and Neville, have determined the boundaries of the solid phases by taking heating and cooling curves, and by microscopically examining specimens, maintained at a given temperature for a period sufficiently long for the attainment of equilibrium, and either quenched or slowly cooled. From 0 to 60 atomic p.c. of zinc the diagram is astonishingly similar to that of the copper-zinc system, and the α, β and γ constituents have microscopic characteristics similar to those of the corresponding phases in the copper-zinc system. On cooling, β undergoes a eutectoid inversion at 264° C. to $\alpha + \gamma$. Alloys in the α range were satisfactorily etched with 25 p.c. aqueous ammonia, to which a few drops of hydrogen peroxide had been added immediately before use.

In an appendix, H. C. H. Carpenter emphasizes the close relationship between the copper-zinc, silver-zinc, and silver-cadmium equilibria, and discusses its theoretical bearing.

Antimony in Copper.†—F. Johnson describes the structure of specimens of copper containing antimony and oxygen together, in different amounts. The oxygen occurs in combination with that part of the antimony which is not in solid solution in the copper, as "oxidules," while oxygen present in excess of that combined with antimony, exists as cuprous oxide, which forms a ternary eutectic with the solid solution and the antimonial "oxidules."

Ternary Alloys of Magnesium, Zinc, and Cadmium.‡—G. Bruni and C. Sandonnini have studied microscopically the numerous alloys used in the thermal investigation of this ternary system, and give detailed descriptions, illustrated with photomicrographs, of the microstructures of both binary and ternary alloys. Nitric acid in amyl-alcohol was found to be a useful etching reagent.

Copper-zinc-nickel Alloys.§—L. Guillet shows that the partial replacement of zinc by nickel in copper-zinc alloys has an effect on microstructure and properties indicated by a "coefficient of equivalence" of nickel of $-1{\cdot}1$ to $-1{\cdot}4$. The effect is much the same as in partially replacing the zinc by copper.

Annealing of Coinage Alloys.‖—T. K. Rose has studied the effect upon scleroscope hardness and microstructure, of annealing cold-rolled specimens of gold, silver, copper, nickel, zinc, and several alloys, at different temperatures for various lengths of time. When the change from the hard to the soft state takes place, re-crystallization occurs almost if not quite simultaneously.

* Int. Zeitschr. Metallographie, iii. (1912) pp. 145–75 (21 figs.).
† Journ. Inst. Metals, viii. (1912, 2) pp. 192–221 (12 figs.).
‡ Zeitschr. Anorg. Chem., lxxviii. (1912) pp. 273–97 (52 figs.).
§ Comptes Rendus, clv. (1912) pp. 1512–14 (4 figs.).
‖ Journ. Inst. Metals, viii. (1912, 2) pp. 86–125 (17 figs.).

Oxygen in Metals and Alloys.*—E. F. Law discusses this subject, and gives photomicrographs of copper and of bronze to show the mode of occurrence of oxides. As a rule, metallic oxides are insoluble in solid metals and alloys, and are found as particles embedded in the metal. The addition of arsenic to copper containing oxygen prevents the formation of the characteristic eutectic structure of copper and cuprous oxide. The oxide occurs in the massive form.

Structure of Electrolytic Copper.†—The microscopic structure of electrolytically deposited copper, and the effect of variation of current density and of concentration of solution have been studied by O. Faust. The crystallites are usually parallel with the direction of the current. Like worked copper, electrolytic copper develops twinned crystals on annealing; this, with other evidence, points to the existence of stress in electrolytic copper.

Formation of Twin Crystals by Quenching.‡—By examination with oblique illumination, with different directions of incidence of the light, C. A. Edwards has shown that the characteristic dark and light acicular structure of quenched aluminium-copper alloys containing 9–16 p.c. aluminium is due to prolific twinning of a homogeneous super-cooled solid solution. In each crystal grain the number of surfaces on which twinning has occurred is very great. The almost identical structure of quenched carbon steels may be due to the same phenomenon of twinning. It is suggested that the hardness associated with the acicular structure in quenched alloys may be due to the formation of large quantities of Beilby's amorphous phase by the mechanical distortion of the solid solutions in twinning and slipping.

Intercrystalline Cohesion in Metals.§—W. Rosenhain and D. Ewen put forward the hypothesis that in pure metals the crystals are enveloped in an amorphous cement, consisting of the pure metal in the form of an undercooled liquid of extremely high viscosity. As such an intercrystalline amorphous cement might be expected to have a vapour-pressure higher than that of the crystalline form, experiments were carried out to determine if, upon heating in a vacuum, a greater loss of weight occurred in fine-grained specimens than in coarse-grained specimens. The fine-grained specimens would naturally contain a greater proportion of the intercrystalline cement. Aluminium, antimony, and cadmium gave inconclusive results, but with copper, silver, and zinc the finely crystalline specimens gave a greater loss of weight on heating in a vacuum, at temperatures up to about 100° C. below their melting points, than coarsely crystalline specimens. The structures developed by "vacuum-etching" and the formation of twinned crystals in silver are described and illustrated by photomicrographs.

* Journ. Inst. Metals, viii. (1912, 2) pp. 222–47 (14 figs.).
† Zeitschr. Anorg. Chem., lxxviii. (1912) pp. 201–12 (20 figs.).
‡ Int. Zeitschr. Metallographie, iii. (1912) pp. 179–94 (11 figs.).
§ Journ. Inst. Metals, viii. (1912, 2) pp. 149–85 (11 figs.).

XIII.—*A Method of Investigating Diatom Structure.* (Preliminary Communication.)

By Hamilton Hartridge, M.A.
Fellow of King's College, Cambridge.

(*Read June* 18, 1913.)

Heretofore the study of Diatoms has been almost limited to the observation under high magnification of the images obtained with various conditions of focus, aperture, and correction of the objective; this has shown the variation the image of a structure may undergo, rather than determined what the structure may be which will yield all the observed images. Abbe suggested a more profitable line of investigation, by directing attention to the relationship between the diatom and the grating. He showed that the study of minute objects is intimately related to the investigation of complex diffraction phenomena, by processes well known in physical optics. In the present research the attempt has been made to carry that suggestion to its logical conclusion, and to investigate the Diatoms by the spectra they set up in the upper focal plane of the objective.

The variation in character and thickness of the markings makes it essential to be able to examine small isolated areas of the valve of known size and position. For this it was found necessary to employ a spectrometer of special design, since it was impossible to rely on chance fractures to provide these areas.

The instrument consisted of the following parts, which will be described in turn :—

1. Monochromatic light source.
2. Condenser.
3. Adjustable slits.
4. Collimator objective system.
5. Grating (*Pleurosigma*).
6. Telescope objective system.
7. Micrometer eyepieces.

Light of standard wave-length was provided by a quartz mercury-vapour lamp, and from it was obtained by transmission through a special absorption filter the brilliant green radiation (5461 A.U.). Filters were, however, provided by which either the yellow (5790 and 5770 A.U.) or the violet (4359 and 4078 A.U.) could be obtained instead. The lamp was enclosed in a light-tight box, which was ventilated by means of a vacuum pump. In the side of the box was mounted a lens, by which a parallel beam of

light was projected on to a large right-angled internal reflexion prism. By this the light was directed vertically upwards through the instrument. The mercury lamp was capable of being run for long periods without attention, but a special switch was provided by which the intensity of the light from the lamp could be, for a short time, very greatly increased.

The parallel beam of light from the lamp, having suffered internal reflexion by the glass prism, was converged by means of a condensing lens on to a small aperture A, which formed part of the collimator; but the light in so doing had to traverse the slits by which the directions of the parallel pencils incident to the grating were ultimately controlled. The number and positions of the slits depended on the type of measurement being made, and will therefore be considered later. The collimator was similar in principle to that used in the ordinary spectroscope; but a more complex lens-system was found to be necessary because, in order to avoid reflexions in the superstage lens-system, the light had to be limited to a portion of one diatom valve. To do this the image of the small aperture A was projected by means of an immersion condenser by Conrady, and supplementary lens, on to the diatom. The supplementary lens was used to shorten and at the same time increase the aperture of the substage lens-system; it had the further property of allowing a more perfect correction of the spherical aberration for the chosen colour to be obtained for the particular cone of the condenser employed. Now for this system to project beams of parallel light on to the diatom, it was found that the slits would have to occupy a position within the triple back lens of the Conrady condenser. The difficulty was, however, avoided by placing the slits below the aperture A and throwing their image instead into the correct position by means of a lens placed immediately beneath the aperture. In this way the beams of light incident on the diatom were rendered strictly parallel.

The reason for the selection of the diatom *Pleurosigma angulatum* for the present research lay in the regularity of its markings. For in order to obtain a record of the positions of the diffracted pencils set up by each individual portion of the diatom valve, it would be essential to be able to examine very small areas. But this is impossible, for two reasons:—

1. The intensity of the beam transmitted would be too small to affect the eye.

2. The diffracted wavelets from several adjacent structural elements must co-operate for well-defined spectra to be formed.

But if no sudden changes take place in the character of the markings, it would be possible by obtaining measurements from comparatively large overlapping areas to calculate the effects of individual elements by a process of differentiation.

Now, as mentioned above, the isolation of these areas was carried out optically, by suitable apparatus applied to the observing telescope; this will now be described. Above an immersion semi-apochromatic objective was mounted a convergent lens, and by these a highly magnified image of the diatom was focused on to a slip of stained gelatin film. This carried at its centre a fine rectangular perforation, and was mounted on an adjustable carrier. The dye with which the gelatin was stained conferred on it the property of being opaque to the green mercury radiation, without affecting its transparency to the yellow or violet. By this means it was possible, by a micrometer eye-piece, exactly to locate the portion of the diatom corresponding to the perforation, using the yellow and violet rays, and then immediately afterwards by simply cutting off these rays with a filter to render the screen opaque, and only to allow therefore those pencils to be transmitted which correspond to the perforation. A few centimetres above the perforation a magnified image of the upper focal plane of the objective was formed, together with the diffracted pencils set up by the area of the diatom corresponding to the perforation; these images could be investigated by a special micrometer eye-piece. The exact technique depended on the measurements being made, and will be separately considered for each case.

The points on which evidence was required were as follows:—

1. The distance between neighbouring structural elements.
2. The angle which a series of these elements make with one another.
3. The contour of the valve as seen in section.
4. The thickness of the siliceous envelope.
5. The character of the markings.
6. The evidence of laminar structure.

The method employed for making each of the above measurements will now be described. Nos. 1 and 2 were carried out simultaneously as follows:—

In the slit-holder was placed a disk of brass bearing two small rectangular apertures. These were situated 8 mm. apart, on opposite sides of the optical axis. Above each was mounted a small glass-plate micrometer, by which the image could be made to shift by small amounts. But the axes of the turn-tables to which the glass plates were fixed were at right angles to one another, so that while one controlled the distance apart of the images, the other changed the angle which they made with an object lying on the stage. The light from these slits was rendered parallel by the collimator and then fell on the diatom, by which a number of diffracted pencils were formed. By slightly rotating the slits, two of these pencils could be made to lie side by side in the centre of the upper focal plane of the objective. And by now adjusting the two glass-plate micrometers, the diffracted images of the slits

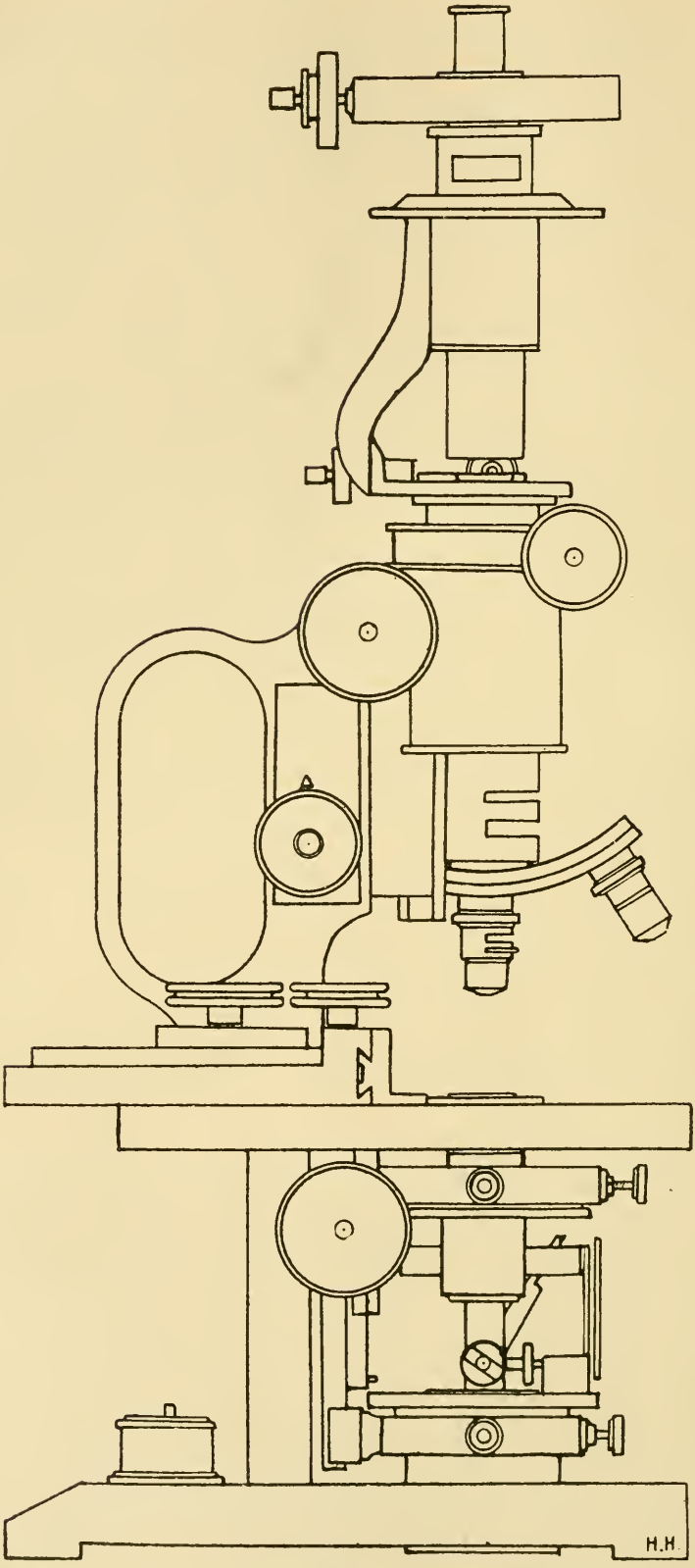
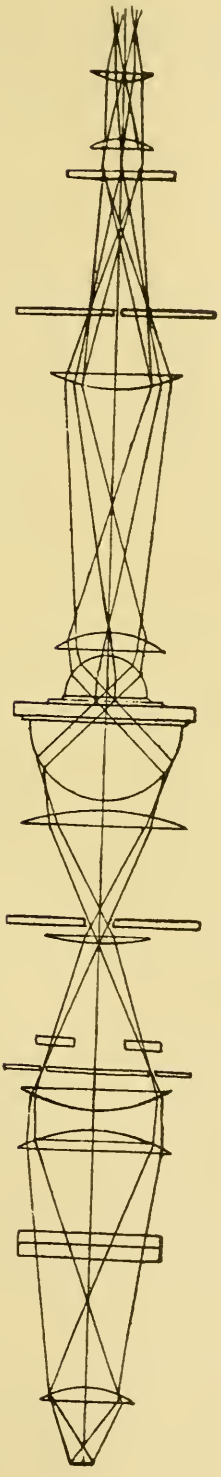


DIAGRAM OF MECHANICAL SYSTEM

Fig. 49.



G. Ramsden Circle.

Ramsden Eyepiece.

S. Micrometer.

G. Adjustable Aperture.

Auxiliary Objective.

S. Plane of Spectra.

Immersion Objective.

G. Slide Pleurosigma.

Conrady Condenser.

S. Images of Stops.

Auxiliary Condenser.

G. Diaphragm A.

Auxiliary Lens.

S. Micrometer Plates.

Slits.

Field Lenses.

Colour Filter.

G. Condenser.

S. Mercury Lamp.

Planes Co-ordinate to Grating, and Slits, are marked G. and S. respectively.

DIAGRAM OF OPTICAL SYSTEM

FIG. 50.

could be made to lie in one straight line, with their edges approximated. When this is the case, the distance s between neighbouring structural elements can be found from the following formula :—

$$s = \frac{2\lambda}{\text{N.A.}}$$

Where λ is the wave-length of the light used for making the measurements.

The theory of the glass-plate micrometer in its application to this type of measurement, has been considered in a previous paper.* In the present research the values of the micrometer scales were previously ascertained by comparing the readings with a standard apertometer and goniometer respectively, by means of a micrometer eyepiece ; the exact method is described elsewhere in this Journal.† Having calibrated the scales in this way, the measurement of successive small areas of diatom were very quickly obtained.

Now the necessity of examining such small portions of the valve, leads, as has been mentioned above, to two difficulties : (1) the spectra formed are of very low intensity ; (2) they have ill-defined borders. The first difficulty was avoided by the use of a very brilliant light source, and by working in a dark room. The second was rendered of little account by the particular method used for making the measurements ; for it was found that two diffracted pencils with edges of the same indefiniteness could be placed in line with almost the same accuracy as if the edges of both were sharp. A similar observation had been made previously when using the method for the measurement of absorption bands. But even so it was found advisable to use an area not less than 10 markings wide at a time, and to use 16 wherever possible.

The technique employed for measuring the contour of the diatom valve as seen in section, depended on the relationship which exists between the angle of incidence of the beam of light on to the grating surface, and the angle of emergence of the diffracted wavelets. The relationship may be expressed as follows :—

If i be the angle of incidence, and d and d' the angles of diffraction of the beams on either side of the normal to the grating surface, then

$$\frac{\lambda}{D} = \sin i + \sin (d - i),$$

and

$$\frac{\lambda}{D} = \sin (d' + i) - \sin i$$

where λ and D have their usual significance.

Now it was found, although the above equations are both

* Journ. Physiol., xliv. (1912) p. 1. † See *ante*, p. 363.

dependent on D, that the ratio of sin d to sin d' underwent but little variation; so that where there was evidence of the period of the markings being approximately regular, the method would give results of sufficient accuracy to fall within the limits of the experimental error.

The measurements were carried out as follows. The apparatus having been set up as for the first series of measurements, a small axial beam of parallel light was caused to fall on to the diatom. Above the movable screen was placed the micrometer eyepiece, and by this the distance between the first order spectra and the direct beam could be estimated; in the present case the observations were limited to those spectra lying at right angles to the long axis of the diatom. The readings were, as before, obtained in terms of N.A., and the ratio of sin d to sin d' at once obtained by division. Reference to the graph then gave the angle at which the area of diatom examined lay.

To determine the exact character of the markings of the diatom valve is a matter of some complexity requiring the accumulated evidence of several modes of investigation: certain of these will now receive consideration. At the offset the field of enquiry can be materially reduced by at once eliminating the possibility of the markings being either opacities, or points of different refractive index, in an otherwise uniform envelope. This can be done by immersing the valve in media of different R.I., and observing the difference that takes place in the spectra of different orders. For spectra are set up by diffraction not only by the light which traverses the transparent framework between the markings, but also by that through the markings themselves, whether they be holes, pits, spines, or otherwise.* These spectra being of the same period will overlie one another, and interference will take place, the positions of the minima and maxima depending on the path-difference of any given wave-length. Now this path-difference will be altered in the case of the perforation, etc., by a change in the R.I. of the medium in which the diatom is placed; whereas it will remain unchanged if the marking be an opacity in an otherwise uniform structure. But further, if a change of intensity is found to follow the change of R.I. of the mounting medium, then by measuring the intensity for a light of given wave-length with media of different R.I., it is possible to calculate the path-difference and thus to estimate the depth of the depression in the case of a pit, or the height in the case of an elevation. Lastly, the evidence for or against the markings being complete perforations may be completed by comparing the value obtained above with a direct measurement of the thickness of the valve, obtained by an interferometer method. In a case where the perforations go through a

* Quekett Journal (1901), p. 13.

valve of considerable thickness or where two membranes lie parallel to one another, the fact would be shown by interference bands running the length of the diffracted spectra. The last determination carried out by this method is the investigation of the possible ratio of the size of the marking to the distance between neighbouring markings.

The method here described in its application to the study of diatom structure, may be used with equal facility for the investigation of the polarization and spectro-photometric properties of microscopic objects.

MICROSCOPY.

A. Instruments. Accessories, etc.*

(1) Stands.

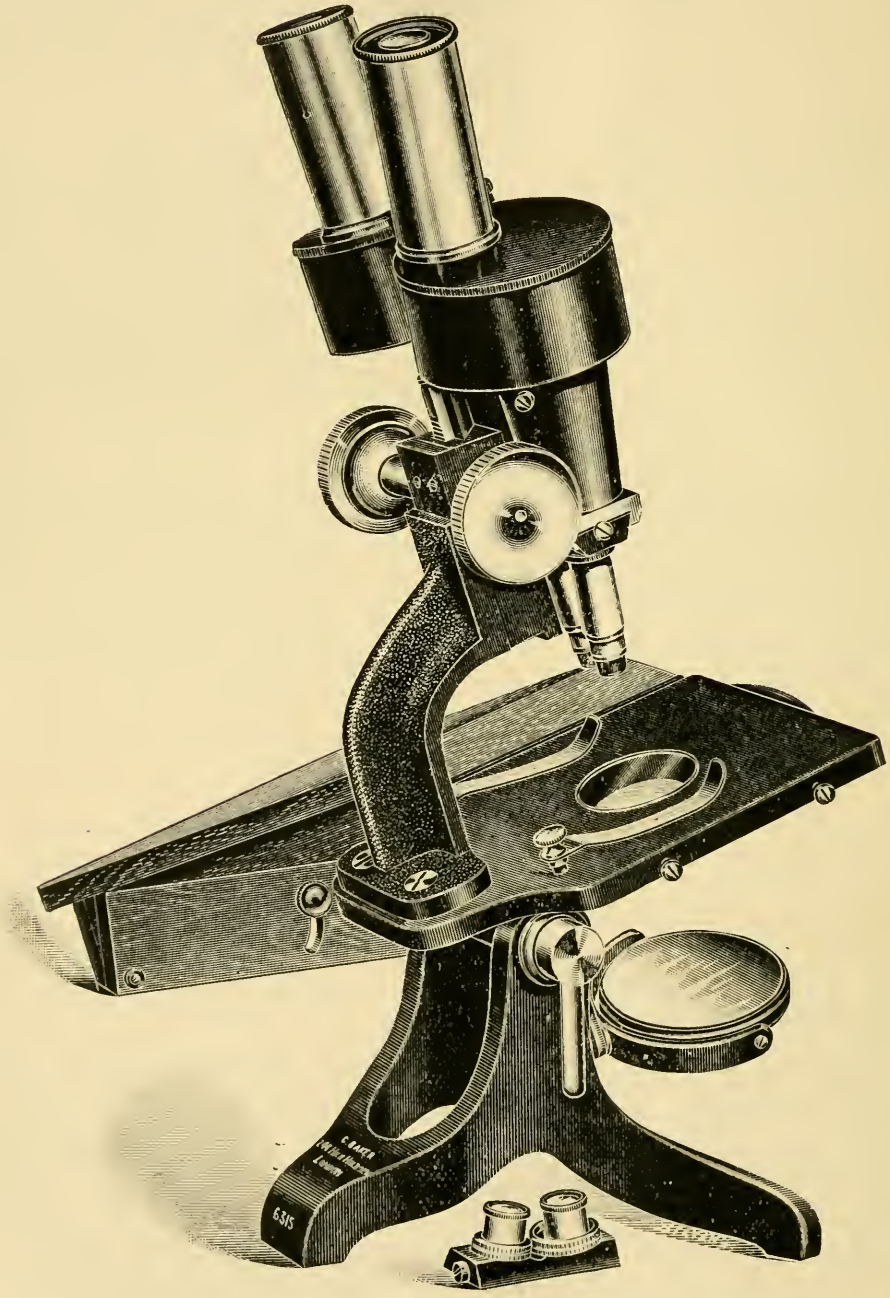


FIG. 53.

* 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 Greenough Binocular Microscope. — This binocular (fig. 53) is a combination of two Microscopes, and, by the application of Porro prisms, a convenient means of erecting the image and giving more pronounced stereoscopic vision is provided. By rotating the prism-boxes sufficient adjustment is obtained for varying the interpupillary distance within normal limits. The tubes are arranged to bring the object into focus at the same point in each field ; for this purpose they are set at an angle to one another. The bodies are mounted on a slide having rack-and-pinion movement, but no fine-adjustment is necessary on account of the low magnification required of this class of Microscope. The instrument can be inclined to 55°, and the hand-rests are so arranged that they may be used when the instrument is in either a vertical position or at any inclination to this angle. The limb is attached,

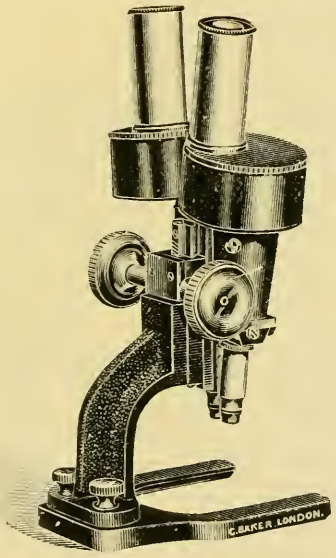


Fig. 54.

by means of two thumb-screws, to a large square stage having a central aperture fitted with a removable glass disk, and can be easily removed and placed on the metal fork, as figured (fig. 54.)

A universal size substage-tube, to carry a spot-lens for illuminating the specimen on a darkground, is provided, and a mirror-box—containing concave mirror and matt-opal glass reflector, fitted on a swinging arm—is mounted in gimbals. Three sets of specially paired objectives, of $2\frac{1}{2}$-in. 2-in., and $1\frac{1}{2}$-in. focus, are made for this Microscope. The magnification obtained by combining the objectives and eye-pieces ranges between × 8·5 and × 52.

C. Baker's New Model D.P.H. Microscope. — This instrument (fig. 55) is provided with a body-tube $1\frac{1}{2}$. in. in diam., in which slides a draw-tube carrying an eye-piece 23·2 mm. in diam. ; it is fitted with diagonal rack-and-pinion coarse-adjustment, which is carried on a limb cast in one piece, with an opening in which the fingers can be placed when lifting. The milled-heads of the fine-adjustment are placed on

either side of the limb and actuate a lever giving a very smooth and delicate movement ; a milled-head screw is now provided under the limb

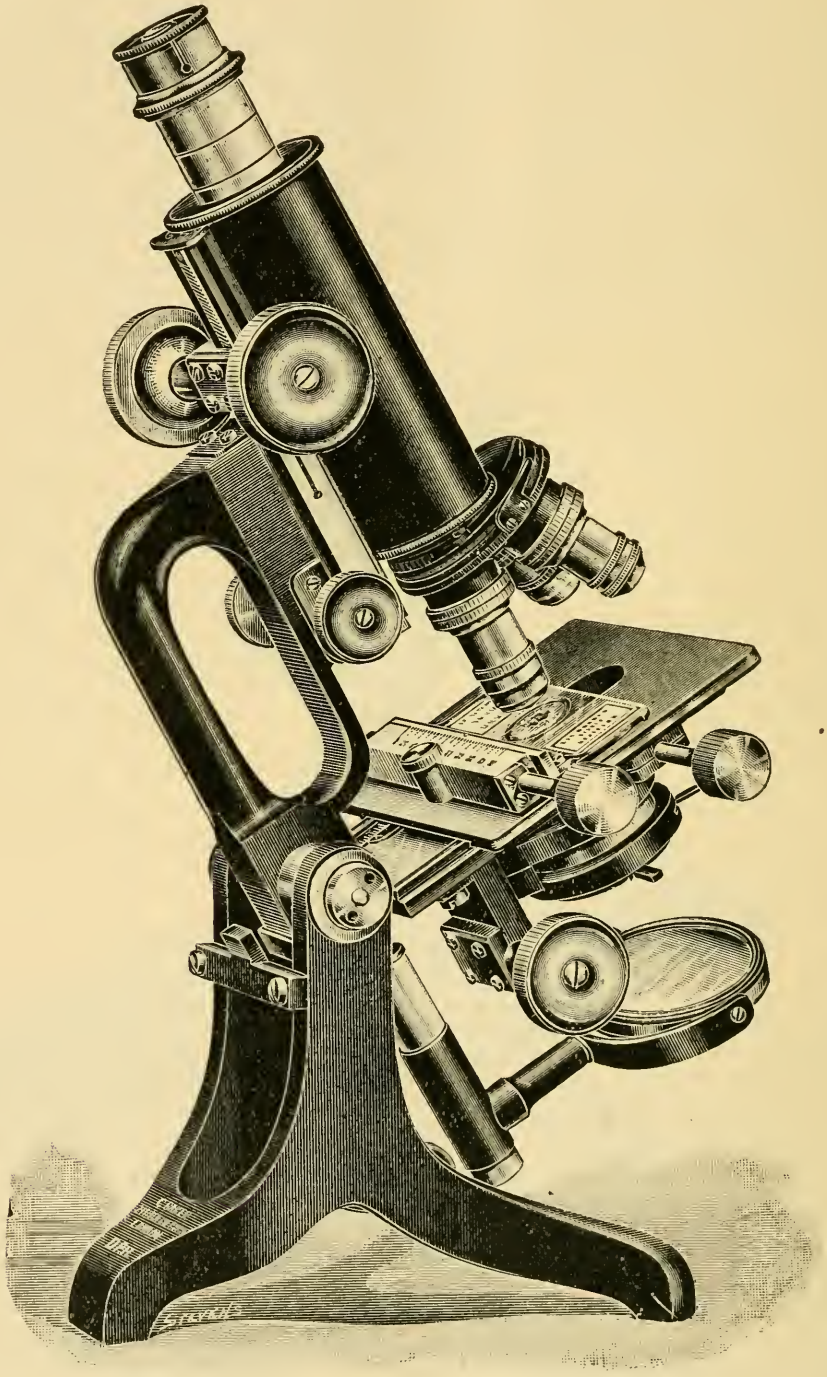


Fig. 55.

to put the fine-adjustment out of action when travelling, and thus prevents any strain occurring to the mechanical action. The body and limb are mounted on a stage below the trunnions, and the instrument

will be found very steady when placed in a horizontal position. The mechanical stage is built on the Microscope, is very rigid and has a range of 25 mm. in a vertical, and 60 mm. in a horizontal direction, both graduated to $\frac{1}{2}$ mm. The mechanism of the latter movement can, if desired, be removed, leaving a large square stage $3\frac{7}{8}$ by $3\frac{1}{2}$ in., on which large sections or the contents of a Petri dish can be examined.

The instrument is mounted on a tripod claw-foot, and is provided with a universal substage having diagonal rack-and-pinion focusing adjustment. Plane and concave mirrors of 50 mm. in diam., mounted in gimbals, are carried on a tail-piece with universal movements.

Zeiss Simplified Binocular Stand XB.*—This Microscope (fig. 56) consists of a heavy foot with upright pillar, sliding cross-piece, and

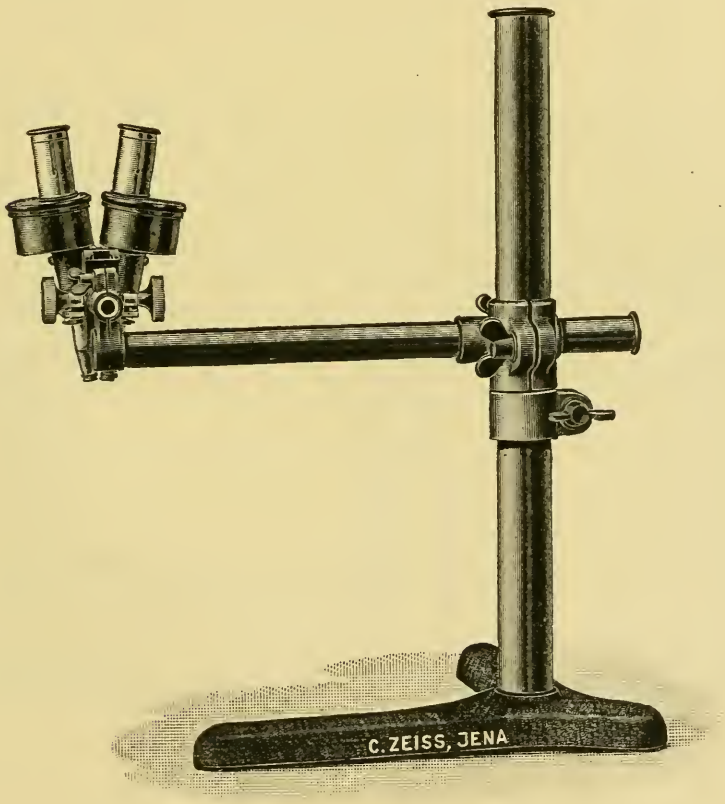


FIG. 56.

horizontal sliding-rod. The latter is fitted on one end with a clamping-arrangement to take the binocular body-tube. The stand is primarily designed for the preparation of large specimens, and is excellently adapted for pond-life study, for observation of portions of large botanical or mineralogical objects, etc.

* Zeiss Catalogue, "Micro 261," 1913, p. 19, fig. 10.

(2) Eye-pieces and Objectives.

New Achromatic Objectives.*—In the most recent catalogue of the firm of Carl Zeiss there are listed two new oil-immersion $\frac{1}{12}$ lenses. One is an ordinary achromatic, with N.A. of 1·25; the other is a fluorite achromatic, the N.A. being 1·30. The equivalent focus of both is 1·8 mm.

(3) Illuminating and other Apparatus.

Recent Developments in Drawing by the aid of Projection Apparatus used on the House-lighting System.†—S. H. Gage describes the

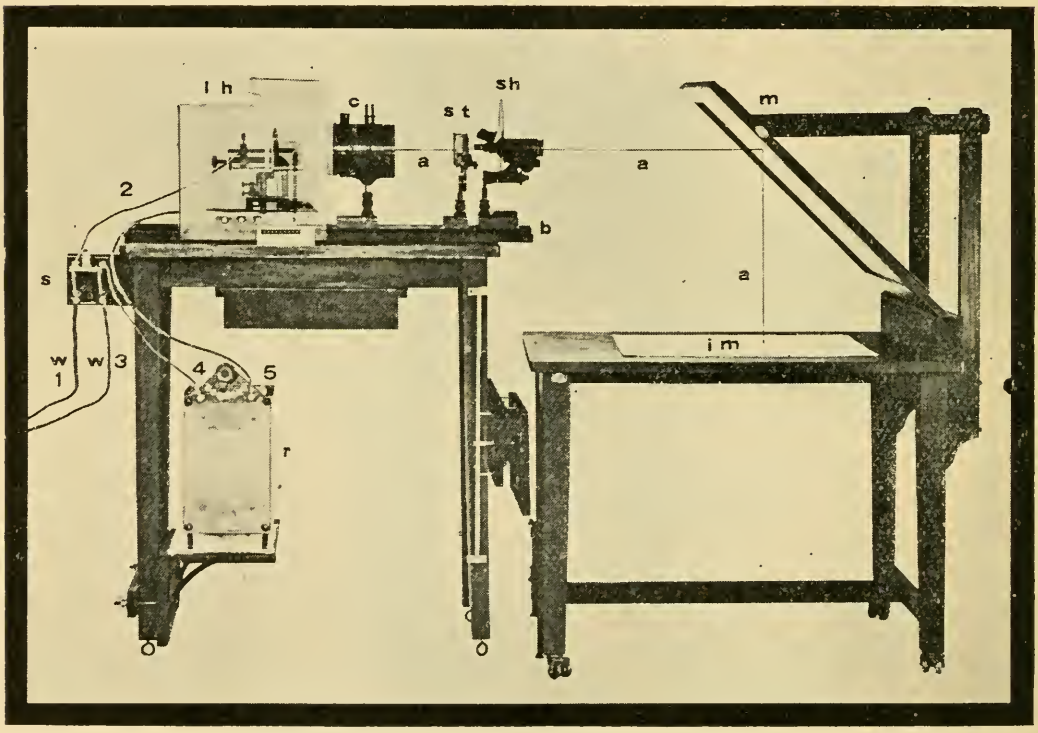


Fig. 57.

chief latest forms of projection apparatus, and gives a large number of practical suggestions. His paper is copiously illustrated, and includes the following plates, which may perhaps be useful to readers of this Journal.

Fig. 57 shows the author's apparatus for drawing with the Microscope and a movable table with large plate-glass mirror. *a-a-a* is the axial ray of the illuminating and image-forming beam; *b*, base-board of the optical

* Carl Zeiss Catalogue, 1913, p. 21.
† Trans. Amer. Micr. Soc., xxxi. (1912) pp. 177–97 (16 figs.).

bench ; *c*, condenser with water-cell ; *i m*, drawing surface where the image is projected ; *l h*, lamp-house. The lamp-house was present only during a part of the exposure of the negative, hence it appears transparent, showing the hand-feed arc lamp within ; *m*, the large mirror attached to the drawing table ; *r*, rheostat. The rheostat is of the ordinary form ; *s*, the double pole ; there is a table switch for opening and closing the circuit ; *w l*, 2, supply wire to the switch and from the switch directly to the arc lamp ; *w* 3, 4, 5 (upper carbon) the supply wire to the switch, and from the switch to the one binding post of the rheostat (4) ; from the other binding post of the rheostat (5) a wire passes directly to the arc lamp (lower carbon). No current can go through the lamp without going through the rheostat with this arrangement ; and with the double pole switch the current is cut completely off the entire apparatus when the switch is open. The adjustable drawing shelf has an arrangement for moving up and down on metal ways which can be attached

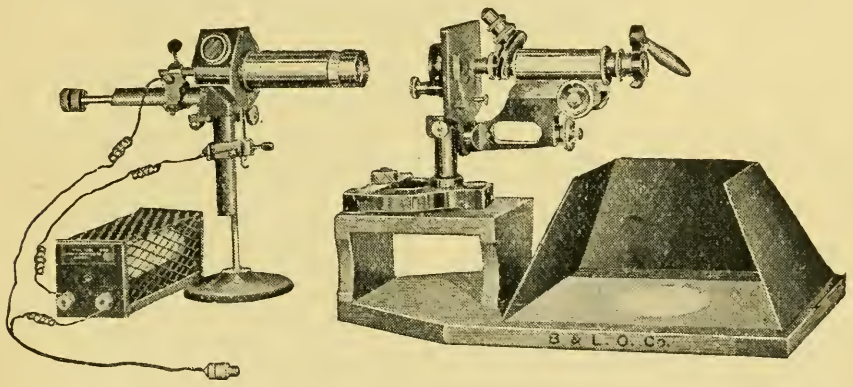


Fig. 58.

to any table, whatever the form of the legs. The supporting brackets are jointed, so that the shelf can be let down when the large drawing table needs to be brought up close to the projection table. Fig. 59 shows the Bausch and Lomb's simple drawing apparatus for the Microscope. It has a hand-feed right-angled arc lamp for small carbons ; wiring and connexions for the house circuit, and a rheostat which will not permit over 6 amperes of current to flow. The lamp-condenser is in a telescoping tube, so that either a parallel or a converging beam of light can be obtained. The Microscope is on a support giving a drawing distance of 25 cm. (10 inches), and the drawing surface is enclosed by a metal shield to keep out stray light. The lamp and the Microscope are put in one line. For this the lamp is adjustable on a vertical support, and it can be inclined at any angle. If one finds it easier to use the mirror and have the lamp at right angles to the Microscope, this outfit lends itself perfectly to that arrangement.

Fig. 59 shows the Spencer Lens Company's apparatus for drawing with the Microscope. It consists of a small arc lamp with the proper

wiring, rheostat, and connexions for the house electric supply. The lamp has all the necessary adjustments; the condenser tube is telescoping, so that the beam of light may be parallel or converging. At the end of the condenser tube is a black disk for cutting off stray light, and serving as a screen upon which the spot of light from the sub-stage condenser can be thrown, thus serving as an aid in getting the mirror at the right angle to send the light through the Microscope. The Microscope is supported on an adjustable shelf which can be raised or lowered on the vertical rods, thus enabling one to get any desired magnification. The vertical supports for the Microscope shelf serve to carry a curved metal band to

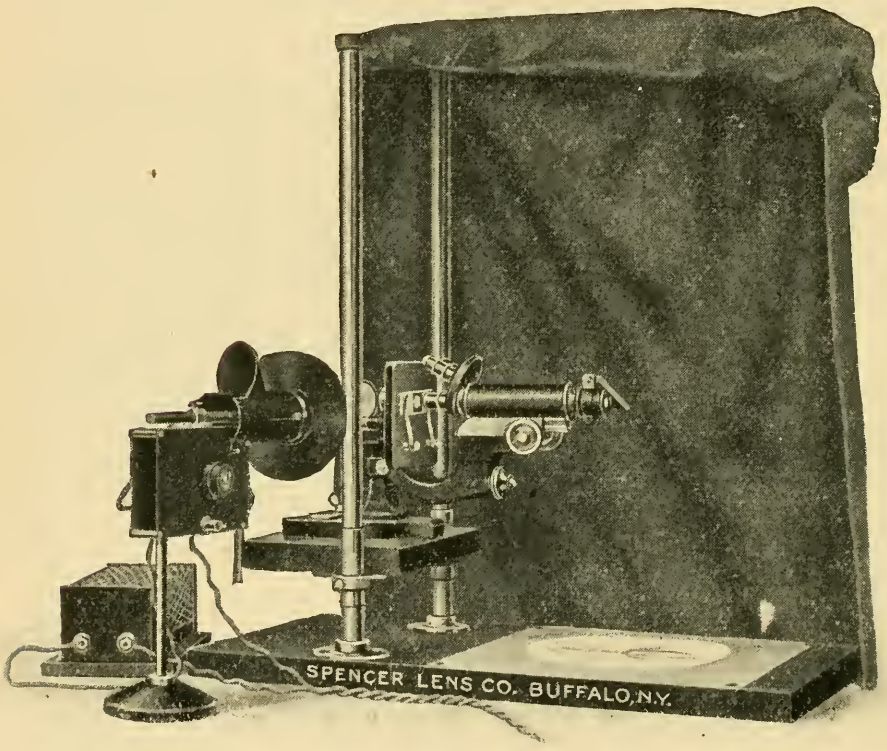


Fig. 59.

support the cloth curtains to shade the drawing surface. There are two curtains, and they hang freely, thus avoiding all interference with the hands in drawing. If one desires, the arc lamp can be put in line with the Microscope and the mirror turned aside. For a reflector beyond the ocular a prism is used, thus avoiding any defects of a mirror.

Beck Dark-ground Illuminator.*—This illuminator (fig. 60) consists of a solid parabolic reflector, and has been designed to give so much light that it can be used effectively with an incandescent gas-burner. The light, which is focused upon the object, is all transmitted

* R. and J. Beck, Special Catalogue, 1913.

at a greater angle than 1·0 N.A., so that dry object-glasses, or a 1·0 N.A. $\frac{1}{12}$ oil-immersion lens, can be used without stopping-down.

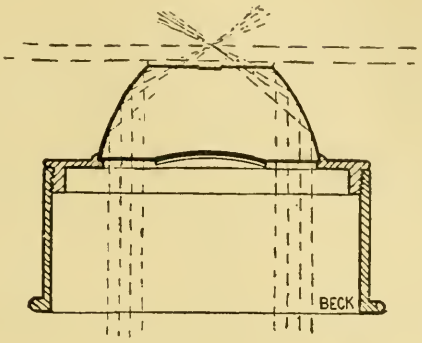


Fig. 60.

Higher angle-immersion lenses should have a stop dropped in behind to reduce the aperture to 1·0 N.A.

(6) Miscellaneous.

Quekett Microscopical Club.—The 490th Ordinary Meeting was held on May 28, the President, Professor A. Dendy, F.R.S., in the Chair. Mr. T. A. O'Donohoe on "Minute Structure of *Coscinodiscus asteromphalus* and of *Pleurosigma angulatum* and *P. balticum*." The author's object was to determine, if possible, which was the correct image, the "white dot" or the "black dot."

June 24. H. Sidebottom, "The *Lagenæ* of the South-west Pacific." This was the second part of a valuable paper which appeared in the Club Journal for April 1912.*

E. M. Nelson, F.R.M.S., "On a New Method of Measuring the Magnifying Power of a Microscope."

B. Technique.†

(1) Collecting Objects, including Culture Processes.

Paraffin as Source of Energy.‡—N. L. Söhngen, by means of appropriate cultural methods, has shown that benzin, petroleum, paraffin oil, and various paraffins, may be used by certain bacteria as a food-stuff supplying carbon, and therefore as a source of vital energy. By inoculation of material from divers sources upon a culture medium consisting of paraffin and inorganic salts, the author shows that a number of bacteria, including *Bacillus fluorescens liquefaciens*, *B. pyocyaneus*, etc.,

* See this Journal, 1912, p. 527.

† 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.

‡ Centralbl. Bakt., 2te Abt., xxxvii. (1913) pp. 595–609.

as well as certain mycobacteria, possess this property. The end products of this action on paraffin are carbon dioxide and water, but intermediate substances, such as acids and fatty acids, are formed.

Isolation of Pathogenic Bacteria from Stools.*—W. R. Stokes and F. W. Hachtel recommend the following modification of Hesse's semi-solid agar for the detection of typhoid and cholera organisms. It contains : Agar 5·5 grm., Liebig's extract of beef 5 grm., Witte's peptone 10 grm., lactose 10 grm., glycerin 50 grm., sodium chloride 8·5 grm., distilled water 1000 c.cm. The beef extract is rendered sugar-free by preliminary inoculation of *Bacillus coli*. Before tubing, a solution of Kahlbaum's azolitmin is added as indicator. Typhoid or paratyphoid colonies are medium sized and of a pink colour. By using starch in place of lactose and glycerin, the intestinal spirilla may be distinguished. By virtue of their amylolytic enzyme, they split the starch and so produce an acid reaction in the medium.

Plate-culture of Anaerobic Bacteria.†—J. W. McLeod describes a piece of apparatus for this purpose which possesses distinct advantages over any of the older devices. It consists of two parts, a porcelain dish to hold the pyrogallic acid and caustic soda solutions, and a special Petri capsule, which has its free margin turned inwards and upwards. The porcelain dish is a hollow chamber, bisected in the lower two-thirds of its depth by a vertical partition, and there is a circular aper-

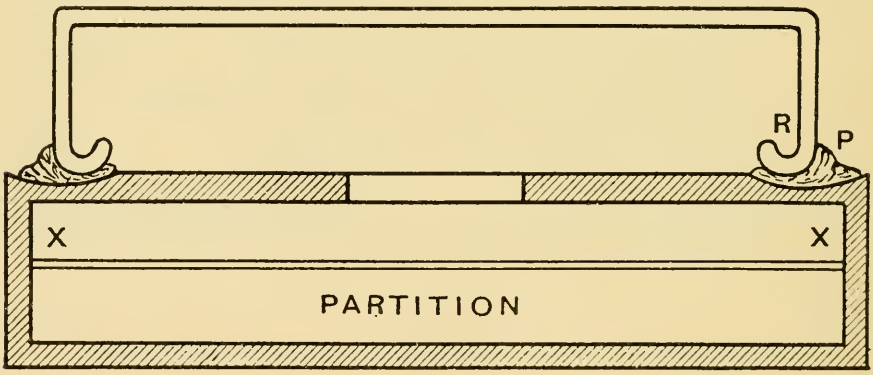


Fig. 61.—Cross-section of the apparatus, to show the Petri dish in position and bisecting the porcelain chamber in the line of the partition. R, Groove to collect fluid exuding from the medium on the Petri dish. P, Plasticine. X, Points at which fluid in chamber passes over the partition when the plate is tilted.

ture in the centre of its upper surface. Around the margin of the upper surface is a shallow groove filled with plasticine. In using the apparatus, caustic soda and pyrogallic acid solutions are introduced into the compartments of the hollow dish. The Petri plate is now pressed

* Centralbl. Bakt., 1te Abt. Orig., lxix. (1913) pp. 346–9.
† Journ. Path. and Bact., xvii. (1913) pp. 454–7.

down upon the plasticine in the groove, and plasticine pushed up round its edge so as to ensure sealing. The dish is then tilted so that

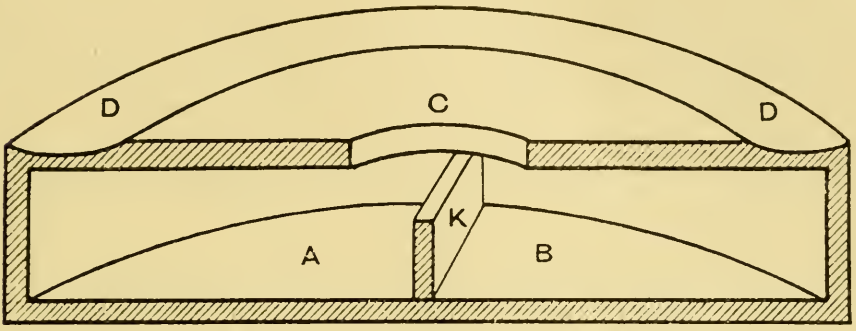


Fig. 62. — Sketch of one-half of the porcelain chamber. A, B, Opposite portions of porcelain chamber, separated by the partition K. C, Central aperture in covering of the porcelain chamber. D, Groove for reception of plasticine.

the pyrogallic and soda overflow the separating partition and mix. Condensation water is retained in the upturned edge of the Petri dish (figs. 61 and 62).

The extent to which oxygen has been absorbed may conveniently be shown by making a blue pencil mark on the upper surface of the porcelain. When the oxygen is rapidly absorbed, this becomes bleached within 48 hours.

Partition of Plate Cultures.*—A Hahn describes a piece of apparatus (fig. 63) for use in the preparation of plate cultures. It consists

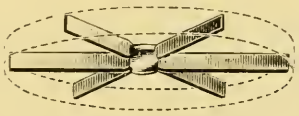


Fig. 63.

of a star-shaped piece of glass fitting the Petri dish, consisting of six rays, which divide the culture medium into as many compartments. It is placed in position before the medium has solidified. The author considers the ordinary method of plating cumbrous and wasteful, and points out that this device, which enables six platings to be carried out on a single dish, will involve considerable saving of time, labour, and space, and facilitate the comprehensive survey of the results in any extensive plating investigation.

New Medium for Gonococcus.†—P. E. Weil and Noiré recommend the following medium as being very successful and satisfactory. The

* Centralbl. Bakt., 1te Abt. Orig., lxix. (1913) p. 228 (1 fig.).
† C.R. Soc. Biol. Paris, lxxiv. (1913) pp. 1321–2.

only precautions necessary are to sow copiously and incubate at once. The casein from a litre of milk is precipitated by means of 2 c.cm. of hydrochloric acid and then filtered off, the filtrate being neutralized with normal sodium hydrate. To this is added an equal bulk of 2 p.c. pepton water, enriched with 1 p.c. saccharose and 0·35 to 4 urea. A jelly is then made with 1·6 p.c. agar. After sterilization and filtration the medium is distributed in tubes and then sterilized afresh.

Method of Growing the Acne Bacillus.*—T. H. C. Benians gives the following procedure for cultivating the bacillus of acne from the comedo for the preparation of vaccines. A comedo is expressed into a sterile glass tube of small bore, the edges of which have been previously rounded-off in the flame. The comedo is dropped into a tube containing neutral broth, which is then covered with a layer ½ in. thick of sterilized olive-oil or lard. The comedo should be made to sink to the bottom of the tube. In 24 to 48 hours the medium becomes turbid from the presence of *Staphylococcus albus*, while in 3 or 4 days the growth of acne bacillus is seen at the bottom and sides of the tube as a granular deposit. At the end of about 10 days films show a relatively few cocci and large masses of bacilli.

(2) Preparing Objects.

Fixing the Pseudopods of Foraminifera.†—H. Reschad places the Foraminifer (*Miliolina*) in a hollow ground slide, letting it lie in a moist chamber until the pseudopoda are well extended. When this has happened the slide is immersed, rapidly and deftly, in the following dilutions of alcohol (5, 10, 20, 35, 60, 80, 95, 99·8 p.c.). After the last the preparation is immersed in Schaudinn's sublimate-alcohol for 10–15 minutes.

Much skill and care are required to prevent the Foraminifer from being washed off during manipulation. It is recommended to immerse the slide on that side towards which most of the pseudopods are directed.

The preparations may be stained in Giemsa (4 drops to 1 c.cm. of water) renewed every 3 minutes during a quarter of an hour. The preparation is then washed with distilled water and afterwards with tap-water.

Then follow alcohol, carbol-xylol, and balsam.

Simple Histological Methods ‡—J. Salkind gives an account of certain procedures, by the adoption of which histological manipulations may be simplified.

Sublimate Fixation.—The troublesome part of this process is the iodine treatment, required to remove the precipitate of mercury salts. If, after fixing in Zenker's or Helly's fluid, the material is placed in a solution containing 3 p.c. potassium bichromate and 1 to 2 p.c. hydrochloric acid—or, as an alternative (where acid solutions are undesirable)

* Lancet, 1913, i. pp. 1801–2.
† Zeitschr. wiss. Mikrosk., xxix. (1913) pp. 526–7.
‡ Zeitschr. wiss. Mikrosk., xxix. (1913) pp. 540–4.

a fluid of the following composition: sublimate 4 grm., potassium bichromate 2·5 grm., chloral hydrate 4 grm., water 100 c.cm.—the iodine treatment may be carried out simultaneously with the removal of paraffin, by placing the mounted paraffin sections in xylol saturated with iodine.

Aceton-ether Method of Paraffin Embedding.—Tissue is removed from water or weak alcohol, and placed in a fluid containing: acetone 2 parts, ether 1 part, water 1 part. In this it remains for at least one hour for each millimetre in the thickness of the tissue. Transfer to a mixture of equal parts of acetone and ether saturated with paraffin. Then transfer to paraffin.

Simultaneous Polychrome Stain.—Saturated watery toluidin-blue, with 3 p.c. formol, 12 parts; alcohol 90 p.c., 8 parts; acetone, 4 parts; saturated naphthol-yellow, in alcohol 90 p.c., 2 parts; saturated erythrosin pur., in alcohol 90 p.c., 3 parts. Mix in the above order. Add 5 to 10 parts of distilled water. Stand. No precipitate should appear, and the fluid should be dark blue, with a violet shade after a few minutes.

Adhesion of Sections to Slide.—When the paraffin sections are floating in warm water, add 1 drop of cedar-wood oil. This spreads as a thin film over the surface of the water. Sections mounted direct from this fluid will adhere firmly.

(3) Cutting, including Embedding and Microtomes.

Method of Handling and Preserving Celloidin Serial Sections.* H. Richter makes use of shallow rectangular glass dishes, with well-fitting lids. One side bears a distinguishing mark, so that the orientation of the vessel and its contents is always known. A piece of blotting-paper, cut to fit, is placed on the bottom of this vessel, and moistened with 70 to 90 p.c. alcohol. The sections are transferred from the knife to the surface of the wet blotting-paper, being arranged in order. When this is finished, a piece of paraffin-paper—of a type used in commerce by vendors of sugar or drugs—is placed over the sections. The lid of the dish is put on, and the sections may be kept in this condition until required. The paraffin-paper may with care be peeled off the sections, and one or more be removed for mounting. When single sections are removed, it is recommended that a small piece of paper with the number of the section be placed in the position it occupied in the dish.

By this method it is easy to study isolated sections from a series at leisure, without breaking the series. Moreover, a diversity of staining methods can be practised upon neighbouring sections.

Wülfing's Rock-slicing Microtome.†—This piece of apparatus has been designed by E. A. Wülfing, and is made by the firm of R. Winkel, Göttingen. Its object is to make thin slices of large pieces of rock, and to examine the qualitative orientation of mineral sections. In the latter case it facilitates the necessary preparatory investigations

* Zeitschr. wiss. Mikrosk., xxix. (1913) pp. 528–30.

† Special Catalogue: Microscopes for Mineralogists; Microtomes and Grinding Apparatus Accessories. Carl Zeiss (Agents) London.

and lends itself to the economical treatment of valuable material. The machine (fig. 64) is driven by a motor of about $\frac{1}{16}$ h.p. at 2000 revolutions per minute. The vertical cutting disk is made of soft sheet

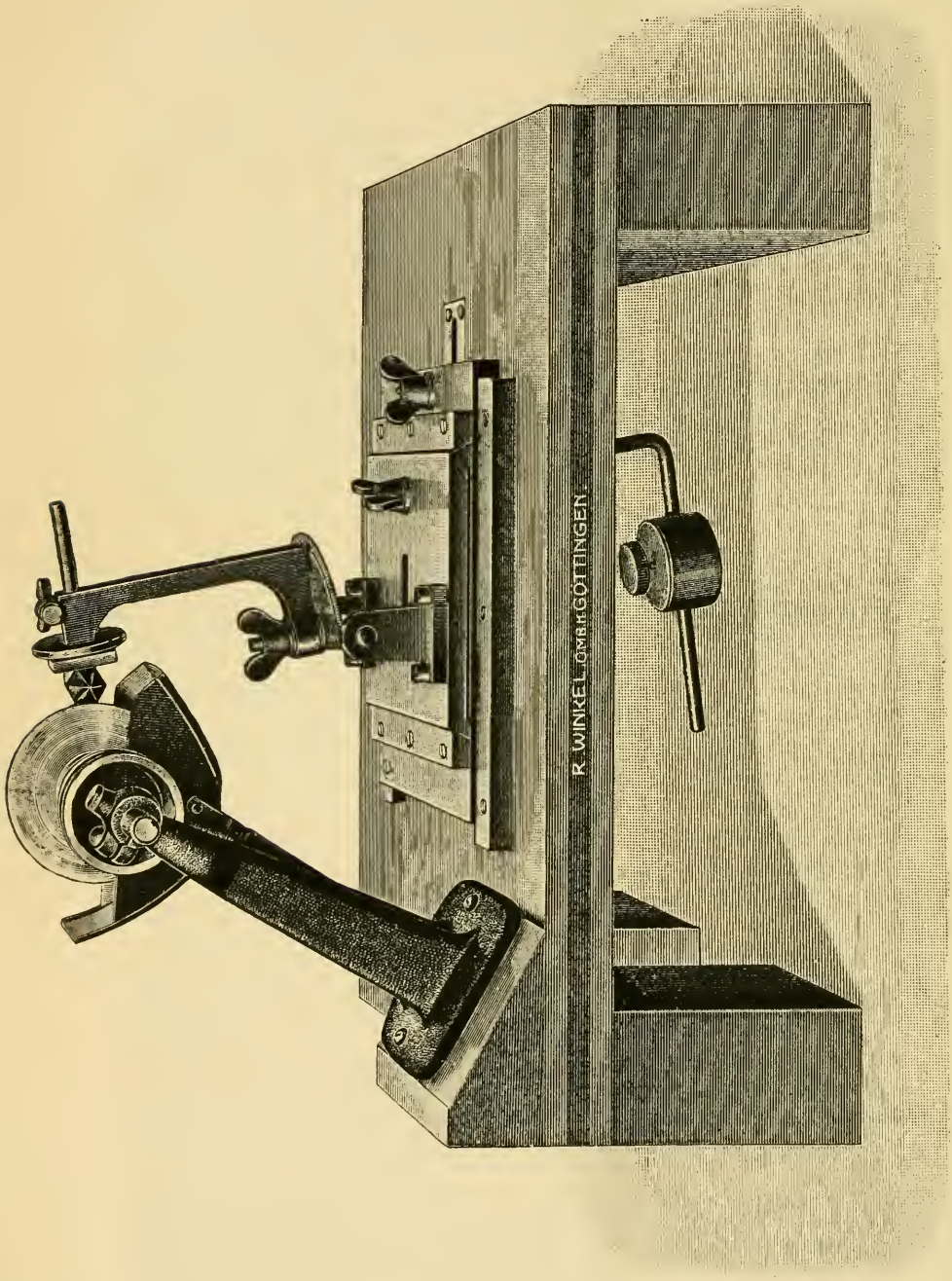


Fig. 64.

iron and is attached to a horizontal axis journalled in a small inclined shaft. The diameter of this disk is about 70 mm.; its thickness about 0·3 mm. The compound holder for receiving the rock specimen is fitted on to a spindle which is parallel to the cutter-shaft, and is held up to

the cutter by means of a counterpoise. The stand, which carries the holder, is fitted to a slide having cross motion and fixing attachment so that the specimen may be advanced towards the cutter, and also be moved right and left. The "crystal holder" is the part to which the specimen itself is attached. It consists of a round graduated metal plate covered on the cementing side by a glass plate, and swivelled on a horizontal axis. It may be fixed in any desired position, and the rotation is read by means of a fixed index. The arm carrying the crystal-holder can be rotated about a vertical axis, the adjustment being read on a graduated half-circle. The compound holder is so designed that both axes of rotation pass through the crystal so that its position in space will be approximately maintained during the adjustment. To render the soft iron disk capable of cutting rock it must be tempered with diamond paste. This is done by slightly notching the periphery of the disk with a knife and then rubbing on a paste made of diamond splinters finely powdered in a mortar and mixed with oil. The machine is then started at a low speed and the glass guard-plate of the crystal-holder lightly pressed against the disk. This will cause a sufficient number of diamond particles to enter into the soft iron so that the machine is ready for use. When the disk has once been properly dressed it will last for a long time and the width of the cut will not be more than 0·4 mm. A cut from 4 to 5 sq. cm. will require about ten to twelve minutes. If this speed is not reached the disk will have to be dressed again. The best lubricant is petroleum.

Winkel's Motor-driven Grinding Machine for Microscopical Sections.*—The shaft which carries the grinding-wheel and belt-pulley is vertically journalled on a cast-iron block fitted with three standing and fixing screws. The waste is received in a trough. The metal grinding-disks can be replaced by glass ones for fine grinding and polishing. According to requirement the machine can be fixed above or below the table.

Automatic Grinding-attachment for Wülfing's Grinding Machine.†—This apparatus is made by the firm of R. Winkel, for operation with the Wülfing grinding machine whose principle is taken to be generally well known.

When specimens require to be ground for a long time or to be ground extremely fine, it will be found rather inconvenient to guide the grinding tripod over the plate. The attachment shown in fig. 65 has therefore been designed for imparting to the tripod movements closely resembling hand movements. A V-shaped bridge, which stands with two vertically adjustable screws on the grinding-plate, carries two pins extending upwards and engaging in corresponding eyes in the tripod. The tripod stands free on the plate and may be weighted if necessary by a couple of small weights. The bridge extends in a long metallic bar which can glide in a sleeve movable in all directions. From above

* Special Catalogue: Microscopes for Mineralogists; Microtomes and Grinding Apparatus Accessories. Carl Zeiss (Agents) London.

† Special Catalogue: Microscopes for Mineralogists; Microtomes and Grinding Apparatus Accessories. Carl Zeiss (Agents) London.

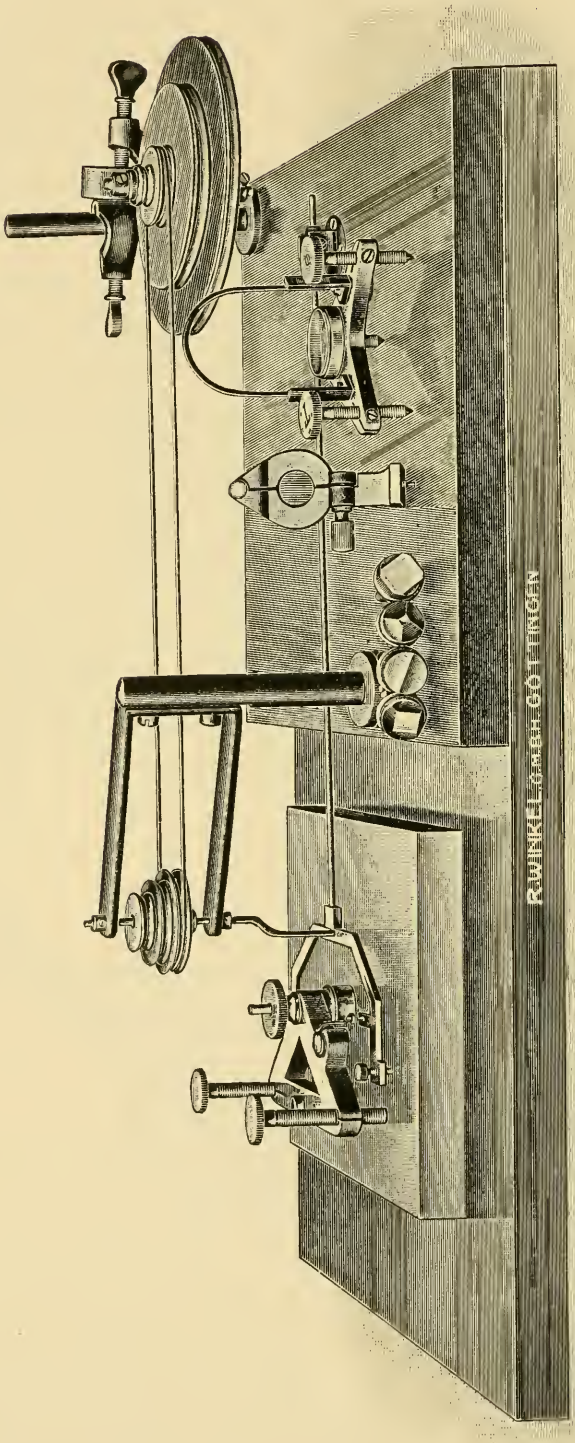


Fig. 65.

a spindle with eccentric pin passes through the bore in the bridge and transmits the rotation of the motor which has been conveyed by a cord pulley countershaft to both bridge and tripod. The speed has been kept so low that no tilting effect is produced in the tripod ; the speed obtained by hand-movement having been taken as a model. Only the crystal should move in the grinding material. Some oil or vaseline is applied beneath the screws and feet of the tripod and bridge. During work the grinding-plate may be moved sideways so that it is used on as many points as possible. The rules for making specimens are otherwise as usual. For measuring, the tripod is lifted and placed on the horizontal bracket. After some practice the operator will know how long the machine must be left running to grind down a given quantity from the specimen. The polishing is carried out in an analogous manner. By the aid of this attachment it has been possible to grind quartz prisms with a refractive angle of 10° at the edge down to $\frac{16}{1000}$ mm. thickness, and polish them. Experiments with iron glance prisms have also proved the efficiency of the attachment, as with these prisms a manual guiding proved unsatisfactory.

(4) Staining and Injecting.

Demonstrating Intracellular Inclusions in Articular Rheumatism.*—F. J. Bosc and M. Carrieu make smears on slides from the joint-fluid, and also use the clot after it is set on cooling. The clot is immersed in acetic-sublimate or in alcohol, and when fixed paraffin sections are made. The bodies found in the cytoplasm of some of the cells are eosinophilous and best stained by Giemsa. The bodies are of varying size, and the authors consider them to be of a parasitic nature.

In a later communication the authors state that they have found similar appearances in the large mononuclear leucocytes of the blood in acute rheumatism.

Staining Properties of the Tetanus Bacillus.†—The familiar text-book statement, defining this organism without qualification as Gram-positive, has long been recognized as misleading. H. Eymer has examined a number of strains of the bacillus, as well as a variety of material from infected animals and other sources, and finds that the majority of bacilli do not retain the stain when treated by this method, while only a few isolated individuals are retentive of the violet colour.

Demonstrating Nerves in Mammalian Ovaries.‡—In this investigation W. Abel and A. Louise McIlroy used the silver nitrate method of Ramon y Cajal. There are several modifications of this method, but the first modification was found to be the most successful. It is carried out as follows : The tissue, which is divided into small blocks of from 2–4 mm., is placed for 24 hours in a bath of 65 p.c. alcohol with 0·75 p.c. ammonia, at a temperature of 32° C. . . . It

* C.R. Soc. Biol. Paris, lxxiv. (1913) pp. 1262–3, 1322–3.
† Centralbl. Bakt., 1te Abt. Orig., lxix. (1913) pp. 1–5.
‡ Proc. Roy. Soc. Med., vi. (1913) (Obstet. and Gynaec. Sect.) pp. 240–7 (4 figs.).

is then transferred to a second bath of absolute alcohol with 0·75 p.c. ammonia for 24 hours at the same temperature. The tissue is then carefully washed in distilled water and placed in a 1 p.c. solution of silver nitrate, and kept in the dark at 32° C. until it assumes a golden-brown colour. It is then washed in distilled water, and transferred to the following developing solution. It is important to note that this manipulation must be done either in the dark or with a red light. Developing solution : pyrogallic acid 1 grm., formalin 5 c.cm., absolute alcohol 10 c.cm., distilled water to 100 c.cm. After the tissue has been 24 hours in this solution at a temperature of 32° C., it is washed in distilled water and then transferred to 50 p.c. alcohol, and carried through the ordinary process of dehydration. This stain colours the nerve-fibres dark brown or black, while the rest of the tissue is bright yellow. The nerve-fibres alone are clearly defined, and for this reason many photographs made of sections stained in this way seem slightly blurred. The materials used were the ovary of the cat, dog, and rabbit. The organs were removed from the animals some hours after death, as it is found to be better than using the tissues absolutely fresh.

Staining Trypanosomes.*—A. Ponselle first treats the dried smear with absolute alcohol 50 c.cm. plus tincture of iodine (French Codex) 10 drops for 5 minutes. The smear is then washed with absolute alcohol and allowed to dry. The preparation is then covered with a layer of some serum, e.g. horse serum heated to 56°. After about 5 minutes the preparation is washed in distilled water, and then stained for 15–30 minutes with Giemsa (1 drop to 1 c.cm. of distilled water). Finally, the preparation is washed with distilled water and allowed to dry. This technique does not give better results than other methods for staining trypanosomes drawn from the blood, but is specially adapted for these organisms obtained by cultivation.

Demonstrating the Clear and Cloudy Fibres of Striated Muscle.† W. Ewald fixes in formalin and cuts frozen sections. The sections are stained with iron-hæmatoxylin, alizarin-blue, or with sudan. The illustrations show distinctly the difference between the clear and cloudy fibres. The appearances are better seen when the muscle is cut transversely.

Celloidin sections were also used, and other stains such as Bielschowsky's and Van Gieson's were employed, but the results from the three first mentioned, either alone or in combination, seem simpler and more useful. For the author's views, and those of P. Schaefer in the same number, the original should be consulted.

(6) Miscellaneous.

Marking Slides.‡—To mark spots on a microscopical preparation, Y. Salkind recommends the following device. A glass disk furnished with an ebonite ring is made so as to fit the top of the condenser, and

* C.R. Soc. Biol. Paris, lxxiv. (1913) pp. 1072–3.
† Abhandl. Senckenberg. Naturforsch. Gesell., xxxi. (1912) pp. 109–50 (5 pls.).
‡ Zeitschr. wiss. Mikrosk, xxix. (1913) p. 544.

to centre with it. The centre of the disk is marked. To define any point on the slide the condenser is racked down, and a minute drop of cedar-wood oil—tinged with carmine—is placed on the centre of this disk. The condenser is racked up until the oil just touches the slide. This is now removed from the stage, and the point indicated by the oil-drop is marked with a diamond.

Apparatus for Counting Bacteria and other Cells.*—R. Donald describes an apparatus for liquid measurement by drops and applications in counting bacteria and other cells, and in serology. In order to promote drop-measuring in serological and bacteriological work the writer claims to have devised a simple system of producing uniform pipettes, clean and sterile, which deliver uniform drops of any required size from $\frac{1}{4}$ c.cm. down to $\frac{1}{200}$ c.cm. or less, and has devised also forms of constant pressure apparatus for use with the pipettes.

The fundamental principle of the method rests on the fact that the size of a drop of any given liquid yielded by a clean pipette is determined by the outer circumference of the pipette at the level where the contact edge of the drop clings round the glass, due allowance being made for the rate at which the liquid is detached and the temperature. For further details of this interesting device, the original should be consulted.

Metallography, etc.

Aluminium-vanadium Alloys.†—N. Czako describes the microstructure of a number of aluminium-vanadium alloys. At 1 p.c. vanadium, brilliant crystals appeared, embedded in aluminium. The proportion of the crystals increased with increase of vanadium, the 34·5 p.c. alloy was nearly homogeneous. By the action of hydrochloric acid on the 30 p.c. alloy, brilliant crystals containing 37·9 p.c. vanadium were isolated, corresponding closely to the formula Al_3V. In a single crystal, cleavage lines and corrosion figures were seen, the corrosion pits having the same form as the crystals seen in the alloy containing 1 p.c. vanadium. In alloys containing not more than 38 p.c. vanadium no etching was necessary; the great hardness of the crystals relative to the aluminium rendering the structure visible upon simple polishing. Beyond this point the alloys were etched either with 50 p.c. nitric acid to which had been added 6 p.c. of chromic acid, or by electrolysis in sodium-chloride solution. Crystals containing 64·8 p.c. vanadium, corresponding to the formula Al V were also isolated.

Cadmium-arsenic Alloys.‡—S. F. Zemczuzny has investigated the cadmium-arsenic system, and describes the microstructure of numerous

* Proc. Roy. Soc., Ser. B, lxxxvi. (1913) pp. 198–202 (2 figs.).
† Comptes Rendus, clvi. (1913) pp. 140–2 (2 figs.).
‡ Int. Zeitschr. Metallographie, iv. (1913) pp. 228–247 (14 figs.).

alloys. Two compounds, Cd_3As_2 and $CdAs_2$ and two eutectics, were identified. In the range 1 to 40 atomic per cent arsenic, crystals of Cd_3As_2 were enveloped in the eutectic which was nearly pure cadmium, etching dark with hydrochloric acid while the compound remained bright. The crystals frequently contained inclusions: it was accordingly impossible to ascertain their composition by a separation method. From 40 to 62 p.c. arsenic the alloys consisted of the same compound with the other eutectic. In this range considerable undercooling of the melt occurred; its influence upon the structure is described.

Copper-aluminium Alloys with 84 to 90 p.c. Copper.* — H. Hanemann and P. Merica describe in detail the microstructure of the copper-aluminium alloys in the range indicated, when submitted to various treatments. The specimens were etched with ferric chloride in hydrochloric acid, or with ammoniacal copper chloride solution. The velocity of crystallization was found to be remarkably great. Slow cooling in the furnace produced large plates of α and γ, and the $\alpha\,\gamma$ eutectoid was lamellar. More rapid cooling in air caused γ to crystallize in star-shaped forms, and α as needles, while the eutectoid was also acicular in appearance. When quenched, alloys containing more than 88 p.c. copper consisted of needles, those containing 86 to 88 p.c. copper consisted of needles $+\gamma$, and those containing 84–86 p.c. copper consisted of γ and β. A remarkable similarity was found between the structure of the copper-aluminium alloys and that of steel.

β-Constituent of the Aluminium-bronzes.† — The copper-rich aluminium-copper alloys consist, according to their aluminium content, of one or two of the constituents α, β and δ, β being the $\alpha + \delta$ eutectoid. A. Portevin has found that this eutectoid may exist in either of two forms, a comparatively coarse sponge-like network and a fine lamellar form resembling the pearlite of annealed steel. Both forms may be present in the same specimen, e.g. in the alloy of eutectoid composition. The coarse network form commonly occurs in contact with excess of the α phase, while the fine lamellar form is found in contact with excess δ. The author has found numerous examples of eutectics which occur in more than one form, and describes as typical the various forms of the $Sb–Cu_2Sb$ eutectic of the antimony-copper alloys. The aluminium-bronze sections were etched with acid ferric chloride in alcohol, or with ammonium persulphate solution, while the structure of the antimony-copper alloys was revealed by simple polishing.

W. Guertler‡ points out the instructive resemblance in microstructure between the eutectic of the antimony-copper system described by Portevin, and the "Ledeburite" eutectic of the iron-carbon system described by Benedicks. Further research on the non-ferrous alloys is revealing complexities analogous to those of the iron-carbon system.

* Int. Zeitschr. Metallographie, iv. (1913) pp. 209–227 (18 figs.).
† Int. Zeitschr. Metallographie, iv. (1913) pp. 257–260 (11 figs.).
‡ Int. Zeitschr. Metallographie, iv. (1913) pp. 261–2 (1 fig.).

Magnesium-aluminium-zinc Alloys.*—G. Eger, in the course of a lengthy report upon the constitution of the ternary magnesium-aluminium-zinc alloys, describes the microstructure of a considerable number of them. Marked brittleness rendered the polishing of many of the specimens very difficult. The presence of hard crystalline compounds frequently caused the structure to be sufficiently revealed by simple polishing.

Ancient Iron Objects.†—H. Hanemann describes the microstructure of some Celtic iron articles probably not less than 2000 years old, found in excavations near Römhild. A pointed tool, the form of which suggested that it had been attached to a wooden handle, was coated with rust to a depth of about 1 mm. The rear part was found to consist of ferrite and pearlite with which much slag was intermingled. The Widmannstätten structure indicated a high forging temperature. The point beneath the rust was hard to the file. A transverse section was found to consist of martensite to a depth of about 1 mm. Below this was martensite containing small patches of osmondite. The structure of this tool, which must have been quenched in water and not tempered, demonstrates the great antiquity of the process of hardening steel, and also indicates that martensite, which is understood to be a metastable constituent, may persist practically unchanged throughout long periods at ordinary temperatures. An axe was found to consist of ferrite with included slag. Etching with hydrochloric or nitric acid developed a network of shadowy lines which had no apparent relation to the crystalline structure of the ferrite. A ring had the structure of unhardened steel. The remaining Celtic objects consisted of ferrite with included slag. An ancient Greek object—a small figure of a faun—consisted of graphite, pearlite, ferrite, and the ternary phosphoric eutectic, and had apparently been gilded. Its cast-iron structure suggested that cast-iron was known to the ancient Greeks.

Ternary Alloys of Iron-nickel-manganese, Nickel-manganese-copper, and Iron-manganese-copper.‡—N. Parravano, in working out the equilibrium diagrams, has studied the microstructure of the ternary alloys. In the copper-iron-manganese system the limits of solid solubility were determined by microscopic examination of specimens which had undergone prolonged annealing. Etching reagents used were a solution of ferric chloride in dilute hydrochloric acid, a mixture of ammonia and hydrogen peroxide, dilute nitric acid, and picric acid in alcohol. In many of the alloys the solid solution crystals had a cored structure.

Constitution of Carbon-molybdenum Steels.§—T. Swinden reports the results of a further lengthy investigation of the properties of a series of carbon-molybdenum steels, and includes a description of the microstructure of specimens (1) quenched from 800° C.; (2) quenched from

* Int. Zeitschr. Metallographie, iv. (1913) pp. 29 128 (58 figs.).
† Int. Zeitschr. Metallographie, iv. (1913) pp. 248–56 (10 figs.).
‡ Int. Zeitschr. Metallographie, iv. (1913) pp. 171–202 (61 figs.).
§ Iron and Steel Inst. Carnegie Scholarship Memoirs, v. (1913) pp. 100–168 (50 figs.).

1200° C.; (3) heated to 1200° C., cooled to 600° C., and then quenched; and (4) cooled in air from 1200° C. Steels with the higher carbon and molybdenum contents showed white polyhedra when quenched from 1200° C.

Elastic Limit of Alloys.*—A. Portevin points out that the only method of ascertaining when the elastic limit is reached at a particular point of the surface of a stressed specimen, is by microscopic observation of the previously polished surface. Slip-bands appear within the crystals as soon as the elastic limit is exceeded. In the author's experiments pyramidal specimens of cast alloys were submitted to compression, one polished face being under microscopic observation. In an alloy consisting of a homogeneous solid solution slip-bands first appear in a few crystals; as the stress rises the number of crystals affected increases until they all show slip-bands. By examination of a stressed pyramidal specimen, a lower elastic limit—corresponding to the stress on the cross section at which slip-bands have just begun to appear—and an upper elastic limit—corresponding to the stress on the largest section at which all the crystals are affected—may be distinguished. In an alloy which, consisting of a chemically heterogeneous single solid solution, possesses a cored structure, the elastic limit of the outer layers of a crystal commonly differs from that of the inner portion, and thus slip-bands may appear in the central part of a crystal and not extend as far as the boundaries. As the stress increases the slip-bands increase in length until the crystal boundary is reached, thus demonstrating the crystallographic unity of a chemically inhomogeneous crystal. Copper-nickel and copper-tin alloys were observed to behave in this manner. In an alloy consisting of two phases, such as the alloy containing 57 p.c. copper, 43 p.c. zinc, the elastic limit of one (α) phase may be reached much earlier than that of the other (β) phase, and the behaviour is then still more complex. The idea that the elastic limit of a metal or an alloy can be truly expressed by a single value is thus seen to be illusory.

Influence of Annealing upon the Structure of Alloys.†—A. Portevin classifies systematically the structural effects of annealing, by which operation is meant heating followed by slow cooling. Annealing is employed (1) to remove or diminish the effects of quenching; (2) to remove the effects of cold-work; (3) to modify the structure of cast or overheated material. If the annealing is wholly within a field of the equilibrium diagram, it tends to restore (1) mechanical equilibrium, by removing internal stresses; (2) physico-chemical equilibrium; solid solutions become homogeneous and unstable phases disappear; (3) structural equilibrium; stable phases become visible microscopically, undergo coalescence, and become clearly separated when two or more are present; (4) crystalline equilibrium; recrystallization and growth of crystals occur. If, during the annealing, transformation lines of the

* Comptes Rendus, clvi. (1913) pp. 1237–40 (6 figs.).
† Rev. Métallurgie, x. (1913) pp. 677–721 (38 figs.).

equilibrium diagram are traversed, the finally resulting phases may not be in equilibrium. Numerous instances of these various effects are described and illustrated by photomicrographs. A cast alloy of 95 p.c. copper 5 p.c. tin was annealed at 800° C. The specimen was polished and etched with a mixture of ammonia and hydrogen peroxide after ½, 1, 2, and 3 hours' annealing. The gradual disappearance of the cored structure was thus followed, the solid solution became homogeneous. The phenomenon of coalescence, due to the action of surface tension, is apparent in the changes occurring when hypereutectoid steels are annealed. The formation of twin crystals by deformation followed by annealing is explained upon the assumption of the occurrence of "proportional translation," a particular mode of slipping in crystals upon their cleavage planes.

Influence of Intercrystalline Cohesion upon the Mechanical Properties of Metals.*—J. C. W. Humfrey advances a modification of Rosenhain and Ewen's theory as to the formation and structure of the intercrystalline cement which joins the irregularly outlined crystals of which metals are built up. It is suggested that if the solidification of a metal takes place sufficiently slowly, there is formed between two crystals which have grown towards each other, a layer in which the molecules are so arranged as to pass by gradual small displacements from the orientation of one crystal to that of the other. A similar layer probably exists between crystals which have been formed by recrystallization in the solid state, if equilibrium between the crystals is complete. If, from rapid cooling or other causes, true equilibrium has not been established in solidification or in solid recrystallization, the crystals may be separated by an amorphous layer. A study of the behaviour of slip-bands at or near the intercrystalline boundaries has afforded support to the author's views. Pure Swedish iron, polished and lightly etched, was microscopically examined during strain. Slip-bands first appeared in the central parts of the crystals, and only spread towards the boundaries as the straining became severe. Slip-bands approaching a boundary at an angle became narrower and tended to bend so as to approach the boundary at a smaller angle. Occasionally slip-bands were observed to cross a boundary. In such a case the slip-band persisted unchanged in direction and was apparently little affected by the boundary. Such an observation is explained on the supposition that the two crystals, though not identical in orientation, have one common gliding plane.

Etching at High Temperatures.†—H. Hanemann holds that the method by which a section, polished at ordinary temperatures, is heated, and etched at a high temperature by the application of a gaseous or liquid reagent, does not give a true picture of the structure at the temperature in question. If re-crystallization takes place during heating, the polished surface, which was made up of sections through crystals at the ordinary temperature, consists of crystal surfaces at the high temperature. The phenomena of segregation and of formation of new

* Iron and Steel Inst. Carnegie Scholarship Memoirs, v. (1913) pp. 86–99 (8 figs.).

† Int. Zeitschr. Metallographie, iii. (1912) pp. 176–8.

phases may cause the external surface to differ considerably from a section. Further, in order that structure may be satisfactorily revealed by etching, it is necessary that the structure should not change appreciably during etching. But the growth of crystals at high temperatures in some materials, e.g. high-carbon steel at 1000° C., is so rapid that the structure may alter considerably even in the short time required for etching.

Thermal Investigations in a Vacuum.*—W. Heike describes a new method of preparing and thermally investigating alloys. Weighed quantities of the metals are placed in a porcelain tube, which is then evacuated and sealed up. The tube is heated above the melting points of the elements, suitably shaken and allowed to cool. Specimens prepared in this way are very suitable for microscopic examination. The rough surface of the metallic regulus often affords valuable information upon the crystalline habit of the alloy. Examples taken from the copper-silver series are described and illustrated.

* Int. Zeitschr. Metallographie, iv. (1913) pp. 143–54 (11 figs.).

MICROSCOPY.

A. Instruments, Accessories, etc.*

(1) Stands.

Reichert's New Movable Mechanical Object-stage.†—C. Reichert describes the above auxiliary, which is represented in figs. 68 and 69. It is completely independent of the form of the Microscope-stage and can be fitted to every Microscope, as it is applicable both to rectangular stages of at least 70 mm. breadth and to circular stages of 90–130 mm.

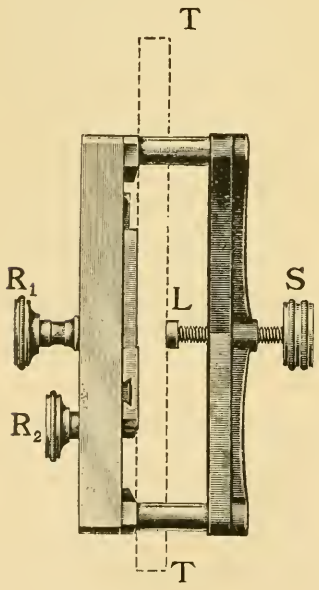


Fig. 68.

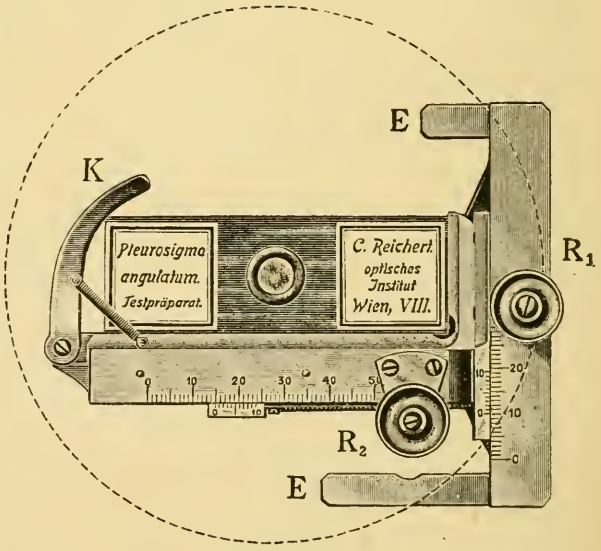


Fig. 69.

diameter. The auxiliary is secured to the Microscope-stage by a single screw S as is shown in fig. 68, in which TT represents the stage-plate. The under-side of the object-stage is made out of a strongly secured cast-iron bar to prevent bending, and contains the screw-nut. The end of the screw-spindle is enlarged into a knob L, which presses against the under-side of the Microscope-stage. Resistance to the screw-action

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

† Zeitschr. wiss. Mikrosk., xxix. (1913) pp. 314–19 (5 figs.).

is given by the arms EE, the effect being that the object-stage firmly grips the Microscope-stage. An up-and-down movement is given by the rack R_1, and R_2 imparts a side-motion. Each guide-bar is graduated and fitted with verniers to facilitate recording of the position of any part of the preparation. The bracket K, regulated by a spring, holds the object.

Leitz' New Fine-adjustment.* — Messrs. E. Leitz have lately fitted the Stand G H of their School Microscope, as well as their small Stands J and K, with a very accurate, simple and ingenious ball micrometer screw, whose operation will be understood from figs. 70 and 71.

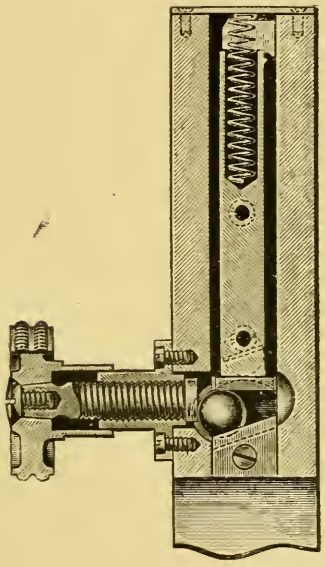


FIG. 70.

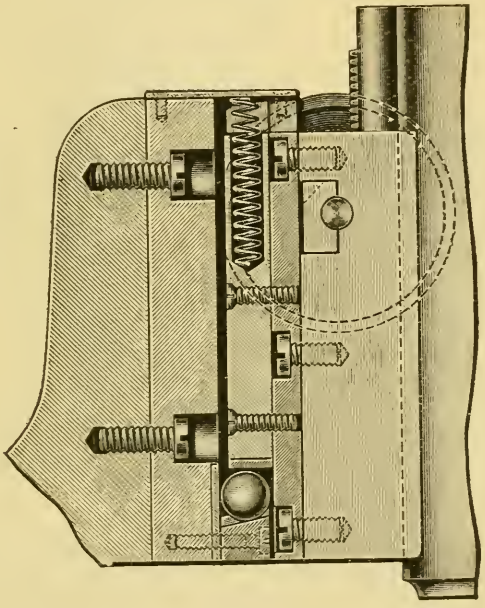


FIG. 71.

The movable piece which carries the Microscope tube with the rack-and-pinion movements rests on a ball which slides up an inclined plane. A spiral spring placed in the upper portion of this movable piece presses against the ball and so obviates dead-way. A milled-head screw pushes the ball and thus causes it to slide up the inclined plane. A micrometer graduation can be applied to this milled head.

Leitz Travelling Pocket Microscope.†—This Microscope (fig. 72) consists of a half-round pillar with rectangular foot-plate, which is clamped to the edge of the table or other similar place by means of a cramp. The tube-carrier may be slid up and down the stand-pillar and is secured in its proper position, when in use, by a set-screw. The adjustment is effected by sliding the tube and by inclining the stage by

* E. Leitz, Wetzlar : Special Catalogue (1913), Mikroskope, p. 22.
† Leitz Catalogue, 45A, p. 82.

means of a screw. The concave mirror which serves for illuminating purposes is universally adjustable. When not in use the upper portion of the tube is unscrewed and screwed into the main tube in the reversed position. Moreover, the main tube is pushed down as far as possible through the large opening in the stage, so that the whole stand takes up

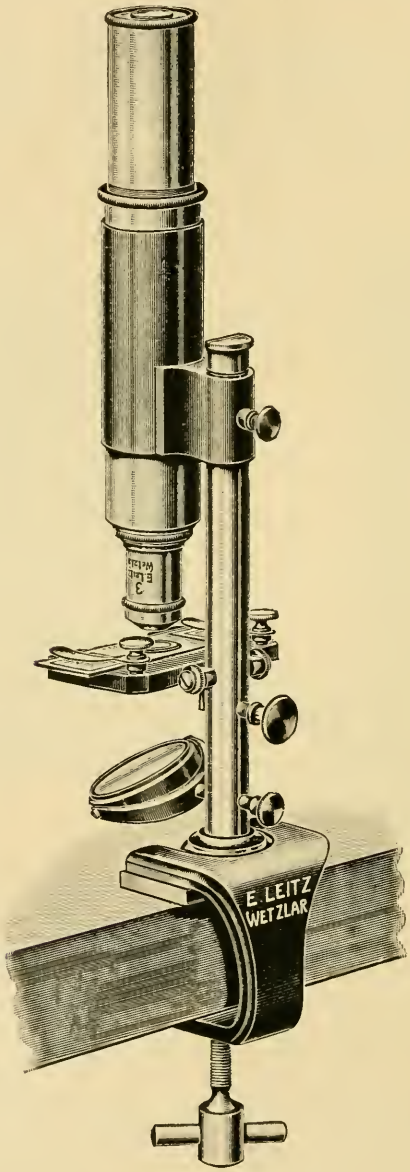


Fig. 72.

little room when being carried. Two specimen clips are supplied with the instrument. The whole stand, with all accessories, is packed in a brown canvas case, and weighs 800 grm.

Swift's new "Premier" Microscope.—This instrument (fig. 73) though designed primarily for photomicrography, is well adapted for

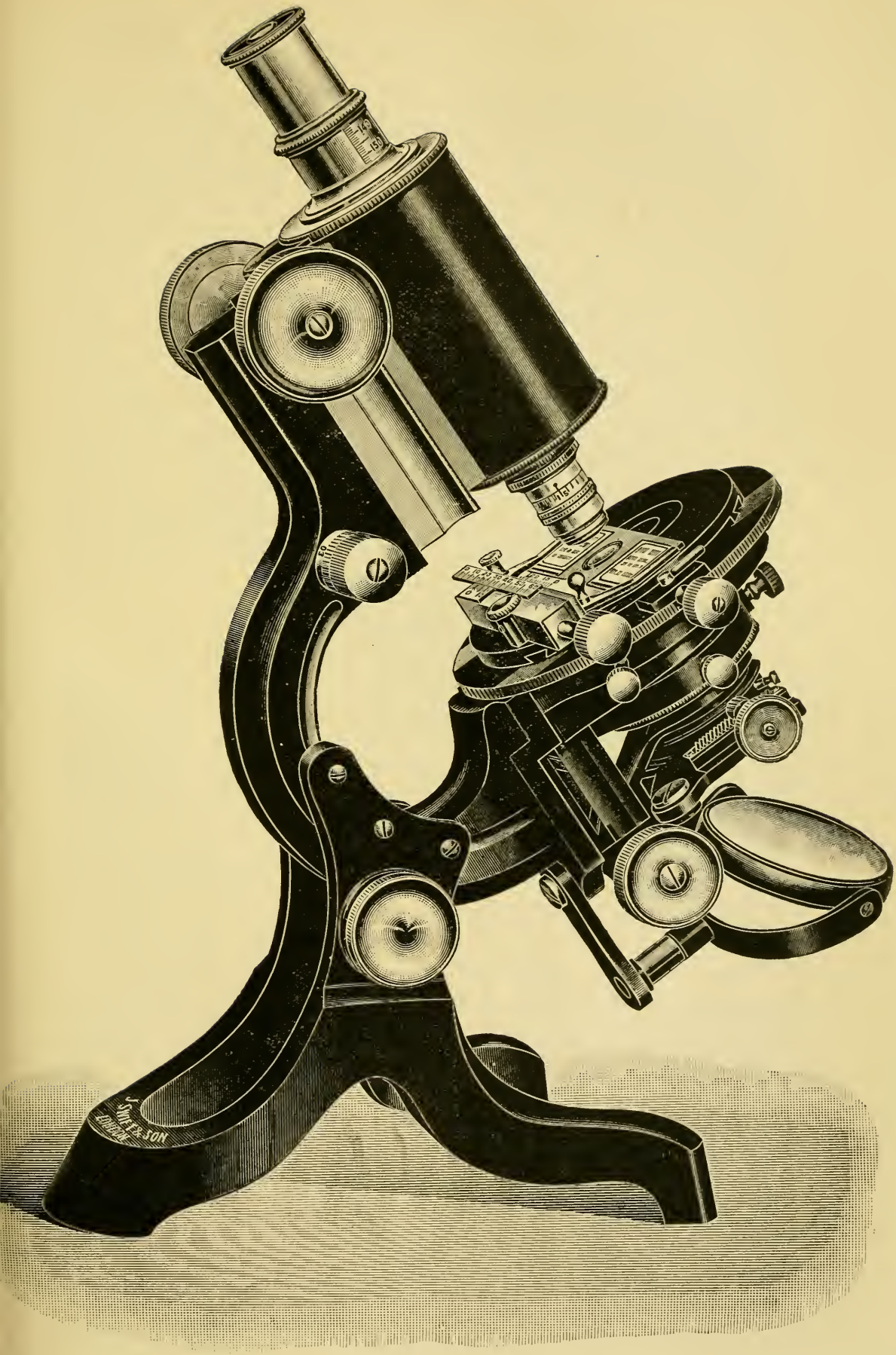


Fig. 73.

other branches of critical research work. One of the outstanding features of this stand is that it is swung through an arc on the Wales principle instead of being inclined by the usual axis joint, and is as steady and rigid in the horizontal as in the vertical position. The rotating mechanical stage has centring screws and can be rotated through an entire circle. The mechanical movements are so arranged that the entire surface of a 3-in. by 1-in. slide can be systematically examined. To allow of the use of a Petri dish the horizontal movement of the mechanical stage can be instantly removed, while for rough work the entire mechanical stage can be taken away and for it a plain vulcanite covered rotating stage can be substituted. The coarse-adjustment is of the usual diagonal rack-and-pinion type, while the fine-adjustment is the improved "Climax" pattern; one division on the divided drum of fine-adjustment corresponds to a movement of 0·001 mm. of the tube. An achromatic condenser is always fitted to this instrument; this condenser is provided with centring screws and also with the Continental type of iris diaphragm, which can be racked excentrically and rotated to allow of the use of illumination from any azimuth. This diaphragm can be swung aside right out of the optic axis quite independently of the condenser.

(2) Eye-pieces and Objectives.

Simple Demonstration Ocular.*—K. Shüno describes the following simple device for directing the attention of a student to any required position in the image. It is based on the same idea as Kuznitzky's pointer, but has the advantage of being applicable to every ocular. The author merely places a short pointed hair between two ring-shaped paper disks gummed together, and rests the whole arrangement on the diaphragm of the ocular. The hair is of such a length that it does not reach the centre of the field. It is therefore excentric and its point describes a small circle as the ocular is rotated. The hair is so fine that it does not interfere with the image, and it can easily be directed towards any required spot.

(3) Illuminating and other Apparatus.

Practical Object-holder for the Microscopical Examination and Demonstration of Mobile Objects (Test-tubes, Capillary-tubes, etc.).† C. Strzyzowski, after referring to the difficulty often experienced in the examination of sublimates and such-like objects in tubes, describes the following simple device which he has found very useful. A plate of metal shaped like an ordinary object-slide is channelled longitudinally for the reception of the tube, and is secured to the Microscope-stage by a small G-cramp. The plate is perforated in the middle for the transmission of the light, and the glass tube is kept steady by a spring-clamp.

* Zeitschr. wiss. Mikrosk., xxix. (1913) pp. 321-2 (2 figs.).
† Zeitschr. wiss. Mikrosk., xxix. (1913) pp. 323-4 (2 figs.).

Leitz Electrical Object-Stage.*—This stage (fig. 74) affords a means of electrically stimulating histological preparations during observation under the Microscope. It can also be used for studying microscopic changes occurring in electrolytic processes. The current is conveyed by

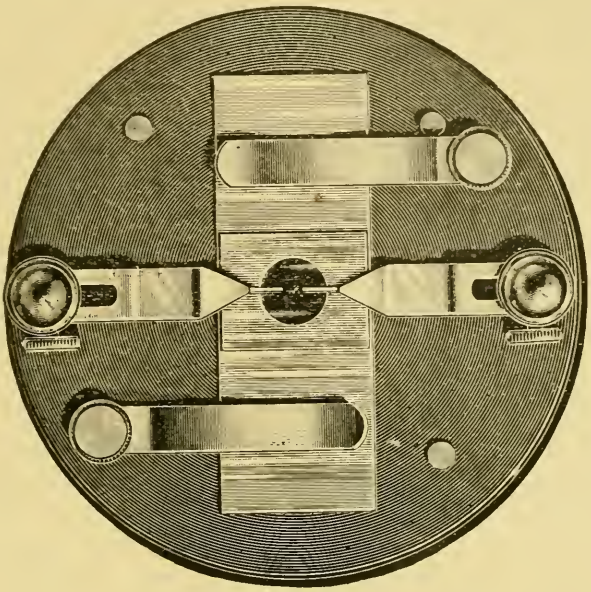


Fig. 74.

means of two terminals and two adjustable electrodes, which carry fine platinum wires at their extremities. The whole is mounted on a vulcanite plate which is secured to the stage of the Microscope by means of two pins.

New Geiger Microscope Lamp.†—M. Wolff speaks in the highest terms of the capabilities of the new 2-ampère Ewon lamp, brought out by the firm of J. Geiger, of Munich. He considers that it possesses practically all the advantages of the 4-ampère Ewon lamp, combined with greater suitability to subjective microscopy. It not only compensates for the best daylight (which cannot be said for petroleum, gas, incandescent, and Nernst light) but makes daylight superfluous, because it furnishes a pure white light capable of graduation. The lamp with 200 normal candle brightness completely attains what should be expected from an ideal Microscope lamp. When used with the strongest dry or immersion systems or with the strongest compensation oculars it gives a brilliantly bright pure white field, whose intensity for subjective work requires to be subdued by a matt-glass disk. It follows that the brightness is sufficient under the most trying conditions to produce satisfactorily bright images. In extraordinarily difficult cases the mere extension of the condenser-tube raises the brightness to the required degree. The amount of heat produced appears to be very

* Leitz' Catalogue, 44D, p. 31.
† Zeitschr. wiss. Mikrosk., xxix. (1913) pp. 328–35 (2 figs.).

small; a preparation only rose 4° C. in degree after some hours' exposure to the lamp rays. Its application to photomicrography has given excellent results. As regards micro-projection, the 4-ampère lamp is probably the best for medium distances, but for short distances the 2-ampère lamp is better.

E. Wychgram* discusses the merits of the Ewon-lamps, and practically agrees with M. Wolff.

New Low-power Condenser.†—The difficulty attending the construction of a low-power condenser has hitherto been the fact that Microscope-stands do not afford the necessary optical length. Messrs. C. Baker have, however, from the designs of E. M. Nelson, obviated the difficulty by constructing the condenser upon the telephoto principle. Their apparatus has a focal length of 4 in. and requires only 1 in. of working distance. With this condenser the image of the flat of the flame bears the same relation to a 4-in. objective with the large field of a Powell and Lealand No. 1A eye-piece, as the image with one of the ordinary universal condensers, with the top off, does to a ^{2}-in.; and this is precisely what was wanted. The condenser has a low aperture of N.A. 0·14, but large enough for the objectives for which it is intended to be used.

(4) Photomicrography.

Stereography.‡—Under the above title F. R. v. Wellheim discusses the principles and methods of stereomicrophotography. His treatise is divided into two parts, the first of which deals with stereomicrographs taken transparently with various kinds of light (ordinary, polarized, dark-ground). The second part discusses the stereography by reflected light of small objects in natural size or reduced. In addition to elucidating the principles, the author summarizes many details of practical importance, and gives several useful numerical tables.

(5) Microscopical Optics and Manipulation.

Method of obtaining Microscopical Bench-marks exactly Circular in Micrometric Observations: Application to the Study of Trunnions in Equatorial Telescopes.§—E. Esclangon has found that drops of mercury vapour condensed on a glass slide make excellent bench-marks for micrometric work. They have the advantage of being clearly defined and are always perfectly circular. They can be obtained of any size, even down to a fraction of a micron. He suggests as a useful illustration of this property its application to the determination of the movement of the trunnion axis of an equatorial telescope. A divergence from perfect circularity of the trunnion introduces errors into the telescopic observations which are by no means negligible. The

* Zeitschr. wiss. Mikrosk., xxix. (1913) pp. 336–9 (1 fig.).
† Journ. Quekett Micr. Club, xii. (1913) pp. 95–6.
‡ Zeitschr. wiss. Mikrosk., xxx. (1913) pp. 1–28 (5 figs.).
§ Procès-verbaux des Séances, Soc. Sci. Phys. et Nat. de Bordeaux, 1910–11, pp. 9–13.

author describes how a series of photomicrographs upon such a group of mercury globules would make it possible to ascertain the exact motion of the trunnion axis and hence arrive at a suitable correction factor.

Measurement of Magnifying Power.*—M. A. Ainslie suggests the following simple methods for obtaining the magnifying power of a Microscope.

1. *Projection on a Screen.*—Excellent results can be obtained with a paraffin lamp and a bullseye. The top lens of the condenser should be removed, and, in order to sharpen the outline of the circle of illumination seen on the screen, the iris diaphragm of the condenser should be closed as far as possible, consistent with the easy visibility of this circle. The Microscope is placed horizontally and the objective removed. The screen should be accurately at right angles to the axis of the Microscope and 250 mm. from the Ramsden disk. If D be the distance of the screen and B the diameter of the circle of light formed there, then $C = \frac{250\ B}{D}$. This quantity C is called by E. M. Nelson the "eye-piece constant," and is really the diameter of the projection of the circle formed by the diaphragm of the eye-piece on a plane 250 mm. from the eye. If now, an objective having been inserted, an object of diameter A just fills the field, M (the magnifying power of the objective) $= \frac{C}{A}$. A would probably be obtained from a stage micrometer or a divided scale.

2. *Pin Method.*—The Microscope being placed horizontally, a board about a foot square is supported horizontally just below the optical axis of the Microscope. A cross-line being drawn on this 250 mm. from the Ramsden disk and at right angles to the optical axis, two pins are stuck into the board on this line in such a position that they are in line with the Ramsden disk and the observer's eye at the moments when the Ramsden disk disappears—which it will do when the observer's eye, placed in rear of the board, is moved far enough to either side of the optic axis. If care is taken that the cross-line is exactly 250 mm. from the Ramsden disk, this method gives C without further calculation, by measuring the distance between the two pins. In this method the Ramsden disk should be reduced to a mere point by closing the sub-stage iris. For correct results, uniform and complete illumination of the field of view is essential.

3. *Sextant Method.*—This method is capable of very accurate results. If θ be the angular subtense of the field of view, as seen in the eye-piece, then $\tan \frac{\theta}{2} = \frac{C}{2} \div 250$, or $C = 500 \tan \frac{\theta}{2}$. If a sextant, provided with a low-power inverting telescope with cross-wires in its eye-piece, is supported horizontally in such a way that the large or index mirror is close to the eye-piece, the edges of the field of view can be brought successively, after reflection at the two mirrors, to coincide with the vertical wire in the eye-piece of the telescope (previously

* Eng. Mechanic, xcviii. (1913) pp. 12–13.

focused on a distant object) by moving the index bar which carries the vernier and index mirror. The difference between the readings of the arc in the two cases gives θ at once, from which C can be computed as above.

It may be of interest to note that the above method of finding C is also capable of giving the N.A. up to about 0·5. If the objective be placed in the draw-tube as an eye-piece (of course, with its front lens outwards), then the N.A. $= \sin \frac{\theta}{2}$, θ being obtained as above. Also the N.A. $= C \div \sqrt{250000 + C^2}$.

Diffraction Bands.*—In this paper J. W. Gordon attempts to exhibit the theory of diffraction patterns in a comprehensive form, and by means of an elementary mode of treatment. He aims at putting the theory of diffraction upon the same text-book level as the theories of refraction and reflection. The mode by which the author introduces this simplification into the subject consists essentially in substituting as the surface of resolution the envelope which forms the boundary of an aplanatic pencil in place of the wave-front which occupies its aperture. By this alteration in the mode of analysis a great simplification in the processes of the analysis is effected, the analogies between different forms of aperture which have little resemblance to one another become apparent, and the elementary form of exposition is rendered possible. The author develops the general doctrine in seventeen propositions, of which the following are specimens :—

(1) The diffraction pattern produced by an aplanatic pencil of polygonal cross-section, when that pattern is formed and observed in an apertural plane remote from the focus, is a series of Fresnel bands bordering the edge of the aperture of the pencil in that plane.

(5) Whatever the shape which the diffraction pattern in a focal plane may assume, that shape is always bilaterally symmetrical.

(11) The ray velocity of diffracted light is equal to the ray velocity of aplanatic light in the region beyond the boundary of the aplanatic pencil.

(16) The diffraction pattern visible within the aperture of an aplanatic pencil near the focal point is produced by visual projection upon the plane examined of the diffraction pattern formed by optical projection in the focal plane.

(6) Miscellaneous.

Note on Pleurosigma angulatum.†—E. M. Nelson gives reasons for thinking that the upper and lower membranes of *P. angulatum* do not "eye-spot" each other, i.e. the apertures in the lower membrane are not directly below those in the upper membrane. Observation with a Leitz apochromat, $\frac{1}{12}$ in. of 1·40 N.A., reveals that the apertures in

* Proc. Optical Convention, ii. (1912) pp. 173-204 (17 figs.).

† Journ. Quekett Micr. Club, xii (1913) pp. 99–100 (4 figs.).

the lower membrane are unmistakably below the intercostals of the upper membrane, and that this is true not only of *P. angulatum* but also of all allied forms that have been examined.

Fluor-Crown, a New Optical Glass.*—E. Zschimmer describes how, by the use of fluor-spar as an ingredient, certain durable glasses suitable for optical work have been obtained. They are numbered respectively in the Jena Glass Catalogue: O 6781, 6500, 7185. Some of their constants are respectively :—

$$\begin{aligned} n_D &= 1{\cdot}4933,\ 1{\cdot}4710,\ 1{\cdot}4637\ ; \\ \text{mean dispersion} &= 0{\cdot}00706,\ 0{\cdot}00701,\ 0{\cdot}00707\ ; \\ \nu &= 69{\cdot}9,\ 67{\cdot}2,\ 65{\cdot}6. \end{aligned}$$

The author is of opinion that further advances may be still possible.

Microscope Construction and the Side-screw Fine-adjustment.† E. M. Nelson summarizes the history of the side-screw adjustment, and points out that in modern times horizontal fine-adjustments may be placed in two groups, viz. (*a*) those with continuous motion, and (*b*) those without. The drawback which those of the first kind possess is that the user does not know whether he is focusing up or down; and

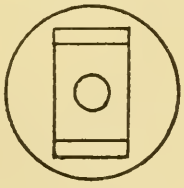


Fig. 75.

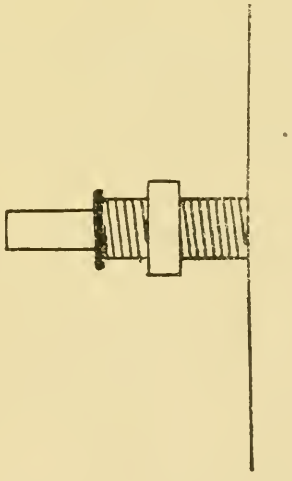


Fig. 76.

the drawback which all the second kind (excepting the Berger) have, is that of damage and injury to the delicate moving parts when they butt up against a stop. The Berger avoids all risk of damage from this source by causing an idle nut to butt against a stop: if this nut receives damage or strain to its thread it is of no importance. The first kind adopt a continuous motion in order to secure immunity from this danger, and put up with the great disadvantage of having a fine adjust-

* Zeitschr. f. Instrumentenk, xxxiii. (1913) pp. 145–8.
† Journ. Quekett Micr. Club, xii. (1913) pp. 96–8 (2 figs.).

ment which does not follow the direction of the movement of the milled head.

The following device has been designed to effectually prevent any damage taking place. To the right-hand side of the limb, where the micrometer drum-head is placed, a short piece of tube, threaded on the outside, is fixed, and through it the fine-adjustment pinion passes, just like the cannon pinion in a clock. An idle nut works on this screw in a slot inside the micrometer drum. It is then arranged that this nut will permit ten rotations of the fine-adjustment pinion to be made, and then stop further motion by butting either against the side of the limb or against the end of the inside of the micrometer drum. Figs. 75 and 76 will make this simple device clear without further explanation.

B. Technique.*

(1) Collecting Objects, including Culture Processes.

Sugar Reactions for Diagnosis of Streptococci.†—Maas has investigated the reactions obtained with fifteen different strains of streptococci, cultivated in serum-pepton-water media, containing a series of twenty-three carbohydrates, glucosides, and alcohols. The author concludes that this method is not of any value for the classification of streptococci.

In discussing this communication, J. Koch stated that sugar media were useful for the diagnosis of certain streptococci, and quotes as an instance the mannite-acidifying property of *Streptococcus longus*. He attributes the divergence of the results obtained by different investigators to the impurity of commercial sugar preparations.

Tellurium-media in the Diagnosis of Diphtheria.‡—Schürmann and Hajòs have investigated the value of the medium of Conradi and Troch for the isolation of diphtheria bacilli. This medium is made up as follows : to a litre of water are added 10 grm. of meat extract, 5 grm. sodium chloride, 20 grm. pepton, and 6 grm. of calcium bimalate. This is steamed for half an hour and filtered. Then is added glucose, 1 grm. per 100 c.cm. of filtrate. Then this fluid is added to fresh ox-serum in the proportion of 1 to 3, and 1 p.c. potassium tellurate is added to the mixture, 2 c.cm. to every 100 c.cm. This is then heated to 85° C. for 15 minutes, when the medium solidifies. The action of the calcium malate and potassium tellurate is to inhibit the growth of intrusive organisms, while permitting that of the diphtheria bacillus. Diphtheria colonies are black owing to their action on the medium, liberating metallic tellurium. The authors, after comparative investigations of a large number of cases, find that the use of this medium

* 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, preservation fluids, etc.; (6) Miscellaneous.

† Centralbl. Bakt., 1te Abt. Ref., lvii. (1913) Beih., pp. 258–62.

‡ Centralbl. Bakt., 1te Abt. Ref., lvii. (1913) Beih., pp. 56–61.

and of fluid media containing tellurium salts is of great service in facilitating the diagnosis of diphtheria. They discuss the relative merits of various enriching methods, but consider that the direct inoculation of tellurium plates gives the best results.

Cultivation of the Myxobacteriaceæ.*—E. Pinoy describes his attempts to cultivate *Chondromyces crocatus*, a highly developed type of the Myxobacteriaceæ, upon artificial media. He found that the organism would not grow upon ordinary sterilized media, but only in symbiosis with lower organisms. In association with a certain micrococcus, allied to *Micrococcus latens*, the organism gave good growth on artificial media. It grew, but with less freedom, upon cultures of the micrococcus which had been killed with chloroform.

Use of "Thermos" Flasks for Biological Work.†—V. Baldasseroni, after alluding to the uses and structure of the thermos flask, shows how it may be rendered useful for biological work. He advises a spherical shape, a short neck and a case, cubical or cylindrical, lined with felt and having at the bottom a rubber cushion (fig. 77). The

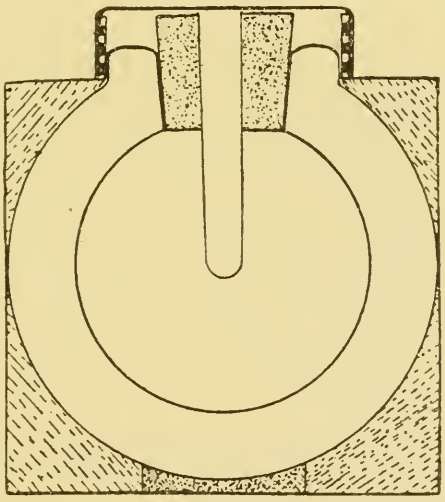


Fig. 77.

stopper, made of cork or rubber, is perforated to admit the tubes. The tube or tubes containing the objects to be impregnated with paraffin or to be warm-stained are placed in the flask, which is to be filled with water of the requisite temperature. The cap is then screwed on. The apparatus retains its heat for some hours and would be of service when any overheating is undesirable.

Selective Medium for Cholera Vibrios.‡—In recent years, a number of authors have described culture-media which favour the growth of

* Comptes Rendus, clvii. (1913) pp. 77–8.
† Zeitschr. wiss. Mikrosk., xxx. (1913) pp. 45–8 (1 fig.).
‡ Centralbl. Bakt., 1te Abt. Orig., lxxx. (1913) pp. 202–8.

the cholera organism whilst inhibiting that of extraneous organisms. Dieudonné's blood-alkali-agar, the first of these, was found to be not strictly selective, permitting the growth of other types of vibrio, of *B. pyocyaneus*, and some other organisms. Moreover, it was not ready for use until 18 hours after the plates were poured. Pilon's blood-soda-agar is ready for use at once, is of no less selective value than Dieudonné's medium, but its usefulness is greatly diminished by the fact that it does not favour the growth of cholera vibrios in first culture from the tissues.

T. Kabeshima's hæmoglobin-extract-soda-agar here described possesses the advantages of being ready for use the moment its preparation is complete, and of being strongly selective for the causal agent of cholera. The method of preparation is as follows. 10 c.cm. of 18 p.c. soda are heated with 80 c.cm. of melted 3 p.c. nutrient agar for 10 minutes. This is cooled to 50° C., and a solution of 3 grm. Pfeiffer's hæmoglobin extract in 10 c.cm. normal saline is added. After thorough mixing, the liquid is poured into seven Petri dishes. These are left uncovered until the agar has set, and are then put into an incubator to dry off the condensation water.

(2) Preparing Objects.

New Method of Blood Fixation.*—H. G. Plimmer gives the following procedure for fixing blood films.

1. *Vapour Method.*—Expose the film whilst wet to the vapour of a solution of iodine in chloroform for 10 to 15 seconds, until it is distinctly yellowish. When the temperature is low the vessel should be warmed in order to get the vapour given off freely. Place the film, when it has become surface-dry, in chloroform, or in alcohol and ether, equal parts, for 2 hours. This removes the iodine, and the film may be stained. The author uses :—A. Giemsa. Three to eight drops are placed on the film, and immediately after double the number of drops of distilled water ; leave for 2 to 12 hours. Wash with tap-water. Drop on two to eight drops of orange-tannin solution, and leave for 15 seconds. Wash in tap-water up to 2 minutes. Dry with filter paper. Mount in cedar-oil or liquid paraffin.

B. Carbol-fuchsin for from 2 to 12 hours. Wash in tap-water. Remove excess of stain with alcohol. Differentiate in oil-of-cloves saturated with orange G. Wash in xylol, and mount in cedar-oil or liquid paraffin.

C. Iron-hæmatoxylin or Kernschwarz for 24 hours.

2. *Solution Method.*—Make a saturated solution of potassium iodide in 0·8 p.c saline, and add iodine to saturation. Mix five to six drops of this with 10 c.cm. of salt solution. Mix in a marked pipette equal parts of this and the blood to be examined. (In the case of organs, small pieces may be crushed in an equivalent quantity of the iodine solution to form an emulsion.) Take large drops and make a thickish film. Wait until the surface has begun to dry, and place in alcohol-ether for 2 hours. Then proceed as in the vapour method.

* Proc. Roy. Soc., Ser. B, lxxxvi. (1913) pp. 289–91.

Marking Paraffin Blocks.*—W. H. Harvey describes a new method of marking paraffin blocks for purposes of orientation or identification. It consists in embedding in the same block as the tissue a thin pencil of coloured paraffin-wax, having a melting-point somewhat higher than that of the embedding mass. While the mass is molten, a length of coloured wax pencil, sufficiently long to project above the block moulds, is placed vertically in the liquid wax in any desired relation to the tissue. A clear and definite mark thus persists throughout the block. Such a means of orientation is particularly useful as a reconstruction guide in embryological investigations.

To make the wax pencils, paraffin of a melting-point 10° C. higher than that of the paraffin oven is drawn into lengths of glass tubing of 0·5–1 mm. in diameter. The inner surface of the glass is first of all thinly coated with oil to prevent the wax from sticking. The tubes when full of wax are allowed to cool, file-marked, and carefully cracked. The pencil may be drawn out of the tubing, and kept ready for use. Of the available pigments, some such as congo-red may be added directly to the wax, while others must first be dissolved in melted stearic acid.

(4) Staining and Injecting.

New Staining Method for Biliary Canaliculi.†—B. M. Vance states that the bile canaliculi are brought out as fine dark blue or black double lines, outlined against the lighter blue of the liver cells, by the following method. Fix in equal parts of Zenker's fluid, without the acetic acid, and 10 p.c. formalin, or in equal parts of 10 p.c. formalin and 5 p.c. sublimate. After hardening, embed in celloidin and place the sections in a dilute solution of iodine in 96 p.c. alcohol for 5 to 15 minutes. Wash thoroughly in 95 p.c. alcohol to remove iodine. Stain with phosphotungstic-acid-hæmatoxylin (Mallory) for 12 to 24 hours. Wash in 95 p.c. alcohol. Clear in carbol-xylol and mount in balsam.

Formula for the Chrom-osmic-acetic Acid Fluid.‡—F. Zieglwallner remarks in connexion with his article on the fixation and staining of glycogen and its demonstration together with fat, that a convenient formula for the alcoholic chrom-osmic-acetic acid mixture is the following: 10 p.c. chromic acid solution in distilled water, 1·5 c.cm.; 2 p.c. osmic acid solution in distilled water, 4 c.cm.; acetic acid, 1 c.cm.; alcohol (75 p.c.), 13·5 c.cm.

Demonstrating Spirochæta pallida.§—C. Levaditi was successful in demonstrating *S. pallida* in about 90 p.c. of the cases examined. The procedure adopted was to take a small piece of the cortex cerebri (2–3 mm.) and tease it out in 2 or 3 drops of saline. Smears were then examined by Burri's Indian ink method, by staining by the Fontana-

* Y. Path. and Bact., xviii. (1913) pp. 8–10.
† Anat. Anzeig., xliv. (1913) pp. 412–13.
‡ Zeitschr. wiss. Mikrosk., xxx. (1913) p. 72.
§ Ann. Inst. Pasteur, xxvii. (1913) pp. 577–96 (1 pl.).

Tribondeau method, and by Loeffler's flagella-staining method. Good results were obtained, and are shown in the coloured illustration.

The Fontana-Tribondeau method is thus given. A smear is made with the emulsion of the cortex, and then fixed for a minute in the following fluid: acetic acid, 1 c.cm.; formol, 2 c.cm.; distilled water, 100 c.cm. Next it is washed in running water, and then mordanted for 30 seconds in carbolic acid, 1 c.cm.; tannin, 5 grm.; distilled water, 100 c.cm. The mordant is heated until it vaporizes. After another wash the film is treated for 30 seconds with the following solution heated till it vaporizes: nitrate of silver, 0 25 grm.; distilled water, 100 c.cm.; liquid ammonia, as many drops as are necessary to re-dissolve the precipitate which is formed when the ammonia is first added. Wash in running water and dry. The spirochætes are brown on a yellow ground.

The smear method is much more reliable and rapid than the method of sections.

Method of Obtaining Pure Trypanosome Strains.*—R. Oehler makes further remarks upon his method of isolating trypanosomes. This method consists of the separating off of single trypanosomes in capillary glass tubing, and then infecting animals with these isolated organisms. The author has made further use of his method, and has been able by this single-organism injection method to infect animals to the fourth passage. Incubation period and course of disease remained unaltered. He further was able in this way, and by injecting infected animals with various doses of salvarsan, to obtain races of trypanosomes possessing different degrees of resistance to arsenic, to investigate the extent to which such resistance is affected by subsequent passage, and to compare resistant and non-resistant strains.

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

New Method of Mounting Microscopical Preparations.†—C. Cépède has devised a method of mounting microscopical preparations so that they can be examined from the upper and lower surfaces, and by means of high powers. An ordinary slide is ground out so as to leave an aperture 19 mm. in diameter, and in such a way that a projecting edge is left all round (fig. 78, *2*). On this edge is placed a coverglass with the specimen; this is then covered with the mounting medium (balsam, gelatin), and then another slip (fig. 78, *2*) slightly larger is imposed.

In addition to the advantage of being able to examine a preparation from the upper and under surfaces, the method will be found convenient for stacking the slides together, so that risk of damage to the specimens is altogether obviated (fig. 78, *3*).

Electrically-heated Object-carrier for Microscopes.‡—F. G. Cottrell describes how a small object-slide with gilded edges can be

* Centralbl. Bakt., 1te Abt. Orig., lxx. (1913) pp. 110–11.

† Comptes Rendus, clvi. (1913) pp. 683–5 (1 fig.).

‡ Journ. Amer. Chem. Soc., xxxiv. (1912) p. 1328 (1 fig.); and Deutsche Mechaniker-Zeitung (1913) pp. 115–16.

kept at any constant temperature. He introduces the slide into a kind of india-rubber stoppered large test-tube. The stopper is perforated for the admission of a platinum thread (anode), and of a small tube terminating in a small piece of platinum foil (cathode). This small tube contains a few drops of mercury to facilitate the passage of the electric

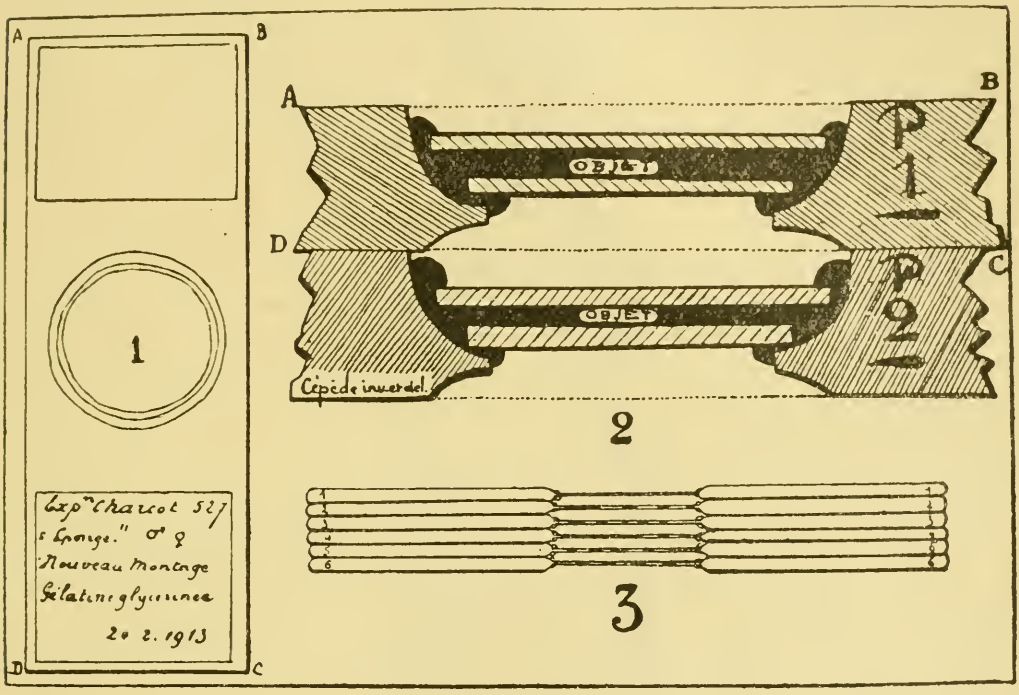


Fig. 78.

current introduced by a coil which sparks to at least 25 mm. The stopper is also pierced by a small tube in connexion with an air-pump. By regulating the current with a rheostat, and by controlling the air-pump, the temperature of the interior, and therefore of the object-slide, can be fixed as required. The apparatus has been found especially convenient for the observation of crystal-formation.

(6) Miscellaneous.

Safety Mixing Cylinder.*—The practice of shaking emulsions of infective material in the ordinary glass-stoppered measuring cylinder is attended with a certain amount of risk, and the subsequent removal of the stopper produces a fine spray of the fluid from the lip of the vessel. To remove the danger of accidental infection from this cause, Lentz has devised a special form of mixing cylinder (fig. 79). It is shorter and stouter than the ordinary type, and stands on a broad base. It is made in 70 and 100 c.cm. sizes, graduated respectively to 35 and 50 c.cm. The

* Centralbl. Bakt., 1te Abt. Orig., lxx. (1913) pp. 108–9.

essential safety contrivance is a glass cap, an extension of the upper part of the stopper which protects the neck of the cylinder in the manner

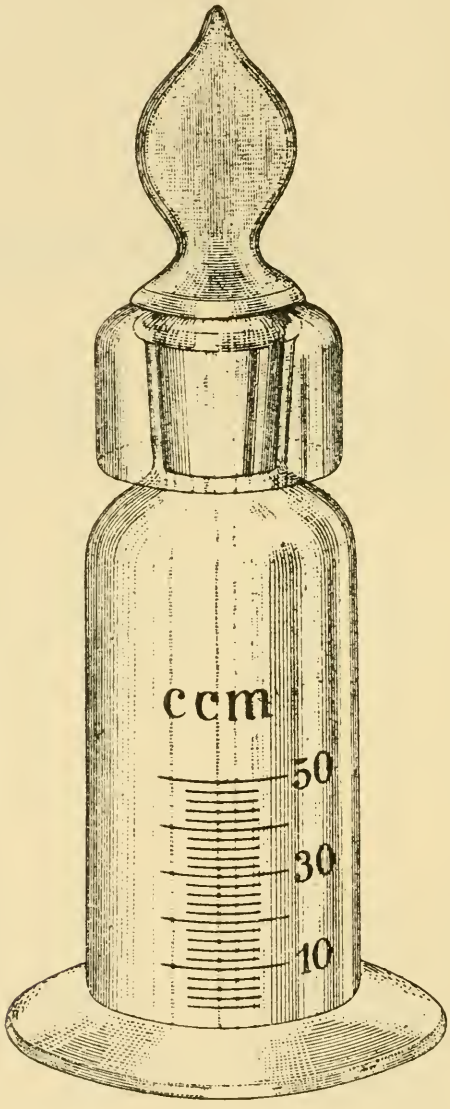


Fig. 79.

shown, and receives any droplets of fluid that may be sprayed out at the moment of withdrawal of the stopper.

Sterilization of Glycerin.*—H. Bullock has investigated the resistance of spores of *Bacillus subtilis* to heating in anhydrous fluids such as glycerin, oil, and similar substances. In view of the increasing use of such materials in modern surgery, the practical value of this research is obvious. He comes to the conclusion that in the sterilization of

* Journ. Hygiene, Cambridge, xiii. (1913) pp. 168–77.

glycerin or oil, the use of the autoclave is of no special value, since exposure to superheated steam acts no more rapidly or effectively than simple heating of those fluids to the same temperature at ordinary atmospheric pressure. Heating of spores in glycerin or oil has no greater sterilizing action than simply heating them in dry air at the same temperature for the same period. For the sterilization of these fluids it is necessary to use a temperature of not less than 170° C. for at least half an hour, or 180° C. for not less than ten minutes. The methods commonly in use for the sterilization of glycerin and similar fluids are quite inadequate to secure sterility with certainty, and accordingly they ought to be abandoned.

Bacterial Investigation of Liquids.—E. Hesse* discusses certain improvements in his method of studying the bacterial content of a large bulk of liquid by means of a Berkefeld filter. The fluid to be examined is drawn through the filter by means of a suction pump, and then a few cubic centimetres of water sent in the reverse direction through the filter will wash off the organisms adhering to the outer side of the filter. Thus the bacteria present in a large quantity of fluid, are concentrated into a few cubic centimetres. The author used at first the Berkefeld candle No. $10\frac{1}{3}$, with extra fine pores, but later he used instead a coarser filter, treated with a fine suspension of kieselguhr, or prepared chalk. By means of experiments on guinea-pigs, the author demonstrated the harmlessness of prepared chalk when injected into animals.

In another place,† the author reviews all the principal methods of bacteriological investigation of water samples by concentration and enriching processes, and gives experimental evidence to show that by the use of a Berkefeld candle impregnated with kieselguhr. 91 p.c. of the organisms present in a large bulk of sample may be recovered in a few cubic centimetres of water, from the surface of the filter.

Metallography, etc.

Microstructure of German Silver.‡—O. F. Hudson describes the structure of German silver containing 58 p.c. copper, 18·5 p.c. nickel, 23·5 p.c. zinc ; this alloy consists wholly of the α solid solution. The cold-rolled alloy had a highly distorted structure to which the cores of the casting structure gave a markedly laminated appearance. Specimens were annealed at 700° C. for 1, 10, 24, 48, and 72 hours. The usual growth of crystal took place, and the cored appearance gradually disappeared, though faint traces of coring could be detected in the specimen annealed for 72 hours. The results indicate the extreme slowness of diffusion in this ternary alloy ; diffusion is retarded by the presence of nickel. In a communication to the discussion, H. Garland

* Centralbl. Bakt., 1te Abt. Orig., lxx. (1913) pp. 331–4.
† Arch. f. Hygiene, lxxx. (1913) pp. 11–28.
‡ Journ. Inst. Metals, ix. (1913, 1) pp. 109–19 (14 figs.).

referred to the cored structure of ancient Egyptian bronzes, in which recrystallization, but not diffusion, appeared to have occurred in the course of some thousands of years at ordinary temperatures.

Heat-treatment of Gun-metal.*—H. S. Primrose and J. S. G. Primrose describe experiments upon Admiralty gun-metal containing 88 p.c. copper, 10 p.c. tin, 2 p.c. zinc, the results of which indicate that the mechanical properties may be much improved by an annealing (e.g. at 700° C.), which causes the disappearance of the δ-containing eutectoid. The annealed alloy consists solely of the α solid solution. Twenty-four photomicrographs illustrate the structure of the alloy after different heat-treatments.

Brasses containing Nickel.†—L. Guillet gives a more complete account of the determination of the "coefficient of equivalence" of nickel when added to copper-zinc alloys, and describes the microstructure of two series of alloys containing respectively 49 and 55 p.c. copper. The nickel ranged from 0 to 10 p.c., and the remainder was zinc. Comparison between the structures of the alloys as cast, and after annealing for two hours at 750° C., indicated that annealing was essential in order to secure homogeneity in structure. In the alloy containing 49 p.c. copper, 10 p.c. nickel, cast in sand, the β constituent possessed a most distinct eutectoid structure. Acid ferric chloride solution was used for etching.

Permanence of Structure in Copper-zinc Alloy.‡—A. K. Huntington describes the structure of copper-zinc alloy stays from the fire-box of a locomotive. In sixteen years of use the stays had been subjected to varying temperatures, and to constant vibration and stresses. The cored $\alpha + \beta$ structure was practically identical with that of a freshly-prepared ingot, and indicated that diffusion or recrystallization had not occurred.

Copper-antimony Equilibrium.§—H. C. H. Carpenter, in the course of a complete revision of the copper-antimony equilibrium, has relied

Constituent	Constitution	Colour	Atomic percentage Copper
α	Solid solution of Cu_3Sb in copper	Golden brown	100 to 96
$\alpha + \gamma$	.. ..	..	96 to 81
γ	Its basis is the compound Cu_3Sb	Greenish grey	81 to 75
$\gamma + \delta$	.. ..	..	75 to 66·6
δ	The compound Cu_2Sb	Purple lilac	66·6
$\delta + \epsilon$	.. ..	..	66·6 to about 1
ε	Almost pure antimony	White	Not more than 1

* Journ. Inst. Metals, ix. (1913, 1) pp. 158–86 (33 figs.).
† Rev. Métallurgie, x. (1913) pp. 1130–41 (20 figs.).
‡ Journ. Inst. Metals, ix. (1913, 1) pp. 39–41 (6 figs.).
§ Int. Zeitschr. Metallographie, iv. (1913) pp. 300–22 (15 figs.).

largely upon the microscopic examination of annealed and quenched specimens. Six weeks annealing was found to be sufficient to establish equilibrium. The β constituent only occurs above 430° C. The solid solubility of antimony in copper is much higher than has previously been suspected. The accompanying table describes the constituents of alloys annealed to equilibrium at 400° C.

Granular Pearlite.*—H. Hanemann and F. Morawe find that granular pearlite may be formed in steel by any one of four different treatments:—(*a*) by very slow cooling through Ar_1; (*b*) by repeated heating and cooling through A_1; (*c*) by re-heating quenched steel at 650° to 700° C. without exceeding Ac_1; (*d*) by long annealing of lamellar pearlite at temperatures just below Ac_1. Small pieces of steel containing 0·86 p.c. carbon were drawn at different speeds from the hot to the cold end of a tube (one end of which was inserted in a Heraeus furnace at 900° C), to obtain different rates of cooling, and were then examined microscopically. When the speed of cooling through Ar_1 did not exceed 0·5° C. per minute, the pearlite was wholly granular; somewhat faster cooling gave mixtures of granular and lamellar pearlite. In steels in which the carbon-content is higher or lower than in the eutectoid, granular pearlite is more readily formed owing to the separation above Ar_1 of excess cementite or ferrite.

Tenacity, Deformation, and Fracture of Soft Steel at High Temperatures.†—W. Rosenhain and J. C. W. Humfrey have studied the tensile properties, at high temperatures, of a sheet steel containing 0·1 p.c. carbon, and record the microscopic observations made upon the specimens. The test pieces were strips cut from thin sheet; they were polished on one face, heated in a vacuum to the required temperature, broken rapidly or slowly, and cooled rapidly or slowly, as desired. As the enlarged ends of the test piece underwent the same treatment as the strained portion, unstrained specimens were in each case available for examination and comparison. Owing to the heat-reliefs developed, combined with the effects of strain and of the vacuum-etching incidental to the method, it was unnecessary to etch the specimens. Substantial confirmation of the amorphous cement theory of crystal boundaries was obtained.

At temperatures well above Ar_3 the material behaved as an aggregate of crystals, themselves relatively strong, embedded in a viscous fluid. The allotropic change occurring at Ar_3 coincided with a marked weakening of the crystals, the cement apparently being unaffected. Thus below Ar_3 the cement was stronger than the crystals, and strain occurred chiefly within the crystals, slip bands being formed. The behaviour of the specimens was much the same in the α range as in the β range. Below Ar_3 the strength of the material was found to be largely dependent on crystal size, unless the rate of straining was extremely slow, when the influence of crystal size practically disappeared. Measurements of crystal size were made by tracing upon a screen the outlines of the

* Stahl und Eisen, xxxiii. (1913) pp. 1350–5 (9 figs.).
† Journ. Iron and Steel Inst., lxxxvii. (1913, 1) pp. 219–314 (50 figs.).

crystals in a magnified image of the heat-relief projected upon the screen by means of a projecting Microscope. The total area, measured by a planimeter, was divided by the number of crystals in it. The comparative vagueness of the slip bands observed in specimens which had been maintained at a high temperature for some time after straining, is ascribed to the volatilization of metal from the surface in the high vacuum employed.

Crystallization of Steel.*—F. Giolitti's experiments lead him to differ from Belaiew as to the process of crystallization in steel, which would rather appear to consist in the formation of mixed crystals from the melt, and the subsequent separation of the ferrite or cementite from the mixed crystals. Slow cooling after eight hours heating at 1000° C. favours the formation of Widmannstätten's figures in steel containing 0·32 p.c. carbon, while rapid cooling renders them less perfect.

Microstructure of Steels.†—Brès describes the microstructure of four steels, each containing about 2·6 p.c. nickel, 0·6 p.c. chromium, 0·2 p.c. carbon. In spite of their similarity in composition and heat-treatment, their mechanical properties differed widely, and corresponding differences were found in their microstructure. In the cast condition, one of the steels consisted of large areas of ferrite and well-formed pearlite. The pearlite in the other steels was more finely divided and confused in structure. These differences were found to persist after rolling at a high temperature, and throughout an experimental series of heat-treatments. It appears that in steels of similar composition, differences in initial structure, which cannot be removed by mechanical or thermal treatment, may occur.

A. Portevin‡ has examined the two steels which differed most widely after forging and annealing, and gives photomicrographs illustrating the marked difference in microstructure at high magnification.

Influence of Phosphorus upon the Properties of Mild Steel.§ E. d'Amico has studied numerous properties, including microstructure, of twelve mild steels containing 0·01 to 1·24 p.c. phosphorus, the carbon being about 0·13 p.c. Specimens were examined as rolled, after annealing and after quenching. Phosphorus above 0·6 p.c. caused irregularity in the distribution of the ferrite and pearlite. The ferrite crystals were large in the phosphorus-rich alloys. Surrounding each pearlite mass, in the phosphorus-rich alloys, was a zone of ferrite distinguishable from the remainder of the ferrite by its lower level in etched specimens. It is suggested that the zone is more rich in phosphorus than the rest of the ferrite.

Influence of Heat-treatment upon Cold-worked Mild Steel.‖—P. Goerens has studied the microstructure, in addition to numerous other

* Atti Accad. Sci. Torino, xlviii. (1912–13) pp. 413–33, through Science Abstracts, Section A, xvi. (1913) p. 393.

† Rev. Métallurgie, x. (1913) pp. 797–807 (18 figs.).

‡ Rev. Métallurgie, x. (1913) pp. 808–10 (2 figs.).

§ Ferrum, x. (1913) pp. 289–304 (33 figs.).

‖ Ferrum, x. (1913) pp. 226–33, 260–70 (21 figs.).

properties, of cold-drawn steel wire containing 0·08 p.c. carbon, before and after annealing at various temperatures. The so-called fibrous structure is rapidly replaced by a granular structure when the temperature reaches 520° C.

Cold Flow of Steel.*—P. Longmuir has studied the structural and other effects of wire-drawing of steel. Both ferrite and pearlite are mobile within the limits of cold flow. Each annealing heals the effect of cold-work, but the crystals do not regain their original size, the structure becoming finer as the wire decreases in diameter. It is doubtful whether cementite, present in high carbon steels, yields at all in drawing.

Influence of the Metalloids on Cast Iron.†—H. I. Coe has studied the properties of fifty-four cast irons, containing varying quantities of silicon, sulphur, phosphorus, and manganese, and describes their microstructure. The crystallization of iron-carbide in the form of thin plates is illustrated by a photomicrograph of a specimen containing 1·6 p.c. silicon, 1·7 p.c. phosphorus, heat-tinted.

Influence of Sulphur on the Stability of Iron-carbide.‡—W. H. Hatfield has made a microscopical and chemical study of the changes occurring in a number of cast irons containing different percentages of sulphur, silicon, and manganese, submitted to different heat-treatments. In etched or unetched sections the cementite, pearlite, and sulphide could not readily be identified at the same time. Sections were therefore prepared by heat-tinting. When heat-tinting was carried to the correct degree, the cementite carbide became brownish-purple, the pearlite a very pale brown, and the sulphide assumed a pale blue tint. The microstructures are described in detail and illustrated with photomicrographs. The author concludes that the increased stability at high temperatures conferred upon iron-carbide by the presence of sulphur in the alloy is due to a chemical action, and is not caused by the mechanical action of sulphide films. The effect is probably due to the small percentage of sulphur associated with the carbide crystals. It is suggested that the effect of silicon in neutralizing the action of sulphur may be explained by the formation of a silicon sulphide.

Crystallization of Metals.§—C. H. Desch describes a method of studying crystal skeletons in metals in three dimensions. Serial sections are photographed and the crystal is reconstructed as a model. The form of a eutectic is generally determined by the crystallizing power of one component, the other serving as a filling material. Illustrations are furnished by the copper-antimony and copper-phosphorus alloys.

* Journ. Iron and Steel Inst., lxxxvii. (1913, 1) pp. 93–117 (28 figs.).
† Journ. Iron and Steel Inst., lxxxvii. (1913, 1) pp. 361–81 (10 figs.).
‡ Journ. Iron and Steel Inst., lxxxvii. (1913, 1) pp. 139–68 (31 figs.).
§ Proc. Roy. Phil. Soc. Glasgow, xliii. (1911–12) pp. 107–20, through Journ Chem. Soc., civ. (1913) p. 567.

Growth of Grain in Metals and Alloys.*—F. Robin gives a more extended account of the work previously summarized.† Crystal growth, and in particular the development of abnormally large crystals by the annealing of cold-worked specimens, has been studied in tin, lead, zinc, aluminium, copper, and iron, and in numerous binary alloys of these metals with other metals. While great irregularities in the rate of growth of crystals were observed, it would appear that when a uniformly cold-worked metal is annealed at different temperatures, large grains are obtained at the temperature at which annealing begins, and also at a temperature just below the melting-point, a minimum grain-growth occurring at some intermediate temperature. Deformed crystals have a remarkable capacity for growth when annealed, and appear to grow most readily at the expense of neighbouring undeformed crystals. Solid solutions resemble pure metals in their development of crystallization on annealing, but do not as a rule show such rapid growth of crystals as pure metals.

Microscopic Examination of Coal.‡—A. Wahl and P. Bagard have applied metallographic methods to the investigation of the constitution of coal. After plain polishing or polishing in relief no structure was visible. Immersion in warm pyridine, for a length of time depending on the character of the coal, developed a distinct banded structure in some of the polished specimens. The method appears to be capable of yielding information as to the degree of homogeneity of certain coals.

* Rev. Métallurgie, x. (1913) pp. 722–68 (48 figs.).
† See this Journal, 1913, p. 109.
‡ Comptes Rendus, clvii. (1913) pp. 380–1 (2 figs.).

MICROSCOPY.

A. Instruments, Accessories, etc.*

(1) Stands.

Model for a Polarizing Microscope.†—W. N. Benson has designed this model for the purpose of demonstrating to students the manner in which light is transmitted through a polarizing Microscope, and the explanation of birefringence and pleochroism.

The model consists of a number of portions strung on a stout wire or knitting-needle (RR in fig. 80), which represents the path of the pencil of rays along the axis of the Microscope. The rays falling on the mirror A (a cork) are reflected along RR, and the pencil is made up of rays vibrating across RR in every azimuth (as shown by B). On reaching C, the

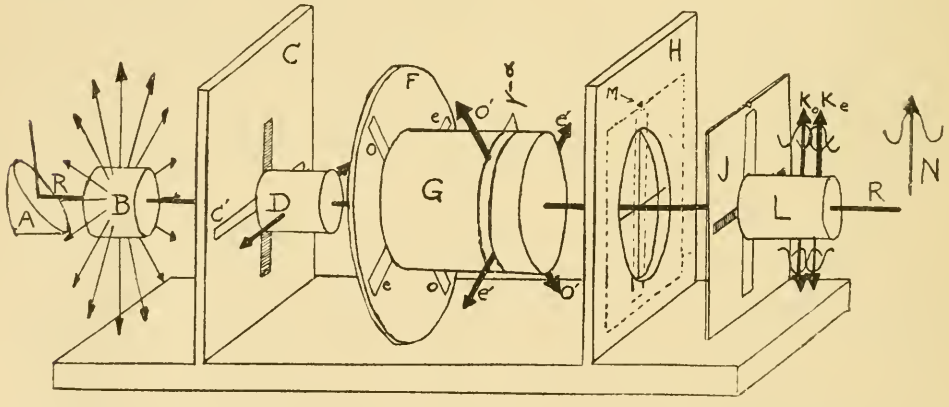


Fig. 80.—RR, path of ray through Microscope axis (lenses not represented): the arrows indicate the planes of vibration; A, substage mirror; C, polarizer; D, plane-polarized light; F, crystal plate; H, cross-wires; J, analyser; *Ko Ke*, interference of vibrations brought into the same by the analyser (birefringence).

polarizer, each of these rays is resolved into two directions, but is transmitted along one only of these directions (through the slot C′). Thus all the light leaving the polarizer vibrates in one plane, as shown by the arrow through the cork D, which is rigidly connected with C. F, representing the crystal plate, rotates freely about RR. The light from the polarizer is resolved into two directions perpendicular to each other, and is transmitted through the crystal as through the slots *o* and *e*. In this passage, however, one ray is retarded more than the other, so that the nature of the light as it leaves the crystal plate is illustrated by the two

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

† Geological Mag., x. No. 10 (1913) pp. 447–8 (1 fig.).

arrows *o'* and *e'* driven through the cork G, which is rigidly connected to F. As the crystal is rotated the intensity of the *o* and *e* rays vary, and this may be indicated by pushing the corresponding arrows in or out of the cork G. The board H shows the position of the cross-wires in the Microscope, and serves to hold RR in place. The analyser J, and vibration arrows K*o* and K*e* are attached to the cork L, which slides on or off RR. When properly in position for the 'crossed nicols' condition, the analyser is held in place against H by the small stop M. The *o* and *e* rays from the crystal on entering the analyser are resolved into two components, and of these only one is transmitted. The light leaving the analyser is therefore made up of the resolved portions of *o'* and *e'*, and is indicated by the arrows K*o* and K*e*, both lying in the same plane, but one behind the other.

The way for the more rigid explanation of the birefringence colours is often made easy by some such phrase as the following: "The two resolved portions of the polarized ray enter the crystal plate perfectly 'in step,' but as one is retarded more than the other while passing through the crystal it falls behind, and when brought by the analyser into the same plane the two rays are found to be no longer 'in step,' and consequently interfere with each other." The interference can be illustrated by soldering to each arrow a portion of a sine curve wire (as at N). By varying the distance between the arrows, the quartz wedge and kindred phenomena can be well shown.

If a large cork be used for L, and the amplitudes of K*o* and K*e* be varied as with *o'* and *e'*, one can illustrate the impossibility of obtaining complete extinction with uncrossed nicols.

Pleochroism is exemplified by removing the analyser and clipping differently coloured glass plates (e.g. brown and green) over the *o* and *e* slots in the crystal plate F. The *o'* and *e'* arrows may be coloured accordingly, and the variation of the tint as the crystal is rotated is brought out well by varying the lengths of the *o'* and *e'* arrows as before, to give two colour intensities in all positions. A little mechanical contrivance may be added to do this automatically, but would require nice workmanship.

The model may be used to illustrate several other points, but its application to these ends will occur to every teacher.

Gemmological Microscope and Dichroiscope.*—E. K. Spiegelhalter, in a paper read before the National Association of Goldsmiths, discusses some of the difficulties involved in distinguishing between true gems and gem copies, especially when the gem copy is a synthetic stone. In this case both are gems, the one having been made in nature's laboratory and the other in man's. Synthetic corundum is now made in large quantities and in almost perfect shape. In the natural gem it exists in two forms—the ruby and the sapphire—the distinction between them is merely that of the oxides forming their colours. The only difference between the natural and the synthetic gem is in the structure-formation. There are few flawless gems, and it is in the difference of structure of the specks or flaws existing in both the

* Optical and Photographic Trades Journ., xlv. (1913) pp. 289–290 (1 fig.).

natural and synthetic gem that we are enabled to discriminate between them. When examined by a loup or by a Microscope the flaws in the natural gem are crystalline or more or less angular in formation. In the synthetic these specks or flaws are globular or semi-curved, and this is the one and only difference between the natural and the synthetic gem. Fig. 81 shows a Microscope, designed by the author and manufactured by Messrs. Raphaels, Ltd., of Hatton Garden, arranged for the convenient examination of mounted or unmounted gems. The

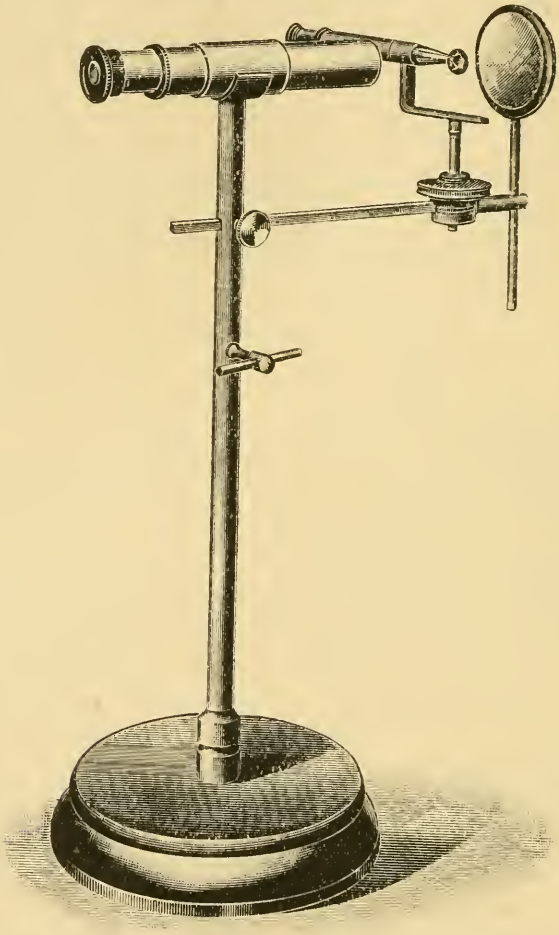


Fig. 81.

instrument has two object-glasses of 1 in. and 2 in. respectively, and these are amply sufficient for the purpose. The structure of the Microscope will be readily understood from the figure. A dichroiscope can be connected, if desired, with the stand.

Beck's Latest "London" Microscope.*—The stand (fig. 82) is made on the Handle Model, which has the limb of the Microscope so shaped that it forms a handle by which the Microscope can be lifted without in any way endangering the fine-adjustment. The base and pillar

* R. and J. Beck's Catalogue, 1913, p. 115, fig. 1334.

are designed on the Continental Model. The stage is square, the upper surface being faced with ebonite. The size is 4 in. by 4 in. It is made specially large for the convenient use of Petri-dishes, or culture plates. A removable mechanical stage can be fitted at will. A special feature of this stage is that an iris-diaphragm is fitted into the stage, flush with the surface, so that if an Abbe condenser is in use the diaphragm can be closed between the top of the condenser and the slide when the former is in focus. The coarse-adjustment is by a spiral rack-and-pinion and is accurately fitted so that comparatively high powers can be focused thereby. The fine-adjustment is by means of a

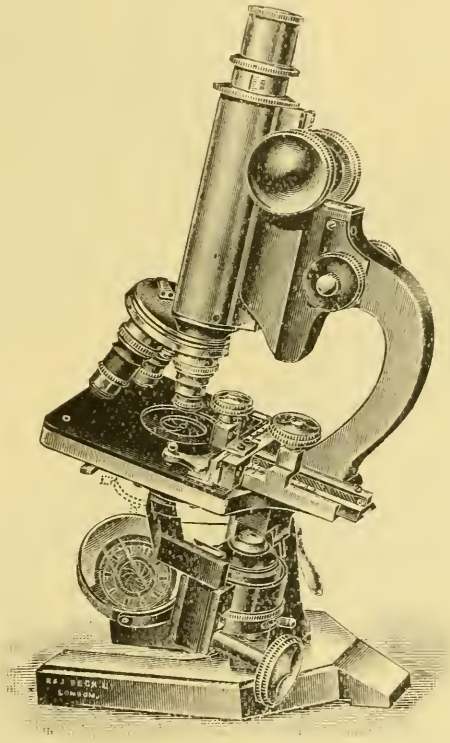


Fig. 82.

lever and a micrometer-screw which gives a very delicate adjustment. The milled heads are at the side of the instrument, and one is provided on each side of the limb so that it can be worked from either side. The body tube of the Microscope is 140 mm. long, with a graduated draw-tube, which can be extended to 200 mm. The sub-stage has a swing-out movement and is focused by means of a rack-and-pinion. It will carry either an Abbe or achromatic condenser. A large size double mirror is provided. The whole instrument is finished in stove black enamel which resists the action of acids and spirits.

Leitz' Microscope for Examination of Brain Sections.*—This stand (fig. 83) has been designed by Messrs. Leitz for objects of unusually large dimensions, and is especially suitable for the examination

* E. Leitz, Wetzlar: Special Catalogue (1913), Mikroscope, pp. 86, 87.

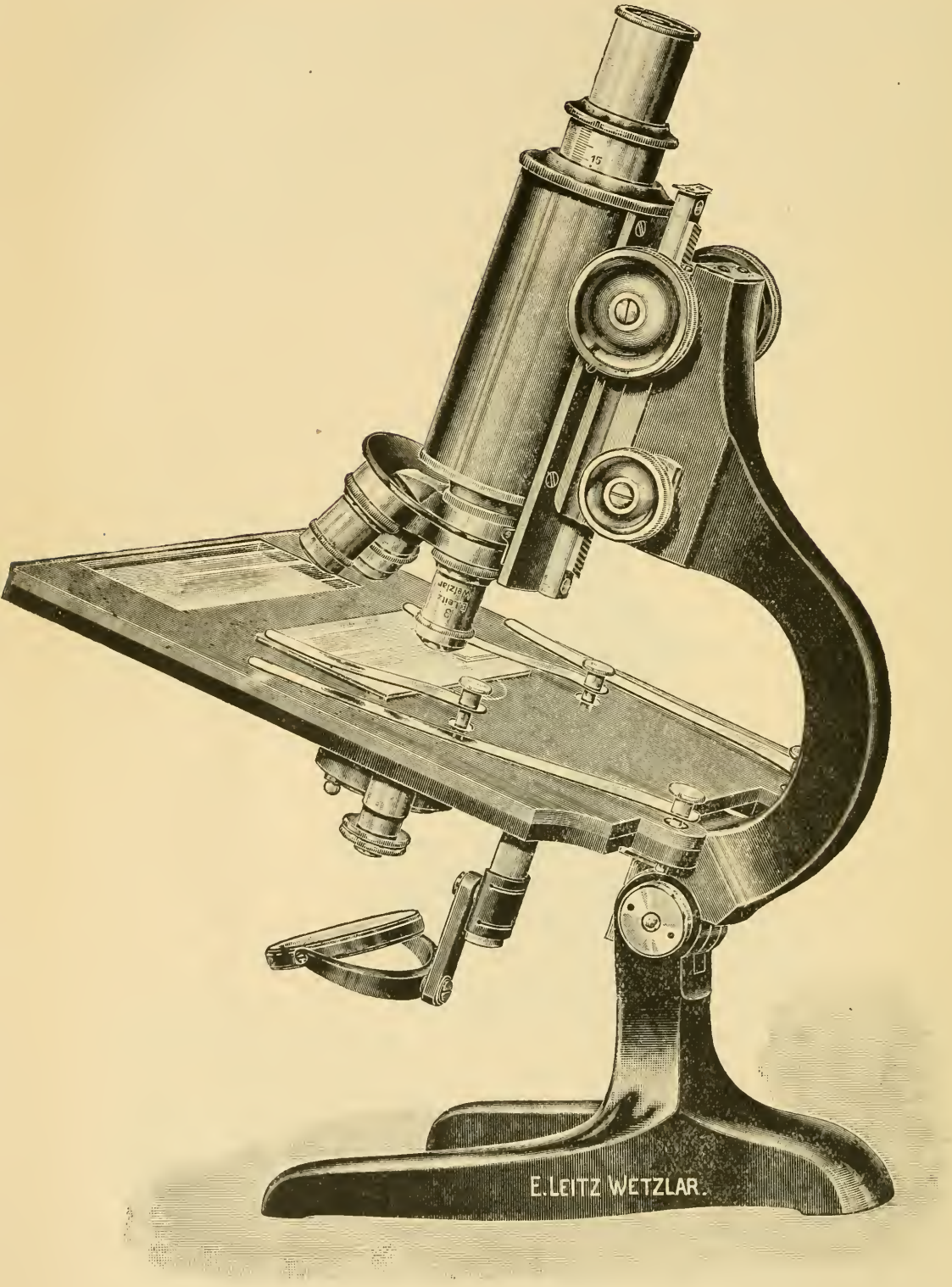


FIG. 83.

of brain sections. It is equipped with a strong square stage 20 × 20 cm. so that the largest sections can be conveniently exposed upon it. The tube is of the same wide diameter as that supplied with the Stand A of the same makers. The instrument is suitable for photographic purposes, and, with weak powers, the whole section-surface can be photographed. It is supplied with a fine-adjustment, so that high power can be used if desired. The coarse-adjustment is by rack-and-opinion.

Swift's Large Measuring and Screw-testing Microscope.—This instrument (figs. 84, 85) has been designed to give absolute measurements of small objects to a very fine degree with extreme accuracy. It is particularly useful for measuring and checking such articles as micrometer screws, divided scales, standard gauges, dies, etc., and is constructed for great ease of manipulation in such work. It is designed to give the length and pitch of a screw to 0·001 mm., the maximum, minimum, and effective diameters and depth of thread to 0·01 mm., and the angle of the thread to 5° without the necessity of moving the screw after it has once been set up for examination.

The object, according to its shape, is either held in one of the chucks A of the rotating divided holder B, or fixed on the stage and its length measured by moving it across the field of the webbed ocular P by means of a micrometer screw with divided head C. The pitch of this screw is 5 mm., and the head is divided into 100 parts; the fractions of these divisions are read from a vernier to 0·001 mm. Entire millimetres are shown by an index on the scale D. The plate of the stage is held against the flint-hard point of the screw by two long spiral springs set in the same place as the dovetailed fittings, one on each side equally displaced. The point of the screw is turned on a separate piece of steel to the thread; it is hardened, ground and polished, and let into the main piece before the thread is cut. This is done to prevent distortion of the thread, which would occur if the hardening were done after cutting. The screw, which is of the most accurate description, is cut between dead centres with a single point.

The width of an object is measured by moving it across the field by means of the milled head F; the amount of the traverse is read to 0·01 mm. by the scale and vernier G.

The angle between two lines, edges, sides, etc., as, for example, the angles of a screw thread, is ascertained by rotating the webbed ocular. One of the webs is brought coincident with a side, and the milled head of the tangent screw H is turned until the web coincides with the other side. The angle is given on the scale and vernier K to 5°.

The milled head L actuates a tangent screw which inclines the object under examination to the optic axis; the degree of inclination is read to 5° by the scale and vernier M. As the object lies in the same plane as the axis of rotation it does not go out of focus on being inclined. When the pitch of a screw is being measured, the screw should be inclined the same number of degrees as the angle at which the thread crosses it; this angle can be approximated or else measured accurately by means of the circle attached to the ocular.

The object is focused by an ordinary rack-and-pinion coarse-adjustment and a micrometer screw fine-adjustment; the milled head N

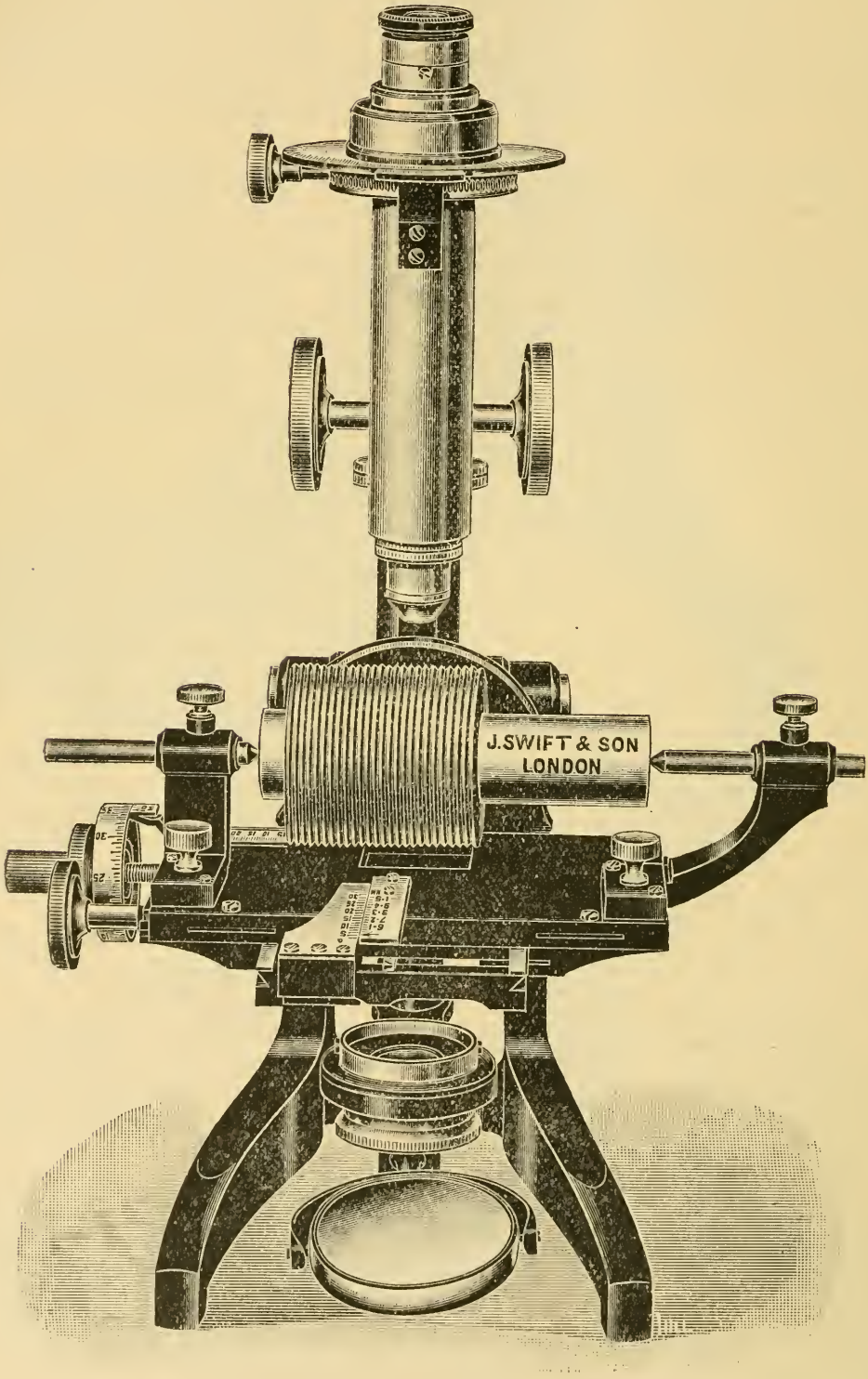


Fig. 84.

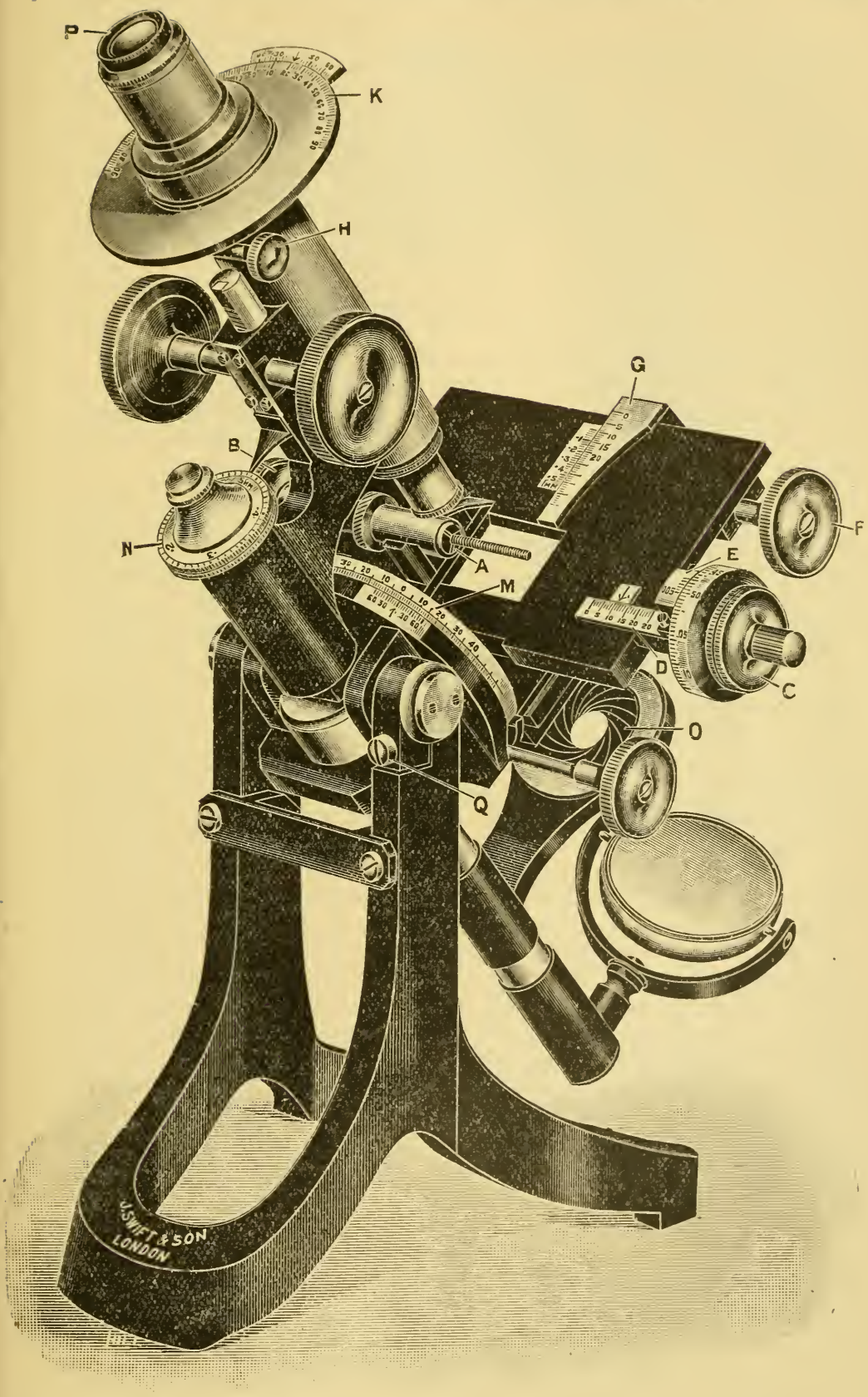


FIG. 385.

of this latter is divided to read direct to 0·01 mm. This divided head is of use in obtaining the correct position for viewing the profile of a screw thread. To effect this the top of the thread is focused on the cross-wires of the ocular, and the body is lowered by means of the fine-adjustment an amount equal to the secant of the angle through which the screw is tilted on the stage multiplied by half the maximum diameter of the thread.

The object is illuminated by means of a mirror or an opal plate, which are mounted with universal motions. An iris-diaphragm, which is of the greatest convenience for controlling and modifying the light, is fitted between the mirror and the stage. This diaphragm can be instantly swung aside if it be not required; when it is brought back to the optic axis, the exact position is indicated by a spring click.

Extremely large objects, such as milling cutters, hobs up to $2\frac{1}{2}$ in. diameter, can be accommodated on the instrument by means of special arms attachable to the stage which hold adjustable male and female centres.

Museum Demonstration Microscope.*—G. Marktanner Turneretscher describes a Microscope, which is in use in the zoological and botanical section of the Joanneum in Graz. It renders microscopical preparations accessible to the general public, inexpert in the use of apparatus. The instrument is enclosed in a cabinet, 45 in. in height. An object-carrying disk. 12 in. in diameter, revolving round a vertical axis, is arranged to hold fourteen microscopical specimens. By turning a screw-head on the right-hand side of the cabinet, the disk is caused to revolve. This movement can only take place in one direction. A spring-catch, working on the circumference of the disk, checks the movement when the specimens are in the correct position for inspection. Two Microscope tubes emerge from the top of the cabinet, a low-power and a high-power. While one slide is in position under the low-power, the neighbouring slide is under the high-power. Both are in correct focus for the normal eye, but to allow for individual variations, a lever is placed to the right of the eye-pieces, which, being moved forwards or backwards cants the object-disk within a limited range, and so shortens or lengthens the focus. Transmitted light is used for most preparations, but for opaque objects requiring reflected light, a small electric bulb is placed over the disk. This is automatically switched on when an opaque object comes into position under the low-power tube. In the left-hand part of the cabinet is a vertical drum, revolving on a horizontal axis, carrying descriptions of the preparations. It is geared to revolve with the object-disk so that as each pair of specimens comes into position under the Microscopes, the letterpress descriptive of them becomes available for study.

(2) Eye-pieces and Objectives.

Reichert's New Comparison Eye-piece.†—This optical device (fig. 86) serves for comparing, by means of a single eye-piece, two objects

* Museumskunde, ix. (Berlin, 1913) pp. 158–62.
† C. Reichert's Special Catalogue, 1913 (3 figs.).

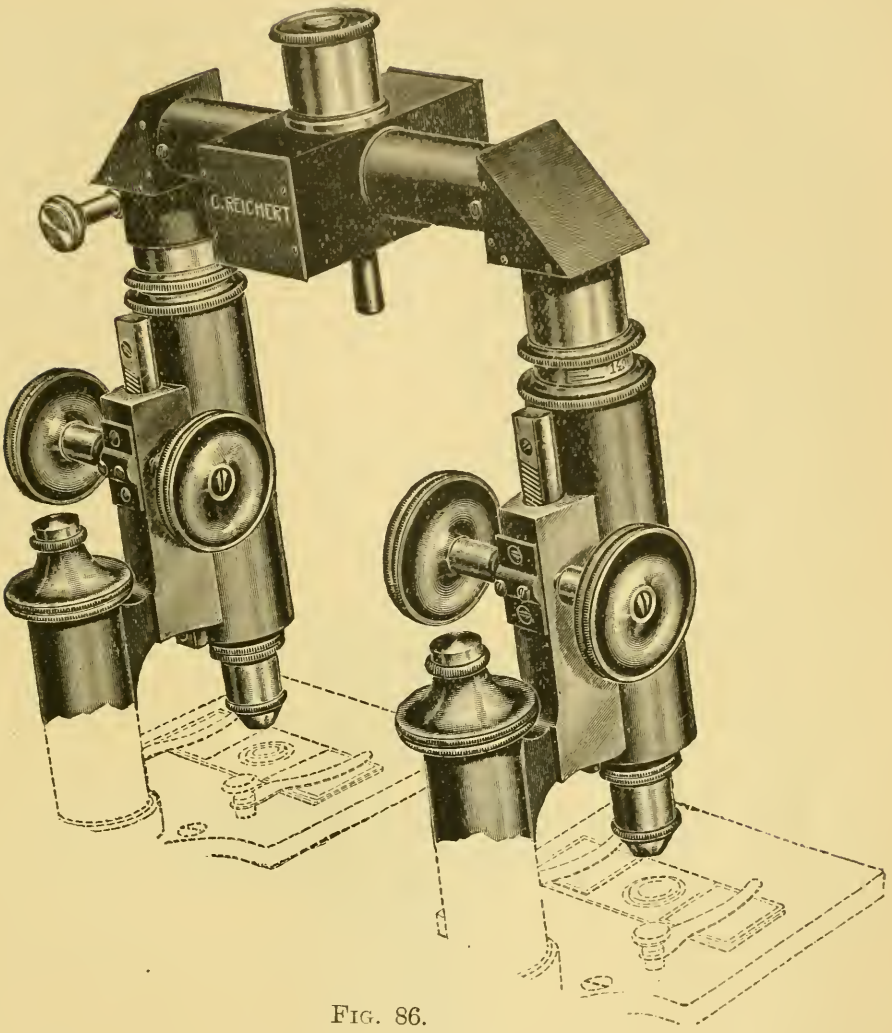


FIG. 86.

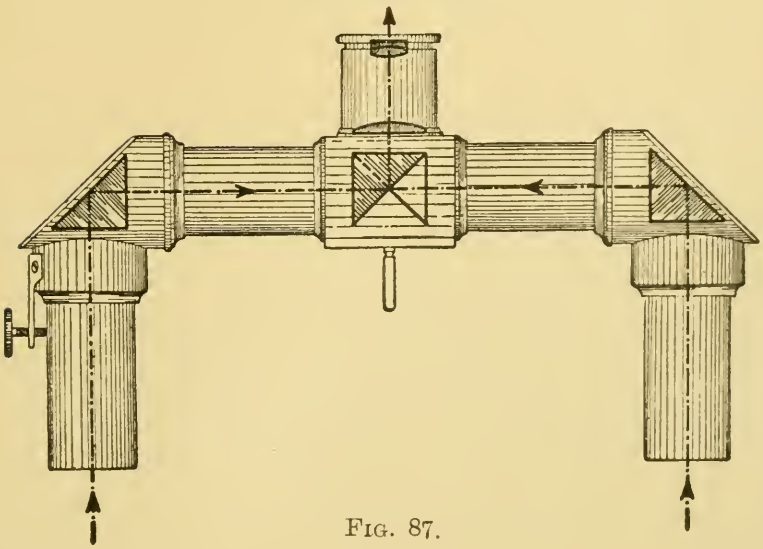


FIG. 87.

placed on the stages of two different Microscopes arranged side by side. The apparatus consists of a metal tube, and a prism casing containing two adjacent and opposed right angled prisms, the latter being surmounted by the eye-piece. A prism is mounted at either end of the horizontal tube. The course of the rays is shown in fig. 87. The sockets of the prism tubes slip into the draw-tube of the Microscopes, one being fixed by means of a clamping screw. Both Microscopes are focused roughly before the comparison eye-pieces are put in position. By means of the projecting stud the prisms below the eye-piece may be displaced transversely for the purpose of viewing either the object on the right or that on the left, or both may be viewed side by side and compared. If polarized light be used the analyser is placed above the eye-piece.

Gordon's Diffraction Micrometer Eye-piece.—This micrometer eye-piece, designed by J. W. Gordon, is of the type in which the reading is obtained by means of a scale projected on the field of the instrument (fig. 88). It is therefore a direct-reading micrometer, and

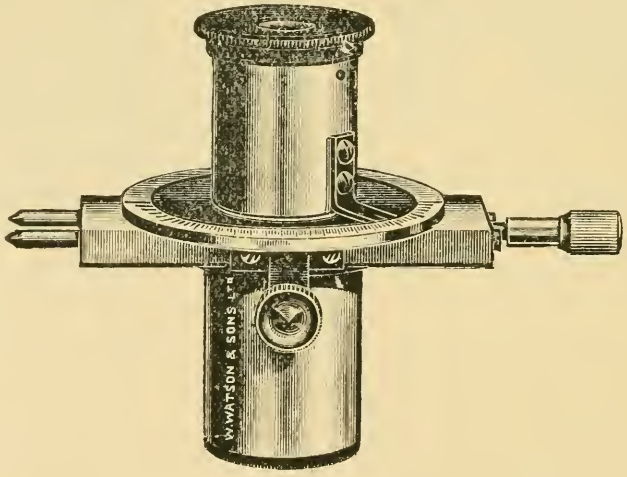


Fig. 88.

possesses the advantage of a direct-reading instrument over those micrometers which have to be read upon the divided head of a screw.

The scale is of special design, and as subdivisions can be actually read and need not be estimated the scale is an open one, with very clearly marked divisions, and is therefore more easy to be read than most projected scales which are intended for accurate work. The extremity of the object to be measured is ascertained by means of a micrometer wire which traverses the field, the position of which is read upon the scale. For the purpose of subdividing the scale divisions a diffraction grating can be placed in position over the eye-piece, and will then, by effecting the superposition of the image of the micrometer wire upon the image of the adjacent scale-division, yield a reading of the fraction of a scale-division over which the two images have to be moved in order to bring them into coincidence.

For the purpose of thus obtaining a reading which subdivides the scale-division, a dark field is provided immediately above the scale. This dark field is merely a very narrow black band stretched across the field of the instrument. It does not in any way interfere with the use of the micrometer wire in taking the reading. But when the diffraction grating is brought into position over the eye-lens this black band fades to a light grey, and on it are seen images of the scale and of the micrometer wire, which appear to be prolonged across its breadth. By rotating the diffraction grating through a small angle about the optical axis these images are made to travel lengthways of the band, and forasmuch as the image of the micrometer wire traverses the band in one direction and the image of the scale in the opposite direction, a position is soon reached in which the image of the micrometer wire coincides with the image of the adjacent scale ruling. The position of the diffraction grating which yields this result affords a measure of the outstanding fraction of a scale-division which expresses the position of the micrometer wire. In this way the scale is subdivided.

Two methods are available for reading this fraction. Thus, it may be read on a subsidiary scale placed below the principal scale in the field of the instrument, or, if the operator objects to the presence of this subsidiary scale, then the fraction can be read upon a segment divided upon the flange of the cell containing the eye-lens.

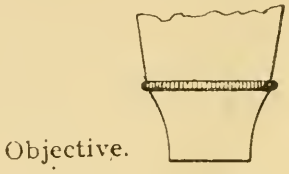
The cap in which the diffraction grating is mounted is made easily removable, so that in the ordinary use of the ocular there are no diffraction images to disturb the observer's attention. The diffraction grating is only brought into use when an accurate reading of the position of the micrometer wire is desired. It may be remarked, however, that these diffraction gratings are so designed as to give extremely feeble images only on the bright field of the instrument, images so feeble that they do not seriously affect the making of an observation. The objection to their presence, though very intelligible, is entirely a question of "nerves." For this reason it is desirable that the diffraction grating should be altogether removable for ordinary use. When employed it yields images which flash out dead black at the moment of super-position, and thus make the taking of an exact reading in this way not only easy but certain.

(3) Illuminating and other Apparatus.

The Insectoscope.*—The above name is applied by P. Marié to an apparatus which he has contrived for facilitating the examination in reflected light of an object in relief. His purpose is to obviate the well-known difficulties met with in the examination by a simple lens of an insect or other such object. While with a loop it is scarcely possible to apply a magnification greater than 20 diameters, his apparatus adapts itself to 80. When the object has been once fixed on its support in the Microscope this support can be moved, without loss of optic centre, in

* Bull. Soc. d'Encouragement pour l'Industrie Nationale, cxix. (Paris, 1913) pp. 638–45 (3 figs.).

an unlimited number of ways and, if the object be too large to be entirely seen in the Microscope, means of orientation are provided. Fig. 89 presents a lateral view of the insectoscope and fig. 90 an end view. The apparatus is entirely supported by the very rigid vertical



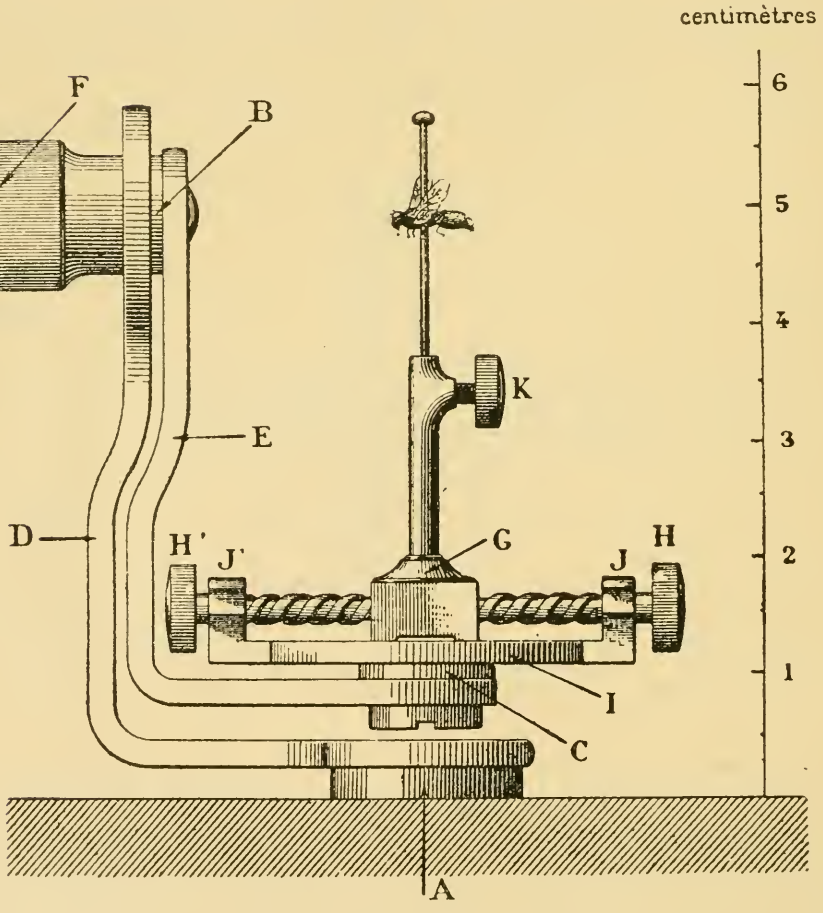


Fig. 89.

axis A, which connects it with the fixed part of the Microscope base. This axis is situated in the prolongation of the optic axis, around which the apparatus turns horizontally. An axle B constrained to remain in a horizontal plane, and connected with the first by the exterior bent arm D, supports the interior bent arm E, at whose extremity is placed the object-carrier G. A milled knob F in one piece with the axis B and the

arm E serves to impart a rotatory vertical movement to E about B. Thus, by the combination of the horizontal and the vertical movements the object-carrier G would describe a vertical sphere. The object to be examined should be mounted on a pin clamped in the tubular support G ;

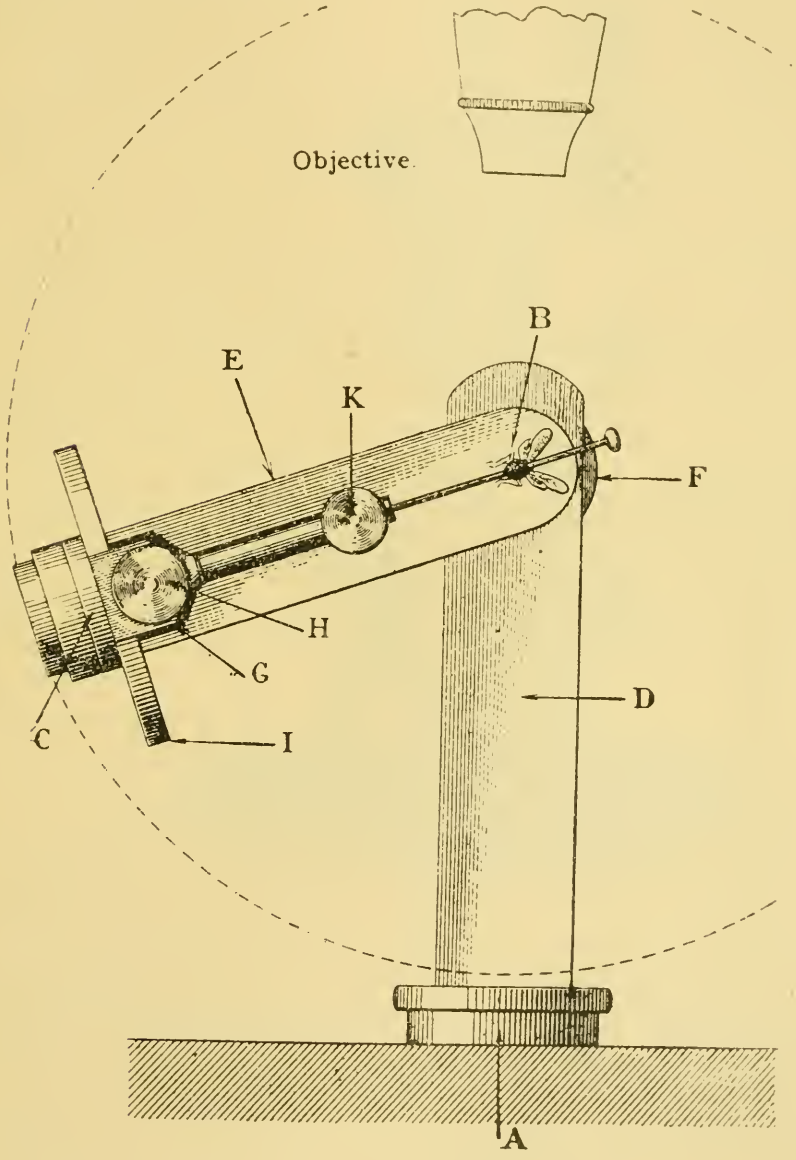


FIG. 90.

the exact postion being determined by rotating the arm into the horizontal and then adjusting the pin-depth in the tube, so that the object occupies the centre of the optic field. By means of the axis C another rotation has been provided. This axis carries a disk I, on which is fixed the pin-holder. When it is desired to examine separately all the parts of an object of a size superior to the field of the objective, the object-

holder is mounted on an endless screw forming a diameter of the disk I, and supported by two flanges J, J^1, at each extremity. This screw is operated by the milled heads H and H^1 and displaces the object-holder,

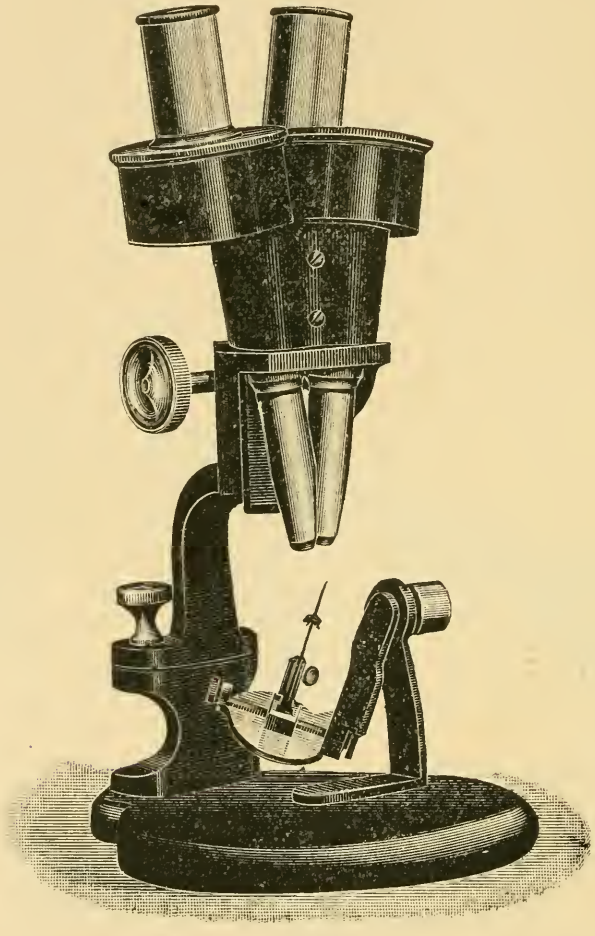


Fig. 91.

and centres the desired part under the objective. It is found that the head of the pin being out of focus does not interfere with the optical image.

Fig. 91 shows the insectoscope mounted on a binocular.

(6) Miscellaneous.

Quekett Microscopical Club.—The 492nd Ordinary Meeting was held on October 28, the President, Prof. A Dendy, F.R.S., in the Chair.

S. C. Akehurst exhibited and described a changer for use with substage condensers. This was on the principle of the Zeiss sliding objective changers.

S. C. Akehurst exhibited and described "A Trap for Free-swimming Organisms." This was a device for taking advantage of the phototropism displayed by most pond-animals.

D. J. Scourfield gave a résumé of a paper by James Murray, F.R.S.E., on the Gastrotricha, a small group of minute animals, chiefly fresh-water, of doubtful affinity. The various sections of the paper describe their form and structure, their haunts and habits, an historical sketch of the group and classification, a key to the genera and species, with a list of all the eighty-three species which have been described, and an annotated bibliography.

E. M. Nelson on "An Improved Form of Cheshire's Apertometer." A number of short arcs of circles of varying radii are employed, avoiding the confusion of many complete concentric circles, and permitting the N.A. to be obtained to the second decimal place with a fair amount of accuracy.

F. J. Cheshire did not think the form of apertometer he had described some ten years ago was capable of greater accuracy. He then described, and subsequently demonstrated, another and more direct method of measuring N.A.

M. A. Ainslie also read a paper on "A Variation of Cheshire's Apertometer," designed to ensure fair accuracy in reading to the second decimal place.

WRIGHT, F. E.—**Graphical Methods in Microscopical Petrography.**
Amer. Journ. Sci., xxxvi. (1913) pp. 509–39 (8 pls.).

,, ,, **A Graphical Plot for use in the Microscopical Determination of the Plagioclase Feldspars.**
Amer. Journ. Sci., xxxvi. (1913) pp. 540–2 (1 pl.).

FARWELL, H. W.—**Optical Bench for Elementary Work.**
Amer. Journ. Sci., xxxvi. (1913) pp. 473–4 (1 fig.).

B. Technique.*

(1) Collecting Objects, including Culture Processes.

Selective Medium for the Paratyphoid-enteritidis Group.†—J. C. Torrey recommends the use of brilliant green broth as a specific enrichment medium for the organisms of this group. After trying various strengths of brilliant green in combination with various degrees of acidity of broth, he found the following to give the best results. Meat-peptone-broth is titrated to the neutral point for phenolphthalein, and 1 p.c. glucose is added. The fluid is tubed in 10 c.cm. quantities and sterilized. A 1 p.c. solution of brilliant green (Grübler's) is prepared, and just before use 0·15 c.cm. of this solution is added to each tube. This gives a concentration of the dye sufficient to inhibit or destroy the dominant fæcal bacteria, without interfering with the growth of paratyphoid and allied bacilli. A very slight increase in the acidity of the broth, in the presence of brilliant green in this strength, will, however, inhibit or kill these organisms also.

* 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.

† Journ. of Infectious Diseases, xiii. (1913) pp. 263–72.

Isolation of Typhoid Bacilli.*—C. H. Browning W. Gilmour, and T. J. Mackie describe a method for the isolation of typhoid bacilli from fæces by means of brilliant green in fluid medium. The diamidotriphenylmethane group of dyes, including malachite and brilliant green, are fairly actively bactericidal to the typhoid-coli group as well as to Gram-positive organisms, but brilliant green is markedly more active than malachite green in its inhibitory effect upon the coli group. It is, therefore, likely to prove useful in the detection of a small number of typhoid bacilli in the presence of a large number of organisms of the *B. coli* type. The method is as follows. A stock solution of Bayer's brilliant green extra cryst. 1 p.c. is made up every few weeks. Before use, a 1 : 10,000 dilution of the dye is prepared from this. Of this dilution, varying quantities—0·04, 0·08, 0·12, 0·16, 0·22, 0·5 c.cm.—are added to a series of peptone water tubes of weakly alkaline reaction. A loopful of fæces is added to each tube. After 20–24 hours incubation at 37° C., a loopful from each tube is stroked on a MacConkey plate (two 10 cm. plates in all are quite sufficient to accommodate three strokes from each dilution). These plates are incubated and examined in the ordinary way. Comparison of results thus obtained with those of direct platings of material upon MacConkey's medium, as well as experiments with artificial mixtures of typhoid and colon bacilli, indicate that this is a selective medium of great value. The optimum concentration of brilliant green for the growth of typhoid bacilli varies for different strains, as the use of the range of dilutions shown above will indicate.

Isolation of Typhoid Bacilli.†—T. Bongartz has made use of Bitter's China-blue method in extensive investigations connected with typhoid epidemics, and has found it of great service, giving more satisfactory results than any other method tried. The method of preparing the medium is given in abbreviated form ; 2 p.c. of lactose is added to a neutral 2 or 3 p.c. meat-juice-peptone-salt-agar. After steaming, there are added to each 100 c.cm. of the hot agar, firstly 9 drops of saturated watery solution of china-blue, and secondly 2·5 c.cm. of a 0·1 p.c. malachite green solution. This is sterilized for ten minutes and poured in plates. Non-lactose fermenters appear on such plates after 16 to 24 hours incubation, and may be tested with a typhoid agglutinating serum. In this way a positive result may be reported on the day after the material is received. This medium is more easily prepared than that of Conradi and Drigalski, and at a smaller cost.

Bacteriological Examination of Soils.‡—After a résumé of the various media used for these investigations, P. E. Brown points out that soil itself is the most suitable medium for the purpose. Fresh soil gives more constant results than sterilized or air-dried soils. For measuring the ammonification due to soil bacteria, albumin solution or dried blood may be added to the soil, but the most satisfactory results are obtained by using casein. 10 c.cm. of 10 p.c. casein solution are added to each 100 gm. of fresh soil. The optimum incubation period at room temperature is three days.

* Journ. of Hygiene, xiii. (1913) pp. 335–42.
† Centralbl. Bakt., 1te Abt. Orig., lxxi. (1913) pp. 228–32.
‡ Centralbl. Bakt., 2te Abt., xxxix. (1913) pp. 61–73.

(2) Preparing Objects.

Preparation of Ascaris Embryos.*—To obtain microscopical preparations showing the various stages in the early development of *Ascaris megalocephala*, H. Joseph recommends the following procedure. Two small paraffin cylinders, of like size and dimensions, are connected together by two thin (1–2 mm. diameter) glass rods, about 2 cm. in length, and placed 1 cm. apart. A sort of flat bobbin or spool is thus obtained. The genital tube is taken from an Ascarid and loosely unravelled. It is unnecessary and unwise to attempt a complete unravelling. The tube is then wound round the glass rods in a flat spiral. The end of the tube is fixed between two previous coils to prevent unwinding. The whole apparatus is put in the fixing fluid, washed, hardened, and embedded in the usual way. In the paraffin bath the ends of the bobbin will melt, and the glass rods may be easily withdrawn. Sections parallel with the coils will show progressive stages of development of the contained embryos.

(3) Cutting, including Embedding and Microtomes.

Microscopical Examination of Skin and Leather.†—G. Abt has examined microscopically, by means of sections, skins and leathers, for the purpose of ascertaining the changes which are associated with the "salt-spots." The spots are very detrimental and lower the price of leather, especially calf, so that spotty skins have to be blacked to conceal the defects.

For skin the following fixatives are recommended: (1) saturated aqueous solution of picric acid 70, formalin 40 p.c. 10, acetic acid 1; (2) chromic acid 0·4, acetic acid 1·5, formalin 0·1, water 100.

After 24 to 48 hours the pieces, which should not exceed 5–6 mm. thick, are washed, dehydrated, and embedded in paraffin. The sections are then stained in various ways and by means of various procedures, such as magenta followed by picric acid and indigo carmin; hæmatoxylin and eosin; safranin; thionin.

Tanned material does not require fixation; the pieces are merely washed and then run through to make paraffin sections, which are stained in the usual way.

In order to demonstrate tannin, 1 p.c. iron alum is used; this imparts to the impregnated fibres a grey to blackish-brown hue. Elastic fibres were stained with orcein (0·4 p.c. in 80 p.c. alcohol, with an equal bulk of 4 p.c. hydrochloric acid in 80 p.c. alcohol).

Micro-organisms were detected by means of Gram's method, but if Gram-negative the results were poor, the least indifferent being obtained by means of thionin and washing with acetic acid, or with magenta-red followed by picro-indigo carmin.

Reconstruction Methods.‡—V. Fedorow uses ozokerite (yellow ceresin) instead of beeswax, for reconstruction work. The physical

* Zeitschr. wiss. Mikrosk., xxx. (1913) pp. 181–4.

† Bull. Soc. d'Encouragement pour l'Industrie Nationale, cxix. (1913) pp. 646–66 (2 pls. and 7 text figs.).

‡ Zeitschr. wiss. Mikrosk., xxx. (1913) pp. 178–181.

properties are similar; ozokerite is not so hard as beeswax, and its boiling-point is a little lower. It is also paler in colour, and most transparent. Beeswax, moreover, costs three or four times as much as ozokerite. The author describes a rack of simple construction for drying the wax plates. The plates rest at two points on their lower edges on horizontal slats, and are slung at a slight angle from the vertical upon string loops. The plates are arranged to have the greatest possible amount of air space between them, and the slinging method permits access of air to the whole surface.

Dehydration and Paraffin-embedding.*—H. Fischer considers that the practice of dehydrating botanical objects to the highest possible degree before embedding in paraffin is not to be recommended. He failed to get satisfactory results by such means, but by using 92–95 p.c. alcohol instead of absolute alcohol, and transferring from this to a chloroform—95 p.c. alcohol mixture and thence to chloroform—he obtained much better preparations. The author defends his method on physico-chemical grounds.

Method of Preparing Tendon Sections.†—M. Heidenhain discusses methods of treating this material in order to obtain sections for class purposes. The method of treating with trichloracetic acid and alchol, and embedding in celloidin has the disadvantage that the sections are difficult to stain suitably. He recommends that dried tendons be cut in as thin sections as possible, freehand, with a sharp scalpel. Such sections are dropped into distilled water to unroll. They are naturally of unequal thickness and unsuitable for fine histological work. Stained with dilute ruthenium red solution they make good preparations. The sections are left in this stain for an hour or so. The tendon-cells and connective-tissue-septa are rose-red, the tendon-fibres almost colourless. Such preparations keep well in 10 p.c. alcohol for a week or so. For examination by students, they are mounted in water or alcohol. They are not suited for permanent preparations.

Another method is as follows; a portion of calf's tendon is fixed in Müller's fluid, hardened in alcohol, and 1 cm. length embedded in celloidin. Longitudinal sections, 30 μ in thickness, are stained for twenty-four hours in Delafield's hæmotoxylin, made alkaline, and treated with an alcoholic solution of chromotrop. They are transfered to alcohol and then to creosote. These sections are then handed to the students, carefully teased and mounted. Tendon cells and fibrils are well shown.

Preparation of Paraffin for Embedding Purposes.‡—B. Farkas refers to the views of various writers upon the best methods of paraffin embedding, and the question whether slow or quick cooling of the block gives the better results. He considers that blocks are unsatisfactory for section purposes when their homogeneity is broken by air-bubbles, and recommends a special treatment of paraffin before it is used for embedding. On arrival at the laboratory, it is placed for a week or longer in

* Zeitschr. wiss. Mikrosk., xxx. (1913) pp. 176–7.
† Zeitschr. wiss. Mikrosk., xxx. (1913) pp. 161–7.
‡ Zeitschr. wiss. Mikrosk., xxx. (1913) pp. 168–74.

flat vessels at a temperature of 70–80° C., and repeatedly filtered through hard paper. It is repeatedly allowed to cool at room temperature and melted again. Thus treated the paraffin becomes cleaner, and more transparent. This process of preparation is continued, until a large quantity of paraffin, slowly cooled at room temperature, remains quite clear from small white flakes.

Blocks should be cooled from below upwards over water at 10–20° C. Any minute gas-bubbles then get free exit upwards, and the lower part occupied by the tissue is quite homogeneous.

(4) Staining and Injecting.

Rapid Maturation of Hæmatoxylin.*—L. W. Strong recommends the use of freshly prepared silver oxide. One gram of silver nitrate is dissolved in 50 c cm. of distilled water. Dilute sodium hydroxide is added drop by drop until there is no further precipitation of silver oxide. The precipitate is washed repeatedly—about ten times—to remove all alkali, and is then added to hæmatoxylin or to methylen-blue solutions. These may be allowed to stand for two hours, and are then filtered. The staining solutions are now mature. Unna's polychrome methylene-blue is rapidly obtained by this means.

Modification of van Gieson's Stain.†—O. Völker has found that the ordinary van Gieson acid-fuchsin-picric-acid staining method did not give clear pictures of the finer details of the collagen connective-tissue fibres, but that better results were obtained by altering the concentration and the proportions of the constituents of the reagent. He recommends the following: a 1 p.c. solution of picric acid in water, and a 1 p.c. watery acid fuchsin solution are prepared. Sections fixed on albuminized slides are placed for 24 hours in a mixture of 100 c.cm. of the picric acid solution to 0·5–1 c.cm. of the fuchsin solution. Then after rapid washing with acidified water, they are dehydrated and mounted in thick balsam. In such sections the finest connective tissue fibrils are clearly demonstrated. Previous staining with hæmatoxylin is undesirable.

Staining Vascular Bundles.‡—A. C. Hof has applied certain methods of selective staining based on chemical principles to the preparation of botanical microscopic specimens. A section of a twig of *Acer æsculus*, or the like stained with acid fuchsin will present a homogeneous red appearance. The application of a reducing agent will, however, discharge the red colour, converting the dye into its leucobase over every part of the section except where the tissues have a specific affinity for the dye. Thus the sclerenchymatous bast bundles stained red show clearly on a pale ground. The author gives a list of dyes, arranged in their chemical groups, indicating which are susceptible to the actions of reducing agents. Of various reducing agents mentioned the author prefers sodium hydrosulphite ($Na_2S_2O_4$). He then describes in detail selective methods for staining various tissues. As an example, may be

* Zeitschr. wiss. Mikrosk., xxx. (1913) p. 175.
† Zeitschr. wiss. Mikrosk., xxx. (1913) pp. 185–7.
‡ Abhandl. Senckenb. Natur. Gesell., xxxi. (1913) pp. 467–82.

quoted the triple staining method applied to fixed preparations of the vascular bundles of *Pteris aquilina*. A section of such material shows seven morphologically different tissues. First, it is treated with ethyl violet [ethyl violet (0·25 p.c. in absolute alcohol) 5 c.cm. ; magnesium sulphate 10 p.c., 15 c.cm. ; absolute alcohol, 20 c.cm. ; distilled water, 20 c.cm.] for several hours., washed in alcohol and reduced in 2 p.c. watery sodium hydrosulphite. Then it is treated with 0·5 p.c. congo-red, washed and reduced as before. Thirdly, Tänus green is applied, and after the third reduction, the section is cleared, mounted, and examined. The violet stain brings into evidence the scalariform and spiral tracheids. The cell walls of the sieve tubes and of the pericycle, and the phloem parenchyma are red, while the endodermis is green. The author illustrates his methods with excellent coloured plates.

Individual Variation in Bacterial Staining.*—H. Kroneberger has studied the results obtained by staining film preparations of certain organisms with modifications of Gram's method. By using methylen-blue or gentian-violet as the first staining solution ; using picric acid solution either in place of or in succession to Gram's iodine, and differentiating with alcoholic eosin, four varieties of the classical staining process are arrived at. If such organisms as staphylococci, streptococci, and *Bacillus coli* are stained in these ways, it is found that individual members of the same species are differentiated from one another. A *B. coli* film for example may show red, light blue and dark blue bacilli. The author regards such methods as individualizing stains, depending upon biochemical variations in the bacilli investigated, and discusses in general terms the nature of biochemical problems involved. Such methods are of no diagnostic value.

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

Paraffin Oil for Mounting Microscopical Preparations.†—G. Giemsa finds that pure liquid paraffin may be used with advantage for mounting preparations stained by the Romanowsky or the May-Grünwald process. Such specimens when mounted in Canada balsam or cedar-wood oil lose the greater part of their colour after a certain time. This deterioration is more rapid and more marked in tropical climates. The method of mounting in paraffin does not differ from that used for Canada balsam. The coverglass should be fixed in position with a ring of wax or gelatin, as the paraffin does not solidify. The author also recommends the use of liquid paraffin for the purpose of storing unstained film preparations until they are ready for examination.

Use of Gelatin in Microscopical Technique.‡—W. Johnson gives the following description of a method for mounting microscopical specimens in gelatin in place of Canada balsam. Sections may be prepared by the freezing, paraffin, or celloidin methods. They can then be stained

* Centralbl. Bakt., 1te Abt. Orig., lxxi. (1913) pp. 240-54.
† Centralbl. Bakt., 1te Abt. Orig., lxx. (1913) p. 444.
‡ Lancet, 1913, ii. p. 1062.

in the ordinary way, except with anilin pigments as these are extracted by immersion in water.

Having completed the staining process, the section is put into water, and is now without further treatment ready for mounting in the gelatin solution.

In the preparation of this a few essentials must be noted. Firstly, the solution must be freshly made and the best results are only obtained when the special gelatin, as used for photographic plates, is employed. Of this, 10 grm. are taken and allowed to soak for two hours (preferably overnight) in 100 c.cm. of distilled water. When about to be used this solution must be warmed to a temperature of 50° C. by means of a water bath in order to render it sufficiently fluid. It is advisable to filter it beforehand also at this temperature.

As much of this warm solution is then gently poured on to the slide as can be put on without any overflowing. It is important to pour on as much as possible in order to get a sufficiently thick film of gelatin in the final result. When large sections are being treated it is better to keep the slide on a warm stage, and in the case of frozen or celloidin sections to pour on a thin layer of the gelatin solution first before putting the section in position on the slide. Larger sections still can, with profit, be immersed in the solution for a few minutes beforehand. The preparation is now left exposed to the air, and in the course of a few hours the water evaporates and one is left with the slide covered with a fine transparent film of gelatin in which the section is embedded. This film behaves in every particular like the gelatin film on a photographic plate. It is intensely hard, resists scratching, and can be packed face to face with other specimens without involving the risk of finding them glued firmly together as is the manner of Canadian balsam. Under the Microscope a perfectly clear picture is given, and if necessary cedar-wood oil, for oil immersion purposes, can be used.

The great advantage of the method is the economy of time and material which results. There is no tedious transferring from dish to dish for the processes of dehydrating and clearing. Thus alcohol, xylol, Canada balsam, and cover-slips are entirely dispensed with, and in addition one does away with the danger of injuring large brain sections which attends too much handling. Apparently specimens will keep indefinitely. Weigert-Pal preparations — for which the method is eminently suitable—have been preserved for three years. Serial sections, which require large slides and cover-slips, lend themselves in this manner of mounting. Finally, perhaps, botanists may find here a useful servant. Their chlorophyll specimens, being untreated by alcohol, are able to retain their pigment unaltered, and so can be mounted in the natural state.

(6) Miscellaneous.

New Suction Cap.*—T. Kitt describes a type of rubber suction cap for the purpose of drawing fluid into pipettes, which has advantages over the common rubber teat. This consists of three parts, a lower tubular section which fits over the end of the pipette, an intermediate

* Centralbl. Bakt., 1te Abt. Orig., lxx. (1913) p. 447.

accordion-like expansion, and a ring at the upper end. By holding the pipette between thumb and middle finger, and inserting the index finger into the ring, it is possible to carry out accurate pipetting work, using only one hand. These suckers are made in 1 c.cm. and 5 c.cm. sizes.

Histology of Man and other Animals. — In the early part of the year the firm of Carl Zeiss presented to the Society a very useful and interesting collection of slides, demonstrating some of the features of the physiological histology of Man and Mammalian Animals.

The slides were prepared under the supervision of F. Sigmund, of Teschen, Austria, and are accompanied by descriptive pamphlets with explanatory diagrams and illustrations. The text of the booklets is rendered into English by C. L. Lewis, of University College, London. The preparations deal with skin, motor organs, central nervous system, reproduction, respiration, and the eye. There are sixty slides; ten in each section.

A careful examination of a similar collection lent by the firm of Carl Zeiss, shows that as a whole, the specimens are excellent and valuable for teaching purposes. The fixation is good, and in the majority of cases the staining also, though in some preparations the sections have been treated too lavishly with eosin. One preparation purporting to be normal thyroid would be welcomed by the pathologist on account of its comparative rarity. Anyway, the preparations and the descriptive pamphlets are well worth the money at which they are priced, and the donation must be regarded as a distinct acquisition to the Cabinet of the Royal Microscopical Society.

Microtomists' Vade Mecum.*—A. Bolles Lee's handbook of the methods of microscopic anatomy has now reached its seventh edition. The present issue records an improvement in histological technique, Gilson's mounting media,† which afford a ready and safe means of mounting direct from alcohol and render visible even in unstained preparations, elements which cannot be detected in the usual mounts. Another important addition is that Ramón y Cajal's methods are now given from the latest original source; the sections dealing with neurofibrils are almost entirely re-written, and also those relating to blood and blood-parasites. It is not necessary to praise this book; it is too well known and too useful to require any laudation.

Microscopical Examination of Skin and Leather.‡—In a paper on the salt-spots which are found in various leathers, and blemish, often to a considerable extent, the finished product, G. Abt first describes the technique adopted by him, and then goes on to state his findings and inferences. The general purport of the author is apparently to support the views enunciated by him in a previous paper§ on the chemical origin of these stains. Anyway his present investigation is almost novel, for very little appears to have been done recently in the micro-

* London: J. and A. Churchill (1913) 526 pp.

† See this Journal, 1907, p. 501.

‡ Bull. Soc. d'Encouragement pour l'Industrie Nationale, cxix. (1913) pp. 646-66 (2 pls. and 7 text-figs).

§ See *ante*, p. 633.

scopical examination of leather. In a note the author mentions that Becker ascribed these spots to the action of micro-organisms, but with this view he does not agree. He divides the spots into two groups, the first of which is characterized by the presence of calcium phosphate, derived from the sulphate, while in the second group there is no accumulation of this salt. He concludes by saying that the determining cause of the spots is special for each group, grains of calcium sulphate in the first case, and in the second possibly the presence of bicarbonate of iron due to microbic action. It is remarkable, however, to find that the spots in the latter instance show less degeneration than in the former class; hence it may be inferred that microbic action could not have been very severe.

The article is very interesting throughout, and is a good example of the utility of the Microscope and microscopical methods in the Arts and Crafts. The coloured illustrations in the plates are extremely good.

Metallography, etc.

Structure of Steel.*—S. V. Biélynsky observes that in one and the same specimen of steel three classes of structure, dendritic, reticular, and granular, may be detected by examination with the naked eye or with a low power. Steels of different carbon content, cooled from the liquid state rapidly, slowly, or at an intermediate speed, were prepared. Sections were polished and submitted to the action of neutral 1 p.c. copper sulphate solution in water. Examination was made before and after the removal of the thin layer of copper by washing, and also after a further rubbing on 000 emery paper. The reticular structure is formed by the ferrite and cementite, the granular structure by small surfaces reflecting light at slightly different angles, the specimen somewhat resembling a galvanized iron surface. An elaborate system of classification of steels, based on the various combinations and relationships of the three classes of macrostructure, is given.

Quenching of Hypereutectoid Tool Steels.†—S. S. Steinberg has examined broken tools which showed a coarse fracture. The microstructure indicated that the coarse fracture was not due to overheating before quenching; the cementite was in the form of a network and needles, the mass of the steel being martensite and troostite. The brittle cementite network appeared to be the cause of the coarse fracture. Forging at 900° C. followed by quenching at 800° C. gave a fine fracture, but the same result was more readily obtained by quenching from 900–950° C., reheating to 800° C., and quenching again. The cementite then took the form of small particles disseminated throughout the steel. Heating to 900–950° C. is necessary to dissolve

* Rev. Soc. Russ. Met., 1912, pp. 396–420, through Rev. Métallurgie, x. (1913) extraits, pp. 495–502 (4 figs.).

† Rev. Soc. Russ. Met., 1912, pp. 613–15, through Rev. Métallurgie, x. (1913) extraits, p. 502.

the cementite network, while the second quenching from 800° C. is required to give the finely crystalline microstructure and the corresponding "amorphous" fracture desired.

Crystallization of Steel.*—F. Giolitti and N. Boyer find that the reticulate microstructure found in hypoeutectoid steels is not due to the crystallization of ferrite at the periphery of the primary mixed crystals, but to the fact that the first crystals of ferrite formed act as germs of crystallization for those subsequently produced as the ferrite crystallizes out on cooling.

Coarsely Crystalline Ferrite.†—A. Stadeler describes the excessively coarse structure of a steelworks product containing only traces of carbon, with very little manganese, phosphorus, or sulphur. The fracture was radiating. A section, polished and etched with copper-ammonium chloride solution, showed radiating ferrite grains 5–7 mm. in length. The fracture passed through the grains, not following their boundaries, suggesting that the crystal junctions were stronger than the gliding planes. Slag inclusions lying within a single crystal were observed to be parallel to each other and to an edge of the crystal. It was not considered probable than the specimen had undergone any long-continued heating at temperatures above 650° C., but it might have been heated for considerable periods at 400–500° C.

Influence of Manganese in Mild Steel.‡—A. Stadeler has studied the properties of seven series of steels containing 0·08 to 0·14 p.c. carbon, the manganese in each series ranging from 0·3 to 0·7 p.c. The variation in manganese content had no effect upon the microstructure.

Formation of Temper-carbon in Malleable Cast Iron.§—A. Lissner has studied, thermally, chemically, and microscopically, the formation of temper-carbon during the annealing of two series of white cast irons. In one series the sulphur ranged from 0·15 to 1·24 p.c., in the other the silicon ranged from 0·4 to 1·25 p.c. Microscopic examination was applied to specimens which had been slowly heated to a high temperature and cooled slowly, and to small pieces which had been heated in a salt bath at a constant temperature for a given time, and quenched in water. The effect of 0·05 p.c. sulphur in preventing the decomposition of iron carbide is neutralized by 0·28 p.c. silicon. Some of the specimens did not weigh more than 1 grm. and were accordingly soldered into larger pieces of steel for grinding and polishing. A 1 p.c. solution of hydrochloric acid in alcohol was used for etching.

* Atti R. Accad. Sci. Torino, xlviii. (1913) pp. 827–35, through Journ. Chem. Soc., civ. (1913) p. 777.

† Ferrum, x. (1913) pp. 376–9 (4 figs.).

‡ Zeitschr. Anorg. Chem., lxxxi. (1913) pp. 61–9 (6 figs.).

§ Ferrum, x. (1912) pp. 44–54 (41 figs.).