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

1907

TO BE OBTAINED AT THE SOCIETY'S ROOMS,

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MICROSCOPY.

A. Instruments, Accessories, &c.*

(1) Stands.

Swift's Students' Petrological Microscope.†—This Microscope (fig. 3) has recently been further improved from suggestions of J. S. Flett. The coarse-adjustment is by means of patented spiral rack-and-pinion, the slow focusing adjustment by a millimetre screw, the milled head of which is divided to read to $\frac{1}{100}$ mm. The glass-covered revolving stage has the edge divided to 360° reading to 5′ by means of a vernier. The polariser is fitted with divided flange and spring-catch to indicate the crossing of the Nicol prisms and is made to throw out of the optic axis when required; immediately above the polariser is fitted the convergent system of lenses. The analysing prism is fitted in a metal box which slides into the optical tube; below this is cut an opening for the introduction of a quartz wedge, undulation plate, or gypsum plate. Above the analysing prism is fitted a Bertrand lens with telescopic adjustment, by means of which the interference figures are perfectly shown in thick or thin crystals. The tube of the cross-webbed eye-piece is provided with an opening to allow of the use of a quartz wedge or micrometer.

Swift's University Binocular Microscope.‡ — This Microscope (fig. 4) is of medium height, and is designed to meet the requirements of the science student and of those who desire a binocular instrument for scientific recreation. The coarse-adjustment is effected by Swift and Son's patented spiral rack-and-pinion, and the slow movement by their Climax fine-adjustment. The stage, $4\frac{1}{4}$ in. by $3\frac{3}{4}$ in., will be found useful for systematically working over a slide. The right-hand corner of the main stage is divided into millimetres for the purpose of recording the position of the object for future reference. On the under side of the stage is a tube of the R.M.S. standard size for receiving apparatus.

Draper's Improved Magnifier.§—This magnifier (fig. 5) designed by D. Draper is intended for the examination of ores, rocks, and other solid bodies. By means of a concave reflector attached to the magnifier light can be concentrated on any portion of the object under examination, and

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

† Swift and Son's Catalogue, 1906, p. 21, fig. 17.

‡ Tom. cit., p. 11, fig. 8.

§ Tom. cit., p. 66, fig. 103.

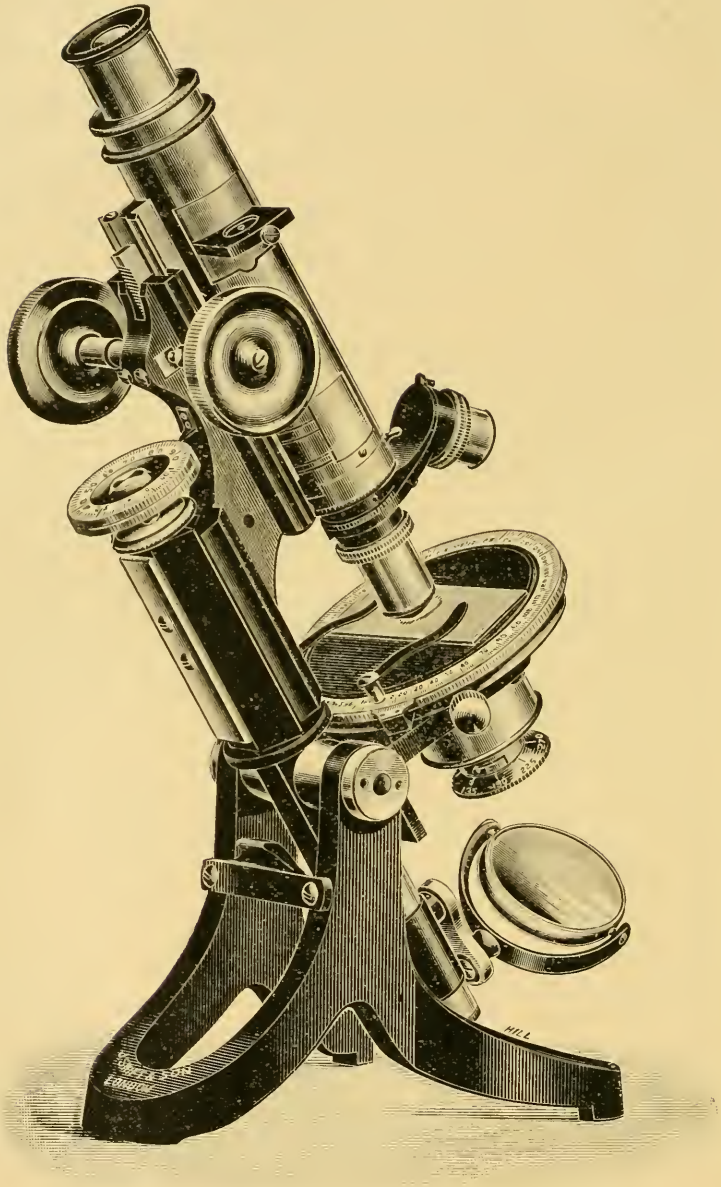

Fig. 3.

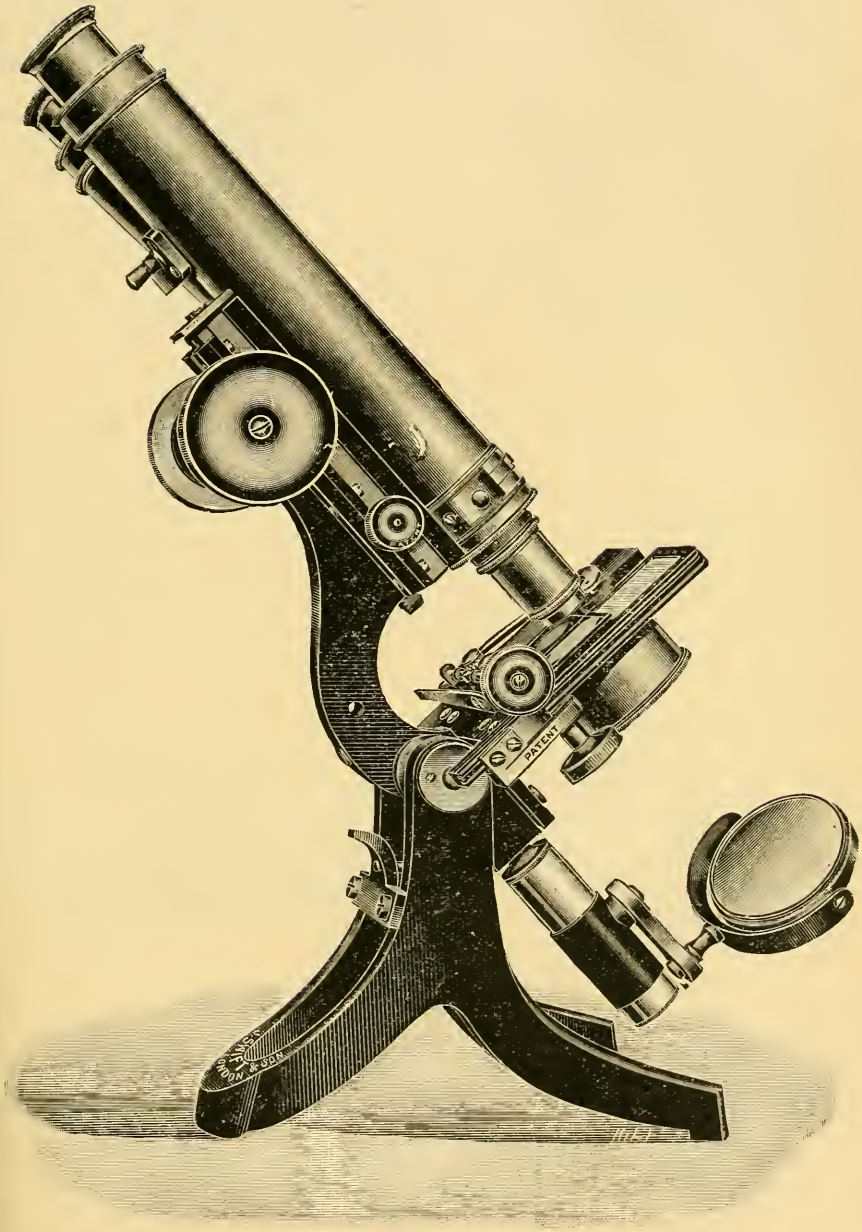

Fig 4.

recesses in ores and rocks can be investigated without the interference of shadows. The combination used consists of a triple achromatic system giving an extremely large and flat field.

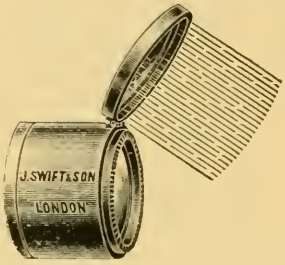

FIG. 5.

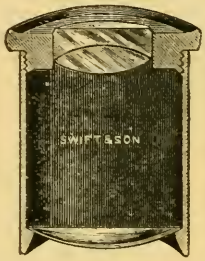

FIG. 6.

Swift's Dissecting Lens.*—This special dissecting lens (fig. 6) magnifies five times, and has a considerable working distance.

Beck's Hand Demonstration Microscope.—This instrument (fig. 7) is specially suitable for lecture classes and demonstrations with mounted specimens, and for examining unmounted specimens laid upon a table. The plate of vulcanite which forms the basis of the instrument has clips on both sides, the upper ones for holding a descriptive card, the lower ones for holding the specimen. The lens which magnifies about seven

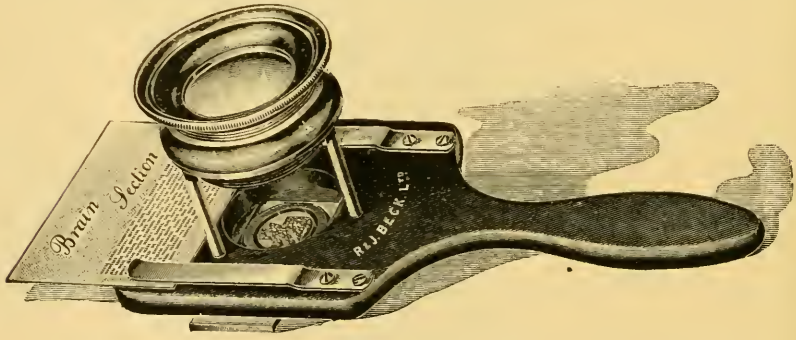

FIG. 7.

diameters and has a large field, is mounted in a screw jacket which gives a large range of focusing motion. The lens-holder is mounted on three pillars forming an unusually strong construction, and enables the instrument to stand rough handling without damage.

Steinach's New Microscope Stand.†—This stand, which was planned by E. Steinach, and made by Carl Reichert, has now borne the test of a

* Swift and Son's Catalogue, 1906, p. 68, fig. 110.
† Zeitschr. wiss. Mikrosk., xxiii. (1906) pp. 308–12 (2 figs.).

year's trial. The designer's object was to contrive an apparatus which should possess the universal applicability and essential advantages of large, and correspondingly expensive Microscopes, without exceeding the cost of small cheap instruments. The ordinary rack-and-pinion movement was used for the coarse-adjustment; but for the fine-adjustment a simple solid slide-movement was constructed (fig. 8). The slide S is applied immediately behind the guide-piece of the coarse adjustment Z, and is pressed against the micrometer screw M by means of the spring F. The efficiency of the micrometer screw-action on the moveable part is secured by the point-contact between the micrometer screwtip and the hardened steel plate K, the result being a clean regular movement and the elimination of all dead-way in either forward or back screwing. The micrometer screw is set obliquely with regard to the guide-piece,

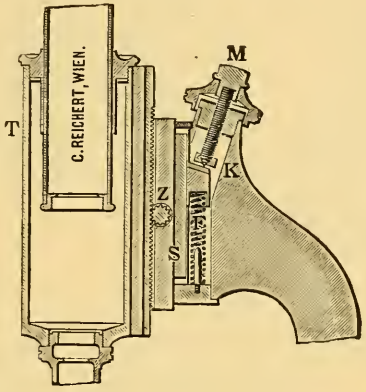

FIG. 8.

partly on account of the proximity of the slide-movement and coarse-adjustment, and partly to facilitate manipulation. This position does not prejudice in the least the delicacy and trustworthiness of the action. The whole arrangement is enclosed within the tube-holder, and thereby completely protected from dust. The large Zeiss * model (i^c) and Reichert's large new Microscopes have lateral micrometer screws, the essential advantage derived being that the upper part of the stand is independent of the fine adjustment mechanism, and can therefore be given a considerable projection. But owing to the complexity of the technical details, the method is costly, and only applicable to expensive Microscopes. The author points out that his simplified construction of the slide-movement accomplishes the same advantage at slight cost. The upper part of the limb projects considerably (fig. 9), and is shaped for a massive hook-like handle. The stage which can, therefore, be of large size, is prolonged into a broad continuation F reaching up to the handle: the median diameter is 125 mm. The extent of the heavy horseshoe foot is 143 mm. long by 113 mm. broad. The height of the

* Cf. Berger's Microscope, see this Journal, 1898, pp. 583-7.

instrument with drawn-out tube, after adjustment of nose-piece and objective, is about 36 cm.; the diameter of the test tube is 32 mm.

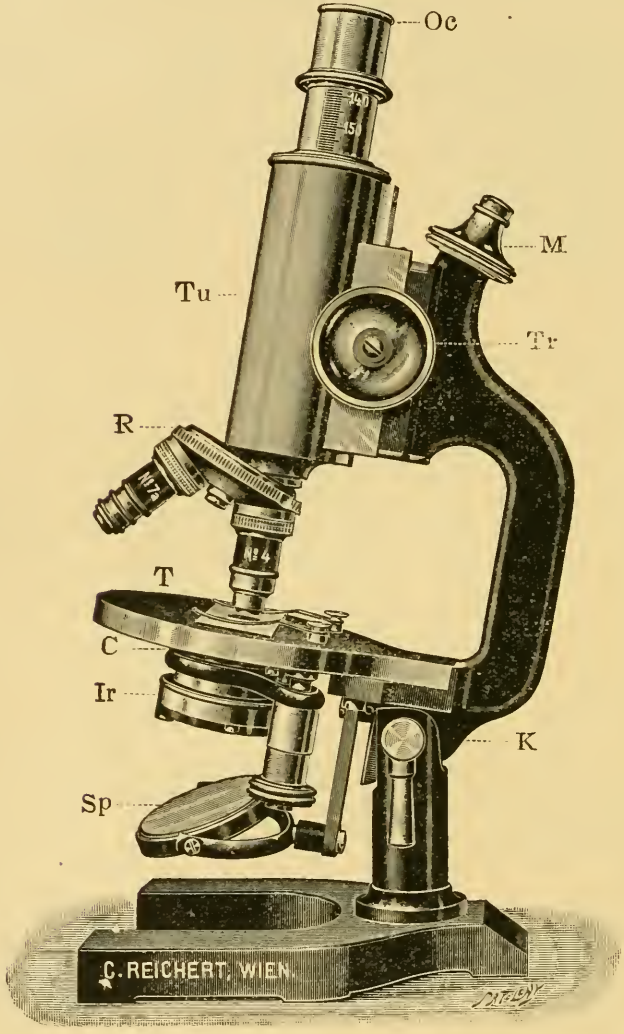

Fig. 9.

Dieck, W.—**Das Photomikroskop für ultraviolette Strahlen und seine Bedeutung für die histologische Untersuchung, insbesondere de Hartgewebe.**
SB. Ges. Natur. Freunde, Berlin, 1906.

Sabine, W. C.—**The Optical Advantages of the Ultra-violet Microscope.**
Journ. of Med. Research, xiv. (1906) p. 455.

SIEDENTOPF, H.—**Ueber ein neues physikalisch-chemisches Mikroskop (Mikroskopie bei hohen Tamperaturen). 13. Hauptversamml. d. Bunsen-Ges. f. angew. physik. Chemie.** *Zeitschr. f. Elektrochemie*, xii. (1906) p. 593.

ZWINTZ, J., & O. THIEN—**Ueber einen neuen elektrisch-heizbaren Objekttisch für Mikroskope.** *Centralbl. Bakt.*, xlii. (1906) p. 179. See also *Zeitschr. wiss. Mikrosk.*, xxiii. (1906) p. 332.

(3) Illuminating and other Apparatus.

Siemens-Schuckert Projection Apparatus.*—The designs of the Siemens-Schuckert apparatus are intended to meet the projection requirements of all kinds of instruction and for audiences large or small. They

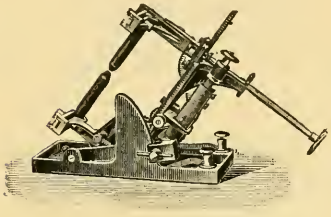

FIG. 10.

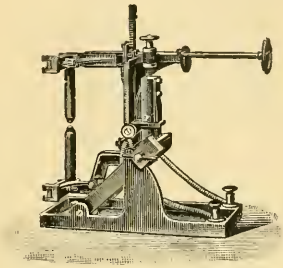

FIG. 11.

are suitable not only for Microscopic and physical demonstrations, but also for the exhibition of spectral and other optical phenomena. The most suitable light-source is the electric arc, both on account of its

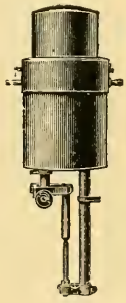

FIG. 12.

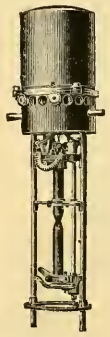

FIG. 13.

simplicity as well as for its certainty. The lamp may be either the Siemens-Schuckert constant-current or variable-current lamp, fitted in a well-ventilated case which carries the optical equipment on its front wall. The lamps may be hand-regulated or automatic. The hand-regulated

* Siemens-Schuckert (Berlin), Special pamphlet, No. 23 (8906).

arc-lamp (figs. 10, 11) may be used, as desired, for constant current or for variable current, and has the further advantage that its current-strength

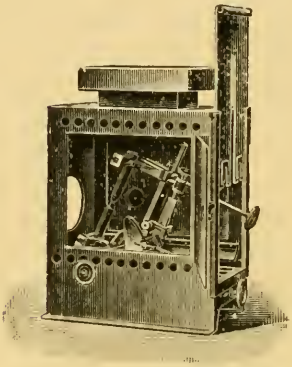

FIG. 14.

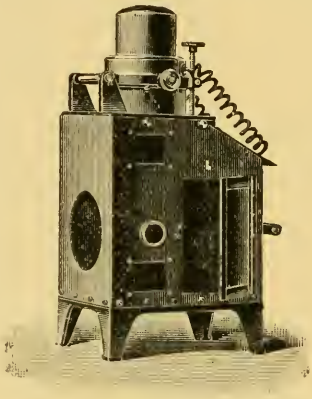

FIG. 15.

may be varied at pleasure by regulation of the resistance. The lamp is thus also useful for experimental purposes. In the projection of

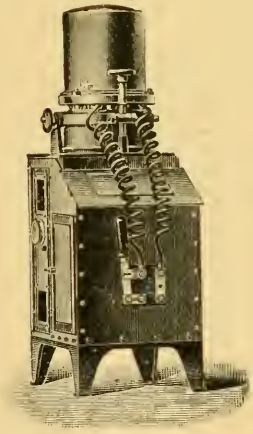

FIG. 16.

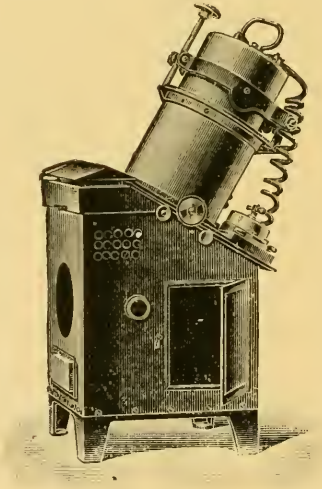

FIG. 17.

diapositives the lamp is used in an inclined position, and for that purpose the upper carbon, in order to attain the optimum position of

illumination, has a movement of about 4 mm. towards the lens-opening, so that the incandescent crater of the upper carbon is formed towards the front. For spectral work the lamp is set upright and is therefore equipped with revolver carbon-holders which facilitate a quick readjustment of carbons when required. The automatic regulating lamps for constant current (fig. 12) and for variable current (fig. 13), are constructed on the differential principle and regulated for an assigned current-strength. In the choice of current-strength attention must be paid to the desired magnification as well as to the size of the audience room. In the use of good transparent diapositives of $8\frac{1}{2}$ by 10 cm.,

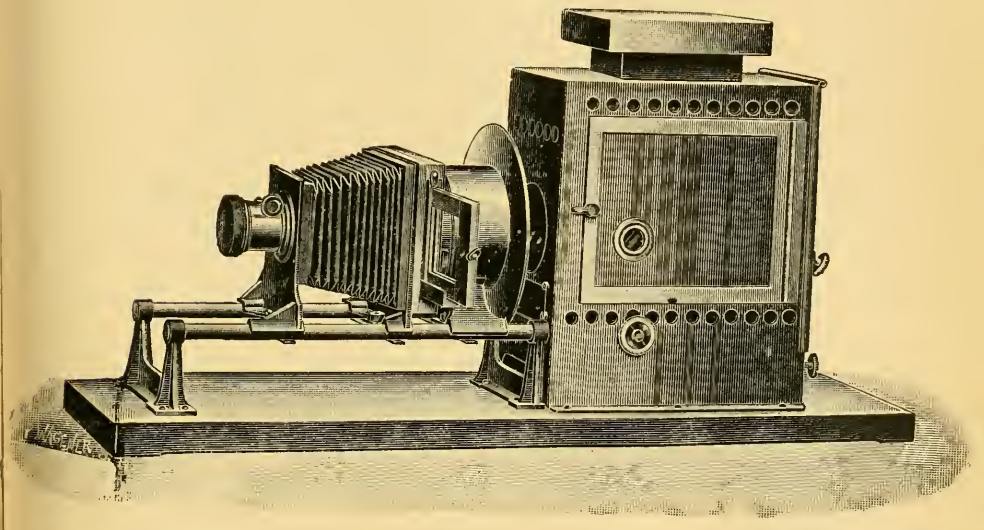

Fig. 18.

and of an image-size of 2–3 metres square at a projection distance of 5–8 metres a constant-current lamp usually requires a current-strength of 10–12 ampères; 8–10 metres projection distance requires 15–20 ampères; and greater distances 20–30 ampères. For a change-current double these strengths should be taken. To attain the most favourable light-values for projections with automatic constant-current lamps, the inclined position should be adopted and the carbons regulated as with the hand-lamp. For spectral work the perpendicular arrangement is required. The variable-current lamp is always set perpendicularly, the lower carbon, in projection work, being slightly advanced. A transformer of 50 volts secondary range is supplied with the variable-current lamp. Figs 14–17 show the lanterns for projection with the two kinds of current; fig. 14 showing the lantern open with hand-regulating lamp, figs. 15–17 an automatic-regulating lamp. The projection apparatus, with complete optical equipment consisting of optical bench, leather

bellows, condenser of 160 mm. diameter and diaphragm, objective of 200 mm. focus for diapositives up to 9 by 12 cm., are represented in figs. 18, 19.

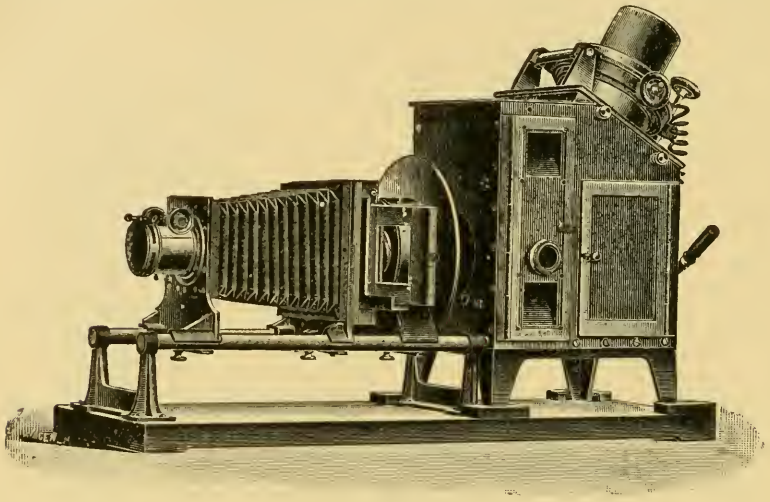

Fig. 19.

Stereoscopic Photo-micrographic Attachment for Monocular Microscopes.*—This apparatus (fig. 20), designed by Professor H. Jackson, allows of beautiful stereoscopic photographs to be taken with low powers such as 3 in., 2 in., and 1 in. objectives. It consists of a short fitting into which the object-glass is screwed, and contains an iris-diaphragm below which a slot is cut. Into the slot a strip of blackened metal slides, and this covers one half of the posterior combination of the objective. If, with the edge of the metal slide vertical, a negative be taken through one half of the lens, and another be taken after removing the slide and reinserting it so as to cover the other half of the back combination of the objective, these these two negatives will give prints yielding a stereoscopic effect such as is seen in a binocular Microscope. The iris-diaphragm is useful for lengthening the apparent depth of focus of the objective. Made by Swift and Son.

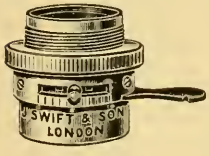

Fig. 20.

A New Slideholder.†—Under the name of Gleitlineal, C. Detto has designed a new form of slideholder. His attention was drawn to the matter by the difficulties of manipulating slides placed vertically in a projection Microscope. His apparatus consists essentially of a rotatory metal fork fastened on the rim of a circular stage of a Microscope. One

* Swift & Son's Catalogue, pp. 66, fig. 102.
† Zeitschr. wiss. Mikrosk., xxiii. (1906) pp. 301-7 (2 figs.).

prong of the fork (in a horizontal projection Microscope the lower one) takes the form of a straight bar ; the other prong is a strong steel spring fitted with a metal roller. The object-slide is gripped firmly between the bar and roller, which glide compactly over the stage. The bar is bevelled inwards and the roller is slightly conical, so that slides of various thicknesses are always firmly pressed upon the stage. The apparatus has a vibratory movement about the attachment-point on the

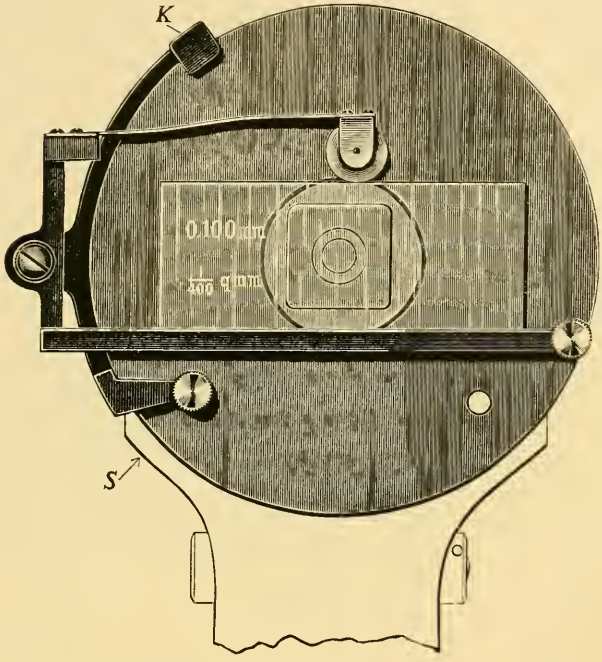

Fig. 21.

stage-rim, which is clamped sufficiently tightly to prevent self-motion, but not so tight as to prevent push-action. The roller spring instead of being made of German silver is of good pliable steel, in order to adapt itself to any possible change of size in the slide. The apparatus has been designed in two forms, one for a strong circular stage (fig. 21), the other for a photo-micrographic stage (fig. 22). The first has a metal strip of same curvature as the stage, and carries at one end K a clamp fixed from underneath by a screw not visible in figure. The other end of this strip terminates in an arm above the stage and held fast to it by a screw similar to that used for the ordinary spring slideholder. In the photo-micrographic stage a different construction is necessary, because the stage here consists of two parallel plates. The peripheral strip now takes the

form of the complete circumference of the upper plate, but the ends terminate in perforated flanges clamped by a screw K; the remainder of the design is as before.

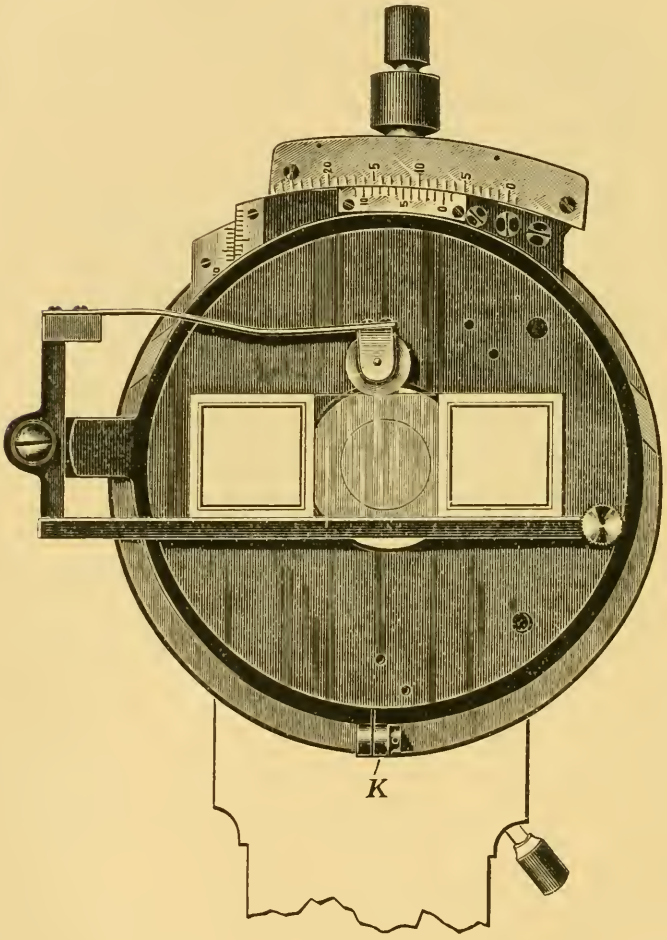

Fig. 22.

Application of the Nernst Incandescent Light to Biological Laboratories.‡—A. Greil, in his experiments to find the most suitable form of light-source for use with projection-drawing apparatus, obtained the best results with a special form of Nernst lamp. The usual three incandescent strands he rearranges in a six-pointed star, the ends of the rays being inserted in correspondingly formed bearers through which

* Zeitschr. wiss. Mikrosk., xxiii. (1906) pp. 257–86 (17 figs).

pass the platinum wires. The bearers are fastened on a circular porcelain plate, and are connected with four contact collars placed on the back of the plate: these collars being themselves connected with the same number of plugs inserted into a slate block and fitted with clamp screws. Means are provided for accurate centring of the light. The slate block, which is circular in form, bears on its circumference a flange which forms the rear wall of the diaphragm arrangement of the projection apparatus. Köhler's combination system of lenses for microprojection is used for the light concentration. This system yields the maximum light-intensity of the Nernst lamp. It consists of three lenses, the first of which, alone or in combination with two others, collects the light-rays. The condenser with a suitable condenser is available either for weak or for the highest magnifications. The lenses and lamp are mounted on a horizontal base board which acts as the optical bench, and is large enough to carry also the Microscope. Means are provided for raising or lowering the whole apparatus as required. A plane mirror, inclined at 45°, is fitted to the body tube of the Microscope, which is, of course, horizontal, and reflects the image on to the drawing-table at which the student sits. This table is adjustable in height, and this convenience added to the vertical adjustability of the optical bench gives considerable control over the distance between the Microscope and the table top. The arrangement has been found very convenient for photomicrography, the drawing apparatus being, of course, replaced by a camera; the uniform illumination afforded by the Nernst lamp specially lends itself to such work.

The author has found the Nernst lamp of the greatest service in the intensive illumination of small objects by incident light. This application is useful not only for photomicrography, but for many other purposes, e.g. the minute examination of manuscript, preparations of embryos, etc. He describes some 10 or 12 different forms of the lamp, the details being modified for special purposes.

(4) Photomicrography.

DEEGENER—**Der. mikrophotographische Apparat von H. O. Juel.** *Natur. Zeitschr. Land. Forstw.*, iv. pp. 220–6.

EDER, J. M.—**Wichtigere Fortschritte auf dem Gebiete der Mikrophotographie und des Projektionswesens.** *Jahrbuch für Photographie und Reproduktionstechnik für das Jahr* 1906; and as a separate pamphlet (8 pp.), Halle (W. Knapp).

ERNST, H. E.—**Ultra-violet photomicrography.** *Journ. of Med. Research*, xiv.(1906) pp. 463–9.

ERNST, H. E., & S. B. WOLBACH—**Ultra-violet Photomicrography.** [A preliminary communication.] *Tom. cit.*, No. 3.

(5) Microscopical Optics and Manipulation.

Ultramicroscopes: Ultramicroscopic Objects.*—The above is a title of a work by A. Cotton and H. Mouton which deals with the present state of knowledge on this branch of Microscopy. It is written in a

* Les Ultramicroscopes: les Objets ultramicroscopiques. Paris: Masson et Cie., 232 pp., 17 figs.

very clear and vivid manner and seems a very complete presentation of the subject. The book is divided into nine chapters, the first three of which deal with the ultramicroscope and the others with ultramicroscopic objects. The first chapter discusses the limits of microscopic visibility, and the second explains how ultraviolet light bears upon the matter. The third chapter describes the ultramicroscope itself. The contents of the other chapters include the ultramicroscopic study of solids, liquids, Brownian movements, colloids, electric transport, and biological applications.

Study of the Rotation Impressed upon the Plane of Polarisation, by the Lenses of the Microscope under Convergent Light.*—G. Cesàro points out that Fresnel's formula for the passage of a polarised ray through a series of isotropic media readily lends itself to a very simple geometrical interpretation which renders it easy to construct the various paths of the ray. For this purpose it suffices to construct two planes :—(1) The plane containing the point of incidence and normal to the refracted ray ; (2) the plane passing through the incident ray and its vibration. The intersection of these two planes gives the desired vibration. The same construction is continued from medium to medium. The author describes a number of experiments which illustrate his method.

Numerical Examination of the Optical Properties of Thin Metallic Plates.†—One of the first workers in this field was MacCullagh, who predicted from theory, and verified by experiment, that if light incident on a gold leaf were plane polarised, the transmitted beam would be elliptically polarised. With the improvement in experimental methods since MacCullagh's day, and the gradual removal of obscurities from the theory of metallic reflection and transmission, an almost exact numerical coincidence may now be looked for between theory and experiment. R. C. Maclaurin, in discussing the subject, points out that the condition of the reflected or transmitted beam is precisely described by means of two quantities—the ellipticity and the difference of phase between the components of the light polarised perpendicular to and parallel to the plane of incidence. The object of his paper is to obtain convenient formulæ for these quantities and to compare them with the results of experiments, selecting the most careful and the most recent that are available.

Colourless Lines produced by Convergent Light in Crystalline Laminæ.‡—G. Cesàro investigates the mathematical theory of the above, when the nicols are crossed at right angles. He starts from the usual equation for the intensity of a ray oblique to the crystalline laminæ and after passage through the analyser, viz. :—

$$I = a^2 \sin 2\alpha \sin 2\beta \sin^2 \pi \frac{R}{\lambda}$$

when α and β represent the angles, which one of the planes of vibration of the ray considered makes with the sections of the polariser and the

* Bull. de l'Acad. roy. de Belgique (Classe des Sciences) 1906, pp. 459–92.
† Proc. Roy. Soc., Series A, lxxviii. (1906) pp. 296–41 (24 figs.).
‡ Bull. de l'Acad roy. de Belgique (Classe des Sciences) 1906, pp. 368–99 (9 figs.).

analyser. The colourless lines are produced by the rays for which I vanishes independently of the value of the retardation R, i.e., by the rays for which either sin $2\alpha = 0$, or sin $2\beta = 0$; in other words by rays of which one of the planes of vibration is parallel to or perpendicular to the section of a nicol. The condition of parallelism is, however, impossible in a conical beam, and therefore the cone of rays giving the colourless line is the locus of rays of which one of the planes of vibration is perpendicular to the section of a nicol. The author follows up three modes of investigation and arrives at an equation (in general of the third degree) for the colourless cone; and at an equation (in general of the sixth degree) for the refracted cone.

In a later article * the author points out that the fundamental formula implicitly supposes that the vibration of the beam emergent from the polariser has not been deviated in traversing the lens which renders it convergent. This is not exact, both by reason of the deviation given by the glass to the vibrations oblique to the planes of incidence, and, *à priori*, by reason of the obliquity of the rays themselves. He therefore reconsiders the question on the basis that the horizontal deviation of a ray must be negligible. The colourless cone thus becomes the locus of directions of propagation, possessing a direction of vibration parallel to the section of a nicol. The author was somewhat surprised to find that he arrived at his previous equations, the explanation being that, if a direction of propagation possess a vibration parallel to the section of a nicol, the plane of vibration which corresponds to its other vibration is normal to the section of the same nicol.

Löwe, F.—**Ein neuer Spektrograph für sichtbares und ultraviolettes Licht.** [This is a description of Pulfrich's auto-collimation-spectroscope, made by C. Zeiss.] *Zeit. f. Instrumentenk.*, xxvi. (1906) pp. 330–3 (5 figs.).

(6) Miscellaneous.

Fluid Crystals.†—Under the title of "Are Crystals Alive," E. E. F. gives an account of a communication which was made by O. Lehmann at the last Congress of German Physicians and Physicists at Stuttgart.‡ It refers to some new and striking analogies between the development and characteristics of crystals and those of the lowest living organisms, and demonstrates the fact that no hard and fast line of demarcation can be drawn. This has been suspected by Haeckel for some time past. That ice-crystals imitate vegetable forms is known to every child. That they grow we all know. They have also a certain recuperative power, and they require a nucleus or germ to start their growth. They have, in addition, a power of absorbing foreign substances, as when salammoniac crystals absorb chloride of iron from a solution, and become darker than the solution itself. In the course of the process they "poison" themselves, and their growth becomes very irregular and imperfect.

But one essential difference remains. Animals are semifluid, or

* Bull de l'Acad. roy. de Belgique (Classe des Sciences) 1906, pp. 493–502 (1 fig.).

† English Mechanic, lxxxiv. (1906) p. 371. See also Zeitschr. wiss. Mikrosk., xxiii. (1906) pp. 377–9.

‡ Physikal. Zeitschr., Nov. 1, 1906.

partly so, whereas crystals are supposed to be essentially solid bodies. This supposition now no longer holds good, for Lehmann and some other chemists have succeeded in producing truly liquid crystals. Of these about fifty varieties have become known up to the present. The first kind discovered consisted of a modification of silver iodide which is stable above 146° C. It is viscous liquid, but under the microscope it reveals a distinctly crystalline structure. The most familiar example is soft soap, which consists of innumerable soft crystals. Some new chemical preparations with alarming names show this structure more strikingly. Vorländer's para-azo-oxy-benzoic-ethyl-ester is seen to consist of numerous crystals in constant motion. Whenever two crystals collide they coalesce with a jerk, just like drops of liquid. Another substance exhibits soft crystals in long straight columns with sharp facets. Gattermann's para-azoxy-phenetol is as liquid as water, and occurs in drops; but each drop possesses a structure which is easily proved to be of a crystalline character. Seen in the direction of the axis of symmetry, each drop appears to have a round nucleus; but seen in a direction normal to this axis, the nucleus appears like a bi-convex lens. Both these structures are unreal. They are products of refraction. But they prove that the drops are not isotropic. When two drops collide they form one drop: but the new drop has two nuclei, with a third between them, and this lasts for several minutes. In polarised light the drops show well-marked dichroism, and between crossed nicols they show beautiful interference colours, just like solid crystals. On squeezing or bending such a liquid crystal and releasing it, it resumes its original shape after a short time, just as an amœba would do. Two species of crystals may be "crossed." Thus, two varieties of cholester-ethyl-caprinate may be combined in a structure recalling the lustre of a butterfly's wings. These phenomena, striking as they are, do not exhaust the wonders of liquid crystals. Vorländer has observed exceedingly curious phenomena in a substance called para-azoxy-cinnamo-ethyl-ester. Under suitable conditions, the crystals take the shape of spheres flattened on one side. When two such drops meet three different things may happen. Either the drops are in the same position—say with both bases downward, and one on top of the other: then they coalesce into one round drop. Or the bases touch: then they form a twin or couple without running together. When they meet in any other way they form a drop with two flat surfaces. The "copulation" of two individuals has a remarkable counterpart in the process of "budding," which is sometimes observed, small buds appearing on the flat surfaces, and dropping off when they reach a certain size. Further, the drops often make a chain resembling a bacterium, growing by intussusception instead of by apposition. These rods may be spirals, and are often seen in serpentine motion. Eventually they break up, and each fragment develops into a perfect individual. These curious experiments, which were exhibited at the Congress, made it practically impossible to assign a definite limit to vital phenomena, or to say where organic matter ends and inorganic matter begins.

Quekett Microscopical Club.—At the 434th Ordinary Meeting of the Club, held on November 16, 1906, Mr. F. P. Smith communicated

a paper on "The British Spiders of the genus *Lycosa*." Mr. F. P. Smith delivered a lecture on "Vagabond Spiders." He said that by "vagabond" he meant "wandering," and included in the term all those spiders which did not make snares. The three principal groups of "vagabonds" were represented by the families Lycosidæ, Thomisidæ, and Salticidæ, and their characteristics were described at some length.

At the 435th Ordinary Meeting, held on December 21, 1906, Mr. W. R. Traviss exhibited and described an expanding central stop for obtaining dark-ground illumination. A "Note on New Diatom Structure," by Mr. A. C. Eliot Marlin, F.R.M.S., was read. This dealt with "veiled" markings recently noted on certain species of *Melosira* and *Hyalodiscus*, and on a *Navicula* and *Aulodiscus*. Details of apparatus employed and illumination used were given. An interesting discussion followed.

Behn, N., & W. Heuse—**Zur Demonstration der Abbeschen Theorie des Mikroskops.** *Verh. d. Phys. Ges.*, viii. (1906) pp. 283–9.

Day, A. L., & E. S. Shepherd—**Quarzglas.** *Deutsch. Mechan. Zeit.*, 1906, p. 137. See also *Science*, xxiii. (1906) p. 670.

B. Technique.*

(1) Collecting Objects, including Culture Processes.

Artificial Cultivation of Spirochæta pallida.†—A. Fontana removed small portions of tissue from primary sores and soft papillæ, and introduced them into various fluid media—sterile human blood, human blood with citrate of sodium solution, blood serum, ascitic fluid, etc.; most of the tubes became overgrown with contaminating organisms by the fortieth day, but in no case was there any cultural development of spirochætes. But examination of the portions of tissue showed that the spirochætes were still present, having withstood the action of the other organisms; and those portions that were kept at 37° C. from 8–30 days showed a great increase in the number of the spirochætes; and this was especially the case when the portions of tissue were brought into ascitic fluid and into gelatin with ascitic fluid and incubated at 37° C.

By placing portions of skin or mucous membrane from non-syphilitic individuals in the test glasses, together with portions of syphilitic tissue, the authors demonstrated in several cases the transference of spirochætes from the diseased into the healthy tissue.

Direct Impression on Photographic Paper to Replace Drawings by Hand.‡—M. Yegounow by the use of Velox paper obtains good shadow images, for which he details many obvious uses and advantages over drawings made by hand, especially in representing cultures on Petri dishes, ascertaining the contours of small objects, and acquiring measurements of colonies.

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

† Centralbl. Bakt., 1te Abt. Orig. xlii. (1906) p. 666.

‡ Op. cit., 2te Abt. xvii. (1906) p. 412.

Lemco Litmus Broth.*—M. H. Gordon, in an investigation of the biochemical characters of *Staphylococcus epidermidis albus*, used the following medium as a test for acid production. The medium is of constant composition, but by the addition or omission of certain ingredients may be found suitable for other purposes. The chief advantage is the substitution of lemco for beef broth. Lemco 1 p.c., pepton 1 p.c., sodium bicarbonate 0·1 p.c., carbohydrate or polyatomic alcohol 1 p.c., 10 c.cm. per cent. aqueous solution of ordinary solid litmus, and 1 p.c. maltose.

VIGUIER, C.— **Nouvel Appareil pour la Recherche et la Récolte rapide du Plankton.** *Archiv. Zool. Expér et gén., Notes et Revue*, v. (1906) pp. xlix.–lviii (6 figs.).

(2) Preparing Objects.

Examining the Thymus of Birds.†—C. Ciaccio fixed the thymus of fowls and pigeons in Bouin's fluid (formol-picro-acetic acid) and in Ciaccio's mixture (formol-chromo-acetic acid). The sections were stained with—(1) Heidenhain's iron-hæmatoxylin ; (2) Apáthy's hæmatein I A, or Mayer's hæmalum—both these stains were followed by eosin or picro-fuchsin ; (3) eosin and thionin or toluidin-blue.

Studying the Spermatogenesis of Pyrrhocoris apterus.‡—J. Gross examined both the larvæ and imagines of *Pyrrhocoris apterus*, collected at various times of the year. The fixatives used were Flemming's mixture and vom Rath's fluid, with and without osmic acid. The sections were stained with iron-hæmatoxylin, and occasionally counterstained with eosin. As controls to the iron-hæmatoxylin, alum-carmine and bleu-de-Lyon and Flemming's triple stain were used. The sections were from 7·5–5 μ.

Fixing and Staining the Œnocytes of Torymus nigricornis.§—R. Weissenberg first benumbed the animals with chloroform, and then immersed them for about 45 seconds in water at about 75°. The cuticula was then ruptured with a needle or scissors, after which the animal was immersed in Carnoy's alcohol-chloroform-acetic acid fluid, or in Petrunkewitsch's modification of Gilson's mixture. Heat, however, was employed in connection with the latter fixative. Staining was effected with Delafield's hæmatoxylin. It was found better to overstain and decolorise with acid-alcohol, and differentiate with ammonia or lithium carbonate.

Fresh preparations were examined in physiological salt solution, or in the juices of the animal itself. For sectioning, the mastix-collodion method was used.

Studying the Larvæ of the Dragon-Fly.‖—Caroline McGill, when studying the behaviour of the nucleoli during oogenesis of the dragon-

* Rep. Local Gov. Board, 1906, Appendix B, pp. 388–9.
† Anat. Anzeig., xxix. (1906) pp. 597–600 (3 figs.).
‡ Zool. Jahrb., xxiii. (1906) pp. 269–336 (2 pls.).
§ Tom. cit., pp. 231–68 (1 pl.).
‖ Tom. cit., pp. 207–30 (5 pls.).

fly, with especial reference to synapsis, used the larvæ of *Anax junius* and *Plathemis lydia*. Fresh and preserved material was employed. Fresh material was examined in salt solution ; in this condition all the details can be clearly demonstrated, as in the fixed and stained egg-strings. For the finer details, sections were necessary, the material being fixed in Flemming's or Gilson's fluid. The abdomens of the larvæ were opened while submerged in the salt solution ; the ovaries were clipped off with fine scissors, and transferred promptly to the fixative. The stains used were Heidenhain's iron-hæmatoxylin, Flemming's triple stain, and the borax-carmin-methyl-green method of Obst.

Demonstrating the Elastic Tissue of the Eye of Birds.*—E. W. Carlier bisected the eyes into anterior and posterior halves, and after removal of lens and vitreous humour the anterior halves were placed in picro-corrosive formalin mixture (Mann). When thoroughly fixed, they were passed through upgraded alcohols, to benzol, benzol and paraffin, and finally pure paraffin. Radial sections, including all the coats of the eye-ball, were then made through the sclero-corneal junction, and after removal of the paraffin were stained with Weigert's elastic stain and mounted in balsam.

(3) Cutting, including Imbedding and Microtomes.

Photoxylin as an Imbedding Medium.†—Bindo de Vecchi finds that photoxylin dissolved in methylic alcohol forms an excellent imbedding medium and is superior to celloidin. The procedure is as follows : (1) Immersion of the piece in absolute methylic alcohol for 24 hours ; (2) Immersion in 1 p.c. methylic-photoxylin for from 24 hours to several days ; (3) Immersion in 5 p.c. methylic-photoxylin for similar period ; (4) Exposure under glass bell jar for short time, to allow evaporation of alcohol ; (5) Trimming of the block and fixing to piece of wood with thick gelatin solution ; (6) Exposure to air for about an hour ; (7) Immersion in 85°–90° alcohol until quite hard.

Sticking Paraffin Sections on the Slide.‡—K. Helly disseminates a device which he says never fails to cause the section to adhere by the water method. It consists in passing the perfectly cleaned slide two or three times through the flame from a Bunsen burner just before depositing the section.

Gelatin-formalin Method of Sticking Microscopic Sections to the Slide.—Olt § makes his adhesive of 10 grm. gelatin which is dissolved in 100 c.cm. of water. The white of one egg is added to the mixture filtered. To the filtrate 10 c.cm. of 5 p.c. phenol is added. A small piece is liquefied on the blade of a knife and rubbed over the surface of a slide. Celloidin sections are then placed on the slide, and are mopped up and at the same time flattened out by means of blotting paper. A strip of thin paper dipped in 10 p.c. formalin is placed over the section, and another slide on the top. In a few seconds the celloidin sections

* Proc. Scot. Micr. Soc., iv. (1906) pp. 70–92 (4 pls.).
† Zeitschr. wiss. Mikrosk., xxiii. (1906) pp. 312–15. ‡ Tom. cit., pp. 330–1.
§ Tom. cit., pp. 323–8.

will have adhered to the underlay. Should special care be demanded the section may be placed for a few minutes in 10 p.c. formalin, or exposed to action of formalin vapour in a closed vessel.

The further treatment of the sections is the ordinary one: there is no fear that the sections will fail to adhere. Paraffin sections are treated in a very similar way. Frozen sections are also amenable to this fixation method. The sections are taken off the knife and transferred to a solution of the gelatin and water (1–10), and then placed on a slide. The preparations are then exposed to the action of formalin vapour in a closed vessel. After at least one hour the preparations are immersed in 10 p.c. formalin. The subsequent treatment is the usual for frozen sections.

Similar devices have been suggested by Koninski* and by Bolton and Harris.†

(4) Staining and Injecting.

Staining Bacteria in Sections.‡—Saathoff advises the following method for staining bacteria in sections, whereby, in a blue and reddish stained tissue, the organisms are stained deep red, nuclear membrane and network appear blue, nuclear granules and protoplasm red. Methyl green 0·15, pyronin 0·5, 96 p.c. alcohol 5·0, glycerin 20, and 2 p.c. carbolic acid water to 100. Stain for 2–4 minutes, wash with tap water until the green colour changes to bluish red, wash in absolute alcohol, clear for few seconds in xylol, and mount in balsam.

Carmin Staining of Glycogen and Nuclei.§—F. Best used celloidin sections, and did not remove the imbedding medium, as this prevented the glycogen from being dissolved out in water. The staining solution was composed of: carmin 2, potassium carbonate 1, calcium chloride 5. These ingredients were boiled in 60 of water for some minutes, and when cold 20 of liq. ammon. caust. were added. The solution must be filtered before use.

For staining, the procedure was as follows. Stain with Böhmer's hæmatoxylin or hæmalum, and differentiate with hydrochloric acid alcohol. Then immerse the sections for 5 minutes in a mixture composed of 2 parts of the carmin solution, 3 of liq. ammon. caust., and 3 of methyl-alcohol. Differentiate in absolute alcohol 80, methyl-alcohol 40, distilled water 100. Dehydrate in alcohol, and mount in balsam. For staining nuclei, almost any preparation of carmin is more or less useful, but the following mixture is effective: carmin 2, ammon. chlorat. 4, lithium carbonicum 1, distilled water 100. Boil, and when cold add liq. ammon. caust. 20. Keep in stoppered bottle, and add some thymol to prevent mouldiness.

Röthig, P.—**Wechselbeziehung zwischen metachromatischer Kern- und Protoplasmafärbung der Ganglienzelle und dem Wassengehalt alkoholischer Hæmatoxylin lösungen.**

[Remarks on the difference of colour in nuclei after treatment with hæmatoxylin solution variously diluted with water.]

Zeitschr. wiss. Mikrosk., xxiii. (1906) pp. 316–18.

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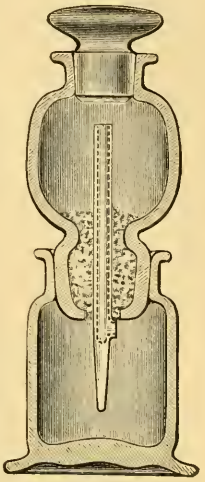
* See this Journal, 1898, p. 686. † Op. cit., 1903, p. 768.

‡ Centralbl. Bakt., Ref., xxxviii. (1906) p. 777.

§ Zeitschr. wiss. Mikrosk., xxiii. (1906) pp. 319–22.

(5) Mounting, including Slides, Preservative Fluids, &c.

Filter Bottle for Mounting Fluids.—H. Taverner exhibited at the November Meeting, 1906, a small filter bottle (fig. 23), the special advantage of which is that volatile micro-mounting fluids can be filtered with or without heat, and without alteration in strength, as any vapour that may be given off is retained in the bottle. The apparatus consists of a bottle-shaped funnel which fits like a stopper into the neck of the lower bottle. In this funnel-stopper a tube is placed, and the surrounding space firmly packed with cotton or glass wool. The fluid to be filtered is placed in the upper bottle, care being taken that it does not reach the top of the tube, which is for the purpose of allowing the air or vapour to pass from the lower to the upper bottle during filtration. The filter has been used for glycerin jelly, glycerin solutions, celluloid varnish, celloidin, benzol, balsam, etc.



Half actual size.

Fig. 23.

(6) Miscellaneous.

Method for Differentiating Bloods.* — Piorkowski, following on his observations that ox serum causes a coagulum with cow's milk, but with woman's milk has no reaction, finds that when hydrocele fluid, ascitic fluid, or human serum, is treated with human blood, after half an hour a red deposit occurs, a clot forms and the supernatant fluid remains clear; other varieties of blood are dissolved in the human fluid. Using the sera of horses, cattle, and other animals, it was found that homologous bloods were coagulated, heterogenous bloods were dissolved.

Improved Methods for Recognition of Blood and Seminal Stains.† E. H. Hankin has found that if a blood stain has been altered by putrefaction or drying it may, nevertheless, give the absorption bands of hæmochromogen, even although the blood-colouring matter is in an apparently undissolved and insoluble condition. The suspected stain is cut out and plunged into boiling water for a few moments. It is then placed on a slide and wetted with ammonium sulphide. It is examined under the microscope and the specimen is moved until the whole field of view is occupied by a portion of the coloured material. If this cannot be achieved with a low power the use of an oil immersion may be necessary. The eye-piece is then taken out and replaced by a microspectroscope. If the stain is of blood the two absorption bands of hæmochromogen will be seen. Should the bands not be visible, as may occur apparently owing to the effects of putrefaction, a drop of 10 p.c. solution of potassium cyanide should be allowed to fall on the stain. Two bands will at once develop resembling those of hæmochromogen, but situated a little nearer to the red end of the spectrum.

* Centralbl. Bakt., Ref., xxxviii. (1906) p. 752.
† Brit. Med. Journ. (1906) ii., pp. 1261 and 1843.

If the stain be on a weapon or piece of jewellery, it should first be wetted with ammonium sulphide. A small portion may then be scraped off with a knife and treated as above.

In dealing with seminal stains the suspected stain is boiled for 2 minutes in an aqueous solution containing tannin ½ p.c. and sulphuric acid 1 per thousand. It is then washed for 2 minutes in a solution made by adding 1 part of saturated ammonia solution to 400 of water. This is followed by immersion for 5 minutes in a solution containing 1 in 10,000 potassium bichromate and 1 in 1000 sulphuric acid. Next it is transferred for 2 minutes to a 2 p.c. solution of potassium cyanide. It is then rapidly washed in distilled water, scraped, and teased up on a slide, dried, fixed by heat, and stained.

Swift's Slitting and Polishing Machine for Rocks.*—This apparatus (fig. 24) is practically self-acting when once the material to be cut has been

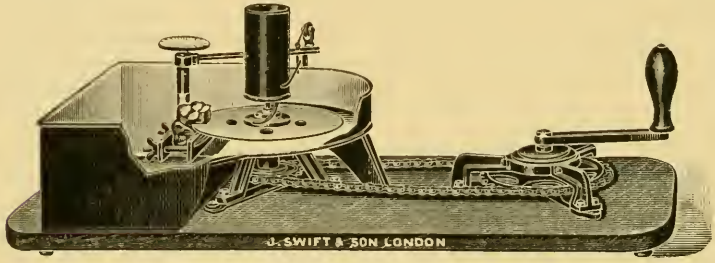


Fig. 24.

placed in position. It is then only necessary to turn the handle, which carries either the slitter or the polishing lap. The apparatus works at considerable speed, which is effected by multiplying-gear fitted to the vertical shaft to which the handle is fixed. The ordinary gut-band is superseded by a fine endless chain, which is geared in such a way that it cannot be deranged. A fine-adjustment is fitted to the clamp which holds the sections, so that a specimen can be cut to any given thickness, thus enabling the sections to be cut so thin that they require little or no reducing upon the lap. The size of the apparatus is 24 in. by 12½ in.

Metallography, etc.

Liquid Crystals of Ammonium oleate.†—F. Wallèrant describes the peculiar optical properties of a layer of ammonium oleate compressed between a slide and a cover-glass. Under the influence of vibration portions of the turbid layer become transparent, then possessing a definite crystalline orientation. Ammonium oleate may exist in four polymorphic modifications.

The Internal Architecture of Metals.‡—A report of a popular lecture by J. O. Arnold at the Royal Institution. Some metallographic

* Swift and Son's Catalogue, 1906, p. 28, fig. 26.
† Comptes Rendus, cxliii. (1906) pp. 694–5 (1 fig.).
‡ Nature, lxxv. (1906) pp. 43–5 (3 figs.).

questions were dealt with in an elementary manner. The formation of a eutectic network by the addition of a small percentage of bismuth to gold, the electrolytic decay of brass resulting in dezincification, the structure of steel, and the failure of steel by fatigue, were among the subjects touched upon by the lecturer.

Crystallisation of Minerals.*—T. M. Lowry discusses Day and Shepherd's study of the crystallisation of the lime-silica series. Among the many difficulties which surround the determination of melting points of minerals are the excessively high temperatures and the slowness with which many minerals attain equilibrium on change of temperature. The employment of the radiation pyrometer, and of iridium vessels (melting point at least 600° C. above that of platinum), has rendered possible accurate work at very high temperatures. The equilibrium diagram given indicates the formation of two definite compounds ($CaSiO_3$ and Ca_2SiO_4) and three eutectics. Silica, and the two compounds, are polymorphous.

Practical Applications of Microscopic Metallography in Works.† In this paper, read at the Brussels Congress of the International Association for Testing Materials, H. le Chatelier gives a comprehensive and somewhat lengthy review of the subject. The paper is divided into sections as follows: (1) Examples of practical application—three striking instances are given. (2) Information furnished by microscopic examination, bearing on (*a*) chemical composition, (*b*) structure, (*c*) deformations. (3) Ways in which metallography may be employed in works, (*a*) for the regular control of manufacturing operations, (*b*) for research with a particular object in view, (*c*) for research of a more indirect and general nature. (4) Particular industries in which metallography is of value. (5) Cost of metallography. Numerous examples are given, fully illustrated by photo-micrographs.

Quenching of Steel.‡—P. Lejeune describes a method of studying the rate of cooling of large pieces of steel in quenching. The Saladin method of recording differences of temperature is used. Two thermo-couples are inserted in the sample (a cylinder 5 cm. by 5 cm.), the junction of one being at the centre, that of the other midway between centre and surface. By means of suitable connections of these couples to galvanometers, the actual temperature of the centre, and the difference of temperature between the two points are recorded. A resistance furnace with carbon as the resistor was used for heating the samples. The author gives some curves he has obtained.

Some Obscure Points in the Theory of Cementation.§—Partiot indicates the wide range of application of case-hardening, and suggests that researches on the following lines will give results of practical value: (1) Determination of the laws giving the depth of penetration as a function of time and temperature; (2) study of cementing media and "anti-cements" (substances which prevent or retard cementation); (3)

* Nature, lxxv. (1906), pp. 112–3 (1 fig.). See also Journ. Amer. Chem. Soc., xxviii. (1906) pp. 1089–1114.

† Rev. Métallurgie, iii. (1906) pp. 493–517 (36 figs.).

‡ Tom. cit., pp. 528–34 (8 figs.). § Tom. cit., pp. 535–40.

study of the causes of crystallisation causing brittleness, developed by cementation ; (4) study of deformation caused by cementation, appearing either after that operation or after the subsequent quenching.

The Composition of the Eutectic Copper-Copper Oxide.*—E. Heyn defends the accuracy of his statement that the eutectic contains 3·5 p.c. oxide. With 5 p.c. oxide (the eutectic composition given by Dejean) the alloy is clearly hyper-eutectic. This is shown by the distinct segregation of a 5 p.c. alloy—a pure eutectic shows no segregation. The author suggests that Dejean's high results are due to faulty sampling of the ingots for analysis.

Fournel's Researches and the Lower Limit of A 2.†—F. Osmond, remarking on the difficulty of determining the temperature at which, on cooling, the magnetic transformation of iron ends, indicates the bearing of Fournel's results (embodied in two papers here given in full) on the question. Fournel determined the critical points by measuring electrical resistance throughout the range of temperature. Osmond considers that, in the curves showing relation between resistance and temperature, the point at which the curve ceases to be a straight line marks the lower limit of the range A 2. This temperature varied from 350° C.–100° C. in the steels used in Fournel's investigations. Osmond gives a diagram showing the proportions of the α, β and γ modifications contained in iron at different temperatures.

Nickel-Silicon Steels.‡—A further instalment of L. Guillet's work on quaternary steels. Forty-nine alloys, prepared to show the effect of increasing amounts of silicon on the three classes of nickel steels (pearlitic, martensitic and γ-iron) were subjected to exhaustive microscopic examination and were tested mechanically. The results appear to agree substantially with the deductions drawn from the author's researches on nickel steels and silicon steels, subject to the following modifications. (1) The addition of silicon tends (*a*) to hinder the formation of martensite : (*b*) to cause a γ-iron nickel steel near the border of the martensitic class to become martensitic ; (*c*) to increase the maximum stress and elastic limit, and diminish elongation and resistance to shock, of pearlitic steels. Size of grain is diminished ; (*d*) to improve the mechanical qualities of γ-iron steels by raising the maximum stress ; (*e*) to raise the position of the thermal critical points. (2) The presence of nickel tends (*a*) to counteract the effect of silicon in causing graphite separation, both in the original condition and after annealing at 900° C. ; (*b*) to cause graphite to be more readily separated in high carbon than in low carbon steels. White areas visible in γ-iron steels of sufficiently high silicon content appear to be a silicide of iron or nickel. Some of the steels containing large amounts of nickel and silicon show extraordinarily complex micro structures. The addition of more than 2 p.c. silicon to nickel steels does not appear to offer any advantages.

Etching Reagents for Steel.§—Kourbatoff states that failures met with in using one of his etching solutions have been due to the employ-

* Rev. Métallurgie, iii. (1906) pp. 543–4.
† Tom. cit., pp. 551–7 (3 figs.). See also this Journal, 1905, p. 516.
‡ Tom. cit., pp. 558–77 (19 figs.).
§ Tom. cit., p. 648. See also this Journal, 1905, p. 392, and 1906, p. 635.

ment of acetic acid instead of acetic anhydride in its preparation. He gives the exact mode of making up the reagent, as follows. Two separate solutions are prepared. (1) 4 p.c. of nitric acid in acetic anhydride; (2) A mixture in equal parts of the three alcohols, methyl, ethyl, and iso-amyl. Immediately before use, 1 part of (1) is added to 3 parts of (2).

The Brinell Method of Hardness Measurement at the Brussels Congress.*—The papers read at Brussels on this method of testing, now assuming considerable importance, are summarised by H. le Chatelier: (1) Influence of variation in diameter of ball, and in pressure. If H is the hardness number obtained under the standard conditions (ball 10 mm. diameter, pressure 3000 kg.), H dp the hardness number given with ball diameter d and pressure p, then—

$$H = H\,dp \sqrt[5]{\frac{d}{10}} \cdot \frac{20{,}000}{17{,}000 + p}$$

(2) Degree of accuracy obtainable—the error should not exceed 0·5 p.c.; (3) Relation between hardness number and maximum tensile stress. This important point is fully considered. For nearly all classes of steel the tenacity may be calculated within 5 p.c. by multiplying the hardness number by a coefficient depending on the kind of steel. The coefficients given by different workers and for different material vary from 0·344 to 0·376; (4) Hardness tests by impact, and the possibility of substituting hardness for tensile tests, are considered.

Alloys of Zinc and Iron.†—S. Wologdine prepared alloys containing up to 9·5 p.c. iron by dissolving iron in molten zinc. By heating an alloy containing 8·5 p.c. iron at 1000° C., a residue with 42 p.c. iron was obtained. The etching reagents giving the best results for microscopic examination were a 5 p.c. solution of iodine in absolute alcohol, and a lead chloride solution. With 0·07 p.c. iron well marked crystals of a hard constituent were detected. With 8 p.c. iron the alloy consisted wholly of this crystalline constituent. By dissolving out the excess of zinc in a 7·1 p.c. alloy with lead chloride solution the constituent was isolated and found to contain 8·14 p.c. iron. It appears to be $FeZn_{10}$. A freezing point curve is given for the system for the range 0 to 12 p.c. iron, showing a maximum at 8 p.c. of 750° C. The melting point of zinc appears to be raised by smallest additions of iron. Zinc and the compound $FeZn_{10}$ do not give solid solutions.

Constitution of Hardened and Tempered Tool Steels.‡—E. Heyn and O. Bauer, investigating the nature of troostite and sorbite, quenched small pieces of a eutectoid steel (carbon 0·95 p.c.) at 900° C. These were then heated at different temperatures and for various lengths of time and again quenched. The hardness of each piece was measured by the Martens sclerometer, and the rate of solution in dilute sulphuric acid determined. The carbon condition was determined by dissolving in 10 p.c. sulphuric acid in absence of air, and estimating carbon,

* Rev. Métallurgie, iii. (1906) pp. 689–700.
† Tom. cit., pp. 701–8 (7 figs.).
‡ Stahl und Eisen, xxvi. (1906) pp. 778–84, 915–22, 991–7 (49 figs.).

(1) escaping as gas (hardening carbon), (2) left as carbide, (3) left as free carbon, denoted by Heyn as Cf. The maximum amount of carbon existing in this state was found in the sample heated at 400° C. The authors' main conclusions are :—(1) The transformation of martensite into pearlite by letting down a hardened steel is not continuous ; a definite, well characterised intermediate phase is passed through. The name "Osmondite" is proposed for this constituent. (2) Osmondite has the highest solubility in dilute sulphuric acid. On solution in sulphuric acid it gives the highest yield of free carbon. (3) On etching with alcoholic acids, osmondite gives the darkest colour, as it is the separation of this free carbon which colours the sample. (4) Quenching, rapid or slow, is equivalent to perfect supercooling to pure martensite, followed by more or less tempering. The extent of the letting down depends on the rate of cooling. According to the authors, the order of transition is martensite, troostite, osmondite, sorbite, pearlite.

F. Osmond discusses this paper.* He suggests that the iron of osmondite may be identical with Beilby's hard phase. He considers that the properties of quenched steel may be due to all of the three following causes :—(1) Retention of the carbon in the state of hardening carbon ; (2) partial retention of the iron in an allotropic modification ; (3) hardening by deformation caused by change in volume. Osmond then gives definitions of the constituents of steel, having regard to Heyn's results.

The original papers should be consulted for a complete account of the experiments leading to the remarkable conclusions here outlined.

Iron-Carbon Alloys.†—P. Goerens discusses the equilibrium diagram of the iron-carbon system, corrected by Roozeboom from the results of Carpenter and Keeling. Heyn's view that all iron-carbon alloys tend to decompose finally into iron and carbon, and that the presence of cementite is due to supercooling, is supported by the author's experiments on three alloys, A, B and C. They were prepared from Swedish iron and sugar-carbon, A contained 3·95, B 4·5, C 4·8 p.c. carbon. They were cast in thick-walled iron moulds, to give rapid solidification and cooling. Microscopic examination showed that A was martensite-cementite eutectic plus a little excess martensite, B was practically pure eutectic, C was eutectic plus a little excess cementite. In molten solutions the carbon exists as carbide. A 4·7 p.c. alloy was cooled in a manner to give incipient graphite formation. It consisted of martensite-cementite eutectic with areas of excess martensite through which ran veins of graphite. The author elaborates a theory, according to which cementite is formed on solidification, decomposing, if sufficient time at a high temperature be allowed, yielding graphite. Remarkably clear photo-micrographs support the author's conclusions.

CLARAGE, E. T.—**The Manufacture of Tool Steel.**
English Mechanic, lxxxiv. (1906) pp. 372–4.

DOERINCKEL, F.—**Alloys of Thallium with Copper and Aluminium.**
Zeitschr. Anorg. Chem., xlviii. (1906) pp. 185–90 (2 figs.).

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* Rev. Métallurgie, iii. (1906) pp. 621–32 (7 figs.).
† Tom. cit., pp. 175–86 (15 figs.).

DUJARDIN, P. F.—**Technique of Metallography.**
Stahl und Eisen, xxvi. 1 (1906), pp. 522–8, and pp. 732–5 (8 figs.).

FRIEDRICH, K.—**Segregation.** *Metallurgie*, iii. (1906) pp. 13–25 (9 figs.).

,, ,, **Lead and Arsenic.** *Tom. cit.*, pp. 41–52 (15 figs.).

,, ,, **Lead and Silver.** *Tom. cit.*, pp. 396–406 (22 figs.).

FRIEDRICH, K., & A. LEROUX—**Silver and Arsenic.**
Tom. cit., pp. 192–5 (7 figs.).

,, ,, **Silver and Silver Sulphide.**
Tom. cit., pp. 361–71 (24 figs.).

,, ,, **Zinc and Arsenic.**
Tom. cit., pp. 477–9 (7 figs.).

GOERENS, P.—**Constitution of Cast Iron.**
Stahl und Eisen, xxvi. 1 (1906), pp. 397–400 (12 figs.).

HEYN, E.—**Notes on Metallographical Practice.** *Tom. cit.*, pp. 8–16 (28 figs.).

,, **Application of Metallography in the Iron Industry.**
Tom. cit., pp. 580–96 (51 figs.).

,, **Metallographical Research in Foundry Practice.**
Tom. cit., pp. 1295–1301 (4 figs.).

HEYN, E., & O. BAUER—**Copper and Sulphur.**
Metallurgie, iii. (1906) pp. 73–86 (26 figs.).

LEDEBUR, A.—**Notes on Cementation.**
Stahl und Eisen, xxvi. 1 (1906), pp. 72–5 (1 fig.).

MATHEWSON, C. H.—**Sodium-Aluminium, Sodium-Magnesium, and Sodium-Zinc Alloys.** *Zeitschr. Anorg. Chem.*, xlviii. (1906) pp. 191–200 (3 figs.).

PETRENKO, G. I.—**Silver-Zinc Alloys.** *Tom. cit.*, pp. 347–63 (10 figs.).

PFEIFFER, V. O.—**Alloying Capacity of Copper with Pure Iron and Iron-Carbon Alloys.** *Metallurgie*, iii. (1906) pp. 281–7.

PÜTZ, P.—**Influence of Vanadium on Iron and Steel.**
Tom. cit., pp. 635–8, 649–56, 677–86 (6 figs.).

ROGERS, F.—**Some Microscopic Strain Effects in Metals.**
Tom. cit., p. 518–27 (2 figs.).

TAMMANN, G.—**Aluminium-Antimony Alloys.**
Zeitschr. Anorg. Chem., xlviii. (1906) pp. 53–60 (2 figs.).

HOITSEMA, C., & W. J. VAN HETEREN—**Metallography as an Aid in the Detection of False Coins.**
Metallurgie, iii. (1906) pp. 128–30 (11 figs.).

WÜST, F.—**Iron-Carbon Alloys of High Carbon Content.**
Tom. cit., p. 1–13 (27 figs.).

,, **Influence of Foreign Elements on Graphite Separation in Cast Iron.**
Tom. cit., pp. 169–75, 201–5 (3 figs.).

VOGEL, R.—**Gold-Zinc Alloys.**
Zeitschr. Anorg. Chem., xlviii. (1906), pp. 319–32 (7 figs.).

,, **Gold-Cadmium Alloys.** *Tom. cit.*, pp. 333–46 (8 figs.).

The Metallurgy of Cast Iron.
[A review of T. D. West's book with this title.]
English Mechanic, lxxxiv. (1906) pp. 347–8.

Metallic Vegetation. *Tom. cit.*, p. 419.

Recording Types of Le Chatelier Pyrometer.
Electrochem. and Met. Ind., iv. (1906) pp. 511–2 (2 figs.).

Comentation Experiments with Gas or Gaseous Cementing Agents.
Metallurgie, iii. (1906) pp. 123–8 (20 figs.).

MICROSCOPY.

A. Instruments, Accessories, &c.*

(1) Stands.

Swift's Substage with Patent Slow Focusing.†—This substage (fig. 25) is fitted with the Climax slow focusing adjustment, and is

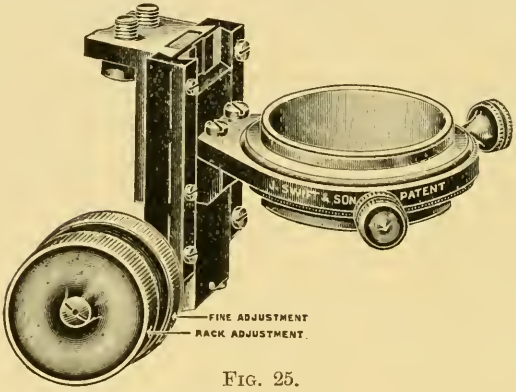

Fig. 25.

adapted for most of this maker's instruments. This apparatus is of great value for finally focusing when working upon a critical image. One entire revolution of the slow-adjustment drilled head moves the condenser 0·005 inch.

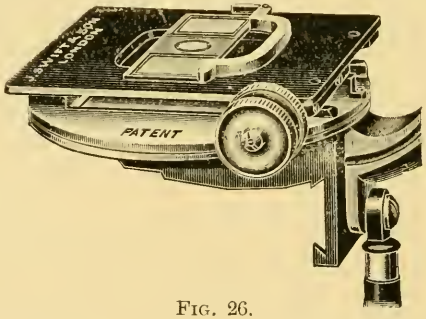

Fig. 26.

Swift's Turrell Mechanical Stage.‡—In this form of mechanical stage (fig. 26) both movements can be simultaneously used without removing the hand from its position. The bar against which the slide rests is removable, thus leaving the top plate of the stage free for the use

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

† Swift and Son's Special Catalogue, 1906. ‡ Tom. cit.

of Petri dishes or objects mounted on extra large slides. The stage is mounted on a base plate, which allows of the object being revolved concentrically in the field of view.

(2) Eye-pieces and Objectives.

Zeiss' Anastigmatic Magnifiers.*—Four lenses enter into the construction of these anastigmatic magnifiers (fig. 27), which have both a large field and large working distance. They are supplied in three different powers, 16, 20, and 27 diameters, either as single magnifiers in

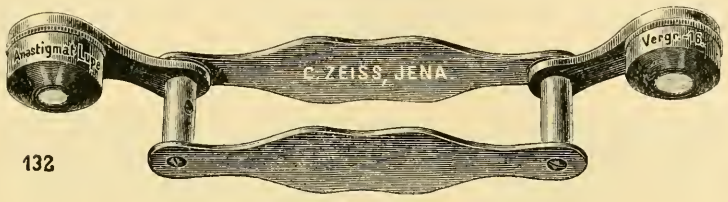

Fig. 27.

a mount suitable for dissecting stands, in the form of folding pocket lenses, or any two powers mounted in pairs, as shown in the illustration.

Fig. 28.

Zeiss' Verant Lenses.†—In these Verant lenses there is a virtual stop about 2·5 cm. behind the nearest lens surface, a sharp and un-

* Carl Zeiss' Special Catalogue, 1906, p. 6. † Tom. cit., p. 7.

distorted image of a plane object being obtained; and in order that a proper and definite distance may be maintained during use, the instrument is provided with an eye-cap, which should be pressed close to the margin of the orbit, as shown in the illustration (fig. 28).

(3) Illuminating and other Apparatus.

Spectroscope for the "Allan Dick" Petrological Microscope.* This modification of spectroscope (fig. 29) will be found useful when examining minerals of the monazite class giving faint absorption bands; such bands can be seen best with a prism of moderate dispersion. The apparatus consists of a prism mounted to fit over the ocular. Fig. 30 is a brass plate with an adjustable slit, and working above this

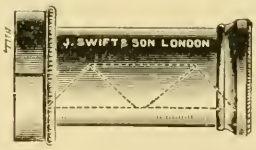

Fig. 29.

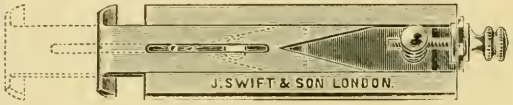

Fig. 30.

is a dovetailed plate with a V cut in the centre for restricting the length of the slit. On the right-hand side of the slit is a perforation for locating the object previous to pushing the slit into position. This piece of apparatus slides into the opening cut into the ocular just above the diaphragm. Made by Swift and Son.

Draper's Improved Dichroiscope.†—The improvement (fig. 31) consists of a revolving stage carrying a small cup filled with wax. The

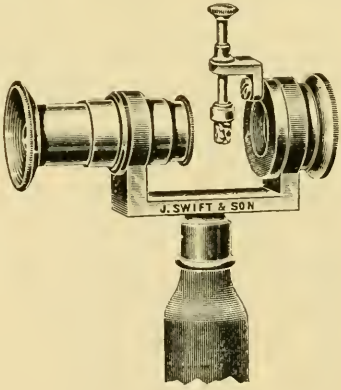

Fig. 31.

crystal can be moved in the horizontal or vertical direction or brought into focus by means of the sliding tube carrying the prism eye-piece. The crystal can also be revolved on the horizontal and vertical axes

* Swift and Son's Special Catalogue, 1906, fig. 19. † Tom. cit., p. 27, fig. 22.

whilst under examination, and the crystal-holder can be thrown out of the field of view in order to fix the object to the wax. Made by Swift and Son.

Swift's Condenser for Illuminating Large Objects.*—This combination (fig. 32) is a modification of one of Swift's photographic lenses. It is

Fig. 32.

$1\frac{3}{10}$ in. in diameter, with an approximate focus of 2 in., and is intended for illuminating uniformly large objects under the lowest powers. The illuminator is mounted in a similar way to the spot lens, and focuses fairly close to the object. It is useful for photographing with Planars or any short-focus photographing lens.

Swift's Simple Hand Polarising Apparatus.†—This apparatus (fig. 33) consists of an analysing and polarising prism, with one lens

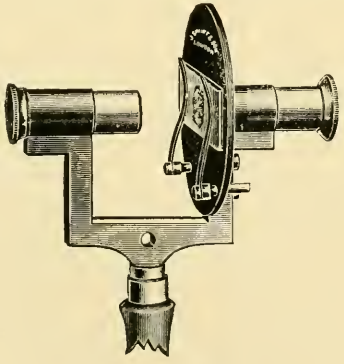

Fig. 33.

acting as a simple objective and another as convergent lens. The instrument is constructed for estimating the thickness of sections of minerals when being ground down to any given thickness previous to finishing them off as microscopic sections, the thickness being ascertained by polarising the mineral under observation.

Herbert Smith Refractometer.‡—The effective range of the refractometer (figs. 34, 35) is between 1·400 and 1·760, and the refractive

* Swift and Sons' Special Catalogue, 1906, p. 50, fig. 55.
† Tom. cit., p. 28, fig. 25.
‡ Tom. cit., p. 27, fig. 24.

indices can be determined within these limits to two limits in the third place of decimals, if a sodium flame be the source of illumination. The

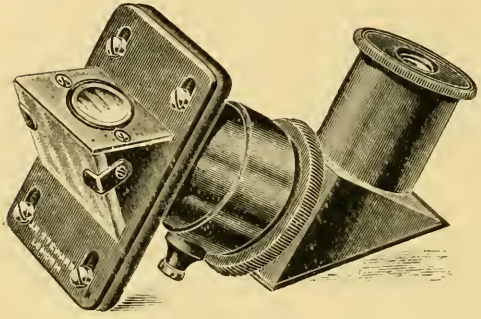

Fig. 34.

Fig. 35.

instrument is calibrated by means of this light, and a table of indices corresponding to every division of the graduated scale within the effective range is supplied with the instrument. Made by Swift and Son.

(4) Photomicrography.

Photography in Natural Colours.—In the Journal for December 1906, p. 720, an abstract was given of G. Lippmann's new method of photography in natural colours. From correspondence which appeared in "Nature," * we note the curious coincidence that the method has been independently invented four times, it having been twice previously invented in this country and once in France. As the methods differ in certain details and suggestions, we give short abstracts.

F. W. Lanchester † takes a grating consisting of a number of opaque parallel bars, with spaces between less than the width of the bars, and places it between the camera and the object, and as near to the latter as possible, so that both are practically in focus on the photographic plate at the same time. The camera has a prism arranged in front or behind the lens, with its axis parallel to the bars of the grating, the dispersion being such that when the camera is focused on the grating the images of the slots form a series of spectra on the focusing screen or plate.

The bars of the grating are sufficiently numerous to prevent the picture being unduly broken or disjointed. In taking a photograph, an isochromatic plate is used; the resulting negative contains a record of the colours of the object in the form of shaded lines of varying intensity. A positive is then made on a lantern plate; this is placed in a similar or in the identical camera with which the photograph was taken, and in the position originally occupied by the photographic plate. The photograph now appears in natural colours, as soon as the grating is

* Oct. 4 and Nov. 29, 1906.
† English Patent Specification, No. 16548, 1895.

illuminated by a uniform source of white light. Reconstruction of the colour picture can also be effected by placing a lamp and condenser at the back of the lantern slide and projecting the picture on to a screen. In landscape photography, when the grating cannot be conveniently arranged near the objects being photographed, the picture is first projected on to the grating, by an additional objective. A field lens is then required between the two objectives. When taking the photograph a light filter is used to cut off the ultra-violet rays.

Julius Rheinberg * suggests the arrangement as above, in which the picture is first thrown on a grating of 300 lines per inch for example, with bars double the width of the spaces, the picture and grating being projected by the second objective, with a prism behind it, on to the photographic plate. It is pointed out that the method necessitates but a single negative, a single exposure, and no colour screens except an orthochromatic filter when taking the photograph. It might be looked upon as an extension of the Joly process of colour photography, the difference being that the artificial lines in three colours are replaced by real spectra produced optically. Regarding practical points, the grating used would require to have the dark interspaces perfectly opaque. The orthochromatic filter used would require to be such that the spectrum gave a deposit on the plate equal in density throughout its entire length. It would differ, therefore, from the ordinary orthochromatic filter, designed to fulfil the condition that the deposit on the plate corresponds to Maxwell's colour curve of visual luminosity. To view the photograph, a finely ground glass screen, or other light-diffusing medium, would have to be placed in contact with the positive. It is suggested that if, at a future date, paper ruled or printed with imitation spectra as fine as 150 per inch could be made, photographs could be produced in natural colours by this method, as easily and quickly as ordinary photographs at the present time.

Andre Cheron † describes his method, which is essentially similar to that described in the two foregoing abstracts, but he makes provision also for the use of a stereoscopic camera instead of an ordinary one. It is pointed out that as the positives are placed in the original camera for viewing purposes, it is a simple matter to place an ordinary stereoscope behind the pictures and see them in relief, the only further adjunct necessary being to have some large field lenses in contact with the positives. It is suggested that for stereoscopic work the lines of the grating should run horizontally in the one-lens system, and vertically in the other. To obtain exact colour registration when viewing the positives, the gratings can be moved by a micrometer screw.

Purifying Gelatin.‡—The following useful method is given in "Die Photographische Welt" for purifying gelatin for photographic purposes, and should be particularly useful for such as is to be used for making colour filters. The gelatin should be broken up into small pieces and soaked in water, which should be changed every half hour,

* British Journal of Photography, Jan. 1904, p. 7.
† French Patent Specification, March 1906.
‡ English Mechanic, lxxxiv., (1907) p. 627.

this being done at least ten times if the gelatin is a very poor sample. Finally, the gelatin should be melted by the aid of heat, and purified by the addition of egg-albumen. The whites of two eggs should be allowed for every pound of dry gelatin, and they should be beaten up to a froth, allowed to again become liquid, and then filtered and added to the cool liquid gelatin. Enough glacial acetic acid should be added to give the mixture a distinct acid reaction. The liquid should now be quickly heated to 212° F. and well stirred, when the whole of the albumen will be coagulated, and can be easily filtered out, carrying with it any solid impurities in the gelatin. The result is a perfectly clear limpid gelatin, which may be used as usual.

Note on Stereo-photomicrography.*—A. E. Smith describes three ways of making stereoscopic slides from microscopic objects.

1. The simplest way is to use an excentric Waterhouse stop just behind the objective. After taking a negative the stop is reversed, and another negative taken. The prints from these negatives are distinctly different, and will make good stereoscopic pairs. The author explains many of the practical details.

2. Another method, suitable for low powers only, is to tilt the object first one way and then the other, and secure a negative in each position.

3. The object may be moved a short distance across the stage, and a negative secured at either end of the movement. This necessitates the use of a larger camera, as the images do not come exactly in the same place.

The examples given range from 11–1500 diameters.

(5) Microscopical Optics and Manipulation.

Entoptic Vision.†—By means of this Entoptiscope, W. F. Barrett‡ has made further observations on the human eye especially in regard to Haidinger's Tufts, the Macula lutea, the Punctum cæcum, Purkinje's figures and and moving corpuscles. The entoptiscope, it will be remembered, is an instrument for the self-examination of one's eye. Its use has enabled the author not only to correct certain inaccurate ideas and measurements, but to ascertain new facts.

Haidinger's Tufts.—These are found to be precisely coincident with the Macula lutea.

Macula lutea.—Taking the nodal point as 16 mm. from the retina the horizontal diameter of the macula was found to be ·9 mm. and the vertical slightly less. The angle subtended by the yellow spot is a little over 3° (not 6–8°, as some authorities state).

Punctum cæcum and Purkinje's Figures.—The instrument lends itself admirably to observation of these phenomena.

Moving Corpuscles.—The author's observations favour the view that these are white blood-corpuscles, either in the retinal vessels or migrating from the capillaries. The rapidly moving points of light which are seen may be due to those corpuscles which are near the walls of the

* Journ. Quekett Micr. Club, ix. (1906) pp. 429–30 (2 figs. and 3 pls.); also in extract form.

† Sci. Proc. of Roy. Dublin Soc., xi. (1906) pp. 111–36 (3 pls.).

‡ See this Journal, 1906, p. 405.

capillary vessels acting as minute spherical lenses, and the larger specks with a slower and more wandering movement may be the amœboid movements of the white corpuscles which have escaped through the walls of the vessels.

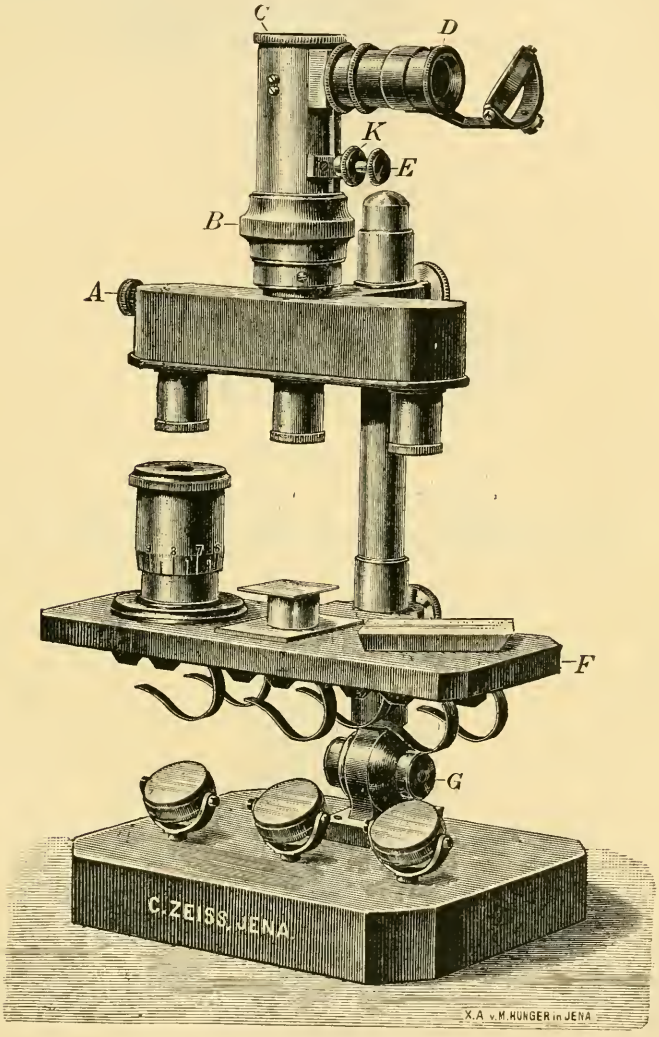

FIG. 36.

Zeiss' Comparison Spectroscope for Colour Technology.*—This apparatus (figs. 36, 37) is devised for simultaneously observing three

* Carl Zeiss' Special Catalogue, 1906, pp. 4–6.

spectra. The construction and manipulation of the instrument are essentially the same as in the laboratory spectroscope.* The absorption

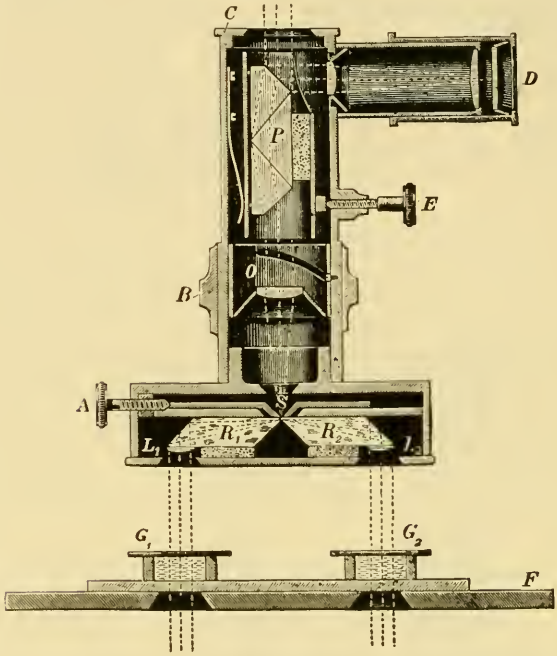

Fig. 37.

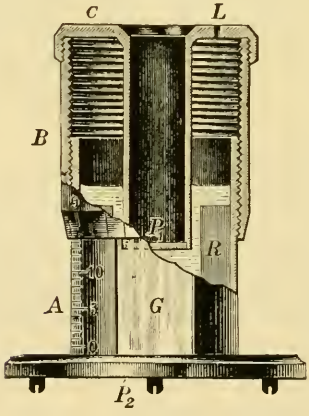

Fig 38.

vessel (fig. 38), in which the depth of fluid can be varied at will, is specially designed for measurement purposes. It unscrews into the four

* See this Journal, 1898, p. 477.

parts A B C R. The fluid is contained in the glass cylinder R, the floor of which is a glass plate. The plunger and cap are in one piece, C L P_1. P_1 is a glass plate, and L an air-hole. The vessel R is filled by unscrewing the cap. For ordinary fluids the plunger is made of metal, but for those with acid reaction or corrosive action, a glass cylinder is substituted. Full directions are given for manipulating the instrument and the absorption vessel.

Zeiss' Hand Spectroscopes.*—These hand spectroscopes are intended for the rapid examination of absorption and emission spectra. They

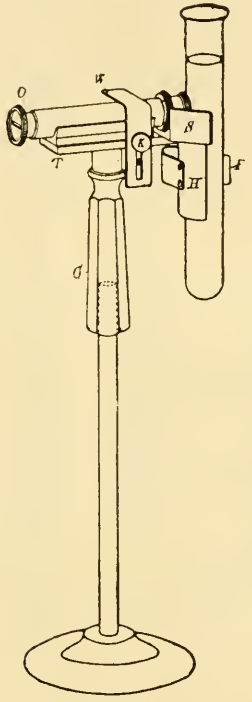

Fig. 39.

allow the whole spectrum to be viewed at a glance, and the slit is symmetrically adjustable. The position of a line is recognised by means of a comparison spectrum, or by a scale of wave-lengths, illuminated by the source of light. Fig. 39 shows the instrument one-fourth size : here it is seen clamped to a small table T by the piece W ; on the underside of T is a bored-out handle, which serves to rest the apparatus on a pillar. S is the mirror for illuminating the comparison

* Carl Zeiss' Special Catalogue, 1906, pp. 6–7.

prism. In fig. 40 is seen a diagrammatic section of the instrument full size, with wave-length scale.

Ultramicroscopic Observations: The Characterisation of Inorganic Colloids.*—W. Biltz has carried out a series of ultramicroscopic experiments on very dilute solutions with the object of making observations on inorganic matter so finely divided as to be within appreciable reach of

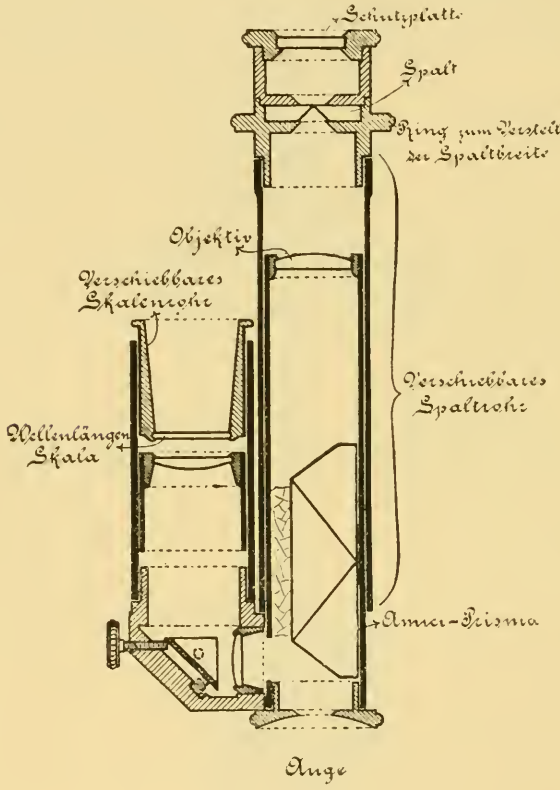

FIG. 40.

molecular division. In addition to completing some earlier investigations he wished to show in what way an ultramicroscopic image is dependent on the mode of preparation of the medium. Some of his previous work † had shown that in an ultramicroscopically discontinuous separation of elementary sulphur and selenium, an undoubted continuous formation of a colloidally suspended substance had taken place. This result naturally suggested further investigation.

* Nach. von d. König. Gesell. d. Wiss. zu Göttingen (Math.-Phys. Klasse, 1906) pp. 141–56.

† Op. cit., 1904, p. 300.

In the present series of experiments the depth of the illuminated part of the solutions was kept smaller than before and restricted to 10–12 μ, so that in an image-breadth of 27 μ, a cross-section of about 300μ^2 was illuminated. The net in the ocular of the observation microscope contained eighteen squares, and corresponded to $18 \times (9\,\mu)^2$ of an upper plane on the object. The net therefore covered an illuminated volume of $11 \times 18 \times 81\,\mu^3$ (roughly $16000\,\mu^3$); and a single square would cover about $890\,\mu^3$. The task of counting reduces itself, in the case of solutions rich in particles, to estimation of those on one square; in the case of weaker solutions, to those on the whole net; while, in the case of fairly empty solutions, those in the entire field (about five times the size of the net) must be counted. In the observations special attention was paid to the number of particles, their movement, their colour, and their brightness: also to the determination of the relative number of the particles of differing colour and brightness and to the age of the solution under examination. The author adopts Siedentoff and Zsigmondy's terms *Submicrons* and *Amicrons*; the former means particles ultramicroscopically perceptible; the latter, those beyond the reach of the ultramicroscope. The author gives in seven tables the results of his efforts.

Iris of Optical Systems.*—A. E. Conrady explains a certain peculiarity of microscopic images referred to by J. Rheinberg,† viz. that when two objects of exactly the same size were placed at different distances from the object-glass (but within reach of its depth of focus), the more distant one was not always depicted as the smaller, but did sometimes actually yield the larger image. As a rule, there is in every optical system one aperture which limits the diameter of the cone of rays passing from any point in the object to the conjugate point in the image. This aperture Abbe called the iris of the system. By means of diagrams the author shows that the images are reversed according as the aperture is placed in front of the object-glass or behind its upper focal plane. There is an important intermediate case, viz. when the iris is placed exactly in the upper focal plane, the consequence being that only those rays can pass which had been parallel to the optical axis before entering the object-glass. The image so produced is definite and unchangeable. Professor Abbe was the first to point out the value of this arrangement for measuring instruments, and introduced the term "telecentric" for object-glasses with the limiting stop in this particular position.

On Stereoscopic Effect and a Suggested Improvement in Binocular Microscopes.‡—Julius Rheinberg, after pointing out that a proper understanding of the subject implies adequate recognition of the fact that stereoscopic vision with the Microscope means viewing objects in three dimensions, of which only a single plane is in perfectly true focus at any one time, passes on to show that points in all other planes are represented in the view plane by diffusion disks, which may vary not only in size, but in shape and position. It is shown that their size

* Journ. Quekett Micr. Club, ix. (1906) pp. 440–2 (3 figs.).
† Tom. cit., p. 375.
‡ Tom. cit., pp. 371–96 (9 figs.).

depends on the free aperture of the objective, that when part of an objective only is utilised, the shape of the diffusion disks is the same as that of the part used (which had not hitherto been adequately recognised), and that their position is likewise determined by the part of the objective used, e.g. when the right half only of an objective is used, points nearer than the plane in true focus get shifted to the right, points further away get shifted to the left. Then follows a lengthy review and comparison of the various causes which operate to give the impression of solidity and plasticity in naked-eye vision, and those which come into play in stereoscopic vision with the Microscope. The subject is treated very fully, experiments being suggested to illustrate the various points. After this comes a discussion of the various forms of binocular Microscopes. They are divided into two classes, those in which separate objectives are used—of which the Greenough Microscope, made by Messrs. Zeiss, is the best example—and those in which separate parts of a single objective are utilised, as in the Riddell, Wenham, and Stephenson form of binocular, and the Abbe stereoscopic eye-piece. Regarding the second class, it is pointed out that :

"On this very simple property, that parts of an objective used by themselves bodily shift the image of any area lying in a plane at right angles to the optic axis of the whole lens, *without any change of actual shape*, depends the stereoscopic effect of the contrivances we are considering. If we may talk of the different parts of an objective as 'looking at' an object, we might say that no separate part of an objective can 'look' along any other direction than one parallel to the optic axis of the whole lens—a very different matter from 'looking at' the object from the actual direction of the part of the object utilised, in which case the object squares we are considering just now would be foreshortened, and assume different shapes according to the point from which they were regarded. Helmholtz appears to have recognised, almost half a century ago, the peculiar manner in which the different parts of an objective 'look at' and 'see' the object, for in his 'Physiological Optics' the action of Nachet's binocular Microscope is explained as due to the causes stated, in a few crisp and short sentences. But no better proof can be given that his explanations were not understood till a much later date, than that Naegeli and Schwendener, in their well-known work on the Microscope, dismiss Helmholtz' remarks in a short footnote as being incorrect.

"The first to explain the whole matter at length was Abbe, who, in a series of papers in 1881 and 1882, notably in his paper 'On the Mode of Vision with Objectives of Wide Aperture,' clearly showed how the lateral shifting of the images of different planes of the object by different parts of the objective constitutes a particular form of parallactic displacements."

Reference is then made to the controversies on the subject both before and after Abbe's paper, the latter, which the author follows, being explained in detail, and it is shown that the truth of the theory is amply confirmed by the diversified action which can be obtained by the Abbe binocular eyepiece.

Being led to a study of the subject of stereoscopic effect with the

Microscope by the stereo-photomicrographs taken by Mr. H. Taverner, by means of excentric circular stops placed behind the objective, Mr. Rheinberg saw that the same method might be applied to binocular microscopes. His justification for this is given in the following extract from the paper—

"If parallactic displacements of out-of-true-focus layers of the object constitute the mechanism by which stereoscopic effect is produced, this in itself furnishes the necessary proof that the whole image, barring the one plane in true focus, consists of diffusion disks. The size and shape of these diffusion disks is therefore an important matter. We saw in the first part of this paper that the size of the diffusion disk varies directly as the size of the portion of the objective used; further, we saw that the shape it assumes is the same as that of the portion of the objective utilised. It is evident, therefore, that to have pictures of maximum clearness it is desirable to have these disks as small as the circumstances permit, and also that they should be circular in shape. At present, in binocular Microscopes no regard is paid to either of these matters; the size of the diffusion disks is not adapted according to the depth of the object to be viewed, and the image is formed of overlapping disks semicircular in shape. An unsymmetrical shape like this results in the image of the same object being less distinct in certain directions than in others, or varying in distinctness according to the position in which it happens to lie in the field.

"How it has come about that these matters have been overlooked is simple enough. As regards Microscope images, attention has been chiefly concentrated—and justly so—on the perfection of the image of the object layer in true and perfect focus in the view plane, and for this particular plane other conditions prevail. It is the one layer which is free from parallactic displacement, no matter which part of the objective may be used. It is also the layer for which the laws framed from the study of the diffraction of light apply more particularly. And one of these laws is that the 'diffraction disks,' of which the image in this plane is composed, vary inversely in size with the aperture of the objective (or of the part of the objective) utilised. Smaller disks mean greater resolving power so long as the image magnification remains unaltered; therefore, for this one plane, the larger the aperture of the objective employed, the better the images, and the largest aperture available in binoculars is the half-objective. An instructive experiment consists in viewing a Grayson band plate with a binocular Microscope. The effect of the semicircular shape of the half-objective may then be shown by rotating the plate. When the rulings lie in the direction of the straight edge of the half-objective, a band with only about half the number of lines per inch is resolved as when they lie in the direction at right angles to this.

"Although within certain limits the same principles hold good with respect to slightly out-of-focus layers, the general feature remains that diametrically opposite conditions apply, as regards diminishing the size of the disks, when the layer of the object is in true focus and when it is not. The one necessitates the employment of parts of the objective aperture as large as possible; the other requires them to be as small as possible.

"To which are we to give more weight, bearing in mind that the essence of stereoscopic effect lies in viewing a great number of planes simultaneously? Should we adapt our instrument for the single plane in true focus, or for all those others seen at the same time? I think you will find it rational—the more so as, even in the single plane, we cannot secure equally good resolution in all directions—that we should extend a good deal of consideration to all those other layers; and the best rule to be followed—one which I believe Mr. Taverner, from his experiments in stereoscopic photomicrogaphy, has also arrived at—is: use circular stops (as in fig. 41), having them just small enough to secure a moderately fair image of the deepest layers which it is required to see simultaneously with the others. In other words, get the necessary depth of focus, but no more; for in securing more, the perfection of the image in other parts is being decreased. Similar objects being exhibited under binocular Microscopes in which this rule has been followed, and under others in which the two halves of the objec-

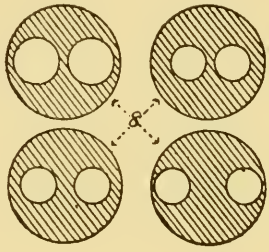

Fig. 41.

tive are left as usual, the improved effect in the former is perceptible at a glance."

The best position for the stops is discussed, and it is suggested that immediately below the Wenham or Riddell prism is the most suitable place, and that a sliding carrier for the stops in this position would be the most convenient plan.

After touching on the difficulties connected with stereoscopic effect, when high powers are used, the paper concludes with remarks on the points of difference between stereoscopic vision with binocular Microscopes and stereoscopic photomicrography.

(6) Miscellaneous.

Mendelism and Microscopy.*—D. J. Scourfield, in the course of a paper on the above subject, suggests that systematic researches on microscopic creatures might do much to correct and extend our knowledge of Mendelism. It is necessary that such creatures should be bisexual, and not too small to prevent the isolation and control of individuals. Their small size would make it possible to carry on

* Journ. Quekett Micr. Club, ix. (1906) pp. 395–422; also in extract form.

extensive experiments in a small space and in a very inexpensive way. Most of them, also, are very quick and prolific breeders, and many generations could be obtained in the course of a year. Then, with regard to the simultaneous study of the germ-cells and body characters, it would probably be found that they would provide much better material than larger animals and plants. Lastly, it would be of the highest theoretical importance to trace the course of heredity of particular characters in cases where parthenogenesis occurs, and such cases can, of course, most easily be found among microscopic animals. The author mentions certain species of Entomostraca, Aphides, and Rotifers, as likely to be suitable subjects. He adds a bibliography of Mendelism.

Quekett Microscopical Club.—The 436th Ordinary Meeting of the Club was held on January 18, the Right Hon. Sir Ford North, F.R.S., Vice-President, in the chair. Mr. T. B. Rosseter, F.R.M.S., contributed a highly technical paper on two Avian tapeworms, *Hymenolepis nitida* and *H. nitidulans*. Mr. A. E. Hilton read a paper "On the Nature of Living Organisms," which gave rise to some interesting discussion.

The 437th Ordinary Meeting, which was also the 41st Annual General Meeting, was held on February 15. The President, Dr. E. J. Spitta, F.R.A.S., F.R.M.S., etc., delivered an address, illustrated by a number of very fine lantern photographs, on "A Review of Photomicrography." This dealt with early attempts and early difficulties, the great advances consequent on the introduction by Abbe of the apochromat and semi-apochromat, and the recent important improvements effected in the manufacture of plates and contrast-screens.

B. Technique.*

(1) Collecting Objects, including Culture Processes.

Cultivation of Root Bacteria.†—A. Rodella adopts the following method for cultivating anaerobic root bacteria:—A root tubercle is washed in distilled water, in 1 p.c. perchloride, and again in sterilised distilled water. It is then transferred to a Burri tube, or ordinary test tube containing glucose-agar; this is exposed to 80° C. for 5 minutes, and after being cooled is incubated at 37° C. for 2–6 days (the tubercle being at the bottom of the tube). Much gas is developed, so that "the whole column of agar will be driven towards the mouth of the test tube." The process is repeated several times in order to obtain a pure culture.

Fresh milk serum is poured into a sterilised wine flask, with a neck about 50 cm. long, until the flask is half full; it is then raised to 60° C., and the entire agar culture, as obtained above, is introduced; more sterilised serum, heated to 60° C., is now added until the flask is filled to within 10 cm. of the mouth; 5 c.cm. of sterilised oil is now poured on to the surface of the liquid, and the whole is placed in a thermostat.

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

† Original Paper by A. Rodella, Padua, 1906.

Fermentation will be apparent before the third day. Cultures thus obtained can be poured on to the soil to be treated.

Quantitative Estimation of Bacterial Mass by the Colorimetric Method.*—J. Zelikow employs the colorimeter of Dubosc to estimate the quantity of bacteria in a culture. The instrument (fig. 42) consists of two beakers C to hold the stained solutions ; the niveaux are regulated by the sinking of a polished glass prism T, the position of which is measured ; light is reflected from mirror M, passed through the coloured solutions, and then reflected by the prism P, so that each beaker will correspond to one half of the field of vision, and the absorption of stain in the two columns of coloured solution may be simultaneously compared. Two flasks of bouillon are inoculated with culture ; after 24 hours the contents of one is passed through a filter ; from the filtrate and also from the unfiltered content of the other flask, emulsions are made ; to definite volumes of these, and also to the pure bouillon, definite amounts of stain are added ; the whole is heated at 70°–80° C. for an hour, and then centrifuged ; the solutions are then drawn off, and the amount of stain absorbed is estimated by the colorimeter. The author gives various precautions to be taken in applying the method.

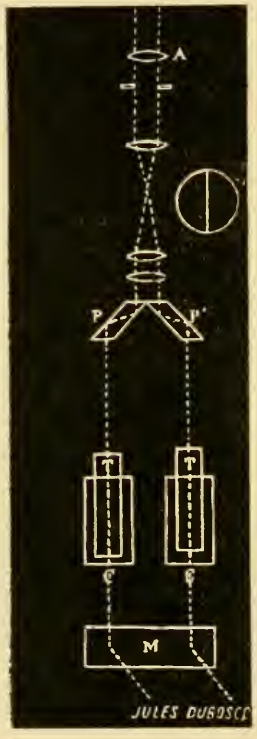

Fig. 42.

Anaerobic Microbes of Water.†—H. Vincent advocates the following method for enumerating and isolating the true anaerobic microbes of water. The medium consists of gelatin 50–75 grm., glucose 5 grm., glycerin 5 grm., peptonised beef broth 500 c.cm., the whole being neutralised, and at the time of using a sufficient quantity of sulpho-indigotate of soda is added.

If the water is probably impure it is added to the medium in amounts of 0·05, 0·02, to 0·01 c.cm. : if likely to be pure, in amounts of 0·5, 1, or 2 c.cm., the medium being previously boiled and brought to a temperature of 30°–35° C. The mixtures being made are then drawn up into 50 cm. pipettes of diameter 3–4 mm. ; these when filled are sealed at both ends and held in a stream of cold water to fix the gelatin.

The strict anaerobes forming diffusely contoured, flocculent, granular colonies, and secreting more gas, are readily distinguished from the facultative anaerobes that form compact limited opaque colonies.

* Centralbl. Bakt., 1te Abt. Orig., xlii. (1906) p. 476 (1 fig.).
† Ann. Inst. Pasteur, xxi. (1907) p. 62.

Reaction of Mammalian and Avian Tubercle Broth Cultures.—O. Bang by growing cultures in very small amounts of medium, and also by employing flasks whereby the lower strata of the media could be readily examined, was able to show by the reaction curves that the substrata of the broth in the cultures of bovine and also of avian tubercle became more alkaline, whereas the similar curves of human tubercle culture reaction showed, after an initial fall towards or below the neutral point, an increased acidity. The author found that the reaction curves depended on the amount of the medium in the culture flask, on the age of the culture, and on the original reaction of the medium.

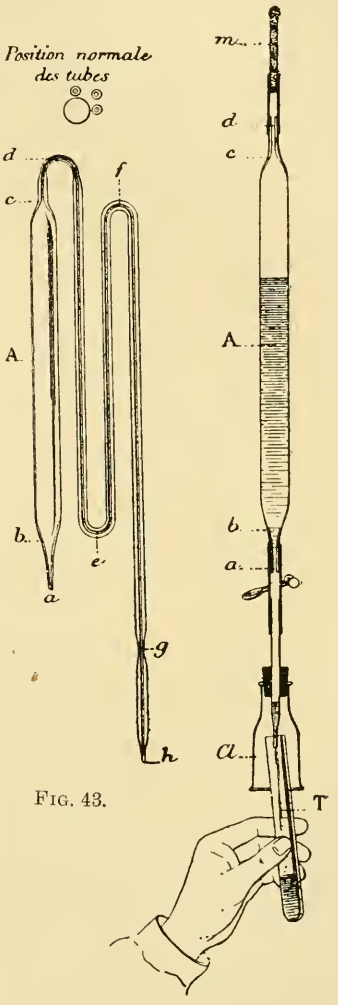

FIG. 43.

FIG. 44.

Collecting Sea-water for Bacteriological Study.†—P. Portier and J. Richard describe an apparatus which consists of a cylindrical glass vessel A, 86 cm. long and 16 mm. in diameter (fig. 43), the wall being sufficiently thick to resist a pressure of at least 600 atmospheres. The vessel ends below in a short capillary tube *a b*, and above in a long capillary tube *c d*, *e f*, *g h*, with three bends. A drop of water is introduced into the ampoule A; the end *a* is then closed in the flame, and the long capillary tube connected with a mercury pump to exhaust the air. When a vacuum is obtained, the tube is closed at *h*. The exhausted tube is then sterilised at 120°. This done, it is inserted in a metal box, being fixed with copper wire in such a way that the point *g h* projects from the upper end of the box. The apparatus is then attached to the plummet line, and let down to the desired depth. By means of a messenger sent down on the plummet line, the box is set free from the collar, it turns over, and the projecting tube strikes an iron bar, whereby it is broken at the constriction *g*. The apparatus then fills with sea-water. It is then drawn up, and as it nears the surface it becomes warmer; in consequence, a fine stream issues from *g*, and this serves to

* Centralbl. Bakt., 1te Abt. Orig., xliii. (1907) p. 34.
† Comptes Rendus, cxlii. (1906) pp. 1109–1111 (4 figs.).

prevent entrance of contaminating germs. Arrived on board, the point at *a* is filed off, and the arrangement shown in fig. 44 is attached; the upper end is then filed through at *d*, the bends are rejected, and a tube filled with cotton wool at one end is fitted on at *d c*. On loosening the pinchcock, the contents of A are removed to vessels filled with cultivation media.

New Cultivation Medium for Bacteria.*—Uyeda finds that mannan makes an excellent medium for cultivating bacteria. In Konjaku plants (*Conophallus konjak*) it occurs in considerable quantity, and is obtained by boiling the roots, when it forms a jelly of the consistence of stiff starch paste. In Japan it is a commercial article and is sold in sheets. For laboratory purposes it is used like ordinary gelatin, i.e. by itself, or to aid in stiffening other media. Bacteria show characteristic growth, liquefaction and pigment formation when cultivated on this medium.

Collecting and Preserving Relict Crustaceans.†—W. Samter and W. Weltner used drag-nets and push-nets of different shapes for capturing *Mysis relicta*. One drag-net was 120 cm. long, and the iron collar was shaped like an isosceles triangle, one side being 80 cm. the others 50 cm. each. Another triangular net was equilateral, the length of the bars being 50 cm., and the length of the net sac 70 cm. The third drag-net was rectangular, the long sides measuring 65 cm. and the short 18 cm.; the length of the bag, which was triangular in shape, was 107 cm. The push-net or scraper was much like a hay-fork, the prongs of which are joined by a bar 25 cm. long.

The animals were fixed and preserved in alcohol and formalin. The latter (1 part commercial formalin to 10 parts of water) gave the best results.

Volvox for Laboratory Use.‡—B. G. Smith has found that *Volvox* can be kept for weeks by means of the following procedure. The water containing *Volvox* should be brought in in considerable quantity, together with a small amount of vegetable material, such as duckweed, *Riccia*, etc., and placed in shallow glass dishes. The dishes are placed near windows and covered with glass plates, except when exposed to direct sunlight. In that case it is advisable to leave room for circulation of air between the cover and the dish, to prevent rise of temperature beyond the optimum. The water need not be changed. Should there be too many inimical organisms present the *Volvox* may be removed to another vessel, filled with water which has been freed from Crustacea, etc., by filtering it through bolting cloth. A moderate amount of decaying plant or animal matter seems necessary for the existence of *Volvox*, and they are more easily kept alive in cool than in warm weather.

Abundant material in the sexual stage was obtained in the spring and fall, and it was noted that when in this condition they often remain hidden in the ooze at the bottom of the dish.

* Bull. Imp. Centr. Agric. Exp. Stat. Japan, i. (1906) p. 59. See also Centralbl. Bakt., 1te Abt. Ref., xxxix. (1907) p. 300.

† Arch. f. Natur., i. (1906), pp. 311–22 (2 pls.).

‡ Amer. Naturalist, xli. (1907) pp. 31–4.

Reiser's Bacterial Filter for Small Quantities of Fluid.*—To the bougie F (fig. 45) is closely adapted a glass cylinder ending above as a tube A, connected with a piece of rubber tubing. Between the filter and the glass cylinder is merely a capillary space so that when the apparatus is set working the fluid can be filtered to the last drop. To the bottom of the cylinder is fitted a brush K, which cleans the filter from bacterial slime.

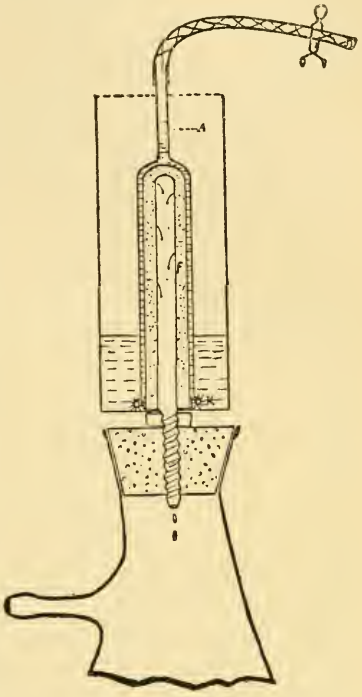

Fig. 45.

Studying Fecundation in Serpula.‡—A. Soulier points out that artificial fecundation in *Serpula* is facile and constant; it is easily obtainable throughout the year. It is quite sufficient to place the male and female genital products on a watch glass; fecundation takes place and development follows its normal course.

The ovules are picked out at various stages of evolution (5, 10, 15 minutes, and so on) and then placed in a fixative.

A temperature not exceeding 15° is advised for observing the normal fecundation course. If from 12°–15°, fecundation takes place in from 30–45 minutes after the sexual elements have been mixed together. Segmentation follows within 5 hours after. By the second and third day the larval organs are complete. If the temperature be 8°, fecundation takes 3 hours, and other stages in proportion.

Numerous fixatives were used, the least unsuccessful ones being the fluids of Flemming, Fol, and Cori. The successful ones were Gilson's, Roule's, and Ripart and Petit's. All these last three gave excellent results provided they were diluted to 1 part fixative to 3 of sea water.

The sections were stained with picrocarmin, safranin, etc., according to the procedures ordinarily used by histologists. Double staining with hæmatoxylin and eosin gave excellent results.

Simple Steam Steriliser and Hot-water Filter.‡—This apparatus (fig. 46) has been devised by A. Frazer to meet the requirements of those who wish to conduct the operations of sterilising and filtering in a single vessel of small size and moderate cost. The apparatus is of the ordinary shape, while the height of the cylinder is 16 in. and the

* Chem. Zeit., xxx. (1906) p. 686. See also Deutsch. Mechaniken-Zeit., 1906, p. 206. † Arch. Zool. Expér., v. (1906) pp. 403-89 (1 pl. and 21 figs. in text).
‡ Proc. Scot. Micr. Soc., iv. (1906) pp. 68–9 (1 fig.).

diameter 7 in. There is a perforated platform about 2 in. from the bottom in which any flask of the size of 1 litre can be placed. About 1 in. from the top there is a circular ring which serves to support an enamelled funnel used for hot-water filtration. By conducting the filtration entirely within a heated chamber the difficulty of keeping the neck of a hot-water funnel sufficiently warm is entirely obviated. The apparatus is arranged for use with an ordinary Bunsen burner, but can be worked efficiently by an Etna blow-lamp.

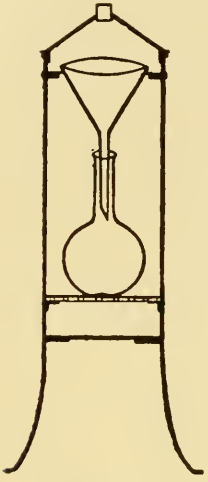

Fig. 46.

Collecting and Preparing Cyanophyceæ.* — N. L. Gardner removed the coarse impurities by the decantation method. The material was then placed in jars in the shade until it had crawled to the centre in a mass. When placed in direct sunlight the mass, owing to the formation of gas, floats to the surface. From the margin new clean growth is formed and this is removed with scissors. In order to get the filaments into a small mass for imbedding they are repeatedly sucked into and forced out of a pipette until thoroughly broken up. On standing for a few hours in the shade they will be found to have crawled together again into a single mass, and in this condition may be killed and imbedded in paraffin for sectioning. Small species scattered among fine debris were cleansed by centrifuging and then decanting off the supernatant fluid and filtering. After the material thus obtained has been washed, it may be dehydrated in a dialyser. To sections of prepared material the author prefers uncut tissue, for all that is demonstrable by the former procedure can be more easily attained from the staining and mounting of uncut cells. The cells may be killed, stained, and fixed to the slide with albumen if not sufficiently gelatinous in themselves, e.g. *Oscillatoria*. In order to kill and separate the cells a strong iodo-potassic iodide solution is advised ; 10–30 minutes or longer will not hurt the plants. The material is then washed with 95 p.c. alcohol and afterwards with water. The cells break apart and adhere well to the slide. Besides iodo-potassic-iodide, 95 p.c. alcohol, Flemming's and Hermann's solutions, sublimate, 1 p.c. chromic acid, and iridium chloride were used as killing and fixative agents. A very long list of staining reagents is given, most of them being anilin derivatives, though the varieties of carmin and of hæmatoxylin are also included. A variant of the Ehrlich hæmatoxylin gave good results. In this Grübler's hæmatin was substituted for hæmatoxylin. This solution was effective as a simultaneous killing and staining agent, and differentiated well after a variety of fixatives.

(2) Preparing Objects.

Studying the Vitellus.†—H. Dubuisson removed the organs from living animals, using an anæsthetic when necessary. The fixative chiefly

* Univ. California Publications (Botany), ii. (1906) pp. 237–96 (6 pls.).
† Arch. Zool. Expér., v. (1906) pp. 153–402 (52 figs.).

used was Bouin's picro-formalin, but for small ovaries Rabl's picro-sublimate was preferable. Flemming's and Borrel's fluids were also employed, but only for small ovules. The material was then passed through upgraded alcohols (30°–80°), 24 hours each. For imbedding, chloroform was used as the solvent for paraffin (m.p. 38°). Heidenhain's bisulphide of carbon method was also employed for imbedding.* The advantage of this procedure consists in the shortening of the heating time. The paraffin sections were stuck on by the albumen method, the paraffin removed by toluene and the picric acid and toluene by alcohol. As a nuclear stain hæmalum served the purpose best. The cytoplasm stains used were (1) aqueous solution of eosin ; (2) acid-fuchsin ; (3) Squire's acid-fuchsin and orange ; (4) modification of Pappenheim's stain (eosin 6, orange 4, aurantia 1, distilled water 500). Some of the foregoing lose their colour during dehydration, but this inconvenience may be avoided by a previous washing in water slightly acidulated with acetic or hydrochloric acid.

Another nuclear stain was the following : indigo-carmin 0·25, saturated solution of picric acid 100. For the osmic acid preparations the author used safranin and magenta-red as nuclear stain, picro-indigo-carmin and light green for the cytoplasm.

Studying the Structure of Spinal Ganglia.†—M. v. Lenhossék made the chief object of his research the spinal ganglia of adult men, but also examined the ganglia of infants, cats, dogs, horses, and cattle. Small ganglia were immersed entire, large ones were cut in half and immersed for 24 hours in the following mixture : alcohol 96 p.c. 100, ammonia 0·5. The pieces, after a rapid wash in distilled water, were placed in 2 p.c. silver-nitrate solution, and incubated for 3 days at 35°. The pieces, on removal, were washed in distilled water and exposed at room temperature to daylight for 24 hours in the following mixture : pyrogallic acid 1·5, distilled water 100, formalin 5. After dehydration the pieces were imbedded in paraffin and sectioned. The sections are then (after the paraffin has been removed in the usual way) treated with gold solution prepared as follows :—to 150 c.cm. of distilled water, 4 c.cm. of the ordinary 1 p.c. gold chloride solution are added. After an immersion of 10 minutes to an hour in order to exchange the silver for gold, a point recognisable by the naked eye by the alteration from a brown hue to a steely-grey hue, the preparations are treated for some minutes with a 5 p.c. solution of soda-fixative. This done, they are thoroughly washed in running water. The transfer of gold for silver may be more safely ascertained by watching the process under the Microscope. The sections may, in addition, be contrast-stained with Mayer's carmalum.

Fixation of Red Blood Corpuscles.‡—F. Weidenreich fixes the red corpuscles in the following way. Some 1 p.c. osmic acid is placed in shallow glass vessels, and the slides to be used are exposed to the vapour for 1 minute. The blood obtained from a clean finger tip is then run

* See this Journal, 1902, p. 111.
† Arch. Mikr. Anat. u. Entwickl., lxix. (1906) pp. 245–63 (2 pls.).
‡ Tom. cit., pp. 389–438 (2 pls.).

over the surface of that side of the slide which has been exposed to the vapour, and a film made. The film side is then at once exposed to the vapour for ¼–½ minute and then allowed to dry in the air. It can then be examined in water. If a permanent preparation be desired, the film must be stained. The stains recommended are Ehrlich's tri-acid, and Giemsa's solutions.

Studying Ascomycetes.*—J. H. Faull, in his study of development of ascus and spore formation in Ascomycetes, used several fixatives, but found that Flemming's weaker solution was the most satisfactory. As stains, Flemming's triple stain of safranin, gentian-violet and orange G, and Heidenhain's iron-hæmatoxylin were superior to all others, but no hard and fast rule can be laid down, as each species requires special staining treatment. Paraffin (m.p. 57°) was used for imbedding, and the sections were from 3–5 μ thick.

In determining the origin of the ascus it was frequently of advantage to crush slices of fresh or preserved material, preferably the latter, and examine in water or potash.

Studying the Anatomy of Boophilus Annulatus.†—S. R. Williams killed the material (gravid females, immature females and males) in hot water, Perenyi's corrosive-acetic, Carnoy's and Hermann's fluids. Poor sections were obtained from fresh material owing to the thick chitinous investment. But with museum specimens which had been kept in spirit for ten years, sections serviceable for study of the general form of organs were obtained by dissecting off the cuticula. The cytological condition was indifferent, but the series were perfect and easily obtained. The suggestion is made that adult females should be fixed in warm solutions and then left in strong alcohol for some days, so that, owing to shrinkage, the chitin can be dissected off with fine needles under a Microscope.

Studying the Anatomy of Mosquito.‡—M. T. Thompson cut off the dorsum of the thorax while the insect was immersed in the fixative. The reagent used was Gilson's fluid, made as follows: 70 p.c. alcohol, 10 parts; distilled water, 86 parts; corrosive sublimate, 2 parts; glacial acetic-acid, ½ part; nitric acid (80 p.c.) 1½ part. Before immersion in the warm Gilson's fluid, the insect was dipped in alcohol to remove air from the scales. Serial sections were cut in the three planes usually employed. Other sections, 30 μ, were made from material fixed in Flemming's fluid, and were mounted without further staining than that derived from the fixative. An excellent method of mounting the whole head of the larva is to stain with picro-carmin and clear with Weigert's fluid.

The pupa stage was studied from serial sections of a series of specimens of known age. Such a series was obtained by segregating mature larvæ in a dish, and each hour removing all pupæ to separate containers in which they could be reared for any desired number of hours.

* Proc. Boston Soc. Nat. Hist., xxxii. (1905) pp. 77–113 (5 pls.).
† Tom. cit., pp. 313–34 (5 pls.). ‡ Tom. cit., pp. 145–202 (6 pls.).

Histology of Uterine Mucosa of Viviparous Sharks and Rays.*—A. Brinkmann fixed the material in the following solutions: (1) Saturated aqueous solution of sublimate in normal salt water, plus 3–5 p.c. acetic acid. (2) 10 p.c. formalin (1 part commercial formalin, plus 3 parts water). (3) Flemming's strong mixture. (4) Hermann's mixture. (5) A mixture of equal parts of No. 1 without the acetic-acid and of No. 2. The last solution gave very satisfactory results. As often as possible the material was pinned to cork, and in order to keep the uterus in its natural shape, P. Mayer's method for fixing intestine was adopted. A glass tube was tied to both ends of the uterus. To the tubes were fixed pieces of rubber tubing supplied with pinchcocks, so that fluid could be run through or retained at will. The uterus was first washed out with 0·75 salt solution and then treated with fixative, usually 10 p.c. formalin. After about 20 minutes this was followed by upgraded alcohols. After dehydration the pieces were treated with toluol and then imbedded in paraffin. The sections were stained with hæmalum, carmalum, gentian, safranin and iron-hæmatoxylin, the contrast stains being light green, eosin, acid-fuchsin and picric acid, indigo-carmin and picric acid, and orange G (1 part 1 p.c. solution plus 25 parts 2 p.c. alum-water). For mucus staining, mucicarmin, thionin and toluidin-blue.

Fixation of Nerve-cells.†—Y. Manouélian, in an article on the mechanism of the destruction of nerve-cells, remarks that the Nissl method (fixation with 96 p.c. alcohol), though well suited for the demonstration of the chromophilous particles, causes considerable shrinkage of nerve-cells, and in order to obtain good and reliable preparations, recourse must be had to mixtures of alcohol, formalin, or sublimate with fluids like acetic acid which balance the shrinkage by their property of causing the protoplasm to swell. These fixative mixtures have the further advantage of not being detrimental to staining reagents. The specimens depicted by the author were fixed in Gilson's fluid (alcohol, acetic and sublimate) and stained with magenta and picro-indigo-carmin.

Studying Naididæ.‡—L. B. Walton made drawings from living specimens with the aid of the camera-lucida. The most satisfactory method was that of transferring the Naid from the culture, by means of a pipette, to a watch-glass, and subsequently to a drop of water on a slide, then placing over the drop a cover-glass, the margin of which was supported by a thin wooden bridge. After a time the specimens, without undue compression, would become quiet, and outline drawings could be made with the camera.

Specimens to be mounted were fixed with hot sublimate-alcohol (sublimate 10 grm., absolute alcohol 100 c.cm., distilled water 100 c.cm., acetic acid 2 c.cm.), stained in borax-carmin, and eventually transferred to balsam, while those sectioned were stained in hæmatin I A (Apáthy), or in iron-hæmatoxylin (Heidenhain), after fixation in cold sublimate-alcohol. The index of refraction of balsam approaches so closely the

* Mit. Zool. Stat. zu Neapel, xvi. (1903) pp. 365–408 (3 pls.).
† Ann. Inst. Pasteur, xx. (1906) pp. 859–68 (1 pl.).
‡ Amer. Naturalist, xl. (1906) pp. 683–706 (12 figs.).

refraction of the transparent setæ, that in order to study them advantageously it was found advisable to kill the specimens by compressing them under the cover-glass, and then at once to make camera-lucida drawings of the setæ in the dorsal and ventral bundles.

Impression Preparations.*—G. Sticker has found that excellent preparations of solid organs can be obtained in the following way. The surface of the tissue or organ is cut smooth with a sharp knife and then a slide is gently pressed down. In this way one or more impressions can be taken on the same slide. As a matter of practice the author advises beginning with lymphatic gland or spleen. The method is not very successful with blood and exudations, or with tough connective tissues. If an organ be very juicy it may be allowed to dry in the air, or treated for a short time with alcohol, formalin, etc. The impression films are best stained by May and Grünwald's† method, or with methylen-blue or carbol-fuchsin.

The author claims that this procedure has many advantages over sections.

Studying the Paraganglia of Birds.‡—W. Kose used the following materials: paraganglion caroticum, paraganglion suprarenale, and sympathetic ganglia. Eleven different fixatives were tried, Müller-formalin giving the best results. The staining reactions of the chromaffin cells, the plasma pigment, the connective tissue, the elastic fibres, were studied by numerous and appropriate methods. Supravital staining with methylen-blue ($\frac{1}{2}$ p.c.) for 1–24 hours, followed by picrate of ammonium for $\frac{1}{4}$–24 hours, was found to show the nerve-fibres very successfully. Digestion experiments were carried out with pancreatin-glycerin and pepsin-glycerin, the former diluted with 0·3 p.c. soda, the latter with 0·3 p.c. HCl. The sections were defatted by means of benzin, and afterwards kept in the digesting fluid at 37°–40° for 24–48 hours.

Technique of Blood Examination in Tropics.§—Sheffield Neave kept his slides in pure lysol, and after a time washed and placed them in boxes ready for use. Any dulling of the surface improved the film. Films from Mammals were easily secured, but with the blood of birds, reptiles and fishes, there was considerable difficulty in obtaining good preparations. The films were treated with Leishman's stain, the slides being placed film downwards in the trough in order to avoid surface deposit. If any deposit occurred it was easily removed by leaving the slide in xylol for $\frac{1}{2}$–2 hours, and then wiping gently with a silk handkerchief, and rinsing again in the trough. The obtaining of useful citrated samples of blood for the purpose of detecting development of parasites was attended with difficulties, one of which is that citrate makes the blood of birds and fishes glutinous and hence more difficult to manipulate, both in the centrifuge and in making films. The system of making thick films and de-hæmoglobinising to detect extra-corpus-

* Centralbl. Bakt., 1te Abt. Orig., xliii. (1907) pp. 206–8.

† See this Journal, 1906, pp. 627–8.

‡ Archiv Mikr. Anat. u. Entwickl., lxix. (1907) pp. 563–663 (3 pls.).

§ Second Report Wellcome Research Lab., Khartoum, 1906, 255 pp., 21 pls. and 106 figs.

cular parasites was unsuccessful with the blood of birds and fishes. The author notes that in films which dry too quickly the red corpuscules become blistered, a condition which also arises in England if artificial heat be used.

Fixation of Spirochæta pallida.* — E. Hoffmann and A. Halle describe an improved method for fixing *Spirochæta pallida*, the details of which are as follows :—5 c.cm. of 1 p.c. osmic acid solution are placed in a watch-glass, and 10 drops of glacial acetic acid added thereto. The watch-glass is placed in a Petri capsule, and clean cover-slips are exposed to the vapour for 2 minutes. Films of the secretion to be examined are then made on these cover-slips in the usual way. The slips are then exposed to the vapour for 1 or 2 minutes. If necessary, the preparation may now be dried in the flame, after which it is placed in a very dilute solution of potassium permanganate for one minute. The film is then washed in water, dried, and stained with Giemsa's solution. The Spirochætes are stained red.

Instead of osmic acid, formalin or pyridin may be used for fixing, but the results are not so good. The authors also mention that fresh, unstained preparations should be used : the secretion should be mixed with normal saline ; this method allows the Spirochætes to be observed alive.

Studying the Spermatogenesis of Forficula auricularia.† — H. Zweiger collected the material in the neighbourhood of Jena during July and August. The testicles were removed and fixed in strong Flemming for 1 or 2 days, but a mixture consisting of platinum-chloride, chromic and acetic acids, was specially useful for the mitosoma. For staining, Heidenhain's method, safranin and Gram, fuchsin-methylen-blue, and Cajal's methods, were used.

Studying the Embryo and Larva of Saccocirrus papillocercus.‡ U. Pierantoni collected the material during the 3 months of December to February from the sand in the Gulf of Naples. The mature females were first observed under the Microscope, and if full of eggs were placed in little vessels filled with sea-water. The eggs were always laid in the morning, and were at once fertilised by spermatozoa, which escaped from the spermotheca. Another device for obtaining fertilised ova was to rupture a mature female with needles, and so let out the eggs, which, as in the natural way, were at once fertilised by the zoosperms which escaped at the same time.

Live ova were studied in the fresh state by placing them on a slide in sea-water, and supporting the cover-glass by means of minute fragments of glass. The fixatives used were Rabl's and Perenyi's fluids : after half an hour the eggs were transferred to 70 p.c. alcohol for 3 days, and then stained with Delafield's hæmatoxylin much diluted, or were overstained and afterwards decolorised with hydrochloric-acid alcohol. For sections the same fixatives were used, and also picric acid sublimate. The material was stained *in toto* with Mayer's hæmulum or hæmacalcium.

* Münchener Med. Wochenschr, July 31, 1906. See also Brit. Med. Journ., 1907, i. Epit. 62.

† Jen. Zeitschr. Natur., xlii. (1906) pp. 143–72.

‡ Mitt. Zool. Stat. zu Neapel, xviii. (1906) pp. 47–50.

The paraffin imbedding was carried out in the same vessel as the fixation, etc., in order not to lose any of the eggs, and also to insure the material being on the surface of the block. For the larvæ similar methods were adopted. Picro-carmin was found to give better results than Delafield's hæmatoxylin when the material was stained *en masse*. Creosote was used immediately after the acid-alcohol stage in order to prevent accidental loss of the minutest larvæ. For the camera drawings of the preparations, black copying paper and finely pointed white pencils were used.

(3) Cutting, including Imbedding and Microtomes.

Method of Cutting Frozen Sections of Fresh Tissues for Immediate Microscopic Diagnosis of Tumors during Operations.*—C. B. Lockwood and E. H. Shaw describe the procedure, which may be divided into two parts, as follows.

1. *The Arranging and Fixing-up of the Apparatus required.*—The microtome must be fixed on a firm table, and all the instruments arranged in a convenient manner. A mental survey of the cutting, mounting, and staining of a section is then made, in order to make sure that everything is present and in its proper place. This insures that no time will be wasted when once the process is begun.

2. *Preparation of the Microscopic Section.*—(*a*) The selected piece of tissue received from the surgeon is placed directly on to the brass disk of an ether-freezing microtome, and is surrounded by gum solution. (*b*) The tissue and gum are frozen, and sections made by a razor on a carrier. (*c*) The sections are transferred to a dish of cold water, and, after separating them with a glass rod, a suitable section is lifted out. (*d*) It is dipped for a moment into pure methylated spirit, and (*e*) then placed in another larger dish of cold water; the currents set up by the spirit in the water cause the section to spread out flat. (*f*) A glass slide is dipped in the water under the section, and the latter is lifted out as the slide is slowly drawn up out of the water again. (*g*) The water is drained off the slide, and a drop or two of stain (Loeffler's methylen-blue) is allowed to fall directly on to the section. (*h*) A thin cover-glass is placed on the stain and section after 3–5 seconds; it is lightly pressed down so as to drive out excess of stain; this is then blotted off, and the specimen is ready for examination under the Microscope.

New Form of Microtome-knife.†—E. G. Martin recommends especially for class purposes, the following instrument (fig. 47). Use is made of the safety razor-blades, and the form for which this instrument is adapted is the one which first appeared on the market. The device consists essentially of a stout blade split lengthwise in a plane passing through the cutting edge, and having two parts hinged together at the side away from the cutting edge.

By means of a set-screw the two parts of the blade may be firmly pressed together and held so. The thin blade which is to be used in the actual cutting edge is placed in position between the two parts of the

* Brit. Med. Journ., 1907, i. pp. 127–9.

† Proc. Indiana Acad. Sci. for 1905 (1906) pp. 203–4 (1 fig.).

supporting blade, with its edge slightly projecting, and is firmly clamped there by tightening the set-screw. The instrument is then ready for use. In the illustration the two blades are shown clamped together in position for use, but without the cutting blade inserted. When the set-

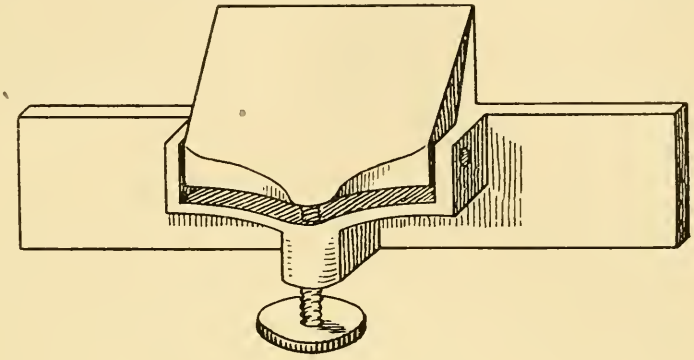

Fig. 47.

screw is loosened the front blade falls forward far enough to allow of the insertion of the cutting blade.

The chief merit of this instrument is that the cutting edge is always satisfactory and sharp; its defect is the shortness of the blade, but for student work the length is found to be ample.

(4) Staining and Injecting.

Staining Spirochæta pallida Schaud.*—Th. Saling, after referring to the work of various authors who have, by means of the silver method, demonstrated the presence of *Spirochætæ* in the tissues and organs of animals and man, states that these spirilla should be regarded as identical with nerve-end fibrillæ.

Demonstrating Negri's Corpuscles.†—Ira van Gieson states that he has found in the following procedure a sure and certain method for examining nervous tissue, especially in reference to the presence of Negri's corpuscles. A piece of grey matter about half the size of a pea is placed upon a slide, and covered with a slip. Gentle pressure is exerted on the slip, and then traction made by drawing the slip slowly along the slide. An excellent preparation, in which many nerve-cells preserve their integrity, is thus obtained.

For the sympathetic nervous system and for the spinal ganglia this method is less suitable, owing to the presence of the connective-tissue element; fair preparations of these parts can, however, be made. Smears produced by the foregoing method may be air-dried or fixed for a few seconds in methyl-alcohol. They are then stained in the following

* Centralbl. Bakt., 1te Abt. Orig., xlii. (1906) p. 120.
† Op. cit., xliii. (1907) pp. 205–6.

solution : saturated alcoholic solution of Rosanilin-violet 2 drops, saturated aqueous solution of methylen-blue 1 drop, distilled water 10 c.cm. The solution must be freshly prepared before use, and for many purposes should be used of double strength. For staining the smears, the solution is allowed to act for 1–2 minutes, and heated until it vaporises. The preparation is then washed with water, dried, and mounted.

Inverse Staining.*—B. Němec gives the following procedure, which is chiefly useful for demonstrating the presence of starch grains. By this method the usual effects of staining reagents is reversed, i.e. the cytoplasm and contents are coloured, while the nucleus and chromosomes remain unstained.

The material was fixed in picric-acetic-sulphuric acid, or with chromic acid, or with Flemming's fluid. It must be noted that osmic acid preparations must be treated with turpentine or peroxide of hydrogen. The sections are transferred from water to 2 p.c. tannin solution for 10–60 minutes. After washing they are placed for 5–15 minutes in 1·5 p.c. tartrate of antimony solution. The sections are then washed in water frequently changed and then are placed in the stain, e.g. aqueous gentian-violet, for half an hour or longer. On removal they are washed for 5 minutes and then passed through upgraded alcohols to absolute, wherein they remain until they no longer give up any dye. When dehydrated (about 5 minutes) the sections are passed through turpentine to xylol and mounted in balsam.

It may be noted that the longer the sections remain in the mordant (tartrate of antimony) the deeper the cytoplasm will be stained. Double stained preparations may be obtained by staining the material *en masse* with paracarmin, or by staining the sections with acid-fuchsin and following this by the inverse method.

Studying the Anatomy of the Kidneys of Gobiesocida.†—F. Guitel adopted the following complicated procedure in his researches on the kidney of *Lepadogaster*, etc.

The animal, having been killed with chloroform, was opened under water along the ventral aspect and the digestive tube removed, care being taken not to injure the kidneys. The body cavity is kept open with a piece of wood and the animal immersed in saturated sublimate, to which 1 p.c. acetic acid is added. After from 2–5 minutes the animal is washed in 70 p.c. alcohol, or in water, and then placed in 70 p.c. alcohol containing 1 per thousand of iodin for 20–60 minutes. The iodin-alcohol solution must be frequently renewed. The kidneys are next removed, but again placed in iodin-alcohol, and afterwards in 90 p.c. alcohol. Arrived at this stage the material may be kept in alcohol for further investigation. Sections of the material were stained with alum-carmin, or with Heidenhain's hæmatoxylin.

Injections of the fixed material prepared as above stated gave fruitful results in the study of the canalicular system. The injection mass used was metagelatin stained with soluble blue. The kidneys to be injected are cut transversely a few millimetres in front of their posterior extremity,

* Ber. Deutsch Bot. Gesell., xxiv. (1906) pp. 528–31.
† Arch. Zool. Expér., v. (1906) pp. 505–608 (5 pls.).

to admit the canula into the lumina of the segmentary canals. The injection is carried out under water, and when over the piece is immersed in 90 p.c. alcohol to set the metagelatin. It is then stained *en masse* with alum-carmin, after which the preparation is carefully stripped of adherent tissues and then cleared up in oil of cloves and mounted in balsam.

By means of Schiefferdecker's corrosion method, casts of the renal cavities were obtained. This method consists in filling the renal canaliculi with celloidin coloured with asphalte, and then dissolving off the tissues with hydrochloric acid.

Soft Injection Mass for Glycerin Preparations.*—C. Skoda finds that hollow viscera, such as intestine, when preserved in glycerin are susceptible of making excellent specimens when injected. The material is immersed in glycerin, to which $\frac{1}{4}$ of a 2 p.c. formal-hydrate solution (1 part commercial formalin and 1 of water). After 6–8 days the specimen is taken out and most of the glycerin removed by squeezing; it is then placed on a dry cloth and rolled up. In this sausage-like state it is placed between two boards, which are either tied together or pressed together by means of a weight. In two days time the specimen is ready for its further treatment. Should the specimen be too dark, it may be bleached for 12–48 hours in $\frac{1}{2}$ p.c. formol solution, to which $\frac{1}{10}$ of a 3 p.c. peroxide of hydrogen solution is added. This bleaching is to be effected before the immersion in the glycerin-formalin mixture.

The injection mass† consists of isinglass, white dextrin, and a pigment, cinnabar for arteries, ultramarine-blue for veins, in the proportion of 2–1, 0·5–1. To this mass, when thoroughly incorporated by rubbing up in a mortar, so much water is added as will impart a honey-like consistence. It may then be injected into the vessels by means of a Teichmann's syringe. The injection is best made under water. The specimen is preserved in glycerin. For further minute details the original should be consulted.

Staining Medullary Sheath of Nerves.‡—W. Stoeltzner communicates the following simple method. The tissue is fixed on formalin and imbedded in celloidin. The section is mordanted for 5 minutes in the officinal liquor ferri sesquichlorati. After a wash in distilled water, it is immersed for at least 10 minutes in 0·5 p.c. aqueous hæmatoxylin solution. The now black stained section is differentiated in Weigert's ferri-cyanide-borax solution or in the iron-chloride mordant mixture.

Injecting the Arteriolæ rectæ of Mammalian Kidney.§—G. C. Huber used a modification of Krassuskaja's injection mass. It was composed of photoxylin 30 grm., camphor 20 grm., aceton 600 c.cm., and was made by adding 0·5 grm. alkanin dissolved in 20 c.cm. aceton to 80 c.cm. of the above described mass. About 10 minutes after injection the organ was cut up into pieces, and these were placed for 24 hours in 75 p.c. hydrochloric acid in which the tissues are so macerated that they may be readily washed away with water, leaving a cast of the blood

* Anat. Anzeig., xxix. (1906) pp. 602–5 (3 figs.).
† See this Journal, 1906, p. 739.
‡ Zeitschr. wiss. Mikrosk., xxiii. (1906) p. 329.
§ Brit. Med. Journ., 1906, ii. p. 1700.

vessels. They may be studied in water or mounted in balsam. The author examined his preparations under a Zeiss binocular stereopticon Microscope.

Studying Phagocytoses in Frogs and Insects.*—L. Mercier, when studying the phagocytic processes during the metamorphosis of Batrachia and insects, adopted the following procedure. Sterilised powdered carmin was injected into the dorsal lymphatic sac of four adult frogs. Next day pieces were cut off the tail of young tadpoles still devoid of feet, and these pieces were introduced into the lymphatic sacs of the frogs which on the previous day had received the carmin injection. On the third, fifth, sixth and eighth subsequent days the frogs were killed: lymph was removed from the sacs by means of a pipette, placed on a slide, and fixed by heat. The films were stained with hæmatoxylin and eosin. The fragments of the tails found in the sacs were fixed in sublimate, and the paraffin sections made therefrom were stained with iron-hæmatoxylin and eosin. The technique used in the case of the Muscidæ was on similar lines to that used for the frogs. The insects in the nymph stage were injected with the carmin solution by means of a very fine glass tube. The larvæ were first fixed by immersion in water at 72°: the animals were then cut open either longitudinally or transversely, and placed in sublimate or in Bouin's or Flemming's fluid.

Injecting Liver.†—P. T. Herring and S. Simpson, for their study of the relation of the liver-cells to the blood-vessels and lymphatics, used a carmin-gelatin mass made according to Carter's formula. The solutions of gelatin and ammoniacal carmin were filtered separately and very carefully, then mixed and rendered slightly but distinctly acid with acetic acid. During the operation the injecting apparatus was kept immersed in warm water. The pressure was indicated by means of a mercury manometer. The cannula was inserted in the aorta or the portal vein. In the former case the inferior vena cava was opened above the diaphragm, and in the latter the inferior cava was ligatured below the liver. A preliminary washing out of the blood-vessels with physiological saline was found to be unnecessary. The pressure employed varied from 60–160 mm. of mercury, when the injection was made through the aorta, and rarely exceeded 20 mm. of Hg when made from the portal vein.

When injection was completed, the liver was removed if the animal was large; if small, the abdomen and thorax were freely opened, and the whole animal placed at once in 10 p.c. formalin, with some ice added. When the gelatin had set the liver was removed and cut into pieces, and put back into 10 p.c. formalin. When thoroughly fixed the pieces were dehydrated and paraffin sections made. These were lightly stained with hæmatoxylin. Deep staining stains the gelatin and masks the carmin.

(5) Mounting, including Slides, Preservative Fluids, &c.

New Dehydrating Apparatus.‡—A Greil describes an apparatus suitable for dehydrating delicate embryological and histological material.

* Archiv Zool. Expér., v. (1906) pp. 1-151 (4 pls.).
† Proc. Roy. Soc., Series B, lxxviii. (1906) pp. 455–97 (2 pls.).
‡ Zeitschr. wiss. Mikrosk., xxiii. (1906) pp. 286–301 (4 figs.).

It consists of two parts, the glass apparatus for dehydrating and a metal frame, which is in connection with a motor apparatus. The latter imparts an oscillating movement to the dehydrator, so that currents are set up whereby the fluids become more rapidly and intimately mixed. The motor apparatus can also be used as a shaker for decalcification, for emulsifying, for photographic work, or for driving a microtome.

The dehydrator proper (fig. 48) consists of an upper bulbous glass receptacle, terminating below in a tube, the extremity of which dips into a glass reservoir intended for the reception of the sections and specimens to be dehydrated. The bulb is closed above by a glass stopper, with a bore for the purpose of admitting air, and for regulating the pressure inside the bulb. The reservoir is supplied with a doubly bent syphon for carrying off superfluous fluid into the lowermost receptacle. The neck of the tube from the bulb is stuffed with dry copper-sulphate and also with cotton or glass wool.

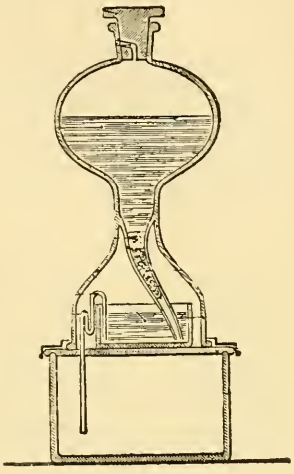

Fig. 48.

Apparatus for Washing Sections.*—A. Frazer has devised an apparatus which consists of a shallow metal trough about 3 in. deep and 4 in. square. Within it are placed four wide test-tubes, into the lower parts of which a number of small holes are made. The trough is furnished with several wires placed crosswise : these keep the test tubes apart and in a vertical position. The various sections to be washed are placed in the tubes, and water is allowed to circulate in the trough. The holes in the tubes are large enough to allow the water to circulate freely, but small enough to prevent the sections from passing out. The apparatus can, of course, be constructed to contain any number of tubes.

Aceton in Microscopical Technique.†—G. Marpmann describes some of the properties of aceton and its uses in microscopical technique. It is miscible with water, alcohol, and other fluids, and a good solvent of most substances except proteids. It can be used as a preservative for animal and vegetable specimens. A mixture of 1 part of aceton and 9 parts of water is extremely serviceable for keeping green or blue algæ. For animal preparations, aceton 1 part, glycerin 3 parts, and water 6 parts, is recommended. As a fixative, aceton 50 parts, water 50 parts, sublimate 1 part, may be used. In this mixture the preparations remain for two or more days according to size, and are afterwards transferred to pure aceton, repeatedly changed. They are then imbedded in celluloid solution or in a solution of pyroxylin 1 part, camphor 1 part, aceton 8 parts. This medium is quite as suitable for section purposes as celloidin.

* Proc. Scot. Micr. Soc., iv. (1906) p. 68.
† Zeitschr. angew. Mikrosk., xii. (1906) pp. 157–61.

For staining purposes, alcoholic solutions of pigments or the dry pigments may be dissolved in aceton.

For mounting purposes, solutions of mastix, balsam, styrax, may be dissolved in aceton, and make serviceable preparations. Celluloid solution dissolved in aceton, and rubbed up with cinnabar, chromoxide, ultramarine, or zinc white, makes an excellent lac or cement for ringing round preparations, etc. This celluloid cement may be used for multifarious purposes in the laboratory, e.g. for stopping gas-leaks, sealing corks, mending broken apparatus, and so on.

The addition of a little amylacetate imparts a greater elasticity to the cement. If gum-soaked preparations be exposed to the action of aceton vapour before cutting, they are more easily sectioned. Aceton, like alcohol, ether, and benzin, is inflammable.

(6) Miscellaneous.

Barberio's Spermatic Reaction.*—J. B. Levinson calls attention to this reaction, which is described as follows. Spermatic fluid or a concentrated solution of it is added to saturated solution, aqueous or alcoholic, of picric acid. Needle-shaped rhombic crystals of a yellow colour, like Charcot crystals in shape, are formed.

Metallography, etc.

Copper Steels.†—P. Breuil states that in steels containing carbon 0·56–0·79 p.c., copper 0·5–20 p.c., the point Ar 1 occurs between 575° and 600° C. In alloys with 3 p.c. or more copper, a separation of copper or of an iron-copper alloy occurs, and a critical point is found at about 1000° C. A number of tensile test results given by the author show that copper increases the tenacity and lowers the ductility of the steel, the extent of this effect varying with the treatment to which the steel is subjected.

A Method of Measuring the Resistance of Metals to Rapid Deformation.‡—P. Vieille and R. Liouville, by simultaneously compressing two identical copper crushers, separated by a light steel piston, by ballistic pressure developed by an explosive, have shown that the inertia forces are negligible. The displacements of the piston receiving the pressure of the gases, and of the piston separating the two crushers, are recorded on a revolving drum. The ordinates of the first curve are double those of the second. If now the second crusher has been previously submitted to a given static pressure, it commences to deform when that pressure is reached. This point is sharply indicated as the origin of the time-compression curve of the previously compressed cylinder. From the two curves, the compression of the new crusher, the velocity of compression, and the actual pressure at this point are obtained. The authors show that the amount of compression for a given

* Berlin Klin. Wochenschr, Oct. 8, 1906. See also Brit. Med. Journ., 1907, i. Epit. 32. † Comptes Rendus, cxliii. (1906) pp. 346–8.

‡ Tom. cit., pp. 1218–1221. See also this Journal, 1906, p. 514.

pressure is different according as the pressure is applied statically or ballistically. The difference may amount to about 8 p.c.

Relation between Breaking Stress and Extension in Tensile Tests of Steel.*—In this paper "breaking stress" is used to mean maximum tension per unit of area of original cross-section of test-piece, and "intrinsic strength" to mean actual intensity of the stress at the broken surface. It has been observed that for test pieces a few diameters in length, the sum of breaking stress (in tons per square inch) and elongation per cent. is very nearly a constant, equal to 67–68, for mild steels free from internal mechanical strain. A. Mallock shows mathematically that this follows from the assumption that the intrinsic strength of a material is a quantity which is not altered by heat treatment. The intrinsic strength of all ordinary steels (excluding cold-worked material) appears to be about 70 tons per square inch.

The Art of Cutting Metals.†—A section of this technical engineering paper by F. W. Taylor, is devoted to an elementary discussion of the micro-constitution and theory of hardening of tool steels. The author criticises Carpenter's explanation of the characteristic properties of high speed steels, and expresses the opinion that no satisfactory explanation of "red-hardness"—i.e. the quality of maintaining a cutting edge at a red heat—has yet been advanced.

Crystallography of Iron.‡—Though it has been shown that the three allotropic states of iron all crystallise in the cubic system, it would appear probable that differences in their intimate structure exist. F. Osmond and G. Cartaud here describe the experimental methods they have adopted, and the results obtained in the further study of this subject. Characters capable of yielding information are :—(1) deformation figures, including lines of translation and mechanical twinning ; (2) congenital twinning ; (3) twinning resulting from annealing after deformation ; (4) mechanical properties functional of the crystalline orientation ; (5) corrosion figures ; (6) synchronous crystallisation figures : (7) segregation figures. For work on α and β iron, the specimens used were very coarsely crystalline fragments of iron, from which single crystals could be cut. At ordinary temperatures these were α iron, at 800° C. β iron. For γ iron, samples of manganese steel and nickel steel were used at ordinary temperatures, the size of the crystals being as large as could be obtained. The authors found that the three modifications exhibited important differences in crystalline characteristics, and embody their results in a table. They suggest, as a possible interpretation, that in the α state the mesh is a simple cube, while the mesh of β iron is a centred cube, and that of γ iron a cube with centred faces. The authors, however, consider attempts at interpretation to be premature.

Constitution of Iron-Carbon Alloys.§—A. Sauveur discusses the Roozeboom diagram. The eutectic forming at about 1130° C., and

* Proc. Roy. Soc., Series A, lxxviii. (1907) pp. 472–8 (5 figs.).
† Proc. Amer Soc. Mech. Eng., xxviii. (1906) pp. 1–248 (154 figs.).
‡ Journ. Iron and Steel Inst., lxxi. (1906) pp. 444–92 (37 figs.).
§ Op. cit., lxxii. (1906) pp. 493–575 (12 figs.).

containing about 4·2 p.c. carbon, is accepted as an austenite-graphite eutectic. The author regards graphite once formed as taking no part in subsequent changes, and explains the horizontal at 1000° as indicating separation of cementite from austenite. Some very pure iron-carbon alloys were prepared and treated in ways calculated to favour the supposed formation of cementite from iron + graphite at 1000°. In each case the alloy was found to contain more graphite than could be formed during solidification, indicating that not only had cementite not been formed from graphite in the cooling after solidification, but that cementite had decomposed, yielding graphite. The author makes some suggestions as to the constitution of austenite, martensite, and troostite. Among the contributors to a lengthy and valuable discussion on this paper were C. Benedicks, H. le Chatelier, H. M. Howe, Jüptner von Jonstorff, A. Stansfield, J. E. Stead, and F. Wüst.

Heat Treatment of Steels containing 0·5 and 0·8 p.c. Carbon.* C. E. Corson has investigated the effect on structure and physical properties of (1) heating to varying temperatures followed by cooling at a constant rate; (2) heating to a given temperature followed by cooling at varying rate; (3) varying the finishing temperature in forging, and also the rate of subsequent cooling. The author's results agree with the generally accepted theories of heat treatment.

Effect of Low Temperature on the Recovery of Steel from Overstrain.† — It is known that steel recovers from overstrain at ordinary temperatures, and that this recovery is hastened by raising the temperature. E. J. McCaustland has shown that the effect of continued low temperature (below 0° C.) on a piece of steel which has been stretched slightly beyond the elastic limit, is to arrest completely the recovery of its elastic properties. The author also studied the progress of recovery at about 20° C., and at the temperature of a steam bath, in steel which had been overstrained and then maintained at a low temperature for some time.

Structure of Metals.‡—A report of a lecture by J. A. Ewing. The crystal granules are regarded as built up of polarised molecules, crystalline orientation depending on their polar quality. An explanation of the phenomena of strain and fatigue, consistent with this theory of the structure of the crystal, is given.

Equilibrium and Solidification Structures of the Iron-Carbon System.§—In this paper on the much-discussed iron-carbon system, C. Benedicks critically reviews at some length the experimental results hitherto obtained, and the theories founded on them. He considers that it has been proved that cementite is endothermic and metastable, and that the reaction, mixed crystals + graphite = cementite, cannot occur. Roozeboom's equilibrium diagram is accordingly simplified by the omission of the horizontal line at about 1000° C. Iron-graphite is

* Journ. Iron and Steel Inst., lxxi. (1906) pp. 603–7 (abstract).
† Tom. cit., pp. 616–21 (abstract).
‡ English Mechanic, lxxxv. (1907) p. 58.
§ Metallurgie, iii. (1906) pp. 393–5, 425–41, 466–76 (36 figs.).

held to be the stable system resulting upon extremely slow cooling, while iron-cementite is the metastable system obtained by more rapid cooling. The eutectic point for the latter occurs at 4·2 p.c. carbon. Transition from the metastable to the stable system takes place upon annealing at a suitable temperature. Graphite may be formed directly from the melt during solidification. The decomposition of cementite is catalytically accelerated by silicon. The author examined microscopically a number of pig-irons of different carbon content: his photomicrographs support the above conclusions. An explanation, consistent with the theory of equilibrium, of the possibility of cementing iron to a high percentage of carbon by heating in contact with carbon, is given. A useful feature of the paper is the bibliography appended.

Heat Treatment of High Carbon Steels.*—W. Campbell has investigated the effect of heating to different temperatures, followed by slow cooling, on the mechanical properties and microstructure of six steels containing 0·7–2 p.c. carbon. The temperatures ranged from 650°–1200° C.; the initial condition of the bars appears to have been as forged to a small section. The tendency of cementite to assume a globular form is noted. When a sufficiently high temperature is reached (1000°–1200° C.), cementite remaining undissolved decomposes into ferrite + graphite. Generally tenacity was found to diminish and ductility to increase with increase of temperature of reheating up to Ac 1. Little further change occurred until much higher temperatures were reached, when overheating effects were apparent.

Constitution of the Copper-Tin Alloys.† — E. S. Shepherd and E. Blough have made a careful revision of the concentration-temperature diagram. The composition of the solid phases was determined by the analytical method of Bancroft, lead being used as the third component. Heycock and Neville's diagram was considerably modified in certain regions. The chief results are (1) the phases which can co-exist with the melt are the α, β, and γ solid solutions, the compound Cu_3Sn, the ϵ solid solution, and pure tin; (2) below 600° C. the δ solid solution, previously supposed to be Cu_4Sn, can exist. The authors indicate the great importance of the time factor in establishing equilibrium relations, and the impossibility of constructing diagrams solely from pyrometric data.

Photographs, showing the structures characteristic of each region, will be given in a later paper.

Influence of Chromium on the Solubility of Carbon in Iron, and on Graphite Formation.‡—P. Goerens and A. Stadeler regard it as proved that in iron-chromium-carbon alloys part of the chromium exists as a double carbide of iron and chromium, the rest being present in solid solution in the iron. The authors have prepared a series of alloys saturated with carbon at 1600° C., and have determined carbon content and taken cooling curves. With increasing chromium content, more carbon is required for saturation, the alloy with 6·2 p.c. chromium containing 9·2 p.c. carbon. The alloys with 0–10·4 p.c chromium have a

* Journ. Amer. Chem. Soc., xxviii. (1906) pp. 1304–22 (29 figs.).
† Journ. Phys. Chem., x. (1906) pp. 630–53 (6 figs.).
‡ Metallurgie, iv. (1907) pp. 18–24 (17 figs.).

solidification point practically the same as the eutectic freezing-point for pure iron-carbon alloys, 1130° C. With still further increase of chromium the freezing-point rises, and with 62 p.c. chromium it is 1535° C. A lower critical point at about 710° C. was found in all the alloys containing not more than 21 p.c. chromium. The failure of silicon additions to cause graphite separation demonstrated the powerful influence of chromium in preventing formation of graphite.

ALLEN, H. S.—**The Photoelectric Fatigue of Zinc.**
Proc. Roy. Soc., Series A, lxxviii. (1907) pp. 483–93 (4 figs.).

BENEDICKS, C.—**Acetate Copper (so-called Allotropic Copper).**
Metallurgie, iv. (1907) pp. 5–17, 33–44 (26 figs.).

BRAUNE, H.—**Importance of Nitrogen in Iron.**
Stahl und Eisen, xxvi. (1906) pp. 1357–63, 1431–7, 1496–9 (21 figs.).

CARPENTER, H. C. H.—**Tempering and Cutting Tests of High Speed Steels.**
Journ. Iron and Steel. Inst., lxxi. (1906) pp. 377–96 (25 figs.).

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Zeitschr. Anorg. Chem., li. (1906) pp. 328–35 (2 figs.).

DOERINCKEL, F.—**Compounds of Manganese and Silicon.**
Op. cit., l. (1906) p. 117–26 (7 figs.).

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Op. cit., xlix. (1906) pp. 72–92 (12 figs.).

GUERTLER, W.—**Electrical Conductivity of Alloys.**
Op. cit., li. (1906) pp. 297–433 (21 figs.).

GUERTLER, W., & G. TAMMANN—**Silicides of Nickel.**
Op. cit., xlix. (1906) pp. 93–112 (15 figs.).

,, ,, ,, **Copper-nickel Alloys.**
Op. cit., lii. (1907) pp. 25–9 (7 figs.).

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Op. cit., xlix. (1906) pp 311–19 (2 figs.).

HEYN, E.—**Metallographic Research in Foundry Practice.**
Stahl und Eisen, xxvi. (1906) pp. 1386–93 (18 figs.).

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Zeitschr. Anorg. Chem., lii. (1907) pp. 129–51 (30 figs.).

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Journ. Iron and Steel Inst., lxxii. (1906) pp. 608–15.

LOSSEW. K.—**Alloys of Nickel and Antimony.**
Zeitschr. Anorg. Chem., xlix. (1906) pp. 58–71 (13 figs.).

MATHEWSON, C. H.—**Sodium-lead, Sodium-cadmium, Sodium-bismuth, and Sodium-antimony Alloys.** *Op. cit.*, l. (1906) pp. 171–98 (4 figs.).

PETRENKO, G. I.—**Alloys of Silver with Thallium, Bismuth, and Antimony.**
Tom. cit., pp. 133–44 (7 figs.).

PÜTZ, P.—**Influence of Vanadium on Iron and Steel.**
[This portion contains the results of the author's investigations on microstructure.] *Metallurgie*, iii. (1906) pp. 714–21 (48 figs.).

RUER, R.—**Alloys of Palladium with Copper.**
Zeitschr. Anorg. Chem., li. (1906) pp. 223–30 (7 figs.).

,, **Alloys of Palladium with Silver.**
Tom. cit., pp. 315–19 (7 figs.).

,, **Alloys of Palladium with Gold.** *Tom. cit.*, pp. 391–6 (7 figs.).

SAHMEN, R.—**Copper-cadmium Alloys.** *Op. cit.*, xlix. (1906) pp. 301–10 (5 figs.).

SAUVEUR, A.—**Metallography applied to Foundry Work.**
Foundry, xxix. (1907) pp. 320-4 (7 figs.).

TREITSCHKE, W.—**Antimony-cadmium Alloys.**
Zeitschr. Anorg. Chem., l. (1906) pp. 217–25 (2 figs.).

TREITSCHKE, W., & G. TAMMANN—**Equilibrium Diagram of Iron and Sulphur.**
Op. cit., xlix. (1906) pp. 320–35 (6 figs.).

v. VEGESACK, A.—**Zinc-thallium and Zinc-iron Alloys.**
Op. cit., lii. (1907) pp. 30–40 (7 figs.).

VOGEL, R.—**Alloys of Gold with Bismuth and Antimony.**
Op. cit., l. (1906) pp. 145–57 (8 figs.).

WEDDING, H.—**Copper in Iron.** *Stahl und Eisen*, xxvi. (1906) pp. 1444–7 (6 figs.); see also pp. 1493–5 (2 figs.).

,, ,, **Nickel Iron.** *Op. cit.*, xxvii. (1907) pp. 195–7.

WILLIAMS, R. S.—**Antimony-thallium Alloys.**
Zeitschr. Anorg. Chem., l. (1906) pp. 127–32 (1 fig.).

WÜST, F.—**Contribution to the Theory of Graphite Formation.**
Metallurgie, iii. (1906) pp. 757–60 (10 figs.).

,, **Mechanical Properties and Composition of Malleable Castings.**
Op. cit., iv. (1907) pp. 45–53 (5 figs.).

WÜST, F., & O. PETERSEN—**Influence of Silicon on the Iron-carbon System.**
Op. cit., iii. (1906) pp. 811–20 (15 figs.).

ZEMCZUZNYJ, S. F.—**Zinc-antimony Alloys.**
Zeitschr. Anorg. Chem., xlix. (1906) pp. 384–99 (14 figs.).

,, ,, **Alloys of Magnesium with Silver.**
Tom. cit., pp. 400–14 (11 figs.).

A Case of Malleability of Grey Cast Iron.
Metallurgie, iii. (1906) pp. 786–7 (2 figs.).

Properties of Alloys. *Nature*, lxxv. (1907) pp. 426–7.

The Commercial Value of the Microscopic Examination of Metals.
English Mechanic, lxxxiv. (1907) pp. 612–13.

MICROSCOPY.

A. Instruments, Accessories, &c.*

(3) Illuminating and other Apparatus.

Beck-Thorp Diffraction Spectroscopes.†—This series of spectroscopes is claimed to be the first serious attempt to apply the advantages of the diffraction grating to the whole field of spectroscopic research. The list includes small instruments to be carried in the pocket of those interested in colour-printing or in chemical or colour industry, as well as more perfect instruments with scales of measurement. These latter include a chemical spectroscope of great dispersion, a sun prominence spectroscope, and a wave-length spectroscope for determining the wave-length of light with great accuracy. Of these we give the following examples.

The Beck-Thorp "Minimum" Pocket Diffraction Spectroscope (fig. 51) gives a dispersion of about 20° or about double that of the

Fig. 51.

ordinary direct-vision prismatic instrument. It will readily show the more prominent Fraunhofer lines, and the rainband lines distinctly.

The Beck-Thorp "Regular" Pocket Diffraction Spectroscope (fig. 52) has a dispersion of about 30° and shows hundreds of lines in the solar

Fig. 52.

spectrum, the D line being well separated. It has an adjustable platinoid slit and a sliding focusing adjustment.

The Beck-Thorp Patent Reading Pocket Diffraction Spectroscope (fig. 53) has the same optical qualities as the foregoing but also an important addition. On looking through the instrument will be seen the spectrum and above it an illuminated arrowpoint. A graduated milled head moves this point along the spectrum and the position of

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

† R. and J. Beck's Special Catalogue (1907) 8 pp. (9 figs.).

any line can thus be registered. The gradations of the revolving drum are observed through the lens by a slight shift of the eye, and in this way

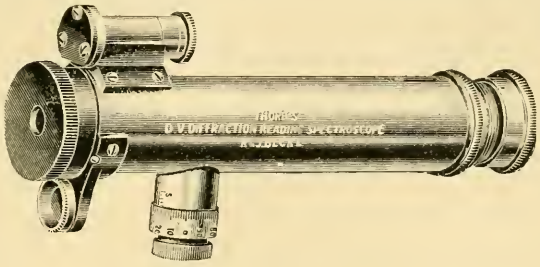


FIG. 53.

the positions of numbers of lines can be rapidly recorded. The whole spectrum is divided into 500 divisions, and a glance at the sun at once gives the ratio that the scale bears to the actual wave-length.

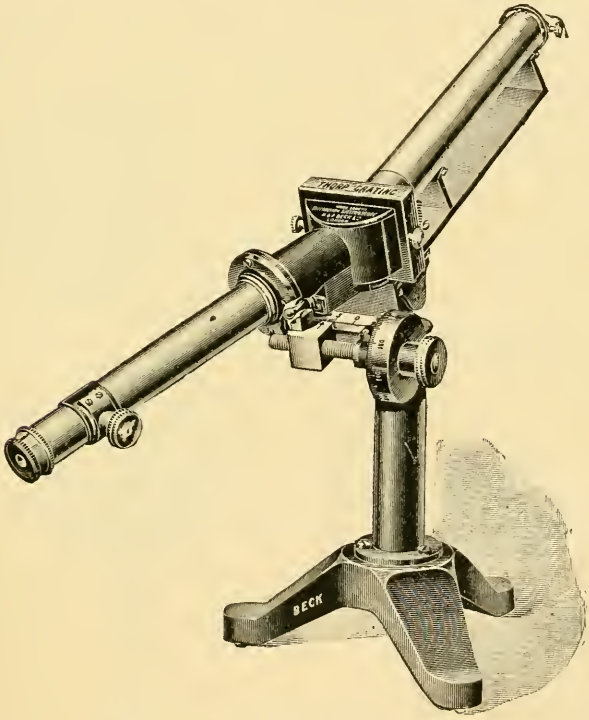


FIG. 54.

Beck's Large Model Wave-length Diffraction Spectroscope (fig. 54). This instrument consists of a large collimator, a diffraction grating, and

an observing telescope with cross wires and rack-and-pinion focusing adjustment. It is of such precision that the various wave-lengths can be easily determined by its use. The observing telescope is moved by a micrometer screw which measures $e \sin \theta$ or the sine of the angle of rotation multiplied by the grating space in Angstrom units.

Expanding Spot for Dark Ground Illumination.*—W. R. Traviss describes in detail the construction of an ingenious expanding spot for dark ground illumination. The principle of the mechanism is the converse of that of the iris diaphragm, that is to say, the thin metal sheaves are so pivoted that instead of producing by their movement a circular opening of adjustable diameter, they produce an expanding disk.

The apparatus is built up on an ordinary "spot" such as is supplied by opticians, fitting into the "spot" carrier or swing arm of their condensers.

Round the spot are drilled a number of pivot holes, as near the edge as possible, one for each sheaf, the number being only limited by the skill of the workman, though 10 or 12 have been found in practice to give a sufficiently rounded disk (plate XV. fig. 6).

The sheaves are actuated by minute pins which fit each into a slot or groove on an upper or moving plate (plate XV. fig. 5), centred on the "spot," to which a lever arm is attached for the purpose. As this slotted plate turns the radial pins are forced to move along the slots or grooves and so the sheaves are uniformly and gradually expanded at the will of the operator.

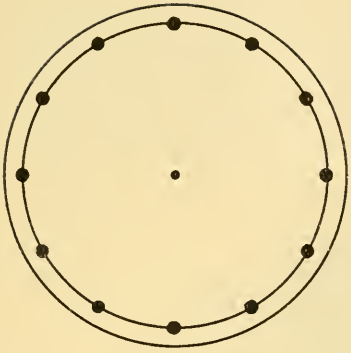
The mechanism, though exceedingly simple, depends for its efficiency on the accurate working of the individual sheaves. The method of securing this is as follows :—

A circular disk of metal, about 0·005 in. thick is taken and a concentric circle inscribed in it at the same distance from the edge as the centres of the pivot holes (plate XV. fig. 6). Starting from any point on this inner circle an arc is inscribed with a radius such that it passes a little above the centre (plate XV. fig. 6) [The part C E of the diameter A C represents the length of the slot (plate XV. fig. 5) and it will be obvious that the number of slots regulates the length of C E, for, as the number increases, so does the risk of their breaking into one another at the centre. These slots may be usefully replaced by radial grooves in a thicker piece of metal ; this greatly increases the strength and rigidity of the apparatus.]

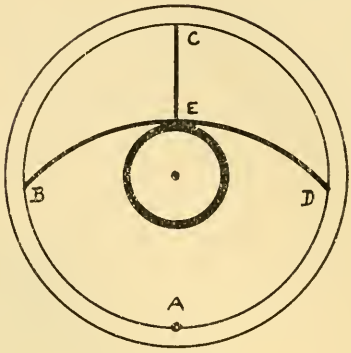
With centre B, the pivot at which the arc cuts the inscribed circle, and the same radius, another arc is inscribed and the sector between B and A is removed, leaving enough metal round the points B and A for the pivot and radial pinholes respectively, as shown in the shaded portions of fig. 3, plate XV. The resulting disk with sector removed as described constitutes a sheaf.

The number of sheaves required having been prepared, one for each pivot hole (plate XV. fig. 6) and a minute pin fixed in each, one up and one down as in plate XV. fig. 4 [the pins shown are intended to have their longer parts cut off flush with the sheaf, leaving the projecting points of

* English Mechanic, lxxxiv. (1907) pp. 596–7 ; see Journ. Quekett Micr. Club, x. (1907) pp. 77–82 (6 figs.).



1



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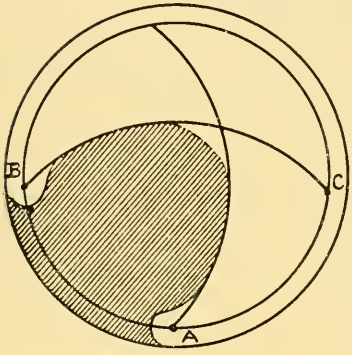

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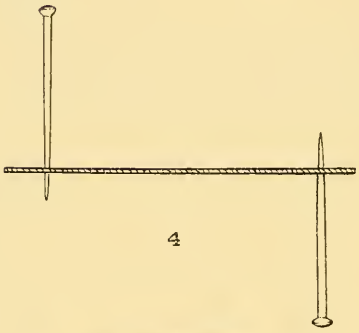

4

5

6

For the use of this Plate we are indebted to the courtesy of the Quekett Microscopical Club.

the length required,] it only remains to blacken the parts in the usual way and fit them together. In order to permit of easy adjustment to the "spot" carrier or swing arm, the ring which carries the spot is sawn through at one point so that it may be "sprung" into place.

The arc of movement is about 140°, and a stop-pin prevents any undue strain on the pins of the sheaves when the upper plate is slotted, or, if grooved to the edge, prevents them slipping out of their place.

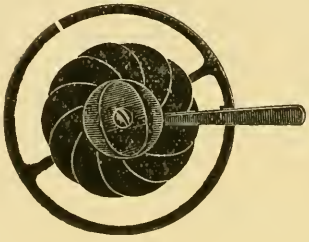

Fig. 55.

A small piece of metal under the head of the centre pin acts as a spring, and serves to keep the sheaves under even tension during their movement, and at the same time prevents their displacement.

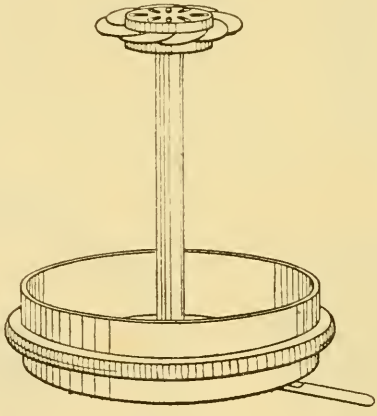

Fig. 56.

Figs. 55 and 56 show two methods of mounting the expanding spot, flat and on a stem, as originally constructed to suit a particular Microscope.

Description of a New Reflecting Condenser by means of which Ultramicroscopic Particles are made visible.—C. Reichert states * that

* Münchener Med. Wochenschrift, No. 51 (1906).

when R. Szigmondy and H. Siedentopf demonstrated their apparatus for rendering ultramicroscopic particles visible, at the meeting of the Naturforscherversammlung, in Cassel, they showed a new way for increasing the efficiency of the Microscope, and opened a new field for scientific research. The firm of C. Reichert, of Vienna, has given considerable attention to the manufacture and design of apparatus of this description ever since its introduction, and has endeavoured to simplify the same and make it more accessible and covenient in use. Various considerations and experiments have resulted in the new reflecting condenser.

This new method of rendering ultramicroscopic particles visible is

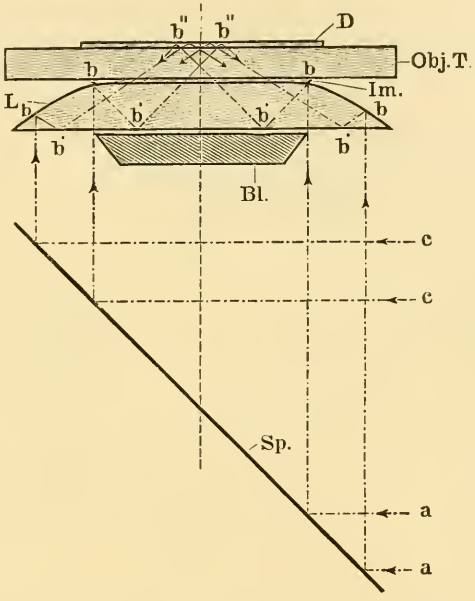

Fig. 57.

on the principle of dark-ground illumination, the light which illuminates the object having a greater aperture than the cone of light entering the objective which produces the image. This relation of the illuminating to the image-forming rays is the reverse of Siedentopf's method as practised at present. The first method has the advantage over the second of utilising the source of light much better. A second advantage consists in the fact that any dry objective can be used without any additions or alterations (such as stops, grinding part of front lens away, etc.) ; moreover the small particles are seen clearly without the disturbing diffraction rings which surround the images obtained with the Siedentopf apparatus.

This new reflecting condenser or spot-lens consists of a plano-convex lens from which the central portion of the curved surface is ground

away. The flat surface thus produced is exactly parallel to the plane surface of the lens. The remainder of the curved surface is silvered. The condenser is brought into optical contact with the object slip by means of a drop of cedar oil.

The path of the rays of light is shown in fig. 57. The rays (*a*) from the source of light are reflected by the mirror to (*b*), and thence to *b'* and *b''*. The rays *c* are likewise reflected to *b*, *b'*, *b''*.

The stop Bl. cuts off all the illuminating rays of less than 1·05 N.A. It is placed close to the under surface of the lens to prevent any disturbing reflections. This stop can be turned aside if desired and ordinary

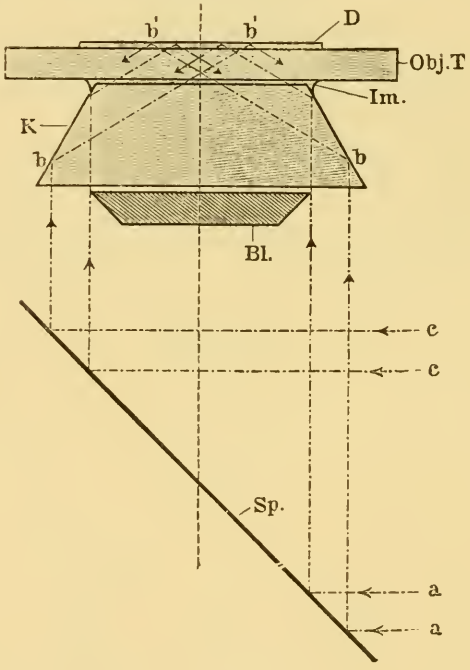

Fig. 58.

mirror illumination obtained. From fig. 57 it will be seen that all rays which enter the condenser of N.A. 1·05 to 1·30 are totally reflected by the upper surface of the cover-glass, so that it is quite impossible for these to enter the object-glass directly. The objective can only receive rays which, after reflection at *b''*, have impinged upon the particles of the object and have been diffracted by these from their original direction. These diffracted rays form the image in the Microscope. The reflecting surface of the condenser throws a well lighted image of the source of light in the plane of the object. The object must always be the same distance from the upper plane surface of the condenser owing to the short focus of the latter. This is easily managed by using glass slips of

a definite size, 2 mm. If this is not done the efficiency of the condenser is reduced—for instance, the small ultramicroscopic particles in the blood cannot be seen by the eye. This drawback led to the modification shown in fig. 58, in which the mirror-lens is replaced by a truncated cone. Inspection of the figure shows the path of the rays. The rays of light are less concentrated on the object, but it is not necessary to keep to a fixed thickness of the glass slide on which the object is placed. Slips from 1–2·5 mm. thick can be used with equal advantage. This latter condenser is specially recommended where sources of light sufficiently powerful are available. The condenser first described gives good results, not only with sunlight and the arc lamp, but also with less intense lights, such as small arc lamps, which can be used on any electric light circuit in place of the ordinary incandescent ones. Nernst lamps also give satisfactory results. Welsbach burners used with compressed coal gas are also practicable for ultramicroscopic work. Fig. 59 shows a

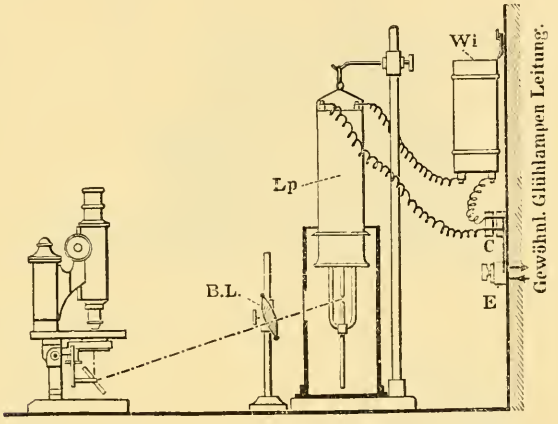

Fig. 59.

small arc lamp fitted up with a condensing lens. Fig. 60 shows the new reflecting condenser in a mount which can be used with any ordinary Microscope in place of the Abbe condenser.

Instructions for Use.—The reflecting condenser has proved of use for examination of (1) colloidal solutions, (2) blood, (3) every kind of unstained living bacteria, (4) transparent solid objects if thin sections can be cut. The most important point is to have the greatest possible cleanliness. Without this good results cannot be obtained. Small particles of dust, scratches, air-bubbles, and other imperfections in the glass slip or cover-glass have a very bad effect. For this reason only very good slides and cover-slips should be used. All objects, liquids, bacteria, etc., are simply placed on the glass slide and covered with a slip. It only remains to have a homogeneous connection, as free as possible from air-bubbles, between the top surface of the condenser and the lower surface of the slide. Cedar oil is best for

this purpose. It is necessary to use a low-power object-glass first in order to bring the image of the source of light to the centre of the field of view before proceeding to examine the object with higher powers. For the examination of colloidal solutions it is advisable to use small chambers on a glass slide, which after filling are covered with a slip. The depth of the chamber can be 0·1, 0·2 or 0·3 mm., as may be required, and the diameter 10 mm. When the liquid to be examined is placed on the slide and covered with a slip, it dries up quickly, but in these simple chambers it can be kept for hours in good condition. When

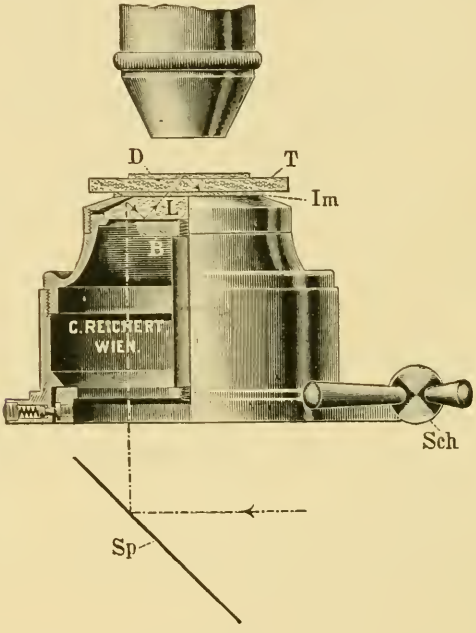

Fig. 60.

large quantities of liquids, or their mixture with other liquids, are to be examined, the arrangement shown in fig. 61 should be adopted. The liquid is forced to flow from one vessel to the other through a space in the centre of the chamber on the slide. The latter is very similar to those already described. For observing bacteria glass slides which have a small concavity ground in them are suitable. As a rule, however, the ordinary slides are all that is required. A drop of liquid containing part of the pure culture is placed on the slide covered with a slip. The flagella of several kinds of bacteria—for instance, *Spirillum volutans*—are distinctly seen by means of the reflecting condenser. It is, however, advisable to employ some means to reduce the extremely rapid movements. It seems also desirable that an imbedding material, the diffraction of which is very different from the

bacteria substance, should be found for each case. In the Pathological Department of the University of Vienna, A. Weichselbaum, and in the Clinic for Skin Diseases, Finger, and more recently Landsteiner and Mucha, have proved that this new instrument is very convenient for rendering visible the *Spirochæta pallida*. Further details are given in the "Wiener klinische Wochenschrift," 1906, No. 45.

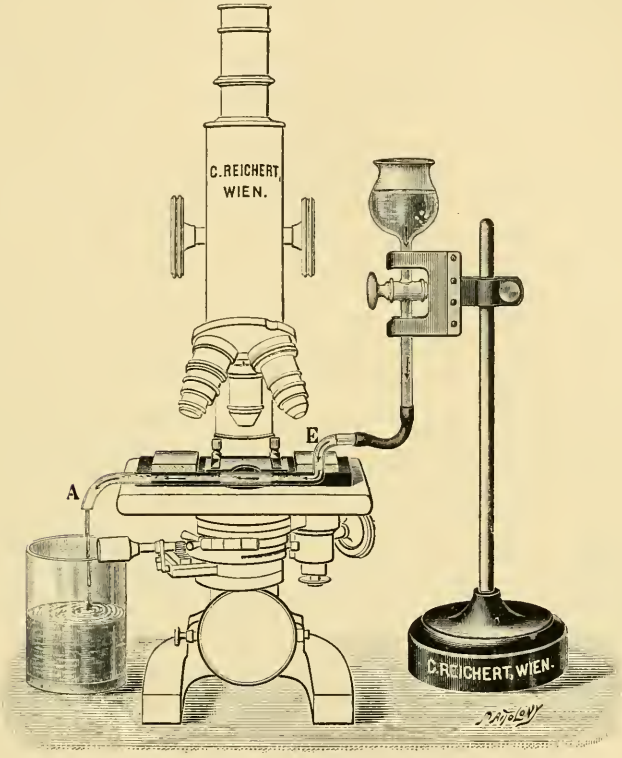

FIG. 61.

Pfund's Simple Photometer.*—A. H. Pfund has got very good results from the following simplified form of the Lummer-Brodhun type of photometer. A piece of plane glass about 2 mm. thick is silvered, highly polished, and then cut in two; the diamond scratch being made on the "glass" and not on the "silver" side. If the break is not perpendicular to the flat surface, that portion of the mirror is selected which has an acute angle at the edge of the silvered surface. Upon close examination, it will be found that the silver extends up to the very edge, and hence, by using this arrangement as a photometer,

* Johns Hopkins Univ. Circular, No. 186 (April 1906) pp. 20–22 (2 figs.).

it is easy to cause the line of demarcation between the two fields to disappear. The method of using the photometer is shown in fig. 62, in which s_1 and s_2 are the two sources whose intensities are to be com-

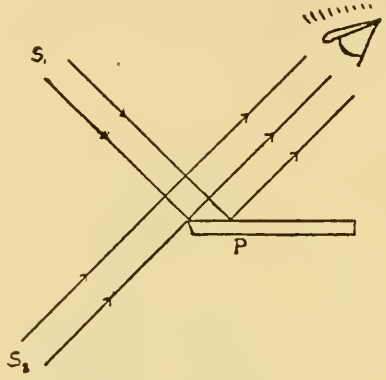

Fig. 62.

pared, and P the photometer. In addition to its simplicity and compactness, the other advantage claimed for this photometer is that it can be used under all conditions of angle which the two beams whose intensities are to be compared make with one another (with the exceptions, of course, of absolute normal and grazing incidence). A photometer of this kind has already been used in a determination of the distribution of light in the various spectra of a grating,* and has yielded very excellent results.

Fig. 63.

Swift's Pan-aplanatic Low Power Condenser.† This condenser (fig. 63), on the triple posterior system, is intended for use with medium powers whose N.A. does not exceed 0·66. It has a N.A. of 0·5, and is so corrected that the aplanatic aperture is within a trifle of its N.A.

(4) Photomicrography.

Selection of Plates and Filters for Photomicrography.‡—The firm of Wratten and Wainwright have issued a table of notes and instructions for the use of their plates and screens, which will, they think, enable the photomicrographer to obtain records of objects which he has long given up in despair.

* Astrophysical Journal, xxi. No. 2 (1905).
† Swift and Son's Special Catalogue, 1906, p. 50, fig. 54.
‡ Catalogue published by Wratten and Wainwright, Croydon (1907) 13 pp.

(5) Microscopical Optics and Manipulation.

Absorption Spectra of the Anilin Dyes.*—H. S. Uhler finds that methyl-green absorbs the extreme ultra-violet rays, and then transmits weakly in the vicinity of 0·35 μ. Then a strong band with its maximum at 0·415 μ extends from 0·36–0·45 μ approximately. This is followed by marked transparency to the green from about 0·45–0·495 μ. Finally, beyond 0·495 μ the longer waves are subjected to powerful absorption, with no return even to partial transparency in the visible spectrum.

Rhodamine B has a pair of beautiful distinct absorption bands at 0·524 and 0·557 μ. Of these, the more refrangible band has the greater intensity.

A Simple Way of Obtaining the Half-shade Field in Polarimeters.† The half-shade effect in polarimeters is usually obtained either by the well-known method of Laurent, or else by the more recent method of Lippich. In the former a quartz plate is employed to give the necessary rotation to one half of the beam of polarised light propagated through the instrument; in the latter, a Nicol prism additional to the polariser serves the same end. It occurred to J. R. Milne that the required effect might be obtained very simply by merely interposing a glass plate in the beam of light, so that half the beam traversed it in the oblique direction. It follows at once, from Fresnel's laws of the intensity of refracted light, that this will produce a slight rotation of the vibration-direction in the traversing half of the beam.

The author goes fully into the mathematical theory, and gives full details of the method in practice.

STREHL, K.—**Einführung in die beugungstheoretische Optik.**
[A series of elaborate articles.]
Central-Zeitung f. Opt. u. Mech., xxviii. (1907) Nos. 1, 2, 3, etc.

CLERICI, E.—**Sulla determinazione dell' indice di rifrazione al microscopio.**
Atti della reale Accademia dei Lincei, xvi. (March 1907) pp. 336–43 (3 figs.).

CESARO, G.—**Contribution à l'étude optique des cristaux en lumière convergente.**
Acad. roy. de Belgique, Bull. de la Classe des Sci., No. 5 (1906) pp. 290–34 (15 figs.).

(6) Miscellaneous.

Rowland's Ruling Machines.‡—J. S. Ames gives an account of the present condition of the three machines constructed by Professor Rowland. All have been found to be more or less out of repair, but two of them have been thoroughly overhauled. Several new and important improvements have been added, and gratings more perfect than any yet ruled can now be produced with a far less percentage of failure than was formerly possible.

Fluid Crystals.§—J. G. Adami and L. Aschoff record the interesting observations made in their respective laboratories at Montreal and Mar-

* Johns Hopkins Univ. Circular, No. 186 (April 1906) pp. 31–6.
† Proc. Roy. Soc. Edinburgh, xxvi. (1906) pp. 522–6 (2 figs.).
‡ Johns Hopkins Univ. Circular No. 186 (April 1906) pp. 62–5.
§ Proc. Roy. Soc., Series B. lxxviii. (1906) pp. 359–68.

burg on the myelins, myelin bodies, and potential fluid crystals. After noticing the physical and chemical characters of myelin, they enumerate the conditions under which myelin bodies may be found, and then point out that ofttimes they possess the property of double refraction. From this and other considerations the doubly refractive globules must be regarded as fluid sphero-crystals.

Investigation showed that a large number of substances of the nature of soaps gave this particular reaction; that the only crystalline fluids known which are in the intermediate state at the room temperature are certain of the oleic acid compounds; that fatty acid is an essential constituent of myelin, and that of the fatty acids oleic acid plays the most important part.

Quekett Microscopical Club.—The 438th Ordinary Meeting of the Club was held at 20, Hanover Square, the President, Dr. E. J. Spitta, F.R.A.S., F.R.M.S., etc., in the chair. A paper by Mr. James Murray, on "The Tardigrada," was read by Mr. D. J. Scourfield. The author gave a general account of the history of this group from the first mention in 1773 down to Richter's work of 1900. A general description of the group followed, and the paper concluded with some suggestions and hints on the collection of specimens. Mr. D. J. Scourfield, F.Z.S., F.R.M.S., read a paper on "An *Alona* and a *Pleuroxus* new to Britain." The first was *Alona weltneri* Keithack, closely allied to *A. costata*, and the second, *Pleuroxus denticulatus* Birge, a typically American species, but taken by Mr. Scourfield at Exminster, Devonshire, in August, 1905.

At the 439th Ordinary Meeting, held on April 19th, Mr. G. C. Karop, M.R.C.S., F.R.M.S., Vice-President, in the chair, Mr. D. J. Scourfield, after some introductory remarks on the group, read a paper communicated by Dr. Eugène Penard, of Geneva, on "The Collection and Preservation of Fresh-water Rhizopods."

Guyer, M. F.—**Animal Micrology: Practical Exercises in Microscopical Methods.** Chicago, University Press; and London, T. Fisher Unwin: (1906) ix. and 240 pp.

B. Technique.*

(1) Collecting Objects, including Culture Processes.

Thermostat for Low Temperatures.†—W. Küntze has devised the following apparatus: A double-walled wooden box, 1·10 m. long, 0·85 m. deep, and 0·93 m. high, lined with zinc, and provided with wooden and glass doors, the space between the walls being 3 cm.; situated above and below are water tanks for cooling and warming respectively. The temperature of the warm tank is regulated by a gas regulator, whilst the temperature of the upper tank is regulated by the inflow of cold water from a water supply which is stopped or increased automatically by the action of an ether vapour regulator (fig. 64).

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, etc.; (6) Miscellaneous. † Centralbl. Bakt., 2te Abt., xvii. (1906) p. 684.

On warming above a certain temperature, the expansion of the ether vapour presses up a column of mercury against and closes the end of the tube *d*, whereby the stream of cold water is able to pass by the opening *e* into the upper tank; on cooling the mercury recedes, the tube *d* is opened, and and the water passes to a waste outside the tank. In order that the temperature of the lower reservoir may be lowered as quickly as possible, a tube passes from the cool tank through the lower warm tank, and as soon as the mercury column allows the cool water to enter the apparatus, the cool water passing through this tube from the upper tank will cool the lower warm tank before it leaves the apparatus by the outflow.

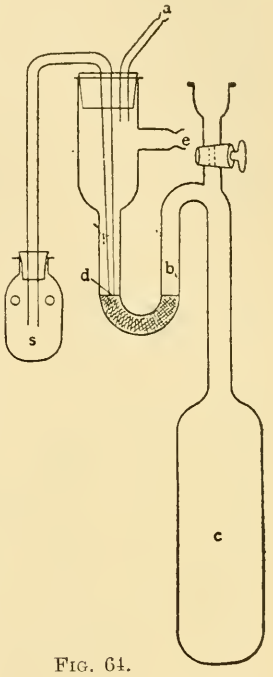

FIG. 64.

Cultivation and Preservation of Mycetozoa. — Microscopists interested in Mycetozoa often experience difficulty in obtaining specimens for study and preservation. Much time may be lost in looking for them, even at suitable seasons and in likely places. A. E. Hilton finds that this difficulty may be partially overcome by taking short pieces of branches, say about 8 in. long by 1·5 in. in diameter, keeping them moist, and examining them twice or thrice a week. In the course of ten days or a fortnight sporangia usually appear, occasionally in considerable numbers. Specimens of *Arcyria*, *Comatricha*, *Brefeldia*, and other genera have been obtained in this way. Branches found in Highgate Woods, treated in this manner, generally produce *Comatricha obtusata*. Pieces recently broken off, and partly covered with bark, give best results. The simplest method of keeping them moist is to take some ordinary glass jars, such as pounds of preserves are sold in; stand the pieces of branches on end, one in each jar; pour in water to the depth of an inch, and replenish from time to time as necessary. Another way is to take some shallow baking tins; cover the bottoms with "felting," or other fibrous material which will retain moisture; keep wet by adding water as often as requisite, and lay the pieces of wood side by side. Spring and autumn are the most favourable seasons for Mycetozoa, as cold, hot, or dry weather does not suit them.

Plasmodia of *Badhamia utricularis* can be cultivated from sclerotia, by moistening the latter in a dish along with fragments of fungi, either *Stereum hirsutum* or *Auricularia mesenterica*. A little water must be added occasionally, and a sheet of glass should be placed so as nearly to cover the dish and prevent too rapid evaporation. Plasmodia grow more rapidly on *Stereum* than on *Auricularia;* but care has to be taken to remove the pieces of *Stereum* when the plasmodia have passed over them, otherwise they are apt to putrefy, and may kill the plasmodia.

The best temperature for cultivation is 50°–55° F. When plasmodia are sufficiently developed, the withholding of food and gradual lessening of moisture induce the formation of sporangia.

To preserve sporangia for exhibition under the Microscope they must be set aside in a dry place until all moisture has evaporated, and should then be mounted in air, in deep glass cells. A good plan is to stick a small ledge of cork to the slip, a little below the centre of the cell, and stick the specimen upon the cork, in its natural position, supported by a portion of the leaf, bark, or other substance on which it has been found ; shellac, or any other adhesive material commonly used, will serve the purpose : and, when quite dry, all can be closed in with a cover-glass. Such slides, however, must be protected from rough treatment, as a fall or jar is likely to cause frail sporangia to fall to pieces.

When under the Microscope, mounted in the manner described, the specimens should be brilliantly illuminated as opaque objects ; and pleasing effects can be produced by placing behind the slide, and therefore out of focus, a piece of coloured paper, or white paper with a piece of blue or green gelatin laid upon it, to furnish a suitable background.

A New Apparatus for Studying Bacterial Enzymes.*—S. L. Schouten has devised the following method. The apparatus (fig. 65) is

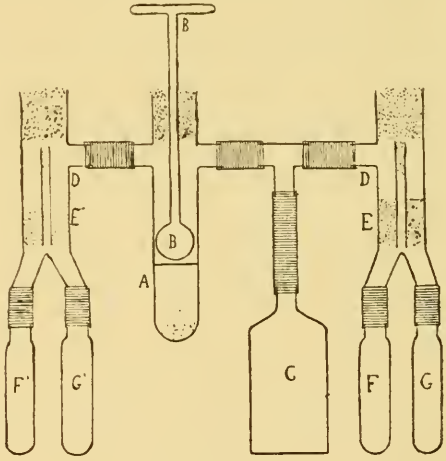

Fig. 65.

of glass, the dotted portions represent wool-corks, the line-shaded portions being rubber tubes. In tube A is a little glass powder on to which is poured a nutrient solution, in which the organism is to be cultivated ; in F, G, F', G', is the material on which the enzyme is to act, and C contains water ; the whole is sterilised, and the tube A inoculated. When sufficient growth has taken place water is poured from C on to the cork E until it is saturated, then some of the medium in A is poured

* Centralbl. Bakt., 2te Abt., xviii. (1907) p. 95.

on to E (avoiding any passing into C), half being allowed to filter into F, and half into G; F and G are then clamped and separated from the apparatus. The mycelium in A is now broken up by the rod B, water is added, and the washing passed on from A into F′ and G′ through the cork E.

Structure of Rhizobium Leguminosarum.*—R. Greig Smith, for the structural examination of this organism, advises the growing of large cells by use of agar containing maltose, citrate and sulphate of ammonium; and staining with fuchsin 0·1 grm., alcohol 10 c.cm., 1 p.c. phenol 90 c.cm. Add a loopful of slime to 4 c.cm. of distilled water in a test-tube warmed to 80° C. in water-bath; the slime is distributed in the water and a uniform suspension of the cells obtained: 2 c.cm. of the stain, at 80° C., is added, and the test-tube is kept at 80° C. for 4–8 hours. A drop of the suspension is then spread on a coverslip, dried in air, flamed, decolorised with 0·5 p.c. acetic acid, dried again, and mounted. When properly stained the rods are seen as bipolar staining spherules.

Action of Particulate Conditions on Microbic Cultures.†—P. Harckman inoculated with 1 c.cm. of well water each of three Petri dishes, containing respectively gelatin dissolved in pure water, gelatin dissolved in a solution holding particles of tin, and gelatin dissolved in a solution holding particles of leather. The gelatin and tin culture showed numerous vigorous colonies after four days, the medium being completely liquefied after fourteen days; the gelatin and leather culture manifested no growth within four days, and the gelatin and pure water showed only a few scarcely perceptible pin-point colonies. The colonies on the medium containing tin had the yellow colour of sulphide of tin and later the violet of oxide of tin. The author concludes that particles of tin are exciters to microbial growth; he found that manganese was also an exciter, but to a less degree than tin. The phenomenon is represented diagrammatically; regarding the living organism as positively electrified, and the particles of tin as negatively electrified, the excitation resulting from the induction of negative ions on the positive ions determines the excitation which governs the production of vital phenomena. The contrary effect results when the particulate ions have a positive polarity, as in the case of leather.

Detection of Bacillus typhosus.‡ — 1. *Cultivation of B. typhosus from the blood by means of bile medium.* H. Conradi recommends the following method for use by medical practitioners: 0·5 c.cm. of blood is taken from the lobe of the ear, mixed with 10 c.cm. of sterilised ox bile, and added to 10 parts of pepton and 10 parts of glycerin contained in an easily sterilised glass tube closed by a glass stopper; this is inclosed in a wooden case and sent to a bacteriological institute. There the tube is incubated at 37° C. for 16 hours, when subcultures should be made on litmus-lactose-agar. After 30 hours the diagnosis of typhoid is established.

* Proc. Linn. Soc. N.S.W., 1906, p. 295 (2 pls.).
† Bull. Classe des Sci., 1906, No. 5, p. 335.
‡ Centralbl. Bakt., Ref., xxxix. (1907) p. 395.

2. *Diagnosis of Typhoid.*—W. Pöppelmann* obtains blood from the finger under aseptic precautions, and prepares films which are dried in the air and placed in the septic solution (May-Grünwald) for 2–6 minutes, washed in distilled water, quickly dried, and examined under 1000 diameters without a cover-glass. Giemsa's stain may also be employed.

Canon† states that the above method has been used by Meisel and Almaquist for twenty years, and he considers that obtaining blood from the hand is a possible source of contaminating error.

3. *Malachite-green Media for the Detection of B. typhosus, B. coli, and B. paratyphosus.* J. Leuchs‡ employs the following preparation. 100 c.cm. of neutral dextrin broth agar, 0·5 c.cm. normal sodium carbonate solution, 10 c.cm. (10v H) nutrose solution, and 1·6 c.cm. of 0·1 p.c. solution of malachite-green. In this medium *B. paratyphosus* type B gave a vigorous growth, but the development of *B. coli* was completely arrested; the growth of three strains of *B. typhosus* was far superior to that on Drigalski-Conradi medium.

Lentz and Tietz§ find that malachite-green agar medium gives 37·7 p.c. better results for typhoid diagnosis than Drigalski-Conradi medium.

4. *Sodium Glycocholate and the Blood Cultivation of Typhoid Patients.* Roosen-Runge‖ modifies the method of Schott-Müller for obtaining cultures from the blood of typhoid patients, by using sodium-glycocholate agar:—1 litre broth, 20 grm. agar, 10 grm. pepton, 5 grm. sodium chloride, 10 grm. sodium glycocholate. By this means it was possible to obtain visible colonies in 13–16 hours; and also, the number of colonies was much greater—in one case as many as 1400 were counted on the fourth day, whereas on ordinary glycerin-agar there were only 800.

5. *Rossi's Typhoid Diagnosticum.*—G. de Rossi¶ prepares his diagnosticum as follows:—10 c.cm. of a broth culture of *B. typhosus*, grown for 1–2 days at 27° C., is transferred to a test tube, and placed for 1 hour in a water-bath at 58°–60° C. To one half of the contents is added a drop of normal serum, and to the other half a drop of the serum to be examined. After half an hour in a thermostat at 37° C. agglutination should result. The test remains reliable for 11 months or longer.

6. *Cultural Observations and Diagnosis of B. typhosus in Fæces, Soil, and Water, by the help of Malachite-green.*—F. Loeffler** finds that the action of this method consists in hindering the growth of accompanying germs, especially those of *B. coli*, and in causing a more vigorous growth of *B. typhosus*. The author gives receipts for the preparation of various green media by which the *B. typhosus* may be separated.

6. *Diagnosis of B. typhosus and B. coli by means of Sulphate of Copper and Prussiate of Potash.*—A. Marrasini and G. Schiff†† prepared peptonised nutrient media from meat extract, and added solutions of sulphate of copper or prussiate of potash to each. After inoculation and incubation at 37° C. for 36 hours, the tubes of *B. typhosus* were clear and

* Centralbl. Bakt., Ref., xxxix. (1907) p. 401.
† Loc. cit.
‡ Tom. cit., p. 396.
§ Tom. cit., p. 404.
‖ Centralbl. Bakt., 1te Abt. Orig., xliii. (1907) p. 520.
¶ Tom. cit., p. 398.
** Tom. cit., p. 405.
†† Tom. cit., p. 409.

stained, whereas those containing *B. coli* were clouded and decolorised in the case of copper sulphate, and stained green by the prussiate of potash.

Modification of Fermi's Method for the Examination of Proteolytic Enzymes.*—S. L. Schouten adds water saturated with thymol to 7·5 p.c. of gelatin, and as much powdered cinnabar as will make the fluid deep red ; by stirring well the cinnabar is prevented from settling, and the mixture is then poured through a long-necked filter into test tubes, about 5 c.cm. into each ; these are then placed in a water-bath at 40° C., and then held for 10 seconds under a cold water tap, the gelatin being thereby thickened but not solidified ; when the tubes are stood vertically there will be a thin elliptical layer of gelatin attached to the wall of the tube ; when thoroughly cooled the fluid to be examined is introduced into the tubes, with an addition of a piece of thymol. The object of the method is that the enzyme comes into contact with a large surface of gelatin, which being in only a very thin layer can be quickly liquefied. All the tubes must be heated to the same temperature, and cooled for the same length of time. The author claims that by this method it is possible to determine after 12 hours whether an enzyme is present, and to estimate how quickly it acts.

Cultivating a Micro-organism found in the Blood in cases of General Paralysis.†—N. Sokalsky obtained blood from three cases of general paralysis, and inoculated tubes of agar, gelatin, potato and broth. Cover-slip preparations made after 24 hours in a thermostat and stained by Bocardi's method and with 1 p.c. alcoholic eosin, showed many round, highly refractile bodies inclosed in the red corpuscles, as many as 20 being contained in one cell ; these bodies were larger than micrococci, stained badly with anilin dyes, but well with concentrated fuchsin, and by 1 p.c. alcoholic eosin ; not staining by Gram's method.

Broth cultures remained clear with a slight deposit which is composed of the same round bodies arranged in pairs or in bundles like sarcinæ. Guinea-pigs inoculated subcutaneously with the broth culture developed paralytic symptoms, and the organism was re-obtained from the heart-blood after death.

Automatic Aerating Device for Aquaria.‡—L. Murbach obtained very gratifying results from the apparatus for aerating aquaria which he invented, and thus describes :

The things needed are a glass filter pump, two wide-mouthed bottles about 8 by 15 cm. and 6 by 12 cm., a cork stopper to fit the larger bottle, a stand with balance beam, glass and rubber tubing. The stopper is bored with three holes, 5 mm., 8 mm., and 11 mm. in diameter. Into the smaller holes are fitted a 24 cm. long tube for the air outflow, and a 15 cm. long tube for carrying the water from the filter pump. The 11 mm. hole is for a wooden rod 15 mm. in diameter and about 15 cm. long ; this is cut down, tapering abruptly from 15 mm. to 8 mm. the rest of its length. The larger end of this rod serves as a valve in the 11 mm. hole in the stopper, being placed vertically so that the

* Centralbl. Bakt., 2te Abt., xviii. (1907) p. 94.
† Op. cit., 1te Abt. Orig., xliii. (1907) p. 213.
‡ Amer. Naturalist, xli. (1907) pp. 61–4 (1 (fig.).

stopper can glide freely along the rod when placed in the inverted bottle. After inserting the glass tubes as shown in the illustration (fig. 66), the wooden rod is inserted through the stopper from the side that goes into the bottle ; then the smaller end of the rod is attached to a block. The large bottle is suspended in an inverted position from one end of the balance beam of the stand, the stopper is inserted, and the small bottle, nearly filled with water, is hung on the opposite end of the beam for counterpoise. The block carrying the wooden rod is moved about on the base of the stand until the stopper moves easily up and

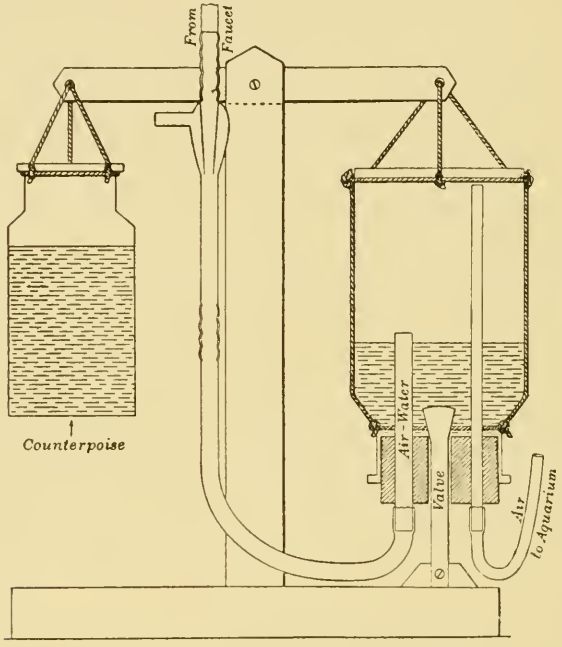

Fig. 66.

down the rod, and is then fastened in this position with a wood screw. If the head of the rod fits the hole in the stopper accurately no water will escape when it is turned on until the weight of water in the inverted bottle exceeds that of the counterpoise ; the weight of the counterpoise may be adjusted so that it will keep the large bottle about one-third full of water, thus preventing the escape of air except through the proper outlet. The water and air should not discharge alternately, and if this take place a longitudinal groove may be cut into one side of the head in the stopper until enough water escapes to balance the inflow when the water pressure is at its lowest. From this point onward it will work automatically.

Simple and Rapid Method of Preparing Agar and Gelatin Media.*—Bissérié describes a simple method for making quite clear culture media.

The agar, gelatin, or any other medium is melted up in a water bath in a beaker A (fig. 67). When the medium is liquefied an inverted flask B is placed on the bottom. The mouth of the flask has been previously covered in the following manner. First, a layer of cambric (batiste) is tied on ; over this is applied a disk of filter paper (chardin), and the latter covered and kept in place by means of another piece of cambric. The whole apparatus is then placed in an autoclave, which is heated at 100° (valve open) until all the air is driven out, then with the valve closed at 120°. By this means all the air in B is driven out and replaced by steam. After a few minutes at 120° the autoclave is allowed to cool. When the indicator points to zero the valve is opened very slowly, in order to let in air very gradually. In consequence of the cooling the atmospheric pressure drives all the hot liquid from A into B, and thus within half-an-hour may be obtained a perfectly clear and sterile medium.

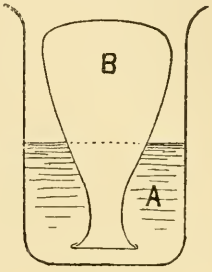

Fig. 67.

(2) Preparing Objects.

Observations on Bacterial Capsules.†—A. Hamm advocates the use of Weidenreich's method of fixation by osmic acid vapour for the examination of bacterial capsules. The author employs a tube in which the fixation may be carried out, which he considers to have advantages over the modified Petri dish devised by E. Levy. This tube is wide-mouthed and bulb-ended, and closed by a ground-glass stopper ; the bulb is filled with glass-wool, which, after sterilisation, is impregnated with 1 p.c. osmic solution or 1 p.c. chromic acid. Cleaned slides are placed in the tube for 1–2 minutes, then taken out and filmed and replaced in the tube for 20–40 seconds, dried in the air and stained either by Klett's method or by Giemsa.

To demonstrate the capsules of bacteria from artificial media the films should not be made with water, but with some viscid fluid, such as blood serum or ascitic fluid.

The author considers that the capsule and the intracapsular network result from the production of slime by the organism. The capsule appears larger in young bacilli and diminishes with age. The substance of the capsule consists of nucleo-proteid and contains no mucin.

Studying the Heart of Arca.‡—A. Theiler first benumbed the animals either in 2 p.c. solution of cocain in sea-water, or 5 p.c. alcohol in order to prevent contraction. After 5 or 6 hours they were transferred to the fixative (sublimate with 5 p.c. acetic acid), by which the shell was at the same time dissolved.

* Ann. Inst. Pasteur, xxi. (1907) pp. 235–6 (1 fig.).
† Centralbl. Bakt., 1te Abt. Orig., xliii. (1907) p. 287.
‡ Jen. Zeitschr. Natur., xlii. (1906) pp. 115–42.

For histological purposes, pieces with the heart attached were dissected out, and fixed in osmic acid or in Flemming's fluid. Smaller animals were decalcified after fixation by immersion in 70 p.c. alcohol with 2–3 p.c. sulphuric acid. As stains, borax-carmin, hæmalum, and various other varieties of hæmatoxylin, were used, and also contrast plasma stains; for histological purposes, iron-hæmatoxylin and van Gieson's method.

Demonstrating Trypanosomata.*—H. G. Plimmer has used the following method for some years and has found it to give uniformly good and accurate results. The specimen is never allowed to dry, there is no skrinkage of cells, and the finest cytological details can be observed. (1) Expose a coverslip to the vapour of osmic acid (1 p.c.) 1 c.cm., glacial acetic acid 3–5 drops, for 2 minutes. (2) Place a drop of fresh blood on one corner of the slip and expose again to the vapour for 30 seconds. (3) Spread the film carefully and expose again for 15–30 seconds to the vapour until the surface appears no longer moist. (4) Place slip in absolute alcohol for 10 minutes. (5) Immerse slip in faintly rose-coloured solution of permanganate for 1 minute (2–3 drops of 1 p.c. sol. to 50 c.cm. H_2O). (6) Wash in water for 5 minutes. (7) Stain in following modified Romanowsky, made by mixing just before use—azur i. (1 p.c.) 1 c.cm.; eosin B.A. (1–1000), 2 c.cm., H_2O 8 c.cm., for 15–30 minutes. (8) Wash. (9) Differentiate in orange-tannin 30 seconds. (10) Wash well and drain. (11) Absolute alcohol for a few seconds. (12) Alcohol-xylol (2–3) two or three changes. (13) Xylol; and mount.

Instead of 7–13 any other method of staining can be used, according to what structures it is desired particularly to show.

Studying Neurosporidium cephalodisci.†—W. G. Ridewood and H. B. Fantham describe a new sporozoon, *Neurosporidium cephalodisci*, which infests the nervous system of *Cephalodiscus nigrescens*. The specimens of *C. nigrescens* obtained by the "Discovery" were fixed, some in 5 p.c. formalin, some in Perenyi's fluid, and some in picric acid solution. Serial sections of the polypides were cut for the purpose of investigating the anatomical structure of this new species of *Cephalodiscus*, and these sections and some others were utilised for the study of the sporozoon. The majority of the sections (5–7·5 μ) were stained with Ehrlich's hæmatoxylin and eosin, others with hæmatoxylin and orange G, or Mayer's hæmalum, or borax-carmin.

Demonstrating the Fibrillary Structure of Nerve-endings in Cutaneous Tissue.‡—Eugen Botezat finds that the methylen-blue and the Golgi methods supplement one another in the study of nerve-endings. For the latter method he adopts the following procedure:—Pieces of quite fresh tissue, from 2–3 c.mm. in size, are immersed in about $\frac{1}{4}$ litre of 1·5 p.c. silver nitrate, and incubated at about 37·5° C. for three days. On removal they are quickly washed in distilled water, and then placed in the reducing fluid. This consists of 1 grm. pyrogallic acid, 2·5 c.cm. formalin, and 50 c.cm. distilled water. In this they remain for about one

* Proc. Roy. Soc., Series B, lxxix. (1907) pp. 95–102 (1 pl.).
† Quart. Journ. Micr. Sci., li. (1907) pp. 83–4 (2 pls.).
‡ Anat. Anzeig., xxx. (1907) pp. 34–44 (9 figs.).

day, after which they are thoroughly washed in distilled water, and then passed through upgraded alcohols to dehydration. Then xylol, paraffin, sectioning, and mounting in Dammar. The author found Dammar was preferable to balsam, as it did not become yellow after lapse of time.

Studying the Life-history of Adelea ovata.*—C. C. Dobell obtained the best results by adopting Schaudinn's methods. The entire gut was removed, and the epithelial cells and the entire gut contents spread out upon a cover-slip. The films thus obtained were instantly fixed by immersion in hot sublimate-alcohol containing a trace of acetic acid. After fixation the films were treated with iodin-alcohol, and stained in Bütschli's modification of Delafield's hæmatoxylin. This is prepared by adding 1 p.c. acetic acid to a 0·5 p.c. Delafield's hæmatoxylin in water until a pink colour is produced.

Staining for all stages, except spores, is complete in from 15–30 hours. Giemsa's stain was not satisfactory. Cross-sections of the gut were unsatisfactory. Moist films were more useful for examining the coccidia.

Studying Spermatogenesis of Myriapods.—M. W. Blackman† found that for fixing the spermatocytes of *Lithobius*, the best reagent was Gilson's nitric-acetic-sublimate mixture. The most satisfactory staining results were obtained with Heidenhain's hæmatoxylin, used either alone or with Congo-red as a counter-stain. For micro-chemical tests Flemming's three-colour stain and the Ehrlich-Biondi mixture was used, the results obtained with the latter being especially satisfactory.

(4) Staining and Injecting.

Criticisms of the so-called Syphilitic Spirochæte.—Th. Saling‡ insists on the nerve-end nature of the "pallida" and "silver" spirillæ. The finding of these in the lumen of the blood-vessels he regards as artificial and accidental, and he refers to their rarity in those tissues in which nerve-endings are scarce. He gives photographs of silver spirillæ seen in the stomach-wall of a healthy rabbit, which may readily be mistaken for spirochætes; here elastic fibres are common and nerve-fibres less so. In a photograph of healthy rabbit pancreas spirochætal forms are shown that are probably nerve-fibrillæ. From a diagnostic point of view, the author refers to the fact that in recent syphilis "pallidæ" can be found only in 39·6 p.c. of the cases; and often these are confused with *Spirochæta refringens*; severe cases of syphilis are reported in which no "pallidæ" could be demonstrated, and cases of not acknowledged syphilis where "pallidæ" were found.

Reply to Saling's Criticism of the "Pallida."—M. Wolff§ charges Saling with stating a hasty opinion from ill-prepared specimens, and challenges him to demonstrate his spirochætal-like nerve-fibrillæ in section of skin of a non-syphilitic animal. The author further considers that Saling does not show by his figures that he has made any real nerve impregnation.

* Proc. Roy. Soc., Series B, lxxix. (1906) pp. 155–63 (2 pls.).
† Proc. Amer. Acad. Arts and Sci., xlii. (1907) pp. 489–518 (2 pls.).
‡ Centralbl. Bakt., 1te Abt. Orig., xliii. (1907) p. 362.
§ Tom. cit., p. 222.

Reply to Wolff's Article relating to the Spirochæte Question.—Th. Saling* maintains that the spirillæ are maceration products, and represent nerve-endings. The author claims that he is supported by Levaditi and Hoffmann, and that Wolff has not made control experiments, and forms his opinion from a neurological point of view.

Transmission of Siphilis to Rabbits.†—E. Bartarelli succeeded in a number of experiments in producing syphilitic keratitis in rabbits, by injecting syphilitic material into the anterior chamber of the eye. In each case spirochætæ were found at a certain distance from the site of the lesion, but not in the lesion itself. Although the symptom complications associated with syphilis were not met with, the author considers that etiologically the lesion was of a syphilitic nature. The lesion was successfully transferred from rabbit to rabbit, with the production of a typical spirochætal keratitis.

Staining Animal Parasites.‡—T.W. Hall stains films of blood, fæces or sediment of secretion for ½–2 minutes, with 1 p.c. aqueous methylen-blue 100 c.cm., glacial acetic acid 5 c.cm. The film is then contrast-stained with saturated alcoholic-eosin solution, used hot in the usual way. The film is then fixed in potash-alum solution for ½–2 minutes, and, after decolorising in alcohol, is mounted in balsam.

Metallography, etc.

Crystallisation and Segregation of Steel Ingots.—J. E. Stead § gives the methods he uses for developing the macrostructure of steel. By etching complete sections of rails, billets, etc., with nitric acid or other suitable reagent, the position of segregated portions resulting from the crystallisation during solidification is made evident. A classification into micro-, minor, blowhole, and axial segregations is given. The author's experiments appear to show that cavities formed in steel by the evolution of gas during solidification are frequently filled up by the still liquid portion; blowhole segregations thus result. By the addition of aluminium to the molten steel, the formation of blowholes, and thus of blowhole segregation, may be prevented. Sulphur segregates the most, phosphorus and carbon follow in that order; manganese and silicon do not segregate to any material extent.

Piping and Segregation in Steel Ingots.—H. M. Howe ‖ discusses at some length the causes of piping and segregation, and the methods of restraining these evils. Piping is due chiefly to virtual expansion of the outer walls of the ingot during solidification, and not to a change of volume accompanying the change from the liquid to the solid state. Among the means suggested for lessening piping are casting with the large end up, liquid compression, and devices for retarding solidification such as casting in wide ingots, or in sand moulds. Segregation may be

* Centralbl. Bakt., 1te Abt. Orig., xliii. (1907) p. 229.
† Tom. cit., p. 238. ‡ Brit. Med. Journ., 1907, i. p. 556.
§ Cleveland Inst. of Engineers (1906) 54 pp., 25 figs. Includes the substance of two papers, one read before the British Association, August 1906.
‖ Bull. Amer. Inst. Mining Engineers (1907) pp. 169–274 (36 figs.).

dealt with either by reducing its amount or by raising the position of the segregate. The degree of segregation is lessened by addition of aluminium to the molten steel and by hastening solidification.

Chromium-Tungsten Steels.—L. Guillet* has examined microscopically 24 steels containing carbon 0·14–0·84, chromium 0·7–21, and tungsten 2–20 p.c., after different heat treatment. Among the author's conclusions are: (1) the constituents present in the normal steel are pearlite, martensite, and a triple carbide of iron, chromium and tungsten, accompanied by martensite, sorbite (or troostite) or γ-iron; (2) the most frequently observed structure of the normal steels resembles that of high speed tool steels—grains of carbide in a matrix of troostite or sorbite. The mechanical properties on the whole are such as might be expected from the micro-constitution and from the author's previous results on chromium steels and tungsten steels. The effect of quenching at different temperatures and the bearing of the numerous facts observed on high-speed steels, are discussed at some length. In the steels containing carbide that constituent could be caused to disappear by heating at 1200° C. for a sufficiently long time; on quenching, an extremely fine martensite resulted.

Alloys of Manganese and Copper.—S. Wologdine† has determined the freezing point curve and investigated the microstructure and hardness of a series of manganese-copper alloys. The melting point of manganese was found to be 1275° C. The alloys are classified in three groups—(1) 0–40 p.c. manganese, apparently solid solutions of manganese in copper; (2) 40–78 p.c. manganese, very hard and brittle, containing two constituents; (3) 78–100 p.c. manganese, also hard and brittle and falling to powder in air. The most satisfactory etching reagents were a very dilute solution of ammonium sulphide in water, boiling water (which attacks manganese), and for the groups (2) and (3) iodine solution. A maximum in the freezing point curve at 1140° C. and 78 p.c. manganese is ascribed to the compound Mn_4Cu. Two minima exist, at 40 p.c. (850° C.) and 89 p.c. manganese (1005° C.). The latter is a eutectic point. Hardness was measured by the Brinell method.

Metal-testing Laboratory.‡—L. Guillet describes the equipment of the temporary laboratory fitted up at Brussels for the Congress of the International Association for Testing Materials, in which were given demonstrations of modern methods of testing. The tests were made with great rapidity and considerable accuracy, and comprised—(1) Preparation of polished and etched sections and of photomicrographs of these; (2) critical point determinations by the Saladin method; (3) shock tests on notched bars in the Guillery machine; (4) Brinell hardness measurements; and (5) shearing tests by Fremont's method. Thirty-six samples were tested in the four days during which the laboratory was working. The principal etching reagents used were picric acid for iron alloys and ferric chloride in hydrochloric acid for alloys of copper.

* Rev. Métallurgie, iv. (1907) pp. 5–24 (16 figs.).
† Tom. cit., pp. 25–38 (13 figs.).
‡ Tom. cit., pp. 189–200 (10 figs.).

Alloys of Nickel and Tin.*—E. Vigouroux prepared three alloys containing respectively 7, 16, and 26 p.c. nickel, and investigated the action of acids upon them. By alternate digestion with nitric acid and fusion with potassium hydrate the compound NiSn was isolated. When the pure metals are heated together up to the melting point of tin in the proportion 2 of tin to 1 of nickel (NiSn) a homogeneous melt is obtained with great evolution of heat.

L. Guillet† has determined the equilibrium diagram and promises a detailed account. Four solid solutions and one compound NiSn are formed. Two of the solutions (α and α' containing 0–5 p.c. tin) are identical in composition, but differ in that one is magnetic, the other not. The β solid solution contains 38–41 p.c., the γ, 55–60 p.c. tin.

ARRIVAUT, G.—**Alloys of Manganese and Molybdenum.**
Proc. Soc. des Sci. Phys. et Nat. de Bordeaux, 1905–6, pp. 7–10.

,, ,, **Alloys of Manganese with Nickel and Cobalt.**
Tom. cit., pp. 107–14.

,, ,, **Alloys of Manganese and Vanadium.** *Tom. cit.*, pp. 152–4.

HAILSTONE, G.—**The Characteristics of Foundry Iron.**
[Contains a section describing the micro-structure of cast iron.]
Foundry, xxx. (1907) pp. 20–30 (17 figs.).

HUDSON, O. F.—**Microscopic Testing of Cast Iron.** *Tom. cit.*, pp. 132–4.

PETRENKO, G. J.—**Alloys of Silver with Lead and Tin.**
Zeitschr. Anorg. Chem., liii. (1907) pp. 200–11 (21 figs.).

,, ,, **Alloys of Silver with Iron, Nickel, and Cobalt.**
Tom. cit., pp. 212–15 (1 fig.).

RUER, R.—**Alloys of Palladium and Lead.**
Zeitschr. Anorg. Chem., lii. (1907) pp. 345–57 (14 figs.).

SAUVEUR, A.—**Metallography applied to Foundry Work.**
Foundry, xxx. (1907) pp. 79–82 (8 figs.).

,, ,, **The Structure of Wrought Iron.**
Electrochem. and Met. Ind., v. (1907) pp. 119–20.

VIGOUROUX, E.—**Alloys of Iron and Molybdenum.**
Proc. Soc. des Sci. Phys. et Nat. de Bordeaux, (1905–6) pp. 2–6, and 67–70.

,, ,, **Alloys of Iron with Nickel and Cobalt.** *Tom. cit.*, pp. 96–8.

The Evaporation of Solid Metals and their Compounds.
English Mechanic, lxxxv. (1907) p. 251.

Melting Points of Elements.
[J. A. Harker's table of melting points is given.]
Electrochem. and Met. Ind., v. (1907) p. 48.

Nitrogen in Iron. *Tom. cit.*, pp. 51–2.

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* Comptes Rendus, cxliv. (1907) pp. 639–41 and 712–14.
† Tom. cit., pp. 752–3.

MICROSCOPY.

A. Instruments, Accessories, &c.*

(1) Stands.

Old Microscope by Cary.—The old Microscope by Cary, with Varley stage (fig. 68), was presented to the Society by Mr. A. W. Waters and

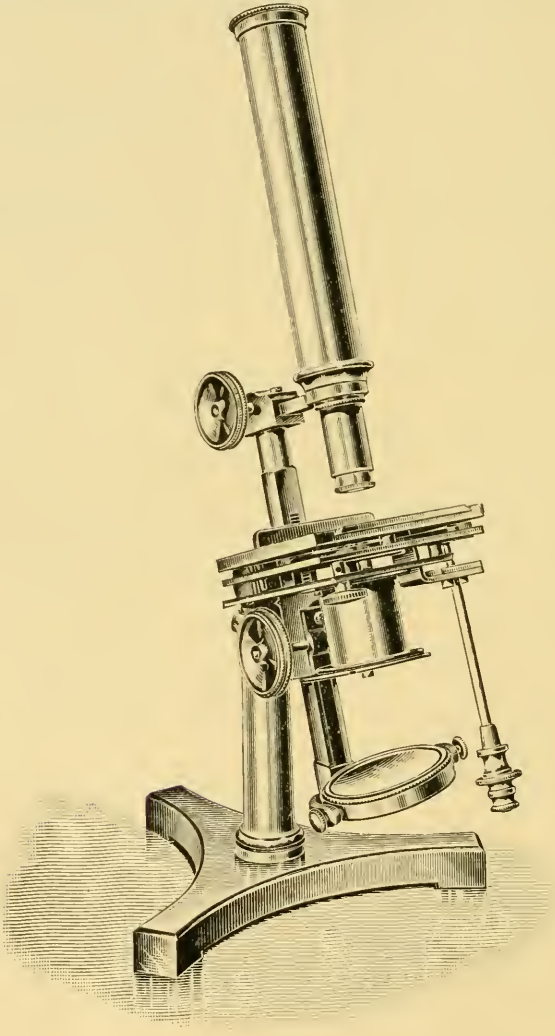


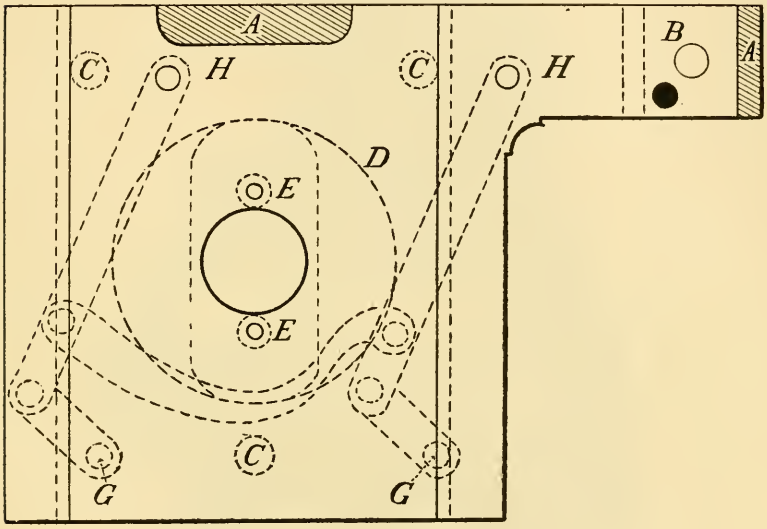
Fig 68.

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

his sister, Miss Celia Waters at the October Meeting, 1902.* It is mounted on a brass tripod-foot, with circular pillar, having joint for inclination.

The coarse-adjustment is by rack-and-pinion, attached to the stage, which moves up and down a square bar ; the latter also carries the mirror, which is of a concave form, in gymbal.

There is no fine-adjustment, but the arm carrying the body is provided with rack-and-pinion, which moves from back to front, and as the whole is mounted on a rotating centre, the body can be brought to almost any part of the stage.



Explanation of Fig. 69.

A. Lower plate.
B. Lever giving motion to upper plate.
C. Three studs, to keep plates apart.
D. Circular disk, held up to underside of stage by screws E, and which acts as a spring and also holds the plates together.
G. Two fixed points upon which the levers turn.
H. Studs screwed into upper plate, and by means of which the movement is obtained.

The most interesting part of this old Microscope is the lever-mechanical stage, engraved "Varley and Son." It consists of two parallel plates, the upper one being moved in any direction by aid of a long lever which extends almost down to the foot ; a diagram of the parallel motion is given above, with explanatory note (fig. 69). The upper plate of the stage carries a sliding plate with V-shaped fittings,

* See this Journal, 1902, pp. 721 and 722.

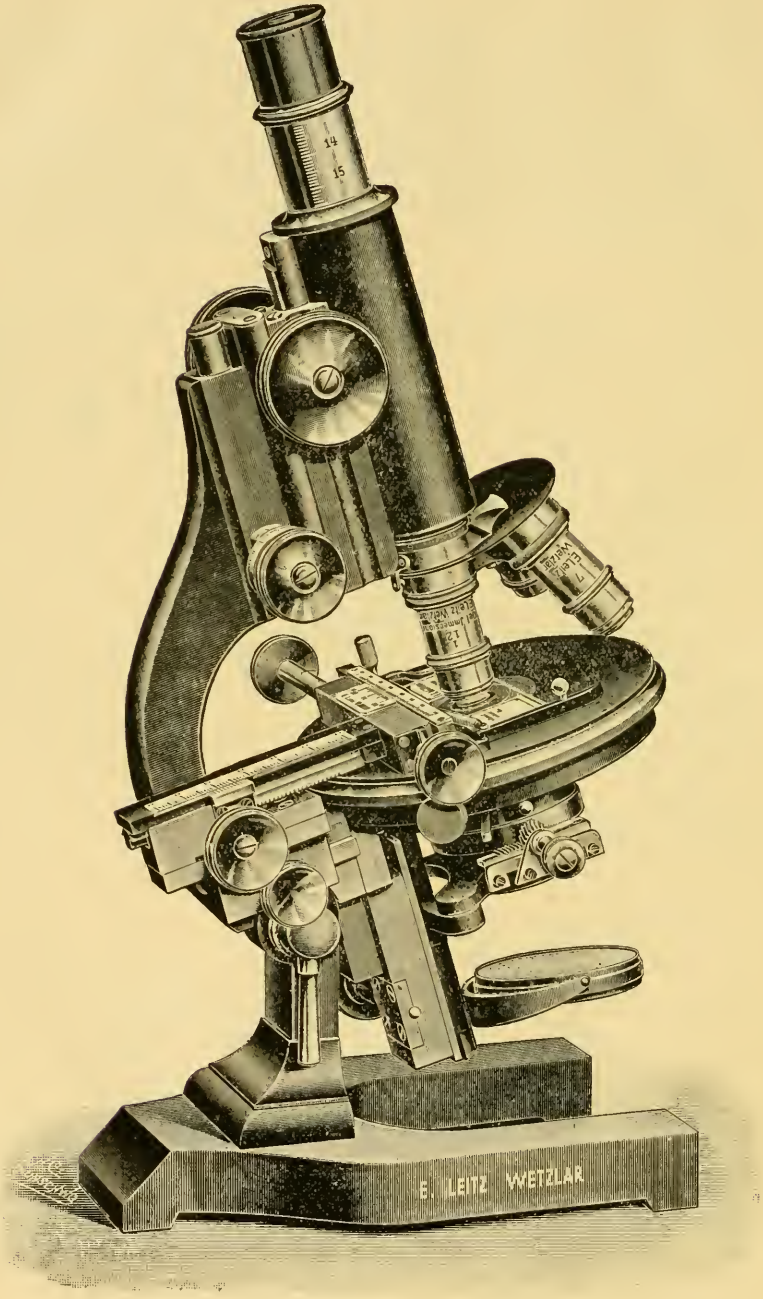


Fig. 70.

and the whole of the mechanical stage can be removed by unscrewing two clamp-screws.

Included in the mahogany case are three objectives, one eye-piece, two live boxes of round form, two stage forceps, and a stand condenser.

Leitz Microscope Stand B.* — This large model (fig. 70) differs from the stand A † in having a horse-shoe instead of a tripod foot. It has the Leitz new form of attachable stage with greatly extended mechanical motions. It is inclinable with hinged joint and clamping

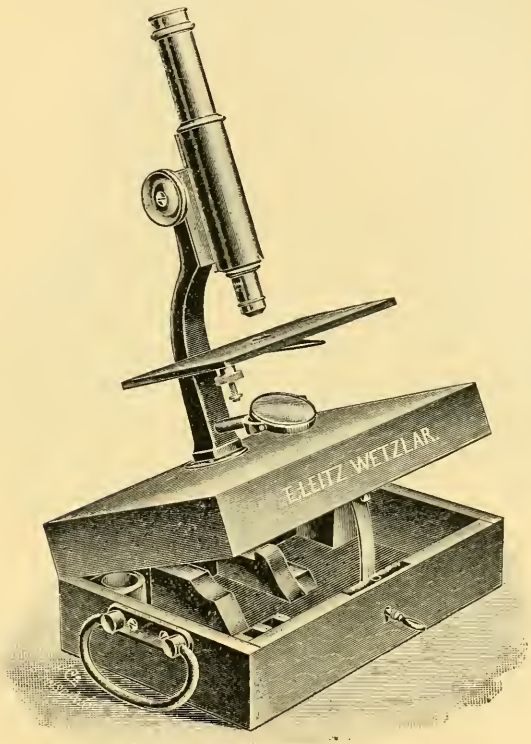


FIG. 71.

lever. The micrometer screw-head of the fine-adjustment is graduated in divisions of $\frac{1}{1000}$ mm. It is fitted with a swing-out substage condenser and iris diaphragm.

Leitz Portable Microscope.‡—This instrument (fig. 71) is the same as the Leitz auxiliary laboratory stand, but is specially adapted for

* E. Leitz' Catalogue, No. 41, English edition, 1905, pp. 28–9.
† See this Journal, 1903, p. 665.
‡ E. Leitz' Catalogue, No. 41, English edition, 1905, pp. 52–4.

travelling purposes, as it takes asunder so as to fit into a comparatively small case (fig. 72). The case serves as a foot for the Microscope, which is provided with a conical pin fitting into a bush in the lid of the case. The stage is provided with a wheel diaphragm, and the upper part of the case is made to slide so as to reduce the size of the case.

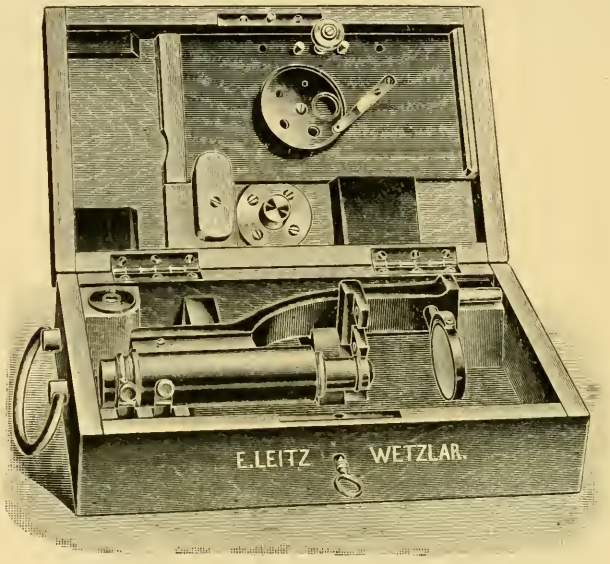


Fig. 72.

Recent Improvements in Leitz Microscope Stands.*—Carl Metz discusses several improvements which E. Leitz has applied to Microscopes, designed for the more refined requirements of medical and botanical research.

Stand II*b*, which is still the simplest available for the purposes of bacteriologists, was introduced in 1895, and has recently been improved, the tripod having been replaced by a more graceful and rigid foot of the horseshoe type (fig. 73). This instrument, besides forming an excellent student's Microscope, has frequently enabled those engaged in research to procure a suitable Microscope in cases where the means for a larger and costlier stand were not available.

The new stands (fig. 74), C, D, and F, differ from the older type mainly by the application of a micrometer screw of a new form. The screw is attached to the body of the Microscope immediately behind the tube, and transmits its motion to a slide carrying the tube. The new micrometer movement met with so much favour that the original inten-

* Zeitschr. wiss. Mikrosk., xxiii. (1906) pp. 430–9 (5 figs.).

tion of adapting it to the medium-sized stands was promptly carried into effect. By reason of the transposition of the fine-adjustment to the

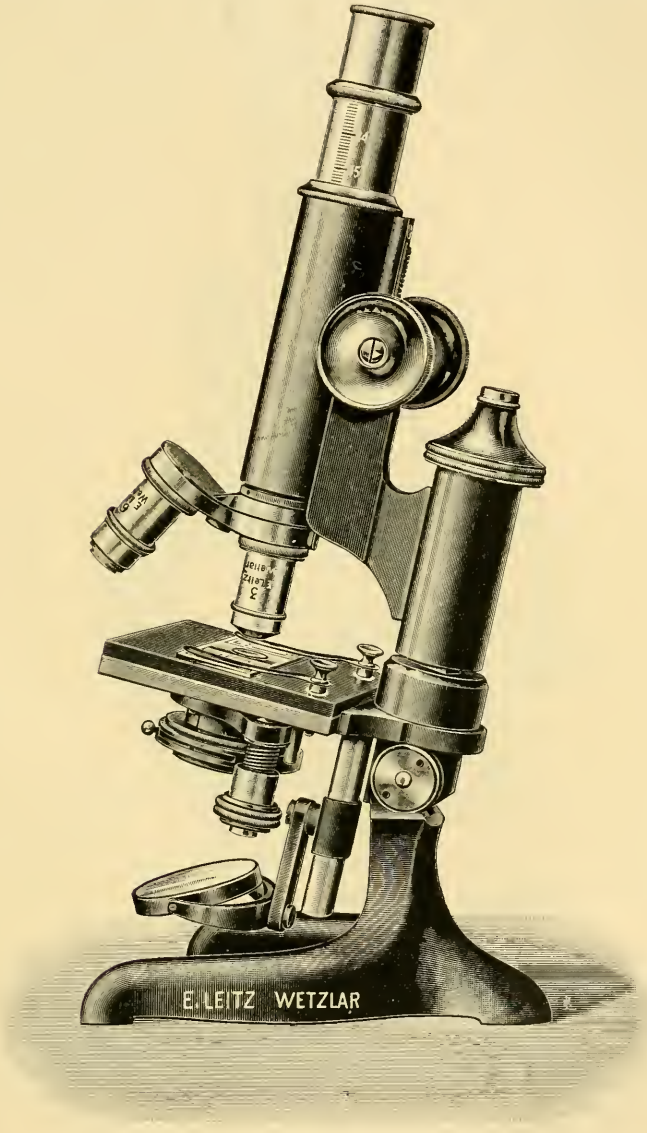


Fig. 73.

front of the body, the micrometer screw, unlike that of the continental stands, is relieved of the weight of the upper body and the tube

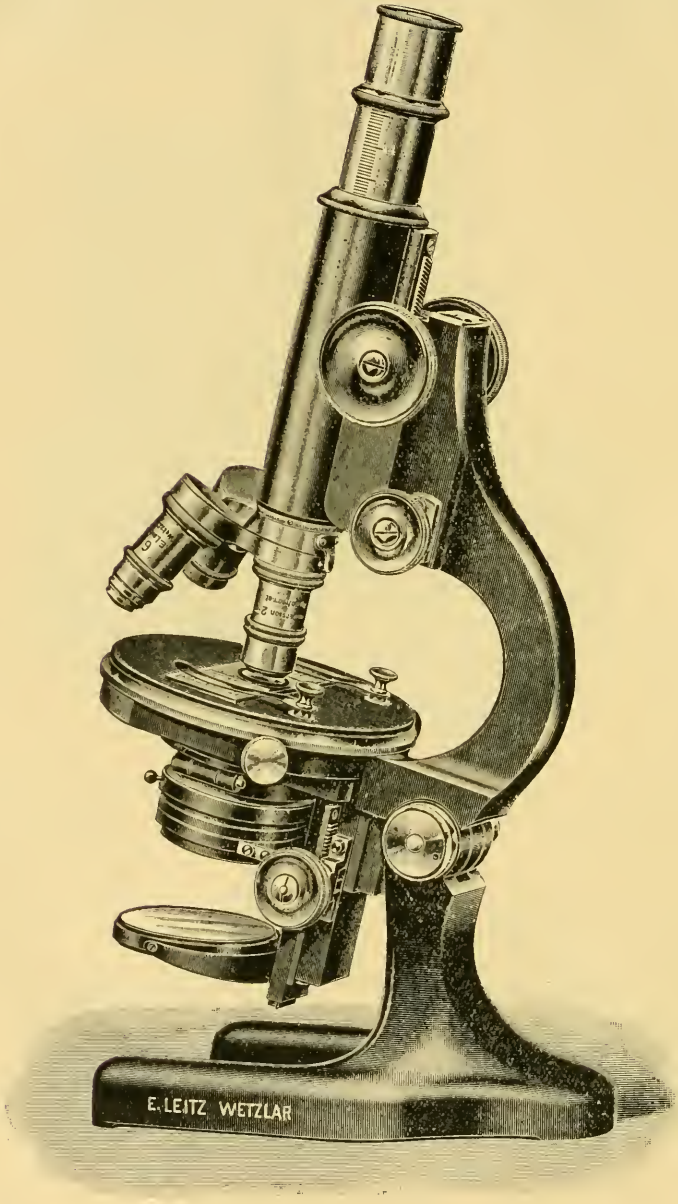


Fig. 74.

carrier, and accordingly it became possible to construct a more delicate movement.

Fig. 75 is a vertical section through the mechanism of the new fine-adjustment. The essentially new element of the movement is a heart-shaped cam *f* composed of two symmetrical and equal parts of a spiral curve. The spirals are of that simplest order in which the distance of the periphery from the centre of rotation increases in the same ratio as the angle of rotation. The maximum change in the peripheral distance amounts to 3 mm. The heart-shaped piece is mounted upon a tooth-wheel *d* in such a manner that its centre of rotation coincides with that of the tooth-wheel. The tooth-wheel is actuated by an endless screw *a*, which is controlled by the two milled heads projecting from the sides of the body. A spring *b* exercises a constant pressure upon the screw-spindle and the tooth-wheel, and thus eliminates play, even when the motion is reversed. The rise and fall of the spiral is transmitted by a

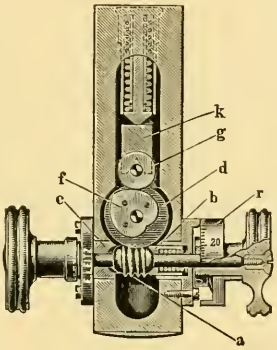


Fig. 75.

roller *g* upon a carrier *k*, which, being rigidly attached to the sliding piece, communicates its motion to the tube. The roller and spiral are kept in permanent contact by the weight of the tube and the spring situated above the roller and depressing the latter. An elevation of 3 mm. of the roller and consequently of the tube is produced by half a rotation of the tooth-wheel, i.e. a rotation of the cam from the point to the base. The tooth-wheel having 60 teeth must accordingly be turned through 30 teeth. Rotation through one tooth thus gives rise to an elevation of the tube amounting to $3/30 = 0{\cdot}1$ mm. The displacement of one tooth is effected by one complete revolution of the worm-screw *a* and its milled head. The drum is mounted upon the screw spindle and divided into 100 equal parts. The rotation of the drum through one division corresponds accordingly to an elevation of $\frac{0{\cdot}1}{100} = 0{\cdot}001$ mm.

In addition to the delicacy and slowness of the movement which is attainable with this screw, it possesses several other advantages. Owing to the association of two symmetrical spirals, so as to form a continuous

cam, the motion is of the nature of an endless rotation, producing a reciprocating motion of translation as alternately one or the other spiral comes into play. The movement encounters no check in either direction, and consequently there is no possibility of injuring the mechanism by rotation beyond any fixed limit.

The movement possesses the further advantage that it effectively guards against the destruction of a cover-glass and an object, since any excessive depression of the tube would merely cause the objective to gradually rest upon the cover-glass, whilst the cam detaches itself from the roller without, however, exerting any mechanical pressure upon the cover-glass, which with rare exceptions will readily bear the weight of the tube with its optical and mechanical appendages.

Immediately after its first description the micrometer movement was criticised,* and the criticism has been reiterated on p. 66 of the present volume of 'Zeitschrift für wissenschaftliche Mikroskopie,' the objection having been raised "that an observer working with this movement was never certain whether the tube was rising or falling, and that uncertainty of this nature was likely to become a serious impediment in ordinary ocular observation no less than in photo-micrography."

If this objection could be sustained, surely Leitz would ere this have removed the supposed defect. It is not difficult to recognise the reason why the maker and the thousand and one workers who already use this mechanism fail to admit the validity of this criticism. As a matter of fact, every practised microscopist focuses an object with a fair degree of accuracy by the rack-and-pinion only, and passes on to the fine-adjustment when he has obtained a pretty distinct image of his object. He then turns the micrometer screw in one or the other direction without experiencing any curiosity as to whether he is raising or lowering the tube, being quite content to obtain the sharpest possible adjustment in a minimum of time. The process is quite analogous to that occurring in other optical instruments requiring a fine adjustment, i.e. in telescopes, photographic lenses, optical lanterns, etc., where the observer is solely concerned in obtaining a sharp image, whereas the direction in which the mechanism moves does not interest him in the least.

In very special cases, e.g. when examining the substance of a thick preparation, an observer may consider it desirable that rotation of the coarse- and fine-adjustment in one direction should carry the tube in the same direction. In such a case he may with the aid of the two fixed marks in the tube-carrier and a movable index on the slider easily ascertain the direction in which the tube is moving. By giving the screw spindle a few turns in the same sense the direction of motion may be recognised at once. If its motion is not in agreement with that imparted by the rack-and-pinion the rotation of the micrometer head should be continued until the two movements become equidirectional. If, moreover, the movable index be placed midway between the fixed marks, it will be a long time before a change of direction occurs, since 30 complete turns of the drum are available before the motion reverses.

The introduction of the new micrometer screw and its transposition to the front of the column have brought with them several improvements

* See this Journal, 1903, p. 665.

in the general design of the Microscope, besides a few advantages which have been secured. The arching of the limb affords not only a convenient handle, whereby the stand may be grasped, but provides also an increased working space on the stage. The stands of this type, thanks to the precision of the new micrometer movement, have within a short time secured such a large measure of popularity as to create the impression that they are gradually supplanting Microscopes of the older type. It would seem that the creation of these new models, by associating the mechanical and optical qualities of German Microscopes with the elegant design of the English models, signalises a new era in the construction of Microscopes.

Leitz Large Mechanical Stage.*—This apparatus (fig. 76), adapted for the Leitz stands A, B, C, D, has very extensive lateral and vertical movements, which are effected by rack-and-pinion.

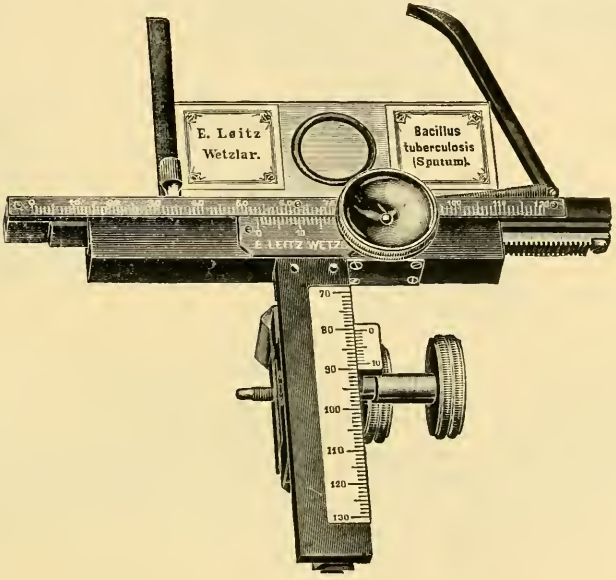


Fig. 76.

Ettles-Curties Ophthalmometer and Ophthalmic Microscope.—This instrument (fig. 77) is provided with a telescope having two objectives well corrected for chromatic and spherical aberrations, and of unusually large working aperture: between these two objectives a Wollaston double-image prism is placed.

The eye-piece is of the Ramsden type, and has a spider web fixed in a set plane. The operator focuses this web and then knows that the

* E. Leitz' Catalogue, No. 41, English edition, 1905, p. 89.

deviation on which the accuracy of registration depends is absolutely fixed.

The arc is of stout brass, concentric with the cornea under observation. It can be rotated around the polar axis of the eye so that any meridian can be observed. A transparent goniometer is attached to the telescope, also pointer and means of sighting to set telescope and insure the images of the mires being within the field of the eye-piece. The arc

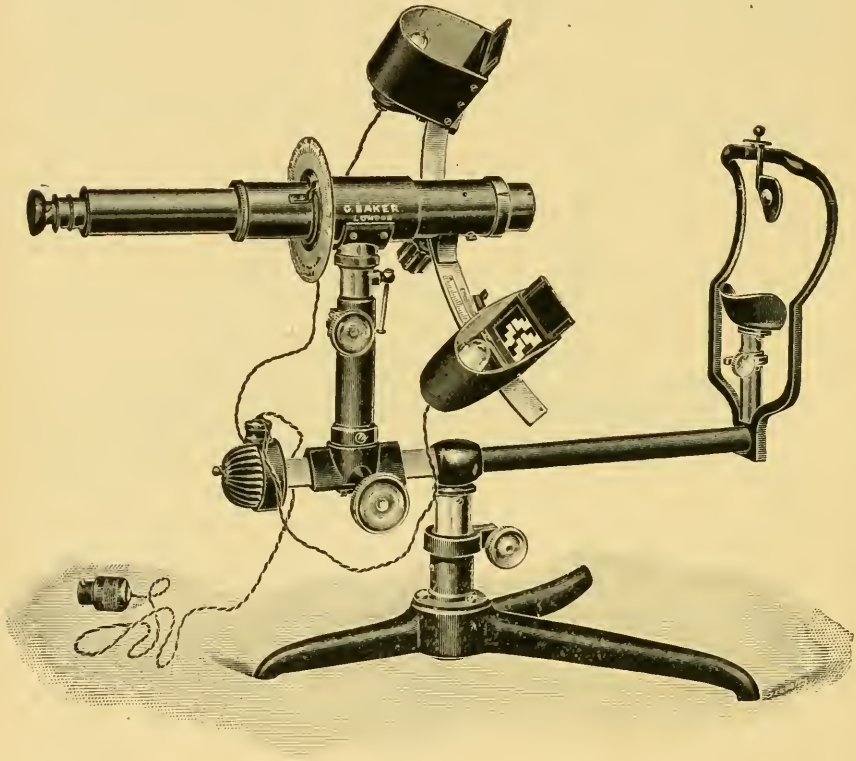


Fig. 77.

carries two symmetrically moving lanterns, or "mires," which are set in motion by rotating a single milled head engaging a double rack. Each mire contains an electric lamp, and one has a stepped stencil, the other a parallelogram with cross-line; the latter carries a red glass and the former one of green tint. The stepped mire is divided into six steps, each of which is exactly equal to one dioptre of curvature. The arc is graduated with two scales, one in half dioptres from 30 D to 60 D, and the other showing the actual radius of curvature of the cornea expressed in mm., from 5·5 mm. to 9 mm. A small mirror attached to arc admits of the scales being read from the eye-piece end of the telescope.

The face-holder has a chin-rest capable of being raised or lowered, and is marked on either side with two white lines indicating the position the patient's outer canthi should occupy.

The instrument is made in two forms, one mounted on a table stand, as illustrated, and the other with a tripod floor-standard on castors. The upright of the stand contains a helical spring which counterbalances the superincumbent weight and facilitates the adjustment of the instrument to the height of the patient's canthi. The whole of the upper part of the instrument can be removed and the ophthalmic Microscope or any other apparatus substituted.

The ophthalmic Microscope (fig. 78) consists of a body with draw-tube and R.M.S. gauge for objective and eye-piece.

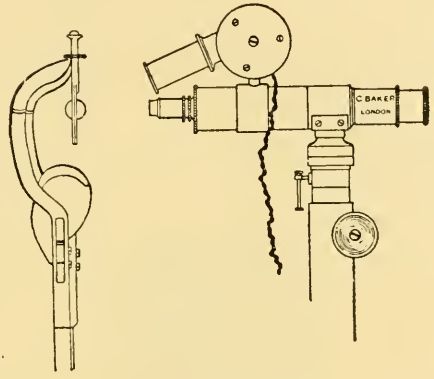


Fig. 78.

The electric illumination is inclosed in a cylinder and mounted on the body in such a manner as to admit of free orientation. It is provided with a condenser, adjustable to give either a parallel beam or a converging pencil, and has also a carrier for tinted glasses.

Objectives ranging from ⅜ in. to 1 in. can be employed.

Dieck, W.—**Das Photomikroskop für ultravioletten Strahlen und Seine Bedeutung für die histologische Untersuchung.**
SB. Ges. Naturf.-Freunde, Nos. 1–5, Berlin, 1905.

(2) Eye-pieces and Objectives.

Measurement of Highly Curved Lenses with the Abbe Spherometer.*—H. C. Lomb shows that the formula usually applied, viz.:

$$R = \frac{r^2}{2h} + \frac{h}{2}$$

is not sufficiently accurate for highly curved lenses. (Here R = required radius of curvature; h the lens thickness as measured by the instrument;

* Deutsch. Mech.-Zeit., 1907, pp. 15–17 (2 figs.).

r the arithmetical mean of the radii r_1 r_2 of the inner and outer edges of the circular holder.) In such cases a closer value of R is got from

$$R = \frac{r_1^2 + r_2^2}{4h} + \frac{h}{2} + \epsilon \quad . \quad . \quad (1)$$

R is first approximately calculated from the formula by omitting ϵ, that is from

$$R = \frac{r_1^2 + r_2^2}{4h} + \frac{h}{2}$$

The value of R, so obtained, is then substituted in—

$$\epsilon = \frac{(\sqrt{R^2 - r_1^2} - \sqrt{R^2 - r_2^2})^2}{8h}$$

Then the value of ϵ is substituted in (1), and the final value of R so obtained. The revised formula gives a result differing by 1·5 p.c. from that obtained from the ordinary formula.

Leitz Photographic Objectives with Iris Diaphragm.*—These new formula objectives (fig. 79) were designed for the Edinger, the

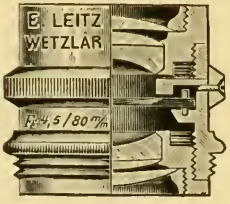


Fig. 79.

photomicrographic and projection apparatus of 64, 42, 35, and 24 mm. focal distance, and have proved useful for a number of purposes.

Hall, J. J.—**The Magnifying Power of Eye-pieces.**
English Mechanic, lxxxv. (1907) Nos. 2200–2.

(3) Illuminating and other Apparatus.

Demonstrating the Pseudo-vacuoles of Yeast-Cells.†—J. J. van Hest, after referring to the difficulty of illuminating yeast-cells and bacteria by any other than transparent light, describes how a kind of incident illumination can be attained by a process of lateral action. Under ordinary circumstances parallel light impinging on the mirror is reflected upwards through the condenser, and the rays cross before entering the objective. The object is therefore illuminated on all sides

* E. Leitz' Catalogue, No. 41, English edition, 1905, p. 11.
† Centralbl. Bakt. Parasitenk., xvii. (1906) pp. 94–5.

from below, and the light, if too strong, may be reduced by help of a circular diaphragm with a central orifice. But if this diaphragm be replaced by an opaque circular disk, out of whose margin a small circular segment has been removed, as shown in fig. 80, then only oblique rays will pass through the object. The result is that the convergent action of the objective procures a lateral and downward view of the object. The author obtained his best effects with a Zeiss objective C, and compensation oculars 8–18.

Fig. 80.

Zeiss Dark Ground Illumination by Stopping-off in the Immersion Condenser.*—The firm of Carl Zeiss have designed this apparatus for the convenient examination of living bacteria, blood-tests, and serum-tests. The method adopted is to insert a star-shaped disk into the diaphragm of the Abbe illuminating apparatus. The little central knob of this disk projects upwards, and upon it is accurately placed a central disk of 24 mm. diameter; the diaphragm-holder is then clamped. During this process the iris has been fully open. The entire fitting is now swung into position. In the majority of cases arc-light illumination would not be required.

Measurement of Light-absorption by means of Rotating Prisms and Motionless Sectors.†—E. Brodhun describes, under the above title, a species of photometer for the accurate determination of the loss of intensity suffered by a beam of light in passing through a given solid or liquid substance. The apparatus is so contrived that the percentage of light thus absorbed is read off on a graduated scale.

Achromatic Illuminator.‡—Percy Dunn describes an achromatic illuminator for examining the surface of the eye, and other similar purposes. The apparatus (fig. 81) consists of an achromatic lens

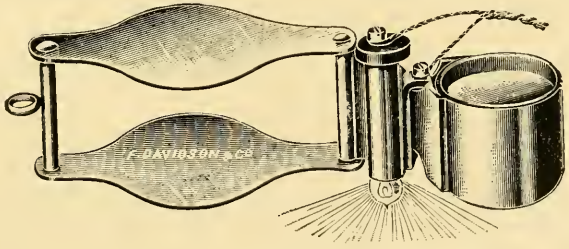


Fig. 81.

of about $\frac{1}{2}$ in. focus fixed in a metal clip, attached to which is a lamp-holder for an electric light. The current is controlled by means of a spring, by pressing which the light is turned on. The lamp is of

* Special Catalogue, Jena, 1907
† Zeit. f. Inst., xxvii. (1907) pp. 8–18 (8 figs.).
‡ Lancet, 1907, i. p. 1718 (1 fig.).

4 volts, and is screwed into the holder. A dry battery is supplied, which with intermittent use may last for more than 6 months. The apparatus can be fitted with 8- and 12-volt lamps for use with various accumulators, and even with the ordinary house current by means of special adapters. The apparatus is made by F. Davidson and Co.

HEIMSTADT, O.—**Spiegelkondensor für ultramikroskopische Beobachtungen.** *Zeitschr. f. Chem. u. Ind. d. Kolloïde*, Jahrg. 1, 1907, heft 9.

(4) Photomicrography.

Instantaneous Photomicrography.*—C. A. François-Franck gave a demonstration of the results he obtained by means of instantaneous photomicrography and of chronophotomicrography. The objects were taken under magnification varying from 60–600 diameters, and included the movements of the appendices, of the heart and intestines of *Daphnia*, colonies of *Vorticella*, respiratory appendages of the larvæ of *Ephemera*, branchia of *Arenicola*, etc.

LEITZ, E.—**Neuer mikrophotographische Universalapparat.** *Zeitschr. f. wiss. Mikrosk.*, xxiv. (1907) p. 40.

LOWENSTEIN, E.—**Versuche über Dreifarbenmikroskopie.** *Zeitschr. f. Tuberk*, x. (1906) p. 34.

(5) Microscopical Optics and Manipulation.

On the Nature of Optical Images.†—Albert B. Porter draws attention to the want of general recognition that all optical images arise

FIG. 82.

by interference, and are, indeed, particular cases of interference patterns, and describes a simple experiment which shows the relation between interference and image formation in a striking manner (fig. 82).

The experiment consists in passing a parallel beam of monochromatic light through a coarsely ruled, black-line, diffraction grating, and then through a convex lens. On the far side of the lens a system of sharply defined interference fringes is formed which can be seen by aid of an eye-piece, or intercepted on a screen, at any point over a considerable range along the axis. Somewhere in this system of fringes is the geometrical image of the grating, but it is visually quite indistinguish-

* C.R. Soc. Biol. Paris, lxii. (1907) pp. 964–7.
† Physical Review, xxiv. (1907) pp. 303–6 (1 fig.).

able from any other transverse section of the fringe system. Clearly in this case, the geometrical image is merely that section in which the geometrical condition of similarity to the object is satisfied.

The best arrangement of the experiment is the following. Light from an arc lamp A is focused by means of the lens B upon a narrow slip C. Thence it passes through a direct-vision prism at D, and the spectrum is focused by the lens E upon the narrow slit of a collimator F G. The parallel beam of monochromatic light thus obtained falls upon the mirror H of a microscope K J, upon whose stage, at I, the grating is placed in such a position that its ruled lines are parallel to the projection of the two slits C and F. Using a black-line grating of 400 lines to the inch, and having both slits narrowed down to a small fraction of a millimetre so as to secure very homogeneous illumination, the field of view was examined with $\frac{2}{3}$-in. objective and 1-in. eye-piece. The interference fringes appeared in the field of the eye-piece with exquisitely sharp definition throughout the whole range of the coarse-adjustment of the Microscope, i.e. over a distance of 58 mm., beginning with the front of the objective in contact with the grating and with its focal plane 7 mm. below the ruled surface ; and the fringes could be traced through a much greater range by withdrawing the eyepiece and moving it back along the axis. As the Microscope is slowly focused upward, the bands undergo curious changes in appearance, the lines showing sometimes close together and again further apart, but the definition is almost equally sharp throughout the whole range of adjustment, so that any section of the fringe system is as good an apparent image as any other section. Similar but less perfect effects may be obtained by illuminating the field by means of sodium light passing through a slit a couple of millimetres wide at a distance of one or two metres.

If the angle of the incidence of the light on the grating is changed by moving the mirror, the whole fringe system shifts to one side or the other except in the focal plane, where it remains stationary. This shows (1) that the focal plane is the plane in which the interference fringes formed by light of all incidences coincide ; (2) that, when a broad source is used, the geometrical image is really a superposition of coincident interference patterns ; and (3) that the usual absence of a sharp image outside the focal plane is due to the more or less uniform illumination resulting from the overlapping of fringe systems due to light coming from various points in the source. When the grating is illuminated by a parallel beam of white light by means of a collimator with very narrow slit, or, less perfectly, by a distant gas flame turned edgewise, the effects are similar except that outside the focal plane the fringes are coloured. Hence (4) the focal plane is also the plane of achromatic interference, i.e. the plane in which the fringes due to light of various wave-lengths coincide.

These experiments show very clearly why it is in general essential to use a condenser to illuminate the field of a Microscope in order to obtain a critical image, i.e. an image which comes sharply into and out of focus and which is hence as free as possible from confusion with details of structure lying above and below the focal plane. It is interesting to observe how, as the illumination is made less homogeneous and more

convergent, the distance through which the interference can be distinguished decreases, and the precision of focusing increases.

In the case of self-luminous objects, although the geometrical image is still to be considered as an interference pattern, the effects outside of the focal plane are greatly modified by the absence of definite phase-relations between the waves emanating from various points.

GLEICHEN, A.—**Leitfaden der praktischen Optik.**
Leipzig: S. Hirzel, 1906, viii. and 221 pp.

(6) Miscellaneous.

Textile Fibres.*—The well-known work of J. Merritt Matthews on the physical, microscopical, and chemical properties of textile fibres has recently passed into a second edition. To the microscopist the microchemical reactions and microscopical appearances and properties of fibres are necessarily the more important topics. These features are prominent, are treated of very fully, and are amply illustrated, mostly from original preparations of the author. The micro-analytical tables, which form a section of the chapter on the qualitative analysis of textile fibres, will be found very useful, not only to the practical operator, but to the amateur.

On the whole the work is fairly well balanced, though cotton receives considerable attention, over one hundred pages being devoted to it. In addition to the text proper, which treats of wool and hair fibres, shoddy, silk, cotton, linen, and other vegetable fibres, are four appendices. These deal with the microscopic analysis of fibres, a machine for determining the strength of fibres, commercial varieties of American cotton, and the bibliography of textile fibres. The volume is well got up, and the illustrations numerous and clear.

Quekett Microscopical Club.—The 440th Ordinary Meeting of the Club was held on May 17, the President, Dr. E. J. Spitta, F.R.A.S., F.R.M.S., in the chair.

A paper by Mr. F. Chapman, A.L.S., F.R.M.S., on "Some Littoral Gatherings of Foraminifera from Victoria, Australia," was read by Mr. A. Earland. The author gives an account of the literature on Victorian Foraminifera, and describes the geology of the localities from which gatherings were obtained. A detailed list of some 103 species is attached. Mr. Earland prefaced his résumé of the paper with some hints on the usual methods of collecting, and some very interesting remarks on the life-history of Foraminifera.

At the 441st Ordinary Meeting, held on June 21, the President in the chair, Mr. C. F. Rousselet, F.R.M.S., read a paper "On *Brachionus sericus* sp. n., and a new variety of *Brachionus quadratus*, and remarks on *Brachionus rubens* Ehrenberg." The new species was first met with in 1895 at Totteridge, and has since been obtained sparingly at other places near London, and also from Dundee and Exeter. In general appearance it resembles *B. urceolaris*.

* New York: John Wiley and Sons; London: Chapman and Hall, 1907, 480 pp., 126 figs.

B. Technique.*

(1) Collecting Objects, including Culture Processes.

Cultivating Bacillus fusiformis and Spirochæta dentium.†—P. Mühlens has isolated *B. fusiformis*, from the mouth, in pure culture, on horse-serum agar; the organism grows at 37° C. only on serum or ascitic fluid, or on media containing such fluids, and is a strict anaerobe. After 44–48 hours there appears under the surface of the serum agar fine yellow colonies with darkish centres and star-like projections; there is no production of gas; anaerobic serum bouillon cultures show a flocculent deposit and clear fluid; all cultures have a fœtid odour. There was only slight pathogenicity for laboratory animals.

The author also cultivated *Spirochæta dentium* for several generations together with a bacterium, on both solid and fluid medium; the colonies show after 8–10 days incubation at 37° C.; they are difficult to distinguish, and appear as a yellow clouding of the serum agar; they have an unpleasant penetrating odour; they grow only in the absence of oxygen, and on media containing animal albumen; sugar is not fermented; there is no production of gas; no growth occurs in milk or on potato. Spirochætes survive 4–6 weeks at 37° C. Pathogenicity for animals was not observed.

Bacteriological Diagnosis of Cerebrospinal Meningitis.‡—O. Brian advocates the following method for the rapid diagnosis of cerebrospinal meningitis. From a serum agar culture obtained from cerebrospinal fluid, a loopful is taken and rubbed in the side of a tube holding some of the patient's serum, and also of a controle tube, evenly-clouded fluids resulting. Both tubes are now centrifuged according to Gaehtgen's method for 10–15 minutes; with the serum giving a positive reaction the cocci are deposited as flocculi.

Cultural Characteristics of Tubercle Bacilli.§—J. v. Szaboky finds that the vigour of growth of the tubercle bacillus varies in different media; the best growth is obtained on lung agar, then on sputum agar, sputum-lung agar, and tubercle-lung agar; growth is less vigorous on egg medium, and on somatose agar; growth is best and quickest when the medium is slightly acid, less good if it is neutral or alkaline, and bad if strongly acid. On somatose agar it grows best if the medium is strongly alkaline; on egg medium growth is best when the medium is strongly acid. Growth is most vigorous on moist media like lung agar.

Apparatus for Isolating Micro-organisms.‖—M. A. Barber has devised the following apparatus for the isolating of single micro-

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

† Centralbl. Bakt., 1te Abt., xxxix. (1907) p. 479.

‡ Op. cit., xliii. (1907) p. 745. § Tom. cit., p. 651.

‖ Kansas Univ. Sci. Bull., iv. (1907) pp. 1–48 (3 figs.).

organisms. To an ordinary glass slide are cemented pieces of glass to form a box, open at the top and at one end (fig. 83), the dimensions of the box being 40 by 25 by 18 mm.; the sides are lined with wet filter-paper; a cover-slip 25 by 40 mm., cleaned and sterilised, is placed on the upper edges of the box, previously vaselined. On the under surface of the cover is placed a drop of a nutrient fluid, and near to it a drop of culture containing the organisms to be isolated: the whole is then placed on a Microscope stage; a fine capillary pipette with a curved tip and a brass holder is clamped to the left side of the stage: the box, with its open end towards the pipette, is adjusted so that the cross lines [x] on the cover are in the centre of the field; the pipette is then

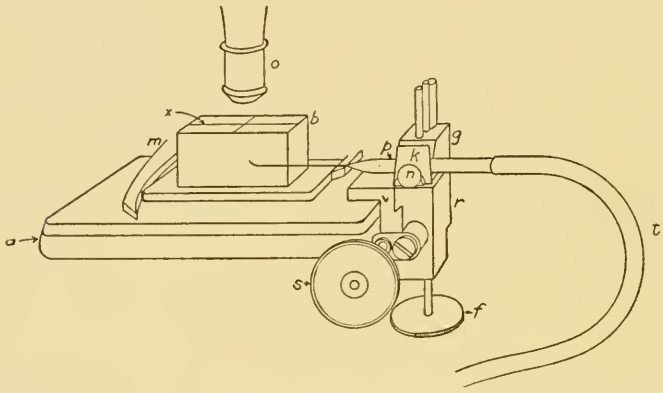


Fig. 83.

adjusted by moving it in the groove at the side of *g*, and by turning the screw *s* that moves the parts *r* and *g* of the holder, until the point is nearly in the centre of the field; the pipette, with the parts *g*, *k*, and *n* holding it, is raised or lowered by the screw *f*, the part *v* being clamped to the Microscope stage.

The portion of the cover bearing the sterile drop of medium is now brought into the field: the tip of the pipette is then raised into it and partially filled; the pipette is then lowered and the culture-drop is brought into the field; the pipette is then again raised until it comes into contact with the micro-organism to be isolated; this at once enters the pipette (often in company with other cells); the cover is then moved by the mechanical stage, until the tip of the pipette can be brought into contact with an unoccupied part of the cover, when its contents are discharged, being blown out gently by means of the rubber tube *t*. The author suggests various modifications to be used in special conditions.

Cultivation of Amœba of Dysentery.*—A. Lesage has found that human dysentery amœbæ, either in the soft or cystic stages, when

* C.R. Soc. Biol. Paris, lxii. (1907) p. 1157–9.

cultivated in the presence of leucocytes (guinea-pig, dog, rabbit, man), not only live but develop, while the leucocytes degenerate. The leucocytic exudate is placed on ice for a day and then centrifuged, and the supernatant fluid used as cultivation medium. Pus from abscess of the liver is sown in the fluid. Intestinal mucus is not very suitable for the purpose, but if necessary, must be injected into the peritoneal sac of a guinea-pig. This gets rid of most of the contaminating bacteria, and the peritoneal fluid may then be used for cultivation. Cultivated in this way, amœbæ have all the known characters of the human parasite.

New Method of Isolating Bacillus typhosus from Infected Water.*—W. J. Wilson describes a new method of isolating *B. typhosus*

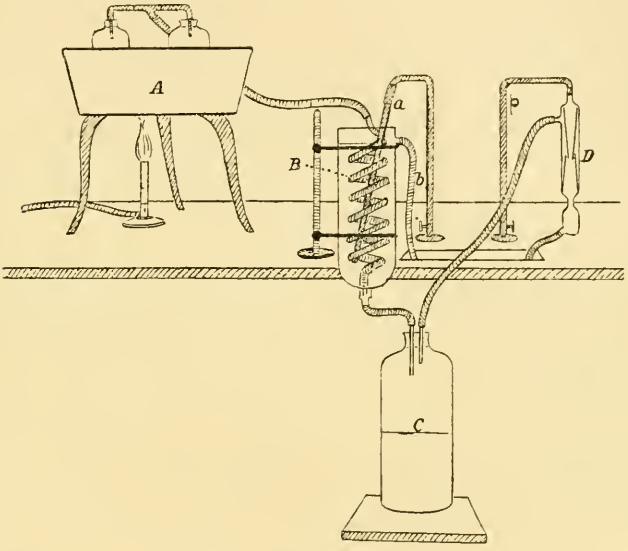


Fig. 84.

(fig. 84) from suspected water, which, according to ordinary standards, might be deemed free from pollution. The principle of the method is to evaporate water under reduced pressure.

A is a water bath maintained at 37–40° C. This temperature can be easily obtained by regulating the height of the flame of the Bunsen burner. No special gas regulator is required, though Reichert's may be used with advantage. In the bath are two Winchester quart bottles containing the water to be examined. Rubber corks fit into the necks of these bottles, and should be so shaped that they will not be driven in when the pressure in the interior of the bottle is reduced. These corks are perforated by glass tubes which project into the interior of the bottles. The surface of the water should be at least 4 in. from the end

* Brit. Med. Journ., 1907, i. pp. 1176–7 (1 fig.).

of these tubes, so as to prevent the water bubbling into them when it begins to boil. These tubes are bent at an angle immediately above the top of the corks. The advantage of an acute bend is that the condensed water finds a suitable gradient towards the worm of the condenser B, with which the tubes are connected by means of a T-shaped glass junction and rubber pressure tubing. Through the glass vessel surrounding the worm there is a continual flow of cold water, entering by the pipe *a* and leaving by the pipe *b*. The worm is connected with a large bottle C, which is also connected with a water filter pump D, which is secured to a pipe *p* coming from the main by means of stout tubing braced with cloth, cord, and wire. By this means a partial vacuum is obtained in the bottles, and the water readily boils at 37° C. The vapour readily condenses, and the distillate is collected in C. It requires 21–22 hours to evaporate a litre of water.

After starting the process it needs no further attention till the end is almost reached, when one should be at hand to stop it at the proper moment.

One filter pump can only deal efficiently with one or two bottles; if more are connected up with it the distillation process is proportionately slowed.

The residual water is plated out on the Conradi-Drigalski medium, and the plates incubated in the usual manner.

Cultivating Meningococcus.*—W. St. Clair Symmers and W. J. Wilson found that the most satisfactory solid culture medium was the following: Raw ascitic fluid 1 part, 3 p.c. agar 2 parts. The agar was made in the usual way, and Chapoteaut's pepton was found to give superior results to Witte's, though the latter was good. In making the medium the agar was allowed to cool to 55° C., and then the ascitic fluid warmed to the same degree was added. Slopes were made. When set the tubes were incubated for 24 hours to test the sterility. For this medium the laboratory name "chapasgar" is suggested.

The authors isolated meningococcus 52 times out of 75 samples of cerebro-spinal fluid, and from the blood of living patients in 3 out of 15 cases. The organism was found to be Gram-negative, did not peptonise gelatin, formed indol, forms acid from glucose and maltose, but not from galactose, does not form gas, grows well in media containing raw ascitic fluid, lives for at least a week in chapasgar, for 2–4 weeks in ascitic bouillon, for 2 weeks to 2 months in fluid sugar media.

R. M. Buchanan,† who has tried various media for cultivating meningococcus, finds that ox-serum after Loeffler's formula (3 parts ox-serum, 1 part bouillon, and 1 p.c. glucose) gives the best results. To this medium neutral red in the proportion of 1 : 10,000 was added as indicator. Meningococcus thrives well, and assumes a pink tint. On plating out meningococcus colonies are easily detected, and their indication is further corroborated by means of serum-sugar media (glucose, galactose, maltose, saccharose). Acid is formed in the glucose, galactose,

* Brit. Med. Journ., 1907, i. pp. 1477–9.
† Lancet, 1907, i. pp. 1590–1.

and maltose media. In the glucose tubes the condensation water is fluorescent, and there is also a pus-like appearance of the growth.

The organism retains its vitality in this medium for at least a fortnight.

Collecting and Preserving Thysanura.*—Alma D. Jackson finds that one of the most successful methods for collecting alive, is to introduce the insects (not more than two or three) into capsules, in which is placed a small piece of lense paper to absorb moisture from the insects, and to give them something to crawl over. The capsule may be perforated with a fine pin-point to admit air; it is important to keep the insects alive, as the antennæ and body begin to shrink directly they die. Another method is to use large-mouthed bottles with a funnel in the neck. Pieces of wood, bark, etc., are gently tapped over the hopper, and the insects fall into the bottle, which should be provided with damp wood, leaves, etc., for the animals to crawl over. For fixing the insects in the field, the collector should be provided with a large number of small, round-bottomed phials filled with the fixative, two or three fine camel-hair brushes, a large square of white oilcloth, and a chisel or pick for dislodging bark or decaying wood. The pieces of bark, etc., are pounded over the cloth on which the insects fall. The brush moistened with fixative is placed over the insect, which, when stupefied, is easily removed to the bottle. The following fixative is recommended: Glacial acetic acid 1 part, absolute alcohol 1 part, corrosive sublimate to saturation. This fixes in a few seconds, but specimens may be left on it for hours, and are then transferred to 85 p.c. alcohol or gradually to glycerin as follows: place the specimens on a stentor dish and add glycerin at one side. After a time the cover is removed to allow the acetic acid and alcohol to evaporate.

For preserving the colour, the following fixative has advantages: Glacial acetic acid 10 parts, glycerin 1–4 parts, corrosive sublimate to saturation. After some minutes, the acetic acid is allowed to evaporate, and then the glycerin should be changed frequently to get rid of as much sublimate as possible. Another method is to pour boiling absolute alcohol over the insects previously placed in a straight-necked phial; after from 5 to 15 minutes they are transferred to 95 p.c. alcohol, and finally preserved in 85 p.c. alcohol. The changes between different grades of alcohol should be made about every 10 or 15 minutes. If the insects are to be mounted in balsam, xylol may be added gradually to the absolute alcohol, or, on the other hand, glycerin may be added and the alcohol allowed to evaporate. Cedar or clove oil may be used in place of xylol with less liability to shrinkage.

One of the best methods for examining Thysanura is to transfer specimens which have been in glycerin for some hours to a thick syrup consisting of apple-jelly and glycerin. After an hour or so they are mounted in pure apple-jelly, to which a small quantity of carbolic acid or of corrosive sublimate has been added.

Specimens may also be examined in cedar or clove oil which has been

* Ohio Naturalist, vii. (1907) pp. 119–22.

boiled down to a thick syrup. Such mounts should be ringed round with Bell's cement.

Thysanura is easily kept alive in the laboratory by placing the insects in a straight-necked bottle, at the bottom of which are a few bits of decayed leaves and dirt. Then a piece of decayed wood is gummed tightly in, and by keeping this moist, and the bottle in a dark place, the insects will do as well as in their natural surroundings.

Bacteriological Diagnosis of Typhoid and Paratyphoid Fever.*— It is not universally known that it is possible to obtain pure cultures of typhoid or paratyphoid bacilli, from the blood-clot of patients after removal of the serum used for the Widal reaction. The clot is spread with a glass spatula over a litmus-lactose-agar plate; or the clot may be placed in a test-tube containing fresh ox-bile recently sterilised, and incubated over night. The next day Endo's or Drigalski-Conradi plates are inoculated from the bile tube. It is claimed that in this way the diagnosis of typhoid or paratyphoid fever may be made in the early stages of the disease, when the Widal reaction is slight or negative, and when the bacilli are not usually cultivable from the fæces.

(2) Preparing Objects.

Examining the Undulating Membrane of Spirochæta balbiani.†— A. Borrell and Cernovodeanu find that in the fresh state the undulating membrane is convex, semi-rigid, and striated. Fixed preparations of any value can only be obtained by killing the spirochætes rapidly by means of osmic acid vapour, and fixing the films afterwards with alcohol or other media. The films may then be stained with the gentian-violet-alcohol-formalin solution of Vlès. When examined, the membrane is found to be attached to the body of the parasite in a spiral line which makes one complete turn parallel to the line of torsion of the cell itself. All along the membrane are seen the striations which the authors regard in the light of a supporting framework, and compare it to the ribs of an umbrella.

Studying the Sporangium of Equisetum hyemale.‡—L. A. Hawkins killed the material with the fluid mixture: chromic acid 0·15 grm., acetic acid 0·35 c.cm., water 99 c.cm. The silicious protective leaves were removed before the young strobili were killed; they were then passed through upgraded alcohols and imbedded in paraffin m.p. 60°. Longitudinal sections, 7 μ thick, of the strobili were cut, the younger stages being stained with Delafield's hæmatoxylin, the older with safranin-gentian-violet-orange G mixture.

Studying the Sperm-cells of Notonecta glauca.§—J. Pantel and R. de Sinéty fixed the material in Flemming's or Bouin's fluid; neither gave complete satisfaction at all stages. In order to facilitate orientation

* Lancet, 1907, i., pp. 1241–2.
† C.R. Soc. Biol. Paris, xlii. (1907) pp. 1102–4 (1 fig.).
‡ Ohio Naturalist, vii. (1907) pp. 124–8 (2 pls.).
§ La Cellule, xxiii. (1906) pp. 87–303 (8 pls.).

the organs to be sectioned, while in the supra-vital state, were placed on a slide in a drop of physiological salt solution and washed with the fixative. This insures the organs retaining the position and attitude desired.

In order to examine sperm-cells *in toto*, it was found best to place efferent ducts or the long spiral duct which forms the pedicle of the spermatheca of the female on a slide in salt solution to which saliva was added and then rupture the sheath by exciting moderate traction. This allowed the sperm-cells to escape; after running off any excess of fluid, the filaments were fixed with formol-picro-acetic acid. The authors note that spermatozoa are very sensitive to desiccation, but not at all to the action of reagents.

Most of the preparations were stained with Heidenhain's iron-hæmatoxylin, but some were treated with fuchsin, followed by picro-indigo-carmin or Unna's blue solution.

Studying Spermiogenesis in the Squirrel.*—J. van Mollé fixed the material in Hermann's, Bouin's, Carnoy's, or Gilson's fluids; of these, Bouin's gave the best results. The sections were stained with the safranin-gentian-violet-orange G mixture or with Heidenhain's hæmatoxylin and Congo red. For examining, Beck's oil-immersion condenser and Koristka's apochromatic or semi-apochromatics were used.

Studying Spirochæta balbiani and S. anodontæ.†—H. B. Fantham obtained the material from oysters and from the crystalline style of *Anodonta cygnea*. Much time was spent in examining these spirochætes in the living condition, and as far as possible in their natural medium. For fixed and stained material the best results were obtained from thin smears of gut contents or solutions of the crystalline style (sea-water for *Ostrea*, fresh-water for *Anodon*), the preparations being fixed wet with osmic vapour. Other fixatives used were Flemming's solution, corrosive sublimate, and alcohol, and in the case of dried smears methyl- and ethyl-alcohol. The preparations were usually mounted in cedar-wood oil or balsam. The most useful stains were gentian-violet (Ohlmacher's formula), iron-alum-hæmatoxylin, thionin, Billet's modification of Giemsa and Delafield's hæmatoxylin, while dilute methylen-blue was best for intravitam staining. The results from Romanowsky's stain were indifferent.

Demonstrating the Presence of the Spirillum of Tick Fever.‡—C. Levaditi and Y. Manouélian infected animals—mice, rats, and monkeys—by means of subcutaneous and intra-peritoneal injections. The animals were killed at varying intervals. The organs were fixed in 10 p.c. formalin, or in Gilson's sublimate-acetic acid alcohol. For demonstrating the presence of the spirilla in sections, the silver-pyridine method used for the study of *Treponema pallidum*, was adopted. For examining the details of phagocytosis the following procedure was necessary: Pieces, about 1 mm. thick, of previously fixed tissue

* La Cellule, xxiii. (1906) pp. 1–52 (2 pls.)
† Ann. and Mag. Nat. Hist., xix. (1907) pp. 493–501.
‡ Ann. Inst. Pasteur, xxi. (1907) pp. 295–311 (2 pls.).

(formalin and absolute alcohol) were soaked in water and then immersed in a 1 p.c. solution of tannin, to which pyridine was added in quantity sufficient to redissolve the turbidity. After about a quarter of an hour in this bath at 50°, the pieces were frequently washed in distilled water. The pieces were next placed in a flask containing a 1 p.c. solution of nitrate of silver, to which 10 p.c. of pyridine had been added, and incubated at 50° for an hour. After a wash in distilled water the pieces were reduced in a 4 p.c. solution of pyrogallic acid, to which as much pyridine had been added as served to render the solution clear. Reduction took only a few minutes. Then distilled water, alcohol, xylol, paraffin, and sections; the latter were stained with a combination of neutral red and methyl (*sic*) blue.

Studying the Spermatogenesis of Blatta germanica.* — A. Wassilieff fixed the testicles in sublimate, sublimate acetic acid, Flemming's and Hermann's solutions, all of which gave good results. Carnoy's, vom Rath's, and Rabl's fluids were unsuccessful. Sublimate preparations stained with iron-hæmatoxylin showed the centrosomes well. Mitochondria were excellently shown when iron-hæmatoxylin was used after Flemming's fixative. Magenta-indigo-carmin with picric acid (Ramon y Cajal's method) was extremely suitable for the study of chromosomes. The last-mentioned stain was also effective for centrosomes, but useless for mitochondria. As the sexual glands function throughout the year, all stages in the development of the sexual products were always obtainable.

(3) Cutting, including Imbedding and Microtomes.

Studying the Nucleus and Kinesis in Spirogyra.†—Jules Berghs fixed the material in Hermann's, Bouin's, or in Moll's modification of Flemming's fluid. The material was gathered once in June and once in September, the former at about 9 p.m., the latter at midnight; both collections gave numerous kinetic figures. The different stages in manipulation from the fixative to imbedding in hard paraffin, were very slowly and carefully carried out, a dialyser being used when transferring from aqueous media to alcohol. When the chloroform stage was reached it was found expedient to use soft paraffin at first and gradually work up to hard. Most of the sections were stained with Heidenhain's iron-hæmatoxylin, but some with safranin and light green, as advised by Benda.

Treatment of Celloidin Serial Sections.‡ — Ino Kubo communicates the following procedure. The sections in series are kept till wanted in a glass vessel. Each series is placed on a numbered strip of bibulous paper moistened with alcohol, and this in its turn is inclosed in another piece, which is tied or rolled.

The slides to be used are first marked with a diamond or with Indian

* Archiv Mikrosk. Anat. u. Entwickl., lxx. (1907) pp. 1–42 (3 pls.).
† La Cellule, xxiii. (1906) pp. 53–86 (3 pls.).
‡ Archiv Mikrosk. Anat. u. Entwickl., lxx. (1907) pp. 173–6 (1 fig.).

ink, and then receive two or three thin coats of celloidin. In order to remove a series from the paper strips, it is only necessary to immerse the section in water, when it floats away to the top, and may then be lifted on to the prepared slide, which must previously be moistened with distilled water. When all the sections are arranged, the excess of water is poured or blotted off, and then with two or four folded strips of paper the sections are firmly pressed down into the celloidin layer on the slide. To insure firm adhesion, the slide is dipped in alcohols upgraded from 80 p.c. to 98 p.c., and on removal the sections are smoothed down each time. Lastly, a little ether is brushed over the surface. After a partial drying, the slides may be stained right away, or preserved for future use in 80 p.c. alcohol.

The adhesion of the sections to the slide is so firm that they can be stained with hæmatoxylin, decolorised with hydrochloric-acid-alcohol, and neutralised with ammonia water without the film stripping off, though care must be taken not to make the changes from alcohol to water too sudden, nor should absolute alcohol be used too long for dehydrating. For clearing up, carbol-xylol answers well. About 10 troughs, 12 by 6 by 4 cm., are required for the different fluids. For accurately disposing of the sections on the slide, the author uses a piece of card or glass some 3 by 2 in., with vertical and transverse lines; this is placed under the slide while arranging the sections.

(4) Staining and Injecting.

New Modification of Romanowsky's Stain.*—R. May has devised the following simple method of applying Romanowsky's stain. The preparation is stained in a 0·25 p.c. methyl-alcoholic solution of acid eosin-methylen-blue, and placed for one minute in distilled water; then, whilst still wet, a drop of 0·5 p.c. methylen-azur solution distributed regularly over the specimen; by the action of the methylen-azur the blue nuclear stain is faded and assumes a red appearance.

The method is suitable for staining bacteria and spirochætes.

Studying Oogenesis in Paludina vivipara and Chromidia in Paludina and Helix.†—M. Popoff fixed the material, ovaries of animals at different ages obtained in spring, summer and autumn so as to get all stages of development, in Zenker's, Petrunkewitsch's and in Flemming's fluids. Flemming gave excellent results for nuclei in *Paludina*, but blackened the cytoplasm too much; on the other hand, for *Helix* it was specially good. The preparations were stained with iron-hæmatoxylin, but for deciding the case of the nucleolus they were controlled with Delafield's hæmatoxylin, hæmatoxylin-eosin, hæmatoxylin-acid-fuchsin, Flemming's double stain, Berlin blue, borax-carmin, and gentian-violet. Teased-out preparations stained with borax-carmin and examined in oil of cloves were of great service.

* Centralbl. Bakt. Ref., 1te Abt., xxxix. (1907) p. 582.

† Archiv Mikrosk. Anat. u. Entwickl., lxx. (1907) pp. 43–129 (5 pls.).

Staining Spirilla in Sputum.*—L. Follet makes use of the following mixture: Glycerin 40 grm., acid-fuchsin 2 grm., pure carbolic acid ½ grm. Mix, and filter after solution. The sputum to be examined should be recently expectorated, and preferably after fasting. Pick out a fragment with a platinum needle, place on slide, and add thereto a minute drop of stain. Mix thoroughly and put on a coverslip and examine. If a little acid green dissolved in glycerin be mixed with the sputum before the acid-fuchsin is used, a brownish hue is imparted to the preparation; and if a double-staining be desired, this may be effected by using in addition to the acid-fuchsin solution the following mixture: Glycerin 40 grm., methylen-blue 2 grm., pure carbolic acid 0·5 grm.

While this medium stains all the spirilla infesting the mouth, so that quite swarms may be observed in the same field, there is no difficulty in differentiating *Treponema pallidum*.

Another method given by the author is suitable both for fixed and fresh films. This consists of chloroform 40 grm., methylen-blue 2 grm., acid-fuchsin 0·25 grm., pure carbolic acid 0·5 grm.

The stained preparations must be thoroughly washed in running water, and if need be in alcohol to remove excess of pigment.

Orlean, a New Stain for Cork and Cuticula.†—P. Sonntag finds that Orlean or Annatto, used for dying wool and silk, and for colouring butter and cheese, makes a good stain for cork and cuticula. The reagent used is a solution of Orlean extract (Extract-Orleanæ spirit. spiss.) dissolved in alcohol and filtered. If this solution be applied for ½–1 hour to sections of *Cystisus Laburnum*, which are afterwards washed in alcohol and then placed in water or glycerin, the cork-cells are found to be stained orange-yellow, contrasting with the whiteness of the rest of the tissue.

Modification of Donaggio's Method for Staining Nerve-cells.‡—Andrea Tomaselli treats the material as follows: Pieces of nervous tissue (spinal ganglia) are immersed in ammoniacal alcohol (absolute alcohol 100, ammonia 4–5 drops) for 6–7 hours. They are then immersed in pure pyridine and kept at a temperature of 36–37° C. for two days, the pyridine being very frequently changed, especially at first. The pieces are then washed in running water for 2–3 hours. The after treatment is the same as that in Donaggio's third method, i.e. the material is treated with an acid solution of molybdate of ammonia for 12 hours, imbedded in paraffin, and the sections stained with thionin (1:10,000).

Bielschowsky's Impregnation Method.§—F. K. Studnička obtains excellent results from Bielschowsky's impregnation method when dealing with connective-tissue fibres in bone, dentine, and hyalin cartilage. The procedure is as follows. The method of fixation is quite immaterial, good results being obtained from alcohol, formalin, 4 p.c. nitric acid, Muller's, Flemming's, Perenyi's, Mayer's, Kleinenberg's, and other

* C.R. Soc. Biol. Paris, lxii. (1907) pp. 567–8.
† Zeitschr. wiss. Mikrosk., xxiv. (1907) pp. 21–4.
‡ Op. cit., xxiii. (1906) pp. 421–2. § Tom. cit., pp. 414–20.

fluids. The material is decalcified in the usual way, but the author used nitric acid with 3 p.c. alcohol. Both paraffin and celloidin sections can be used. The sections, after thorough washing in water, are placed in 3 p.c. silver nitrate solution for about 4 days. They are then washed in distilled water, and afterwards transferred to an ammoniacal silver solution, prepared as follows: to a 10 p.c. solution of silver nitrate a 40 p.c. solution of caustic soda is added drop by drop until a precipitate is no longer produced. The sediment is then dissolved in ammonia. The slightly yellowish fluid is filtered and made up to four times its bulk with water. In this fluid the sections become darker, and of a yellowish-brown hue. After washing they are placed in 10 p.c. formalin, which turns them brown. After 5 minutes or so, they are washed, and then placed in ½ p.c. gold chloride solution, in which their colour becomes grey to black. They are next transferred to a 5 p.c. solution of fixative soda, which renders them less opaque as some of the unreduced silver is dissolved. Then follows a thorough washing in water, alcohol, oil, xylol, balsam.

The sections may be contrast-stained with advantage, e.g. with acid-fuchsin or with Van Gieson's picric-acid—acid-fuchsin mixture.

Demonstrating the Presence of Negri Corpuscles in Salivary Gland of Mad Dogs.*—Élise Stefanescu fixed the material in formalin and made frozen sections, which were stained by Mann's method (methylen-blue and eosin) modified to suit the requirements of the case. The sections were staining for 20–30 minutes. They were then washed with water, dehydrated in alcohol, cleared up in xylol, and mounted in balsam. The Negri corpuscles were stained red-violet, which easily differentiates them from the blue colour of the cytoplasm.

Studying Sympathetic Nervous System of Mammals.†—A. Kohn used rabbit embryos in his research and fixed the material for 24 hours in the following fluid: 25 c.cm. of 5 p.c. aqueous sublimate solution, 75 c.cm. of 3½ p.c. potassium bichromate solution, 5 c.cm. acetic acid. After washing for 24 hours in running water the material was passed through upgraded alcohols to 95 p.c. alcohol. To this last some tincture of iodine was added, and, after sufficiently iodising the material, was preserved in 95 p.c. alcohol. The material was stained *en masse* with alum-cochineal or with dilute hæmatoxylin, and in the latter case the sections were contrast-stained with picro-fuchsin, eosin, Congo-red, etc. Sections were also treated with Weigert's iron-hæmatoxylin-picro-fuchsin stain and also by Ramon y Cajal's silver method.

Demonstrating the Presence of Striated Muscle in the Thymus.‡—R. Weissenberg killed the fowls with chloroform and fixed the tissue with some preparation of osmic acid, Flemming's strong solution giving the best results. Tellyesnicsky's fluid was also used. Sections 3 μ thick were stained with iron-hæmatoxylin or by means of Bielschowsky's silver method. The sections were mordanted for 4 hours,

* C.R. Soc. Biol. Paris, lxii. (1907) pp. 886–8.
† Archiv Mikrosk. Anat. u. Entwickl., lxx. (1907) pp. 266–317 (3 pls.).
‡ Tom. cit., pp. 193–226 (1 pl.).

stained for 16 hours, and differentiated with iron-alum for 20 seconds only. The correct degree of differentiation was gauged by examining under an oil-immersion.

New Method of Staining the Tubercle bacillus.*—M. Barberio's method consists in staining the film with a solution of magenta and phenol, and afterwards treating it with a dilute solution of nitrous acid, which does not affect the staining of the tubercle bacillus, but decolorises most bacteria owing to the conversion of the basic magenta into a colourless diazo-compound. The preparation is first treated for 25–30 minutes at 40–50° with a mixture of 2 c.cm. of a cold saturated solution of magenta in 96 p.c. alcohol, and 2 c.cm. of a 5 p.c. aqueous solution of phenol. It is then rapidly washed in water and immersed for 10–15 minutes in 10 c.cm. of a dilute solution of sodium nitrite (1 : 20,000) containing a drop of dilute hydrochloric acid (D 1·12). Bacteria, other than tubercle bacilli, can be stained differentially by means of methylen-blue. The preparation is finally washed in water, dried, and mounted in balsam.

Tetrachrome Staining Mixture.†—G. Delamare has devised a four-colour solution for simultaneously staining nuclei and connective, elastic and muscular tissue. It consists of two solutions which are mixed in equal parts. The first is composed of orcein, 1 grm. ; hydrochloric acid 1 c.cm., absolute alcohol 50 c.cm. ; the second of Ehrlich's hæmatoxylin 2 c.cm., saturated aqueous solution of acid fuchsin 1 c.cm., saturated aqueous solution of picric acid 200 c.cm. The paraffin sections are first immersed in slightly acidulated water, and afterwards in the stain at 45° for 20–30 minutes. On removal they are rapidly washed in acidulated water (4 or 5 drops to 100 c.cm.), and then placed in tap water to bring out the blue of the hæmatoxylin. Then alcohol, xylol, balsam. Nuclei, blue ; muscle fibre and protoplasm, yellow ; connective-tissue, yellow ; elastic fibres, black.

Examining the Sputum in Cancer.‡—L. Follet has found a micro-organism with double contour, and apparently a yeast in the sputum of persons affected by cancer. He stains fresh unfixed films with the following mixture : glycerin, 40 ; methylen-blue, 2 ; carbolic acid, 0·5. The ingredients are dissolved and the mixture filtered. In order to obtain permanent preparations he adopts the following procedure : 40 grm. chloroform, 20 grm. liquid ammonia, and 10 grm. of carbolic acid are mixed in a flask, and after a few hours the chloroform is syphoned off, and then to this carbolate of ammonia a gramme of methylen-blue is added ; the mixture is then filtered. A film of the sputum to be examined is made in the usual way, and stained without heating ; a few drops of chloroform are poured on the film, and when this has evaporated, the slide is washed in running water and afterwards dried with blotting-paper. The films may also be stained with the

* Rend. Accad. Sci. Fis. Mat. Napoli, xii. (1906) pp. 446–9. See also Journ. Chem. Soc., xcxi.–xcxii. (1907) p. 381.

† C.R. Soc. Biol. Paris, lviii. (1905) pp. 828–9.

‡ Tom. cit., lxii. (1907) pp. 790–2.

following mixture: methylen-blue, 2; fuchsin, 0·3; carbolic acid, 0·5; glycerin, 40; distilled water, 20. This imparts a double stain and shows the details well.

The author has found the micro-organisms he mentions more than a hundred times in cases of undoubted cancer, and has frequently been led to diagnose the condition in cases where malignant disease has not been suspected.

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

Euparal, a New Mounting Medium.*—G. Gilson finds that sandarach, or pounce, a resin derived from *Callitris quadrivalvis*, is a valuable basis for mounting media. The principal menstruum is a mixture of camphor and salol, called for short "camsal," which forms a colourless liquid having a refractive index of 1·53576. In this menstruum, sandarach is only slightly soluble, the addition of some alcohol or other solvent being necessary. The two alcohols which were found suitable for the purpose were isobutylic and propylic. The mixture of sandarach, camsal, and propylic alcohol makes a medium having a refractive index of 1·47892.

Isobutylic alcohol was found to have properties more suitable for microscopical technique; thus it is extremely useful for dehydrating delicate objects, and when used as solvent for camsal and sandarach, forms a balsam having a refractive index of 1·47892.

The two foregoing media have the inconvenient defect of dissolving pigments, so that they are practically useless for mounting stained preparations. In a mixture of eucalyptol and paraldehyde, the author found an efficient substitute for the alcohols, and to the mixture of sandarach and camsal with eucalyptol and paraldehyde, he gives the name of "euparal." The refractive index of euparal is 1·48302.

Under the name of essence of euparal, Grübler supplies a mixture for dissolving euparal. This essence is mixed with euparal in the proportions of 1 : 1, or 2 : 1, and is useful in technique, as the preparations can be taken directly from 70° alcohol to the medium. Euparal is stated to possess all the qualities of an ideal mounting medium.

Water-glass for Marking Slides.†—R. F. Griggs describes a method for marking slides which is specially useful for serial sections. The medium is water-glass, aqueous solution of sodium or potassium silicate, thinned if necessary till it will flow well from a pen. A steel pen of the stub or ball-pointed sort is used. After the slides are marked they must be heated by holding them for a few seconds in the blue cone of a Bunsen flame till the water-glass decomposes, giving off strong jets of sodium light, and at the same time effervescing so as to leave behind a rough sandy surface. This is then rubbed down against some hard object, such as a table edge. This leaves a ground-glass surface, which will be unaffected by any reagent. If desired,

* La Cellule, xxiii. (1906) pp. 425–32.
† Ohio Naturalist, vii. (1907) pp. 157–8.

some inert dye, such as carmine, may be stirred into the solution to make the marks more conspicuous.

Mounting Worms in Amann's Lactophenol.*—Langeron killed Nematoda in 5 p.c. formalin, and then gradually substituted for the fixative Amann's lactophenol (carbolic acid 20, lactic acid 20, glycerin 40, distilled water 20), in which menstruum the worms were mounted.

(6) Miscellaneous.

Studying the Plumes of Cephalodiscus.†—W. G. Ridewood studied the development of the plumes in the buds of *Cephalodiscus*, and describes the procedure adopted. In the youngest stages the whole bud was mounted in diluted glycerin, and gold size was run round the edge of the cover-glass to keep it firmly in position and to prevent the glycerin from accumulating dust. Most of the buds were dissected, the shield being first removed by tearing through its stalk by the aid of fine needles, and then the collar region, with plumes and post-oral lamella, was removed by carefully manipulating the needles between these parts and the "body" of the bud. The three parts, shield, collar-region, and "body," with its stalk, were then mounted on the same slide in dilute glycerin. In some cases these three parts were drawn separately on tracing paper, and the perfect bud reconstructed by a superposing of these transparent sheets. No staining fluids were used. The dissections were made under a Greenough binocular erecting Microscope, magnifying 20 to 40 diameters.

Examining the Chromatin-masses of Piroplasma bigeminum.‡—H. B. Fantham fixed and stained the blood-films by Romanowsky's method, and in order to eliminate as far as possible sources of error incidental to stained preparations, the slides were examined under various kinds of illumination. These were (1) critical illumination, using as the source of light the sharp edge of a paraffin flame; (2) monochromatic light (green or yellowish-green was best); (3) light from a Welsbach burner or an electric lamp. Only the first two were useful; while the chromatin could always be distinguished from the cytoplasm of the parasite, very bright white light failed to accurately show the relative sizes of the chromatin masses, there being also a lack of detail. Too strong a light gave wrong impressions as to size and condition of the vacuoles. Daylight was also used. The objectives used were Zeiss' 2 and 3 mm. apochromats, with 8, 12, and 18 oculars. Relatively pale-stained preparations were found to be far superior to more deeply stained ones, as the finer chromatic details and the looser chromatin in the latter are obscured, and the finer structural details masked.

Appliances for Counting Blood-corpuscles, Yeast-cells, Bacteria, etc.§—C. Zeiss and Co. describe their counting chambers and mixing pipettes. The counting chamber is made by cementing a glass plate

* C.R. Soc. Biol. Paris, lviii. (1905) pp. 449–50.
† Quart. Journ. Micr. Sci., li. (1907) pp. 221–52 (11 figs.).
‡ Tom. cit., pp. 297–324 (1 pl. and 44 figs.).
§ Carl Zeiss' Special Catalogue, Jena, 1906.

with a circular aperture upon an object slide, and cementing a smaller plate of less thickness into this aperture. The surface of both plates being parallel and ground accurately plane, the depth of the chamber, or distance between the two surfaces, is regulated by selecting plates of desired thickness. By placing a plane cover-glass upon the outer plate, a plano-parallel cavity, the dimensions of which can be accurately determined, is formed between the cover-glass and the inside plate. This inside plate is ruled with cross-lines by means of which the observer is enabled to successively examine fluids on separate fields, and to count the corpuscles in each. These cross-lines are designed of different forms

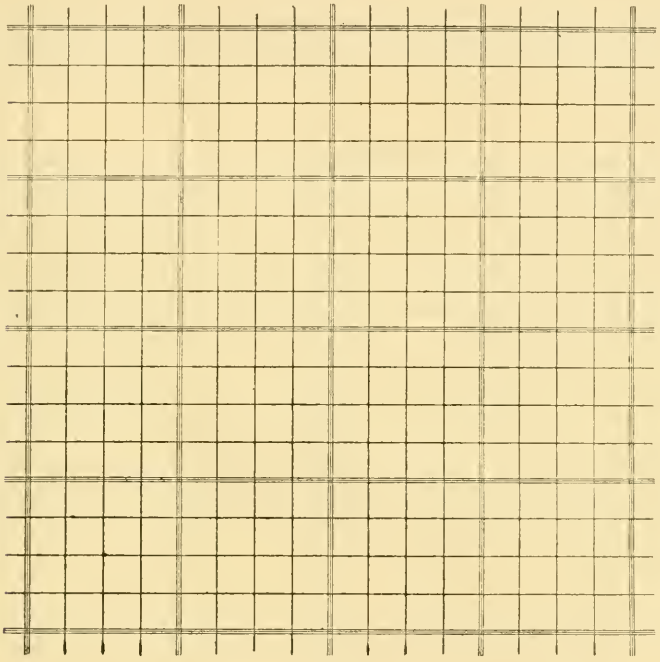


Fig. 85.

to facilitate the counting of both red and white corpuscles; the latter being considerably fewer than the former in a given volume of blood, the areas to be counted should vary in size. The counting chamber advocated by Fuchs and Rosenthal for the cytological investigation of cerebrospinal fluids has a depth of 0·2 mm. The simple plan of cross-lines is shown in the figure (fig. 85). The mixing pipettes consist of an accurately calibrated capillary tube dilated above to form a cavity, and provided with a rubber suction tube. The capillary tube is graduated, the uppermost mark being 1, and the 101 mark being just above the cavity; so that if the fluid to be examined is drawn in up to

the mark 1, and diluting fluid drawn in until the whole stands at 101, a mixture of 1 p.c. is obtained. A glass pebble in the cavity assists the uniform intermixture on shaking.

Numeration of Blood-platelets.*—G. Vallet advocates the following method for the enumeration of blood-platelets. A drop of 1 p.c. osmic acid solution is placed on the back of the thumb just above the nail, and a needle-prick is made across the drop. Some of the mixture of blood and osmic acid is drawn up into a fine pipette, and a very small drop is transferred at once to a clean cover-slip. The specimen is then fixed for half an hour in absolute alcohol, and stained with Giemsa's solution for two hours, washed in water and dried. Fifteen to thirty fields are then examined, and the hæmatoblasts and leucocytes are counted, and their relative proportions noted. The exact number of leucocytes in 1 c.mm. being known from a corpuscular count, it is easy to calculate the number of platelets.

Convenient Laboratory Devices.†—J. S. Fulton describes various laboratory accessories: (*a*) A dust-proof sterilising and storage box for Petri dishes, consisting of a brass base with three upright arms, two of which are fixed and one pivoted and bearing a loose riveted ring; the plates are stacked against the fixed arms, the loose arm is raised and the ring slipped over embracing the two uprights; a cylindrical cover is then slipped down between the uprights and the plates, thus forming a dust-proof package.

(*b*) A cage for holding inoculated plates during incubation. It consists of a brass plate carrying two bent wires that cross in contact at a convenient height, forming four uprights against which the plates may be stacked; a similar wire loose-jointed to the base crosses the other two, and engages a notch at the middle of the bend where all the wires cross; by pressing the two stiff wires together the space on the opposite side opens enough to allow the plates to be stacked; the loose arm is then swung up and sprung into the notch, converting the whole into a safe package.

(*c*) A tray for fermentation tubes. This consists of a brass plate carrying twelve brass pins $1\frac{1}{4}$ inch high, over which are slipped the hollow stems of the tubes; into the end of each pin is sawn a fine slit, into which is fixed a piece of rubber band, which grips the side of the glass stem and prevents wobbling.

(*d*) An express package for samples of water for bacteriological examination.

(*e*) A portable charcoal oven for making plate cultures at the well side.

(*f*) An extensible box for carrying inoculated plates.

(*g*) A scale for reading gas percentages in fermentation tubes.

(*h*) A new form of water-bath, by which within 10 minutes as many as 70 test-tubes of solid culture material can be melted and cooled ready for inoculation.

* C.R. Soc. Biol. Paris, lxii. (1907) p. 540.

† Centralbl. Bakt., 1te Abt., xliv. (1907) p. 89.

New Fluid for the Hæmocytometer.*—A. Edington has prepared the following solution for use with the hæmocytometer: neutral citrate of sodium 7·5 grm., formalin 2 c.cm., dahlia 0·03 grm., chloroform 5 drops, distilled water 250 c.cm. Mix the stain with the water, and then add the citrate and formalin. Leave for a few days, and use the supernatant fluid; if necessary, filter before use.

Walton, L. B.—**Contributions to Museum Technique: Cataloguing Museum Specimens.**
[Gives a description of a practical method of registering specimens by means of the card system.] *Amer. Naturalist*, xli. (1907) pp. 77–96 (3 figs.).

Lee, A. B., u. P. Mayer—**Grundzüge der mikroskopischen Technik für Zoologen und Anatomen.** Berlin: R. Friedländer u. Sohn, 3rd edition, 1907, vii. and 522 pp.

Metallography, etc.

Cadmium-bismuth Alloys.†—A. Portevin has determined the equilibrium diagram of this series. The metals were melted together in glass tubes in a current of hydrogen and cooling curves taken, a thermocouple being used. Tammann's method for determining the quantity of eutectic in each alloy was employed. The equilibrium diagram obtained is very simple. No compounds or solid solutions occur; two branches meet at the eutectic point 138° C., 63 p.c. cadmium. The horizontal eutectic line extends completely across the diagram. Microscopic study of the series showed that the alloys consisted of eutectic, together with either acicular crystals of cadmium or cubic crystals of bismuth.

Iron and Arsenic.‡—K. Friedrich has determined the equilibrium diagram and investigated the microstructure of the range of alloys from 91·6 to 44·0 p.c. iron. Five crystalline phases were distinguished. The author has demonstrated the existence of the compounds Fe_2As and Fe_3As_2, and considers that of FeAs as probable. The nature of two phases, one apparently containing more than 90 p.c., the other 48·3 p.c. iron, remains in doubt. With the first of these Fe_2As forms a eutectic at 70 p.c. iron and 830° C. Fe_3As_2 is the product of a chemical reaction occurring in the solid state at 800° C. The freezing point of Fe_2As is 919° C., that of FeAs about 1030° C. No indication of the formation of Fe_3As was obtained. The conclusions drawn from the freezing point curve were confirmed by microscopic examination of the alloys.

Nickel and Arsenic.§—The equilibrium diagram of the series of alloys, containing from 0–57·4 p.c. arsenic has been determined by K. Friedrich. Owing to the complexity of the diagram—15 fields are

* Lancet, 1907, ii. p. 86.
† Rev. de Métallurgie, iv. (1907) pp. 389–94 (6 figs.).
‡ Metallurgie, iv. (1907) pp. 129–37 (19 figs.).
§ Tom. cit., pp. 200–16 (37 figs.).

shown in the region investigated—the results are not adapted for abstraction; the original should be consulted. The compounds are Ni_5As_2 (existing in two modifications), Ni_3As_2 and NiAs. Good agreement was found between the diagram and the results of microscopical examination.

Latent Heat of Recalescence in Iron and Steel.*—F. K. Bailey has determined the mean specific heats of a number of steels of different carbon content between temperatures varying from 470° C. to 860° C. and 20° C., by a calorimetric method. A sphere was heated in an electric resistance furnace with vertical tube, and when at the required temperature dropped into water contained in a calorimeter below. Heating and cooling curves were also taken. From the results obtained were calculated the values of the latent heat of recalescence.

Binary and Ternary Alloys of Tin, Lead, Bismuth and Cadmium.†—The original plan of this research by A. Stoffel was the investigation of the solidification of a quaternary system, these four metals being chosen as giving the simplest case possible. It was found that the systems containing tin and cadmium showed a transformation in the solid state. This introduced so much complication that the study of the quaternary system was abandoned. The author here gives an account of previous work on the six binary systems together with his own results on these and two of the ternary systems. The tin-cadmium series was examined microscopically, but though good preparations were obtained no conclusions as to constitution could be drawn. The theory of equilibrium of ternary systems is worked out fully. The composition of any ternary alloy may be represented by a point within an equilateral triangle, the lengths of the perpendiculars from this point to the three sides representing the percentage of each metal. Thus the three angular points of the triangle represent the three pure metals. If a perpendicular to the plane of the triangle is erected from each point within it, its length proportionate to the freezing temperature of the alloy whose composition is indicated by the point, the surface obtained by joining the upper ends of these ordinates is the solidification surface. A straight line joining one vertex of the triangle to a point on the side opposite is the projection of a series of alloys containing two of the metals in constant proportion to each other with varying proportions of the third. The temperature concentration diagram of this series may be figured in the way adopted for a binary system, ordinates representing temperature, abscissæ the percentage of the varying metal. The liquidus curve is then a section of the solidification surface of the ternary system. By taking cooling curves of a large number of ternary alloys, classified in series forming such sections, the author determined the form of the complete solidification surfaces of the Sn, Cd, Bi, and the Sn, Cd, Pb systems. In the latter the eutectic point is at 145° C. and the composition 57 tin, 21 lead, 22 cadmium atomic p.c. The freezing-point of the eutectic of the other system is 103° C., the composition is 33·2

* Physical Review, xxiv. (1907) pp. 129–51 (8 figs.).
† Zeitschr. Anorg. Chem., liii. (1907) pp. 137–83 (29 figs.).

tin, 39·3 bismuth, 27·5 cadmium atomic p.c. The compound Sn_4Cd is formed in both systems: its normal temperature of formation is 125° C.

Lead-thallium and Lead-indium Alloys.*—N. S. Kurnakow and N. A. Puschin have determined the equilibrium curves of these two systems. The freezing-point curve of the lead-thallium alloys rises from the melting points of both metals to a maximum at 380° C. (33–40 atomic p.c. lead), and shows a sudden change of direction at 310·4° C. (5·5 atomic p.c. lead). The equilibrium curve of the lead-indium system is simple, and indicates a continuous series of solid solutions. The micro-structure of the alloys was investigated.

K. Lewkonja† has also determined the equilibrium diagram of the lead-thallium system; there are important differences between his results and those obtained by the above authors. The maximum at 374° C. is held to indicate the compound $PbTl_2$.

Effect of Stretching on Conductivity.‡—J. A. Donaldson and R. Wilson have determined the specific resistance and density of lead wires, permanently stretched to different extents. The change in conductivity produced was found to be small, and appears to be within the limits of experimental error.

Thermal and Electrical Effects in Soft Iron.§—E. H. Hall, L. L. Campbell, S. B. Serviss, and E. P. Churchill, in carrying out their intention of determining the various properties of the same specimen of soft iron, have obtained the following additional results.‖ Temperature coefficient of thermal conductivity between 115° and 204° C. referred to the value at 115° = −0·00068 approximately. Electric resistance, absolute, 17260 at 100° C. and 26140 at 218·2° C., with a mean temperature coefficient 0·00661 (on the basis of the value at 0° C.) between 100° C. and 218° C. Values for the Thompson effect coefficient are given.

Specific Heat of Iron at High Temperatures.¶—J. A. Harker determined the total heat evolved by iron of a high degree of purity, in cooling from temperatures ranging from 216° C. to 1144° C. to ordinary temperatures. The specimens, enclosed in porcelain protecting tubes, were heated in an electric resistance furnace to the required temperature, then dropped into a thin-walled vessel containing light magnesia, surrounded by the water of the calorimeter. The results indicate that the specific heat rises up to about 900° C., then falls considerably.

Tin-nickel Alloys.**—L. Guillet criticises severely the purely chemical methods employed by Vigouroux for examining alloys, and contends that the determination of equilibrium diagrams and investigation of microstructure must form the basis of all study of alloys. The

* Zeitschr. Anorg. Chem., lii. (1907) pp. 430–51 (9 figs.).
† Tom. cit., pp. 452–6 (1 fig.).
‡ Proc. Roy. Soc. Edinburgh, xxvii. (1907) pp. 16–20.
§ Proc. Amer. Acad. Arts and Sci., xlii. (1907) pp. 597–626 (2 figs.).
‖ See this Journal, 1905, p. 667.
¶ Coll. Researches Nat. Phys. Lab., ii. (1907) pp. 207–14 (2 figs.).
** Rev. de Métallurgie, iv. (1907) pp. 535–51 (17 figs.).

author's diagram showing 22 fields is deduced from the cooling curves and microstructure of 21 alloys. The eight constituents are pure tin, the compound NiSn, and three solid solutions, one of which exists in two, another in three modifications. It is held that a maximum in the liquidus curve does not necessarily correspond with a definite compound.

Recording Pyrometer.* — S. Wologdine describes a method of recording time-temperature curves on a fixed photographic plate. The temperature is indicated by the horizontal deflection of a galvanometer mirror, while a vertical movement is given to the ray of light by a mirror, which is rotated about a horizontal axis. This rotation is secured by means of an arm in connection with a float in a vessel containing water, the level of which falls at a uniform speed. The spot of light thus passes over equal vertical spaces on the photographic plate in equal intervals of time.

Alloys of Cobalt and Tin.†—F. Ducelliez claims to have extracted by chemical methods the compound CoSn from several ingots prepared by melting cobalt and tin together.

Constitution of Alloys of Copper.‡—L. Guillet states some general conclusions regarding the binary alloys of copper. A zone of extreme brittleness occurring in each series, corresponds to a single constituent always behaving in the same manner with reagents.

Boron Steels.§—L. Guillet has examined four steels containing boron 0·2–1·5, carbon 0·18–0·28 p.c., and two with boron 0·15 and 0·41 p.c., carbon 0·47 and 0·59 p.c. Maximum stress is raised by boron both in the normal and quenched conditions. The steels are brittle. The normal steels are constituted of a solid solution iron-boron of low boron content, pearlite, and a special constituent occurring as rounded grains, somewhat resembling cementite in its metallographic reactions. It appears to be a boro-carbide of iron of low carbon content.

Electrical Conductivity of Alloys.‖—W. Guertler deduces from the results obtained by previous workers the relationship between constitution and temperature coefficient of electrical conductivity. While in nearly all pure metals and in alloys free from mixed crystals the temperature coefficient has about the same value, the presence of mixed crystals in alloys lowers this value. The relation between conductivity and its temperature coefficient given by Matthiessen is supported by later results.

Alloys of Iron with Tin and Gold.¶—E. Isaac and G. Tammann give the equilibrium diagrams of these two systems. Iron and tin are not miscible in all proportions in the liquid state. The range in which two layers are formed extends at 1140° C. from 50–89 p.c. tin, and is

* Rev. de Métallurgie, iv. (1907) pp. 552–6 (5 figs.).
† Comptes Rendus, cxliv. (1907) pp. 1432–4.
‡ Tom. cit., pp. 845–8.
§ Tom. cit., pp. 1049–50.
‖ Zeitschr. Anorg. Chem., liv. (1907) pp. 58–88 (13 figs.).
¶ Op. cit., liii. (1907) pp. 281–97 (14 figs.).

probably smaller at higher temperatures. Crystallised γ-iron may contain up to 19 p.c. tin ; the solubility of tin in α-iron is not appreciably different. The temperature of magnetic transformation of iron does not appear to be affected by additions of tin or gold. Tin and iron form at least one compound (at 893° C.) ; its exact composition is not established. Iron and gold give a homogeneous melt in all proportions. They form no compounds. The solubility of gold in iron and of iron in gold in the solid state falls considerably with falling temperature.

Iron-carbon Alloys.*—P. Goerens develops the theory that graphite never separates from the melt as such, but is invariably the product of the decomposition of cementite in the solid state. While the stable system is iron + carbon, iron + cementite being metastable, the accepted diagram represents the equilibrium between iron and cementite. In the molten alloys the carbon exists as carbide. The eutectic at 4·2 p.c. carbon solidifying at 1130° C, is a mixed crystals + cementite eutectic. The formation of kish in high carbon cast iron is explained as follows : On cooling, cementite first separates out from the melt ; this splits up into graphite and iron ; the iron redissolves in the molten solution of cementite in iron, and the flakes of graphite float to the surface. Among the author's experimental work are determinations of melting points of alloys, and investigation of the microstructure after varying heat treatment. Of two alloys of the same carbon content, existing in one as cementite, in the other chiefly as graphite, the graphitic alloy has the higher melting point ; the white cast iron begins to melt at the same temperature at which its solidification ceases. A useful table is given showing the action of various etching reagents on the different constituents.†

Copper and Phosphorus.‡—E. Heyn and O. Bauer have made a complete investigation of the freezing-point curve and the microstructure of the copper-phosphorus alloys. The curve indicates the existence of the compound Cu_3P, confirmed by determinations of density and of E.M.F. against copper in a copper sulphate solution. A eutectic (8·27 p.c. phosphorus, 707° C.) is formed by Cu_3P and a solid solution of very low concentration of Cu_3P in copper. The hardening effect of phosphorus on copper is greater than that of tin ; Cu_3P is very hard. Alloys containing more than 15 p.c. phosphorus cannot be prepared by melting, but by heating copper filings and phosphorus to 300°–400° C., richer alloys result. On raising these richer alloys to higher temperatures they lose phosphorus, a definite concentration corresponding to each temperature. At 1100° C. it is 14·1 p.c., i.e. the compound Cu_3P. The alloys over 14·1 p.c. appear to consist of mixed crystals of Cu_3P and Cu_5P_2. Copper ammonium chloride solution was used for etching the microscopic sections.

Copper, Silver, and Lead.§—K. Friedrich and A. Leroux have revised and completed the equilibrium diagrams of the binary systems copper-silver and lead-copper, and have determined the diagram of the ternary system. Two crystalline phases are found in the copper-silver

* Metallurgie, iv. (1907) pp. 137–49, and 173–85 (44 figs.).
† See also this Journal, 1907, p. 116.
‡ Metallurgie, iv. (1907) pp. 242–7 and 257–66 (30 figs.).
§ Metallurgie, iv. (1907) pp. 293–315 (83 figs.).

system, pure (or nearly pure) copper and a solid solution of copper in silver with a maximum concentration of 6 p.c. Osmond had stated that silver could not hold more than 1 p.c. of copper in solid solution. Lead and copper do not mix in all proportions in the liquid state. No compounds occur: the solid phases are the nearly pure metals. Satisfactory agreement with Heycock and Neville's results was found. The ternary system was investigated by taking cooling curves of a large number of alloys. The results are shown as equilibrium curves of 31 series, each series containing a constant percentage of one of the metals. The complete system is represented by the usual method of triangular co-ordinates; the solidification surface is constituted of three portions, any two of which cut each other along a line, while the three meet at the ternary eutectic point (0·5 p.c. copper, 2 p.c. silver, 97·5 p.c. lead) at a temperature 0·5–1° C. below the eutectic freezing temperature of the silver-lead system. Microscopic examination confirms the conclusions based on the equilibrium diagram.

Variation in Melting Point of Eutectic Mixtures.*—C. Benedicks and R. Arpi point out that though a eutectic, like a pure chemical body, has a definite freezing and melting point, yet it is easy to raise the temperature of a eutectic above its true melting point, while this cannot be done with a pure substance without melting taking place. The influence of size of grain was investigated by mixing together powdered lead and tin in eutectic proportion (30 : 70) and taking heating curves. The size of grain varied in different experiments. The authors found that the larger the grain, the higher was the melting point. The bearing of their results on the difference between the melting points of white and grey iron of the same carbon content is indicated.

Chemical and Metallographical Studies of Chilled Cast Iron.†—H. Wedding and F. Cremer give the results of an extended research carried out by the latter. A line is introduced into the iron-carbon diagram indicating that in white cast iron the carbon content of the carbon-saturated first separating mixed crystals is greater than in grey cast iron with the same total carbon. The composition of the mixed crystals is a function of the speed of cooling through the solidification range. In grey cast iron, resulting through slower cooling, the fineness of the graphite flakes appears to be affected by the speed of cooling. The form of the crystals of white iron is characteristic of crystals obtained by the solidification of a super-cooled melt.

Adams, J. M.—**Transmission of Röntgen Rays through Metallic Sheets.** *Proc. Amer. Acad. Arts and Sci.*, xlii. (1907) pp. 671–97 (4 figs.).

Braune, H.—**Micrographic Research on Iron and Steel.** *Zentralbl. f. Eisen.*, ii. (1907) p. 39.

,, **Nitrogen in Iron and Steel.** *Tom. cit.*, pp. 41–3.

,, **Nitrogen Absorption in the Cementation of Iron.** *Tom. cit.*, p. 248.

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* Metallurgie, iv. (1907) pp. 416–19 (2 figs.).

† Stahl und Eisen, xxvii. (1907) pp. 833–8 and 866–70 (25 figs.).

BURGESS, G. K.—**Measurement of High Temperatures.**
Electrochem. and Met. Ind., v. (1907) pp. 220–1.

CAMPBELL, A.—**Magnetic Testing of Cast Iron.**
Coll. Researches Nat. Phys. Lab., ii. (1907) pp. 243–54 (7 figs.).

CARPENTER, H. C. H.—**Structure and Critical Ranges of High-speed Tool-steel.**
[For abstract, see this Journal, 1905, p. 776.]
Tom. cit., pp. 53–88 (24 pls.)

CARPENTER, H. C. H., R. A. HADFIELD, & P. LONGMUIR—**Iron-nickel-manganese-carbon Alloys.**
[For abstract, see this Journal, 1906, p. 636.]
Tom. cit., pp. 131–204 (71 figs.).

CHARPY, G.—**Influence of Heat on the Brittleness of Metals.**
Zentralbl. f. Eisen., ii. (1907) p. 50.

CHIKASHIGÉ, M.—**Copper and Tellurium.**
Zeitschr. Anorg. Chem., liv. (1907) pp. 50–7 (7 figs.).

GUERTLER, W.—**Modern Metallography.**
Chem. Zeit., xxxi. (1907) pp. 495–6 (4 figs.).

HARKER, J. A.—**New Type of Electric Furnace, with a re-determination of the Melting-point of Platinum.** *Coll. Researches Nat. Phys. Lab.*, ii. (1907) pp. 37–52 (1 fig.).

HINRICHSEN, F. W., & O. BAUER—**Microchemical Tests for Sulphur, Selenium, and Tellurium, in Copper.** *Metallurgie*, iv. (1907) pp. 315–17.

JÜPTNER, H. v.—**Microstructure of Steel.**
Zentralbl. f. Eisen., ii. (1907) p. 334.

KIP, H. Z.—**A New Method for the Determination of the Hardness of Minerals.**
Amer. Journ. Sci., xxiv. (1907) pp. 23–32.

KURNAKOW, N. S., & S. F. ZEMCZUZNY—**Alloys of Copper with Nickel and Gold.** *Zeitschr. Anorg. Chem.*, liv. (1907) pp. 149–69 (10 figs.).

LUDWIK, P.—**Hardness Measurements by the Brinell Method and Related Impression Methods.** *Zentralbl. f. Eisen.*, ii. (1907) pp. 339–40.

MALMSTRÖM, R.—**Influence of Ball Diameter and Pressure in the Brinell Hardness Test.** *Tom. cit.*, pp. 120–1.

PREUSS, E.—**Results of Recent Fatigue Research on Metals.**
Tom. cit., pp. 199–200

RINNE, F., & H. E. BOEKE—**Transformations of Sulphide of Iron.**
Zeitschr. Anorg. Chem., liii. (1907) pp. 338–43 (1 fig.).

RUDOLFI, E.—**Silicides of Copper.** *Tom. cit.*, pp. 216–27 (14 figs.).

TAMMANN, G.—**Isomorphism of the Elements.** *Tom. cit.*, pp. 446–56 (1 fig.).

The Corrugation of Rails. *Engineering*, lxxxiii. (1907) pp. 763–5 (12 figs.),

MICROSCOPY.

A. Instruments, Accessories, &c.*

(1) Stands.

Old Microscope by Jackson.—The Microscope (fig. 87) was presented to the Society at the October Meeting, 1902, by Mr. John

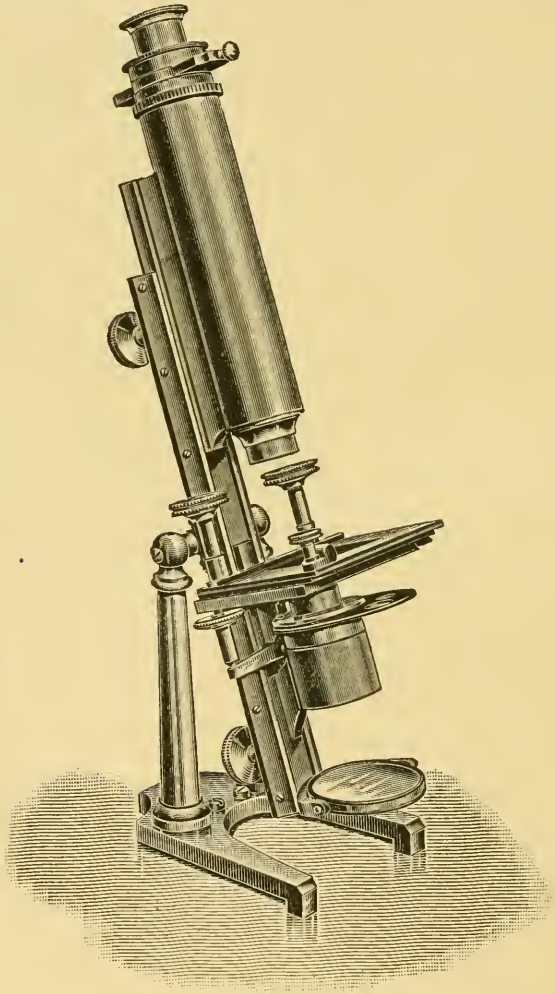

Fig. 87.

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

Jackson (see this Journal, 1902, p. 721), and is an interesting type, being the forerunner of the well-known Jackson-Lister model. The foot is of the flat horse-shoe form, carrying two turned brass pillars, to which the limb is attached by means of a cross-bar working through centres at the top of the pillars. The limb is grooved its entire length, and has V-shaped fittings in which the body, mechanical stage and substage work. One side of the V fitting is screwed on to the limb, so that any wear can be compensated for.

The rack-and-pinion movements to body and substage are actuated by milled heads placed behind the limb.

The mechanical stage has rack-and-pinion movement in both directions, and is also provided with a micrometer screw and lever fine-adjustment. The substage sliding-piece also carries the mirror, which is a plane one only, mounted in gimbals.

The substage condenser, which consists of a Huyghenian eye-piece with wheel of diaphragms placed between the lenses, has a tinted glass cap for modifying the illumination ; the lenses also are so arranged that either can be easily removed when not required.

The body of the Microscope is of large size, and is provided with a draw-tube.

The mahogany box into which the instrument packs also contains the following apparatus :—3 eye-pieces, one of which is provided with a Jackson screw micrometer ; 1½-inch objective, by Jas. Smith, with lieberkuhn ; $\frac{4}{10}$-inch objective by Jas. Smith, with lieberkuhn, and correction collar ; ¼-inch objective by Smith and Beck, 6 Coleman Street ; stand condenser, stage forceps, tweezers, box of dipping-tubes, live-box, dark-well and carrier, and stage micrometer.

A New Microscope and its Applications to Stereoscopic Photomicrography, by A. Quidor and A. Nachet.*—This instrument (fig. 88) satisfies with a single apparatus all the requirements of the laboratory—minute dissections, histology, cytology, photomicrography, photographic enlargements, or diminutions. Its main purpose, however, is to obtain the stereoscopic presentation of objects examined or dissected. Two cases may be distinguished according to the size of the objects :—

1. When the object can be examined only by a Microscope.

2. When the object can be examined either with a loup, or without a loup.

(1) The general arrangement of the Microscope resembles that of ordinary instruments. But, whilst the object-stage remains horizontal, the over-stage M with the objective O is jointed at C, and is inclinable to the right and the left of the plane of symmetry, the amount of inclination being measured by the index E. Moreover, a rod bearing a photographic camera with a frame for receiving slides of ordinary stereoscopic form can be placed instantaneously above the Microscope, the camera being connected on by a double tube T, which effectually shuts out all exterior light. The Microscope is now inclined at an angle a to obtain on the side B of the sensitive plate a first photograph of an object in the focus of the objective O, situated at the apex

* Original communication. See also Comptes Rendus, cxliv. (1907) pp. 908–10 (1 fig.).

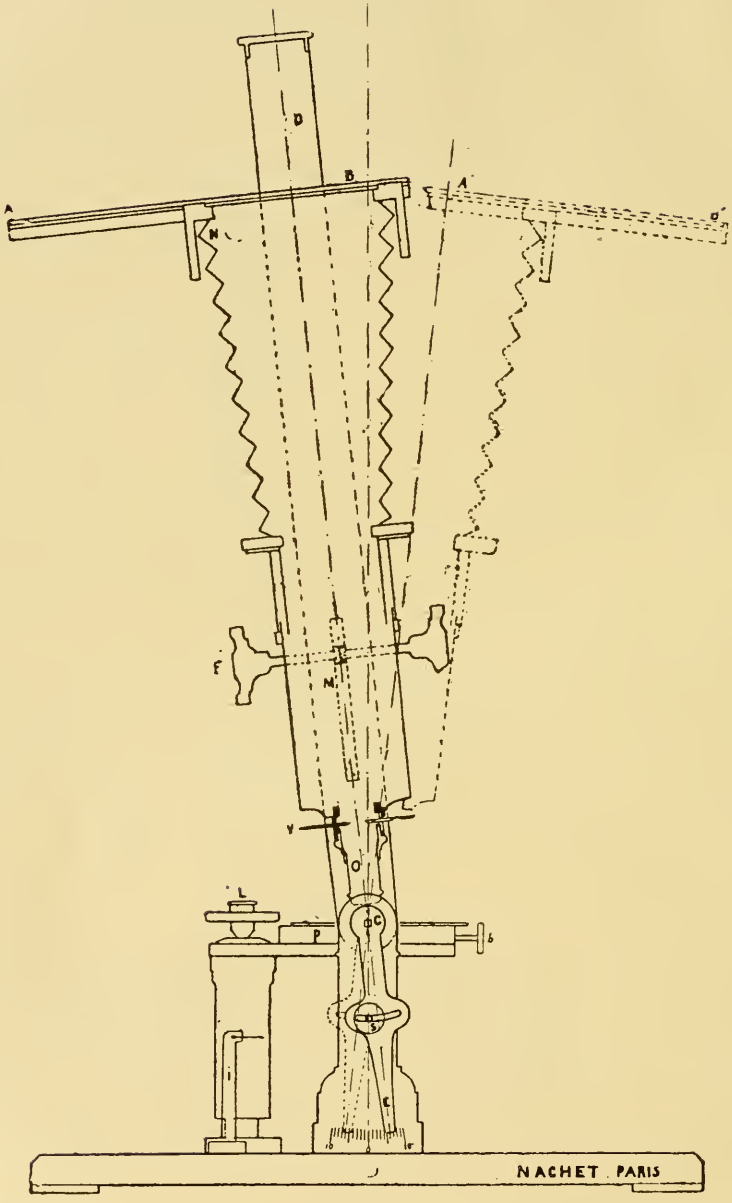

FIG. 88.

of articulation C ; then a second photograph is obtained on the part A of the plate under an inclination symmetrical with the first. The two views are thus obtained on the same stereoscopic plate in the order in which they should be observed to give the sense of relief, thereby avoiding the necessity of inverting the proofs, which has to be done with an ordinary stereoscope. In certain special cases—e.g. when the relief of the object and the depth of the objective render photography impossible, the photographic image of an object can be replaced by two drawings made with the camera-lucida at different angles ; these two drawings juxtaposed and viewed in the stereoscope give also a good stereoscopic presentation. It is essential that the object should be at the exact level of the axis of rotation C. To obtain this arrangement a method suitable for medium magnifications is to place the object approximately at the level of C, the Microscope tube being vertical ; the tube is then inclined ; if the object no longer remains in the centre of the field, it is either too high or too low, and correction must be made with the micrometric screw. With high magnifying powers the following method is best. The objective O is first focused on the surface of the stage P, whose coincidence with the plane of the axis is indicated by the index I. Then a preparation, whose thickness is, of course, variable, is placed on the stage P ; the object is thus necessarily higher than C, and must be made to descend by the required amount to the level of C by a movement of the micrometric screw L, the exact focus being at the same time obtained. But the rackwork F must not be touched, nor the original position of the objective O modified in any way.

(2) When the objects to be dealt with exceed 15 mm. the camera is rotated 180° around its rod ; it is then behind and away from the Microscope. Into the tube T a photographic objective of low magnifying power is now introduced, and the object is arranged on a shelf at the level of C. In this way the enlargement varies from 3·5 to 1. Exactly the same arrangement suffices for the diminution (from $\frac{1}{3}$ to $\frac{1}{15}$) of too large an object.

The authors state that, in comparison with ordinary binocular methods, their Microscope yields a photographic field 1·5 to 4 times larger, according to the extension of the bellows. The great value of their instrument, however, consists in the means of stereoscopic photography with high powers, whereas with binocular Microscopes the photographic enlargement is very limited, inasmuch as their principle depends on the juxtaposition of two equifocal objectives, with necessarily short frontal distance. Moreover, binoculars necessitate photographing on two half-plates, instead of on a single plate of ordinary size.

Nachet's Oscillating Stage for Stereoscopic Microphotography.* A. Guieysse, who was working on this subject simultaneously with, but independently of, MM. Quidor and Nachet, conceived the idea of an oscillating stage, the Microscope, of course, remaining stationary. He afterwards discovered that, so far back as 1866, Moitessier had hit upon

* C.R. Soc. Biol. de Paris, lxiii. (1907) pp. 18, 19 (1 fig.).

the same idea. Ultimately, with the collaboration of M. Nachet, Moitessier's design was reconstructed and improved. The arrangement, viewed from behind, is seen in fig. 89. The stage, composed of a plate RR perforated by an aperture, is applied on the stage of the Microscope, and carries the oscillating system formed of an axis pivoting around O, and bearing the oscillating stage PP with its screw-supports C. Behind, the axis is traversed by a horizontal bar BB, carrying at its extremities two screws C intended to limit the movement of oscillation, which can be controlled in advance by an index marking on a drum the degree of displacement. A screw A can lower the stage below the axis of rotation so as to neutralise the thickness of the object-glass. In using the apparatus it is first centred with the help of a disk, which is pierced by a small hole, and which has to be applied in the central aperture. The disk is then replaced by the preparation, and the screw

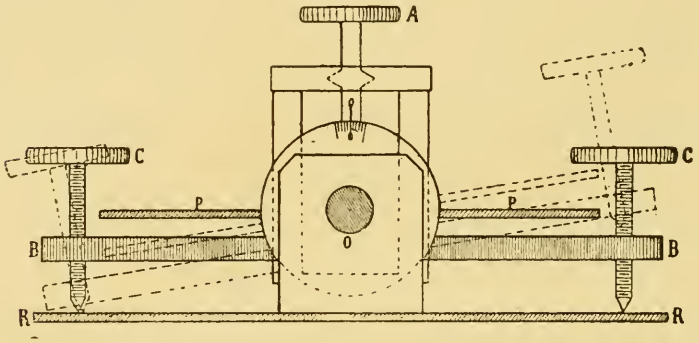

FIG. 89.

A regulated to such an extent as to reduce to a minimum the lateral displacement of the object-glass in the movement of oscillation. The stage is then inclined alternately on each side, and photographs taken.

Microscopical Observations at High Temperatures: Gas-heat Condenser and Air-Cooling Apparatus.*—The apparatus referred to above is due to O. Lehmann of Karlsruhe, and completes the adaptation of his crystallisation Microscope to projection purposes. The firm of Carl Zeiss supply these auxiliaries in such a form that they can be immediately fitted to their ordinary Microscopes, which are then suitable both for subjective observation, for the projection of the formation of fluid crystals, and for observation of heated preparations. The Gas-heat condenser (fig. 90) is inserted with the push-tube (*a*) into the push-collar of the Abbe illuminating apparatus under the Microscope, in lieu of the ordinary condenser, and then clamped. It consists of: the polariser (*b*); the iris diaphragm; the illuminating lens; the gas-burner

* Special Catalogue, Carl Zeiss (Jena), 1906.

(*d*); and the heat-guide (*l*). The polariser *b* is rotatory about an excentric axis and can be swung into, or out of, the ray path. The position of its polarising plane can be read off on the graduated scale which is shown in the figure. At insertion the tooth *n* engages in the notch *k*. The polariser is a Grosse Air-Nicol, whose side is twice as large as its length. It is rectangular in cross section, and has a side length of 25 mm.; its shortness and large aperture make it very useful here on account of the small available space. The iris diaphragm is placed immediately above the polariser, and is provided with a handle *g* for regulating the aperture of illumination; during observations it is in general to be kept fully open. With a central stop in the objective the iris secures dark ground illumination. Immediately over the iris is

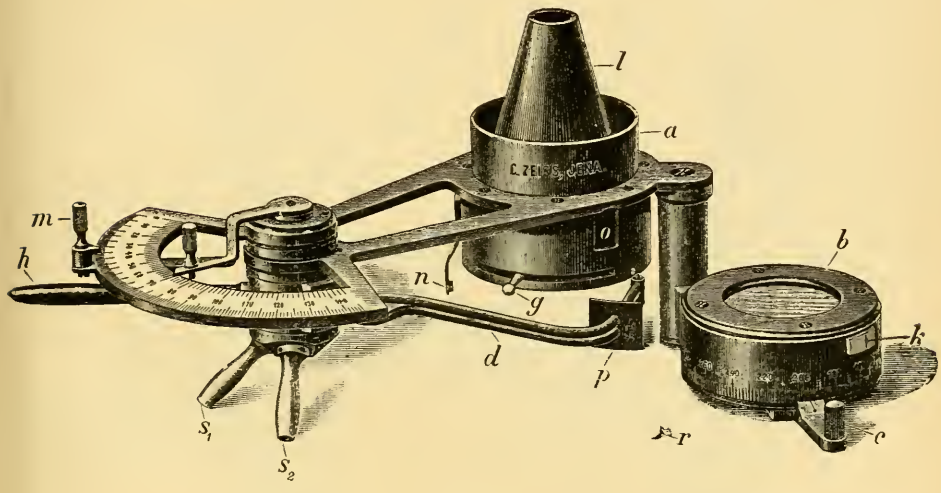

FIG. 90.

the unspherical illuminating lens (not visible in figure), which induces a good combination of the illuminating beams and thereby secures an increased brightness, a matter of great importance in projection. Between the illuminating lens and the preparation the controllable gas-burner *d* is applied and is pushed in and out by the lever *h*, being passed in through the aperture *o* until the aperture is closed by the plate *p*; the effect of the plate is to exclude lateral air-currents. After insertion the burner stands over the middle of the illuminating lens. The burner is adapted for heating the preparation to comparatively low temperatures (100°–200°), as well as to high temperatures (about 700°). It is constructed with two tubes, one for gas and one for air. In the case of low temperatures, however, only one tube is used, viz. that one whose nozzle is marked G. The gas supply is regulated by the handle *m*, which operates an index moving over the outer graduated circle. The

burner is so arranged that increase of the gas supply, so long as the index is on the first half of the scale, is comparatively slight ; but on the second half each scale division implies a greater increase of gas supply. In heating to high temperatures, gas is admitted through the other nozzle *s*, air being passed through G, and the small cap *r* is screwed on to the point of the burner. The two scales serve, first, to afford an accurate mark for the adjustment of the burner ; secondly, to provide a method of applying a systematic course of heating. As the heating of the preparation, when the flame is very small and therefore

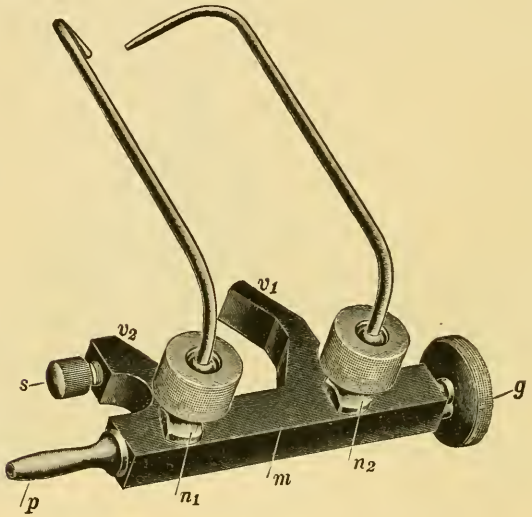

Fig. 91.

comparatively far from the preparation, is not lateral to the axis, the heat-guide *e* is inserted from above through the stage aperture of the Microscope. This guide is a conical brass tube with an external asbestos coat.

The attainment of a temperature constant for a long time is assisted by a downward cooling, which, moreover, steadies the under heating. Lehmann's air-cooling arrangement (fig. 91) used for the purpose is made of a brass rod of rectangular cross section perforated with an air-canal. This canal has on its upper side two openings on which, by means of air-tight ball-joints, two adjustable air-tubes are placed. In the long axis of the brass rod there is, on one side, a nozzle for the air-supply and on the other a regulating screw for the strength of the air-current. The brass rod is fitted on both sides with projecting arms so arranged that the whole can be laid around the flange at the foot of the upper part of the Microscope used, and can be tightened by a screw. The arms vary in form according to the flange, and are so adjusted that their maximum effect is exerted on opposite sides of the field of view. The

air is supplied under pressure, and by combination of the gas-burner and air-supply, any desired temperature can be maintained for a long time in the centre of the field.

Zeiss Heat-Microscopes.*—Figs. 92, 93, 94, show various forms of these instruments. Fig. 93 is Lehmann's Crystallisation Microscope

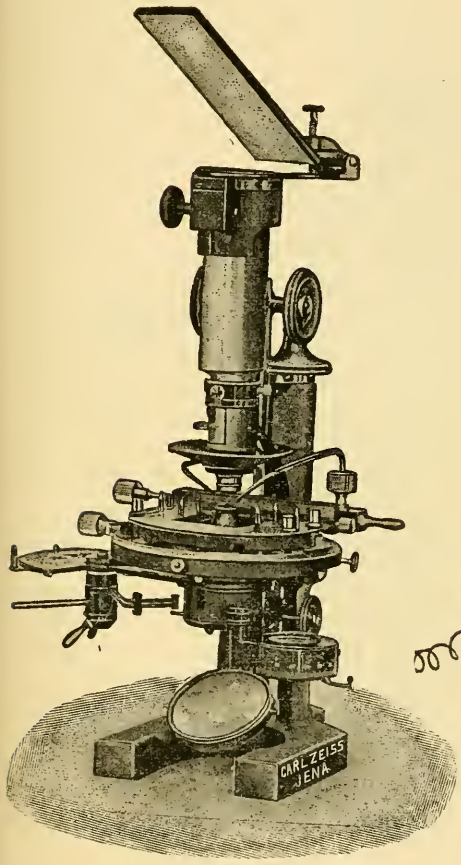

Fig. 92.

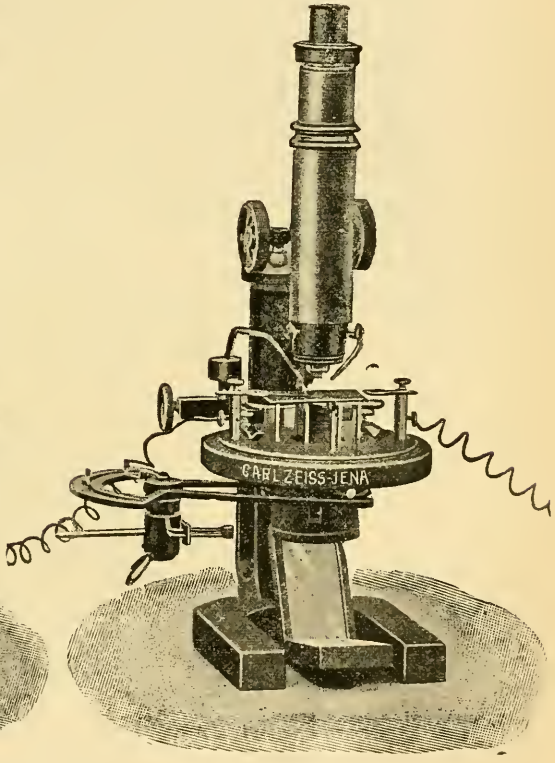

Fig. 93.

arranged for subjective observation at high temperatures. Fig. 92 is a new Physico-Chemical Microscope for subjective observation and projection at high temperatures (900° C.) fitted with a gas-heat condenser, an air-cooling arrangement, and a polarising apparatus.

* Special Catalogue, Carl Zeiss (Jena) 1906.

Fig. 94 is for the instantaneous photomicrography of heated objects (e.g. molten crystals) with simultaneous subjective observation.

Koristka's Large Model Stand IIe.*—This instrument (fig. 95) corresponds to the stand IIc on page 21 of the maker's catalogue N 12.

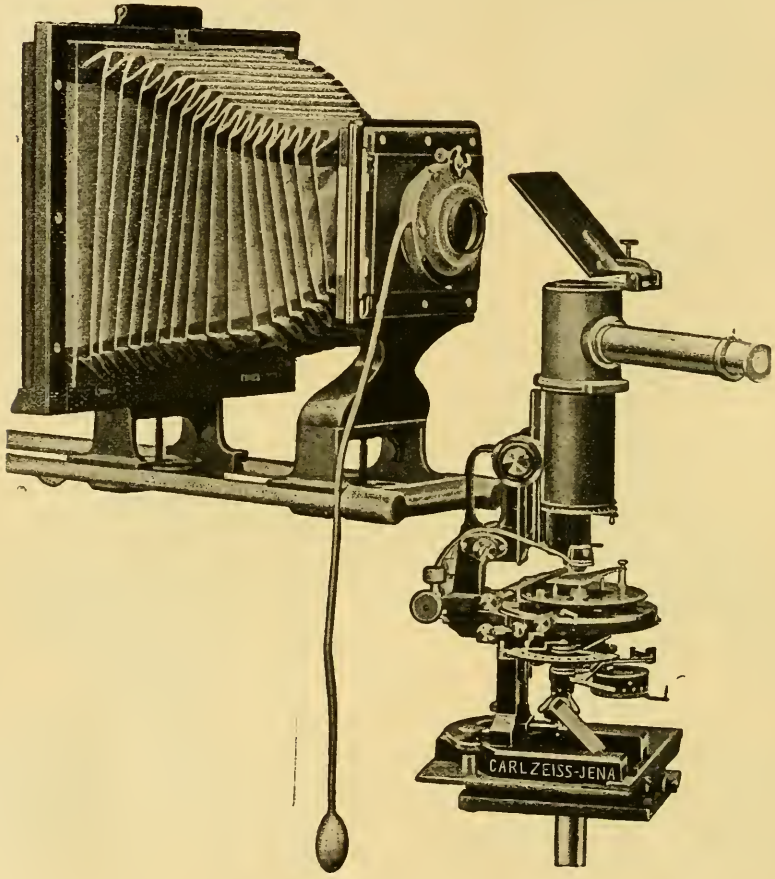

Fig. 94.

It is fitted with a complete Abbe apparatus (condenser of N.A. 1·40) and iris diaphragm; diaphragms are introduced by a cylinder into the condenser. The circular ebonite stage has a diameter of 110 mm.; it is rotatory, and is governed by clamping screws for the adjustment of the preparation. The tube of the objective-holder is of ample dimen-

* Supplement to General Catalogue N 12, Milan, April 1907.

sions to adapt it for photomicrography. The model may be compared with the figs. of IVa., pp. 101–2, of this Journal, 1905.

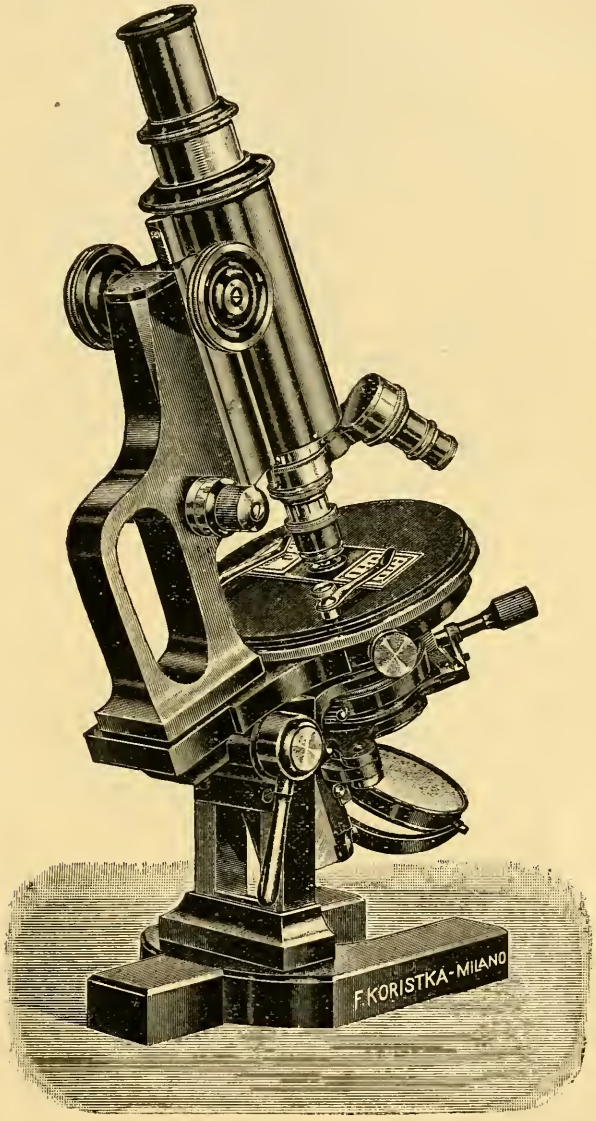

Fig. 95.

Martens Ball-jointed Metallographic Preparation Microscope.* This instrument is shown in fig. 96, and is intended to be used for observing the progress of the polishing and etching operations required to adapt specimens for metallography. As is evident from the figure, the stand here takes the form of a double ball-jointed arm. By this means the specimen can be viewed at any angle. In order to avoid any

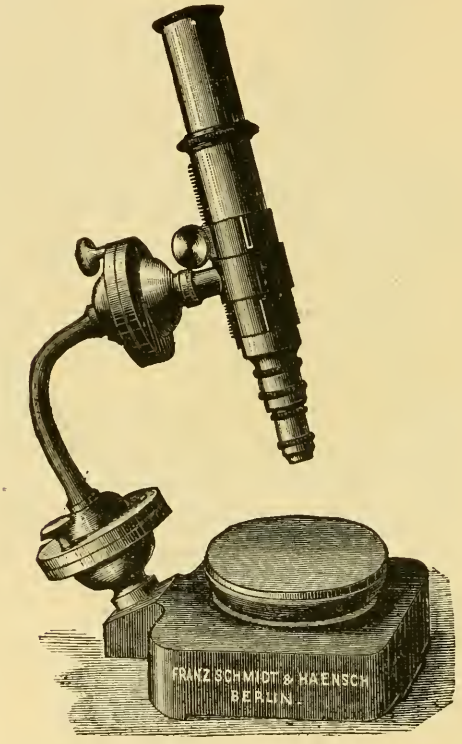

FIG. 96.

risk of injury to high-priced objectives and oculars, which might arise from the proximity of the etching and polishing substances, a special series of achromatic objectives and Huyghenian oculars is supplied by Messrs. Carl Zeiss.†

Voigtländer and Sons' Large Mechanical Stage.‡—This is designated No. 1 by the makers. Its character will be understood from

* C. Zeiss' Catalogue, entitled "Estimate for an Outfit for the Photomicrography of Metals," Jena, March 1907; and Martens and Heyn, "Ueber die Mikrophotographie im auffallenden Licht und über die mikrophotographischen Einrichtungen der Königtech. Versuchanstalt in Charlottenburg (Mitt. Königtechnik Versuchanstalt, Berlin, 1899, p. 85).

† Tom. cit., p. 5.

‡ Catalogue (English Edition) 1907, p. 17.

fig. 97. It has a range of 30 and 45 mm. in both directions, which can be read on three scales with verniers.

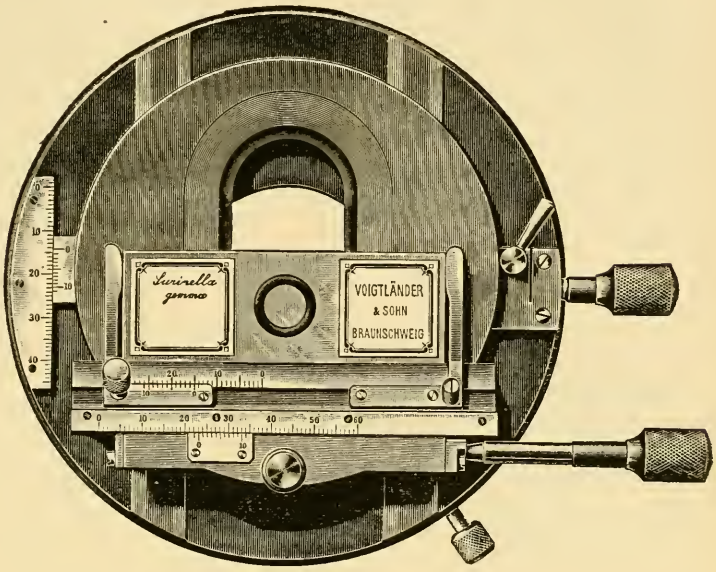

Fig. 97.

(2) Eye-pieces and Objectives.

Siedentopf's Microscope Ocular with Quartzwedge Compensator.* This ocular with push-action quartz wedges resembles that described by J. Amann.† It has the shape of the ocular screw-micrometer ‡ except that the lateral measuring drum is omitted and in lieu thereof an opening is contrived into which the quartz wedges can be pushed. Fig. 98 shows the ocular with the wedge, and fig. 99 shows the wedge by itself. The whole arrangement is dropped into the Microscope tube, thus replacing the usual ocular, and clamped. The ocular is a Ramsden, and the wedge operates in its focal plane. The optical axis of the wedge is parallel to its long sharp angle, and the wedge is adjustable in direction of its length. On its upper face is a graduation which gives in thousandths of a millimetre the retardation difference experienced by the ordinary and extraordinary rays in their respective cross-sections as they pass through the wedge. When the polarising planes of the polariser and of the analyser (inserted on the ocular) are crossed and inclined at 45° to the principal plane of the quartz wedge, and so placed on the preparation under examination that the polarising plane of the quicker wave lies perpendicularly to the optic axis of the quartz wedge,

* Extract from Centralbl. f. Min. etc., 1906, No. 23; published by Carl Zeiss, Jena.

† Zeitschr. wiss. Mikrosk., xi. (1894) p. 440–54. See also this Journal, 1895, pp. 237–40.

‡ Zeiss' Catalogue, Mikroskope, 1906, p. 33.

and that of the slower wave parallel to the optic axis, then the phase-retardations in the preparation and in the quartz wedge are placed in opposition. It is possible, therefore, to push the wedge into such a position that these opposite retardations are equal and neutralise one another. At this cross-section of the wedge a black band will appear, whilst to its right and left are coloured bands similar to the colours of their plates. When this adjustment is attained, the before-mentioned retardation difference in the preparation is read off. In order to attain extreme accuracy without too long a wedge, three interchangeable wedges are supplied corresponding to retardation-differences in the proportion of 0–2, 2–8, and 8–39. The first wedge consists of two quartz wedges whose axes are perpendicular to each other, and a scale-

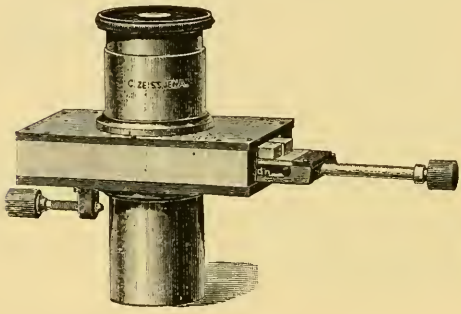

Fig. 98.

Fig. 99.

division corresponds in their case to a retardation difference of 0·01 μ, thus enabling 0·001 μ to be easily read. The other wedges are similar in principle. The line selected as standard is the green quicksilver line $\lambda = 546\ \mu\mu$.

Determination of the Properties of Objectives.—A. E. Conrady gives the following report of a demonstration by F. W. Watson Baker at the Quekett Club on May 17, 1907, dealing with the determination of the equivalent focus of objectives by Abbe's method, with the measurement of their numerical aperture, the difference between ordinary and compensating eye-pieces, and with methods of testing the correction of objectives.

Determination of the Equivalent Focus of Objectives (according to Abbe).—By this method two observations of a stage micrometer with different tube-lengths are made to yield the true equivalent focus of an objective and also the position of its upper focal plane. The principle is clearly shown in fig. 100, where O Q represents an objective producing an image A B of an object *a b*. As A B is a sharp focused image of *a b*, it follows that all rays of light passing from points in the object through the object-glass are re-united in the corresponding points of the image, and therefore any single ray of light proceeding from a point in the object through the object-glass, is a geometrical locus of the image, and is sufficient to determine its size at any given point of the optical axis.

The most convenient ray to employ for this purpose is the one proceeding from a point such as b in the object in a direction parallel to the optical axis. Such a ray after refraction passes through the principal focus F of the objective, and if the incident ray from b and the refracted ray passing through F are produced until they intersect at b', then by definition a plane $b'\,a'$ perpendicular to the optical axis and containing this point is the upper cardinal plane of the objective, and its distance a' F from the principal focus of the objective, or the upper focal plane as it is usually called, is the equivalent focus of the objective.

Now, it is immediately apparent that $a'\,b'$ F and A B F are similar triangles, and as $a'\,b'$ is equal in size to the object $a\,b$, and a' F is the

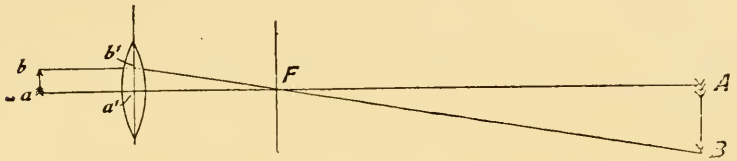

FIG. 100.

equivalent focus, we can immediately deduce the proportion, that A B, the size of the image, is to $a\,b$, the size of the object, as the distance A F between image and upper focal plane is to a' F, or the equivalent focus of the lens. Or in mathematical form

$$(\mathrm{A\,B} \div a\,b) = (\mathrm{A\,F} \div a'\,\mathrm{F})$$

$(\mathrm{A\,B} \div a\,b)$ is the magnification of the image A B, and we will introduce the symbol M for this, as well as the symbol f for the equivalent focus of the lens, and our expression thus becomes

$$\text{I.} \qquad \mathrm{M} = (\mathrm{A\,F} \div f)$$

which is the simple equation used in Abbe's method of determining the equivalent focus, all the apparatus required being a stage micrometer and an eye-piece micrometer divided to the same unit, that is to say both in fractions of millimetres or both in fractions of inches.

As is obvious from the diagram, no lens must intervene between the objective being measured and the magnified image A B, and if the eye-piece micrometer is to be used in the usual Microscope eye-pieces of Huyghenian type, it is absolutely necessary that the field-lens of the eye-piece be removed, as otherwise totally erroneous results must be obtained.

By observing how many divisions of the eye-piece micrometer correspond to a division of the stage micrometer, we determine directly the magnification M in our equation I.

By measuring off the position of the eye-piece micrometer with regard to the upper end of the Microscope tube, we can also determine the point A in our diagram, but the point F cannot easily be determined by the same method, and therefore both quantities of the right hand side of our equation must be regarded as unknown and two observations

with different tube-lengths will be necessary to determine both. Two such observations give us two equations :

$$\text{II.} \qquad \begin{aligned} M_1 &= (A^1 F \div f) \\ M_2 &= (A^2 F \div f) \end{aligned}$$

and subtracting the second from the first we obtain

$$M_1 - M_2 = (A^1 A^2 \div f)$$

which, transposed and put into ordinary language, means that the equivalent focus of the objective is equal to the increase of tube-length between the two experiments divided by the resulting increase of magnification of the primary image.

The equivalent focus having thus been determined, it can be introduced into one of the equations II. ; for instance, the first of them ; and will then determine the distance $A^1 F = M_1 \times f$; and the position of A having been measured off in the manner suggested above, it is a simple matter to lay off the length $A^1 F$, and thus to determine the point F usually described as the position of the upper focal plane of the objective.

In the experiments shown at the demonstration, an 8 mm. Holos objective was employed with a short tube-length. It was found that one space of $\frac{1}{10}$ mm. of the stage micrometer covered 18·6 similar spaces in the eye-piece micrometer. When the tube had been lengthened by 73 mm., it was found that one space of the stage micrometer now covered 28 spaces of the eye-piece micrometer. An increase of tube-length of 73 mm. had therefore produced an increase of magnification of 9·4 times ; and on dividing the first number by the second, according to the above rule, the equivalent focus of the objective is found to be 7·8 mm. Multiplying the latter figure by the magnification found in the second measurement, it was found that the upper focal plane lay 217 mm. below the eye-piece micrometer, and making the measurement suggested above, this led to fixing the upper focal plane itself at a position 14 mm. below the shoulder of the standard screw. It should be mentioned that when Professor Abbe introduced his system of nomenclature when bringing out the apochromatic objectives, the angular magnification assigned to the compensating eye pieces was based on the assumption that the upper focal plane of the objectives should lie 32 mm. below the shoulder of the standard screw. It follows, therefore, that if the position of the upper focal plane differs from this, as indeed it does in the case of the above 8 mm. Holos objective, the magnification obtained according to Abbe's rule by multiplying the initial power of the objective into the angular magnification of the eye-piece will give a wrong result, and to compensate for this, opticians occasionally purposely mis-state the equivalent focus of objectives in order that the magnification determined by Abbe's method may come out approximately correct. Thus, in the case of our example, it would appear at first sight as if the objective, being of 7·8 mm. focus instead of 8 mm., would magnify about $2\frac{1}{2}$ per cent. too much. As a matter of fact, this is heavily over-compensated by the circumstance that its upper focal plane lies 18 mm. higher than Abbe's assumed

position, making the optical tube-length 252 instead of 270 mm., so that for this reason it would magnify about 7 per cent. too little.

The result of the combination of both effects is, therefore, that the Holos 8 mm., although really of 7·8 mm. focus, nevertheless magnifies nearly 5 per cent. less than a true 8 mm. fulfilling Abbe's assumption as to position of focal plane.

Determination of Numerical Aperture.—Three Microscopes were adapted to demonstrate the use of the Abbe apertometer and certain dangers to be avoided. The latter refer to the probability of obtaining too low a reading when measuring objectives or condensers with a large

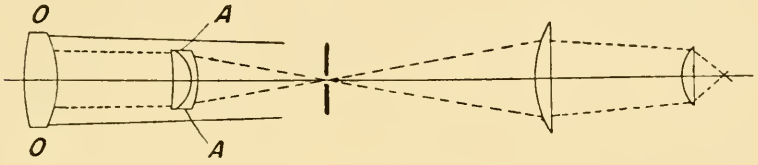

Fig. 101.

clear aperture, owing to the auxiliary Microscope not having a sufficiently large field to receive light from the marginal zone of objectives and condensers of this type. Figs. 101 and 102 show clearly how this trouble arises, and the causes to which it is due.

In fig. 101 it is shown how the cone of rays proceeding from the large objective O O is of too large a diameter to be completely received by the auxiliary objective A A supplied with the apertometer, the result

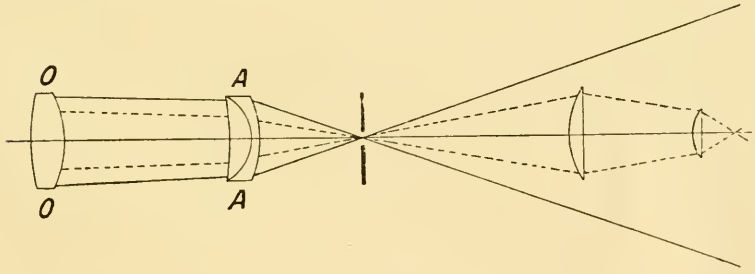

Fig. 102.

being that only light corresponding to the dotted cone enters the auxiliary Microscope, and that if a measurement is attempted under these conditions, the numerical aperture of the dotted cone instead of the full cone will be obtained.

Another way in which the trouble arises is illustrated in fig. 102. In this case the auxiliary objective A A is large enough to receive all light coming through the objective O O, but owing to an excessively long draw-tube, or to the fact that an eye-piece of too high a power is used, the marginal part of the light is spread out too much to enter the eye-piece, and is thus cut off at this end of the instrument; and by

tracing back the amount of light which can enter the eye-piece, it is again found that the marginal zone of the objective is cut off, and that too low a result will be obtained in this case also.

The remedy in all such cases is to do away with the auxiliary Microscope altogether, and to observe the back of the objective to be measured by looking directly at it down the Microscope tube, for as this danger only exists in the case of unusually large clear apertures, it is quite easy and accurate to observe without a magnifying instrument.

Numerical Aperture and Resolution.—A neat contrivance was also shown to demonstrate the fact that resolving power increases with aperture. The instrument simply consisted of four pieces of wire netting, graduated in fineness and mounted in a suitable frame, and of a plate with four perforations of different diameters, placed at a suitable distance from the frame, so that the latter might be observed by looking through any of the perforations. The distance between screen and perforations being adjusted so that when looking through the largest perforation all four meshes could be distinctly seen, it was found that on looking through the next smaller perforation only three of the meshes were resolved, the finest appearing without detail; the still smaller perforation would resolve only the two coarser meshes, and the smallest perforation would only show the coarsest of all. A complete analogon was thus provided of the effect of aperture in either telescope or Microscope.

Ordinary versus Compensating Eye-pieces.—In order to demonstrate the difference between ordinary and compensating eye-pieces, two Microscopes were set up side by side, one fitted with a strictly achromatic objective, calling for an ordinary eye-piece, the other fitted with a Holos objective, requiring a considerable compensating effect in the eye-piece. Two Holos eye-pieces were accurately adjusted, one to suit the achromatic, the other to suit the Holos objective, and visitors were invited to notice the effect of exchanging these eye-pieces, in order to dispel the rather prevalent idea that there was some special virtue in compensating eye-pieces to which a great part of the excellence of modern objectives was due; the exchange producing either good images in both Microscopes or else bad images in both Microscopes, the latter being characterised by the appearance of broad coloured fringes on the edges of the silver lines of the Abbe test-plates which were employed as objects; and it was pointed out that the only special effect produced by the compensating eye-piece was that it has a higher magnifying power for a red object than for a blue object, and as the modern high-power objectives with unachromatic thick front lens have a similar difference of magnifying power in the opposite direction, the compensating eye-piece, if properly adjusted, will produce an image free from colour fringes on such objectives.

Tests for Objectives.—Another four Microscopes were shown demonstrating the use of the Abbe test-plate for examining objectives and determining the nature of their defects.

The first of these instruments showed how spherical aberration can be readily detected by shifting a comparatively narrow cone of light gradually from the central to the marginal zone of the objective under test, either by using the usual turn-out ring of the substage, or, more

conveniently, by use of a mechanical substage with rack-and-pinion movement, by means of which the iris can be set centrally or excentric at will. When spherical aberration is present in an objective, the different zones focus at a different level, and consequently if the light is changed from central to oblique without changing anything else, the lines of the test-plate will go out of focus if spherical aberration is present, and the latter will thus be immediately detected.

It was pointed out in this connection, that on the same principle an extremely sensitive test for spherical aberration might be obtained by using a condenser stop of such size and so decentred that it just reached from the centre to the margin of the objective, and then noticing whether the two edges of the test-plate line running across the centre of the field were sharply in focus simultaneously.

It is said that by this method of observation the correct tube-length of a high-power objective can be determined within one or at most a few millimetres.

In a second Microscope the same excentric stop was employed for testing the chromatic correction of an objective. The aperture in the substage should in this case be quite small, so as to test a very narrow zone of the objective at one time. Under these conditions, the edges of the lines of the test-plate show complementary colours, which in the case of a perfectly corrected modern objective should be apple-green and purple or claret-colour, no matter what zone of the objective other than the central one is tested.

The achromatic objectives of the older type show a continual change of the secondary colour-tints when the stop is moved from the centre to the edge of the aperture. They usually show a bluish-green, or even blue, instead of the apple-green near the centre of the aperture, and a yellow, or even orange, instead of the apple-green in the marginal zone.

The third of the Microscopes in this section was fitted with a badly centred objective, the result being that when the light had been carefully centred and adjusted, unsymmetrical colour fringes and fogginess became apparent on the edges of the lines of the test-plate. One-sided defects of this kind with carefully centred illumination are nearly always due to centring defects in the objective, but may sometimes be caused by the stage not being accurately square to the optical axis, or to a badly mounted object having its cover-glass similarly out of square to the optical axis.

The fourth of these Microscopes showed the importance of either using the correct thickness of cover-glass or else compensating the effect of change in this respect by altering the tube-length, or by using a correction collar. The 4-mm. Holos objective had been correctly adjusted to the thinnest cover-glass on the Abbe test-plate. By moving the mechanical stage so as to bring the adjacent thickest cover-glass under the objective, the excellent image obtained in the first case was immediately replaced by a hopelessly bad image caused by the change of cover-glass thickness.

In an adjoining room, the Watson-Conrady apparatus for photomicrography had been set up, and its distinctive features were fully explained and the method of using it demonstrated.

As shown in fig. 103, the apparatus consists of a comparatively small but fully corrected condensing lens C C, mounted in close proximity to an iris diaphragm I I. About 12 in. from the condensing lens, there is mounted an auxiliary iris A A, and close to this a simple lens L L. The Microscope is set up at such a distance from the auxiliary iris that its substage condenser S is in the right position to throw a sharp image of the auxiliary iris upon the object to be photographed. The adjustment of the apparatus is such that the main condensing lens C C throws a sharp image of the source of light centrally upon the auxiliary iris A A, which latter image is then focused by the substage condenser S upon the object on the stage. The auxiliary simple lens L L is approximately of the right power to form an image of the iris I I upon the back lens B B of the substage condenser. The purpose of this lens is thus to prevent the spreading out of the light passing from the source through the condenser C C by bending the cones of rays near the auxiliary iris A A, so as to direct them centrally upon the substage condenser in the manner clearly shown in the diagram. The characteristic feature is, therefore, that all scattering of the light is completely prevented.

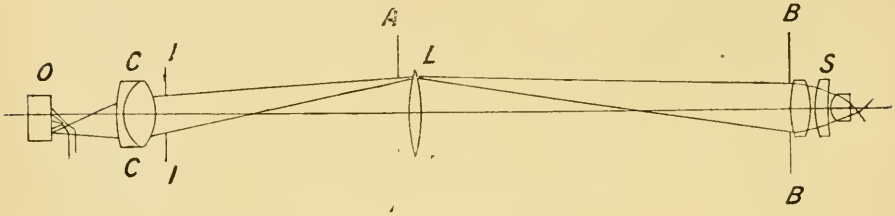

Fig. 103.

To adjust the apparatus, the auxiliary iris diaphragm should first be placed at a distance from the substage condenser equal to the distance from the lamp flame for which the substage condenser is corrected—generally about 8 inches.

The substage condenser should next be centred, after which the auxiliary iris should be closed and its image focused centrally over the object to be photographed by using the centring screws of the auxiliary iris, and the focusing movement of the substage condenser. The next step is to adjust and focus the source of light and the Watson-Conrady condenser, so as to produce an enlarged image of the brightest part of the source of light centrally on the auxiliary iris. The iris of the Watson-Conrady condenser is now to be closed so as to fill the substage condenser completely with light whilst preventing an excess of light from flooding the surroundings. A satisfactory image may then be produced on the focusing screen in the usual way, but before making an exposure the auxiliary iris should be carefully closed until it begins to reduce the size of the picture on the screen. This final step shuts off all false light from the outer parts of the object, beyond the portion to be photographed.

(3) Illuminating and other Apparatus.

Kaiserling's New Model of a Universal Projection Apparatus.* This apparatus is made by E. Leitz of Wetzlar, and its general character

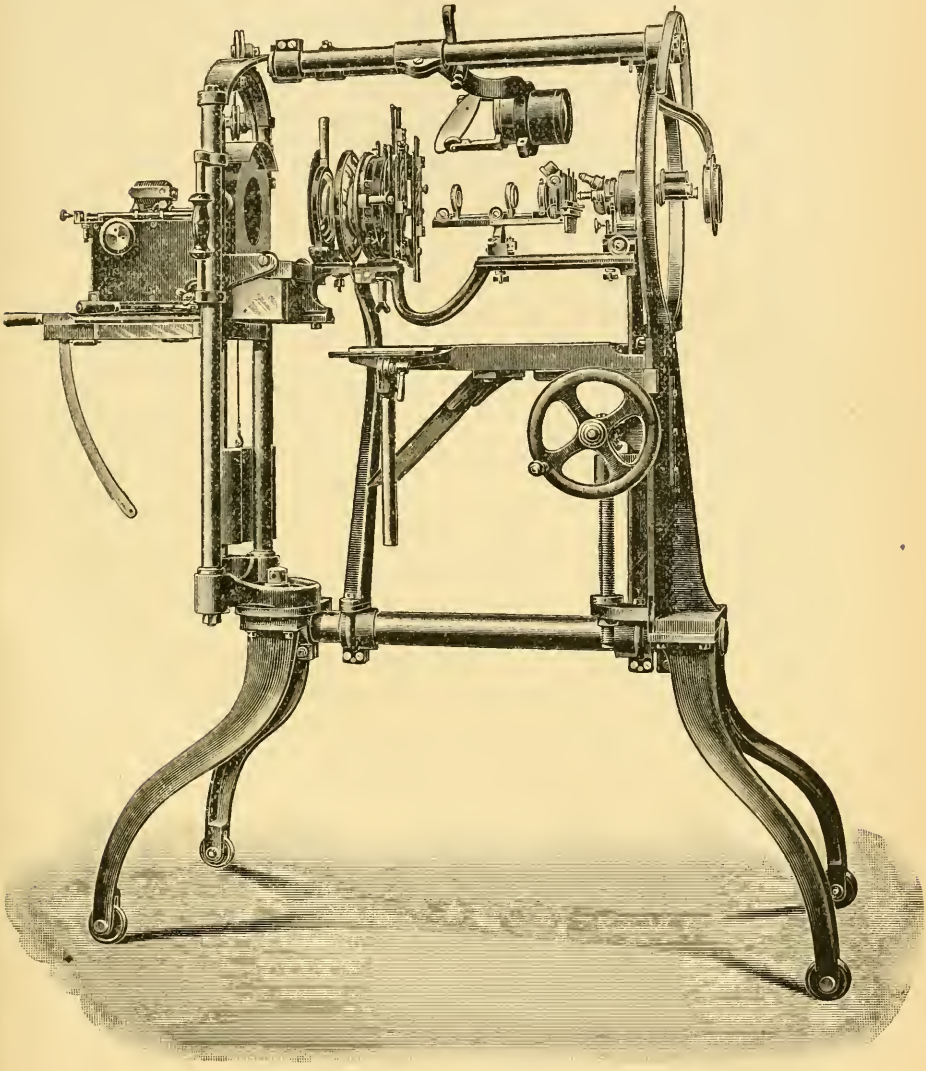

FIG. 104.

is shown in fig. 104. The base is formed of two pairs of cast-iron bent legs mounted on rollers and connected together by a very strong

* Zeitschr. wiss. Mikrosk., xxiii. (1906) pp 440–8 (7 figs.).

horizontal steel rod. The hinder pair supports the double lamp-carrier rotatory about a vertical axis. A Thomson lamp may be used as the light source; but a better result is obtained from a 30-ampere lamp with right-angled carbons. This lamp is adjustable in the optic axis by a lever. The usual vertical, horizontal and lateral centrings of the light-source are now reduced to a perpendicular and lateral adjustment of the lamp itself, a great gain in the case of an inexperienced demonstrator. The lamp, moreover, whilst being moved up and down on its carrier-pillars, is counter-balanced by a weight. This vertical movement is, however, only required in the case of change to diascopic projection of large section with right-angled reflected light. Both of these centric positions are firmly secured by clamps. The rotation of the lamp through 45° to the normal optic axis serves for the projection of objects situated in a laterally incident light. On the front pair of legs stands a bearer of T-section diminishing upwards and carrying in its grooved lower part the guide-nut for the perpendicularly movable large object stage for the macroscopic objects. The bearer also carries the adjustment arrangement of this stage operated by a cranked wheel. At its top end the bearer develops into a circular frame for the reception of the diaphragm arrangement. A strong horizontal steel rod finally connects it with the lamp-carrier, and serves as a holder of the large projection objective; it also carries a diaphragm adjustable in the optic axis, and on this diaphragm the screen-cloth is screwed. [The screen-cloth is not shown in the figure.] The large condensers are mounted on the horizontal lamp bearer, and both lenses are free for convenience of cleaning. Lamp and condenser are arranged for tilting. The appliances necessary for micro- and diapositive projection are so mounted on an optical bench, which is fastened each way on two long T-carriers, gripping the connected rod of the legs, that they can be moved either way. They are held in centric and lateral position by strong clamps. In order to diminish the possibility of a wrong position of any of the parts, and to facilitate exchange of diapositives, the optical bench is bowed underneath like a handle. The cooling trough and the diapositive holder are placed on the short arm. The author illustrates the details of the various methods of projection by suitable figures, one of which also shows the convenience of the bow in the bench as affording hand-room in exchanging diapositives, as above mentioned.

New Model of a Simple Movable Object Slide.*—G. Schorr has found the following contrivance very useful in dealing with serial sections. A slab of glass, about 3 mm. thick and 9 × 13 cm. surface, has a semicircular excision in one of the long edges, and on each side of this and on the upper surface a narrow strip of glass is cemented. The under surface of the slab is divided into three strips, A, E, B (fig. 105), of equal breadth, A and B being ground and E clear. In application A and B are moistened with water, or, better, with a mixture of glycerin and water. The slab will then, by capillary attraction, adhere firmly enough to the Microscope stage to retain any position which it may be required to take; at the same time a slight push-action is sufficient to move it.

* Zeitschr. wiss. Mikrosk., xxiii. (1906) pp. 425–7 (1 fig.).

The sections are laid on the upper surface in the ordinary way. In the case of a very large number of sections it may be preferable to dispense with the ground strips; but even then the capillary action will be found sufficient to answer the purpose.

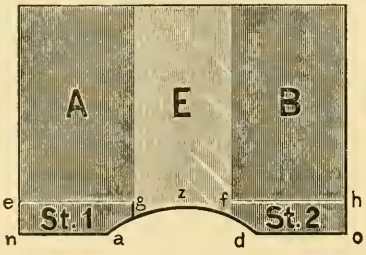

Fig. 105.

Reiff's Polariser.*—This instrument, which is described as a polariser without change of direction and without axis-displacement of the light-ray, is similar to Grimsehl's "Reflex polarisator," and is distinguished from it only in containing a much larger number of reflexions, but at the same time the light-intensity is strongly diminished. The instrument is designed in two models. In one an exchange of directions above and below may take place or may be avoided; the second model has one reflecting plane more than the first.

Koristka's Achromatic Oil-immersion Condenser.†—This has a numerical aperture of 1·30 and focal length 5·6 mm. It is applied to the Abbe fitting in the usual manner. It is essentially an objective of good central chromatic and spherical correction for homogeneous immersion. This property enables the luminous source to be projected in the plane of the preparation without the formation of coloured rings, and also permits of its use as an objective of weak magnification.

Cox, Alvin J.—**A New Comparator.**
Philippine Journ. Sci., ii. (1907) pp. 139–42 (3 figs.).

(4) Photomicrography.

Photomicrography in Colour with Autochromatic Plates of A. and L. Lumière.‡—Ch.-A. François-Franck appears to have met with very gratifying success. Even preparations requiring polarised light presented no special difficulty. Thus reproductions of crystals in Mont Blanc gneiss were faithfully obtained in all their colours. The time of exposure was not found capable of expression by any simple rule: experience only could determine it. In many cases 12 seconds would give

* Zeitschr. Physik. u. Chem. Unterr., xix. (1906) pp. 28–9 (2 figs.); see also Zeitschr. wiss. Mikrosk., xxiii. (1907) p. 497.

† Supplement to General Catalogue, N 12, Milan, April 1907.

‡ Comptes Rendus, cxliv. (1907) pp. 1340–1; see also C.R. Soc. Biol. de Paris, lxii. (1907) pp. 1099–1102.

excellent results, but with thick or obscure specimens 60 seconds might be required. When full solar light was not obtainable the investigators used arc-light.

SCHEFFER, W.—**Microscopical Researches on the Effect of the Persulphate and Ferricyanide Reducers, as also on the Re-developing of Bleached Negatives with Alcoholic Developers.**
Brit. Journ. Photog., liii. (1906) pp. 964–5 (9 figs.)

,, ,, **Note on the Reversal of Solarised Negatives with Farmer's Reducer.** *Tom. cit.*, p. 1027 (2 figs.).

,, ,, **Microscopical Researches on the Size and Distribution of Plate Grains.** *Op. cit.*, liv. (1907) pp. 116–20 (19 figs.).

,, ,, **Microscopical Researches on the Plate Grain.**
Tom. cit., pp. 271–3 (7 figs.).

HANSEN, F. C. C.—**Einige Farbfilter, sowie einige histologische Färbungen für mikrophotographische Aufnahmen.**
[The author's experience leads him to recommend certain solutions.]
Zeitschr. wiss. Mikrosk., xxiii. (1907) pp. 410–14.

FRANÇOIS-FRANCK, CH.-A.—**Note générale sur les prises de vues instantanées microphotographiques (plaque fixe à pellicule) avec l'arc voltaïque.**
C.R. Soc. Biol. Paris, lxii. (1907) pp. 637–9.

(5) Microscopical Optics and Manipulation.

Ultramicroscopic Studies on certain Organic Colloids. Two Optic States of Organic Colloids.*—A. Meyer, under the above title, describes a series of experiments which show that organic colloids can be met with in two states optically different, viz. hydrogels, solidified or liquefied, relatively homogeneous; hydrosols, showing numerous granules. One state may be transformed into the other, and in the course of this transformation arise the solutions of "globulines" and of "albumine."

New Method of Determining Indices of Refraction.†—G. Cesaro employs for this purpose Wollaston's goniometer, without the use of any other special apparatus. Instead of deducing the index of refraction from observation of the angle of minimum deviation, the author previously determines on a certain deviation $2a$. He then determines by the goniometer the two positions, on alternate sides of the minimum deviation, in which the refracted ray undergoes this said deviation. The angle u, through which the prism must turn about its edge to pass from one position to the other, the angle ϕ of the prism, and the deviation $2a$, suffice for the calculation of the refractive index. The author gives a full account of the details and calculations.

Direct Visibility of Neutral Layers in Bodies supposed to contain them.‡—H. Siedentopf has succeeded in taking photographs of these under several conditions. One of his experiments was to bend a strip of plane-parallel glass, so that the middle part in cross-section was made semicircular, some of the original plane remaining as bilateral

* C.R. Soc. Biol. Paris, lxii. (1907) pp. 42–4.
† Bull. Classe Sci. Acad. Roy. Belgique, 1907, pp. 135–162 (10 figs.).
‡ Pamphlet reprinted from the Zeit. des Osterr. Ingenieur- und Architekten-Vereines, lviii. (1906) No. 33, Vienna (10 pp.).

flanges. The shape was, therefore, something like a capital Omega  . The convex part of the bend would conceivably be in extension and the concave part in compression. Between the two there might be expected a neutral layer. By means of a beam from an arc-light passed through lenses and two Nicols and projected upon a camera, a photograph was obtained which showed the neutral layer to lie about midway between the parallel surfaces and roughly parallel to them. He also obtained some remarkable figures in a similar examination of highly strained glass rod. His experiments were largely based upon the researches of O. Hönigsberg.

SIEDENTOPF, H.—**Über die physikalischen Principien der Sichtbarmachung ultramikroskopischer Teilchen.**

Berliner Klinischen Wochenschrift, 1904, No. 32; and as a separate pamphlet, 7 pp.

(6) Miscellaneous.

Textiles and Colours in the Ultramicroscope.*—J. Schneider and G. Kunzl have studied this subject for the purpose of discovering whether undyed and dyed textiles give characteristic spectra when viewed with the ultramicroscope. Their conclusions are as follows :—

1. The ultramicroscope is adapted for the testing of dyed as well as of stamped products of the textile industry, especially in the case of small patterns and mixed colours.

2. In the investigation those appearances which are characteristic of the dye are to be distinguished from those which correspond to the light not penetrating the colour fabrics.

3. The most trustworthy test of the dye is that with the spectral-ocular; it is also possible without the same to distinguish colours contained in the spectrum.

4. The most instructive image is that received from silk with the use of both polarising prisms.

5. Fabrics coloured according to various methods show various characteristic features in the ultramicroscope; distinction is chiefly found between colours obtained from insoluble and applied dye-stuffs and those obtained by direct dyeing.

B. Technique.†

(1) Collecting Objects, including Culture Processes.

Cultivation of a Bovine Piroplasma.‡—M. Miyajima adopted the method used by Rogers for cultivating the parasites of kala-azar. The blood containing the intracellular parasites is drawn from the jugular vein, and then quickly defibrinated under strict precautions so as to avoid bacterial contamination. It is then mixed with ordinary nutrient bouillon in proportions varying from 1 : 5 to 1 : 10, and placed asep-

* Zeitschr. wiss. Mikrosk., xxiii. (1907) pp. 393-409 (1 fig.).

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

‡ Philippine Journ. Sci., ii. (1907) pp. 83-91 (3 figs.)

tically in sterile test-tubes, which are thereafter maintained at a temperature of 20°–30° C. Motile forms begin to show themselves on the third day, and reach the maximum between the tenth and fourteenth day.

Asbestos Filter.* — O. Bujwid describes a method for filtering cloudy or turbid liquids. This consists in shaking up the liquid with a small quantity of asbestos and then filtering the whole, a completely clear liquid resulting. The author has employed this method not only for clearing broth and gelatin, but also for turbid liquids containing bacteria. It is, however, not suitable for filtering fluids used for the preparation of diphtheria toxins.

Collecting and Preserving Medusæ.†—E. T. Browne has used the following methods for some years. A small, flat hand-made net of bolting silk is useful for catching medusæ swimming at the surface. For towing nets the following sample is described. It has a circular mouth 17 inches in diameter, and the net is about 5 feet in length, gradually tapering down to 3½ inches in diameter, which is the diameter of the zinc can attached to the end of the net. The nets are made of bolting-silk; three nets form a series with 30, 50, and 70 threads respectively to the inch.

The speed of towing the net is important, and the speed is about right when the line can be comfortably held on one finger; this amounts to about a ⅜-lb. pull.

When the net is taken on board, the contents of the can should be poured into one or more glass vessels. The medusæ are then picked out and placed for half an hour or more in another vessel until they have recovered from the shock. If they lie heaped up at the bottom of the vessel they should be stirred up with a glass rod. The medusæ are quickly fixed and preserved by means of formalin (5–10 p.c.), but in order to do this successfully they must be kept in motion by stirring up with a glass rod while the formalin is slowly poured in. After a few hours they are transferred to 10 p.c. formalin, changed once before sealing up the bottle.

To obtain medusæ in a nice state of expansion, it is necessary to use an anæsthetic. Add about 3 c.cm. of 1 p.c. cocain for every 100 c.cm. of sea-water, stirring gently the while with a glass rod. If in from 10–15 minutes the tentacles are expanded, and do not contract when touched with a glass rod, no more cocain need be added, but if still active the process must be repeated. When the medusæ are anæsthetised, stir them round gently, and add the formalin, still stirring the while. Specimens must not be left too long in a cocain solution, as it has a softening action.

For Scyphomedusæ the addition of chromic acid is an advantage. The author uses one vol. 5 p.c. chromic acid and nine vol. 10 p.c. formalin. After soaking for several days in the chromic-formalin solution, to which a little strong formalin is added daily, the specimen is transferred to 10 p.c. formalin for permanent preservation.

* Centralbl. Bakt., 1te Abt. Orig., xliv. (1907) p. 191.

† Trans. Linn. Soc., Zool., x. (1906), pp. 163–80 (1 pl.)

(2) Preparing Objects.

Studying the Maturation and Fecundation of the Mammalian Egg.*—H. Lams and J. Doorme used white mice and guinea-pigs in their research. The ovaries, tubes, and uterine cornua, removed under an anæsthetic, were at once placed in some fixative, Flemming, Benda, and Hermann giving the best results. After hardening in upgraded alcohols, paraffin sections 2–5 μ were made with a Minot microtome. Most of the sections were stained with Heidenhain's hæmatoxylin. For demonstrating mitochrondria, Benda's method was adopted, the fixative being a modified Flemming (1 p.c. chromic acid 15 c.cm., 2 p.c. osmic acid 4 c.cm., 3 drops glacial acetic acid). After a long immersion in the fixative the pieces were transferred to a solution consisting of equal parts of pyroligneous acetic acid and chromic acid solution, then to 2 p.c. bichromate of potash. After washing and dehydrating, the pieces were imbedded in paraffin. The sections were mordanted for some hours in a 4 p.c. solution of iron-alum, and then in a solution of sulphalizarinate of soda. After this, they were hot-stained in freshly prepared crystal-violet solution. The sections were differentiated in 30 p.c. acetic acid, and after drying were passed through acetone, oil of bergamot, and xylol to balsam.

Mitochondria are also stainable by Benda's method.

(3) Cutting, including Imbedding and Microtomes.

New Method of Making Celloidin Serial Sections.†—W. Rubaschkin adopts the following procedure. He uses albumen-glycerin in the proportion of 2 : 1 for sticking the sections to the slide. While cutting, the sections are temporarily arranged on the back of the knife to the handle, and when a sufficient number has been made they are removed to the slide. It is important that every section should be quite flat and without creases; they are easily smoothed out by means of a brush and gentle pressure. When satisfactorily arranged on the slide they are covered with a mixture of equal parts of clove-oil and anilin-oil. When the sections are quite clear and transparent, which will be in from 3–5 minutes, the oil is poured off and the slide immersed in 90° alcohol to remove the remains of the oily mixture. The slides are then removed to 70° alcohol and kept there till required. If it be desired to remove the celloidin, the slides are placed in 96° or absolute alcohol, and afterwards in a mixture of equal parts of alcohol and ether. When the celloidin is dissolved out, the slides are passed through 96° to 70° alcohol, after which they can be submitted to any further treatment.

(4) Staining and Injecting.

New Injection Apparatus.‡—W. Lindemann, having experienced the desirability of an injection apparatus which should work at constant pressure, has designed that shown in fig. 106. A is an injection pipette which acts either as an air-chamber or as a reservoir for the injection

* Archiv Biologie, xxiii. (1907) pp. 259–365 (3 pls.).
† Anat. Anzeig., xxxi. (1907) pp. 30–1.
‡ Zeitschr. wiss. Mikrosk., xxiii. (1906) pp. 427–30 (1 fig.).

material. It is a cylindrical glass tube of about 120 c.cm. capacity with a three-way cock at the upper end and a simple cock at the lower. An open glass tube is laterally and internally melted on to it and almost reaches to its roof. Externally this tube bifurcates, one branch becoming a manometer 80 cm. long and the other connected by a thick-walled rubber tubing with a funnel B, held by a clamp on to the iron pillar of

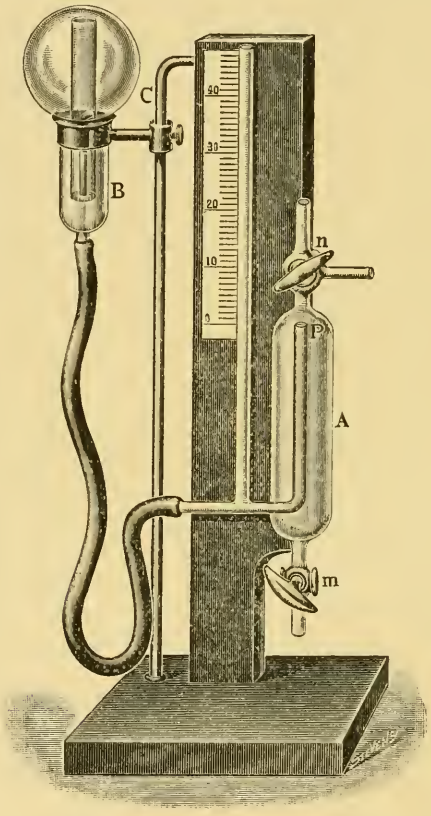

Fig. 106.

a vertical stand. The whole is first filled with quicksilver, which compresses the air in A to a pressure regulated by the mercury levels in the funnel and the manometer ; these can be read off from the scale. In order to keep this pressure constant by slow ingress of mercury from the funnel, a spherical flask is inverted and fitted into the funnel neck. This flask is also filled with mercury, which can only flow when the level in the funnel is low enough to allow the admission of air into the neck of the flask. The action of the flask is improved by the open tube soldered into its neck, and the outflow of mercury takes place through a

small hole in the lower part of this tube. The impetus of the air-bubbles is useful in certain cases of injection. But if the oscillations caused by them are not required, then A should be only used as an air-reservoir, the elasticity of the air acting as a compensator. The cock *m* serves for drawing off the mercury which has flowed into A. The pressure attainable ranges from 0–500 mm. of mercury.

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

Mounting Media of High Refractive Index.*—H. van Heurck, who at various times since 1883 has introduced to the notice of Microscopists mounting media of high refractive index, makes a further communication on this subject. With regard to Styrax he finds that the commercial variety can be quickly purified by first baking to get rid of as much moisture as possible, and then dissolving in boiling absolute alcohol. After filtering, the liquid thus obtained is evaporated to dryness and the yellowish-brown mass dissolved in benzine. This solution should be filtered anew. The author mentions that L. van Italie obtains a light-coloured styrax by treating the raw commercial article with petroleum ether. The dissolved portion is evaporated, and the extract thus obtained is of a quite light colour.

By dissolving equal parts by weight of piperine and styrax or liquid amber a medium with refractive index of 1·63 is obtained. This has remained perfectly unchanged for about five years. By mixing 6 parts of the foregoing with 1 part of piperine a still higher index is obtainable. This medium is liable to deposit crystals, but if re-melted and a little liquid amber added the crystals do not re-form.

If real benzoin of Siam be dissolved in chloroform it gives a medium with index about 1·60. It is yellowish, and sets quite hard.

By melting together in a porcelain capsule 3 parts of piperine and 2 parts of bromide of antimony, a medium with a refractive index about 1·70 is obtained. Too much heat should not be employed, as the mixture may become brown. The successful result is a yellowish substance which is very durable.

Monobromide of naphthaline and iodide of methyl have refractive indices respectively of 1·658 and 1·743. Both of these, while having excellent features as mounting media for diatoms, are subject to inconveniences which render them difficult for practical purposes.

The double iodide of mercury has a refractive index of 1·654, and though showing up the details of diatoms admirably, is not very convenient in practice. It is prepared by adding the red iodide of mercury to a saturated solution of potassium iodide until no more is taken up.

The arsenical medium of H. L. Smith, though most excellent, is liable to become opaque from the deposit of sulphur. The cause of this is due to insufficient boiling. If the heating be prolonged until all the bromide of arsenic has been driven off, the mounts will be found eventually to be perfectly stable. After the slide has cooled down, the coverslip should be ringed round with paraffin, and this afterwards varnished over.

The author opines that Canada balsam mounts are of no value, and

* Mém. Soc. Belg. Micr., xxviii. (1907) pp. 56–63.

that as liquid amber is so difficult to obtain, recourse must be had to styrax. The double iodide of mercury and potassium, which is miscible with water, is useful for rapid examination of valves or frustules, the structure of which is to be examined as soon as they are taken from water. It is a dangerous liquid, and care must be taken that it does not come in contact with objectives as the mounting of the lenses may be attacked. Smith's arsenical medium should be reserved for the examination of ultra-difficult details.

(6) Miscellaneous.

Mark, E. L.—**Electric Wax-cutter for Use in Reconstructions.** [Describes an ingenious machine for cutting out the wax plates, intended for the reconstruction of objects, by means of an electrically heated wire.]
Proc. Amer. Acad. Arts and Sci., xlii., 1907, pp. 629–36 (3 figs.)

Metallography, etc.

Evolution of Modern Tool Steel.*—H. C. H. Carpenter deals with some questions raised in F. W. Taylor's recent paper.† He considers that hardened steel is some form of combination of carbon with a solution of carbon in either β- or α-iron or both, and has an acicular microstructure. The best treatment of high-speed steels consists in heating to a very high temperature, cooling rapidly to about 815° C., then at a moderate speed to cold, and re-heating to about 620° C. The tool after this treatment is a mixture in which there is present some γ-iron, the remainder consisting of an almost structureless material, probably of an extremely fine and hard martensitic type. Chromium is an indispensable constituent of high-speed steel, and appears to bring about a condition of complete solution of the constituents. Carbon content may vary within wide limits. It is suggested that a cutting test with a tool maintained at a temperature over 900° C. would give valuable results.

Magnetic Behaviour of Certain Nickel Alloys.‡—B. V. Hill has determined the temperature of magnetic transformation of alloys of nickel, to test the applicability of van 't Hoff's law relating to the lowering of the freezing-point of a liquid by dissolved substances, to the lowering of the transformation-point of a magnetic metal by the addition of another metal. The transformation takes place over a wide temperature interval. The following results were obtained for the transformation temperatures of the nickel-copper alloys :—

Copper.	Temperature.	
p.c.	Hard.	Annealed.
0	355°C.	340°C.
4	310	295
8	280	265
20	155	140
40	−100	—

* Engineering, lxxxiii. (1907) pp. 569–71 and 633–4 (9 figs.).
† See this Journal, 1907, p. 251.
‡ Physical Review, xxiv. (1907) pp. 321–36.

The depression of the transformation point is proportional to the amount of the added metal both in the nickel-copper and nickel-tin alloys, but not in the alloys of nickel with silver. The latent heat of transformation of nickel was determined by an indirect method, a mean value of 4·48 being obtained. The author concludes from his own results and those obtained by other workers that there is no simple relation between the atomic weight of the added metal and the lowering of the transformation temperature of nickel.

Change of Structure in Iron and Steel.*—W. Campbell, discussing the equilibrium diagram of the iron-carbon system, takes the view that the same diagram may represent either the solidification of cementite with formation of a cementite-martensite eutectic or the solidification of graphite with the formation of a graphite-martensite eutectic. The author gives the results of some heat-treatment experiments on six high carbon-steels.† A general description of the structure of iron and steel is included, with some notes on the effect of heat-treatment.

Piping in Steel Ingots.‡—A. Obholzer gives his experience of the advantages resulting from the use of thermit to diminish piping.

Tantalum Steels.§—L. Guillet has examined 4 steels containing 0·09, 0·15, 0·60 and 1·05 p.c. tantalum, carbon 0·12–0·18 p.c. A ferro-tantalum made in the electric furnace was used in the preparation of the alloys. No special difficulty in melting or in mechanical treatment was experienced. The normal steels were found to be pearlitic. Tantalum appears to have a slight hardening effect. The influence of this element on microstructure and mechanical properties is small, and the author concludes that tantalum steels are of little practical interest.

Relations between the Diagram of Binary Alloys and their Malleability.‖—L. Guillet states some general laws deduced from data available, dealing with each possible type of equilibrium diagram. The malleability of an alloy is a function of the malleability of each solid phase and the proportion of malleable to non-malleable phases present. An alloy consisting of a pure compound or a pure solid solution (corresponding to a maximum of the liquidus and solidifying at a constant temperature) is not malleable. A solid solution rich in a malleable metal is malleable. Two metals which form a continuous series of solid solutions are either both malleable or both non-malleable, and the alloys have the same characteristics.

Constitution of Alloys.¶—A. Portevin fully describes Tammann's method of thermal analysis, passing in review the numerous cases, corresponding to the different types of equilibrium curve met with in the study of alloys, for which the method has been worked out at the University of Göttingen. The principle of the method is as

* Journ. Franklin Inst., clxiii. (1907) pp. 407–34 (35 figs.).
† See this Journal, 1907, p. 253.
‡ Journ. Franklin. Inst., clxiv. (1907) pp. 1–11 (10 figs.).
§ Comptes Rendus, cxlv. (1907) pp. 327–9.
‖ Op. cit., cxliv. (1907) pp. 1273–5.
¶ Rev. de Métailurgie, iv. (1907) pp. 797–813 (13 figs.).

follows. Given a univariant equilibrium occurring at a temperature t° between three phases of concentrations ϕ_1, ϕ_2, ϕ_3, owing to the formation or decomposition on cooling of the phase ϕ_3, according to the reversible and isothermal reaction

$$\phi_1 + \phi_2 \gtrless \phi_3$$

an evolution of heat is produced on cooling the amount of which may be estimated by the length of the step at t° in the cooling curves. The heat evolution is at a maximum for the concentration ϕ_3 and nil for the concentrations ϕ_1 and ϕ_2. If now curves are plotted showing the variation of these heat evolutions as a function of the concentration, ϕ_1, ϕ_2 and ϕ_3 may be determined by extrapolation. The author emphasizes the extreme importance of the method, and the value of the data which have been obtained by its application to numerous series of alloys.

Alloys of Nickel and Lead.*—A. Portevin gives the equilibrium diagram obtained by the application of Tammann's analytical method to the cooling curves of twelve alloys. The diagram indicates that (1) from 0–0·07 p.c. nickel, lead first separates from the liquid, solidification of the eutectic occurs at 323° C.; (2) from 0·07–7 p.c. nickel, crystallisation of nickel takes place along a steep branch of the curve, and is followed by solidification of the eutectic as before; (3) from 7–60 p.c. nickel, the mixture, completely liquid above 1365° C., is composed of two non-miscible portions: nickel separates from the nickel-rich layer at 1365° C., the liquid remaining (7 p.c. nickel) solidifies as in (2); (4) from 60–100 p.c. nickel, a branch of the curve rising from 1365° C.–1484° C. indicates the separation of nickel from a homogeneous liquid. When the concentration of the liquid falls to 60 p.c. nickel at 1365° C. the subsequent changes are as in (3). No compounds or solid solutions are formed, the solid alloys containing more than 0·07 p.c. nickel are composed of nickel and the lead-nickel eutectic.

Ternary and Quaternary Vanadium Steels.†—L. Guillet gives an account of Pütz's researches on vanadium steels, comparing the results with those obtained by himself. A description of the author's latest work on nickel-vanadium steels follows, in which increasing amounts of vanadium were added to pearlitic nickel steels near the martensitic boundary. The vanadium appears slightly to increase the tendency towards the formation of martensite; it also raises progressively the maximum stress and elastic limit. To obtain the best properties it is necessary to maintain the carbon content low, the nickel as high as is consistent with a pearlitic structure. The industrially useful steels fall within the limits 0·1–0·3 p.c. carbon, 2–7 p.c. nickel, and 0·1–0·3 p.c. vanadium.

Boron Steels.‡—A more complete account is given by L. Guillet of his investigation of six boron steels.§ The ferro-boron used in the pre-

* Rev. de Métallurgie, iv. (1907) pp. 814–18 (5 figs.).
† Tom. cit., pp. 775–83.
‡ Tom. cit., pp. 784–96 (17 figs.). See also Journ. Iron and Steel Inst., lxxiv. (1907) pp. 207–18 (17 figs.).
§ See this Journal, 1907, p. 508.

paration of the steels contained 32 p.c. boron, and was made in the electric furnace from calcium borate. Boron raises the thermal critical points of steel. The special constituent (boro-carbide of iron) may be caused to disappear by heating above 850° C., followed by quenching, but with increase of boron-content the difficulty of thus dissolving the boro-carbide increases. The presence of this body causes brittleness, and is accordingly objectionable. It is only in the quenched state that these steels appear to be suitable for any industrial application. A boron content of 0·5 p.c. gives the most interesting results.

Copper Steels.*—P. Breuil has previously published results of his work on these alloys.† The present complete account contains much new matter. Four series were examined, containing carbon about 0·15, 0·35, 0·65, and 1·0 p.c., copper in each series increasing from 0·5–30 p.c. Ar 3 and Ar 2 are lowered by the presence of copper in soft steels. In medium carbon steel Ar 1 is lowered, but not below 550° C. The position of Ar 1 in hard steels is not affected. Tensile strength increases with copper content—copper thus has an effect comparable with that of nickel; resistance to shock is good. Copper steels are commercially serviceable up to about 4 p.c. copper; no segregation occurs below this limit. Free copper occurs in the steels containing more than 8 p.c. copper. Talc was used in place of alumina as the polishing powder for micro-specimens. More than 100 photomicrographs are given.

Cast Iron as Cast- and Heat-treated.‡—W. H. Hatfield has attempted to locate the regions of temperature in which the carbide of iron breaks up into iron and carbon. Test bars of a white iron containing 3·4 p.c. carbon (all combined), 1·1 p.c. silicon, were cast in sand, and were heated together in an annealing oven. One bar was cooled in air, and one quenched in water when the temperature had risen to (1) 780° C., (2) 820° C., (3) 860° C., (4) not higher than 900° C. and cooled extremely slowly (*a*) to 750° C., (*b*) to 650° C. As regards distribution of annealing carbon, the quenched bars differed little from the air-cooled bars. Sections from all the bars were microscopically examined. Annealing carbon first appeared in the bars cooled from 820°C., and increased progressively in the subsequently cooled specimens. The massive cementite appeared to decompose between 800° and 900° C., while the bulk of the pearlite disappeared during cooling from 750°–650° C., giving ferrite and temper carbon. From his experiments on influence of casting temperature, the author concludes that while great variation in strength is found between cast irons of the same composition as cast, there is no direct relation between strength and casting temperature.

Non-Metallic Impurities in Steel.§—By microscopical and chemical methods, E. F. Law has demonstrated the existence in steel of sulphide, silicate, and oxide of iron, sulphide and silicate of manganese. Sulphide of iron is rarely found in commercial steels, the sulphur existing

* Journ. Iron and Steel Inst., lxxiv. (1907) pp. 1–78 (16 figs., 10 pls.).
† See this Journal, 1906, pp. 516 and 740.
‡ Tom. cit., pp. 79–93 (23 figs.).
§ Tom. cit., pp. 94–105 (11 figs.).

as sulphide of manganese, which usually is comparatively harmless. The silicates have a decidedly injurious effect. Oxide occurs as minute black specks, visible in the polished section with a magnification of 1000 diameters. These specks are invariably found in steels which give blisters on pickling: this supports the view that the blisters are due to the presence of oxide. Oxygen was determined by passing hydrogen over heated drillings and weighing the water formed. The samples examined by the author were found to contain 0·02 to 0·06 p.c. oxygen. The presence of oxygen in steel appears to favour corrosion to a marked degree. The pitting of boiler plates and tubes is ascribed to oxide.

Relation between the Process of Manufacture and some of the Physical Properties of Steel.*—F. W. Harbord gives the results of a large number of tensile and other tests, bringing out the important differences in strength of steels having the same carbon content but differing in process of manufacture. For a given maximum stress a basic open hearth steel requires the most, and an acid bessemer the least carbon.

Ageing of Mild Steel.†—C. E. Stromeyer gives a large number of instances in which lapse of time appeared to have an effect on the physical properties of steel. Frequently this effect was a development of brittleness. The author carried out bending tests on strips sheared from plates, the time between shearing and testing being varied. Some of the test pieces were submitted to treatments such as annealing, maintaining at a low temperature, heating at 100° C. and at a blue heat. The results are conflicting, but appear to show that certain steels deteriorate gradually after local straining caused by shearing, or nicking with a chisel. In some cases the steels improve with the passage of time.

Carbon-tungsten Steels.‡—T. Swinden has prepared nine steels containing an approximately constant tungsten content (3 p.c.), carbon varying from 0·14 to 1·24 p.c., and has carried out mechanical tests, microscopical examination, and determination of critical ranges. Numerous curves were taken by the direct method to determine the effect of initial temperature on critical ranges. Among the author's conclusions are—

1. A definite compound, Fe_3W, is formed by melting the two elements together in certain proportions.

2. Maximum tensile stress is higher, and elastic ratio much higher than for carbon steels of the same carbon content.

3. Below a certain initial temperature (the "lowering temperature") which is higher as the carbon content is greater, the critical points are the same as for carbon steels. In steels below 0·35 p.c. carbon heating beyond this temperature lowers Ar 1 to a definite "low point" (570° C. for the 3 p.c. tungsten steels). With carbon 0·35 to 0·9 p.c. Ar 1 is first lowered. As the initial temperature is further raised, Ar 3, 2, is

* Journ. Iron and Steel Inst., lxxiii. (1907) pp. 181–99 (6 figs.).
† Tom. cit., pp. 200–260 (31 figs.).
‡ Tom. cit., pp. 291–327 (26 figs.).

displaced towards Ar 1. With the higher carbon steels Ar 3, 2, 1 is lowered as a whole by heating beyond the lowering temperature and produces a single low point. The eutectic composition is the same as for carbon steels.

Platinum Alloys.*—F. Doerinckel has determined the equilibrium diagrams for the binary alloys of platinum with copper, silver, gold, tin, and lead by thermal methods, confirming the results by microscopical examination. With gold and copper, platinum forms a continuous series of mixed crystals. With silver a similar series of mixed crystals is found from 0–48 p.c. platinum. With lead and tin a number of compounds are formed. Of the three lead-platinum compounds, the formula of one only, PtPb, has been established. Pt_3Sn and PtSn are indicated as the formulæ of two of the four platinum-tin compounds, while the other two are probably Pt_2Sn_3 existing in two allotropic modifications, and Pt_3Sn_8. The relationship of platinum to the definitely electro-positive metals would appear to be more remote than to those of the middle part of the periodic system. All these platinum compounds except Pt Sn appear to decompose on melting, forming a liquid of definite concentration and another solid phase.

Ternary Alloys of Lead, Magnesium, and Tin.†—A. v. Vegesack devotes the first portion of this paper to a theoretical consideration of the conditions of equilibrium of a ternary system in which two binary compounds occur, but no ternary compounds and no ternary mixed crystals. The three components are assumed to be miscible in all proportions in the liquid state, and the compounds to be fusible without decomposition. The numerous types of equilibrium possible are separately considered in two main classes: (1) no mixed crystals are formed; (2) the two compounds are isomorphous. The author has determined the equilibrium diagram of the lead-magnesium-tin series by thermal analysis of the cooling curves of more than 100 alloys, which were also examined microscopically. The two compounds $SnMg_2$ and $PbMg_2$ which occur in this series form with each other two series of mixed crystals α and β. These, with the two compounds and the three pure metals, are the only solid phases. α has a limiting concentration (α_1) 22 p.c. Mg, 21 p.c. Sn, 57 p.c. Pb, by weight. With more $PbMg_2$ the reversible reaction

$$\text{mixed crystals } \alpha_1 + \text{melt} \gtrless \text{mixed crystals } \beta_1$$

occurs at 570 C.

It is not possible to give here more than a general outline of this illuminating contribution to the study of ternary alloys.

Alloys of Antimony with Manganese, Chromium, Silicon, and Tin; of Bismuth with Chromium and Silicon; and of Manganese with Tin and Lead.‡—R. S. Williams has determined the equilibrium diagrams for each of these binary systems, and summarises the results in a table which is too lengthy to be reproduced here. 10 p.c. ferric

* Zeitschr. Anorg. Chem., liv. (1907) pp. 333–6 (23 figs.).
† Tom. cit., pp. 367–416 (33 figs.).
‡ Op. cit., lv. (1907) pp. 1–33 (34 figs.).

chloride solution, dilute nitric acid, and the vapour of concentrated nitric acid, were the etching reagents. The compounds are Sb_2Mn_3, $SbMn_2$, Sb_2Cr, SbCr, SbSn (?), $SnMn_4$, $SnMn_2$, SnMn (?). The magnetic properties of some of the alloys were studied.

Behaviour of Iron with Lead, Bismuth, Thallium, and Cadmium.* E. Isaac and G. Tammann show that solid iron is completely insoluble in these molten metals, and non-miscible in the liquid state with lead and bismuth, while the boiling points of cadmium and thallium are below the melting point of iron. No alloys could therefore be obtained.

Alloys of Iron with Platinum.†—E. Isaac and G. Tammann give the equilibrium diagram. At high temperatures the two metals form a continuous series of mixed crystals. At lower temperatures, this is transformed into two other series of mixed crystals containing respectively 0–50 p.c. and 60–100 p.c. platinum. The transformation temperature of iron (Ar 3) is lowered by addition of platinum. The analogy between these alloys and the nickel-iron alloys is indicated. Dilute nitric acid and hot aqua-regia were the etching reagents, one or the other being used according to platinum content.

Potential and Nature of Metallic Alloys.‡—N. Puschin has determined the potential curves of some binary alloys. The E.M.F. is that given by a cell made up of one pure metal, the alloy, and the aqueous solution of a salt of the metal. The typical curves proper to different types of binary series of alloys are described. The application of the method to the study of alloys is indicated.

BELL, J. M.—**The Composition of Solid Phases in Four-component Systems.**
Journ. Phys. Chem., xi. (1907) pp. 394–5.

BEAUMONT, W. W.—**Corrugation of Tramway Rails.**
Engineering, lxxxiv. (1907) p. 256.

GUILLET, L.—**Constitution of Copper Alloys.**
[The author's conclusions regarding the existence of a brittle zone in each series of binary alloys of copper are illustrated by photomicrographs.]
Rev. Métallurgie, iv. (1907) pp. 622-7 (5 figs.).
See also this Journal, 1907, p. 508.

GUERTLER, W.—**Modern Metallography.**
Zentralbl. f. Eisen., ii. (1907) pp. 478–9.

HEATHCOTE, H. L.—**Passive Iron.**
Journ. Soc. Chem. Ind., xxvi. (1907) pp. 899–917 (28 figs.).

OBHOLZER, A.—**Avoidance of Pipe Formation.**
Stahl und Eisen, xxvii. (1907) pp. 1117–21, 1155–60 (17 figs.).

VIGOUROUX, E.—**Nickel-tin Alloys.** *Comptes Rendus*, cxlv. (1907) pp. 246–8.

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* Zeitschr. Anorg. Chem., lv. (1907) pp. 58–62 (2 figs.).
† Tom. cit., pp. 63–71 (7 figs.).
‡ Journ. Soc. Chem. Ind., xxvi. (1907) p. 826. See also J. Russ. Phys.-Chem. Ges., xxxix. (1907) pp. 13–54.

MICROSCOPY.

A. Instruments, Accessories, &c.*

(1) Stands.

Voigtländer and Sons' Dissecting Stand.†—Fig. 109 shows this large dissecting stand, which is fitted with round horse-shoe foot, rectangular stage 95 × 108 mm., transparent glass stage and revolving

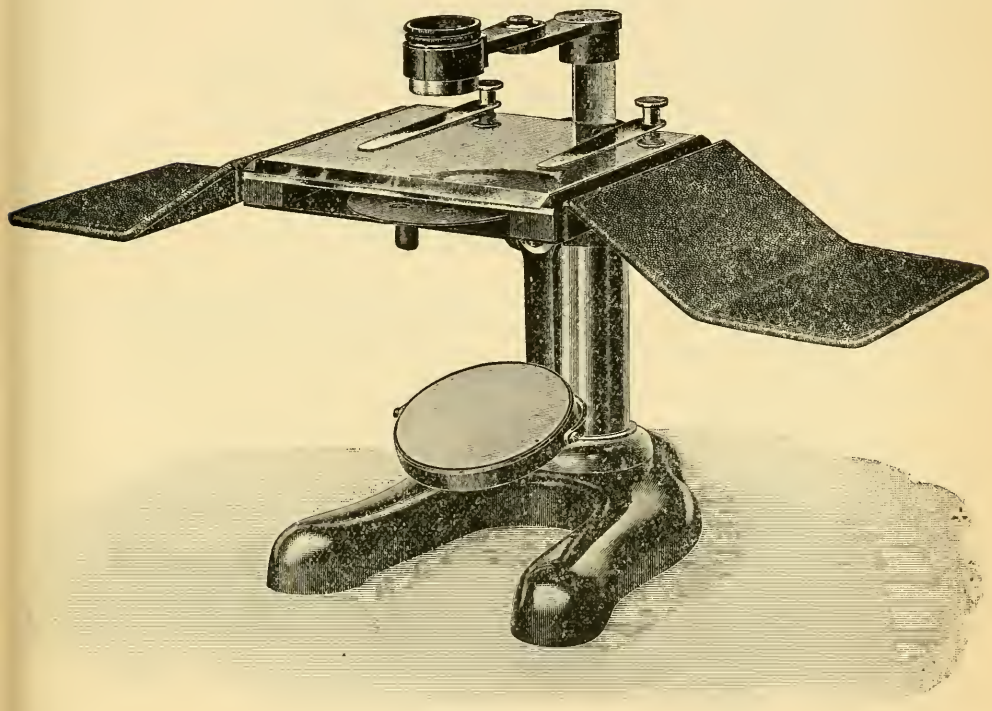

Fig. 109.

diaphragm. The focusing is by rack-and-pinion, and there is a double movable magnifier holder. The mirror is double, 55 mm. in diameter. The hand-supports are leather covered.

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

† Catalogue (English Edition) 1907, p. 39.

Voigtländer and Sons' Stand VIIa.*—This small stand (fig. 110) inclines to 45° and has a movable vulcanite stage 90 × 170 mm., re-

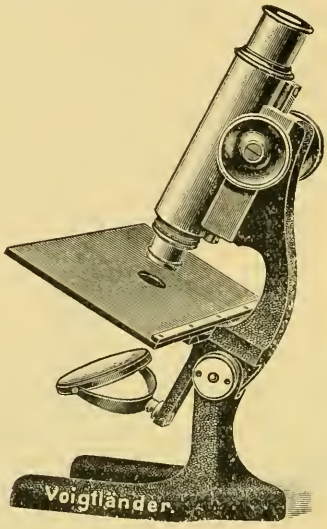

Fig. 110.

volving diaphragm, mirror 55 mm. diameter, and rack-and-pinion focusing adjustment.

Voigtländer and Sons' Hand Microscope for School and Demonstration.†—This is a cheap Microscope for class demonstration (fig. 111).

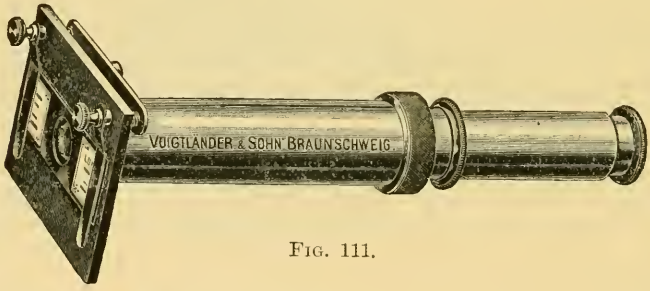

Fig. 111.

The focusing is done with the eye-piece tube. There is a rectangular stage and revolving diaphragm.

Voigtländer and Sons' Stand I.‡—This large model is shown in fig. 112. It has complete inclination, rack-and-pinion coarse-adjustment, and new micrometer focusing with division of the milled head in 0·002 mm. The wide outer tube is of 50 mm. and the large mechanical stage of 130 mm. diameter. The Abbe illuminating apparatus has a swing-out condenser (N.A. 1·40), iris diaphragm for oblique illumina-

* Catalogue (English Edition) 1907, p. 37. † Tom. cit., p. 38.
‡ Tom. cit., p. 25.

tion, and a double mirror of 55 mm. diameter. The whole illuminating apparatus is moved by rack-and-pinion motion, and remains perpendicular to the stage of the Microscope. There is a revolving nose-piece for three objectives.

Voigtländer and Sons' Stand IVa.*—This stand (fig. 113) has inclination to 45° only, and is fitted with a handled tripod foot. There is

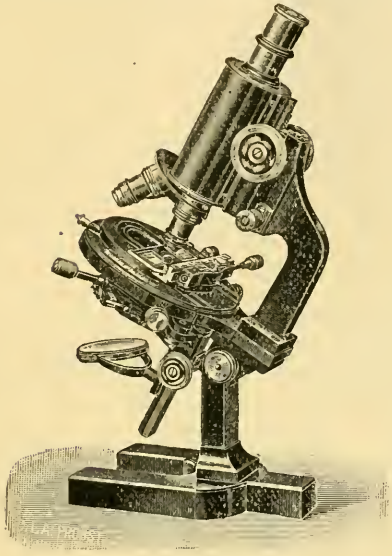

FIG. 112.

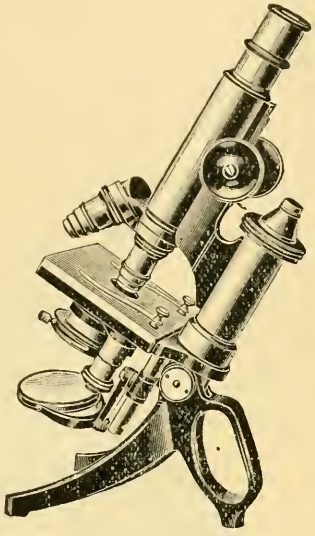

FIG. 113.

a rack-and-pinion coarse-adjustment. The older form of micrometer fine-adjustment with division of the milled head in 0·01 mm. is used. The outer tube is 30 mm. in diameter and has a sliding draw-tube. The rectangular vulcanite stage is 85 × 95 mm. and the double mirror is 50 mm. diameter. There is a revolving triple nose-piece. The condenser is ordinary (N.A. 1·20) with fixed iris diaphragm, four diaphragms, and carrier for a blue or ground glass disk. The condenser has a side-screw adjustment.

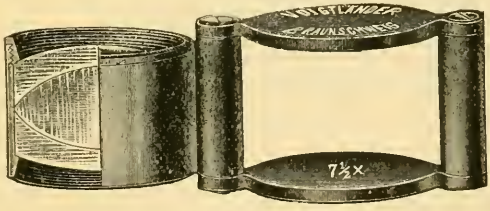

FIG. 114.

Voigtländer and Sons' Magnifiers.†—Their Steinheil loups are made in six powers, viz.: 7·5, 10, 12, 18, 25, and 35. They may also be obtained in clasp mountings and fitted with a micrometer divided in 0·1 mm. (fig. 114).

* Catalogue (English Edition) 1907, p. 32. † Tom. cit., pp. 14, 15.

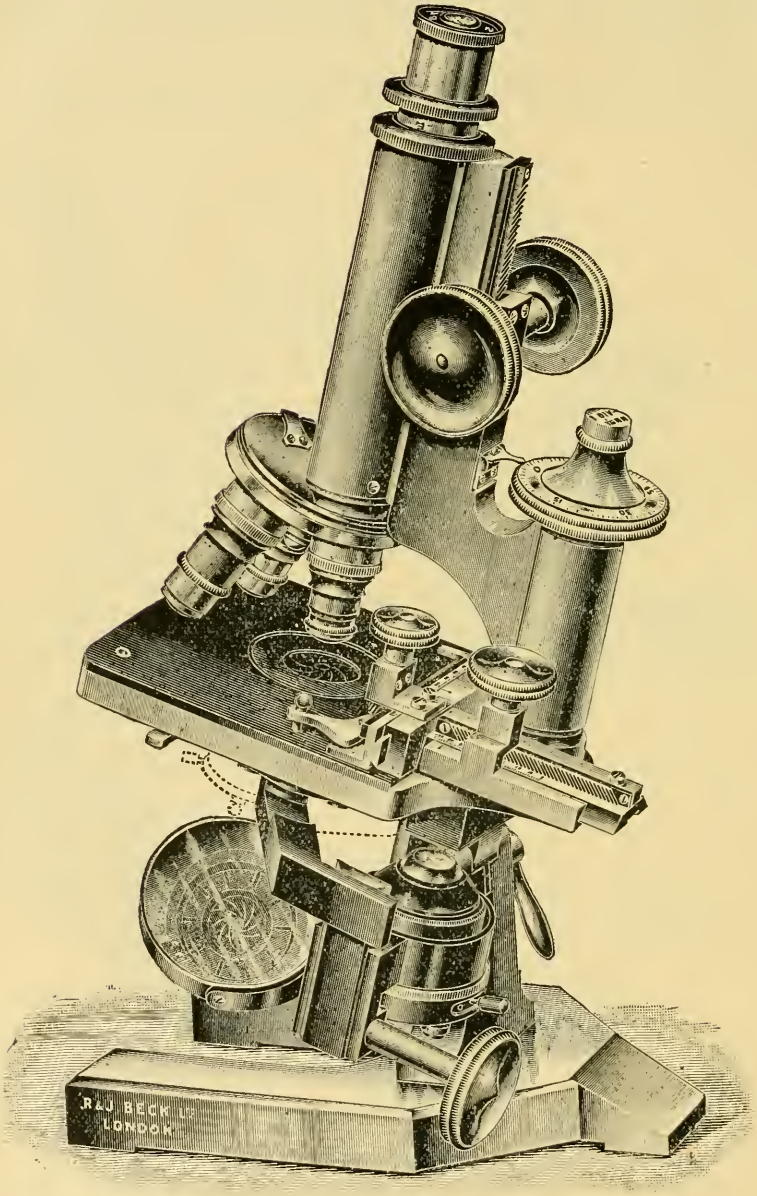

Fig. 115.

Beck's London Microscope: Iris Model.* — In this new model (fig. 115) of the London Microscope † there are the following improvements and additions: a clasp handle for the inclining joint; more room between the stage and the base; an iris diaphragm to the stage; and an arrangement whereby the substage can be swung aside, so that the condenser can be instantly displaced from the optic axis by means of the same milled head which actuates the focusing adjustment. As soon as the condenser has been racked down to its lowest limit, it swings clear of the stage.

(2) Eye-pieces and Objectives.

Koristka's $\frac{1}{12}$ Oil-immersion Objective.‡—The focal length of this has been reduced to 1·80 mm., and thus a higher magnification is obtained. The objective is adapted for the most diverse purposes. While the instrument is equal in effect to a $\frac{1}{14}$ inch, the old denomination has, for simplicity, been retained. It is made with N.A. of 1·30 or 1·37.

Koristka's New Objective 6*.—This, numbered as above,§ has a focal length of 4·3 mm. and N.A. 0·82. It resembles No. 6 in the same maker's series, which has the same focal length, but N.A. 0·72. Its frontal distance is 0·50 mm., and both act as objectives of strong penetration, being very useful in such matters as the computation of the red and white blood corpuscles. The new objective, however, acts better in those researches in which a higher power of resolution is required, e.g. the cases of diatoms.

Voigtländer and Sons' Objectives.‖ — The construction of the apochromats is shown in fig. 116. They are absolutely free from chromatical aberration; hence their applicability to microphotographic work and the finest and most difficult examinations. Among their new lenses of this class are those of focal lengths, 12 mm., 6·5 mm., and 3·7 mm.; with respective N.A. 0·5, 0·75. 0·95.

The achromatic objectives of the dry systems have low optical indices, the highest being that of 16 mm. focal length and 0·28 N.A.

The firm have brought out a new water immersion achromat of 5 mm. focal length and N.A. 0·75; and a new oil-immersion of 2·7 mm. and N.A. 0·35.

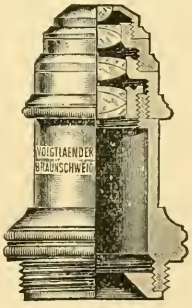

Fig. 116.

Voigtländer and Sons' Eye-pieces.¶—These include four Huyghenian eye-pieces of magnifications 5·5, 7·5, 9·2, 11·4; and five compensating eye-pieces of powers 6·2, 8·3, 11·4, 16·7, 25·0.

* R. and J. Beck's Special Catalogue, 1907.
† See this Journal, 1901, pp. 694–5, fig. 145.
‡ Supplement to General Catalogue, N 12, Milan, April, 1907. § Loc. cit.
‖ Catalogue (English edition) 1907, p. 7. ¶ Tom. cit., p. 11.

Voigtländer and Sons' Screw-micrometer Eye-piece.*—Fig. 117 shows this auxiliary in section and end elevation. It is intended for the most exact measurements, and contains a carefully cut screw moving a

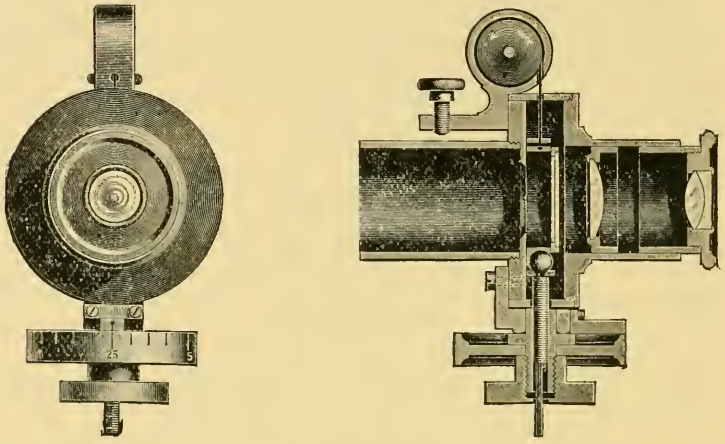

Fig. 117.

glass scale divided in millimetres. The parts of division on the drum are 0·01 mm., and therefore measurements of 0·001 mm. are obtained. The apparatus is placed in the tube in lieu of the ordinary ocular.

"H."—**Eye-pieces of the Huyghenian or Negative Type as corrected for Achromatism and Equal Deviation at the Lenses.**

[Among other things it is shown that in practically constructing a telescope eye-piece, it is necessary to depart widely from Huyghen's formula, the only one discussed in text-books.]

Eng. Mechanic, lxxxv. (1907) pp. 567-9 (6 figs.); pp. 588-9, 612-13.

(3) Illuminating and other Apparatus.

Simultaneous Projection of Two Different Preparations in the Field of the Microscope.†—F. K. Studnicka's "pancratic" Microscope has been noticed in this Journal,‡ and the author now describes how it may be advantageously employed for simultaneously viewing two different preparations. One of his pancratic methods involved the accurate insertion of a reverse objective in the diaphragm-carrier of the Abbe illuminating apparatus from which the condenser had been removed. On a special stage below the ordinary one, a preparation is placed which comes into focus as a reduced reverse image not far from the plane of the ordinary stage, and can be observed in the usual manner. If another preparation be now arranged on the upper stage, the two objects can be brought into simultaneous view, the lower object being racked up or down as required. If the sizes of the objects are large,

* Catalogue (English edition) 1907, p. 42.

† Zeitschr. wiss. Mikrosk., xxiv. (1907) pp. 34-8.

‡ See this Journal, 1905, p. 643.

then only portions of them can be simultaneously seen. In this latter case, however, comparison may be easily made if one of the stages be adapted for swinging out of the field. The method, which is naturally only adapted to transparent preparations, succeeds best with low-power objectives, for the difference in the magnification of the two objects might be inconvenient with strong lenses. The oculars employed should be weak and not too intensive. If the Abbe condenser is used, its iris should be as much as possible closed. The author recommends the arrangement not only for subjective observation, but also for photomicrography.

Simple Method of Adjusting the Nicols in a Mineralogical Microscope.*—In order to provide a cheap and trustworthy means of accurately determining whether the nicols of a mineralogical Microscope are in a perfectly crossed position, E. Sommerfeldt proposes the use of a twin crystal of gypsum. This crystal would be applied to the slit, and, owing to its extreme fissibility, it would be easy to obtain it in the required degree of thinness. Such a crystal plate must be so applied that in the rotation of the object stage, a position is found in which both members of the twins appear equally bright. The twin limit then accurately coincides with a thread of the thread-cross when the Microscope is properly adjusted—otherwise the adjustment must be corrected until this condition is attained. If the preparation is then rotated 45° either way in its plane, a second position of equal brightness in the twins is found. In this way those positions can be noted, or tested, which are usually indicated on the tube of an expensive mineralogical Microscope.

Siedentopf's Paraboloid Condenser: a New Method for Dark-field Illumination.†—This apparatus of H. Siedentopf's is especially adapted for securing visibility of living bacteria (especially of *Spirochæta pallida*), and for their instantaneous photography. From the optical standpoint *Spirochæta pallida* is characterised less by its spiral form than by its extreme thinness, which usually lies below the resolution-limits of microscope objectives. While, no doubt, large specimens can be seen with bright-field illumination, the observer will experience greater difficulties and obtain less satisfactory results than with dark-ground effects. But for dark ground the objective must have deeper penetrating power in consequence of the greater contrasts ; while, on the other hand, owing to the naturally increased resolution of high aperture with oblique light, moderately strong systems of 7–4 mm. focus suffice, one effect being to produce a larger and more extensive view-field. In contrast with these advantages, dark-ground illumination has the disadvantage of increasing the difficulties due to any deficiency of cleanness in the preparation, or to dust on the cover-glass. Ultramicroscopic methods are not required for revealing living bacteria. A very simple and successful dark-ground illumination of another kind is obtained by inserting a diaphragm of 24 mm. diameter under the immersion condenser of 1·4 N.A., the object-slide being connected with the condenser

* Zeitschr. wiss. Mikrosk., xxiv. (1907) pp. 24–5.
† Tom. cit., pp. 104–8 (1 fig.).

by cedar-wood oil. In consequence of the total reflexion at the cover-glass, a very useful dark ground can be obtained with dry systems.

The author's paraboloid condenser (fig. 118) is an improved form of Wenham and Stephenson's, and can be fitted on to every Microscope which possesses a condenser push-sleeve of ordinary width (36·8 mm.). It is inserted in the position of the condenser sufficiently far to bring its upper plane approximately to the level of the stage, and a cedar-wood oil connexion, as far as possible bubble-free, is made between the under side of the slide and the condenser. The thickness of the oil-layer is 1·0 to 1·5 mm. The illuminating beams have a N.A. of about 1·1 to 1·4 and are totally reflected at the upper plane of the cover-glass in contact with air. The paraboloid has improved spherical correction ; but its main advantage is that it reflects the rays instead of refracting them. Dry systems of medium strength are used, Zeiss DD with correction-collar being the most suitable. The best results

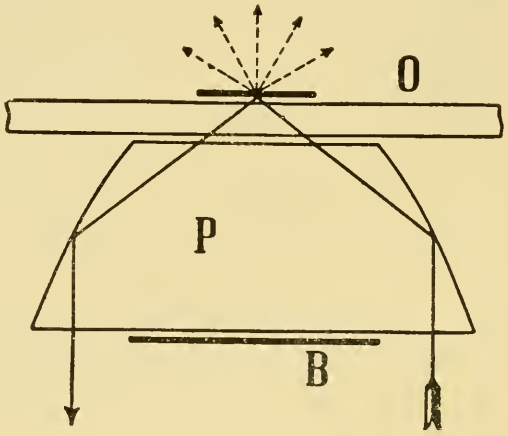

Fig. 118.

are obtained when this objective is screwed on to the tube with a small centring arrangement ; the focus of the paraboloid can then be made to coincide with that of the objective. Strong compensation oculars (No. 12 or 18) complete the optical equipment. Incandescent mantles, Nernst-light, or, best of all, electric arc-light may be used. Sunlight, or arc-light with this condenser, is sufficiently intensive for the instantaneous photography of living bacteria. The path of the rays in the paraboloid is shown in the figure, those refracted in the object itself being dotted. P is the plano-convex glass whose convex curve is an accurate paraboloid of revolution. B is the central diaphragm, which stops off rays of aperture 0·0 to 1·1 ; it is covered with tin-foil to prevent over-heating. O is the object-slide, and in its upper surface is the focus of the paraboloid. There are no diffraction circles apparent when central illumination is used ; and, if the adjustment is carefully performed, a living *Spirochæta* may be seen in five different typical appearances.

Dark-field Illumination and Ultramicroscopy.* — The first two out of the three sections of this article are devoted by H. Siedentopf to methods which are substantially those noticed in our abstract immediately above. In his third section he discusses the examination of colloidal solutions, serum, and drinking water. He points out that the difficulties caused by the tendency of the ultramicrons to collect on the underside of the cover-slip, or on the upper side of the object-slide, include not only diffraction but those due to currents set up by variations in the concentration. All these difficulties are avoided if an arrangement be adopted similar to that used by Siedentopf and Zsigmondy in their original ultramicroscopic experiment, whereby the directions of illumination and observation are mutually perpendicular. The best test object for this method is a deep red colloidal gold solution, whose parts appear green on a bright ground, with a strong water-immersion objective (Zeiss' D∗) and strong ocular (Zeiss' compensation ocular 12 or 18). This method is the only one suitable for the examination of ultramicrons in solid bodies, e.g. glasses and crystals. Direct observation of such objects would require the preparation of very thin, highly polished sections, and it is found that the light-effects from the polishing errors drown out the other effects. The author states that he has never succeeded in resolving the gold particles of ruby gold glass by direct observation with dark-field illumination.

Measurements of some Modern Micrometers.†—From a preliminary study of some modern micrometers, M. D. Ewell arrives at the conclusion that no advance in precision has been made in the last twenty-five years. The measurements of the different scales are given.

Microscope Lamp.‡—"Antares" remarks that for ordinary investigation, when daylight is past, an electric lamp is more clean and convenient than any other; but for "critical" observation its usual form is not successful. His consists of a metal cylinder $2\frac{1}{4}$ in. diameter and 6 in. long; the aperture is at the top, under an inclined cover, so that the incandescent lamp is not visible, and it is painted a dead white inside, giving a "white cloud" effect. The cylinder can be inclined at any angle, and is adjustable for height from the base by a racked pillar and pinion. In the back of this cylinder, about the middle, he has now made a longitudinal slit, $\frac{1}{2}$ in. long and $\frac{1}{10}$ in. wide (rather narrower might be better), which can be brought, by rotating the lamp-socket, opposite to one of the straight parallel filaments of a tubular Edison-Swan lamp of $2\frac{1}{2}$ c.p. and 100 volts, so that $\frac{1}{2}$ in. of filament glows through the slit. When the lamp is used in this way the ordinary aperture of the cylinder is closed by a bent card, and the illumined slit is brought by movements of the lamp-stand into line with the axis of a substage condenser. The effect is thus similar to that of a small paraffin flame placed edgewise, but more constant, and, he thinks, quite as successful.

* Zeitschr. wiss. Mikrosk., xxiv. (1907) pp. 13–20.
† Proc. Amer. Phil. Soc., xlvi. (1907) pp. 187–90.
‡ English Mechanic, lxxxvi. (1907) p. 42.

Cheshire's Apertometer.* — This instrument (fig. 119), made by R. and J. Beck, consists of a glass disk with a series of concentric rings in its lower surface. The object-glass to be tested is focused to a mark on the upper surface, and, the eye-piece having been removed, the

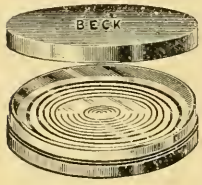

Fig. 119.

Fig. 120.

number of rings seen in the back lens of the object-glass gives the aperture in decimals, each ring denoting 0·1 N.A.

For high powers, when the lens is small and the rings difficult to count, a special eye-piece (fig. 120), which focuses to the back focal-plane of the object-glass, is required. This is inserted in place of the usual eye-piece.

Edinger's Drawing and Projection Apparatus.—This apparatus, which has more than once been noticed in our Journal,† has been recently revised and improved.‡ It is shown in figs. 121–125, of which fig. 122 illustrates the principles of construction and is lettered for reference. The apparatus is primarily intended for facilitating the work of preparing drawings of microscopic objects and is available for comparatively high magnifications. To this end the image of the object is projected directly upon the drawing surface where it may be traced with a lead pencil. The instrument is likewise adapted for demonstrating to a small audience objects on the screen and for photomicrography. The apparatus consists of a cast-iron column S mounted upon a rectangular frame in which the drawing-board Z is made to slide in or out. The column S is provided with a guide-bed along which the entire optical outfit, together with the lamp, can be made to slide up and down after loosening the screw R. The movable part B has likewise guide-bars for the independent displacement of the lamp L, object stage O, and lens-holder H. The lamp, together with the condenser K, may be displaced along the optic axis by means of the handle G. The object stage O may be raised or lowered, as required, according to the objective used, and its position is shown on a scale divided into $\frac{1}{2}$ cm. The lens-holder H remains fixed at a distance of 1 cm. from the lower end of the guide-bar, and should not be detached excepting during the removal of the apparatus. The object-stage carries the condenser K_2. The latter consists of two lenses, either of which may be employed separately, in addition to which the condenser may be swung aside. The iris dia-

* R. and J. Beck's Catalogue of Microscopical Apparatus, 1907, p. 6.

† See this Journal, 1905, p. 650; 1891, p. 811.

‡ Zeitschr. wiss. Mikrosk., xxiv. (1907) pp. 26–34 (5 figs.). See also Leitz' Special Catalogue (Wetzlar) English edition.

phragm, situated above the condenser, is provided for work with high-power objectives. The specimens are placed upon the stage and fixed thereon by means of clips, care being taken that the cover-glass is turned

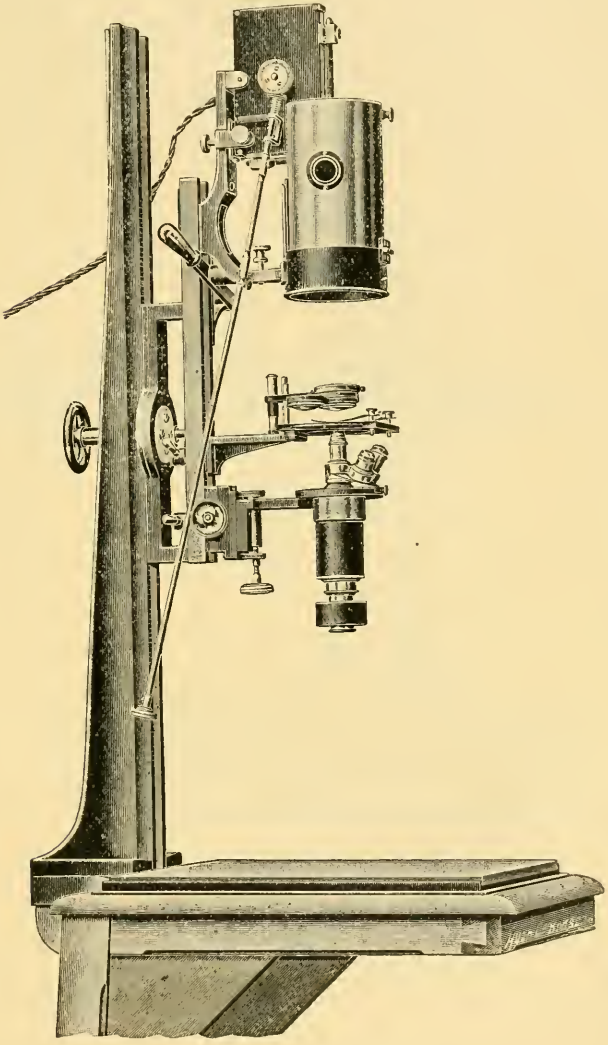

Fig. 121.

downwards so as to face the objective. The stage is provided with interchangeable stops of graded apertures, and the lens-holder has an adapter for the accommodation of a nose-piece ; also an adapter for microsummar

projection lenses. The Microscope-tube T slides into the sleeve attached to the lens-holder. When the distance of the fine-adjustment micrometer screw exceeds a convenient limit, as in fig. 124, the focusing gear supplied

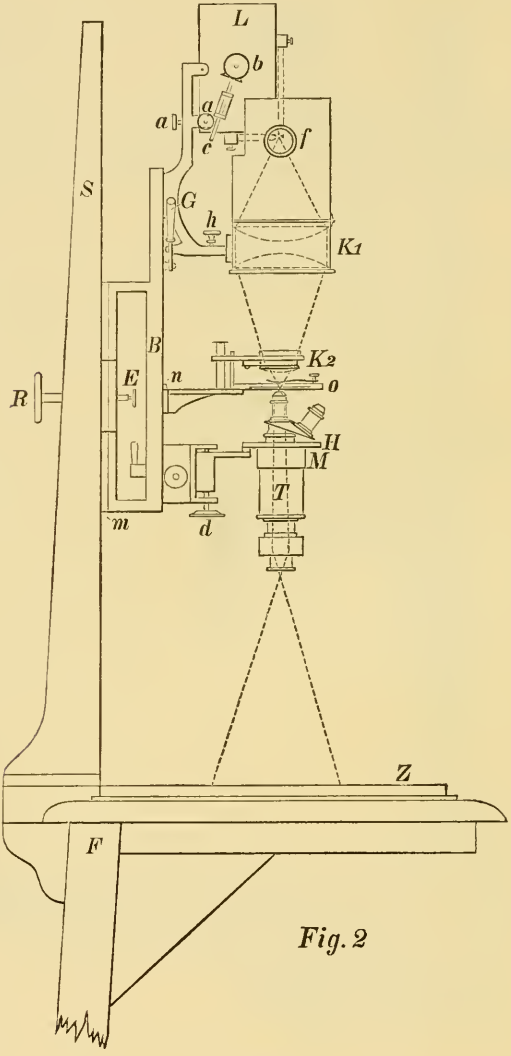

Fig. 122.

with the apparatus should be attached. The hand-regulated lamp requires a 4-ampere current, and has its carbons inclined at 90° to each other, the positive carbon being held in the direction of the optic axis.

Lamps for alternating currents may also be adapted. The lamp is provided with a rheostat for 110 volts. The two screws a_1 a serve to direct the crater accurately into the optic axis of the apparatus. The screw b is for feeding the carbons. When the lamp is at the top of the apparatus (fig. 121), the carbons may be regulated by a flexible rod affixed at c. The position and working of the carbons may be watched through the window f. For work in a lighted room, the apparatus is provided with a cloth screen attached to a hinged ring of wood, which can be made to envelop the condenser K, and secured by means of a screw h. When the apparatus is required for projection, the locking arrangement E

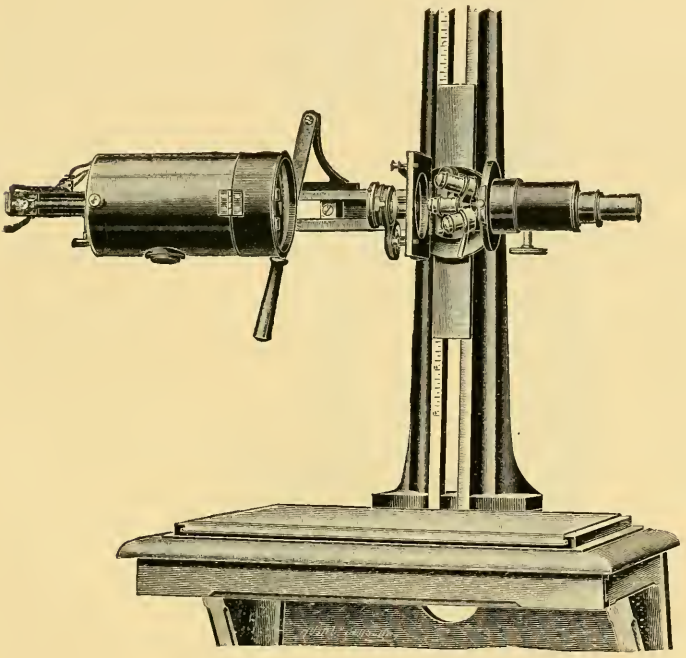

Fig. 123.

should be released, and B together with its optical equipment turned about the horizontal spindle R, until E fixes the optical axis in a horizontal position (fig. 123). Photomicrographs are prepared with the aid of a camera fitted with a dark slide available for plates up to 30 × 40 cm. The camera with the dark slide downwards should be placed upon the drawing board and attached to the column S. After adjusting the part B, the camera end should be moved upwards until the sleeve at the camera end incloses the sleeve attached to the draw-tube of T, or sleeve M when a microsummar is being used. This insures a light-tight connexion between the two parts. For sharp focusing, the bellows may be detached from the dark-slide holder (fig. 124). The image

appears then on a paper screen which may be slid in after the manner of a ground-glass focusing screen. The distance from the eye-piece to the

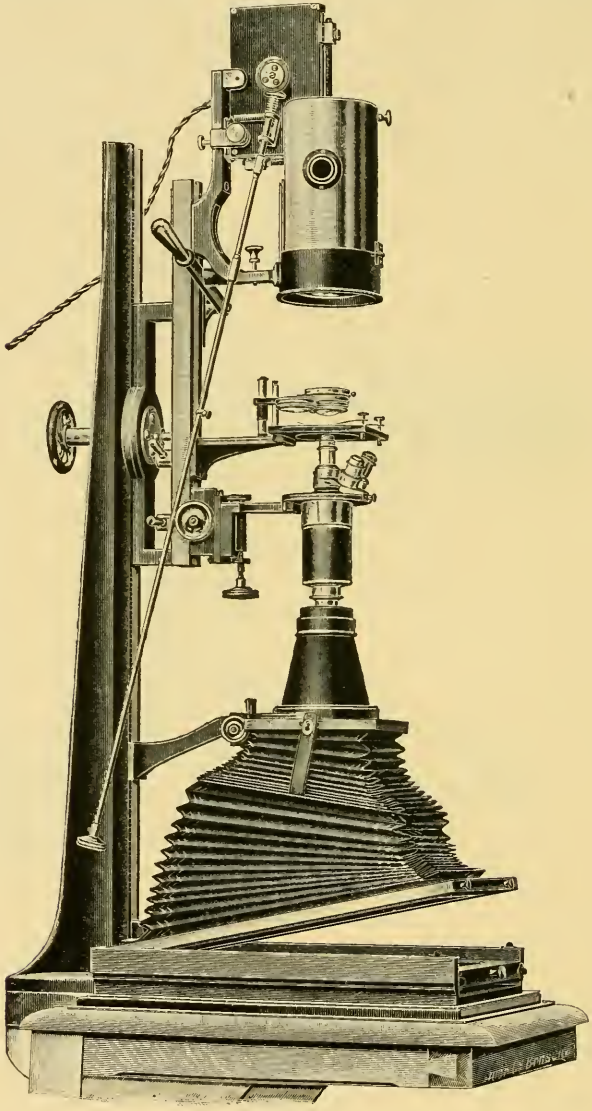

Fig. 124.

drawing surface may be measured by means of a wooden set-square, which forms part of the apparatus. By raising B to the extreme top

and placing it horizontally, sufficient room is obtained to fix the camera to the column S in an inverted position, i.e. with the dark slide upwards.

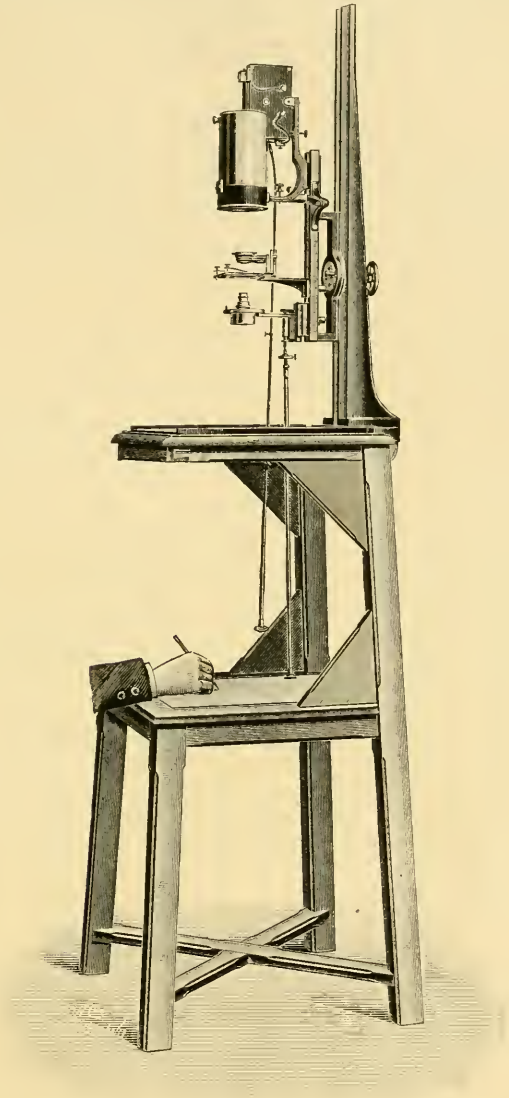

Fig. 125.

In this position the camera is available for the photography of opaque objects placed upon the drawing board Z. The entire apparatus may be

set up on any table, but a special stand F has been designed for the purpose (figs. 122 and 125). This stand has the advantage that, after the removal of the drawing-board Z, a more highly magnified drawing may be made on the lower table-top. Also that, owing to its greater height, it is better adapted for projection on the screen.

(5) Microscopical Optics and Manipulation.

Polarisation of Refraction and Propagation of Light in a Medium Non-homogeneous.*—C. Fabry discusses the observations of Salet, who failed to detect evidence of polarisation in the light emitted from the solar protuberance, as reported by certain astronomers. The passage of a ray refracted through a series of media of progressive indices of refraction is evidently connected with the reflections which would take place at the successive surfaces and which might result in some polarisation of the ray. The author's experiments tend to support Salet's observations.

Hartl, H.—**Ein Modell zur Erläuterung der Zerlegung eines linear polarisierten Lichtstrahls bei der Doppelbrechung.** *Zeit. f. Unterricht.*, xix. (1906) p. 175.

Koerber, F.—**Ein Freihandversuch zur Bestimmung der Brechungsexponenten des Glases.** *Tom. cit.*, p. 167.

(6) Miscellaneous.

Brownian Movement in Gases: its Visibility through an Ordinary Microscope.†—F. Ehrenhaft has observed the above phenomenon by the aid of an ultra-Microscope; but H. Molisch has found that in many cases the use of an ordinary Microscope with weak objectives suffices to render the Brownian movement visible, even with

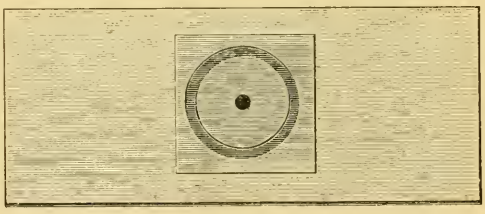

Fig. 126.

ordinary illumination. A glass ring, about 12 mm. inner diameter and 3–5 mm. high, is cemented on to a glass slide (fig. 126). On the lower surface of the slide and accurately at the centre of the ring, a circle of Indian ink 1–3 mm. diameter is painted, for the purpose of attaining dark-ground illumination. The author uses Reichert's Microscope with objective 3 and ocular 2 (magnification 50–76 diameters), completely removes the collar and stop, and adjusts the black point of the object

* Comptes Rendus, cxlv. (1907) pp. 112–15.
† Zeitschr. wiss. Mikrosk., xxiv. (1907) pp. 97–103 (2 figs.).

slide exactly on the centre of the diaphragm aperture. Tobacco smoke is then slowly blown into the chamber formed by the slide and glass ring, the chamber being immediately closed with a cover-glass (fig. 127). In direct sunlight and very oblique illumination the smoke particles then appear as countless white spots on a dark ground and exhibit a dancing or trembling motion similar to the Brownian movement in fluid. The stronger the light source the more visible are the

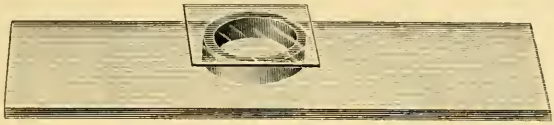

Fig. 127.

particles. They can also be seen with arc-light or incandescent gas, or even with diffused daylight. Although the size of the dark spot stands in a certain proportion to the objective and the distance of the optic plane from the eye, it is possible to obtain the effect without it by merely shading the lower half of the mirror with one's finger, or by interposing a piece of black paper. The appearance of the field resembles that of a star-lit sky. If direct incident illumination be used the object is screened off by a black shade and the sunlight allowed to pass through a small slit 5 mm. broad, being previously concentrated on it by an illuminating lens. The activity of the molecular movement is influenced by the temperature of the particles, but their gradual subsidence, due to gravity, is clearly noticeable under the Microscope. The author experimented with many other vapours, e.g., phosphorus and ammonium chloride. Bodaszewsky, who has also worked at this subject, estimates the diameters of the smoke particles at approximately 0·0002–0·0003 μ, and therefore on the limit of microscopical perception. The author, however, considers that they are in general much larger.

Microscopy: by E. J. Spitta.*—As will be gathered from the brief description of its contents which follows, this book deals in a very complete manner with the Microscope from both the mechanical and the optical point of view, a characteristic feature being the exhaustive treatment of many interesting aspects of the subject which have hitherto been passed over lightly, if treated at all.

An introductory chapter, in which the various forms of simple lenses and their general properties are described, is followed by one dealing with the simple Microscope, which is illustrated in all its usual forms.

Chapters III. and IV. are devoted to the Compound Microscope, all the mechanical details being discussed in the former, whilst the latter describes the optical construction, and is distinguished by the thorough way in which the various "corrections" are dealt with.

* Microscopy: The Construction, Theory, and Use of the Microscope. By Edmund J. Spitta. London: John Murray, 1907, pp. xx. and 468 (17 pls. and 215 figs. in text).

The fifth chapter deals with numerical aperture and depth of focus and gives all information required for ascertaining these important properties of lens systems.

Chapter VI., on Eyepieces, is remarkable for the clear way in which the chromatic correction of oculars is described and illustrated, thus throwing much-needed light on a subject which is much neglected and frequently misunderstood.

Magnification and its limits having next been dealt with, the author proceeds in Chapter VIII. to describe and discuss the substage condenser, and to establish rules for its proper use, the subject being followed up in the succeeding chapter by a description of auxiliary lighting apparatus, such as bullseyes, lamps, heliostats, the author's arrangement for obtaining monochromatic light by a direct-vision Thorpe grating, etc. The question of the proper use of oblique light and of dark-ground illumination is also dealt with, and the chapter closes with a description of polarised light and its use in the Microscope.

Chapter X. describes in great detail the proper manipulation in setting up the instrument and preparing it for practical use, and is, as a matter of course, full of valuable hints.

Binocular Microscopes, in the English as well as in the Continental form, are described in Chapter XI., whilst Chapter XII. deals with the measurement of microscopical objects, the instruments used for the purpose, and the units in which the measurements are usually expressed.

Chapter XIII. contains illustrations and descriptions of many forms of Microscopes, from the simplest to the most elaborate, classified according to the purpose for which they are most useful. This chapter concludes with statements of a large number of well-known microscopists as to the kind of optical outfit which they find most useful for their respective branches of research, statements which should be most valuable to new beginners in these fields.

The fourteenth chapter is one of the best in the book, dealing very thoroughly with the testing of objectives, chiefly by means of the Abbe test-plate, which is so little known in this country, and yet so valuable. The various methods of effecting the chromatic correction are gone into, and minute instructions given as to the methods of determining the state of objectives in this respect as well as with regard to spherical correction.

Chapters XV. and XVI. are contributed by Mr. A. E. Conrady, who here gives a short account of the undulatory theory of light, and of the principal results obtained by applying it to the theory of the Microscope, which latter is treated from an essentially historical standpoint.

A number of accessories of a specialised type, such as metal-holders, spectroscopic attachments, and some of the latest novelties, are described in Chapter XVII.

"Hints" upon common faults and means of cure are dealt with in the last chapter. It is needless to say that some of these hints are very valuable.

Seventeen magnificent photomicrographic plates illustrating the principal test-objects call for special mention, and the very complete index must prove a welcome addition to the book.

Microscopy of Technical Products.*—A. L. Winton, in collaboration with Kate G. Barber, has translated Hanausek's useful and well-known text-book, The Microscopy of Technical Products. After a short description of the Microscope, its accessories, and of micro-technique, the author passes on to the microscopy of the most important types of technical raw material, such as starch, vegetable and animal fibres, stems and roots, leaves, flowers, fruits, and seeds. Most of the volume is devoted to the foregoing, the characters of teeth, bone, and horn being summed up in one short chapter. The last section of the work deals with michrochemical analysis. Hanausek's work is already so well known in its original garb that it seems almost unnecessary to point out that its object is to teach by the aid of the Microscope how to identify technical products, and at the same time to inculcate the fundamental principles of vegetable histology, and the histology of certain animal materials. The translator and his collaborator are to be congratulated on the result of their task, more especially as the present volume is an augmented and revised edition of the last German work. The volume is admirably got up, and copiously and excellently illustrated.

Quekett Microscopical Club.—At the 442nd Ordinary Meeting of the Club, held on October 18, the President, Dr. E. J. Spitta, F.R.A.S., F.R.M.S., in the chair, the following papers were read.

A note by Mr. E. M. Nelson, F.R.M.S., on a new semi-apochromatic $\frac{1}{6}$ inch objective computed by Mr. A. E. Conrady, F.R.M.S., and made by Messrs. Watson and Sons; a note on "Three Water-mites new to Britain, *Thyopsis cancellata* Protz, *Sperchon glandulosus* Koen, and *Lyania bipapillata* Thor," communicated by Mr. G. P. Deeley; a note on "Secondary Markings in *Naricula Smithii*," and a note on "Secondary Markings in *Navicula crabro* Ehr. (*N. pandura* Bréb.)," both by Mr. A. A. C. Eliot Merlin, F.R.M.S.; and a résumé by Mr. F. P. Smith of a valuable paper on "British and Foreign Pseudo-Scorpions," by Mr. Edv. Ellingsen, of Kragerö, Norway. The paper gives descriptions, mostly at length, of some 20 species of this order belonging to the genera *Chelifer*, *Chiridium*, *Ideobisium*, *Obisium*, and *Chthonius*.

B. Technique.†

(1) Collecting Objects, including Culture Processes.

Natural Culture of Trichomastix serpentis.‡—C. C. Dobell examined the fluid from the rectum of a rattlesnake dead of canker of the mouth. The fluid, which was brownish, almost odourless and alkaline, was transferred to a glass dish and covered with a thick glass plate fixed down with vaselin. In this fluid the parasites lived for about 120 days, increasing in number for some five or six weeks, when they reached their maximum, afterwards gradually dying out. Attempts to cultivate

* New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1907, xii. and 471 pp., 276 figs.

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

‡ Quart. Journ. Micr. Sci., li. (1907) pp. 449–50.

on artificial media failed. The method of examination was as follows: A few drops of the culture were drawn up in a fine pipette and examined fresh either in a hanging drop preparation or under a cover-slip with wax feet, and waxed round the edges. In this latter condition the animals remained alive for 13 days.

Good permanent preparations were hard to obtain, owing to the small numbers of the parasites and the large amount of gritty foreign substances in the fluid. For successful preparations the stains used were Delafield's hæmatoxylin, Heidenhain's iron-hæmatoxylin, and Giemsa. Observations of the living animal were often facilitated by intravitam staining with neutral red. Brilliant cresylblau and methylen-blue were of little use.

Simple Method of Obtaining an Oxygen-free Atmosphere for Cultivating Anaerobes.*—Stan. Růžička uses a Kipps' apparatus for producing hydrogen, and gets rid of the remaining oxygen with pyrogallol and caustic potash. As indicator he uses a mixture of phenol soda, grape-sugar, and indigo sulphate.

Cultivation of Essential Anaerobes in a Vacuum.†—U. Biffi employs the following apparatus (fig. 128) for the cultivation of anaerobes. This consists of a strong thick-walled Erlenmeyer flask, of 250 c.mm. capacity, closed by a rubber cork, perforated by a short glass tube that extends from the lower surface to about 3 cm. above the top of the cork; this glass tube is inclosed by rubber tubing about 8 cm. long, the further upper end of which holds a short piece of glass tubing about 2 cm. long, and which at its free end is closed by wool.

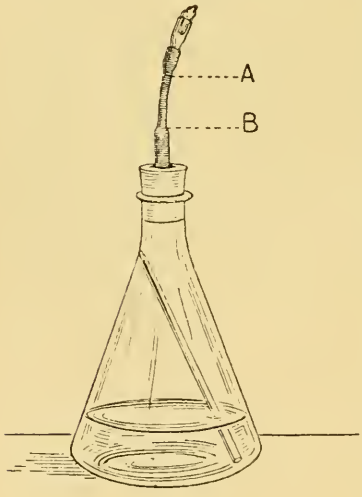

Fig. 128.

The flask is filled to one-third of its height with broth, and into this is plunged a thin glass tube 2–3 mm. in diameter, and long enough to reach from the bottom of the flask nearly to the stopper; this tube is closed at the upper end, and serves as a manometer to indicate the pressure in the flask. The apparatus is then sterilised, and all the tube joints are smeared with Canada balsam. The broth is then slowly boiled, and on the first appearance of small bubbles around the manometer tube, the wool plug is removed from the outer tube. As soon as the steam commences to escape strongly from the opening, the rubber tube is seized with a pinchcock between A and B, and the whole is removed from the heat, and the wool plug replaced. When the apparatus has cooled, it is ready for use. The inoculation from the culture material is effected into

* Archiv f. Hyg., lviii., p. 327. See also Centralbl. Bakt. Ref., 1te Abt., xl. (1907) pp. 308–10. † Centrabl. Bakt., 1te Abt., Orig., xliv. (1907) p. 280.

the rubber tube between A and B by means of a Pasteur pipette ; if the material is solid it is suspended in a small quantity of sterile fluid.

New Method for Closing Cultivation Tubes.*—G. C. Chatterjee states that cotton-wool plugs are not suitable for stopping test-tubes in tropical climates, as they soon get overgrown with fungi, etc. He has found that if the one tube be covered by means of another of slightly larger diameter, and kept in its place by means of a spring attached to a ring on the lower tube, many advantages accrue and the disadvantages are obviated.

New Method for the Cultivation of Anaerobic Bacilli.†—N. Pende and L. Viviani employ an apparatus for the cultivation of anaerobic bacilli, which consists of a small glass tube closed at both ends and containing rarefied hydrogen gas ; one end of this tube is drawn out into a fine point ; this point is broken under the surface of the culture fluid, some of which is drawn up into the tube, which is now closed again by a flame, and placed in a thermostat.

Aerobic Culture of Essential Anaerobes.‡—A. Wrzosek has found that the substance existing in animal and vegetable tissues that favours the aerobic growth of essential anaerobes was not affected by exposure to high temperatures, but exposure to the air destroyed the active properties of this substance. A series of tubes were taken, each containing 10 c.cm. of ordinary neutral broth, and into each was introduced fresh-cut cylinders of potato or animal tissue weighing 2 grm., and into some of the tubes melted paraffin was then poured ; the whole were sterilised at 120° C. for 15 minutes. Some tubes were placed in the dark, and others exposed to the action of the light. After an interval of time the tubes were inoculated with broth cultures of the same anaerobic organism, and incubated at 37° C. The results showed that the medium in those tubes that were not closed by paraffin were altered, whereas the medium in the closed tubes remained active even for over 101 days, so that the air and not the light was the agent for destroying the medium for the culture of anaerobes. Previous drying of the portions of animal or vegetable tissue had no effect as regards the culture of some anaerobic organisms, but with others the growth was not so good, and as in the case of the tetanus bacillus no spores were formed.

The author also obtained cultures of anaerobes when plant seeds, such as barley grains, were substituted for the potato or animal tissue in the culture tubes. The substance that favours the aerobic growth of anaerobes was also demonstrated in wood charcoal, coal and coke, but the growths were not vigorous and spores were not formed. The presence of this substance was also demonstrated in chalk, zinc, and iron. It has long been known that anaerobes can develop in ordinary broth, if an aerobe is simultaneously grown in the same tube, a fact explained by Pasteur as due to the absorption of the oxygen by the aerobe. The author has shown that potato, charcoal, etc., all possess a high degree of reducing power, though with chalk, fresh potato, and zinc this only occurs to a slight degree.

* Lancet, 1907, ii. pp. 1083–4 (1 fig.).
† Centralbl. Bakt., 1te Abt., Orig., xliv. (1907) p. 282. ‡ Tom. cit., p. 607.

Microbe of Whooping Cough.*—J. Bordet and O. Gengou find that the best medium for isolating this organism is a mixture of rabbit's blood and agar containing a little glycerin extract of potato. The frequent presence of Pfeiffer's influenza bacillus is a serious obstacle to the isolation of the whooping cough organism, since it grows more rapidly and freely, and is often difficult to distinguish microscopically, though in culture and in agglutination reactions they are distinct. The authors immunised a horse against this organism and obtained a highly agglutinative serum. The serum of children suffering from or convalescing from whooping cough shows very varying reactions, so that the serum diagnosis of this disease is as yet not practical.

(2) Preparing Objects.

Detecting Fatty Degeneration of the Blood.†—S. G. Shattock and L. S. Dudgeon made films on slips and slides. The films were kept moist from first to last. When made they were at once placed, film-side downward, in a specially devised glass vessel containing formalin, so that they were constantly exposed to the action of the vapour. After an exposure of from 15 minutes to 24 hours or more, the slides were transferred to a solution of Scharlach for 24–48 hours.

The Scharlach solution was made by saturating 75 p.c. alcohol in the cold, and subsequent filtration.

After removal from the Scharlach the slides or slips were washed for a few seconds in 75 p.c. alcohol, then in distilled water, and then immersed in hæmalum for 3 minutes. This was followed by distilled water, tap-water, Farrant's medium. By this method the fat was stained red, but certain granules brown. The latter are called Scharlach-granulations, the exact nature of which the authors leave undetermined.

Berg, W.—**Die Veränderungen des Volumens und Gewichtes des Gewebes bei der histologischen Fixation, dem Auswässern, der Härtung und des Paraffineinbettung.**

[Describes the changes of bulk and weight of tissues during fixation, dehydration, hardening, and paraffin imbedding.]

Anat. Anzeig., xxxi. (1907) pp. 252–68.

Mencl, Em.—**Ueber em neues praktisches Alcoholometer für Präparationszwecke.**

[A pycnometer which is graduated for alcohols of 15-70 p.c.]

Zeitschr. wiss. Mikrosk., xxiii. (1907) pp. 423–4 (1 fig.)

(3) Cutting, including Imbedding and Microtomes.

Imbedding Small Objects in Paraffin.‡—P. Mayer, after referring to G. Lefevre's method of imbedding small objects,§ states that a metal (brass) mould made in two pieces answers better than the watch-glass with an excavation. The illustration (fig. 129) shows Mayer's apparatus of natural size (25 × 25 × 2 mm.). Paraffin blocks made in this mould have quite sharp edges, and are very suitable for sectioning.

* Ann. Inst. Pasteur, xxi. (1907) p. 720.
† Proc. Roy. Soc., Series B, lxxix. (1907) pp. 427–40 (1 fig.).
‡ Zeitschr. wiss. Mikrosk., xxiv. (1907) pp. 128–32 (5 figs.).
§ See this Journal, 1903, p. 233.

The author then describes his method for transferring the objects from alcohol to paraffin. For this purpose he uses gelatin capsules (20 mm. long and 7 mm. in diameter). As these capsules are impenetrable to alcohol, this latter must be replaced by benzol or chloroform. The gelatin capsule is easily removed by immersing it in water. As the resulting block is cylindrical, it is made rectangular by immersion in paraffin. For this purpose the brass mould is used.

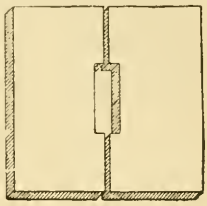

Fig 129.

Pietsch Microtome.*—E. P. Dolby describes this instrument, which is a modification of the Minot microtome, and claims that it has been simplified and modified. The knife-holder is so constructed that it serves both for paraffin and celloidin sections, and enables the operator to note the angles of inclination most suitable for the work in hand. The active part of the knife may be restricted in order to obtain the greatest rigidity and to use the entire length of the edge before re-sharpening. It is clamped against a three-point plane.

The object-carrier is clamped by only one screw instead of two or three, and also allows a horizontal adjustment of the preparation in order to bring it close to one of the knife clamps.

The coarse-adjustment has been greatly improved and all the gearings reduced, both as to size and number.

The automatic feed is entirely new. It is provided with a worm, and is an inclined plane gliding on another inclined plane, the worm-gear, friction and wear being thereby reduced to a minimum. This feed is the only one which advances when the object is clear of the knife.

Examining the Structure of the House-fly, Musca domestica.†—C. G. Hewitt studied the anatomy by means of dissections of fresh and preserved material under a binocular Microscope, with magnifications varying from 25–65 diameters. Serial sections were made to confirm the dissections and to study the histological details. Perfect series of sections of the whole fly were hard to obtain, on account of the brittle nature of the internal chitinous structures. Colloidin sections were but little superior to paraffin sections. The best results were obtained by fixing the flies for 24 hours in Henning's solution, which is nitric acid 16 parts, chromic acid (0·5 p.c.) 16 parts, corrosive sublimate saturated in 60 p.c. alcohol 24 parts, picric acid saturated in water 12 parts, and absolute alcohol 42 parts, washing out with iodine-alcohol. This fixes and somewhat softens the chitin. The imbedding should not be too protracted, as the chitin becomes brittle again. Serial sections of recently emerged imagines made before the chitin has hardened give good results. Other fixatives used were Perenyi, Rabl's chromoformic, Boum's picroformol, glacial acetic acid, and absolute alcohol. The most satisfactory stains were Heidenhain's iron-hæmatoxylin, Brazilin, and Delafield's hæmatoxylin. By overstaining with the last and differentiating with acid-alcohol perfect results were obtained. The structure

* Trans. Amer. Micr. Soc., xxvii. (1907) pp. 152–3.

† Quart. Journ. Micr. Sci., li. (1907) pp. 399–400.

of the thoracic ganglion was studied by means of reconstruction. The sections were drawn by means of a camera-lucida on Bristol board of a thickness proportional to the magnification. They were afterwards cut out and seccotined together. The resulting model was trimmed and soaked in melted paraffin, taken out and dipped several times till a thin coat of paraffin covered the model. This was then trimmed down to the original size, all the interstices having been filled with paraffin. After a coating of graphite it was electrotyped in copper. In this way a permanent model was obtained.

(4) Staining and Injecting.

Apparatus for Transporting Clean or Prepared Cover-slips.*—A. Hinterberger has found, from practical experience, that cover-slips may be sent by rail or post without danger of damage or contamination by placing them in a glass trough, similar in shape and construction to those used for staining and other purposes. Fig. 130 shows the apparatus and also cross-pieces which enable two slips to be packed in each section.

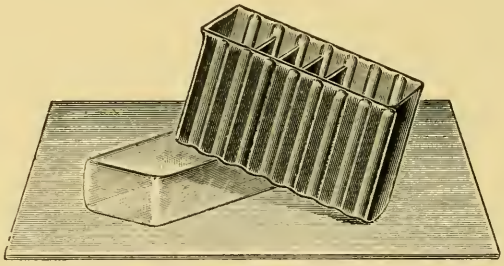

Fig. 130.

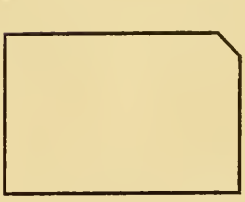

Fig. 131.

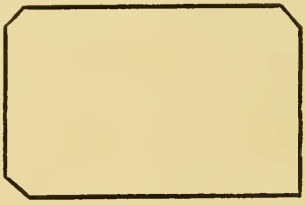

Fig. 132.

The author goes on to mention what he has found to be a time-saving device for examining several cultures simultaneously. Figs. 131 and 132 represent a couple of rectangular cover-slips from which one or three corners have been removed. By making drawings of these on paper, and noting at what corner a film has been deposited, it becomes possible to fix and stain simultaneously on one cover-glass several cultures.

* Zeitschr. wiss. Mikrosk., xxiv. (1907) pp. 145–7 (2 figs.).

Method for Accelerating Slow Staining by Electric Current.*—. Foix and Mallein, using a Leclanché battery giving 4 volts, have found that, by passing the current through the staining solution during the process of staining, it is possible in 10 minutes to stain *Spirochæta pallida* a violet colour with Giemsa's fluid; the red blood cells being stained, not pink as usual with this stain, but green or pale blue. Similar acceleration was obtained with staining tubercle bacilli by Ziehl's method; the bacilli being thoroughly stained after 10 minutes.

Staining Negri's Corpuscles.†—O. Lentz takes from the cornu ammonis pieces 2–3 mm. thick and places them in aceton for 1 hour at 37°; the pieces are next saturated with paraffin m.p. 55° for 1½ hour at 58° and then imbedded. The sections, stuck on by the water method, are freed from paraffin with xylol and then stained. The solutions required are:—(1) eosin extra B 0·5, 60 p.c. ethyl-alcohol 100; (2) Loeffler's methylen-blue; (3) absolute alcohol 30, 1 p.c. solution of caustic soda in absolute alcohol 5 drops; (4) absolute alcohol 30, 50 p.c. acetic acid 1 drop; (5) Gram's iodine solution.

Two procedures are given:—A. (1) Stain in the eosin solution 1 min; (2) wash in water; (3) stain in methylen-blue solution 1 min.; (4) wash in water; (5) mop up on blotting-paper; (6) differentiate in alkalin-alcohol; (7) differentiate in acid-alcohol; (8) wash in absolute alcohol; (9) xylol-balsam. Films and smears need only be dried after (8).

B. (1) Stain in eosin solution for 1 min.; (2) wash in water; (3) stain in methylen-blue solution 1 min.: (4) wash in water; (5) mordant with the Lugol solution; (6) wash in water; (7) differentiate in methyl-alcohol; (8) wash in water; (9) contrast stain in methylen-blue solution for ½ min.; (10) then proceed as in A from (4) onwards.

Procedure B gives the more definite picture, but in both the bodies are red bestippled with blue spots.

New Method of Flagella Staining.‡—H. C. Plant describes the following method, which is a combination of the Ermengem and Zettnow procedures. (1) The material consists of a loopful of culture in ¼ c.cm. of 2 p.c. formalin solution. (2) The slides to be used are treated with hot strong sulphuric acid, followed by washing, 15 p.c. caustic soda, washing, alcohol, rubbing with fine linen cloth moistened with alcohol-ether mixture āā. (3) Upon the cleaned slide is placed a drop of boiled, filtered, distilled water, and with this is mixed a loopful of the formalin-bacteria mixture. (4) After drying under cover, the film is fixed for 1 hour in a mixture of equal parts of alcohol and ether. (5) It is then mordanted with iodopotassic-iodide solution (1–2 : 300) for 3 minutes; this is followed by alcohol and then water. (6) The film is further mordanted by Ermengem's method: 2 p.c. osmic acid 1 part, 10 p.c. tannin 2 parts (to 100 c.cm. 5 drops acetic acid). The film is left covered with the foregoing solution for 4 hours at room temperature, or for half an hour at 50°; it is then washed with water and alcohol

* C.R. Soc. Biol. Paris, lxii. (1907) p. 1201.
† Centralbl. Bakt., 1te Abt. Orig., xliv. (1907) p. 374–8 (3 photos and 2 pls.).
‡ Tom. cit., pp. 310–16 (1 pl.).

alternately until all trace of the mordant has disappeared. (7) To a saturated solution of silver sulphate and distilled water in equal parts, æthylanin is added until no precipitate occurs. Silver sulphate solution is then dropped on until a precipitate occurs. The film is then covered with this solution and kept moving until a brown colour appears. It is then washed and examined under a low power, and if flagella be not visible, the process should be repeated and this time with the aid of heat. (8) If flagella are visible, then treat with sublimate 1 : 100, until the brown colour has vanished. (9) Follow this with gold chloride 1 to 1000 distilled water, and allow to act for 5 minutes. (10) Next use Zettnow's reducer, 2 p.c. soda solution 4 drops, alcoholic pyrogallic-acid solution (1 : 20) 1 drop ; warm slightly ; dry and mount.

Simple Methods for Staining Liquid Blood.*—R. Ross describes three methods for staining blood.

1. Glass Rod Method : A large drop of blood is taken upon a slide and a drop of stain not larger than the drop of blood is quickly placed close beside it with the end of a glass rod. Then with the other end of the rod the two drops are thoroughly mixed together, and small quantities of the mixture (say of the size of a pin's head) are transplanted on to other slides, and each covered with a slip. Aqueous solutions of many stains may be employed, and will not generally dissolve the red corpuscles if the amount of solution used be not in excess of the amount of blood. One of the most useful stains is an old polychrome filtered saturated aqueous solution of methylen-blue in 0·5 p.c. salt solution.

2. Agar Method : Ordinary nutrient agar is melted and mixed with filtered saturated solutions of various stains (e.g. polychrome methylen-blue) and poured on sloped slides so as to obtain very thin films of the stained agar on the glass. The agar sets at once, but does not dry for some time. While still moist, a coverslip charged with a droplet of blood is placed on it. In a few minutes the elements absorb the stain from the agar. The agar film should be very thin but deeply stained.

3. Drained-drop Method : A cover-slip is charged with a droplet of blood slightly spread out upon it, and is then inverted on a shallow cell made with vaselin on a slide. The coverslip is then pressed down so that the blood-film is in contact with the surfaces of the slip and slide. For staining, the blood may be mixed beforehand with a solution of some stain or perhaps better with a few particles of the undissolved stain.

Ammonio-silver Method for Staining Cancerous Tissue.†—W. F. Robertson and M. C. W. Young communicate the following technique of the ammonio-silver method with gold toning and cyanide decoloration. Place thin slices of tissue in Heidenhain's sublimate solution. After from 12–24 hours, wash the pieces shortly in water and place them in 80 p.c. alcohol (made with absolute alcohol), to which iodin dissolved in absolute alcohol has been added until the fluid has the colour of pale sherry. Renew this fluid daily until it ceases to be decolorised (generally from 4–6 days). Then place the tissues in 80 p.c. alcohol

* Lancet, 1907, ii. pp. 219–20. † Tom. cit., pp. 358–61 (10 figs.).

without iodin. After 24 hours transfer them to 5 p.c. formalin in water. In this they may remain for an indefinite period, but at least one day must elapse before the next stage is proceeded with. Place a piece of tissue in a bowl of water (which should be changed at least once) for from 2–3 hours. Make the ammonio-silver solution by adding 5 p.c. ammonia to 5 p.c. silver nitrate in distilled water, until the precipitate which at first forms is completely dissolved; then add more silver nitrate until a distinct cloudiness returns. Filter this solution into a bottle or specimen tube, add the piece of tissue, and put the bottle, tightly corked, in the incubator at 37° C. for 7 days. The silvering may thereafter be continued in the cold if it is not convenient to go on at once to the next stage. Place a piece of the impregnated tissue in a bowl of water (500 c.cm.) to which about 2 c.cm. of 5 p.c. ammonia have been added. Remove the surface deposit as far as possible. This is best done simply with the aid of the fingers whilst the piece of tissue is held under water. Transfer the piece to a second bowl of ammonia and water. Renew the fluid after about an hour, and leave the tissue in this for 3–4 hours longer. Transfer to dextrin solution (dextrin 5 oz. or 140 grm., water 10 oz. or 280 c.cm.; dissolve by boiling; filter the solution through cotton-wool while still hot; after it has cooled add 1 p.c. of carbolic acid) to which ammonia has been added in the proportion of 10 drops of a 5 p.c. solution to 1 oz., immediately before use. Allow the tissue to remain in this from 12–24 hours. Cut thin sections on the freezing microtome. Transfer them from the knife to a bowl of water to which about 10 drops of 5 p.c. ammonia have been added. After about 5 minutes transfer the sections to another bowl of ammonia and water, and after a similar period give them a third wash. Transfer the sections to a bowl of water to which have been added from 5–10 drops of a saturated solution of citric acid in water, and allow them to remain in this for 4–5 minutes. Place the sections in a bowl of tap water, and after a few minutes transfer them to a second bowl of water. They are now ready for toning.

The reagents required for the toning and decoloration processes are 1 p.c. solution of gold chloride in distilled water, 1 p.c. solution of pure sodium tungstate in distilled water (it is necessary to effect the solution of the salt by boiling), and 1 p.c. potassium cyanide in distilled water. Using only a clean glass rod or platinum needle, place from six to twelve sections in a watch-glass containing a mixture (carefully filtered) of the sodium tungstate and gold chloride solution in equal portions. Allow the sections to tone for about half an hour, or until they assume a distinct red tint, and then transfer them to a bowl of water in which they should be allowed to wash for some minutes. Next place the sections one at a time in a watch-glass containing a little of the cyanide solution. When the section has lost its deep red colour and assumed a light pink tint, transfer it to a bowl of water and allow it to wash for from 10–15 minutes, giving at least one change of water. Next stain the section for from 5–10 seconds in Loeffler's or Neisser's methylen-blue, wash it well in water, dehydrate with absolute alcohol, clear in equal parts of turpentine and benzol, and mount in benzol-balsam.

Fixing of Stains by Bacteria.*—G. Péju and H. Rajat experimenting on the staining properties of various bacteria during life with a number of different staining reagents, find that these latter may be considered in three groups. Firstly, those stains that colour the medium, often intensely, but leave the colour of the culture unaffected, and which includes carmin, fuchsin, hematein, hematoxylin, blue-azur, malachite-green, etc. Secondly, those stains that colour the medium and culture alike, and includes eosin, methylen-blue, neutral-red, Merck-red, picric acid, heliantin, etc. Thirdly, those stains that are taken up by the bacteria, the medium being decolorised.

RÖTHIG, P.—**Wechselbeziehung zwischen metachromischer Kern- und Protoplasmafärbung der Ganglienzelle und dem Wassergehalt alcoholischen Hämotoxylin Eösungen. Parts 2 and 3.** (For Part 1 see this Journal, 1907, p. 110.) *Zeitschr. wiss. Mikrosk.*, xxiv. (1907) pp. 109–28.

(6) Miscellaneous.

Detection of Bilharzia Ova in Urine and Fæces.†—T. Mazzei finds that the following procedure gives better results than the methods usually adopted. The sediment of the urine or of the diluted fæces is spread out on slides, and the thickish and extensive layer dried at a gentle heat until all the water is evaporated. The preparation is then washed for 5–10 minutes in an aqueous 3 p.c. solution of hydrochloric acid, and examined under a low power to see if all the salts have been dissolved out. They are then washed for 5–10 minutes in a 30 p.c. solution of caustic soda or potash, in order to get rid of the mucus and other organic elements. The films are then dried with gentle heat and after this may be examined under the Microscope to ascertain if any parasites are present. It is sometimes better to stain the preparation with borax methylen-blue, and afterwards differentiate with 1 p.c. hydrochloric acid. Instead of methylen other pigments may be used, such as carbol-thionin or Ehrlich's hæmatoxylin.

Microscopic Study of Pen and Ink Lines.‡—M. D. Ewell finds that the serrations in ink and pencil lines are due to irregularities in the surface of the paper itself. By making very thin films on glass with carbon from a smoky flame, or with a solution of wax and asphaltum in benzol, and writing thereon with the dry steel pen, it was found, on examination under a power of over 120 diameters, that the lines were clear, sharp, and free from serrations of any sort. The ordinary writing of the same persons on paper with pen and ink had previously shown abundant serrations. Other explanations of the phenomenon are that the inequalities are due to variations of nerve force or to pulsations from the vascular system.

Errera's Practical Course of Vegetable Micro-chemistry.§—By micro-chemistry the writer of this little treatise means the localisation of substances in plants, "microscopical topo-chemistry." The booklet consists of the notes used by Léo Errera in the practical course of

* C.R. Soc. Biol. Paris, lxii. (1907) p. 954.
† Riforma Medica Ann., xxi. No. 24.
‡ Trans. Amer. Micr. Soc., xxvii. (1907) pp. 21–3.
§ Bruges, 1906, 24 pp.

vegetable micro-chemistry, which was given to the students who desired to present themselves for the Doctorat en Sciences at the University of Brussels.

Prowazek's Manual of Microscopical Technique.*—S. v. Prowazek's little manual for the microscopical technique of Protozoa, is principally intended for medical men, though it also appeals to zoologists. It deals with the mode of examination in living and fixed preparations of Rhizopoda, Mastigophora, Sporozoa, and Ciliophora.

Woithe—**Vorrichtungen zum gefahrlosen Befestigen und aufspannen wilder Ratten.** [Description of apparatus for fastening and extending rats for laboratory purposes.] *Centralbl. Bakt. Orig.*, 1te Abt., xliv. (1907) pp 709–19 (11 figs.).

Metallography, etc.

Alloys of Aluminium and Copper.†—H. C. H. Carpenter and C. A. Edwards have carried out an extended investigation of this series. Forty-eight alloys were examined. The work consisted chiefly of determination of the mechanical properties of the industrially useful alloys—i.e. those lying outside the range 11–96 p.c. aluminium. The equilibrium diagram was also worked out, and the microstructure of the alloys studied. Alloys with 0–8 p.c. Al have a low yield point, moderate ultimate stress and high ductility, and are not sensitive to heat treatment. From 8–11 p.c. Al the ultimate stress is high, yield point relatively low, ductility good from 8–10 p.c. Al. Alloys in this class are hardened by chilling from above 800° C., and considerably affected by other forms of heat treatment. The increase of hardness occurring at about 8 p.c. Al coincides with the appearance of a dark, acicular constituent. Alternating stress tests in the Stanton machine showed that the ratio

$$\frac{\text{maximum range of stress}}{\text{primitive yield point (in tension)}}$$

increased from 1·3 in the alloy with 0·1 p.c. Al to the remarkably high figure of 1·9 in the 9·9 p.c. alloy. The addition of copper to aluminium progressively raises the tenacity up to 4 p.c. copper, ductility correspondingly falling. The authors consider that the great evolution of heat resulting from the addition of aluminium to molten copper, is due to oxidation of the aluminium by copper oxide dissolved in the copper. It is suggested that the growth of size of crystal observed on remelting certain alloys is due to the persistence of crystalline orientation in the molten state—i.e. to the occurrence of "liquid crystals." The etching reagents used were sodium hydrate solution for aluminium and the aluminium-rich alloys, ferric chloride in dilute hydrochloric acid for the copper-rich alloys, and for copper, concentrated nitric acid followed by washing in a heavy stream of water on the commencement of chemical action. A comparison is drawn between the equilibrium diagram and

* Leipzig: J. A. Barth, 1907, 66 pp.

† Proc. Inst. Mech. Engineers, 1907, i. pp. 57–378 (204 figs.). (Eighth Report to the Alloys Research Committee.)

that of the copper-tin series. The compounds found are Cu_4Al, Cu_3Al, and $CuAl_2$. In the discussion W. Rosenhain gave results showing the fall in tenacity of certain of the copper-rich alloys with rising temperature. G. H. Gulliver severely criticised the equilibrium diagram and submitted an amended diagram. The authors claimed that Gulliver's objections were due to misunderstanding of their results.

Constitution of the Aluminium Bronzes.*—B. E. Curry has determined the equilibrium diagram above 400° C., obtaining thermal data entirely from heating curves, thus eliminating super-cooling effects. The thirty-four alloys prepared were also examined microscopically, after annealing of sufficient duration to produce equilibrium. The diagram given differs in important respects from that given by Carpenter and Edwards. Only one compound, $CuAl_2$, was found, with six series of solid solutions. Two thermal changes occur below the solidus.

Tensile Strengths of the Copper-Aluminium Alloys.†—B. E. Curry and S. H. Woods have investigated the relation between constitution and mechanical properties, and give a series of tables of results of tensile tests of alloys in the ranges of composition 0–25 p.c. and 86–100 p.c. copper. The test pieces were cast to size in Acheson graphite moulds. The alloys were tested as cast, and after annealing and quenching at various temperatures. Two successive additions of aluminium to molten copper each caused a rise of temperature, showing that the heat evolution is due to heat of solution, and not to oxidation of the aluminium by oxygen dissolved in the copper. The author concludes that (*a*) in the aluminium-rich series (1) the maximum dependable strength occurs in the neighbourhood of the 10 p.c. copper alloy; (2) annealing at 400° C. for 3–6 days reduces tensile strength, and increases ductility; (*b*) in the copper-rich alloys (1) with more than 92 p.c. copper, annealing has little effect; (2) with 89–91 p.c. copper the mechanical properties are considerably affected by heat treatment; (3) alloys with less than 90 p.c. copper are brittle and unreliable.

Methods of Testing.‡—This paper contains a description of the methods elaborated by the International Committees appointed by the Association, with the unification of testing methods as its aim. The length (l) of a tensile test-piece is calculated according to the formula $l = n\sqrt{f}$, f being the area of cross-section, and n a coefficient, for which the value 11·3 has been adopted in many countries. Elastic limit may be considered to lie at the point where the permanent deformation is about 0·001 p.c. Limit of proportionality is to be regarded as the stress up to which equal increments of about 100 kilos. per sq. cm. produce equal elongation. The apparent elastic limit is to be taken as the stress which causes a permanent elongation of between 0·2 and 0·5 p.c.

* Journ. Phys. Chem., xi. (1907) pp. 425–36 (2 figs.).

† Tom. cit., pp. 461–91 (7 figs.).

‡ Methods of testing metals and alloys; hydraulic cements and woods; clay, stoneware and cement pipes. Recommended by the 4th (Brussels) Congress of the International Association for Testing Materials, 1906. London: E. & F. N. Spon, 54 pp. (5 figs.).

Some Phenomena of Permanent Deformation in Metals.*—G. H. Gulliver corrects his earlier hypothesis that the "contractile cross" is the result of the slipping of crystalline grains over each other. By subjecting thin strips of aluminium—rendered coarsely crystalline by heating nearly to melting point—to tension, and watching the progress of deformation by the Microscope, the author has found that (1) the phenomena of constriction and fracture are due to excessive local "slipband" deformation; (2) the contractile cross passes through the crystalline grains; it is somewhat influenced by the degree of coarseness of the crystalline structure, but is independent of the directions of the boundaries of the crystalline grains.

Passage from the Liquid to the Solid State.†—Three papers ‡ by G. Cartaud are here reprinted, together with a series of remarkable photomicrographs and a necessarily incomplete account by F. Osmond of the further researches of Cartaud interrupted by his death. Indications of a cellular, as distinct from a crystalline structure, are obtained when lead, tin, zinc, and other metals are cast on a sloping sheet of glass. In this manner a thin and rapidly solidified layer of the metal is formed. There appears to be some relation between the cellular network and the crystalline structure. Cartaud applied the term "metalloblast" to the primitive cellule, "crystalloblast" to the incipient crystal. It is suggested that metals, during solidification, pass through the cellular state before becoming truly crystalline. Osmond considers this subject to be a fruitful field for research.

Hardness of Tool Steels.§—Demozay gives the results of determinations of hardness by the Brinell method of tool steels, some being high-speed steels containing chromium and tungsten, hardened at different temperatures in air, oil, or water. Similar measurements were made at 100° C., 250° C., 400° C., and 500° C., on the steels after different previous treatments. For the high-speed steels the hardness rises to a maximum at 200–250° C., slowly decreasing as the temperature is further raised. For certain steels the temperature of maximum hardness is higher as the quenching temperature is higher.

Phenomena of Solidification and of Transformation in Alloys.‖—A. Portevin works out afresh the application of the phase rule to the equilibrium of a two-component system. The departure from stable equilibrium, produced by insufficiently slow cooling, and resulting in a condition of labile equilibrium, which occurs so frequently in alloys having transformation points in the solid state, is fully considered.

Specific Heat of Iron.¶—P. Oberhoffer has made very careful determinations of the mean specific heat of iron between 0° C. and temperatures from 265–1523° C. A full account is first given of previous work. Objections which can be urged against the methods of

* Proc. Inst. Mech. Engineers, 1907, ii. pp. 519-24 (9 figs.).
† Rev. de Métallurgie, iv. (1907) pp. 819-32 (72 figs.).
‡ Comptes Rendus, 1901, 1903, and 1904.
§ Rev. de Métallurgie, iv. (1907) pp. 885-900 (11 figs.).
‖ Tom. cit., pp. 915-25 (5 figs.).
¶ Metallurgie, iv. (1907) pp. 427-43, 447-55 and 486-97 (22 figs.).

Pionchon, Harker, and others, are stated. Preliminary experiments with the water calorimeter and the Bunsen ice calorimeter led to the selection of the latter for the author's determinations. The sample (iron containing 0·06 p.c. carbon and 0·05 p.c. manganese) was heated in vacuo by means of a resistance furnace. For very high temperatures the furnace resistance was a carbon spiral cut from a tube. A detailed description of the apparatus evolved by the author is given. The following values (mean specific heat between the given temperature and 0° C.), selected from the author's table, show the course of the curve. The rapid rise from 650–750° C. is notable.

250° C.	0·1221
650° C.	0·1463
750° C.	0·1675
800–900° C. (practically constant)	0·1698
1100–1500° C. „ „	0·1661–0·1667

The course of the curve in the neighbourhood of Ar 2 renders it highly probable that the transformation of β to α iron proceeds through a continuous series of mixed crystals, as suggested by Osmond. The specific heat of γ iron is practically constant. A useful bibliography is appended.

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