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
1909

TO BE OBTAINED AT THE SOCIETY'S ROOMS,
20 HANOVER SQUARE, LONDON, W.
OF MESSRS. WILLIAMS & NORGATE, 14 HENRIETTA STREET, LONDON, W.C.
AND OF MESSRS. DULAU & CO., 37 SOHO SQUARE, LONDON, W.

III.—*A Workshop Microscope.*

By J. E. Stead, F.R.S.

(*Read December* 16, 1908.)

The Microscope exhibited at this Meeting has not any special novelty beyond the illuminating device. It was designed by myself, and made by Messrs. Swift and Son, for the use of engineers and workers in metals, who occasionally require the use

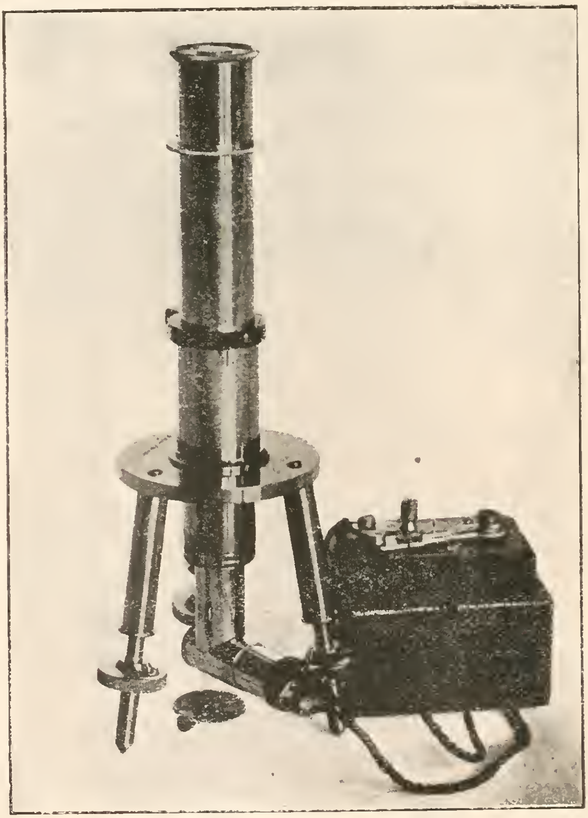


Fig. 2.

of a Microscope in the most simple form in their workshops. As the metal objects are opaque, the necessity of having a substage is avoided.

The stand, as will be seen in the illustration (fig. 2), has no substage, and is supported on a tripod base.

The lower terminals of the legs consist of hard steel points, and the upper ends are secured by screws into the brass disk.

The microscopic tube, 8 in. in length, is free to slide through a second tube secured in the centre of the disk, and when in use focus is obtained by moving the tube upwards and downwards by the fingers. When the focus is found, the tube can be fixed, if desired, by a small set-screw.

Such a Microscope cannot replace the more elaborate Microscopes, and is designed, as previously stated, for use in the workshop and office of the works foremen.

The illuminating arrangement can, however, be used in conjunction with any Microscope.

MICROSCOPY.

A. Instruments, Accessories, &c.*

(1) Stands.

Reichert's Demonstration Microscope.†—This instrument (No. 115 in the maker's catalogue), is shown in fig. 7, and will be easily understood from the illustration. A prominent feature is the hand-grip bow.

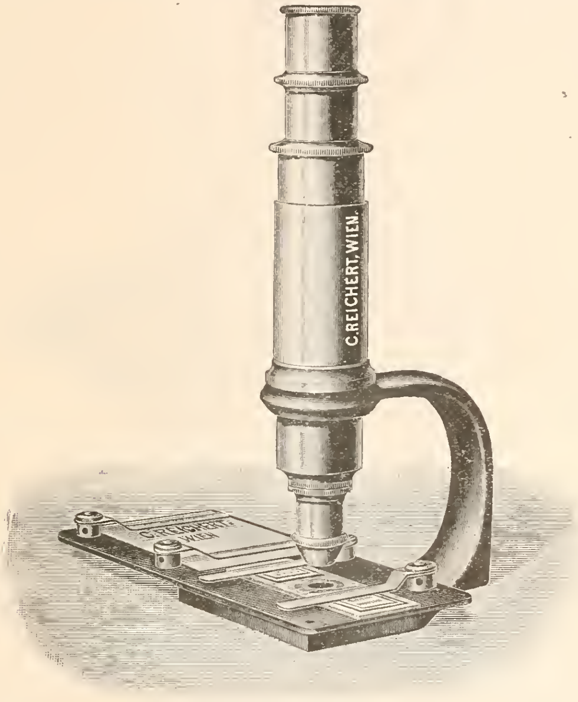


Fig. 7.

Watson's "Standard" Microscope.‡—This instrument (fig. 8) is of a new type, in which the milled head of the fine-adjustment is placed at the side of the limb. The foot and limb are of solid brass. The coarse-adjustment is of the diagonal rackwork and spiral pinion form. The fine-adjustment, one rotation of the milled head of which raises

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

† C. Reichert, Vienna, Catalogue, Mikroscope, No. 36 (1908) p. 46.

‡ Watson and Sons, Ltd., Catalogue, 1909, pp. 54–5 (fig.).

or lowers the body $\frac{1}{250}$, is effected by a coned pin of steel, a steel roller being kept in contact with the cone by a reactionary spring. The body-tube is 145 mm. long, and by extension of the draw-tube is 225 mm.

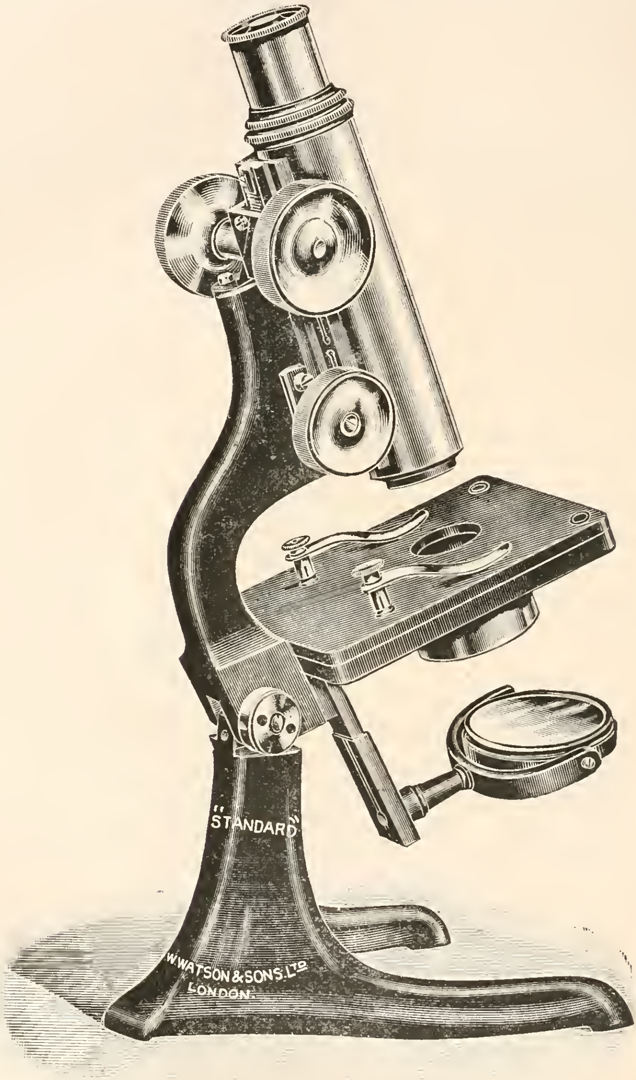


Fig. 8.

The stage, $3\frac{1}{2}$ in. square, is covered with ebonite and fitted with grip stage springs. The instrument is adapted for either compound, rackwork substage, or spiral focusing substage.

Watson's "Club" Portable Microscope.*—This instrument (fig. 9), adapted for travelling purposes, is rigid and compact, and can be stowed away in its case without taking any parts to pieces. The legs fold back-

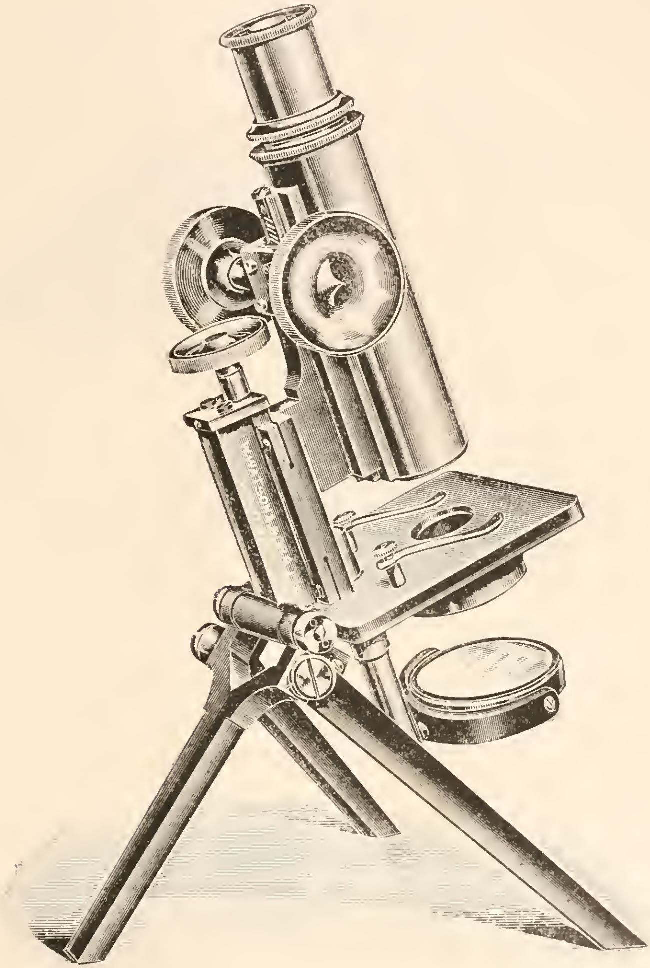


FIG. 9.

wards around the limb; the mirror tail-piece pushes upwards through the stage, and there is sufficient space in the leather case for eye-pieces and objectives.

* Watson and Sons, Ltd., Catalogue, 1909, p. 66 (1 fig.).

Watson's "Simplex" Dissecting Microscope.*—This stand (fig. 10) is adapted for the firm's aplanatic magnifiers mounted for dissecting. For focusing it is supplied with a spiral-screw adjustment, and it is

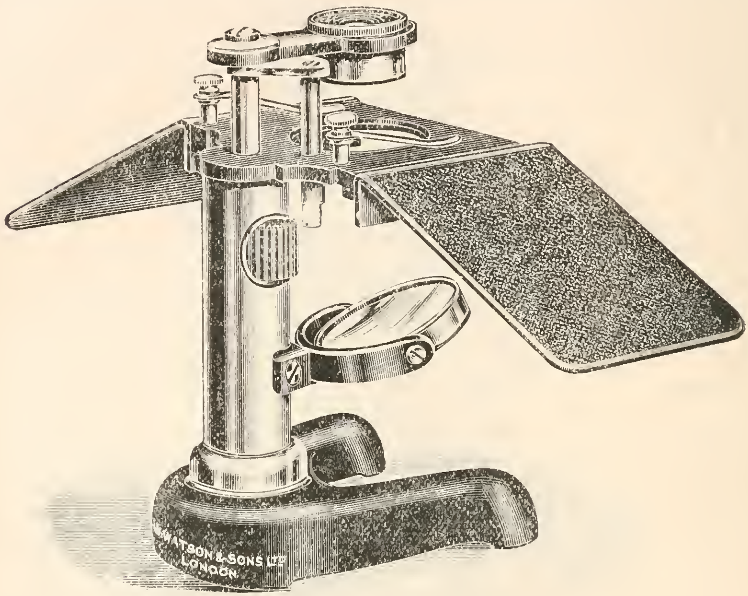


FIG. 10.

fitted with a glass disk for stage, a plane mirror and matt opal reflector, and hand-rests.

(2) Eye-pieces and Objectives.

Bifocal or Multifocal Lenses.†—Under the title of "An Interesting Lens" the English Mechanic describes an improved method of manufacturing bifocal lenses. It will be seen that the method may be applied to multifocal lenses. The process consists in so uniting two or more bodies of glass, differing in index or kind, while both bodies are in a molten state, and in so shaping the united bodies, while molten or plastic, that bifocal, achromatic, and compound or toric lenses can be produced by simple grinding. By uniting white and coloured glasses of the same or different indices a lens may be produced having a coloured and a clear portion. By joining the different kinds of glass in such a manner while both are in a molten state the blank, from which the finished lens will be subsequently formed, may be blown, pressed, rolled, or otherwise shaped into spherical, cylindrical, or curved shapes, as may

* Watson and Sons, Ltd., Catalogue 1909, p. 70 (1 fig.).
† English Mechanic, lxxxviii. (Nov. 20, 1908) pp. 367–8 (6 figs.)

be desired. Although it is possible to form the blank by rolling or pressing, the inventor of the process, W. J. Seymour, of the Merry Optical Co., Kansas City, prefers to form the blank by blowing the united bodies. He accomplishes this by gathering on the end of a blowpipe a body of glass of a certain kind, or index, or colour, and by then dipping it into a pot of molten glass of a different kind, index, or colour. In the action of dipping care must be taken that the molten glass moves progressively along the body, thereby washing away any air-bubbles, foreign matter, or imperfections on the surface of such body; this, moreover, insures a perfect union between the two layers. The body of glass, consisting of the two uniting layers, may be shaped by blowing alone, but preferably by blowing in a suitable mould in the manner well known in the art of blowing, so as to insure regularity and

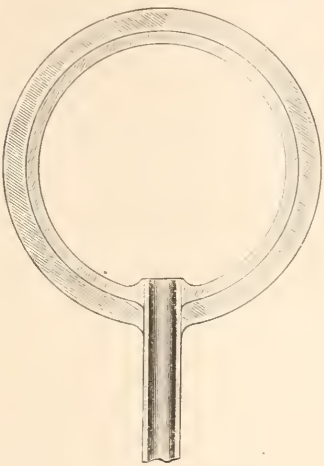


FIG. 11.

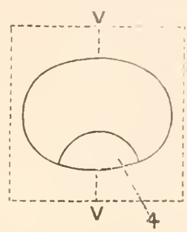


FIG. 12.

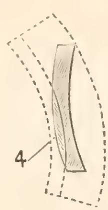


FIG. 13.

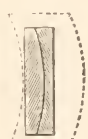


FIG. 14.

uniformity of contour (fig. 11). After the shell, consisting of two or more layers, has been produced a section or blank (shown by dotted lines in figs. 12, 13, 14) is cut from the body of this shell. This section is then ground so as to form a lens (shown in full lines in figs. 12, 13, 14) which is made up of a plurality of kinds or colours of glass. In making bifocal lenses the blank is ground to the shape shown in full lines, so that the different focal centres are placed in the desired parts of the finished lens. Thus a lens is secured of as many focal powers as desired, the number being dependent upon the number of glass layers of different kinds, index, or colour, which have been formed into one integral body, the arrangement of the focal centres being adjusted by the grinding process. It will be understood that in grinding a bifocal lens from a blank which has been formed by this process one or more of the layers of which the blank is composed may be cut entirely away, except for a portion of the lens surface, and thus a lens will be produced having a number of foci. In fig. 14 is shown an achromatic lens formed by grinding the outer surfaces of the blank, the uniting surfaces between the two layers being properly curved in forming the shell.

(5) Microscopical Optics and Manipulation.

Microscopic Measurements.* — A correspondent, J. D., in the English Mechanic, points out the too frequent omission of information as to the real sizes of objects delineated in book-illustrations of microscopic objects. Even when a size is given (e.g. $\times$ 200), such a statement is incomplete unless the particular combination of the eye-piece and objective used is stated. The writer suggests that it might be desirable to give the magnification obtained in microns (e.g. 100μ). He also emphasizes the convenience of the squared eye-piece micrometer, and points out that it may even be used for angular measurement. If the left-hand bottom corner of a group of squares be regarded as the centre of a circle, radii may be imagined intersecting the horizontal and perpendicular lines where they cross one another. Taking the bottom line as radius, the tangential perpendiculars may be expressed as decimal fractions of this radius, from which decimals the included angles can be found by inspection in any table of natural tangents, and other angles thereby estimated. On the same principle the angles round any point of intersection, within the group of squares, may be easily determined and tabulated, if likely to be of use; and for angles above 90°, the choice of a suitable centre, conjoined with a little additional calculation, is all that is necessary.

(6) Miscellaneous.

Gage's Microscopy.† — The Microscope: an Introduction to Microscopic Methods and to Histology, by S. H. Gage, has quite recently reached the 10th edition. The work has been practically re-written, and though retaining the well-known features which have rendered it so popular and valuable, a vast amount of information as to recent advances and improvements in Microscopy and Technique has been added, more especially in the direction of Histology. To enter into detail as to its merits would nowadays be superfluous, but it is permissible to state that this text-book will be found of the greatest service to teacher as well as student, whether they be of the "brass and glass" or "bug and slug" tendency.

Cholesterol, Fluid Crystals, and Myelin Forms.‡ — C. Powell White draws the following conclusions from facts ascertained after many complicated experiments. The potassium salts of "oily" fatty acids can be obtained in a crystalline fluid condition, which probably represents a hydrate of the salt. In aqueous solutions of these salts (where the corresponding acid is insoluble in water) cholesterol and some other substances give myelin forms, which are due to variations in surface

* English Mechanic, lxxxviii. (1908) p. 356.
† Comstock Publishing Co., Ithaca, New York, 1908, 345 pp. (258 figs.).
‡ Med. Chron. (1908) pp. 1–19.

tension acting on the cholesterol fatty acid mixture. This mixture is quite different from the corresponding ester, the acid presumably existing as an "acid of crystallisation." Anisotropic globules and myelin forms occurring in the tissues are, therefore, no evidence of the presence of oleates or cholesteryl esters as suggested by Adami, Aschoff, and others. Anisotropic globules and anisotropic myelin forms are probably identical in structure, though differing in shape; it is possible that their presence in some tumours has given rise to the suggestion that "parasites" were responsible for the condition. Finally, the association of cholesterol and fatty acid in unstable combination being so frequent, it may be deduced that cholesterol has an important place in the processes of fat metabolism.

Crystals in Tumours.*—C. Powell White, as the result of various micro-chemical experiments, comes to the following conclusions: (1) That crystals consisting of a loose combination of cholesterin with fatty acids, lecithin, or other substances occur in or among the cells of malignant tumours, and in some other conditions. (2) These crystals seem to be associated with cell proliferation rather than with cell degeneration, in which condition simpler crystals of fat, fatty acids, or cholesterin are more usual. (3) There are grounds for supposing that cholesterin may be in some way associated with the regulation of cell proliferation.

Crystals in Fat-cells.† — T. Lorrain Smith and C. Powell White conclude that the crystals found in fat-cells, hitherto spoken of as margarine, margaric acid, stearic acid, etc., are in reality those of neutral fats.

Quekett Microscopical Club.—The 451st Ordinary Meeting was held on November 6, 1908, the President, Professor E. A. Minchin, M.A., F.Z.S., in the chair. Reference was made to the death, on October 11, of Mr. W. Saville Kent, F.L.S., F.Z.S., etc., author of the well known manual of Infusoria. The President exhibited and described a number of preparations of blood-parasites—trypanosomes and trypanoplasms—of fresh-water fish, chiefly from the Norfolk Broads. It was supposed that the infection of the fish was effected by leeches. The group was entirely confined to the Vertebrates; nearly every known species was the host of a trypanosome, but very many are quite harmless. Mr. T. A. O'Donohoe read a note on "The Photographic Evolution of the Fine Structure of the Podura Scale." He had photographed the fine mycelioid structure and minute horizontal filaments joining the vertical lines described by Mr. Nelson (see this Journal, 1907, p. 400). Mr. F. P. Smith contributed a paper on "Some British Spiders taken in 1908." He also gave a lecture, illustrated with lantern slides, on "Flies, from several points of view." The "points of view" dealt with were those of the man at the museum, the individual who recognises some 40,000 species of flies, then the man with the Microscope, and the man with the pocket-lens. Following these were the man at the farm, the medical man, and the man in the street, and the final view-point—a consideration of those creatures which assisted in the destruction of superabundant flies.

* Journ. Pathol. and Bact., xiii. pp. 3–10. † Med. Chron., 1907.

The 452nd Ordinary Meeting was held on December 4. A new growing cell for use with the highest powers, designed by Mr. A. A. C. Eliot Merlin, F.R.M.S., was exhibited by Messrs. Baker. Mr. D. J. Scourfield, F.Z.S., F.R.M.S., gave a lecture, illustrated with lantern slides, on "The Locomotion of Microscopic Aquatic Organisms." The organisms discussed included *Amœba*, flagellated organisms, and those with cilia. Other more specialised types were dealt with, such as those with medusoid motions, the methods adopted by Nematodes and by *Salpa*, and the highest form of locomotion—that due to appendages actuated by muscles—in more complex forms.

At the 453rd Ordinary Meeting, held on January 1, 1909, Mr. A. Earland gave a lecture, illustrated by a large number of specimens under Microscopes, on "The Selective Powers of Arenaceous Foraminifera." The preparations shown were chosen to show the great diversity of structure and technical skill exhibited in the tests of this group. Nearly every species has well marked characteristics, which serve to distinguish its test from those of closely allied forms, and nearly all possess the power of selecting material, which, when considered in relation to the extremely low organisation of these animals, can only be regarded as wonderful. This selective power reaches its highest development in the genus *Technitella*, but varies in different species. A new and as yet undescribed species of this genus was shown, which built its test entirely of calcareous plates from Echinoderms.

Rules for the Sections and Sectional Meetings.—Sections for the informal study and discussion of such branches of science connected with the Microscope and its use as may from time to time be sanctioned by the Council may be formed by voluntary association on the part of not fewer than ten Fellows of the Society, subject to the following rules :—

1. Membership of the Sections shall be open to all Fellows. Any Fellow joining one or more of the Sections shall signify his adhesion thereto and his acceptance of these rules by signing a book to be retained in the custody of the Hon. Secretaries of the Society.

2. The general management of each Section shall be vested in a Committee consisting of a Secretary and four other Members of the Section. The Committee shall be elected at the first Meeting of the Section in each year. Any vacancies occurring during the year shall be filled up by election by the remaining Members of the Committee. The Sectional Committees shall be responsible to the Council for the proper management of their respective Sections.

3. Each Sectional Secretary shall keep a list of the Members of his Section and an attendance book to be signed by all persons attending a Sectional Meeting. He shall report to the Council any infringement of these rules, or any matter connected with the Section that may appear to him to be necessary. He shall also report any other matter on which the Council may desire to have information. He shall not be required to keep any Minutes or other record of the proceedings of his Section.

4. Sectional Meetings may be held in the Society's Rooms at any convenient time between 6 p.m., and 10 p.m., on any Wednesday except the third in each month, from November to June.

5. Only one Sectional Meeting shall be held on any one evening, the dates of Meeting for each Section to be fixed by the Sectional Secretaries in agreement with the Assistant Secretary of the Society.

6. Visitors may be present at Sectional Meetings on the invitation of Members of the Sections.

7. No account of the proceedings at the Sectional Meetings shall be published in any form whatever, except such as the Editor may think fit to publish in the Journal of the Society, and no action shall be taken by the Sections which would involve the Society in any financial or other liability.

8. Any Member of a Section may withdraw therefrom upon notice given to the Secretary of the Section, and he shall cease to be a Member if he discontinues his attendance at the Meetings of the Section for the period of a whole Session, or if he ceases to be a Fellow of the Society. In case the Membership of any Section shall fall below the number of five and continue to be less than five for the period of a Session of the Society, that Section shall be dissolved and automatically become extinct at the end of that Session. Any Section may at any time be dissolved by a resolution of the Council of the Society.

9. The Council may suspend any Fellow from Membership of a Section for the infringement of any of these Rules or for any other reason it may deem sufficient.

Note.—For the present the Sections authorised are as follows :—

A. Microscopical Optics and Microscope Construction Section (Brass and Glass).

B. Biological Section (Pond Life and Microscopical Organisms generally).

C. Bacteriological Section (Histology, Bacteriology, Disease-producing Organisms, etc.).

These Sections have been duly constituted, and are now meeting as follows :—

1st Wednesday at 8 p.m.	. . . .	Bacteriological.
2nd ,, ,, 7 for 7.30 p.m.	.	Biological.
4th ,, ,, ,,	. . .	Brass and Glass.

B. Technique.*

(1) Collecting Objects, including Culture Processes.

Marine Expeditions.†—A. G. Mayer laments the loss of time, the waste of money and energy of the numerous marine expeditions organised by civilised nations, and then describes his plan for obtaining more valuable results. It is an improvement on the general practice which has hitherto obtained, viz. that of sending out a collecting vessel and relegating the catches to experts at home. For this procedure the author would establish shore stations, properly equipped in all respects, i.e. as to men and material. These stations would be served by the

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

† Science, xxvii. (1908) pp. 669–71.

collecting steamer, on which would reside a small permanent staff, and would be suitable for the transport of the staff and material of the shore stations.

The author also points out some of the marine problems on which much light would be thrown by adopting his suggestions.

Methods of Plankton Research.*—W. J. Dakin, in an interesting and very useful paper on Planktonology, continues a description by J. T. Jenkins in 1901 of the nets and methods invented and devised by Victor Hensen. The author describes plankton nets; method of using the quantitative net; preservation and estimation of the catch; pump, tube, and filter method; method of investigation for the smallest organisms; other plankton apparatus used for qualitative work; and then gives a summary of the results of the plankton work and its aims.

The author had personal experience of the acquaintance with the apparatus he describes on the occasions when he was permitted to accompany the German expeditions in the North Sea and Baltic.

Behaviour of Certain Pathogenic Micro-organisms at Low Temperature.†—E. Almquist finds that certain strains of *Bacillus paratyphosus* and *B. coli* grow well on agar slopes at 10° C.; but the organisms of cholera, typhoid, and dysentery grow only feebly, and appear as coarser forms, which produce germinating granules (kugeln). If these forms are transferred to fresh medium at a higher temperature they rapidly produce "granules," which begin to germinate at once. The earlier forms thus produced are non-motile; the cholera granules quickly give rise to comma-bacilli, and can also form new granules; the typhoid and dysentery granules may form new granules, but usually only give rise to rods.

The author found the same developmental processes occurred with all strains of cholera and dysentery organisms, but not with all examples of *B. typhosus*.

Differentiation of Bacilli of Typhoid Group.‡—G. C. Chatterjee employs the following tests for differentiating the organisms of the typhoid group. *Bacillus typhosus* is grown on agar slopes, the whole surface being inoculated; after 3 to 4 days at 37° C., all visible growth is washed away by sterile normal salt solution; if these washed surfaces are re-inoculated with *B. typhosus*, no growth occurs, but if inoculated with *B. paratyphosus A*, or *B. paratyphosus B*, Shiga's bacillus, or *B. coli*, growth occurs in all tubes after 48 to 72 hours at 37° C. Similar tests are made with scraped agar cultures of *B. coli*, *B. paratyphosus A*, etc., with similar results, except in the case of *B. coli*, where the scraped surface has a growth-inhibiting effect not only on *B. coli* but also on *B. typhosus* and bacilli of the typhoid group.

The author concludes that the bacilli produce in the agar a specific growth-inhibiting toxin, which is insoluble in salt solution; it is destroyed at 55° C. for one hour: though inhibiting growth it does

* Proc. and Trans. Liverpool Biol. Soc., xxii. (1908) pp. 500–52 (7 figs.)
† Centralbl. Bakt. 1te Abt. Orig., xlviii. (1908) p. 175.
‡ Tom cit., p. 246.

not kill the bacilli: this specific property can be used to identify *B. typhosus* from other allied bacilli.

Achromogenic Cultures of Micrococcus prodigiosus.*—M. Cordier, H. Rajat, and G. Péju placed open agar-tube cultures of *Bacillus prodigiosus* in a 150 c.cm. flask filled to one-third with sulphuric ether: a glass vessel, part full of cotton wool, was inverted over the whole, covering at the same time the opening of the culture tube and of the flask; after standing in the dark, at the temperature of the laboratory, growth slowly appears, but of a white porcelain aspect, and showing no trace of pigment. A control tube, inclosed in a similar flask containing water, showed typical pigmented cultures.

If the achromogenic cultures are transferred to fresh media, the subcultures are also free from pigment, but after a few generations the red colour reappears. The author finds that the longer the duration of cultivation in ether vapour, the slower is the reappearance of pigment in subcultures; but a true achromogenic variety cannot be permanently obtained. Similar results were observed by substituting ethyl- or methyl-alcohol, chloroform and xylol for ether.

Blood Cultures.†—Lafforgue adopts the following procedure for blood cultures. The blood is obtained by venous puncture and mixed with citrate of soda: one drop ($\frac{1}{50}$ c.cm.) of 20 p.c. citrate solution to 1 c.cm. of blood. The mixture is centrifuged and the supernatant liquid decanted, and the deposit is distributed into flasks or tubes of broth. The removal of the serum, which contains comparatively very few germs, is not likely to cause serious error, and at the same time its slightly inhibiting action is also removed.

The method is economical, and permits the transmission of blood specimens, without any liability to interfere with subsequent bacteriological investigation.

Action of Meningococcus and similar organisms on Sugar Media.‡ C. Dopter and Raymond Koch employ the following media for studying the action of meningococcus and allied organisms in various sugars. To 75 c.cm. of slightly alkaline agar is added 1 grm. of lævulose, dextrose, or maltose, etc.; after sterilisation there are added 25 c.cm. of ascitic fluid, and 1 c.cm. of sterile 1 p.c. solution of neutral red; the mixture has an orange tint, and is kept in a water-bath at 60° C. for 1 hour, until the formation of a fine precipitate of neutral red occurs. The medium is then poured into Petri dishes—it has a yellowish tint in thin layer—and cultures are made for meningococcus, pseudo-meningococcus, and gonococcus, and incubated at 37° C.

The authors find that meningococcus, after 24 hours on dextrose and maltose, gave a carmin-red colour: on lævulose and other sugars no fermentation occurs. The coccus *catarrhalis* is without action on any sugar. Flavus i. and ii. ferment lævulose, dextrose, and maltose, but Flavus iii. has the same reactions as meningococcus.

Diplococcus crassus (*Pseudomeningococcus* Jaeger) ferments most all the sugars. Gonococcus only ferments dextrose.

* C.R. Soc. Biol. Paris, lxv. (1908) p. 344.
† Tom. cit., p. 340. ‡ Tom cit., p. 351.

(2) Preparing Objects.

Researches on the Leucocytes and Lymphoid Tissue of Invertebrates.*—M. Kollmann fixed the material with Zenker's fluid (with and without acetic acid), Lindsay's fluid, and in certain cases with Dekhuysen's mixture (potassium bichromate 6·25 grm., filtered sea-water 250 c.cm., 2 p.c. osmic acid 54 c.cm.). The last fluid is isotonic with sea-water, and gives excellent results for very delicate elements. In some cases, Gastropods, Lamellibranchs, and Echinoderms, the plasma being deficient in albumen coagulates in flakes, and does not stick to the slide. Various devices to meet this emergency must be resorted to, the only one mentioned being that of Regaud, which consists in collodionising the slides. For staining the films the following were used : hæmatoxylin-eosin-orange, toluidin-blue-eosin-orange, safranin-light-green, magenta-Benda. For the granules, the triacid, the C mixture of Ehrlich and Giemsa, were used. For the lymphogenic organs, the same fixative which succeeded best with the blood was used, while for demonstrating the stroma, 2 per thousand potassium bichromate, or Merkel's fluid, was substituted Sections were made by the gum method, but if the presence of a network can be detected by the naked eye, the paraffin method may be adopted.

The author then describes his method of making a differential count of the corpuscles. A drop of blood is obtained by means of a pipette ; this is spread on a slide fixed with osmic acid vapour, dried and stained with triacid. All the corpuscles in the whole of the film are then counted and classified. It is advisable to count several thousand.

(4) Staining and Injecting.

Bacillus of Anthrax and Silver Impregnation. —J. Yamamoto finds that young vegetative forms of *Bacillus anthracis* are silver-negative, only the contour staining as a sharp black line ; in older forms, when spore-formation is commencing, the entire bacillary body is diffusely stained, more especially at the centre, but also at other points black flecks are found which later become larger and circumscribed, and appear as spores. In older cultures they stain less well. These observations applied to cultures on all the media investigated.

The bacilli in smears from heart-blood or in organs from an anthrax-infected mouse, are not so constantly silver-negative, many organisms showing a black stain ; the capsule remains unstained, as is the case with other encapsuled bacteria.

Staining of Fat with Basic Anilin Dyes.‡—J. Lorrain Smith says that if a section of fat-containing tissue be stained with an aqueous solution of a basic anilin dye, and then exposed to the air in a thin layer of Farrant's solution for 2 or 3 days, the fat will attract the dye from

* Ann. Sci. Nat. Zool., viii. (1908) 240 pp. (2 pls.).
† Centralbl. Bakt., 1e Abt. Orig., xlviii. (1908) p. 253.
‡ Journ. Pathol. and Bact., xii. (1907) pp. 415–20.

adjacent tissues and stain deeply. This is due to the carbonic acid of the air converting the neutral fats into fatty acid and glycerin, the former taking up the basic stain very readily. CO_2 produces a parallel change in carbohydrates, glycogen, and possibly proteids. This method may be expected to throw light on the action of excessive CO_2 in the blood, it also affords an explanation of why the tubercle bacillus with its fatty capsule is "acid-fast." The acid rather fixes the dye than fails to remove it. In the case of the *Smegma* bacillus the compound so formed is very soluble in alcohol; in the case of tubercle it is less so, i.e. tubercle is also "alcohol-fast."

Simultaneous Staining by Oxazine Dyes.*—The same author describes an investigation on the staining of fat by oxazine dyes, undertaken with the view of finding a stain which would, in the same section, differentiate neutral fat from fatty acid.

Nile-blue, and certain other dyes of the oxazine series, are capable of being converted into a red compound, and aqueous solutions of (e.g.) Nile-blue are found to contain two bases, a blue oxazine base which forms a blue soap with fatty acid, but does not combine with neutral fat, and a red oxazone base which is soluble in and colours both fatty acid and neutral fat. The oxazone base can be obtained from the oxazine by heating with a little sulphuric acid.

The practical application of this method of fat-staining requires further elaboration; but to give an example of the results obtained, it was found in sections of liver from cases of obstructive jaundice that the fat adjacent to the congested bile-ducts stained deep blue; and that more remote, purple or red. This may be presumed to indicate that the action of the bile is instrumental in converting neutral fat into fatty acid.

Principles of Weigert's Method.†—According to J. Lorrain Smith and W. Mair, there are certain substances of a fatty nature present in most tissues which are able to combine with chromium oxide; the compound so formed will lake hæmatoxylin, i.e. will "stain." The chromium-oxide compound is best obtained by keeping the unsaturated substances in a concentrated solution of potassium dichromate at incubator temperature (37° C.) for some days; but if this action be allowed to continue too long, the compound capable of laking hæmatoxylin is converted into a fully saturated compound which is unstainable, or "over-chromed."

The spinal cord contains various elements differing in the rate at which they oxidise, so that by stopping the bichromating at different stages we can stain separately, first the medullary sheath, then in order the nucleoli, the axis-cylinder, the cell-body and processes, and, lastly, the neuroglia. If the bichromating be longer continued, no staining at all takes place, all the unsaturated groupings being occupied.

Even entirely unsaturated fats, however, stain less readily than the medullated nerve-sheath, and this seems to depend on the presence in

* Journ. Pathol. and Bact., xii. (1907) pp. 1–4.

† Op. cit., xiii. (1908) pp. 14–27.

the latter of substances which, on examination by crossed Nicol prisms, are found to be anisotropic. These substances appear as globules, or "myelin figures"; they are normal in the suprarenal gland, and occur very frequently in pathological tissues, characterising a most important type of fatty degeneration. These substances are composed of fatty acids and cholesterin, neither of which will stain separately; but if the two are present in a "myelin-like" compound, staining or oxidisation immediately takes place. Several experiments make it almost certain that cholesterin is the substance oxidised. This seems to throw fresh light on the part which cholesterin plays in cell-metabolism. Two other constituents of the medullary sheath, viz. lecithin and protargon, do not seem to be concerned in the results of Weigert's myelin method, which would appear, then, to depend on the existence in the medullary sheath not merely of unsaturated fats, but of such in the form of a compound with cholesterin, which gives "myelin figures" when heated in contact with water.

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

Mounting Amphibian Eggs.*—K. Ogushi describes a procedure for mounting eggs of Amphibia for demonstration purposes. It consists in immersing the eggs in 0·5 p.c. formalin, after previous fixation in chrom-acetic acid, Zenker's fluid, or sublimate. In about six months the gelatinous sheath has dissolved away. The next step is to make a very thick ring on a slide with balsam by aid of the turntable. The circular well is then filled up with the prepared roe and closed by means of a cover-slip, previously heated. After pressing down the slip, the margin should be further secured by means of some varnish. The slides should be allowed to rest for some months.

(6) Miscellaneous.

Photomicrographic Atlas of Fibres important in Arts and Commerce.†—The first part of this atlas (the sub-title of which is A Manual of Microscopical Research Methods for materials used in textile fabrics, in the manufacture of paper, rope, string, and yarn) has recently appeared. The author is Alois Herzog, one of the principals in the Prussian High School at Sorau, where there is a special textile industry department. The work, which is subsidised by the Prussian Government, represents the results of fifteen years' labour. In the text are described the apparatus required, the necessary technique, the microchemical reactions, and the microscopy of the fibres and of the plants from which they are derived. The atlas contains 222 photomicrographs, one being in three colours. These are all most excellent, and of course are faithful reproductions of the originals. This atlas will form one of the most valuable works on this particular branch of microscopy, and will be of the greatest assistance to students and learners.

* Anat. Anzeig., xxxiii. (1908) pp. 381–2.
† Munich: J. B. Obernetter, 1908.

Apparatus for the Aeration of Aquaria.*—B. Jöckel describes the following arrangement (fig. 15) for aerating aquaria. The completely closed cistern A is connected by the tube W with a water supply; through an opening in the top of A is passed a siphon tube H that reaches nearly to the bottom, and has its free arm ending as low as possible below the vessel; a second opening in the top of A admits the tube L, which is the commencement of the air supply which passes through the bent tube L to the valve flask V, and air box W K, to the aquarium D; a third opening admits the open tube St.

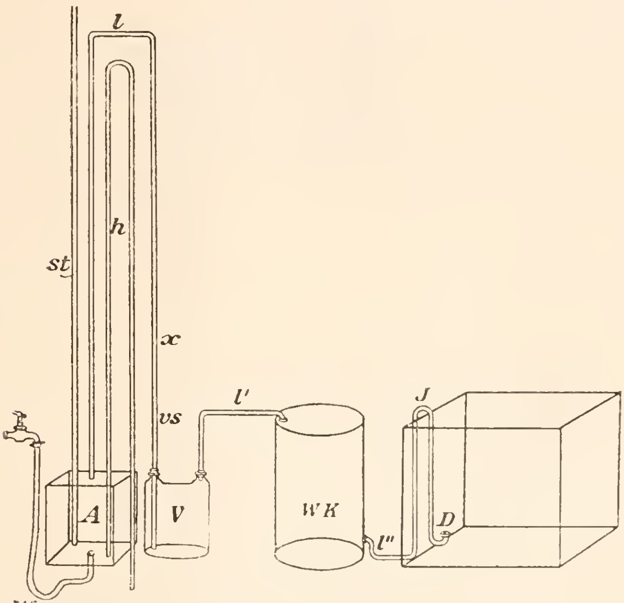


FIG. 15.

When a constant stream of water passes into A the bottom of the vessel will soon be covered, and when the lower openings of the tubes H and St are closed then the connection of the inside of A and the air present in the air supply tube with the outside atmosphere will be broken; water now begins to rise in the siphon tube H and in the tube St, and continues to do so until the pressure is sufficiently great to overcome the resistance at the outlet nozzle in D, and at this moment ventilation commences. When the cistern A is full the columns of water in the tubes St and H rise until the liquid tips over the bend of H and brings into action the free arm of the siphon, whereby the vessel A is quickly emptied, when it will be filled with air sucked in by the tube St; the process is then repeated. It is necessary that the upper end of St and

* SB. Gesell. Naturf. Freunde, 1906 (Feb.) p. 66.

the highest point of L should be higher than the bend of the siphon tube H.

Aeration of Aquaria.*—O. Thilo describes the following apparatus for ventilating aquaria (fig. 16). A piece of rubber tubing of 2–3 mm. bore and 30 cm. long is drawn through the tube of a glass funnel so as to leave the upper portion of the rubber tubing sticking out of the funnel tube; into the lower end of the tubing is pushed a piece of

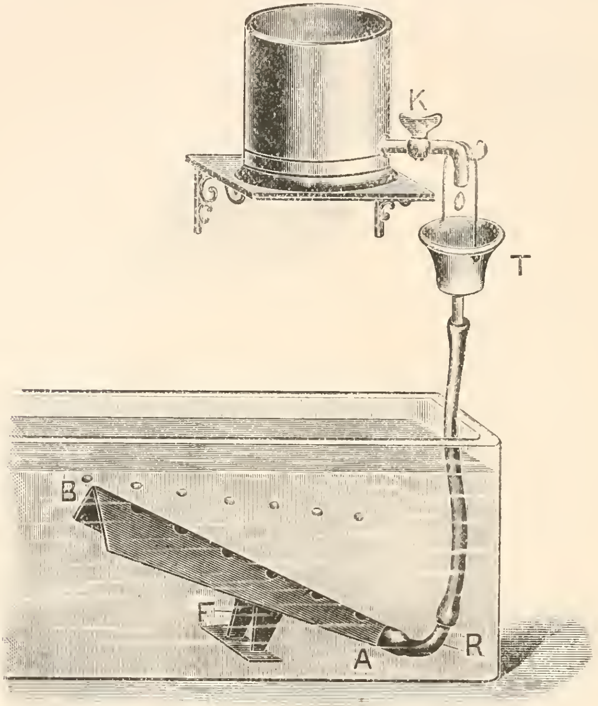


Fig. 16.

metal tubing, and on to the free end of this tube is fixed a rubber tubing of about 4–5 mm. bore, and the end of this rubber tube is pulled over another metal tube R (fig. 17). The funnel is suspended under a tap, and water is allowed to drip into it; the air in the tubing will be driven into the aquarium, on the floor of which rests the tube R. The author finds it is necessary that for a depth of 50 cm. of water in the aquarium, the funnel should be at least 150 cm. above the floor of the aquarium. It is also useful to place a perforated shield over the tube R in order to

* SB. Gesell. Naturf. Freunde, 1906 (May) p. 139.

distribute the air after it escapes; and this is also facilitated by tilting the end of the tube R to 23° from the horizontal.

Schweizer's Reagent.*—G. B. de Toni has discovered a way of making this reagent, which obviates the tiresome task of repeatedly washing the copper hydroxide, and thus simplifies the preparation: 10 grm. of pure crystallised sulphate of copper are reduced to a fine powder in a mortar. While grinding, 2 grm. of powdered caustic soda are added a little at a time: from time to time a few drops of distilled water are allowed to fall on the mixture. To the resulting greenish

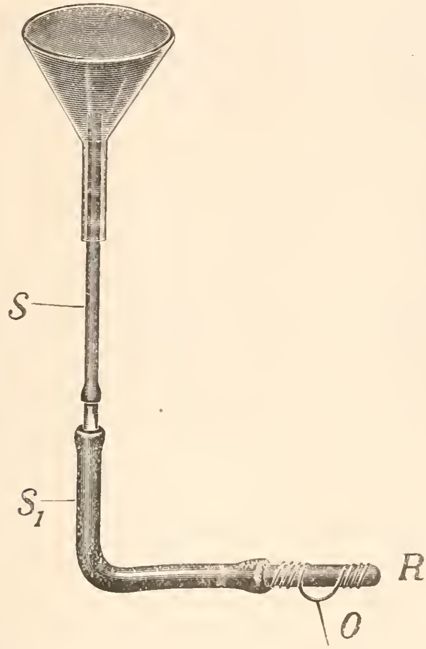


FIG. 17.

mass are added gradually, and stirring the while, 25–40 c.cm. of strong ammonia (26–29 Baumé), which dissolves the hydroxide of copper formed by the action of the soda on the copper sulphate. The mixture is then filtered through glass wool: the filtrate of a dark blue colour has all the properties of Schweizer's reagent. Cotton, when treated with this fluid, is completely dissolved, and when the cupro-ammoniacal solution is treated with water, or better with acidulated water, cellulose is precipitated in fine white flakes.

Another method of preparing the reagent is given by the author: 10 grm. of copper sulphate are dissolved in 200 c.cm. of distilled water and mixed with 7 grm. of barium hydroxide dissolved in 200 c.cm. of water. The precipitate which forms is filtered off on glass wool, and

* Atti R. Istit. Veneto, lxv. (1905–6) pp. 593–6.

then 50 c.cm. of strong ammonia poured over it. The blue liquid which passes through is poured back again several times over the precipitate in order to obtain all the copper hydroxide and leave only the insoluble barium sulphate. The fluid thus obtained is found to have a strong solvent action on cotton.

Apparatus for Observing the Suction of Insects.*—G. Zirolla has devised the following apparatus (fig. 18), by means of which an isolated

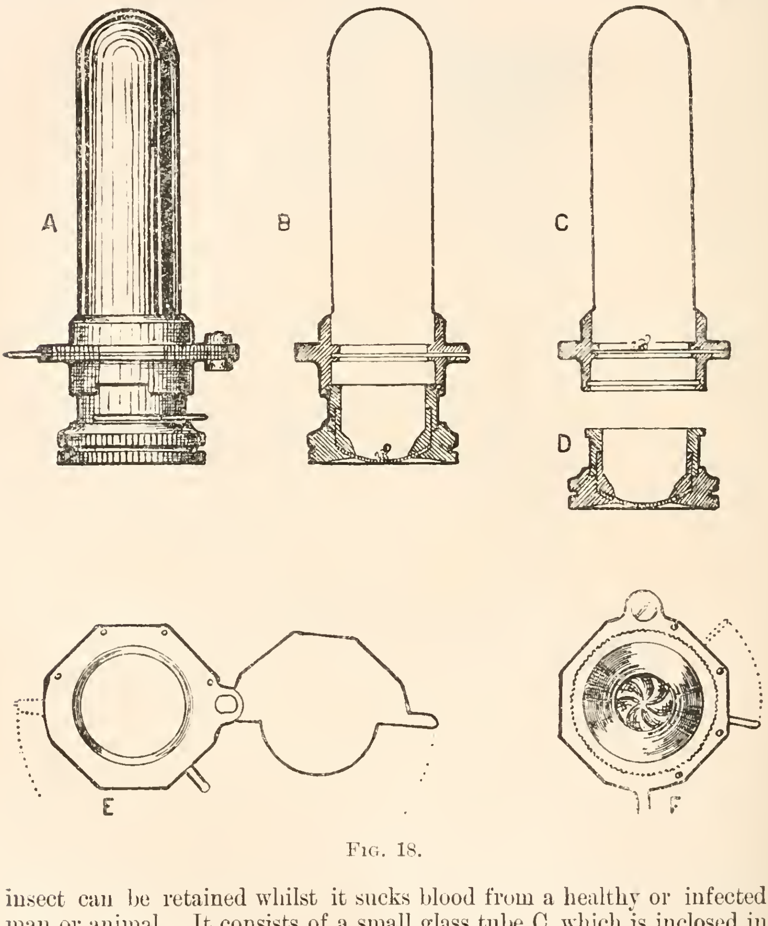


Fig. 18.

insect can be retained whilst it sucks blood from a healthy or infected man or animal. It consists of a small glass tube C, which is inclosed in a nickel vessel provided with an easily movable disk, by which the tube can be closed or opened. This tube is hitched to a nickel stand D, which at its base has an iris-diaphragm with a convex lower surface.

* Centralbl. Bakt., 1te Abt. Orig., xlviii. (1908) p. 173 (1 fig.).

This stand is placed on the body of the animal whose blood the insect in the tube C is required to suck; the disk in the tube is removed, and the diaphragm of D is opened, and the insect is thus brought in contact with the skin. When suction has taken place the diaphragm is slowly closed, whereby the insect is drawn back again into the tube; the apparatus is now removed and inverted, so as to allow the insect to fall to the bottom of the tube C, which is then closed again by the metal disk, and removed from the stand. In this way a number of insects may be successively used and preserved for further observation or experiment.

Small Bacterial Grinder.*—B. White describes a small mill (fig. 19) for grinding dried bacterial cultures. It consists of a thick glass flask with a ground stopper, holding 20–30 smooth agate marbles, about 1·5 cm.

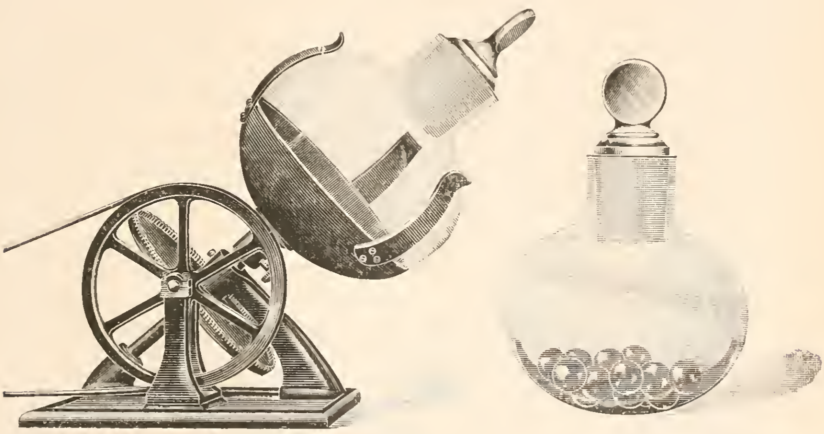


Fig. 19.

diameter. The flask is fixed to a metal holder, fitted with an axis, which by a simple mechanism can be slowly rotated. The apparatus is readily sterilised, and very fine state of powder can be obtained.

After ten hours a dried culture of *Bacillus typhosus* exhibited no bacillary bodies.

Methods of Textile Chemistry.†—This work, by F. Dannerth, though it does not directly appeal to the microscopist, will be found very useful by anyone interested in textile fabrics, owing to a very excellent glossary of trade terms.

* Centralbl. Bakt., 1te Abt. Orig., xlviii. (1908) p. 254.
† New York: John Wiley and Sons; London: Chapman and Hall, 1908, viii. and 164 pp.

Metallography, etc.

Quenching Velocities.*—C. Benedicks has carried out a lengthy and painstaking investigation on the cooling power of liquids, on quenching velocities, and on the constituents troostite and austenite. From the results given by two different methods, in which the temperature of a body heated by electrical energy and cooled by a flowing liquid was measured, it is concluded that, as Le Chatelier had found by another method, mercury is much inferior to water in cooling power, that the main factor in the cooling power of a liquid is its latent heat of vapour; specific heat has a secondary influence; conductivity for heat and viscosity may probably be neglected. Experiments in which photographic time-temperature curves of small pieces of steel quenched in water were taken, demonstrated that the time occupied in cooling through a given range (700°–100° C.) is directly proportional to the mass, but almost independent of the surface area of the specimen. Speed of cooling is increased by raising the temperature from which the sample is quenched. Troostite is held to be a solid colloid solution of cementite in iron, and "osmondite" is a state with a maximum content of troostite. For the detection of austenite, a new etching reagent, 5 p.c. alcoholic solution of metanitrobenzolsulphonic acid was found to be useful. The preservation of austenite in carbon steel requires a high mechanical pressure.

Iron-Carbon Equilibrium.†—G. B. Upton proposes a greatly modified iron-carbon diagram, based upon the experimental results obtained by Carpenter, Wüst, Goerens, and others. The hypothesis of iron-graphite as the stable system with iron-ironcarbide metastable, is considered to be unnecessary. The phases crystallising from the melt are solid solution and graphite, forming a eutectic at 1145° C. of 4·3 p.c. carbon. At 1095° C. the inversion γ + graphite to $\gamma + Fe_6C$, or Fe_6C + graphite occurs. At 800° C., Fe_6C breaks up into $Fe_3C + \gamma$; and at 615° C., Fe_3C decomposes into $Fe_2C + Fe$. The two new phases Fe_6C and Fe_2C are introduced to account for the thermal critical points found by Carpenter and Keeling in the neighbourhood of 800° and 600° C. The existence of these compounds appears to be supported by the work of Campbell and others on the chemical constitution of cast irons.

The author deals in a very thorough manner with the various phenomena (such as formation of temper-carbon) exhibited by the cast irons, and accounts for all of them in his equilibrium diagram, which, however, appears likely to meet with much well-founded criticism.

Copper and Copper Alloys.‡—J. T. Milton discusses numerous cases of abnormal behaviour, and indicates directions in which investigation should be pursued. The effect of hot and cold work, and of annealing, is imperfectly understood. The influence of heat-treatment on the

* Journ. Iron and Steel Inst., lxxvii. (1908) pp. 153–257 (51 figs.).
† Journ. Phys. Chem., xii. (1908) pp. 507–49 (13 figs.).
‡ Ironmongers' Chronicle (Special Report Number, Institute of Metals, Birmingham Meeting) lxi. (1908) pp. 11–15.

copper-zinc alloys is discussed. The author suggests that the effect of high casting temperature on copper-tin and other alloys is due to slower rate of solidification caused by the greater heating of the mould.

Mechanism of Annealing.* — G. D. Bengough and O. F. Hudson discuss the annealing process in copper alloys. In the case of single phase alloys or pure metals the effect of annealing seems to be essentially the conversion of Beilby's hard A phase into the C or crystalline phase. In more complex alloys, such as Muntz metal, annealing may produce a change of constitution. The annealing temperature of cartridge brass may be between 550° and 730° C., preferably 600°–650° C. The Microscope affords a ready means of controlling the annealing process.

Phosphor Bronze.†—A. Philip has collected a large number of chemical analyses and mechanical tests of phosphor bronze, and from them deduces the following as a suitable specification :—copper 90–92, tin 7·4–9·7, phosphorus 0·3–0·6 p.c. The author prefers to examine micro-sections polished but not etched. A grey network is probably Cu_3P. The presence of this network of hard copper phosphide in a matrix of softer copper-tin alloy renders the metal suitable for bearings.

Metallographic Investigation of Alloys.‡—W. Rosenhain discusses metallographic methods, dealing chiefly with those in which there is considerable divergence in the practice of different investigators. The necessity for using pure materials, for checking by actual analysis the composition of each alloy prepared, for using reasonably large quantities of metal in the thermal investigations, for accuracy of temperature measurement (by a potentiometer method when thermocouples are used), and for employing slow rates of cooling, is emphasized. The paper contains much criticism of the methods employed in Tammann's laboratory at Göttingen.

Intermetallic Compounds.§ — C. H. Desch gives an account of criteria for the existence of compounds. In binary metallic systems the methods available for the establishment of the existence and formulæ of compounds are :—1. Thermal analysis. 2. Microscopic examination. 3. Determination of electromotive force between an alloy and one of its component metals. 4. Chemical examination of residues (apt to give misleading results). 5. Measurements of (*a*) hardness, (*b*) density, (*c*) electrical conductivity. 6. Determination of heat of formation (an untrustworthy method). The combination of thermal and microscopical examination offers the most certain means of detecting compounds, electrical conductivity probably ranking next in importance. The author gives a list of well established compounds.

Structure of a Brittle Steel Sheet.‖—A. Sauveur has examined a steel sheet, carbon 0·05 p.c., exhibiting brittleness of the kind described by

* Ironmonger's Chronicle, lxi. (1908) pp. 5–20.
† Tom. cit., pp. 25–30. ‡ Tom. cit., pp. 30–40 (5 figs.).
§ Tom. cit., pp. 40–3 (5 figs.).
‖ Electrochem. and Met. Industry, vi. (1908) p. 271 (3 figs.).

Stead, probably the result of prolonged heating between 600° and 700° C. In micro-sections taken from a strip annealed at 835° C., thick bands were observed in the ferrite grains. The bands in any one grain were parallel, and appeared to have been attacked by the etching solution more strongly than the remainder of the grain.

Magnetic Changes in Steel.*—H. M. Boylston describes a laboratory experiment for illustrating the changes in magnetic properties occurring at the thermal critical points in steel. A drilled test-piece, within which is the hot junction of a thermo-couple, is supported just below an electromagnet, and is heated by blast lamps. The critical point is indicated by the test-piece beginning or ceasing to be attracted by the magnet, on cooling or heating.

Hard Spots in Steel Castings.†—A. P. Scott found that a hard spot in a roll casting consisted of an envelope of metal containing 12 p.c. manganese, 1·8 p.c. carbon, sharply differentiated from the steel and surrounding a cavity. Manganese had been added to the molten steel in the ladle only in the form of 80 p.c. ferromanganese. From the results of a number of experiments, in which molten steel was poured into small moulds containing small pyramids of ferromanganese, the author concludes that ferromanganese, when added to molten steel, first melts and then gradually absorbs iron, and probably gas also, from the surrounding metal. Complete diffusion does not take place till the liquid manganese alloy has been very considerably diluted. Solidification of a globule of the manganese alloy results in the formation of a hard spot.

Methods of obtaining Cooling Curves‡—G. K. Burgess gives an outline of the various methods which have been developed for obtaining cooling curves, and briefly describes the apparatus employed. Only those methods of measuring temperature which depend on the use of thermocouples of the platinum metals are considered. An analytical discussion concludes the paper, and leads to the same result as the examination of the experimental methods: that the most certain and complete data may be obtained by combining temperature-time observations with those given by the differential method.

Recalescence Curves.§—W. Rosenhain discusses the methods of observing recalescence phenomena, and gives examples of heating and cooling curves obtained by the "time-temperature" and the "differential" methods. The "inverse-rate" and "derived differential" methods of plotting are explained. The author considers that the differential method of obtaining cooling curves is eminently satisfactory, and has important practical advantages over the "inverse-rate" method. The critical point at about 600° C., found by Roberts-Austen in iron, and by Carpenter and Keeling in iron-carbon alloys, is attributed to the presence of crystalline silica in the furnace walls. The author has found a recalescence in crystalline silica at about 580° C.

* Electrochem. and Met. Industrry, pp. 273–4 (2 figs.).
† Tom. cit., pp. 281–6, 323–6 (11 figs.).
‡ Tom. cit., pp. 366–71, 403–5 (11 figs.).
§ Proc. Phys. Soc., xxi. (1908) pp. 180–208 (18 figs.).

Transparent Metallic Films.*—T. Turner finds that thin films of gold, silver, or copper, heated in air between glass slips, become transparent at temperatures below 550° C. In the case of gold and silver, microscopic examination proves that the apparent transparency is due to destruction of continuity of the film, the metal aggregating when heated into separate granular masses. Under similar conditions copper oxidises, forming a continuous transparent film, bright green at first, then gradually darkening to deep brown. The discovery of a transparent stage in the oxidation of copper supports the view that the spectrum colours, which appear on the surface of certain metals by oxidation, are due to the formation of a transparent film.

Structure of Eutectics.†—As a preliminary to the study of a pure eutectic alloy, W. Rosenhain and P. A. Tucker have re-determined the equilibrium diagram of the lead-tin system.‡ The eutectic point is placed at a concentration of 63 p.c. tin. Transformations of the lead-rich alloys, occurring in the solid state, are regarded as the separation of tin from the solid solution of tin in lead, which changes from the β to the α state. The eutectic consists of grains, in each of which there is a systematic orientation of the laminations produced by layers of the two constituents. The authors take the view that these grains are true spherulitic crystals.

Partition of Silver between Zinc and Lead.§—G. N. Potdar has investigated the constancy of the partition coefficient of silver between liquid zinc and liquid lead. Weighed quantities of the three metals were maintained at 540° C. for several hours, the mass was allowed to solidify, and the percentage of silver determined in each of the two layers. The separation of the lighter and heavier layers was not quite perfect: this caused discrepancies in the results. The author concludes that the coefficient is constant for the more dilute solutions, and is about 300. The partition coefficient of silver between solid zinc and liquid lead (of importance in the Parkes process), is much higher.

Troostite.‖—C. Benedicks defends the appellation "colloidal solution" as applied to troostite, on the ground that dispersed systems containing ultramicroscopic particles of metals are universally admitted to be colloidal solutions. H. le Chatelier considers that the expression "colloidal solution" must fall out of use, since the condition indicated is not one of solution in any true sense.

* Proc. Roy. Soc., Series A, lxxxi. (1908) pp. 301–10 (9 figs.).
† Tom cit., pp. 331–4 (1 fig.).
‡ See this Journal, 1908, p. 523.
§ Journ. Coll. of Sci. Tokyo, Japan, xxv. (1908) Art. 9 (4 figs.).
‖ Rev. Métallurgie, v. (1908) pp. 878–9.

MICROSCOPY.

A. Instruments, Accessories, etc.*

(1) Stands.

Bausch and Lomb's Stand D D H.†—This Microscope (fig. 41) is the largest of the makers' series, and is intended for the highest class of work, its equipment being designed to make it well suited to research and all lines of precise investigation. The body-tube is made of suffi-

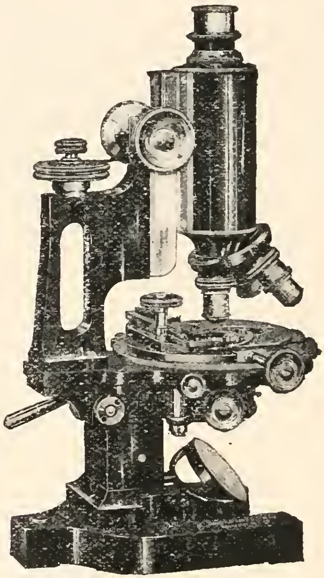


Fig. 41.

cient size to permit the use of a 72 mm. Micro-Tessar, with the full angle of view which that lens embraces. In the construction of the instrument the prime consideration has been the excellence and completeness of the finished product, and, while this policy adds to the cost, the resulting instrument is meant to be of a quality likely to be appreciated by those workers who require the best. The limb is fully inclinable, and the arm, large and very strong, is arranged so as to leave a distance of 75 mm. to the centre of the stage. The stage is circular, measuring

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

† Bausch and Lomb, Rochester, N.Y., Catalogue, Microscopes and Accessories.

112 mm. inside and 126 mm. outside the graduations, which are in single degrees. The stage is fitted with centring-screws, and may be removed when it is desired to substitute the plain stage. The mechanical stage may be revolved, and the movements for the slide-adjustment are very wide. Graduations are provided for recording the field. The sub-stage is complete in every particular. The lower iris-diaphragm may be revolved, and is actuated by a rack-and-pinion, so that any degree of oblique illumination may be obtained. The condenser stage swings out, leaving an iris-diaphragm in the main stage. The upper iris is removable at will, and the entire substage is focused by a rack-and-pinion. The body-tube is graduated, and is made of aluminium to

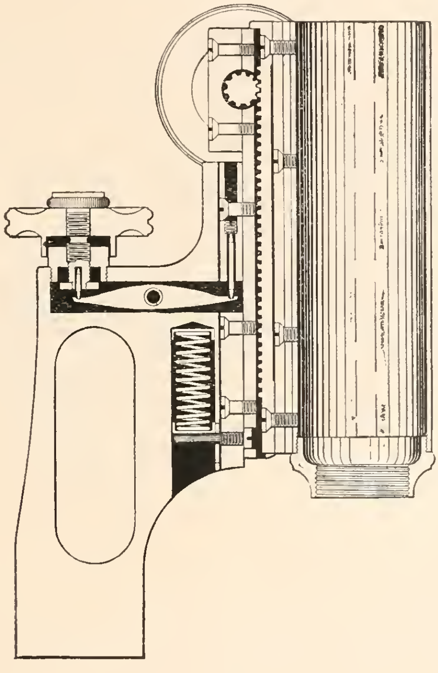


Fig. 42.

secure lighter weight; it is extra large for photomicrography. The lower collar is removable for attaching the Micro-Tessar objectives. The coarse-adjustment is by rack-and-pinion, and the fine-adjustment is by the new lever type. Each graduation on the micrometer screw-head, which is divided to give two speeds, equals 0·0025 mm. in vertical movement. The new lever fine-adjustment is shown in fig. 42. It is recommended as possessing no lateral motion, which in some types is observable after prolonged usage. The action is direct, and the response to the slightest turn of the micrometer-screw is immediate. The mechanism is entirely incased for the purpose of protection from dust.

The adjustment is controlled by the position of the fulcrum, and in the D D H the parts of the lever bear the relation of 2 to 1. The slide is very near the optical axis, the weight of the body-tube and optical parts only being moved, regardless of the length of the arm. This permits the use of larger stages without detriment to the fine-adjustment. With it, no force greater than the weight of the body-tube and its accessories is exerted on the cover-glass, for at the moment of contact the further movement of the screw has no action whatever upon the adjustment, and in this way damage is prevented.

Hensoldt's New Micrometer Microscopes.*—Fig. 43, numbered 48 in the makers' catalogue, illustrates an instrument intended for reading off meridian circles and geodetic instruments. The objective is achromatic, the flint lens being turned towards the graduation. The ocular is achromatic and orthoscopic. In order to give a maximum light-intensity the objectives are constructed of as diminished a focal length as possible; they thus require a weaker, and therefore less tiring, eye-piece. The micrometer-box is dust-proof, and the movement is destitute of dead-way. The measuring apparatus is double-threaded, and there are 5–10 teeth in the field of view, the drum being divided into 60, 100, or 120 parts. The illuminator is rotatory, to give maximum light, and the micrometer-screw has a movement of 0·25 to 0·3, or 0·5 mm.

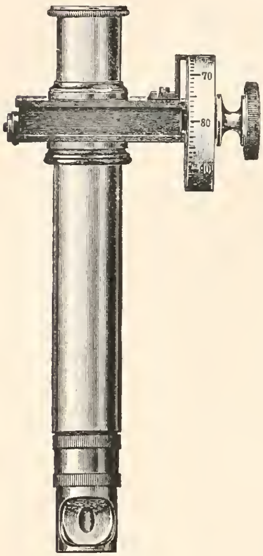


Fig. 43.

Application of Microscopes as a Means of Demonstration in Public Museums.†—G. Marktanner-Turneretscher, while fully cognisant of the difficulties arising from manipulation and expense which would attend the introduction of Microscopes into public museums, yet thinks that the interest which would be aroused by the observation of Microscopic objects deserves to be encouraged. He, therefore, discusses with considerable detail the principles which should underlie the construction of a museum Microscope. The instrument should be inclosed within a suitable glass case, in such a manner that the ocular protrudes. The object-stage should be rotatory and should carry at least twelve preparations: the rotatory apparatus should be controllable from the outside. The adjustment, as strong magnifications would never be required, should not be by micrometer-screw, but by sleeve-work with rack-and-pinion; he recommends a lever action in preference to milled-heads. There should

* Hensoldt and Sons, Wetzlar, Catalogue, Astronomische-Optik, pp. 7, 8.
† Museumskunde, v. pp. 39–42.

be a position-screw to prevent impact of the objective on the preparation. The author thinks, however, that there is much to be said in favour of a fixed tube and a movable object-stage, inasmuch as two tubes might then be fixed, for high and low powers respectively. Such tubes would be best placed at opposite ends of a diameter of the rotatory disk.

Bausch and Lomb's Pocket Dissecting Microscope Stand S.*— In designing this little instrument, fig. 44, compactness and convenience of carriage have been especially borne in mind. A stage attached firmly to the under side of the reversible cover holds the mirror set at the proper angle, together with a glass stage and a

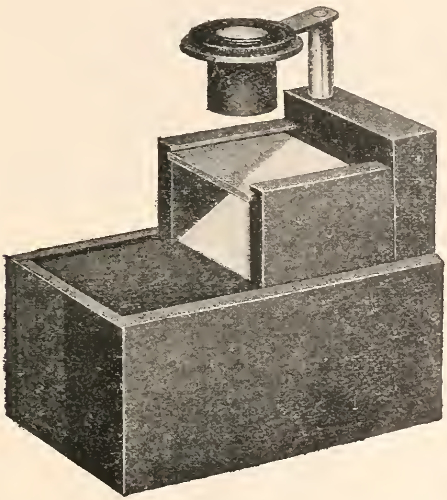


FIG. 44.

post for carrying the lens. A black and white metal plate is supplied with each instrument, and is to be placed over the mirror, according as a black or white background is desired. The lens is adjustable for focus on a metal post, and can also be used as a hand magnifier. The box is of mahogany, 45 × 65 × 102 mm., and can be easily carried in the pocket. The post and lens are removable, and fit in the box. The cover slides in a groove ; when right side up, it closes the box ; when under side up, after insertion of the metal post in its opening, the dissecting Microscope is ready for use.

Bausch and Lomb's Compound Erecting Body.†—This instrument (fig. 45) is intended for use as a dissecting Microscope. By means of two double-reflecting prisms the image from the objective is inverted,

* Bausch and Lomb Optical Co., Rochester, N.Y., Catalogue, Microscopes and Accessories, p. 49.

† Tom. cit., p. 57.

so that when seen through the eyepiece an object is viewed as seen with the eye—not inverted and reversed, as with an ordinary Microscope. The body is mounted on a jointed arm to permit examination over large surfaces, and has a post to fit any of the firm's dissecting stands.

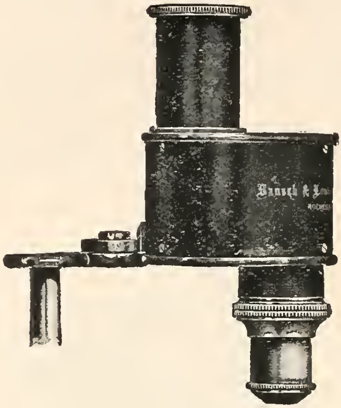


FIG. 45.

Koristka's Loup of Two Achromatic Lenses.*—In this instrument (fig. 46) the lenses are mounted in nickelled brass, and give a large flat field. The complete combination gives a magnification of ten

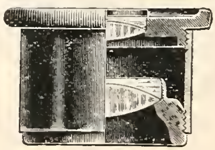


FIG. 46.

diameters, a field of 20 mm., and a frontal distance of 17 mm. By unscrewing the lower lens and operating only with the upper, a magnification of five diameters is attained, the field being 26 mm. and the frontal distance 27 mm.

MARX, H.—**Ein handliches Obduktionsmikroskop.**
Zeitschr. f. Medizinalb. Jahrg., xx. pp. 744–5.

PETRI, R. T.—**A. van Leeuwenhoek's Mikroskop.**
Natur. Wochenschr., xxii. (1908) pp. 1–7.

SCHERTEL, S.—**Der Bau des Mikroskops.** *Mikrokosmos*, i. (1907) hefte 1–2.

,, ,, **Uber frühere mikroskopische Forschungen und Bilder.**
Tom. cit., hefte 3–4.

SEIBERT, W. & H.—**Neues Stativ 5 C.**
Zeitschr. f. angew. Mikrosk., xiv. (1908) p. 85.

* F. Koristka, Milan, Catalogue xiii. (1908) Micrscopi ed Accessori, p. 77.

(2) Eye-pieces and Objectives.

Hensoldt's Micrometer-Oculars.*—These are manufactured with threaded insertions which can be cut to suit customers' instruments. Those described below are of a new type, and possess a notably increased field of view. The visible field is given by the angle under which the circumference of the field-diaphragm appears to the eye, and the real field of view is obtained by dividing the visible field by the telescope magnification. Fig. 47 is Hensoldt's orthoscopic micrometer-ocular. The visible field is about 42°, and the image is completely plane and achromatic. The optical combination consists of one double achro-

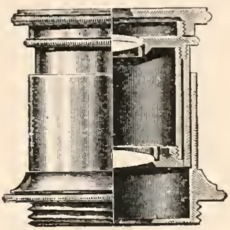


FIG. 47.

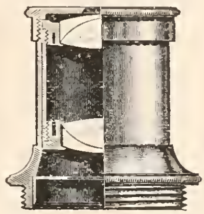


FIG. 48.

matic lens and a bi-convex lens. Fig. 48 is Hensoldt's euryscopic micrometer-ocular. Here the visible field is 45°, and the optical combination is two double achromatic lenses. The field is remarkably large, and absolutely colourless and plane. The image-point and eye-point are well separated.

(3) Illuminating and other Apparatus.

Koristka's Complete Apparatus for Macro- and Micro-projection.†
The maker's catalogue shows the arrangements for (1) the macroscopic projection of diapositives on glass; (2) macroscopic projection of opaque objects; (3) microscopic projection of liquid preparations; (4) microscopic projection of solid preparations. The last of these is reproduced here (fig. 49). The light source is a Schuckert lamp with a very sensitive regulator for maintaining absolute constancy at the light focus. The first condenser, the iris diaphragm, the second condenser and trough are easily recognised in the diagram. They are all carried on suitable supports sliding on an optical bench, and have adjustments for keeping the incident beam in the optical axis. The light is then ready for transmission on to the solid object on the Microscope stage, and thence on to the objective. To facilitate the exhibition of numerous slides, the makers have designed a disk pierced with sixteen excentric apertures. The disk is fitted with suitable clips so that sixteen preparations may be affixed in situ, and, the disk being pivoted, these preparations may be brought as rapidly into the field of view as desired. A second disk is

* Hensoldt and Sons, Wetzlar, Catalogue, Astronomische-Optik, pp. 5, 6.
† F. Koristka, Milan, Catalogue xiii. (1908) Microscopi ed Accessori.

provided, so that an assistant may equip it with slides and exchange it for the first disk at the proper time. It is recommended that the ocular be removed, and projection effected by a projection-objective alone.

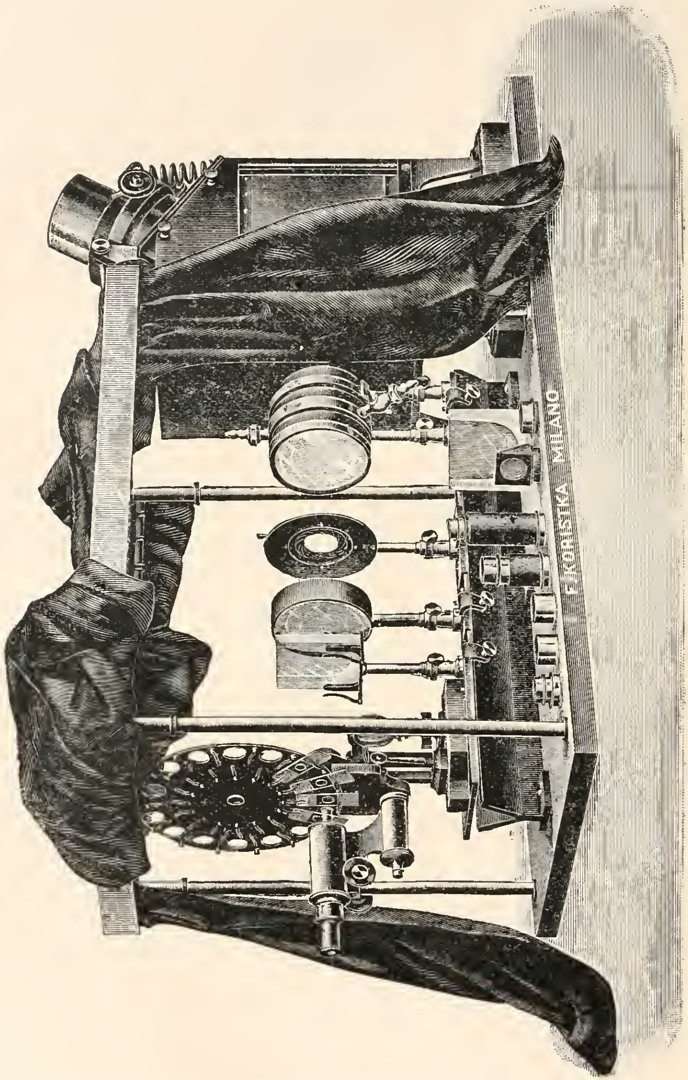


Fig. 49.

Koristka's Apparatus for Drawing with Weak Magnification.*— This apparatus, shown in fig. 50, consists of three distinct parts:

* F. Koristka, Milan, Catalogue xiii. (1908) Microscopi ed Accessori, p. 61.

the source of light in a metallic box fitted with a double condenser; a support for the separation and projection objective; and a reflecting-

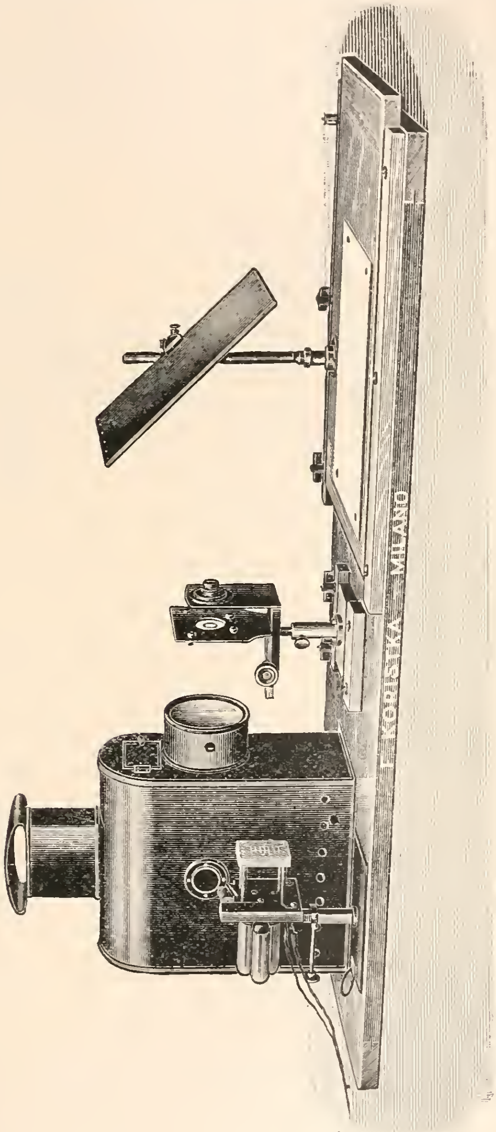
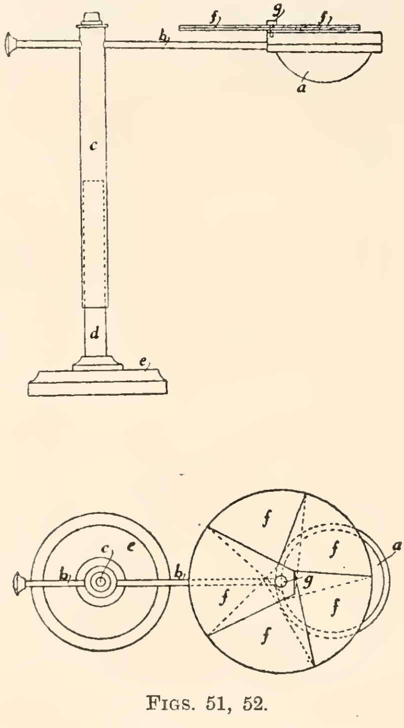


FIG. 50.

mirror fixed by a post to a sliding drawing board. The whole is mounted on a wooden base 1·3 by 0·5 m. The position of the mirror is variable, and a catch-spring marks the position of 45°. The projection and objective support slides between guides fixed to the base-board. The preparation-stage is adapted for the largest preparations, and the objective is focused by rack-and-pinion. The drawing-board is 40 × 50 cm. and the reflecting-mirror 20 × 28 cm. Microplanar projection objectives are recommended. The best source of light is a Nernst lamp with automatic regulation. The luminous intensity is about 700 candle-power with 110 volts; and 1400 candle-power with 220 volts. In the absence of electricity an incandescent gas-lamp is recommended.

Colour-disks for Microscope Condensers.* — R. Cleminson has invented a simple means of applying colour-disks to an ordinary con-



Figs. 51, 52.

denser so that the colours may be readily changed or varied. In the accompanying illustrations fig. 51 is a side elevation, and fig. 52 a plan view of a condenser of well known type provided with the colour-disks; *a* is the condenser itself secured to an arm *b*, carried by a tube or sleeve *c*, which latter is adjustably mounted upon a rod *d* supported by the base-plate *e*, while *f* represents strips of variously coloured

* English Mechanic, lxxxviii. (1908) p. 368 (2 figs.).

transparent celluloid, which are adapted to be moved in fan-wise fashion about a pivot-piece *g* screwed to the condenser rim. By moving one or more of these coloured strips over the condenser, the desired colour-effect upon the object may be attained.

Bausch and Lomb's Filar Micrometer.*—This micrometer (fig. 53) consists of a series of ruled lines 0·5 mm. apart, with every second graduation number up to ten in either direction from a long centre line. This scale is mounted with an eye-piece, and its position with reference to the edge of the image may be regulated by means of the milled head

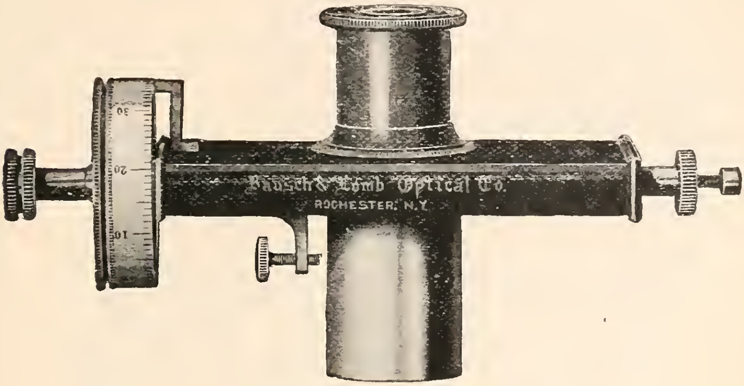


FIG. 53.

shown at the right in the illustration. A complete revolution of the micrometer-screw moves the cross-hair a distance of 0·5 mm. upon the scale.

Schmidt and Haensch's Special Episcope.†—This apparatus is intended for the projection of large illustrations, engravings, maps, etc., up to a magnitude of 40 × 40 cm.

As will be inferred from fig. 54, the apparatus essentially consists of a steel box containing an arc-lamp, a lens system, and a water-cooler. There is also an easily adjustable metal plate 65 × 65 cm.: also, two objectives in association with two plane front-silvered mirrors. A cloth curtain effectually screens any three sides, so that pictures, etc., may be introduced from any desired fourth side. The arrangement of the individual parts and the ray-path are shown in fig. 55. In order to attain an increased brightness of image two arc-lamps of 35 amperes are inserted, one behind the other. The second lamp and condenser are not visible in the figure, as they lie directly behind L_1 and K_1. This duplex arrangement is recommended as being more effective, and as requiring no greater consumption of current than in ordinary forms of such apparatus. To avoid unnecessary waste of light the rays after

* Bausch and Lomb Optical Co., Rochester, N.Y., Catalogue, Microscopes and Accessories, p. 61.

† Deutsche Mechaniker-Zeitg. (Nov. 1908) pp. 213–16 (2 figs.).

issuing from the water-cooler impinge upon the stage (40×40 cm.) and the object thereon. If it should be desired to make the illuminated area on the stage smaller and brighter, an additional condenser K_2 can

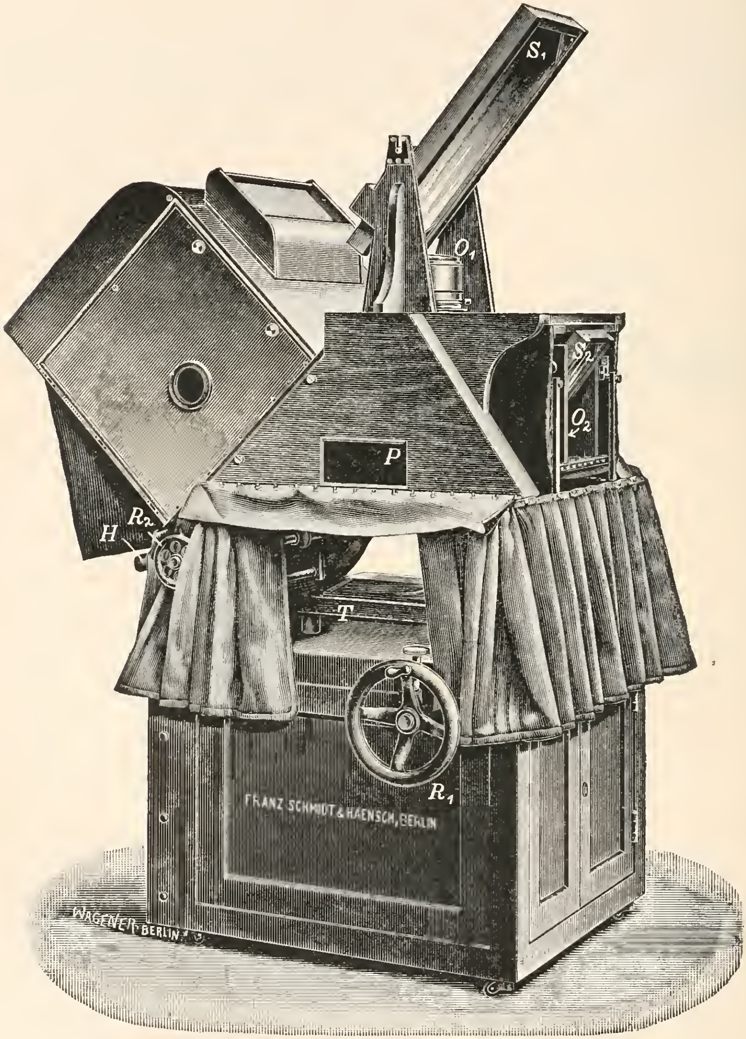


Fig. 54.

be pushed into the dotted position so as to parallelise the rays. Small adjustments of the two lamps are effected by the handwheel R_2. The rays reflected from the stage pass through the objective O_1, and, after impact on the front-silvered adjustable mirror S_1, are projected on to the screen. Sharpness of projection is attained by manipulation of the handwheel R_1 governing the objective. The magnification attained is 8 to 10-fold, and the images are 3·2–4·0 m. in diameter. A second objective of shorter focus is provided for the purpose of bringing out

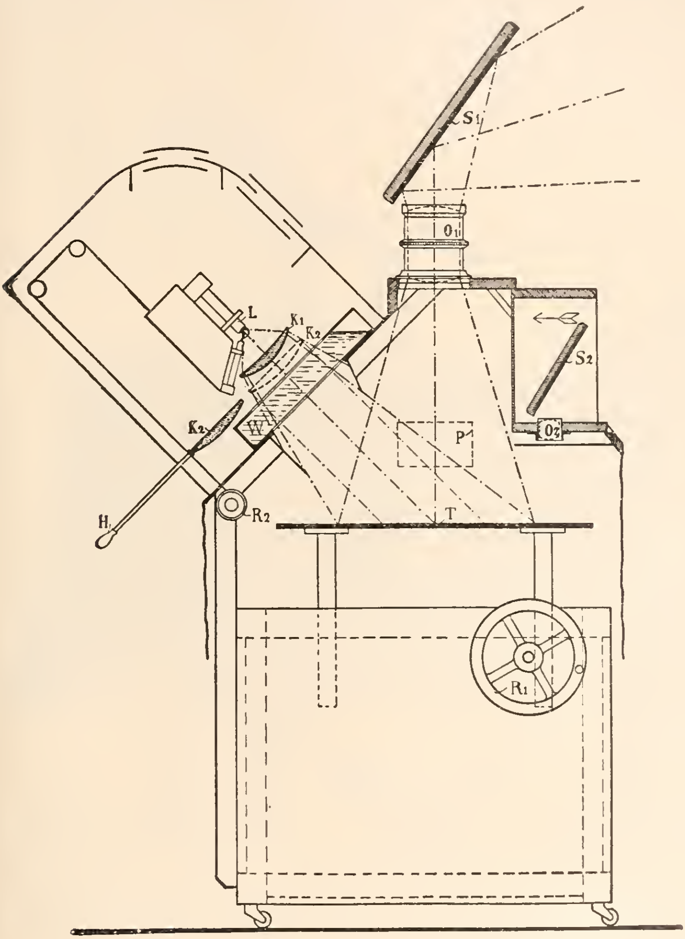


FIG. 55.

peculiarities of the larger pictures. This second objective O_2, fitted with a similar mirror S_2, is pushed into position in the direction of the arrow, and O_1 is thereby automatically put out of action. S_2 is so mounted that it forms its image in the same spot as S_1 does. P is a smoked-glass plate for convenient observation of the object on the stage. It has been thought best not to provide this apparatus with a contrivance for the projection of diapositives, as the convenience of the hand-movements would irretrievably suffer.

Diapositive projection, as well as the projection of physical experiments, is performed by Schmidt and Haensch's apparatus shown in fig. 56. A lever h_1 can insert a reflecting glass plate s_1, inclined at 45°, for receiving the light-rays coming from the source on the left.

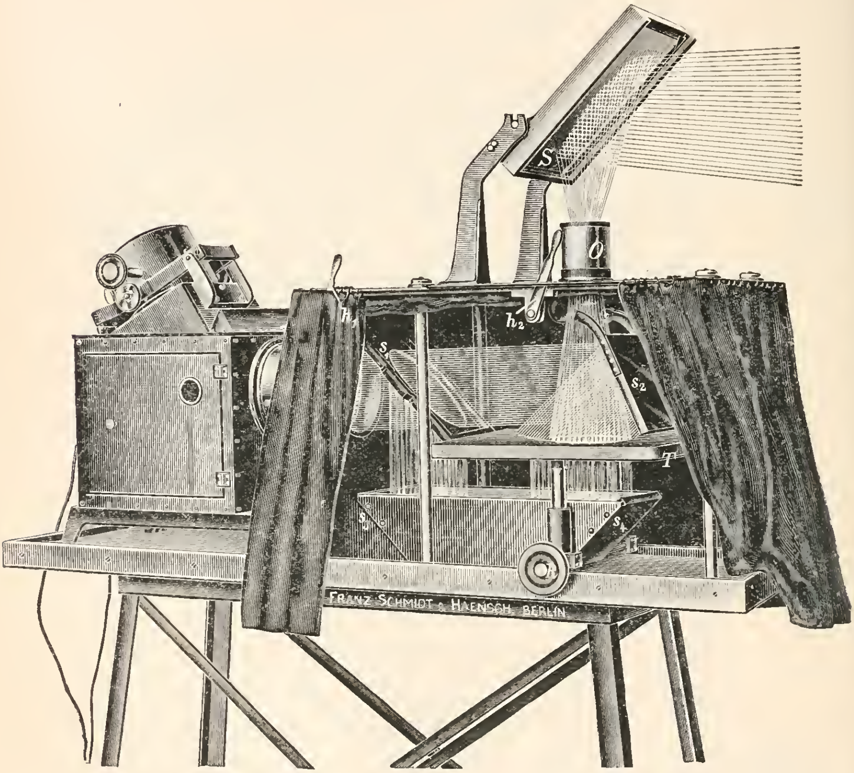


Fig. 56.

In consequence, most of this light is reflected downwards at s_1, and by means of mirrors s_3, s_4, impinges on the under side of the object placed on the stage at T. Some of the light, however, passes through s_1, and therefore illuminates the upper surface of the object at T. The effect is to bring out structural and inner details so that a much improved image, by help of the objective O and mirror S_1, is projected on the screen. If desired, a mirror may take the place of s_1, and the object would now be entirely illuminated from below. Or, again, the rays may fall directly on s_1, thus giving upper illumination only.

Krüsz's Epidiascope.*—This instrument is intended for the projection (1) of opaque objects in reflected light; (2) of transparent objects in transmitted light; (3) of physical investigations in the horizontal position with transmitted light; (4) of microscopic objects with the polarising Microscope; (5) of spectral, polarising, and interference phenomena with the optical bench. The light-source is an arc-lamp with a horizontal positive carbon and a vertical negative carbon. The lamp is adjustable on runners. The light-rays emanating from the crater B (fig. 57) are collected by the condenser K, and issue therefrom, according to the position of the lamp, as a parallel, slightly divergent, or convergent beam. The rays then pass through the

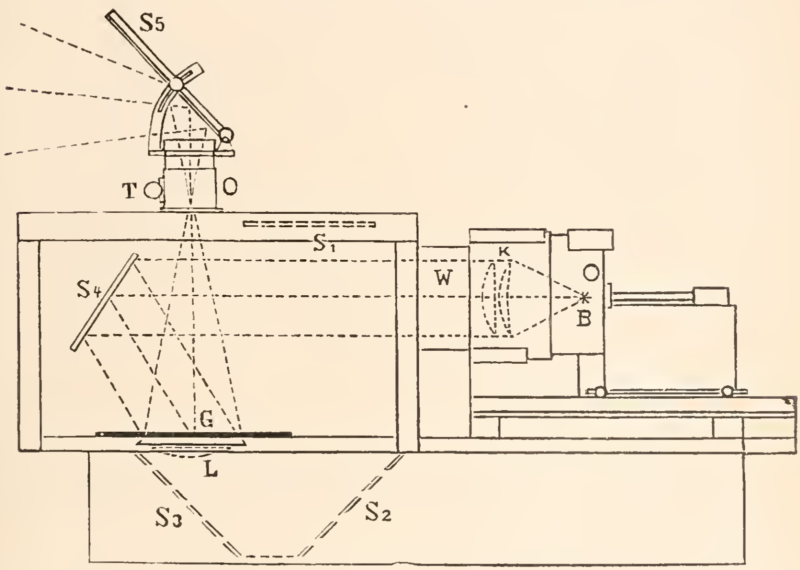


Fig. 57.

cooling-trough W. Two mirrors, S_1 and S_4, are placed under the upper plate of the apparatus. When the projection of opaque objects is required, as in fig. 57, the mirror S_1 is put out of action, and the rays, after impinging on S_4, are reflected on to the stage, which by means of an inserted board now form an unbroken plane. The illuminated object on the stage is focused through the objective O, on to the adjacent reversing-mirror S_5, and thereby projected on to the screen. The stage of the apparatus is large enough for the reception of drawings and pictures with a breadth of 60 cm. and with any desired length. When the apparatus is wanted for the projection of transparent objects, the mirror S_1 is brought down into the position shown in fig. 58, so as to receive the incident light, and the rays take the direction shown by the dotted lines. After reflexion at S_1 the rays pass through an aperture

* Deutsche Mechaniker-Zeitg. (Sept. 1908) pp. 166–8 (2 figs.).

in the stage-floor on to the mirror S_2, whence they pass on to the mirror S_3, and thence from the lens L on to the object D. The light, after transmission through the transparent object D, has the same course as for the projection of the opaque object. For physical de-

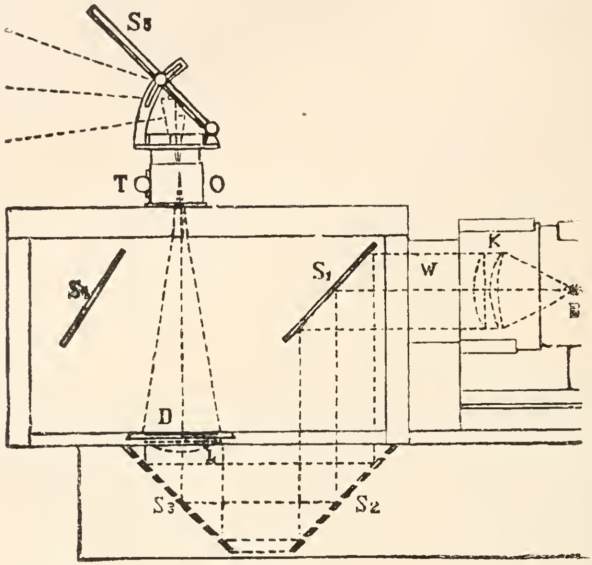


FIG. 58.

monstrations both the mirrors, S_1 S_4, are put out of action, the front wall of the apparatus is folded down, and direct projection is made on to the screen.

EVATT, EV. J.—**The Cameragraph: a Drawing Apparatus.**
Journ. Anat. Physiol., ser. 3, iii. No. 42 (1908) pp. 335–6 (1 fig.).

FRANCÉ, R. H.—**Das Zeichnen mikroskopischen Objekte.**
Mikrokosmos, ii. (1908–9) hefte 1–2.

HEINSTÄDT, O.—**Spiegelkondensor u. paraboloid.**
Zeitschr. wiss. Mikrosk., xxv. (1909) pp. 188–94.

SIEDENTOPF, H.—**Spiegelkondensoren.**
[Polemical writings as to priority of invention of mirror condensers and paraboloids.] *Tom. cit.*, pp. 195–8.

SIEDE, W.—**Hilfsapparate des mikroskopischen Zeichnens.**
Mikrokosmos, ii. (1908–9) hefte 1–2.

(4) Photomicrography.

Contribution to the Theory of the Photographic Web.*—H. Calmers and L. P. Clerc, in discussing the above theory, deal with a

* Comptes Rendus, cxlvi. (1908) pp. 905–7 (2 figs.).

chequered web formed of two systems of parallel and opaque equidistant bands, whose width equals that of the transparent intervals, the bands intersecting at right angles and so forming square transparent meshes. If such a web is placed a short distance in front of a sensitive photographic plate inside a suitably constructed apparatus, the diaphragm in the objective projects behind the web cones of full light, and cones of pure shadow connected by a zone of varying penumbra. It is possible to determine the variations in the illumination of the sensitive plate when the diaphragm is subject to ordinary conditions, that is when the diaphragm presents a square aperture whose diagonals are parallel to the bands of the web, the dimensions being such that the plane of the sensitive plate contains the vertices of the cones. This will be the case when the ratio of the diagonal of the mesh to the distance between the web and the plate equals the ratio of the side of the diaphragm to the extension of the camera. In the absence of the web and after focusing, the diaphragm seen from any point of the web-plane appears to be a luminous surface of uniform brightness, the said brightness being proportional to that of the point conjugate to the object-point at which we supposed the eye placed. The light-beam illuminating each point π is limited by the pyramid having π for vertex and the contour of the diaphragm for base. Owing to the interposition of the web, there will be a reduction of the illumination at π if the opaque bands of the web which impinge on this pyramid, reduce the useful section of the beam by the plane of the web. This section can be taken as a measure of the illumination. The authors show that the curves of equal illumination (isophotic curves) take the forms of circles and of equilateral hyperbolas. They also show that a knowledge of these curves renders possible a previous determination of the web-image at a given part of the sensitive plate.

Advances in Photomicrography and Projection.*—In the Jahrbuch für Photographie und Reproduktionstechnik für das Jahr 1908, G. Marktanner-Turneretscher summarises, with his usual thoroughness, the most important contributions to photomicrography and projection, published in the scientific journals of different countries. The results are classified under the headings of : (*a*) Mikrophotographie ; (*b*) Projektion ; (*c*) Kinematographie.

JENCIC, A.—**Ein wichtiger Fortschritt der mikroskopischen Beleuchtungmethoden.** *Allgm. Zeitschr. f. Bierbr. u. Malzfabrikat.*, xxxvi. (1908) pp. 179–82. (6 figs.)

(5) Microscopical Optics and Manipulation.

Brownian Movements.†—J. Perrin, in commencing his article on the above subject, reminds his readers that every particle situated in a fluid in equilibrium, is in a condition of continuous and quite irregular agitation in proportion to its minuteness. Gouy has shown that this eternal agitation is an essential property of fluids, and has suggested a very attractive explanation, by supposing that it is a visible consequence of

* Edited by Dr. J. M. Eder. Halle : W. Knapp ; also separately as a pamphlet.
† Comptes Rendus, cxlvi. (1908) pp. 976–70.

molecular shocks acting irregularly against the particles. J. Perrin now describes experiments which he believes prove that molecular movement is indeed the real and only cause of Brownian motion. He obtained an emulsion of gamboge, and found it full of microscopic particles exhibiting active Brownian movement. By centrifuging this emulsion he obtained a finer emulsion, from which, although unchanged to outer appearance, the microscopic particles had disappeared, leaving ultra-microscopic spherical particles (or granules) in their place. He studied the distribution of these particles at various levels, and, as the result of averaging several thousands of readings, he found that if the concentration of particles at a certain level be represented by 100, it is represented at levels 25, 50, 75, and 100 microns lower by numbers closely approximating to 119, 142, 169, 201, which are in geometrical progression. This leads to the conclusion that the distribution of equilibrium of these particles in the gamboge emulsion, and probably in every other colloidal solution, resembles those of a gas in equilibrium under the influence of its own weight. But in this case reduction to half-density, which in the atmosphere requires an elevation of six kilometres, here requires one-tenth of a millimetre. By further experiments, involving minute measurements, he showed that the osmotic pressure exerted by these particles corresponds, within the limits of experimental errors, to the laws of gaseous pressure. Thus the spherical particles in suspension act as visible molecules of a perfect gas. The mean kinetic energy of a granule of a colloid is thus equal to that of a molecule.

E. E. Fournier d'Albe,* in summarising the present state of knowledge on this subject, remarks that if particles one-tenth of a micron in size could be observed, the conditions would be favourable for observing Brownian motions in gases themselves.

Aberration of Sloped Lenses, and their Adaptation to Telescopes of Unequal Magnifying Power in Perpendicular Directions.† — Lord Rayleigh, in treating the above subject, divides his paper into two parts, which are, to a large extent, independent. The first part deals with mathematical aspects of the question, while the second discusses the advantage which often attends a magnification unequal in different directions, and describes the methods available for obtaining it. Among these methods is that of the sloped object-lens. Such sloping introduces in general unsymmetrical aberration, and the intention of the first part is largely to show how this may be minimised so as to become unimportant.

It is a common experience in optical work to find the illumination deficient, when an otherwise desirable magnification is introduced. Sometimes there is no remedy except to augment the intensity of the original source of light, if this be possible. But in other cases the defect may largely depend upon the manner in which the magnification is effected. With the usual arrangements magnifying takes place equally in the two perpendicular directions, though perhaps it may be required in only one

* English Mechanic, No. 2285 (1909) p. 529.

† Proc. Roy. Soc., lxxxi. No. A 544 (July 1908) pp. 26–40.

direction. For example, in observations upon the spectrum, or upon interference bands, there is often no need to magnify much, or perhaps at all, in the direction parallel to the lines or bands. If, nevertheless, we magnify equally in both directions, there may be an unnecessary and often very serious loss of light. The author has found the use of a cylindrical lens (e.g., a glass rod, 4 mm. in diameter), give a very high magnification in one direction, and it appeared that the combination of such an eye-lens with a sloped object-lens constituted a very satisfactory solution of the problem. After the reading of the paper before the Royal Society, the author found that use of cylindrical lenses had been previously made by Rudolf, Lippich, and S. P. Thompson, though with differences in detail.

(6) Miscellaneous.

Quekett Microscopical Club.—The 454th Ordinary Meeting, which was also the 43rd Annual General Meeting, was held at 20, Hanover Square, W., on Friday, February 5, 1909, the Right Hon. Sir Ford North, F.R.S., Vice-President, in the chair. Mr. F. W. Watson Baker, F.R.M.S., for Messrs. W. Watson and Sons, Ltd., gave a demonstration on "The Making of a Microscope Objective." The chief exhibits were—Examples of optical, flint- and crown-glass, with pieces "slit" ready for working. An optical-worker's lathe, at which the preliminary stages in the production of a lens were carried out. At another bench the final figuring and polishing of a high-power "front" were shown, together with examples of "proof-plates," which take the place of the old-fashioned templates. The 43rd Annual Report of the Committee was read by the Hon. Sec., and the Hon. Treasurer presented his Report for the year 1908. The officers elected for the year 1909 are the same as for 1908. Dr. Duncan J. Read, M.B., C.M., gave a lecture on "A Method of Estimating the Exposure required in Photomicrography with Axial Cone Illumination." With a given class of subject and with known N.A. and magnification, the correct exposure is obtained experimentally. A table is constructed for this N.A., calculated for other magnifications in the usual method. When employing other N.A. it is necessary to measure this immediately before making the exposure, and to apply a correction from a second table. The N.A. may be obtained as follows: Measure the diameter of the Ramsden disk of the ocular. Multiply half this diameter by the magnifying power of the ocular, and divide by the focal length of the objective. This gives the required N.A.

The 455th Ordinary Meeting was held on March 5, Dr. E. J. Spitta, F.R.A.S., F.R.M.S., Vice-President, in the chair. A paper on "The Structure of the Eye Surface, and the Sexual Differences of the Eyes in Diptera," communicated by Mr. W. Wesché, F.R.M.S., was read by Mr. F. J. Perkes. Mr. T. B. Rosseter, F.R.M.S., gave an account of some recent work on the genus *Hymenolepis* (avian tapeworms), and described a new species, *Hymenolepis accicula-sinuata* sp. n., taken from *Anas boschas fera*. This will be fully described and figured in the next issue of the Journal of the Quekett Microscopical Club.

B. Technique.*

(1) Collecting Objects, including Culture Processes.

Media for Detection of Bacillus coli in Drinking-water.†—G. E. Gage finds that lactose-neutral-red broth is a good means of making presumptive tests for *Bacillus coli* in drinking-water, but the test must be limited; the author's results are based on a reaction which calls for 25–30 p.c. gas formation with reduction of the neutral-red, three days being allowed for a complete reaction.

The bile-salt broth of MacConkey and Hill gives a reaction in a shorter time, but not so readily when only a few colon bacilli are present. Smith's solution of ordinary broth with 1 p.c. dextrose does not give such uniform results, and does not exclude organisms which have the power to ferment glucose. In using Endo's medium, forty-eight hours must be allowed for a complete reaction; a pink or light red coloration is not sufficient; if in forty-eight hours dark red colonies show up, *B. coli* may be assumed to be present. Lactose-litmus-agar is not very useful for plating the organisms, since it does not react readily to the smaller traces of acid produced by different strains of the colon bacillus.

Filtration of Agar through Glass-wool.‡—Th. Porodko finds that the velocity of filtration of agar solution through glass-wool is greater than through filter paper, and that the transparency of the solution is 80–90 p.c. greater: but for the thin layers generally used in plates and tubes this difference of transparency is not appreciable.

Simple Medium for Gonococcus.§—Piorkowski states that on a medium of the following composition, gonococcus grows well and keeps alive for 8 to 12 days, and further mentions that pneumococcus and meningococcus thrive therein:—To a litre of fresh milk are added 5 c.cm. of dilute hydrochloric acid (1 : 4), and incubated at 37° C. until all the casein has precipitated (16 to 20 hours). Or instead of this the milk may be boiled. The filtrate is neutralised with 10 p.c. soda solution and then boiled in a steam bath for a couple of hours, after which it is neutralised again and filtered. The medium is now distributed into flasks or test-tubes and sterilised at 100° C. for one hour. With this stock a fluid medium may be made by mixing with equal bulk of broth or a solid medium with agar (1 : 2).

Should any casein subsequently separate out from the stock, the supernatant clear fluid should be teemed off and mixed with broth or with agar liquefied at from 40–50° C.

Cultivating Amœbæ and Anguillulæ for Class Work.‖—A. Le Dantec obtains amœbæ by tearing up pieces of moss by the roots and

* 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., xlviii. (1908) p. 280.

‡ Op. cit., 2te Abt. Orig., xxi. (1908) p. 424.

§ Münchener Med. Wochenschr., 1908, p. 735.

‖ C.R. Soc. Biol. Paris, lxvi. (1909) p. 237–8.

floats them on a beaker filled with water, and then incubates them at 35°. After 3 or 4 days a culture of amœbæ and bacteria is found on surface. After a few more days the amœbæ are found in the encysted stage. To obtain anguillulæ the droppings of guinea-pigs or a mixture of the droppings of guinea-pigs and rabbits are floated on the surface of water in a vessel so as to make a continuous layer. After an incubation at 35° of from 8 to 10 days, if the surface of the crust be scraped and examined under the Microscope, anguillulæ will be easily detected.

Differential Reaction for Bacillus coli communis and Bacillus typhosus.*—Lippens finds that *Bacillus coli* exerts a biochemical action on blood, and uses this to distinguish this bacterium from *B. typhosus*; 2 c.cm. of physiological salt solution are placed in two test tubes and then two drops of centrifuged and washed red corpuscles of the horse. To the one tube is added 1 c.cm. of a young broth culture (24 to 48 hours) of the typhoid bacillus, and to the other a culture of *B. coli.* The mixtures are shaken and placed in a rack. In 5 or 6 minutes the reaction begins to show itself at the bottom of the *coli* tube, where the mixture assumes a vinous violet hue. The reaction reaches its maximum in 10 to 15 minutes, after which it fades away. The typhoid tube remains unaltered. After having been placed in the rack the tubes must not be handled or shaken. The paratyphoid and paracoli bacilli give intermediate results.

(2) Preparing Objects.

Studying the Development of Cecidomyidæ.†—W. Kahle found that fixing the larvæ whole was useless. He therefore ripped up the mother-larvæ from head to tail with a needle; this was done under a dissecting Microscope, the insect being placed in salt solution. The eggs or embryos were then transferred by means of a capillary pipette to the following fixatives: either formol-alcohol-acetic acid (30 parts water, 15 parts 96 p.c. alcohol, 6 parts formol, and 1 part acetic acid), or Flemming's fluid. The former was allowed to act for 5 hours, the latter for 24 hours or more. The fixative is placed in a small tube, the mouth of which is covered with gauze. After fixation is ended, the fluid is removed by diffusion in upgraded alcohols. When dehydrated, the preparations are transferred to a glass cube, with a concave floor, by means of a camel-hair brush. In this is placed a mixture of alcohol and oil of cloves. Oil of cloves is added drop by drop until the fluid in the cube is approximately pure oil of cloves. The next step is to remove the objects to a mixture of equal parts of oil of cloves and collodion dissolved in ether, and thence to a glass plate, on which they are oriented under a binocular dissecting Microscope. They are next treated with xylol for 12 hours, and then, together with the glass plates, imbedded in paraffin; the plates are afterwards easily removed by immersion in water. The sections were stained with carmin, anilin dyes, and hæmatoxylin, of which Heidenhain's method proved the best. En masse staining was best done with acid-carmin; such preparations were either mounted in resinous or aqueous media.

The author, at the conclusion of his remarks on technique, mentions

* C.R. Soc. Biol. Paris, lxvi. (1909) pp. 95-6.
† Zoologica, xxi. (1908) No. 55, 80 pp. (6 pls. and 38 figs.).

that he eventually found in aceton a medium for fixing the larvæ without dissection, as in the foregoing procedure. After an immersion of 2 to 3 hours, the larvæ were transferred to 50 p.c. alcohol.

Preparing Disease-carrying Insects.*—A. E. Hamerton first strips off some pieces of the chitinous wall of the head, thorax, and abdomen and at once immerses the insect in the fixative, or dissects out the parts to be examined in the fixative. After an immersion of from 1 to 6 hours the material is transferred to 60 p.c. alcohol. A good fixative is picro-acetic acid (saturated solution of picric acid 100, acetic acid 1), which must be washed out with alcohol; it is more rapidly extracted with warm alcohol to which a little lithium carbonate has been added.

Other useful fixatives are :—1. Saturated solution of sublimate, with 2 p.c. glacial-acetic acid. 2. Absolute alcohol 1, glacial-acetic acid 1, chloroform 1; sublimate to saturation; time, a few seconds to a few minutes. As soon as the objects become opaque, they are transferred to 70 p.c. alcohol. 3. Flemming's solution; time, one to many hours or days; the fixative must be thoroughly washed out in running water.

The next step is to dehydrate in upgraded alcohol, from 10 to 100 p.c. The object is then imbedded; into a test-tube is poured sufficient cedar-wood oil to cover the object, and on the top of the oil a thin layer of absolute alcohol. The dehydrated tissue is then placed on the layer of alcohol, and when it has sunk to the bottom of the tube it is left for ½ hour or so in paraffin of low-melting point, say 50° C. A second paraffin bath is advisable; time of saturating, 1 to 3 hours. When quite soaked with paraffin, a block is made as follows. Place a thin layer of glycerin in a Petri dish and heat slightly over a spirit lamp; then pour over the glycerin a thin layer of the melted paraffin: and when this is beginning to solidify, pour in the rest of the paraffin, together with the pieces of tissue, and arrange them with a hot needle. Immerse the Petri dish in cold water, and then the paraffin cake will float off. Blocks are then cut out and trimmed for the microtome.

When dealing with chitinous structures, the material, after washing out the fixative, should be boiled gently for about 1 hour in 10 p.c. KHO.

For studying the mouth-parts of biting insects, the following procedure for keeping the component parts in their natural position is given. Take four small test-tubes. In tube i. make a saturated solution of gum-acacia in ether. In tube ii. make a thick syrupy solution of celloidin in ether. Mix the contents of these two tubes in equal quantities in tube iii. When proceeding to cut sections, take another tube, iv., and put into it 2 c.cm. of ether and a few drops of absolute alcohol. Then with a camel-hair brush moistened in water take a drop or two from tube iii. and mix it well with contents of tube iv. With this mixture paint the surface of the paraffin block after cutting each section. When fixed to the slide these sections must be treated with ether to remove the celloidin.

The sections are stuck on the slides by Mayer's albumen method, stained with Grenacher's alcoholic-borax-carmin, Delafield's hæmatoxylin, or Heidenhain's iron-alum-hæmatoxylin, and mounted in balsam.

* Journ. Roy. Army Med. Corps., xi. (1908) pp. 243–9.

Studying Spermatogenesis in Acrididæ and Locustidæ.*—H. S. Davis dissected out the testes in 0·6 p.c. salt solution, and placed them at once in the fixative. Many fixatives were tried, but only one, viz. Hermann's platino-aceto-osmic was much used, though in a few cases Flemming's fluid was adopted. After immersion in the fixative for from 1 to 2 hours, the testes were passed through alcohol and imbedded in paraffin. The best staining results were obtained from iron-hæmatoxylin, preceded by Bordeaux R. The sections were immersed in 1 p.c. Bordeaux R for 24 hours, then in the iron-alum for 1 or 2 hours, then in the hæmatoxylin for from 4 to 6 hours. It was necessary to dehydrate very rapidly, as Bordeaux R is very solvent in alcohol.

Studying Fat-absorption in the Intestine.†—G. E. Wilson fed guinea-pigs on egg-yolk diluted with tap water, or with olive oil. At suitable intervals the animals were killed, and pieces removed from the duodenum. The pieces were placed in the following fluid: 0·1 p.c. chromic acid 15 parts; 2 p.c. osmic acid 4 parts; glacial acetic acid 1 part, for about 12 hours. On removal the pieces were washed in running water for half an hour, and then in upgraded alcohols from 50 p.c. to absolute, this hardening and dehydrating stage taking about 132 hours. The pieces were imbedded in paraffin or in celloidin. The sections were stained with iron-alum, hæmatoxylin, and eosin, or with scarlet (scharlach R). The scarlet should be dissolved in 70–80 p.c. alcohol, shaken up from time to time and filtered. It should then be tested on a slide with olive oil, when, if good, a deep red reaction ensues in about a minute. For this dye the intestine may be fixed in formalin, and frozen sections used. The scarlet solution is allowed to act for about 45 seconds, and then, after a few seconds in tap water, the section is mounted in glycerin.

Studying the Chorda-cartilage of Urodela.‡—F. Krauss fixed the material in picro-sublimate-acetic-acid and in Carnoy's fluid, and stained the paraffin sections with kresyl-violet RR. This dye, which is a metachromatising pigment, stains cartilage and also mucin a rose colour, while the nuclei are blue. It was found better, however, to stain the nuclei with hæmalum. Care must be taken to dehydrate rapidly, as alcohol extracts the kresyl-violet rapidly. Methylen-blue and Bismarck-brown were also used. To the methylen-blue a little hydrochloric acid was added, and the stain fixed with molybdanate of ammonia. A triple combination of borax-carmin, Bismarck-brown, and light-green, gave effective pictures.

Demonstrating Hepatic Glycogen.§—N. Fiessinger fixes pieces of liver for 24 or 48 hours in 95 p.c. alcohol, and then immerses them in 10 p.c. tannin for half an hour to one hour, according to their thickness. They are then removed to 2 p.c. bichromate of potash for about 10 minutes. The pieces may then be washed, imbedded, and sectioned without risk of dissolving out the glycogen. The sections are stained with anilin oil-safranin, differentiated in alcohol, and mounted in balsam.

* Bull. Mus. Comp. Zool. Harvard, liii. (1908) pp. 59–158.
† Trans. Canadian Inst., viii. (1906) pp. 241–58 (2 pls.).
‡ Arch. Mikr. Anat. u. Entwickl., lxxiii. (1908) pp. 69–116 (3 pls.).
§ C.R. Soc. Biol. Paris, lxvi. (1909) pp. 182–4.

The glycogen stains bright red, the nucleus pink and the cytoplasmic framework pale yellow. Two disadvantages of the procedure are mentioned, viz., the induration of the pieces and the superficiality of the tanning. The tanning even of thin pieces is often limited to the outer layers. In cutting the sections this must be borne in mind.

Carbon-dioxide for Killing Marine Animals.*—A. G. Mayer fills a siphon-bottle with sea-water and charges this with carbonic-acid gas by means of the "sparklet-bulb." The charged sea-water is then poured into a vessel containing sea-water in which the marine animals are living, and in a few moments they are completely narcotised and may then be killed in a fully expanded state by the addition of some fixative. In the case of Siphonophoræ the CO_2 should be followed by the addition of a small quantity of chloretone to prevent the swimming-bells from being cast off.

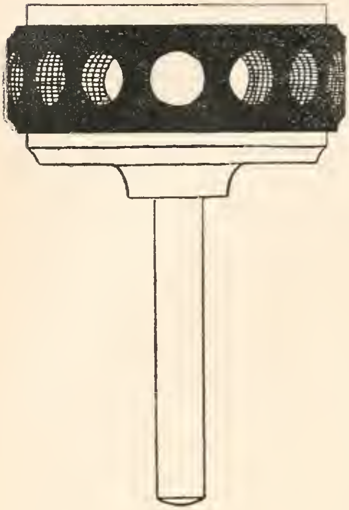


Fig. 59.

(3) Cutting, including Imbedding and Microtomes.

New Freezing-stage for the Zimmermann Microtome.† — M. Wolff, having been disappointed by the results of freezing with liquid carbonic acid, tried a spray of ethyl-chloride, and was surprised beyond expectation with the result. He experimented with a block 3 mm. high of *Angioma* freshly fixed in 10 p.c. formol with a section-plane of 2 cm. square. The freezing proceeded successfully in spite of the high temperature (19° C.) of the room. He applied the block to a Zimmermann microtome, and in one minute had cut so many sections (thickness 9 to 12 μ) that only 1 mm. of the block-height remained. The value of the ethyl-chloride expended was only 15 pfennige. This result encouraged the author to design a freezing-chamber specially adapted for ethyl-chloride, and his design (fig. 59) was executed by the firm of E. Zimmermann, Leipsic. His freezing-plate is, in contrast to the plates of the paraffin-stage, provided with concentric grooves. It has somewhat of the shape of a pill-box lid; its underside faces the interior of the apparatus, and is bored out cylindrically. The underside is covered with a coarse fibrous material for receiving the ethyl-chloride which would otherwise drop off. This freezing-plate is now screwed on a vulcanite ring connected with the usual stage carrying the footpiece clamped into the object-holder. The vulcanite ring is pierced with fifteen sufficiently large perforations through which the chloride spray can, in every position of the chamber, be directed on to the

* Biol. Bull., xvi. (1908) No. 1, December.
† Zeitschr. wiss. Mikrosk., xxv. (1908) pp. 169–84 (4 figs.).

underside of the freezing-plate. The objects, fixed in 10 p.c. formol, are left in running water for two hours to wash out the fixing medium, and then, rinsed with distilled water, are applied to the freezing-plate. Even with a room-temperature of 21° C. blocks of 3 × 10 × 20 mm. will then remain frozen for five minutes. The after-freezing from the chloride-saturated fibrous layer supplies an additional and very welcome protection from the heat produced in working the microtome. Four grammes only of ethyl-chloride were found sufficient to produce the regelation described, and sometimes under favourable circumstances smaller quantities answered the purpose.

(4) Staining and Injecting.

Staining Spirochæta pallida in Smears with Largine.* — P. Ravaut and A. Ponselle describe their method of staining *Spirochæta pallida* by means of albuminate of silver. It is well known that the *Spirochæta* is stainable in sections by the silver method, whilst its demonstration in films is attended with difficulty. The authors have tried various trade preparations of albuminate of silver, but have obtained successful results only with Largine (Lilienfeld). They fix the smear with osmic acid vapour, with a mixture of osmic acid and bichromate, or chromic acid, and also merely with methylic-alcohol. The Largine solution consists of 2–100 grm. of distilled water. It should be fresh and kept in yellow bottles.

The fixed films are immersed in the Largine solution and incubated at 55° for two hours. Borrel's bottle is used, as it prevents evaporation. The slide is then transferred directly to a bath of 5 p.c. pyrogallic acid for a few minutes: it is advisable to pass the slide into a second bath for cleansing. The slide is then washed in distilled water, after which comes a second bath in Largine for half an hour, and this is followed by pyrogallic acid. It may then be examined. One of the features of this method is that all the microbes are stained. The authors admit that the films lose colour in a few weeks.

Fat-granules of Bacteria.†—P. Eisenberg describes very fully his experiments on *Bacillus anthracis* and *B. tumescens* with numerous pigments in order to demonstrate the presence of fat-granules. The paper is illustrated by two coloured plates, showing the effect of these dyes on the bacteria. The specimens were drawn under a magnification of 3000 diameters. In the bibliography there is no mention of Shattock's demonstration of fat in *B. mallei* quite ten years ago.

Demonstrating Bacillus tuberculosis in Cerebrospinal Fluid.‡ Manicatide draws off 20–80 c.cm., or even more, of the fluid by lumbar-puncture into sterilised test tubes, which are left for 6 to 24 hours. The delicate clot which always forms is then fished out with a platinum needle, spread out on a slide, and carefully teased out. The film is then fixed and stained in the usual way. The examination of the slide may be tedious and lengthy, but the results claimed by the author for his method are very satisfactory and definite.

* C.R. Soc. Biol. Paris, lxv. (1908) pp. 438–40.
† Centralbl. Bakt., 1te Abt. Orig., xlviii. (1908) pp. 257–74 (2 pls.).
‡ C.R. Soc. Biol. Paris, lxv. (1908) pp. 523–5.

Demonstrating Chondriosomes.*—F. Meves, when examining for the chondriosomes in the cells of fowl-embryos from the second half of the first to the beginning of the fourth day of incubation, fixed the material on the following modification of Flemming's fluid :—½ p.c. chromic acid with addition of 1 p.c. common salt, 15 c.cm. ; 2 p.c. osmic acid, 3–4 c.cm. ; acetic acid 3–4 drops. The sections were stained with iron-hæmatoxylin, and also by Benda's crystal-violet method. Successful staining by the latter method was attained with objects fixed in Flemming, even though the preparatory treatment advised by Benda (pyroligneous acid, 1 p.c. chromic acid, and 2 p.c. potassium-bichromate), were omitted.

Staining Treponema pallidum.†—T. G. Perrin allows a drop of blood to dry on a slide. This done, the film is treated with acetic acid-alcohol (absolute alcohol, 10 c.cm. ; acetic acid, 10 drops). This fixes the treponemes and leucocytes and dissolves out the hæmoglobin. The film is then stained by Giemsa's or other method. For staining the parasite in tissues, the material is fixed by immersion for 24 hours in the following fluid : formol, 10 c.cm. ; water, 100 c.cm. ; ammonia, 5 drops. After, the pieces are washed in water for several hours and then transferred to 15 p.c. silver-nitrate and incubated at 35° for six days. The blocks are now washed in distilled water and then immersed for 24 hours in the following reducer :—pyrogallic acid or hydroquinone, 1·5 grm. ; formol, 8 c.cm. ; water, 100 c.cm. On removal, they are washed in distilled water and then hardened in upgraded alcohols before imbedding in paraffin.

The author also gives a useful recapitulation of numerous other methods for staining spirochætes.

New Method of Nerve-cell Staining.‡—E. and Therese Savini use borax-methylen-blue prepared in the following way. A flask holding 200–250 c.cm. and made of glass which will stand sudden cooling with water, with a well fitting cork or stopper is used. Into this are poured 1 grm. medically pure methylen-blue, 4 grm. borax crystals, and 100 c.cm. of distilled water. The flask, without the stopper, is then placed in a water bath and boiled for half an hour. It is then removed, the stopper inserted, and cooled down with a stream of water, being shaken vigorously the while and the stopper removed occasionally. The flask is then re-boiled and removed several times for a further 30 to 40 minutes. The fluid is filtered before use. The method of use is essentially the same as that of Nissl, but celloidin sections are preferred. The stock solution is diluted one-half. The stained sections are differentiated in anilin-alcohol, cleared up in Cajuput-oil, washed in benzene, and mounted in benzene-colophonium. When mixed with 1 per thousand eosin solution in the proportion of 4 eosin to 1 borax-blue, it may be used like Romanowsky, etc., for blood and bacteria. In such case the stained films are rapidly washed in 2–4 per thousand acetic acid and then in absolute alcohol.

* Arch. Mikr. Anat. u. Entwickl. lxxii. (1908) pp. 832–3.
† Bol. Inst. Alfonso XIII., iv. (1908) 103 pp.
‡ Centralbl. Bakt., 1te Abt. Orig., xlviii. (1909) pp. 697–701.

Minute Structure of Bacteria.*—A. Amato employs the following method for studying the minute structure of bacteria. A thin layer of alcoholic solution of "brillant kresylblau" is spread on an object-slide, the alcohol is allowed to evaporate, and a drop of broth-culture of the organism to be examined is placed on the slide. If a solid culture be used, a loopful should be mixed with a drop of broth. In this way physical and chemical actions of fixation processes are avoided, and the form of the bacterial cells is almost unchanged.

The author gives drawings of the appearances observed in the potato bacillus, *Bacillus subtilis*, *B. mycoides*, and *Spirillum volutans*, of nuclear-like bodies and granules which he regards as nuclear equivalents.

Metallography, etc.

Colour-photography in Metallography.†—L. Révillon and P. Beauverie have used autochrome plates with much success. The yellow screen supplied by Lumière was quite unsuitable for use with the Nernst lamp, the light from which was found, indeed, to contain an excess of red rays. When a green screen (a solution of picric acid and methylen-blue) was used, the colours obtained on the plate corresponded with those observed by eye. Four reproductions of colour-photomicrographs are given, one of a 20 p.c. nickel steel, cemented, the other three of bronzes and brasses, which were etched by immersion in a boiling 50 p.c. solution of caustic soda, to which had been added a few drops of oxygenated water. This etching reagent is recommended for general use with alloys of copper.

Resilience, and Testing by Impact.‡—Resilience has been defined as resistance to shock expressed in kilogrammetres per square centimetre of original cross-section. L. Revillon has investigated the effect upon this "specific impact work" § of variation in dimensions of test-piece and in distance between supports. A Guillery machine was used. The energy absorbed is greater the less the distance between supports. If, however, all the dimensions of test-piece and also the distance between supports are altered in the same proportion, energy absorbed per unit area is then the same. The results of shock tests should always include an exact statement of the conditions of the test.

Shock-tests at Different Temperatures.‖—L. Guillet and L. Révillon have determined the work absorbed in rupture, in the Guillery machine, of eight different steels, at temperatures ranging from 20°–650° C. Resistance to shock increases up to about 200° C., then falls to a minimum at 475° C., again increasing at higher temperatures. There is no relation between resilience and the transformation temperatures. The results do not indicate that steel is brittle at a "blue heat" (300°–325° C.).

Temper-colours.¶—L. Guillet and A. Portevin find that the oxidation tints produced on a bright steel surface depend not only on the

* Centralb. Bakt., 1te Abt. Orig., xlvii. (1908) p. 385.
† Rev. Métallurgie, v. (1908) pp. 885–6 (4 figs.).
‡ Tom cit., pp. 887–92.
§ See this Journal, 1908, p. 261.
‖ Rev. Métallurgie, vi. (1909) pp. 94–101 (2 figs.).
¶ Tom. cit., pp. 102–4.

temperature reached, but also on the time for which the temperature is maintained. As, however, the tempering effect on hardened steel also increases with time of heating as well as with temperature, the correctness of the practice of judging the degree of "letting down" by the colour is confirmed.

Hardness of Steels at Low Temperatures.*—F. Robin has made Brinell hardness measurements on a large number of steels, at $-20°$, $-80°$, and $-185°$ C. He finds that hardness increases as temperature diminishes, the rate of increase being greater at the lower temperatures. Steels cooled to $-185°$ C., and allowed to return to the ordinary temperature, showed a slight permanent increase in hardness. Microscopic observations were made on austenitic steels cooled to low temperatures, and, together with low-temperature hardness measurements, confirmed the occurrence of a transformation in the austenite.

Hardness of Steels at High Temperatures.†—F. Robin has made a large number of careful hardness measurements, by the Brinell method, on steels at temperatures 10°–900° C. At the highest temperatures the impression was made by impact, while static loading was employed throughout the greater part of the range. The results are embodied in numerous curves. In general, for carbon steels, the hardness fell off with increasing temperature, up to 100°–150° C. It then increased, reaching a maximum at about 250° C., then diminished, more rapidly as the temperature rose. At 850° C. the difference in hardness of steels of different carbon content was small. The form of the temperature-hardness curves of the high-speed steels differed considerably from that of the carbon steels, these special steels retaining a much greater proportion of their original hardness at temperatures up to 600° C.

Silicon-silver Alloys.‡—G. Arrivaut finds that no compounds are formed in the silicon-silver system. Silicon is not held in solid solution by silver, but at the other end of the diagram there is a series of solid solutions of silver in silicon, having a maximum concentration of 10 p.c. The eutectic contains 5 p.c. silicon, and melts at 820°–830° C. The equilibrium diagram was obtained by thermal methods and confirmed by microscopic examination.

Micrography of Cement.§—E. Stern has microscopically examined cements at different stages of the hardening process, by reflected light. Polished and etched sections show two constituents, A, alite, present in greater amount than B, which, in hardening slowly, increases at the expense of A. The etching reagents found to yield good results were alkalis, alcoholic hydrochloric acid, alcoholic iodine solution, and 25 p.c. hydrofluoric acid.

Microscopic Study of Mortar.‖—G. Gallo has ascertained by microscopic examination of mortar that the calcium carbonate formed is distinctly crystalline; it is concluded that the lime and carbon dioxide

* Rev. Métallurgie, vi. (1909) pp. 162–79 (25 figs.).
† Op. cit., v. (1908) pp. 893–908; and vi. (1909) pp. 180–4 (19 figs.).
‡ Tom cit, pp. 932–4 (1 fig.).
§ Stahl und Eisen, xxviii. (1908) pp. 1542–6 (12 figs.).
‖ Journ. Chem. Soc., xciv. (1908) pp. 843–4 (from Gazetta Chimica Italiana, xxxviii. (1908) pp. 142–204).

must be in solution before the reaction takes place. The necessity for the presence of water is thus explained. The author deals fully with the reactions occurring during the setting of pozzuolana.

Different Phases of Matter.*—C. E. Guillaume gives an account of the experiments of Tammann, Spring, and others, on the behaviour of metals and other solids when submitted to great pressure. In general, wire-drawn metals are less dense than normal samples. Probably all solids under heavy pressures tend to be converted into an amorphous state, which has no discontinuity with the liquid and gaseous phases.

Study of Breakages.†—W. Rosenhain discusses the causes of breakages, and insists on the importance of investigating all cases of failure. Segregation, overheating, cold working are dealt with, and details of several instances of failure of steel are given.

Microstructure and Mechanical Properties of Steel.‡—The term "tenside" is adopted by A. Jude to express the roughness of the surface of a tensile test piece after breaking. The degree of roughness is a reliable index of the coarseness of the structure. Photomicrographs are given, supporting the author's view that, on the whole, there is a decided concurrence of the "tenside," the impact results, and the size of grain.

Experimental Study of the Thomas Process.§—In the course of a detailed study of the basic Bessemer process, F. Wüst and L. Laval have investigated the metallography of the iron-carbon-phosphorus alloys (containing also silicon, manganese, and sulphur), formed at different stages. The original iron contained cementite, mixed crystals, and a ternary mixed crystals-cementite-phosphide eutectic. As the carbon was eliminated, this ternary eutectic was replaced by a binary mixed crystals-phosphide eutectic. Many photomicrographs, two of which are in colour, are given.

Solidification of Cast Iron.‖—N. Gutowsky has studied, by means of heating and cooling curves, quenching experiments, and microscopic examination, the processes occurring in the solidification and melting of a commercial cast iron containing 3·57 p.c. carbon, 1·32 p.c. phosphorus, 2·05 p.c. silicon. He finds that phosphorus separates as a binary phosphide eutectic. The occurrence of the binary instead of the ternary eutectic required by the theory of ternary alloys, is due to graphite formation. Melting begins with the fusion of the phosphide eutectic at about 980° C. Solidification of the main body of the cast iron is completed at about 1100° C., while the high-phosphorus portion finally solidifies at 944° C., the solidification point of the binary phosphide eutectic. Graphite formation proceeds throughout the solidification range of the binary eutectic mixed crystals-cementite.

* Engineering, lxxxvi. (1908) p. 115 (from Rev. Gén. Sci.).
† Tom. cit., pp. 340–3 (16 figs.). See also Electrochem. and Met. Industry, vi. (1908) pp. 459–61.
‡ Tom. cit. p. 772 (8 figs.).
§ Metallurgie, v. (1908) pp. 431–62, 471–89 (61 figs.).
‖ Tom. cit., pp. 463–70 (27 figs.).

MICROSCOPY.

A. Instruments, Accessories, &c.*

(1) Stands.

Bausch and Lomb's Petrographical Microscope Stand L C H.†—This instrument (fig. 60) is intended to combine convenience of manipulation with completeness of equipment. The excellence of the same makers' L C stand included Nicols of extra quality and size in addition to a special illuminating device. The present instrument combines these features with the lever fine-adjustment and handle-arm, the latter being so placed as to give 75 mm. to the centre of the stage. The stage itself is circular, and measures 90 mm. inside, and 102 mm. outside; the graduations, which are in single degrees, are read by convenient vernier. The stage-plate has a vulcanite top, and is provided with spring-clips and centring-screws; it has two scales at right angles to each other, graduated in millimetres. The plane-stage may be removed and the revolving mechanical stage substituted. This mechanical stage can be completely rotated, and is graduated similarly to the plane-stage; it is designed to carry the size of slides usually used in petrographical work. The holders are adjustable. Both movements are fitted with verniers and graduations for recording the field. The substage has a mounting for the polariser or Abbe condenser, and is focused by an accurate rack-and-pinion of long range; the polariser may be swung out of the optical axis when desired. The body-tube is of fixed length and is slotted for the Bertrand lens, beneath which an iris diaphragm is mounted, so that the image of

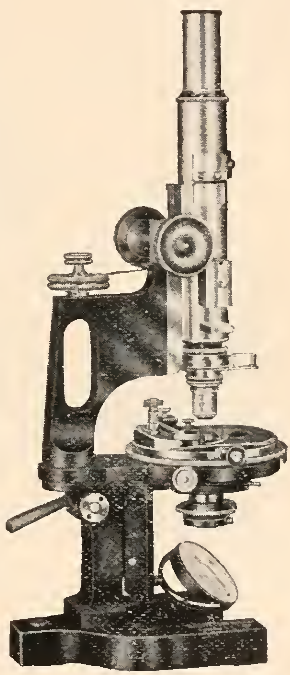


Fig. 60.

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

† Bausch and Lomb Optical Co., Rochester, N.Y., Catalogue, Microscopes and Accessories, p. 46.

the interference figures may be made sharp. The lens may be focused by a small rack-and-pinion attached to the body-tube. The prism-box is adjustable, so that the analyzer may be removed from the optical axis when not used. A slot, which may be closed, is provided for the quartz-wedge, gypsum-plate, red of first order, or a $\frac{1}{4}$ undulation mica plate. The coarse-adjustment is by rack-and-pinion. The micrometer screw-head of the improved lever type of the fine-adjustment is divided to give two speeds, and the larger part is graduated into one hundred divisions, each one equal to 0·005 mm. in vertical movement; the indicator is hinged. The polariser is a large Nicol prism in a revolving mount graduated in single degrees and read by a fixed pointer. A stop indicates the zero position, and an iris diaphragm is attached below the prism. The polariser is used in the substage. A large Nicol prism, mounted in a prism-box sliding in the body-tube, acts as the analyzer. The illuminating apparatus consists of a two-lens condenser so as to give converged polarised light. The upper lens is mounted in a metal hemispherical shell, so attached to the mounting of the polariser that it may be instantly thrown in or out of the optical axis without disturbing any of the other parts; it is operated by a conveniently placed lever.

Watson and Sons' Porro-prism Erector for Dissecting Microscopes.*
This apparatus (fig. 61) fits the firm's Laboratory and Simplex Dissecting Microscopes, and enables ordinary Microscope objectives to be used instead of the usual dissecting type. Greater working distance with high powers is thereby afforded, and, as the image is erect instead of inverted, dissection is facilitated.

Fig. 61.

(3) Illuminating and other Apparatus.

Siedentopf's Dark-ground Illumination.†—For dark-ground illumination with Siedentopf's paraboloidal condenser, the Zeiss firm recommend incandescent gas, spirit incandescent, the Nernst light, or, best of all, the electric light, as sources of light. With the aid of a spherical flask K (fig. 62), placed at a distance of about 15 cm. between the source of light B, and the plane mirror of the Microscope M, an image of the source of light is projected on the latter, and at the same time effectually prevents injurious heat affecting the specimen under examination. For instantaneous photomicrography of live bacteria, sunlight, projected on to the mirror of the Microscope by means of a heliostat provided with a clockwork motion, is in most cases essential. An exceedingly accurate adjustment of all the component parts is also necessary.

* W. Watson and Sons, Ltd., Catalogue, 1909, p. 69.

† Carl Zeiss, Jena, Special English Catalogue (1907) Ultra-microscopy and Dark-ground Illumination, part 4, p. 3.

Microscope Illumination.*—E. Giltay describes two forms of lamps which he has found very satisfactory. One lamp is a gas lamp and the other an electric lamp. The gas lamp consists of an erect incandescent mantle flame of the usual form, but raised on a stand so as to be of a convenient height. The stand carries a kind of cage-like framework so contrived that an opaque curtain surrounds the upper part of the lamp. The light which passes upwards through the curtain is ignored, but the light which passes under the curtain is made useful to the microscopist by being made to pass through a slab of ground glass before impinging on the Microscope mirror. The framework also supports an opaque glass shade which serves to reflect on to the glass slab much of

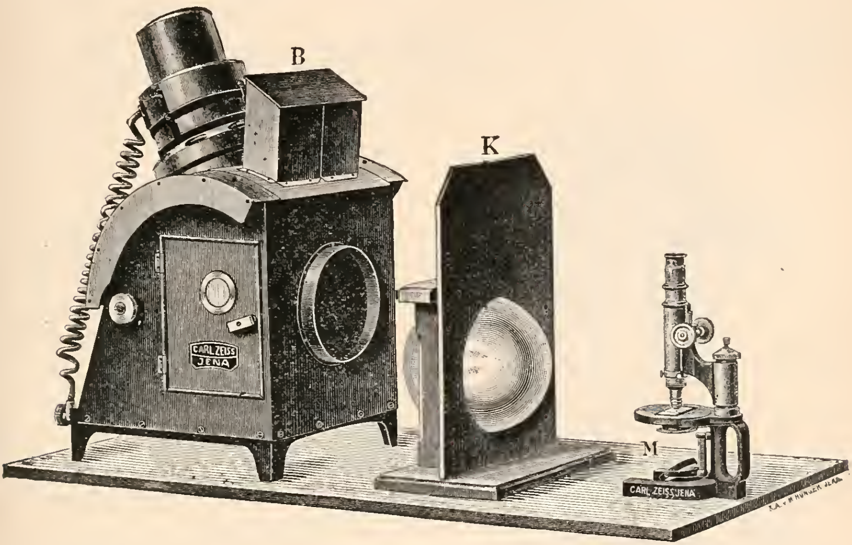


Fig. 62.

the light which would otherwise reach the ceiling. There is provision for inserting more than one slab, so that the same lamp may easily answer the needs of two or several workers, especially if it be set in the centre of a round table.

The electric lamp is an adaptation of one of the new Osram lamps of only 4-volt tension. This is supplied with two accumulators, and has a current of 0·9 ampere. The lamp is clamped on to a pillar mounted on a stand of such a shape that it slides over one of the prongs of the horse-shoe foot of the Microscope and is secured to it by screws. The lamp is thus brought into the usual position of the mirror. The best results were attained with diffused light, the side of the lamp turned upwards having been ground with carborundum powder and a ground glass disk inserted into the diaphragm. This arrangement also secured

* Zeitschr. wiss. Mikrosk., xxv. (1908) pp. 163–8 (3 figs.).

a suitable magnification of the light source. The ground glass disk was made out of the thinnest possible object-glass, and its corners were melted off so that it did not fit quite perfectly over the diaphragm, the purpose being to avoid displacement of the object by air currents which might otherwise intrude between the ground glass and the object slide: this plan gives a ready passage to such air-currents. A copper ring suitably inserted prevents impact of the ground glass disk on to the object slide. The above description applies to a stand fitted merely with a diaphragm and without an Abbe condenser; but in the case of a stand fitted with a condenser, the above disk must be applied under the condenser lens.

Watson and Sons' Eye-piece Analyser.*—This analyser (fig. 63) fits over the eye-piece, has a large field-prism, and rotates with index against a divided circle.

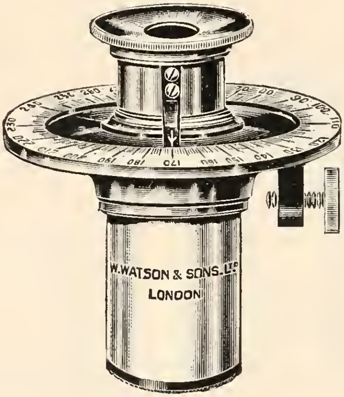


Fig. 63.

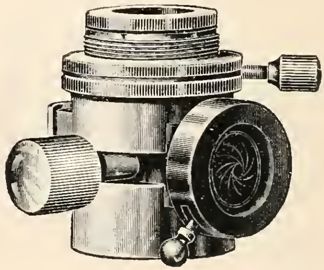


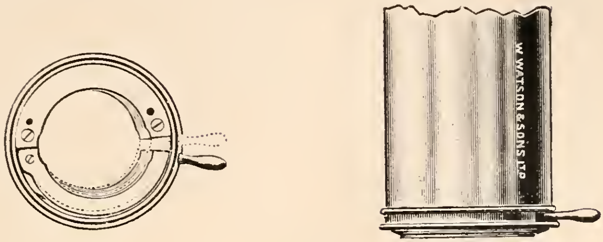
Fig. 64.

Koristka's Illuminator for Opaque Objects.†—This piece of apparatus (fig. 64) is principally intended for the study of metals. It fits into the tube of the Microscope, and contains a totally reflecting prism for receiving lateral light, and reflecting it through the centre of the objective on to the preparation. An iris-diaphragm in front of the prism serves to regulate the incident light. The whole of the prism arrangement with the iris slides in a groove in such a manner that any desired portion of the field can be illuminated, and the best position of the prism ascertained. The light should be directed on the iris by an illuminating lens.

Hall's Grip Nose-piece.‡—This fitting (fig. 65), made by W. Watson and Sons, is placed at the lower end of the Microscope tube, and the objective is slipped into it after pressing the handle. On releasing the

* W. Watson and Sons, Ltd., Catalogue, 1909.
† F. Koristka, Milan, Catalogue xiii. (1908) Microscopi ed Accessori, p. 57.
‡ W. Watson and Sons, Ltd., Catalogue, 1909, p. 110.

handle the objective is firmly gripped. It adds only $\frac{1}{4}$ inch to the length of the body.



A B

Fig. 65.

Stiles' "Universal" Microscope Lamp.* — This lamp, made by W. Watson and Sons, as will be seen from the illustration (fig. 66), will be found very serviceable for Microscopical work.

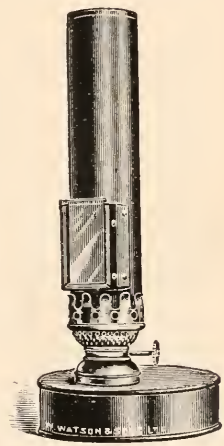


Fig. 66.

(6) Miscellaneous.

Some Hairs upon the Proboscis of the Blow-fly.†—E. M. Nelson recommends a study of the visibility and measurement of the hairs upon the proboscis of the blow-fly as not only an excellent practice in minute microscopical work, but as a very desirable introduction to the more difficult examination of the flagella of bacteria. He classifies four varieties of such suitable hairs:—(1) The minute spinous hairs with filamentous ends upon the upper surface of the membrane of the sucker. 2. Pliant and soft hairs upon the rostrum. 3. Comparatively giant hairs found both upon the rostrum and upon the maxillary palpi. These are five times thicker than the others are long. One measures 0·063 in. in length and 0·002 in. in breadth, while a minute hair measures 0·00044 in. in length and 0·000036 in. in breadth. 4. Tubular blunt-ended hairs 0·0187 in. in length and 0·00036 in. in breadth ranged round the edge of the suctorial disk. The same supply of air which inflates the tongue also inflates these hairs. The object of this is twofold: first, it renders them stiff enough to afford special protection to the delicate edge of the suctorial disk: and, secondly, when the tongue is relaxed they become flaccid and in no way interfere with the folding up of the organ into the head capsule.

Navicula Smithii and N. Crabro.‡ — A. A. C. Eliot Merlin, in examining specimens of *Navicula Smithii* from the Bay of Naples, has

* W. Watson and Sons, Ltd., Catalogue, 1909, pp. 122–3.
† Journ. Quekett Micr. Club, 1908, pp. 227–8.
‡ Tom. cit., pp. 247–50.

found that the distinctive diagonal double rows of "pearls" have the primaries crowned with a very beautiful kind of perforated secondary structure which should be within the reach of any good oil-immersion lens capable of standing a large working aperture. The author has also found that *N. Crabro*, a form analogous although differently shaped to *N. Smithii*, and possessing likewise a double row of "pearls," also possesses an exactly similar structure. The specimens, presumably Belgian, figured in Van Heurck (Plate B, fig. 23, and plate ix., fig. 1), do not show these secondaries. It may be that there is a difference in structure between the Belgian and Italian varieties of these diatoms.

Quekett Microscopical Club.—The 456th Ordinary Meeting was held on April 2, Mr. C. F. Rousselet, F.R.M.S., Vice-President, in the Chair. Mr. C. Lees Curties, F.R.M.S., for Messrs. Baker, gave an interesting exhibition of some of the different illuminants for the Microscope. A paper by E. Heron-Allen, F.L.S., F.R.M.S., and A. Earland on "A new species of *Technitella* from the North Sea, with some observations upon Selective Power as exercised by certain species of Arenaceous Foraminifera" was read by Mr. Earland. The new species is *Technitella Thompsoni* sp. n., and is fully described and illustrated in the current Journal of the Quekett Microscopical Club (April 1909). The test is built up entirely of echinoderm plates. Mr. E. F. Law gave a lecture, illustrated with photomicrographs in the lantern, on "The Relation between the Microscopic Structure and Properties of Alloys."

At the 457th Ordinary Meeting held on May 7 the postponed presidential address was delivered by Professor E. A. Minchin, M.A., F.Z.S., who took for his subject "Some Applications of Microscopy to Modern Science and Practical Knowledge." He gave a very interesting account of malaria, sleeping sickness, and yellow fever, describing the life-history, so far as it is at present known, of the parasites causing these respective diseases.

B. Technique.*

(1) Collecting Objects, including Culture Processes.

Flask for Fluid Media.†—A. H. Caulfield advises the following modification of the flasks used for holding fluid media by which the wetting of the plug from often unavoidable shaking is obviated. The neck of an ordinary flask is throttled and plugged by a glass ball rather larger than the contriction: this can be readily blown from a piece of small glass tubing, and if provided with a short handle it can be conveniently held in position by the wool plug. The author found this form of flask useful for cultures made on patients living at a distance from the laboratory.

* 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., xlix. (1909) p. 463.

(2) Preparing Objects.

Method for Demonstrating Spores of Tubercle Bacilli.*—L. von Betegh employs the following method for demonstrating the spores of tubercle bacilli. Thin smears are prepared, dried, and fixed in the flame; these are then placed in 10 p.c. nitrate of silver, and heated for one minute at 80°–90° C. (but not allowed to boil), and then thoroughly washed in water; they are then treated with several drops of freshly made 50 p.c. aqueous solution of rodinal, for 20 to 30 seconds, until they become brown or black-brown; again washed in water, dried, and mounted. By this means only the spores are stained black-brown, and the organism may be subsequently stained by treating the film with carbol-fuchsin, without warming, for 1–2 seconds.

HAHN, H.—**Apparat zur Einbeltung in paraffin.**
[A sideboard into which is let a tank, with hot and cold water supply, worked through a 3-way tap by means of a pedal. In order to regulate the temperature of the water in the tank, this is divided up by a number of partitions.] *Zeitschr. Wiss. Mikrosk.* xxv. (1908) pp. 184–7 (2 figs.).

(4) Staining and Injecting.

Methods for Staining Tubercle Bacilli.†—A. Cann compares the methods of Ziehl-Neelsen, Much, and Hermann. The methods of Much consist of several modifications of Gram's method; Hermann's stain is a solution of crystal-violet and ammonium carbonate, and various modifications for this stain when used for sections are suggested. The author finds from the examination of a number of specimens stained by these processes that both the method of Much and those of Hermann compare favourably with that of Ziehl-Neelsen; that many cases which are negative with Ziehl-Neelsen are also negative with the other methods; but twice as many cases which gave a positive result with Hermann's methods were negative with Ziehl-Neelsen, and a less number were negative with Much's method. Granules and granular rods are more often demonstrated by the methods of Much and Hermann than by Ziehl-Neelsen.

MASUR, A.—**Beiträge zur Histologie u. Entwicklungs-geschichte der Schmelzpulpa.** *Anat.*, xxxv. (1907) pp. 265–92 (6 pls.).

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

Mounting of Algæ.‡—J. A. Nieuwland calls attention to G. S. West's method of killing, fixing, mounting, and preserving algæ. The fluid used is a 2 p.c. solution of potassium acetate, made just blue with copper acetate. This medium reduces plasmolysis to a minimum. For permanent mounts thick slides should be used, and the coverslip sealed down with gold size several times after each drying.

With *Vaucheria*, plasmolysis is hard to avoid, and the best procedure is to kill rapidly with 3 or 4 p.c. formalin, which must be completely washed out afterwards, or the preparations will turn black. The *Vaucheria* are then removed to 5 to 10 p.c. glycerin, to which a

* Centralbl. Bakt., 1te Abt. Orig., xlix. (1909) p. 461.
† Tom. cit., p. 637. ‡ Bot. Gaz., xlvii. (1909) pp. 237–8.

little thymol is added, and the fluid is then allowed to inspissate by evaporation by placing the vessel near a radiator.

The author's procedure for mounting algæ is as follows: after killing and fixing in the potassium-copper-acetate solution an equal bulk of 10 p.c. glycerin is added; the mixture is then allowed to concentrate by evaporation in a warm place, protected from dust. It is necessary to separate the algæ from all dirt, otherwise a precipitate of copper oxide occurs.

(6) Miscellaneous.

Shake Apparatus.*—A. Wolff-Eisner has devised the apparatus shown in the accompanying figure (fig. 69). It consists of an excentric-

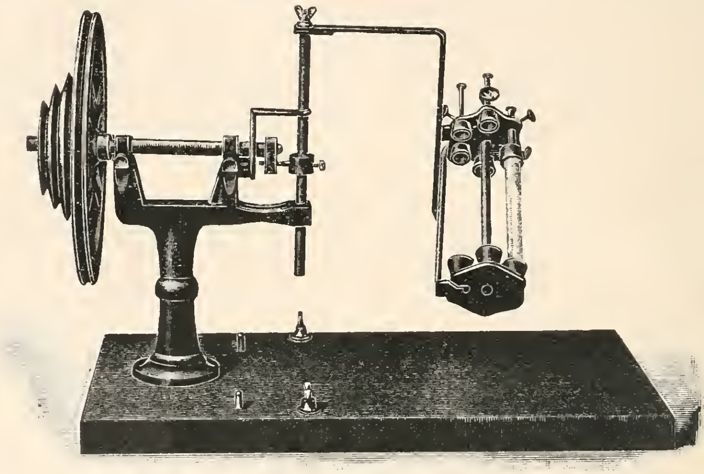


Fig. 69.

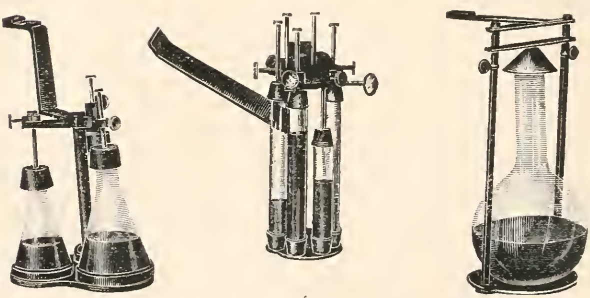


Fig. 70.

ally moving carrier, by means of which the material to be mixed is shaken right and left and up and down at an angle of about 23°, and sideways movement being about 8°. Various holders (fig. 70) are shown for receiving different kinds of flasks and test-tubes. The rotating wheel may be attached to a small motor.

* Centralbl. Bakt., 1te Abt. Orig., xlix. (1909) p. 654.

Metallography, etc.

Platinum-antimony Alloys.* — K. Friedrich and A. Leroux have determined the equilibrium diagram for the range 0–91·3 p.c. platinum. The presence of the following phases in the solid alloys has been established: pure or nearly pure antimony, $PtSb_2$ and Pt_5Sb_2. Pure platinum may exist in the platinum-rich alloys. Pt_5Sb_2 is the product of a reaction occurring in the solid state. Heat-tinting was employed to render visible the micro-structure.

Influence of Manganese on the Iron-carbon System.† — F. Wüst gives a comprehensive account of previous work on iron-manganese alloys, with and without carbon, and describes his investigations on thirty-three alloys, prepared by melting pure cast iron with manganese and an excess of carbon. The alloys contained manganese 0·06–80·45 p.c., carbon 4·03–6·9 p.c. The solidification point of cast iron is somewhat lowered by manganese additions up to 13 p.c.; it then rises, till at 80 p.c. it is about 1250° C. The "pearlite point" (Ar_1) is lowered by small additions of manganese, and at 5 p.c. disappears altogether. Alloys with more manganese contain no pearlite. Manganese increases the capacity of iron for dissolving carbon, and alters the position of the eutectic point. This point in pure iron-carbon alloys lies at 4·2 p.c. carbon, and at 4·05 p.c. when 15 p.c. manganese is present. The presence of manganese favours the formation of troostite and solid solution. Many of the sections, of which photomicrographs are given, were etched with nitric acid in amyl-alcohol.

Heat-contents of Binary Systems.‡—G. Tammann represents the thermal equilibrium of binary mixtures by means of a three-dimensional model, the base of which is the ordinary temperature-concentration diagram. The height of the surface of the model, at any point, is proportional to the heat content of unit mass. Photographs of models corresponding to different cases are given.

Recalescence Temperatures of Nickel.§—T. A. Lindsay has taken cooling curves of nickel containing less than 2 p.c. of impurities, by the differential method, using copper as the neutral body. In cooling from 900° to 180° C., nickel gives out heat gradually from about 700° to about 285° C. At some points in this range the heat evolution is more rapid, small recalescences occur about 660° C. and 525° C., a larger one from 440°–370° C., and the most marked recalescence from 370°–285° C.

Melting-point Curves of Binary Alloys.‖—D. Mazzotto applies two corrections to the melting-point curve, one depending on the heat of

* Metallurgie, vi. (1909) pp. 1–3 (13 figs.).
† Tom. cit., pp. 3–14 (20 figs.).
‡ Zeitschr. Phys. Chem., lxiii. (1908) pp. 129–40 (16 figs.).
§ Proc. Roy. Soc Edin., xxix. (1908) pp. 57–67 (6 figs.).
‖ Journ. Chem. Soc., xciv. (1908) pp. 660–1. See also Nuovo Cim., xv. (1908) pp. 401–22.

mixture, the other on the association of the dissolved metal. The curves of the bismuth-tin and other series, thus corrected, approximate very closely to the ideal curves. The presence of a solid solution or a chemical compound renders the method inapplicable.

Alloys of Iron and Carbon.*—G. Charpy reviews recent work on the iron-carbon system, and discusses the application of the various methods of investigation to the construction of the equilibrium diagram.

Ultra-microscopic Observations.†—J. Reissig describes the ultra-microscopic examination of colloidal solutions of brown tellurium, selenium, and silver, and of red and blue gold. The stability of the colloidal gold, indicated by the slowness with which flocculation takes place on addition of hydrochloric acid, is greater in dilute than in concentrated solutions.

Freezing-point of Iron.‡—H. C. H. Carpenter states briefly the present condition of high temperature pyrometry, and gives an account of the determinations which have been made, of the freezing-point of iron. This point is best defined either on the thermo-electric or the optical scale. The mean value of several closely agreeing determinations by different workers is 1505° C. on the thermo-electric scale, corresponding to 1519° C. on the optical scale, which is probably more nearly the true value. The freezing-point is independent of the atmosphere in contact with the iron.

Constitution of Carbon Steels.§—E. D. Campbell gives an account of the commonly accepted views as to the nature of the constituents of steel, and describes some experimental work on the separation of carbides from a 1·17 p.c. carbon steel by electrolysis in a neutral solution of ferrous sulphate. The carbide separated from the steel quenched in water from 900° C. corresponded to the formula $C_{10}Fe_9$, while the steel in the troostitic condition resulting from reheating to 350° C. after quenching in water from 900° C. gave a carbide with the approximate empirical formula CFe_2. The author suggests the possibility of the existence of a number of carbides of iron in addition to the well-known Fe_3C.

Influence of Thermal Treatment on Linear Deformations of Steels.‖—Demozay gives at some length the results of experiments on the effect of heat treatments, such as quenching in oil and in water, and annealing at a high temperature, upon the breadth and thickness of bars (dimensions originally 100 × 10 × 5 mm.), of 7 steels of carbon 0·19–1·15 p.c. Each treatment was repeated a number of times. Repetition of a treatment accentuates the deformation, which increases in proportion to the number of treatments.

* Journ. Chem. Soc., xciv. (1908) pp. 697–8. See also Bull. Soc. Chim., iii. (1908) pp. 1–46.
† Tom. cit., pp. 933–4. See also Ann. Physik, xxvii. (1908) pp. 186–212.
‡ Journ. Iron and Steel Inst., lxxviii. (1908) pp. 290–9.
§ Tom. cit., pp. 318–35.
‖ Rev. Métallurgie, vi. (1909) pp. 413–41 (44 figs.).

Simple Apparatus for Micrography.*—G. Revol describes an inexpensive Microscope suitable for the examination of metal surfaces in the workshop.

Alloys of Iron with Sulphur.†—Ziegler gives a lengthy description of the microstructure of iron-sulphur alloys containing 0–30 p.c. sulphur, and also of alloys containing varying amounts of carbon, manganese, etc., in addition to the sulphur. In the iron-sulphur system two constituents only were observed, ferrite, and the eutectic iron-sulphide of iron. The compound structure of the eutectic is visible only when the alloy has been slowly cooled. Oxygen may be present as an impurity in the eutectic. The addition of moderate amounts of carbon to the alloy causes pearlite to appear, but does not otherwise affect the structure. Troilite, the constituent containing the sulphur in meteorites, appears to be a similar eutectic, but probably contains some oxide in addition to the iron and sulphide of iron. The structure of most of the alloys was visible after polishing, but was more clearly revealed by etching with picric acid in alcohol, either a 5 p.c. or a saturated solution.

Metallography of Quenched Steels.‡—C. Benedicks presents some criticisms of the conclusions reached by Kourbatoff and by Maurer.§ It is possible that austenite undergoing transformation into troostite always passes through the martensite stage. The existence of a reversible transformation at 137° C., austenite $\rightleftarrows$ troostite, is not probable.

National Physical Laboratory.||—The annual report contains much matter of interest. The following points in the report on the metallurgical department may be noted. The great complexity of the equilibrium diagram of the ternary system, copper-aluminium-manganese, has necessitated the restriction of its investigation to the region 0–10 p.c. manganese and 0–12 p.c. copper. A peculiarity, as yet unexplained, has been noted in a small group of the alloys prepared. The freezing-point of one of these alloys remelted several weeks after its preparation is lower than that of the freshly-made alloy. An improvement has been effected in the ultra-violet photomicrographic apparatus by the introduction of a "compensating lens" into the optical system of the Microscope. If the image is visually in focus with blue lights the compensating lens being used, the ultra-violet image is photographically in focus when the compensating lens is removed. Good definition has been obtained in ultra-violet photomicrographs at 400 diameters, but serious obstacles, arising chiefly from internal reflections, have been met at higher magnifications.

A series of determinations of "temperature-density" curves has been made. The work projected for the current year includes further investigation of the alloys of copper and aluminium with manganese,

* Rev. Métallurgie, iv. (1909) pp. 442–5 (3 figs.).
† Tom. cit., pp. 459–93 (22 figs.).
‡ Tom. cit., pp. 494–501.
§ See this Journal, 1908, pp. 783–4.
|| Nat. Phys. Laboratory, Report for 1908.

nickel, and zinc, and a continuation of the study of the crystalline structure and mode of solidification of eutectic alloys.

Platinum-lead Alloys.*—N. A. Puschin and P. N. Laschtschenko have studied this system by the electric potential method, and have found two compounds, PbPt and Pb_2Pt. The existence of these compounds was confirmed by microscopic examination of the alloys.

Alloys of Silicon.—S. Tamaru† has investigated the silicon-tin, silicon-lead, and silicon-thallium systems. Silicon does not mix in the molten state with either lead or thallium, but mixes in all proportions with tin. There are no compounds in the silicon-tin system. The three equilibrium diagrams are given.

R. Vogel ‡ finds that magnesium and silicon are miscible in all proportions in the liquid state, form one compound Mg_2Si, two eutectics (42 and 96 p.c. magnesium), and no solid solutions. Mg_2Si melts at 1102° C. The equilibrium diagram deduced from the thermal data, and confirmed by microscopic examination, is given. Dilute hydrochloric acid was used for etching.

Silicon-magnesium System.§—P. Lebeau and P. Bossuet conclude from microscopic and chemical evidence that $SiMg_2$ is the only compound that silicon forms with magnesium. The alloys were prepared by melting magnesium filings with crystals of silicon, a small quantity of potassium fluosilicate being added, or by heating magnesium with a mixture of fluosilicate of potassium and magnesium. Alumina was used for polishing, but scratches could not be avoided. Alloys containing little silicon were observed to be grains of magnesium surrounded by a eutectic. At about 2 p.c. silicon, crystals of a silicide began to appear, and the 36·15 p.c. silicon alloy consisted wholly of this silicide. With further increase of silicon another eutectic appeared, and alloys with more than 50 p.c. silicon were observed to contain crystals of free silicon. The structure of many of the sections was visible after polishing, while dilute hydrochloric acid was used for etching others. The composition of the silicide was established by analysis of crystals isolated by dissolving out the magnesium in a 25 p.c. Si alloy with ethyl iodide in anhydrous ether.

Alloys of Manganese.‖—G. Arrivaut has applied chemical methods to the study of the binary alloys of manganese with numerous other metals. The alloys were prepared from pure materials in magnesia crucibles by the aluminothermic process or by melting the metals together in the absence of air. The alloys were treated with various reagents (acids, alkalies, etc.) in such a way that only the manganese was dissolved, the other metal remaining in the residue. According to the nature of this residue the alloys are divided into two classes: (1) those from which one or more constituents corresponding to simple

* Zeitschr. Anorg. Chem., lxii. (1909) pp. 34–9 (1 fig.).
† Tom. cit., pp. 40–5 (3 figs.). ‡ Tom. cit., pp. 46–53 (7 figs.).
§ Rev. Métallurgie, vi. (1909) pp. 273–8 (8 figs.).
‖ Mém. Soc. Sci. Phys. Nat. de Bordeaux, ser. 6, iv. (1908) pp. 67–160 (20 photomicrographs).

formulæ could be separated; (2) those in which the residue consisted of the second metal only, no compound being isolated. The first class includes the binary alloys of manganese with aluminium, silver, molybdenum, chromium, and vanadium, the second class the alloys with cobalt, nickel, copper, tungsten, lead, platinum, zinc, cadmium, tin, bismuth, and antimony. Some observations on the remarkable magnetic properties of the manganese-bismuth, manganese-tin, and manganese-antimony alloys are recorded. The author fully recognises the provisional character of the deductions drawn as to the number and formulæ of the compounds existing in each system.

New Form of Pearlite.*—C. A. F. Benedicks describes as "bead pearlite" an intermediate form between laminated pearlite and the coarse granular pearlite which is obtained by annealing laminated pearlite below the critical temperature. The new form was observed in grey Swedish pig-iron after heating to 670° C., and disappeared on further heating. The structure of the "bead pearlite" appears to indicate its formation by a partial coalescence of the thin lamellæ of laminated pearlite into larger masses.

Heat-treatment of Steel.†—A. Campion describes the elementary properties of steel upon which heat-treatment is based. Time of heating and mass are possibly the most important factors, apart from temperature, in determining the structure and properties of the material.

ARRIVAUT, G.—**Alloys of Copper and Manganese.**
Procès-verbaux des séances de la Société des Sciences physiques et Naturelles de Bordeaux, 1907–8, pp. 142–3.

„ „ **Arsenides of Manganese.** *Tom. cit.*, pp. 159–62.

DUCELLIEZ, F.—**Cobalt-lead Alloys.** *Tom. cit.*, pp. 31–4.

„ „ **Action of Heat on a Mixture of Arsenic and Cobalt.** *Tom. cit.*, pp. 57–73.

„ „ **Cobalt-antimony Alloys.** *Tom. cit.*, pp. 175–87.

VIGOUROUX, E.—**Nickel-lead Alloys.** *Tom. cit.*, pp. 28–30.

„ „ **Action of Arsenic on Nickel.** *Tom cit.*, pp. 48–56.

„ „ **Siliciuration of Iron and Manganese.** *Tom. cit.*, pp. 78–80.

„ „ **The Arsenides NiAs and Ni_3As_2.** *Tom. cit.*, pp. 137–41.

„ „ **Arsenides of Iron.** *Tom. cit.*, pp. 155–8.

„ „ **Antimonides of Nickel.** *Tom. cit.*, pp. 169–74.

VIGOUROUX, E., & SANFOURCHE—**Arsenides of Chromium.** *Tom. cit.*, pp. 144–50.

„ „ „ **Arsenides of Silver.** *Tom. cit.*, pp. 163–8.

ROSENHAIN, W., & P. A. TUCKER—**Eutectic Research. No. 1. Alloys of Lead and Tin.**
[A more complete account of the work described in the paper summarised in this Journal, 1909, p. 117.]
Nat. Phys. Laboratory, Collected Researches, v. (1909) pp. 83–118 (42 figs.). Reprinted from *Phil. Trans. Roy. Soc.*, A 209 (1908).

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* Iron and Steel Times, i. (1909) pp. 135–8 (5 figs.).
† Tom. cit., pp. 157–66 (14 figs.).

MICROSCOPY.

A. Instruments, Accessories, &c.*

(1) Stands.

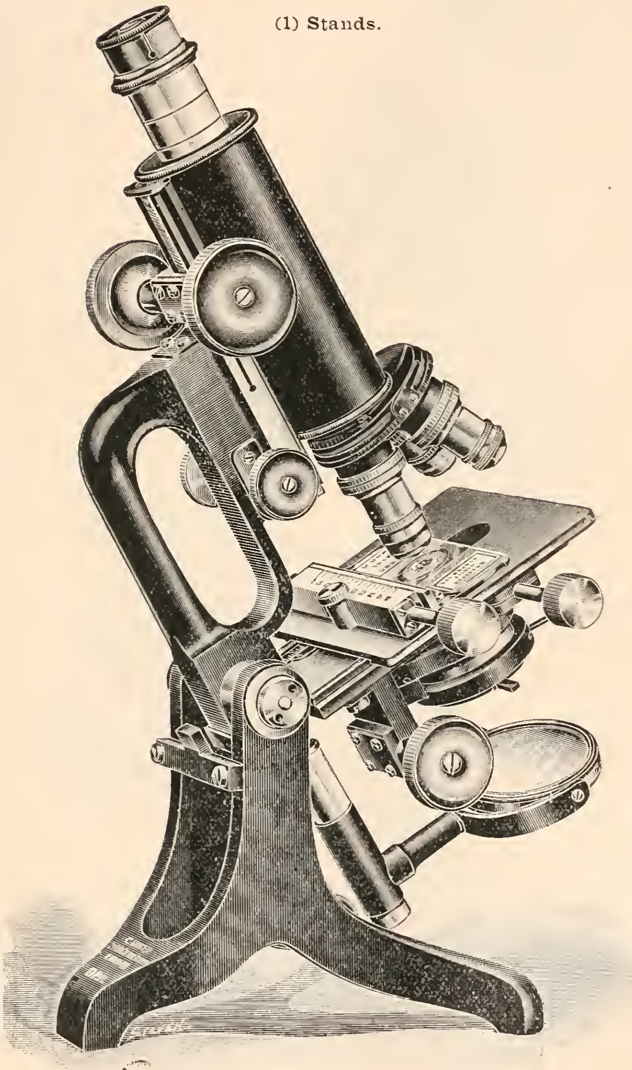

Fig. 73.

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

C. Baker's New Model D.P.H. Microscopes.*—These instruments are provided with a body-tube $1\frac{1}{2}$ in. diameter, in which slides a draw-tube carrying an eye-piece 23 2 mm. diameter. They are fitted with

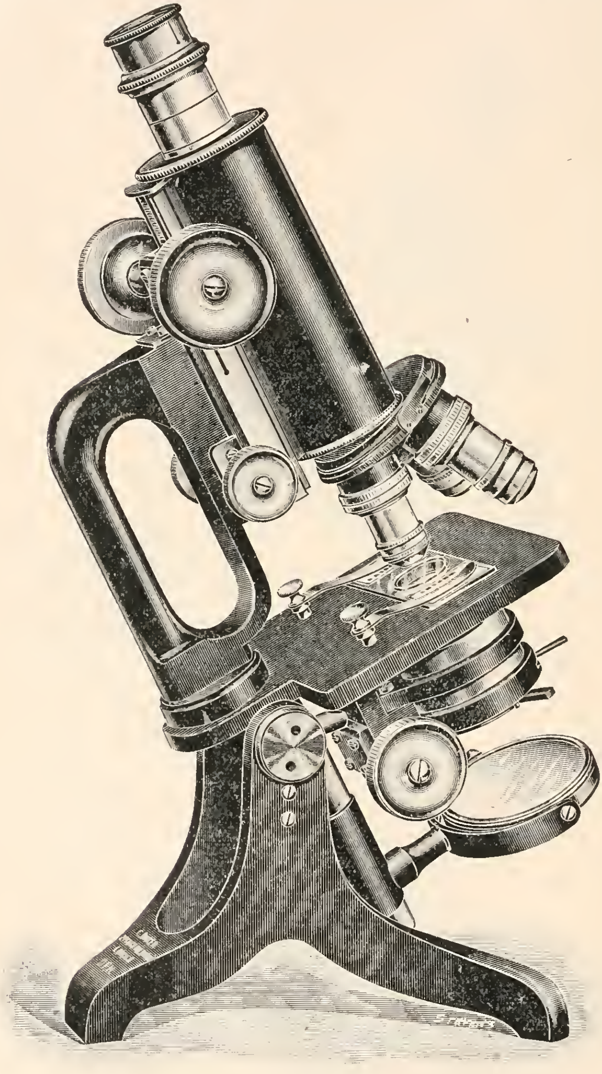

FIG. 74.

diagonal rack-and-pinion coarse-adjustment which is carried on a limb cast in one piece with an opening in which the fingers can be placed when lifting. The milled heads of the fine-adjustment are placed on

* C. Baker's Special Catalogue, 1909.

either side of the limb and actuate a lever giving a very smooth and delicate movement.

In Stand No. 1 (fig. 73) the body and limb are mounted on a stage below the trunnions, and the instrument will be found very steady when

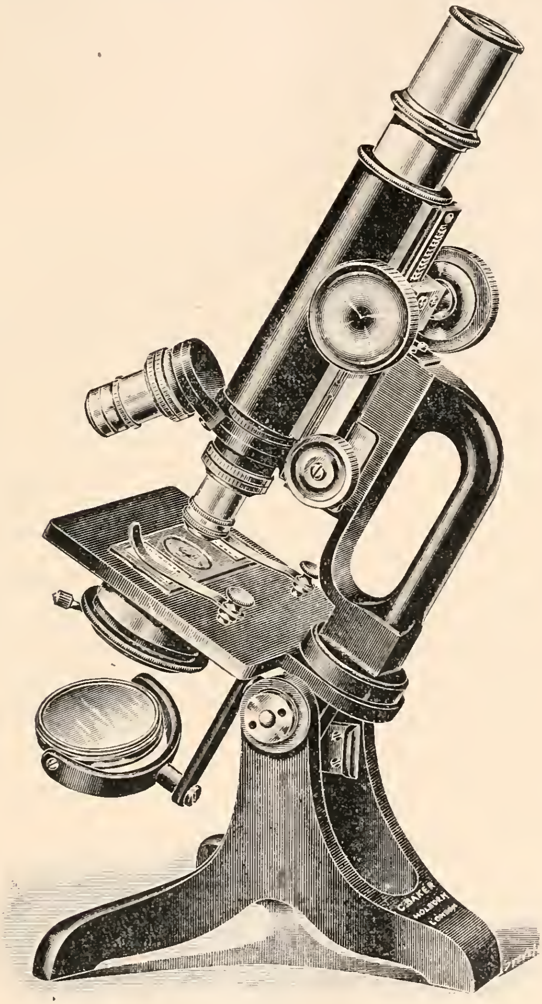

Fig. 75.

placed in the horizontal position. The mechanical stage, which is built on the Microscope and is very rigid, has a range of 25 mm. in a vertical and 60 mm. in a horizontal direction, both graduated to $\frac{1}{2}$ mm. The mechanism of the latter movement can, if desired, be removed, leaving a large square stage 3⅞ in. by 3½ in., on which large sections or the contents of a Petri dish can be examined.

Stand No. 2 (fig. 74) is similar to the above, with the exception of the stage, which is mounted above the trunnions to allow a Mayall adaptable mechanical stage being fitted. The instrument is mounted on a tripod claw foot and is provided with either a substage having diagonal rack-and-pinion or spiral screw focusing adjustment.

Plane and concave mirrors of 50 mm. diameter are supplied in gymbals, mounted on a tail-piece with universal movements.

Baker's New Model Histological Microscope.*—This instrument (fig. 75) is a smaller type of the D.P.H. No. 2, but has only one milled head actuating the fine-adjustment.

NACHET—**Microscope pour déterminer les taches de sang visibles ou invisibles, récentes ou anciennes, sur un corps opaque.**
C.R. Assoc. Anat., 10 Réun., Marseilles, 1908, pp. 201–3 (2 figs.).

GEBHARDT, W.—**Aus Optischen und Mechanischen Werkssatten ii.**
[The writer continues his review of improvements in English and foreign Microscopes.] *Zeitschr. wiss. Mikrosk.*, xxv. (1908) pp. 452–71 (10 figs.).
Note.—For the writer's first paper see *Tom. cit.*, p. 36.

(3) Illuminating and other Apparatus.

Simplified Apparatus for Drawing with the aid of the Projection Microscope.†—W. A. Riley's simple device is intended for use in the lecture room where a projection outfit stands, without duplication of

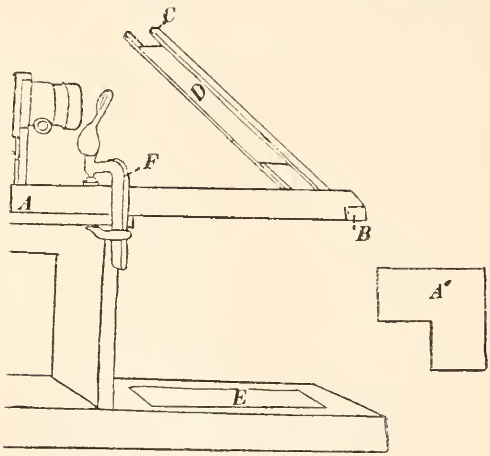

FIG. 76.

apparatus or requirement of extra space. It consists (fig. 76) of a rod holding a mirror at an angle of 45°, clamped to the stand which carries the projection lantern or the micro-projection outfit. In a darkened

* C. Baker's Special Catalogue, 1909.
† Science, xxix. (1909) pp. 37–8 (1 fig.).

room the projection of microscopic preparations, lantern slides, or of photographic negatives may be easily traced, and a glance at the illustration will show the simplicity of the construction. A, shown also in end section at A′, is a piece of wood 2 × 2 in. and about 3 ft. long, grooved by means of a rabbet plane, so as to clamp firmly to the lantern table (see A′). The arm B bears the two grooved strips C, which carry at an angle of 45° the mirror D. This casts the image on the drawing surface E, where it may be traced with ease. The magnification depends directly upon the distance of the drawing-board from the mirror. Thus if the enlargement is two times when the line E–D is 10 in., the image will be enlarged four times if the line E–D is 20 in. Magnification also depends upon the distance of the mirror from the lens.

Direct-vision Prism and Apparatus for the Projection of Spectra and for Illumination with Spectral Light.* — J. Koenigsberger describes under the above title the fluid prisms made by the firm of F. Hellige and Co., of Freiburg, Breisgau. He recommends them as superior in cheapness and efficiency to any others, and as more adapted for projection.

Illuminating Arrangement for the Metal-Microscope.†—W. v. Ignatowsky draws attention to the difficulty of effectively illuminating

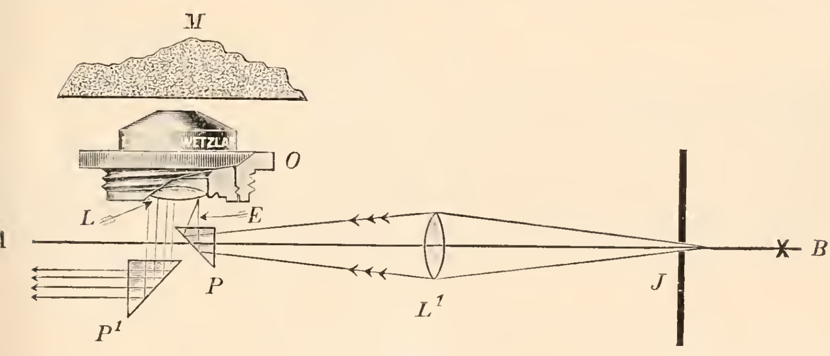

Fig. 77.

the object in high-power metallography, and points out that illumination must therefore be through the objective. Reflections at the back surfaces of the constituent lenses, however, interfere with the object, and, although these reflections can be to a certain extent cut out by a stop, the manipulation is tedious and difficult. The author suggests, therefore, the arrangement shown in fig. 77. B is the light-source; J, an iris; L_1, a small lens; M, the metal object; O, the objective; L, the back lens; and P the prism. This prism, P, is rotatory about a perpendicular axis, and can also be moved backwards and forwards along A B. The result is that, when the iris-opening is reduced, any

* Zeitschr. wiss. Mikrosk., xxv. (1909) pp. 287–8.
† Tom. cit., pp. 434–8 (3 figs.).

rays reflected at L are thrown aside and do not reach the second prism. This adjustment is described as easy and rapid.

Fig. 78 shows the complete apparatus, as built up by Messrs. Leitz, on Le Chatelier's principle. The object is simply laid on the stage T, and adjustment is performed by stage-movement, the other parts of the apparatus being unmoved. By means of the second prism P (fig. 77) the rays required for vision are switched off to the left, and the actual observation is through O and a corresponding prism. If this last prism be taken out, the photographic apparatus comes into action. A small lamp of constant current-strength (4 amperes) with hand-regulation serves as the light-source.

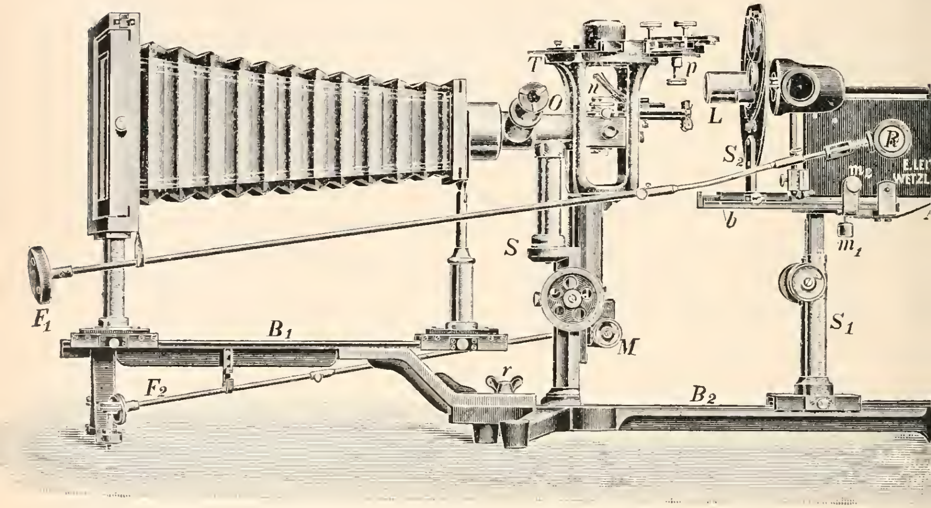

Fig. 78.

Microscopical Observations with Dark-ground Illumination.*—In this article H. Siedentopf discusses the following points connected with dark-ground work:—(1) Brightness of condenser; (2) criteria for under- and over-correction; (3) cover-glass correction due to tube-movement; (4) observations with immersion-systems; (5) advantages of dark-ground illumination with coloured preparations; (6) variations in images.

In dealing with the first head, the author describes a method of testing the brightness of a condenser by directly observing the visibility of the issuing rays. A black glass plate G (fig. 79) and a small prism A are cemented on to the underside of a cover-glass D, leaving between them a hollow space 15 mm. long, 3 mm. high, and 2–3 mm. broad. This space is to receive a fluorescing immersion fluid, cedar-

* Zeitschr. wiss. Mikrosk., xxv. (1909) pp. 273–82 (3 figs. and a plate of 9 microphotographs).

wood oil being recommended, as in arc-light it fluoresces without further treatment. This little apparatus is set centrally on the condenser P. The dark-ground condenser is then so placed on the Microscope stage that the middle of the prism A lies in the Microscope axis. Capillary attraction draws the cedar oil up into the hollow space. A narrow slit (fig. 81) is arranged under the condenser, the slit being about 2 mm. broad between the two slips of cardboard, and lying approximately centrally over the central diaphragm C. As the condensers are figures of rotation, it suffices to discover the ray-combina-

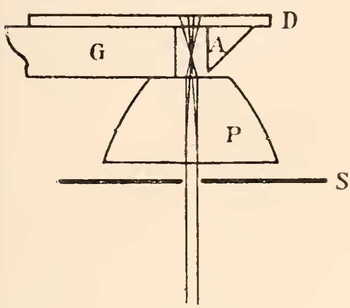

Fig. 79.

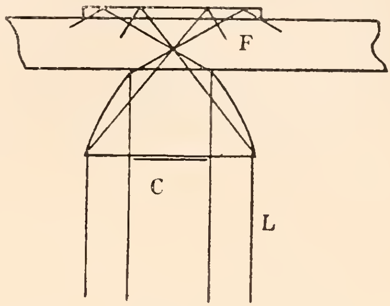

Fig. 80.

tion in a plane-section containing the axis of rotation. Such a part is stopped out by means of the slit S. When the length of the oil-chamber has been made to coincide with that of the slit, it is then possible, by help of the prism A, to observe the course of the rays directly with a loup, or with a low Microscope system. Two ray-courses are observed near the prism: one from above, one from the side. Fig. 80 gives a diagrammatic representation of these rays L, which pass outside the central stop C, and through the slip S enter the condenser approximately parallel. These come to a focus at F in the cedar-oil space, and are then totally reflected at the cover-glass. The prism A reveals these rays against the dark background of the black glass G. Arc-light must be used at a distance of 1–2 metres, and the horizontally incident rays are not reflected up the Microscope from a mirror (which usually gives two images) but from a right-angled totally reflecting prism; in one series of observations the arc-light being focused by a lens, the second series being without any such control. In the former case a larger illuminated view-field and a much more intensive dark-ground illumination were obtained. The author gives a plate of nine photomicographs showing the illumination under different circumstances. The superior brightness in the cases when an illuminating lens was used is very noticeable.

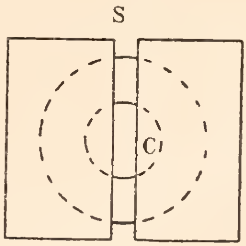

Fig. 81.

Work with the Paraboloid Condenser.*—W. Scheffer communicates, with much technical detail, an account of certain work with the Zeiss paraboloid condenser. The plate appended to his paper consists of six instantaneous photographs of various objects (spermatozoids, blood-corpuscles, etc.), some of which were photographed while in active motion.

Hensoldt and Sons' New Angle Prisms for 90°, 180°, 45°, and Roof-prism.†—The Wetzlar firm strongly recommend these prisms as being much superior to the glass mirrors frequently used in optical instruments. Their special advantages are: (1) Very large field of view; (2) absolute accuracy; (3) invariability; (4) quick orientation with regard to the object. The manner of use is to obtain coincidence of object and the image, as is often done by mirrors in instruments of older type.

Fig. 82 shows the "pentagon" prism, which is adapted for deviating

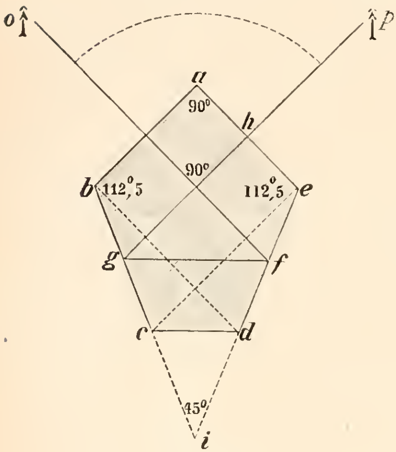

Fig. 82.

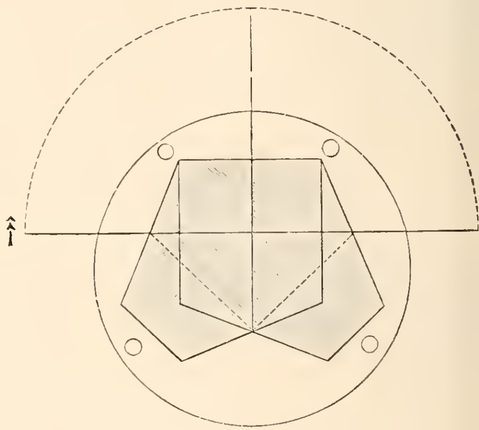

Fig. 83.

a ray through 90°. The path of the ray proceeding from *o* and falling perpendicularly on the surface *b a* is easily traced on the diagram. It will be noted that the prism is made of one piece.

Fig. 83 shows a combination of two "pentagon" prisms reversed and rotated through 90°. This arrangement gives a deviation of 180°.

Fig. 84 shows the "pentagon" prism bisected through *i* and inverted. If now the observer looks over the prism in the direction *a c* at an object *p* he will find *p* coincide with the image of *o* seen by refraction and reflection along the broken line *o g r s t*. In this way an angle of 45° was obtained.

* Zeitschr. wiss. Mikrosk., xxv. (1908) pp. 446–50 (1 pl.).

† Catalogue, M. Hensoldt und Söhne, Wetzlar.

Fig. 85* shows the same firm's new roof-prism ("Dachprisma"). It is intended to serve the purpose of an erecting-lens in optical instruments, accomplishing the same object without loss of light. The prisms are totally reflecting, and have no cement layer.

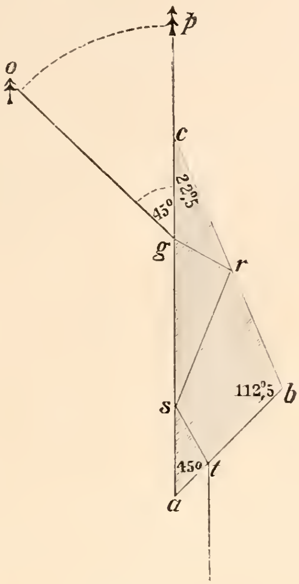

FIG. 84.

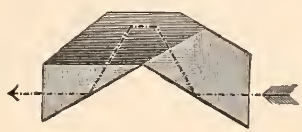

FIG. 85.

Simple Drawing and Projection Apparatus.†—W. Imboden has devised an apparatus for drawing microscopical low power objects. It

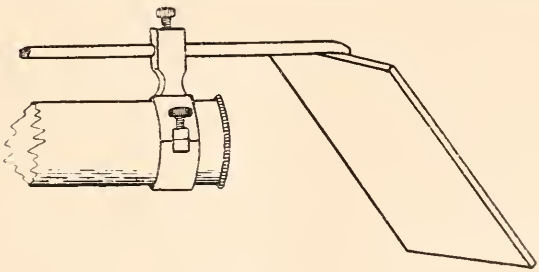

FIG. 86.

consists of: (1) a Microscope inclined to a horizontal position, fitted with a long-focus condenser, a 1-in. objective and one or two oculars; (2) a projecting mirror; (3) a light-screen; and (4) an adequate

* Catalogue, Astronomische-Optik.
† Journ. Quekett Micr. Club, x. (1909) pp. 353–6 (2 figs.).

illuminant. The projecting mirror (fig. 86), about 4 × 3 in. in size, is fixed to a metal arm, about $4\frac{1}{2}$ in. long, which is connected with the draw-tube of the Microscope by means of a clamping ring. It is fixed so as to incline towards the face of the ocular at an angle of 45°, and can be adjusted for length by sliding the arm in or out.

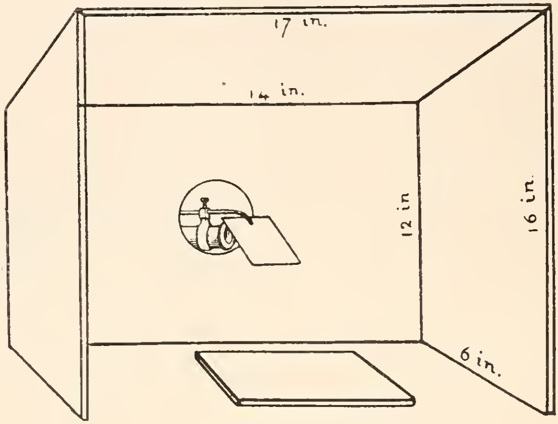

FIG. 87.

The screen (fig. 87), the shape and size of which, and also the position of the ocular and mirror, may be gathered from the illustration, is constructed of cardboard or thin wood.

(4) Photomicrography.

Resolution of Edges in Microscopical Images.*—In this article, H. Siedentopf discusses the resolution of objects which are ultramicroscopic in two dimensions only. Such objects are frequently exemplified in the case of free edges, bacteria, scratches, etc. The edges produce ultramicrons of the nature of diffraction-stripes rather than of diffraction-disks, and are best seen by dark-ground illumination. The breadth of the stripe varies as the aperture of illumination and as the wave-length. But, while with ultramicrons of approximately equal diameter the direction of light-concentration is immaterial, it is altogether another matter with edges, which are necessarily best revealed with light of a suitable inclination. Such objects are, therefore, closely dependent upon the *azimuth of illumination*. The author explains this term by supposing the Microscope tube vertical and by considering a ray which strikes the tube-axis at a certain angle. This ray and the axis are in a certain plane, and if the observer on looking down the tube imagines a clock-dial in front of him, the position of this plane can be fixed by reference to the plane containing the tube-axis and the figures xii and vi on the dial. Thus an azimuth of 90° would lie to the due right of the observer. The azimuth of an edge in a microscopical

* Zeitschr. wiss. Mikrosk., xxv. (1908) pp. 424–31 (1 pl. and 2 figs.).

preparation can be similarly stated and the *relative azimuth* of such an edge to the illumination would be the difference of edge-azimuth and illumination-azimuth. As a good working principle, the author lays it down that considerable quantities of light are diffracted by edges and such-like objects in a direction perpendicular to themselves (i.e. in the direction of the Microscope axis) only if the illumination-azimuth is approximately perpendicular to the plane which contains the edge and the Microscope axis.

The appearance is easily studied in the back focal plane of the Microscope objective after extraction of the ocular. It is seen with both transparent and absorbent bodies and with both microscopic and ultramicroscopic edge-thicknesses. Among objects with ultramicroscopic edges must be reckoned many bacteria as well as very fine crystalline needles. These last would essentially decompose the light in the neighbourhood of an edge, which might perhaps act as a very sharp-pointed prism. In order therefore to make edges visible in the microscopical image, it is requisite that the illumination lie in relative azimuth of 90° or 270° to them. If it is desired that at any selected azimuth all edges in the object should appear in the image, then the illuminating rays must impinge at all azimuths, and all azimuths of the illuminated condenser aperture must be filled with light. But if the azimuth of illumination be limited by a slit-diaphragm (fig. 88) placed in the Abbe diaphragm holder, then in the microscopical image only those edges appear whose azimuth relative to the slit is 90° or 270°. On rotation of the slit-diaphragm a continuous alteration of the image will result, some edges disappearing and others coming into view.

FIG. 88.

The author illustrates his treatise by a plate showing the images of some plankton material from the Mediterranean. One view is due to light in all azimuths and two views of the same object to light at azimuths of 90° to each other. The views, at first sight, would seem absolutely discordant.

If the condenser is racked a little out of focus, the centre of the field appears dark and the diffraction-stripes group themselves in a merry-go-round fashion (Karusselförmig), and as the slit-disk is rotated these continually change, only those edges coming into view which are perpendicular to the azimuth of illumination. The author suggests that an application of his ideas might be of practical value in helping to bring out special detail in an object. As another illustration he shows the very different appearances presented by *Spirochæta pallida* under similar treatment.

Simple Stand for Photography of Macro- and Microscopic Objects.* — H. L. Heusner has found that he can get a very useful stand out of a cylindrical iron rod of 20–25 mm. diameter and 100–150 c.cm. length. (fig. 89). The lower end fits into a heavy foot and rests upon the floor, or on a stove, and the upper end is arranged for convenient clamping to

* Zeitschr. wiss. Mikrosk., xxv. (1908) pp. 432–3 (1 fig.).

the edge of a table. The camera slides on the rod and can be clamped in any position required. A few inches below the camera, and at a suitable distance for focusing, slides a stage intended to receive a clear glass plate, a milk-glass plate, a sheet of cardboard, or a metal plate. A hinged arm carries an incandescent lamp for illuminating the upper surface. By means of a mirror on a lower stage the lamp-light can be directed upwards on to the lower side of a transparent object. Both stages can be clamped at any desired height, they can also be easily swung out of action, and this is done for photomicrography, the Microscope being then placed on the stool, or floor, vertically under the camera.

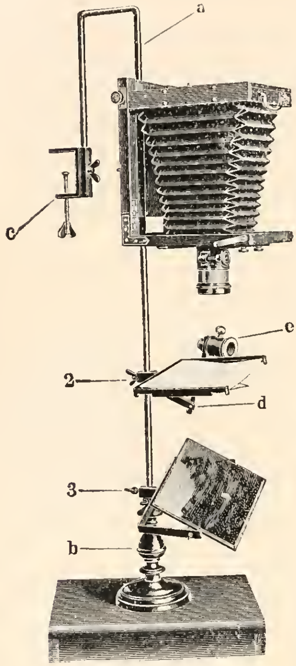

Fig. 89.

Economical Monochromatic Filters.*—J. Jullien gives the following directions for obtaining filters. Take an unexposed sensitive plate, fix it by hyposulphite, and wash it as a negative. Afterwards immerse it for some minutes in a solution of 70 p.c. alcohol, 200 cm. Mars yellow (aniline) 1 gr. Dry it out of reach of dust. This gives filters very nearly approaching the ideal yellow. Other aniline colours, after comparative trials with the spectroscope, will give by this process excellent screens of other tints; the green is, after the yellow, most frequently employed.

Kinematography of Fertilisation and Cell-division.†—J. Ries describes how he applied a kinemato-photomicrographic apparatus to record the successive changes occurring during fertilisation and cell-division. The author used (fig. 90) a Zeiss Microscope and photographic apparatus, a prism being inserted between the ocular and bellows. The correct focus was obtained by means of a mirror, revolving 45°, placed in the box intervening between the bellows and the kinematograph; the image being thrown on a round glass disk. When the egg was ripe for division, the mirror was turned, the rays from the Microscope being then directed on to the kinematograph film. The progress of division was from time to time controlled by means of the mirror. The kinematograph apparatus was the ordinary Lumière's, and was actuated by a clockwork mechanism which turned the crank seven times a minute. The illuminant, an electric metallic film lamp,

* Bull. Soc. Zool. de Genève, 1908, p. 104.
† Arch. Mikr. Anat. u. Entwickl., lxxiv. (1909) pp. 1–31 (2 pls. and 12 figs.).

is described as defective, but later the author had recourse to a special apparatus which allowed the use of sun- and arc-light, so that higher powers could be employed.

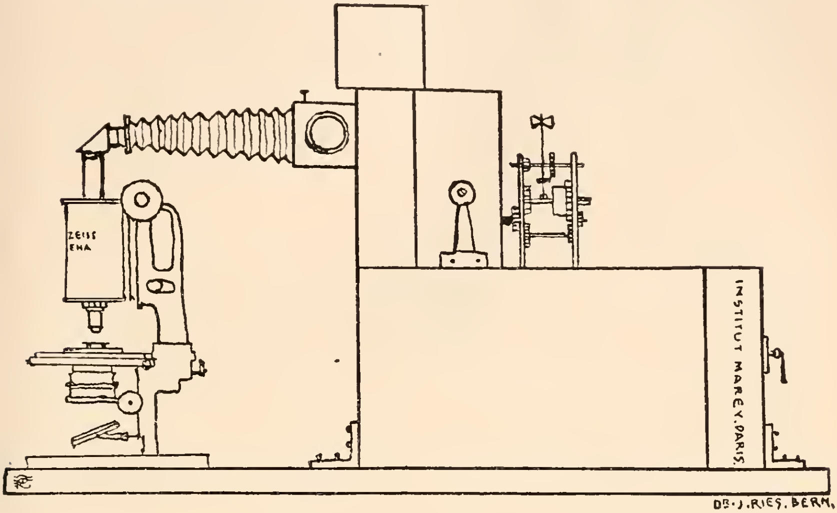

FIG. 90.

Practical Photomicrography.*—J. Jullien describes how an operator, moderately skilful with his hands, can make a framework which will give very satisfactory results at an outlay of about a couple of shillings. The bottom of a kind of box on suitable trestles is pierced for the insertion of the microscope tube, and the top is formed of a ground-glass plate. The apparatus is thus a camera of peculiar form. The light source is an incandescent gas lamp, and the author gives full practical details.

MILNE, J. R.—**A Special Form of Photographic Camera for Recording the Readings of the Scales of Scientific Instruments.**
Proc. Roy. Soc. Edinburgh, xxix. (1908–9) pp. 176–81 (4 figs.).

(5) Microscopical Optics and Manipulation.

BARNARD, T. E.—**Ultra-microscopic Vision.**
[Gives a clear account of the present state of this subject.]
Nature, lxxix. (1909) pp. 489–90 (2 figs.).

(6) Miscellaneous.

Quekett Microscopical Club.—The 458th Ordinary Meeting was held on June 4, Dr. E. J. Spitta, F.R.A.S. F.R.M.S., Vice-President, in the Chair. A specimen of *Navicula lyra* exhibiting abnormal markings, one of several found in the same gathering, sent by Mr.

* Bull. Soc. Zool. de Genève, 1908, pp. 101–4 (1 fig.).

Walter Bagshaw, was shown by Mr. C. Lees Curties, F.R.M.S. Dr. Spitta referred to the great variability of *Navicula smithii*. Mr. F. Martin Duncan, F.R.P.S., gave a lecture on "The Romance of Forest Life," with lantern illustrations.

KOCH, L.—**Die mikroskopische Analyse des Drogenpulver. Ein Atlas für Apotheker, Drogisten, und Studierende der Pharmazie.**
Berlin: Gebr. Bornträger, 1908. Vierter Band (Schlussband): Die Samen und Früchte (14 lith. Taf. u. 16 Holzschritten).

B. Technique.*

(1) Collecting Objects, including Culture Processes.

Cultivation of Spirochæta Duttoni.†—C. M. Duval and J. L. Todd have successfully cultivated this organism on a medium which is prepared as follows:—"The yolks of two fresh hen's eggs are carefully separated from the whites under aseptic precautions and dropped into a 200 c.cm. Erlenmeyer flask, to which has been previously added 100 c.cm. of a sterile mouse decoction, made by boiling the skinned bodies of six mice in 500 c.cm. of water. This mixture is thoroughly shaken until it is homogeneous, when 5 c.cm. of defibrinated sterile mouse blood is added to it. The flask is now sealed, to prevent drying of the medium, and placed at 37° C. from six to eight weeks until the mixture undergoes partial digestion. The semi-fluid mass first becomes solidified and finally, through autolytic action, is broken down to a mush-like, grumous mass. In our experience this partial auto-digestion of the medium seems essential to the multiplication of the *Spirochætæ*. If the egg mixture is coagulated at higher temperatures it seems to be no longer suitable for the growth of the parasites." The authors formulate the following conclusions as the result of their experiments:—(1) That *Spirochæta duttoni* can be maintained virulent for white mice for forty days; (2) that it will multiply and can be successfully transferred in artificial media.

Examining Living Leucocytes in vitro.‡—C. Ponder describes a method whereby he obtains perfectly clean preparations of a great quantity of leucocytes obtained direct from any blood, the leucocytes being kept alive for quite a long time. The necessary apparatus is to be found in all pathological and physiological laboratories; the only other unusual material is modelling clay or "plasticine."

The essential point is the preparation of a blood-chamber whereby the white cells are allowed to escape from the clot and adhere to the surface of a slide or coverslip, the clot being afterwards removed. To make this chamber a morsel of plasticine, half the size of a pea, is rolled out until it is as thin as the lead of a pencil and about an inch and half long; this is then taken and gently fixed on a clean slide, so

* 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.

† Lancet, 1909, i. pp. 834–5.

‡ Proc. Cambridge Phil. Soc., xv. (1909) pp. 30–3 (2 figs.).

as to wall in a small chamber with an entrance passage leading into it (fig. 91).

A drop of blood is allowed to fall into the chamber at *A*, a coverslip is imposed and gently pressed down with a glass slide, so that as the plasticine is flattened, blood and air are driven out of the passage *B*, which must be kept patent so that the chamber is completely filled with an even layer of blood (fig. 92).

The chamber is now incubated at about blood temperature for any length of time, from ten minutes to three or four hours, according to requirements. The whole slide in which the chamber has been prepared is immersed in a dish of normal (75 p.c.) saline. During

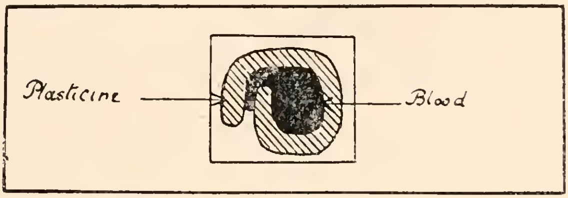

FIG. 91.

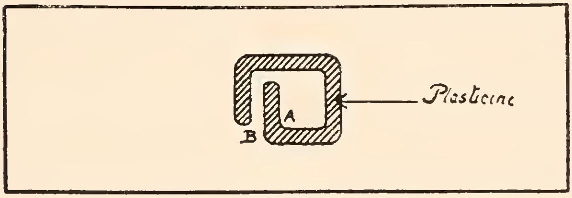

FIG. 92.

incubation the blood clots, the leucocytes escape and adhere firmly in hundreds to the surface of the slide and coverslip which form the floor and roof of the blood-chamber. It is now only necessary to clean away the clot. To do this the coverslip is removed while under the surface of the warm saline by passing beneath it the point of a knife or needle, and what remains of the clot and the plasticine is scraped away with a small knife. The slide should now be washed in the warm saline until all free red cells have been rinsed off. The slide may now be examined in saline under the warm stage or it may be kept for a time by means of a thin plasticine chamber constructed on a coverslip and filled with saline.

Æsculin Bile-salt Media for Water and Milk Analysis.*—F. C. Harrison and J. van der Leck recommend the use of æsculin in media especially when searching for *B. coli*. Æsculin is a glucoside and undergoes a hydrolytic fermentation when attacked by *B. coli* and other organisms. It splits into sugar and æsculetin, and the latter combines with the iron of the medium to form a dark-brown salt. The reaction

* Centralbl. Bakt., 2te Abt., xxii. (1909) pp. 547–52.

takes place only in sugar-free media. Colonies of *B. coli* are black and easily counted against a white background. Certain other organisms, notably *B. lactis aerogenes*, form black colonies, but are distinguishable from those of *B. coli* in being larger, moister, and more raised.

The method of making the media is given as follows: Weigh out 1–2 p.c. Witte's peptone; 0·5 p.c. sodium taurocholate; 0·1 p.c. æsculin; 0·05 p.c. iron citrate; 100 c.cm. tap-water. After steaming from fifteen to thirty minutes the medium is filtered and filled into test-tubes. For æsculin agar 1·5 p.c. agar is used, and after dissolving the agar in part of the water the remaining ingredients are added, brought to the boil and filtered, or else the medium is cooled by the addition of white of egg or albumen, again brought to the boil and then filtered and tubed. The tubes are afterwards sterilised in the usual way. In the broth the medium turns black. After inoculating tubes and slopes with the suspected fluid, the rest of the sample receives some 10 c.cm. of 4-times strength æsculin bile-salt broth and then all tubes, plates, bottles, etc., are incubated.

Modification of Kindborg's Acid-fuchsin Agar.*—Doepner appreciates Kindborg's acid-fuchsin agar for detecting *Bacillus typhosus* in stools and urine. To this medium, which is composed of agar stained red by means of 5 p.c. of saturated aqueous solution of acid-fuchsin, and also containing 5 p.c. lactose, the author advises the addition of malachite-green, thus combining the benefits of the two procedures.

Cultivation of Leishmania infantum, the parasite of Infantile Kala-azar.†—C. Nicolle shows that this disease occurs in Tunis, and describes the method he adopted for successfully cultivating this organism. Agar is macerated in cold water for 24 hours, the water being changed once. The amount of water absorbed is noted. The formula is as follows: agar 14 grm., common salt 6 grm., water 900 c.cm. This is distributed into test-tubes without neutralising or alkalinising, and then the tubes are sterilised in the autoclave. The tubes, the contents of which are liquefied at from 48°–52°, then receive one-third of their volume of rabbit's blood removed from the heart aseptically. The tubes are then sloped for 12 hours, and are afterwards incubated for 2 to 3 days at 37°. As the condensation water was small it was found advisable to add an equal volume of normal serum. The inoculations were made with a pipette or with a platinum loop. The foregoing method is a modification of that devised by Novy and McNeal.‡

Method of Detecting Indol.§—G. Morelli uses strips of blotting-paper soaked in a hot saturated solution of oxalic acid. When cold the strips are suspended in the culture tube, and if indol be formed they turn red.

New Method of Isolating Human Tubercle Bacilli.‖—F. W. Twort states that by means of a glucoside, ericolin, tubercle bacilli can be

* Centralbl. Bakt., 1te Abt. Orig., l. (1909) pp. 552–60.
† Ann. Inst. Pasteur, xxiii. (1909) pp. 361–401 (2 pls.).
‡ See this Journal, 1904, p. 116.
§ Centralbl. Bakt., 1te Abt. Orig., l. (1909) pp. 413–15.
‖ Proc. Roy. Soc., Series B, lxxxi. (1909) p. 248.

isolated quite easily from human sputum, though it be contaminated with other organisms. The glucoside is made up with distilled water to a 2 p.c. solution ; a lump of sputum is placed in a test-tube containing the ericolin and incubated at 38° C. for ¾ to 1 hr. Cultures are then made on Dorset's egg medium, and pure growths of tubercle bacilli will be obtained in 14 to 28 days. The tubes are sometimes contaminated with a few other organisms, chiefly streptococci and streptothrix, but they are so few that they do not interfere with the tubercle colonies, and subculturing is easy.

LENDVAI, J.—**Wie kann man die thermostaten mit alcohol einfach heizen.**
[Describes an apparatus for heating incubators, etc., by means of alcohol.]
Zeitschr. wiss. Mikrosk., xxv. (1909) pp. 303–6 (2 figs.).

(2) Preparing Objects.

Examining Euphausidæ.*— E. Taube filtered the catch through silk gauze, examined small portions under a simple Microscope, and picked up the objects with a pipette. If, however, the catch contained numerous eggs, as was the case in material obtained from Norway, there was no need to use a loup, and the filtered catch was at once fixed. The fixative chiefly used was Bouin's fluid (saturated aqueous picric acid 15, formol (40 p.c.) 5, acetic acid 1). After 3 to 5 hours the eggs were transferred to 70 p.c. alcohol, which was very frequently changed ; later on 96 p.c. alcohol was used. The stains mostly used were borax and picrocarmin. The preparations were examined in toto and in sections. To examine the eggs properly they must be rendered transparent by means of glycerin or of oil of cloves. The latter reagent, however, rendered the eggs too brittle, so was abandoned in favour of the former. In order to prevent shrinkage the transference from alcohol to glycerin must be extremely gradual, and at first the evaporation method must be adopted, the eggs being removed from 70 p.c. alcohol to a mixture of 2 parts 70 p.c. alcohol and 1 part glycerin. As the alcohol slowly evaporates the glycerin becomes more and more concentrated, and finally the eggs are quite clarified, and when in this condition give most excellent pictures of whole eggs and their contents. When examining eggs in sections greater difficulties are met with, chiefly those of orienting, but on reaching the gastrula stage the ordinary paraffin method gave fair results.

Studying the Relations between Acari and Cancer.†—A. Borrel fixes the pieces of skin removed during life from cases of suspected early cancer in the following solution : water 350, osmic acid 2, chromic acid 3, platinum chloride 2, glacial acetic acid 20.

Paraffin sections are made parallel to the surface of the skin and stained with magenta-red-picro-indigo-carmin, after the manner given in a previous memoir. Made in this way, about 200 serial sections from each tumour were examined, so that the appearances of the hairy system could be accurately studied at different and numerous levels. With a little practice the acari, when present, are easily recognised.

* Zeitschr. wiss. Zool., xcii. (1909) pp. 427–64 (2 pls.).
† Ann. Inst. Pasteur, xxiii. (1909) pp. 97–124 (4 pls. and 12 figs.).

Phosphomolybdic Acid as Fixative.*— B. Rawitz praises the virtues of phosphomolybdic acid for fixing tissues. Phosphomolybdic acid in solution (Kahlbaum) 40 c.cm., alcohol (93–95 p.c.) 50 c.cm., acetic acid 10 c.cm. The solution should be prepared fresh each time, though the alcoholic solution of the acid may be kept in stock and the acetic acid added just before use. The objects should be left in the fixative for 24 hours, and then transferred to up-graded alcohols from 70–100 p.c. Paraffin sections made in the usual way from the hardened material must be further treated for from 2 to 24 hours by immersing them in water to which an aliquot part (5 to 10 drops) of a 5 p.c. solution of calcium acetate has been added. They are then repeatedly washed in distilled water and afterwards stained.

Demonstrating the Organic Constituents of Enamel.†—L. Fleischmann imbeds small slices of enamel with the adjacent dentine in celloidin, and then, after the usual manipulation, decalcifies in 5 p.c. nitric acid. The slice is found to be decalcified when the celloidin becomes clear. It may afterwards be sectioned and stained in the usual way. Safranin is recommended.

Wash-bottle for Microscopical Purpose.‡—R. Krause has devised a bottle for washing microscopical preparations, the construction of which is intended to obviate the running dry or overflowing arising from variations in pressure of the water supply. As will be seen from the illustration (fig. 93), the inflow siphon has three elbows, the top of one being a little higher than the angle of the outflow siphon, the inside leg of which almost touches the bottom of the bottle, the interval being a mere capillary cleft.

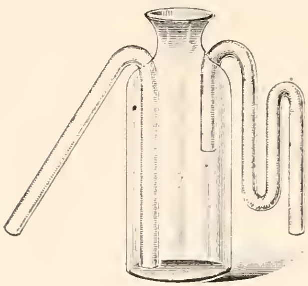

Fig. 93.

Demonstrating the Kinoplasmatic Connecting Threads between the Nucleus and the Chromatophores.§—B. Lidforss made thin handcut sections of the tissue and exposed them for from 5 to 15 seconds to the vapour of 2 p.c. osmic acid. The sections were then transferred to up-graded alcohols at intervals of about 2 to 5 minutes until absolute was reached; in this they were kept for 12 to 24 hours. When quite hard the sections were retransferred to water and afterwards stained. The stain mostly used was Zimmermann's fuchsin-iodin-green or fuchsin-methyl-green. Renault's hæmatoxylin-eosin occasionally gave good results.

* Zeitschr. wiss. Mikrosk., xxv. (1909) pp. 385–96 (1 pl.).
† Tom. cit., pp. 316–18.
‡ Zeitschr. wiss. Mikrosk., xxv. (1909) pp. 300–2 (1 fig.).
§ Acta Univ. Lundensis, iv. (1908) pp. 8–11 (4 pls.).

(3) Cutting, including Imbedding and Microtomes.

Leitz' Base Sledge Microtome.*— This instrument (figs. 94, 95) consists of a cast iron base provided with a horizontal slide bed, within which moves an accurately fitted heavy sledge which supports the object-carrier. The latter is raised by a micrometer mechanism which is mounted upon the sledge, but which is actuated independently of the motion of the sledge. The knife is supported by two pillars, which can, by means of T-bolts and variously placed slots, be clamped in any desired position, so that the knife may be fixed at right angles for paraffin cutting, or obliquely for celloidin cutting, with respect to the direction or motion of the sledge. When the object is exceptionally high the knife may be raised by placing below the knife-

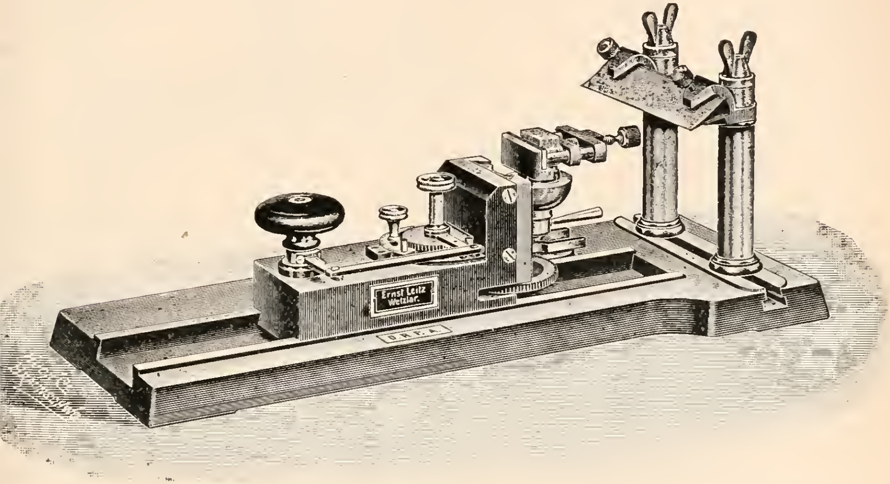

Fig. 94.

clamps the rings which are usually immediately below the wing nuts at the top of the pillars. The latter may, moreover, be placed as close together as the size of the object will admit, so that small preparations may be cut with a closely supported blade, and therefore under conditions of the greatest stability. Like the fixing of the knife, the bedding and movement of the object-holder insures the utmost degree of rigidity. The advantages resulting from this rigid arrangement for supporting the object are further enhanced by the addition of a new object clamp provided with a universal ball-and-socket joint. This clamp surpasses the usual form of cross-jointed clamps in that the preparation remains in all positions almost strictly at the centre of the clamping device. The micrometer movement is at the back of the sledge, and is operated by the rotation of a knob, which likewise serves to move the sledge to and fro. By suitably adjusting the

* E. Leitz' Special Catalogue, 1909, 4 pp. (2 figs.).

tappet a single rotation of the knob may be made to impart to the object an elevation varying from 0·001 to 0·020 mm. Thicker sections than these may be cut by turning the knob more than once. Any kind of knife may be used in conjunction with this microtome. Celloidin preparations are appropriately cut with a knife having a blade 24 cm. long and 33 mm. wide, and a back 13 mm. thick. The various parts of the microtome are either enamelled or nickel-plated.

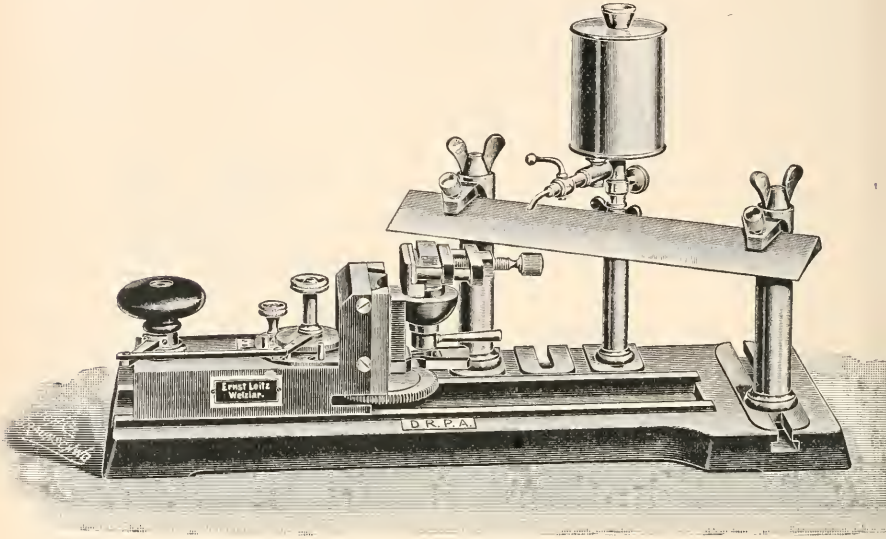

Fig. 95.

Rapid Examination of Tumours for Diagnostic Purposes.*—A. Leitch finds the following method gives very satisfactory results :—Thin slices of the doubtful tissue, about 1 mm. in thickness, are removed, and placed immediately in acetone and taken to the laboratory. The slices are transferred to hot water for a few seconds, dipped in gum solution, and placed on the stage of a freezing-microtome. The current of carbon dioxide is turned on, and the whole tissue is well frozen in less than one minute. The microtome used is a very handy little apparatus made by Leitz, the knife-carrier of which is sufficiently heavy to give a good momentum to the razor. The sections, as they fly off tangentially, are caught in a basin of water held by an assistant. They are floated on to a glass slide, the excess of water is dried off, and a drop of acetone solution of "krystallviolet" is placed on the section. This fixes it to the slide and stains it rapidly. The excess stain is removed with water and acetone, and the section is cleared with xylol, and is then in a condition to be examined under the Microscope. Good histological preparations can thus be obtained and may be kept permanently. Allowing 2 minutes for conveyance of the tissue from

* Brit. Med. Journ. (1909) i. pp. 1226–7.

the operating theatre to the laboratory, during which time the specimen lies in acetone, the author has found that on an average the whole time occupied, from the removal of the tissue till the diagnosis is given to the surgeon, is 7 minutes.

Combined Imbedding Method.*—Herzog Gandolfi hardens and dehydrates the object in upgraded alcohols, and then transfers to a mixture of equal parts of toluol and absolute alcohol for a day, and afterwards to a solution of celloidin in the foregoing fluids and having the consistence of cedar wood or olive oil. According to its nature the object requires from 3 to 7 days saturation. When sufficiently saturated the object is transferred to chloroform, in which are placed a few drops of ether and some bits of paraffin, and incubated at about 56° for some 15 minutes, and then transferred to pure paraffin for 30 minutes or so, after which it is imbedded and sectioned in the usual way.

HOYER, H.—**Eine neue Vorrichtung zu Injektionen.**
[An apparatus intended for injecting small animals.]
Zeitschr. wiss. Mikrosk., xxv. (1909) pp. 412–20 (3 figs.).

SSOBELEW, L. W.—**Zur Celloidintechnik.**
[Gives the author's precedure in minute detail for dealing with a celloidin section.] *Tom. cit.*, pp. 410–12.

(4) Staining and Injecting.

Differentiating Ergastoplasm and Mitochondria in the Human Submaxillary Gland.†—C. Regaud and J. Mawas find from their examinations that the mitochondria and ergastoplasm differ in shape, situation, and histochemical reactions. They deduce their conclusions from a comparative study of four kinds of preparation, viz.: (1) fixation with fluid containing 5 p.c. acetic acid; (2) fixation with formalin and chromic acid or a chromate. The tissues thus fixed were stained with (1) hæmalum and (2) iron-hæmatoxylin.

New Method for Staining Spirochæta pallida in Tissues.‡—J. Yamamoto has modified the original procedure in the following way. The tissue to be investigated may be preserved in various solutions, and is then cut into small pieces 10 mm. long and 5 mm. in thickness and breadth. These are washed free from the fixing medium by rinsing in water for 24 hours, and finally in distilled water for one hour. Each piece is then put into 10 c.cm. of a 5 p.c. solution of silver nitrate in brown-coloured bottles and kept at 37° C. for 48 hours. At the end of this time they are placed in a reducing solution containing 2 p.c. of pyrogallic acid and 1 p.c. of tannic acid in distilled water in similar brown bottles, in which they are kept for 24 hours at 37° C. It is, however, necessary to change this solution after the first half-hour, since it is rendered turbid by the reduction. After this the pieces of tissue are placed in water for an hour, and then washed in alcohol of increasing strength until decolorised; they are then imbedded in paraffin or celloidin, the latter giving better

* Zeitschr. wiss. Mikrosk., xxv. (1909) pp. 421–2.
† C.R. Soc. Biol. Paris, lxvi. (1909) pp. 461–3.
‡ Centralbl. allgem. Pathol. u. pathol. Anat., Feb. 29, 1909. See also Lancet, (1909) i. p. 933.

results. If it is desired to counterstain the tissues, the sections should be dipped in Löffler's methylen-blue solution for a second. The celloidin is removed in the usual way, and the specimen cleared by oil of origanum instead of by xylol, and then mounted in Canada balsam.

Staining Vegetable Phosphorus Compounds.*—C. Bongiovanni recommends the following methods for detecting organic phosphorus compounds in plant tissues, and has applied it to the seeds of *Ricinus communis*, wheat, and *Tropæolum majus*.

1. Sections of the seeds are warmed gently with dilute hydrochloric acid, washed several times with water, treated with 10 p.c. ferric chloride solution, again washed, immersed in 10 p.c. potassium thiocyanate, and, after further washing, examined under the Microscope, when the globoids are seen to be stained yellow.

2. The sections are immersed for about fifteen minutes in a saturated solution of molybdic acid in hydrochloric acid and then placed, without washing, in a 10 p.c. stannous chloride solution containing a few drops of 5 p.c. potassium or ammonium thiocyanate solution. In this way the cell-sap is coloured a faint yellow, and the globoids of the aleurone granules an intense reddish-violet, whilst the protoplasm either remains colourless or assumes a faint violet coloration.

Staining Fibrocartilage.†—B. Lunghetti obtains good contrast results by staining the sections for half-an-hour in the aqueous solution of tropæolin, and then after-washing in 0·2 p.c. methyl-violet for 1 to 5 minutes. After another wash the sections are immersed in 10 p.c. acetic acid for 5 minutes. Differentiation is obtained by means of alcohol. The basis is orange and the cells violet.

Another stain which gives good contrast by metachromatism is thionin, the hyalin substance being red-violet and the fibrous blue.

New Method of Staining Negri's Corpuscles.‡—F. Neri fixes smears with absolute alcohol and sections by Henke and Zellers' method. He then treats the preparations for 10 minutes in iodine-eosin, and after washing in distilled water, counterstains for 5 minutes with 1 per thousand aqueous methylen-blue. The preparations are then washed, dehydrated, and differentiated in 95 p.c. alcohol and mounted in balsam. The composition and preparation of the eosin-mordant are as follows: 0·1 grm. of iodin and 0·2 grm. potassium iodide are dissolved in a minimum quantity of distilled water, and then the mixture is made up to 50 c.cm. with distilled water. To this is added the eosin solution, made by dissolving 1 grm. of eosin in 50 c.cm. of distilled water. Negri's corpuscles assume a violet-red hue, and are therefore easily detected.

Silver-staining of Spirochæta pallida.§—J. Barannikoff fixed and hardened pieces of tissue, 1 c.cm. by 0·5 c.cm., in different fluids, e.g.

* Staz. Sperim. Agrar. Ital., xlii. (1909) pp. 116–20. See also Journ. Chem. Soc., xcv. and xcvi. (1909) p. 512.
† Zeitschr. wiss. Mikrosk., xxv. (1909) pp. 306–16 (1 pl.).
‡ Centralbl. Bakt., 1te Abt. Orig., l. (1909) pp. 409–12.
§ Tom. cit., pp. 263–7.

5–10 p.c. formalin, Zenker's, Kultschishky's, Schaudinn's. After treating the material when necessary with potassium iodide and hydric peroxide, the pieces were placed in upgraded alcohols and kept in 80 p.c. alcohol. Pieces of the hardened material not thicker than 2–5 mm. are placed in alcohols downgraded to 30 p.c., and then immersed in 1–1½ p.c. silver nitrate at 42° C. for 48 to 120 hours. On removal from the thermostat the pieces are washed for one hour in water, and then placed in 3–4 p.c. aqueous solution of pyrogallic acid at room temperature for 15 to 24 hours, or for a similar time in 10–7½ p.c. aqueous solution of "Agfa"-Rodinal. To the developer is added 3–4 p.c. formalin. On removal the pieces should be washed in running water for an hour, and then passed through upgraded alcohols to equal parts of alcohol and ether, and afterwards to pure sulphuric ether before imbedding in celloidin. The sections may be mounted at this stage in the usual way, or afterstained with hæmatoxylin-eosin, hæmatoxylin-fuchsin, methylen-blue and eosin, or the author's own stain for malaria parasites. All the foregoing procedures, from the moment when the pieces were placed in the brown-glass vessels filled with silver nitrate solution, were carried out in a dark room illuminated with ruby-red glass lamps.

Thionin and Picric Acid after Silver Impregnation of Spirochætes.*—J. Sabrazès and R. Dupérié have found that after staining sections of syphilitic organs by Levaditi's method it is advisable to counterstain with carbol-thionin and then treat with picric acid. The "thionine picriquée" method was devised by Sabrazès in 1897. By this combination the spirochætes are well shown against the yellow and green background of this preparation.

Vanadium-hæmatoxylin and Picro-Blue-black.†—M. Heidenhain recapitulates the formula of his vanadium-hæmatoxylin solution, and refers to his experience of this stain, which he has now used for over 15 years. To a freshly prepared 0·5 p.c. solution of hæmatoxylin is added half its volume of a 0·25 p.c. solution of ammonium vanadate. This should be kept in an hermetically sealed vessel and shaken daily until ripe (8 to 10 days). Connective-tissue, cartilage, etc., are blue, blood-corpuscles, nucleoli, and granules yellow, muscle yellowish brown, cell-plasma dark brown. For connective-tissue he finds the following useful: blue-black B, 1; picric acid, 400; methyl-alcohol, 80; water, 320. This solution may be used or diluted with an equal bulk of water. The stain should be used in conjunction with carmalum.

New Staining Methods.‡—B. Rawitz gives the following formulæ:

1. Nitro-hæmatein: Hæmatein 1 grm.; aluminium nitrate 10 grm.; distilled water 250 c.cm.; glycerin 250 c.cm. The aluminium nitrate is dissolved in the distilled water, the hæmatein is then added, and the mixture heated on a sand-bath to boiling. When cold the glycerin is added. The solution does not overstain.

* C.R. Soc. Biol. Paris, lxvi. (1909) pp. 690–1.
† Zeitschr. wiss. Mikrosk., xxv. (1909) pp. 401–10.
‡ Tom. cit., pp. 385–96 (1 pl.).

2. Nitro-cochineal: Cochineal 4 grm.; aluminium nitrate 4 grm.; distilled water 100 c.cm.; glycerin 100 c.cm. The powdered cochineal is added to the solution of aluminium nitrate, and the mixture is then heated on a sand-bath and allowed to boil for 5 minutes. When cold, the glycerin is added. The staining results are very permanent.

3. Cobalt-cochineal: Cochineal 4 grm.; cobalt-ammonium sulphate 4 grm.; distilled water 100 c.cm.; glycerin 100 c.cm. This solution is prepared on exactly similar lines to the foregoing. It keeps well.

4. Acid-alizarin blue B.B. Höchst: Acid-alizarin blue B.B. 1 grm.; aluminium-ammonium sulphate 10 grm.; distilled water 100 c.cm.; glycerin 100 c.cm. The pigment and the alum are dissolved in the water, and then heated on a sand-bath to boiling. The solution is allowed to cool slowly, and then the glycerin is added. It may be used after any fixative except Flemming. Sections are stained in the strong solution for $\frac{1}{2}$ to 2 minutes, and may then be mounted after washing in distilled water; but it is better to counterstain with picric-acid-fuchsin mixture.

5. Acid-alizarin green G Höchst: Acid-alizarin green G 1 grm.; aluminium-ammonium sulphate 10 grm.: distilled water 100 c.cm.; glycerin 100 c.cm. Prepared in similar way to foregoing. Sections are stained for $\frac{1}{2}$ to 2 minutes, washed in distilled water, and then counterstained with Van Gieson.

Permanence of Microscopic Preparations.*—M. Heidenhain states that sublimate-fixed objects which are treated with iodine do not keep well, but if de-iodised with sodium thiosulphate the iodine is completely removed. A 2·5 aqueous solution is diluted 10 times with water, and the yellow sections are completely bleached by its use in a few minutes. The author also alludes to the advisability of using neutral balsam, large cover-glasses, and as little balsam as possible.

(6) Miscellaneous.

Use of Atropin Sulphate for Anæsthetising Birds.†—R. Pearl and F. M. Surface find the following procedure most useful for anæsthetising birds for surgical operations. Immediately before beginning the administration of the anæsthetic (ether) a $\frac{1}{200}$-grain atropin sulphate tablet is dissolved in 1 c.cm. of warm normal saline solution, and is then injected subcutaneously into the axillary region. The anæsthetic is at once proceeded with and is administered from a mask, which permits the condition of the comb being seen during the operation. The bird is ready for operation in from 15–20 minutes after the anæsthetic has begun to be administered.

Detection of Spirochæta pallida.‡—A. C. Coles states that he has found the most certain and easiest method of detecting *Spirochæta pallida* is by the examination of cover-glass preparations made from the serum by means of dark-ground illumination. Examined by this

* Zeitschr. wiss. Mikrosk., xxv. (1909) pp. 397–400.
† Journ. Amer. Med. Assoc., lii. (1909) pp. 382–3.
‡ Brit. Med. Journ. (1909) i. pp. 1117–20.

method *S. pallida* appears as a shining silver-like thread with corkscrew turns lying in a black or blackish background. In order to obtain a satisfactory result it is necessary to make the films (wet or dry) from the serum only, or as little contaminated with red corpuscles as possible. Fixed films are best stained with Leishman's stain, which has less tendency to deposit than Giemsa's ; but many anilin pigments made up with phenol answer very well. The serum may be stored up in sealed capillary tubes.

Detection of Seminal Stains on Clothing.*—Corin and Stokis have recently shown the affinity of spermatozoa for staining agents containing iodine such as Bengal rose and especially erythrosin. This last substance is a brown powder, forming in water a solution stable in the presence of ammonia. It is used in the strength of 1 in 200 in pure ammonia solution, in which form it keeps indefinitely. In examining a supposed seminal stain a single fibre of the fabric is removed with scissors, and immersed in the staining solution for 1 or 2 seconds. It is then transferred to a drop of distilled water on a slide which is placed on a dark background, and the fibre is thoroughly teased with needles. It may then be covered and examined with a low power, when the fibres of cloth being unstained it is easy to pick out masses of red points, which on higher magnification are seen to be the heads of the spermatozoa. The presence of the ammonia prevents the staining of the vegetable fibres while the spermatozoa are deeply stained, and their tails may be easily seen by using a small diaphragm. When the seminal stain has dried into the cloth the tails of the spermatozoa may be more difficult to demonstrate, but in this case a deeper coloration may be obtained by immersing the fragment of cloth before staining for a few minutes in Müller's fluid (bichromate of potash 1 part, sulphate of soda 2 parts, water 100 parts). This method is applicable to linen, cotton, silk and wool fabrics. The age of the stain seems of little consequence, spermatozoa being readily found in material 10 years old. The erythrosin solution stains most of the cellular structures of animal origin likely to be met with in suspected clothing such as pus, and epithelial cells, but while it shows these very clearly it does not detract from its value in the detection of spermatozoa, the appearance of which is characteristic.

REID, E. E.—**Electrically-controlled Gas-regulator.**

[Can be made quickly and easily out of materials at hand in the chemical laboratory, and is easily cleaned.]

American Chem. Journ., xli. (1909) pp. 148–52 (2 figs.).

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* La Presse Médicale, Feb. 13, p. 120. See also Med. Record, 1909, p. 207.

Metallography, etc.

Application of the Microscope to the Study of Metals.*—Microscopic examination of metals is considered by W. Rosenhain as giving information upon (1) chemical constitution, the mode of combination of the elements present, and the relative arrangement of the constituents; (2) defects existing in the metal, and the causes of failure; (3) the intimate structure of the constituents and the behaviour of the crystals when the metal is strained. The author develops his theory of the structure of eutectics. The tin-lead eutectic appears to consist of spherulitic crystals of tin, between the dendritic arms of which the lead has been forced to solidify. The structure of all other eutectics examined is consistent with the view that the metal present in larger quantity forms a crystalline network, while the other metal solidifies in the interstices of this network. The forms assumed by laminated eutectics have a striking resemblance to the forms assumed under certain circumstances by thin films of liquids under the action of surface tension.

The author elsewhere † indicates the value of microscopic investigation of the causes of breakage of engineering materials. The first step should be the examination of the microstructure of the material close to the actual fracture, and also at some distance away from the fracture. The inclusion of microscopic examination in the regular tests carried out on engineering materials is advocated. The use of the Microscope to control the annealing of copper and its alloys is described.

Resistance of Metals to Impact.‡—T. E. Stanton and L. Bairstow have determined the relative resistance to shock of thirteen samples of wrought iron and steel of different carbon content. The methods of testing were—1. Bending-impact tests on notched specimens: (*a*) by one blow; (*b*) by repeated blows. 2. Impact tests by direct tension of plain specimens: (*a*) by one blow; (*b*) by repeated blows. Various static tests were made for comparison. The results obtained lead the authors to conclude that for the detection of two important faults in materials—brittleness and low elastic resistance—two distinct tests are necessary. The bending test on a notched bar seems to be the most searching; for the detection of brittleness the one-blow method should be used, while weakness in elastic resistance is revealed by the many-blow method. The development of slip lines in polished specimens submitted to alternate blows in tension and compression was found to be the same as under gradually applied alternating stress. Neumann lines were found in specimens broken by a very small number of blows.

F. W. Harbord § throws doubt on the value of impact testing because of the considerable variation between duplicate tests found in a comprehensive series of tests, which were carried out on various steels, to compare different methods of impact testing on notched bars.

* Journ. R. Soc. Arts, lvii. (1909) pp. 349–58 (6 figs.).
† Nature, lxxx. (1909) pp. 250–2 (2 figs.).
‡ Proc. Inst. Mech. Eng., 1908, pt. 4, pp. 889–919 (22 figs.).
§ Tom. cit., pp, 921–71 (12 figs.).

Ferromagnetism.*—P. Weiss discusses some of the consequences of Langevin's kinetic theory of ferromagnetism. He deduces from this theory that the magnetic investigation of an alloy resolves itself into the determination of the intensity of magnetisation at saturation, as a function of the temperature. The author's apparatus for this determination is described. The test-piece, in the form of an ellipsoid of revolution, is suspended obliquely between the poles of an electromagnet giving a field sufficiently powerful to magnetise the test-piece to saturation, and the moment of the couple acting on the test-piece is measured. For determinations at high temperatures the test-piece is suspended within a small electric-resistance tube furnace. It is suggested that α and β-iron are not two distinct phases, and that the thermal effects on heating and cooling coinciding with the change from α to β, or β to α, are caused by a change in specific heat.

Dimensional Changes produced in Iron and Steel Bars by Magnetism.†—W. J. Crawford found that the elongation of mild steel tensile test-pieces, maintained in a state of magnetic saturation throughout the test, was less than the elongation of similar test-pieces when unmagnetised. The amount of decrease of elongation caused by magnetism varied from 3 to 16 p.c.

Magnetic Alloys of Manganese.‡—F. Heusler and F. Richarz have continued their investigation of the magnetic properties of certain of the manganese-aluminium-copper alloys. Their explanation of the magnetic behaviour of these alloys is based on the independently established data (1) that copper and aluminium form a compound, $AlCu_3$; (2) that manganese and copper form a series of mixed crystals with a minimum in melting-point at a manganese-content of about 30 p.c.

Silicon-calcium Alloys.§—S. Tamaru has attempted the determination of the equilibrium diagram. Silicon and calcium are miscible in all proportions in the molten state. From about 35 p.c. to 100 p.c. silicon, practically pure silicon separates, which at 990° C. reacts with the 35 p.c. liquid to form the compound $CaSi_2$. No other compounds were found, but, owing to the great experimental difficulties encountered, their absence has not been definitely established.

Sulphur-arsenic System.‖—W. P. A. Jonker has investigated this system as an example of "heterogeneous equilibrium," since arsenic passes at atmospheric pressure directly from the solid to the gaseous phase. Both the melting-point and boiling-point curves were determined; the equilibrium diagram given accordingly includes the gaseous as well as the liquid and solid phases. As_2S_2 is partially dissociated in both liquid and gaseous states. As_2S_3 may be distilled without dissociation. No clear indication of the existence of As_2S_5 was obtained.

* Rev. de Métallurgie, vi. (1909) pp. 680–96 (7 figs.). (Paper presented to the International Congress of Applied Chemistry, London, 1909.)
† Nature, lxxx. (1909) p. 339.
‡ Zeitschr. Anorg. Chem., lxi. (1909) pp. 265–79 (3 figs.).
§ Op. cit., lxii. (1909) pp. 81–8 (1 fig.).
‖ Tom. cit., pp. 89–107 (4 figs.).

Nature of the Cast-irons.*—G. B. Upton adduces further evidence in support of his modification of the iron-carbon diagram.† The effects of silicon, phosphorus, sulphur, and manganese on total carbon and on graphite-content are analysed and expressed numerically. Grey cast iron has crystalline flake graphite mixed with a metallic matrix, which is a solution of silicon and carbon in γ-iron. White cast-iron is a super-saturated solution of carbon and silicon in γ-iron. Malleable cast iron has temper-graphite mechanically mixed with a metallic matrix, which is α-iron, ferrite, with more or less pearlite. None of the irons as cast are homogeneous from crystal to crystal.

Thermal Treatment.‡—L. Guillet indicates the importance of the time effect in the heat treatment of steel. The quenching temperature should exceed the highest critical point, but not by more than 50° C. A method of quenching frequently employed is to heat the steel considerably higher than this—say to 900°–950° C.—and allow it to cool to the upper critical point before quenching.

A. Portevin § discusses the heat treatment of alloys of copper. The properties of some of the copper-tin and the copper-aluminium alloys are modified by quenching. A correlation between the mechanical properties and the micro-structure of cold-worked brass annealed at various temperatures has been established.

Special Steels.‖—L. Guillet states that the alloy steels found to be industrially useful, are nearly all of the pearlitic class. The composition of several of these steels, and their mechanical properties after given treatments, are included.

Industrial Applications of Metallography.¶—L. Révillon signifies the directions in which metallography is usefully applied in the manufacture and employment of bronzes, brasses, and steels. Ferric chloride solution is a good etching reagent for bronzes and brasses.

Polishing Metals for Examination with the Microscope.**—A. Kingsbury recommends the use of paraffin-wax as a supporting substance for polishing powders. The polishing discs, grooved on the flat face, are warmed to about 100° C., laid flat, and the melted paraffin is poured on them to a depth of about ½ in., a removable ring or band retaining the melted wax. Hard foreign particles settle out before the wax sets. After the hardening of the wax, the discs are placed in the spindle of the polishing machine, and the face of the wax turned flat by a hand-tool. The author uses three grades of emery powder, which are mixed to a

* Journ. Phys. Chem. xiii. (1909) pp. 388–416 (10 figs.).

† See this Journal, 1909, p. 114.

‡ Rev. de Métallurgie, vi. (1909) pp. 807–9. (Paper presented to the International Congress of Applied Chemistry, London, 1909.)

§ Tom. cit., pp. 814–18. (Paper presented to the International Congress of Applied Chemistry, London, 1909.)

‖ Tom. cit., pp. 810–13. (Paper presented to the International Congress of Applied Chemistry, London, 1909.)

¶ Tom. cit., pp. 819–22. (Paper presented to the International Congress of Applied Chemistry, London, 1909.)

** Proc. Amer. Soc. Mech. Eng., xxxi. (1909) pp. 615–18.

paste with water and applied to the rotating wax discs with small brushes; rouge is used for finishing. A little water is required throughout the polishing process.

Polishing Machine for Metallographic Work.*—J. Aston describes a new machine of the vertical spindle type, with rotation of the polishing surface in a horizontal plane. The polishing discs are of sheet iron, held in position by a magnetic clutch, and can be replaced without stopping the machine. A number of V-shaped cuts are made near the circumference of the discs, and the points, bent down and sharpened, form fasteners on which the cloth or other covering material is hooked.

BROWN, W.—**Mechanical Stress and Magnetisation of Iron.**
Sci. Proc. Roy. Dublin Soc., xii. n.s. (1909) pp. 101–22, 175–89 (15 figs.).

DUMAS, A.—**Chaleur spécifique des substances ferromagnétiques, alliages de fer et de nickel.**
[Some theoretical considerations are discussed, and a detailed description of the method and apparatus used in the determination of the specific heat of high-nickel alloys at different temperatures is given.]
Arch. Sci. Phys. et Nat. (Bibliothèque Universelle) xxvii. (1909) pp. 352–82 (3 figs.).

ROSS, A. D., & R. C. GRAY—**Magnetic Properties of certain Copper-alloys.**
Proc. Roy. Soc. Edinburgh, xxix. (1909) pp. 274–86 (5 figs.).

GRAY, J. G., & H. HIGGINS—**Low-temperature Experiments in Magnetism.**
Tom. cit., pp. 287–94 (7 figs.).

SIEMENS, A.—**Tantalum, and its Industrial Applications.**
[Discourse delivered at the Royal Institution.]
Nature, lxxx. (1909) pp. 290–2.

ZOELLNER, A.—**Porzellan als Isolierungsmaterial vom physikalisch-chemischen Standpunkte.**
[The microstructure of some samples of porcelain is described.]
Electrotechn. Zeitschr., xxix. (1908) pp. 1257–8 (4 figs.).

* Electrochem. and Metallurg. Ind., vii. (1909) pp. 15–16 (3 figs.).

MICROSCOPY.

A. Instruments, Accessories, etc.*

(1) Stands.

Old Microscope by George Adams.—This Microscope was presented by Members of the Council to the Society's collection, and was exhibited at the Meeting on June 16.

The instrument, which is in excellent condition, almost as good as new, has the following inscription engraved on it:—"Invented & Made by Geo. Adams at Tycho Brahe's Head in Fleet Street, London." It is a combination of his "New Universal Single" and "New Universal Double" Microscopes, described and figured in his "Micrographia Illustrata," published in 1746. †

It is not easy to assign a date to the instrument in the absence of any description or reference, but as the same descriptions and figures just referred to appear in the 4th edition of "Micrographia Illustrata" published in 1771, it may fairly be concluded that the instrument now described may be of a somewhat later date.

Fig. 96 represents the instrument arranged as a Double Microscope, and it is to a scale of about one-half the actual size. It has a folding tripod base, from which rises an octagonal pillar bored out to receive a cylindrical stem that slides telescopically within it. The stem carries an eight-lobed disk, or "scollop'd plate" as Adams terms it, containing eight bi-convex lenses of graduated powers, No. 1 being the highest. The disk can be rotated beneath a fixed wheel, so that any lens can be brought into use. The flat rim of the wheel protects the lenses from dust, the arrangement thus clearly anticipating by about 130 years the principle of the modern dust-proof rotating nose-piece. It is upon this flat rim that the inscription referred to is engraved. An "eye" is formed in the periphery of the wheel, into which is screwed the ornamental body, which is simply a glorified eye-piece, made of ivory blackened and polished.

When it is desired to use the instrument as a "Single Microscope" the body is removed, and an eye-guard, very much like a lieberkuhn inverted, made of blackened ivory, is screwed in in its place in order to screen the eye from extraneous rays of light.

The coarse-adjustment is effected by releasing the pinching-screw at the back of the pillar, and raising or lowering the stem carrying the disk and body to the required position, which is shown by index numbers on the octagonal pillar; the screw is then tightened up, and an object mounted in a "slider" placed on the stage will be in focus. The

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

† See also Mayall's Lectures on "The Microscope," delivered before the Society of Arts in 1885, published in Journ. Soc. Arts, 1886.

numbers on the pillar from 1 to 8 correspond with the numbers of the lenses in the disk.

The fine-adjustment is actuated by the milled head of a micrometer

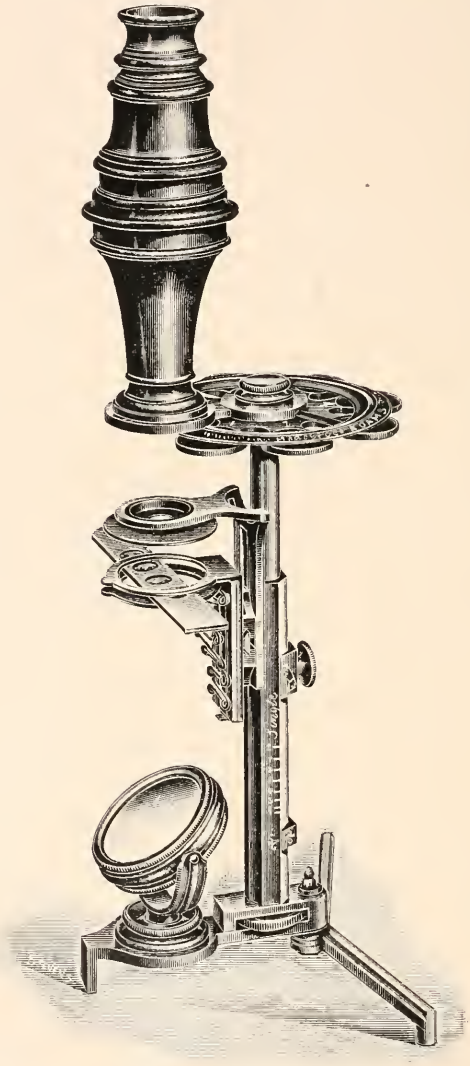

Fig. 96.

screw at the base of the pillar; this acts on a steel rod that passes up the inside of the cylindrical stem, with which it is connected when the pinching-screw is tightened up, so that, having made the coarse-adjustment and tightened up the pinching-screw, the fine-adjustment can be applied.

It will be noticed that this instrument is not a stage-focusing one, the optical parts being focused on the object as in modern Microscopes.

The principal points of difference between this instrument and its progenitors—the New Universal Simple and the New Universal Double Microscopes—which form improvements of more or less importance, are :

1. A double mirror carried on a bridle, instead of a single mirror hinged at the back.

2. The stage, and also the forceps, are carried on fittings that slide sidewise into a dovetailed groove on the pillar, instead of being fitted with shanks that were pushed into a hole therein.

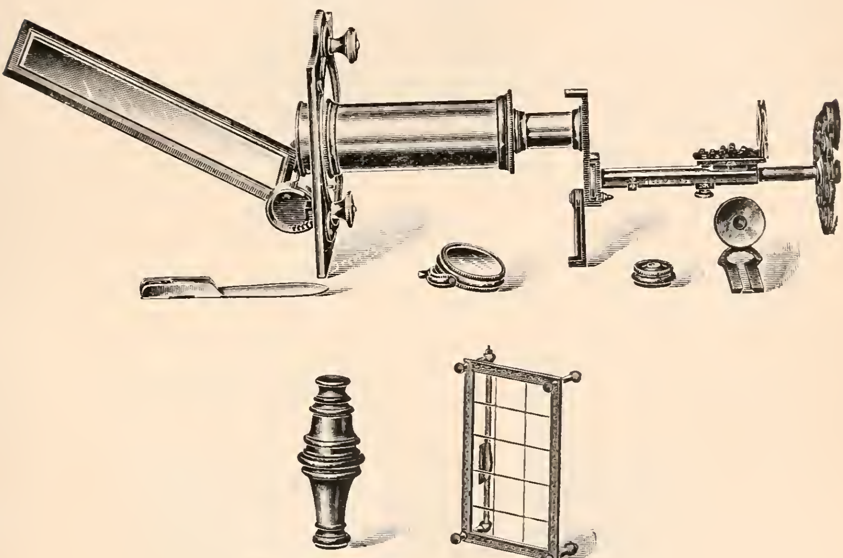

Fig. 97.

3. There are eight lenses in the disk instead of six, and three lieberkuhns instead of one. There is also a special fitting, seen in the figure, for carrying the lieberkuhns.

4. In the "Universal Double Microscope" there is a prolongation to the pillar above the level of the disk ; on this is fitted a sliding socket carrying at its lower end the rotating disk, and at its upper end there projects a bracket for carrying the body, so that the optical parts can be raised or lowered for focusing. In this instrument the body, as previously described, is inserted in an eye formed in the periphery of the fixed wheel ; by this arrangement one stand serves for both "single" and "double" Microscopes, and the upward extension to the pillar is not required.

By removing the mirror and screwed plug into which it fits, the "single" Microscope can be attached to the heliostat that accompanies it as an accessory; it then forms a solar projection Microscope (fig. 97). At the bottom of this illustration will be seen another accessory designated "A New Apparatus for confining Frogs, Mice, Bats, or any other Creatures of like Size particularly adapted to the Universal Microscope."* This apparatus consists of a rectangular brass frame $4\frac{3}{8} \times 2\frac{9}{16}$ in., upon which a frog or fish could be stretched for examination under the Microscope.

To the left of the same figure will be seen a "Contrivance to confine a small fish," whereby the circulation of the blood in its tail may be viewed "with Ease and Pleasure."†

There are other pieces of apparatus usually supplied with Microscopes at that time.

(3) Illuminating and other Apparatus.

Reichert's Reflecting Condensers for Dark-Ground Illumination, and some Auxiliaries.‡—These condensers are intended for the demon-

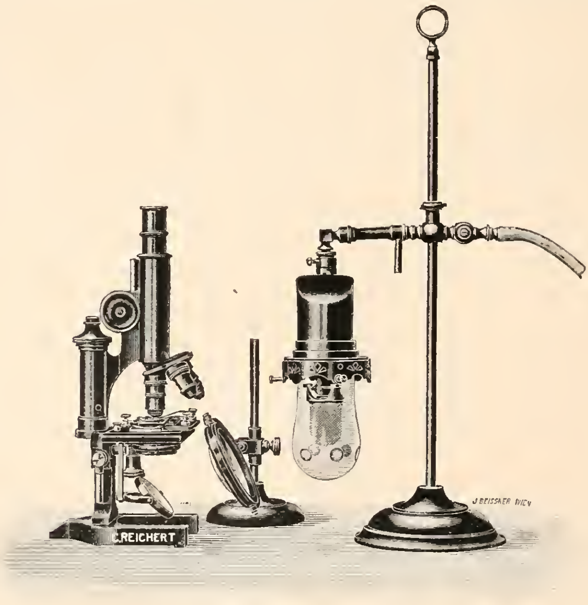

Fig. 98.

stration of ultra-microscopic particles, and, besides bringing into view ultra-microscopic particles in colloid liquids and fresh blood, serve to

* Micrographia Illustrata, by George Adams. The Second Edition, 1747, p. 42.
† Tom. cit., p. 3.
‡ Pamphlet, with above title. C. Reichert, Vienna.

produce contrasts in the illumination whereby, even in unstained preparations, structural details are disclosed which hitherto have required special staining methods. The reflecting condensers should preferably

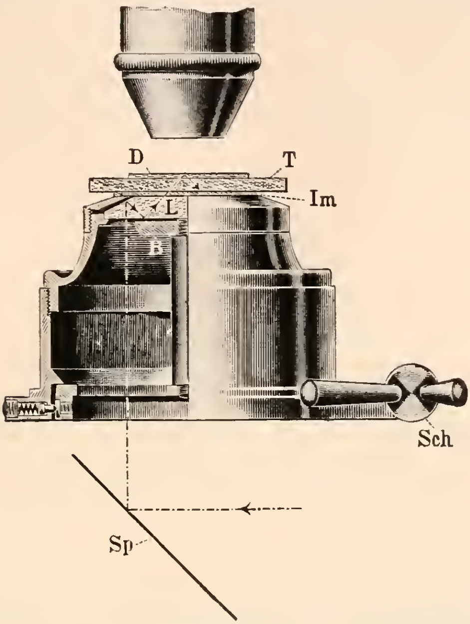

Fig. 99.

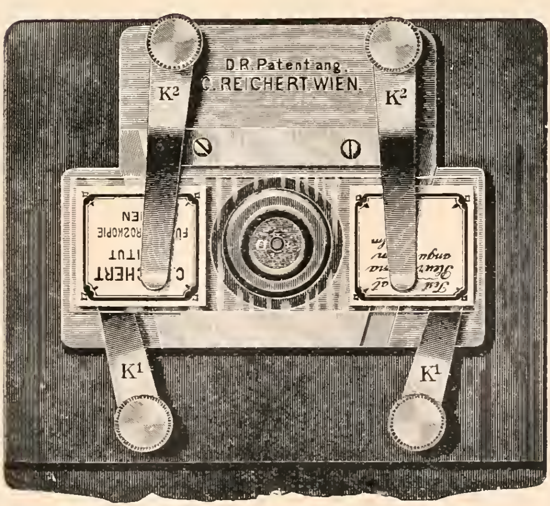

Fig. 100.

be used in conjunction with arc lamps working with a current of about 10 amperes. Any excess of power may easily be reduced with the aid of an iris-diaphragm or by increasing the distance of the lamp. Nernst lamps of 250 to 500 c.p. or the Liliput lamp should be used in conjunction with an illuminating lens and a screen on a stand. With the arc lamp and also with the Nernst and Liliput lamps it is advisable to protect the eyes by screening off all stray light with the aid of a hood. Nernst and Liliput lamps may by means of an ordinary wall plug be worked from the house supply service, but purchasers should,

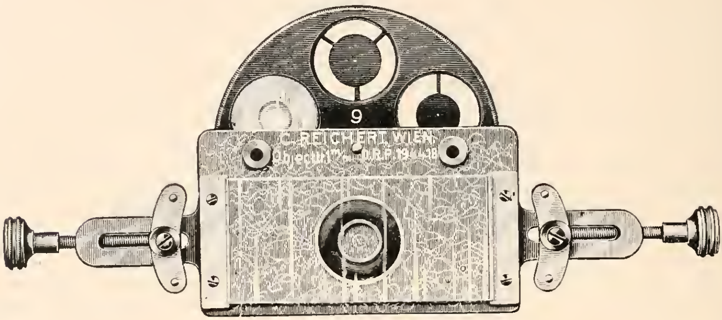

Fig. 101.

Fig. 102.

when ordering, state in each case the voltage and the nature of the current, i.e. whether it is continuous or alternating, the frequency being likewise indicated in the latter case. When gas is available, the illuminating appliances illustrated in fig. 98 may be employed. Some of the Reichert reflecting condensers have been recently modified, so as to give greater light-transmitting power, and to be suitable for special purposes.

The Reflecting Condenser, fig. 99, is, without any need of special adaptation, attachable to any Microscope provided with a sufficiently large cylinder diaphragm or Abbe condenser. It is provided with two pin stops, one being adapted for dry objectives, the other for immersion lenses. The Plate Condenser, shown in fig. 100, is adapted for dry objectives, and may be used without special adaptation on any Microscope, and is clamped to the stage by ordinary stage clips. The Universal Condenser (fig. 101), with wheel diaphragm, may be placed upon any square or round Microscope stage, and is available for use with oil-immersion and dry lenses. The wheel diaphragm furnishes a means of appropriately stopping down the pencil of light and also of conveniently moderating the light furnished by different sources of illumination and of facilitating the transition from dark-ground to ordinary illumination. The plate is attached to the stage by means of two screws. This type

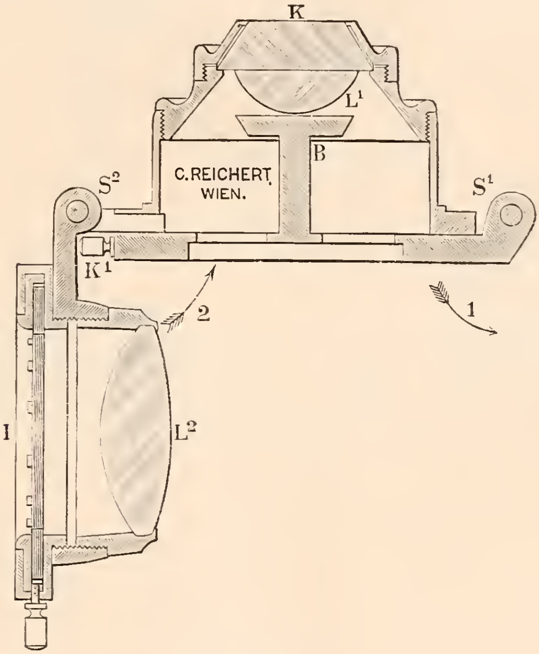

FIG. 103.

may also be procured fitted with an iris diaphragm. The Reflecting Slide Condenser is shown in fig. 102. It is mounted upon a stout glass plate which serves as a carrier, and is available for use with any Microscope. A circle ruled with a diamond upon its surface facilitates the operation of centring. The Swing-out Reflecting Condenser is shown in fig. 103. It is alternatively available as an Abbe condenser and as a dark-ground illuminator, the latter condition being obtained by swinging-out the lower lens L_2 and swinging-in the centre pin stop B. It may be used with either dry or oil-immersion lenses. Fig. 104 shows a chamber for the transfusion of liquids. It is available only for use

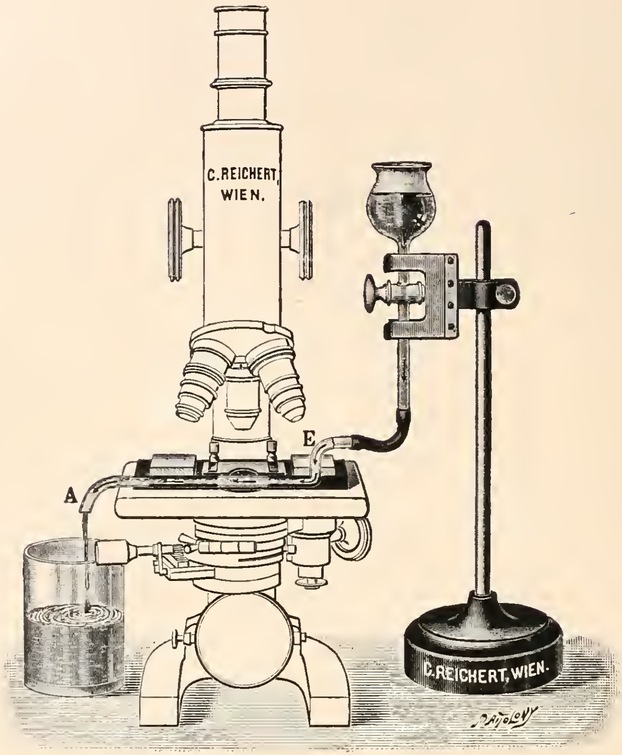

FIG. 104.

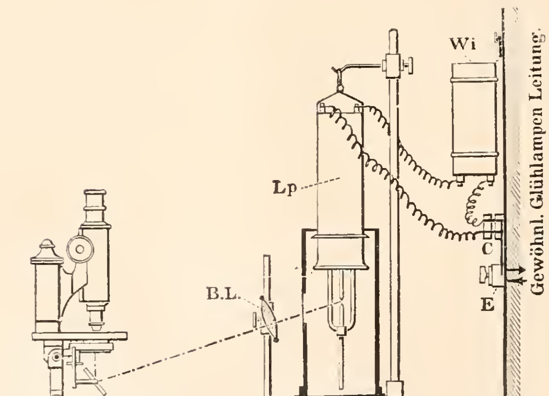

FIG. 105.

with condensers arranged for object slides, having a thickness of 2 mm. Fig. 105 shows a Liliput lamp with hood, as adapted for continuous current, and giving a light of about 500 candle power.

Divergent Microscopical Amplifier.*—A. Berget points out the inconvenience sometimes felt, owing to the excessive shortness of frontal distance, in the study of an object under a high power. Having had occasion to experience this difficulty, it occurred to him that the difficulty might be overcome by the interposition of a divergent system. His method is shown in fig. 106, one (or more) divergent lenses of short focal length being inserted in a tube sliding with body of the Microscope. The system must be inserted in such a manner that the real image $\alpha\beta$, which the objective would give were it not for the divergent lens, may be placed between this lens L and its focus F. Under these conditions it acts as a "virtual object" and gives an image real, enlarged and of the same sense, A′B′, of the object AB. It is this image A′B′ which is observed by the help of the ordinary ocular of the Microscope. In

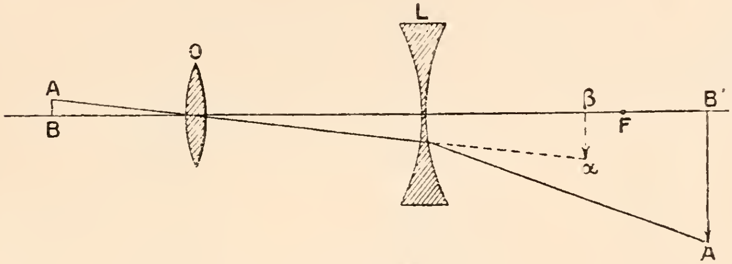

FIG. 106.

illustration of his method the author found that with a No. 3 objective focused on a micrometer divided into hundredths of a mm., the ocular being provided with a thread governed by a micrometer screw and divided drum, it was necessary to rotate the drum-head eight divisions in order to measure an interval of 10 μ. But when the divergent system was interposed, everything else remaining unchanged, a displacement of 60 divisions on the drum-head was necessary. In other experiments the frontal distance was about 1 cm. To have obtained the same magnification without the divergent system, a No. 7 objective would have been necessary, with a frontal distance equal to a small fraction of a mm. The author considers that his method could be usefully applied in many cases.

Apparatus for Measurements of the Defining Power of Objectives.†
The theory of the distribution of intensity in the image formed by a lens with circular aperture has been discussed by Lord Rayleigh in his article on "The Wave Theory of Light," in the Encyclopædia Britannica,‡

* Comptes Rendus, cxlviii. (1909) pp. 1097–9 (1 fig.).
† Proc. Roy. Soc., Series A, lxxxii. (1909) pp. 307–14 (5 figs.).
‡ See also Collected Papers, iii.

and some of the curves have been calculated by Struve.* J. de Graaff Hunter has now designed an apparatus adapted for use with the Beck photographic lens-testing bench at the National Physical Laboratory. The lens for test is held in the Beck bench so as to be free to turn about a vertical axis through its back nodal point, thus permitting the definition for oblique pencils to be readily examined. As an object, the image of which is to be examined, is employed an "edge," forming the boundary line between a half-bright, half-dark field. The "edge" is placed at the focus of a collimator, so that it may be regarded as virtually at an infinite distance from the optical system, say a photographic lens, to be examined; the image formed by such lens is viewed by a Microscope. In the focal plane of the eye-piece of the Microscope (Ramsden) is placed a fine slit, parallel to the "edge," through which alone the light passes. The slit is traversed across the field by a micrometer screw. The edge which serves as object is cut on the semi-circumference of a metal disk. Only a very small portion of the edge is actually seen in the image, and this is straight to the order of accuracy necessary. Over the other half of the circumference are sectors, cut to such a depth that the inner radius is less than the radius of the edge. The edge, at the part viewed, is uniformly illuminated from behind. When this disk is rotated, over half the rotation there appears in the Microscope field the blurred image of the edge; over the other half there is uniform illumination in the field, reduced only by 50 p.c. owing to the interposition of the sectors. In general, at an appropriate speed of rotation, there will be a flicker as passage is made from one half of the circumference to the other. A second disk placed behind the first gives the means of making a measurement. If the two disks be rotated together, over the one half of the rotation is seen the blurred image of the edge, the illumination being everywhere reduced by one-half owing to the sectors; over the other half of the rotation there is uniform illumination, which, however, can be changed, in a measurable proportion, by adjustment of the second disk relative to the first.

The author describes the practical details, and the results are found to be in complete agreement with the usual theory.

Meyer's Search-stage ii. (Perquirator).†—A. Meyer describes this auxiliary, which is made by the firm of Seibert in Wetzlar, and is numbered 72 in their Catalogue.‡ It is really an improved form of the same author's Search-stage i., designed as far back as 1901, and numbered 71 in the same Catalogue.§ The perquirator (fig. 107) is essentially a mechanical stage with two mutually perpendicular movements, and can be used as such an ordinary stage if the knob F (fig. 108) is brought to the middle position, so that the toothed wheel actuating the search-stage is put out of gear. The forward and backward movement is by such rackwork as is used in mechanical stages. But here the spindle-screw S, operating the lateral movement, is connected with an arrangement consisting of two toothed wheels, by means of which a lever H imparts a cross-movement to the preparation applied to the apparatus.

* Wiedemann's Annalen, xvii. (1882) p. 1008.
† Zeitschr. wiss. Mikrosk., xxvi. (1909) pp. 80-3 (2 figs.).
‡ Catalogue, 1909. § Loc. cit.

The lever motion is so regulated by suitable adjustment of the index J (fig. 108), movable on a graduated circular disk, that it ranges between 1 to 35 teeth. The toothed wheels are in such relation to the pitch of the screw that the movement of one tooth corresponds to 1 mm. It is therefore possible to adjust the apparatus approximately for any desired field of view whose diameter lies between 0·1 and 3·5 mm. Thus in every complete up-and-down movement of the lever the object is moved laterally almost entirely around the field. If the breadth of

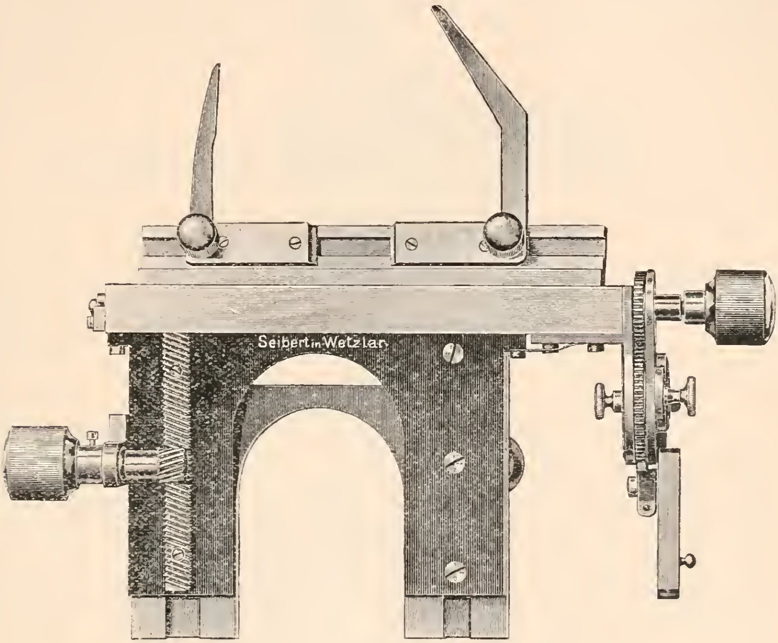

Fig. 107.

the field is measured, the adjustment in millimetres is known, without further observation, by the position of the upper sharp edge of the index J. If the diameter of the field of view is unknown, it may be ascertained in the following manner. An object-slide is marked in any suitable way, an object-micrometer is inserted, and the mark so adjusted that it is exactly at the left boundary line of the view-field. The lever H is now turned forward and downwards until it reaches the pin *p*; the knob F, which at first was central, is moved to the right, the screw of the index is loosened, and the index pushed close up to the lever H. The observer now carefully draws the lever towards himself, and at the same time follows in the Microscope the movement of the mark. When the mark has reached the opposite verge of the view-field, the index is clamped, and the range of lever-play is then accurately known. The small knob F is in connection with a small spring-lever concealed by the strong lever H, and clicks in three resting-spots. At the centre of one of these spots the two teeth z of the cog-wheel lying behind the lever H are released, so that H goes out of gear. When F is moved to the right spot, the object is also moved to the right through a distance of the field-diameter. When F is moved to the left resting-spot, the object is similarly moved the distance of a diameter to the left. The apparatus, it will be observed, bears some resemblance to Engel's mechanical stage, as made by Leitz. But the distinctive peculiarity of the perquirator is that its movement is adjusted for a diameter of the new field. Fig. 107 shows the perquirator in plan. Fig. 108 shows it in lateral elevation.

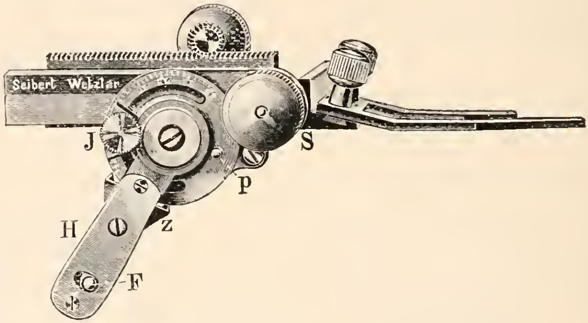

Fig. 108.

New Method of Measuring Hardness.*—V. Pöschl has devised a combination of sclerometer and Microscope for the purpose of measuring hardness with more precision than is possible by the ordinary methods. His sclerometer (fig. 109) consists of a zinc plate on three levelling screws, and a circular level is attached to the plate. When the plate is level the axis of a certain lever is also horizontal. This lever carries at one end the scratching-point surmounted by a scale-pan for receiving any suitable weight. A pointer attached to the lever-axis works on a graduated arc (something like the pointer of a balance), and insures that the lever remains at a constant inclination. The beam carrying the lever slides up and down in a hollow vertical pillar attached to the zinc plate, and can be clamped at any required height. The crystal, or other hard body to be tested, is set, so as to have the tested surface horizontal on a specially designed bearer. This bearer rests on a carriage working on three runners attached to the zinc plate. A cord running through a system of pulleys pulls the carriage with the bearer and crystal across the zinc plate, and so brings the crystal into contact with the scratching-point. Although there are other methods of estimating hardness, the author considers that it should be taken as proportional to the weight pressing upon the scratching-point.

Next, it is necessary to examine microscopically the breadth and depth of the scratch upon the crystal, and hardness is now considered to be inversely proportional to the size of the furrow. The instrument used was Reichert's Metall-mikroskop, as designed by Rejtö. It was combined with the sclerometer in such a way that the crystal, after being

* Zeitschr. wiss. Mikrosk., xxvi. (1909) pp. 104–10 (1 fig.).

scratched, came immediately under the objective, the scratch bisecting the field. With strong magnification the scratch appears as a band. Its breadth can be accurately measured with an ocular micrometer and its

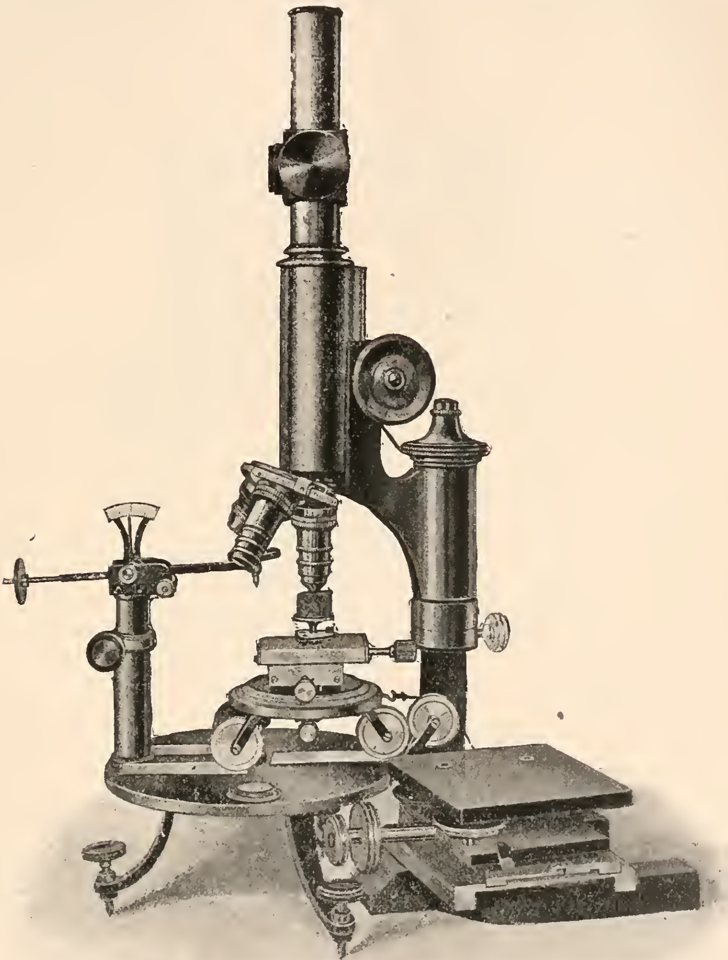

FIG. 109.

depth with a micrometer-screw, to a limit of 2 or 3 μ. In order to get a serviceable result as regards the comparison of various crystals, the diamond scratching-point must remain completely unaffected, a condition which can be examined by the Microscope. The author, however, had nothing to complain of in this respect. He also found that the velocity of the carriage had no perceptible effect upon the dimensions of the scratch, which, by the way, was frequently invisible to the naked eye. His experience seems to warrant the conclusion that the scratch obtained and measured by his method is a trustworthy indication of the hardness of the material.

Swift and Son's Stage Goniometer.—This goniometer (fig. 110), which is a modified form of Professor Miers' Stage Goniometer,

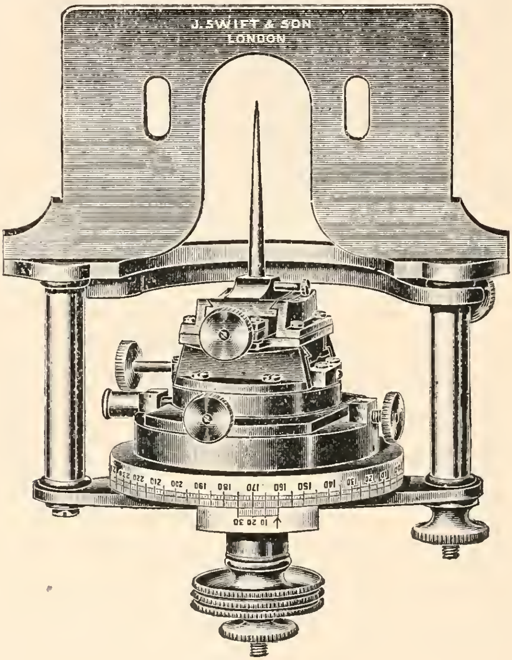

Fig. 110.

designed by Professor H. L. Bowman, is clamped by two screws to the stage of a "Dick" petrological Microscope. It is fitted with complete arrangements for adjusting and centring a crystal similar to those employed on the large instruments. By means of these adjustments a small crystal, mounted on the end of the steel pin, can be brought to coincide with the turning axis, and adjusted so that one of its edges is parallel to this while it remains under observation. The instrument is specially designed with a view to great rigidity and delicacy of adjustment in order to enable a crystal mounted on it to be observed under high powers. It is, therefore, invaluable for the examination of minute crystals, particularly such as show twin lamellation or similar complex structures, in respect to etching pits and extinction angles on different faces. The optic-axial angle of a bi-axial crystal or fragment can be measured with absolute accuracy. The crystal can, if necessary, be immersed in a drop of oil of suitable refractive index placed between the objective and condenser.

The radial dovetails, whose arcs are both struck from a common centre —the point of the steel pin—are built solid, brass bearing on gun-metal. They are operated by specially arranged steel tangent screws of 0·5 mm. pitch. All movements can be clamped after adjustment. The large circle is divided to 0·5° reading to 1 in. by a vernier.

Watson's New Holos Immersion Paraboloid.—This apparatus (fig. 111) gives an intensely black background on a brilliantly illuminated object with high power objectives up to 0·95 N.A. The maximum effect is obtained by using a brilliant light and a bull's eye. It is specially suited for the exhibition of unstained living bacteria.

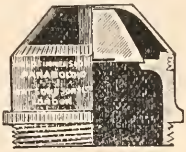

Fig. 111.

(4) Photomicrography.

Photography by Reflection under Contact.*—E. E. Fournier d'Albe, under the above title, describes a new process likely to be of interest to photographers of all kinds. In the usual methods of contact photography a copy is taken of the original or negative by allowing light to pass through the latter on to a sensitive surface: the resulting picture is due to differences in opacity in the various points of the original or negative. But the author's new process consists in transmitting the light in the reverse direction, and in producing a picture, not by differences of opacity, but by differences of reflecting power in the original. The obvious objection to such a method is that the sensitive film, being exposed to a uniform incident illumination coming through the back of the plate, will be uniformly fogged, and the resulting positive will be marred by a brightness which invades and obliterates all the dark portions. If this difficulty can be overcome, we obtain a method of copying any flat picture or design without a camera; and we avoid the difficulties of distortion, curvature of field, chromatic and spherical aberration, and so on. When the original to be copied has no half-tones, it is possible, by suitable exposure and development, to eliminate the fog entirely. The general principle is to employ exposures and developers which, in ordinary photography, "suppress the detail in the shadows," or, in other words, confine the developed image to those portions which have received the maximum illumination. The author gives details and illustrations of the method.

But the fog may also be eliminated by reduction and subsequent intensification. Howard Farmer's reducer (potassium ferricyanide and hyposulphite of soda) dissolves away the fog more than the full tone if sufficiently concentrated. The negative is intensified with mercuric chloride and silver-nitrate. The best results are obtained with slow plates of the "photomechanical" class, and the developer used was the following:—Solution No. 1: Hydroquinone 80 gr., pot. metabisulphite 120 gr., pot. bromide 10 gr., water, etc., 10 oz. Solution No. 2: Caustic potash 200 gr., water, etc., 10 oz. Equal parts of both solutions are mixed. The best fixing agent is potassium cyanide, on account of its solving

* Sci. Proc. Roy. Dublin Soc., xii. (1909) pp. 97–100 (1 pl.).

action on thinly deposited silver. The author, however, used the ordinary "hypo" bath.

Excellent paper negatives were obtained with rapid bromide papers, and also with gas-light papers. On printing positives from them in the ordinary way, the grain of the paper negative disappears, as it is automatically compensated by the grain within the paper which gave rise to it. Printing-out papers also give negatives which can be used for printing positives on bromide paper without previous toning and fixing, but the exposure has to be very long.

In applying the process to black or white originals, certain advantages are gained over the ordinary methods with the camera :—1. The reproduction is of the exact size of the original. 2. The sharpness of definition is only limited by the size of the silver grain in the plate. 3. All differences in the angle of reflection of light by the original are avoided, all the effective light emerging at right angles to the surface.

Chronophotomicrography.*—L. Chevroton points out the importance of photographing moving objects at known intervals of time, and describes the arrangements she has successfully used for the purpose. She employs a Zeiss optical bench with the usual fittings and a voltaic arc, as light source, of 20–25 amperes and 60 volts continuous current. But in front of the water cooler a sector-disk is inserted capable of revolution at a known rate. Thus, if a sector cuts the optical axis 30 times a minute, and the interval between the sectors is about 11°, 30 images are received per second and each of these has $\frac{1}{960}$ in. of pose. A Zeiss stand is fixed vertically on the general support of the camera and independently of the optical bench ; the chronophotographic apparatus is itself in a direct connection with the stand by means of a telescopic tube in order to avoid all loss of light, an essential condition. The sector-disk may be operated by hand or by a motor.

Mirror-reflex Camera for Photomicrography.†—This apparatus was designed by W. Scheffer mainly for instantaneous photomicrography, but has been found to succeed well with either transparent light or with dark-ground illumination. It has, therefore, been found useful to the microscopist for other purposes, including that of the cinematography of microscopic objects. The task before the designer was to devise an arrangement by which the movements of the object could be observed on the ground-glass screen, while at the same time all the arrangements necessary for photomicrography were in readiness and could be brought into instantaneous action. Fig. 112 shows diagrammatically the principle of the apparatus. Two mirrors, A and B, are arranged in a wooden case. The beam of rays proceeding from the Microscope comes through O, and is twice reflected at the mirrors A and B on to the ground-glass screen M. The ocular end of the Microscope is connected in light-tight fashion by the customary funnel with O. In V is a window arrangement, which is opened when the mirror A is rotated round the axis D from the position D E into the position D E′. If the window V is opened, the light of the Microscope travels

* C.R. Soc. de Biol., lxvi. (1909) pp. 340–2 (1 fig.).

† Zeitschr. wiss. Mikrosk., xxvi. (1909) pp. 111–15 (3 figs.).

rectilinearly in the direction of the arrow on to the sensitive plate P in the cassette C. The space in front of P is completely dark when V is closed. For the purpose of long exposures V may be removed. When the operator judges that the proper moment has arrived, he pulls a lever at G, thus opening V and allowing the light to fall on the sensitive plate at P. The author adds a figure showing how his apparatus is adapted to Zeiss' large photomicrographic camera. The space in front of P is occupied by the bellows, and the light-path from O to M has to equal that from O to C.

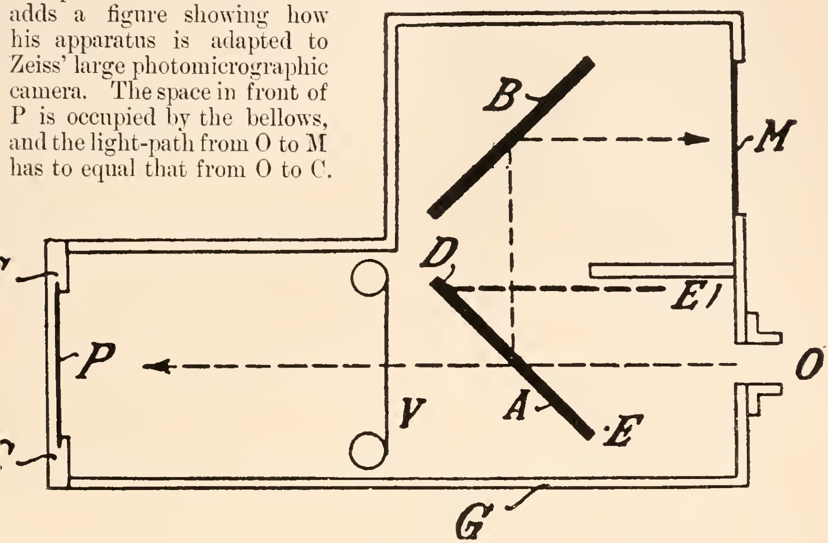

Fig. 112.

(5) Microscopical Optics and Manipulation.

Simple Arrangement for determining Microscopically the Index of Refraction.*—E. Clerici describes his method of carrying out a simple mode of obtaining the refraction-index with an accuracy sufficient for mineralogical and petrographic purposes. His method involves the use of an object-slide fitted with a cylindrical cell, to the bottom of which is fixed a small glass prism. A ray passed through this will, of course, be refracted, and its duration can be measured by the cross-threads of the ocular micrometer. If the cell be filled in succession with liquids of known refractive indices, and a coverslip added, a curve can be constructed and the whole arrangement being thus calibrated is adapted for the investigation of an unknown liquid. The author discusses the advantages of several varieties of simple and compound prisms.

Chevroton L., and F. Vlès.—**Examen de la striation musculaire en lumière ultra-violette.** *C.R. Soc. Biol. Paris*, lxvi. (1909) pp. 1057–9.

(6) Miscellaneous.

Telescopic Vision.†—Under the above title Johnston Stoney discusses the defects of the telescope, and inquires into the process by

* Atti d. Reale Acad. dei Lincei, xviii. ser. 5 (1909) pp. 351–5 (6 figs.). See also xvi. (1907) p. 336.
† Phil. Mag., xvi. (1908) Aug., Nov., Dec.

which nature constitutes those images which are formed in optical instruments or on the retina. Two images, and their relation to one another, are considered. One of these is the image of the celestial object presented to the telescope or to the eye. The other, referred to as the concentration image, can be formed by the same identical light, but is an entirely different image. The method of analysis which has proved to be the most efficient in tracing out how images are actually formed by nature is the analysis of the light, within any space occupied by a uniform medium, into its constituent undulations of flat wavelets. It is by the interferences of these undulations that the image is formed. The author describes an apparatus for making experiments which will disclose the imperfections of necessity existing in the images furnished by astronomical telescopes, and which will indicate the causes of these imperfections and how they may be mitigated. He also discusses why it is that, when a large and a small object exactly similar to each other are examined with the same telescope, the large one will be seen satisfactorily, while the small one, though of precisely the same shape, will, if small enough,

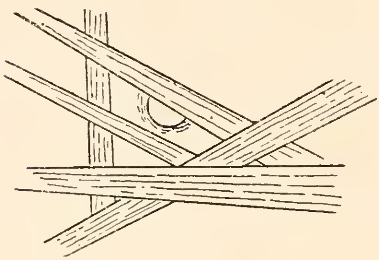

Fig. 113.

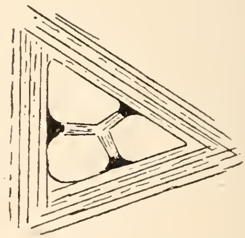

Fig. 114.

appear when viewed through the telescope to be transformed into something unlike itself.

He appeals to microscopical experiments * in illustration of his subject, and describes certain observations on the proboscis of a blowfly. Fig. 113 shows an arrangement of hairs on a certain specimen. A small triangular patch of bright light happened to be shut in between three of the hairs or bristles which grow near the base of the proboscis. These hairs had been pressed in the mounting of the specimen so that they lay near to one another and nearly in a plane perpendicular to the optic axis. Another, and thinner hair, which we may call the canal, divided the triangle of light into a smaller triangle below and a quadrilateral space above the canal. Within this quadrilateral was seen about half of the base of another small hair, presenting the semicircular appearance in fig. 113, and being somewhat darker on the right-hand part of the semicircle than on the left. The rest of this hair lay outside the triangle of light to which attention is being called. This object was examined through one of Zeiss' 24 mm. apochromatics, over which an iris diaphragm had been fitted to enable the observer to diminish its aperture to any desired extent. The succession of appearances while

* Phil. Mag., xvi. (1908) pp. 976–7.

the aperture was being diminished was most suggestive. The object was fairly well seen until the aperture became rather small, but then on further contraction of the aperture a succession of new phenomena sprang into existence, until at a certain stage the appearance became that represented in fig. 114, and was then utterly unlike the real object. The semicircle has disappeared, and instead of it and the one straight canal across the triangle, we have what appear to be three canals of nearly equal thickness, and abutting nearly perpendicularly upon the three sides of the entire triangular space. And at the same time "carets" have developed themselves at the outer ends of these three optically-produced canals. These unsteady appearances, which sometimes metamorphose an object into something utterly unlike itself, are of the same kind as those by which the astronomer, who occupies himself upon minute details, is but too likely to be misled, unless he avails himself of some such aids as those which the author has ventured in his memoir to recommend. [In looking at fig. 114 the reader is requested to exercise his imagination, for none of the features as seen in the Microscope had the hard outlines of the diagram. The three "canals" were dusky streaks with straight but nebulous edges, and the boundary of the triangular bright space was also nebulous. The "carets" were the darkest part of the image.]

Royal Microscopical Society's Microscopes at the Franco-British Exhibition.

The Royal Microscopical Society contributed, as announced at the May Meeting of the Society last year, a collection of Microscopes to the British Science Section of the Franco-British Exhibition. The collection was illustrative of the development of the Microscope from the earliest times, and comprised, in addition to twenty-three instruments belonging to the Society, four which were lent by Fellows: two by Sir Frank Crisp and two by Mr. E. M. Nelson.

The collection was distributed into five groups as follows:

1. Simple Microscopes.

2. Compound instruments of the Scarlet and Culpeper type, in which the lenses are carried in a body which slides in a ring for the purpose of focusing, and in which no attempt is made to obtain achromatism.

3. Instruments of a more highly developed type, in which screw motions are introduced for the purposes of focusing and the instruments were what was at the time called the universal type, that is to say, were adapted to be used either as simple or as compound instruments, and fitted for the observation of opaque or transparent objects under various conditions of stage and illumination. They, however, are non-achromatic.

4. The Catoptric type, in which an attempt was made to get over the difficulty of achromatic aberration by substituting mirrors for lenses in the objective. This type of instrument was represented by a single specimen (Cuthbert's reflector Microscope).

5. The group of achromatic Microscopes, leading up, in their full development, to the modern instrument.

The following is a descriptive list of the instruments exhibited.

Class 1.—Simple. (*To illustrate the Early Type of Simple Microscope.*)

LEEUWENHOEK. (Copy.) About 1673.

Type—Simple Microscope.

Two thin metal plates are fastened together by rivets. Between these plates a very small double convex glass lens is mounted between two concavities provided with minute apertures. The object is held in front of the lens on the point of a short pin, the other end of which screws into a small block or stage of brass, which is riveted on the end of a long coarse-threaded screw acting through a socket angle-piece attached behind the lower end of the plates. It is with such instruments, of the rudest kind mechanically, that Leeuwenhoek astonished the world with his discoveries of Infusorians, Bacteria, and other microscopic forms of life.

Described and figured in Mayall's Cantor Lectures, 1885, p. 20, and in Journ. R.M.S.,, 1886, pp. 1047–9.

Lent by Sir Frank Crisp.

MUSSCHENBROEK. Date, about 1690.

Type—Simple Microscope.

Consists of a hollow handle, through the length of which slides a tube, which is controlled by a knob at the base. Various forms of object-holders can be inserted in the tube, whilst the handle is provided with hinge-joints set at right angles, and by means of two thumb-screws, acting against springs, the object can be moved laterally and adjusted to the focus of the lens. The small biconvex lenses are mounted between two thin plates of brass, fitted to slide in metal grooves in the carrier, over which slides a metal box, with a pivoted sector of diaphragms. This is the first time this system of changing diaphragms occurs, and it is the precursor of the modern wheel of diaphragms. The carrier is connected to the handle by means of a strong brass wire bent to two right angles; this arrangement gives considerable scope for movements forward or backward, and laterally.

Described and figured in Zahn's Oculus Artificialis, 2nd ed., p. 783, and in Mayall's Cantor Lectures, 1885, p. 24.

Lent by Sir Frank Crisp.

LIEBERKUHN. About 1738.

Type—Simple Microscope.

Lieberkuhn devised a combination of a simple biconvex lens, mounted in the central aperture of a polished metal reflector, which formed a small hand Microscope for the special purpose of viewing opaque objects. This construction, in an improved form and applied to achromatic object-glasses, is in use at the present day.

The present model shows this form as made by Adams. See Adams' Micrographia Illustrata, 1747, p. 16.

WILSON'S Screw-Barrel Microscope. Invented about 1702.

Type—Simple Microscope.

Two specimens of this instrument are exhibited, the one showing its adaptation to the examination of transparent objects, the other, its use with opaque objects. In the one case the object-slide is held by a spiral spring and focused by a screw-barrel, which also carries an illuminating lens. In the other case a rod, provided with forceps, replaces the object-slide, and a lens-carrying arm enables the magnifier to be suitably displaced for viewing an object held by the forceps. This was a very popular model in the eighteenth century.

See Phil. Trans., xxii. pp. 1241–7.

Described and figured in Journ. R.M.S., 1905, p. 740.

CLASS 2.—COMPOUND. (*To illustrate the Old "Double Microscope."*)

JOHN MARSHALL'S "Double" Microscope. Invented about 1704.

Type—Compound Microscope, uncorrected.

Points to be noted :—(1) The provision of a screw for fine focusing adjustment; (2) the stage clamped to the pillar. Early models of this make of Microscope had a ball-and-socket joint at the base of the pillar, but no mirror as late as 1718. In the present specimen the ball-and-socket is replaced by a rigid pillar, and the addition of a mirror and modifications of the stage show that it is of somewhat later construction—about 1744.

This instrument was described in the original advertisement of it as "John Marshall's New Invented Double Microscope for Viewing the Circulation of the Blood." The word "double" here signifies that it was a compound instrument provided with an objective for forming an image of the object and an ocular for viewing the image so formed. Concerning this instrument see Mayall's Cantor Lectures, 1885, p 37.

CULPEPER'S Compound Microscope. Date, before 1738.

Type—Compound, uncorrected.

It will be observed that this is a modification of Wilson's simple Microscope. A body-tube of ivory, with draw-tube, is provided for the purpose of transforming it into a compound instrument which is mounted on a pillar with a ball-and-socket joint. The ball-and-socket was a favourite mounting contrivance with the early makers. It was fitted to Hooke's instrument, and was adopted in his earlier models by John Marshall. Its use for this purpose has been now entirely abandoned in favour of the compass hinge.

This instrument is described and figured in Mayall's Cantor Lectures, 1885, p. 34.

CULPEPER AND SCARLET. Invented about 1738.

Type—Compound, uncorrected.

This tripod form of Microscope stand, mounted on a wooden box, was a favourite model for more than a century. It was copied and made by successive opticians with many variations in form, material, and finish until about the middle of last century. The body of the present model is made of wood and cardboard, and the focusing is done by sliding the body. There is no fine-adjustment. The object-glass is a single biconvex lens, and the eye-piece has two lenses. A mirror with ball-and-socket motion is fixed to the box foot.

This instrument is described in R. Smith's "Opticks" (Cambridge, 1738), ii. p. 407, and figured in Mayall's Cantor Lectures, 1885, p. 40.

NATHANIEL ADAMS. About 1740.

Type—Compound, uncorrected.

This is of the Culpeper and Scarlet pattern, and is rendered even more unhandy than its original by the addition of a fourth pillar in the space surrounding the stage. This inconvenience was incurred, no doubt, for the sake of the greater rigidity secured by the fourth pillar —a distinct advantage in focusing the instrument. Attention may be drawn to the elaborate chain of ball-and-socket joints by which a condensing lens is connected to the stage.

Presented to the Society May 17, 1905. See Journ. R.M.S., 1905, p. 397.

DOLLOND. About 1816.

Type—Compound, uncorrected.

This again is of the Culpeper and Scarlet pattern, but shows a great advance in its mechanism, being made all in brass and fitted with a rack-and-pinion focusing arrangement. This specimen is remarkable for its date as showing the persistence and continued improvement of an obsolete type of instrument at a time when instruments of a much better design were being produced.

Described in the Journ. R.M.S., 1901, p. 227.

JOHN CUFF'S "Single" and "Double" Aquatic Microscope. Date about 1760.

Type—Alternatively Simple or Compound, uncorrected.

Compared with its predecessors, and in particular with instruments of the Culpeper and Scarlet model, the present instrument shows distinct improvements. The following points may be noted :—1. It is provided with a fine-adjustment which focuses the lens and body, not the stage. 2. The instrument is inclinable. 3. The stage has lateral movement on a pivot. 4. The pillar is mounted excentrically on its oval base-plate and is capable of rotation, which gives the Microscope greater stability in different positions. 5. It can be folded for portability. 6. A clip is provided to clamp the slide. This is the earliest known example of slide clip.

Described and figured in Journ. R.M.S., 1898, p. 675.

Lent by Mr. E. M. Nelson.

Class 3.—Compound and Simple Combined. (*Complex Instruments, showing the development of the Stand, and illustrating the use of the "Double" Microscope, in combination with Simple Microscopes, prior to the introduction of the Achromatic Objective.*

JOHN CUFF'S Compound Microscope. Invented about 1744.

Type—Alternatively Simple or Compound, uncorrected.

The inventor of this model made a distinct improvement in the mechanical construction of the Microscope, and it forms an important link in the evolution of the instrument. The stand is firmer and more rigid, and altogether more handy, whilst the stage is more accessible ; the fine-adjustment applied to the body has greater delicacy. After Cuff's death this model was made by various opticians, such as Adams, Dollond, Nairne, etc., with various additions and improvements.

Described by Baker, "Employment for the Microscope," 1753, pp. 442-6.

Presented to the Society Nov. 16, 1904. See Journ. R.M.S., 1904, p. 727.

BENJAMIN MARTIN. 1760.

Type—Alternatively Simple or Compound, uncorrected.

The maker of this instrument devised numerous improvements in the mechanism and optical arrangement of the Microscope, and the present model is an important link in its development. For the first time there is a slow and fine movement for focusing, by rack-and-pinion and by screw, both applied to the stage, with the constant action of a spring to check the motion. A small compass-joint at the top of the pillar allows the carrying-ring to be turned out of the way when the instrument is used as a simple Microscope.

Presented to the Society March 21, 1900. See Journ. R.M.S., 1900, p. 269.

BENJAMIN MARTIN. 1771.

Type—Alternatively Simple or Compound, uncorrected.

This exceedingly elaborate instrument, of exquisite workmanship, with every conceivable movement, is said to have been made for King George III. Its authentic description is "Benjamin Martin's Large Universal Microscope." The meaning of the word "universal" is that it can be used for viewing opaque or transparent objects with either a single or double lens combination, that is to say, either as a simple or as a compound instrument, and that it possessed, in addition, the joints and accessories necessary to enable the user to direct his gaze in a horizontal, vertical, or inclined direction at his choice, and to carry the body of the instrument over the different parts of the stage by what was then called the "aquatic" traversing motion. The triangular upright stem has a compass joint at its base, and is fixed to an elaborate foot, over which it is adapted to rotate. This foot is, in most descriptions of the instrument, erroneously described as a tripod. The three feet do not, in fact, support the instrument, but serve only to steady it, the weight being carried by the knob in the middle of the foot. The stage has micrometric movements in three directions; it moves the object over a wire scale in the eye-piece. This method of micrometry was invented by Benjamin Martin, who also wrote a book about it. The double mirror, as well as the stage, can be raised and depressed by rack-and-pinion. The compound body can be removed and replaced by a simple Microscope; the stage also can be removed and replaced. Provision is made for holding and illuminating living objects and large opaque specimens. To accommodate the instrument to the case it has been placed in the horizontal position, and its stage has been dismounted and laid upon the table at the foot of the instrument.

This Microscope is fully described in the Transactions of the R.M.S. of 1862, p. 31.

GREGORY AND WRIGHT. 1785.

Type—Alternatively Simple or Compound, uncorrected.

The makers of this instrument were successors to Benjamin Martin. It will be noticed that they follow his lead by making the stem inclinable by a joint at its base, where it is fixed to a folding tripod foot. The body is attached to a movable arm, which, in turn, is carried by the stem. This arm can be swung about the axis of the stem, and moved to and fro in its socket, these movements facilitating the exploration of a large specimen. In consequence of this adaptation such Microscopes were, in the latter half of the eighteenth century, called "aquatic." Focusing is effected by rack-and-pinion, which move the stem and body, whilst the stage is fixed. This Microscope has a rotating multiple lens-carrier nose-piece, invented by Père Cherubini d'Orléans.

Described and figured in Journ. R.M.S., 1908, p. 154.

SHUTTLEWORTH. 1786.

Type—Alternatively Simple or Compound, uncorrected.

The stand of this instrument is a somewhat later imitation of the Benjamin Martin type. The triangular stem has a compass-joint at its base, by means of which the whole Microscope is inclinable. The stage has rack-and-pinion focusing movement. The body is fixed to a movable and rotating arm, and carries François Watkins' rotating multiple lens-carrier nose-piece. The mirror and condensing lens slide on the triangular pillar.

Described and figured in Journ. R.M.S., 1908, p. 365.

JONES. 1798.

Type—Alternatively Simple or Compound, uncorrected.

This model follows an earlier form of François Watkins, inasmuch as the compass-joint making the Microscope inclinable is raised to the top of an upright stem, fixed to a tripod folding foot. To the joint is fixed a square limb on the top of which a short arm, movable by rack-and-pinion, supports the body of the Microscope. The stage moves on the limb by rack-and-pinion, which serves for the focusing of the object. The mirror and condensing-lens slide on the same square limb. The object-glasses are contained in a rotating multiple lens-carrier nose-piece.

The instrument was described by its makers (W. and S. Jones, of Holborn) as the "most improved" Microscope, a description much better justified than superlatives—and especially the superlatives used by salesmen—commonly are, for this instrument does, in fact, represent the culminating point reached by the dioptric instrument before the introduction of the achromatic objective.

Described and figured in Adams' "Essays on the Microscope," 2nd ed., 1798, p. 99.

Class 4.—Reflecting.

CUTHBERT'S Reflecting Microscope. About 1827.

Type—Compound: Catoptric.

The attempts made at the close of the eighteenth and beginning of the nineteenth centuries to produce achromatic object-glasses for the Microscope having failed, owing to technical difficulties, the maker of this Microscope attempted to produce achromatism by means of mirrors, carrying into effect a suggestion originally made by Newton which one or two other makers had followed up. Cuthbert's instruments are said by Mayall to have been the best of their type. The magnification of objects is here effected by means of very small reflecting specula, and the result for low and medium powers was very fairly satisfactory. The body is fixed by a compass-joint on the top of the telescopic stem supported on a folding tripod. The focusing is effected by moving the stage, and the latter has rectangular motion.

Described and figured in Mayall's Cantor Lectures (1885), p. 58.

Class 5.—Instruments Fitted with Achromatic Objectives.

DELLEBARRE'S "Microscope Universel." About 1777.

Type—Compound : Achromatic.

This stand is a French model on the lines of the English Microscopes of the period. The square limb is fixed on to a scrolled folding tripod foot, and has a hinge about its middle by means of which the upper part can be inclined. The body is fixed to an arm which slides in a rotating socket at the top of the limb. The concave mirror and condensing lens slide on the limb. The arm carrying the stage has a pinion moving in a rack cut in the limb for the purpose of focusing.

Dellebarre endeavoured to obtain achromatism by the use of oculars built up of crown and flint glass lenses, the excessive correction of the ocular compensating for want of correction of the objective. His plan was not, however, successful, and the first practical achromatic Microscope was not produced until fifty years after his time.

Described and figured in Petri's "Das Mikroskop," p. 162.

LISTER-TULLEY Microscope. Made by James Smith, 1826.

Type—Compound : Achromatic.

This Microscope was designed by Mr. Joseph T. Lister, who also himself made an achromatic object-glass for it. This is the first achromatic Microscope made in this country. A folding tripod foot supports a pillar, on the top of which is hinged an arm which supports a body having two draw-tubes and a focusing rack at the side. A substage is provided, fitted with a compound condenser. The stage has rectangular movements by means of two pinions, one of which is placed in a vertical position. Steadying rods are used to support the body in the inclined and horizontal positions.

Described and figured in Journ. R.M.S., 1900, p. 550.

Lent by Mr. E. M. Nelson.

CHEVALIER "Microscope Achromatique." 1834.

Type—Alternatively Simple or Compound : Achromatic.

The brothers Chevalier, of Paris, were the first opticians to produce, about 1823, practically useful achromatic object-glasses for the Microscope. The present instrument is an early specimen made by Charles Chevalier. The mechanical model followed is still that of Jones's "most improved," with various modifications. The arm carrying both the body and the limb is fixed by a compass-joint to the top of the stem, which itself is supported on a flat solid tripod. Focusing is effected by rack-and-pinion to the stage, which itself is mechanical in one direction only.

Described and figured in Chevalier's "Des Microscopes et de leur Usage," 1839, pp. 98–100, pl. 3.

CHARLES CHEVALIER. About 1840.

Type—Alternatively Simple or Compound: Achromatic.

This exceedingly well made instrument is an enlarged and improved Microscope upon the model of the preceding, embodying a number of devices for use in an erect or in a horizontal position, and for the observation of chemical reactions. It is described by its maker as his "Microscope Achromatique Universel." The focusing arrangements, both coarse and fine, are still attached to the stage, whilst the body remains fixed. In the horizontal position a right-angled prism is used for deflecting the rays into the tube. The mirror is plane and concave, and is movable by rack-and-pinion. The whole Microscope is exceedingly steady, and all the motions very smooth.

Described and figured in Chevalier's "Des Microscopes et de leur Usage," p. 88, pl. 4.

HUGH POWELL. 1839.

Type—Compound: Achromatic.

This Microscope is of very great interest, because it embodies new features which have now been very generally adopted in the design of the Microscope. The body, stage, and mirror are carried by the limb, which itself is attached by a compass-joint to an upright telescopic pillar raised on a solid tripod. The coarse-adjustment by rack-and-pinion for the first time moves the body of the Microscope, but the fine-adjustment is applied to the stage by a wedge acted on by a micrometer screw. In this model also Hugh Powell systematically applied the method of "springing" in the movements to prevent loose action; its application to the pivots of the mirror can be well seen.

Described in Journ. R.M.S., 1901, p. 728.

HUGH POWELL'S Large Microscope. 1841.

Type—Compound: Achromatic.

This Microscope is one of three which the Council of the Microscopical Society of London, soon after its formation, ordered of the three best makers of the day—Hugh Powell, James Smith, and Andrew Ross. This almost too elaborate and substantial stand was considered the best of its day, and embodies all the most refined movements and apparatus the maker was able to devise. The body is moved by rack-and-pinion, and is attached to a hollow triangular bar. The fine-adjustment actuates the stage. Originally this was a monocular Microscope, but the binocular body with Wenham's prism was fitted to it after the invention of the latter in 1863.

Described and figured in Journ. R.M.S., 1900, p. 285.

JAMES SMITH. 1841.

Type—Compound: Achromatic.

This stand was made in execution of an order given by the Council of the Microscopical Society of London in August 1840, and has become a model on which many English stands have since been made. A substantial pillar mounted on a solid tripod supports a grooved limb, which itself carries directly the body, stage, and mirror. Coarse-adjustment is effected by rack-and-pinion moving the body, whilst fine-adjustment for the first time by lever and screw acts on the nose-piece only. The mechanical stage has rectangular motion, and can be rotated.

Described and figured in Microscopic Journal, ii. p. 1, and in Journ. R.M.S., 1900, p. 553.

ANDREW ROSS. 1842–3.

Type—Compound: Achromatic.

In execution of an order by the Council of the Microscopical Society of London in 1841, Andrew Ross produced this type of Microscope. The pillar is mounted on a circular base, which rotates so as to increase the steadiness of the base when the Microscope is inclined. The body slides in the grooved limb, and the fine-adjustment acts by a lever on the nose-piece. The mechanical stage has rectangular movements and also rotates. The original instrument, made for the Society in 1841, was exchanged in 1863 for a Ross binocular instrument. The present specimen was presented to the Society by Messrs. W. Watson and Sons in 1899.

Described and figured in Journ. R.M.S., 1899, p. 214.

Dr. EDWIN QUEKETT'S Microscope. 1844.

Type—Compound: Achromatic.

This instrument was designed and mainly constructed by Dr. Quekett, the founder of the Royal Microscopical Society, and was bequeathed by him to the Society. Whilst following James Smith's Microscope in general arrangement, this model is characterised by greater rigidity of the foot and pillar. The mechanical stage is made on A. Ross' pattern. Below the stage there is a focusing condenser.

Bequeathed to the Society by Dr. Quekett, who died June 28, 1847.

POWELL AND LEALAND. 1848.

Type—Compound: Achromatic.

This model is the first example in which the Microscope is hanging in a tripod, and also the first example in which the fine-adjustment moves the nose-piece by means of a lever within a bar. The mechanical stage has Turrell's rectangular movement, and possesses a focusing condenser. This type of Microscope appears to have been first made in 1843, but as in all the features mentioned it is being reproduced at the present day, it may be said to represent the modern instrument.

Described in Journ. R.M.S., 1901, p. 727. A duplicate of this instrument is described and figured in the Journ. R.M.S., 1898, p. 125.

B. Technique.*

(1) Collecting Objects, including Culture Processes.

Bacillus typhosus and B. coli on media containing Blood and Carbohydrates.†—E. P. Bernstein has observed the different behaviour of *B. typhosus* and *B. coli* when grown on agar containing 1 p.c. of various (16 varieties) carbohydrates, to each 15 c.cm. of which 1 c.cm. of sterilised ox blood has been added. On lactose blood agar typhoid colonies produced no hæmolysis; coli colonies did. On raffinose blood agar typhoid colonies are umbilicated with radiating lines; coli colonies do not show these peculiarities. On maltose blood agar typhoid colonies are almost black; coli colonies are dull white. On dextrose blood agar typhoid colonies caused a precipitation and were of a black colour; coli colonies caused hæmolysis and were white.

Special Nutrient Medium for Cholera Vibrio.‡—A. Dieudonné finds that alkaline blood agar is a favourable medium for the cholera vibrio and is antagonistic to the growth of *B. coli* and other intestinal organisms. The medium is prepared by mixing defibrinated blood with an equal amount of normal caustic potash and sterilising; 30 parts of this solution are then added to 70 parts of nutrient agar prepared in the usual way.

Cultivation of Bacillus Lepræ.§—M. T. Clegg describes attempts to grow the bacillus of leprosy in combination with an amœba and its symbiotic bacterium on a medium composed of agar 20, sodium chloride 0·3, beef-extract 0·3. A culture of amœbæ was obtained from a dysentery stool, and after a sufficient growth of the amœbæ had occurred to over-balance the symbiotic bacteria, leprosy bacilli were added by smearing the surface of the media with pulp from a leper's spleen. A short, plump, acid-fast bacillus developed, and from this sub-cultures were made. Successful results were obtained from two different cases of leprosy.

Fixation Methods and the Swelling of Alga Membranes.‖—F. Tobler makes an attempt at estimating the magnitude of the errors arising out of certain fixation methods and the amount of swelling of alga membranes. The materials used were the youngest portions of the red alga *Polysiphonia*. The fluids experimented with were :—(1) Iodine in sea-water. (2) Merkel's Solution (equal parts 1–400 platinum chloride and 1–400 chromic acid made up with water or sea-water). (3) Flemming's weak solution. (4) Formalin 40 p.c. diluted with water or sea-water. (5) Saturated solution of picric acid in 50 p.c. alcohol.

Demonstrating Karyokinesis in Stypocaulon Scoparium.¶—E. Escoyez fixed the material in Bonin's or Flemming's fluid; the latter

* 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., l. (1909) p. 1. ‡ Tom. cit., p. 107.

§ Philippine Journ. Sci., iv. (1909) pp. 77–9.

‖ Zeitschr. wiss. Mikrosk., xxvi. (1909) pp. 51–8.

¶ La Cellule, xxv. (1909) pp. 181–201 (1 pl. and 30 figs.).

gave the better results. Under a dissecting Microscope pieces were cut off the ends of the filaments, and by means of a pipette were transferred to a small dialyser. When a sufficient number had been collected the alcohols were slowly upgraded and afterwards chloroform was added. When pure chloroform was reached, paraffin dissolved in chloroform was added, the oven temperature being 52° C. On arriving at pure paraffin the contents of the dialyser were poured into a paper boat placed on an iron blade heated sufficiently to keep the paraffin liquid. The pieces were then arranged parallel to one another by means of needles. As this procedure was always tedious and often unsuccessful, it was replaced by the following :—A larger dialyser was used and into it several hundreds of bits from the tips were thrown. The liquids were changed as before, but when they arrived in paraffin the boats were kept in the oven at 52° C. until the fragments had sunk to the bottom ; the paraffin was then suddenly cooled. The sections were stained with iron-alum-hæmatoxylin with or without Congo red. The use of gentian-violet aided the differentiation. The greatest obstacle to success was the presence of diatoms which covered the surface of the filaments of *Stypocaulon*. As many as possible were removed by means of a brush.

Cultivating the Parasite of Oriental Sore.* — R. Row planted material from the sore in sterile sodium citrate solution (2 p.c.), and in human blood serum. Some of the cultures were left at laboratory temperature (25–28° C.), and some were incubated at 35° C. Those incubated at 35° C. and those planted in the sodium citrate solution did not show any growth, and soon disintegrated. In the blood serum cultures, kept at laboratory temperature, they increased in size. multiplied greatly, and finally became Herpetómonas-like flagellates. The author describes in detail the phases in the life-cycle, and gives reasons for discriminating between the parasite of oriental sore and that of kala-azar.

(2) Preparing Objects.

Demonstrating the Structure of Trypanosoma lewisi.† — E. A. Minchin, in an important paper on the structure of *Trypanosoma lewisi*, in relation to microscopical technique, gives a mass of information relative to manipulation and procedure from personal experience. He begins by showing how Trypanosomes may be effectively examined in hanging drops. To a hollow ground slide is cemented a ground-glass ring ; the upper edge of the ring is painted with vaselin, and a drop or two of 4 p.c. osmic acid placed in the well. A cover-glass is then spread with a drop of blood and placed, film side downwards, on the ring. After a certain time the cover-glass is removed and placed, film side downwards, on a slide and insured against further evaporation by luting it with a mixture of beeswax and venetian turpentine. Such preparations are termed by the author "standard." In some of these standard preparations a small drop of $\frac{1}{2}$ p.c. methyl-green in 1 p.c.

* Quart. Journ. Micr. Sci., liii. (1909) pp. 747–54 (1 pl.).
† Tom. cit., pp. pp. 755–808 (3 pls.).

acetic acid was placed on the slide after fixation in osmic acid. This tinges the nuclei of the Trypanosomes and does not affect their size. The method of testing the effects of the technique was carried out as follows:—The preparations were examined and drawn under exactly similar conditions, i.e. the Microscope and drawing arrangements were invariably the same; the illumination was an end-on flame concentrated by a collecting lens through a monochromatic screen on the mirror of the Microscope, and thence reflected through a centring achromatic condenser.

The author then goes on to point out why he gave up slide-smears for cover-glass preparations. The cover-slip is dropped down plump into the fixative, and the films or smears were always stained and mounted without being allowed to dry during any part of the process. The use of cover-slip films necessitates a modification in the mode of applying the osmic acid vapour. The requirements are a square block of hard paraffin and a ground-glass ring; the latter is heated and stuck on to one surface of the block, and a hollow is then dug out in the block. Osmic acid is placed in the cell thus made, and then the cover-glass with the blood-smear placed thereon. After sufficient exposure, the cover-slip is lifted off and dropped into alcohol, or some other fixative.

The fixatives used were osmic acid vapour followed by alcohol, mixtures containing osmic acid, and mixtures in which corrosive sublimate is the principal ingredient. The staining methods chiefly used were Giemsa, Heidenhain's iron-hæmatoxylin, and Twort's stain (a combination of neutral-red and light-green).

For numerous other details the original should be consulted.

LENDVAI, J.—**Ein neuer Apparat zur Fixierung und Färbung der in wasser lebenden Mikrobien.** *Centralbl. Bakt.*, 2te Abt., xxiv. (1909) pp. 192–4 (2 figs.).

(3) Cutting, including Imbedding and Microtomes.

New Freezing and Cooling Arrangement for the Microtome.* — R. Krause, after discussing the advantages and disadvantages of several cooling reagents, including liquid air, describes his experiences of solid carbonic acid gas, which he has found very satisfactory. To obtain carbonic acid in this condition the liquid form is allowed to issue slowly from the steel cylinder in which it is bought, and as this issue is under high pressure the sudden expansion lowers the temperature sufficiently to cause a deposit of carbonic acid snow. Small bags of the best silk velvet were found to be the best receptacles for this solid, which was afterwards transferred to a small Dewar flask, similar to those used for storage of liquid air. Such a flask is of double-walled glass, the inside of the walling being vacuous and silver plated; the whole arrangement is something like a beaker within a beaker (fig. 115), the two beakers being united at their rims. This freezing-chamber is inclosed in a brass cylindrical case of suitable size for the microtome-stage, and lined with non-conducting material (e.g. felt). The inner "beaker" receives a slightly smaller brass cylinder, the upper side of whose bottom has a vertical

* Zeitschr. wiss. Mikrosk., xxv. (1909) pp. 289–300 (4 figs.).

spiral spring, intended to press upward a little platform. The solid carbonic acid is accumulated on this platform, and the action of the spring forces it against the microtome-stage. An object on the stage therefore experiences a freezing effect. The outer and inner brass cylinders and microtome-stage are threaded and fit compactly together. The size of the whole, exclusive of the actual stage, is 45 mm. diam. and 85 mm. high. The author found that the cost of 1 hour's freezing was only one penny. The object to be frozen was moistened with a

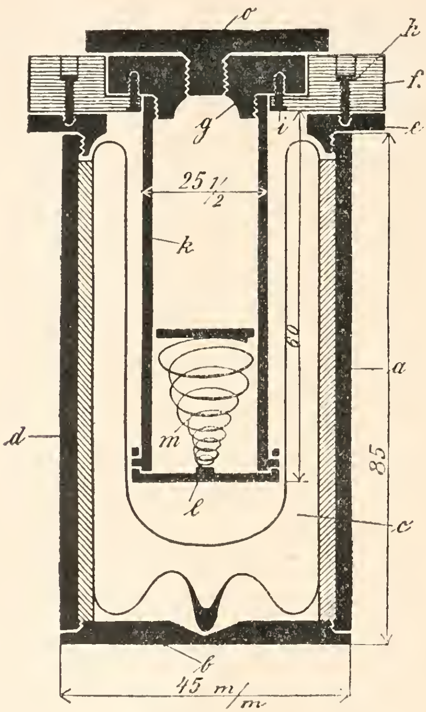

Fig. 115.

few drops of water, and the frost fastened it firmly to the stage. The author found he could cut a long series of faultless sections 5 μ thick from rather large objects, and he seems to have been well satisfied with his results. He also found that he could apply carbonic acid to the cooling and hardening of paraffin-imbedded objects.

Minot's Small Microtome.*—M. Wolff has designed a small form of the Minot-Zimmermann Microtome, Model I., and states that it

* Zeitschr. wiss. Mikrosk., xxvi. (1909) pp. 84–104 (5 figs.). See also a special pamphlet (No. 21) E. Zimmermann, Leipzig.

possesses the advantages of the well-known apparatus in a form adapted for private operators and for small institutions. The price, moreover, is reduced by more than one-half. Fig. 116 shows (for comparison), the

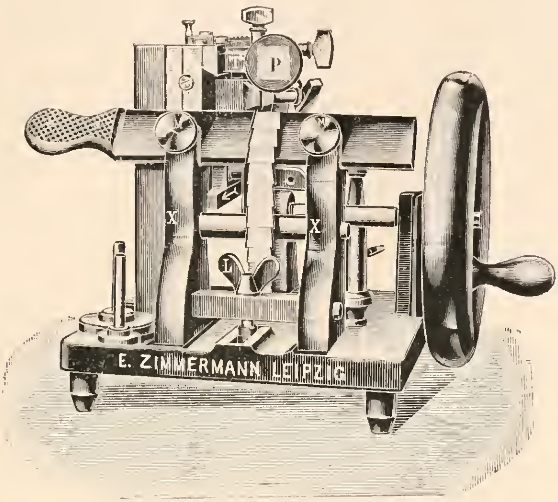

FIG. 116.

Model I., the ground-plate of which is 17 × 17 cm., the weight (net) 9·050 kg., maximum size of section 3·3 to 4·2 cm. × 5·5 cm., maxi-

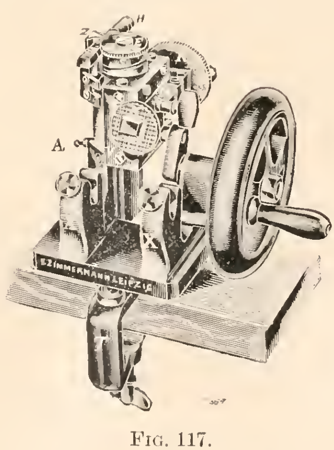

FIG. 117.

mum height of block 3·5 cm. Fig. 117 shows the new small model, which is described as having the following recommendations :—Automatic adjustment of section-thickness from 5 to 30 mikrons; maximum section-plane 30 × 25 mm.; maximum block-height 20 mm.; inclination of knife to section-plane regulated by clamping-screws; displacement of knife or object impossible; applicability for freezing (ethyl chloride); easy working by means of a well-balanced flywheel gear; compactness for travelling. No pains have been spared to secure precision of movement, and the machine may be operated quickly or slowly. The large clamp T fastens the instrument rigidly to the working table. The two strong pillars of the knife-holder X are cast on to the ground-plate, and the groovings for the knife are fitted with clamps for regulating the knife-inclination in order to adapt it as delicately as possible to the requirement of the object. The crank of the vertical slide V is balanced by the flywheel, and is operated in a very simple manner by the gearing; it can also be fixed in its highest position by a stop, so that coarse adjustments, supplementary paring of the block, treatment of the freezing chamber with ethyl chloride, etc., may be undertaken. The object-slide M is adapted on its upper half to excentric movement, and is actuated by a micrometer-screw of 0·5 mm. thread, and the progress forward of the preparation always follows upon the knife-cut. The ratchet H engages in the teeth of the cogged wheel R connected with the micrometer-screw and rotates it 1 to 6 teeth at each drop of the vertical slide according to the adjustment of the screw-head E; each tooth = 5 mikrons. The screw-head E is graduated into 1 to 6 parts, which correspond to the number of teeth to be moved. In addition to these automatic section arrangements it is possible, by putting the ratchet H out of gear, to cut freehand sections less than 2½ or greater than 30 mikrons, as desired. A well-defined straight line with millimetre divisions is used for the adjustment of blocks with parallel edges, and is inserted in the knife-holders conformably with the adjustment of the object in the object-holder. When the flywheel is rotated the block is lowered (or raised) just sufficiently to allow the upper (or lower) surface to come to the right level for cutting; a needle then traces a furrow in the block, which can then be trimmed off.

(4) Staining and Injecting.

Differential Staining of Spores.*—G. Proca and P. Danila find that the easiest way of staining killed spores is to treat the film with boiling decinormal solution of caustic soda for a few minutes and then to stain with their methylen-blue-fuchsin solution.

Twort's Neutral-red and Light-green Stain.†—This reagent is prepared by making up half-saturated solutions of neutral-red and of Grübler's Licht-grün in distilled water. The neutral-red solution is placed in a large open vessel, and sufficient light-green solution is added. A precipitate forms, and this is allowed to sediment. The supernatant fluid is decanted off, and then the precipitate is rinsed in distilled water

* C.R. Soc. Biol. Paris, lxvii. (1909) pp. 307–9.
† Quart. Journ. Micr. Sci., liii. (1909) pp. 755–808 (3 pls.).

and dried at 37° C. The dry pigment is fairly soluble in methyl-alcohol, and more so if 5 p.c. glycerin be added. To make up the stain for use it is advisable to pound up 0·25 grm. with some sharp clean sand: this prevents the stain going into a sticky mass when the alcohol is added. Then dissolve the dry residue in methyl-alcohol containing 5 p.c. glycerin.

Stain for 5 minutes or more in a solution made with 2 parts stock solution and 1 part distilled water. Rinse in distilled water. Fix for ½ to 1 minute in Unna's glycerin-ether mixture 2 p.c. in H_2O. Rinse in distilled water. Differentiate and dehydrate in absolute alcohol. Any precipitate is easily removed by means of methyl-alcohol, or by equal parts of absolute alcohol and xylol. Then xylol and balsam. This stain does not appear to act well after osmic acid or its mixtures, but good results are obtainable from sublimate and its mixtures.

SAVINI, E., & TH. SAVINI-CASTANO—**Zur Technik der Elastika und Bindegewebs-färbung.** *Zeitschr. wiss. Mikrosk.*, xxv. (1909) pp. 29–47.

SOMMERHOFF, E. O.—**Die Färbung der Pikrinsäure auf Seide.**
A phenomenon of *Osmosis*, in which the sheath of the silk filament acts as an animal membrane; chromaturgical considerations in reference to the staining of bacteria. *Tom. cit.*, pp. 48–51.

CAVAZZA, L. E.—**Studi microchemici e fisiologici sui Tannini.** *Tom. cit.*, pp. 59–64.

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

Examining and Mounting the Digestive System of Schizopoda.*—C. Gelderd fixed the material in the following fluid:—Formalin, 40 p.c., 5 c.cm.; alcohol, 94 p.c., 30 c.cm., H_2O 100 c.cm.; or in Gilson's fixative: Nitrate of copper, 200 gr.; formalin, 500 c.cm.; sea-water, 200 c.cm.: 7 c.cm. were used with 100 c.cm. of sea-water. The sections were stained and mounted in the usual way, or with Gilson's euparal, which has the advantage of being able to be used after dehydrating in 70 p.c. alcohol.†

Isobutyl-alcohol was very useful when mounting in euparal, as it is less volatile and absorbs water less rapidly than ethyl-alcohol, and delicate objects could be manipulated by its aid without danger of contracting the tissues. The procedure was as follows:—Dehydrate with ethyl-alcohol at 70 p.c.; wash in isobutyl-alcohol; mount immediately in euparal.

(6) Miscellaneous.

Metal Filter.‡—E. Gobbi describes a filter, made of nickel, the pores of which are fine enough to hold back ultra-microscopic particles. Such an apparatus should be invaluable in bacteriological laboratories.

DON, J.—**The Filtration and Purification of Water for Public Supply.** *Proc. Inst. Mech. Eng.*, 1909, pp. 1–209 (3 pls.)

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* La Cellule, xxv. (1909) pp. 7–68 (4 pls.).
† See this Journal, 1906, p. 501.
‡ Comptes Rendus, cxlviii. (1909) pp. 1126–8.

Metallography, etc.

Structure of Coinage Bronze.*—F. Giolitti and E. Pannain have studied the microstructure of Italian coinage bronze, containing 95·8 p.c. copper, 3·82 p.c. tin, and 0·38 p.c. impurities. The polished sections were repeatedly etched with hot nitric acid 0·24 p.c., and were gently repolished with chromium oxide after each etching. The alloy as cast was found to consist of the solid solutions α and β, though a bronze of this composition should consist entirely of α. The presence of β-crystals is due to the speed of cooling, which is too great to permit of the establishment of equilibrium between the first α-crystals and the liquid. The concentration of the liquid in tin thus increases beyond the theoretical value, and the β-crystals, rich in tin, result. The β-crystals were not removed by heat treatment. The authors investigated the effect of mechanical work on the alloy.

Arsenic and Antimony in Copper.†—A. H. Hiorns and S. Lamb have studied the influence of small quantities of arsenic and antimony on copper. Thirteen alloys were prepared containing 0·05 to 2·9 p.c. arsenic, and thirteen alloys containing 0·1 to 3·5 p.c. antimony. Various physical tests were carried out, and sections for microscopic examination were cut transversely from both quickly and slowly cooled ingots. Both series of alloys were found to consist of dark soft crystals, surrounded by a lighter and harder constituent which increased in quantity as the proportion of the foreign element was greater. In the slowly cooled alloys small quantities of bodies, which appeared to be the chemical compounds Cu_3As and Cu_3Sb, were noted.

Gold-tellurium Alloys.‡—H. Pélabon has determined the solidification temperature curve of the gold-tellurium system. A eutectic containing 16·5 p.c. gold solidifies at 415° C. A maximum (472° C.) at 41 to 45 p.c. gold indicates the existence of a definite compound, which appears to correspond to the mineral calaverite Au_2Te_4. From 45 to 56 p.c. gold the curve falls to 452° C., the melting-point of tellurium. All the alloys containing more than 56 p.c. gold solidify at 452° C., but at higher temperatures are increasingly pasty as the content of gold is greater. No indication of the existence of Au_2Te was obtained.

Cobalt-tin Alloys.§—S. F. Zemczuzny and S. W. Belynsky give an equilibrium diagram obtained by thermal methods and confirmed by microscopic examination of the alloys. Two compounds, Co_2Sn and CoSn, and two eutectics were found. CoSn is non-magnetic, as are also all the alloys with less cobalt than this compound.

Boiling-points of Metals.‖—H. C. Greenwood has employed a vertical carbon tube resistance furnace; in it was suspended a long graphite

* Atti R. Accad. Lincei, xvii. (1908) pp. 668–70, through Journ. Chem. Soc., xcvi. (1909) pp. 144–5.

† Journ. Soc. Chem. Ind., xxviii. (1909) pp. 451–7 (8 figs.).

‡ Comptes Rendus, cxlviii. (1909) pp. 1176–7.

§ Zeitschr. Anorg. Chem., lix. (1908) pp. 364–70 (7 figs.).

‖ Proc. Roy. Soc., Series A, lxxxii. (1909) pp. 396–408 (2 figs.)

crucible containing the metal the boiling-point of which was to be determined. The temperature of the outer walls of the crucible was taken by a Wanner optical pyrometer. The surface of the metal was observed from above; the commencement of boiling could easily be noted. For metals which combine with carbon, the graphite crucibles were lined with magnesia. The following temperatures are given as approximate boiling-points :—

Aluminium	1800° C.	Copper ..	2310° C.	Manganese	1900° C.
Antimony	1440	Iron ..	2450	Silver ..	1955
Bismuth ..	1420	Lead ..	1525	Tin ..	2270
Chromium	2200	Magnesium	1120		

Structure of Steels at High Temperatures.* — A. Baykoff first confirmed Maurer's results by obtaining homogeneous austenite from a steel containing 1·79 p.c. carbon, 2·14 p.c. manganese, 0·89 p.c. silicon, quenched from 1110° C. Pure austenite has been defined by H. le Chatelier as a solution of carbon in γ-iron, stable between the solidification temperature and a temperature varying from 700–1200° C., according to carbon content. The purest austenite hitherto obtained, homogeneous at ordinary temperatures, is Maurer's, containing about 2 p.c. manganese. In order to ascertain the structure of pure austenite in its stable range, the author etched previously polished sections of five steels containing 0·12–1·94 p.c. carbon, some being almost free from other elements, at 1120° C. The polished sections were placed in the porcelain tube of an electric resistance furnace. Hydrogen was passed through for several hours, and the temperature was then raised to the required degree. Hydrochloric acid was then introduced for several seconds, the current of hydrogen continued for 2 to 3 hours, and the furnace allowed to cool. The steels, etched in this way at 1120° C., all showed the polyhedric structure characteristic of austenite. Twinning was noted in several cases. Etching at 870° C. in a similar way failed to reveal a martensite structure. Martensite does not appear to be stable at any temperature, but to be a structure developed only by quenching.

Structure of Hardened Steel.† — W. J. Kurbatow and M. M. Matwejew find that the best method of producing austenite is to quench steel of 1·8–2·2 p.c. carbon, heated nearly to melting, in mercury at 130° C. The lance-shaped crystals occurring between the austenite crystals, are troosto-sorbite. The equilibrium austenite $\rightleftarrows$ sorbite proceeds from right to left between 90° and 150° C., and above 1000° C. Between 150° and 750° C. the equilibrium proceeds from left to right, most rapidly at 250° C. All the constituents of steel are crystalline. Austenite is probably a carbide of iron Fe_7C (?) (Fe_6C – $Fe_{10}C$). Troostite and sorbite are solutions of carbon in iron, α or β. The austenite is unchanged after heating at 65–85° C. for several months. At 118° C. recrystallisation is evident in a few days. At 180° C. austenite changes to troostite. The old scheme of transformation austenite-martensite-troostite-sorbite-pearlite is inaccurate.

* Rev. de Métallurgie, vi. (1909) pp. 829–34 (10 figs.).

† Metallurgie, v. (1908) pp. 721–8 (8 figs.).

Hardening and Tempering of Iron and Steel.*—E. Maurer gives an account, previously published elsewhere, of his work on this subject, and adds lengthy and important conclusions drawn by F. Osmond. By quenching from a sufficiently high temperature γ-iron may be produced in hypo-eutectic as well as in hyper-eutectic steel. Cold working may also produce a small proportion of γ-iron. No causal relation exists between carbon (as hardening carbon), and hardness of steel. The increase of electrical resistance, due to quenching, appears to be a measurement of the amount of carbon which has gone into solution, and the curve connecting electrical resistance, a function of the hardening carbon, with temperature of re-heating of quenched steels, does not follow the hardness curve. Carbon appears to remain in solution because of the γ-iron present in martensite. The letting down of quenched steels proceeds in four distinct stages :—(1) from the ordinary temperature to 150° C. ; (2) 150–300° C. ; (3) 300–450° C. ; (4) 450° C. to the recalescence point. For the complete theory of hardening, founded by Osmond on the facts observed by Maurer and others, the original should be consulted.

Electrolytic Iron.†—A. Müller has obtained a considerable quantity of electrolytic iron, containing 0·03–0·05 p.c. fixed impurities and small amounts of hydrogen and nitrogen, and has studied its thermal and other properties. Microscopic examination showed that the iron was deposited in a laminated form and contained numerous blowholes and mechanical inclusions. With high magnification, systems of lines radiating from points were observed. This star-like structure appeared to be related to the crystalline structure of the iron. Several fusions of the iron, in a magnesia crucible, heated in a vacuum electric resistance furnace, were required to drive off hydrogen and nitrogen. The critical points on heating were found at 917° C. and 765–774° C., and on cooling at 894° C. and 766–759° C. Other critical points were found in hydrogen-containing samples, the most marked being at 1210° C.

Iron-phosphorus System.‡—E. Gercke gives an equilibrium diagram, obtained by thermal and microscopical methods, for the range 0 to 22 p.c. phosphorus. Phosphorus is completely soluble in solid iron up to 1·7 p.c. From 1·7 to 10·2 p.c. a eutectic line is found at 980° C. The eutectic solidification-point may, however, be lowered to 880° C. by supercooling. The eutectic iron-phosphide of iron contains 10·2 p.c. phosphorus.

Iron-phosphorus-carbon System.§—P. Goerens and W. Dobbelstein conclude, from a study of sixteen alloys of different carbon and phosphorus content, that, as regards phenomena of solidification, this system may be considered as a ternary system, the components of which are iron, carbide of iron, Fe_3C, and phosphide of iron, Fe_3P. The ternary eutectic solidifies at 953° C., and has the composition C 1·96 P 6·89 Fe 91·15 p.c. The equilibrium diagram is given. Metallographic methods were found

* Metallurgie, vi. (1909) pp. 33–52 (64 figs.). See also Rev. de Métallurgie, v. (1908) pp. 711–50; and this Journal, 1908 p. 784.
† Tom. cit., pp. 145–60 (15 figs.).
‡ Op. cit., v. (1908) pp. 604–9 (14 figs.). § Tom. cit., pp. 561–6 (14 figs.)

to give results more definite than those obtained from cooling curves. In alloys of nearly eutectic composition the separation of primary crystals could hardly be detected by thermal methods, whilst the crystals were clearly distinguished microscopically. The structure of most of the sections was developed by etching and heat-tinting, followed by light repolishing.

Alloys of Iron with Arsenic and Bismuth.*—C. F. Burgess and J. Aston have studied these alloys, prepared, free from carbon, from electrolytic iron. The effect of arsenic in acid pickling baths in retarding the rate of attack of the acid upon steel had suggested that arsenic in steel might render it less readily corrodible. The author's experiments did not bear out this notion, the iron-arsenic alloys resisting corrosion little better than iron and steel containing no arsenic. The addition of arsenic to iron improves its magnetic properties, but more than 0·25 p.c. is detrimental in its physical effects.

Some Iron-silicon-carbon Alloys.†—W. Gontermann has investigated this ternary system within the limits Fe-Fe_3C-FeSi by the method of thermal analysis, and has also revised the equilibrium diagrams for the iron-carbon and iron-silicon systems. It is suggested that the formation of "kish" in the high-carbon alloys of the iron-carbon system may be explained by the decomposition of cementite on melting into two immiscible liquids, one considerably richer in carbon than the other. The equilibrium diagram of the ternary system, given and explained by the author, does not permit of a brief summary. Typical photomicrographs are given.

Special Steels.‡—L. Guillet indicates the directions in which progress has been made in the manufacture of alloy steels since the Brussels Congress. While the polyhedric steels are losing in importance, pearlitic special steels are receiving wider application.§ In their manufacture the objects aimed at are (1) increase in mechanical strength; (2) simplification of thermal treatment; (3) for parts exposed to friction, increase in resistance to abrasion.

Heat-treatment of Spring Steel.‖—L. H. Fry has determined the transverse elastic limit and modulus of elasticity of steel containing 1·01 p.c. carbon, 0·38 p.c. manganese, heat-treated in various ways. The modulus of elasticity was found to be practically constant and independent of the heat-treatment, its value being $29-30 \times 10^6$ lb. per square inch.

"Slag Enclosures" in Steel.¶—W. Rosenhain calls attention to the possible effect upon the strength of steel of those non-metallic bodies which may be designated as "slag enclosures." A number of photomicrographs of typical forms of these enclosures are given. The

* Electrochem. and Met. Ind., vii. (1909) p. 276.
† Zeitschr. Anorg. Chem., lix. (1908) pp. 373-413 (15 figs.).
‡ Proc. Int. Assoc. for Testing Materials No. 5 (1909) 7 pp.
§ See this Journal, 1909, p. 538.
‖ Proc. Int. Assoc. for Testing Materials, No. 5 (1909) 9 pp. (2 figs.).
¶ Op. cit., No. 10, (1909) 10 pp. (7 figs.).

distribution of sulphide of manganese may be ascertained by taking a "sulphur print." Baumann's method is to apply a sheet of photographic bromide paper, moistened with dilute sulphuric acid, to the steel. The sources of sulphide and silicate of manganese have been held to be the sulphur, manganese, and silicon present in the steel, and the oxygen of the atmosphere, but the author considers that these enclosures may also arise from the inclusion within the steel of furnace slag, or of siliceous matter picked up by the molten metal in its passage from furnace to ingot mould.

Sulphur as a Cause of Corrosion in Steel.*—G. N. Huntly has investigated the pitting of a steam boiler. Blisters on the interior surface of the boiler were found to contain a solution of ferrous sulphate, together with free sulphuric acid, and a pit was forming in the centre of each blister. The only possible source of the free acid appeared to be the manganese sulphide in the steel.

Nickel Steel Injured by Over-heating.†—E. Heyn and O. Bauer have investigated the cause of the cracking in forging of two pieces of steel containing 5·49 p.c. nickel and 0·09 p.c. carbon. Sections polished and etched with copper-ammonium chloride showed a very coarse structure, similar to that of a casting, but no segregation or slag inclusions. The steel became fine-grained when heated at 900° C. for one hour. Forging tests made on pieces heated at different temperatures, for different lengths of time, showed that the steel cracked on forging when heated above a certain temperature. This limiting temperature was found to depend both on the size of the piece and the duration of heating.

Cementation.‡—In the first and second of these articles F. Giolitti points out the disadvantages involved in the rapid fall of carbon content from surface to interior of steels carburised in the usual way. A more uniform percentage of carbon in the carburised layer may be obtained by employing, as cementation agent, a mixture of carbon monoxide and carbon dioxide, or a hydrocarbon. The composition of the gas mixture is adjusted to give the desired carbon content in the steel.

The third article, by F. Giolitti and F. Carnevali, deals with the lower limit of the temperature interval within which cementation may be effected. The discrepancy between the author's previous statement that 700 C. is the lower limit, and Charpy's results, is explained by the observation that at lower temperatures carbon monoxide acts upon iron, forming an adherent layer, probably a carbide of iron. This is not cementation in the sense understood by the authors.

Malleable Cast Iron.§—F. Giolitti, F. Carnevali, and G. Gherardi have studied the conversion of cast iron containing 2·9 to 3·6 p.c.

* Journ. Soc. Chem. Ind., xxviii. (1909) pp. 339–40.

† Stahl und Eisen, xxix. (1909) pp. 632–5 (13 figs.).

‡ Rend. Soc. Chim. di Roma, vi. (1908) pp. 337–41, 354–8, 359–63, through Journ. Soc. Chem. Ind., xxviii. (1909) p. 205.

§ Rend. Soc. Chim. di Roma, vi. (1908) pp. 388–93; Atti R. Accad. Lincei, xvii. (1908) pp. 662–7, 748–54, through Journ. Soc. Chem. Ind., xxviii. (1909) pp. 205, 215.

carbon, 0·1 to 0·2 p.c. silicon, and 0·03 to 0·18 p.c. manganese, into malleable cast iron by heating in oxide of iron at about 1000° C. In samples withdrawn after different periods, estimations of carbon at different depths and microscopic examination showed that the carbon content increased gradually with the depth, passing through a pearlite zone of constant composition. The chief factor in decarburisation is the diffusion of oxidising gases from the iron oxide into the interior, but the diffusion of carbon from the interior outwards also plays a part. The statement of Wüst,* that the formation of temper-carbon from cementite is a necessary preliminary to decarburisation is disputed.

Decarburisation of Iron-carbon Alloys.†—W. H. Hatfield disagrees with Wüst's view that in the decarburisation of white iron the carbon must be precipitated as temper-carbon before it is eliminated. Pieces of cemented Swedish bar-iron containing 1·64 p.c. carbon, all combined, were packed (1) in charcoal, (2) in sand, (3) in iron ore, and heated slowly. The temperature was maintained at 890° C. for 24 hours, then raised to 960° C., where it was kept for 48 hours. The temperature then fell very slowly. In (1) the carbon content was unchanged, in (2) it had fallen to 0·75 p.c., in (3) to 0·15 p.c. No temper-carbon could be found in any of the three samples, either by chemical analysis or microscopically. Carbon may therefore be eliminated without previous formation of temper-carbon. The examination of white iron at different stages in its conversion to malleable iron fully confirmed this view.

Progress in Metallography.‡—E. Heyn reviews the output of research in metallography and related subjects, from the Brussels Congress of 1906 up to the beginning of 1909. A comprehensive list of papers published is given, with valuable explanatory and critical comments. The papers are classified as dealing with :—1. Researches for establishing the chemistry of intermetallic compounds, chiefly by the determination of equilibrium diagrams of systems of alloys, without regard to their practical utility. 2. The iron-carbon system. 3. Iron and manganese alloys, including special steels. 4. Alloys of industrially useful metals other than iron. 5. Metallographical investigation of phenomena in the manufacture of metals other than iron. Friedrich's studies relating to the formation of matte and speiss are examples. 6. The phase theory, physico-chemical methods, crystallography, etc. 7. Accessories for metallographical work. 8. Industrial application of metallography.

Metallographic Notes.§—K. Friedrich ranges over a variety of subjects. The employment of ultra-violet light for photomicrography does not offer advantages commensurate with the increased difficulties of manipulation. Some questions arising in the study of the nickel-cobalt-arsenic alloys are dealt with. No evidence was found for the existence of a compound Ni_2As.

* See this Journal, 1908, p. 258.
† Journ. Iron and Steel Inst., lxxix. (1909) pp. 242–60 (7 figs.).
‡ Proc. Int. Assoc. for Testing Materials, No. 5 (1909), 20 pp. Report presented to the 5th Congress, Copenhagen, September, 1909.
§ Metallurgie, v. (1908) pp. 593–604 (16 figs.).

Industrial Application of the Microscope.*—W. H. Davis describes the method of employing the Microscope in controlling the roasting of a sulpho-telluride gold ore, chemical analysis failing to give sufficiently definite information as to the relation between the condition of the gold and the roasting temperature.

Illumination in High-power Photomicrography.† — C. Benedicks points out that published metallographical photomicrographs at 1000 or more diameters, with a few exceptions, leave much to be desired in sharpness of definition. This appears to be due to the neglect of an important factor. The Beck illuminator, a thin glass plate set at an angle of 45° in the Microscope tube, has, on account of certain disadvantages, been replaced to a large extent by the Zeiss or Nachet prism. Such totally-reflecting prisms cut off one-half of the light rays proceeding from the objective, and the author proves that this is equivalent to a large reduction in numerical aperture. Tests of a Zeiss 2 mm. apochromat N.A. = 1·30, with and without a piece of black paper fixed above one half of the objective, were made on various test-objects viewed by transmitted light. The resolving power was greatly reduced by the presence of the paper. Photomicrographs at 1200 diam. are given of the same field of lamellar pearlite illuminated (1) by a reflecting prism; (2) by a cover-glass at 45°; (3) as (2), but with one-half of the cone of light cut off by a diaphragm placed above the glass disk: (2) showed much sharper definition than either of the other two photomicrographs. The faults of the Beck illuminator are shown to be not serious: it is accordingly to be preferred to the prism for high-power work.

Autographic Registration of Cooling Curves.‡ — E. F. Northrup describes a sensitive autographic recorder to be used with a resistance pyrometer. The author discusses the various methods of taking cooling curves, and concludes that the direct time-temperature curve gives all the information required.

Measurement of Hardness.—P. Ludwik § submits the official report to the Copenhagen Congress. Only those methods which have been extensively introduced into technical practice are dealt with—the ball-pressure and cognate cone-pressure tests.

A. Martens and E. Heyn ‖ recommend the measurement of depth of impression rather than diameter in the ball-hardness test, and describe a machine for impressing the ball into the test-piece and measuring the depth with great accuracy.

A. Gessner ¶ has investigated the relation between hardness (as measured by the cone-pressure test) and tensile strength of permanent-way materials.

H. Moore ** has determined the limiting conditions (minimum thickness and diameter of test-piece permissible) for the ball-pressure hardness

* Metallurgie, v. (1908) p. 734 (4 figs.).
† Op. cit., vi. (1909) pp. 320–3 (3 figs.).
‡ Electrochem. and Met. Ind., vii. (1909) pp. 273–4 (1 fig.).
§ Proc. Int. Assoc. for Testing Materials, No. 6 (1909) 12 pp. (5 figs.).
‖ Tom. cit., 10 pp. (6 figs.). ¶ Tom. cit., 2 pp.
** Op. cit., No. 9, 11 pp. (1 fig.).

test. It is suggested that mean pressure per unit area be taken to represent the hardness of the material tested, when the diameter of impression is one-half the diameter of ball. Meyer's formula for expressing the relation between load and diameter of impression, $P = ad^n$, is confirmed; the value of n almost invariably lies between 2 and 2·5. The author points out that $n - 2$ may be taken to represent capacity for hardening by cold work.

T. Turner * discusses the definition of hardness, and compares, as four typical methods for determining that property, the Turner sclerometer, the Shore scleroscope, the Brinell test, and the Keep drill test.

Internal Friction in Loaded Materials.† — G. H. Gulliver draws the following conclusions from experimental work on the modes of deformation of steel and other metals under stress, and from theoretical considerations. The general directions of internal sliding in a body under load, as revealed by the lines of Lüders and by fractured surfaces, are consistent with the action of a frictional resistance between the particles of the body, differing little from that of ordinary external frictional resistance. Determinations of strength show variations far too great to allow of even an approximate calculation of the value of the coefficient of internal friction.

Influence of Time and Temperature on Impact Tests. ‡ — A. le Chatelier points out that rate of loading, in tensile tests at temperatures above 100° C., has an enormous influence on the results. Thus a mild steel wire, at 170° C., gave a tensile strength of 45 kg. per sq. mm., and elongation 10 p.c. when the test occupied 20 minutes, while when the wire was broken in 2 seconds the tensile strength was 27 kg. and elongation 28 p.c. It is probable that variations in speed in shock tests will have an equally great influence. This being so, the results given by Guillet and Révillon § will hold only for the speed of testing used: probably at lower speeds the temperature of maximum brittleness would be lower. The author summarises the results of his experimental investigations on the effect of time and temperature on the mechanical properties of steel.

L. Guillet and L. Révillon ‖ have made shock tests at temperatures from 20–650° C. on a 0·35 p.c. carbon steel, causing the striking velocity to vary through a considerable range. No effect due to variation in speed of testing could be detected, the temperature of maximum brittleness remaining constant at 460–480° C. Further results of shock tests at various temperatures are given for a number of special steels, selected as possessing typical microscopic structures (pearlitic, martensitic, polyhedric, etc.).

"Damping" in the Testing of Iron.¶—A. Guillet suggests a new method of testing metals. A metallic rod, fixed at one end, deformed

* Journ. Iron and Steel Inst., lxxix. (1909) pp. 426–43 (1 fig.).
† Proc. Int. Assoc. for Testing Materials, No. 7 (1909) 7 pp.
‡ Rev. de Métallurgie, vi. (1909) pp. 914–17.
§ See this Journal, 1909, p. 263.
‖ Tom. cit., pp. 918–24 (2 figs.).
¶ Rev. de Métallurgie, vi. (1909) pp. 885–7.

elastically by bending and then suddenly let go, resumes its position of equilibrium after a series of oscillations, more or less "damped." As the "damping" (amortissement) depends on the internal structure, an investigation of the rate at which the vibrations die away should give useful information. It was found that the damping of a specimen of soft iron was three times as rapid as that of a mild steel. A method of measuring the damping is described.

H. le Chatelier * considers that the method may be valuable, as measuring a new elementary property of metals, which is possibly of great importance in their practical applications. The desirability of fully investigating this method of testing is insisted upon, and an outline programme of research is given.

Friction in Compression Tests.†—G. H. Gulliver has studied the effect of the friction of the crushing plates upon the yield-point of short compression specimens. With plates harder than the material under test, the end friction causes an increase in the apparent yield-point. When the crushing plates are softer than the material under test, the apparent strength of the specimen is diminished. Calculated numerical values for both effects are given.

Elastic Limits of Iron and Steel under Cyclical Variations of Stress.‡—L. Bairstow finds that iron or steel is capable of adjusting itself to variations of stress, cyclically applied, after a sufficient number of repetitions. When the adjustment is complete the specimen is found to have become perfectly elastic throughout the whole cycle, and fatigue does not occur. An extension of length of specimen occurs during this adjustment. The greater the extension, the greater is the amount by which the elastic limits are raised.

GULLIVER, G. H.—**Effect of Internal Friction in Cases of Compound Stress.**
Proc. Roy. Soc. Edin., xxix. (1909) pp. 427–31.

HOWARD, J. E.—**Endurance of Steels to Repeated Alternate Stresses.**
[In tests made on a machine in which the rotating test bar is submitted to a bending stress, fracture resulted at stresses much below the elastic limit. The existence of internal stresses is suggested as an explanation.]
Proc. Int. Assoc. for Testing Materials, No. 5 (1909) 7 pp. (4 figs.).

* Rev. de Métallurgie, vi. (1909) pp. 887–9.
† Proc. Roy. Soc. Edin., xxix. (1909) pp. 432–44 (6 figs.).
‡ Proc. Roy. Soc., Series A, lxxxii. (1909) pp. 483–5. (Abstract.)

MICROSCOPY.

A. Instruments, Accessories, &c.*

(1) Stands.

Dissecting Stand, with Lens.†—This instrument (fig. 118) consists of a heavy cast-iron base supporting a brass pillar about 13·5 cm. high.

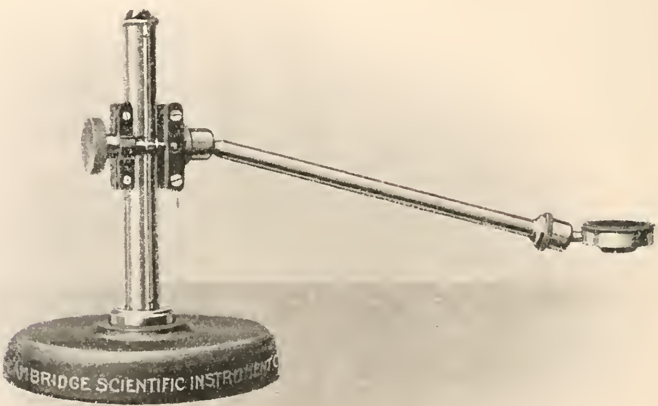

Fig. 118.

On this pillar a carriage slides up and down. This up and down movement is secured by Lucas's patent slow motion mechanism, which

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

† Cambridge Scientific Instrument Co., Ltd., Cat. No. 57 (1909) p. 10, fig. 11.

consists of a small pulley with a V-groove being forced by a spring to bind on a round steel rod, which is screwed to the main pillar. This results in a far nicer movement than the rack-and-pinion gives, since a geometric fit is obtained, and there can be no play or backlash. The movable carriage carries through a ball-joint an arm, at the far end of which the lens-holder is mounted, a ball-joint being used here also. The total length of the arm from the centre of the pillar to the centre of the lens is 23·6 cm.

Koristka's Large Model I.*—This stand (fig. 119) is specially constructed for photomicrography. The upper part is inclinable to 90°, and can be fixed in any position by means of a clamp. There is a mechanical stage with ample vertical and horizontal movements, and the substage arrangements are very complete.

REICHEL, C.—**Das Mikroskop als Hifsmittel in der Werkstatt.**
[The author points out how a Microscope of small magnifying power (10 diam.) may be made very useful in checking the accuracy of fine machine work.] *Deutsch. Mechan. Zeitschr.*, 1909, p. 1.

(2) Eye-pieces and Objectives.

Improved Triple Object-glass.†—Although J. W. Gifford designed this object-glass for a telescope, yet the method of its construction will be interesting to microscopists. The principle, briefly put, is the construction of a single compound lens out of three varieties of glass so selected that three rays of the solar spectrum (B, D and C) are combined, and that therefore perfect achromatism as regards those rays is obtained. An essential preliminary was the determination of the refractive indices of suitable glasses to the utmost accuracy. It was found that indices extending to five places of decimals were insufficient, and the author carried his observations to seven places.

The author had already previously described‡ a method by which the optical constants of glasses can be very accurately measured. To obtain the refractive index it is necessary not only to measure the deviation of the ray from the normal due to the action of the angle of the prism through which it has passed, but also to measure the angle itself, an operation far more liable to error than measuring the deviation. To avoid this the prism is polished on all three sides, the deviations are measured at all the angles, are added together, and the mean deviation, on the principle that the three angles of every triangle are always equal to two right angles (180°), may be used for the purpose of calculating the refractive index as being the deviation for an angle of 60°, although no angle has actually been measured.

The method is not absolutely correct, but the average error due to the method is less than unity in the seventh decimal place. This error is caused by the three angles not being quite equal to one another, but as, with measurements by the ordinary method, it is difficult to avoid error even in the fourth decimal place, it will be readily seen that for all practical purposes considerably greater accuracy is obtained. The

* Koristka's Catalogue, xiii. (1908) pp. 8 and 9, fig. 3.
† Monthly Notice, Roy. Astro. Soc., lxix. (1908) pp. 118–25 (1 pl. and 2 figs.). See also The Observatory, Jan. 1909, pp. 41–2.
‡ Proc. Roy. Soc., Feb. 13, 1902.

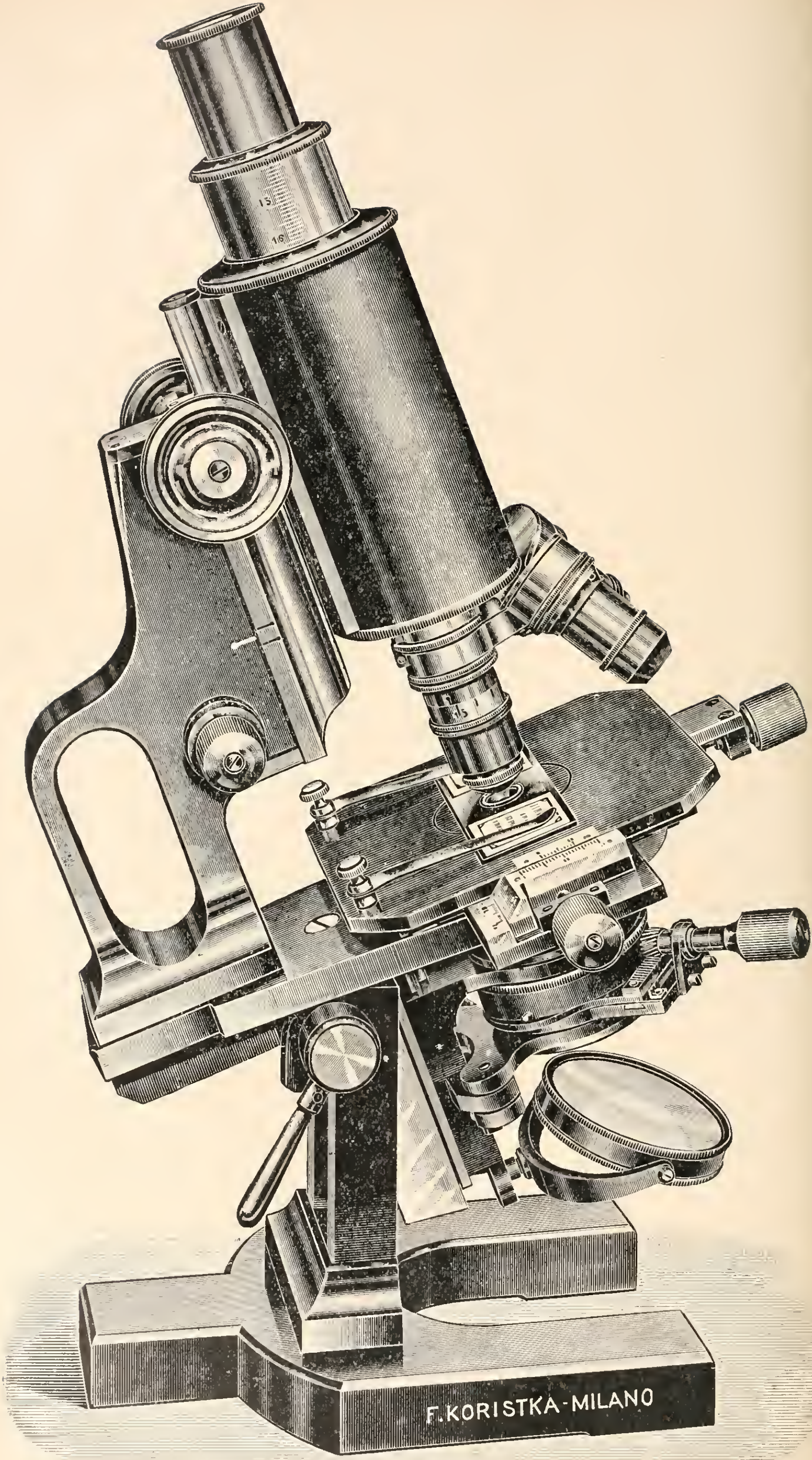

Fig. 119.

measurements of deviation are also made more accurate by taking advantage of the two burrs thrown up by the engraving-tool on each side of every division of the goniometer circle. These are so illuminated as to appear as two fine white lines, and a quartz fibre being brought over each in turn, the mean reading is taken.

In order to get thoroughly representative figures for each glass-melting (about 150 lb. weight), three pieces are chosen at hazard from different parts of it, and these are made into prisms. The average index is then taken as that of the melting, each prism having been measured as to deviation as stated.

Finally, the author checks the errors of his working instrument by comparing the indices with those of a larger goniometer having an 18 in. circle and object-glasses of 3 in. aperture and 30 in. focus. There is also a careful correction for temperature. By the method described it is considered that another decimal place is gained.

Prof. Hastings having long since given as his opinion* that the inconsistencies in his results in the calculation of objectives made of three separate glasses were due to want of accuracy in the refractive indices, Mr. Gifford has made a comparison of the optical constants sent out with the glasses by the makers with those found by his method as well as with the results obtained with them. He finds that the triple is so sensitive to variation of index that, in the case in point, if four decimal places only, instead of five, are taken in the index, then the focus of one of the component lenses, from being positive, becomes a minus quantity. Hence it is quite imperative that the refractive indices should be carried to as many decimal places as the accuracy of the deviations warrants.

Lines B, D, and G of the solar spectrum were used as a basis of calculation for some of the earlier triples. Mr. Gifford uses B′, a red helium line, Λ, a lead line, and Φ, the 6th cadmium line, the two latter being respectively the visual and photographic maxima for rays which have passed through the glasses used. By employing these he gets the further advantage of shallower curvatures.

The paper goes on to describe a lens actually constructed, and concludes with an appendix giving the formulæ for the first approximation and for the trigonometrical trace of a ray, as well as a diagram of the curve of focal lengths of the triple for the different wave-lengths as compared with those of a doublet. The trigonometrical trace is, with very slight modifications, applicable to object-glasses for the Microscope.

The following will illustrate the author's method of finding the reciprocals of the foci for the apochromatic triple :—

μ is baryta light flint ; μ' is borosilicate flint ; μ'' is borosilicate crown. The differences of proportional spectra are : Λ′ – D, 0·00168 ; D – F, – 0·00030 ; F – G′, 0·00805. The refractive indices are :—

B′, 7066 (He)	Λ, 5607 (Pb)	Φ, 4678 (Cd_6)
$\mu_1 = 1·569074$	$\mu_2 = 1·576104$	$\mu_3 = 1·584492$
$\mu'_1 = 1·569909$	$\mu'_2 = 1·577675$	$\mu'_3 = 1·586869$
$\mu''_1 = 1·497250$	$\mu''_2 = 1·502400$	$\mu''_3 = 1·508365$

* Amer. Journ. Sci. and Arts, xviii. p. 433.

If the curvatures corresponding to these rays be A, B, C, then—

$$A = \{(\mu_3 - \mu_2)(\mu'_2 - \mu'_1) - (\mu'_3 - \mu'_2)(\mu_2 - \mu_1)\}(\mu_2'' - 1)$$
$$= 0 \cdot 0000002549117$$

$$B = \{(\mu''_3 - \mu''_2)(\mu_2 - \mu_1) - (\mu_3 - \mu_2)(\mu''_2 - \mu''_1)\}(\mu'_2 - 1)$$
$$= 0 \cdot 0000007303256$$

$$C = \{(\mu'_3 - \mu'_2)(\mu''_2 - \mu''_1) - (\mu''_3 - \mu''_2)(\mu'_2 - \mu'_1)\}(\mu_2 - 1)$$
$$= 0 \cdot 0000005904547$$

$$F = 1$$

$$\frac{1}{f} = \frac{C}{A + B + C} = 5 \cdot 132568 \qquad \frac{1}{f'} = -\frac{B}{A + B + C} = -6 \cdot 348405$$

$$\frac{1}{f''} = \frac{A}{A + B + C} = 2 \cdot 215837$$

$$\frac{1}{f} + \frac{1}{f'} + \frac{1}{f''} = 1 \qquad f' = -0 \cdot 157519$$

Corresponding curvature sum—

$$= \frac{\frac{1}{f'}}{\mu'_2 - 1} = -10 \cdot 989579$$

HARTMANN, J.—**Die Korrektur des potsdamer 80-cm. Objectivs.**
[The author describes how the constructional errors of this large lens were gradually reduced.]
Zeitschr. f. Instrumentenk., xxix. (1909) pp. 217–32 (1 pl. and 6 figs.).

(3) Illuminating and other Apparatus.

Arrangement for Microscopical Observations at Extreme Temperatures.*—H. E. Boeke describes the following apparatus intended for use with the ordinary polarising Microscope. It admits of observations and measurements in parallel and convergent polarised light, strong carbonic acid and ether, or liquid air being used as the cooling medium. The apparatus (fig. 120) consists of two cylindrical glass troughs G_1, G_2 of about 8·5 cm. diameter, set one above the other. Two thin-walled central glass tubes form the observation tube, and are made in one piece with the troughs. The height of the lower trough is 5 cm., and that of the upper 4 cm. These troughs serve for the reception of carbonic acid and ether or of liquid air. Quartz-glass for the troughs is to be preferred on account of its durability, in spite of its high cost. Both troughs are inclosed in a highly polished nickel casing, in two parts, so as to reflect off any external heating influences. The upper part of the nickel casing N_1 slips over the lower N_2, and contains a nickel floor *b b* with an asbestos layer, on which the upper cooling trough rests. A slide *s* of nickel plate is placed in this floor, and receives the preparation. A slit made in the upper nickel casing is large enough to admit

* Zeitschr. f. Instrumentenk., xxix. (1909) pp. 72–4 (1 fig.).

the ordinary plane-parallel mineral slab in a cork mount. A wooden handle *h* closes the slit. Two small holes are provided for the passage of thermo-elements intended for recording the temperature. The slit is also used for pouring through a special funnel the liquid air into the lower trough. Graduations of temperature were arranged by partly filling the lower trough. The upper trough is covered with a lid *d*, of nickel or of boxwood. The illuminating apparatus is placed in the lower central glass tube, and consists of a push-out collar with a plano-convex lens, and eventually with the condenser for convergent light. The observation tube is placed below, and is shut off by a vacuous double window *f*, this arrangement excluding trouble arising from ice or water condensation. Ordinary objectives do not suffice, because they are too short; a lengthening tube-piece is therefore required. Moreover,

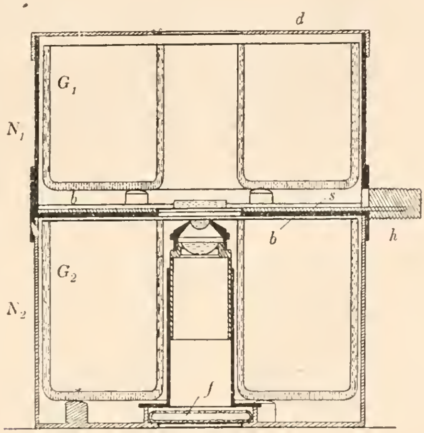

FIG. 120.

the microscope-stand is, in general, not sufficiently high to receive on the object-stage the cooling apparatus of some 10 cm. in height. A metal connecting-piece must therefore be fitted to the stand. The author tested his apparatus on gypsum, and used carbonic acid and ether as the first cooling agent. The interference colours of the gypsum plate instantly changed from red of the first order to the vivid blue of the second order. The effects with liquid air were still more marked. The author considers that his apparatus will also be of great use in examining the fluid deposits sometimes found in minerals.

Highly Reflecting Lantern Screens for Autochrome and other Projections.—A translation of a paper by H. Lehmann on the above subject has appeared in the Monthly Supplement to the British Journal of Photography.* Lehmann's paper was originally contributed to a German learned society, and appears in amplified form in recent issues

* Vol. iii. No. 30, June 1909, pp. 44–7 (4 figs.).

of Photographische Chronik. It deals with the preparation and use of screens of diffused metallic surface, whereby a greater degree of luminosity of projected picture is obtained. The higher the reflecting power of the screen the brighter will be the picture, and this consideration is of especial importance when the magnification is large, as it is in the case of cinematograph displays. Hence attempts have been made to produce screens with a metallic surface. Silvered glass has been used, but most successfully when the silvering has been applied to the matted instead of the polished face.

This silvering of the screen was the method employed by Lewis Wright in 1899, when he gave a display before our Society.* Instead of using silvered glass, however, Wright applied silver to a surface minutely ribbed or striated in a vertical direction, and the result was that not only persons sitting in front of the screen, but also those at the sides, could see. Wright also exhibited his screen before the Quekett Microscopical Club.†

Lehmann seems to have re-discovered Wright's process, but varies it by substituting aluminium for silver on a specially prepared and permanently rippled paper. He finds that, by suitable choice of the furrow or indentation on the screen, the distribution of the brightness may be regulated to a certain extent. It is best not to apply the aluminium as "paint," or, more strictly, as emulsion, but to apply a foundation of suitable viscosity and then to dust over with dry aluminium powder. The picture produced is extraordinarily bright, and reveals details of colour and structure which are quite unattainable on ordinary screens.

The same number of the Monthly Supplement ‡ notices an article on the same subject by Baron von Hübl, contributed to the Wiener Mitteilungen. The Baron discusses the angles within which persons in the auditorium would have the best view. Diagrams are given, and fully illustrate the necessary conditions.

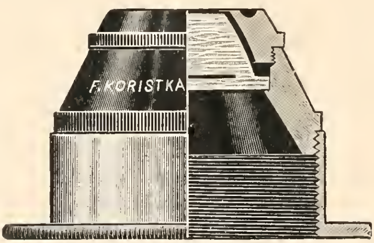

Fig. 121.

Koristka's Paraboloid Condenser.§—This condenser (fig. 121) is modelled on that of Siedentopf—the central part of the inferior surface is rendered opaque by means of a diaphragm, so that the emergent light is peripheral.

* See this Journal, 1899, pp. 247–8.
† Journ. Quekett Micr. Club, ser. 2, vii. (1898–1900) p. 241.
‡ Tom. cit., p. 47.
§ Koristka's Catalogue, xiii. (1908) p. 55, fig. 28.

Koristka's Projection Apparatus for Liquid.*—The disposition of the various parts of this apparatus are shown in fig. 122. The source of

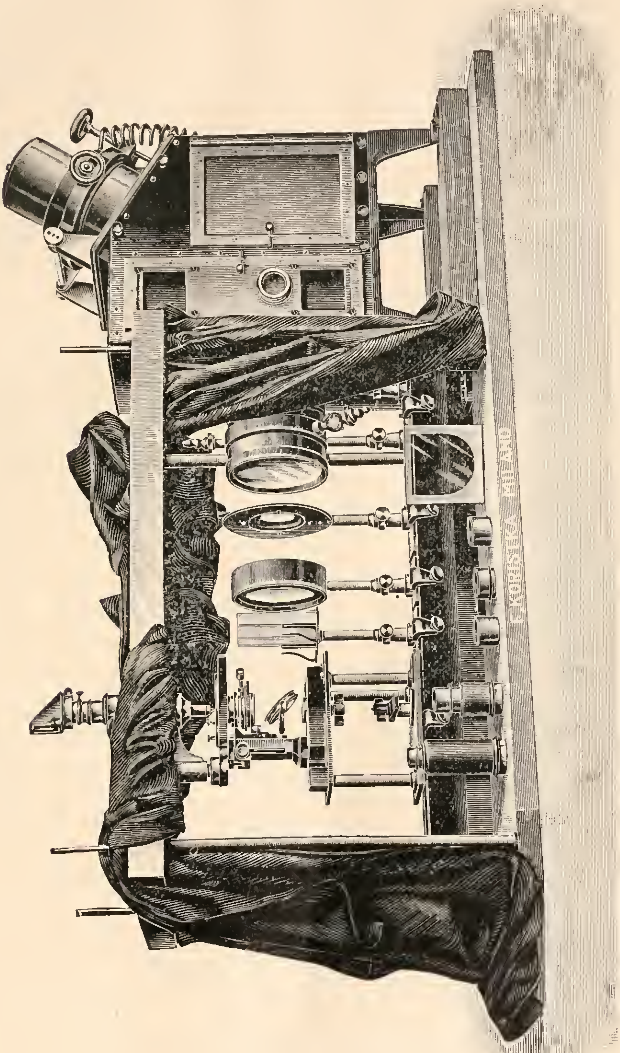

Fig. 122.

light is an electric arc lamp; the light passes through collecting lenses to the mirror up through the axis of the Microscope to a totally reflecting prism.

* Koristka's Catalogue, xiii. (1908) pp. 91-6, fig. 86.

(4) Photomicrography.

Elementary Photomicrography.*—W. Bagshaw's book, with the above title, has now reached its second edition. It is a work expressly intended for the beginner, and endeavours to encourage him instead of to dismay him. With this purpose in view, the author keeps strictly within suitable limits, and the beginner will, therefore, find exactly the help he requires. The instructions are all very clearly and unmistakably set forth, and no one attempting to follow them is likely to fail. The illustrations include examples of several beautiful objects.

(5) Microscopical Optics and Manipulation.

Microscopical Image Formation.†—Under the above title, F. J. Keeley discusses the present views on the theory of microscopic vision. He points out that there are two schools, the "diffraction" and the "dioptric." Although both of these have to deal with diffraction, the latter concerns itself only with such as arises within the instrument itself: the former attaches pre-eminent importance to diffraction originating in the object under examination. The author's aim is to study both theories in an unprejudiced manner supplemented by experiments, with the view of endeavouring to learn whether they are wholly irreconcilable. Up to the time of Abbe, the dioptric view had been unquestioned. This view, however, has had to give way to Abbe's theory, which has stood unrefuted up to the present time. But, recently, a feeling has been aroused that, without further modification, it fails to fully account for all features of observed microscopical images. Wright's "Principles of Microscopy," published in 1906, fully restates and expounds the old dioptric view, and performs its task so well that Keeley finds but one point open to criticism, viz., the employment of bright points and lines, as equivalent to self-luminous objects in explaining the formation of the diffraction patterns termed "anti-points." For the purpose of definitely testing the effects of aperture, he made a very careful series of observations with high-power objectives on two well-stained human blood corpuscles. Full details of the experiments are given by him, the N.A. varying from 1·20 to ·20. The variations in the results were well within the limits of experimental error, whence the author concludes that the unquestionable presence of "anti-point" phenomena need not be taken into consideration in connection with micrometry with white light, as a trained eye can select the same margins to measure under any ordinary conditions of illumination. This is not in the least contradictory to the theory, but demonstrates the possibility of overcoming a theoretical difficulty in actual practice.

In considering diffraction phenomena originating in the object, it will be well to first assume conditions under which the objective will be of greater aperture than the illuminating cone, and will, therefore, when examined with ocular removed, exhibit a disk of light, the dioptric beam, surrounded by an unilluminated space. The insertion of an object in the focus of the objective will result in this dark space showing

* Iliffe and Sons, London, 1909 (45 illustrations).
† Proc. Acad. Nat. Sci. Philadelphia, lxi. (1909) pp. 177–92.

more or less light which may be both refracted and diffracted by the object. If the latter has a fine structure, periodically arranged, this light reaching the outer zone of the objective's aperture will be mostly of diffraction origin, and will take the form of separated spectra. As the iris of the condenser is opened, however, it can be seen that the diffracted beams expand to the same extent as the dioptric beam, finally overlapping it and each other, until when the aperture of the objective is entirely filled with dioptric light it must unquestionably be similarly filled with diffracted rays. Unfortunately, there seems no way in which the beams derived from the two different sources can be completely separated, and the best expedient the author could devise to obtain some idea of the conditions present was to insert a semicircular diaphragm in the condenser, so oriented that the left side of the back of objective was completely filled with light up to its margin, the right-hand side receiving no direct rays whatever. Thus there would be full-cone conditions on one side, while the other would receive only refracted and diffracted rays; or, if certain suitable objects are employed, nothing but diffracted rays whose behaviour could be separately studied. For this purpose a binocular Microscope should be employed with a specially short-mounted objective, say a sixth of about ·80 N.A., the back lens of which will come close to the Wenham prism. All the direct light from the fully-illuminated left half of the objective will now pass up the right-hand tube of the Microscope, while the diffracted beams from the right-hand half of objective will be reflected up the left tube. Assuming that *Pleurosigma angulatum* is the object, and oriented longitudinally across the field in a right and left direction, on examination of the back of the objective, the previously dark space on the right will be found practically filled by three of the characteristic spectra of the object, and the other three will be present, although invisible, in the illuminated half. Thus, through the right-hand tube of the binocular, the image will be produced by a full dioptric beam supplemented by diffracted beams corresponding to those resulting from a small central illuminating cone; while through the left-hand tube it is derived from diffracted beams alone corresponding to those present with a full cone of illumination. On examination it will be found that both images are fairly well defined, but that the resolution of the fine structure is noticeably sharper and more distinct in the diffraction image through the left tube. The fact that the diffraction image is blue in colour is a proof that it is due practically exclusively to diffracted rays. Still further proof is, however, required to demonstrate that it is free from refracted rays. For this purpose the author inserts a narrow slit diaphragm in the condenser, thereby producing a sharp spectrum which can be magnified by a low-power objective inserted in the draw-tube. The Microscope can now be used as a spectroscope, and by allowing the light to pass through some colouring matter (e.g. eosin) which has well-marked absorption bands, these bands will be visible in the spectra at the back of the objective. It will be found that the absorption band in the spectrum derived from a diatom structure is perfectly black, thus furnishing a proof that it is practically free from refracted rays, for if it contained scattered refracted rays, as has been claimed, the absorption band would not appear black, but of the same colour as the light illuminating the object, which in this case is visually a bright red. If the previous diatom diffraction image be now examined under these new conditions it will be found that it is just as blue with this visually red light as it was with white light, owing to the fact that eosin transmits the blue rays freely; but the midrib of the diatom, and particularly any granular incrustation, such as may usually be found at places between the valve and cover-glass, will be tinted red, indicating that refracted rays or complete diffracted beams enter into their image formation.

The author considers that three important questions have now been settled: Firstly, that the diffracted beams from certain structures are free from refracted rays; secondly, that sharp, distinct images may result from such diffracted beams exclusively; thirdly, that, where such beams are sufficiently separated from the dioptric beam to permit of their being eclipsed by a suitable screen, no image of the elements producing them will be visible.

The author discusses several experiments described in Wright's "Principles of Microscopy," and points out their "fallacies," but for details of these criticisms reference must be made to his original paper.

The author's conclusions are adverse to the dioptric theory, and he reminds us that Abbe's knowledge of optics was so profound that he was liable to assume an equal knowledge on the part of his readers. If Abbe's later application of the diffraction theory to the images of coarser details, earlier termed "absorption images," could be interpreted as a denial that any refracted rays, outside the dioptric beam, entered into the image at all, then, indeed, some modification of what is generally understood as the Abbe theory is necessary, as most objects unquestionably refract light outside the dioptric beam; and not only do the simplest laws of refraction require that these rays find a place in the image, but there is no other way of accounting for what becomes of them. It is more likely, however, that Abbe regarded this fact as self-evident. At any rate, the important work he undertook was not to refute the dioptric theory, but to supplement it by accounting for phenomena which it then, as now, failed to explain.

Brownian Movement and Molecular Constants.—J. Perrin and Dabrowski * refer to the fact that molecular hypotheses anticipate that identical granules agitated by Brownian movement will behave as a function of the depth (as a perfect gas does under the action of gravity), and that they will satisfy the equation

$$\log \frac{n_0}{n} = \frac{N}{R\,\tau} v\,(\Delta - \delta)\,g\,h\,;$$

where n_1 and n_0 are the concentrations of the granules in two layers at a distance h apart; v, the volume of the grain; $\Delta - \delta$, its apparent density (excess of true density over density of the fluid); N, Avogadro's constant (number of molecules contained in any molecule-granule). Experiments as to granules of gamboge have verified the above equation, and give for N the value $70 \cdot 5 \times 10^{22}$. At the same time,

* Comptes Rendus, cxlix. (1909) pp. 477–9.

M. Chaudesaigues working with the same granules, found that the following equation, also based on molecular hypotheses, was satisfied:

$$\xi^2 = \tau \frac{R\,\tau}{N} \frac{1}{3\,\pi\,a\,\zeta};$$

where ξ^2 is the square of the mean projection on an axis O_x of the displacement in a time τ of a granule of radius a as a fluid of viscosity ζ. In this case N works out to 70×10^{22}.

The authors have repeated these experiments with granules of mastic obtained by aqueous precipitation from the alcoholic solution of this resin. The apparent density of these granules is only one-third of that of gamboge, so that they formed a very suitable material for further verification of the formulæ. The layers measured were separated by intervals of $6\,\mu$. The granules were obtained after fractional centrifugation, and their radii were found to be $0 \cdot 52\,\mu$. Evaluation of the formulæ gave results confirming those of the previous experiments, and the average value for N was $70 \cdot 75 \times 10^{22}$. Hence it follows that the charge e of the electron is $4 \cdot 1 \times 10^{-10}$ electrostatic units.

J. Perrin * has also attempted to verify by experimental observation measurements the rotational equation given by Einstein,†

$$a^2 = \tau \frac{R\,\tau}{N} \frac{1}{4\,\pi\,\zeta\,a^3},$$

where ζ denotes the viscosity of the fluid, a the mean square of rotation of the granule in time τ about an arbitrary axis; R, T, N have the same meanings as above. The author had some difficulty in finding granules suitable for observation, but ultimately succeeded with a preparation of urea. The theoretical value of N is 65×10^{22}, and the experimental value (after many observations) found was $70 \cdot 5 \times 10^{22}$. The conclusion to be drawn is that the kinetic molecular hypothesis finds experimental corroboration in the study of Brownian movement.

(6) Miscellaneous.

History of Optical Glass.‡—M. von Rohr gives an interesting sketch of various personalities connected with the great Jena industry from about 1800 to the present time. The first names mentioned are those of P. L. Guinand and his son A. Guinand, who, with J. Fraunhofer, directed the manufacture till December 1813. A final separation seems to have then taken place, when J. Fraunhofer went to Benedictbeuren and the Guinands to France. G. Bontemps, who had gained his experience with the French house, entered the service of Chance Brothers, Birmingham, in 1848, and placed his knowledge of optical glass at the service of his employers. A kind of genealogical table is given showing clearly the connection of the various names with one another.

Practical Microscopy.§—The first edition of Shillington Scales' Microscopy was so much appreciated that only four years have elapsed

* Comptes Rendus., cxlix. (1909) pp. 549–51.
† Ann. der Physik, xix. (1906) p. 371.
‡ Zeitschr. f. Instrumentenk., xxix. (1909) pp. 50–7.
§ London: Baillère, Tindall, and Cox, 1909, xvi. and 324 pp. (122 figs.).

since it was first published as Elementary Microscopy. The second edition is called Practical Microscopy, an Introduction to Microscopical Methods. Much new matter has been incorporated, the scope of the book has been considerably enlarged, it has been nearly doubled in size, and much has been re-written, notably chapters iii. and vi., dealing with the choice of a Microscope, and with the practical optics of the Microscope. An entirely new chapter on Photomicrography has been added, and that on Microscopical Technique has been materially amplified.

B. Technique.*

(1) Collecting Objects, including Culture Processes.

Study of Tubercle bacilli.†—C. Siebert, from observations of two strains of tubercle bacillus, found that in glycerin broth the growth is associated with the production of acid; there is no difference in the acid formation of human tubercle and bovine tubercle. The amount of growth of tubercle bacilli in broth is greater if the acid formed is neutralised with soda, or if a piece of marble is added to the medium.

Dextrose and Lactose for Detecting the Colon Bacillus.‡—W. R. Stokes and H. W. Stoner consider that for the detection of the colon bacillus, dextrose, lactose, and saccharose broths should all be used, and that the organism should be plated out in pure culture. If one sugar must be used to identify sub-cultures, it should be lactose, and not dextrose, because there are many other types of organism that ferment dextrose exactly like *B. coli.* The authors consider that any organism producing 18–80 p.c. of gas in dextrose, lactose, and saccharose broths might be regarded as *B. coli* if it also showed the usual cultural characters.

Normal Cerebrospinal Fluid as Nutrient Medium for Pathogenic Bacteria.§—L. Vincenzi finds that *Diplococcus pneumoniæ*, *Gonococcus*, *Streptococcus erysipelatis*, and the bacilli of plague, diphtheria, and tubercle do not grow in normal cerebrospinal fluid. *Staphylococcus aureus* and anthrax grow badly, while *B. typhi*, *B. coli*, *B. paratyphi A* and *B*, *V. choleræ*, *B. dysentericus* Shiga, and *M. melitensis* grow fairly well but not luxuriantly.

Shaker (Kinotherm), for Use at a Desired Temperature.‖—P. Uhlenhuth has devised this apparatus (fig. 123) for shaking any substance such as bacterial extracts, etc., in a vessel. The motion is imparted

* 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., li. (1909) p. 305.

‡ Tom. cit., p. 459.

§ Op cit., lii. (1909) pp. 154–6.

‖ Zeitschr. f. Immunität. forsch. u. exper. Therapie, ii. (1909) No. 3, through Centralbl. Bakt., 1te Abt. Ref., xliv. (1909) pp. 629–31 (1 fig.).

through the band B, driven by a water-motor, A, to the wheel C. The rotary movement is converted into a swinging one through the rods E, G, J. To J can be fixed, by means of a clamp, any vessel, such as an Erlenmeyer's flask; this swings in a water bath, L; the level of the water is so arranged that about one third of the vessel is immersed. The water is kept at the desired temperature by means of a gas thermo-

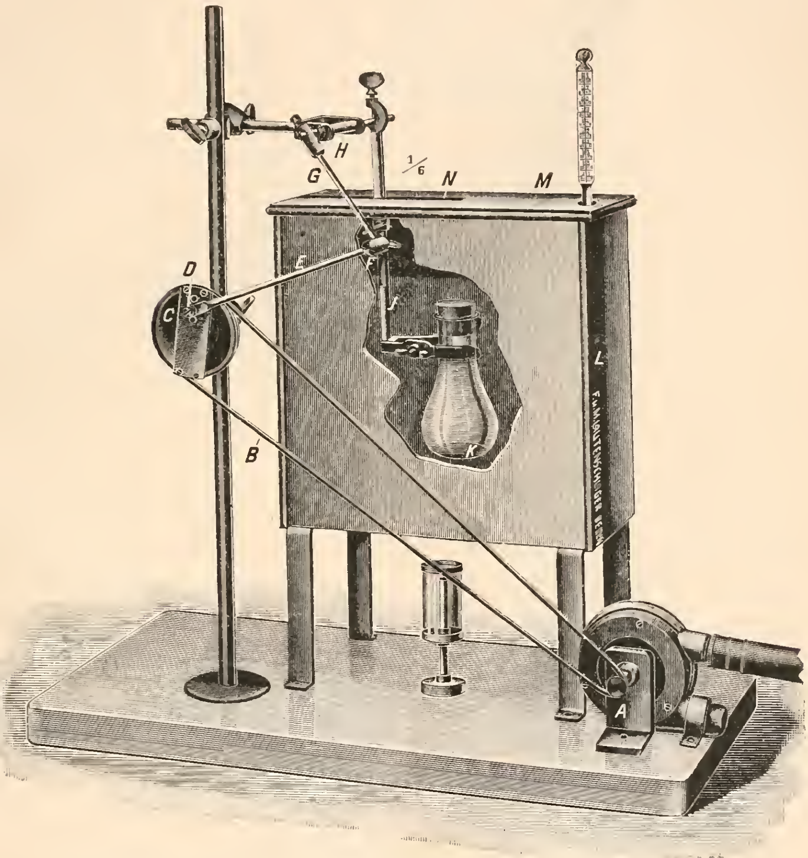

FIG. 123.

regulator. The number of oscillations is given by the turns of the motor, and these can be regulated within certain limits.

Different kinds of oscillation may be imparted by setting the rod E in different holes at D, and these movements may be further graduated through the intermediary of the block F, to which the rods E, G, J are connected directly, and with the wheel C and the piece H indirectly.

Altmann's Shakers.*—In the accompanying illustration are given two varieties of shaker made by Altmann. One is worked by a water turbine (fig. 124), the other is driven by electricity (fig. 125).

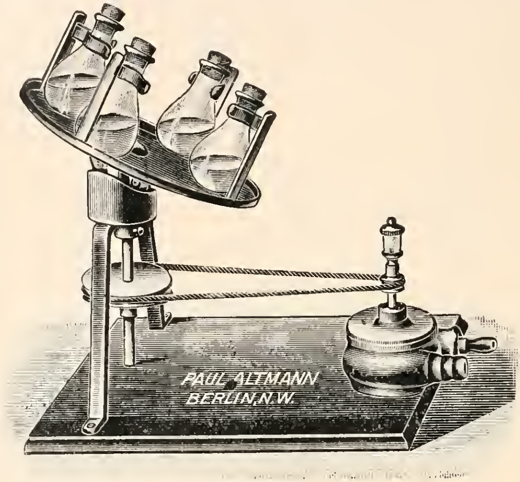

Fig. 124.

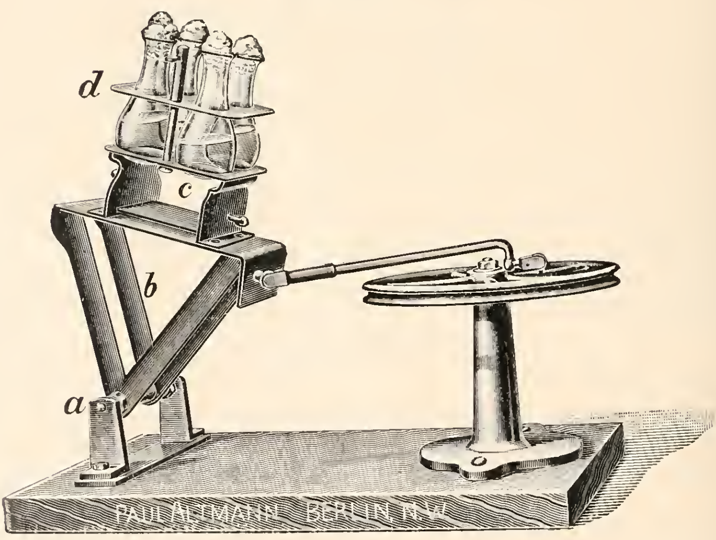

Fig. 125.

Buckingham, Edith, N.—**Light-weight Portable Outfit for the Study and Transportation of Ants.** *Amer. Nat.*, xliii. (1909) pp. 611–14 (2 figs.).

* Paul Altmann's Special Catalogue, 1909.

(3) Cutting, including Imbedding and Microtomes.

Theory and Practice of Whetting.*—L. W. Ssobelew discusses this important subject at considerable length, with especial reference to microtome and surgical blades. The former is naturally of most interest to microscopists, but both classes of blades involve the principles of wedge and saw. Most knives have a wedge-shape and numerous tiny teeth on the edge. A knife, when used, is not only pushed deep into the tissue, but also acts as a saw. The best treatment of a tissue is attained by making the wedge as thin and as sharp as possible; the saw being as slender, and its teeth as small, as possible. In whetting a knife the inclination of the blade is of the first importance. The proper angle of inclination may be attained freehand by an expert: but a safer method is to fasten the blade in a little tube-shaped frame slit longitudinally for the reception of the back of the blade. The blade in its frame is then placed on the hone, the edge forwards, and is drawn towards the operator, the movement commencing at the heel (i.e. the part nearest the handle) and finishing at the knife-point. A blade with a curved edge will also require a correspondingly curved stroke. The knife should then be reversed and the other side similarly treated. Pressure is scarcely needed, the weight of the knife should suffice. Pressure is apt to favour a "furred" edge, which, however, is unimportant beyond the useful edge of the instrument. The best way of testing an edge is by the thumb. For this purpose the knife-handle is held in one hand and its back rests on the four fingers of the second hand, the thumb of which gently feels from above the keenness of the edge. This co-ordination of the two hands secures great delicacy of touch and a clear perception of the character of the edge—whether it is sharp, or turned, or bowed—and, finally, whether a coarse-grained or a fine-grained stone should be used. With practice, it may even be judged whether the knife can cut sections 5 μ or 10 μ thick. The critical sensation is obtained at the moment of lifting off the thumb, and therefore only short distances, 2 or 3 cm. at a time, should be tested. The author, in the application of this test, has never cut himself deeply enough to draw blood. For surgical knives such a mode of testing would be unsuitable, as the existence of any slight wound might be a source of danger. The author therefore recommends that such a knife held at a sharp angle should be pressed on the hair at the back of the operator's head. If it cuts the hair freely, it is ready for stropping. Among materials suitable for hones he finds that:—

1. Natural red Russian sandstone, moistened with water, soon gives an edge, although somewhat of a coarse one.
2. Grey natural whetstones, moistened with water or oil, act somewhat slowly, but give a very fine edge.
3. Yellow Belgian whetstones (said to be artificial, but not always homogeneous), moistened with oil, give a fine edge very suitable for microtome knives.
4. White American natural whetstones, called Arkansas or Mississippi stones, are slow, but give a very good edge; especially suitable in cases where stropping is impossible, e.g. with dentists' and oculists' instruments.

A whetstone should always be moistened with a suitable fluid (e.g.

* Zeitschr. wiss. Mikrosk., xxvi. (1909) pp. 65–79 (7 figs.).

ordinary water, soapy water, petroleum, olive oil), and the knife should be wiped with a clean linen cloth.

A fine-grained, smooth strop should be selected, and its under side should be used. The under side is at first covered with connecting tissue, but this has to be carefully rubbed away with emery paper so as to expose

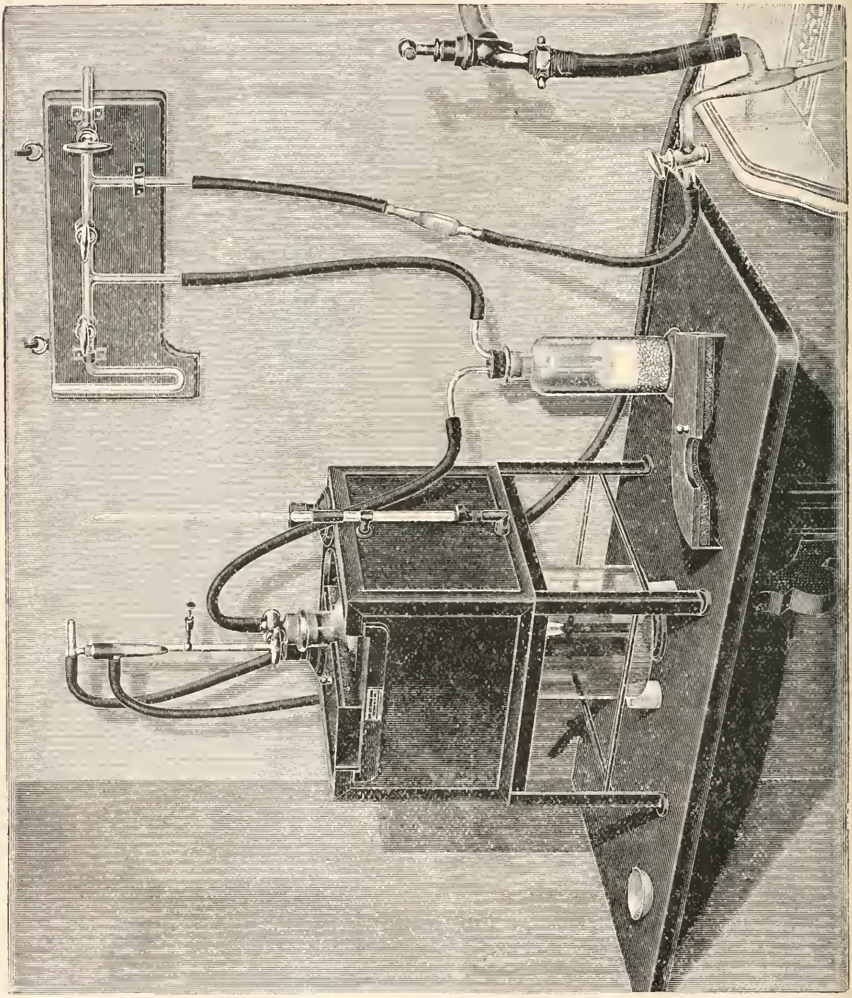

Fig. 106.

the corium. The strop, set on a pad of yielding felt, is then mounted on a board and is ready for use. The knife is placed as in whetting, but is urged forwards. A knife may be preserved from possible oxidation by imbedding it in paraffin or fat. Some blades may be wrapped up in wadding.

Vacuum Paraffin Oven.*—L. Materna describes a paraffin stove (fig. 126) for imbedding, the principal feature being a thermostat, the copper jacket of which is filled with distilled water. The outside of the thermostat is covered with linoleum, and the apparatus is fitted with

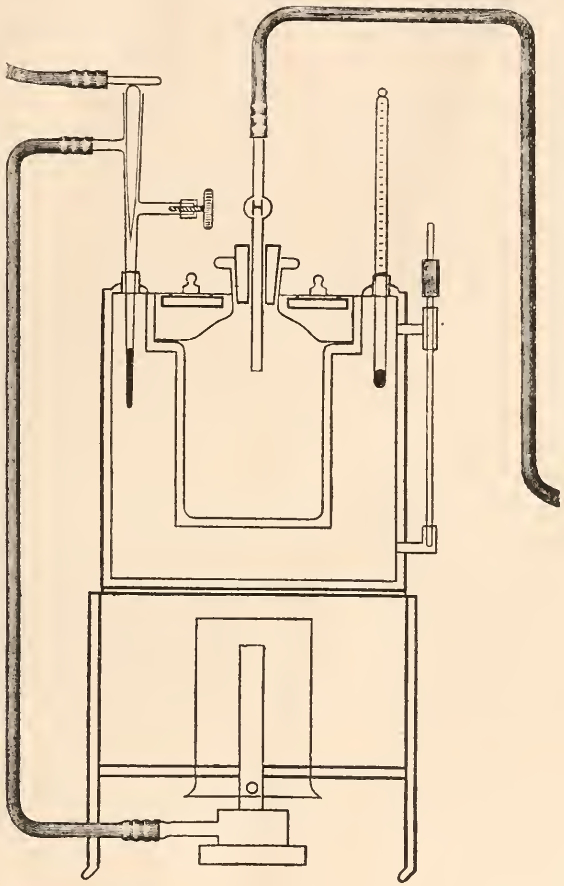

Fig. 127.

the usual thermometer and thermo-regulator, and is heated by means of a Bunsen burner. Inside the thermostat is a strong glass jar (fig. 127) connected by tubes with a water-pump. Between the water-pump and the thermostat are inserted a manometer for indicating the pressure, and a wash-

* Zeitschr. wiss. Mikrosk., xxv. (1908) pp. 439–45 (2 figs.).

bottle to prevent any dirt from interfering with the manometer. The top of the thermostat is covered with a double lid which is divided into two halves, each of which is surmounted by a knob for facilitating removal. The object of this double lid is to keep as much heat in as possible; one half is shown separately lying on the base board of the thermostat (fig. 126). The temperature of the water in the jacket should range from 62–65° for a paraffin mixture with a melting point of about 55°. For the preliminary saturation the author uses water-free aceton chloroform or xylol. To start the apparatus the taps of the exsiccator and of the water-pump are turned on, and after about half an hour the water-pump tap is turned off. The tap of the manometer is then carefully and slowly opened until the mercury in the closed limb has risen. As soon as the atmospheric pressure is restored the exsiccator may be opened.

Transparent Red Injection Mass.*—R. Krause uses a tin trough 28 × 15 × 10 cm. A sieve-tray rests inside, supported by the handles; the measurements are 1 to 2 cm. less than those of the trough. The lid has pieces cut out to slip over the handles. The gelatin is placed in the tray, and macerated in water for about 2 hours; the sieve is then lifted out, and the water allowed to drain off for $\frac{1}{4}$ to $\frac{1}{2}$ hour. It is then stained with borax-carmine. 100 grm. of borax are dissolved in 2 litres of hot water, and 15 grm. of powdered carmine added, after which the mixture is boiled. Next day the supernatant fluid is poured off into the trough; the tray with the gelatin is then replaced in the trough. In 48–72 hours the tray is removed, the gelatin allowed to drain, and then washed several times in the trough with fresh water. The colour is fixed by means of 2 p.c. hydrochloric acid, of which 5–10 litres are necessary. The gelatin plates, 5 or 6 at a time, are removed from the sieve and immersed in the acid until they become of a cherry red colour. After this they are replaced in the tray, and the trough filled with water kept running in order to remove any excess of acid ($\frac{1}{2}$ to 1 hour). The gelatin thus prepared may be preserved for future use by means of camphor. The mass does not diffuse through the walls of the injected vessels; it is always transparent, and the carmine never precipitates.

Hickling, G.—**The Microscopic Study of Rocks.**

[The author deplores the fact that microscopists pay little attention to the study of rocks: simple directions are given for making slides of rocks.] *Trans. Manchester Micr. Soc.* 1908, pp. 64–70.

(4) Staining and Injecting.

Double-staining Vegetable Tissue.†—A. E. López first treats the sections with eau de javelle or with an aqueous solution of chloral-hydrate. After repeated washings the sections are placed in a concentrated solution of caustic potash for 10 minutes. They are again washed, and then stained in a mixture of Delafield's hæmatoxylin and 1 p.c. iodine green for 10 minutes. The hæmatoxylin and iodine green

* Zeitschr. wiss. Mikrosk., xxvi. (1909) pp. 1–4 (1 fig.).
† Bol. R. Soc. Española Hist. Nat., ix. (1909) pp. 237–8.

solutions are mixed in the proportion of 10 to 1: after a good shaking the solution is ready for use. On removal from the stain the sections are washed in water and mounted in glycerin, glycerin jelly, or balsam.

Modification of Nissl's Method.*—Rodenwaldt describes a simplified Nissl method and its application to Beriberi. A solution of Azur ii. in the proportion of 1 grm. to 750 c.cm. of distilled water is made, and to 10 c.cm. of this solution 4 drops of a saturated solution of potassium-carbonate are added immediately before use.

Van Gieson and Romanowsky Stains for Detection of Coccidia.†
P. B. Hadley recommends Van Gieson's stain for rapidly detecting coccidia in the intestines or cæca. It is made as follows: To 10 c.cm. of distilled water add 2 drops of saturated 95 p.c. alcoholic solution of rose-anilin-violet and 10 drops of a 50 p.c. solution of methylen-blue. The smears, made in the usual way, are fixed in alcohol. The stain is heated to vaporisation, and then the slide is washed in water, mopped up with blotting paper and dried in air.

The Romanowsky stain was used for demonstrating the finer nuclear structure of different stages of *Coccidium cuniculi.*

Demonstrating the Intracellular Network of Nerve-cells.‡—F. Marcora places the pieces for 7 to 8 hours in a mixture consisting of arsenious acid 0·75 p.c., 40 parts; formol, 10 parts. After this they are immersed for 12 hours in 2 p.c. silver nitrate solution. The developer consists of hydrochinon 20, sodium sulphite 5, formol 50, distilled water 1000. After this the pieces are cleared up and imbedded in paraffin. The sections, which should be 10–15 μ thick, are then passed through downgraded alcohols to water, and afterwards treated with the following mixture, which is composed of two solutions. Solution A contains sodium hyposulphite 30, ammonium rhodanate 30, distilled water 1000. Solution B: gold chloride 1, distilled water 100. The sections are next washed in distilled water and then bleached by the following method. For 5 to 10 minutes the sections are immersed in the following mixture: potassium permanganate 0·5, sulphuric acid 1, distilled water 1000; and then passed rapidly through a 1 p.c. solution of oxalic acid, after which they are frequently washed in distilled water. This is followed by Nissl's procedure, viz. staining with an aqueous solution of magenta-red warmed to vaporisation; then 95 p.c. alcohol and differentiating in oil of cloves. Dehydration; xylol; balsam. By this method not only is the intracellular network well shown, but it also demonstrates that Nissl's bodies lie in the interspaces of the network.

Staining Treponema pallidum.§—F. L. de Verteuil fixed smears in absolute alcohol and then stained them with 10 p.c. silver nitrate for an hour at about 100° F. and afterwards reduced with 5 p.c. pyrogallic acid for 10 minutes.

* Monats-schrift. f. Psych. u. Neurol, April 1908. See also Zeitschr. wiss. Mikrosk., xxv. (1909) pp. 332.

† Centralbl. Bakt., 1te Abt. Orig., lii. (1909) pp. 147–50.

‡ Anat. Anzeig., xxxv. (1909) pp. 65–9 (1 fig.).

§ Lancet, 1909, ii. pp. 884–5.

Absence of Altmann's Granules in Cancer Cells.*— H. Beckton adopted the following procedure in an investigation as to the absence of Altmann's granules from cells of malignant new growths :—1. Take small pieces of tissue as soon as possible after an operation. 2. Place in formol-Müller (1 in 49) at room temperature for a week, renewing the solution on the second and fourth days, and then in Müller's fluid for another week. Usually for very small pieces, 1 mm. thick, 3 days are sufficient. 3. Wash overnight in running water; a few hours is sufficient time for very small pieces. 4. Alcohol in increasing concentration; cedar-wood oil or xylol; paraffin, 75° C. 5. Cut sections not thicker than 5μ and mount on slides. 6. Xylol; absolute alcohol; rinse in water. 7. Stain in anilin-acid-fuchsin. 8. Differentiate with picric-acid alcohol or with aqueous solution of sodium bicarbonate (1 in 10,000). 9. Absolute alcohol; xylol; Canada balsam.

The stain is prepared thus :—To 100 c.c. of filtered cold saturated watery solution of anilin add 20 grams of acid-fuchsin; shake well and filter. The picric acid alcohol is made by adding 7 volumes of 20 p.c. alcohol to 1 volume of saturated picric acid solution in absolute alcohol.

The process of staining may be carried out at room temperature, the slide being placed vertically in the staining fluid for, say, half-an-hour. This method is free from any objection which may be urged against the use of a hot staining fluid. The following method, however, gives the same results and is most expeditious and convenient. Cover the section with staining fluid, and this in turn with a watch-glass, and heat for 2 minutes to about 60° C., using either a thermostat or a strip of copper heated at one end and tested from point to point by means of a piece of paraffin wax. Next pour off the stain, blot, and differentiate; a point is soon reached at which but little further colour comes away. As a rule, at ordinary temperatures differentiation is complete with picric-acid alcohol in about 2 minutes, and with sodium bicarbonate in about ½ minute.

It may be noted here that absolute alcohol does not decolorise a section, but dilute alcohol discharges the colour rapidly, while plain water removes it but slowly, and indeed differentiates sufficiently to enable one to detect the presence of granules. Again, while in moderately dilute mineral acids the colour remains in a section for a long period, moderately dilute alkalis rapidly discharge it, and very dilute alkalis may be used as differentiating fluids.

After fixation with formalin alone, as well as after formol-Müller solution, granules can be demonstrated in the essential cells of pancreas, submaxillary gland, liver, kidney, columnar epithelium of the alimentary tract, etc.; but this is not the case with lymphocytes, plasma cells, endothelial cells, fibroblasts, fat-cells, etc., which show granules only after fixation with formol-Müller. It thus appears that the granules by this method may be appropriately referred to as belonging to a "gland cell group" and a "connective-tissue cell group" respectively.

The conclusion drawn from the results of this investigation is, that in malignant new growths granules tend to disappear, or to be absent altogether, from the particular type of cell involved.

* Brit. Med. Journ., 1909, ii. pp. 859–61 (3 figs.).

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

Newton, A.—**Preparing Insects and Parts for Mounting in Balsam.**
Trans. Manchester Micr. Soc., 1909, pp. 79–80.

H. M. C.—**Mounting Slides.**
English Mechanic, xc. (1909) pp. 165, 189–90, 212

(6) Miscellaneous.

Micrometer Attachment.*—S. A. McDonald describes the following modification of the ordinary micrometer. A piece of brass tubing (fig. 128) is reamed out to make a sliding fit on the anvil of the micrometer. The

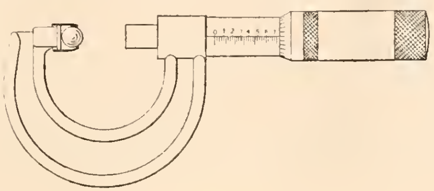

Fig. 128.

tubing holds loosely a $\frac{1}{4}$ in. bicycle ball, which extends beyond the end of the tube, the latter being bent over to prevent the ball from falling out. The reading is taken from the 0·250 in. graduation as zero.

Metallography, etc.

Meteoric Iron.†—W. Fraenkel and G. Tammann have studied two pieces of meteorite containing respectively 7·8 and 9 p.c. nick el Sections were examined, after heating to different temperatures under conditions which almost entirely prevented oxidation. The temperatures of magnetic transformation were also determined. Attempts were made to reproduce artificially the structure of meteorites, but without positive results. Long heating of meteoric iron at 420° C. causes the kamacite to granulate ; it would therefore appear that meteoric nickel-iron alloys are unstable at the ordinary temperature. The constitution of meteorites and the causes of the structural differences between meteorites and alloys of the same composition prepared by melting the metals together, are fully discussed. Possibly, as in the case of chromium and molybdenum steels, changes take place in the molten state dependent on the maximum temperature attained, and the characteristic constitution of nickel-iron meteorites may be due to the attainment of an exceedingly high temperature at some period in their history.

Structure of "Steely" Cast Irons.‡—J. Guillemin has examined microscopically four cast irons containing 2·65–2·95 p.c. graphite,

* "Machinery," see English Mechanic, xc. (1909) p. 178.
† Zeitschr. Anorg. Chem., lx. (1908) pp. 416–35 (27 figs.).
‡ Rev. Métallurgie, vi. (1909) pp. 946–50 (12 figs.).

0·50–0·65 p.c. combined carbon, 0·57–0·64 p.c. manganese, 0·30–0·42 p.c. phosphorus, 0·08–0·10 p.c. sulphur, 1·30–1·51 p.c. silicon. Photomicrographs were taken of specimens (1) as cast; (2) annealed for 1 hour at 600°, 700°, 800°, 900°, and 1000° C.; (3) quenched in water after 5 minutes heating at 700°, 800°, 900°, and 1000° C.; (4) quenched after 1 hour heating at temperatures as in (3): (5) reheated for 1 hour at 400° C. after above quenchings. Kourbatoff's reagent, nitric acid and orthotrinitrophenol in ethyl-alcohol, was used for etching. Austenite was observed in some specimens quenched at 1000° C. The mechanical properties of these cast irons may be improved either by annealing at 900° C., or by a quenching from 900° C. followed by reheating.

Separation of Graphite in Cast Iron.*—G. Charpy has heated powdered white cast iron at temperatures 600°–1200° C. under pressures up to 15,000 atmospheres. The iron was placed in a hollow magnesia-lined steel cylinder, and the pressure applied through pistons, one at each end, through which the electric current for heating the sample passed. In all cases graphite resulted from the decomposition of carbide of iron, at temperatures 700°–1100° C.

Solubility of Steel.†—E. Heyn and O. Bauer have further extended the application of their method of investigating the constitution and condition of steel by determining its rate of solution in 1 p.c. sulphuric acid.‡ The influence of the treatment of steel on its solubility in sulphuric acid is here dealt with. The effect of quenching and subsequently reheating to different temperatures was studied with steels containing 0·95 and 0·07 p.c. carbon. The influence of cold working and annealing was determined with steels containing 0·05, 0·06, 0·08, and 0·19 p.c. carbon. Many of the authors' conclusions have been given previously.‡ Differential heating curves of steel containing 0·95 p.c. carbon, quenched from 900° C., indicate that the bulk of the heat produced by the decomposition of the martensite is evolved below 400° C. This points to the segregation of one or more solid bodies, x, the nature of which is doubtful, from the solid solution martensite during tempering up to 400° C. Whether the segregation proceeds ultra-microscopically or microscopically is an open question. For some chromium-tungsten steels examined, there appears to be a direct connection between quenching temperature and solubility in sulphuric acid. The solubility of mild steel in sulphuric acid is increased by cold work, and falls again when the cold worked steel is reheated. Very small amounts of permanent distortion in structural steel can be detected by solubility tests.

In the correspondence on this paper, C. Benedicks replies to certain objections raised by the authors to the view that troostite is a colloidal solution, or, to use a preferable term, a colloidal system. H. M. Howe sums up the evidence for each of the rival theories of the constitution of troostite, the colloid theory and the osmondite theory. Neither theory yet appears to be established or disproved.

* Rev. Métallurgie, vi. (1909) pp. 983–5 (1 fig.)
† Journ. Iron. and Steel Inst., lxxix. (1909) pp. 109–241 (53 figs.).
‡ See this Journal, 1907, pp. 115–16. ‡ Loc. cit

Heat-treatment of Steel.*—A. McWilliam and E. J. Barnes have carried out tensile tests, and Arnold alternating stress tests on nine acid Bessemer steels, heat-treated in various ways. The carbon content of the steels varied from 0·10–0·86 p.c.; the samples were treated in the form of 1 in. round bar. The steels were tested (1) as received; (2) air-cooled from 950° C.; (3) slowly cooled after 35 hours at 950° C.; (4) quenched in water from 850°, 900°, or 950° C., and tempered at 400°, 500°, 600°, or 700° C. The very slow cooling of treatment (3) caused the cementite of the pearlite to coalesce into globules; no pearlite remained in the 0·10 p.c. carbon steel after this treatment. No difference in micro-structure was observed between the steels tempered at 500° C., and those tempered at 700° C. A Bessemer steel, with 1 p.c. manganese, consisting entirely of pearlite, contains about 0·80 p.c. carbon.

Ageing of Mild Steel.†—C. E. Stromeyer has further investigated this subject,‡ and finds that brittleness in mild steel is frequently due to excessive percentages of phosphorus and nitrogen, the latter element being particularly dangerous.

High-tension Steels.§—P. Longmuir gives the results of a large number of tensile and other tests of nickel steels, nickel-chromium steels and chromium-vanadium steels, heat-treated in various ways, and concludes that nickel steels are inferior to either of the two other classes, chromium-vanadium steels giving especially high values.

Uniform Nomenclature of Iron and Steel.‖—H. M. Howe and A. Sauveur present the second report of the committee appointed to consider this subject. The report includes definitions of the microscopical constituents of iron and steel. "Metaral" is suggested as the equivalent of "microscopical constituent." Austenite is a solid solution of carbon, or carbide of iron, in γ-iron, stable above the critical range. The authors adhere to the transformation scheme, austenite-martensite-troostite-sorbite-pearlite.

Binary Alloys.¶—K. Bornemann reviews all the published work on the constitution of binary alloys of metals, and gives a large number of equilibrium diagrams. From a critical comparison of the results obtained by different workers on the copper-zinc system, the author concludes that the compound Cu_2Zn_3, melting without decomposition, undoubtedly exists. Another compound, more rich in copper, possibly has the formula CuZn, and decomposes, more rapidly at higher temperatures, into copper and Cu_2Zn_3. The copper-aluminium and copper-tin systems are discussed at some length. These papers collect, in useful form, a large quantity of scattered data.

* Journ. Iron and Steel Inst., lxxix. (1909) pp. 348–82 (12 figs.).
† Tom. cit., pp. 404–25 (2 figs.).
‡ See this Journal, 1907 p. 640.
§ Journ. Iron and Steel Inst., lxxix. (1909) pp. 383–403 (1 fig.).
‖ Proc. Int. Assoc. for Testing Materials, No. 10 (1909) 18 pp.
¶ Metallurgie, vi. (1909) pp. 236–53, 296–304, 326–36, 490–500 (93 figs.).

Binary Systems.—J. J. van Laar* develops mathematically the theory of the form of the melting-point or solidification-point curves of binary systems when the solid phase is an amorphous solid solution, or mixed crystals, of the two components. In a later paper† the author deals with the cases in which a compound occurs.

Hardness of Metallic Solid Solutions and Chemical Compounds. N. S. Kurnakow and S. F. Zemczuzny‡ collate the results obtained by themselves and others relating to the hardness of binary alloys. When the metals form a continuous series of solid solutions, the curve showing relation of hardness to composition is continuous and passes through a maximum, this maximum corresponding to the minimum of electrical conductivity. The occurrence of a chemical compound, which may be harder or softer than the two metals, causes a break in the curve. If the alloys are mechanical mixtures of the two metals, the curve is a straight line. The hardness curve of more complex binary systems is a combination of the above types.

C. Benedicks§ discusses the above paper, and points out that the character of the curves connecting electrical properties with composition indicates that, while in the case of metallic aggregates conductivity is a suitable criterion of composition, resistance is more suitable for solid solutions.

Formation of Alloys by Pressure.‖—G. Masing has submitted mixtures of finely divided metals to pressures of 1000–5000 atmospheres, to ascertain if alloys similar to those obtained by melting could thus be produced. The numerous binary mixtures pressed are classified according to their behaviour upon solidification from the corresponding binary melts:—(1) the two metals solidify as pure components; (2) compounds are formed, but no solid solutions; (3) a continuous series of solid solutions is formed; (4) interrupted series of solid solutions are formed. The block obtained by pressing was examined microscopically, and heating curves were taken. The author concludes that the mass obtained by compressing file-dust of two metals together consists exclusively of grains of the two metals; in no case could the presence of solid solutions or compounds be established. Thus pressure does not induce the formation of compounds or solid solutions. The only possible influence of pressure is to bring about more intimate contact between the metals. Pressed mixtures differ essentially in structure and properties from alloys obtained by melting whenever those alloys contain solid solutions or compounds. If, however, two metals can form a compound, noticeable amounts of the compound may be formed in the solid state. If solid solutions occur in the system, diffusion may take place in the solid state at ordinary temperatures, and more rapidly at higher temperatures. The heating curve of a pressed block differs from that of the alloy obtained by melting, and accordingly cannot be reproduced by a second heating of the same mass.

* Zeitschr. Phys. Chem., lxiii. (1908) pp. 216–53; lxiv. (1908) pp. 257–97 (53 figs.).
† Op. cit., lxvi. (1909) pp. 197–237 (14 figs.).
‡ Zeitschr. Anorg. Chem., lx. (1908) pp. 1–37 (12 figs.).
§ Op. cit., lxi. (1909) pp. 181–6 (1 fig.).
‖ Zeitschr. Anorg. Chem., lxii. (1909) pp. 265–309 (43 figs.).

Some Silver Alloys.*—E. Pannain finds that copper may with advantage partially be replaced by nickel or cobalt in silver coins. Methods of preparation and the properties of the alloys obtained are given.

Some Chromium and Manganese Alloys.†—G. Hindrichs has studied the binary alloys of chromium with tin, lead, copper, silver and aluminium, and of manganese with aluminium and silver, by thermal and microscopical methods. As chromium at its melting point, 1550° C., is viscous, it was necessary to exceed this temperature considerably to obtain homogeneous alloys. Owing to the great experimental difficulties, the results are somewhat uncertain. The metals of each binary system were found to be only partially miscible in the liquid and less so in the solid state. The existence of the only compounds indicated, $AlCr_3$, Al_3Mn, and $AlMn_3$, is doubtful. Tammann's rule that in a binary system A B, A being the metal with the lower melting point, the solid solubility of A in B is greater than that of B in A, is confirmed. It is assumed that when the melting point of A is not appreciably lowered by the addition of the more difficultly fusible metal B, B is insoluble in A at that temperature.

Electrical Conductivity of Magnesium-lead Alloys.‡—N. J. Stepanow has worked out a method for the determination of the conductivity of brittle and easily oxidised alloys. Magnesium and lead were melted together in a graphite crucible under a layer of fused salts. The alloy was drawn up into a previously heated hard glass tube lined with soot. After cooling the tube was broken away. Rods, several cm. long and 3–4 mm. diameter were thus obtained; their conductivity was measured at 25° and 100° C. The concentration-conductivity curve agrees generally with the equilibrium diagram obtained by thermal and microscopical methods. The existence of a solid solution, containing up to 4 atomic p.c. lead, not detected by thermal or microscopical methods, is indicated by the more sensitive electrical conductivity method. The general relation between constitution and electrical conductivity of alloys is discussed.

Compounds of Nickel and Phosphorus.§—N. Konstantinow has determined the equilibrium diagram by thermal methods and examined the alloys microscopically. The compounds Ni_3P, Ni_5P_2, Ni_2P, and one still more rich in phosphorus, were found. Ni_5P_2 exists in two modifications, α and β.

Lead-palladium Alloys.‖—N. A. Puschin and N. P. Paschsky have determined the electric potential of a number of alloys of lead with palladium, against pure lead in a solution of lead nitrate. The form of the potential curve indicates the existence of the compound Pb_2Pd.

* Gaz. chim. ital., xxxviii. (1908) pp. 349–51, through Journ. Soc. Chem. Ind. xxvii. (1908) p. 813.
† Zeitschr. Anorg. Chem., lix. (1908) pp. 414–49 (7 figs.).
‡ Op. cit., lx. (1908) pp. 209–29 (3 figs.).
§ Tom. cit., pp. 405–15 (11 figs.).
‖ Op. cit., lxii. (1909) pp. 360–3 (1 fig.).

Gold-magnesium Alloys.*—R. Vogel has determined the equilibrium diagram by the method of thermal analysis, and confirmed it by microscopic examination of alloys. The system is compared with the gold-cadmium and gold-zinc systems. Three maxima indicate the occurrence of the compounds $AuMg$, $AuMg_2$, $AuMg_3$. Three series of solid solutions occur.

Tin-lead Alloys.†—P. N. Degens has redetermined the equilibrium diagram. The quantity of alloy used for cooling curves was about 160 grams, and the cooling from 300–100° C. occupied 25–35 minutes. The freezing point curve indicates complete miscibility in the liquid state, the formation of a eutectic freezing at 181° C. and containing 24·4 atomic p.c. lead, a solid solubility of tin in lead of 12 atomic p.c., a very small solid solubility of lead in tin, and gives no evidence of the formation of compounds. In alloys containing 0–88 p.c. lead a thermal critical point was found at 146° C., and the occurrence of a change at this temperature was confirmed by dilatometric measurements. The author holds that a compound separates at 146° C. Lead-rich alloys were etched with a 5 p.c. solution of acetic acid in ethyl-alcohol.

Sub-oxides of Caesium.‡—The solubility of metallic oxides in the molten metals has some important practical bearings in metallurgy. For the study of this phenomenon Rengade has selected caesium because of its low melting point and its capacity for holding in solution a large amount of oxide. The caesium-oxygen system was studied by the method of thermal analysis. The equilibrium diagram given was derived from data yielded by heating curves in preference to cooling curves, as the supercooling observed in the solidification of the melts rendered the indications of cooling curves uncertain. The operations were carried out in vacuo or in an atmosphere of nitrogen. Starting with the pure metal, melts of increasing concentration in oxygen were obtained by admitting, successively, known quantities of oxygen to the glass tube containing the caesium. The compounds found were Cs_7O, Cs_4O, Cs_7O_2, Cs_3O, Cs_2O. Three eutectic points were observed, one belonging to a labile equilibrium. No solid solutions occur. Some microscopic observations were made.

Physico-chemical Studies in Tin.§—E. Cohen has studied the occurrence of "tin-pest" in old coins, and ascribes it to the change from the usual form of tin to the brittle-grey variety, taking place below 18° C.

Basic Bessemerising of Copper-matte.‖—F. Schreyer, in the course of investigations on this subject, has made a metallographic study of the system $FeO - Fe_2O_3$ with indefinite results. Sections cut from fused mixtures of the oxides, in different proportions, were polished and etched

* Zeitschr. Anorg. Chem., lxiii. (1909) pp. 169–83 (13 figs.).
† Tom. cit., pp. 207–24 (18 figs.).
‡ Rev. Métallurgie, vi. (1909) pp. 934–45 (5 figs.).
§ Zeitschr. Phys. Chem., lxiii. (1908) pp. 625–34 (15 figs.).
‖ Metallurgie, vi. (1909) pp. 190–7 (22 figs.).

with concentrated nitric acid. Attempts to colour the different oxides by the action of ferro- and ferri-cyanide of potassium were unsuccessful.

Mounting of Specimens.*—R. Baumann describes some useful contrivances, which do not appear to be generally known, for mounting polished sections. Small objects may be placed within a turned metal ring on a level surface, with the polished surface down, and a slide on which is a piece of modelling-wax, pressed down on the specimen. Two pairs of rings, diameter 25 and 50 mm., height 15 and 25 mm., used singly or in combination, give six variations of the arrangement for objects of different size. Mounted in this way, the specimen may be held by means of the stage clamps on the stage of a horizontal Microscope. R. Winkel's apparatus for marking a particular field is useful. Screwed into the tube in place of the objective, it scratches a circle on the polished section by means of a diamond point. Specimens too heavy for observation with a horizontal Microscope when mounted as above, may be mounted in a similar way, but with the polished surface at right angles to the slide, and are then supported on a supplementary stage projecting (horizontally) at right angles from the ordinary stage. For large and heavy objects the Microscope must be so constructed that it can be placed on the object. The Zeiss I C stand permits of the replacement of the foot and substage by a foot-plate, through an opening in which the specimen is observed. For photography, a reflecting prism is fixed above the eye-piece.

Magnetic Properties in relation to Mechanical Tests.†—A. Grünhut and J. Wahn report on von Hoor's proposal to utilise the magnetic and electric properties of materials to determine the mechanical properties. Magnetism appears to be definitely related to almost all physical phenomena, to mechanical stresses of all kinds, as well as to influences of temperature, chemical composition, and structure. The inter-relation between these phenomena is not sufficiently uniform, however, to allow of the determination of physical properties from magnetic tests.

Impact Tests.‡—G. Charpy discusses the present position of the impact bending test on notched bars, and concludes that this test furnishes useful information which is not yielded by the tensile test.

F. Schüle and E. Brunner§ have determined the volume of metal strained beyond the yield point, in impact bending tests on notched bars, and find that the influence of the depth of notch can be eliminated by calculating the work done in fracture per unit of this volume.

P. Breuil‖ states the conclusions he has drawn from a number of impact tensile tests on plain bars.

A. Leon and P. Ludwik¶ find that the amounts of work done in static bending and in dynamic bending are not in any uniform relation.

* Metallurgie, vi. (1909) pp. 407–8 (8 figs.).
† Proc. Int. Assoc. for Testing Materials, No. 6 (1909) 5 pp.
‡ Op. cit., No. 7 (1909) 20 pp. (Official Report on Impact Tests of Metals, submitted to the Copenhagen Congress, September 1909.)
§ Op. cit., No. 6 (1909) 6 pp. (3 figs.).
‖ Op. cit., No. 10 (1909) 2 pp. ¶ Tom. cit., 2 pp.

Consequently there can be no uniform relation between static tensile test and notched bar impact test.

P. Welikhow * finds that impact tensile tests give numerical values which agree with the results of static tensile tests, and give in addition the kinetic strength of the material.

Irregular Stresses due to Non-homogeneity.†—A. Leon summarises the results of mathematical investigations concerning the irregular stresses which arise in elastic bodies owing to the presence of inclosures, hollow spaces, and superficial flaws. Inclosures of any kind will cause local increase of stress, and thus a diminution in the strength of the material. These increases in stress are greatest within the elastic range, and diminish rapidly when permanent deformations occur.

Thermo-electric Measurement of Elastic Limit.‡—E. Rasch deduces from theoretical considerations that when a metal is stressed in tension its temperature falls so long as its deformation is purely elastic, but rises when inelastic permanent deformation begins. A method of determining elastic limit founded on this property is described. The change of temperature of a tensile test-piece when submitted to increasing stress is followed by means of a thermo-couple placed in contact with the test-piece and connected to a delicate galvanometer. The critical stress—i.e. elastic limit—is indicated by a reversal in the temperature record.

Influence of Increased Temperature on the Mechanical Qualities of Metals.§—M. Rudeloff describes the various methods which have been employed for carrying out tensile and other mechanical tests at high temperatures. The results of high temperature mechanical tests made by the author and others on steel, cast iron, copper, brass, bronze, manganese bronze, and delta metal are summarised. A comprehensive bibliography is appended.

PORTEVIN, A.—**Binary Alloys.**

[A. Portevin has continued his account of the investigations carried out in G. Tammann's laboratory at Göttingen (see this Journ., 1908, pp. 522 and 787). The alloys of nickel, lead, antimony, silicon, tin, and zinc are here dealt with.]

Rev. Métallurgie, v. (1908) pp. 838–56, 909–27; vi. (1909) pp. 241–71, 951–82 (127 figs.).

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* Proc. Inst. Assoc. for Testing Materials, No. 10 (1909) 9 pp. (2 figs.)
† Op. cit., No. 9 (1909) 6 pp. ‡ Op. cit., No. 11 (1909) 7 pp. (2 figs.).
§ Op. cit., No. 12 (1909) 30 pp. (25 figs.).