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.

EDITED BY

R. G. HEBB, M.A. M.D. F.R.C.P.

Physician to Westminster Hospital

WITH THE ASSISTANCE OF THE PUBLICATION COMMITTEE AND

J. ARTHUR THOMSON, M.A. F.R.S.E.

Regius Professor of Natural History in the University of Aberdeen

A. N. DISNEY, M.A. B.Sc. CECIL PRICE-JONES, M.B. Lond.

FELLOWS OF THE SOCIETY

AND

A. B. RENDLE, M.A. D.Sc. F.L.S.
Assistant in Botany, British Museum

HAROLD MOORE, B.Sc.
Woolwich Arsenal

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

FOR THE YEAR

1905

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MICROSCOPY.

A. Instruments, Accessories, &c.*

(1) Stands.

Koristka's large Model Microscope.†—F. Koristka's large model Microscope, IV. *a* (fig. 25) has a rectangular ebonite stage, 88 × 85 mm.,

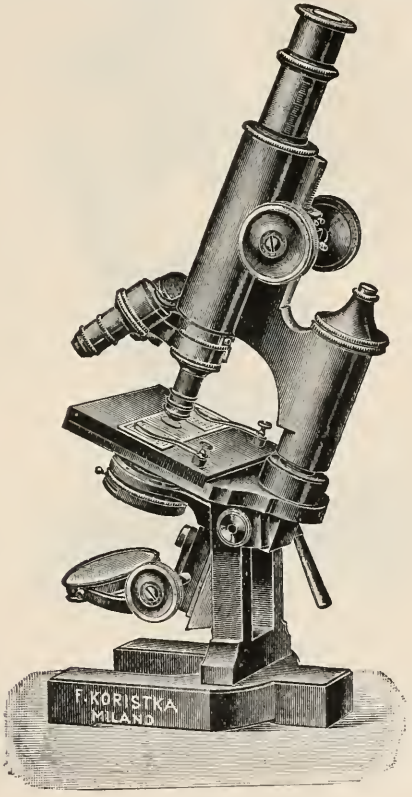

Fig. 25.

and an Abbe condenser of N.A. 1·2. The substage apparatus is raised and lowered by means of rack and pinion movement, and is supplied

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

‡ F. Koristka's Special Catalogue, Milan, November, 1904.

with an iris diaphragm. The stage can be fixed at any angle by means of a clamping handle, and the draw-tube is marked with millimetre divisions. Instead of a rectangular, the instrument can be supplied with a circular stage of 95 mm. diameter (fig. 26), the rotation axis of which

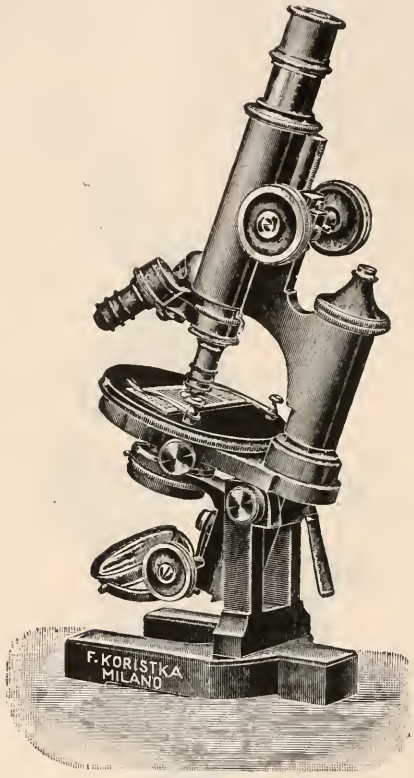

Fig. 26.

can be centred on the optic axis of the instrument by means of two binding screws. By means of these covers there is afforded a displacement of 6 mm. in every direction, so that this stage may be made to work as a travelling stage.

Differential Screw Fine Adjustment.* — W. Forgan had three "two speed" differential fine adjustments made upon Ashe's plan.‖ In the first, the quicker motion was $\frac{1}{50}$ inch, and the slower $\frac{1}{375}$ inch for each revolution; in the second, the slowest motion was $\frac{1}{1200}$, and in the third, $\frac{1}{200}$ for a revolution. As some slight hesitancy was observed

* Proc. Scot. Micr. Soc., 1903–4, p. 47.

‖ Journ. Quekett Micr. Club, ser. 2, viii. (1901) p. 131; Journ. R.M.S., 1902 p. 232, figs. 40–2.

when the motion was reversed, notwithstanding that the opposing spring was a strong one, a "single speed" lever motion was tried, the ratio of the arms of the lever being 8 to 1, the fine adjustment screw having 100 threads to the inch, with an opposing spring strong enough to require 7 lb. to move it. This was found to require a weight of only $\frac{3}{4}$ oz. to turn the head of the fine adjustment screw, and to work in a perfectly satisfactory manner.

(2) Eye-pieces and Objectives.

Spencer Objective.*—F. J. Keeley describes a Microscope objective of $\frac{1}{4}$ inch focus made in 1860 by Charles A. Spencer. It was recently necessary to take apart the back system for re-balsaming, when it was found to consist of five lenses, three of which were convex and two concave. One of these proved, on examination with polarized light, to be fluorite. This objective is historically interesting as illustrating the complex nature of the corrections adopted by Spencer at so early a date, as well as confirming the previous reports that he had appreciated the possibilities connected with the use of fluorite in securing superior colour corrections, and employed it for the purpose twenty years before it came into use abroad. The objective has an aperture of 142 to 152 degrees, according to position of the collar adjustment, which acts by the movement of the back systems, and it is unusually well corrected for colour. It resolves *Pleurosigma angulatum* sharply into dots with central light from mirror, and with oblique illumination resolves markings 76,000 to the inch.

H.—**Construction of aplanatic combinations of lenses, with or without achromatism.** *English Mechanic*, lxxx. (1904) pp. 252–3, 321–2, 340, 406–8.

MERLIN, A. A. C.—**Microscopical high powers and deep eye-pieces.**

[The writer says that if a given objective capable of affording a really clear, brilliant, and well-contrasted image under a × 12 ocular when a large solid illuminating cone is used, it may be employed, if necessary, in conjunction with the deepest eye-pieces, so as to give results just as satisfactory as would be attainable with a higher power objective of equal N.A. combined with a shallow eye-piece. *Tom. cit.*, p. 455.

VILLAGIO—Ditto. *Tom. cit.*, p. 384.

(4) Photomicrography.

Photomicrography with the Aid of Ultra-Violet Light.†—Text-books of science, as a rule, explain microscopic vision with the aid of rays. This elementary explanation does not fix any limit to the possible magnification, but as long as we have not to deal with dimensions which are comparable to the wave-length of light, it does not bring us into conflict with observed facts. But we reach the limit of resolution when the distances between the lines of the object are less than half a wave-length of the light with which we illuminate the object. The theory which Helmholtz advanced for self-luminous objects, and Abbe, about the same time, for illuminated objects, regards the microscopic images as diffraction phenomena; and this theory, some points of which Dr. Glazebrook has recently cleared up, also indicates the way in which

* Proc. Acad. Nat. Sci., Philadelphia, lvi. (1904) p. 475.
† Engineering, lxxviii. (1904) p. 760.

further resolution may be procured. We ought to work with light of very small wave-length. Since the wave-length is determined by the quotient $\lambda = \frac{V}{N}$, the velocity of light divided by the number of vibrations, two ways seem to be open in order to obtain a smaller λ. We may either decrease the velocity of the light, or increase the number of vibrations. The first can be accomplished by immersing the object in a liquid of high refractive index—glycerin, balsam, salt solution, etc. The method is applied to a certain extent, but does not carry us much further. The second method illuminates the object, not with ordinary white light, but with violet vibrations of higher frequency. It was first proposed by Amici, and is also used. But the intensity of the violet light is very feeble, or, rather, the eye is not very sensitive to violet rays. In photomicrography the second objection does not count, but the feeble intensity remains a drawback. A. Kohler, of Jena, has therefore tried ultra-violet light, notably the rays given out by electric sparks passing between cadmium electrodes. These rays, of wave-length 275 $\mu\mu$, have a high intensity. Dr. Kohler described his new camera-microscope, which has been constructed by the Zeiss Glas Werke, of Jena, before the Breslau meeting of the Naturforscher-Versammlung. The lenses of this Microscope are made of crystal and of fused quartz; they need only be corrected for spherical aberration, because no chromatic aberration has to be guarded against when monochromatic light is used. As the ultra-violet light is invisible, however, an artificial eye has to be combined with the Microscope for focussing and adjusting. This artificial eye consists of optical parts made of crystal, and of a retina made of fluorescent glass, which responds to ultra-violet rays. The observer examines through a lens the image thrown on this artificial retina. The instrument can, indeed, also be used for subjective vision by ultra-violet rays, and for this purpose magnesium light, of wave-length 280 $\mu\mu$, is still more suitable than the cadmium light. But the fluorescent light is injurious to the eye, and the finest detail can only be studied by photography. Yet the fluorescence helps in bringing out further detail. Dr. Kohler also immerses his specimens—so far, mostly organic tissues—in a mixture of glycerin and water, or in salt solution, of which physiologists make large use. The ultra-violet rays at once show differences in the structure, which, hitherto, staining had alone revealed. Thus the horny portions of the epidermis, the membranes of plant cells, and other parts, are more or less impermeable to ultra-violet rays, so that other advantages are realised in addition to the increased resolution. It would not be surprising if ultra-violet illumination should also render good service in metallography.

Three-Colour Photography.*—Chapman Jones gives the following résumé of two processes of colour photography.

König's Three-Colour Process.—This process, only recently published, has attracted a good deal of attention, and deservedly so, for it not only illustrates a new principle as applied to the purpose of colour photography, but has been worked out by its author to a successful

* Knowledge, i. (1904) pp. 285–6.

issue. Whether or not it will be found to fulfil the conditions necessary to establish itself as a standard or commercial process, only time can prove. It is a triple film method, but differs from those previously proposed, in that each colour is printed out by light.

Many of the organic dye-stuffs yield on reduction colourless or leuco-derivatives, which can be oxidised to reproduce the original colour with more or less facility, and exposure to light generally facilitates this oxidation. By choosing a dye of a suitable colour, and one that yields a leuco-derivative of sufficient stability to withstand the necessary operations and yet is sensitive enough for practical printing purposes, it is obvious that the colour may be obtained directly by exposure to light under the negative, and the necessity for a relief produced by the chromated gelatin process, or any similar indirect method of getting the required distribution of the colour, is obviated.

These leuco-derivatives were found to be useless by themselves or in an inert film, as they then gave only poor and flat images, but the presence of a nitric acid ester was discovered to overcome this difficulty. Pyroxylin being an ester of nitric acid a collodion film is employed, and mannite nitrate is very suitable for further augmenting the sensitiveness. The removal of the excess of the leuco-derivative after exposure was at first a difficulty, as ordinary solvents and acids were found useless for the purpose. But monochloracetic acid is effective, and it is used as a 10 p.c. solution.

The process consists in coating a suitably surfaced paper with a $1\frac{1}{2}$ p.c. collodion, to which the leuco-derivative and other desirable materials have been added, exposing under the appropriate negative until the colour is sufficiently intense, fixing in the chloracetic acid solution, washing, and dipping into a gelatin solution that contains chrome alum, and drying. The print is again dipped into the gelatin solution and dried to effectively protect the collodion film during the application of the collodion that is to furnish the second colour. This routine is repeated for the second colour, and again for the third, and the print is finally varnished.

The method of judging when each colour is correctly printed is not very clear, as it seems impossible to adjust the depth of tint of the films that are sealed up by the subsequent coatings. The process is apparently rather tedious, as there are three collodion films, six gelatin coatings, and a final coating of varnish to dry. The obvious objection to the number of films because of their combined thickness is probably invalid, as the collodion and the gelatin solution used are weak, and the films they give correspondingly thin. A real difficulty I should have expected to be due to the action of the chloracetic acid on the gelatin films under the collodion film that is being subjected to the fixing operation, but doubtless this possibility has received attention.

Lumière's Starch Method of Three-Colour Photography.—This process, which was described about six months ago, contrasts very emphatically with König's method in the simplicity of the necessary manipulation. No colour-screens or filters are needed, there are no films to stain, no colours to produce of the correct intensity to match one another, no separate negatives with subsequent printings, but merely one exposure,

ordinary development, and then, instead of fixing, the silver image is dissolved out and the remaining silver salt reduced to the metallic state. But if the work of the photographer himself is simple, it is because of the complex character of the prepared plate; and presumably it is the difficulties of manufacture that have led to the delay in putting the prepared plates on the market. The plates are made by selecting starch granules of from 15 to 20 thousandths of a millimetre in diameter, staining quantities of them red, green, and violet respectively, drying them, mixing them so that neither colour predominates, but that the whole presents a neutral grey tint, and spreading the mixture on glass one layer thick. The interstices are filled in with a fine black powder, and the layer is fixed and protected by a coat of varnish. On this is put a film of suitably colour-sensitised emulsion. Exposure is given through the glass, and the subsequent treatment of the plate is as described above. The dyed starch granules form an irregularly grained three-colour screen, which serves the double purpose of taking and viewing.

It is easy to describe such a process, but besides the obvious mechanical difficulty of preparing the plates, there must be many compromises made before the result can be passably satisfactory. The best three colours for the exposure are not the best three for viewing the picture, but in this case they have to be the same. If the stained starch granules are mixed to the most neutral tint possible, it appears that a perfectly orthochromatised sensitive film would be necessary. The imperfections of the film in this matter must be neutralised as far as possible. Indeed, the difficulties of which the photographer is relieved have to be overcome by the manufacturer, and in this particular case they are so many and complex that if it had not been stated that results have been obtained in the manner described, we might very well doubt the possibility of it.

Photomicrography and Photomicrometry.*—J. Thompson employed a fixed magnifying power (say 1000 diams.) for photographing the object to be measured. This is obtained by using an oil immersion $\frac{1}{12}$ with a certain eye-piece, a fixed tube length, and screen distance. A sheet of paper is ruled in squares. This is photographed by an ordinary camera, and reduced until the squares measure 1 mm. on the negative. This negative is printed on the same positive as the photomicrograph; a direct measurement can therefore be made, because each mm. represents a micron magnified 1000 times. Other fixed magnifying powers are treated in a similar manner.

MATHET, L.—**Sur la reproduction des objets difficiles par la photomicrographie.** (A series of articles on the photomicrography of difficult objects.)
Rev. Sci. Photographiques, i. (1904) pp. 18–22, 48–53, 117–22, 176–80, 231–4 (23 figs.).

(5) Microscopical Optics and Manipulation.

Aperture Table.—It will be noticed that the limit for resolving power for white light in the aperture table, printed upon the fly-leaf of this

* Proc. Scot. Micr. Soc., iv. (1903–4) p. 44 (pls. iii.–vi.).

Journal, has been altered. Mr. Gifford's measure of λ for white light, viz. 0·5607 μ has been substituted for that hitherto used, viz. 0·5269 μ (line E). In the calculation the new metrical conversion table "for same temperature" was employed.

Resolution of Amphipleura Pellucida.* —C. Mostyn has resolved the transverse striæ on the *Amphipleura pellucida* with a water immersion $\frac{1}{12}$ N.A. 1·18, by means of superstage illumination, simply obtained by reflecting sunlight with the mirror turned up above the stage. The author is able to obtain an "ink-black" ground by this means, and observes that light from an $\frac{1}{2}$-in. paraffin wick is not sufficiently powerful for this kind of superstage illumination.

Ultramicroscopic Observations on the Decomposition of Sulphur from Thiosulphuric acid and of Selenium from Selenic acid.†—The investigations of Siedentopf and Zsigmondy with ultra-microscopical particles suggested to W. Biltz that, although the measurements of so-called "molecular dimensions" are somewhat beyond the limits of resolution, yet the observer's methods might be usefully applied to the investigation of certain cases of chemical composition and decomposition. He considers that (1) the ultramicroscope draws a sharp distinction between completely homogeneous (or "optically empty") solutions and those which appear turbid through a more or less fine suspension of minute particles: the diagnosis of so-called colloidal solutions being thereby simplified; (2) that it lends itself to a more accurate study of certain processes by which a heterogeneous medium is formed out of one originally homogeneous. He has examined the decomposition of thiosulphuric acid into sulphurous acid and sulphur ($H_2S_2O_3 = H_2SO_3 + S$), and the conversion of selenic and sulphurous acids into selenium and sulphuric acid ($H_2SeO_3 + 2H_2SO_3 = H_2O + Se + 2H_2SO_4$). Great difficulty was experienced in freeing the reagents, especially distilled water, from dust, but eventually success was attained. It was found that india-rubber couplings had to be avoided owing to partial solution. Experiments were also performed with proper mixtures of sodium thiosulphate and oxalic acid. Observations were made at suitable time-intervals, and several tables are given recording the growth of the particles and their colour-changes. In some cases the growth seems to be continuous, in others discontinuous.

Colours in Metal Glasses and in Metallic Films.‡—J. C. Maxwell Garnett seeks to explain the phenomena observed by Siedentopf and Zsigmondy by proving that the metal particles observed in gold glass are spherical in shape when the diameters are less than 10^{-5} cm. The fact that such particles are spherical throws light on the manner in which metals crystallise out of solution, the particles taking first a spherical form under the influence of surface tension, and later, when they become too large for the forces of surface tension to overcome the

* Knowledge, i. (1904) p. 307. An interesting question arises from this note, How does light of an obliquity greater than the critical angle get into the slide?—Ed.

† Nachrichten Königl. Gesell. wiss. zu Göttingen, (1904) pp. 300-10.

‡ Proc. Roy. Soc., lxxiii. (1904) pp. 443-5.

crystallic forces, becoming amenable to the latter. He also shows that every transparent medium containing metal spherules, so that the average distance between two neighbouring spheres is considerably less than a wave-length of light, has a perfectly definite colour by transmitted light depending only on the optical constants of the metal of which the spheres are made, on the refractive index of the substance in which they are imbedded, and on the quantity of metal, but not on the size or distance apart of the spheres. It results that the presence of metal spheres accounts for the optical properties of gold ruby glass, and that the irregularities in the effects of colour and polarisation, sometimes exhibited by gold glasses, are due either to excessive distance between adjacent gold particles or to excessive size of such particles—the latter, however, involving the former. The author found that this regular colour can be produced in a colourless metal glass containing the metal in solution (which is the state in the manufacture of gold or copper ruby glass before the second heating) by the β-radiation from radium. The author also investigates the optical property of media built up out of metal spheres so that the volume of metal may have any value between zero and unity, instead of remaining very small as in metal glasses. He thus arrives at an explanation of the changes in colour of gold and silver films observed by G. T. Beilby, and of potassium and sodium films deposited on the insides of exhausted glass bulbs.

Construction-Principle of an Optical Apparatus for obtaining very Large Magnifications [The Diastoloscope].*—M. C. Chabrié has investigated the question whether, instead of the ordinary mode of obtaining an image geometrically like the object, it would not be more advantageous to produce images, deformed but highly enlarged, and then afterwards, by an inverse geometrical construction made on paper to a suitably selected scale, reconstruct the objects in their true proportions. His method depends upon the effect of viewing an object (a disc) through a crystal in the shape of a right cone with an accurately circular base. The cone-axis is arranged perpendicularly to the plane of the object (fig. 27). The image projected on a screen is found to be an annulus, whose centre is the point where the cone-axis meets the screen. The point on the image immediately under the apex of the cone is refracted into the outer circumference of the annulus, and other points in the neighbourhood of that point are projected into the inner neighbourhood of that outer circumference. The magnification will be the ratio of the image-circumference to the object-circumference. As the magnification of the centre point of the object becomes infinite, it will be readily understood that points near it will be very highly enlarged. It will also result that points on same concentric *circumference* of the image will have equal magnification, and that, therefore, if a region of the object between two points is to be examined, the object must be moved so as to bring these points on to the same circumference in the image. The object may of course be considered as composed of concentric, equidistant zones, whose common centre is the intersection of the cone-axis

* Comptes Rendus, cxxxviii. (1904) pp. 265–8, 349–51, 560–3, 656 (14 figs.).

with the object-plane ; let these be numbered, mentally, 1, 2, 3, 4, *from* the centre (fig. 28). In the same way let the image be similarly divided into the same number of concentric and equi-distant zones, 1, 2, 3, 4, *towards* the centre (fig. 29) : then the zones bearing the same number will correspond. If, also, object and image be divided up by radii at equal angular distance, then the object-intersection of a zone of a certain number with a radius of any number will correspond to the image-intersection of zone and radius of similar numbers. If the image be received on a glass plate engraved with such a system of circles and radii, the object can then be reconstructed. The author shows that the scale of magnification is a hyperbola, which can be easily drawn and used as a scale of reference. He recommends that the image be viewed

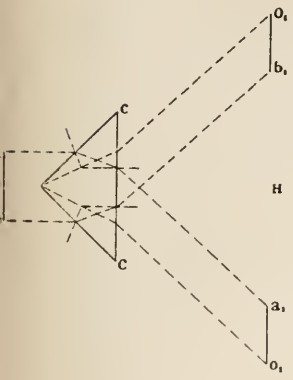

Fig. 27.

Fig. 28.

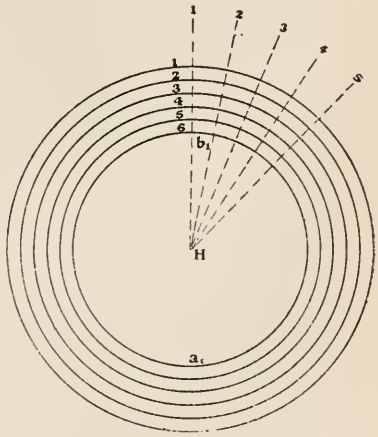

Fig. 29.

through a second cone of the same material of more obtuse vertical angle than the first cone : these two cones are mounted in sliding-tubes so that the distance between them may be varied ; and the whole is applied to a Microscope in place of the usual ocular. The Microscope, having an objective in the usual way, is introduced into the bottom of a camera, and arranged so that the objective image is sharply focussed on a ground glass plate. This image could be photographed. The diastoloscope is then applied. The author hopes to realise magnifications of 5000–6000 diameters. He gives some specimens of his results with diatoms.

F. R. M. S.—**Amphipleura Lindheimeri.**

[The writer states that he has counted 76,000 transverse and 65,000 longitudinal striæ to the inch upon this diatom in a Watson's styrax slide.

English Mechanic, lxxx. (1904) p. 455.

Hunter, J.—**"Cross" formula.** *Proc. Scot. Micr. Soc.*, iv. (1903-4) pp. 49-51.

(6) Miscellaneous.

Czapski, Siegfried—**Grundzüge der Theorie der optischen Instrumente nach Abbe.** Second edition, edited by O. Eppenstein and M. von Röhr, 490 pp., 176 figs. J. A. Barth, Leipzig, 1904.

Zeiss, Carl—**Die Bilderzeugung in optischen Instrumenten, vom Standpunkte der geometrischen Optik.** By the Scientific Staff of Carl Zeiss's Works. Edited by M. von Röhr, 558 pp., 133 figs. J. Springer, Berlin, 1904.

B. Technique.*

(1) Collecting Objects, including Culture Processes.

Diagnostic Media for the Study of Bacteria.†—G. Marpman describes the uses and methods of preparing various media for differentiating bacteria according to the products formed by the growth of the rganism. The production of acids or alkalies is indicated by using lacmus gelatin or chalk gelatin; reducing action is detected by lacmus gelatin or "Rhodan-Eisen" gelatin; sulphuretted hydrogen by lead gelatin; sulphur and sulphates by gelatin containing nitroprusside of sodium; carbonic acid by chloride of calcium gelatin; the formation of aldehyde is demonstrated by "Malachit Sulfit" gelatin; the presence of agglutinins is shown by safranin gelatin; and silver gelatin, poured into specially devised yellow glass petri dishes, is used to detect the formation of toxins, antitoxins, agglutinins, coagulins, etc.

Detection of Bacillus Enteriditis Sporogenes in Water.‡—R. T. Hewlett recommends the following method. Into boiling tubes, 40 c.cm. of milk are introduced; the same are plugged and sterilised. At the time of using, the tubes are boiled in a water-bath for a few minutes to expel air, and 60 c.cm. of the water to be examined are added. The wool plugs are now replaced by a cover of two thicknesses of sterile filter-paper kept in place by a rubber band, and the tubes are then heated at 80° C. for 10–15 minutes, and incubated anaerobically at 37° C. in a Bullock's apparatus, or in a stoppered museum jar of suitable size containing alkalin pyrogallic solution. By using a dozen tubes, 700 c.cm. of the water can thus be examined.

Plate Culture of Anaerobic Bacteria.§—The apparatus described by O. Berner consists of a flat vial with parallel faces, to one side of which is fused a glass cock. The nutrient medium, to which has been added some methylen-blue to indicate the absence of oxygen, is poured into the vial, the neck of which is closed by a wool plug, and the whole is boiled in a vessel of water until the blue colour begins to disappear. The wool plug is now replaced by a perforated rubber stopper, provided with a short glass tube and rubber tubing. Hydrogen is then passed into the apparatus until the blue colour has entirely disappeared; the vial is taken out of the water, the neck now closed with

* 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, &c.; (6) Miscellaneous.

† Zeitschr. angew. Mikr., x. (1904) pp. 169–74.

‡ Trans. Path. Soc., lv. (1904) p. 123.

§ Centralbl. Bakt., 1te Abt., xxxvii. (1904) pp. 478–80 1 fig.).

a solid rubber cork, and the glass cock turned, and the whole set aside to cool, and if solid medium to solidify. When the medium is inoculated the vial is held neck downwards, the rubber cork is removed, hydrogen is conducted through the glass cock; and after inoculation, it is corked again without any air having been let in.

Isolating Bacillus Typhosus from the Blood and Organs after Death.*—By the method devised by Fraenkel and Simmonds the spleen is incubated for 24 hours, and the bacilli can then be readily shown histologically. For cultivation from the blood, 10–25 c.cm. are distributed on four to six plates of glycerin agar. This medium is preferred to Loeffler's serum, as it is transparent, is not liquefied, and keeps well.

Bacteriological Examination of Water in the Atlantic Ocean.† Otto and Neumann, during a voyage from Europe to Brazil, made a number of examinations of sea water taken at different depths and at different distances from the land. They found that the numbers of organisms were less in the high sea than nearer to shore; their results in mid-ocean at a depth of 5 metres show a maximum of 120 and a mean of only 60 germs per cubic centimetre. The fact that the numbers were often less at the surface and slightly below it than at a depth of 50 metres, they attribute to the disinfecting action of the sun's rays. The greater numbers found at certain depths may be explained by the presence of deep currents. Their plates showed Coli-like bacilli, Fluorescentes, Proteus-like liquefying organisms, sometimes white and yellowish non-liquefying colonies of rods; occasional vibrios and moulds.

They devised a special collecting apparatus that would act at definite depths and under the varying conditions of the sea, and the rate of travelling of the ship. This consists of a copper cylinder firmly bound to a rope line at the end of which is a 30 kilogrm. lead weight; the cylinder is provided above and below with a 6-holed brass plate, which is closed by means of rubber plates held fast by screws. At the side there is an opening by which the collected water can be let off. When the apparatus is lowered into the depth, the rubber plates will be raised and the water rushes in through the cylinder; on raising by pulling on the line, the resulting enormous pressure forces down the rubber plates and closes the openings of entry and exit, and the water has been collected at the desired depth. To determine the exact depth at which the sample was collected, an inverted test-tube lined with chromate of silver was fixed to the line; the red of the chromate is changed to white from below upwards, according to the height to which the sea water has entered the tube, and this is dependent on the pressure existing at the depth. With this instrument a scale of true depths was made.

Isolating Tetanus Bacillus from the Spleen.‡—Creite states that broth cultures, inoculated with portions of the excised wound and

* Centralbt. Bakt., Ref. 1te Abt., xxxv. (1904) p. 654.
† Op. cit., 2te Abt., xiii. (1904) pp. 481–9.
‡ Op. cit., 1te Abt., xxxvii. (1904) pp. 312–14).

incubated anaerobically, showed the presence of typical Tetanus bacilli with spores after 48 hours. Portions of the spleen, taken at the autopsy, were inoculated into a guinea-pig, which died with symptoms of Tetanus (coverslip preparations from the local lesion showing typical bacilli with spores). Broth cultures, inoculated from the local lesion and incubated anaerobically, showed the presence of Tetanus bacilli associated with streptococci and staphylococci. In three other cases of Tetanus all attempts to isolate the organism from the spleen, cerebral fluid, heart blood, and bone marrow gave negative results. He refers to the cases of Oetlingen and Zumpe, Nicolaius and others, where the Tetanus bacillus was isolated from the organs of the body.

Varieties in the Growth of Bacillus Pyocyaneus on Nutrient Agar.*—Hinterberg and Reitman find that there are differences in the growth of this bacillus on nutrient agar, according as the medium contains more or less water, and has a moist or dry surface. They give details of their methods for obtaining nutrient agar of various concentrations, and the technique of making moist or dry surfaces to the medium in the Petri dishes. When grown on weak moist agar, they find that the colonies of *B. pyocyaneus* are smooth and shining, almost fluid, of a blue-green colour, and with iridescent margins; they spread over the entire surface of the medium; and are most easily removed by the platinum needle.

Grown on dry and concentrated agar, the colonies are scanty, of a pale-green colour, often appearing as if etched on the surface; the centre of the colony is somewhat gelatinous, the margins slightly wrinkled; they hardly extend beyond the inoculated surface, and are so firmly attached to the medium that it is difficult to remove the growth with a platinum needle. Coverslip preparations were made and stained by Van Ermengem's method. Those made from the moist agar 24 hours' old colonies, showed only bacilli with polar flagella. Those from the dry agar colonies of the same age, showed a spider-web network of very fine threads, stretching between clumps of bacilli, lying among them a few bacillary bodies with indistinctly outlined capsules, and some free flagella.

They found that if the concentration of the medium is carried too far, the bacilli cease to grow well; they are smaller and stain feebly; and it was harder to obtain a clean preparation, since portions of the medium were always taken away with the culture. They consider that the network of threads, which are seen in the stained preparations made from cultures grown on agar of high concentration, is produced by portions of stained medium, which have become included in the emulsion made on the coverslip. The bacilli grown on the moist weak agar can readily move over the surface, and, moreover, they need to do so, and they accordingly produce motile organs. The same organism, grown on a rich medium with a dry surface, can move less easily, but finds sufficient nourishment in its immediate vicinity, and grows roots.

Cultivation and Staining of Amœbæ.†—W. E. Musgrave and M. T. Clegg, who have been studying the subject of amœbiasis for

* Centralbl. Bakt., 1te Abt. xxxvii. (1904) pp. 169-77.

† Publications Bureau Gov. Lab., No. 18, part i. Manila (1904) 85 pp., 35 figs.

some years, especially in relation to human disease, recommend that after the administration of a saline cathartic, the examination should be made from the fluid portion of the stools. They significantly point out that the diagnosis of amœbæ should never be made unless they are in a motile state, for even with typical resting or encysted forms mistakes may occur. The stock medium for cultures used by the authors is composed of agar 20 p.c., sodium chloride 0·3–0·5 p.c., extract of beef 0·3–0·5 p.c. The finished medium should have an alkalinity of 1 p.c. to phenolphthalein. This is obtained by starting with an initial alkalinity of 1·5 p.c.

The stock medium was varied by diminishing the amount of salt and beef extract, or by the addition of a minute amount of peptone. Attempts to obtain pure cultures were always negative or doubtful, and the authors' results were obtained from symbiotic cultures of amœbæ and bacteria. Pure bacterial cultures were employed, and much difference was found in the adaptability of particular bacteria for the purpose in view. The medium, made into plates in the usual way, was inoculated with the bacterial culture by smearing a loopful in concentric circles on the surface of the agar, and then depositing some of the amœba culture in the middle of the innermost bacterial circle. In from 24 to 72 hours the protozoa will have passed one or more rings, and from such locations may be taken for transplantings.

Transplantation of a single amœba is effected by the following ingenious device. Examine the surface of the plate, and locate an isolated amœba in the centre of the field of a low-power lens. Turn on a dry high-power lens, and lower it until it touches the surface of the medium. Raise quickly, and examine with low-power lens whether the amœba is still present, or has been picked up by the high-power objective. If it has been, rub the face of the objective gently over that of a new plate. In this way symbiotic cultures from a single amœba may be obtained.

Amœbæ show marked preference for certain kinds of bacteria, but this selectiveness may be due possibly to environment. The authors had most success with the colon group.

Amœbæ do not develop below the surface of solid media unless in association with a liquefying organism, and then do not extend beyond the liquefied area. The growth and spread of amœbæ over the surface of plate cultures is quite rapid, and they seem to follow the path of the bacteria. In relation to their pathogenicity the authors do not attach much importance to the size, which has been stated by various writers to vary from 5 to 50 μ. The optimum temperature of the amœbæ, studied by the authors and obtained from different sources, is room temperature. Growth was much less luxuriant at incubator and ice-box temperatures.

For staining living amœbæ the authors recommend a dilute solution of neutral red, which should be run under the cover glass. For staining permanent preparations of amœbæ from cultures they praise Wright's modification of the Romanowsky method, the technique being the same as that for blood films.

The authors also notice the following procedures: (1) Zorn's method consists in mixing a few cubic centimetres of fæces with 3 or 4 volumes of a solution consisting of 15 parts of 1 p.c. chromic acid and 3 parts of

1 p.c. osmic acid. After shaking for 10 minutes the mixture is centrifuged, and the deposit mixed with 5 volumes of 25 p.c. Beale's carmin solution. After half-an-hour this is again centrifuged, and the deposit washed in a weak solution of the same carmin and mounted on glycerin, or dehydrated and mounted on balsam. (2) Doflein's methods. This writer suggests fixation of the material in one of the following solutions: A. Saturated aqueous solution of sublimate 100 parts, alcohol 50 parts, acetic acid 5 parts. B. Picric acid 2 parts, alcohol 50 parts, acetic acid 5 parts.

Doflein makes a film of the protozoa on a slide, or handles them in bulk imbedded in paraffin, and treated as sections.

STULER—**New methods for anaerobic cultures and anaero-cultures.**
Centralbl. Bakt., 1te Abt., xxxvii. (1904) pp. 298–307.

(3). Cutting, including Imbedding and Microtomes.

New Imbedding Bath.*—The imbedding bath recently brought out by the Cambridge Scientific Instrument Company is similar to the

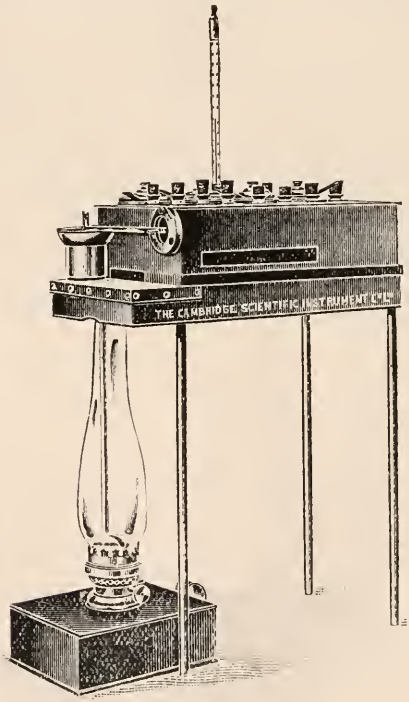

FIG. 30.

gas-heated baths made by the same firm, in which a gas regulator is operated by the expansion of mercury, so as to maintain a constant

* Cambridge Scientific Instrument Company, Special Catalogue, 1904.

temperature. A further advantage of the apparatus is that it can be used with gas or with a paraffin lamp as desired. In the illustration (fig. 30) a paraffin lamp is seen in position. A damper, which rises with the increasing temperature, controls the heating effect of the lamp. The device by means of which the damper is actuated depends on the relative expansion of two metals, aluminium and nickel steel; their disposition being such that the hotter the bath becomes the higher the damper is raised, so that the heat supplied to the bath becomes correspondingly less. Very close regulation of temperature is claimed for this apparatus, a constancy within 1° C. being readily maintained without the attention of the operator being required. The temperature to be maintained can be readily adjusted to a higher or lower point on the scale by a simple setting of the regulator. The bath is provided with an equipment of wax-pans, bottles, and so forth.

(4) Staining and Injecting.

New Method of Making Romanowski's Chromatin Stain.*—Giemsa uses the following receipt: Azur ii. eosin, 3·0 grm.; and Azur ii., 0·8 grm., are placed in a desiccator over sulphuric acid and well dried, thoroughly pulverised, sifted through a fine-meshed silk sieve, and dissolved by shaking up with glycerin, 250 grm. (Merck chem. rein), at 60° C. Methyl-alcohol, 250 grm. (Kahlbaum 1), previously warmed to 60° C., is then added to the mixture and well shaken, allowed to stand for 24 hours at room temperature and then filtered, and the solution is ready for use. He gives the following directions for using the stain: (*a*) the film dried in air is fixed in ethyl-alcohol, or for 2–3 minutes in methyl-alcohol, and dried with blotting-paper; (*b*) dilute the staining solution by shaking up 1 drop in about 1 c.cm. of distilled water (warming the water to 30°–40° C., assists the stain); (*c*) cover the film preparation with the freshly diluted solution, and stain for 10–15 minutes; (*d*) wash in running water; (*e*) dry with blotting-paper and mount in Canada balsam.

Staining and Preserving Algæ.—J. Q. T. gives the following particulars of a method of staining and preserving algæ, which he has found very satisfactory. The reagents required are made up as follows: Fixing solution: chromic acid, 1 oz.; glacial acetic acid, 4 oz.; formaldehyde as formalin (Schering's), 4 oz. Preserving fluids: best glycerin, 8 oz.; glycerin jelly, 1 oz. Chromo-acetic acid: chromic acid, 1 grm.; acetic acid, 1 c.cm.; water, 100 c.cm. Formalin (4 p.c.): Schering's formalin, 10 c.cm.; water, 90 c.cm. (for a 2 p.c. solution take half the quantity of formalin). Stains: hæmalum (Grübler); hæmatoxylin solution: hæmatoxylin cryst. puriss., 1 grm.; water, 200 c.cm. Iron alum solution: iron alum, 3 grm.; water, 100 c.cm. (The iron alum should be in pale violet crystals, not yellow or green, and should be kept in an air-tight tube.) Eosin solution (water soluble): eosin, 1 grm.; water, 200 c.cm.

* Centralbl. Bakt., 1te Abt. Orig., xxxvii. (1904) pp. 308–11.
† Knowledge, i. (1904) pp. 305–6.

The material, which may be "fruiting" or sterile, is gathered in jars and brought home in water, or can be placed directly in the fixing solution at the time of gathering, this last being generally preferable. If fixed in the chromo-acetic mixture it will require about 12 hours for thorough fixation, and 24 hours in the formalin. After chromic acid, the material must be washed in running water or frequent changes for at least one hour, or, better, for three hours. The following simple little piece of apparatus is very useful for washing. It consists of a test-tube fitted with a cork, through which two pieces of glass tube pass. One of these is connected to a water-tap by a piece of rubber tubing, which, in turn, is connected to a piece of glass tubing passing through a cork jammed in the mouth of the tap. A piece of thin muslin is tied over the end of the other tube inside the jar to prevent the escape of specimens. With formalin no washing is necessary.

The material being fixed, the next question is the stain. If nuclei are the only details required, hæmalum will be the best to use. It should either be used strong for 5 minutes, or diluted (1 c.cm. to 50 c.cm. of water) for 24 hours. The staining must be carefully watched in both cases. Overstaining may be remedied by water acidulated (0·1 p.c.) with hydrochloric acid, but the method is somewhat risky. The other methods of staining are as follow: stain with iron alum solution for 3 hours, wash in running water for 1 hour. Stain in hæmatoxylin solution for 6–12 hours. Now comes the delicate part, for the tissues are much overstained, and must be washed in the iron solution till the details are brought out, examining with the Microscope the whole time. Immediately the details are out (generally in about a quarter of an hour) the decolorisation is stopped by placing the object in tap or rain water. Now place some water in a watch-glass and add 5 p.c. of glycerin. Transfer the algæ to the dilute glycerin and cover it with an inverted watch-glass, to prevent dust without checking evaporation. Leave until the glycerin is thick enough for mounting, mount in a shallow tin cell in just enough glycerin to fill the cell (this requires some practice), seal with gold size, and when dry ring with Brunswick black. In some cases a contrast stain may be desired. This can be obtained by placing the tissue in the eosin solution for 30 seconds or less, previous to the transference to the 5 p.c. glycerin.

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

Two Methods for Comparing Normal with Abnormal Tissues under the Microscope.* — S. G. Shattock and C. F. Selous exhibited sections illustrating the above, which they named the method of superposition and that of the composite block. The methods were more particularly adapted for class purposes, and were more especially applicable in the study of bone marrow, the central nervous system, and the blood. The plan of superposition consisted in mounting a normal section directly underneath the diseased, that is, without the intervention of a second cover-glass, so that by merely altering the focus the two could be studied in rapid succession. The sections should be

* Rep. Path. Soc., Nov. 1, 1904. See Brit. Med. Journ., 1904, ii. p. 1249.

cut from paraffin blocks, and should not be more than 2 μ in thickness. Although mounted in direct apposition there was quite a distinct microscopic interval between them, owing to the intervention of a thin layer of the mounting medium; and they were readily studied with $\frac{1}{12}$. One section was fixed to the slide, and the other to the cover-glass; or in the case of blood two cover-glasses were mounted in apposition, and then mounted to the slide. By a composite block was meant a block compounded of two; a broad face of tissue was first exposed in each of the two blocks, and the latter were then cemented together in paraffin; the sections were afterwards cut at right angles to the plane of apposition, so that by placing the section with the line of junction across the field of the microscope, a view was obtained of both the normal and abnormal tissues at the same time.

Hanging-Drop Preparations.*—J. R. Collins describes the following simple contrivance for making a hanging-drop preparation. A small rubber elastic band or washer of appropriate diameter and thickness is smeared with vaseline upon one side. This side is then applied to the slide. The upper surface of the band is now smeared with vaseline, and the cover-glass with hanging-drop is applied to it. An air-tight cell is thus readily made. This avoids the necessity for keeping special hollow-ground slides, and is more convenient than the clumsy and troublesome method of making a similar cell out of damped blotting-paper.

By the use of rubber bands of different sizes the cells can be made of any width and depth desired. Rings with a lumen of from 1–2 cm. in diameter and of 2 mm. in thickness are very convenient.

All-Metal Cover-Glass Holder.†—E. Horder has devised a cover-glass holder (fig. 31) which has the following advantages: (1) it will

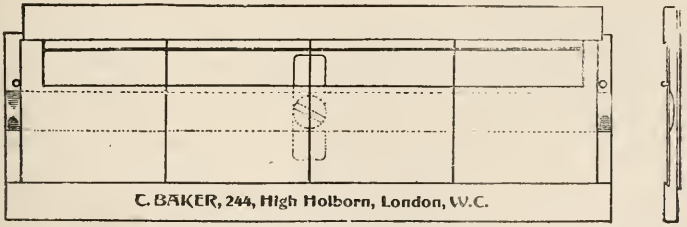

Fig. 31.

receive cover-glasses of any size in general use; (2) being made entirely of metal, it can be easily washed or sterilised; (3) specimens requiring heat can be placed in an oven with the films in position without fear of ruining the holder. Directions for use: with the holder between finger and thumb of left hand, pull sliding bar with the right until the opening is a little wider than necessary. Place cover-glasses on base-plate, bring sliding bar into apposition with covers, and the holder is prepared for taking a spread. A small projecting pin at end of plate secures covers

* Brit. Med. Journ., 1904, ii. p. 1635. † Tom. cit., pp. 759–60 (1 fig.).

from sliding off. The groove along centre of base-plate will enable the operator to remove cover-glasses easily by means of forceps.

TREADLE—**Mounting Volvox.** *English Mechanic*, lxxx. (1904), p. 300.

VILLAGIO—**Mounting Algæ.** *Tom. cit.*, p. 345.

(6) Miscellaneous.

Böhm and Oppel's Microscopical Technique.*—This well-known little volume on microscopical technique contains curt and compressed information for the histological investigation of animal tissues and organs, and its value is increased by a contribution from the late G. Born on reconstruction methods. Though the present issue has been revised and added to by A. Böhm, no reference is made to the Jenner or Romanowsky methods of staining, both procedures being in everyday use and of the greatest value.

DARWIN, H.—**Electric Thermostat.**

[An instrument designed and constructed for the special object of maintaining the prism and other parts of the spectrograph of a 24-inch refractor at a constant temperature, but the principle of the apparatus might be adapted for other kinds of thermostats.]

Phil. Mag., vii. (1904) pp. 408–14 (1 pl.).

HESKETH WALKER—**Notes on marine aquaria.**

English Mechanic, lxxx. (1904) p. 324.

HUGGINS, C. H.—**Acetylene as a gas for bacteriological laboratories.**

Centralbl. Bakt., 1te Abt. Orig., xxxvii. (1904) pp. 317–20.

ROSENAU, M. J.—**Method for inoculating animals with precise amounts.**

Hyg.-Lab., U.S. Mar.-Hosp. Service Bull. 19, Washington, 1904, p. 7 (2 figs.).

Metallography, etc.

Hardness of Metals.†—At a meeting of the Birmingham Metallurgical Society of the Municipal Technical School, Professor Turner gave a lecture on the hardness of metals. The lecturer said that hardness was a property of great importance in connection with the practical application of metals to the arts. In some cases, as with a knife-blade, the continuance of a good cutting edge was of the utmost importance; while in other instances, as with castings which have to be machined, softness was a special requisite. The relatively small differences in hardness which resulted in success or failure were such as could only be measured by accurate methods. Hardness might be defined as the resistance offered by a body to penetration by another body. As the penetrating substance might act in various ways, such as by making a sharp cut, an indentation of considerable size, or an abrading effect, the measure of hardness would depend upon the system of test adopted, and the rapidity with which the test was made. No one test would suit all practical requirements. It was pointed out that in alloys the hardness differed from the mean of the constituents, and was usually higher than that with pure metals. The lecturer then gave a brief historical account of the developments of the methods for determining relative hardness. Among the methods specially recommended by the lecturer

* R. Oldenbourg, Munich and Berlin, 5th ed. (1904) 271 pp.

† English Mechanic, lxxx. (1904) p. 404.

were the Sclerometer, using a weighted diamond point, general application, the method of Brunel for mild steel and similar materials, and the drilling test of Keep for cast iron. In conclusion, the lecturer emphasised the necessity for greater attention to the quantitative determination of the relative hardness of metallurgical products on account of the enormous differences in the usefulness and length and life of tools, nails, tires, and numberless other articles, due to what might at first sight appear to be unimportant differences of hardness.

Possible non-brittleness of Steel under certain conditions.*—C. Frémont points out that the general opinion as to all steels and irons, whatever their quality, becoming brittle in consequence of a permanent deformation effected statically or by shock between 200° and 450° C., is only a hypothesis. He quotes experiments to show that Denain steel, used for the boilers of locomotives on the West of France Railway, is an exception. Hence he concludes that the usual brittleness is not an inherent property of the metals, but is a defect capable of being overcome by suitable conditions of manufacture.

Certain Properties of Alloys of Silver and Cadmium.†—The variability in composition of silver-copper alloys has always been a difficulty in questions of trial plates for coinage and silversmiths' work. Samples taken from the corners and centre of the same ingot will, even under the most favourable circumstances, show a difference in composition of 1·2 per 1000, or sometimes more. T. K. Rose has found that trustworthy and convenient trial-plates can be made of silver and cadmium. His investigations included a study of the microstructure from which he concludes: (1) That evidence is afforded of the existence of the compounds $AgCd_3$, Ag_2Cd_3, AgCd, Ag_3Cd_2, Ag_2Cd, and Ag_4Cd; (2) That the alloys containing from 0–25 p.c. of silver consist, when solid, of crystals of $AgCd_3$ set in a matrix of cadmium. Those containing between 25 and 40 p.c. of silver consist of the compound Ag_2Cd_3 set in a matrix consisting mainly of $AgCd_3$. The alloy containing about 50 p.c. of silver consists of crystals of a silver-rich body set in a matrix consisting chiefly of $AgCd_3$. The matrix or eutectic solidifies at 420°, or nearly 300° C. below the freezing point of the crystals. The alloys containing from 50–60 p.c. of silver consists, at temperatures above 420° C., of mixtures of two different solid solutions, one of which is chiefly composed of the compound AgCd, and the other of Ag_3Cd_2. Traces of the eutectic freezing at 420° C. are still visible. When more than 80 p.c. of silver is present, the alloys consist of a mixture of two bodies at temperatures between the liquidus and solidus curves, but these unite to form a single solid solution at points on the solidus curve; (3) That the alloys containing over 80 p.c. of silver do not undergo segregation under ordinary conditions, and are practically homogeneous and uniform in composition. They are well suited as a material for the manufacture of trial-plates.

* Comptes Rendus, cxxxix. (1900) pp. 1032–3.
† Proc. Roy. Soc., lxxiv. (1904) pp. 218–30 (8 figs.).

MICROSCOPY.

A. Instruments, Accessories, &c.*

(1) Stands.

Ladd's Student's Microscope.—This instrument (fig. 34), kindly presented to the Society's Collection by Mr. Wynne E. Baxter, was exhibited at the Meeting on May 18, 1904. It was made about 1864. Its features are: a very light tripod foot, consisting of a framework of tubes; a body fixed on a frame, which slides on a straight dove-tailed bar, on the Jackson plan; the substage slides on the same bar, and is movable by rack-and-pinion, whilst the stage, which is also fitted in the same dove-tailed groove, is fixed.

Motion is not imparted to the body by rack-work, but by a chain working round a spindle turned by the milled head, which gives a movement of remarkable smoothness and free from backlash. A part of the chain is visible in the figure, above the top of the dove-tailed bar.

The fine-adjustment is made by a lever which hangs down from a collar formed on the right-hand milled head of the coarse-adjustment.

The mechanical stage is also moved by chains in both directions.

The substage referred to is peculiar, and consists of two movable plates carried by a third plate which is fixed to a bracket that slides in the dove-tailed groove already mentioned.

The centring of the substage is effected by means of the two movable plates. The upper plate is pivoted on the lower, and the latter is pivoted on the fixed plate. The pivot of the upper plate is seen in the figure, to the right of the tube for receiving the condenser. The pivot of the lower plate is to the front of the tube, and is hidden by the upper plate. Motion is given to each plate by means of a pinion geared into a short rack cut in the edge of the plate near the corner. The pinion and milled head for moving the lower plate are seen in the figure, and the pinion for moving the upper plate is in a corresponding position on the other side. Owing to the positions of the pivots, the movements of the plates are at right angles to one another, so that the condenser can be adjusted to the axis of the instrument.

The mechanical stage is moved in both directions by chains passing round spindles.

There are two eye-pieces and two object-glasses, of 1 in. and $\frac{1}{4}$ in. focus.

This Microscope is described in Carpenter, 4th edition, 1864.

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

Portable Microscope. — This instrument (fig. 35) — presented by Dr. C. St. Aubyn-Farrer, May 18, 1904—though probably by Cary, is

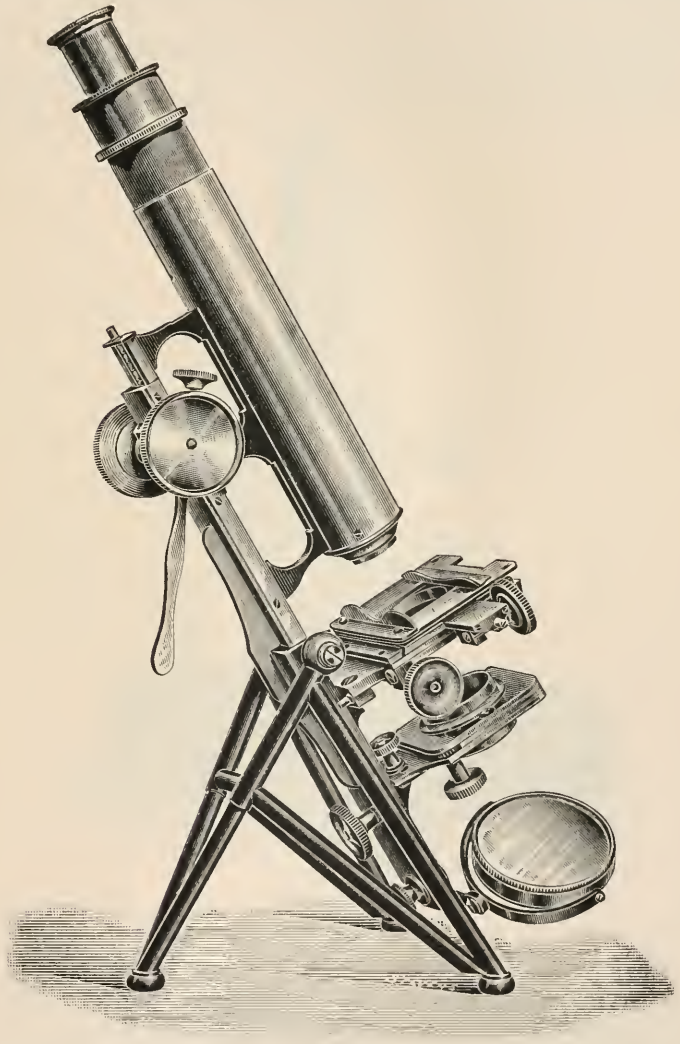

Fig. 34.

without the maker's name, and is similar to that made by Cary, after the design of C. Gould, about 1828.

This Microscope differs from the one in the Society's Collection

in having an eye-piece with two lenses only, instead of three, although the presence of a screw-thread seems to indicate that provision for this third lens had been made, which, however, is not essential for the production of a good image.

The spring-clip to the stage is fixed on the upper side, instead of the under side—a much better position.

The mirror is plane, and under $\frac{11}{16}$ in. in diameter (less in diameter

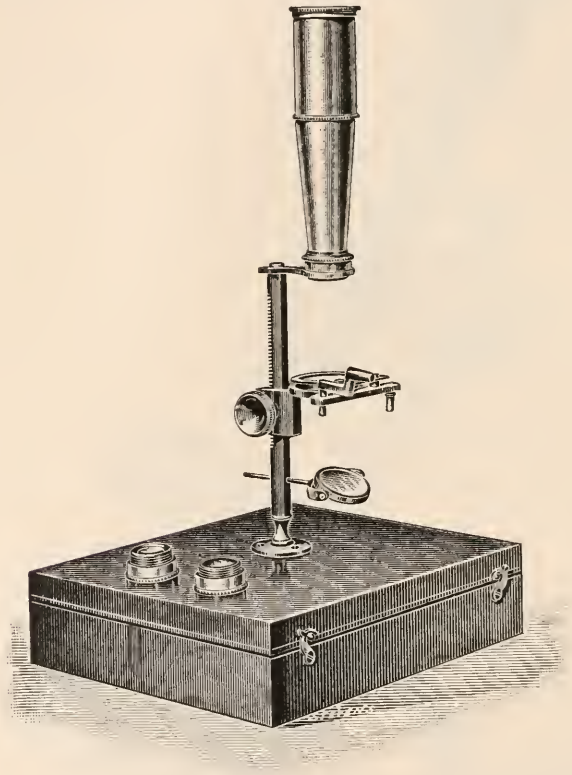

Fig. 35.

than a sixpence). It can be used for illuminating opaque objects by inserting the stem in the socket seen to the right-hand of the stage.

The object-glasses are three simple lenses, which may be used singly or in combination. By removing the body the instrument can be used as a simple Microscope.

Zeiss's New Laboratory Stand.*—This instrument (fig. 36) is intended for use in the laboratory, and for demonstration purposes. One

* Carl Zeiss's Special Catalogue, x. (1904).

of its chief features is an obvious and convenient handle, a most useful adjunct to an instrument intended for elementary microscopists who are prone to lift the stand by its fine-adjustment. The instrument is supplied with rack-and-pinion coarse-adjustment, and a micrometer movement fine adjustment. The fixed stage is circular, and of large dimensions ($4\frac{3}{8}$ inch diameter), but this may be easily removed and replaced by a rotating stage, provided with a scale of degrees whenever polarised light is required. The usual accessory substage fittings and

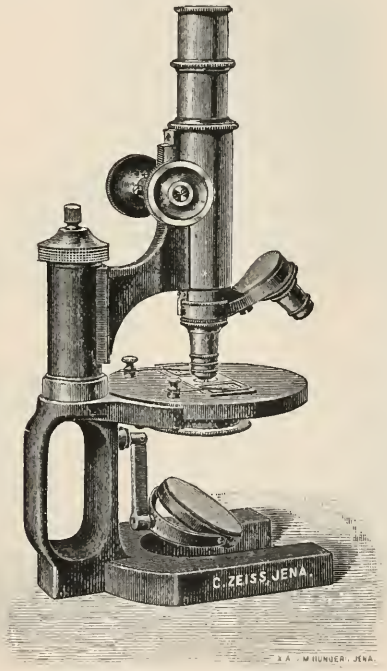

Fig. 36.

apparatus are supplied. Their addition adds somewhat to the cost, but materially increases the effectiveness of the instrument.

Reichert's New Large Stand, A 1, with Extra Wide Tube and New Lateral Micrometer-screw.* — In this instrument (fig. 37) the body-tube projects specially far over the stage, and permits of the examination of large plate preparations or Petri's dishes. The pillar can be used as a handle without danger of disturbing the fine-adjustment. The circular rotating stage can be centred by means of the screws *c c'*, which also provide a small lateral movement. Larger movements up to 100 mm. may be obtained by means of a new mechanical stage, which

* C. Reichert (Vienna), Catalogue No. 25 (Mikroscopie, 1904) pp. 14–15.

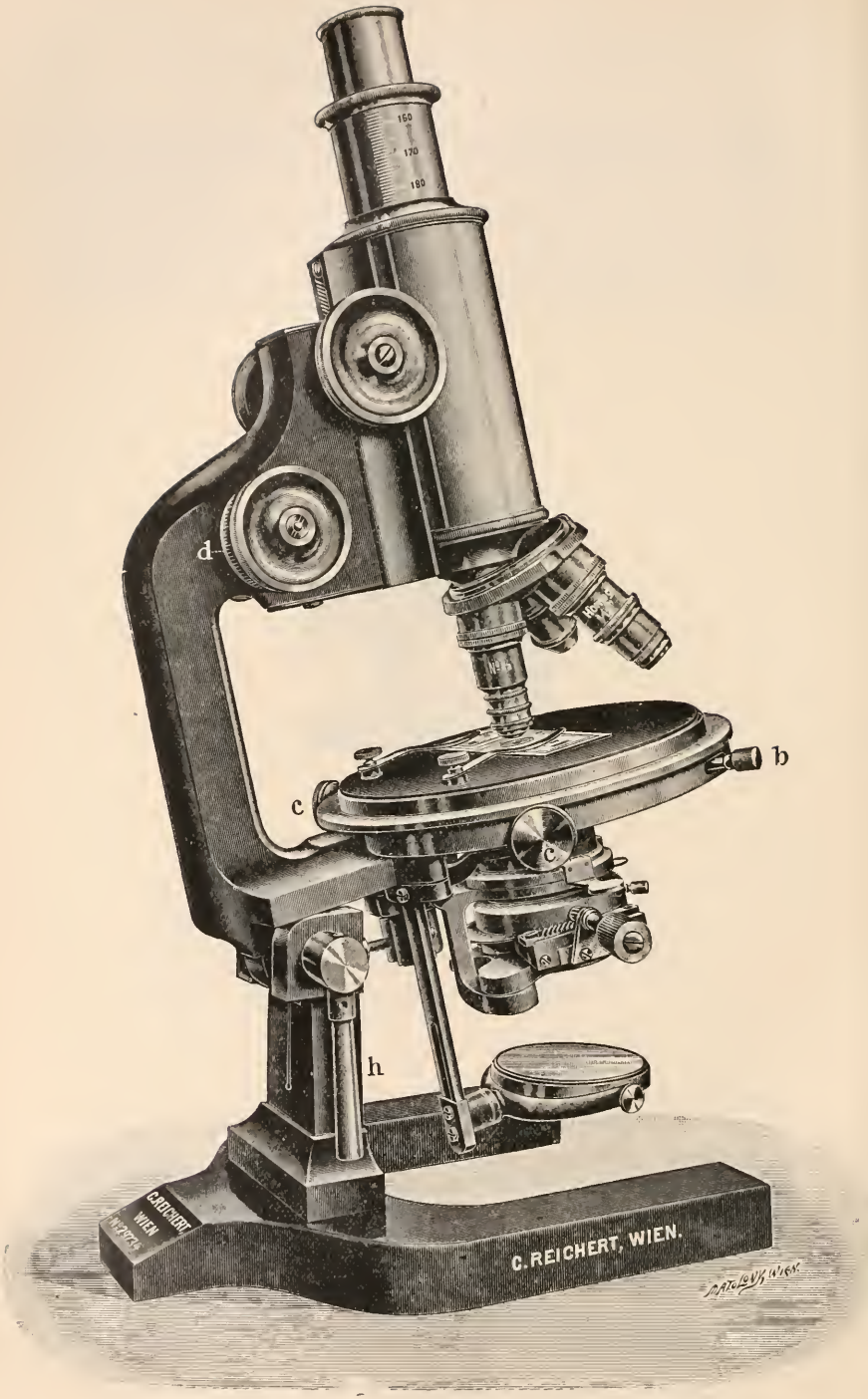

Fig. 37.

can be fitted above the rotating stage. The coarse-adjustment is by rack-and-pinion. The fine-adjustment (fig. 38) is by means of a new micrometer-screw, which operates thus: by turning the milled head *m* a spindle on which a worm is cut actuates a worm-wheel, by the rotation of which a roller is raised or lowered, and with it the tube. In this manner a fine-adjustment of the greatest delicacy is attained. The movement of the micrometer-screw is an endless one, which is a feature of considerable importance. Since the only downward pressure is that of a delicate spring and the slight weight of the aluminium tube, the resistance to the micrometer-screw is exceedingly small, and injury to the

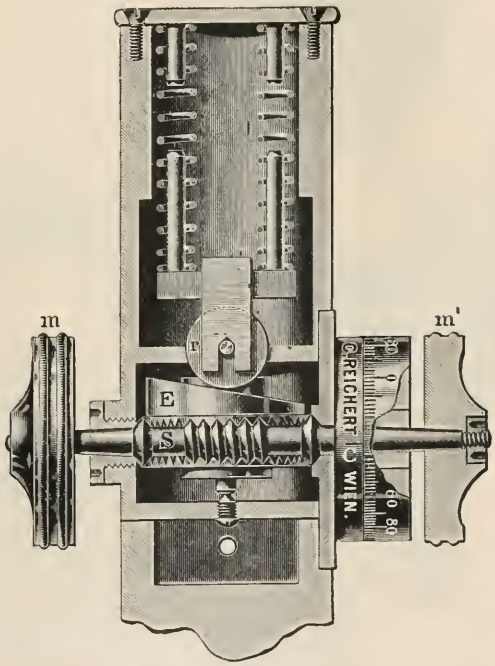

Fig. 38.

cover-glass is almost impossible, even should the objective come into contact with it. All bearing surfaces are of steel, and the entire mechanism is protected within the frame of the Microscope. The head of the micrometer-screw is so graduated that one division is equivalent to 0·001 mm. movement of the objective.

Reichert's Large Stand, No. 1 A, fitted with Tip-up Stage-Clips.* The movable object-stage of this instrument (fig. 39) was figured and described in the Journal for 1898 (p. 383, fig. 43), but attention was not called to the tip-up stage-clips, which are here seen in position.

* C. Reichert (Vienna), Catalogue No. 25 (Mikroskopie, 1904) pp. 17–18 (figs. 4, 4*a*).

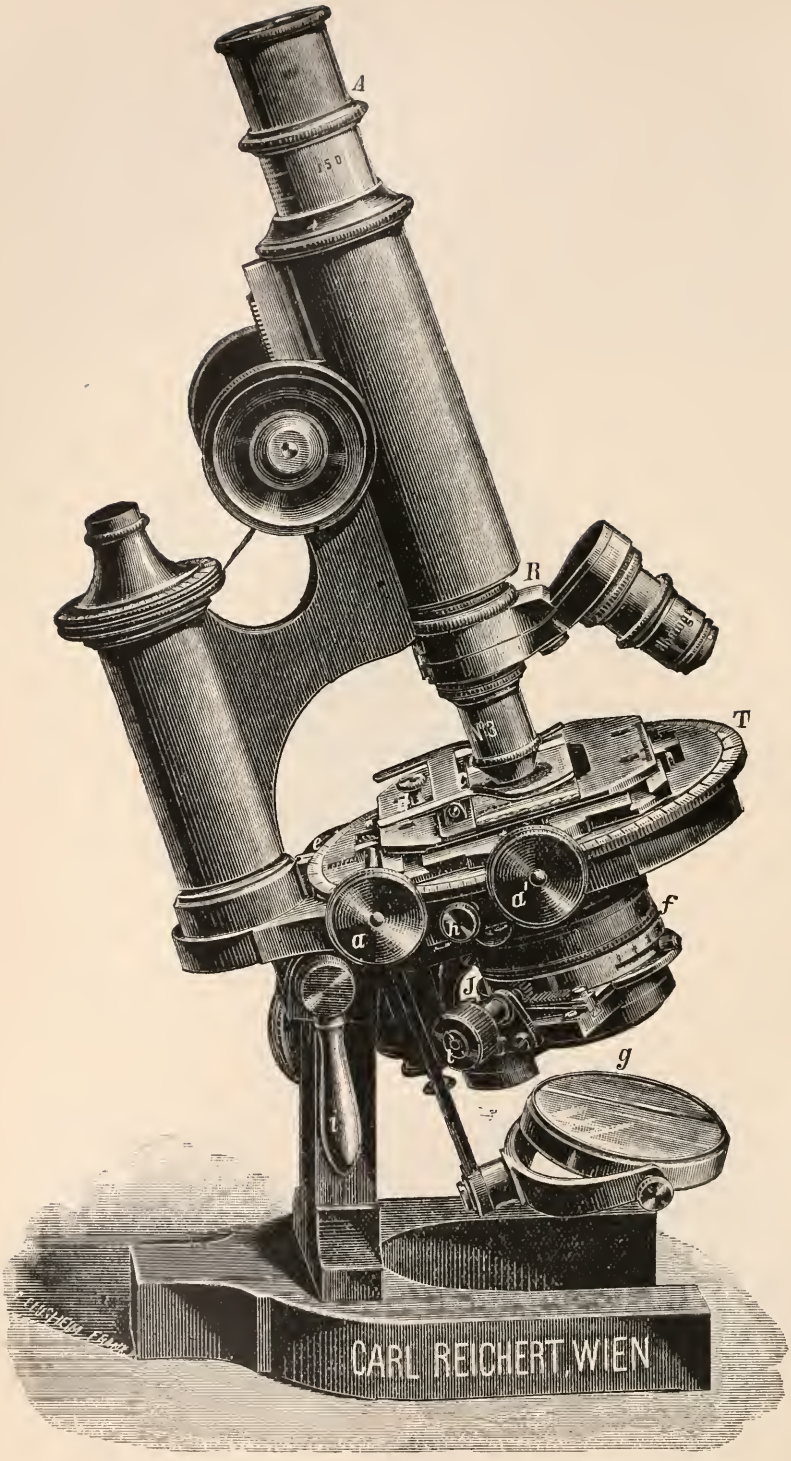

Fig. 39.

Reichert's New Mineralogical Stand.*—This instrument (fig. 40) is similar in size and adjustment to the last described model. The

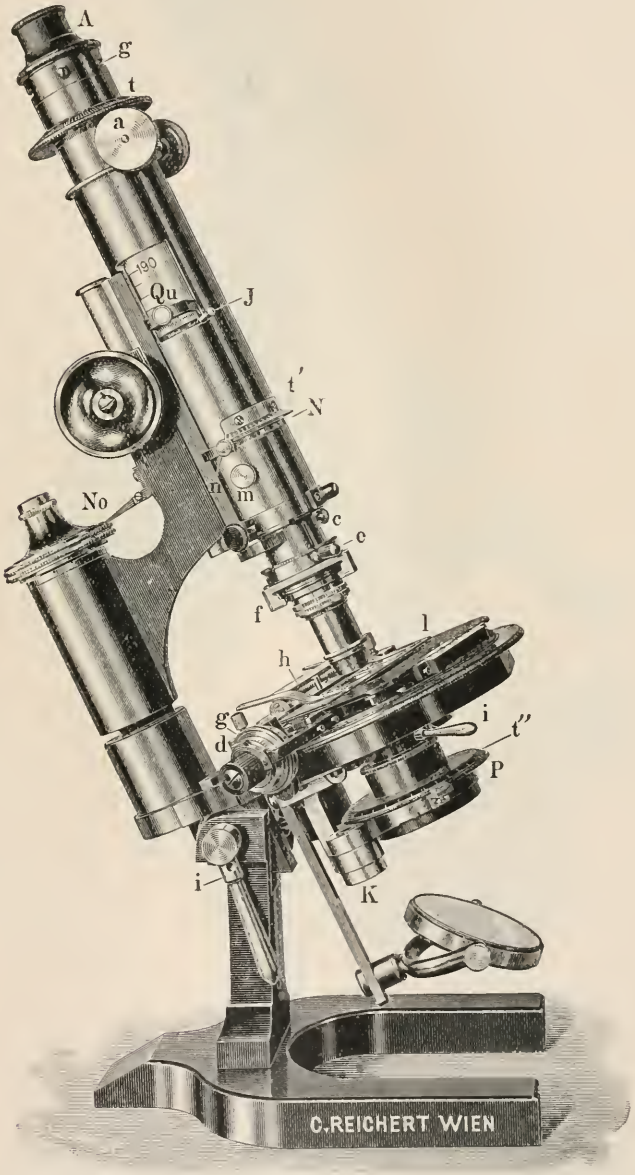

Fig. 40.

* C. Reichert (Vienna), Catalogue No. 25 (Mikroskopie, 1904) p. 30, fig. 16c.

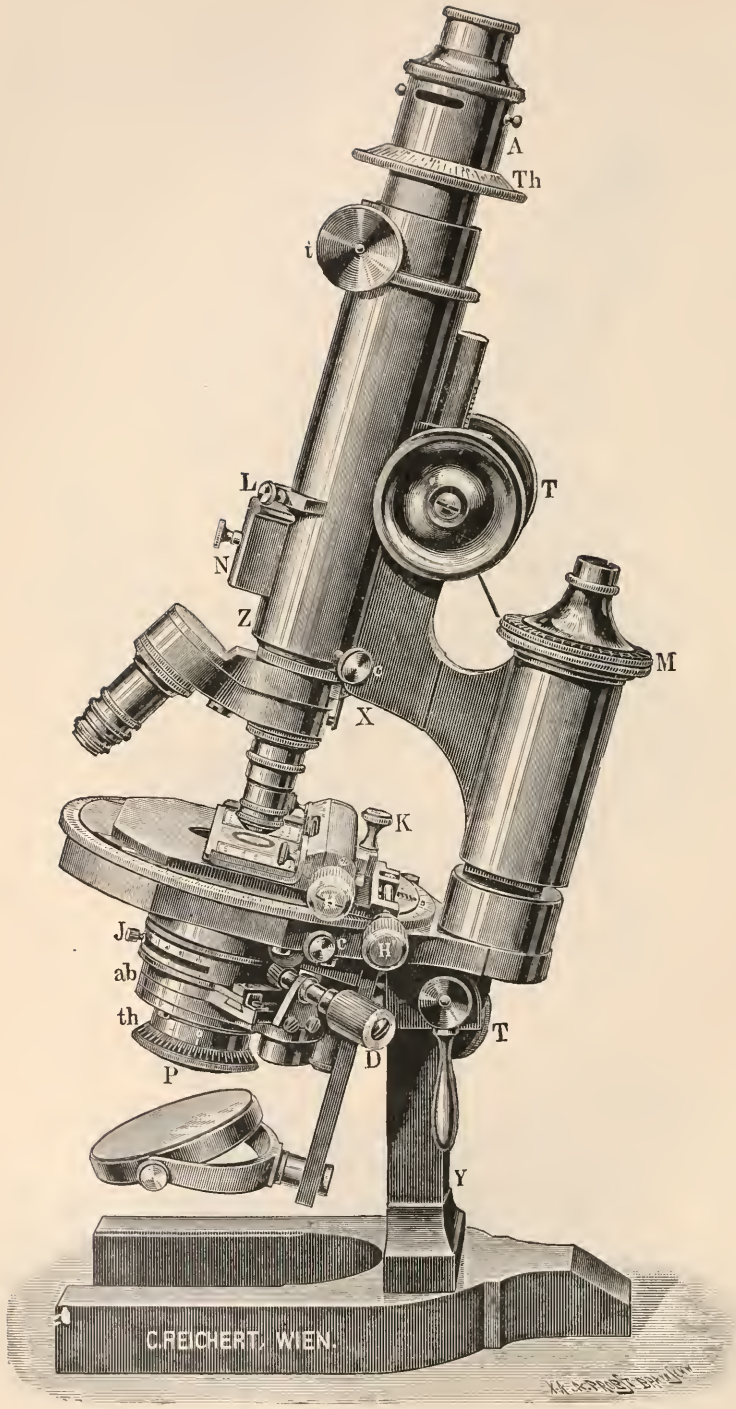

Fig. 41.

object stage is completely rotatory around the optic axis, and has also rectangular movements—one with slow micrometer adjustment, readable to 0·01 mm., the other with quicker movement, readable to 0·1 mm. The circular graduations are into 360° with a vernier. The rotatory object-stage, by lifting the fixing screws at its sides, can be removed and replaced by a vulcanite stage with a finding arrangement, and is likewise graduated into 360°. The micrometer-screw has a vernier; the third Nicol is rotatory for about 90° in a collar within the tube; there is a Bertrand condenser.

Reichert's Large Mineralogical Stand.*—This instrument, catalogued as No. 1 *b*, is shown in fig. 41, and is made with a rotatory object-stage, divided into 360°, and crossed by two millimetre scales at right angles for orientating known objects. The mirrors are hollow-plane, and adjustable at various heights. The coarse-adjustment is by rack-and-pinion, and the fine by a new delicate graduated micrometer-screw. Both polariser and cylinder-diaphragm have a vertical rack movement, and are fitted into a diaphragm-carrier of Abbe's complete illuminating apparatus, in order to afford a rapid change from polarised to unpolarised light. The analyser is placed above the ocular, and is fitted with a graduated circle divided into 360°. It has also an opening for the insertion of a quartz prism, and can be removed and replaced without disturbing the ocular. The polarising Nicol is easily rotatory, and the four quadrants of rotation are indicated by the clicking of a spring. The third Nicol, without any interference with the adjustment of the instrument, can be applied as an analyser immediately above the objective. The application of a pin ensures that the cross-threads, ocular, and the graduated circle are always in connexion. The screws *c c'* are for accurately centring the objective. Nicols with large field of view, or quartz plates, can be inserted at Z. A condenser facilitates the observation of axial images of mineral sections. By drawing out the lens L the rays through the objective can be changed from parallel to divergent pencils; the necessary draw-out adjustment of ocular is then performed by the rack *t*. The iris on the Abbe condenser receives the disks of calcite and mica.

Reichert's Microscope for Determining Hardness of Substances.† This instrument, which has been constructed from the designs of J. A. Brinell, is shown in fig. 42. The principle of the method depends upon measuring the area in square millimetres of the circular dent produced in a substance when a superposed steel sphere is subjected to a known pressure in kilograms. The ratio of pressure per square millimetre gives the "hardness number" of the substance. The general view of the instrument is given in fig. 42, and the chief parts are:—(1) T (fig. 43) the tube forming a special Microscope, with cross-threads, ocular and objective, working up to about 50-fold magnification; (2) M_1 the object-stage, acting also as foot of the whole, with a pillar carrying the rotatory upper parts; (3) a horizontal arrangement of parts—some fixed, some movable—serving for the lengthwise and diagonal movements of the tube; (4) a vernier for reading off the

* C. Reichert (Vienna), Catalogue No. 25 (Mikroskopie, 1904) pp. 28–9, fig. 16.
† Tom. cit., p. 36, fig. 17*e*; and Special Circular.

diameter of the circular dent. The milled screw-head S provides for the vertical adjustment of the tube ; S′ and S″ govern the backwards-and-forwards movement in the direction of its length ; S‴ controls the

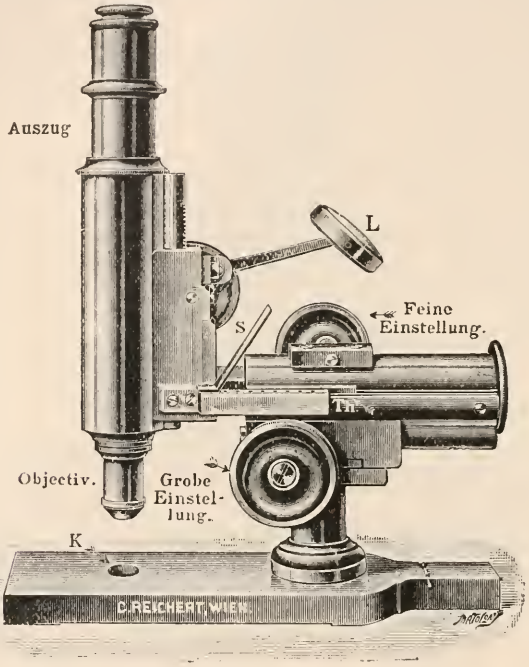

Fig. 42.

horizontal motion perpendicular to the last and moves the whole of the over-stage parts. In taking the measurements, the tube is first got upright, and the vernier by means of the screw S′ brought to the zero ;

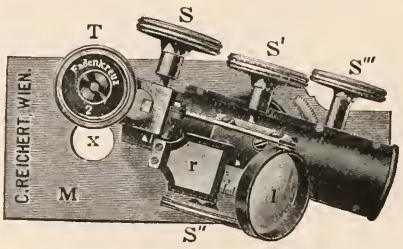

Fig. 43.

the dent to be examined is then applied to the object-stage, and the tube, by means of S″, moved so that one cross-thread is tangentially over the edge of the dent, thus $\overline{O}$. The tube is now moved sideways until the other thread (perpendicular to last) passes through the centre of the

dent. By means of S′ the tube (with the objective) is carefully moved over the dent until the first cross-thread reaches a similar tangential position on the opposite side. The reading of the vernier gives the diameter of the circular dent. A shade *r* and lens *l* are provided to facilitate reading the vernier. In the case of large objects the whole instrument is placed on the specimen so that the aperture X is over the dent.

(2) Eye-pieces and Objectives.

Reichert's Objectives with Bourguet's Spring Safety Action.*— C. Reichert has fitted this protective action to all his achromatic

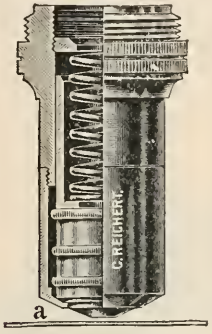

FIG. 44.

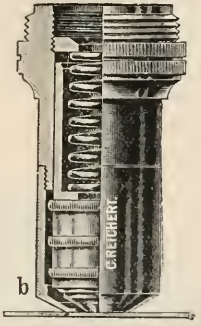

FIG. 45.

objectives numbered 6 and upwards. The arrangement is shown in figs. 44 and 45. Under ordinary circumstances the elasticity of the spring keeps the combination in proper adjustment, but if there should be contact with the object, the lens-holder is pushed within its sheath.

H.—**Construction of Aplanatic Combinations of Lenses with or without Achromatism. IV.** *English Mechanic*, lxxx. (1905) pp. 595–6.

(3) Illuminating and other Apparatus.

Reichert's Swing-out Condenser and Iris Diaphragm.† — The complete arrangement is shown in fig. 46. It will be seen that the con-

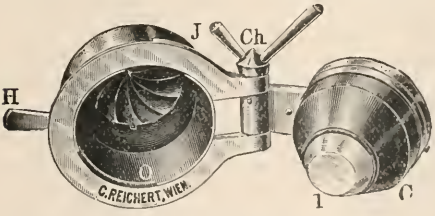

FIG. 46.

FIG. 47.

denser can be swung out of the iris by the action of the hinge *Ch*, which is operated by twisting the bifid lever. Fig. 47 shows the condenser in more detail.

* C. Reichert (Vienna), Catalogue No. 25 (Mikroskopie, 1904) p. 5.

Electric Warm-Stage, for Use with the Microscope, combined with a Nernst Lamp to Illuminate the Microscope.—H. C. Ross gives the following description of this apparatus (figs. 48 and 49) exhibited at the December Meeting.

"With the assistance of Engineer-Lieut. Fielder, R.N., I have invented an electric warm-stage, which has the following advantages:—(1) As it fits on top of the slide, it can be slipped on or off without altering the focus. (2) It can be used with the highest powers of the Microscope and with the Abbe condenser. (3) It does not interfere with the movements of the mechanical stage, the warm-stage moving backwards and forwards with the slide. (4) It requires no attention, for so long as the current is running through it, so long will the temperature of the centre of the slide be 37° C.

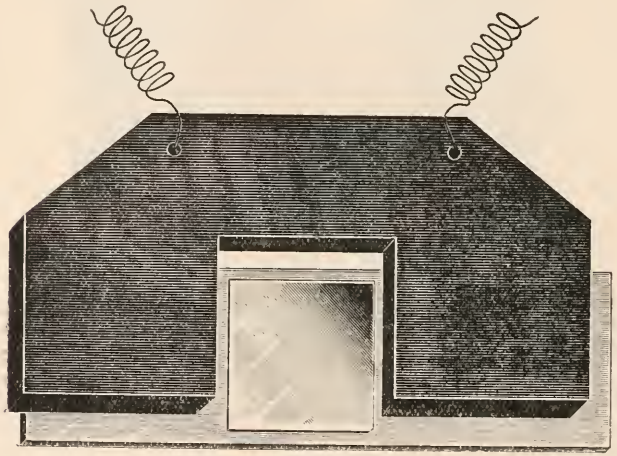

Fig. 48.

"The apparatus consists of a box of ebonite, about the same length as but a little wider than an ordinary slide, and it is three-eighths of an inch thick. There is a gap in the centre 1 in. square, to allow for the cover-slip and objective of the Microscope.

"Pressed into the ebonite box is a coil of wire, which offers a standard resistance to the electric current, and this again is covered in by a sheet of mica—the mica surface being in contact with the slide. Two wires connect the warm-stage with the main electric light circuit. Two brass clips are supplied with each apparatus, so that the warm-stage can be clipped on to the slide if desired.

"That the temperature of the centre of the slide can be maintained at 37° C., it is necessary that there should be a certain amount of resistance on one of the wires connecting the apparatus with the light circuit, which resistance varies according to the voltage. In the first apparatus I made,

* C. Reichert (Vienna), Catalogue No. 25 (Mikroskopie, 1904) pp. 12-13.

this took the form of a resistance coil, but it struck me that all the current passing through the coil was wasted, so it was replaced by a lamp, which could light the Microscope and also be the resistance for the warm-stage. For the suggestion that the lamp should be of the Nernst pattern, I am indebted to my brother, Professor Ronald Ross.

"The lamp fills another purpose besides illuminating the Microscope and regulating the amount of current to the warm-stage : it simplifies the question of a change of voltage. Suppose an instrument were procured for a current of 100 volts, and one wished to use it with a current of 230 volts, all that would be necessary would be to change parts of the lamp, and the apparatus is ready for use.

"The lamp is mounted on an oak base, and is supplied with two switches, one for the lamp and one for the warm-stage."

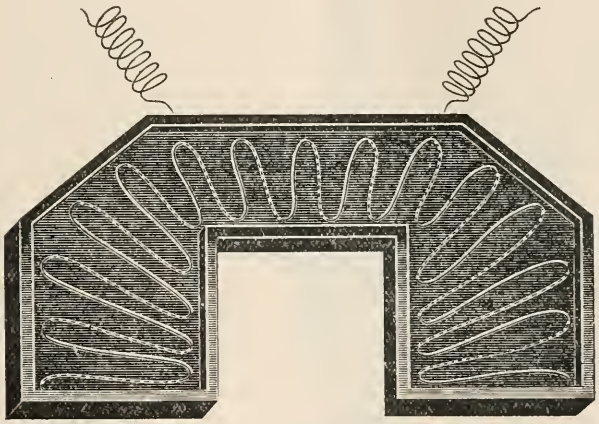

Fig. 49.

Improved Methods of Working with the Vertical Illuminator.* Method I.—With the image of a stop. Method II.—With the stop and the vertical illuminator.

The accessories necessary for Method I. are (1) source of light ; (2) carrier for stop ; (3) condenser ; (4) vertical illuminator. The condenser is first set between the light and the vertical illuminator, so that it forms an aërial image of the source of light at a distance from the vertical illuminator equal to that from the vertical illuminator to the top of the eye-piece. The carrier for the stop is then placed between the light and the condenser in such a position that its aërial image is exactly adjusted and falls sharply in focus at the back lens of the objective. This will give an effect precisely the same as placing a stop or diaphragm over the vertical illuminator itself, while the upward path of the rays from the object to the eye is unimpeded.

The accessories necessary for Method II. are (1) source of light ; (2) bull's-eye condenser ; (3) vertical illuminator with stop or diaphragm

* Knowledge, ii. (1905) p. 43.

fitted *to its side*. For this method, the lamp and bull's-eye are adjusted as in Method I., care being taken that proper distances are kept, when the same effect will be produced as with a stop or diaphragm placed immediately over the vertical illuminator.

C. Baker's Electric Lamp for the Microscope. — This illuminant consists of a Nernst electric lamp (fig. 50), mounted upon a heavy tripod stand, the feet of which are corked. It is capable of adjustment in a vertical direction, and there is also a tilting movement, to enable the lamp to be used at any angle required.

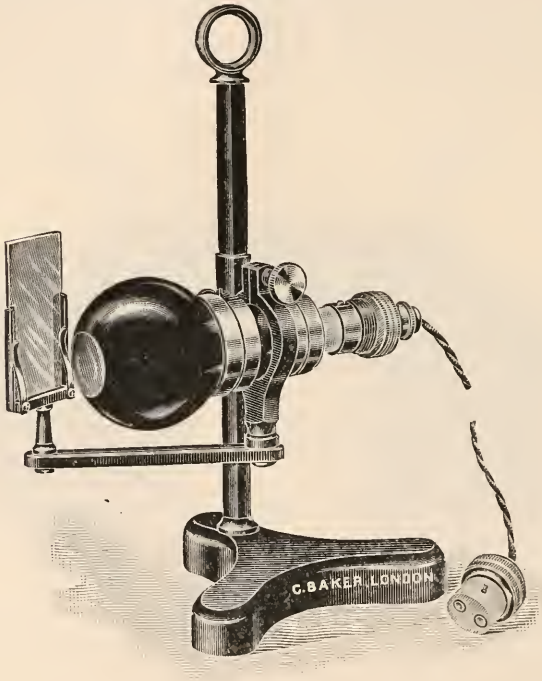

Fig. 50.

There are three parts to the Nernst lamp, namely, the lamp holder, containing an automatic cut-out; compensating resistance (a small glass bulb containing a fine spiral wire); and the filament itself, mounted on porcelain, and having an electric heater behind it.

These lamps are made for use on two currents, namely, 100 volts and 200 volts, and are provided with either plug or bayonet-joint connections.

The globe covering the luminous filament is blackened, leaving only a small aperture in front, through which the light passes.

Coloured and ground-glass screens, for modifying the light, are carried in front of the globe by means of a removable carrier.

(5) Microscopical Optics and Manipulation.

MILNE, J. R.—**New form of Spectrophotometer.**
[Paper describing the developed form of the instrument, the principle of which was indicated in a previous communication.]
Proc. Roy. Soc. Edinburgh, xxv. (1905) pp. 338–54.

„ „ **New form of Juxtapositor, to bring into accurate contact the edges of the two beams of light used in Spectrophotometry with an application to Polarimetry.**
Tom. cit., pp. 355–63 (3 figs.).

(6) Miscellaneous.

Linnæus and the Use of the Microscope. — Mr. Frank Crisp has kindly forwarded the following letter and extract for insertion in the Journal :—

Perhaps it might be worthy of a note in the Journal to call attention to the fact that Linnæus used a Microscope. I had never heard that he did, but at a Meeting of the Linnæan Society not long since the President, Professor S. H. Vines, F.R.S. D.Sc., mentioned the fact, and I asked him for the authority, which he has sent me as per enclosed manuscript.

Cuff's name has been spun out in the Latin. I should have thought that Cuffianus would have been sufficient. Possibly they thought his name was Cuffin.

Memorandum as to the Use of Microscope by Linnæus.

Amœnitates academicæ, vii., Dissertation cxlvi., Mundus Invisibilis (Roos, 1767), p. 399. Speaking of the Smut of Wheat (*Ustilago*) the author says :—

"Perhibet Auctor, pulvere hoc aquæ immisso et æstivo calore per aliquot dies exposito, vera ovis excludi animalcula. Experimentum hoc iteratum vidimus apud N. D. Præs (i.e. Linnæus) ubi microscopio Cuffiniano hæc (nudo alioquin oculo invisibilia) ad multas vidi myriades."

Translation.—The author asserts that when this powder has been mixed with water, and exposed for some days to summer heat, true animalcules are given off by the ova. We have seen this experiment repeated in the presence of our Mr. President, where, with a Cuffinian Microscope, I have seen them—i.e. the animalcules—(though they are invisible with the naked eye) in many myriads.—S. H. V.

Method of Constructing small Glass Tanks.*—T. G. Kingsford describes the following simple method of constructing glass tanks suitable for aquaria and for light filters.†

The construction is simple and within the range of the amateur mechanic. It consists of 2 glass disks for the sides, a band of thin

* Journ. Quekett Micr. Club, ix. (1904) pp. 117–20 (2 figs.).
† See this Journal, 1904, pp. 383 and 479.

sheet metal (A, figs. 51 and 52) lined with rubber B, and a metal clip or small bolt C, to draw the ends of the band toward each other. In order

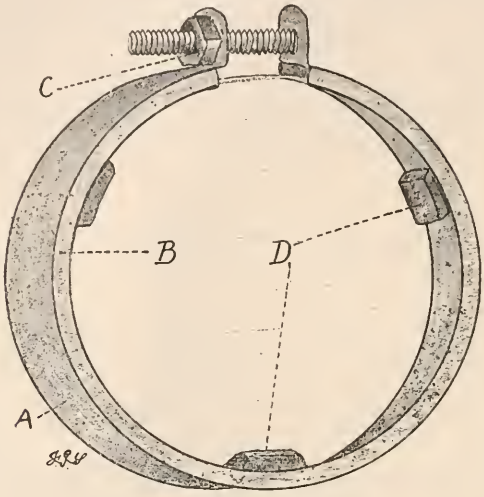

FIG. 51.

to leave an opening for the introduction of fluid the ends of the band do not quite meet. Short strips of rubber, D, are solutioned on to the rubber lining. These serve to keep the glass sides the desired distance

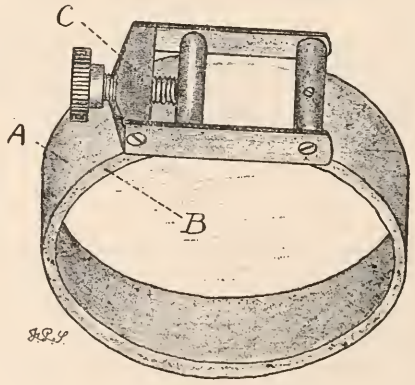

FIG. 52.

apart. Fig. 51 shows a tank ready for use, and intended to be attached to an ordinary bull's-eye condenser stand. The glass sides recommended are bevel-edged clock glasses, obtainable in sizes from

about $\frac{3}{4}$ in. to about 8 in. in diameter. The metal band should not be too stiff.

The form of the tightening clip will depend on the use to which the tank is to be put. If a clear opening be not necessary, the ends of the band are turned up at right-angles, and a small bolt passed through them (fig. 51), but if a clear opening be desired, the form shown in fig. 52 should be used.

Rock Crystal.*—F. J. Cheshire describes the geological conditions of the places where rock crystal, the brazilian pebble of the optician, is obtained, and gives an account of its crystalline nature. In connection therewith, he points out that for high-power spectacle lenses the crystal should be axis-cut, so that the effect of the double refraction of the crystal is minimised as far as possible.

Photogrammetric Focimetry.†—V. Legros treats this subject in a series of articles whose nature may be gathered from his following divisions of the subject :—

Part I. Chap. 1. Principles of the method.
„ 2. Errors of the method.
„ 3. Determination of the nodal points.
„ 4. Curvature of field.
„ 5. Astigmatism.
„ 6. Anomalies of focal length.
„ 7. Definition, focal length, focal volume, luminosity.
„ 8. Chemical focus.
Part II. Chap. 1. Relations of microbiology and of military technology.
„ 2. Improvised microscopic focimetry.
„ 3. Photogrammetric focimeter for microscopical optics.
„ 4. Conclusions.

A New Spherometer.‡—This instrument for measuring the curvature of lenses is described by C. V. Raper. The material for the framework was made of Dr. Guilleaume's "Invar." In figs. 53 and 54 a sectional elevation and plan are given, and it will be seen that the instrument consists essentially of a tripod frame, and a very fine worm and worm-wheel. The frame is built up of the invar rod-stays B and B_1 attached to the top-centre A_1. The two B stays have the conical-pointed feet F affixed at their lower extremities, as plainly shown by the elevation. The B_1 stay, however, lying in the same vertical plane as the horizontal lifting-bar H, is affixed thereto, and the B stays are similarly attached to other horizontal stays H_2 (fig. 55). The horizontal lifting-bars are screwed into the lower centre-piece A_1, both these (top and bottom) centre-pieces being of invar. The invar tube C forming the vertical strut, and also the bearing and nut for the worm-wheel spindle, is a drive-fit into both centre-pieces, and is further secured in the lower centre-piece A by the screwed ends of the two horizontal lifting-

* Revue des Sciences Photographiques (Paris, 1904), Nos. 1–8, about 72 pp., 3 figs.
† Brit. Optical Journ., 1904, pp. 202, 221, 239, 262 (20 figs.).
‡ English Mechanic, lxxx. (1904) pp. 358–60 (4 figs.).

bars H and H_1 penetrating it. The spring pressing on the top of C, the compression of which can be regulated by the knurled brass nut D, is to keep the screwed part of the centre spindle up into the nut,

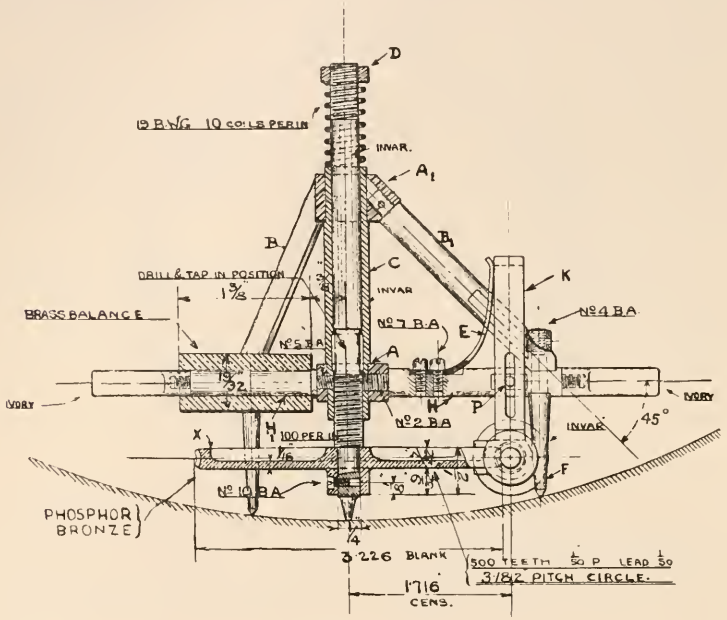

FIG. 53.

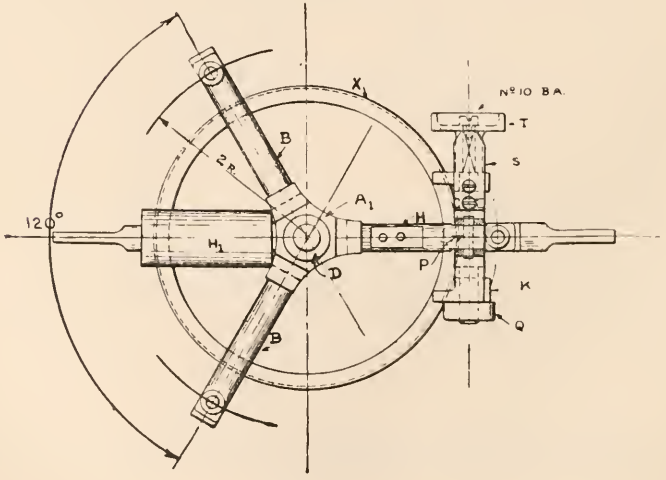

FIG. 54.

thus avoiding any back-lash. The worm-wheel is carried in the invar frame K, pivoting on pin P, which frame is fitted with a slot to accommodate the rise and fall of the worm-wheel, so that worm, wheel and frame can move together. The worm or tangent-wheel W, as shown in the end elevation (fig. 55), is turned solid with its shaft, and is rotated by means of the aluminium thumb-screw T, which is screwed to the worm-wheel shaft, as shown at fig. 55. The invar worm-wheel is kept in gear with the phosphor bronze worm by means of the constant pressure of the tuning-fork-shaped spring E, which spring is screwed to the horizontal lifting-bar H by a couple of screws, as shown by the elevation at fig. 53. The worm-wheel X is driven fast on the centre spindle,

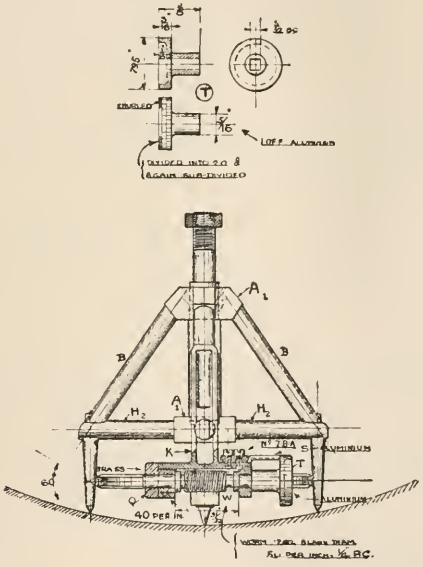

Fig. 55.

and further secured by the No. 10 B.A. screw (fig. 53). The lifting-bar H_1 is fitted with a balance weight, and both lifting-bars have ivory tips. The balance-weight was carefully reduced from an excess until exact balance was obtained, this being highly necessary; balance in the other direction being similarly attained by the bearing Q (fig. 54). The pointed ends of the conical feet F have the sharpness removed sufficiently to prevent them scratching the lens. The vertical spindle is screwed 100 to the inch, the worm-wheel has 500 teeth, one-fiftieth inch pitch, and the worm has 50 threads per inch; thus for one revolution of the worm the vertical spindle, together with the worm-wheel, is raised or lowered one fifty-thousandth of an inch, or one-millionth of an inch for one-twentieth of a revolution of the worm-arbor. It was found that the error of this spherometer was

about one three-millionth of an inch, and as, of course, one five-millionth would make a difference of one-fiftieth of an inch in the focal length of lenses of certain curvature, this error, though mechanically small, is optically considerable. At the same time, the author is doubtful whether a spherometer of greater accuracy could be constructed, and even in that event he thinks the personal and temperature errors would probably nullify the advantage.

F.R.M.S.—Visibility of Minute Flagella.
English Mechanic, lxxx. (1905) p. 527 (4 figs.).

Zeiss, C.—Stereoscopy: Pulfrich Stereo-Comparators.
[A catalogue by the Jena firm of this valuable instrument, which is especially applicable to the purposes of Stellar Astronomy, Metronomy, Observations of Sun and Moon, Meteorology, Geology, Topography, Photogrammetry, etc.]
Jena, 1903, 16 pp.

The following reprints of pamphlets by C. Pulfrich bearing on the Stereo-Comparator have been also published by Julius Springer, Berlin; they are extracts from the "Zeitschrift für Instrumentenkunde":—

1. **Ueber einige stereoskopische Versuche.**
August 1901, pp. 221–4 (1 fig.).
2. **Ueber eine Prüfungstafel für stereoskopisches Sehen.**
September 1901, pp. 249–60 (1 fig. and 1 pl.).
3. **Ueber neuere Anwendungen der Stereoskopie und über einen hierfür bestimmten Stereo-Komparator.**
March, 1902, pp. 65–81; May, 1902, pp. 133–41; June 1902, pp. 178–92 (15 figs.).
4. **Neue stereoskopische Methoden und Apparate für die Zwecke der Astronomie, Topographie und Metronomie. Part I.**
[This is practically a collection of all the previous articles.]
J. Springer (Berlin, 1903) 69 pp., 27 figs.
5. **Ueber einen Versuch zur praktischen Erprobung der Stereo-Photogrammetrie für die Zwecke der Topographie.**
November 1903, pp. 317–34 (2 figs.).
6. **Ueber die Anwerdung des Stereo-Komparators für die Zwecke der topographischen Punkbestimmung.** February 1904, 4 pp.

Other reprints, also obtainable through C. Zeiss, on Stereoscopy, are:—

1. C. Pulfrich—**Ueber die bis jetzt mit dem Stereo-Komparator auf astronomischen Gebiete erhaltenen Versuchsergebnisse.**
Reprinted from *V. J. S. der Astron. Gesell. Jahr.* 37, 9 pp., with a stereogram of the moon.
2. Von Hübl, A. F.—**Die Stereophotogrammetrie.**
Reprinted from *Mitt. des K. u. K. Militärgeogr. Inst.*, Band xxii., 16 pp.
3. „ „ **Die Stereophotogrammetrische Terrainaufnahme.**
Op. cit., Band xxiii, 30 pp., 6 figs., and a stereogram of a mountain landscape.

B. Technique.*

(1) Collecting Objects, including Culture Processes.

Cultivation of Tubercle Bacilli from Bacterial Mixtures.†—A. Dworetzky shortly describes Spengler's formalin method for the pure cultivation of tubercle bacilli from bacterial mixtures, and gives details of numerous attempts made by him to obtain pure cultures of the tubercle bacillus from various sources, in every instance without success. After varying the strength of the formalin used, and the time of exposure of the mixtures, he concludes that tubercle bacilli are destroyed with as equal readiness as the other bacteria.

New Levelling Apparatus.‡—This apparatus, devised by S. Serkowski, consists of a thick three- or four-cornered glass or porcelain plate, to which are attached three or four screw feet. After levelling, it may be used for plates or dishes with fluid media; for drying cover-glass preparations, where it is necessary to have thin and even films, also for the observation of fluid preparations, such as urine sediments, the entire microscope being placed on the levelled plate; a microscope, covered by a bell jar, can be more thoroughly protected from dust if kept on this apparatus. If one half is coloured black, and under the other half is pasted a line-ruled white card, like a Wolffhugel's apparatus, it will serve to count the colonies on a plate.

Simplification of the Drigalski Medium.§—In preparing this medium, Hagemann recommends the addition of milk in the place of nutrose and milk-sugar. He obtains the same good results as with the Drigalski-agar, and the preparation is considerably simplified. He stores the milk-agar in quantities of 200 c.cm., and adds alkali, litmus and crystal-violet to the medium immediately before using it. He recommends a 2 p.c. instead of a 3 p.c. agar, since it is more readily filtered.

Differentiation of Streptococci.‖—M. H. Gordon finds that different varieties of streptococci behave in different ways with regard to acid production when grown in litmus broths containing saccharose, lactose, raffinose, inulin, salicin, and mannite; he considers, therefore, that these substances may be of service in differentiating the varieties of these organisms.

Anaerobic Cultures with Phosphorus.¶—A. W. Sellards finds phosphorus a very convenient oxygen-absorbing agent as compared with alkaline pyrogallate. Neither the oxides of phosphorus formed, nor 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, &c.; (6) Miscellaneous.

† Centralbl. Bakt., 1te Abt. Orig., xxxvii. (1904) pp. 628–31.

‡ Tom. cit., pp. 637–40 (1 fig.).

§ Op. cit., 1te Abt. Ref., xxxv. (1905) p. 794.

‖ Centralbl. Bakt., 1te Abt. Orig., xxxvii. (1904) p. 728.

¶ Tom. cit., pp. 632–7.

vapours of the original phosphorus, affect the nutrient properties or the reaction of the media employed. For hanging drop cultures, special cells were devised to protect the media from the vapours of phosphorus and from its oxides. Test tube cultures were made by substituting a few small pieces of phosphorus for the pyrogallic acid of a Buchner's apparatus. On addition of the potassium hydroxide solution, phosphoric pentoxide is formed, which at once takes up water to form phosphoric acid, which descends as a white cloud; in a few hours the main portion of the oxygen is absorbed, but complete absorption does not result until after 24 hours at the temperature of the incubator.

Spores of *B. tetani*, in 1 p.c. glucose broth, germinated overnight at 37·5° C., and went into spore-formation in 48 hours; stab cultures of this organism grew equally well at the surface and in the depth of the stab; growth was more rapid than by Buchner's method.

Aspergillus niger, a strict aerobe, refused to grow; *Penicillium glaucum* also refused to grow, and still showed no growth on subsequent exposure to air, the spores being destroyed by the absence of oxygen.

B. pyocyaneus and *B. megatherium*, facultative anaerobes, showed no growth within 24 hours; *B. coli communis* and *B. typhosus* at 37·5° C., in glucose broth, showed abundant growth within 24 hours, the colonies of *B. coli* being thin and transparent, those of *B. typhosus* being denser.

Details are given for modifying the method when applied to plate cultures, or for numbers of tube cultures and Smith's fermentation tubes.

In glucose gelatin stabs *B. graveolus*, *B. pyocyaneus*, *B. megatherium*, *B. anthracis*, *Staphylococcus pyogenes aureus*, *Sarcina lutea*, and *Proteus vulgaris* grew feebly, and produced neither liquefaction nor pigment, but on being exposed to the air they regained their vigour and properties of liquefying and producing pigment. The inversion of cane-sugar bouillon inoculated with yeast and also with a mixed culture of inverting forms, was prevented by keeping the cultures in anaerobic conditions. The oxygen was so completely absorbed by the phosphorus that uninoculated media, stained with litmus or methylen-blue, were decolorised within 24 hours.

Cultivation of the Amœbæ of Tropical Dysentery.*—A. Lesage succeeded in cultivating amœbæ from intestinal mucus in the following way: Mucus was taken from, say, 10 places and transferred to as many Petri's capsules. Only capsules which contained living amœbæ were retained, the others being rejected. The living amœbæ were then cultivated in flat glass vials or in test tubes, the medium being agar, which had been washed for 8 days and afterwards sterilised.

The cultivation temperature was from 18° to 25°. The essential feature of the method was to prevent the amœbæ being overgrown by bacteria.

In a few days, small amœbæ could be found. Cultivations were also made on plates on which a paracolon bacillus was growing. In this way living amœbæ could be passed from the human intestine on to a plate without going through the encysted stage.

Another method consisted in cultivating amœbæ from the encysted forms. Some mucus containing living amœbæ was placed in a glass

* Ann. Inst. Pasteur, xviii. (1905) pp. 9-16 (2 pls.).

vessel and a little sterilised water added. The mucus was allowed to dry slowly at from 18–25°. After a few days the dried mucus and water were sown on plates of washed agar. About 1 plate in 10 gave a successful culture. Each of these served as a starting point for obtaining the pure mixed culture by progressively eliminating the bacteria.

Each time the amœba was sown at the bottom of the tube, and the symbiotic bacterium at the top. The plate was kept at 25°. After a few days the amœba reached the upper part, and from here the amœbæ were taken for the next culture.

Cultivating the Bacillus of Leprosy.* — E. R. Rost cultivates *Bacillus leprœ* and also other acid-fast bacilli on media from which chlorine has been removed. The medium is made by distilling beef extract, or by passing a current of superheated steam from the autoclave over boiling beef extract, or by passing superheated steam over the beef extract soaked in pumice stone in bottles inside the autoclave.

By the last procedure a growth of *B. tuberculosis* is obtained in from 1–3 days, of *B. leprœ* in from 3–5 days. The characteristic appearance is a curly white, stringy, heavy deposit at the bottom of the tubes, which is hard to shake up, but, when shaken up, appears as a curly white stringy shred in the tubes.

A satisfactory solid medium is obtained by dialysing nutrient agar in frequently changed warm distilled agar; by this means the sodium chloride is disposed of, and on the surface of the medium the acid-fast group of bacteria grow with greatest ease. The bacillus of leprosy grows at first as a white and later as a yellow, or brick-red, curly thick growth, very much like the bacillus of tubercle on the glycerinised nutrient agar.

The author then calls attention to the staining reactions of *B. leprœ*, and states that it may be differentially diagnosed from other acid-fast bacteria as follows: (1) It retains the stain of acid dyes much more than any of the other bacteria of this class. It retains the stain of carbol-fuchsin even after decolorisation in 25 p.c. nitric acid. (2) It is more irregular than the tubercle bacillus, and not curved, and is somewhat smaller. (3) It contains small oval spores within itself, which are highly refractile, and the end of the bacillus may be open where some have presumably escaped. (4) It has a beady appearance, due to the presence of these oval spores. (5) Like the *B. tuberculosis*, it may grow out into cultures into long, branching filaments, but there are often oval spores separate in the cultures, and these may be alone visible at times. (6) In the body it is found in great numbers inside epithelial cells, generally in the middle of the cells, whereas the *B. tuberculosis* is found in small numbers inside giant cells at the polar ends.

In order to obtain pure cultures from a given case, a tube of the medium is inoculated with a piece of leprous tissue, and incubated at 100° F. In from 3–5 days the thick deposit is examined. It is usually found to contain the bacilli of leprosy and other organisms. The tube is then placed in a warm Petri dish of the dialysed medium. In from 3–5 days colonies of *B. leprœ* may be picked out in the usual way.

Then follows the method of making the toxin, or leprolin.

* Brit. Med. Journ., 1905, i. pp. 294–6.

(2) Preparing Objects.

Preparing Suprarenal Bodies of Guinea-Pigs.* — F. Fuhrmann, who studied the finer structure of the suprarenal bodies of guinea-pigs, found that the best fixatives were Zenker's fluid, Müller's fluid, and formalin in proportion of 9–1 ; 4 p.c. formalin and saturated sublimate solution in 0·75 p.c. salt solution. For cell examination Hermann's platinum-chloride-osmic-acetic acid mixture, or Flemming's chrom-osmium-acetic acid mixture, gave excellent results, provided the glands were cut up into slices of about 2 mm. thick. After fixation, the pieces were washed in running water, and then hardened in alcohol. Paraffin and celloidin sections were made. For the latter, solutions of celloidin dissolved in methyl-alcohol were used, and the pieces were transferred from ethyl-alcohol to the thinnest, and afterwards passed through the thicker sections. The celloidin was hardened in 65 p.c. alcohol, and was ready for cutting in about an hour. The sections were cleared with origanum oil. One great advantage over the ether-alcohol method is that the fat is much less dissolved out.

The sections were stained by Benda's method—i. e. they were first mordanted with sulphate of iron, and then treated with 1 p.c. aqueous hæmatoxylin solution. They were afterwards differentiated in the freely diluted mordant, or by van Gieson's method. Alizarin I., diluted with 5 parts of water, and with the addition of a few drops of calcium acetate, is also recommended. In this solution the sections remain for 24 hours at incubation temperature. Several other ordinary staining methods gave good results.

Bayon—**Demonstration von Präparaten der normalen und pathologischen Schilddrüse.**

[Contains some remarks on the action of fixatives on the colloid substance of the thyroid gland, and on the nature of the vacuoles.]

SB. Phys.-Med. Gesellsch. Würzburg, 1904, pp. 97–102.

Zilliacus, W.—**Die Ausbreitung der verschiedenen Epithelarten im menschlichen Kehlkopfe und eine neue Methode dieselbe festzustellen.**

[Gives method for differentiating the different kinds of epithelial cells in human larynx.] *Anat. Anzeig.*, xxvi. (1905) pp. 25–30.

(3) Cutting, including Imbedding and Microtomes.

Celloidin Method for Hard Plant Tissues.† — A. B. Plowman describes the following celloidin method which was developed and perfected by E. C. Jeffrey. Wood should be cut up into cubic blocks, not more than 1 c.cm., and in such a way that the faces represent the desired plane of section. If dry, the material must be repeatedly boiled to remove the air ; the vacuum pump should also be used. Living tissue should be killed and fixed by immersion in the following mixture :— Saturated solution of sublimate in 30 p.c. alcohol, 3 parts ; saturated solution of picric acid in 30 p.c. alcohol, 1 part. After 24 hours the fixed blocks are passed through 40, 50, 60, 70, 80 p.c. alcohol, the stay

* Zeitschr. wiss. Zool., lxxviii. (1905) pp. 552–60 (2 pls.).

† Bot. Gazette, xxxvii. (1904) pp. 456–61.

in each being 24 hours, and the 80 p.c. having enough iodine solution to make it a deep brown colour.

The next step is to remove silica or other mineral constituents by immersing the blocks in 10 p.c. hydrofluoric acid for 3 or 4 days, the acid being changed once or twice. This is followed by washing in running water for 2 to 4 hours.

The next step is to dehydrate thoroughly in graded alcohols in the usual way, and remove any residual air with the vacuum pump.

The material is now ready for impregnation with celloidin, which is dissolved in ether and synthol or ether and absolute alcohol. Ten grades from 2 to 20 p.c. celloidin are to be used. The blocks are placed in a bottle, which can be firmly and tightly stoppered, covered with 2 p.c. celloidin solution, and the bottle incubated for 12–18 hours at from 50°–60° C. On removal the bottle is quickly cooled in cold water, after which the 2 p.c. is replaced by the 4 p.c. solution, and so on till the thickest grade is reached. On removal from the last, the celloidinised block is placed in chloroform for 12 hours, and then transferred to a mixture of equal parts of glycerin and 95 p.c. alcohol.

Sections are best made with a sliding microtome; for histological examination a thickness of 10 μ is sufficient, but for photomicrographic purposes they should be as thin as 5 μ or less.

For staining and mounting it is usually advisable to remove the celloidin at this stage by placing the sections for 10 or 15 minutes in ether, and afterwards in 95 p.c. alcohol. The most useful stain is hæmatoxylin, followed by safranin. After staining, the sections are treated in the usual way, and mounted in balsam. It is advisable to clear the sections in the same kind of liquid as is used for dissolving the balsam. For photographic purposes the best stain is Heidenhain's iron-hæmatoxylin. The sections should be repeatedly washed in distilled water after the iron-alum and before they are placed in hæmatoxylin.

In some cases it is necessary to retain the celloidin matrix; the sections should then be dehydrated in a mixture of alcohol and chloroform.

In order to make serial mounts, the sections are cut on the following mixture:—Alcohol 90 p.c., 85 parts; glycerin 15 parts. As the sections are cut, they are arranged on strips of thin smooth paper, and when the alcohol has evaporated the strips are turned face downwards on slides coated with albumen fixative. Several layers of paper are piled on, and the whole pressed down with a squeegee roller covered with another slide. The lot is then clamped together and placed in an incubator to dry for not more than 12 hours. When removed, the paper is stripped off, and the slide with adhering section is treated in the usual way.

Preparing and Staining the Eggs of Haminea Solitaria.* — A. M. Smallwood fixed the eggs with Kleinenberg's picrosulphuric and Conklin's picro-acetic mixtures. In order to facilitate penetration of the fixative, the capsules were torn through with wooden needles. The eggs were left in the fixative for 1 hour, and then transferred to 70 p.c. alcohol, which was changed until the colour due to picric acid was removed.

For staining, Heidenhain's iron-hæmatoxylin was used, followed by

* Bull. Museum Comp. Zool. Harvard. xlv. (1904) pp. 261–318 (13 pls.).

an aqueous solution of Bordeaux red. This procedure was the best, except for fertilisation stages.

In order to differentiate the sperm within the egg from the deutoplasm, the eggs were stained with Delafield's hæmatoxylin, and differentiated with a weak solution of picric acid in 90 p.c. alcohol. This makes the deutoplasm reddish yellow, but leaves the sperm black.

Later experience found that Brazilin was superior to iron-hæmatoxylin. After sectioning, the eggs were mordanted in a solution of iron in 70 p.c. alcohol for 30 to 60 minutes, and then stained for 30 minutes to 2 hours in a ½ p.c. solution of Brazilin in 70 p.c. alcohol. The Brazilin gives a double stain, nucleoplasm staining intensely black, and cytoplasm a Bordeaux red hue. It has the further advantage of being a shorter process, and that it rarely overstains.

Demonstrating Enzyme-secreting Cells.* — H. S. Reed, for his study of the enzyme-secreting cells in the seedlings of *Zea Mays* and *Phœnix dactylifera*, used the following killing fluids:—(1) Saturated solution of picric acid in 50 p.c. alcohol; (2) Aqueous picro-corrosive fluid. This was made by adding 1 vol. of saturated aqueous solution of mercuric bichloride to 3 vols. of saturated aqueous solution of picric acid. After lying 12–18 hours in this fluid, the material was washed in water and dehydrated in alcohol; (3) Kleinenberg's picro-sulphuric acid; (4) Chrom-osmo-acetic acid;† (5) Iridium chloride in acetic acid (1 p.c. aqueous solution of iridium chloride, 25 c.cm.; glacial acetic acid, 75 c.cm.); (6) Worcester's killing fluid (saturated aqueous solution mercury bi-chloride, 96 parts; formalin, 4 parts; 10 p.c. acetic acid, 10 parts; formic acid, 5 drops to each litre of solution). The tissue was immersed for 10–20 hours, then transferred to 70 p.c. alcohol which contains 1 p.c. potassium iodide; (7) Saturated aqueous solution of mercury bi-chloride in absolute alcohol. The paraffin sections were stained with picro-nigrosin; Kleinenberg's hæmatoxylin; Heidenhain's iron-alum hæmatoxylin; Zimmermann's-fuchsin-iodine green; Gram's method; eosin-toluidin-blue; eosin and anilin-blue; eosin and gentian violet; Flemming's triple stain.

The best staining results were obtained from the eosin-toluidin-blue.

CHAMBERLAIN, C. J.—**Celloidin method for hard tissues.**
[A note in reference to E. C. Jeffrey's method given above.] *Bot. Gazette*, xxxviii. (1904) p. 145.
„ „ Ditto. *Tom. cit.*, pp. 382–3.
JEFFREY, E. C.— Ditto. *Tom. cit.*, pp. 381–2.

(4) Staining and Injecting.

Staining Protozoa.‡ — F. Marino found that azur in aqueous or alcoholic solution stains well the nucleus and protoplasm of Protozoa fixed in alcohol, and that very dilute aqueous solution of eosin (1:20,000) differentiates them.

A mixture of an aqueous solution of methylen-blue and of azur

* Ann. Bot., xviii. (1904) pp. 269–87 (1 pl.).
† Mottier's formula, Pring. Jahrb., xxx. p. 170.
‡ Ann. Inst. Pasteur, xviii. (1904) pp. 761–5 (1 pl.).

(blue 0·5, azur 0·5, water 100) and an aqueous solution of carbonate of soda 0·5 p.c., is incubated at 37° or more for 24–48 hours. To this is added an aqueous solution of eosin, the strength of which varies with the quality of the blue. The exact quantity must be determined by trying, e.g. 0·1, 0·25, 0·3 p.c. From the filtered mixture is obtained a powder soluble in water and absolute alcohol. The method of staining is as follows :— 0·04 grm. of the blue prepared as given above is dissolved in 20 c.cm. methylic alcohol and 0·05 grm. eosin in 1000 of water. On an 18 mm. cover-glass is placed some protozoal blood. To this are added 4 drops of the blue solution. After exactly 3 minutes, and without washing, 8–10 drops of the eosin solution are poured on and allowed to act for 2 minutes.

If the coverslips be larger, a proportionately larger quantity of the staining solutions must be used, and, of course, slides may be used instead of slips.

The preparations are merely washed in water, dried, and mounted in balsam.

While the staining is going on, the preparations must be covered to avoid evaporation and precipitation.

For staining films of microbes fixed in the flame, a 1 : 500 aqueous solution of the blue is allowed to act for half to one minute.

Differential Staining of Bacillus Typhosus in Sections.*—Bonhoff recommends the following method. The section, taken out of absolute alcohol, is washed and fixed on the slide ; it is then treated cold for two minutes, with 5 drops of a freshly prepared mixture of saturated alcoholic methylen-blue (4 drops), Ziehl's solution (15 drops) and distilled water (20 c.cm.) ; it is now warmed over a small gas jet until it commences to steam, washed in water, then in 1 p.c. acetic acid, and again in water ; dried with blotting paper, and washed with several lots of anilin and xylol equal parts, and mounted in balsam. The section is stained throughout a light red, the bacilli having an intense sky-blue colour.

Christian, H. A.—**Newer aspects of the Pathology of Fat and Fatty Degeneration.** [Mentions use of Osmium tetraoxide, Sudan iii., Scharlach R., and Indophenol for staining fat, and the technique required.]
Johns Hopkins Hosp. Bull., xvi. (1905) pp. 1–6.

Metallography, etc.

Sulphides and Silicates of Manganese in Steel.†—J. E. Stead points out that the identity in shape of the globular masses of these substances may have caused them to be confused with one another. He found that, if the polished surface of a section were examined previously to etching, particles of a pale dove-colour could be tentatively accepted as sulphide. In the case of very minute particles, the reflected actinic light from sulphide of manganese is greater than that from the silicate,

* Centralbl. Bakt., 1te Abt. Ref., xxxv. (1905) p. 794.
† Iron and Steel Mag., ix. (1905) pp. 105–13 (4 figs.).

and a sensitive dry-plate in the camera will show a great contrast between them. Without etching, whilst the object is still under the Microscope, a drop of sulphuric acid (1 of strong acid to 3 of water) should be placed on the surface, and from each sulphide particle a bubble of gas will be evolved, but no gas will form over the pure silicate. This gas can be recognised as H_2S by cementing a small cell or ring of glass on the polished specimen, and placing over this a cover-glass whose underside has been moistened with lead acetate. In a short time a dark stain of lead acetate will form, easily recognisable under the Microscope. The liquid may be removed in a capillary tube and further tested, with nitric acid and bismuthate of soda, for a permanganate reaction. The areas of sulphide and silicate can best be seen after heat-tinting the polished specimens to a light-brown colour, when the patches appear relatively light on a brown ground.

ANDREWS, T.—**Microscopic Observations on Naval Accidents.**
[The author describes his investigations of the cause of failure of the steel connecting-rod of H.M.S. *Bullfinch*.] *Engineering*, Dec. 2, 9, 16, 1904; *Iron and Steel Mag.*, ix. (Jan. 1905) pp. 163–8.

GLEDHILL, J. M.—**Development and Use of High-Speed Tool Steel.**
[A paper read at the Iron and Steel Institute Meeting, New York, Oct. 1904. An historical and descriptive article, describing some of the most recent improvements.] *Iron and Steel Mag.*, ix. (Jan. 1905) pp. 19–44, with figs. and photomicrographs.

SEATON, A. E., & A. JUDE—**Impact Tests on the Wrought Steels of Commerce.**
[The author describes his experiments, and illustrates them by numerous photomicrographs.] *Proc. Inst. Mechanical Engineers*, read Nov. 18, 1904, 33 pp., 10 pls. and 8 figs

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JOURNAL

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TRANSACTIONS OF THE SOCIETY.

III—*Micro-Metallography with Practical Demonstration.*

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

(*Read February 15th*, 1905.)

As metals are opaque, it is impossible to deal with them as the mineralogist deals with his rocks and minerals. Therefore, the metallographer is obliged to depend upon what is revealed upon their polished surfaces. On this account it is not necessary to have specimens of any particular shape, size or thickness. The only thing absolutely essential is that one surface is perfectly flat, and is polished so as to have a mirror-like appearance, free from scratches.

It was Dr. Sorby, of Sheffield, who first elaborated a system for the examination of the micro-constituents of Iron and Steel. His methods are so well known that it is scarcely necessary to give them here in detail. It is sufficient to state that the metals were polished by hand on a series of emery papers diminishing in coarseness, and finished upon rouged parchment.

Polishing by hand takes a long time, and although the work when properly finished is perfect, it has been found a very great convenience to expedite the process by means of quick running discs and grinding appliances worked by electrical or other power.

Professor Martens polished on beds of pitch containing grinding powders mechanically suspended, which were placed on the head of a wheel running horizontally. A series of many specimens were fixed with cement to a holder, which was caused to traverse backward and forward across the polishing surface.

Osmond proceeds by first grinding on emery papers by hand, roughly polishing on rouged cloth, and then on a wheel covered

with rouged parchment for fine polishing. He has given, in his book upon the microstructure of metals, detailed instructions for the polishing of metals and the preparation of the emery papers which he found most suitable.

Professor Arnold prepares his specimens on revolving horizontal polishing blocks, and Mr. Sauveur on vertical running wheels, the polishing being effected on the sides of the discs. Professor H. Le Chatelier, on the other hand, polishes on the periphery of vertical wheels.

Each authority quoted has done excellent work, and it may be accepted that all the devices have given satisfaction in the hands of the operators.

Professor H. Le Chatelier prepares alumina powder for the polishing, and a description of the method has already been furnished to this Society by Mr. W. H. Merrett.

Messrs. Carling and Son, machinists, Middlesbrough, have for many years been devoting much attention to the construction of suitable devices for polishing metals by machinery, examples of which are exhibited here to-night by their consent. The principle of working is the same as that of other machines, such as are used by Professor Ewing, Mr. W. Rosenhain, Mr. W. H. Merrett and others, but there are certain improvements which are possible advantages, and which have enabled me to perfectly polish a specimen of steel one centimetre square in about five minutes after it is cut by the saw, or filed smooth.

An examination of the accompanying photograph (fig. 56) will show at a glance the construction of the machine.

The shaft of the revolving wheel rests upon a polished steel ball to prevent friction, and is caused to revolve by the cord connected to a power-driven pulley, preferably a $\frac{1}{8}$-horse power electric motor, running at such a speed that the little wheel revolves at the rate of between 500 and 1000 revolutions per minute. The sheath S prevents the projection of the water, which is caught and conveyed to the trough T. The sheath has the additional advantage that it affords a rest for the hand when holding the specimen, and enables the operator to regulate the pressure.

A series of loose conical blocks B are placed simply alternately as required on the top of the wheel A, the friction of which is sufficient to carry them round without slipping.

The block, No. 1, is prepared by stretching a piece of the finest emery cloth over its surface and securing it in position by pressing the ring over the cloth and cone. The surplus cloth is removed with a knife.*

The other blocks are prepared in precisely the same way, but instead of emery cloth the paper manufactured in France for

* These conical blocks are similar to the hand-polishing blocks designed by Professor Arnold.

polishing engraving plates is substituted. The second block is covered with paper marked "Hubert 0," the third block with

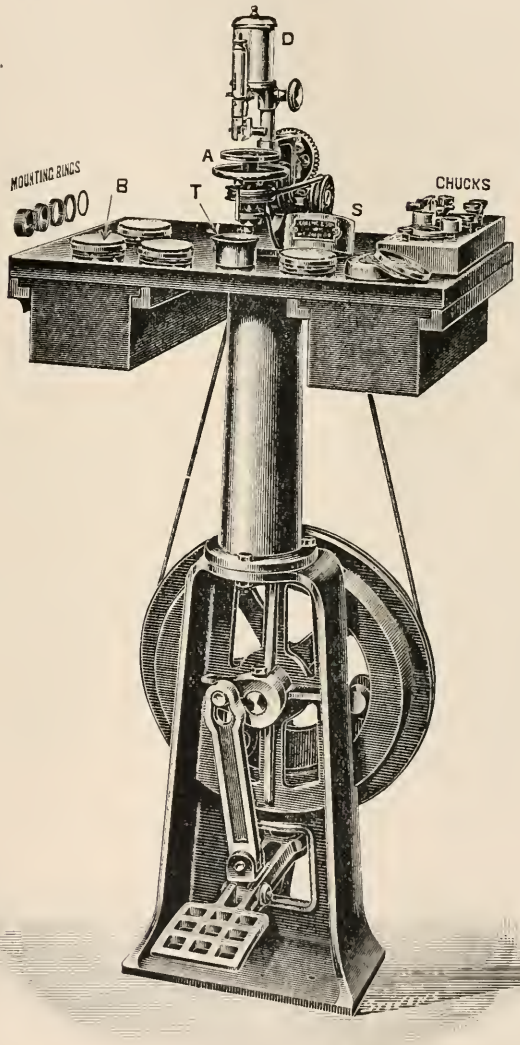

Fig. 56.

paper marked "Hubert 000." The fourth block is covered with a ribless cloth of considerable thickness, denseness and texture.

Special care is necessary in the preparation of this block, for upon it the polishing is finished. On the top of the block is placed a small disc of cloth of exactly the same diameter as the upper area of the block. Upon this is sprinkled pretty thickly a covering of about one gramme of diamantine powder, a preparation of calcined alumina manufactured by A. Guyot Dupold, Tocle, Switzerland, which is quite as satisfactory as the calcined alumina prepared as directed by Professor H. Le Chatelier, and it has the advantage that it can be readily obtained from any jeweller at a small price. This diamantine powder, having been placed upon the cloth disc, a larger piece of cloth is placed over it and the ring pressed home over the cone. Arranged in this way, any of the larger particles of powder are prevented from passing upwards through the pores of the cloth, and only the finest portions reach the upper surface and are utilised in the polishing.

Professor Arnold has independently found this method of procedure to be very useful.

Many metallographers prefer to use large blocks or wheels for polishing, but in my experience it has been found that with smaller ones there is less danger of dust getting on the cloth, and the apparatus is more convenient and less cumbersome.

In the many designs for polishing apparatus, shown at this meeting, it will be observed that some are fitted with a series of blocks in which all the necessary grinding and polishing surfaces are close together, and there is no necessity of changing the blocks. On the other hand there is a machine with larger blocks to suit those who prefer them, and there is also a single table with interchangeable discs. All these machines can be fitted with the traversing specimen holders, so that polishing becomes practically automatic. I am under great obligation to the makers for allowing these to be exhibited this evening.

Selection of Specimens.

When a metallographer is called upon to make an examination of a metal structure, which has broken or failed when in use, it is most important that all particulars should be provided him, with exact details as to the nature of the strains and stresses applied, where they were applied, and whether, or not, any local distortion of the metal substance has been produced in the machine shop, or when in practical use.

In selecting the position from which specimens shall be taken, the metallographer must be largely guided by the information he receives. All fractures or failures in metals have initial starting points, and it not infrequently happens that the seat of weakness is located exactly at this point, and possibly nowhere else. A

MICROSCOPY.

A. Instruments, Accessories, &c.*

(1) Stands.

Engineer's Metallurgical Microscope.†—This instrument (fig. 57) was designed by J. E. Stead, F.R.S., for use in engineering works, where large forgings require examination when in the lathe, or when laid on

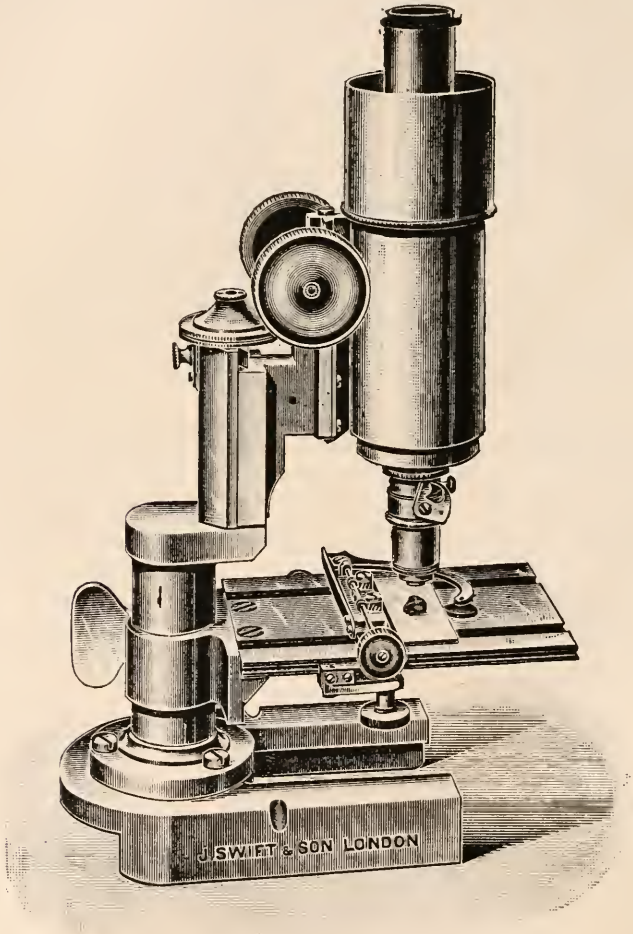

FIG. 57.

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

† J. Swift and Son's Catalogue, 1904, p. 35.

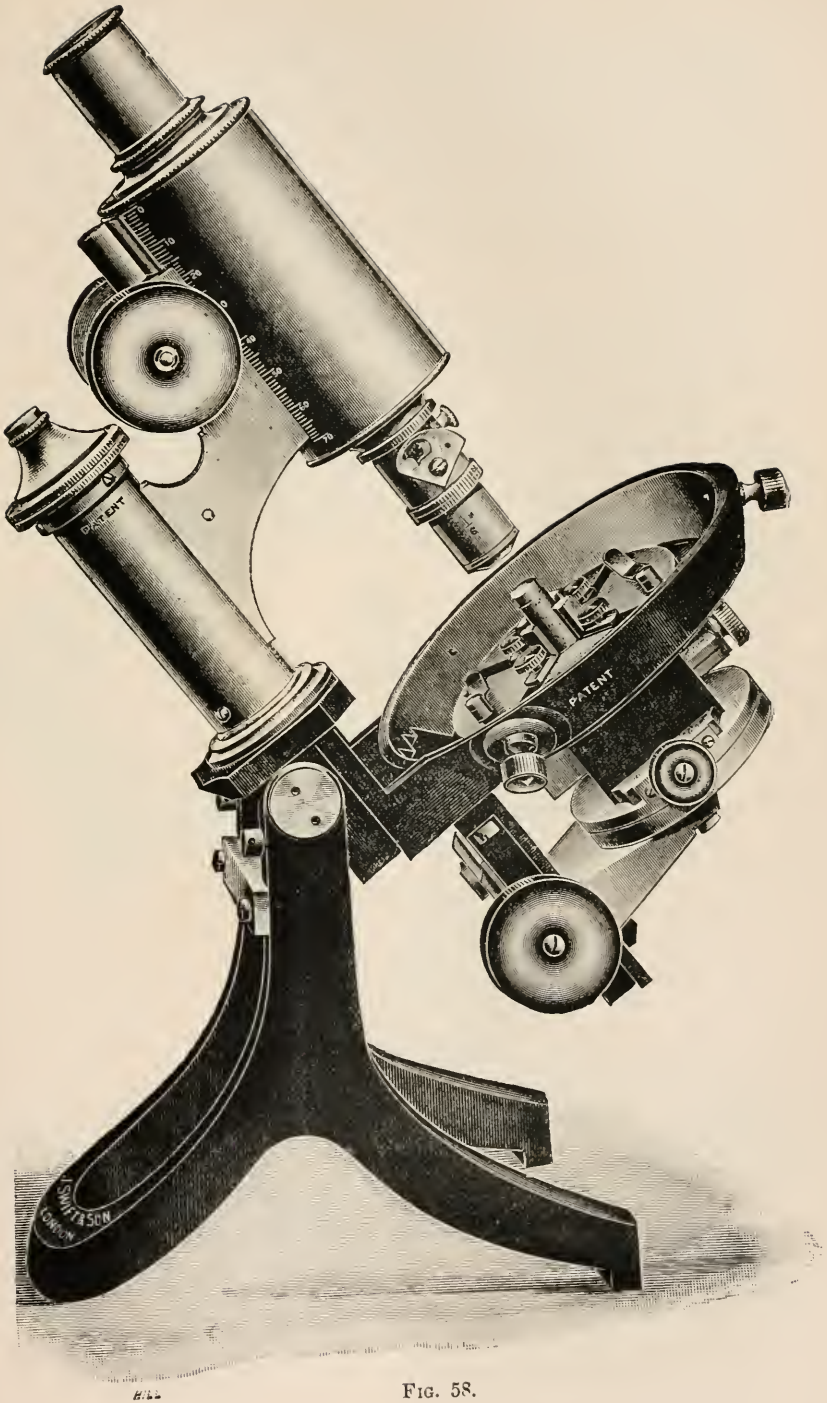

Fig. 58.

the ground. It is specially massive. A solid stage is made to swing round, so that the object-glasses can be brought into focus on the forging or casting upon which the foot or fork rests. To effect this, an inside tube carrying the object-glasses slides within the outer barrel and can be lowered to a sufficient distance. By means of a simple wire rope strap the stand is rigidly held in any required position on the piece of metal under examination. When in focus the position of the barrel is fixed by a screw at one side of the rack and pinion. When so fixed a ¼ plate conical camera may be placed on the top of the barrel and photographs taken.

Swift's New Compound Metallurgical Microscope.*—In this instrument (fig. 58), specially designed for the Royal Arsenal, Woolwich, the optical tube is 2⅛ in. in diameter, and is divided to show the position at which any objective will allow of an object being tilted without going out of focus. The stage is so designed that after focussing the object in the horizontal position it may be tilted or turned in any direction without affecting the focussing. The ordinary slide is held on the top of the stage by means of steel springs, while pieces of metal are held in position by four clamping dogs sliding in dovetails and fixed by small clamping screws.

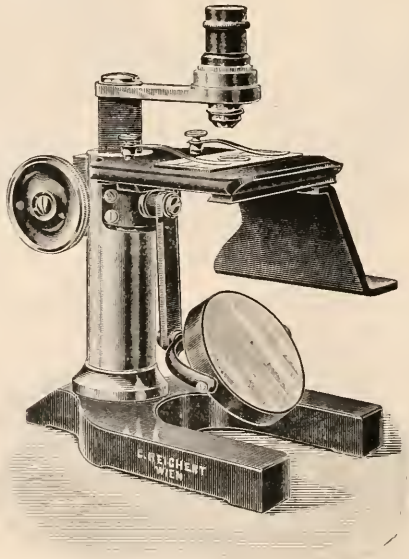

Fig. 59.

Reichert's Medium Dissecting Microscope.†—This instrument (fig. 59) has a rack and pinion adjustment, large stage, and a couple of leather-covered hand-rests. The doublet has a magnification of 10 times.

* J. Swift and Son's Catalogue, 1904, pp. 36–7.
† C. Reichert's Special Catalogue, No. 25 (1904) fig. 19.

Reichert's New Microscope for Brain Sections.*—This large model Microscope, shown in fig. 60, is made with an unusually large equip-

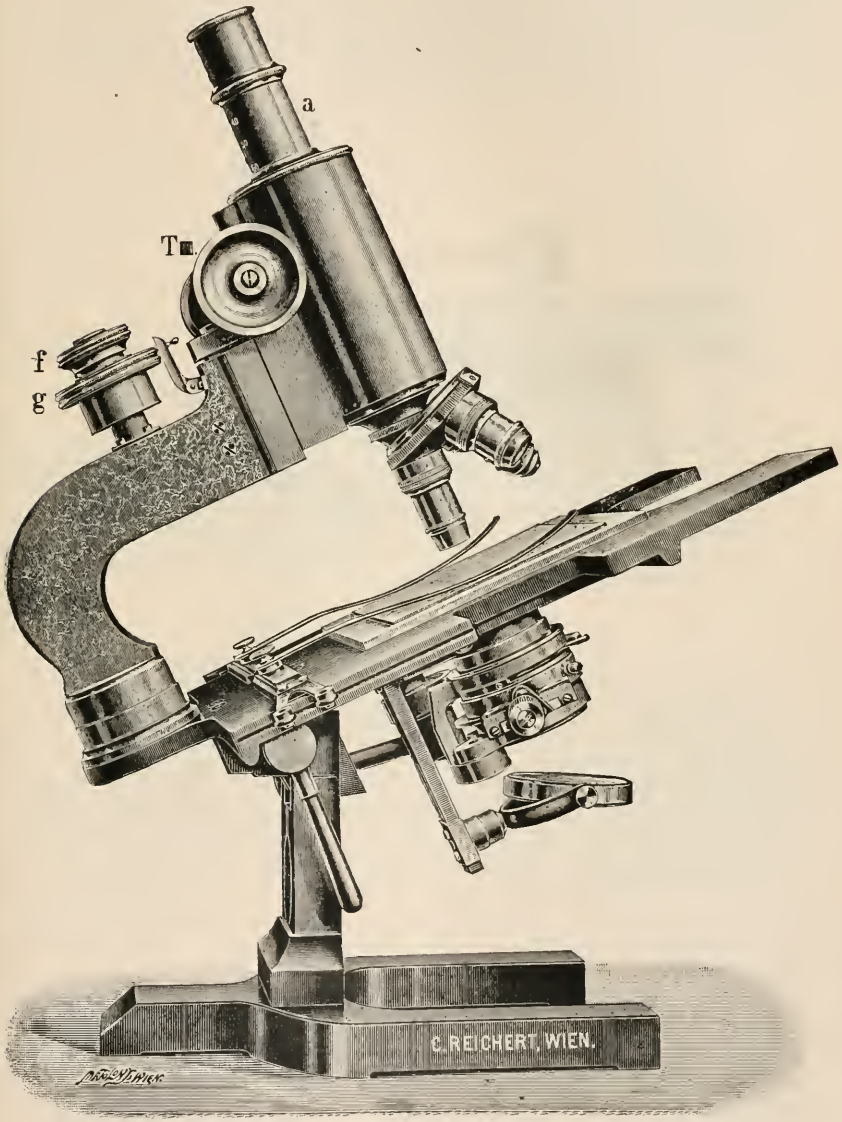

FIG. 60.

ment and with an extra-size stage, for the thorough exploration of such large objects as brain-sections, etc. The object-slides are moved by

* C. Reichert (Vienna) Catalogue No. 25 (Mikroskopie, 1904) p. 36, fig. 17*d*.

hand motion. The coarse adjustment is by rack and pinion; the fine by micrometer screw. The Microscope is fitted with the Abbe illuminating apparatus, hollow and plane mirrors.

Tafner's New Preparation Stand.*—This is made by G. Reichert, and is shown in fig. 61, about one-third full size. The arrangement will be easily understood from the illustration.

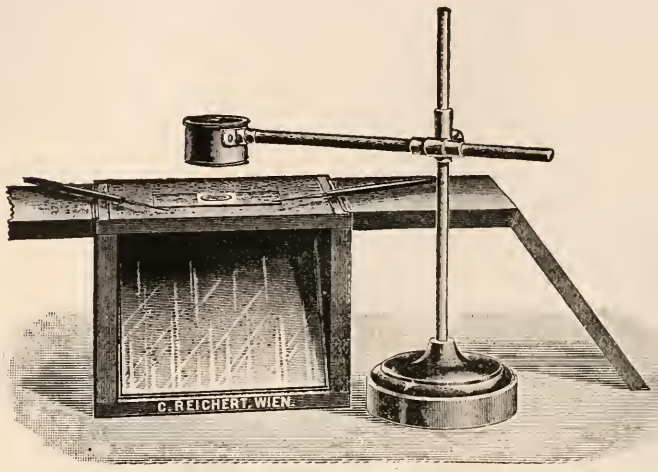

Fig. 61.

Imperial Standard Yard.†—A description of the Comparator, and the method of using it, would be outside the range of our work, but we may legitimately examine the micrometer Microscopes by which the measurements are made. These seem to be of a most elementary type, and as such wholly inadequate for the work in hand. The N.A. of the objectives is something under 0·1, their greatest separating power is therefore less than ·0001, so that $\frac{1}{10000}$ in. must be taken as the limit of the accuracy of this comparator. All refinements, such as an error of ·01° C. in a thermometer, or the compression of the rod due to a change in the barometric pressure, are meaningless when such elementary microscopical micrometers are employed. Apparently the whole of the apparatus was made abroad.

(2) Eye-pieces and Objectives.

Reichert's New Erect Image Preparation System for Preparation Microscopes.‡—This system of lenses, as applied to Reichert's Large Model Preparation Microscope, is shown in fig. 62. The arrangement of Porro prisms by which an erect image is obtained is seen in section.

* C. Reichert (Vienna), Catalogue No. 25 (Mikroskopie, 1904) p. 41, fig. 20*a*.

† Memorandum on the Construction and Verification of a new copy of the Imperial Standard Yard. Part I. London, 1905, 57 pp., 4 pls.

‡ C. Reichert (Vienna) Catalogue No. 25 (Mikroskopie, 1904) p. 40, fig. 20.

The Microscope itself is of large size, and is equally fit for the examination of brain sections or of small objects. It has a glass stage 10 cm. by 10 cm., which may be replaced by an accompanying metal plate. The base is a heavy horseshoe: the hand-rests are mahogany and of large size. The lens-carriers have both horizontal and vertical

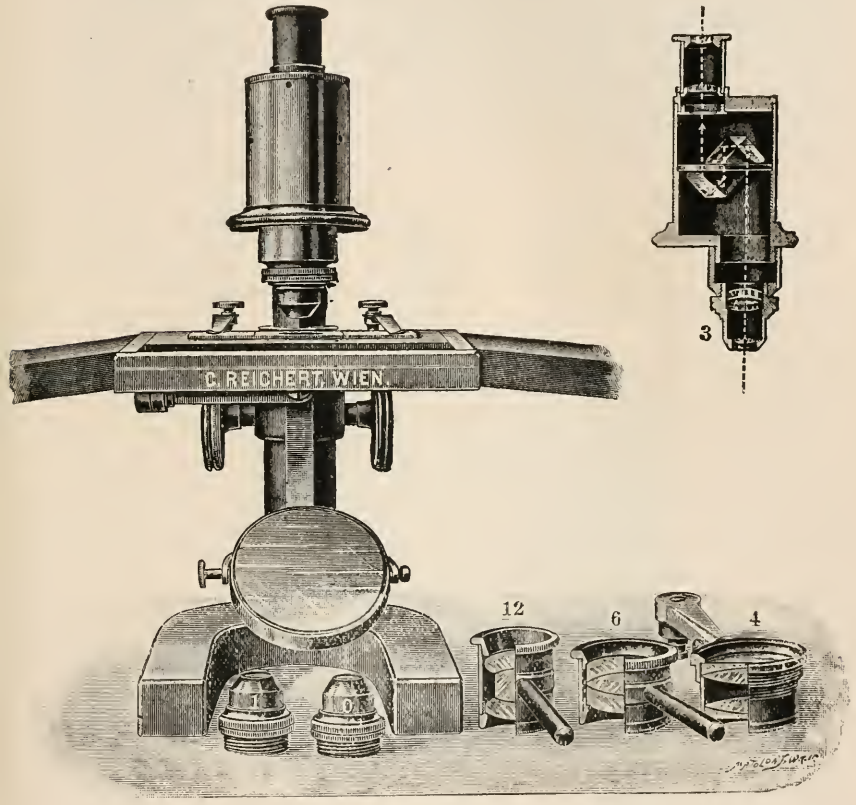

Fig. 62.

adjustments, and there is provision for a second carrier of weak magnification. There is a sub-stage arrangement for reducing the light at pleasure; the mirrors are plane and concave, and can be placed so as to illuminate from above.

New Method of using the Plankton Searcher.*—P. Mayer has found a simple means for obviating the difficulties attendant on the use of the Plankton Searcher.† These difficulties, more or less attendant on the great working distance, have been got over by means of a glass

* Zeitschr. wiss. Mikrosk., xxi. (1904) pp. 447–9 (2 figs).
† See this Journal, 1898, pp. 677–8; 1899, pp. 111–12.

tube from 35–50 mm. long, and having an outside measurement of about 15 mm. (fig. 63) which is inserted for a distance of about 5 mm. into a piece of rubber tubing 20–25 mm. long, and just wide enough to grip the objective firmly. The parts are fitted together as follows :— Screw the objective on to the Microscope barrel, push up the tube, reverse the barrel, fill the tube slowly with water, put a cover-glass or piece of paper on the top, and then insert the barrel in the stand. As soon as the free end of the tube is immersed in the vessel, the cover-glass or paper falls off. By shifting the rubber tubing on the objective, the operator can adapt the apparatus to the height of the water in the vessel and the objects therein. A depth of 10 mm. is

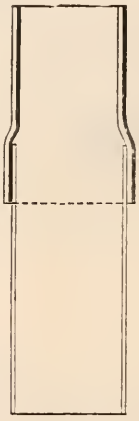

Fig. 63.

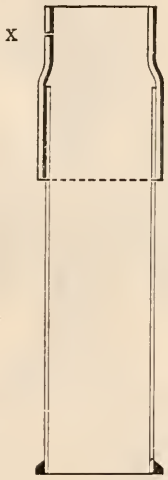

Fig. 64.

sufficient, but if the objects are thick, or at a distance from the bottom, more water is necessary.

If the operator prefers to work with a closed tube, the rubber tubing must have a small perforation (fig. 64) to allow water to escape when the objective is pushed down.

The cover-glass forming the bottom of the tube may be stuck on with marine glue or with Mendelejeff's cement. An advantage of this method is that the objective may be surrounded with distilled water. The cover-glass does not in any way interfere with the sharpness of the image.

Simple form of Index Ocular.*—G. C. van Walsem, after descanting on the usefulness of the index ocular for demonstration purposes, points out that a simple and effective index eye-piece can be made by merely

* Zeitschr. wiss. Mikrosk. xxi. (1904) pp. 174–7 (1 fig.).

drilling a hole in the ocular just above the diaphragm. The aperture should be of such size that it will admit the passage of a medium-sized pin (about 3 cm. long) to serve as indicator.

(3) Illuminating and other Apparatus.

Pfeiffer's Hot-Air Chamber.*—This apparatus, made by C. Reichert, is seen in fig. 65. It is intended for the heating of the whole Microscope. It is fitted with a thermometer and a gas thermo-regulator.

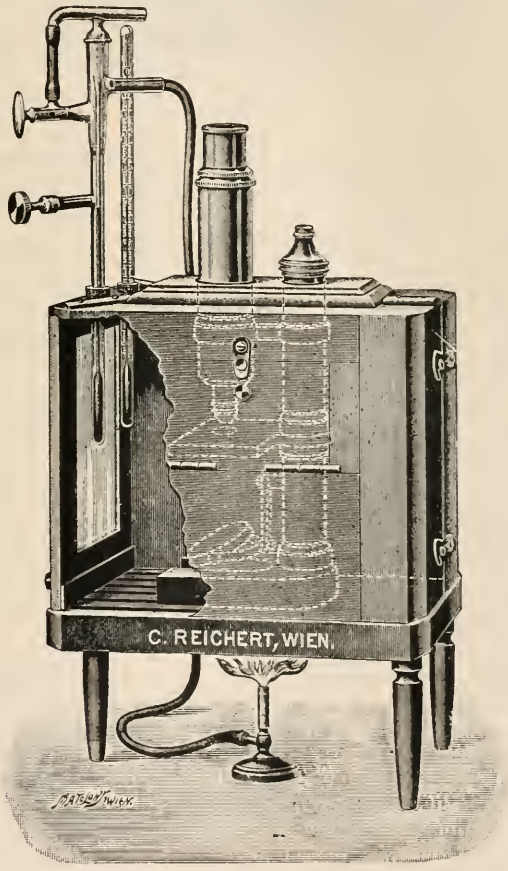

Fig. 65.

Reichert's New Achromatic Condenser.† — This illuminating apparatus has an aperture of 1·30, and as will be seen from the illustra-

* C. Reichert (Vienna) Catalogue No. 25 (Mikroskopie, 1904) p. 53, fig. 26*b*.
† C. Reichert's Catalogue, No. 25 (1904) p. 13.

tion (fig. 66) the iris diaphragm has a scale marked above the slit, a feature often of great convenience.

Fig. 66.

J. E. Stead's Illuminator for Opaque Objects.*—This is a simple and effective apparatus for illuminating metallurgical specimens by reflected light, but is only intended for use with low-power objectives, 1½–3 in. The illustration (fig. 67) sufficiently explains the principle of illumination. The metal box has one of its sides cut at an angle of 45°, this being faced with a small square of glass, the surface of which is illuminated by means of a lamp with or without the intervention of a bull's-eye condenser. The circular collar pushes on to the body of the objective.

Fig. 67.

Siedentopf & Szigmondy's **New Microscopic Apparatus for rendering visible Ultra-microscopic Particles in Glasses and Liquids.**

[This apparatus is now made by C. Reichert.]

C. Reichert (Vienna) Special Circular.

(6) Miscellaneous.

High Power Microscopy.†—In an address at the Royal Institution J. W. Gordon observed that in the exhibition of a microscopic object under high magnifying power there are three stages in which difficulties have to be met and surmounted—(1) In the preparation of the object for exhibition under suitable conditions of illumination ; (2) in the representation of the object by means of an image ; (3) in the transmission of the image so found in the instrument to the eye of the observer. Professor Wright classified the preparation of objects into colour pictures by means of stains and outline pictures. The method of staining having manifest limitations, Mr. Gordon proceeded to refer to the use of cross-lighting or "dark-ground illumination" in order to show outlines, with especial reference to Dr. Siedentopf's application of this principle to the exhibition of so-called "ultra-microscopical particles."

* J. Swift and Son's Catalogue (1904) p. 35.

† Knowledge, ii. (1905) pp. 114–15.

In ruby glass, for instance, the colour is due to minute particles of gold diffused through the glass, so small as to be beyond the powers of the Microscope as ordinarily used. By special methods of illumination, however, at right angles with the optical axis of the Microscope, and by limiting the plane of such illumination, the particles come into view as diffraction discs. Mr. Gordon then dealt with some experiments of his own, originally suggested by a paper of Lord Rayleigh's, but which were still incomplete, which consisted especially of a method of lighting up the object by means of diffracted light, the principle being explained by a diffraction slit formed by the edges of two knives stuck in a board so that their edges overlapped towards the points, but were about an eighth of an inch apart near the handles. It was such a piece of apparatus that Sir Isaac Newton worked when he made his first precise recorded observations on the subject of diffracted light. Mr. Gordon referred to the observation of Helmholtz, as far back as 1874, that the limit of a useful power in a high-power objective is reached when the lens of the objective is of such focal length that its diameter is rather less than the diameter of the pupil of the eye, and that beyond that point there was no advantage in increasing the magnifying power of the objective, but that further magnification was best obtained by increasing the power of the eye-piece. But this method had also drawbacks owing to the smallness of the emergent pencil of light; such, for instance, as the greater prominence of dust upon the lens or of floating particles in the eye. Mr. Gordon considered that this was responsible for the limitation of magnifying powers at present in use by microscopists to 1500 or 2000 diameters, whilst most good work was done with magnifications of from 400 to 600—a statement, however, which surely needs some qualification, whatever may be the incidental disadvantages due to high eye-piecing. However, Mr. Gordon's method of getting over the difficulty is by the interposition in the tube of the Microscope of a ground-glass screen on which the image is received from the objective, so as to scatter the incident rays of light, the screen being made to oscillate in order to prevent its grain from becoming visible and so impairing the details of the picture. This picture can then be magnified again by means of a second Microscope in place of an ordinary eye-piece, with consequent greatly increased magnification. It may not perhaps be superfluous to recall that the mere magnification of an object, or even the rendering visible of what could not otherwise be seen to be existent, as under Siedentopf's experiment, does not give any optical solution as to its true shape and size. In fact, it has been mathematically proved, and remains true, to quote Lord Rayleigh's own words, "In the Microscope there is nothing except lack of light to hinder the visibility of an object however small. But if its dimensions be much less than half a wave-length, it can only be seen as a whole, and its parts cannot be distinctly separated, although in cases near the border-line some inference may possibly be founded upon experience of what appearances are presented in various cases. . . . What has been said about a luminous point applies equally to a luminous *line*. If bright enough it will be visible, however narrow; but if the real width be much less than the half wave-length, the apparent width will be illusory."

Elements of Applied Microscopy.*—The author, C. E. A. Wilson, in an apologetic introduction, remarks that this little work which is intended for the teacher and the beginner with the Microscope, contains very few original data, and treats no single subject with completeness. In less than 170 pages, divided into twelve chapters, the author flits over the following fields, functions and parts of the Microscope :—Its manipulation ; mounting and preparation ; micrometry ; common starches ; foods and drugs ; textile fibres ; paper ; the Microscope in medicine and forensic medicine ; microchemistry ; petrography and metallography. To those who desire a superficial glance at the possibilities of the Microscope and its practical application, this elementary treatise may be of service.

Optical Dictionary.†—This new glossary of terms chiefly relating to optics and optical instruments is mainly intended for the use of students and members of the optical industry. It will, however, be found helpful to a wider circle, as it deals with terms used in ophthalmology, photography, mathematics, and closely allied sciences. The volume is edited by C. Hyatt-Woolf.

Microscopist's Screen.‡—J. Peiser describes a screen for protecting the eyes of microscopists against the light. The framework clips on to the ocular and to the ring is attached a T-shaped piece of wire to which is fixed a piece of black satin.

B. Technique.§

(1) Collecting Objects, including Culture Processes.

Flagella of Bacillus Typhosus.—W. J. Dibdin exhibited photographs of the *Bacillus typhosus* at the April meeting, showing the flagella in a more marked manner than usual. It was found as the result of a considerable number of cultures of this organism, that the flagella are most highly developed in cultures which are between 12 and 20 hours old. In the photograph the considerable extensions of the flagella are shown.

The method of preparation was as follows :—The culture used was a 16-hour-old agar streak sub-culture from a gelatin streak culture. Some of the growth, as much as was obtained by touching the culture with a sterile wire, was smeared on a watch-glass and 1 c.cm. of sterile tap-water added. Without mixing in any way, the watch-glass and contents were then incubated at 40° C. for 30 minutes. Drops of the water, throughout which the more active of the flagellated bacilli had spread, were taken from the edges and spotted on cover-glasses. These cover-

* New York, John Wiley and Sons; London, Chapman and Hall (1905) xii. and 168 pp., 60 figs.

† London, Gutenberg Press, Limited (1905) 77 pp.

‡ Zeitschr. wiss. Mikrosk., xxi. (1904) pp. 467–9 (2 figs.).

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

glass preparations were set aside until they had become thoroughly air-dry, and were then fixed in the usual way by passing through a flame.

The dried and fixed preparation on the cover-glass was next flooded with a tannate of iron mordant, and heated till the mordant steamed, when the latter was removed by washing in distilled water. After drying, the mordanting process was repeated, and finally the preparation was stained with Ziehl fuchsin solution.*

The photographs were taken by means of a Powell and Lealand $\frac{1}{12}$ in. apochromatic 1·43 N.A. and No. 10 compensating eye-piece. Messrs. Powell and Lealand's apochromatic condenser was used together with Gifford's light screen, the latter more particularly to absorb some of the heat-rays from the condensed beam of the limelight employed, before they reached the condenser. By means of this arrangement the photographs were obtained with an exposure of three minutes. The magnifications are approximately equal to 2500 and 5000 diameters respectively.

With regard to the question of employing high magnifications, it may be of interest to point out that in the print taken with only 2500 diameters magnification, the appearance in one case is such that it might easily be assumed that the flagella were bifurcated, and at first this was taken to be the case, but the higher magnification clearly shows that this appearance is due merely to juxtaposition of the bent middle portion of a detached flagellum, with the terminal of an attached flagellum.

The fact that the flagella seem to reach their maximum growth in from 12 to 20 hours and then are soon lost, combined with their number and character, suggests the possibility that they are used in the manner of tentacles for attachment until certain functions are discharged, whereupon the flagella cease to be required, and are lost.

Quantitative Estimation of the Bacillus Coli in Drinking Water.† A. Gautié considers that it is not the mere presence of *B. coli*, but its abundance or rarity that should be regarded as an index of the fæcal contamination of drinking water ; a great increase in the number of this microbe in a water that usually contains only a small number, is of equal importance with the sudden appearance of this organism in a water in which it never existed previously. For this quantitative analysis he employs the method of Peré, which consists in the addition to the suspected water of a small quantity of pepton broth and a known proportion of carbolic acid. He gives details of the technique carried out by Peré ; this he modifies in practice, by working not only with 100 c.cm. of water, but with decreasing amounts from 100 c.cm. to 1 drop, adding always proportionate amounts of carbolic acid.

Rothberger's Neutral Red Reaction.‡—Otto Heller describes Rothberger's neutral red reaction which is used as a differential diagnosis between *B. typhosus* and *B. coli*. He refers to the several modifications

* Fuchsin solution: 5 p.c. solution of phenol in water. To this add 1 grm. fuchsin and shake well, and add slowly, drop by drop, 10 c.cm. absolute alcohol.

† Ann. Inst. Pasteur, xix. 1905) p. 124.

‡ Centralbl. Bakt., Orig., 1te Abt., xxxviii. (1905) p. 117.

of the method as suggested by different workers, which depend on the variations in the nature or composition of the media employed. He contrasts the media of Rothberger and Oldenkop with media prepared with ordinary broth and gelatin to which neutral red in similar amounts has been added. The details of his observations on 30 different strains of organisms, mostly belonging to the *Coli* group, are given in tabular form. From these results he concludes that the neutral red reaction is best obtained by [the use of ordinary laboratory gelatin with the addition of sterilised, saturated, aqueous solution of neutral red, and incubating at 37° C.; under these circumstances he finds that the reaction appears quickly within 6 hours, is uniform and reliable, and remains permanent, being influenced neither by the medium nor by the oxygen of the air.

Methods for Isolating the Micro-organisms of Nitrification.*—R. Perotti uses blocks of commercial carbonate of magnesium, which are sawn up into slices about 10 cm. long, 2·5 cm. broad, and 1 cm. thick. Of course any other size or shape will do. The slices are first polished with glass, and afterwards rubbed down quite smooth with the finger.

The nutritive medium is composed of three solutions. (1) Ammonium sulphate, 2 grm.; potassium phosphate, 1 grm.; magnesium sulphate, 0·5 grm.; distilled water, 1000 grm. (2) Sulphate of iron, 2 grm.; distilled water, 100 grm. (3) Saturated solution of sodium chloride. To 50 c.cm. of (1) are added one drop of both (2) and (3). The solution must be made fresh when required for use.

The magnesium carbonate slab is placed in a tube, and then as much of the medium poured in as will suffice to soak the block and allow a deposit of from 5–10 c.cm. at the bottom of the tube. The whole is then steam-sterilised.

It is important to have some of the medium at the bottom of the tube for the purpose of keeping the slab moist.

The surface of the block is inoculated by running over it a few drops of the fluid containing the micro-organisms.

The presence of the organisms is detected by the appearance of minute excavations of a dirty yellow hue on the surface of the medium.

Endo's Method for Detecting Typhoid Bacilli.†—The medium devised by S. Endo is composed of the following ingredients:—1000 c.cm. neutralised nutrient agar (3 p.c. agar); 10 grm. chemically pure lactose; 5 c.cm. alcoholic solution of fuchsin; 25 c.cm. 10 p.c. sodium sulphite solution; 10 c.cm. 10 p.c. soda solution.

The medium is prepared as follows:—500 grm. of chopped beef, 1 litre of water, 10 grm. of pepton, 5 grm. of salts, and 30 grm. of agar are well boiled, filtered, neutralised, and alkalinised by the addition of 10 p.c. soda solution.

The lactose and fuchsin solution are then added. This makes the medium red, but after the addition of the sodium sulphite it gradually loses colour, and when the agar is set it is quite colourless.

* Atti R. Accad. Lincei, xiv. (1905) pp. 228–31 (1 fig.).
† Centralbl. Bakt., 1te Abt. Orig., xxxv. (1903) pp. 109–10.

The medium is next distributed into test tubes, and steam-sterilised for about 30 minutes. Plates are made from these, and the plates inoculated after the manner recommended by Drigalski and Conradi. *Coli* colonies are red and the typhoid colourless. The latter eventually become larger than the *Coli* colonies. The explanation offered as to the redness of the *Coli* colonies is very plausible; the rosanilin salt loses its colour through the action of the sodium hyposulphite; hence, as the *Coli* bacteria produce acid, they restore the colour.

Simple Medium for Cultivating Gonococcus.* — B. Lipschütz recommends a nutrient medium which contains a 2 p.c. solution of white of egg.

The method of making the medium is as follows: A 2 p.c. solution of white of egg in tap-water is placed in a glass flask, and to every 100 c.cm. are added 20 c.cm. of a $\frac{1}{10}$ normal caustic soda. After half-an-hour, during which time the mixture should be carefully shaken a few times, the raw medium is filtered in quantities of 30–50 c.cm. into Erlenmeyer's flasks, and sterilised two or three times. The albumen mixture should be colourless to pale yellow, quite clear, and alkaline to litmus.

The albumen mixture thus prepared may be added to agar (agar 1 p.c., NaCl $\frac{1}{2}$ p.c., pepton 1 p.c.), or to bouillon in the proportion of one part of the solution to 2 or 3 parts of agar. The broth may be used first and transfers made to the agar in about 48 hours.

The gonococcus colonies are said to be easily distinguished from contaminations.

For the method of obtaining the infective material the original should be consulted.

New Method for obtaining Pure Cultivation of Yeast.† — H. Wichmann and H. Zickes first take a droplet from a suspension of yeast in beerwort and with this make a surface culture on wort-gelatin. In this way droplet-plates are made on square cover-glasses, and placed in a Böttcher's chamber, or over a hollow-ground slide ringed round with thin vaselin. The authors find that this droplet-plate method is suitable for obtaining cultivations of almost all kinds of Blastomycetes.

Effect of Coffein on Typhoid and Coli Cultures.‡—F. Kloumann finds that when coffein is added in slight amount to nutrient media it inhibits the growth of both *Coli* and typhoid bacteria, acting, however, more strongly on the former than on the latter. In stronger concentration the number of *Coli* bacteria is diminished, the effect on typhoid being negative. In still stronger concentration the *Coli* bacteria die off altogether, while the number of the typhoid bacteria are more or less diminished. The author did not find any degree of concentration which would simultaneously inhibit the growth of *Coli* and promote that of typhoid bacteria.

* Centralbl. Bakt., 1te Abt. Orig., xxxvi. (1904) pp. 743–7.

† Allgem. Zeitschr. f. Bierbrauerei u. Malzfabrik., xxxiii. (1905) No. 1. See Centralbl. Bakt., 2te Abt., xiv. (1905) p. 244.

‡ Centralbl. Bakt., Orig. 1te Abt., pp. 312–17.

Fuchsin-Agar as a Diagnostic Medium for Typhoid Bacteria.*—D. S. Petkowitsch recommends a medium with the following composition for differentiating *Bacillus typhosus* from *B. coli* and allied organisms. 1000 grm. neutral agar (3 p.c.); 10 grm. (1 p.c.) milk-sugar; 5 c.cm. (0·5 p.c.) alcoholic solution of fuchsin; 25 c.cm. (2·5 p.c.), 10 p.c. sodium sulphite solution; 10 c.cm. (1 p.c.), 10 p.c. soda solution.

The alkalinity should be at least 0·1 p.c.; usually it amounts to 0·1–0·15 p.c. pure soda, titrated with litmus paper as indicator. On this medium the typhoid colonies are colourless, while those of the *Coli* group are red or reddish in from 15 to 24 hours.

Cultivation of the Leishman Body.†—J. C. B. Statham successfully cultivated the Leishman bodies from a case of Dum-Dum fever in citrated blood, obtained from the spleen and liver. Apparently about 4 c.cm. of blood was mixed with 1 c.cm. of 4 p.c. solution of sodium citrate, and the tubes incubated at 20° C.

Subcultures on the same lines were also successful, but the life-period of the cultivated parasite appears to be limited to 14–21 days.

The ordinary body is roundish, with macro- and micronucleus; after a period of growth the body elongates and develops a flagellum in the vicinity of the micronucleus. The motility of these flagellated forms is sluggish, and the parasites advance with the flagella end foremost. The flagellated parasites may give rise to spirillar forms by a process of unequal longitudinal fission.

Use of Acid Media in Isolation of the Plague Bacillus.‡—W. C. C. Parkes and F. H. Joseph find that by the use of acid media the growth of pneumococcus is inhibited in cultures of sputum of cases affected with plague. By this means the pneumococcus has been eliminated, and the animals which had been inoculated with acid broth culture died of plague infection.

Bacteriology of Plague.§—H. Watkins-Pitchford makes the following interesting observations on the plague bacillus: (1) The *Bacillus pestis* grows vigorously between 15° C. and 40° C., showing the ease with which the organism can adapt itself to the varying seasonal temperature. (2) Growth of the bacillus seems to be almost inhibited in carbonic dioxide. (3) After 50 days' culture in bouillon, with 2·5 p.c. sodium chloride, the plague organism is incapable of further growth when re-transplanted upon other media. (4) The same observation held true after a lapse of 75 days for glucose agar and glucose bouillon. (5) After 100 days, however, the cultures on glycerin agar, ox serum, salt agar, glycerin bouillon, and plain bouillon proved fatal to guinea-pigs. (6) An animal may retain plague bacilli alive within its tissues and not manifest signs of the disease. This was proved by an experiment in which an inoculated rat showed no signs of illness, but when, after 23 days subsequent to inoculation, the rat was killed, a drop of pus was found in a

* Centralbl. Bakt. Orig. 1te Abt., pp. 304-12.

† Journ. Roy. Army Med. Corps, iv. (1905) pp. 13-15, 321-34 (1 pl. and 2 figs.).

‡ Brit. Med. Journ. (1905) i. p. 136.

§ Report on the Plague in Natal, 1902-3. By Ernest Hill. London, Cassell and Co., 1904, 192 pp., with map, charts, and photomicrographs.

gland of the groin, and in the pus a few plague organisms; cultures therefrom proved virulent for guinea-pigs. (7) The liability to confuse the *Bacillus pestis* with such germs as those of chicken-cholera, rabbit septicæmia, swine plague, pneumopleurisy of calves, etc., is insisted upon by the author. He holds that the Microscope alone is incapable of distinguishing between these bacilli, and that it is only by bacteriological investigations and by testing the virulence and behaviour of the bacillus experimentally in animals that a definite and conclusive diagnosis can be made.

(2) Preparing Objects.

Apparatus for the Automatic Fixation of Embryos.*—L. Sanzo describes an apparatus which he has devised for the purpose of automa-

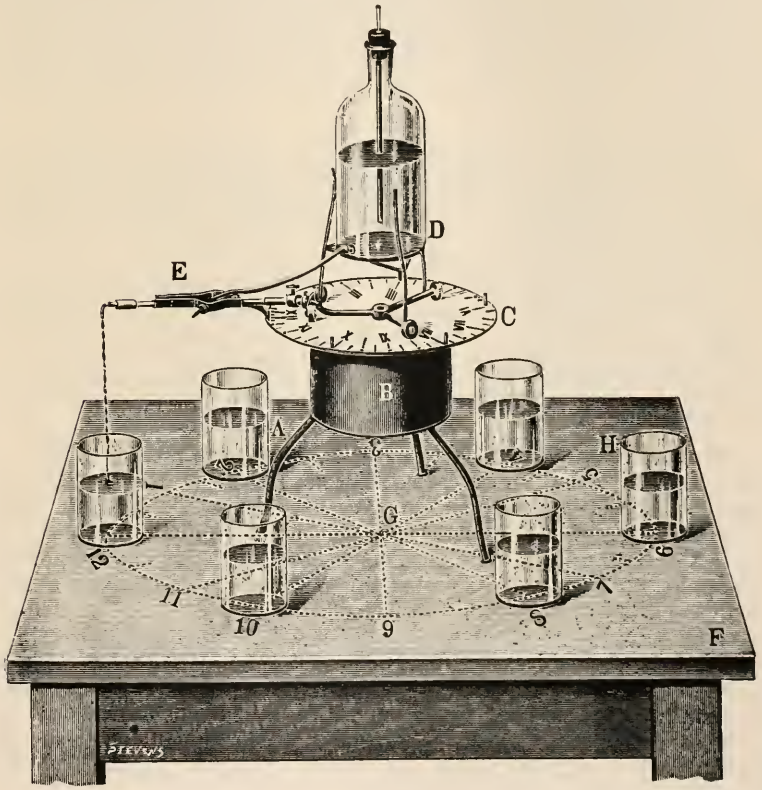

Fig. 68.

tically fixing embryos at any desired stage of development. The essential points are a clockwork motor and a special kind of stopcock or tap (fig. 68). The drum B which contains the motor is surmounted by

* Zeitschr. wiss. Mikrosk., xxi. (1904) pp. 449–57 (4 figs.).

a plate C. This acts both as a dial and a support for the framework and the bottle D. The dial face C is perforated near the periphery by a series of holes for pegs, which, as the drum revolves, strike a lever, and so cause the tap E to open and let out some of the fixative from the Marriotte's bottle into the beakers. The beakers, which contain the embryos, are ranged round the margin of a divided circle drawn on the table F. It may be seen that, according to the strength of the fixative, the amount of fluid in the beakers, and the number of pegs inserted in the dial face, almost any desired fixation may be obtained for any one or more sets of embryos. For further details of this ingenious apparatus the original should be consulted.

Preparing Germ Cells of Pedicellina Americana.*—L. I. Dublin fixed the material in corrosive sublimate with 5 p.c. acetic acid. The stains employed were Heidenhain's haematoxylin, Auerbach's fluid, thionin, and Flemming's triple stain ; but the first gave by far the best results. The colonies were imbedded and sectioned *en masse*, and in this way there were obtained on the same slide, male and female individuals of all ages.

Removing Avian Blastoderms.†—E. A. Andrews finds that by the following method good preparations of blastoderms can be obtained. It consists essentially in separating the blastoderm from the vitelline membrane and of fixing it partially, and then separating it from the yolk while the latter is still fluid.

To accomplish this result, picro-sulphuric acid is injected between the blastoderm and the vitelline membrane. When the blastoderm is partially fixed and become coherent, it is removed with the yolk.

The pipette used has the upper part of sufficient size to hold a fair quantity of fixative, while the lower end is drawn to a point, the extremity being bent at an angle.

Examination of Bone Marrow.‡—C. Price Jones obtains marrow from ribs or vertebræ by squeezing it out of the bone with forceps and transferring on a platinum loop to the following dissociating fluid. The latter is prepared by diluting glycerin with ammonia-free distilled water to form a 10 p.c. solution, and titrating this against decinormal sodium hydrate, using phenolphthalein as indicator. The initial reaction of this solution varies from $+0{\cdot}1$ to $+0{\cdot}5$ (Eyre's scale), and has a specific gravity of $1{\cdot}029$ at $15{\cdot}7^{\circ}$ C. A loopful of 10 p.c. glycerin is placed on a coverslip, and to this a loopful of the marrow emulsion is added and spread over the surface of the slip. The film is then air-dried and afterwards fixed and stained with the Jenner bloodstain. It is then washed with distilled water, dried, and mounted. Care should be taken to avoid making the emulsion too concentrated or the films too thick.

Fixation of Tissues by Injection into the Arteries.§—B. D. Myers is enthusiastic over the procedure he adopts for fixing tissues. The

* Ann. New York Acad. Sci., xvi. (1905) pp. 1–64 (3 pls.).
† Zeitschr. wiss. Mikrosk., xxi. (1904) pp. 177–9 (1 fig.).
‡ Brit. Med. Journ., 1905, i. p. 409.
§ Johns Hopkins Hosp. Bull., xvi. (1905) pp. 66–8 (1 fig.).

animals are injected by means of an airblast apparatus or aspirator to which a manometer is attached for indicating the pressure.

The vascular system is first washed out with normal saline and then injected with the fixative heated to 40° C. The solutions used were sublimate, formalin, and Hermann's fluid. The results appear to have been excellent.

VASOIN, B.—**Ueber die Veräuderungen des Rückenmarkes bei der Fixierung.**
[Calls attention to the different histological appearances in the peripheral and central portions of spinal cord after fixation.]
Zeitschr. wiss. Mikrosk., xxi. (1904) pp. 420–31 (1 pl.)

(3) Cutting, including Imbedding and Microtomes.

Paraffin Imbedding Bath.*—The paraffin bath, invented by F. Fuhrmann, is designated a universal paraffin imbedding thermostat, as it is adapted for *in vacuo* as well as the ordinary impregnation. The con-

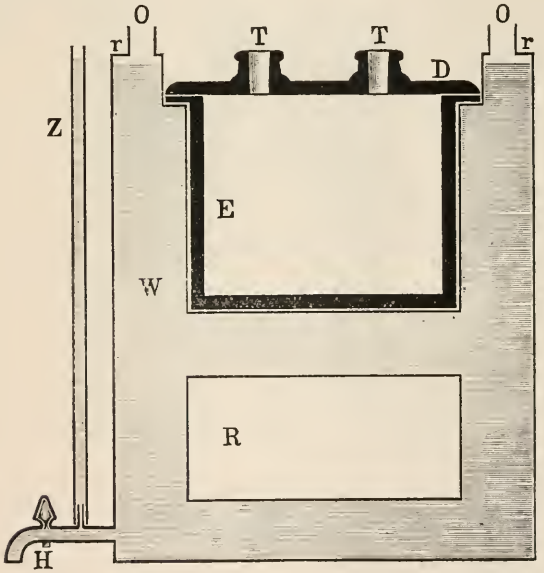

FIG. 69.

struction is shown in the accompanying illustrations (figs. 69, 70). R is the ordinary and E the vacuum bath. O, O are openings for thermometer and thermo-regulator. Z is the water-level, and H the outflow-tap. D is the lid of the vacuum bath, and the two holes therein are for a thermometer and the exhaust tube which is provided with two stop-cocks and a manometer. The case is made of copper and is covered

* Zeitschr. wiss. Mikrosk., xxi. (1904) pp. 462–7 (2 figs.).

with linoleum. Fig. 69 shows the bath in section. Fig. 70 gives the outside view of the apparatus. The air pump and other accessories thereto are omitted.

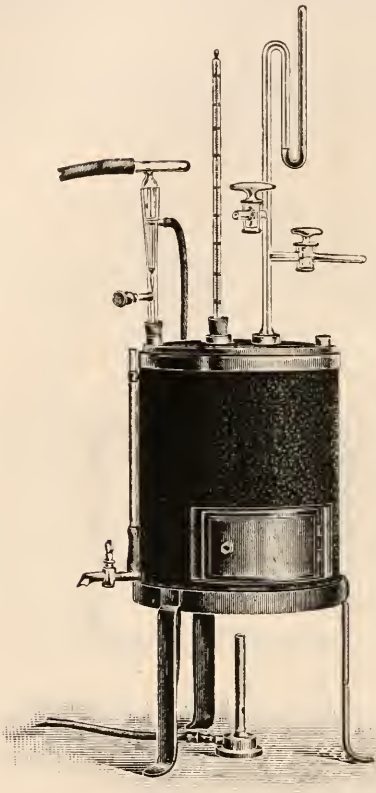

Fig. 70.

Reichert's Medium Microtome.*—The section-cutting in this apparatus (fig. 71) is regulated by the draw-back of the knife, so that, at pleasure, a thickness of from 0·002–0·02 mm. may be automatically obtained, and a series of uniformly thick sections produced. As the object is only moved vertically, a much shorter bed-length will suffice than in oblique microtomes. The object can be directly inserted, or imbedded in paraffin, or celloidin, in the usual way. The bed and frame are made of cast-iron. The micrometer screw is worked with especial care, and has a diameter of 10 mm. and a pitch of 0·4 mm. A zinc-

* C. Reichert (Vienna), Catalogue No. 25 (Mikroskopie, 1904) p. 58, fig. 29.

plate tray is provided to catch droppings from the machine and keep the working table clean. The bed-length is 28 cm.

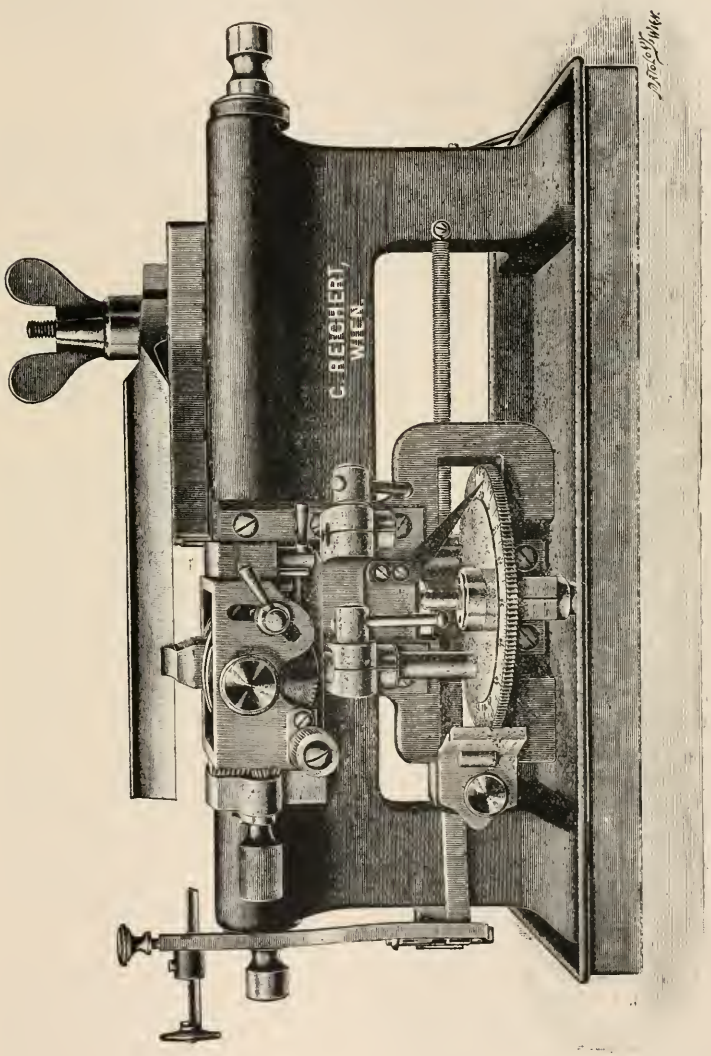

Fig. 71.

Use of Iodine after Fixation in Sublimate.*—R. Pirone finds that sublimate is more rapidly removed when the material is treated in the

* Zeitschr. wiss. Mikrosk., xxi. (1904) pp. 179–81.

section stage, than in bulk. The sections are left for 20–25 minutes in iodo-potassic iodide solution (Mayer's formula), diluted with distilled water to a wine-colour or in 70 p.c. alcohol mixed with the same iodine solution. On removal the sections are washed in alcohol to remove the iodine, and, in case they remain yellow, they are treated with magnesium water.

(4) Staining and Injecting.

Method of Differentiating the Cortical from the Medullary Portions of Adrenals.*—O. V. Sdrinko fixes the adrenals of man and other mammals in 4–5 p.c. formalin (commercial formalin, 5 parts; distilled water, 95 parts). The solution is renewed every two days for a week to a fortnight. The material is then washed for about half an hour in distilled water, and after treatment with 70 and 90 p.c. alcohol, is imbedded in celloidin or paraffin. The celloidin sections are stained with equal parts of ripe Böhmer's hæmatoxylin and distilled water for about five minutes. They are then washed and mounted, or they may be contrast-stained with eosin. By this method the medullary portion is stained much darker than the cortical, and removes any difficulty of distinguishing between the cells of the two parts.

Fugent: a New Stain.†—F. H. Joseph communicated a note on the above at the January meeting of the Pathological Society. The stain consisted of a mixture of alcoholic solutions of methylen-blue, fuchsin, and gentian-violet. The following formula was arrived at after many trials:—(1) Methylen-blue, saturated alcoholic solution, 4 parts; (2) basic fuchsin, saturated alcoholic solution, 3 parts; (3) gentian-violet, saturated alcoholic solution, 5 parts. The mixture is allowed to stand for from three weeks to a month. One part of the stain is diluted with 2 parts of distilled water, and allowed to remain on the dried cover-slip for 45 seconds, washed in water, dried, and mounted. Bacteria appear of a deep red colour, whilst the capsules are of a light violet tint.

Staining Arteries.‡—T. D. Savill recommends acid orcein for staining sections of arteries. The solution gave better results after fixation with alcohol than with bichromate or other fluids. The mixture consists of neutral orcein, 2 grm.; hydrochloric acid, 2 c.cm.; alcohol (70 p.c.), 96 c.cm. The sections are removed from 60 p.c. alcohol, and immersed in the filtered stain for 4 or 5 minutes. After washing in weak spirit, the sections are dehydrated in absolute alcohol and mounted in balsam.

Demonstrating the Finer Structure of the Nervous System.§—E. S. London adopted the following procedure for studying the finer nerve-structures of the leech, white mice, and dogs. Pieces were placed in ammoniated alcohol (4 c.cm. ammonia in 96 p.c. alcohol). After 24 hours the pieces were cut up into slices 2–3 mm. thick, and placed in

* Anat. Anzeig., xxvi. (1905) pp. 172–4 (1 fig.).
† Brit. Med. Journ., 1905, i. p. 136.
‡ Trans. Path. Soc., lv. (1904) p. 412.
§ Archiv Mikrosk. Anat., lxvi. (1905) pp. 111–15 (1 pl.).

fresh ammonia-alcohol for 1–2 days. On removal they were washed for 5–10 minutes in distilled water, and then impregnated with 1 p.c. silver nitrate (3–6 days at 35°–37° C.). On removal the pieces were dried with blotting paper, and then developed in diffused light in pyrogallol solution (pyrogallol 2, formalin 5, distilled water 100). This was followed by alcohol, chloroform, imbedding in paraffin, sectioning. The sections were placed in 1 p.c. gold chloride solution for 5–10 minutes, and then in 5 p.c. sodium hyposulphite for 5–10 minutes, after which they were mounted. If the sections be too thick it is advisable to omit the gold stage. Pieces thus treated are free from precipitate.

Differential Staining of Typhoid Bacilli in Sections.*—H. Bonhoff recommends a modification of Pick and Jacobsohn's method of demonstrating gonococci in tissues for the differential staining of *Bacillus typhosus* in sections. Instead of 8, he uses 4 drops of a saturated alcoholic solution of methylen-blue, and adds these to 15 drops of Ziehl's solution, and 10 c.cm. of distilled water. The stain is first allowed to act for 2 minutes cold, and is then gently warmed. 1 p.c. acetic acid is used for differentiating. After washing, the section is dehydrated in anilin-xylol (equal parts). The typhoid bacilli are deep blue on a red background.

Spore Staining.†—E. Thesing mordants the films with hot 1 p.c. platinum chloride solution. After washing and drying, the film is hot stained, and then thoroughly washed with 33 p.c. alcohol. The film is again dried and contrast-stained in the cold for 3 minutes.

New Method of Spore Staining.‡—Scagliosi recommends that the material should be fixed with van Gehuchten's or Hermann's fluid. After staining with carbol-fuchsin, wash in water or dilute sulphuric acid, and contrast-stain with methylen-blue.

Method of Staining Sensory Nerve Sheaths.§—A. Ruffini describes a method for staining the subsidiary sheath of sensory nerves. (1) Small pieces of skin or muscle are left for half an hour or more in a solution composed of 20 p.c. formic acid 66 parts, and hot saturated aqueous solution of sublimate 34 parts. This mixture must be prepared some time in advance. (2) The pieces are washed quickly in running water. (3) They are placed for 20–40 minutes in 1 p.c. solution of gold chloride. (4) They are mopped up with blotting paper, and placed in 2 p.c. solution of formic acid, and kept in the dark for 12–15 hours. (5) The vessel is then exposed to sunlight for 6–8 hours. (6) The pieces are dried carefully and placed in glycerin. (7) After 8–10 days they are teased out and mounted in glycerin.

New Method for Staining Glycogen.‖—A. Fischer describes the following method for staining glycogen, which was tested on the liver of the pig and mouse. Fixation in alcohol: the paraffin sections are

* Archiv Hygien, l., No. 3. See also Zeitsch. angew. Mikr., x. (1905) p. 301.
† Loc. cit. See also Zeitschr. angew. Mikr., x. (1905) p. 306.
‡ Riforma Med., 1904, No. 49. See also Centralbl. Bakt., 1te Abt. Ref., xxxvi. (1905) pp. 263. § Zeitschr. wiss. Zool., lxxix. (1905) p. 151 (2 pls.).
‖ Anat. Anzeig., xxvi. (1905) pp. 399–400.

placed in alcohol and passed straight away to a 10 p.c. aqueous solution of tannin for 10–15 minutes. The sections are washed in 1 p.c. solution of potassium bichromate and then placed for 10-15 minutes in 10 p.c. potassium bichromate for fixation. The glycogen is by this time almost insoluble, and will stand washing with water and staining with aqueous solutions. Staining for 10 minutes in safranin-anilin water solution gives beautiful pictures. After staining, the preparation is rapidly treated with alcohol and xylol, and mounted in balsam.

Other basic anilin dyes, such as gentian-violet, methylen-blue, etc., may be used ; these stain only the glycogen. The acid anilin dyes do not stain.

Pyronin Methyl-Green.*—Whitney recommends a 1 p.c. solution of these two pigments, mixed in the proportion of 4 parts of the pyronin to 1 part of the methyl-green solution, as an effective double stain for cells and bacteria.

Methods of Staining the Diphtheria Bacillus.†—J. M. Blumenthal and M. Lipskeron in an interesting and useful contribution on the comparative value of the differential methods for staining the diphtheria bacillus, award the palm to the methods of Falières and of Ljubinsky. In the former the staining solution is composed of methylen-blue 2, borax 0·5, distilled water 100, absolute alcohol 8 drops.

After washing in tap-water the stained film is further treated for half-a-minute with a 1 : 1000 aqueous solution of vesuvin. The granules of the bacteria are stained blue, and show up well on the brown background.

Ljubinsky's method consists in staining the fixed film for ½–2 minutes with a solution composed of Merck's pyoktanin 0·25 ; acetic acid (5 p.c.) 100.

After washing with water the preparation is after-stained for half-a-minute with a 1 : 1000 solution of vesuvin.

The results are stated to be excellent, but the authors think they have improved on it by substituting chrysoidin for vesuvin, using, however, a solution three times as strong.

Eleven other methods are described, but for these the original should be consulted.

Staining Negri's Bodies in Hydrophobia.‡—G. Fasoli adopts the following method. The material is fixed in sublimate solution, and the sections first stained with aqueous eosin. After washing with water they are differentiated with alcohol, made alkaline with a few drops of 1 p.c. soda solution. The sections are again washed, and then stained with methylen-blue, until they are of a pale blue colour. After dehydration they are cleared up with xylol, and mounted in balsam.

New Yolk Stain.§—K. Peter gives the following modification of Spuler's iron cochineal stain. 10 grm. of powdered cochineal are boiled in 250 c.cm. distilled water, and the decoction evaporated down to

* Boston Med. and Surg. Journal, May 1903.

† Centralbl. Bakt., 1te Abt. Orig., xxxviii. (1905) pp. 359–66.

‡ Policlinico sez. Med., 1904, No. 7. See also Centralbl. Bakt., 1te Abt. Ref., xxxvi. (1905) p. 385.

§ Zeitschr wiss. Mikrosk., xxi. (1904) pp. 314–20.

50 c.cm. After filling up to 150 c.cm. with distilled water, it is filtered, and to every 40 c.cm. of the filtrate, 3 drops of pure hydrochloric acid are added. After the precipitate has subsided, the clear orange-red fluid is ready for use.

Paraffin sections are incubated in the stain for 18–24 hours, and then, after a washing with distilled water, are treated for ½–2 minutes with 1 p.c. iron-alum solution, which, should they turn black, is changed. The sections are again washed and then passed through graded alcohols to xylol and balsam.

For staining *en masse* the pieces are incubated for 48 hours, and mordanted with the iron-alum solution; if a 2½ p.c. be used, then for 15–60 minutes; if a 1 p.c., for 12–24 hours.

The preparations show the chromatin of the nuclei black, the protoplasm grey, the yolk granules red, nucleoli red.

If the centrosomes are to be stained, the following modification must be adopted. The sections are stained for one day in the cochineal decoction, and, after a short mordanting, are placed in Weigert's hæmatoxylin solution for two days, after which they are differentiated in 2½ p.c. iron-alum solution.

The material used was chiefly the larvæ of *rana esculenta*, and the best fixative was found to be Zenker's fluid.

Demonstrating Fatty Infiltration in Tissue.*—P. Foà has abandoned the method of fixing the material with Flemming's fluid and staining with safranin and picric-alcohol, for Marchi's method, which he finds more effective.

The pieces are placed for 3 or 4 days in Müller's fluid, and then transferred for a similar period to the osmic-bichromate mixture. On removal they are washed and then hardened in alcohol. By this procedure the elasticity of the tissues is well preserved, the osmic acid penetrates thoroughly, and the sections can be stained with hæmatoxylin and eosin, or by Van Gieson's method.

KAPPERS, C. U. A.—**Ein kleiner apparat für die Gesamtbehandlung vieler Objektträger.** (A clamp for holding together and simultaneously treating several slides.) *Zeitschr. wiss. Mikrosk.*, xxi. (1904) pp. 185–8 (1 fig.).

LICHTENBERG, S.—**Objektträgergestell zur gleichzeitigen Behandlung zahlreicher Schniffe.** (A frame for the simultaneous treatment of numerous sections.) *Tom. cit.*, pp. 321–4 (1 fig.).

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

Copal as a Mounting Medium.†—J. G. R. Powell recommends copal dissolved in absolute alcohol for mounting vegetable sections. Though somewhat difficult to prepare, it acts well. It is not suitable for diatoms. Apparently it takes about two months to dissolve properly.

Method for Removing Small Quantities of Centrifuged Deposit.‡—G. C. Van Walsem uses a Pravaz's syringe, and fills the canula and

* Atti R. Acad. Sci. Torino, xl. (1905) pp. 65–78 (1 pl.).
† English Mechanic, lxxxi. (1905) p. 133.
‡ Zeitschr. wiss. Mikrosk., xxi. (1904) pp. 172–4 (1 fig.).

lower part of the syringe with olive oil. The whole or any part of the deposit is sucked up by turning round the screw ring on the piston rod. The canula should be quite 4 cm. long, and have the ends rounded off.

(6) Miscellaneous.

Modification of Cornet's Forceps.*—V. Schläpfer describes the following modification of Cornet's forceps. One half of the instrument (fig. 72) is at the same time the spring and the handle. To the rounded ends are jointed on the grips, the ends of which are curved so that when closed they form an ellipse. The great advantage of this form of

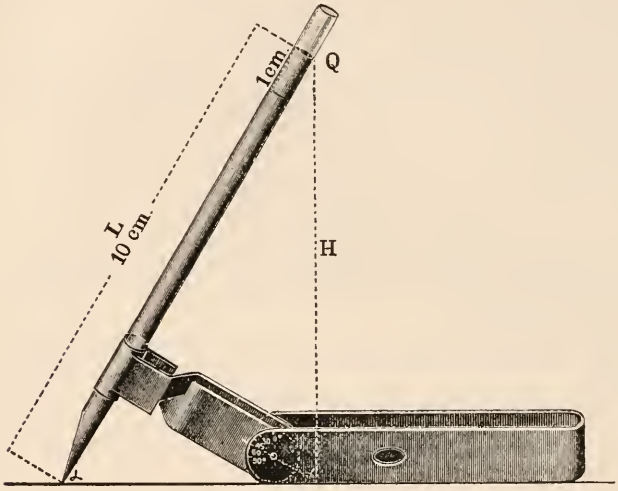

Fig. 72.

grip is that the staining fluid does not run under as it does in the ordinary pattern. It will serve to hold capillary pipettes as shown in the illustration, as well as cover-glasses.

Simple Method for Distinguishing between Human and Animal Blood.†—H. Marx and E. Ehrnrooth describe a method for distinguishing between the blood of man and the lower mammalia. It depends on the observation that the action of homologous and heterologous sera on fresh human blood is recognisable under the Microscope. Human red corpuscles are rapidly agglutinated by an alien serum, the erythrocytes becoming pale and accumulating in clumps directly after contact with the foreign serum. The technique is simple. A solution of the suspected blood is made with 0·6 p.c. salt solution. Some of this is placed on a slide, and to it is added a droplet of fresh human blood. The two

* Zeitschr. wiss. Mikrosk., xxi. (1904) pp. 458-60 (1 fig.).
† Münchener Med. Wochenschr., li. (1904) p. 293 (2 figs.).

are stirred together with a glass rod, and the mixture having been covered with a slip, is observed under the Microscope.

The fresher the heterologous blood, and the more concentrated the solution, the more rapid is the reaction.

Permanent preparations showing the reaction may be made in the usual way.

Apparatus for Making Wax Plates for Reconstruction Models.*—A. Fleischmann uses a smooth cast-iron plate (60 by 90 cm.), levelled by means of adjusting screws as a surface for rolling out wax plates. The roller is 50 cm. long, and 4 cm. in diameter, and is made of steel. A circular disc is inserted between the handles and each end of the roller for the purpose of regulating the thickness of the plate. This device is far more effective than placing strips of glass or metal on the table.

Fig. 73.

Needle for obtaining Blood for Examination.†—J. Ries describes a needle which he has invented for the purpose of pricking the skin to obtain blood for microscopical and other examinations. As will be seen from the illustration (fig. 73), the head, which is perforated for the reception of the needle, is actuated by a spring. The needle is fixed by a screw, the head of which is pressed into the side groove. By exerting slight pressure on the knob the spring is released, and a rapid and painless incision made in the skin. The upper end of the case serves to keep spare needles in.

Examining Caoutchouc by the Aid of the Microscope.‡ P. Breuil examines caoutchouc by reflected and by transmitted light, by the aid of a Microscope which is also fitted up for photographing the preparations. Thin films are obtained by evaporating solutions of caoutchouc in divers solvents. Delicate transparent strips may also be used. For examining with reflected light, an arc light of 20 amperes is necessary, and the specimens used are prepared after the manner used in metallography, i.e. the pieces are shaped, polished, and etched with sulphuric and nitric acids. Microscopical inspection enables the observer to detect the nature and purity of the rubber, as well as the presence of impurities and adjuvants.

Schaper, A.—**Eine Methode zur Durchschneidung grober Wachsplatten Modelle.**) (Method for cutting through large wax plates by means of a thin metal wire heated by the electric current.) *Zeitschr. wiss. Mikrosk.*, xxi. (1904) pp. 200–6 (4 figs.).

* Zeitschr. wiss. Mikrosk., xxi. (1904) pp. 479–80 (2 figs.).
† Tom. cit., pp. 445–6 (1 fig.)
‡ Comptes Rendus, cxl., (1905) pp. 1142–3.

Metallography, etc.

The Defects in Ingot-Iron Castings.*—K. H. Wedding classifies the defects in ingot-iron castings, usually termed steel castings, as (1) blowholes, (2) shrinkage cavities, (3) gas cavities from other sources, (4) surface markings, (5) cracks. The ingot-iron is generally made in the open hearth furnace, or in the crucible, seldom in the Bessemer converter. Blowholes are caused by the liberation of gas during solidification of the molten metal, all carbonised iron when fluid having the property of absorbing gases. The addition of silicon or aluminium prevents the formation of blowholes by causing the gases to remain alloyed with iron, manganese having a contrary effect. Shrinkage cavities—"pipes"—are a consequence of the contraction of iron during solidification and cooling, and are usually unavoidable. Small pores between the crystals, only visible by means of the Microscope, may be attributed to the separation of gas, and are essentially harmless. Surface markings have been attributed to segregation. Cracks are caused by contraction, and their formation is influenced by chemical composition. Cavities may be filled by electric welding, by pouring molten iron over the defective part, by thermit treatment, or by hammering in iron at a welding temperature. The results of filling by these methods are frequently not satisfactory.

Notes on the Etching of Steel Sections.†—W. C. Smeaton distinguishes the processes by which the micro-constituents may be differentiated on the polished surface of a metal, as (1) heat-tinting, (2) electro-deposition, (3) polishing in bas-relief, (4) use of solvent etches. The last method is the only one fully dealt with by the author. The nature of the polished surface affects the etch: crystals of the same constituent may be differently coloured by a reagent owing to the plane surface of the section cutting them in different relations to their crystallographic axes. Solid solutions are attacked most rapidly. α-, β-, and γ-iron are attacked at different rates by the same reagent. Beilby has shown that surface flow on metals, caused by the mechanical work involved in polishing, results in the formation of a surface film, differing from the mass of the metal. This film must be removed by the etching agent in order to develop the true micro-structure. Carborundum and wet rouge used as polishing agents on surfaces at high speeds, lead to the formation of pronounced films. Alumina is not so liable to cause films. Surface flow may be diminished by care in polishing. 2 p.c. sulphuric acid, acting at 60° C. for 2 minutes, removes films, producing only a very light etch. The etching action is approximately proportional to the degree of electrolytic dissociation of the active etching agent in the case of water solutions of nitric acid, ammonium nitrate, etc. The author adds an indifferent substance with a common ion, e.g. potassium or sodium nitrate with nitric acid, to alter the electrolytic dissociation. Solutions of potassium and sodium salts are without noticeable etching action. Ammonium salts have an etching action; concentrated solutions,

* Iron and Steel Mag., ix. (1905) pp. 209-21.
† Tom. cit., pp. 222-30 (1 fig.).

however, do not give good results: 2 p.c. ammonium nitrate has been found most satisfactory, especially at 40° C. Persulphates have also been employed. Reaction velocity is of importance, and is in most cases increased by rise of temperature.

The Effects of Momentary Stresses in Metals.*—B. Hopkinson gives the results of his experiments in which the extension of copper and iron wires, subjected to momentary stresses, was measured. A piece of wire, of No. 10 gauge, and about 30 ft. long, was hung vertically, being fixed at its upper end. It was kept taut by a tension (20 to 200 lbs.) applied at the lower end, and a cylindrical 1 lb. weight allowed to fall down the wire, being arrested by a stop fixed to the end of the wire. The extension on 20 in. was determined by an arrangement devised for the purpose, and was found to be in close agreement with the extension calculated from J. Hopkinson's formula. The author concludes that iron and copper wires may be stressed much beyond the static elastic limit, and even beyond their static breaking loads without the proportionality of stresses and strains being substantially departed from, provided that the time during which the stress exceeds the elastic limit is of the order of $\frac{1}{1000}$ second or less.

Further Observations on Slip-Bands in Metallic Fractures. Preliminary Note.†—W. Rosenhain has employed a new method of investigating the micro-structure of metals, to meet the criticisms of F. Osmond and others on the conclusions reached by J. A. Ewing and the author, as to the nature of slip-bands. The difficulties met with in the examiation of a transverse section of a metallic surface, upon which slip-bands had been produced, were overcome by electro-deposition of another metal on the surface. The piece of metal was then cut through and polished, a sectional elevation of the surface being thus obtained. Strips of the mildest steel were polished along a short portion of their length, and were then strained in tension to produce slip-bands on the polished surface. A thin film of copper was deposited from a bath of copper cyanide. The pieces were then removed to the usual copper sulphate bath, and a thicker layer (4–5 mm.) deposited. Sections were made, roughly parallel to the direction of the original tensile strain, at right angles to the surface showing slip-bands. Calcined magnesia was used as the final polishing medium, as rouge eroded the surface. The film of metal smeared over the boundary was removed by slight etching with picric acid. A clearly defined boundary line between iron and copper was then visible, showing well marked steps or serrations. The author concludes that the sectional views of slip-bands thus obtained, strongly confirm the theory of deformation by slip. He suggests that the method of investigation described might be applied to the study of a number of questions, and has employed it in obtaining sections of fractures, with satisfactory results.

Effects of Stress upon Metals.‡—E. G. Crocker describes the behaviour of metals when subjected to stress. The recovery of over-

* Proc. Roy. Soc., lxxiv. (1905) pp. 498–506 (2 figs.).
† Tom. cit., pp. 557–62 (4 figs.).
‡ English Mechanic, lxxxi. (1905) pp. 146–7.

strained specimens is hastened by raising the temperature, and retarded or arrested by lowering the temperature. The formation of slip-bands on a polished surface, subjected to tensile stress, is described.

Metallography of Quenched Steels.*—M. Kourbatoff has experimented with a large number of etching reagents, to determine which are the most useful for the differentiation of the constituents of quenched steels. Three samples of steel, selected to give a great variety of constituents, were etched with the different solutions; they were (1) steel containing 1·8 p.c. carbon, quenched during the recalescence; (2) the same, quenched when one end of the specimen was at its melting point, the other end being cold; (3) steel containing 15 p.c. nickel, 0·8 p.c. carbon. The possible causes of the varying colorations of different constituents upon etching are discussed, the author concluding that the colorations are probably due to the formation of complex organic compounds, in which the nitro groups present in many reagents are concerned. The rapidity of action of solutions of nitric or picric acids appears to depend on the electric conductivity of the liquid. The most suitable reagents for distinguishing the constituents are: (*a*) solution of 4 p.c. nitric acid in iso-amyl alcohol; (*b*) solution of 20 p.c. hydrochloric acid in iso-amyl alcohol, to which is added $\frac{1}{5}$ of its volume of a saturated solution of nitraniline or nitro-phenol in ethyl alcohol. The best reagents for colouring sorbite and troostite without acting upon other constituents are: (*c*) equal parts of a solution of 4 p.c. nitric acid in acetic anhydride, methyl alcohol, ethyl alcohol, and iso-amyl alcohol; (*d*) 3 parts of a saturated solution of nitro-phenol, 1 part of a 4 p.c. solution of nitric acid in ordinary alcohol.

From experiments on re-heating quenched samples, the author concludes that: (1) during re-heating austenite changes to sorbite; (2) martensite decomposes into layers of cementite and crystals of sorbite; (3) at 300° the whole of the martensite and austenite are changed to sorbite and cementite; (4) troostite remains unchanged up to 400°. The hardness of austenite appears to be variable in different samples and in different parts of the same sample.

The Cooling of Steel in Quenching.†—P. Lejeune gives a number of cooling curves, obtained by the Saladin photographic method—in which two galvanometers are employed—of samples of steel quenched in different liquids. The author concludes that quenching in small volumes of mercury is less rapid than quenching in water. The influence of the viscosity, boiling-point, and specific heat of the quenching liquid were also investigated.

Aluminium Steels.‡—L. Guillet has continued his researches on alloy steels. Two series were employed, one containing 0·15 p.c., the other 0·75 p.c. carbon, the aluminium varying in each series from 0 to 15 p.c. Physical properties and microstructure were studied in the steel (1) as forged, (2) quenched, (3) annealed. Up to 2 p.c. the influence of aluminium is slight. The pearlite appears to be more

* Rev. Metallurgie, ii. (1905) pp. 169–86 (23 figs.).
† Tom. cit., pp. 299–311 (10 figs.).
‡ Tom. cit., pp. 312–27 (24 photomicrographs).

compact and to lose its lamellar structure, these effects being more pronounced as the percentage of aluminium increases. With the higher proportions of aluminium a new constituent, exhibiting all the characteristics of cementite, is distinguished. The belief that aluminium causes the separation of graphite in steel is shown to be erroneous. Steel containing 3 p.c. or more of aluminium is brittle. Aluminium also causes some increase in hardness. The aluminium appears to exist in the state of solution in the iron, and when notable quantities of aluminium are present, this solution is incapable of dissolving carbon, even at high temperatures.

FLATHER, D.—**Case-hardening.**
[Describes the most modern methods of carrying out this operation.]
Iron and Steel Mag., ix. (1905) pp. 305–22 (1 fig.)

GIRAUD—**Constitution du Cuivre Oxydé.** *Rev. Metallurgie*, ii. (1905). pp. 297–8 (5 figs.).

Special Nickel-Steel Alloys. *Iron and Steel Mag.*, ix. (1905) pp. 256–60.

STEAD, J. E.—**Science in the Iron Foundry.** *Tom. cit.*, pp. 322–34.

The Ashe-Finlayson "Comparascope."

(An instrument to facilitate comparisons being made between different objects by projecting their images together into the field of the Microscope.)

By D. Finlayson, F.L.S.

The desirability of some method whereby two objects may be simultaneously examined in the same field of view, is often experienced by microscopists and analysts, especially by those who are engaged in work which necessitates frequent comparisons being made between objects which present very similar appearances.

It seems strange, therefore, that no attention, so far as can be ascertained, has hitherto been directed towards the construction and perfecting of apparatus to serve this purpose.

In examining objects of a totally different appearance and structure, the use of such an adjunct would be obviously unnecessary—in fact, its employment would be a positive disadvantage, by its limiting the area of the object seen to one-half of the field of view; but when the differences of structure or variations of form are too slight to be readily perceived, then the ability to place by instrumental means the subject to be examined, and the standard by which it is to be compared, side by side, in the same field, is an advantage so great that its value need not be dwelt upon.

The purpose in view could be carried out most effectively by the construction of a complete Microscope specially built for the purpose, but as such an instrument would necessarily be expensive, and limited in the scope of its general utility, it seems desirable to confine the problem to the construction of an apparatus which can be used as an adjunct to, and in conjunction with any existing type of Microscope, of which it should not require the alteration or special adaptation of any part, nor interfere with its use as an ordinary instrument when required.

The device now described (fig. 82) fulfils these conditions in a manner that promises complete success.

The construction is based upon the fact that if an objective be placed at right angles to the axis of a Microscope, any rays of light passing through it may be deflected up the tube to the ocular by means of a mirror placed at a suitable angle, and that any object in the focus of the secondary objective will be seen simultaneously with the image produced by the direct rays from the primary objective.

Two images will thus be transmitted to the ocular, and appear superimposed upon each other, and consequently blurred.

To prevent this overlapping and confusion of images, it is necessary to confine each set of rays to one side of the tube and one segment of the field of view. This is accomplished by inserting into the draw-tube a removable diaphragm or division plate,

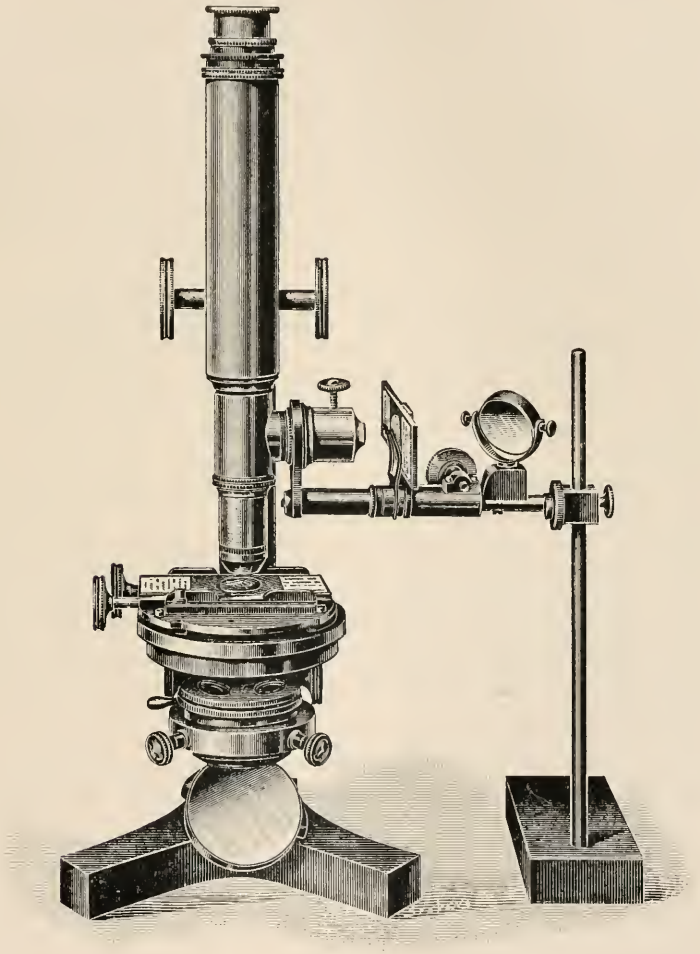

Fig. 82.

which extends from the fitting containing the reflector to within an inch or so of the ocular, the tube thereby being divided into two semi-cylindrical sections, each of which transmits rays from a different object, and the image of which will occupy separate segments of the field of view.

The instrument is the joint invention of Messrs. Ashe and Finlayson, and was designed to suit the special requirements of the latter in his examination and comparison of food materials, meals, starches, and fibres; also for use in the medical profession for those engaged in research work, such as the comparison and identification of bacteria and disease germs of every kind. Hence the name "Comparascope," which has been given to the invention.

It consists of a vertical pillar fixed in a heavy case. To this pillar is clamped at any required height a horizontal bar, which carries at one end an objective, and at the other a mirror capable of universal motions, whilst between the two there is a stage or slide-clip, which traverses the bar by a rack-and-pinion movement for focussing purposes, as the position of the objective is required to be a fixture.

On the nose-piece of the Microscope is screwed a fitting consisting of a tube an inch long, with a hole in the middle of one side. Inside this aperture is fixed a reflector of tinted glass, worked to a perfect plane on its upper surface. It is placed at an angle of 45° to the axis of the tube, beyond which it does not extend, in order to allow free passage for the light from the primary objective.

A prism might be employed, but a reflector is more simple—in fact the inventors in their early experiments used a Becks' vertical reflector, with a prism turned to project the light upwards instead of downwards, and they found the result was quite satisfactory.

For use with high powers and wide-angled lenses a condenser will necessarily have to be employed to illuminate the secondary objective, and this is best effected by attaching a condensing system to the movable stage, instead of giving it independent movement on the same bar.

In use the instrument is very simple, and there is no difficulty in getting the fields equally illuminated, and if the lenses are duplicates, the definition and magnification should be the same.

*An Optical Paradox.**

By Lord Rayleigh, O.M., F.R.S.

Consider the following combination:—A point source A of approximately homogeneous light (λ) is focused by the lens LL upon the object-glass of a telescope T. In its turn the telescope is focused upon L. According to geometrical optics the margin of the lens L should be seen sharp by an eye applied to the telescope; but when we consider the limitation of aperture at the object-glass of the telescope, we come to the conclusion that the definition must be very bad. The image of A at C constitutes the usual diffraction pattern of which most of the light is concentrated in the central disc. The diameter of this disc is of the order $\lambda . LC/LL$. If this be regarded as the effective aperture of T, the angular resolving power will be found by dividing λ by the above

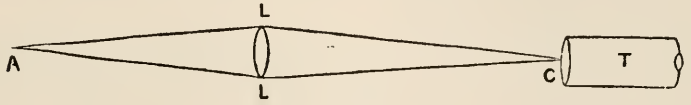

Fig. 83.

quantity, giving LL/LC; so that the entire angular magnitude of the lens LL is on the limits of resolving power.

If this be admitted, we may consider next the effect of enlarging the source A, hitherto supposed to be infinitely small. If the process be carried far enough, the object-glass of T will become filled with light, and we may expect the natural resolving power to be recovered. But here we must distinguish. If the enlarged source at A be a self-luminous body, such as a piece of white-hot metal or the carbon of an electric arc, no such conclusion will follow. There is no phase-relation between the lights which act at different parts of the object-glass, and therefore no possibility of bringing into play the interferences upon which the advantage of a large aperture depends. It appears, therefore, that however large the self-luminous source at A may be, the definition is not improved, but remains at the miserably low level already specified. If, however, the source at A be not a real one, but merely an aperture through which light from real sources passes, the case may be altered.

Returning to the extended self-luminous source, we see that the inefficiency depends upon the action of the lens L. If the glass

* Reprinted by permission of the author from Phil. Mag., June 1905, pp. 779–81.

be removed from its seat, so that A is no longer focused upon the object-glass, the definition must recover.

I do not know how far the above reasoning will seem plausible to the reader, but I may confess that I was at first puzzled by it. I doubt whether any experimenter would willingly accept the suggested conclusion, though he might be unable to point out a weak place in the argument. He would probably wish to try the experiment; and this is easily done. The lens L may be the collimating-lens of an ordinary spectroscope whose slit is backed by a flame. The telescope is removed from its usual place to a distance of say 10 feet and is focused upon L. The slit is at the same time focused upon the object-glass of the telescope. Although the image of the slit is very narrow, the definition of L as seen in the telescope does not appear to suffer, the vertical parts of the circular edge (parallel to the slit) being as well defined as the horizontal parts. If, however, at the object-glass a material screen be interposed provided with a slit through which the image of the first slit can pass, the definition at the expected places falls off greatly, even although a considerable margin be allowed in the width of the second slit.

This experiment gives the clue to the weak place in the theoretical argument. It is true that the greater part of the light ultimately reaching the eye passes through a very small area of the object-glass; but it does not follow that the remainder may be blocked out without prejudice to the definition of the boundary of the field. In fact, a closer theoretical discussion of the diffraction phenomena leads to conclusions in harmony with experiment.

In the case of a point-source and the complete circular aperture LL, the question turns upon the integral

$$\int_0^\infty J_0(\alpha x)\, J_1(\beta x)\, dx,$$

J_0, J_1 being the Bessel's functions usually so denoted. The integral passes from 0 to $1/\beta$, as α passes through the value β *.

If the aperture of LL be reduced to a narrow annulus, the integral to be considered is

$$\int_0^\infty J_0(\alpha x)\, J_0(\beta x)\, x\, dx.$$

This assumes an infinite value when $\alpha = \beta$ †.

If the apertures be rectangular, the integrals take still simpler forms.

* A theorem attributed to Weber See Gray and Matthews' "Bessel's Functions," p. 228.

† See "Theory of Sound," § 203, equations (14). (16).

New Hot Stage.

By W. S. Lazarus-Barlow, M.D., F.R.C.P.

Plate VII.

The inventor exhibited and described at the June Meeting a new form of warm stage, which can be heated by either gas or oil. The principle of the apparatus is that of a balance and a manometer combined. The stage itself is a brass box, which contains a series of flattened and communicating glass bulbs, connected with a mercury manometer of particular shape. A glass tap is fused into the manometer between it and the stage itself. Over the mercury in the open limb of the manometer is an iron float, suspended by silk from one arm of the beam of a balance. This beam is supported on a knife-edge, and is provided with an adjustable weight at the end distal from the warm stage, and a silver rod suspended by loops of platinum-iridium at the proximal end. The silver rod is bent downwards at one end, and is placed at right angles with the beam, both being in the horizontal plane. The bent portion of the silver rod dips into a small bath, which is brazed to the side of the warm stage, and contains paraffin of M.P. about 58°.

The apparatus works as follows. Heat from a flame is applied to the silver rod at the unbent end, and is conducted to the paraffin in the bath at the side of the stage, and thence to the stage itself. Variations in the temperature of the stage are conveyed to the air in the glass bulbs within the stage, and express themselves by expansion or contraction of that air, and therefore by variations in the level of the mercury in the manometer. These variations of the level of the mercury allow the entire weight of the iron float in the distal limb of the manometer to act upon the beam (when the mercury recedes sufficiently to lose contact with the float), or remove the entire weight of the float from the beam (when the mercury rises sufficiently to slacken the silk thread connecting the beam and the float). Intermediate positions of the mercury, of course, allow intermediate proportions of the weight of the float to act upon the beam. Hence the weight on the side of the beam towards the warm stage varies inversely as the volume of the air within the glass bulbs, i.e. inversely as the temperature of the stage itself. Consequently (the beam being free to move about its fulcrum) the cooler the stage the deeper the heated silver rod is plunged into the bath of paraffin, and *vice versâ*; this greater immersion of the heated silver rod heats the stage, expands the air in the bulbs, raises the mercury in the distal limb of the manometer, supports the iron float, and allows the beam to revert to its original horizontal position—or

even become somewhat tilted in the opposite direction—with the result that less heat is given to the stage, the stage cools somewhat, and the cycle of events re-commences.

It will have appeared from the last paragraph that the construction of the beam and its component parts is of some importance. The beam itself is made of magnalium — a newly-discovered alloy of magnesium and aluminium, which is rigid and of low specific gravity—in order to re-act readily to slight variations in weight at either end. In commencing work, the beam is so adjusted by means of the adjustable weight and the silk thread attached to the float, that when the entire weight of the float is acting the beam is inclined downwards towards the stage, and the bent portion of the silver rod is well immersed in the paraffin; when the iron float is supported, the inclination of the beam is such that the silver rod is just above the level of the paraffin, and when the float just touches the surface of the mercury, the beam is horizontal.

Having arranged the beam satisfactorily, the glass tap connected with the glass bulbs is turned full open, and heat is applied to the silver rod. As soon as the desired temperature has been reached, as indicated by a thermometer inserted in one side of the stage, the glass tap is turned off, and the oscillations about that temperature commence. The stage shown had been kept at a temperature not varying more than 1° on either side of 100° F. day and night for a week.

In describing the apparatus (fig. 84, pl. VII.) the author referred to many difficulties met with during its evolution, and particularly that dependent upon the existence of an irregular expansion of copper about the temperature of 100° F. It was this which necessitated the employment of glass bulbs to contain the air, instead of allowing the stage itself to act as the air-containing closed box connected with the manometer.

The Bunsen burner for the apparatus is of a new model, being provided with a safety cock for shutting off the gas in case of accidental "firing back." This cock is situated close to the base of the burner on the horizontal tube, and is provided with a long arm, to which a spring is attached. This arm is soldered with soft solder to the bottom of the vertical tube of the burner, and in this position the gas is full on and the spring is stretched. If the Bunsen fires back, the lower part of the burner becomes rapidly heated, the solder melts, and the recoil of the spring turns the cock and shuts off the gas.

The author acknowledged the great help he had received in the preliminary stages from Mr. W. T. Hillier, M.R.C.S., his former assistant in the Cancer Research Laboratories of the Middlesex Hospital, and from Mr. Swift, of Tottenham Court Road, who made the finished apparatus from rough models and drawings.

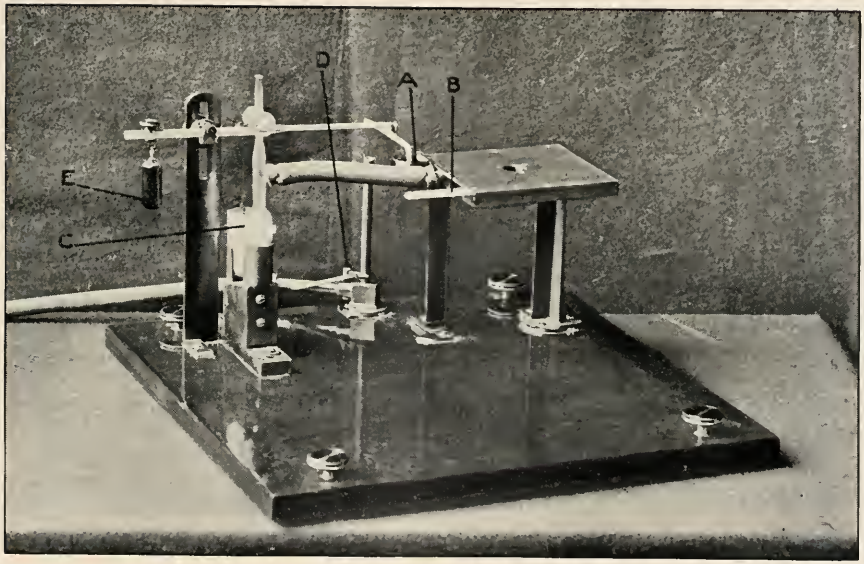

FIG. 84.

A. Points to the paraffin bath brazed to the stage, into which dips the bent end of the silver heat-conducting rod.

B. The thermometer.

C. The manometer, with its glass tap on the limb (nearer the observer), and its open limb, over which hangs the iron float (further from the observer).

D. The spring safety cock attached to the gas supply of the Bunsen burner.

E. The adjustable weight at the distal end of the beam.

[To face p. 420.

MICROSCOPY.

A. Instruments, Accessories, &c.*

(1) Stands.

Koristka's Large Model Mineralogical Microscope.†—This instrument (fig. 85), fitted with the most recent improvements, was constructed under the direction of Professor L. Brugnatelli.

The upper end of the pillar is elongated, in order to allow the use of auxiliary apparatus, such as a Klein's or Federow's plate.

The rotatory stage has a diameter of 120 mm., is divided into degrees, and has a vernier reading to 10′ and even 6′. It also has rectangular movements, with micrometer adjustments, the milled heads of which J K are divided up to 0·01 mm. and 0·04 mm. respectively.

The illuminating apparatus has a special fitting for instantly removing the condenser, and for changing from convergent to parallel light, or *vice versa*.

The polariser is raised by a rack-and-pinion N, and has an iris diaphragm with graduated collar R. The screw-head H is for centring the objectives, and the slit I for a Klein's quartz or other accessory.

The analyser G is easily thrown out of the field, has a rotation of 90° and a graduated scale F. It is supplied with a special lens for maintaining the focal length of the optical system. The ocular tube is moved up and down by rack-and-pinion B; it has a displacement of 36 mm. and has mm. divisions for marking its position.

At its lower end it is fitted with a diaphragm D, and also has a slit C, with a Bertrand lens for observing the axial image.

The upper end of the ocular tube is adapted for the reception of a second analyser, having a circular graduated scale, and also for the insertion of any kind of eyepiece.

Leitz' Mineralogical Stand No. I.‡ — This instrument (fig. 86) corresponds in its dimensions to Stand No. I. in the maker's catalogue. The coarse adjustment is by rack-and-pinion; the fine, by Leitz' new fine adjustment with side-knobs,§ the drum being divided into 100 parts, so that one graduation means a movement of 0·001 mm. Condenser, iris diaphragm, and polariser are raised and lowered by a lateral screw. A three-limbed condenser with iris diaphragm facilitates convenient observation of the axial pictures in the Microscope. Both the upper lenses of the condenser can be drawn out by a lateral lever if one wants to change

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

† Koristka's Catalogue, No. 12, Turin, 1905, p. 31, fig. 15.

‡ Catalogue No. 41 (Mikroskope) 1905, pp. 59-61.

§ J.R.M.S. 1903, pp. 667.

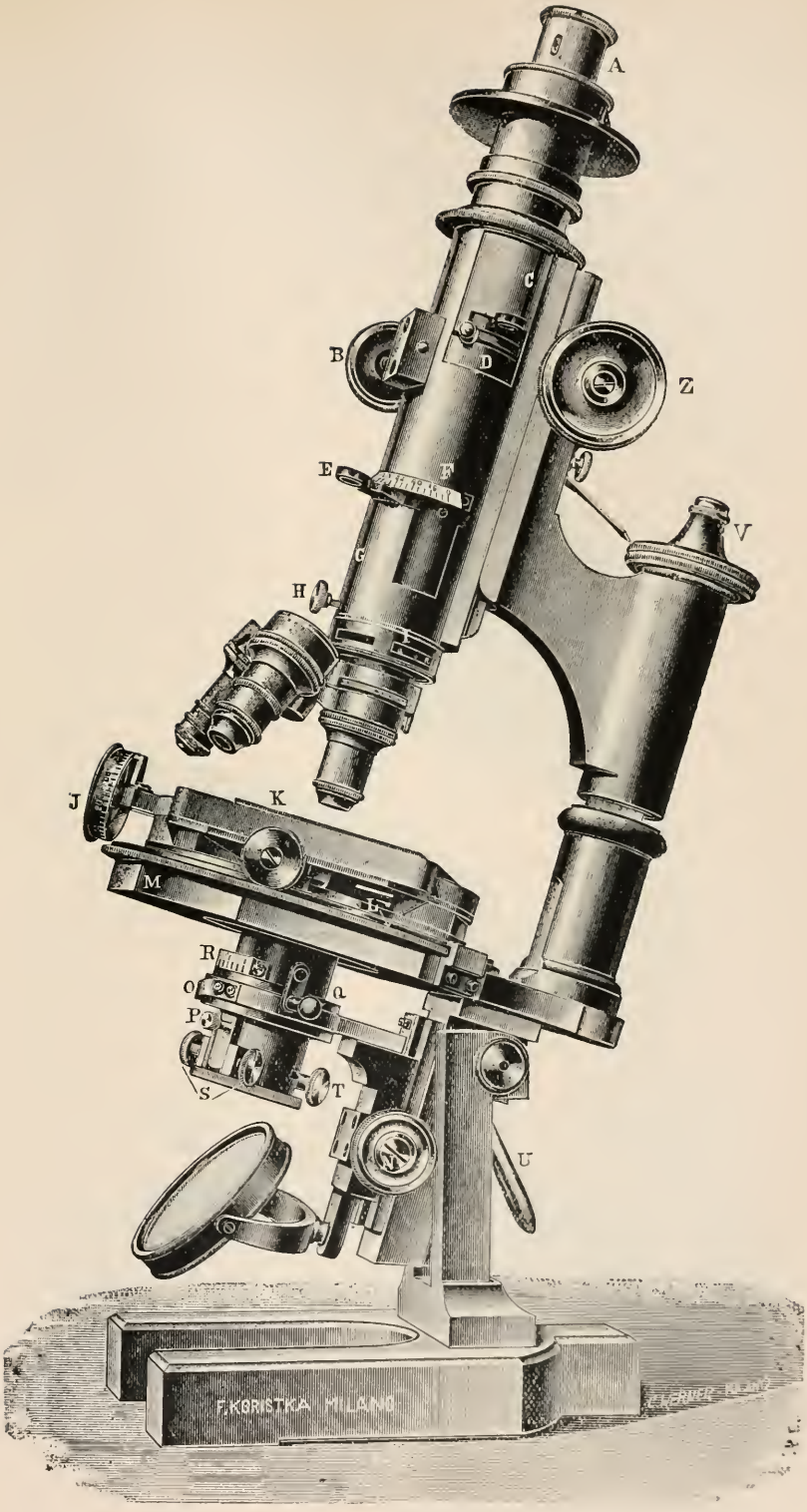

Fig. 85.

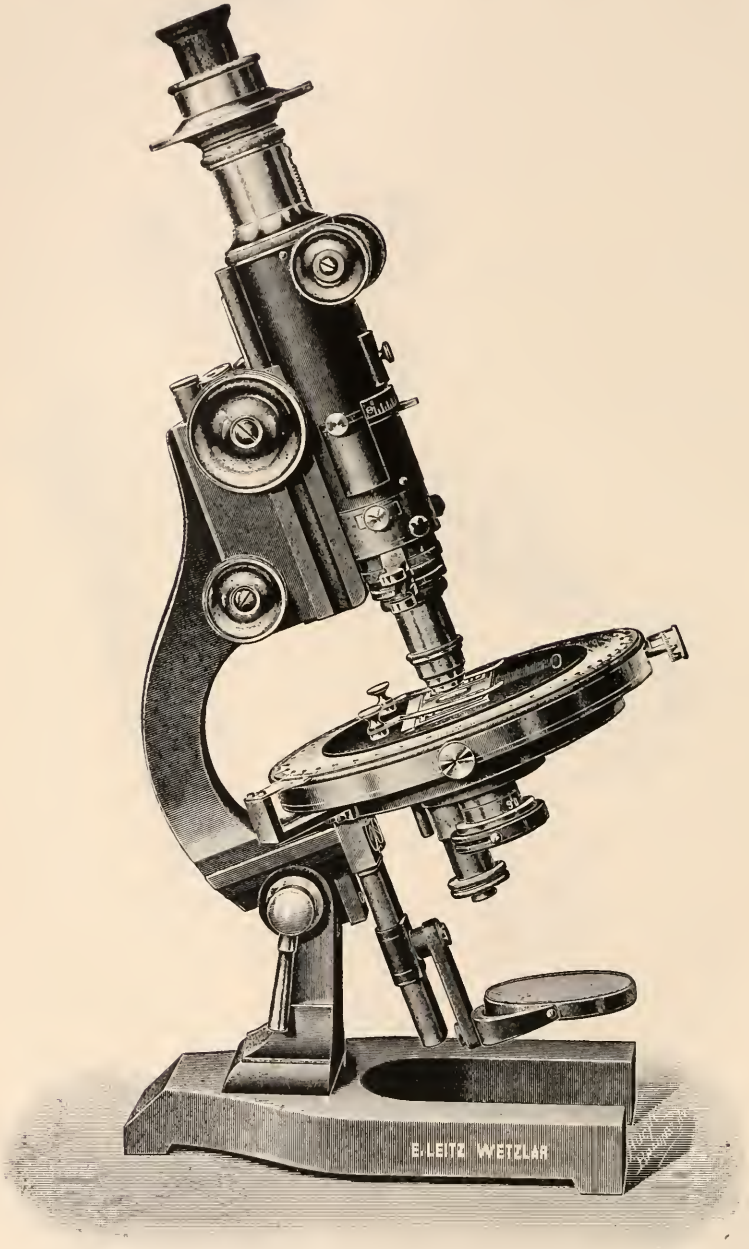

Fig. 86.

from convergent to parallel light. By a connecting-piece applied to the tube end, the objective is centred on the rotation centre of the rotatory object stage, which is graduated into 360° with a vernier. The stage has orientation marks, and there are two drum-graduations at the side of the stage for reading off lateral movements, which can be performed up to 20 mm. The Nicol polariser can, after the removal of the iris carrier, be drawn out of the screw from below, and an illuminating apparatus with iris can be inserted instead. The zero of this Nicol is marked, as well as the 90°, 180° and 270°. The analyser, in a metal collar, is placed above the ocular, and rotates on a rim rigidly connected with the ocular mount. This rim is graduated into 360°. On the front side of the tube is a flap, which can be opened or closed, and through which access can be had to the inner tube. In this flap is a slit for the Bertrand lens, and under the lens is an iris for the sharp delimitation of the interference figures.

Leitz' Demonstration-Microscope.*—This instrument, shown in fig. 87, is intended for weak and medium magnifications. The stage is rectangular with rotatory diaphragm. The tube-adjustment is by push action and a clamp-ring. A fine adjustment, condenser, and iris can be adapted if desired.

Fig. 87.

Leitz' Mineralogical Stand No. II.†—The instrument (fig. 88) now issued with this title (maker's series, No. 38) is a somewhat simplified and smaller form of the same firm's Mineralogical Stand No. I., previously described in this Journal,‡ their former No. II. having now become Stand No. III. The coarse adjustment is by rack-and-pinion, the fine by micrometer screw, a division signifying a movement of 0·01 mm. The condenser, iris and polariser can be raised and lowered by a lateral screw. A three-limbed condenser allows the convenient observation of the axial images in the Microscope; both the upper lenses can be put out of action by a lever. By means of an intermediate piece applied to the tube-end the objective can be centred on the centre of the rotatory object-stage, which is graduated into 360° and fitted with a vernier. The stage also has graduations for orientation. The polarising Nicol can after the expansion of the iris be drawn out from underneath. The zero of this Nicol is marked, as also the 90°, 180°, 270°. The analyser rotates on a disc, whose circumference is

* Catalogue No. 41 (Mikroskope) 1905, p. 51.
† Tom. cit., p. 63. ‡ J.R.M.S., 1903, p. 758, fig. 163.

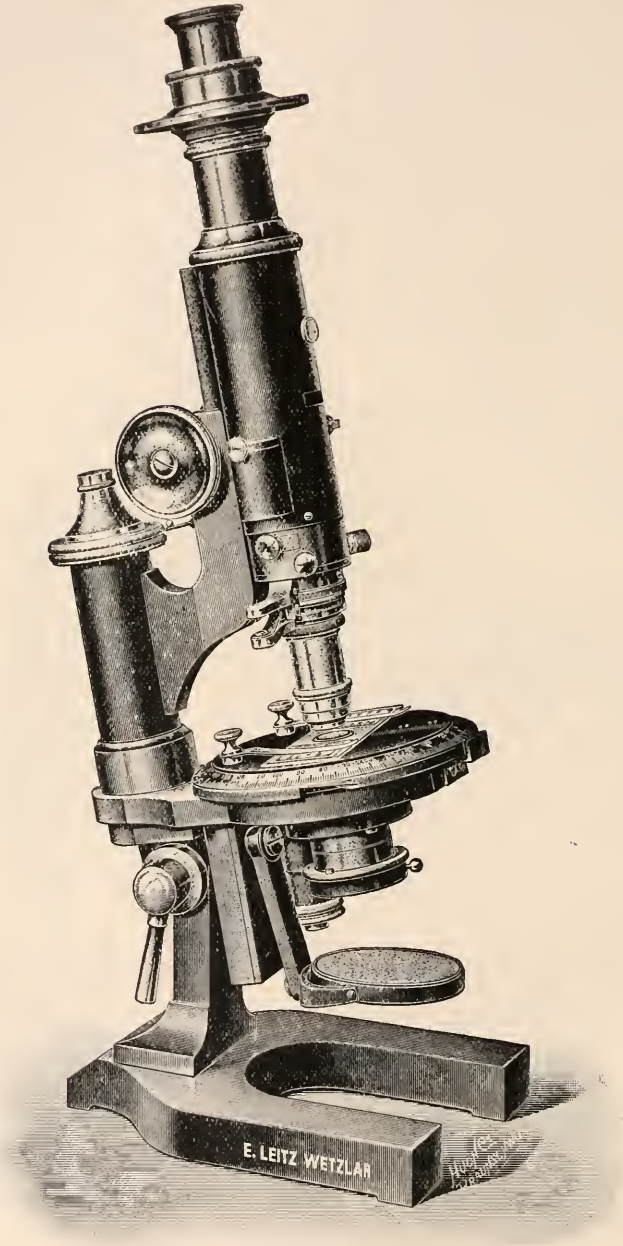

Fig. 88.

divided into 360°. On the front of the tube is a slit for receiving the Bertrand lens.

Leitz' Mechanical Stage.*—This (fig. 89) is an improvement on the earlier form noticed in this Journal.† It will be seen that the horizontal pinion goes right through the stage and carries a milled head at each end. The previous pattern had the screw-head only on the right-hand. The two rectangular movements are fitted with scales and verniers. The ranges are respectively 50 and 30 mm.

Object-stage, with Sliding Measurement Adjustment.‡—J. Tuzson and M. Herrmann have sought to produce a measuring apparatus which should be accurate, easy to manage, and independent of the lens

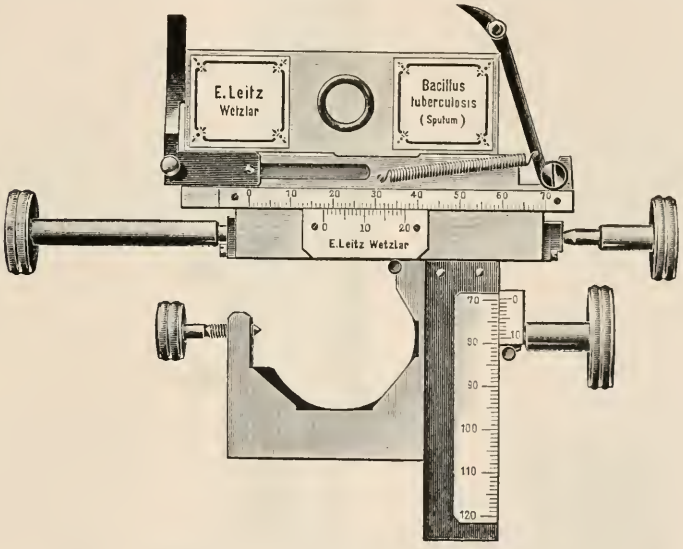

Fig. 89.

system. The principle of their method consists in pushing the object under the fixed cross-threads of the ocular by means of a specially constructed micrometer screw. The amount of the push-movement is obtained by direct reading and without calculation.

The general appearance of the apparatus is shown in fig. 90, and in section in fig. 91. The rotatory object-stage A is of ordinary construction, and, by means of a hollow circular flange (conical in section), works in the slide-rest B without play. This slide can be urged backwards and forwards in a straight line in a prism-groove of the ground plate C, which is rigidly attached to the Microscope stand. The arrangements are such that the Abbe illumination is unaffected, and the movable

* Catalogue No. 41 (Mikroskope) 1905, pp. 83–4.
† J.R.M.S., 1904, p. 105.
‡ Zeitschr. wiss. Mikrosk. xxi. (1904) pp. 189–99 (4 figs.).

parts have a push-range relative to the motionless parts of 5–6 mm. The movement of slide and rotatory object-stage is actuated by the micrometer screw D working in a bearing which is of same piece as the ground

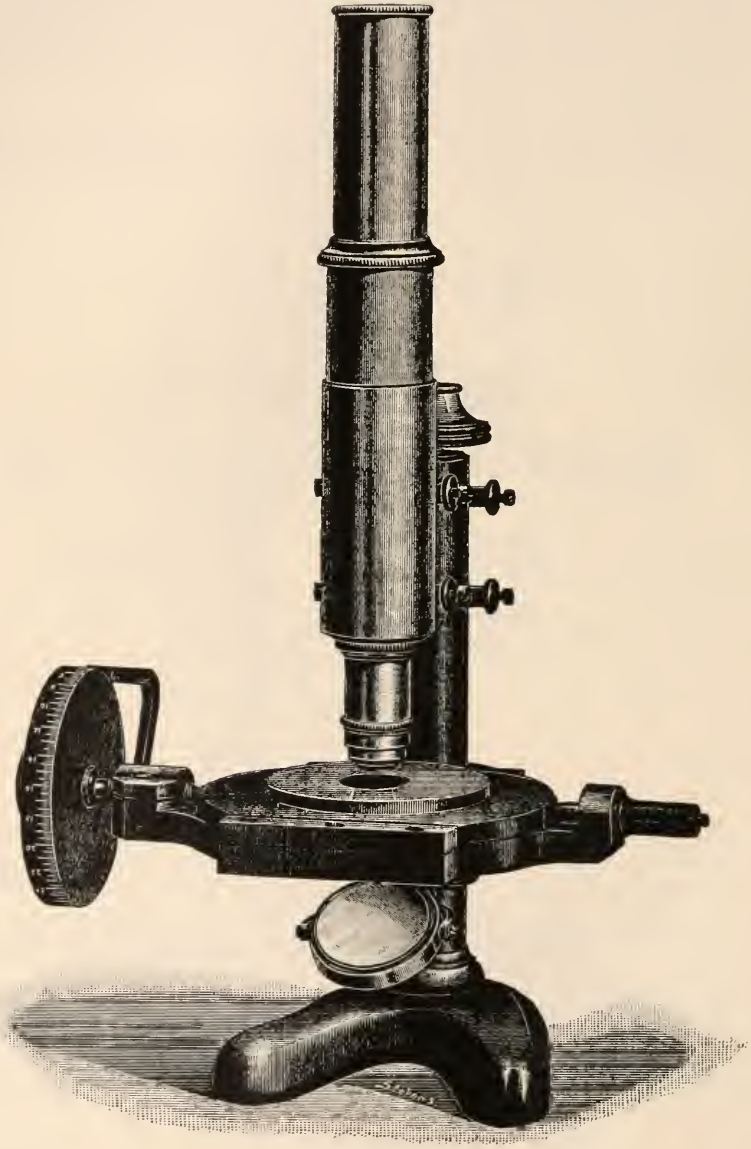

Fig. 90.

plate. The slide is actuated by the rounded end of this micrometer screw, and at the other end presses against the spring and rod E. All movements involved are exact and free from looseness. The screw and rod are accurately co-axial. A graduated drum F regulates the movement of the micrometer screw, and a pointer attached to the ground plate facilitates reading. The graduations are so arranged that zero corresponds to the position where the tube-axis coincides with the centre of the rotatory stage (i.e. the medium position); whole rotations of the micrometer screw are read off on the pointer, while fractions are given by the drum. One rotation of screw gives a length-movement of 0·5 mm. The drum is 66 mm. in diameter, and its circumference is divided into 500 parts, so that a rotation of one division gives a slide-movement of

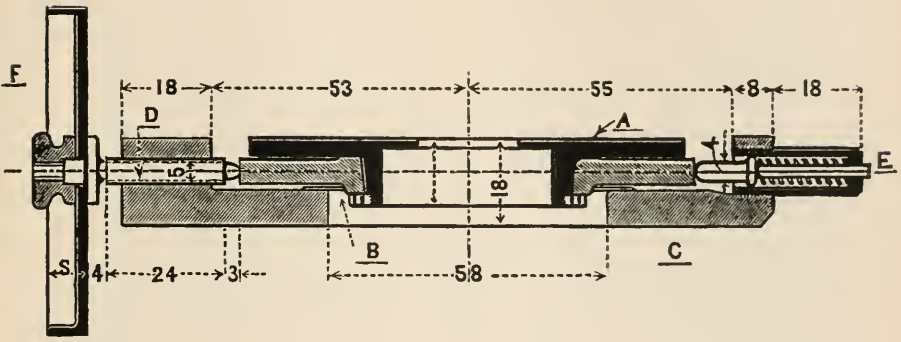

Fig. 91.

about 1 μ; thus readings can be taken directly to the thousandth of a millimetre, and, by estimation, to the ten-thousandth. The apparatus affords five complete rotations of the drum forwards and backwards, and therefore a total movement of the stage of 5 mm., which is sufficient for the purpose. The authors point out that the apparatus would also be serviceable for centring objective and ocular, and for orientating objects. Satisfactory tests of accuracy were made.

Hirschwald, J.—**Uber ein neues Mikroskopmodell und ein "Planimeter-Okular" zur geometrischen Gesteinanalyse.** *Centralbl. f. Mineral.*, 1904, p. 626.

Käsewurm—**Neue Trichinenschaumikroskope.** *Zeit. f. Fleisch. u. Milchhygien*, Bd. xiv. (1904) p. 269.

Meyer—**Das Ultramikroskop.** Kosmos, Bd. i. Heft i.

Rinne, F.—**Le Microscope polarisant. Traduit par L. Pervinguière, avec préface par A. de Lapparent.** Paris, 1904, 160 pp.

(2) Eye-pieces and Objectives.

New Formula Object-glass.—Messrs. Leitz, of Wetzlar, have lately introduced two new object-glasses, viz. a $\frac{1}{6}$ and $\frac{1}{8}$, on an entirely new plan. They may be described as semiapochromats containing fluorite. In these we have a new type of lens, which is neither a semiapochromat

nor an apochromat, but something between the two. They might, therefore, be appropriately called $\frac{3}{4}$ apochromats. These glasses are of very high quality, and their price is but little in advance of that of the makers' ordinary lenses.

Leitz' New Objectives.*—The Wetzlar firm has now produced achromatic fluorite objectives, numbered 6A and 7A respectively. The colour correction is more perfect than in Nos. 6 and 7, but the magnification and numerical quantities are unaltered. The details are—

	Focal Length.	N.A.	Micrometer Value.
No. 6A	4·4 mm.	0·82	3·5 μ
No. 7A	3·2 ,,	0·85	2·6 μ

The Notation of Microscopical Objectives.†—L. Malassez inquires whether it may not be possible to evolve a uniform system of notation applicable to all objectives. He points out how various and defective all existing methods are, and expresses the opinion that objectives should evidently be designated by some indication of their magnifying power. The differential character of objectives depends chiefly upon the range along the principal axis of the ultimate position of their *characteristic* (i.e. the line forming the limit of all the magnifications which the objective is capable of producing). The more remote this ultimate position the greater the magnification produced. To a smaller extent the differential character depends also upon the position of posterior focus of the objectives; the more remote this focus, the greater the magnification. The objective notation should then be based upon these qualities. As regards the distance of *characteristic*, the author proposes to represent it by what he calls the *specific magnification*, viz. that produced by the objective at each increasing unit of distance, or, in other words, that which it produces at unit distance from its posterior focus. The decimeter should be taken as the unit of distance. This *specific magnification* γ can be evaluated in various ways: it may be obtained by merely using micrometric oculars and taking any two magnifications whatever (G, g), and noting the distance δ between them; it can be shown that $\gamma = \frac{G - g}{\delta}$. Among other methods the author recommends the use of the Weiss focimeter. As regards the position of the posterior focus, the author proposes the epithet *posterior foco-facial* for the distance between this focus and the posterior (or issuing) face of the objective. Moreover, as this posterior focus is sometimes behind this face (weak objectives), sometimes in front of it (strong objectives), he employs the letters p (post) and a (ante) to express the two cases respectively. This distance, ϕ_p or ϕ_a, can be easily calculated if one knows the specific magnification γ of the objective, any magnification g produced by it, and the distance d between the position of magnification and the pos-

* Catalogue No. 41 (Mikroskope) 1905, p. 14.
† Arch. Anat. Micr., vii., fasc. ii. pp. 270–350 (8 figs.).

terior face of the objective. It can be shown that $\phi_p = d - \frac{q}{\gamma}$ and $\phi_a = \frac{q}{\gamma} - d$. These relationships can also be obtained by graphic constructions. The notation is thus established by means of two figures, without complicated formulæ or special apparatus—merely by help of ordinary microscopic auxiliaries. A number of interesting facts regarding a lens may be easily deduced from γ and ϕ, including a graphic diagram. Again, the first of the two figures would be the ordinary title of the lens, the second (ϕ) could be engraved on the mount. Thus objectives would be known by figures giving their magnifying power at the same distance, viz. 1 decimetre from their posterior face. The author suggests that makers should, in anticipation of the universal adoption of his scheme, supplement their ordinary descriptions of objectives by two columns recording the new notation. This is now actually being done by one maker, Stiassnie, of Paris, who has materially helped the author with the necessary information and apparatus for drawing up the lists and tables in the treatise.

Theory of Symmetrical Optical Objectives.*—S. D. Chalmers, as the result of his investigation, concludes that, subject to the errors introduced by the want of correspondence of the stop and its image, the combined system is completely corrected for astigmatism, curvature of field, and spherical aberration, provided the back component is so corrected. This want of correspondence, however, introduces some slight errors, but in practical systems these are almost negligible.

Construction of Aplanatic Combinations of Lenses with or without Achromatism.†—"H" discusses this subject in a series of four letters to the "English Mechanic," illustrated by very clear diagrams. He takes, as his model, the lens figured by Engel in plate xi. of Schellbach's "Geometrical Optics." The writer's design is to simplify the subject as much as possible, and his method is a combination of graphics with calculations from Halley's formulæ. These classic formulæ have the advantages of (1) great simplicity and clearness; (2) absence of all error from incomplete recognition of the effect of "thickness"; (3) the comparatively small number of figures needed in working out the details; (4) the accurate way in which they may be got to supplement a partly graphic method, as both deal with one surface at a time. The formulæ are—

$$f_1 = \frac{m\,d\,r}{(m-n)\,d - n\,r} \qquad f_2 = \frac{m\,d\,r}{(m-n)\,d + n\,r}$$

$$f_3 = \frac{m}{m-n} \times r \qquad f_4 = \frac{m\,d}{n}$$

where $\frac{m}{n}$ = ratio of refraction, d = distance of radiant, r = radius of curvature of surface.

* Proc. Roy. Soc., lxxiv., No. 482, pp. 267–72; No. 504, pp. 396–9 (3 figs.).

† English Mechanic, Nos. 2068, pp. 321–2; 2069, p. 340; 2072, pp. 406–8; 2080, pp. 595–6.

Leitz' Camera Ocular.*—This auxiliary apparatus (series No. 93) is shown in fig. 92. The distinction between this and other forms of such apparatus made by the Wetzlar firm, is that the drawing plane lies horizontally on the work-table directly in front of the observer. This

Fig. 92.

is effected by inclining the Microscope at an angle of 45°, and by employing a somewhat changed form of prism. The diminution of the light is attained by the use of two neutral-tinted glass discs set in movable arms.

Blakesley, T. H.—**Single-piece Lenses.**
Proc. Phys. Soc., London, xviii. (1903) p. 591.

Conrady, A. E.—**On the Chromatic Correction of Object-glasses.**
Monthly Not. Roy. Astron. Soc., lxix. (1904) p. 274.

Féry, Ch.—**Méthode nouvelle pour la Détermination des Constantes des Lentilles.**
Bull. Soc. Franç. de Phys., 1903, p. 226.

Spitta, E. J.—**Improvements in Modern Objectives for the Microscope Popularly Explained.**
[The author reviews the chief defects of lenses, and shows how Jena glass is adapted to neutralise them. He emphasises Abbe's labours in this field.]
President's Address. Journ. Quekett Micr. Club, Feb. 1905. pp. 141–52 (2 pls., 12 figs.).

Trozewitsch, S. E.—**Anfertigung von Objecktiven für Teleskope, Mikroskope und Photographische Apparate, die Optische Technik der Mikroskope und Teleskope (Russisch).**
Warsaw (1903) 322 pp.

„ „ **Zur Frage über das Aplanatische System.**
Zeits. f. Math. u. Phys., li., (1904) p. 100.

(3) Illuminating and other Apparatus.

Leitz' Apparatus for Observation of Ultra-Microscopical Particles.†—This apparatus is shown in fig. 93. It consists of a plate applied to the object-stage and clamped to the pillar. This plate contains a small chamber through which, by means of an india-rubber tube, the liquid for examination is conducted. The rate of flow is controlled by a stop-cock, and a small window admits light into the chamber. The fluid may be observed bare or protected with a cover-glass. The

* Catalogue No. 41 (Mikroskope) 1905, p. 80. † Tom. cit., pp. 66–67.

chamber can be replaced by a small stage for the examination of solid bodies such as ruby glass. Illumination is by arc-light, or by mirror-reflected sunlight, and the light after passing through a diaphragm tube is concentrated by a lens on a slit arrangement, which is adjustable on both sides; the length and breadth of slit are both measurable by drum

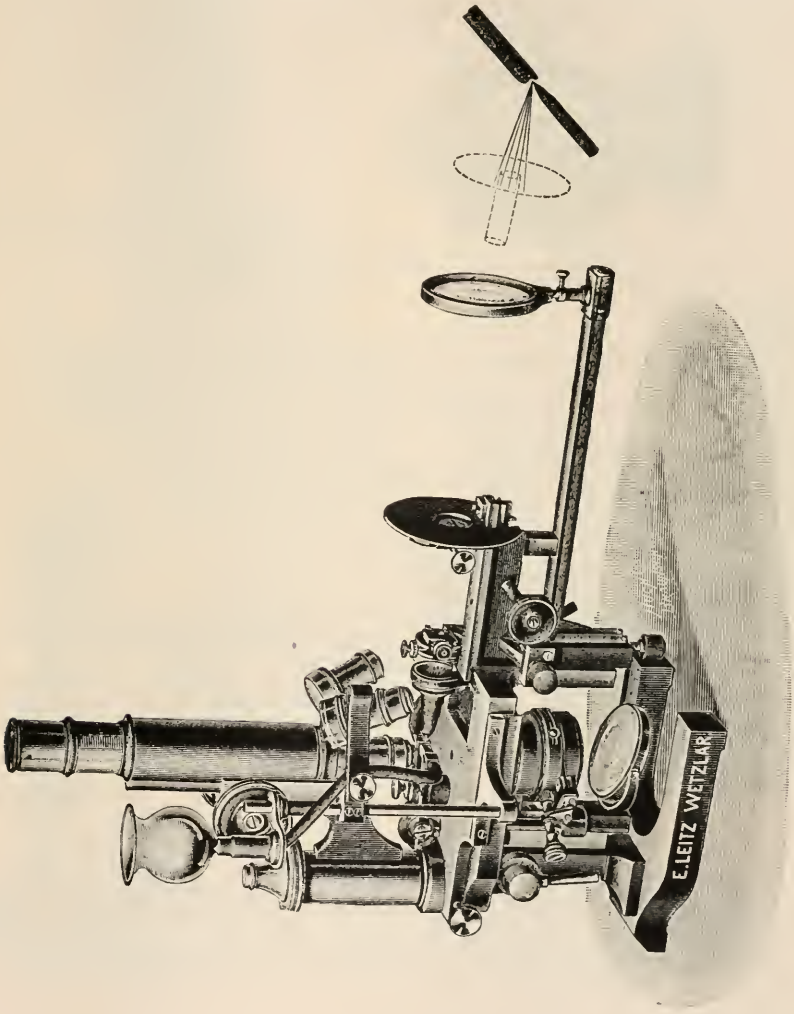

Fig. 93.

graduations. The slit can be rotated through 90°. A stronger, adjustable objective focuses the slit into the field of view. The optical axis with lenses, etc., can be arranged vertically or horizontally.

For obtaining dark-ground illumination, a special objective and diaphragm are used (figs. 94, 95). Behind the optical part of an objective a spring stamp-diaphragm is screwed, which presses against

the rear lens. Leitz' immersion objectives are particularly convenient for this arrangement. The effect is to make the objects (e.g. bacteria) appear bright on a dark ground even with the strongest ocular magnification.

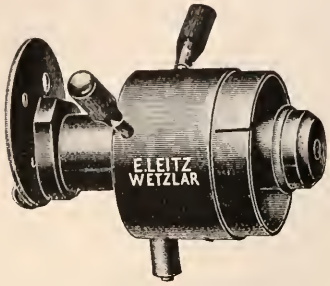

Fig. 94.

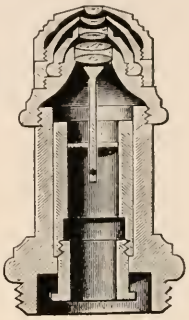

Fig. 95.

Leitz' Universal Projection Apparatus.*—This apparatus is adapted for diascopic, microscopic, and episcopic projection, the last being

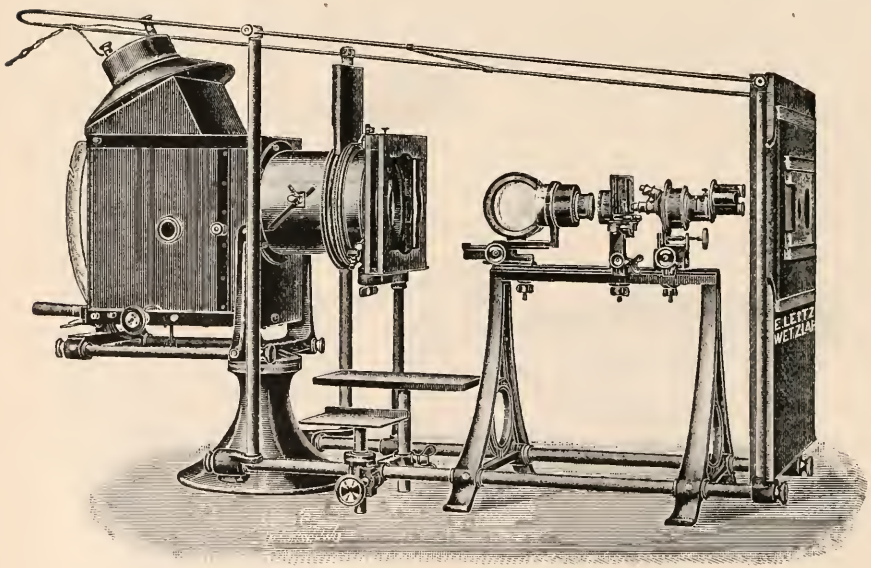

Fig. 96.

attainable with either downward or lateral illumination. The essential characteristic in all is that, owing to direct illumination of the object,

* Catalogue, No. 41 (Mikroskope) 1905, pp. 91-4.

an unusually brilliant image is projected. The self-regulating lamp has a current-strength of 30 amperes and 48 volts E.M.F.; higher voltages must have a corresponding rheostat equipment. The lamp can be centred, and has a three-fold adjustable collective lens system of 210 mm. diameter, and is protected from the heat by a hard glass disc. A cooling chamber stands in front of the lenses. The arrangement for *microscopic projection* (fig. 96) consists of a two-fold condenser, large cross-stage with preparation cooler, Microscope tube with iris, rack-and-pinion adjustment, micrometer screw, triple objective, and ocular revolver, all mounted on an optical bench.

For *diapositive projection* the movable stage with Microscope tube

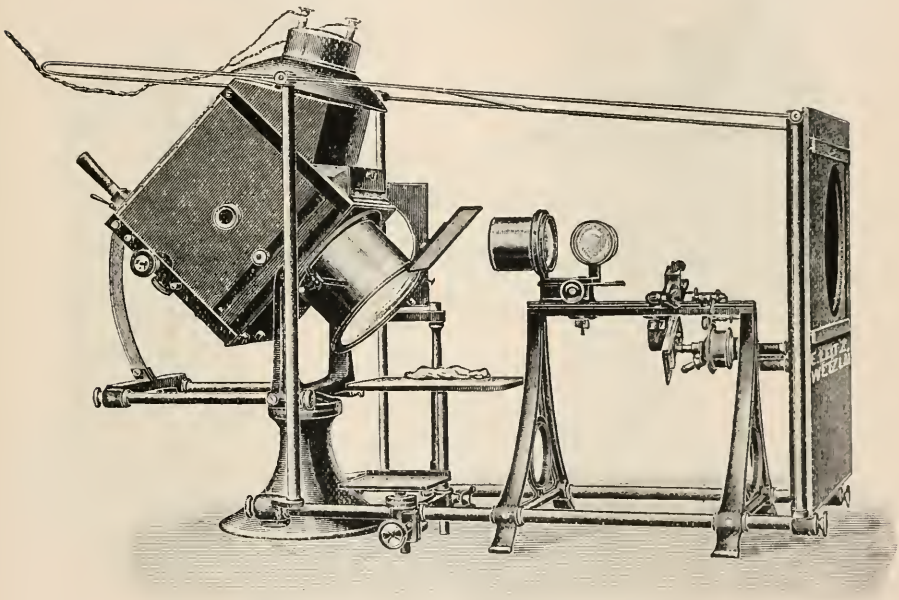

Fig. 97.

is, by means of a hinge, swung aside. Simple projection objectives are set up in lieu of the Microscope condenser. A diapositive holder, with exchange-frame and apertures 13 by 13 cm., and a plate with clamps for projection of larger section-preparations, are placed before the large cooler.

For *episcopic projection with downward illumination* (fig. 97) the lamp is slanted upwards on a strong axis in a vertical plane at an angle of 45°, and the object placed on a large stage is thus illuminated. The projection objective of 400 mm. focus is rotated into the optical axis. A mirror over the lens-system receives the image and reflects it at 90° into the projection-objective.

For *episcopic projection with lateral illumination*, the lamp takes a horizontal position, but is rotated laterally through 45°. A smaller object-stage, adjustable vertically, is set up laterally; the mirror is rotated 90°, and projection takes place as before (fig. 98).

The whole apparatus is screened with black curtains, and on the front is a round opening, reducible, at pleasure, for the different kinds of projection.

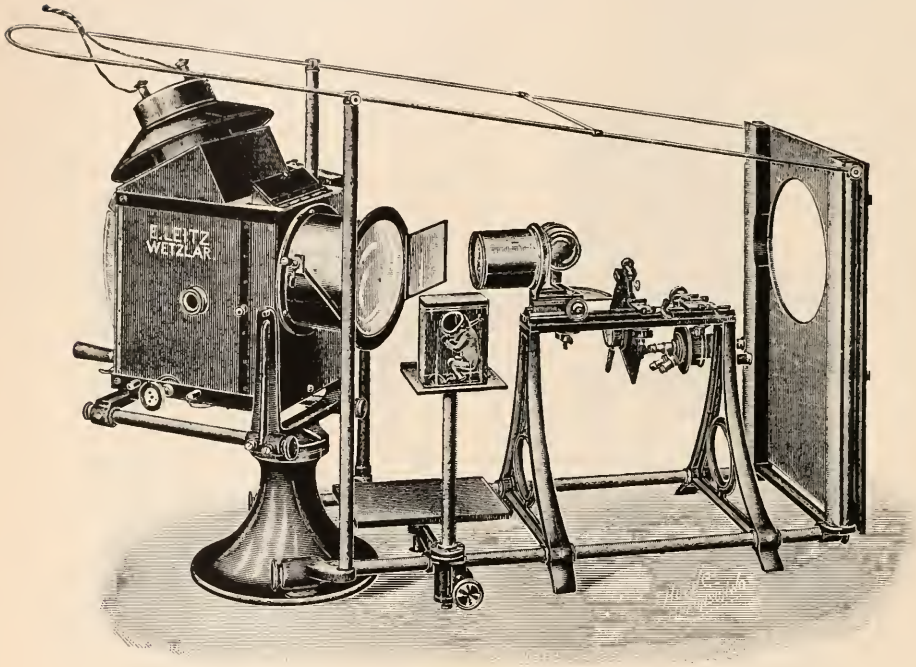

Fig. 98.

New Vertical Illuminator for Metallurgical Examinations.*— The firm of R. and J. Beck has brought out a new vertical illuminator of the prism type, fitted with an iris diaphragm beneath the prism for cutting off outside light, and a plate of stops so arranged that the position of the beam of light impinging on the prism can be varied until parallel light of the right angle is obtained (fig. 99).

The principle is that a beam of light sent at right angles to the optic axis of the Microscope is reflected by a prism or piece of cover-glass, down upon the object, so that each objective acts as its own condenser. It is probably the only means of illuminating objects mounted dry when

* Knowledge, ii. (1905) p. 43; R. and J. Beck's Special Catalogue, 1905.

they are examined with immersion lenses, though in this case it is necessary that the object should be in actual contact with the cover-glass.

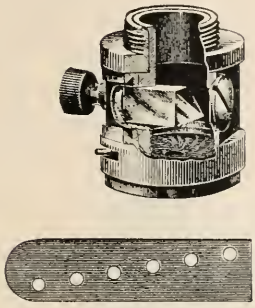

Fig. 99.

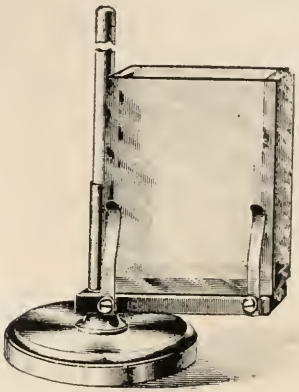

Fig. 100.

Monochromatic Trough.*—This trough (fig. 100), made by the firm of R. and J. Beck, is 4 by 3 by 0·8 in. in size, and is easily adjustable as to height and angle. It may be filled with fluid of any tint, though the saturated solution of copper acetate is that most often required.

Leitz' Triple Revolver with Large Protection Diaphragm.†—This is clearly shown in fig. 101.

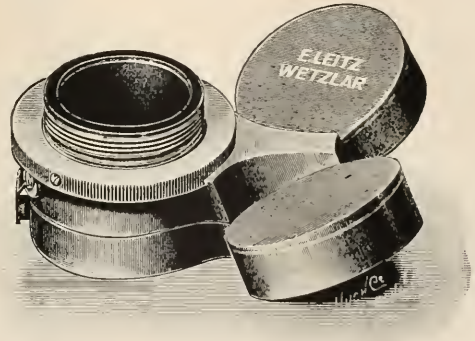

Fig. 101.

Leitz' Thermometric Stages.‡—The Schultze pattern is shown in fig. 102. A metal stage bears at its sides wing-like projections under which the heating flame can be applied. Observation is carried on by a

* R. and J. Beck's Special Catalogue, 1905.
† Catalogue No. 41 (Mikroskope) 1905, p. 110. ‡ Tom. cit., p. 85.

condenser lens with large magnification. The temperature is indicated by a thermometer and can be extended up to 100° C.

In the Stricker pattern the stage forms a metal chamber through which warm water can be passed. A condenser lens and thermometer are used, as in the last. The stage can be screwed to a table.

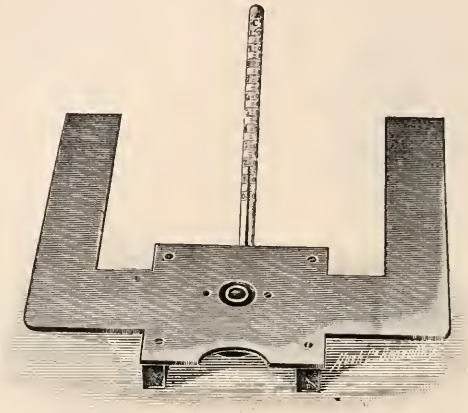

Fig. 102.

Leitz' Drawing Board (Simple Form).* — This is shown in fig. 103 inclined at 12°, at which angle it is adapted for use with Leitz' camera ocular, series No. 92.

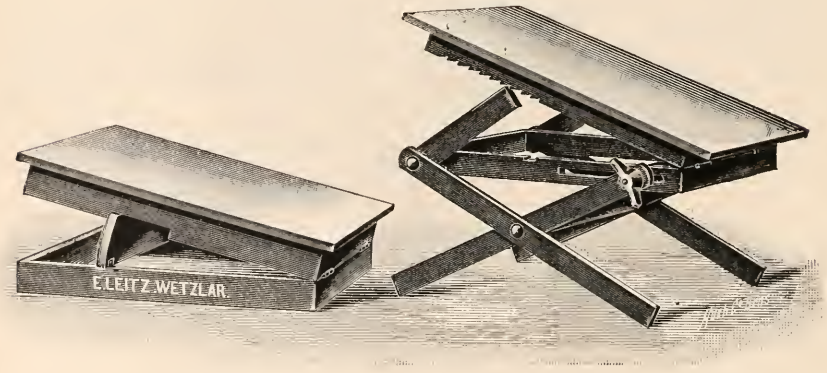

Fig. 103. Fig. 104.

Fig. 104 shows Giesenhagen's drawing board. In this apparatus the board may be adjusted at various angles, and raised or lowered with facility.

* Catalogue, No. 41 (Mikroskope) 1905, p. 81.

Polariscope.*—E. Holmes writes that a good polariscope for some purposes may be made by black varnishing two sheets of glass, and so placing them that the light reflected from one lying flat on the table is again reflected to the eye by the second plate. Objects to be examined are placed in the beam of light. There is no gain whatever in using a pile of plates for a reflecting instrument in this way. A dozen microscopical cover glasses put in a paper tube at an angle of about 57° make a good analyser. Whatever the number of plates the angle remains the same for maximum effect.

The Micro-pantograph as a Drawing Apparatus.†—G. C. van Walsem has re-designed this instrument (fig. 105), which was originally contrived in 1872 by J. Roberts. It is described by von Apáthy in his

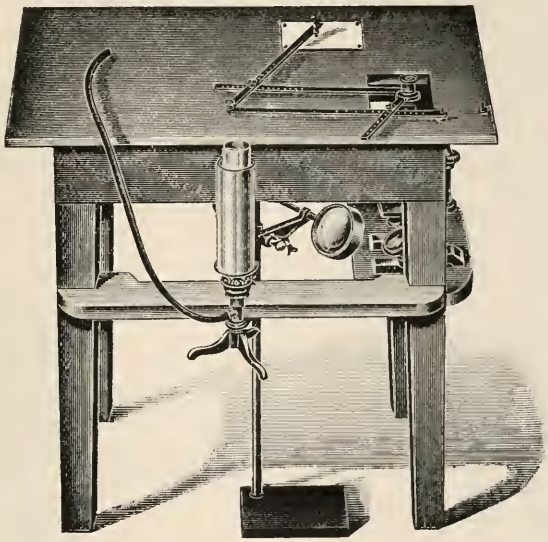

Fig. 105.

"Mikrotechnik der tierischen Morphologie."‡ Roberts' instrument, however, had the disadvantage of reproducing the microscopic image reversed. The essential feature of Walsem's improved form is a special double ring-link which embraces the "object-point," i.e. the Microscope tube. The diameter of this ring is 37 mm., so that the ring is large enough not only to encircle the tube and to be moved freely about within certain limits without jarring it, but its centre in the case of a weak ocular and a correspondingly large ocular diaphragm can be made to explore the whole field. It is obviously important to reduce friction as much as

* English Mechanic, lxxxi. (1905) p. 383.
† Zeitschr. wiss. Mikrosk., xxi. (1904) pp. 166–72 (2 figs.).
‡ Zweite Abteilung, p. 361.

possible, and for this purpose the upper surface of the inserted ring has been cut out in such a way that it is in contact with the under surface of the other ring at only three points. The upper ring has in its rim a vertical slit for receiving a fine needle, or bristle, whose end should exactly coincide with the ring centre. A ring, corresponding to the thickness of the diaphragm, has to be soldered on to the ocular so that, when inserted into the tube, the ocular rests on this ring. About 1·5 mm. above this ring in the ocular is a cross-slit extending to about one-fourth of the circumference for receiving the bristle, which should now be sharply defined in the field of view, and should, moreover, be in its centre when the lens rings are concentric. The apparatus requires a special table (85 cm. high, long side 72 cm., short side 51 cm.). The observer sits at one of the short sides (we will suppose at the right of the figure) and at his left hand, 8 cm. from both long and short sides, is a rectangular hole 14 by 11 cm., the 14 cm. corresponding to the short side of table. The table legs are connected by a horizontal cross-board, whose upper surface is 52½ cm. above the floor. The difference of height between this surface and the table-top surface is just sufficient for the object-stage (17½ cm.) and extended draw-tube (170 cm.). In addition, the height of the pantograph and the height of the upper plane of the ocular must be allowed for. The "fixation-point" of the pantograph is seen at the observer's lower left hand. This point is secured by a knob with a pointed top, on which the pantograph hooks. There are, in reality, two of these fixation points: the one shown in use in the figure is 1 cm. from the rectangular hole, and is suitable for strong magnifications; the other, about 7 cm. away, is for weak magnifications. In the "stay-joint" (diagonally opposite to the object-point, or Microscope) of the pantograph is a rounded knob, which moves to and fro in the rotations about the fixation-point. A little wheel under this knob facilitates the motion and reduces the friction. The wheel, instead of moving on the wooden table-top, moves on a glass plate, thereby securing greater regularity and freedom of motion. The other joints produce a sliding movement of the bars relative to one another. An arrangement is made for artificial illumination, if required. The possible range of magnification was found to be between 2 and 10. This is, of course, quite independent of the ocular magnification, and, therefore, a strong eye-piece is recommended as giving sharper control in the tracing out of the outline. The framework should be made of L-shaped aluminium bars.

Koristka's Illuminator for Opaque Objects.*—This apparatus is principally intended for the study of metals. It is screwed to the Microscope tube, and contains a total reflexive prism which receives the light from the front and directs it by means of the objective on to the preparation. The prism occupies only half the field, thus leaving the other half free for vision. An iris diaphragm placed in front of the prism serves to regulate the light which it is to receive. By pulling out the arm which carries the prism the latter may be removed from the

* Koristka's Catalogue, No. 12 (1905) p. 50, fig. 56.

optic field, so as to leave it quite free. For use with this illuminator (fig. 106) a lens of 35 mm. diameter, and 72 mm. focus, is recommended.

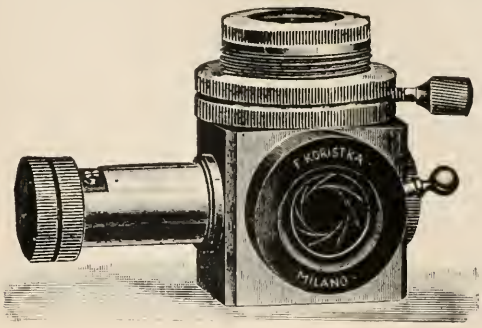

Fig. 106.

Bausch and Lomb's Improved Form of Camera Lucida.* — The construction of this camera lucida (fig. 107) presents a number of improvements over older forms, although retaining the original optical principle. The Abbe prism is mounted in a closed box provided with a

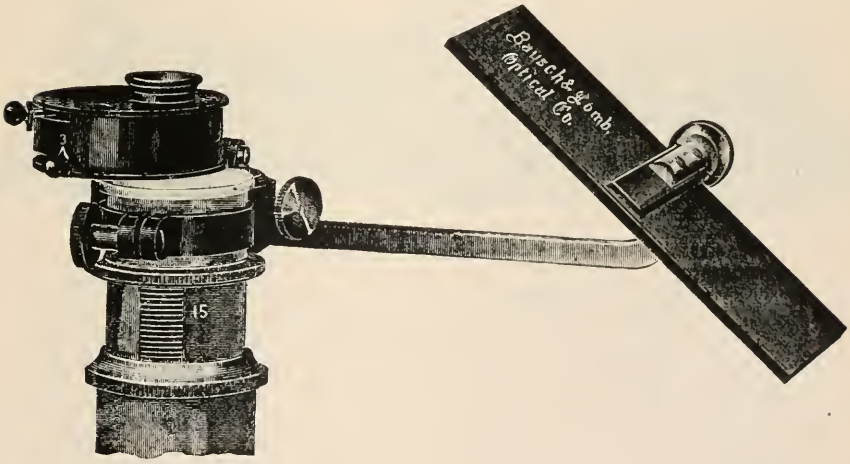

Fig. 107.

rotating disc carrying a series of dark glasses of different shades. These glasses come between the prism and light from the Microscope eye-piece, and serve to moderate its intensity. A similar series of coloured glasses is arranged to moderate the light coming from the mirror. With the

* Catalogue A. 1904 (Microscopes and Accessory Apparatus) p. 68.

two series, a clear view of object and pencil point can be had with any combination of objective and eye-piece. The prism mounting has a centring arrangement, so that the aperture in the prism can be centred to the Microscope eye-piece, giving a clearly defined and equally illuminated image of the object. The prism can be turned back, permitting the use of the Microscope and the changing of eye-pieces without disturbing the camera lucida. The mirror is extra large, giving large drawings. The mirror bar is graduated in millimetres, and is movable, so that the distance between mirror and prism may be varied to suit conditions. The camera lucida is attached to the Microscope draw-tube by a collar with binding screw, so that the prism can be set at the proper distance from the eye-lens, as, without this adjustment, the camera lucida cannot be used with all eye-pieces.

Bausch and Lomb's Adjustable Drawing Board.*—The necessary inclination of the mirror of the Abbe camera lucida to the drawing

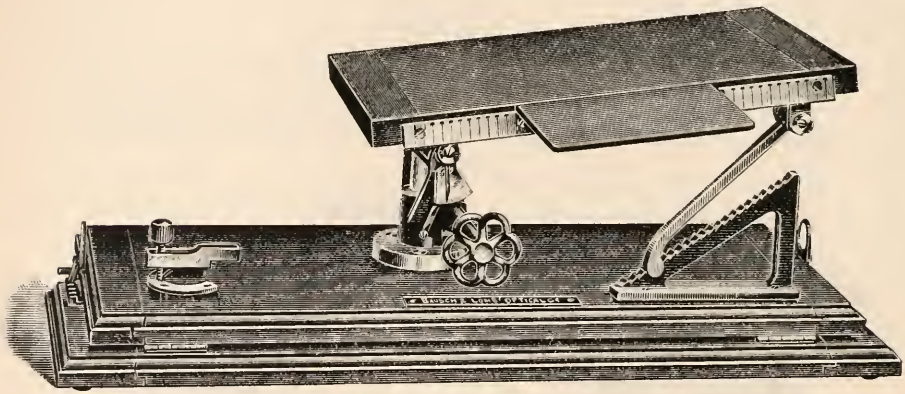

Fig. 108.

surface produces a constantly increasing elongation of the visual field when the drawing surface is parallel to the field of the Microscope, except when the mirror of the camera lucida is at 45°. It is, therefore, necessary to incline the drawing surface (fig. 108) in order to obtain accurate reproductions of any considerable size. The drawing board is vertically movable on a strong metal axis, to secure the same magnification on the paper as in the Microscope. The drawing plane is inclined by raising the right hand end of the board, a ratchet arm holding it firmly in any position. The angle of inclination is read off on the graduated arc. The Microscope is held in place by a clamp.

Davis, D. J. A.—**A Method of Microscopic Observation by means of Lateral Illumination.** *Trans. Chicago Pathol. Soc.*, vi. (1904) p. 90.

Dowdy, S. E.—**Attachable Object-finder.**
English Mechanic, lxxix. (1904) p. 410.

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* Catalogue A, 1904 (Microscopes and Accessory Apparatus) p. 70.

Fedorow, E. v.—**Einige neue Hilsapparate für das polarisationsmikroskop.** *Ann. de Géol. et Minéral de Russie*, iv. (1901) p. 142, and *Zeits. f. Kristallogr.*, xxxvii. (1903) p. 413.

Gleichen, A.—**Die Vergrösserung des Mikroskops unter Berucksichtigung der Refraktion und Akkommodation des Auges.** *Mechaniker*, xii. (1904) p. 135.

Grattarola, G.—**Figure d'interferenza ottenute usando lastre spulite come analizzatore.** *Atti d. Soc. Tosc. d. Sci. Nat.*, xiv. (1905) pp. 164–71.

Greil.—**Beleuchtungsapparate mit Nernstschem Glühlicht.** *Anat. Anz. Ergänzungsheft z.*, xxv. (Jena, 1904) p 178.

Kalähne, A.—**Über das Woodsche Lichtfilter für ultraviolette Strahlen.** *Phys. Zeits.*, v. (1904) p. 415.

Pflüger, A.—**Die Quecksilberlampe als ultraviolette Lichtquelle.** *Phys. Zeits.*, v. (1904) p. 414.

Regaud, Cl.—**Lampe électrique pour la Microscopie.** *Comptes Rend. Assoc. des Anatomes*, Toulouse, 1904; *Bibliogr. Anatom. Supplém.* p. 293.

(4) Photomicrography.

Photomicrography with Ultra-violet Light.*—The equipment for this class of work has been described by A. Köhler and M. von Rohr, and is now obtainable from Carl Zeiss.† The results which, by the application of ultra-violet light to microscopical technique, are likely to be attained, are mainly—

1. That the resolving power of the objective is increased in the same proportion as the wave-length of the applied light is reduced. The apparatus presently described doubles the value of an objective of equal numerical aperture with daylight.

2. That numerous colourless organic objects exhibit considerable differences in their transparency, although in white light they show no colouring; they behave, in regard to ultra-violet light, exactly as if they were objects diversely coloured.

3. That on living and defunct organic objects, ultra-violet light exerts, to some extent, marked physiological effects.

Photography is practically essential to the attainment of the first two objects; but the results of the latter can be observed by white or coloured light and with ordinary achromats or apochromats. For the ultra-violet rays the specially manufactured objectives used are termed monochromats. They have been designed by M. von Rohr, and are corrected for wave-length 275 $\mu\mu$ (0·000275 mm.). The N.A. of the strongest system is 1·25, while the resolving power, on account of the small wave-length of the light used, becomes equivalent to a N.A. of 2·5 with daylight. A table of this *relative resolving power* is supplied in C. Zeiss' catalogue. The lenses of the monochromats are manufactured out of molten quartz. Both the strongest systems are immersion lenses, while the immersion-fluid is a mixture of suitable refractive index, and is composed of chemically pure glycerin and distilled water. The cover-slip is also of molten quartz, and the object slides are formed from thin

* Zeitschr. f. Instrumentenk., xxiv. (1904) pp. 341–9 (6 figs.).

† Special Catalogue, Mikrophotographische Einrichtung für ultraviolettes Licht (wave-length 0·275 μ).

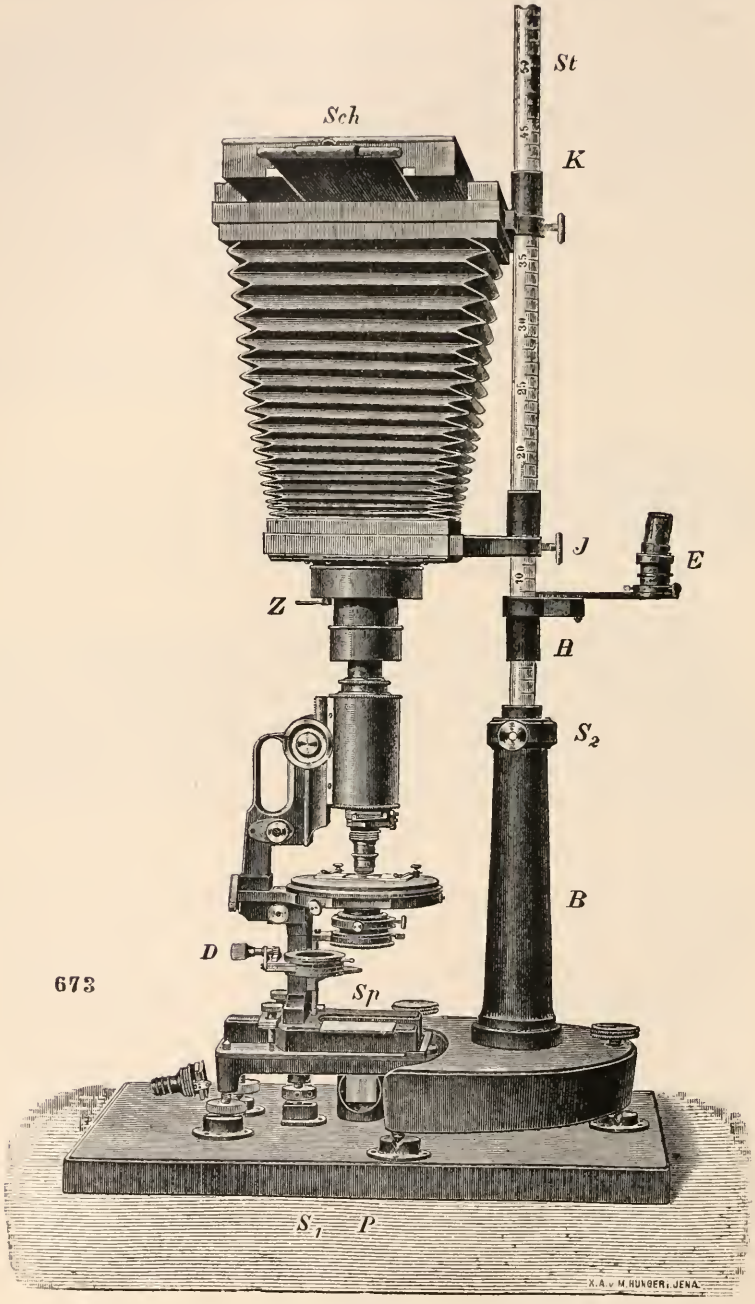


FIG. 109.

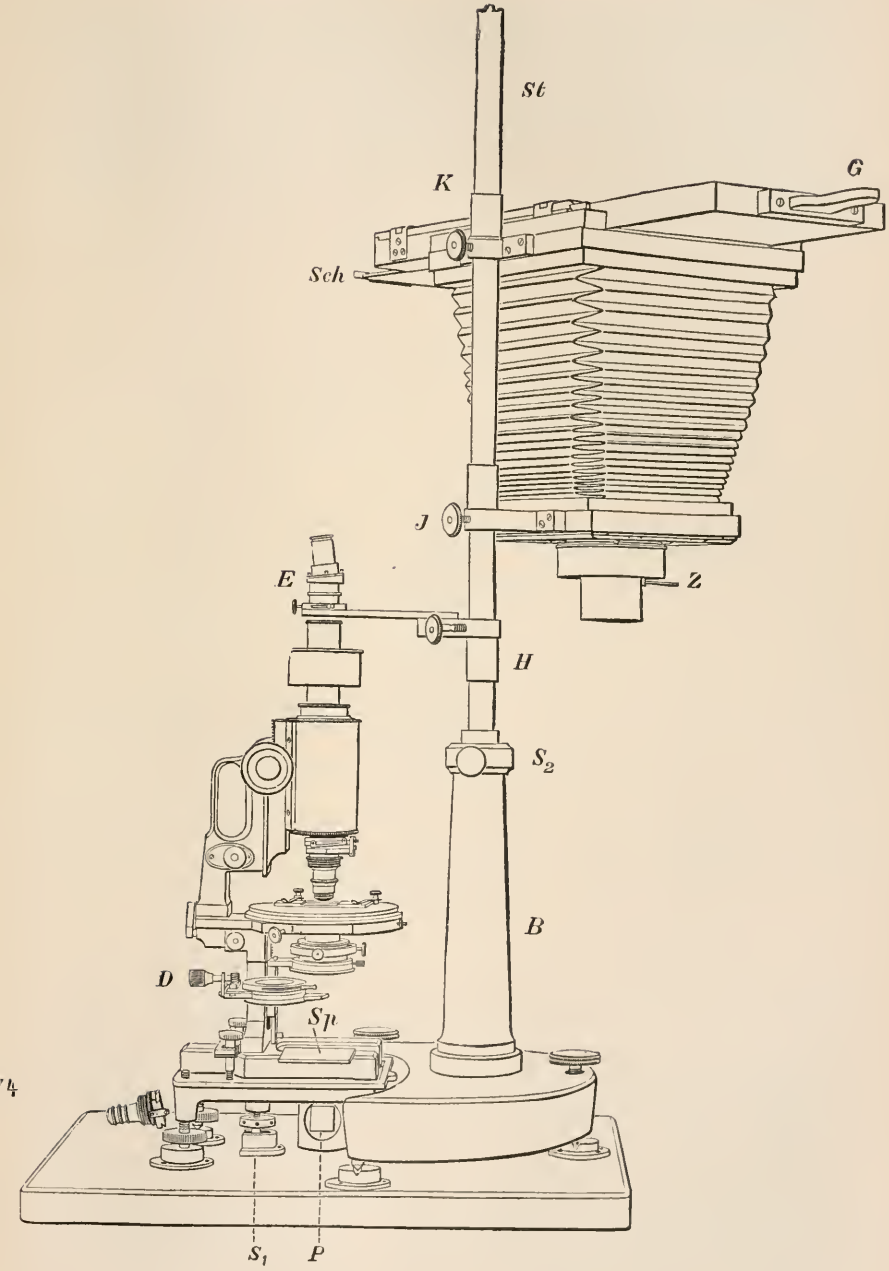


Fig. 110.

slips of rock-crystal or of ultra-violet transparent glass. The makers give warning that the monochromats cannot be used with daylight; and also that immersion-fluids of other composition, unless they have the same refractive index, cannot be used for ultra-violet photomicrography. For projection of the image on the photographic plate a special series of rock-crystal oculars has also been constructed. The ocular number gives, as in the case of the compensation oculars, the angular magnification.

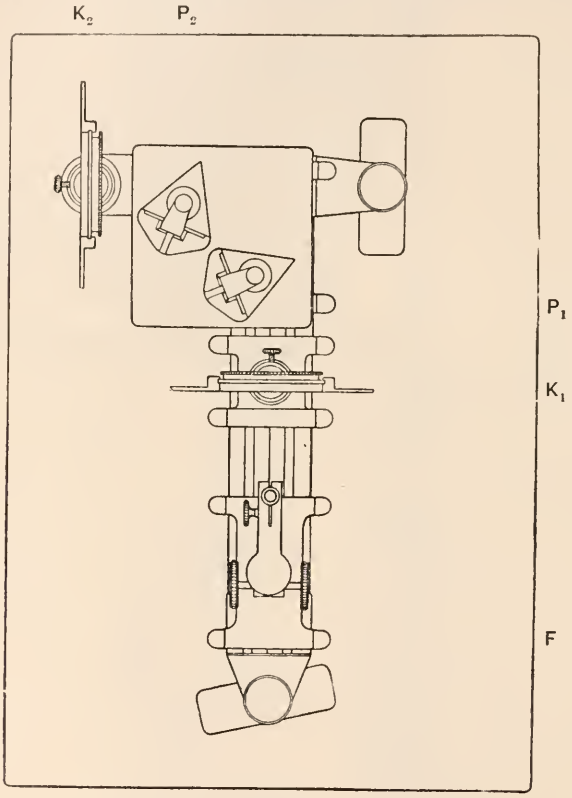


Fig. 111.

Zeiss' vertical camera is used as the photographic apparatus, because the perpendicular position offers various advantages over the horizontal. This is shown in fig. 109, about one-sixth of the full size. S_1 is the screw for firmly receiving the foot-plate for the Microscope; P is the rock-crystal reflexion prism, which reflects the horizontally incident light along the axis of the Microscope; S*p* is a plane mirror for observing the spark image on the uranium glass; D a diaphragm carrier with inserted uranium glass-plate swung aside. The upper arrangements are shown more clearly in fig. 110, which is also one-sixth of full size. B is the foot of the vertical camera; S_2 a clamp-screw for securing the rotatory graduated pillar S*t*; H the adjustable sleeve for the "finder".

(see below) E ; J and K adjustable carriers for the camera ; Z exposure shutter ; S *c h* draw-off slide of the dark slide shutter ; G handle of the frame for inserting the photographic plate. The "finder" is for personal observation and for adjustment, and is applied over the ocular of the Microscope. It is a specially constructed auxiliary, whereby the image can be thrown on to a fluorescent plate and observed through a strong loup. When the image is sharply defined on the fluorescent plate it will be also sharply defined on the photographic plate after the finder has been replaced by the camera. The plate must be set up 30 cm. from the ocular cap. Variations, not exceeding a few centimetres, of

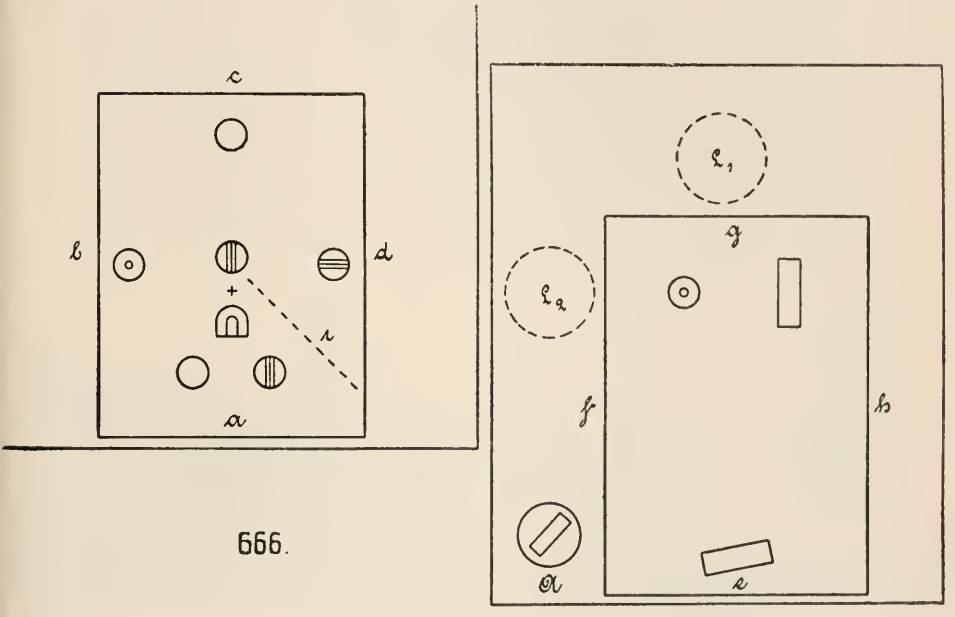


Fig. 112.

the camera-length do not much affect the sharpness of the image. The spark discharge between cadmium electrodes (in certain cases magnesium electrodes) of a Leyden jar, worked by an induction machine, serves as a light-source. The spark-length should be about 10 cm. The spark-light is led through a special illumination apparatus of rock-crystal lenses and prisms, and the light of wave-length 275 $\mu\mu$ (if of magnesium 280 $\mu\mu$) is separated off by an iris diaphragm. This diaphragm forms the entrance-pupil of a rock-crystal condenser, which takes the place of the ordinary glass condenser. The light then passes, as a cone of larger or smaller aperture, to the object. In fig. 111 there is shown the stage-plate with the illuminating apparatus, one-fifth full size. F is the spark-stand ; K_1 the collimator ; P_1 P_2 the rock-crystal prisms for conducting the rays of various wave-lengths from the light-source F ; K_2 the collector, which gathers the rays of a certain wave-

length for a spark-image. The rays of selected wave-length emerging out of the collector then fall on the reflexion prism P, and are thereby conducted to the Microscope condenser. Fig. 112 (one-tenth full size) shows the installation of the entire apparatus; *a b c d* is the stage-plate for the Microscope and camera, with the slots for the position-screws of the foot-plate and the camera; it is set up on a table of ordinary height; *e f g h* is the stage-plate for the illuminating apparatus, with slots for its screws; it is set up on a table or cabinet 23 cm. lower than the above mentioned table. A lamp (e.g. an incandescent) is set up at L_1 or L_2 for examination of the object, with an achromat. If the lamp is placed at L_1 the rays are reflected at the last face of the prism P_2 laterally in the direction of the axis of the collector K, and reach the condenser of the Microscope after another reflexion at the prism P. If the lamp is placed at L_2 its rays fall direct on the prism P. This light must, of course, be removed when the ultra-violet light is used. A fluorescent screen *i* serves, on setting up the apparatus, to orientate in the spark-spectrum. Zeiss' catalogue gives full particulars of the lenses and all auxiliaries. A. Köhler,* who has both made a long series of investigations and has designed the apparatus, relates the history of his researches. He gives six plates, all of well-known objects, such as *Pleurosigma angulatum*, to illustrate his results.

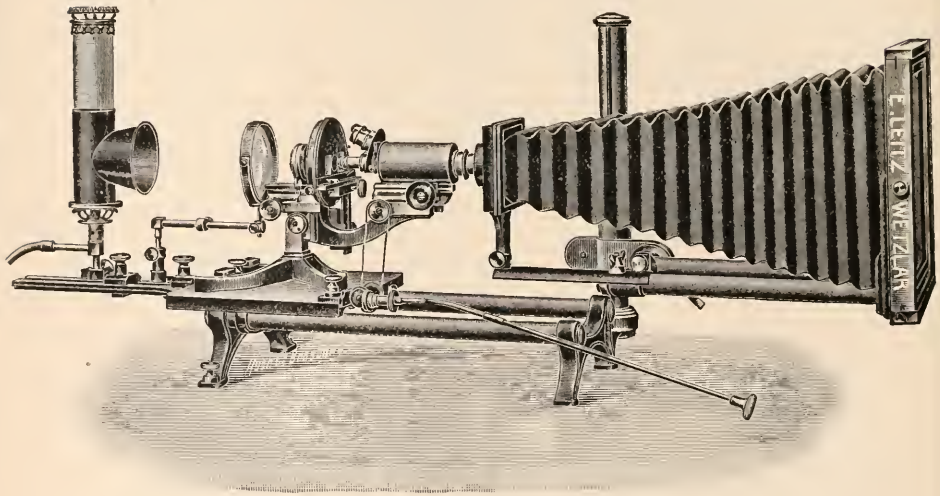


Fig. 113.

Leitz' "Universal" Microphotographic Apparatus.† — This is described by F. G. Kohl, but will now also be found in the latest

* Zeitschr. wiss. Mikrosk., xxi. (1904) pp. 129-65, 273-304 (6 plates of photomicrographs). Also as a separate pamphlet, with title Mikrophotographische Untersuchungen mit Ultraviolettem Licht.

† Zeitschr. wiss. Mikrosk., xxi. (1905) pp. 305-13 (3 figs.).

catalogue* of the Leitz firm. It is shown in figs. 113–115. Fig. 114 shows the arrangement for vertical work. The base-frame rests on four feet, two of which are fitted with screws. A large foot-plate with push-movement on the two rails of the base carries the Microscope, and can be clamped when in position. A small bench is connected with the foot-plate, and carries an adjustable lens and a lamp with ground-glass disc. The camera is supported by pillars, and can be clamped at any desired height and inclination.

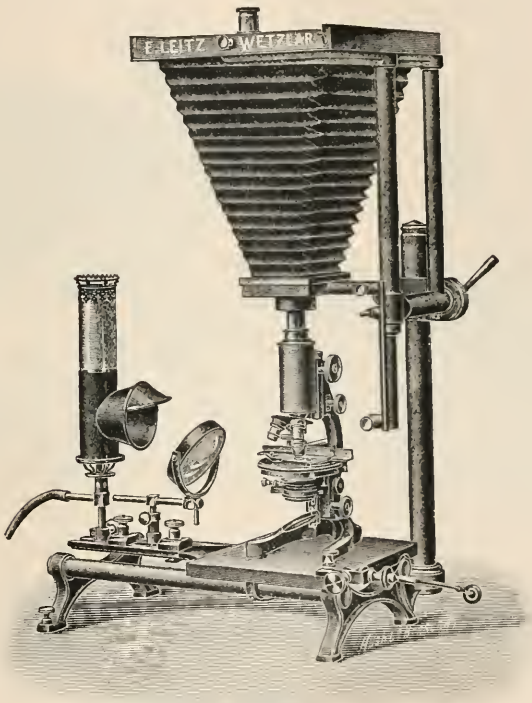


Fig. 114.

Fig. 113 shows the arrangement for horizontal work. In this position the maximum bellows extension can be attained—up to 500 mm.—with the help of a push-arrangement, on both ends of which the carrier of the camera collar can be clamped. A gearing is affixed to the large foot-plate for controlling the fine adjustment of the Microscope, by means of a cord operated by a pliable rod. For photographing transparent preparations up to 100 mm. diameter, with weak magnification, a small erect stage with diaphragms (fig. 115) can be clamped on to two sides of the large foot-plate so that it is at right angles to the camera axis.

* Catalogue No. 41 (1905) pp. 86–8.

The camera-neck is provided with a screw-thread on which, by means of an adapter ring, photographic objectives can be fixed. This arrangement also affords facilities for the application of Edinger's apparatus as well as for photographic purposes. For stereoscopic photography the erect stage is provided with a cross-slit so that the preparation can be pushed in two directions. Reflected light can be used with the vertically placed camera, and the foot-plate with the object is then pushed up to the ground-glass disc ready for the stereoscopic arrangement.

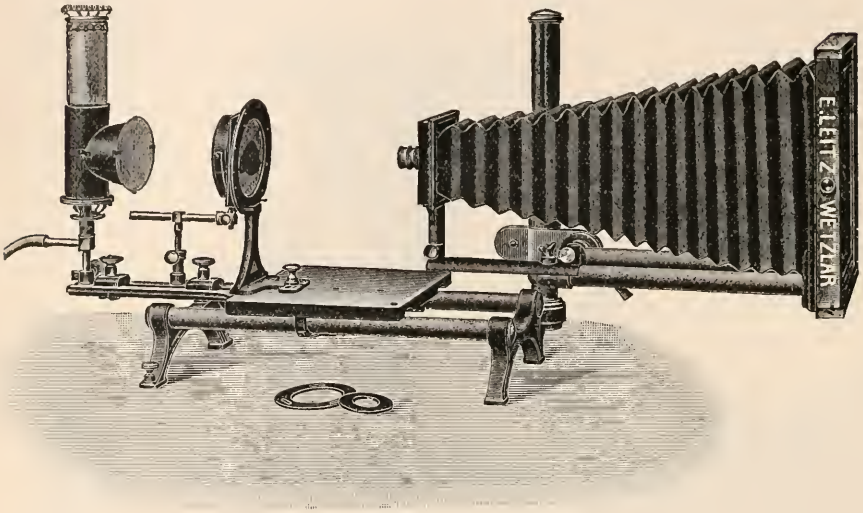


Fig. 115.

Crosbie, F.—**Directions for Photomicrography.** *Lancet*, 1903, p. 233.

Ives, F. E.—**Eine photomikrographische Vorrichtung.** *Zeits. f. Opt. u. Mech.*, xxiv. (1903) p. 3.

„ „ **Stereoscopic Photomicrography with high powers.** *Trans. Amer. Micr. Soc.*, xxiv. (1902) p. 23.

Leiss, C.—**Über eine neue Camera zur stereoskopischen Abbildung mikroskopischer und makroskopischer Objekte.** *Zeitschr. f. Instrumentenk.*, xxiv. (1904) p. 61.

(5) Microscopical Optics and Manipulation.

Dark Field Illumination.*—C. Troester describes this method for the observation of living and unstained preparations of bacteria. It consists in showing a light object on a dark ground, and is obtained by shutting out the axial portion of the cone of light that comes from the condenser by means of a centrally placed screen, so that no direct light reaches the ocular. He obtains excellent results by allowing sunlight to pass through a spherical flask filled with water, and placed in the

* Centralbl. Bakt., 2te Abt., xiv. (1905) p. 511.

focus of a ground-glass plate ; a short distance behind this plate is the Microscope that receives the light by means of a concave mirror. With this illumination 300 magnifications of living bacteria can be obtained with the same ease as with a good stained preparation.

Resolution of Grayson's Bands.*—A student, after detailing some resolutions of Grayson's bands, says : "The net results of these experiments show that on a bright ground a certain size of illuminating cone is required to develop the resolving power of any given objective, but an increase in the cone beyond that certain size is always accompanied by a falling off in resolving power. On a dark ground the case is somewhat different ; with a ground just dark and no more, the highest resolving power of the lens is not developed, but all objects just short of the minimum resolvable are well seen. When light of greater obliquity is employed, the lens attains its maximum resolving power, but the resolution of objects well within its grip is impaired."

Doubling of Lines in the Abbe Experiments not due to the Diaphragms above the Objective.†—J. Rheinberg demonstrates this by using a single-aperture diaphragm, which he places in the upper focal plane. A coarse grating of about 100 lines to the inch (the widths of lines and spaces being equal) is placed on the object stage, and by giving a lateral movement of about $\frac{1}{16}$ inch to the diaphragm the effect of single and doubled lines is alternately produced.

Limit of Visibility of Isolated Elements in the Microscope.‡—K. Strehl makes some observations on this subject.

Bright Spots on a Dark Ground.—He regards the speculations of Siedentopf and Zsigmondy partly as hypothetical, partly as not free from objection, and therefore attaches more importance to their results as actually attained. With the most intense sunlight an illuminating system of N.A. 0·3, and an observation system of N.A. 1·2, and strong oculars, the least value they obtained for the edge of their cube-shaped gold particles was $4\,\mu\mu = 0{\cdot}000004$ mm.

Dark Spots on a Bright Ground.—On the basis of the diffraction theory, with N.A. 1·5, wave-length 500 $\mu\mu$, eye sensitiveness limit 5 p.c., and a completely aberration-free pencil, the author has demonstrated the following limits of visibility :

	Self-luminous.	Illuminated.
Smallest diameter of round dark apertures ..	48 $\mu\mu$	34·5 $\mu\mu$
Smallest breadth of straight dark slits	10·5 „	2·5 „

The comparison of both methods of observation is just as instructive as the results are important in the investigation after ultra-microscopic bacteria.

Achromatisation of Approximately Monochromatic Interference Fringes by a Highly Dispersive Medium, and the consequent Increase in the allowable Path-difference.§—R. W. Wood obtained

* English Mechanic, lxxxi. (1905) p. 339.
† Journ. Quekett Micr. Club (1905) p. 173 (2 figs.).
‡ Central. Zeit. f. Optik. u. Mech., xxvi. (1905) p. 117.
§ Proc. Amer. Acad. Arts and Sci., xl. No 16 (1905) pp. 595-600 (3 figs.).

his results during the progress of an investigation of the dispersion of sodium vapour. He had previously found that the path-difference under which it is possible to obtain interference-fringes with helium (D_3) light can be more than doubled by the introduction of a small amount of sodium vapour into the path of one of the interfering beams. This development of fringes far out in the system by the dispersive action of the vapour is accompanied by their complete disappearance at the centre of the system, where the difference of path is zero. The author worked with a narrow range of the spectrum symmetrical about the D lines. This was obtained by opening the slit of the monochromatic illuminator, bisecting it with a wire, and adjusting the prisms so that the region of the D lines was screened off by the wire. By means of a small screen either of the two narrow portions of the spectrum bordering the D lines could be screened off. The effect of the sodium vapour on the fringes formed when the interferometer was illumined by either one or both of the two portions of the spectrum could then be studied at leisure. It was found that when a considerable amount of the vapour was present, the apparent centre of the greenish-yellow fringe system was widely separated from the centre of the orange-yellow system. When both sorts of light were used at once, there was a periodic visibility in the region in which the two systems overlapped.

CROOKES, SIR W.—**Ultra-Violet Spectrum of Radium.**
[The author has, with some exceptionally pure material, repeated the experiments of Runge, Demarçay, and Exner and Haschek. His results differ materially from theirs.] *Proc. Roy. Soc.*, lxxii., No. 482 pp. 295–304 (3 pls.).

„ „ **Ultra-Violet Spectrum of Gadolinium.**
[The author's experiments confirm those of Exner and Haschek, but do not seem to support Urbain's view that Gadolinium and Victorium are identical.]
Op. cit., lxxiv. No. 504, pp. 420–2.

FABRE, M. G.—**Les perfectionnements du Microscope.**
[The author gives an interesting resumé of recent investigations on ultra-microscopical bodies.] *Mém. de l'Acad. des Sci. de Toulouse*, Dixième Série, iv. (1904) pp. 314–20.

HAGA, H.—**Ein Vorlesungsversuch für die Bestimmung der Wellenlänge des Lichtes.** *Zeits. f. Unterricht.*, xvii. (1904) p. 288.

MARPMANN, G.—**Ueber ultramikroskopisches Sehen.**
[The author reviews our present knowledge of operating with ultra-violet rays.]
Zeits. f. ang. Mikr. u. Klinische Chemie, xi. (April 1905) pp. 1–7

MERLIN, A. A. C. E.—**Amphipleura pellucida (Resolution of).**
English Mechanic, lxxix. (1904) p. 284.

SCHIMMELPENNING, VON DER OYE, V.—**Zur Theorie du Doppelbrechung.**
Teil i. (Brünn, 1903) 29 pp.

SCHUSTER, A.—**Introduction to Theory of Optics.**
London (E. Arnold), 1904, 356 pp.

STONEY, JOHNSTONE, G.—**How to Exhibit in Optical Instruments the Resolution of Light into its component undulations of Flat Wavelets, and how to employ this resolution as our guide in making and in interpreting experiments.**
Rep. Brit. Assoc Southport, 1903 (1904) p. 568.

Treadle—Amphipleura (Resolving).		*English Mechanic*, lxxix. (1904) p. 63.
„	Diatoms (Resolving).	*Tom. cit.*, p. 84.
„	Pinnularia nobilis (Resolution of).	*Op. cit.*, lxxviii. (1904) p. 554; *Op. cit.*, lxxix. (1904) pp. 14, 35.
Villagio—Resolution of Diatoms, etc.		*Tom. cit.*, p. 193.

(6) Miscellaneous.

Comparison of British and Foreign Students' Microscopes.*—"Paterfamilias," under the heading of "The Microscope and the Fiscal Question," thus compares the London-made Microscopes with those of foreign manufacture:

Foreign Microscopes.

Germany, Jena. In Zeiss' catalogue we find that the kind of instrument we require, i.e. one suitable for a student, is represented by Stand No. VI. A, and that its price is 12*l.* 10*s.* (The focusing of the substage condenser is by a sliding tube.)

America. Messrs. Bausch and Lomb supply an instrument very similar in every respect to the Zeiss for 11*l.* 6*s.*

Italy. Koristka, of Milan, supplies a Microscope precisely like the Zeiss for 10*l.* 16*s.*

Austria: Reichert, of Vienna. The Microscope of this maker differs from those preceding inasmuch as it has a lever interposed in the fine adjustment action, a sliding-bar to the main stage, screw focusing and centring action to the substage. Notwithstanding these accessories its price is 9*l.* 15*s.*, or 22 per cent. less than Zeiss.

Germany: Berlin. Messrs. Leitz supply a Microscope with a bent claw tripod foot and a sliding-tube focusing substage, but in other respects similar to the Zeiss Microscope, for 7*l.* 5*s.*, or 42 per cent. less than the Zeiss.

British Microscopes.

Messrs. C. Baker, of Holborn, quote a Microscope with a bent claw tripod foot, a differential screw fine adjustment, otherwise the same as the Zeiss, for 8*l.* 15*s.* 6*d.*

Messrs. Swift and Son, of Tottenham Court Road, supply a Microscope with a fine adjustment having an interposed lever, after the method of Reichert's, for 8*l.* 6*s.* In other respects it is the same as the Zeiss.

Messrs. Watson and Son, of Holborn, quote a "Fram" Microscope, having a tripod foot and a lever fine adjustment, for 8*l.* 8*s.*

These three Microscopes, of British manufacture, have a sliding-tube focusing substage at the price quoted.

Messrs. Beck and Co., of Cornhill, make a "London" Microscope with a screw focusing substage, otherwise similar to the Zeiss stand, for 7*l.* 11*s.*, or 40 per cent. less than the Zeiss.

In comparing the prices quoted by the various makers, we can see at once that in the foreign group of Microscopes the Jena, American and Italian are by far the most expensive, because they have the ordinary

* English Mechanic, lxxxi. (1905) pp. 290–1.

direct-acting screw fine adjustment, and a substage focusing by means of a sliding tube.

The Austrian is more expensive than the Berlin maker, but, on the other hand, he gives you more for your money. A lever is interposed in the fine adjustment, the substage has screw focusing as well as centring adjustments, and the main stage has a sliding bar.

In the English group, Baker, Swift and Watson all have a more complex fine adjustment than that of the ordinary Continental type; but they have only sliding-tube focusing arrangement to their substages. Beck's, on the other hand, retains the Continental form of fine adjustment, but adds the screw focusing adjustment to the substage, and that at a price lower than any similar class of Microscope of either British or foreign manufacture.

Czapski, S.—**Grundzüge der Theorie der Optischen Instrumente nach Abbe.** Leipzig: Joh. Ambros. Barth, 2nd edition, xvi. and 490 pp.

Die präzisionsmechanik und optik auf der Weltausstellung im St. Louis. *Deutsche Mechan.-Zeit.*, 1904, p. 181.

Hager, H.—**Das Mikroskop und seine Anwendung.** Berlin: J. Springer, 1904, 9th edition, 392 pp. (401 figs.).

Niemann, G.—**Das Mikroskop und seine Benutzung in pflanzenanatomischen Unterrichte.** *Magdeburg* (*Creutzsche Verlagsbuchhandlung*) 1904.

Reinisch, R.—**Petrographisches Praktikum. Zweiter Teil: Gesteine.** Berlin, Gebru. Borntträger, 1904, vii. and 180 pp. (22 figs.).

Rheinberg, J.—**The Collected Papers of Abbe and Microscope Theory in Germany.** [The author has translated into English Dr. Ambronn's review (Zeit. f. wis. Mikr., January 1905) of the collected papers of Professor Abbe, published last year.] *Journ. Quekett Micr. Club* (March 1905) pp. 153–66.

Treadle—**British versus Foreign Microscopes.** [Adversely criticises the heavy horseshoe foot and spring clips to stages. He advocates a sliding bar, and with regard to a tube fitting substage he says that "it is a great advantage if it screws, not into the stage itself, but into a flat ring screwed to the stage, the holes in the ring, through which the attaching screws pass, being quite loose to the screw shanks. Then the tube, with the condenser in place and focused, can be made to centre exactly, once for all, to, say, the $\frac{1}{6}$ objective, and made fast." He is of the opinion that a lever fine adjustment is very much superior to *any* direct-acting screw.] *English Mechanic*, lxxxi. (1905) pp. 312–13.

B. Technique.*

(1) Collecting Objects, including Culture Processes.

Spontaneous Action of Radio-active Bodies on Gelatin Media.† J. B. Burke calls attention to his interesting experiments on the action of radium salts on nutrient gelatin. In from 1–4 days there appears a culture-like growth, the nature of which is obscure. The bodies, as seen in the illustration, are round and possess a nucleus. They are soluble in water, and when they attain a certain size, subdivide. They disappear on heating and on exposure to sunlight, but reappear after a few

* 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, &c.; (6) Miscellaneous.

† Nature, lxxii. (1905) pp. 78–9 (3 figs.).

days. The first visible growth is on the surface of the medium, but in about a fortnight the substratum may be invaded to the depth of a centimetre. As the bodies are not microbic or crystalline in nature the author is disposed to regard them as colloid substances, and terms them radiobes in view of their resemblance to microbes and of their nature and origin.

(2) Preparing Objects.

Blood Spreader.*—This instrument, devised by M. J. Rosenau, is made by welding two pieces of solid glass rod together (figs. 116, 117).

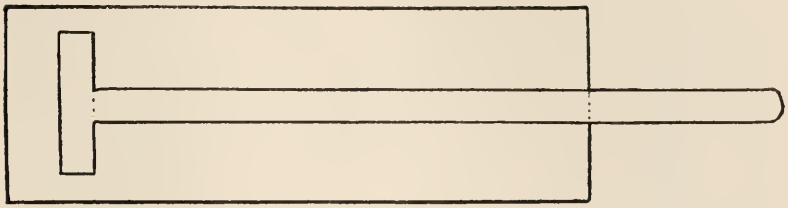


Fig. 116.

The short arm should be true so as to lie flat when applied to the slide, and should be several millimetres shorter than the width of the slide. A drop of blood is taken from the ear or finger-tip and placed upon one

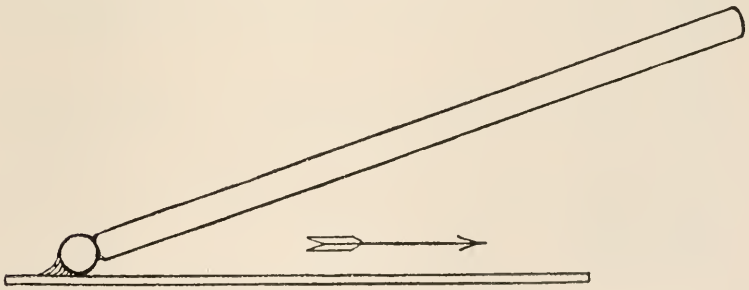


Fig. 117.

end of the slide in the usual manner. The spreader is then applied to the drop, and if the glass be clean the blood will at once be drawn by capillary attraction across its whole length ; it is then stroked gently along the slide.

Preparing and Staining Eye of Honey Bee†.—For demonstrating the structure and development of the compound eye of the honey bee, E. F. Phillips proceeded as follows. Larvæ and pupæ were fixed in

* Yellow Fever Inst., Bull. 14 (Washington, 1905) pp. 52-3 (2 figs.).
† Proc. Acad. Nat. Sci. Philadelphia, lvii. (1905) p. 125.

Flemming's fluid, Hermann's fluid, picro-sulphuric, picro-acetic and picric acid saturated in 50 p.c. alcohol, but of these the Flemming and Hermann preparations yielded the best results. For the smaller larvæ it was not necessary to dissect before fixation, but for older lavæ and pupæ the head was removed to make penetration easier. For adult material, where penetration is difficult, the best fixative was acetic acid, generally a 10 or 20 p.c. acetic solution in 80–100 p.c. alcohol. Kleinenberg's picro-sulphuric and picric acid in 50 p.c. alcohol were also used, with fair results when the head was cut in two.

The material was all cut in paraffin, and it was found that for adult material long imbedding was necessary, 4–8 hours, to get the paraffin all through the tissues. Some material was imbedded for a shorter time to see whether the heat had produced any artefacts in the other material which was imbedded for the longer period, but in such cases the lens invariably separated from the retinular layer, no difference was observed in the internal tissues due to long heating. In staining, the best results were obtained in the use of Heidenhain's iron-hæmatoxylin, and by a strong mordant for a long time. For material of this kind there seems to be no better stain. It was found that by destaining to different degrees the various parts of the eye would show differences in colour, the rhabdome, for example, staining an intense black in rather deeply stained material. The nerve fibrils of the retinular cells also stained black with this stain. Other stains, such as Delafield's hæmatoxylin and eosin or Bordeaux red, were employed with very good results.

For depigmenting, Grenacher's solution with a somewhat greater percentage of acid was used. Parker's solution was also used, though the former gave better results.

Imbedding with Incomplete Dehydration.*—W. J. V. Osterhout gives the preference to a saponaceous medium for imbedding vegetable tissues over paraffin. He finds that cocoanut oil and sodium hydrate when mixed in the proportion of 70 c.cm. of oil to 38·5 c.cm. of 28 p.c. solution of caustic soda in water, makes an excellent basis. The oil is warmed in a water bath and the lye added gradually, the mass being stirred the while.

The tissue to be imbedded is warmed in a water bath and the soap added as long as it will dissolve. The whole is then poured into a suitable receptacle until sufficiently firm to cut into blocks. These blocks are treated after the paraffin method. Perfect sections 1 micron thick and several feet long are easily obtained. The sections may be treated in the usual way either by sticking them on slides or by immersing them in water and dissolving out the soap. But if they are to be fixed to slides in serial order, the ribands are placed on slides previously coated with white of egg and then dried ; they are moistened with xylene, which makes them spread out and adhere. A piece of absorbent muslin is then pressed gently on the sections, and when the xylene has evaporated the muslin is moistened with water. The slide is then cautiously heated to coagulate the albumen and fix the sections to

* Univ. California Pub. Bot., ii. (1904) pp. 87–90.

the slide. The muslin is now moistened again, and afterwards carefully removed. The sections may now be treated in the usual manner.

Instead of water, alcohol may be used for imbedding. The tissue partly dehydrated is placed in alcohol on a water bath, and soap added till no more will dissolve.

Fixation in Vacuo.*—W. J. V. Osterhout describes a simple air-pump for removing air from vegetable tissues. The construction of the pump is seen in fig. 118. A piece of glass tubing 12–15 inches long is stopped at one end with sealing wax. A rubber disc (*r*) is pushed about an inch down the tube, and after carefully warming the glass, melted sealing wax is poured in. The piston may be prepared as follows: Insert a rubber stopper at the unsealed end of the tube, press it in gently and then cut it off cleanly just at the top of the tube. In the upper half of the stopper make another cut just above the first so as to slice off a disc about $\frac{1}{8}$ inch in thickness. With an awl make a hole exactly in the centre of this disc and force through it a brass rod about $\frac{3}{16}$ inch in diameter and of the form shown in the illustration. This should be provided with a thread at the end and carry a nut (*n*) above the disc and a nut and washer (*w*) below it. The washer should be a little smaller than the inside diameter of the tube.

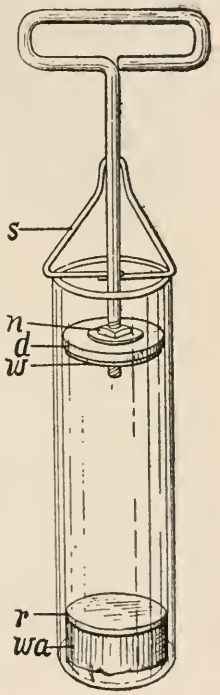


Fig. 118.

In order to use the apparatus the tissue is placed in the tube and the fixative poured over it. When the piston is pushed down the disc springs back to allow the air to escape. When it comes below the liquid it is pulled back, the result being the production of a very good vacuum. In order to inject tissues with fixative, the pieces are secured by means of wire or wedges so that they cannot rise in the liquid. The piston and the inner surface of the tube are then coated with vaselin to prevent the piston from sticking. The piston should be forced down about $\frac{1}{2}$ inch below the surface of the liquid and then drawn up again, when the springs (*s*) will hold it in place.

(3) Cutting, including Imbedding and Microtomes.

Agar-Agar and Paraffin Method for Imbedding Plant Tissues.†—H. H. York first kills the tissues, then imbeds in 2 and 5 p.c. agar solutions, afterwards imbedding in paraffin in the usual way. To the agar solutions 1 part of formalin to 9 parts by volume of agar is added. The tissues are placed in the 2 p.c. agar solution at 70° C. for two hours,

* Univ. California Pub. Bot., ii. (1904) pp. 78–80 (1 fig.).
† Ohio Naturalist, v. (1905) pp. 344–5.

and are then transferred to the 5 p.c. solution for one hour or more. In the 5 p.c. solution the tissues are blocked on bits of wood or glass plate, after which the blocks are passed through graded alcohols to paraffin. The layer of agar round the tissues is rendered very firm by the alcohol and prevents the material from being torn. The sections are very satisfactory.

If the material contain silicon it should be placed in water at 70° C. for an hour, and then in 10 p.c. hydrofluoric acid for 12 hours. On removal it is washed in water and treated as above.

Accessory for Freezing Microtomes.*—This invention of N. B. Harman consists of a box of thin metal, the walls of which are prolonged below the bottom of the box for the distance of a centimetre; the box is clothed in a jacket of felt. When sections are to be cut the chamber is filled with a mixture of ice and salt, and the box placed on the glass plate of the microtome, so that the specimen is enclosed in an atmosphere below freezing point. This device saves both time and ether.

Simple Freezing Microtome.†—W. J. V. Osterhout describes a microtome suitable for botanical purposes. It consists of an iron stand

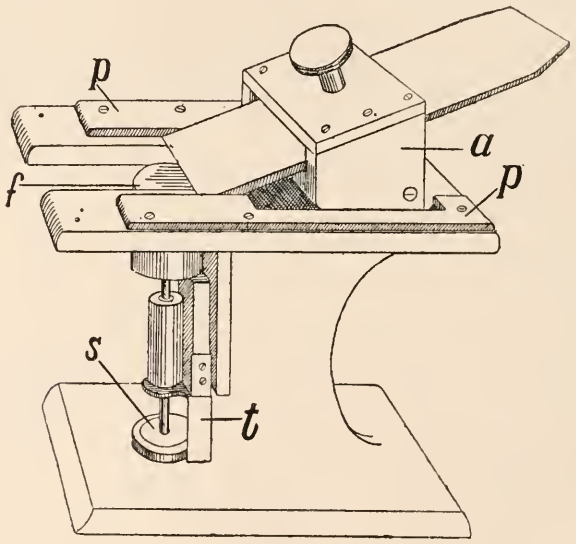


Fig. 119.

(fig. 119), which may be made from a piece of heavy T-rail about 8 in. long with a width of 4 in. at the top. At one end it is cut away so as to leave the two projecting arms, between which the freezing chamber *f* rests. This chamber is raised and lowered by means of the micrometer

* Lancet (1905) i. p. 1505, 1 fig.
† Univ. California Pub. Bot., ii. (1904) pp. 73–7 (2 figs.).

screw *s*. The knife is a carpenter's plane-iron, and this is fitted into the carrier *a*, which serves also for the purpose of sharpening on the hones. Two plates, *p p*, about $\frac{1}{16}$ in. thick, are fastened to the top in order to prevent the edge of the knife from coming in contact with the microtome. A small piece of tin *t* bent at right angles is so fastened that when its edge comes in contact with the milled head of the micrometer screw *s* it makes a clicking. The microtome works equally well with cold brine, carbon dioxide, ether, or rhizolene.

A sectional view of the attachment, which serves both as knife-carrier and handle for sharpening, is seen in fig. 120. It is made of brass or copper. The knife *k* is firmly held in place by means of the screw *s*,

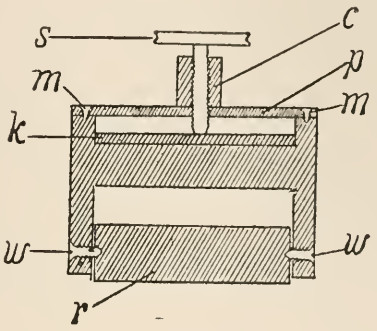


Fig. 120.

which passes through a collar *c* soldered to the top plate *p*, which in turn is fastened to the main body of the attachment by the screws *m m*. A cylindrical piece of brass *r* serves as a roller and turns on the screws *w w* as bearings. When the knife is placed for the first time on the hone the carrier is so adjusted by means of the screw that the ground surface lies flat on the hone. This position should be marked, so that when re-sharpening is required the same position may be readily attained. When placed in the microtome for cutting it is put $\frac{1}{4}$ to $\frac{1}{2}$ in. further back, so that its position is more vertical than when being sharpened.

(4) Staining and Injecting.

Staining the Tubercle Bacillus with Eosin.*—A. Mendoza states that the bacilli of tubercle, leprosy, smegma, and others can be stained by means of eosin. The preparations are treated for 24 hours in the cold, or heated for about 15 minutes. The fuchsin is made up with carbolic acid or an aldehyde of the aromatic series, to the action of which the author ascribes the penetrability of the staining solutions. When stained the preparations are decolorised with 10 p.c. acid alcohol.

Staining the Spirochætæ of Syphilis.†—E. J. McWeeney finds the spirochætæ of syphilis are negative to Gram, and that the results

* Bol. Inst. Alfonso xiii., 1 (1905) pp. 9–11.
† Brit. Med. Journ. (1905) i. pp. 1262–4 (1 fig.).

from carbol-fuchsin are poor. The best results were obtained with Giemsa's modification of the Romanowsky stain,* which imparted to the spirochætæ a distinctly reddish-violet tinge, while the bacteria came out blue. The films which were made from syphilitic sores and discharges were dried in the air, fixed for 10 minutes in absolute alcohol, and stained for some hours. The movements of the spirochætæ may be readily observed in hanging drops.

Affinity of Artificial Colouring Matters for Connective Tissue.†—Curtis and P. Lemoult record experiments which show that in order to develop the selectivity of connective tissue for certain pigments, it is necessary to work in presence of picric acid or some other tri-nitrite derivative, and moreover to use stains having at least three sulpho groupings (SO_3H) fixed in the chromogen and distributed as uniformly as possible. Satisfactory results are obtained from the use of acid fuschin, red-violet, 4 RS and 5 RS, which stain connective tissue red, or from Ponceau S extra, from diamine blue 2 B, or from naphthol black B, which stain respectively red or blue and possess the advantage of being fast.

Theory of Histological Staining.‡—G. Halphen and A. Riche, when studying the theory of histological staining, tested the action of dyes on sections of different animal tissues fixed by means of alcohol. The stain was dissolved in a thousand times its weight of water and used cold. After removing excess of stain with water the sections were dehydrated in a mixture of 1 volume absolute alcohol and 3 or 4 volumes of petroleum-ether. It was found that when slight quantities of acid were added to acid dyes their staining property was increased, and a similar effect resulted when basic dyes were treated with alkali. These results are referred to the basic and acid properties of the albuminoids. These properties are profoundly altered by the action of fixatives, such as formalin and Müller's fluid; so in order to prevent these influences the tissues to be experimented with were dried under bell-jars in the presence of glycerin or of sulphuric acid. Prepared in this way, the sections failed to show the presence of nuclei or cells of any sort, and the tissues were found to possess the property of energetically decomposing oxygenated water, a property which tissues preserved in alcohol do not possess.

Multiplex Slide-holding Device for Staining Sections.§—E. F. Miller describes an apparatus which consists of a series of perforated vulcanised rubber plates, placed in a holder, having a carrying capacity of 26 slides, so that they may be clamped against a metal plate by means of a thumb-screw. The principal advantages claimed for the apparatus are the saving of time and expenditure of reagents.

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

Imbedding Microscopic Algæ.‖—W. J. V. Osterhout remarks that the most serious difficulty in imbedding microscopic algæ lies in the fact

* J.R.M.S., 1905, p. 115.
† Comptes Rendus, cxl. (1905) pp. 1606–8. ‡ Tom. cit., pp. 1408–10.
§ Johns Hopkins Hosp. Bull., xvi. (1905) pp. 132–3 (1 fig.).
‖ Univ. California Pub. Bot., ii. (1904) pp. 85–6.

that they are usually mixed with dirt, which soon ruins the knife edge. This may be got rid of by rubbing them up gently in a considerable quantity of water and then decanting into a long tube, ¼ to ½ in. in diameter, closed at the lower end with a piece of rubber tubing and a burette clamp. As soon as the dirt has settled to the bottom it may be drawn off. The tube may then be shaken up and the process repeated until no more dirt remains.

After being freed from dirt the algæ must be collected into a small space in order that they may be imbedded. The following method * has proved very successful for this purpose. A glass tube of about ¼ in. interior diameter is first smeared at the lower end with glycerin and then dipped into a solution of collodion or photoxylin. As soon as the collodion film has become firm it is pushed down a little so as to allow the end to be cut off with the scissors. An ordinary pipette bulb is now attached to the upper end and the lower end is again dipped in the collodion solution. As soon as it is withdrawn the bulb is compressed, with the result that a collodion bubble is blown at the lower end. The bulb is kept compressed until the bubble hardens into a firm sack. The pipette bulb is now removed and the tube is filled with the water containing the algæ. These gradually sink down into the collodion sack, which may then be compressed at the top with a pair of forceps while the water is poured off. Fixing fluid may then be poured into the tube and after an appropriate time got rid of in the same manner. The algæ may be washed with several changes of water, in the same manner, in order to remove the fixing fluid. The sack may now be held with the forceps as just described and cut off close to the bottom of the tube. The cut surfaces may then be brushed with a solution of collodion, which serves to seal the sack. It may then be dehydrated, together with the contained algæ, and imbedded in the usual way.

It often happens that the algæ remain suspended in the water and refuse to sink to the bottom even after some days. The addition of fixing fluid to the water often causes them to sink, but even this sometimes fails. In such cases the author has tried the expedient of adding a little white of egg, which soon coagulates, both in the water and in the fixing fluid, forming a flocculent precipitate which slowly settles, carrying the algæ down with it. Very obstinate cases may be treated by partly emptying the tube of water and cautiously pouring in alcohol of any desired grade. This gradually diffuses downward, and when the proportion of alcohol becomes great enough the algæ sink to the bottom.

In many cases it is possible to concentrate the algæ rapidly by simply filtering through the Schleicher and Schüll Filter paper No. 575, either with or without the use of a filter pump. This filter paper is hard and smooth, and the algæ, even when gelatinous, do not stick to it and can be washed down into a compact mass. Chamois skin may be used in the same way; in this case the filter pump is a necessity. The algæ cannot be washed down, but can be easily removed without the slightest injury (even in the case of swarm spores) by simply laying the wet chamois skin flat on a board and scraping with a knife. The knife must be pressed down firmly against the chamois skin so as to squeeze out the

* See also Strasburger's Practicum, 3rd ed., p. 366.

water (and the contained algæ) as it travels along, leaving the skin dry behind it. It will then be seen that the knife does not really come in contact with the algæ at all.

The collected algæ may be enclosed in a collodion sack as before or placed in a narrow vial and run up into paraffin by carefully decanting the successive liquids. When the paraffin is cooled the bottle is broken and the block cut in the usual way.

Rapid Method of Mounting in Aqueous Media.*—W. J. V. Osterhout has found the following method very successful. The examination is made in a drop of fluid placed on a cover-glass 1 in. square, and covered by a smaller one; both rest on an ordinary slide. Excess of fluid is removed so as to leave the margin of the larger cover-glass clean and dry. A drop of balsam dissolved in xylene is placed on another slide, and the cover-glasses placed thereon in an inverted position so as to bring the smaller one underneath. The arrangement is shown in section in fig. 121, *s* being the slide, *m* the material, *c c* the cover glasses,

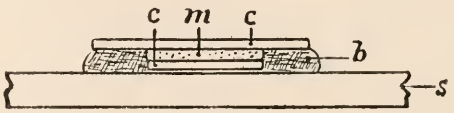


Fig. 121.

and *b* the balsam. The balsam must be quite fluid, and pressure and heat must be avoided. The preparation is then set aside to dry. Thick specimens, such as free-hand sections, may be treated as follows: They are placed on a slide in a drop of fluid, which is then surrounded by broken fragments of cover-glass. A large cover-glass is then imposed on these supports, the superfluous fluid is removed, and a drop of balsam run in. The zone of contact afterwards becomes cloudy, but this does not in any way detract from the value of the preparation.

Simple Slide-holder.†—W. J. V. Osterhout states that a very satisfactory holder for the simultaneous treatment of numerous slides can be made out of nickel or copper-plated steel wire. This is wound round a bar from $\frac{1}{4}$ to $\frac{1}{2}$ the diameter desired for the coil, and should be hammered while still closely wound on the bar. As both sides of the coil are available, and as two slides placed back to back may be inserted in each space, it is obvious that a very large number, over a hundred, may be manipulated at the same time.

Modification of the Rousselet Live-box.‡—A. A. C. E. Merlin draws attention to the following modification of Rousselet's live-box. In order to retard evaporation the large cover-glass should be cemented to the carrier, instead of being held loosely in it by the screw arrangement, which is intended to facilitate the replacing of a fractured cover.

* Univ. California Pub. Bot., ii. (1904) pp. 83–4 (1 fig.).
† Tom. cit., pp. 81–2 (1 fig.).
‡ Journ. Quekett Micr. Club., ix. (1905) pp. 169–70 (1 fig.).

The carrier can easily be constructed with a broad flange to facilitate this, and in the event of breakage few would experience any difficulty in fixing another cover. In addition to the cemented cover-glass, it is only necessary that the carrier should accurately fit into the box in such a way that an elastic band may be placed round the rim over the line juncture, thus rendering the appliance practically airtight (fig. 122).

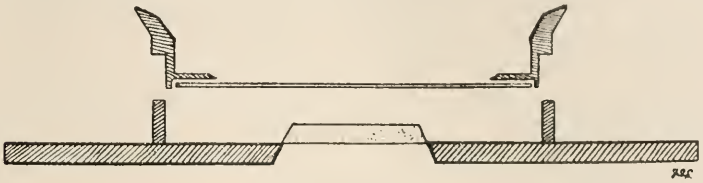


Fig. 122.

Method for Freeing Paraffin from Cedar-wood Oil.*—In the use of cedar-wood oil for imbedding tissues in paraffin it is a disadvantage that the oil is not volatile, and is thus retained in the paraffin, rendering it unfit for further use. W. Mair has found that by the following simple method a large part of the paraffin can be recovered in a tolerably pure condition. The contaminated paraffin is allowed to solidify at room temperature. It is then placed on top of a pledget of cotton-wool in a suitable vessel and allowed to remain in the incubator at body-temperature over-night. Next morning the wool will be found saturated with a melted mixture containing a great deal of oil and little paraffin, while the solid mass of paraffin above is fairly pure. This is removed and placed in the paraffin oven to filter, and the filtrate will be found quite satisfactory for at least the first paraffin bath.

Method for Preserving Bacterial Cultures for Class Purposes.† E. S. G. Fowler writes: After subcultivating the purer colonies on fresh tubes and obtaining results which show the main features of particular growths, I pour on to the sloped or straight surface (streak and stab cultures) of the medium a covering some $\frac{1}{4}$ in. to $\frac{3}{8}$ in. deep of the following preparation: Gelatin, 50 grm.; formalin (40 p.c.) 20 minims; water (distilled), 1 fl. oz. The gelatin is dissolved in the water by heat, and when nearly cool the formalin is gently stirred in, so as to avoid air-bubble formation. Just before it sets it is poured over the growth to the depth required, and the plugs replaced and the tube left in position to cool. I next cut the wool plugs level with the tube mouth, and dip the plugged end into melting white wax and so seal them. The specimen is stored preferably in a cool, dark place. The preparation, being transparent, seems to serve the following purposes: (1) If the growth is not quite pure no further growth takes place after treatment, so that the specimen is fixed with features required; (2) no growth occurs from contamination, with ordinary care; (3) being transparent, it does not interfere with good viewing of the growth; (4) it checks

* Brit. Med. Journ. (1905) i. p. 1381. † Tom. cit., p. 1412.

drying of the medium for a considerable time; (5) there is little if any action on the specific colour of the growths on which I have tried it. Only one of my preparations is at all cracked, and not so as to affect the specimen. The others seem to have dried a little, but have quite a glassy surface.

ABEL, R.—**Taschenbuch für dem bakteriologischen Praktikanten, enthaltend die wichtigsten technischen Detailvorschriften zur bakteriologischen Laborotoriumsarbeit.** Würzburg: A. Stuber, 8th ed. (1904) vi. and 144 pp.

BESSON, A.—**Technique microbiologique et sérothérapique.** Paris: Baillière et fils, 3rd. ed. (1904) 340 figs.

FORSTER, W. H. C.—**Simple Technique for the Enumeration of Organisms in any fluid.**

[A modification of the method of A. E. Wright for the estimation of the number of living organisms in a given culture, and also used for researches on blood serum, *Lancet* (1901) i. p. 1532.]

Lancet (1905) i. pp. 1641–2.

LEDERMANN, R.—**Die Mikroskopische Technik mit besonderer Berücksichtsgung der Farbertechnik.** *Med. Handbibliothek*,, Bd. vi., Wien and Leipzig, A. Hölder, 1903.

PRENANT, A., BOUIN, P., & MAILLARD, L.—**Traité d'histologie. I. Cytologie gênérale et spéciale.** Paris: C. Reinwald, Schleicher, frères et Cie. (1904) xxxiii. and 977 pp., 791 figs.

RÖTHIG, P.—**Handbuch der embryologischen Technik.** Wiesbaden: J. F. Bergmann, 1904.

STÖHR, P.—**Traité technique d'histologie.** Paris: translated by H. Toupet and Critzmann, 3rd French ed., 514 pp., 399 figs.

Metallography, etc.

International Committee for Investigating the Constituents of Steel.*—The confused state of knowledge on the subject of the constituents of steel, and the want of agreement as to their number, characteristics, and modes of formation, have led, at the instance of R. T. Glazebrook and H. le Chatelier, to the selection of an international committee, which will undertake researches with the object of arriving at authoritative conclusions, and of drawing up a common system of nomenclature. The difficulties met with in the study of the constituents of steel are due to (1) the numerous allotropic states in which iron exists, (2) the fine state of division of the constituents, (3) the impossibility of separating by chemical means the different solid solutions present in quenched steels, owing to the similarity of their properties. The programme of preliminary researches proposed to be undertaken, to determine the conditions under which the various constituents are produced, is given. The co-operation of independent investigators will be welcomed.

Cobalt Steels.†—L. Guillet finds that the effect of cobalt upon iron, is, contrary to what has been supposed, altogether different to that of

* Rev. Metallurgie, ii. (1905) pp. 329–34. † Tom. cit., pp. 348–9.

nickel. Samples of steel containing up to 30 p.c. cobalt with 0·8 p.c. carbon, were examined and found to be pearlitic without exception. As the percentage of cobalt increases, the breaking load and elastic limit are gradually raised, with a corresponding reduction in elongation and contraction of area ; no abrupt change in mechanical properties occurs. Cobalt steels have no industrial application.

Classification of Ternary Steels.* — L. Guillet recapitulates the results he has obtained in the course of his extensive investigations on alloys of iron and carbon with a third element, and draws some general conclusions. The method adopted was to examine, micrographically and mechanically, two series of alloys in each group, containing respectively 0·2 p.c. and 0·8 p.c. carbon, the percentage of the third element gradually being increased. The elements, the effects of which upon steel the author has thus demonstrated, are nickel, manganese, chromium, tungsten, molybdenum, vanadium, silicon, aluminium, cobalt, tin, and titanium. The steels are classified according to the results of microscopical examination as—(1) pearlitic ; (2) martensitic ; (3) containing γ iron ; (4) containing a carbide ; (5) containing graphite.

The influence of the third element upon the mechanical properties of the steel is shown in a series of curves, in which the abscissæ are percentages of the element, and the ordinates represent the differences between the properties of the alloy and those of carbon steel containing the same percentage of carbon. Diagrams of this kind are given for maximum tensile stress, elongation, and brittleness. The correspondence between micro-structure and mechanical properties is thus strikingly demonstrated. The author proposes to take up the investigation of quaternary alloys, such as nickel-manganese, nickel-chromium, and nickel-vanadium steel.

Metallography Applied to Foundry Work.† — In an article advocating the use of the Microscope in foundry work, A. Sauveur points out that the information as to the chemical composition and physical properties of metals obtained by an inspection of fractures, a method which has been universally employed in the foundry, may be largely supplemented by microscopical examination of polished and etched sections. Chemical analysis, again, while furnishing the ultimate composition of the metal, fails to suggest its proximate analysis ; valuable information as to this proximate analysis may be obtained by the use of the Microscope. The author describes the methods which he has found to be most satisfactory for the preparation of the surfaces of sections.

Scientific Development of the Art of Polishing.‡—In the course of a lengthy article on this subject, F. Osmond and G. Cartaud show how the preparation of metallic surfaces for microscopical examination may affect the results obtained. The operation of polishing consists in the removal of metal from the surface, by means of a file, emery, or

* Rev. Metallurgie, ii. (1905) pp. 350–67 (13 figs.).

† Iron and Steel Mag., ix. (1905) pp. 547–53 (1 fig.).

‡ Rev. Gen. des Sci., xvi. (1905) pp. 51–65 (46 figs.). See also Eng. Mag., xxxix. (1905) pp. 261–3.

other abrasive, which produce a series of scratches. These scratches become finer and finer as the polishing proceeds, finer abrading materials being used until ultimately the marks are invisible. The formation of scratches on the metallic surface sets up internal stresses, so that the skin of the metal is in a different molecular condition from the interior of the mass. A strained surface film may thus result, which upon etching gives deceptive appearances not at all representing the structure of the mass. The authors state that by exercising care in polishing, these deceptive conditions may be almost entirely avoided.

Special Constituent Obtained by Quenching Aluminium Bronze.* P. Breuil has obtained some remarkable results when studying the effect of quenching on an aluminium bronze known as "Fortior." This alloy melts between 1010° and 1030° C., and shows a critical point between 690° and 730° C. Normally it is made up of large grains of copper or a copper-aluminium compound imbedded in a eutectic. By quenching at 650° C. and higher temperatures a constituent having a microstructure resembling that of martensite is obtained. The appearance of this martensitic constituent coincides with an increase in the elastic limit, maximum stress, and Brinell hardness number. Quenched at 850° C. the alloy is made up wholly of this constituent.

ANDERSON, W. C., & LEAN, G.—**Properties of the Aluminium-Tin Alloys.**
Proc. Roy. Soc., lxxii., No. 482, pp. 277–81 (2 figs. and 1 pl. of photomicros.)

BUFFET, E. P.—**Equipment and Work of Metallographical Laboratories in Germany.**
American Machinist, xxviii. (1905) pp. 348–9 (7 figs.).

GOLDSCHMIDT, H.—**Effect of Vanadium and Titanium on Steel.**
Electrochem. and Metallurgical Industry, iii. (1905) pp. 168–70.

GRADENWITZ, A.—**Methods of making Tests on Metals.**
[The machines devised by Guillery for determining hardness by the Brinell method, and for testing metals by impact on notched bars, are described.]
Iron and Steel Mag., ix. (1905) pp. 528–33 (4 figs.).

GUMLICH, E.—**Versuche mit Heuslerschen ferromagnetischen Mangan-Aluminium-Kupfer Legierungen.** *Electrotech. Zeitschr.*, ix. (1905) pp. 203–7 (7 figs.).

Impact Testing of Notched Bars. *Engineer*, xcix. (1905) pp. 249–50 (9 figs.).

KRYLOFF, DE—**Balance électro-magnétique pour l'essai des propriétés des aciers et des fers.** *Rev. Metallurgie*, ii. (1905) pp. 425–40 (11 figs.).

MALETTE, J.—**Special Steels.** *Rev. Technique*, xxvi. (1905) pp. 147–50.

MAHLER, P.—**Expériences sur la résistance électrique de l'acier.**
Rev. Metallurgie, ii. (1905) pp. 345–7.

* Comptes Rendus, cxl. (1905) pp. 587–90.

MICROSCOPY.

A. Instruments, Accessories, &c.*

(1) Stands.

Old Microscope by Shuttleworth.—This instrument (fig. 138) presented by Mr. C. Lees Curties, was made by Shuttleworth, of London, and is a modification of Ellis's Aquatic Microscope, described by Adams. The pin supporting the lens holder goes through the middle of the pillar, but the stage does not move by a rackwork, as is the case in

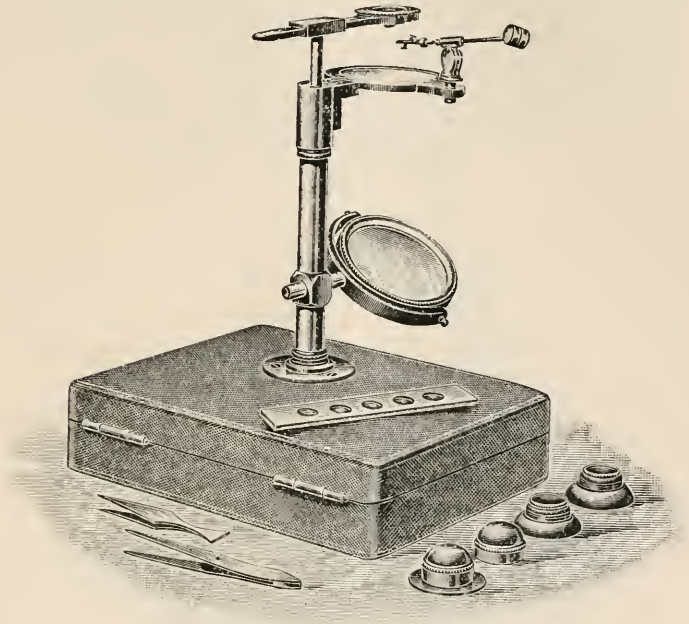


Fig. 138.

the model by Bate presented to the Society last year.† In other respects the two instruments are much the same. There are four object glasses, two of which have lieberkühns.

Old Microscope by W. and S. Jones.—This old Microscope, presented to the Society by Mr. W. S. Rogers at the April Meeting, bears the inscription "W. and S. Jones, 30 Holborn, London." Its date is about 1800, and it is a modification of Ellis's Aquatic Microscope, which was made by Cuff about 1751. The modification consists in the pillar being made cylindrical, instead of square, with an inner sliding

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous. † See this Journal, 1904, p. 354.

pillar moved by rack-and-pinion for focusing. In Ellis's Aquatic Microscope the stem for carrying the lens-holder passes through a socket at the back of the pillar, but in the instrument it passes down a hole in the centre of the inner pillar. These alterations in the original design were referred to by Adams in his Essays on the Microscope (1787). Another alteration was the making of the stage removable to economise space in the case. There are six lenses, two being provided with lieberkühns.

The case is covered with red leather instead of the fish-skin so commonly used at that period. The instrument was said by the dealer who sold it many years ago to have been the celebrated Dr. Jenner's Pocket Microscope.

A very similar Microscope made by Bate was presented to the Society by Mr. E. B. Stringer, and is figured and described in the Journal for 1904, p. 354.

Pocket Botanical and Universal Microscope. — This instrument (fig. 139) was presented to the Society by Mr. C. Lees Curties. It was

Fig. 139.

made by W. and S. Jones, and is figured and described in Adams' Essays on the Microscope, 2nd Edition, 1798, as a Pocket Botanical and Universal Microscope. It is evidently an improved form of the "Common Botanical Microscope," described in the first edition of Adams' work, 1787, which had only two lenses and no adjustment screw to move the stage. This example is well and neatly made, has three lenses which can be superposed one over the other, and also a focusing screw which is clamped to the stem and moves the stage. The stem slides in a square brass socket screwed on to an oval ebony base.

Wilson Screw-Barrel Simple Microscope. — This instrument (fig. 140) was presented by Mr. C. Lees Curties and was exhibited with the

two previously described at the June meeting. It is of ivory, and, though bearing no maker's name, was probably made by Adams about 1746. There are seven object glasses, a lens-carrier for opaque work,

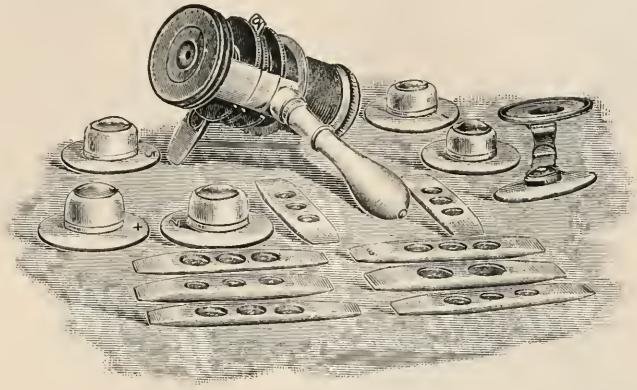


Fig. 140.

and nine ivory object slides. A light condensing lens is mounted on a brass slide just below the object slide.

Horizontal Travelling Microscope.*—This instrument (fig. 141) made by the Cambridge Scientific Instrument Company, is for measuring

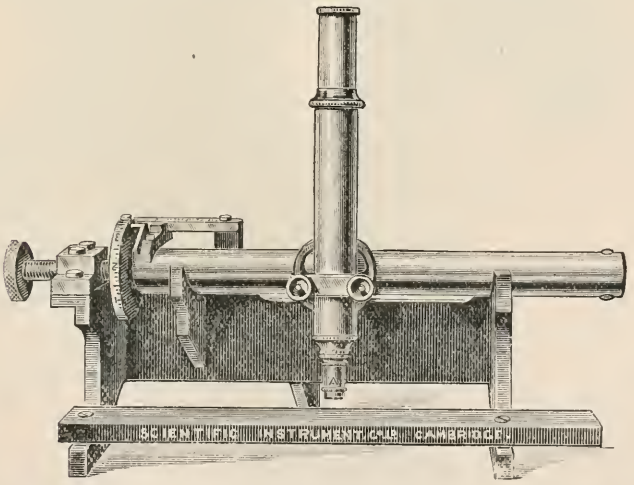


Fig. 141.

small differences of length. A vertical Microscope is fixed to a carriage mounted on a geometric slide and is moved in a horizontal direction by a micrometer screwreading to 0·1 mm.

* Catalogue Optical Convention, 1905, p. 219, fig. 11.

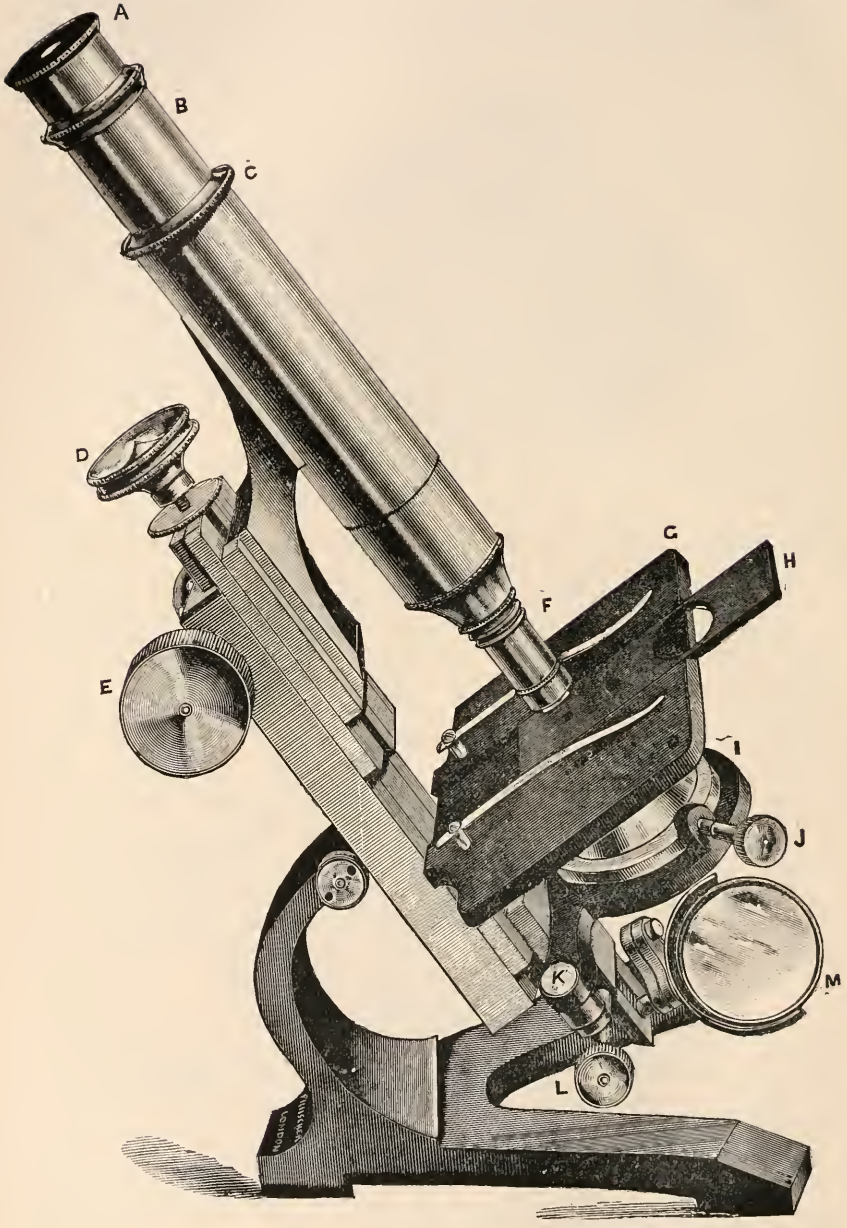


Fig. 142.

Pillischer's New Model "Kosmos."*—This instrument (fig. 142) has the following features: a substantial solid and firm stand, having rack-and-pinion course adjustment; micrometer screw fine adjustment; substage with centring screws and rack-and-pinion focusing adjustment; new form of sliding pinhole diaphragm and iris diaphragm; two eye-pieces; $\frac{5}{8}$, $\frac{1}{7}$ and $\frac{1}{5}$ objectives; and Abbe condenser 1·20 N.A.

Microscope specially adapted for Mineralogical Investigations at High Temperatures.†—E. Sommerfeldt has designed this instrument to meet the difficulties felt in applying heating chambers to mineralogical Microscopes, as it is usually found that such chambers interfere with the rotatory arrangements of the Microscope. C. Leiss has, it is true, made some models intended to overcome the difficulty, but at the disadvantage of complications. E. Sommerfeldt, therefore, aims at simplicity. In

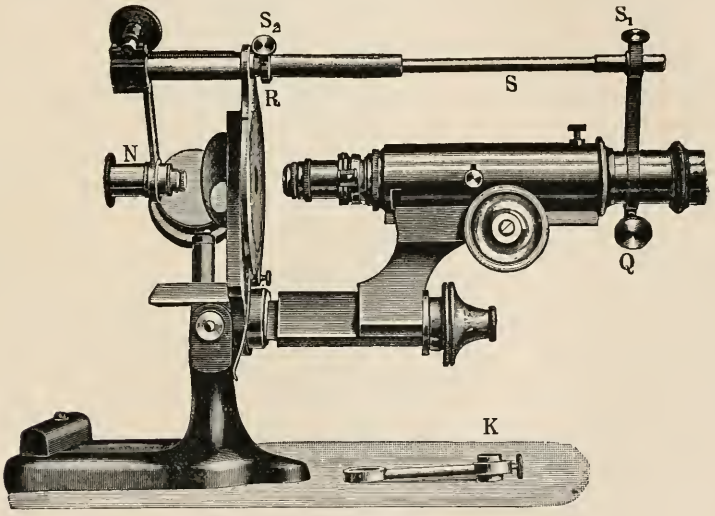


Fig. 143.

his apparatus, fig. 143, the same rotation axis and the same divided circle suffice for the rotation of both object-stage and Nicol prisms. The rotatory object-stage consists of a strong divided circle, which is surrounded by a ring R carrying the vernier, while perpendicularly to its object plane the ring carries a rod S, to one of whose ends is attached a rack-and-pinion movement for the polariser N, and the other, by means of an adjustable cross-rod, grips the ocular collar at S_1; this arrangement makes possible a rotation of object-stage and polariser about the axis of the instrument. In order to follow the movement of the tube during the adjustment, either the screw S_1 or the screw S_2, which move along grooves, should be loosened. For measurement of angles of rotation, these screws are naturally clamped. The rod S and cross-rod Q can,

* Catalogue Optical Convention, 1905, p. 116, fig. 25.
† Zeitschr. wiss. Mikrosk., xxi. (1904) pp. 181–5 (1 fig.).

if required, be completely removed. In order to connect a preparation in the central part of the object-stage circle with the peripheral ring and vernier, a transparent plate is firmly attached to the latter, and covers over the divided circle. In ordinary cases this transparent plate would be of glass, but, for heated objects, it is replaced by one of mica. The object to be viewed is set in a special clamp K, to be secured to the rod S. It may easily happen that the clamp holding the preparation may press the mica plate hard on to the divided circle; but, although this difficulty could have been easily met, the author considers that with heating arrangements it is advantageous that rotation of the Nicol should take place under a tight grip, as it were, of the preparation. The projecting part of the object-stage not only carries the rod S, but secures that the latter shall not, in its rotation, interfere with the mirror.

Hirschwald's New Microscope Model and Planimeter-Ocular.*—This instrument is made by R. Fuess, of Steglitz, Berlin, and is shown in fig. 144. An essential difference between this new model and Microscopes hitherto made with combined Nicol-rotation consists in that the Nicol rotated is not an analyser placed over the ocular, but that an analyser inserted at N in the tube is rotated at the same time with the polariser. A disadvantage of the ordinary ocular-analyser clearly is that the field of view (i.e. the focal distance of the ocular used) is pushed back on account of the lengthened eye-distance of the Nicol; this results in a more or less intense diminution of the field. But the new construction allows the rotation of the *inner* analyser only (the analogue of the ordinary ocular-analyser) relative either to the stationary polariser P, or to the preparation, stationary or rotatory, on the object stage T. In both cases the ocular and analyser rotate and the ocular-threads mark the rotation-directions of the Nicol. The design also permits of two other controlling movements, less frequently required: the analyser may move *relatively* to the stationary polariser and ocular; or, the polariser may move *relatively* to the analyser and ocular. For these combinations the requisite arrangements are as follows:—

(*a*) *Polariser, Analyser, and Ocular rotate in unison.* The screw-head *b*, under the stage T, is loosened. A connecting screw is inserted in the large ocular rim T_1. The arm *o*, appended to the vernier arm *s* and rotatory about a hinge, is unlocked. For orientating the ocular there are two lines scored on the ocular mount-collar T_1.

(*b*) *Polariser remains stationary, Analyser and Ocular rotate.* To carry out this movement the Nicol circle T_1 must be set at zero, the screw-head *b* under the stage is tightened, and the screw on the Nicol circle T_1 loosened. The arm *o* is unlocked. Rotation takes place on the rim of the Nicol circle T_1.

(*c*) *Polariser and Analyser rotate in unison and the Ocular remains stationary.* The arrangement is the same as for *a*, but the arm *o* is locked over the projecting screw on the ocular.

(*d*) *Polariser and Ocular remain stationary and Analyser rotates.* The arrangement is the same as for *b*, but the arm *o* is locked up as in last.

* Zentralbl. f. Mineral, 1904, p. 626; Zeit. f. Instrumentenk., xxiv. (1904) pp. 367–8 (2 figs.).

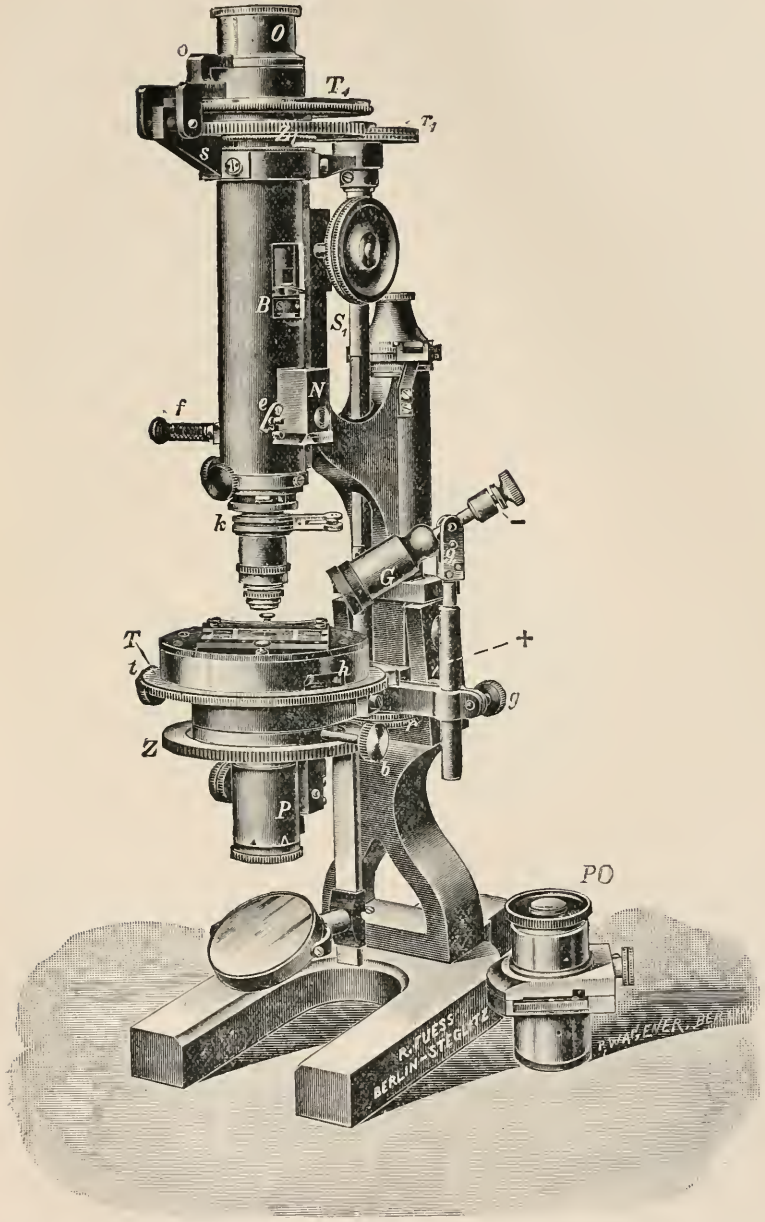

O
o
T_1
r_1
s
B
S_1
N
e
f
k
G
T
t
h
g
Z
P
PO
R. FUESS
BERLIN-STEGLITZ
P. WAGENER, BERLIN

FIG. 144.

The *Observation Oculars* used have an enlarged field of view about double the extent of ordinary oculars. In their image plane is a disc with a round and a square diaphragm, so that a round or a square periphery can, as desired, be given to the image. The latter serves for the quicker enumeration of constituent parts in any section. The other arrangements are practically identical with those of ordinary large polarisation-microscopes. The object stage T and the Nicol circle T_1 are graduated in degrees and their verniers read to 5 minutes. The Bertrand lens B and the analysing Nicol N can be cut out of the pencil of rays; the latter by means of the spring rod *f*; the former by means of a small clip swung back during rotation. The tooth-wheel gear has the well-known arrangement for avoiding dead-way in the teeth.* In lieu of the cross-slit stage this instrument has for swift investigation of a section a simple slide arrangement, by means of which a slide can be pushed by hand-motion freely in two rectangular directions. For upper-surface illumination an adjustable holder for an electric glow-lamp G can be installed near the object stage.

The *Planimeter-Ocular* is seen at P O in the right of fig. 144. It is

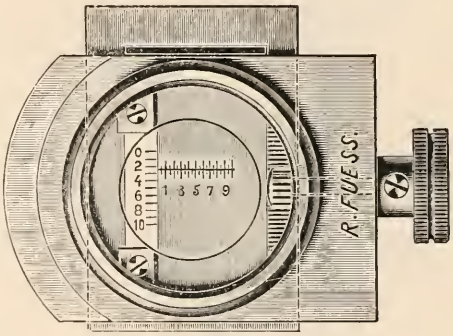


Fig. 145.

used for determining the volume-proportion of any mineral constituents in a thin rock-section. In the image-plane of the ocular two micrometer scales (fig. 145) perpendicular to each other are cut on glass. They serve to give ordinates and abscissæ; the scale for the former being fixed; the latter adjustable by rack-and-pinion. Their combined motions explore a space of one square cm. The planimeter-ocular is applied in such a way that corresponding to the grain of the rock the abscissæ are adjusted on a particular graduation of the ordinates and the condensation index is read off for the various parts. The section is then rotated, or the planimeter-ocular rotated, through 90°, and the reading repeated in the perpendicular direction.

Microphotoscope, or Military Staff Map Loup.†—This arrangement is designed by its inventor, O. Vollbehr, for the avoidance of the in-

* Zeit. f. Instrumentenk., xvi. (1896) p. 17.

† Extract from Kriegstech. Zeitschr., 1905, Heft. 1ª, 12 pp. and 3 figs., Berlin, E. S. Mittler and Sohn; Zeitschr. f. Instrumentenk., xxv. (April 1905) pp. 117–18; Central-Zeit. f. Opt. u. Mech., xxvi. (May 1905) p. 106.

convenience (and for military purposes in front of the enemy, of the dangers) involved in the employment of topographical maps by night or in bad weather. By the aid of the new map-loup small transparent diapositive maps in the shape of about 20 sq. cm. (5 × 4 cm.) are used in lieu of large paper sheets. The microphotoscope can be used by day or by night; in the latter case, the necessary illumination is supplied by a glow-lamp actuated by a dry battery. For the arrangement to work conveniently, the loup must have strong magnification, and the loup-map be of a minimum size. The loup has, at present, been constructed of 13½ fold magnification; it seems scarcely possible to increase this, and, indeed, does not seem necessary. The composition of a sufficiently grainless emulsion for the preparation of the small map diapositives appropriate to the selected magnification has already revealed great difficulties, but these may now be regarded as entirely overcome. The diapositive lies well protected between two glass plates. The loup is, of course, accommodated to the observer's eye, and, moreover, is adjustable over the plane of the diapositive. For a selected position of the loup 175 sq. kilos. would be readable at once on a diapositive of the map of the German Empire (1 : 100,000). Sheets of the map of the German Empire should be first prepared as diapositive loup-maps, afterwards those of the most important foreign topographical maps. On a diapositive a square-meshed net is drawn with sides corresponding to 2½ kilos., so that in all directions estimation of routes and elevations can be made.

Studnicka's Pancratic Preparation Microscope.*—F. K. Studnicka points out that the principle involved in the lens combination described in the previous article, is essentially that of a "pancratic" Microscope. The term is not a new one; pancratic Microscopes were familiar instruments in the first half of the nineteenth century,† and were generally used as dissection-microscopes. They seem to have been found unsatisfactory and to have gradually dropped out of notice. The author, however, thinks that this oblivion is not deserved. He proposes to accurately insert a reversed objective, by means of a simple connecting piece, in the diaphragm-carrier of the Abbe illuminating apparatus, from which the condenser has been removed. Both objectives thus come, in this way, into the approximately proper distance from one another; at most the tube may require to be lowered a little. The side-light is screened off by the side-walls of the upper iris of the illuminating apparatus; the lower objective is fairly close to the object and by rack-and-pinion may be brought still closer to it. The object must be placed on a special stage under the inverted objective, and this stage should be fitted with supports for the hands. Such a stage can be easily improvised out of two pieces of wood and a glass plate. It is possible to use the ordinary stage "pancratically," but the ordinary objective is then inserted at the lower end of the draw-out tube, and the inverted objective fitted to the lower end of the tube (or revolver) with a connecting piece. Tubes with rack-and-pinion movement would be most

* Zeitschr. wiss. Mikrosk., xxi. (1904) pp. 440–4 (1 fig.).

† *Vide*, e.g. Fischer, Le Microscope pancratique, Moscou, 1841; Hartrig, Das Mikroskop, 1859, pp. 198 and 766. The 'Telemikroskop' of Deschamps (Comptes Rendus, cxxx., 1900) deals with a similar lens-combination.

convenient for this arrangement. On account of the increased working height the author considers this method inferior to the condenser adaptation.

GLATTON—**Right and Wrong Way of using a "Magnifying Glass."**

1. The lens should be held as far from the object as will afford a clear sharp view of it.

2. The eye should be at the same distance from the lens as the latter is from the object.

The advantage of the latter condition is very apparent when examining portraits with a reading glass. I have frequently seen the glass held either close to the eye or close to the paper, both of which are wrong—the latter absurdly so, as no attempt is made to focus the object.

English Mechanic, lxxxi. (1905) pp. 449–50.

(2) Eye-pieces and Objectives.

The Abbe Condenser used as an Objective.*—F. K. Studnicka, after reminding his readers that the condenser of the Abbe illuminating apparatus is an objective reversed, points out that by using it in the latter way, with a proportionally stronger objective, a continuous series of weak magnifications very useful for certain purposes may be obtained. He considers that the cases in which such a method is likely to be useful are :—

1. That preparations can be quickly and simply explored, especially when large (i.e. brain-sections).

2. That the peculiarity of producing graduated magnifications (according to working distance, etc.) will be welcome to an observer who wishes to draw.

3. That it may be made to answer the purpose of a preparation Microscope, and so be economical to an observer.

4. That with the help of the Abbe condenser and the plane mirror an erect Microscope can be easily turned into a horizontal one, and be used as an aquarium Microscope.

5. That the peculiarity of neighbouring objects appearing reduced or enlarged, or even in natural size, facilitates the drawing or copying of objects—the usual drawing apparatus being now combined with the Microscope.

The author illustrates his methods with figures.

Discrepancy between Diffraction Theory and Geometrical Optics in Actual Instances of Telescope and Microscope Objectives.†—K. Strehl has examined an improved achromatic Microscope-objective made by A. Kerber, to test how far the lens performs what theory would have predicted of it. The lens is of 4 mm. focal length and of 0·6 N.A. He is able to state the following discrepancies between diffraction theory and geometrical optics in this particular case :—

1. The wave-surface of the colour C, which in and for itself has the greatest spherical aberration, and, compared with the brightest colour (550 $\mu\mu$), has the maximum chromatic aberration, approximates the most closely to the ideal spherical surface of brightest colour.

* Zeitschr. wiss. Mikrosk., xxi. (1904) pp. 432–9 (3 figs.).

† Central.-Zeit. f. Opt. u. Mech., xxv. (1904) p. 265.

2. The wave-surface of the colour E, which in and for itself has the second least spherical aberration, and, compared with the brightest colour, the least chromatic aberration, departs the most widely from the ideal spherical surface of the brighest colour.

3. The wave-surfaces of the two colours (C and 550 $\mu\mu$), which for peripheral rays have the least cross-sectional difference, deviate on the periphery the second-furthest from one another.

4. The wave-surfaces of the two colours (D and F), which have the maximum cross-sectional difference for peripheral rays, combine on the periphery.

The following statement may also be enunciated:—

5. Those wave-surfaces of the two colours, E and 550 $\mu\mu$, incline the least to one another from the axis to the periphery, which in the spectrum lie nearest to one another, and, for axial rays, have the least cross-sectional difference.

In support or the foregoing statements the so-called Gauss construction may be appropriately quoted.

6. If the section-distances for axial and peripheral rays of two colours are equally great, then most certainly are the light-paths corresponding to one another from the two wave-surfaces to the image-point not equally long; for (*a*) the medial errors (zones) are in both colours of different magnitude, and therefore also the final result at the periphery. (*b*) The refracted rays of the two colours (direct illumination being pre-supposed) claim different zones (red becomes more strongly refracted than blue).

In another case the author examined a giant objective of over 50 cm. diameter and over 10 cm. focal length. It warranted the following statement (optical paradox).

7. If combined zonal errors were half as great as the actual ones, then the definition-brightness (excellency of image) would be half as great as the reality; if the zonal errors were even less, then, indeed, would the image excellency be rapidly augmented.

K. Strehl hopes that the time may come when no expensive telescope or Microscope objective will be sold without having been submitted to a diffraction theory test. In the case of telescope objectives this would have to be done for each specimen; but in the case of micro-objectives of a given number, the test could be made once for all. Neither can it be objected that the application of the diffraction theory would be too difficult or too tedious. On the contrary, it is quite easy, and at most a specimen would only require two days.

In another journal the author has an article entitled, "Test of a Microscope Objective," * in which he describes his methods and gives full details of his results.

(3) Illuminating and other Apparatus.

Locking Arrangement for Microscopical Demonstrations.†—A. Fischer has designed an arrangement, more particularly applicable to

* Untersuchung eines Mikroskopobjektives, Zeit. f. Instrumentenk., xxv. (1905) pp. 3–10 (1 fig.).

† Zeitschr. wiss. Mikrosk., xxii. (1905) pp. 100–4 (2 figs.).

the Zeiss No. 1A stand, for preventing interference with the adjustments by inexperienced persons at microscopical demonstrations. The stiff cardboard capsules, which C. Zeiss supplies for covering the milled screw heads of the rack-and-pinion coarse adjustment, the author proposes to unite by a small bent metal bar, and instead of cardboard he would make the caps of brass. The effect is to completely cover up the coarse adjustment, and to place it beyond the risk of displacement. For obtaining similar security with the fine adjustment, he, in the first place, makes the index pointer of rather stouter dimensions than usual, and hinges it so that it can be folded up against the Microscope tube, while

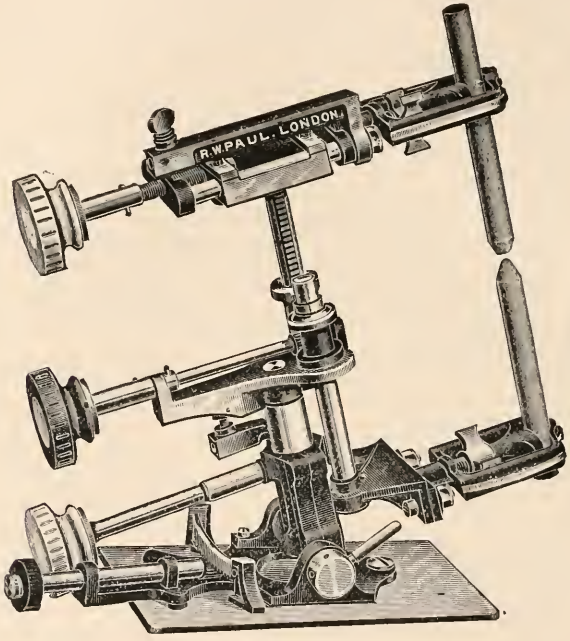


Fig. 146.

the demonstrator is focusing. Two (or more if thought necessary) little pins project 4 mm. about the rotating head of the fine adjustment, so that, when the index is folded down, rotation of more than half a circle is prevented. The observers would thus have a sufficient range within which they could safely vary the focus. It would be best to arrange so that for normal vision the pointer should be midway between the two pins, and to obtain this it might be necessary to make some change in the previous coarse adjustment.

Optical Arc Lamps.*—R. W. Paul makes these lamps in two sizes, for 30 and 60 amperes (fig. 146), the special features being the form of horizontal traverse which gives a firm and even motion; the construction

* Catalogue Optical Convention, 1905, p. 198, fig. 6.

of the carbon holders, which have the terminals cast in one piece with them; and the adjustments for taking up wear in all parts.

Locke's High Power Jet.*—This jet (fig. 147) made by R. W. Paul has a mixing chamber of new design placed next to the inlet valves and connected to the jet by a long delivery tube, thus ensuring perfect mixing of the gases and silence under high pressure.

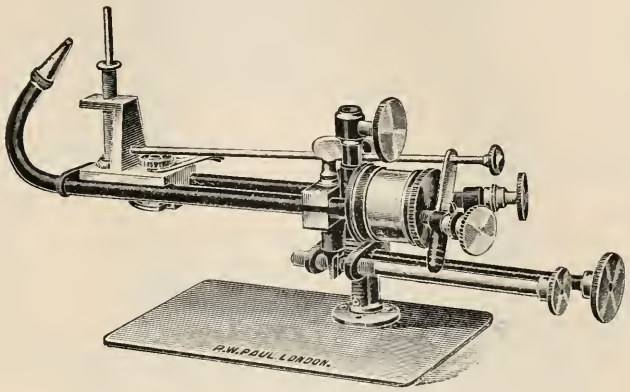


FIG. 147.

Leppin and Masche's Projection Apparatus with Optical Bench Extension.†—The main idea of this apparatus is to produce an initially simple instrument which should be capable of additions as required, so as to render it capable of performing all the most varied purposes expected from such apparatus. Fig. 148 shows the arrangement for simple projection. The iron camera is lined within with asbestos, and has two doors: in addition to the ordinary mode of ventilation there is also a removable outlet for the warm air. The condenser is of 130 mm. diameter. The achromatic Petzval objective has 54 mm. diameter, 130 mm. focal length, and diaphragms. The simple form includes also an object-holder, a stage, and a bench with three riders. Slides of 85 by 100 mm. up to 90 by 120 mm. can be projected, and a magnification of 30–40 diameters attained. Fig. 149 shows the section of the twin rails on which the riders slide. The two prismatic bars, at right angles to each other, give smoothness of motion, security of position, and facility for quick interchange of parts. This arrangement is an essential novelty in the apparatus. Clamping screws are not required, and the time necessary for tightening them consequently saved. The apparatus is installed on a travelling table. It is thought that this mobility will be useful and lead to further economy of time. The height of the table is so designed that projection can be made over the demonstrator's table, and the images received on a screen at a suitable height. Moreover, it is pre-supposed that the apparatus would be stationed near the lecturer's table for use as required, and thus place

* Catalogue Optical Convention, 1905, p. 198, fig. 9.

† Central.-Zeit. f. Opt. u. Mech., xxvi. (April and May 1905) pp. 93–4, 105–6 (6 figs.).

the lecturer beyond the need of a lantern assistant. The table consists of an under part and of a set-back upper part; both parts are of pine

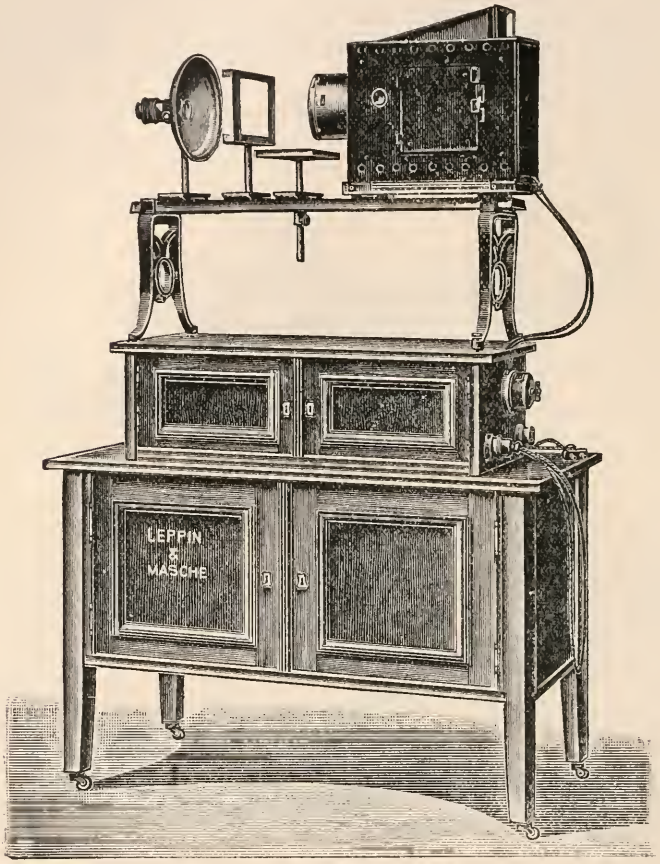


FIG. 148.

wood with oaken tops. The upper part is hinged, in the neighbourhood of the electrical terminals, to the lower, and the opposite face can be raised—this movement would be advantageous in lecturing to a large assembly. Both upper and lower parts are fitted up as cabinets, which are convenient receptacles for the various fittings and auxiliaries. Incandescent gas, acetylene, lime, or electric light can be used, of which the last-named is undoubtedly the best. The makers strongly recommend their self-regulating differential arc lamp in preference to a hand-controlled one. Proper attention must be paid to current strength and resistance.

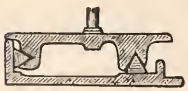


FIG. 149.

To adapt the apparatus to the purposes of microscopic preparations, of a megascope, or of horizontally placed objects, a greater length of optical bench is required. The method of attaining this is shown in fig. 150. Horizontal lateral shelves are drawn out from the ends of the upper part, and by their help a second pair of twin rails is set up and

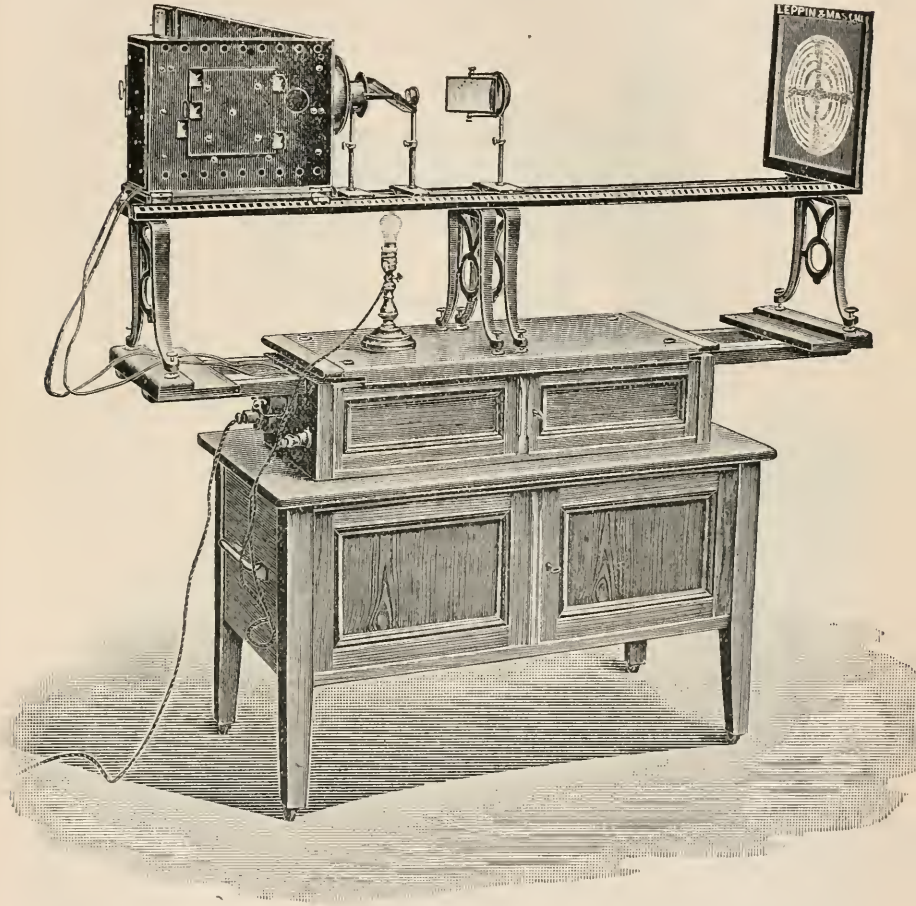


Fig. 150.

combined with the first, so as to give a total bench length of 2 metres. The two sections of bench are rigidly coupled together. It is found that with the proper combination of Nicols and a black mirror polarisation effects are easily attained, and without slanting the camera. For cooling purposes a suitable water-filled large trough with plane-parallel walls is found to answer well; in lengthy investigations the water should be renewed.

Edinger's Projection and Drawing Apparatus.*—As shown in the illustration (fig. 151), this apparatus is an improved form of an older

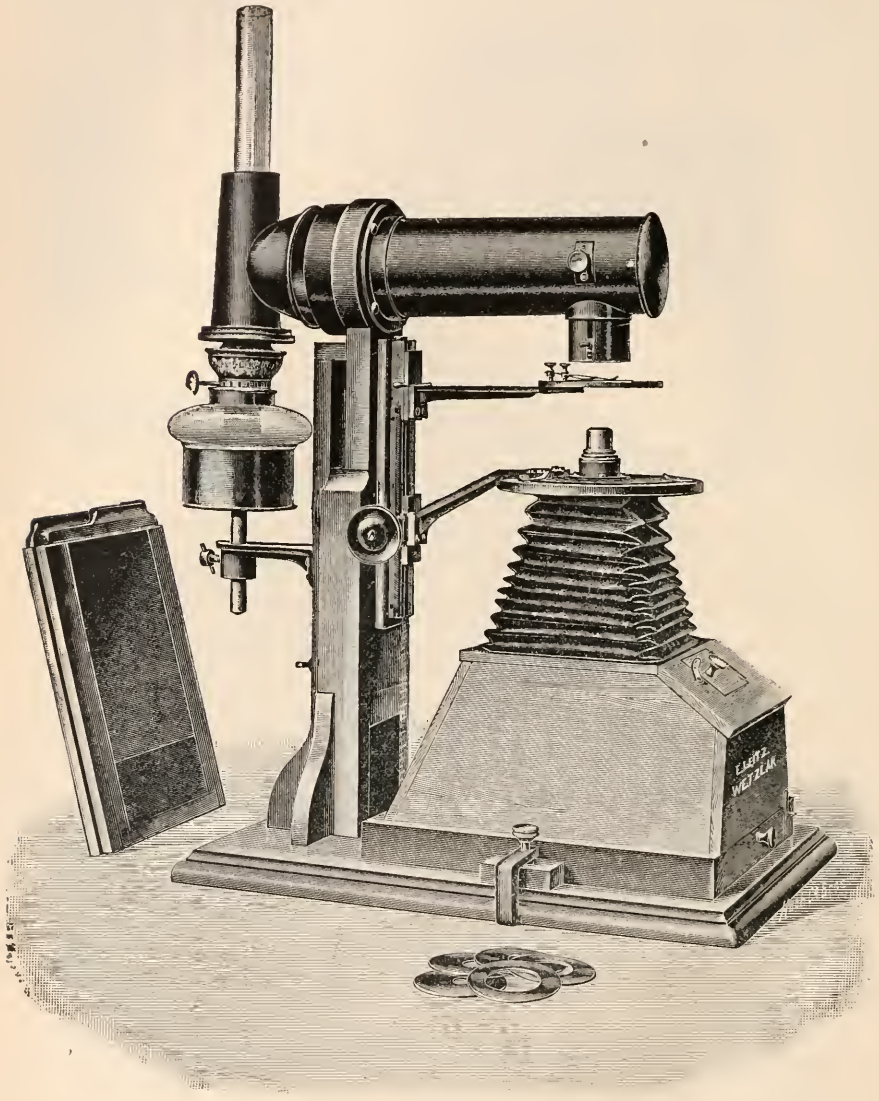


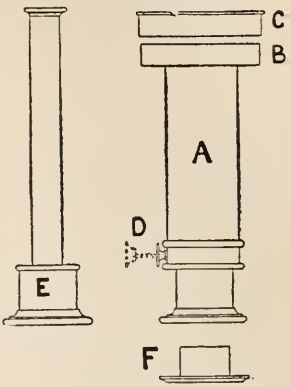
Fig. 151.

type previously described,† and now also adapted for photographic purposes by the addition of Nieser's camera.

* Leitz' Catalogue, No. 41, 1905, p. 98.

† See this Journal, 1891, p. 811.

Simple Apparatus for Drawing and Photographing Microscopical Sections.*—This apparatus, designed by J. Tandler, consists (1) of a drawing-box carrying on its top a photographic bellows; (2) of a box enclosing the light source. The drawing-box is closed in front, open behind, and has a trapezoidal-shaped base of dimensions: rear 65 cm., front 35 cm., width 35 cm. The front wall is strong and 55 cm. high; the back wall (oblique) is not so high, and slopes roof-wise towards the level top. The reason for this shape is that the observer, sitting at the side of the box, may comfortably work with his right arm in the box. In both the front and back walls there is a series of slides for receiving the drawing board. A right-angled totally-reflecting prism with the hypotenuse blackened, is placed over the upper end of the bellows. Rays of light originating from the light-source then pass horizontally through the Microscope, are reflected at the prism, and pass vertically downwards through the bellows on to the drawing board in the box. The source of light is generally an incandescent lamp. The author keeps the arrangement installed in the rear of his workroom, the front (closed) side being towards the window. In this way he finds that the image projected into the box is bright enough without further darkening of the room. By removing the prism, and by setting the bellows horizontally on a board with runners, the apparatus can be used for photomicrography.



(4) Photomicrography.

J. W. Gordon's Apparatus for Photomicrography.†—In this application of photography to the Microscope, the instrument is used in a vertical position. The apparatus consists of a tube A, about 6 in. long, which is placed over the eye-piece. At the upper end of this tube B, a photographic plate, $1\frac{5}{8}$ in. square, is held by means of a cap C, in a light-tight chamber; between this and the eye-piece is a projection lens focused upon the plate, and a small exposing shutter D is placed in the tube for making the exposure (fig. 152).

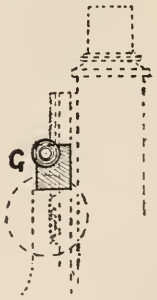


Fig. 152.

If the observer's eyesight be normal, the photograph will be sharp when the Microscope is in its ordinary focus, but, as almost everyone has slight errors of vision, it has been found desirable to supply a duplicate tube E, with a focusing eye-piece of high power, which is first placed on the instrument in order to focus, and is then replaced by the camera.

* Zeitschr. wiss. Mikrosk., xxi. (1904) pp. 470–4 (3 figs.).
† R. and J. Beck's Special Catalogue, 1905, 4 figs.

A small flange F fitted over the eye end of the Microscope is required, to form a table upon which to rest the camera.

In order to overcome the tendency of the body to move downwards during a prolonged exposure, a block of metal G, which slides up and down the coarse adjustment, and can be clamped in any position, is supplied.

A yellow screen H (fig. 153), fixed on a stand with universal motion, should be employed between the Microscope mirror and the light in connection with isochromatic plates for all powers higher than a $\frac{2}{3}$ in., otherwise the focus cannot be relied on with certainty.

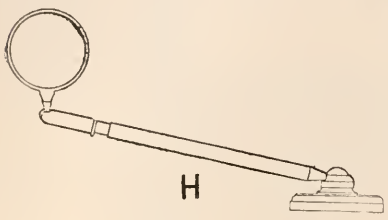


Fig. 153.

With this apparatus photographs can be made $1\frac{3}{8}$ in. in diameter, having such fine detail that they will bear enlargement to any reasonable extent. One of the chief advantages of this extremely simple method of photomicrography is that the optical performance of the Microscope is exactly the same as when it is used for visual observation. The apparatus is made by the firm of R. and J. Beck.

A Perfectly Steady Stand for Photomicrography.*—J. Ries has sought to attain (1) the advantages of the Zeiss large photomicrographic camera by a less costly construction; and (2) to contrive an apparatus which shall be useful for all kinds of photography. The Zeiss model requires two tables, one for the Microscope and one for the camera, so that the unavoidable slight disturbances of the camera due to manipulation shall not extend to the Microscope. The cost and the dimensions of so much apparatus practically limit its use to institutions. The author seeks to make his Microscope perfectly steady and at the same time independent of the camera by mounting it securely on a heavy triangular base. This base fits freely but accurately within a triangular frame to which the optical bench with camera is attached. Thus the size of the whole is kept within moderate limits. The bellows are 45 cm. long, and are controlled by a double rod-rack gear. The front and back frames are secured on two platforms clamped to the optical bench and governed by the rod-gear. The camera can be easily set up or removed. It may be used without the Microscope, and thus serve for all photographic purposes. The author illustrates his method by suitable diagrams.

H., Dr.—**Unsichtbares Licht im Dienste der Mikroskopie.**
[Mainly deals with Dr. Köhler's photomicrography with ultra-violet rays.]
Central.-Zeit. f. Opt. u. Mech., xxvi. (1905) p. 34.

Simon et Spillmann, L.—**Application de la photographie à la numération des éléments figurés du sang.** *Comptes Rendus*, lvii. (1904) pp. 659–60.

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* Zeitschr. wiss. Mikrosk., xxi. (1904) pp. 475–8 (5 figs.).

(5) Microscopical Optics and Manipulation.

Czapski's Elements of the Theory of Optical Instruments.*—This work, whose nature is well expressed by its full title, has now reached its second edition, and contains 479 large octavo pages. It has become nearly double the size of the first edition, and, like its predecessor, forms a part of Winkelmann's "Handbook of Physics." The original nine sections are now extended to sixteen, and are so enlarged and revised that this second edition is practically a new work.

Sections VIIB, XIII, XIV, are by Dr. Eppenstein; VIIIA, IX, X, by Dr. von Rohr; and the others are by Dr. Czapski. The scope of the work will be inferred from the following list of the section titles :—

I (pp. 1–26). Geometrical optics.
II (pp. 27–64). Geometrical theory of the optical image.
IIIA (pp. 64–86). Realisation of the optical image by small pencils in the neighbourhood of the axis of centred spherical surfaces.
IIIB (pp. 86–100). Realisation of the optical image by oblique elementary pencils (astigmatic refraction).
IIIC (pp. 101–2). The image by astigmatic refraction or reflection on doubled curved surfaces.
IIID (p. 103). General theorems on homocentric refraction.
IV (pp. 104–163). Artificial enlargement of the image-limits (theory of spherical aberration).
V (pp. 164–183). Chromatic aberrations of dioptric systems (theory of achromatism).
VI (pp. 184–210). Prisms and prism-systems.
VII (pp. 211, etc.). Limiting of the rays and the properties of optical instruments dependent thereon.
VIIA (pp. 212–247). Diaphragms as a means for the selection of the rays essential for an optical image.
VIIB (pp. 248–260). Diaphragms as a means for the plane representation of a space.
VIIC (p. 260). Development of the theory of ray-limitation.
VIII (pp. 261–269). The eye.
VIIIA (pp. 270–295). Vision.
IX (pp. 295–320). The photographic objective.
X (pp. 320–328). Spectacles.
XI (pp. 328–335). The loup, or single Microscope.
XII (pp. 335–373). The compound Microscope.
XIII (pp. 373–4). Enlarged projection-systems.
XIV (pp. 375–385). Illumination-systems.
XV (pp. 386–432). The telescope.
XVI (pp. 432–471). Methods for the empirical determination of the constants of optical instruments.

The numerous figures are very clearly drawn, and to most of the sections bibliographies are appended.

* Grundzuge der Theorie der Optischen Instrumente nach Abbe, von Dr. Siegfried Czapski; unter Mitwurkung des Verfassers und mit Beiträgen, von M. von Rohr; herausgegeben von Dr. O. Eppenstein; mit 176 Abbildungen. Leipzig : Johann A. Barth, 1904.

Von Rohr's Image-formation in Optical Instruments from the Standpoint of Geometrical Optics.*—This work, whose full title is given below, forms the first volume of a treatise on the theory of optical instruments. It is dedicated to Professor Abbe, and the preface has been written by Dr. Czapski. It is divided into ten chapters, as follows, the names of the respective contributors being given in square brackets :—

I (pp. 1–35). The claims of geometrical optics. [H. Siedentopf.]
II (pp. 36–82). Calculation-formulæ. [A. König and M. von Rohr.]
III (pp. 83–123). Abbe's geometrical theory of the optical image. [E. Wandersleb.]
IV (pp. 124–207). Realisation of the optical image. [P. Culmann.]
V (pp. 208–338). Theory of spherical aberrations. [A. König and M. von Rohr.]
VI (pp. 339–372). Theory of chromatic aberrations. [A. König.]
VII (pp. 373–408). Calculation of optical systems on the basis of the theory of aberrations. [A. König.]
VIII (409–465). Prisms and prism-systems. [F. Löwe.]
IX (pp. 466–507). Ray limitation in optical systems. [M. von Rohr.]
X (pp. 508–547). The ray-path through optical systems. [M. von Rohr.]

Many of the chapters are followed by collections of historical and bibliographical notes.

Diffraction-Image and Absorption-Image.†—K. Strehl has found that S. Apáthy's attitude towards the diffraction theory of microscopic vision is not always understood, that he is even accused of "attacking the Abbe theory of microscopical image formation." He states that Apáthy does not dispute the Abbe theory, but that he only limits it. Apáthy is of opinion that the ordinary microscopic image may be, as it were, a superposition of three images, quite different in their nature, i.e. of a diffraction-image in Abbe's sense, of a refraction-image, and of an absorption-image. He ascribes the chief function to the last named image. K. Strehl endeavours to make the views of himself, Apáthy and Abbe clear on these points.

Michaelis, L.—**Ultramikroskopische Untersuchungen.** *Virchow's Arch. f. pathol. Anat.*, Bd. clxxix. (Folge 17, Bd. ix.) 1905, pp. 195–200.

Walker, J.—**Analytical Theory of Light.** C. J. Clay (London, 1904) 432 pp.

(6) Miscellaneous.

Optical Properties of Glasses produced by Chance Brothers.‡—By the courtesy of Messrs. Chance Brothers and Co. we are enabled to give the following table of the optical properties of the glasses produced

* Die Bilderzengung in Optischen Instrumenten vom Standpunkte der geometrischen Optik. Bearbeitet von den Wissenchaftlichen Mitarbeitern an der optischen Werkstätte, von Carl Zeiss, P. Culmann, S. Czapski, A. König, F. Löwe, M. von Rohr, H. Siedentopf, E. Wandersleb. Herausgegeben von M. von Rohr. Berlin: J. Springer (1904) 8vo, 587 pp., 133 figs. in text.

† Zeitschr. wiss. Mikrosk., xxii. (1905) pp. 1–10.

‡ See also Catalogue Optical Convention, 1905, pp. 2–3.

Table of Optical Properties.

No.	Name.	n_D	v	Medium Dispersion. C−F	Partial and Relative Partial Dispersions.					
					C−D	$\frac{C-D}{C-F}$	D−F	$\frac{D-F}{C-F}$	F−G′	$\frac{F-G'}{C-F}$
C 644	Extra hard crown	1·4959	64·4	0·00770	0·00228	0·296	0·00542	0·704	0·00431	0·560
B 646	Boro-silicate do.	1·5096	63·3	0·00803	0·00236	0·294	0·00562	0·700	0·00446	0·555
A 605	Hard do.	1·5175	60·5	0·00856	0·00252	0·294	0·00604	0·706	0·00484	0·554
C 577	Medium barium do.	1·5738	57·9	0·00990	0·00293	0·296	0·00697	0·704	0·00552	0·557
C 579	Densest barium do.	1·6065	57·9	0·01046	0·00308	0·294	0·00738	0·705	0·00589	0·563
A 569	Soft do.	1·5152	56·9	0·00906	0·00264	0·291	0·00642	0·708	0·00517	0·570
B 563	Medium barium do.	1·5660	56·3	0·01006	0·00297	0·295	0·00709	0·704	0·00576	0·572
B 535	Barium light flint	1·5452	53·5	0·01020	0·00298	0·292	0·00722	0·701	0·00582	0·570
A 490	Extra light do.	1·5316	49·0	0·01085	0·00313	0·288	0·00772	0·711	0·00630	0·580
A 485	Extra light do.	1·5333	48·5	0·01099	0·00322	0·293	0·00777	0·707	0·00640	0·582
C 474	Boro-silicate do.	1·5623	47·4	0·01187	0·00343	0·289	0·00844	0·711	0·00693	0·584
B 466	Barium light do.	1·5833	46·6	0·01251	0·00362	0·288	0·00889	0·711	0·00721	0·576
B 458	Soda do.	1·5482	45·8	0·01195	0·00343	0·287	0·00852	0·713	0·00690	0·577
A 458	Light do.	1·5472	45·8	0·01196	0·00348	0·291	0·00848	0·709	0·00707	0·591
A 432	Light do.	1·5610	43·2	0·01299	0·00372	0·287	0·00927	0·713	0·00770	0·593
A 410	Light do.	1·5760	41·0	0·01404	0·00402	0·286	0·01002	0·713	0·00840	0·598
B 407	Light do.	1·5787	40·7	0·01420	0·00404	0·284	0·01016	0·715	0·00840	0·591
A 370	Dense do.	1·6118	36·9	0·01657	0·00470	0·284	0·01187	0·716	0·01004	0·606
A 361	Dense do.	1·6214	36·1	0·01722	0·00491	0·285	0·01231	0·715	0·01046	0·608
A 360	Dense do.	1·6225	36·0	0·01729	0·00493	0·286	0·01236	0·715	0·01054	0·609
A 337	Extra dense do.	1·6469	33·7	0·01917	0·00541	0·285	0·01376	0·720	0·01170	0·655
A 299	Densest do.	1·7129	29·9	0·02384	0·00670	0·281	0·01714	0·789	0·01661	0·678

by their firm. The glasses are arranged in order of descending values of v. Those whose factory number is preceded by the letter A are the ordinary silicate crowns and flints which have been in use for over half a century. Those marked with the prefix B are of more modern introduction, while those preceded by C are of quite recent introduction.

The optical constants as given in the table are to be regarded as type values, which are adhered to with considerable accuracy from one melting to another. The spectrum lines used for the specification of these constants are the lines of the hydrogen spectrum known as C, F and G′, and the sodium line D to which latter the refractive index n_D refers. The wave-lengths of these lines may be taken in micro-millimetres as follows :—

C = 0·6563	D = 0·5893
F = 0·4862	G′ = 0·4341

The difference between the refractive indices for the C and F lines, generally called the interval C − F, is defined as the mean dispersion, while the partial dispersions and their relative values, obtained by dividing the partial dispersion by the mean dispersion, are also specified. The value of v is given by

$$v = n_D - \frac{1}{C - F}.$$

Chance Brothers' Cover Glasses of thin Glass for Microscopic Preparations.*—This thin glass is made in three thicknesses, and in all usual sizes both square and round ; larger pieces for special purposes are also supplied. This glass is chemically of the "hard crown" type, but differs in its mode of manufacture. Its optical constants, which have been measured by means of specially prepared prisms, are as follows :—

n_D	v	Medium Dispersion. C−F	Partial Dispersions.		
				D−F	F−G′
1·5158	57·4	0·00898	0·00294	0·00604	0·00511

Manipulation of the Microscope.†—This most excellent manual, the work of Edward Bausch, was originally published twenty years ago, since when it has deservedly run through four editions. In simple language are described the stand, its various parts and accessories, how to manipulate these in the proper way and with the best effect, the volume ending with instructions as to the care of a Microscope. The index is quite complete.

Elementary Microscopy.‡—This handbook on Elementary Microscopy is the outcome of a series of articles on "Microscopy for Beginners," by F. Shillington Scales. The material has been re-cast

* Catalogue, Optical Convention, 1905, p. 4.

† Bausch and Lomb Optical Co., Rochester, N.Y., 4th ed., 1901, 202 pp., with numerous illustrations.

‡ London: Baillière, Tindal and Cox, 1905, xii. and 179 pp., 77 figs.

and practically re-written. The work deals with the simple and compound Microscope, the choice of a Microscope, objectives and eye-pieces, accessory apparatus, the practical optics of the Microscope, the manipulation of the Microscope and its accessories. The volume may be heartily recommended as a useful guide to beginners.

B. Technique.*

(1) Collecting Objects, including Culture Processes.

Formate Broth in the Differential Diagnosis of Micro-organisms.† W. Omelianski refers to the differentiating properties of media containing alkaline salts of formic acid in the diagnosis of micro-organisms. Whereas most pathogenic forms behave negatively or passively, the nearly allied non-pathogenic bacilli split up the formate, with the development of gas, CO_2 and H, and the formation of carbonates. If phenolphthalein has been added to the medium, the increased alkinity will be shown by the appearance of a red coloration ; but this reddening of the medium occurs not only from the splitting up of formates, but also by the decomposition of albuminous substances in the medium. Cultures of *B. coli* and *B. typhi* grown on this medium (formate agar bouillon) both produce a red coloration, which in the case of *B. coli* is more intense and appears earlier. The weaker and later appearing redness of the culture of *B. typhi* is not because this organism decomposes the formate more slowly, since it has no action on these salts, but is due entirely to the formation of alkaline decomposition products of albuminous substances ; in the same manner is explained the reddening of the medium with cultures of *B. fæcalis alcigenes* and *B. dysenteriæ* Flexner. The author has contrived to set aside this objection by estimating the amount of gas produced by the cultures, using for this purpose an arrangement of Einhorm's saccharometer. The medium he uses is ordinary pepton broth, with the addition of 0·5 p.c. of sodium formate.

With six different strains of *B. typhi abdominalis*, and by making all possible variations—both as to the strength of the formate present and the age of the culture used—he was in no instance able to show the slightest evidence of any decomposition of the formate. All cultures of *B. coli communis* showed energetic destruction of the formate with an abundant production of gas ; with cultures of paratyphoid A and B the decomposition of the salt and production of gas were equally energetic ; five different strains of *B. dysenteriæ* behaved like those of *B. typhi*, producing not the slightest decomposition of the formic salt.

Identification of Colonies of Pneumococcus.‡—L. Buerger prepares the following media : neutral agar made from meat juice, and containing 1·5–2 p.c. of pepton, and 2·5 p.c. of agar, is melted down, 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, &c.; (6) Miscellaneous.

† Centralbl. Bakt., 2te Abt., xiv. (1905) p. 673.

‡ Centralbl. Bakt., 1te Abt., xxxix. (1905) p. 20.

when cooled sufficiently below the coagulating point of the serum to be employed, one-third of its volume of sterile ascitic fluid is added, mixed and poured into tubes; glucose serum agar is made in the same way, 0·5–2 p c. of glucose agar being used. He finds that on these media, after 18–24 hours, the surface colonies of pneumococcus appear as flat circular disks, which when viewed from above show slightly depressed centres, whereas side on and by transmitted light they appear as milky rings enclosing a transparent centre, a "ring type," of various sizes. In older colonies, 72 hours, the central opacity increases and the ring is less marked. The author considers that this type of colony is diagnostic of pneumococcus, and must be distinguished from the ring forms occasionally seen with streptococcus, but which possess a distinct nucleus, and from those colonies that only show rings by transmitted light, but which by reflected light show a definitely raised centre.

Apparatus for Dissolving and Filtering large Quantities of Gelatin and Agar, etc.*—C. Blecher describes the following apparatus. It consists of four parts: (1) The heating kettle of enamelled iron to receive the solution from the suction vessel. It has a tight-fitting lid provided with two perforations, one for a thermometer, the other for the suction tube connected with an air pump. (2) The solution vessel. (3) The suction vessel, which in size and shape is like the solution vessel, excepting that near the rim it is provided with a tube in which is fixed a glass tube bent at right angles and carried up parallel to the wall of the vessel and through the perforation in the lid. (4) The filter, also of enamelled iron, with a perforated bottom that fits by means of a rubber hoop to the rim of the suction vessel. In using the apparatus the solution vessel containing the substance to be dissolved and the solvent is placed in the kettle, which is filled 10 cm. high with water, heated to boiling-point and kept at that temperature until the solution has attained the desired temperature; the kettle is then closed, and when solution is complete the solution vessel is taken out. The suction vessel, with the filter attached, is then placed in the kettle, the bottom of the filter being fitted with a moistened layer of washing flannel or filter-paper; the fluid from the solution vessel is now poured into the filter vessel, the suction pipe is passed through the opening in the lid; this is closed, and the pipe is joined with the pump; whilst the suction is taking place the temperature is kept constant by gentle heating. When filtering is completed, the gelatin, etc., is found to be quite clear in the suction vessel.

Methods for Determining the Immunity Unit for Standardising Diphtheria Antitoxin.*—M. J. Rosenau gives details of the methods used in the determination of the standard of immunity. After briefly discussing Ehrlich's "side-chain" theory of immunity, he finds that from a theoretical point of view, the unit of immunity, in the case of diphtheria, may be defined as that quantity of diphtheria antitoxic serum which will just neutralise 200 minimal lethal doses of a pure poison, that is a poison which contains only toxin, and no toxoid, toxone, or other substances capable of uniting with the antibodies. The minimal lethal dose is defined as that quantity of toxin which will surely kill

* Centralbl. Bakt., 2te Abt., xiv. (1905) p. 415 (1 fig.).
† Hyg. Lab. Bull. No. 21 (1905) Washington, U.S.A.

every guinea-pig weighing 250 grm. in the course of 4 days, or at the very latest, 5 days.

For the preparation of the toxin he uses a culture of "Park's bacillus No. 8" grown as a surface growth in a special bouillon; the strongest poisons being obtained when the surface growth is heavy and the broth remains clear. The medium known as "Smith's bouillon" is prepared as follows: the meat is ground in the usual way, the expressed juice being collected, weighed and added to twice its weight of water, placed in the cool for 24 hours, strained, and again weighed; it is then neutralised with sodium hydrate to 1·5 p.c. acidity to phenolphthalein; it is now inoculated with *B. coli communis*, by adding 10 c.cm. of a 24-hour old broth culture for each litre of the meat infusion; this is grown at 37° C. for 24 hours; add the white of one egg for each litre of the infusion, heat for 20 minutes to coagulate the albumen, and filter while hot through paper; weigh the filtrate obtained, and add water to make up the loss; neutralise with sodium nitrate to an acidity of 0·5 p.c., add 1 p.c. pepton, ½ p.c. sodium chloride, and 0·1 p.c. dextrose; heat again for 20 minutes in streaming steam in an open autoclave; again neutralise to 0·5 p.c., filter through paper and fill into Fernbach flasks, then sterilise in the autoclave at 120° C. for 20 minutes. The flasks are then inoculated on the surface from a 24-hour old culture, and incubated for 7 days at 37·5° C. The bouillon is then passed through a porcelain filter by means of a vacuum, and stored in flasks provided with a syphon and Maasen nozzle for the convenience of drawing off small amounts from time to time. The toxicity of the poison is then determined by inoculating guinea-pigs. The writer describes the usual method of preparing antitoxic serum, and indicates the precautions to be taken in order to keep the serum dry and free from the oxidising action of the air, by the influence of phosphoric anhydride, and by storing it in a special ice-box at 5° C., and so guarding it against the action of light and maintaining it at a constant low temperature. For determining the antitoxic value of this serum, a glycerinated solution is made by weighing 1 grm. of dry serum and dissolving it in 1 part physiological salt solution (0·85) and two parts glycerin. From this solution, by means of specially made pipettes, varying dilutions with physiological salt solution are obtained. Exact amounts of the dilutions of toxin and of serum are now filled into specially prepared syringes, where they are actively shaken to obtain an intimate mixture and are placed at room temperature in diffused light one hour before inoculation into the guinea-pigs. The animals always receive a total of 4 c.cm. of fluid, injected subcutaneously in the median abdominal line. As the limit of the minimal lethal dose or the mixture containing the L + dose of the toxin and one immunity unit is approached, one of three results occurs: (*a*) the animal dies from acute poisoning on about the fourth day; (*b*) it develops post-diphtheric paralysis between the fourteenth and thirtieth day; (*c*) it recovers.

Method for Growing Anaerobic Organisms under Aerobic Conditions.*—G. Tarozzi has devised a medium on which he has succeeded

* Centralbl. Bakt., 1te Abt. xxxviii. (1905) p. 619.

in growing, under aerobic conditions, certain strictly anaerobic saprophytes obtained from the intestinal contents of dogs and from putrefying human bodies, and which from their morphological relationship with the Tetanus bacillus he denotes as the group of Pseudo-tetanus bacilli; he also obtained good results with *B. tetani* and with the bacillus of symptomatic anthrax. The medium is prepared as follows:—A mouse, guinea-pig or rabbit is killed, opened aseptically, and with sterile forceps and scissors, pieces of liver, spleen, kidney, etc., are cut out, and placed in an equal number of tubes of broth and agar; these are incubated at 37° C. for two days and the contaminated tubes are discarded. He found that if a piece of fresh tissue was placed in a tube of broth, and after a few hours was taken out again, and the tube then inoculated with an anaerobic germ, the conditions were as favourable for its growth as if the portion of tissue were still present in the medium.

Difference of Behaviour of Bacillus typhosus and B. coli communis in Media containing Sulphate of Copper and Red Prussiate of Potash.*—A. Marrassini and R. Schiff-Giorgini find that nutrient broth, or broth and glycerin to which is added copper sulphate in proportions varying from $\frac{1}{5000}$ to $\frac{1}{1000}$, is quite decolorised by *B. coli communis*, and the medium rendered turbid, while when *B. typhosus* is sown therein no change takes place. An analogous reaction is observed when ferricyanide of potash, in the proportion of 2–5 p.c., is added to the medium. Here, after incubation at 37° C. for 48 hours, the medium inoculated with typhoid retains its greenish-yellow hue, while that in which *B. coli communis* has been sown has turned green, the colour becoming intensified as time goes on. The colour is due to the formation of a blue precipitate, and the precipitate to the production of lactic acid by the *Coli* organisms.

(2) Preparing Objects.

Fixing and Staining Nuclei.†—In his researches on the testing nucleus and mitosis, K. v. Tellyesniczky makes special reference to the effect of fixatives. As good fixatives are distinguished Flemming's strong solution and a mixture of 100 c.cm. 3 p.c. potassium bichromate and 5 c.cm. acetic acid. The sections were mordanted for 24 hours in saturated solution of copper acetate, then washed and stained in 1 p.c. hæmatoxylin solution for 24 hours, and finally differentiated in Weigert's decoloriser.

Fixation and Staining Muscle Fibres.‡—G. Schlater fixed embryos of the fowl in Hertwig's fluid, which consists of chromic acid (1 p.c.) 150 c.cm.; saturated solution of sublimate, 150 c.cm.; glacial acetic acid, 15 c.cm.; formalin (40 p.c.) 50 c.cm.; distilled water, 135 c.cm. Paraffin sections of the material were stained with Heidenhain's iron-hæmatoxylin.

Demonstrating Blood Formation in Osseous Fishes.§—H. Marcus fixed the eggs of *Gobius capito* in Carnoy's fluid (6 parts alcohol, 3 parts chloroform, and 1 part acetic acid) for 2–3 hours. After about an

* Atti Soc. Toscana Sci. Nat., xiv. (1905) pp. 174-7.
† Archiv Mikrosk. Anat. u. Entwickl., lxvi. (1905) pp. 367–433 (5 pls.).
‡ Tom. cit., pp. 440-68 (3 pls.). § Tom. cit., pp. 333–54 (1 pl.).

hour's immersion the capsule was removed with forceps or needles. From this fluid the eggs were removed to chloroform, and thence through chloroform-paraffin to paraffin m.p. 40°. This process is rather slow, but it avoids the overheating, which is so detrimental to the yolk. Formalin was found to fix the embryo badly. Tellyesniczky's fluid gave good results. After a fixation of 24 hours the material was washed, then stained with borax-carmin, and afterwards imbedded by the chloroform method in paraffin m.p. 40°. The sections were fixed to the slide with clove-oil-collodion.

(3) Cutting, including Imbedding and Microtomes.

Leitz' New Microtome.*—This instrument is described by Professor Henneberg who, after several months' use, has found it very satisfactory

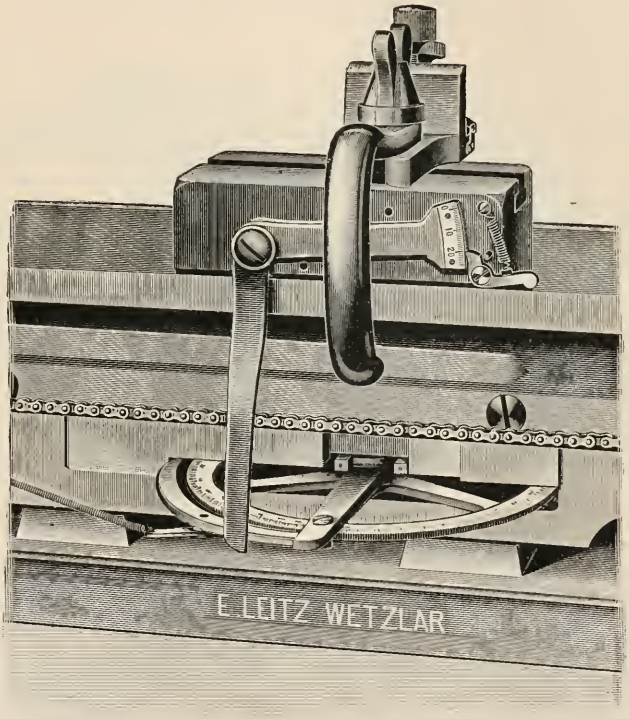

Fig. 154.

and adapted to its purpose. The instrument is a firmly-built sliding microtome, with automatic object-movement and large, heavy knife-slide, which can be worked direct by the hand or by chain and tooth-wheel. It is made in two sizes, with track-lengths of 32 and 42 cm.

* Zeitschr. wiss. Mikrosk., xxii. (1905) pp. 125–30 (4 figs.).

respectively. For most purposes the small size suffices. When hand-motion is desired, a bent pin is fastened to the block (fig. 154) by means of the same screw which holds the knife-clamp. For chain-use the microtome is provided at each end with a beam-like projection, each of which carries a chain-wheel, one for the winch, the other for the straining of the chain. The winch can be fitted as shown in fig. 155, or at the other end, and thus an operator can rotate the winch either with his left hand or his right. Fig. 154 shows the manner of the automatic elevation of the object. The rotation of the tooth-wheel occurs indirectly through a bent curved movable lever screwed to the block (hence the "block-angle"). The lower end of the lever in the movement of the slide to the end of the track engages with a spring-hook, which itself engages in the teeth of the wheel and moves it on

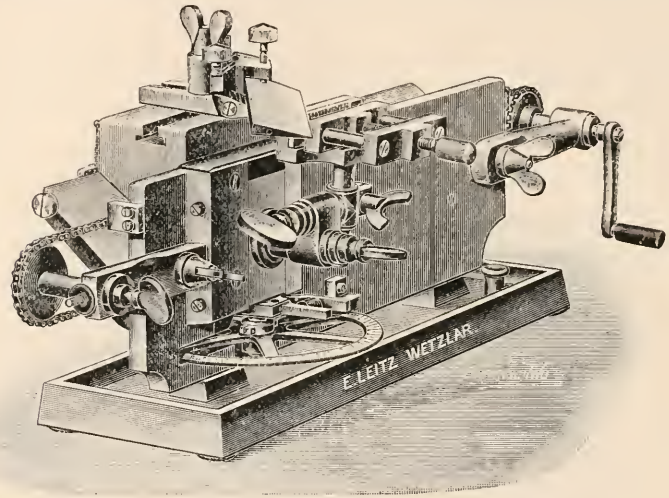

Fig. 155.

one notch. The length of the stroke, about which the block-angle rotates the wheel in this way, is dependent on the downward lever-end. The length is longer or shorter, as the block-angle is steeper or more oblique. The block-angle is arranged by the help of a small clutch which is set to the small scale at the lever-end, the numeration corresponding to the number of the wheel-teeth rotated at that particular position of the block-angle. A wheel-tooth corresponds to a section thickness of 0·001 mm. In its steepest position the block-angle corresponds to a wheel-rotation of 25 teeth, and the section thickness is then 25 μ. The forward movement of the clutch results from the action of the spiral spring visible in fig. 154, the clutch sliding over the teeth until a resistance is met with on the vertical wall of the microtome. In order that the tooth-wheel should not move too easily, a small brake (not shown in figure) is applied and regulated by a screw. For facilitating the adjustment of the object-holder the female-screw

fastened to it, and in which the tooth-wheel spindle moves, is formed of two halves, on each of which, as in a forceps, a limit is affixed. A spring applied between these presses both parts sufficiently tight

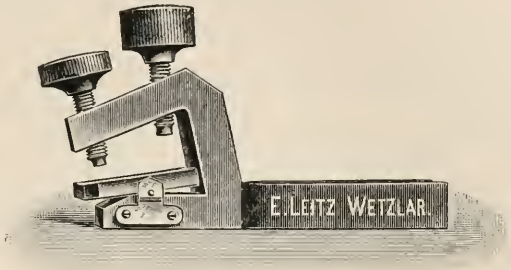

Fig. 156.

together. A pressure on the limb suffices to open the screw, and the object-holder can then be pushed up and down.

By the use of two screws in the knife-holder it is possible to set the

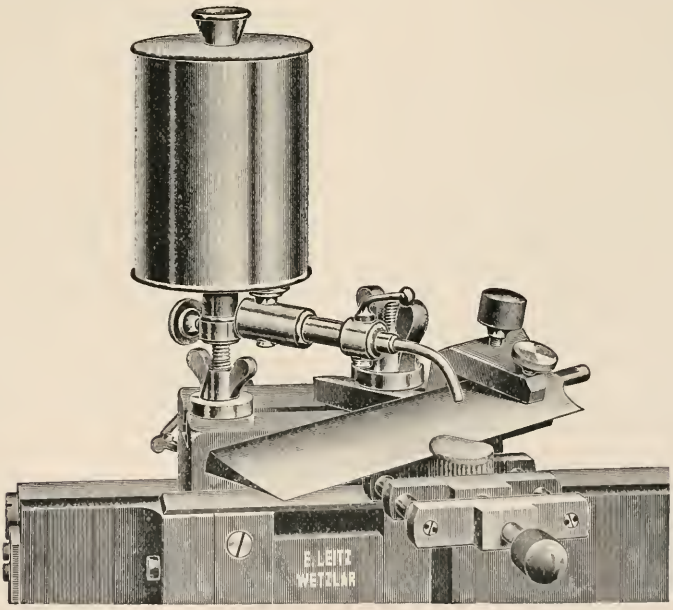

Fig. 157.

knife flat or oblique; moreover, the knife moves on a slab rotatory about an axis (figs. 155 and 156). The screw for clamping the knife-rest moves on a block in a groove, whereby the adjustment of the clamp

is very conveniently performed. A dropping apparatus is added for moistening the knife with 70 p.c. alcohol in the cutting of celloidin sections. The alcohol reservoir is rotatory about the supporting axis, and the outflow tube is set excentrically for the adjustment of the delivery. This dropping apparatus is secured to the knife-block, and moves with it (fig. 157).

Arndt's Double Saw.*—The introduction of this auxiliary, which was noticed in this Journal† a few years ago, has been found so useful that the inventor has brought out an improved form. It is intended for preparing microscopic sections from hard objects. The working space of the saw has now been increased to 6·5 cm., and there are also other improvements.

(4) Staining and Injecting.

Differential Stain for Gonococcus.‡—R. Leszczynski employs the following method: cover slip preparations are made from the pus diluted with water in the usual way, and after fixing in the flame are treated for 60 seconds with thionin solution (sol. sat. aq. thionin 10 c.cm. ; aq. dest. 88 c.cm. ; acid carbol. liquef. 2 c.cm.) and washed in water. Then treat for 60 seconds in picric acid solution (sol. sat. aq. acid picric; sol. aq. caustic potash 1 : 1000 ; āā 50 c.cm.). Without washing in water, treat for 5 seconds with absolute alcohol ; wash in water, dry, and mount in balsam.

The protoplasm of the pus cells is stained straw-yellow and the nuclei red-violet, the gonococci appearing as black sharply contoured diplococci, the other bacteria are yellowish-red to pinkish-red. The extra-cellular cocci and those lying deeply in the protoplasm of the cells are often not stained in a characteristic manner.

Persio-acetic Acid as a Stain for Vegetable Tissue.§—G. Beck von Managetta recommends a new pigment, Persio, for staining vegetable tissue. It is a red indigo, and is much like Orseille in origin and composition. It is a purple powder, easily soluble in water and acetic acid, and little or not at all in alcohol. As persio-acetic acid it is extremely valuable, a strong solution staining deeply in 1–2 minutes. The stained sections may be mounted in glycerin, potassium acetate, and venetian turpentine, by all of which the tone is advantageously altered. Persio-acetic acid will combine with other pigments. The author mentions combinations with nuclear black, nigrosin, methyl-green, and gentian-violet.

New Method of Rapid Staining Nervous Tissue with Gold Chloride.‖—B. de Nabias fixes the tissue in any solution which allows after-treatment with iodine. The sections on the slide are dehydrated, and then immersed in Gram's iodine solution until they become yellow. After washing in distilled water they are placed in 1 p.c. gold chloride

* Zeitschr. wiss. Mikrosk., xxi. (1904) pp. 104–13 (5 figs.).
† J.R.M.S. 1902, p. 112.
‡ Centralbl. Bakt. Ref., 1te Abt., xxxvi. (1905) p. 692.
§ SB. Deutsch. Naturwiss. Vereins f. Böhmen, "Lotos," 1904, No. 7. See also Zeitschr. wiss. Mikrosk., xxii. (1905) pp. 166–8.
‖ C. R. Soc. Biol., lvi. (1904) p. 426.

solution. They are again washed, and then treated with 1 p.c. anilin water. After washing again in distilled water the sections are passed through graded alcohols to xylol and balsam.

Method of Contrast Staining with Bleu de Lyon and Picric Acid.§—Skrobansky takes the sections which have been previously stained with borax-carmin from distilled water and places them in the following mixture:—Distilled water 50 parts; saturated alcoholic solution of bleu de Lyon 2 parts; saturated aqueous solution of picric acid 5 parts. In this the sections remain for 2–3 minutes, and are then passed through graded alcohols to xylol and mounted in balsam.

Staining Tubercle Bacillus.‖—A. Mendoza, in some further observations on this subject, remarks that other mixtures produce a perfect staining. Thus iodine-green, when the water is saturated with oil of turpentine, stains the bacilli beautifully, though the strength of the decoloriser must be reduced. Some pigments will give a double stain, e.g. methylen-blue, when used in conjunction with thymol (saturated aqueous solution of thymol 80 c.cm.; saturated alcoholic solution of methylen-blue 10 c.cm.; alcohol 10 c.cm.). The bacilli stain dark blue and the rest of the elements a red-violet, though to obtain this result the strength of the decoloriser must be reduced to one-fifth (20–80 of water).

New Method of Capsule Staining.¶—L. Buerger's method requires the following solutions:—(1) Blood serum, diluted with equal bulk of normal saline or ascitic or pleural fluid; (2) Müller's fluid, saturated with sublimate; (3) 80–95 p.c. alcohol; (4) tincture of iodine (7 p.c.); (5) fresh anilin water, gentian-violet solution, or fuchsin solution; (6) 2 p.c. aqueous salt solution. A film is made by mixing some culture with a drop of serum on a cover-glass. When it is about half dry the film is covered with fixative. It is then gently warmed, and after a quick wash in water is passed through alcohol, and then treated with the iodine solution for about a minute. The cover-glass is then washed with alcohol until no more iodine comes off. After drying in the air, the film is stained for three seconds; it is then washed and mounted in salt solution. The preparation may be ringed round with vaselin before examination.

If the films be stained with fuchsin, they should be examined in water. Gram's method may be adopted, and the preparations afterstained with 10–15 p.c. aqueous fuchsin. Mounting in balsam destroys the sharp outline of the capsule, though the preparations are fairly good.

Demonstrating Fat in the Animal Liver.*—C. Deflandre, when investigating the adipogenic function of the liver† had recourse to the following histo-chemical methods. The freshly removed liver was cut up into thin slices and immersed in strong Flemming [chromic acid (10 p.c.) 15 parts; osmic acid (1 p.c.) 80 parts; glacial acetic acid 10 parts; distilled water 95 parts] for 24 hours. The pieces are then

* Intern. Monatschr. Anat. u. Phys., xxi. (1904) pp. 21–2. See also Zeitschr. wiss. Mikrosk., xxii. (1905) p. 138.

† Bol. Inst. Alfonso XIII., i. (1905) pp. 61–2. See *ante*, p. 529.

‡ Centralbl. Bakt., 1te Abt. Orig., xxxix. (1905) pp. 216–24, 335–52 (9 figs.).

§ Journ. Anat. et Physiol., xl. (1904) pp. 79–80.

‖ J.R.M.S. 1904, p. 301.

washed in running water for 24 hours. For washing, a funnel with a siphon stem was used. This, when placed under a tap, kept filling and emptying automatically. A large number of pieces, if properly labelled, can be washed by this method at the same time.

The pieces were next dehydrated in absolute alcohol, cleared up in xylol, and imbedded in paraffin. Impregnation with paraffin should be done as quickly as possible, as protracted immersion in xylol tends to dissolve out the fat droplets. The sections may be mounted unstained in glycerin or stained for 24 hours in safranin. The safranin was a strong alcoholic solution mixed with anilin water. Magenta red and picric acid were also used, but the effect was less delicate.

Staining Nerve Endings in Skin of Mammals.*—A. S. Dogiel used a 1–2 p.c. solution of silver nitrate wherein were placed small pieces of skin, the solution being incubated at from 34°–36° C. for 3–5 days. The pieces were quickly washed in distilled water and then transferred to the reducing solution of formalin and pyrogallic acid for 3–5 days. If the silver had been reduced the preparations were washed in distilled water, then hardened in absolute alcohol, and, after imbedding in celloidin, were sectioned.

Examination of Cultures and Smears from Throat and Nose.†—W. T. G. Pugh recommends the following procedure for detecting the presence of diphtheria bacilli in exudations of the throat and nose. The stain consists of toluidin blue 1 grm. dissolved in 20 c.cm. absolute alcohol and 1 litre of distilled water, to which 50 c.cm. of glacial-acetic acid are added. The films and smears should be stained for two minutes or longer. When examined by artificial light the Babes-Ernst granules, whether in bacilli or cocci, are seen to be stained reddish-purple, the diphtheria bacilli thus standing out prominently.

Staining Nerve Fibrils.‡—According to A. Bethe the staining of nerve fibrils is due to the presence of an acid, "fibril acid," which is insoluble in ether. He gives three methods. (1) The old ether method, which is uncertain as to its results. The piece of fresh tissue is placed in ether, which is frequently changed. After two days it is transferred to a solution of toluidin blue, 1 : 3000, and on the following day to ammonium molybdate. It is then imbedded and sectioned. (2) New ether method. The fresh tissue is first treated with ether, and afterwards dehydrated with absolute ether. It is then transferred to xylol and afterwards imbedded. (3) Ammonia method. Fix with alcohol, to 7–10 parts of which 1 part of ammonia is added; imbed and stain as before.

Use of Electrolysis for the Metallic Impregnation and Staining of Tissues.§—L. Sanzo places the two electrodes of a battery in a basin filled with distilled water. To the negative pole is fixed a piece of tissue previously impregnated with nitrate of silver. A weak current is then passed and this decomposes the silver nitrate, the acid radicle going to

* Anat. Anzeig., xxvii. (1905) pp. 97–118 (10 figs.).
† Lancet, 1905, ii. pp. 80–1.
‡ Zeitschr. wiss. Mikrosk., xxi. (1904) pp. 344–8.
§ Anat. Anzeig., xxvii. (1905) pp. 269–70.

the positive pole while the silver remains at the negative, being free to combine with the tissue elements.

By fixing unimpregnated tissue to the positive pole an acid reaction is obtained, and this makes the tissue more receptive of the silver salt. In a similar way by placing pieces of tissue on the anode or cathode the tissues may be rendered acid or basic, so as to mordant them as it were for basic or acid stains.

(6) Miscellaneous.

Microtomists' Vade Mecum.*—The new edition of the Microtomists' Vade Mecum, a handbook of the methods of Microscopic Anatomy, by A. Bolles Lee, contains much new matter, room for which has been found by condensation and rearrangement. Some chapters, e.g. on connective tissues and on blood and glands, have been practically rewritten, and those on the nervous system have been elaborated and much new and important matter added. The Microtomists' Vade Mecum is so well known and so universally consulted by every class of histologist that it is unnecessary to launch out into praises of its many merits, and it only remains to congratulate the author on his energy in bringing his invaluable work up to date.

Ball, M. V.—**Essentials of Bacteriology.** London: Kimpton, 1904, 4th ed.

Klopstock, M., u. Kowarsky, A.—**Praktikum der klinischen, chemisch-mikroskopischen und bakteriologischen Untersuchungsmethoder.** Wien: Urban u. Schwarzenberg, 1904, 296 pp.

Lindner, P.—**Mikroskopische Betriebskontrolle in den Gärungsgewerben mit einer Einführung in die technische Biologie, Hefenreinkultur und Infektionslehre.** Berlin: Paul Parey, 1905, 4th ed. enlarged, 521 pp., 237 figs., 4 pls.

Lynch, R.—**Mikroskopische Untersuchung der Fäces. Ihre Bedeutung und ihre Anwendung in der ärtzlichen Praxis.** Leipzig: G. Thieme, 1904, 35 pp.

Miethe, V.—**Traité pratique de recherches bactériologiques.** Paris: Malonie, 1904.

Stöhr, Ph.—**Lehrbuch der Histologie und der mikroskopischen Anatomie des Menschen mit Einschluss der mikroskopischen Technik.** Jena: G. Fischer, 1905, 456 pp., 352 figs.

Winslow, Ch.-E. A.—**Elements of Applied Microscopy. A Text-book for Beginners.** New York: John Wiley and Sons, 1905, 183 pp.

Metallography, etc.

Thermal and Electrical Effects in Soft Iron.†—E. H. Hall, Churchill, Campbell and Serviss have made delicate measurements of the Thomson effect. Two bars of iron (99·93 p.c. Fe) were employed, one end of each bar being inserted in a mixture of ice and water, the other end in boiling water. An electric current (25 amperes) was passed through the bars, from cold to hot in one bar, from hot to cold in the other. The direction of the current could be reversed. The

* London: J. and A. Churchill, 6th ed., 1905, x. and 538 pp.
† Proc. Amer. Acad. Arts and Sci., xli. (1905) pp. 23–55.

differences of temperature (due to the difference in direction of the main current) between corresponding points in the two bars, were measured by means of thermo-electric couples of copper and German-silver, connected to a sensitive galvanometer. Similar measurements were taken with the main current reversed. Numerous details of the method and the precautions adopted are given by the authors. The following values were obtained for the Thomson effect coefficient ν,

$$\text{approximately} \begin{cases} -757 \times 10^{-10} \text{ mean, from } 13^\circ \text{ to } 90^\circ \\ -715 \quad \text{,,} \quad \text{,,} \quad \text{,,} \quad 13^\circ \text{ ,, } 51^\circ \\ -793 \quad \text{,,} \quad \text{,,} \quad \text{,,} \quad 51^\circ \text{ ,, } 90^\circ \end{cases}$$

Influence of Nitrogen on Iron and Steel.*—H. Braune points out that the abnormal brittleness frequently met with in iron and steel, especially in basic products, cannot be ascribed to the presence of large percentages of phosphorus, sulphur, or other elements, the effect of which is well known. As the result of six years work, the author states that this brittleness is caused by the presence of nitrogen absorbed by the metal in the processes of manufacture. The nitrogen exists as nitride of iron in solid solution in ferrite. To determine the effect of nitrogen on the quality of the metal, the author heated bars of high-grade iron and steel in ammonia gas at 800° C. for varying periods. Different proportions of nitrogen were absorbed; the bars were then annealed to bring about a regular diffusion of nitrogen through the metal. Curves are given showing the effect of increasing proportions of nitrogen on the mechanical properties of (1) soft iron containing 0·06 p.c. carbon, (2) steel containing 1·15 p.c. carbon. The effect is wholly injurious: 0·08 p.c., or more, nitrogen renders soft iron brittle; in the case of the high carbon steel the same effect results with only 0·03 p.c. nitrogen. Photomicrographs are given showing the remarkable changes in structure brought about by increasing percentages of nitrogen.

In an editorial note appended to the above article, H. le Chatelier† cites a number of facts—such as the well known difference in properties between acid and basic steel of the same composition—as to hitherto unexplained departures from established laws governing the relation between physical properties, chemical composition, and thermal treatment of steel. These irregularities have been attributed to the presence of elements, such as hydrogen and oxygen, which are difficult to estimate. H. Braune's researches suggest that the explanation may be sought in the presence of nitrogen. H. le Chatelier gives some results he has obtained in endeavouring to establish a relation between brittleness of metals and their microstructure. He suggests that nitrogen, when present in moderate proportions, may have the effect of facilitating the development of brittleness under unsuitable thermal treatment, rather than that of rendering the metal hopelessly bad.

The method of estimating nitrogen in iron, together with further details, is given elsewhere by H. Braune.‡

* Rev. Metallurgie, ii. (1905) pp. 497–502 (7 figs.).

† Tom. cit., pp. 503–7 (3 figs.).

‡ Op. cit., Extraits, ii. (1905) pp. 361–4 (4 figs.). See also Braune, H., "Sur le rôle de l'azote dans les fers et aciers." Bâle. Editeurs, Walz et Mieville, 1905.

Brittleness of Cemented Mild Steels.*—To determine the cause of the brittleness resulting from the cementation of mild steel, J. Lecarme worked on steels of the following composition :—

	1.	2.
Carbon	0·100 p.c.	0·090 p.c.
Manganese	0·300 „	0·623 „
Phosphorus	0·031 „	0·065 „
Silicon	0·750 „	0·152 „

Four groups, each made up of ten pieces of each steel, were packed (*a*) in neutral matter, (*b*), (*c*), and (*d*) in carburising material of different degrees of activity, and heated at 1000° C., the different pieces in each group being maintained at this temperature for varying periods. The object of this series of experiments was to determine whether the brittleness is due to heating at a high temperature, or is influenced by the composition of the carburising material. After treatment the pieces were submitted to mechanical tests and microscopically examined. The changes in microstructure are shown by photomicrographs. The author concludes that the thermal treatment necessarily accompanying cementation does not induce brittleness, this fragility being caused by some chemical change in the soft core taking place simultaneously with the superficial cementation. Widely differing degrees of brittleness result when steels obtained from different sources, though of similar chemical composition, are submitted to the same treatment. It is usually possible by suitable treatment to remove the brittleness resulting from cementation.

H. le Chatelier† puts forward some criticisms of J. Lecarme's inferences, and remarks that the chief object of their publication is to induce other workers to investigate the subject more fully. The presence of nitrogen may influence the results.

Technique of Microscopic Metallography.‡—H. le Chatelier describes the improvements in the details of polishing, etching, etc., effected in his laboratory since the publication of his former article on the same subject.§

Grinding.—A rapidly revolving emery wheel, against which the section is lightly pressed, gives the best results. For quenched steels which surface-heating might let down, a wheel flooded with water and revolving at slower speeds should be used. It has been stated that if the section does not become too hot to hold with the fingers, the temperature cannot rise sufficiently to have any effect on the metal. This is not the case, as the surface pressed against the emery wheel may be considerably hotter than the mass of the piece. To remove the modified skin which appears to be the unavoidable result of grinding on emery wheels, the section should be rubbed by hand on moderately coarse emery paper. Moistening emery paper with oil of turpentine

* Rev. Metallurgie, ii. (1905) pp. 516–25 (6 figs.).
† Tom. cit., pp. 526–7.
‡ Rev. Metallurgie, ii. (1905) pp. 528–37 (3 figs.)
§ Bull. Soc. d'Enc.; see also "Contribution à l'étude des alliages," pp. 421–40, and Metallographist, iv. (1901) pp. 1–22.

hastens the operation. The edges of the section should be bevelled to avoid tearing the polishing papers and cloths.

Fine Polishing.—The author insists on the importance of using powders of uniform dimension of grain. The time spent in their preparation is fully repaid by the increased rapidity of polishing. For iron and steel three powders are used, sieved emery, levigated emery (finer), and washed alumina. The author's methods for the preparation of these are given in detail. Fine flannel maintained in a state of tension on glass is used as supporting medium for the polishing powders. Filtered soap solution serves to fix the powder to the cloth. Surfaces thus prepared may be used for polishing dry or damp. To shorten the time occupied in polishing, revolving wooden discs, covered with fine cloth, or felt discs, may be used in the final stage when alumina is employed.

Methods of Etching.—A 5 p.c. solution of picric acid in alcohol has come into general use. Two reagents recommended by Kourbatoff are: (1) amyl alcohol containing 4 p.c. nitric acid; (2) 4 p.c. solution of nitric acid in ordinary alcohol 1 part, saturated solution of nitrophenol in ordinary alcohol 3 parts. Cementite is readily coloured, other constituents not being affected, by a solution containing 25 p.c. sodium hydrate and 2 p.c. picric acid, at 100° C.

Microscope.—The author has abandoned the use of the mercury arc lamp, owing to the difficulties of manipulation and the long exposure required, though excellent photographs were obtained by its aid. A Nernst lamp with two thick filaments, so placed that their light is superposed on the illuminator of the Microscope, gives good results; the source of light is sufficiently broad to eliminate the interference fringes which give trouble when an ordinary Nernst lamp with a thin filament is used. For steel sections exposures of 2–5 minutes are usually sufficient. Several modifications in the Microscope and camera used by the author are described. It is more satisfactory to obtain high magnifications by employing objectives of higher power than by increasing the distance between plate and eye-piece.

Alloys of Copper and Aluminium.* — L. Guillet confirms the melting point curve (liquidus) of the copper-aluminium alloys obtained by H. le Chatelier, with some slight differences. To determine the curve of the "solidus" he has investigated the cooling curves of different alloys and the micrography of alloys quenched at varying temperatures. The alloys containing 8 p.c. to 14 p.c. aluminium have one and frequently two critical points. The author distinguishes seven constituents in all, three of which are compounds—Al_2Cu, AlCu, $AlCu_3$ (?)—the others being solid solutions. Their characteristics and conditions of formation are described in detail.

Constitution of Iron-Carbon Alloys.†—In an important paper dealing with Roozeboom's application of the phase doctrine to the iron-carbon system, E. Heyn points out that the science of metallography has advanced enormously with the development of the theory of solutions

* Rev. Metallurgie, ii. (1905) pp. 567–88 (4 diagrams, 28 photomicrographs).

† Iron and Steel Mag., ix. (1905) pp. 407–17 and 510–18; x. (1905) pp. 42–52 (27 figs.).

and the phase doctrine. The important part played by the Microscope in its development should not, however, be forgotten. While the phase-rule furnishes information regarding stable equilibria, the Microscope is almost the only means of investigating metastable conditions of alloys. Starting with a diagram of the critical points of iron-carbon alloys, agreeing closely with that given by Roberts-Austen, the author describes the changes which take place when cooling is sufficiently slow to permit the attainment of stable equilibrium. When the rate of cooling is somewhat accelerated, stable equilibrium does not result. Assuming that by rapid quenching from a temperature T the alloy is retained, at a lower temperature *t*, in a condition corresponding to stable equilibrium at T, a number of cases are taken and the final constitution of the alloy inferred. Such complete supercooling, however, is not possible in the case of iron-carbon alloys. The condition of an alloy rapidly cooled from a temperature T to *t* is unstable, and is intermediate between the condition stable at T and that stable at *t*. T is assumed to be above, and *t* below the critical range. Transition constituents, which must not be considered as phases, are thus formed. Martensite and troostite are well known examples of such constituents. Possibly austenite may also belong to the same category, instead of being, as Osmond regards it, a separate phase. As a means of distinguishing troostite from martensite and other constituents microscopically, 1 p.c. hydrochloric acid in absolute alcohol is recommended as an etching reagent. The author gives his reasons for doubting the occurrence of the transformation—

$$\text{martensite} + \text{graphite} \rightleftarrows \text{carbide},$$

which, according to Roberts-Austen and Roozeboom, takes place at 1000° C. Their view is not supported by experimental data. An alternative theory is advanced, the condition corresponding to the two phases, iron and graphite being accepted as stable, while the existence of carbide is due to supercooling. Carbide (cementite) is thus a metastable form.

Metallography applied to Foundry Work.*—A. Sauveur describes the various methods suitable for differentiating the constituents in a microscopical section of cast-iron. 10 p.c. nitric acid in absolute alcohol is recommended as an etching reagent. Graphite may be distinguished by examination of the section after simple polishing.

On the Magnetisation and the Magnetic Change of Length in Ferromagnetic Metals and Alloys at Temperatures ranging from −186° C. to +1200° C.†—K. Honda and S. Shimizu have measured the magnetisation and magnetic change of length of pure iron, nickel, cobalt, tungsten steel, and 12 specimens of nickel steel containing from 24 p.c. to 70 p.c. nickel, at the temperature of liquid air, at 1200° C., and at intermediate temperatures. Temperatures between −186° C. and −15° C. were obtained by surrounding the specimen by a jacket containing liquid air. Uniform slow cooling thus resulted. High temperatures were obtained by inserting the specimen in a platinum-wound electric resistance tube furnace. A platinum German-silver

* Iron and Steel Mag., x. (1905) pp. 29–32 (2 figs.).
† Journ. Coll. Sci. Tokyo, xx. Art. 6, pp. 1–63 (4 pls.).

thermo-electric couple was used for measuring low temperatures. Numerous results are given by the author ; those given by the experiments on the irreversible alloys of iron and nickel are of especial interest.

Carpenter, H. C. H., & Keeling, B. F. E.—**The Range of Solidification and the Critical Ranges of Iron-carbon Alloys.**

[A reprint of the well-known paper read before the Iron and Steel Institute in May 1904. A number of cooling curves necessarily omitted from the paper as originally published are included. A very complete investigation of the critical temperatures of iron-carbon alloys.]

Collected Researches of the National Physical Laboratory, i. pp. 229–44 (5 pls. 4 figs.).

Charpy.—**Modification de la qualité du métal des rivets par l'opération du rivetage.**

Comptes Rendus, cxli. (1905) pp. 327–8.

Frémont, C.—**Influence de la fragilité de l'acier sur les effets du cisaillement, du poinçonnage, et du brochage dans la chaudronnerie.** *Tom. cit.*, pp. 325–7.

Guillet, L.—**Constitution des alliages cuivre-aluminium.**

[Included in the article on the same subject published in Rev. Metallurgie and abstracted above. See also J.R.M.S., 1905, p. 536.]

Tom. cit., pp. 464–7.

Job, R.—**Some Causes of Failure of Rails in Service.**

Iron and Steel Mag., x. (1905) pp. 97–106 (8 figs.).

Osmond, F.—**Contribution à la discussion du mémoire de M. Hadfield "Experiments relating to the effect on Mechanical and other Properties of Iron and its Alloys produced by Liquid Air Temperatures."**

[Hadfield's conclusions regarding the allotropic theory of iron, based on the behaviour of alloys at low temperatures, are disputed. The difference in the influence of liquid air temperatures on nickel steel and on manganese steel is shown to be quite consistent with the allotropic theory.]

Rev. Metallurgie, ii. (1905) pp. 595–600 (2 figs.).

Saniter, E. H.—**Etching of High Carbon Steel.**

[The specimen is dipped in absolute alcohol, then strong nitric acid, and washed at the tap.] *Iron and Steel Mag.*, x. (1905) p. 156.

Vanadium and Vanadium Steel. *Tom. cit.*, pp. 134–40.

MICROSCOPY.

A. Instruments, Accessories, &c.*

(1) Stands.

Note on a Microscope Presented by Linnæus to Bernard Jussieu.†

The Microscope herewith presented for the inspection of the American

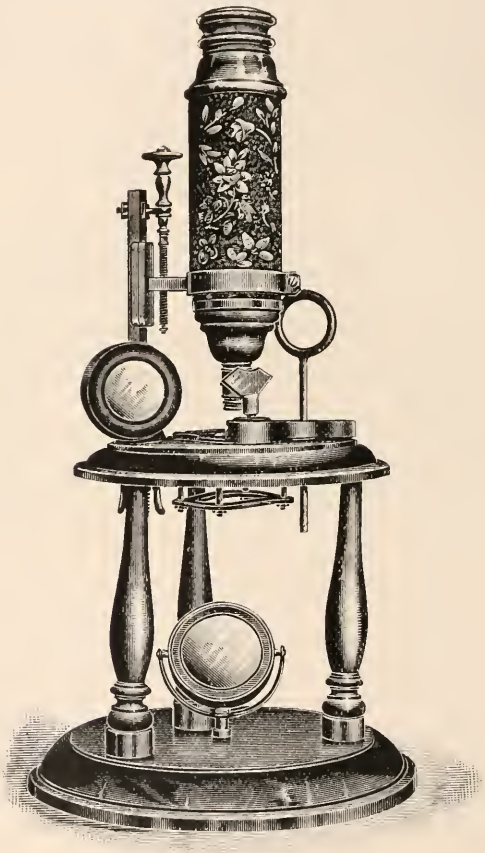

Fig. 159.

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

† Reprinted and illustration reproduced, by permission, from the Proceedings of the American Society of Microscopists (now the American Microscopical Society), vol. ix. 1888, pp. 214–15. The instrument was exhibited and the description read at the meeting of the Society held at Pittsburg, Pa., on September 1, 1887. In connection with this instrument, it is interesting to recall Mr. Frank Crisp's letter anent Linnæus and the use of the Microscope, see this Journal (*ante*, p. 253).

Society of Microscopists, says Jacob F. Henrici, was found in a lumber room of the Harmony Society, a German community at Economy, Pennsylvania (fig. 159). It contains, in a drawer at the base of the stand, a Latin inscription, signed by Bernard Jussieu, setting forth that he received the instrument from his very dear friend Linnæus, as a gift of friendship, in lasting memory of the pleasant intercourse which they had at Paris in the month of August 1738. The Microscope is said by the present aged members of the Harmony Society to have belonged formerly to Frederick Rapp, one of the founders of the Society, who came to America from Germany in 1804, and who died at Economy in 1834. He was a man of considerable culture, and much of the prosperity of the community was due to his intellectual activity. No one knows when or how the instrument came into his possession, or what use he made of it. The body of the Microscope is of pasteboard, or papier-mâché, with wooden mountings, and fixed vertically on a wooden stand. It is provided with a draw-tube, and the adjustment is by means of a screw. Ten objectives accompany the instrument, each consisting of a single lens, ranging in focal distance from about a quarter of an inch to an inch. The lenses range in diameter from six millimetres to a centimetre; but when in position they are stopped down by brass caps to an aperture of about two millimetres diameter. Unfortunately one of the lenses of the eyepiece is lacking, and in order to exhibit the power of the instrument, I have replaced it for the moment by a corresponding lens from my working Microscope. No maker's name appears on any part of the instrument. The inscription, in full, is as follows :—

Audax Iapeti genus
Ignem fraude malâ gentibus intulit
Nil mortalibus arduum
—*Hor. Carm. Lib.* i. 3.

In perpetuam memoriam
consuetudinis quam cum
dulcissimo suo sodali
Carolus Linne Parisiis
habebat hoc ab eo amicitiæ
donum accepit, mense
Augusto, MDCCXXXVIII
Bernardus Jussieu.

Aside from the interest attaching to this Microscope from its association with two of the great scientific workers of the last century, it is encouraging to compare our Microscopes of to-day with this crude instrument, which Jussieu deemed worthy of the admiration expressed in Horace's line, "Nil mortalibus arduum."

Wilson Screw-Barrel Simple Microscope. — This instrument, fig. 160, was kindly presented at the October Meeting by Major Meade J. C. Dennis, who says that its date is about 1750, and that it belonged to his great-grandfather. The Society has two other specimens of the Wilson Screw-Barrel Microscope in its collection; one bears the name of Sterrop as maker, and the other, without a name, was presented to the Society by Mr. C. Curties at the June Meeting, and will be found figured and described in the Journal for October, pp. 636–7.

These three examples differ from each other in detail, though they are very similar in general construction, and are after the pattern as made by Adams.

The history of Microscopes focusing by means of a *screw cut on the barrel* dates back to Campani in 1686, though this arrangement was preceded in 1665 by Hook, whose Microscope was focused by means of a screw *cut on the nose* of the instrument. Grindl followed in 1687, and Bonanni in 1691. Hartsoeker, in 1694, further developed this system of focusing, and his instrument was clearly the prototype of the Wilson, which was published in 1702. Probably before 1738 Culpeper applied a pillar with folding tripod base to the Wilson model; he also provided an attachment by which it could be converted into a compound Microscope. The Society possesses two examples of this instrument, the workmanship of which is very beautiful. Finally, Adams produced his model, which had a great sale, and was produced by other makers.

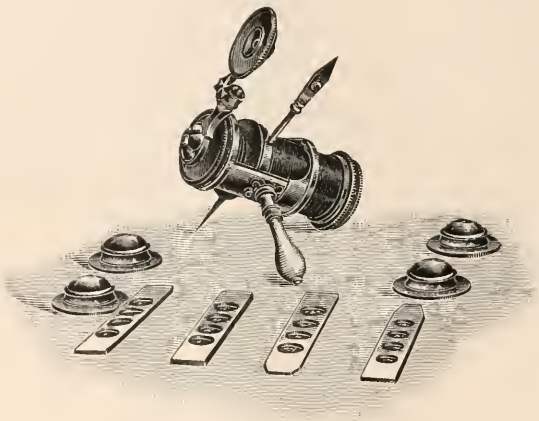

Fig. 160.

The instrument presented by Major Dennis is in very good condition. It has five powers, the usual lens carrier for viewing opaque objects, and forceps for holding the objects; the stem of the forceps when thus used is passed through small holes in the screwed barrel at the back of the stage plates, as seen in the figure. These holes are referred to in Adams' description, but are not visible in his figure of the instrument, and this is the only example in the Society's cabinet—including the Culpeper examples—that is provided with this particular method of holding the forceps. There is also a double-ended box containing ten slides, having forty objects mounted between tales in the manner then common.

Watson's Praxis and Bactil Microscopes.*—W. Watson and Sons have recently brought out a new model, which embodies an advantageous method of construction. Solid castings from specially constructed

* W. Watson and Son's Special Catalogue (September 1905) 12 pp., 11 figs.

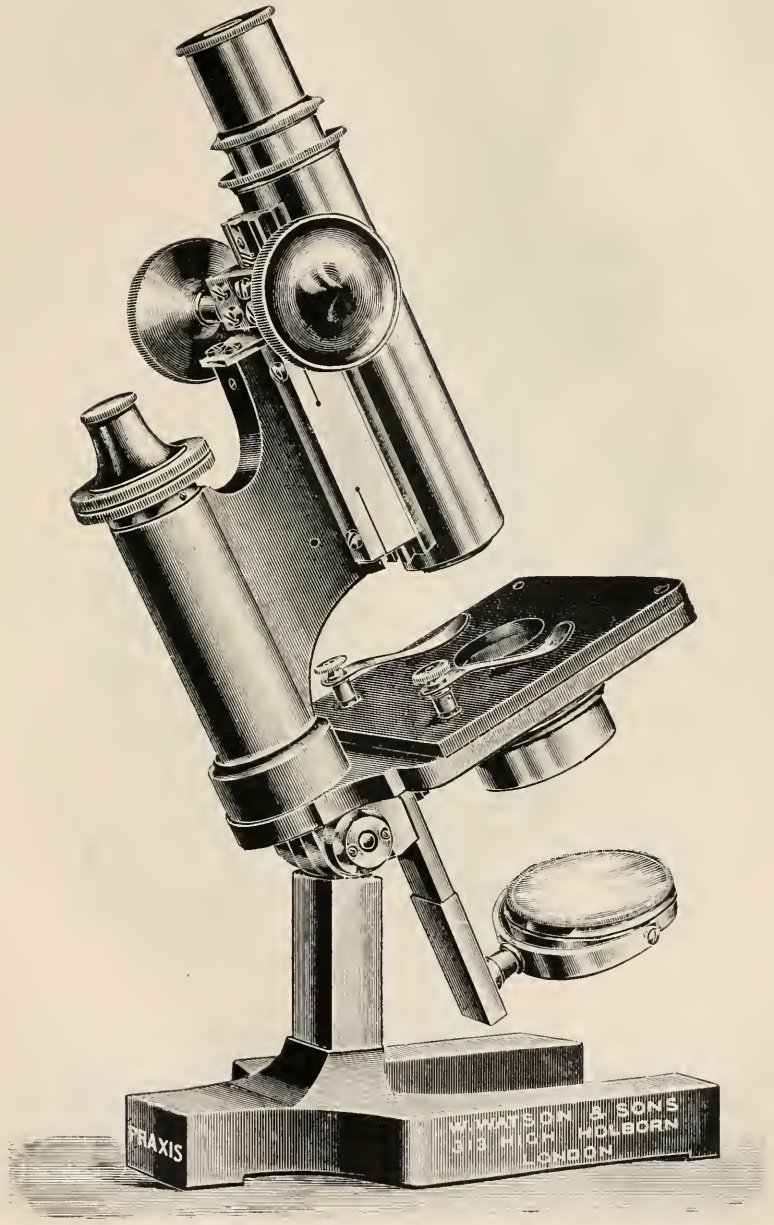

Fig. 161.

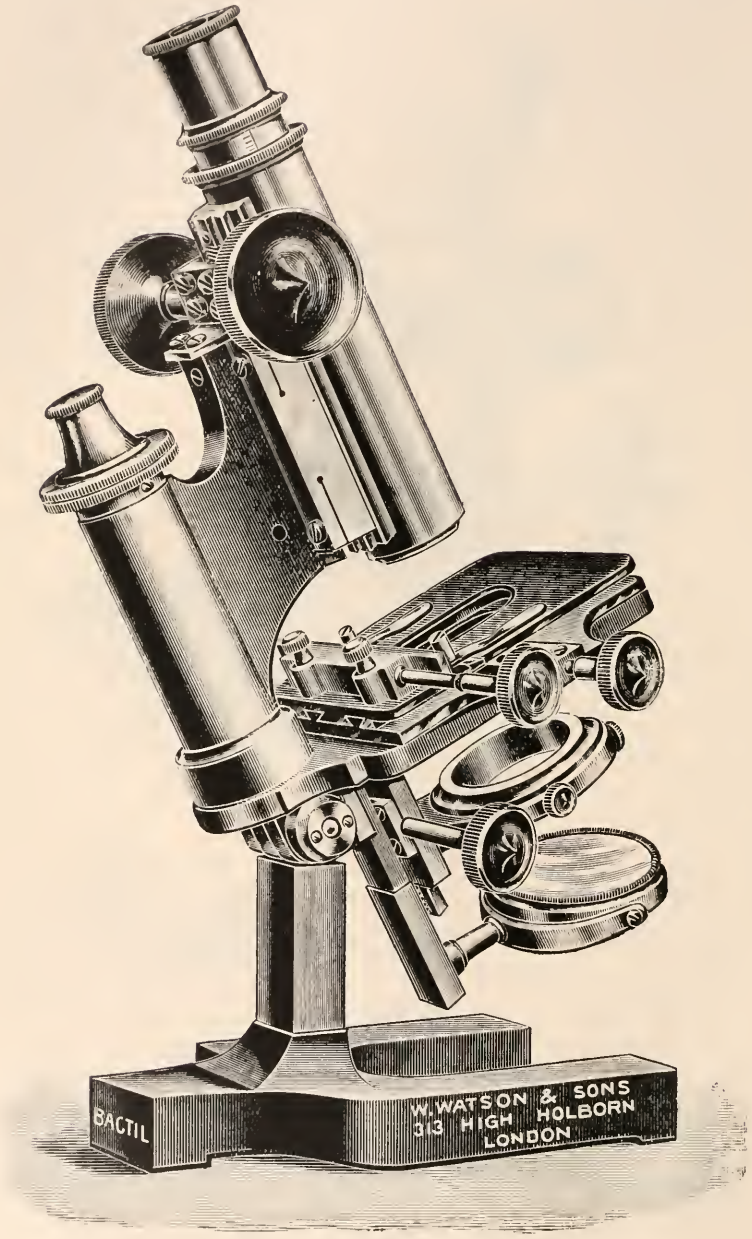

Fig. 162.

moulds replace separate pieces screwed together. Thus the foot and pillar and the stage and limb are both cast in one solid piece. The two pieces are connected by a strong knuckle joint, upon which the instrument is inclinable to the horizontal. As far as the stand is concerned, there is

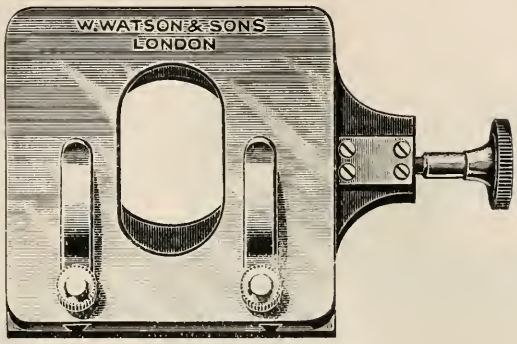

Fig. 163.

no difference between the Praxis (fig. 161) and Bactil (fig. 162) models. The important feature of the latter is a new form of mechanical stage, which has a travel of 2 in. horizontally and 1½ in. vertically. The horizontal movement (fig. 163) can be removed by unscrewing two

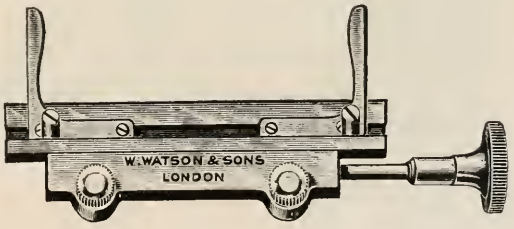

Fig. 164.

thumb-screws, leaving the surface of the stage 3½ in. square, as shown in fig. 164. The compound substage is fitted with focusing rackwork and centring screws, and can be turned out of the optic axis when desired. Other accessories supplied are a coned iris diaphragm and a spiral focusing screw with Scop condenser in lieu of the one previously described.

Beck's "Imperial" Metallurgical Microscope. — This Microscope (fig. 165) is a modification of the Imperial Microscope, specially made for metallurgical purposes, in which the large concentric rotating stage is replaced by a square mechanical stage, the whole of the stage and sub-

stage being capable of focusing up and down to an extent of 2 in. The body is 2 in. in diameter, and a photographic lens may be placed in

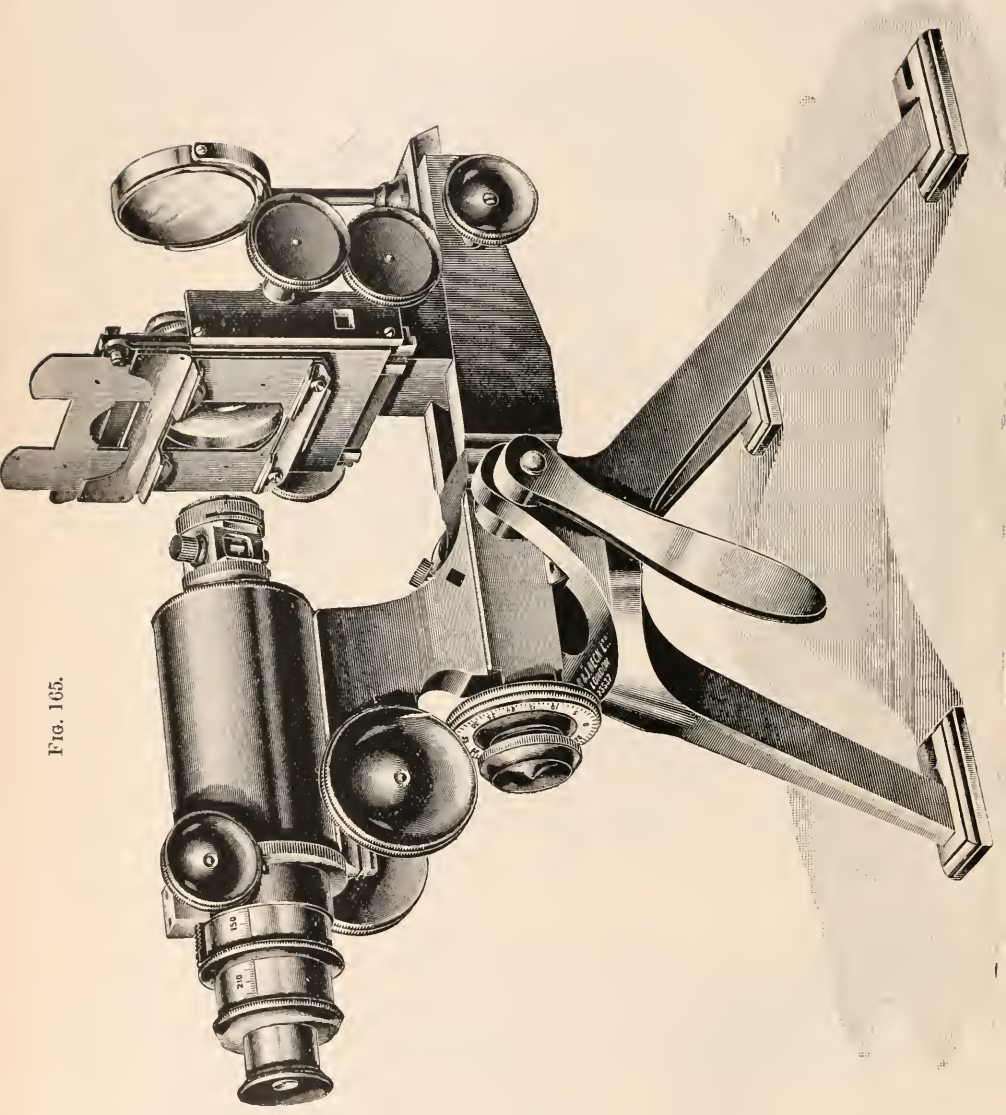

Fig. 165.

the centre for photographing large objects, with a rack-and-pinion draw-tube and sliding draw-tube, which as well as the nose-piece, are removable.

The slow motion has a double-speed lever action patent slow motion invented by Mr. Ashe. The whole instrument is very massive, the spread of the tripod being $8\frac{1}{2}$ inches by 9 inches, the height of the optic axis $9\frac{1}{2}$ inches, the maximum distance from the nose-piece to the stage 6 inches.

A powerful clamp is supplied to the joint, and a square hole in the limb of the Microscope allows illuminating apparatus to be carried on the Microscope itself.

R. & J. Beck's Metallurgical Microscope, "London Model."—This metallurgical Microscope (fig. 166) is on the model of the "London" Microscope, except that it is carried on a much larger pillar and base. The latter, which is unusually large and steady, measures $6\frac{3}{4}$ in. in length by $4\frac{1}{2}$ in. in width.

The coarse focusing adjustment is by spiral rack-and-pinion, so accurately fitted that even comparatively high powers can be focused thereby. The fine adjustment consists of a triangular prism upon which slides smoothly a solid metal sleeve which fits this prism so perfectly that there is no lateral motion. The adjustment is obtained by a fine micrometer screw actuating a supplementary pointed rod which impinges upon a hardened steel block. The limb of the Microscope is so designed that there is ample room for the fingers when turning the milled heads.

The body is made of a large diameter, 1·27 in., No. 3 Royal Microscopical Society's standard gauge, so that a large angle of view can be obtained for photo-micrography, or large field eye-pieces can be used if desired.

The stage is carried on an exceedingly strong dovetailed slide, and has a rack-and-pinion focusing motion up and down of 2 in.

The mechanical stage gives vertical and lateral motion of 1 in. and is very solidly constructed. If the mechanical stage is not supplied, a square stage, $3\frac{3}{4}$ in. by $3\frac{1}{4}$ in. of solid construction is supplied.

A substage with screw-focusing adjustments is supplied in the most complete form, but the instrument may be supplied with or without this adjustment. A double mirror and strong case accompany each instrument.

Ashe-Finlayson Comparascope.—By the use of this apparatus (fig. 167), exhibited at the October Meeting, exact comparisons may be made of two objects which may be seen side by side in the same field of view. For certain classes of microscopical work this is most valuable. It is applied without any difficulty to any ordinary monocular Microscope, as the apparatus may be screwed in like an object-glass and be clamped at any convenient position so that it projects at right angles to the body of the instrument, either in the front or to one side or the other, according to the most convenient position from which to take the light.

The whole apparatus, by means of an adapter A, fig. 168, screws into the body of the Microscope in place of the object-glass, and the ordinary object-glass screws into the apparatus as shown at O 1.

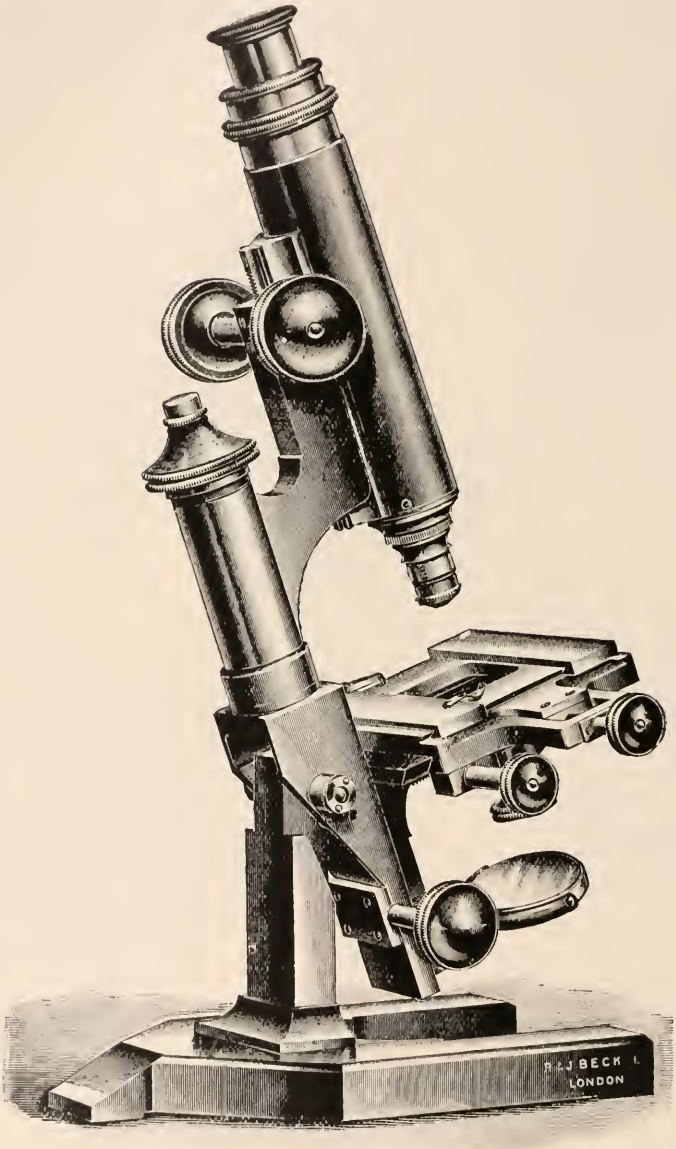

Fig. 166.

The Comparascope consists of a mount into which a second object-glass O 2 can be screwed at right angles to the body tube. A strong but very light dovetailed bar D projects about 3 in. from the Microscope tube, and carries upon it a movable stage S, upon which an ordinary 3 in. by 1 in. slide is held by spring clips. At the far end of the dovetailed bar slides a mirror M in gimbals, and in the centre of the comparascope mount is a right angle prism P, which reflects the light from the object-glass O 2 into one half, while the light from object-glass O 1 proceeds directly to the other half of the field of the Microscope.

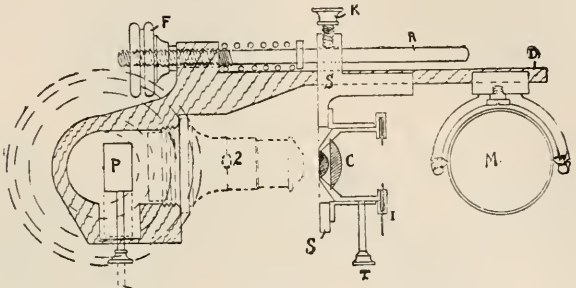

FIG. 167.—VIEW FROM ABOVE.

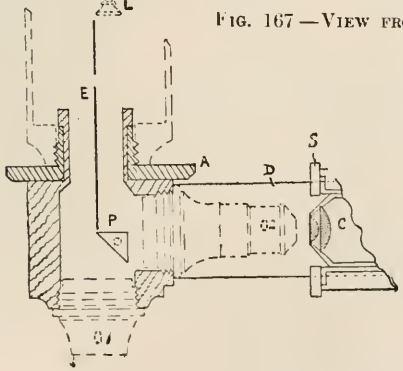

FIG. 168.—SIDE VIEW.

Fitting into the Comparascope mount is a thin septum E, which projects sufficiently far into the body tube to prevent the light from one side of the field reaching the other half. The prism P can be slipped out of position by means of the milled head L at any time, thus throwing the Comparascope out of use. The stage S which slides along the dovetail D, may be clamped in any position by the screw K upon the rod R, and a fine adjustment for focusing high powers is then available by revolving the milled head F. In order that the instrument may be equally serviceable for high powers, a small substage carrying a condenser C,

with an iris diaphragm I, is supplied. The condenser may be focused by means of the milled head T, which acts through a spiral slot and moves it up or down.

The partition E should be of suitable length for the Microscope with which the Comparascope is to be used, so that it is advantageous in ordering the instrument to state the length of the tube of the purchaser's Microscope. Any Microscope object-glasses can be employed, though it is generally convenient to use a pair of object-glasses of approximately the same magnifying power. For those who have not duplicate object-glasses, these can be supplied, the powers of which will be sufficiently similar for ordinary work. Where extremely delicate observations are to be made, specially paired object-glasses can be obtained. In this case the two images are identical in magnifying power. The apparatus, which has been patented, is made by the firm of R. and J. Beck, who are the sole licensees.

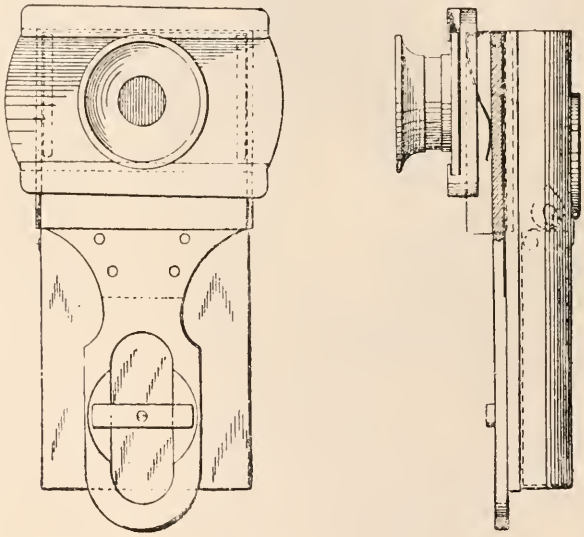

Fig. 169.

Vollbehr's Microphotoscope.—This apparatus (fig. 169) was described in the October Journal, p. 642.

Reichert's New Microscope Stands with Handles.*—The principal feature of these stands is the handle, a convenience which will be much appreciated in laboratories and in class work. The illustrations

* Reichert's Special Catalogue, 1905, 16 pp.

FIG. 170.

(figs. 170–171) give the appearance of the instruments fitted with the new accessory, and also the class of model to which they have been adapted.

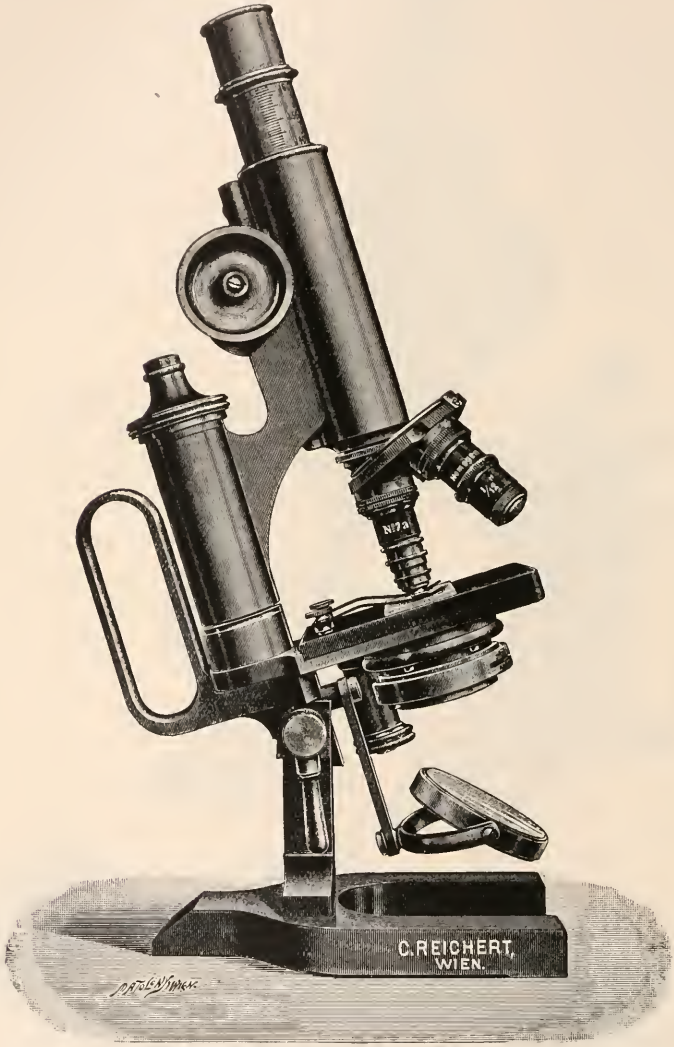

Fig. 171.

The addendum is an economical substitute for the bent-out limb which has only of recent years been properly appreciated.

(2) Eye-pieces and Objectives.

Direct Determination of the Curvature of Small Lenses.*—C. V. Drysdale exhibited and described apparatus for the direct determination of the curvatures of small lenses, such as the objectives of Microscopes. Parallel light from a distant source falls upon a plane unsilvered mirror inclined at an angle of 45°. Some of the light is reflected and brought to a focus by an ordinary convex lens. The surface to be tested is placed at this point, and the reflected rays proceed as if they had come from a point on the surface. They pass through the plate glass into a telescope focused for parallel rays, and an observer sees an image of the distant source. If the surface is convex and is brought nearer to the lens, then, when it reaches such a position that its centre of curvature is at the focus of the rays emerging from the lens, the light will again retrace its former path, and a distinct image of the source will be seen in the telescope. In order to obtain the two images, the surface has therefore been moved through a distance equal to its radius of curvature. If the surface is concave, it must be moved away from the lens. The author showed how the method could be carried out by means of an auxiliary piece fitted to an ordinary Microscope. He also described a method of testing the spherical and chromatic aberration of microscopic objectives. Light from a distant point is partially reflected by means of a piece of plate-glass down the axis of the Microscope. In passing out of the objective it is brought to a focus upon a mirror, and retraces its path along the axis of the instrument until it reaches the plate glass. It passes through, and by means of a telescope an observer can view the distant source. The light having passed twice through the lens to be investigated, the effects of chromatic and spherical aberration are doubled, and at the same time the effect of coma is eliminated.

(3) Illuminating and other Apparatus.

New Ultra-Violet Mercury Lamp (Uviol Lamp).†—O. Schott and those who work with him at problems involving ultra-violet rays have found "Uviol" a convenient abbreviation. In the construction of this lamp full advantage has been taken of that new Jena glass which is pervious to ultra-violet rays. Platinum wires are fused into the extremities of a suitably shaped, generally straight, uviol-transmitting glass tube of from 8 to 30 mm. diameter, and of a length of from 20 to 130 cm. The platinum wires terminate inside the tube in the form of carbon heads, and admit of the use of either pole as positive or negative. Interiorly the lamp requires a mercury charge of from 50 to 150 grm. according to its size. The purpose of the mercury is not only to supply the vapour required for illumination, but also to effect the starting and to divert heat in order to cool the negative pole. The lamp is started by tilting; the two poles then become connected by the mercury, the current having, of course, been previously switched on. At the first moment of contact between pole and mercury, part of the

* Nature, lxxi. (1904) p. 142.

† Schott and Ger., Jena, Pamphlet No. 421, 16 pp., 1 pl., 1 fig.; Nature, 1873 (1905) p. 513.

latter is disintegrated simultaneously with the formation of a column of light and of an induction track for the current, which continues after the return of the mercury into its original position. The inconvenience of the long tube may be reduced by adopting a U-shape, which not only reduces the length to one-half, but is found to facilitate the starting and to enlarge the illuminated area. This shape is also more convenient for application to various parts of the human body. Several of these lamps may be electrically joined side by side, above or below, or in such ways as may be found desirable. The spectrum of the uviol lamp is exceedingly rich in lines, and extends down to wave-length 253. The specific intensity of the visible radiation fluctuates between 0·31 and 4·3 Hefner candles per sq. cm. according to the dimensions of the lamp. It follows that the uviol-lamp is an extremely advantageous means of converting electrical energy into effective radiating energy of short wave-length. It is likely to be useful not only in photography but in many chemical investigations, and in certain skin diseases. It has a deadly effect on bacteria and minute living organisms, as well as on the smaller species of insects. Under a lamp suspended during a summer night in a room with windows opened, thousands of dead insects were swept up the following morning.

Beck's Eyeshade.—This eyeshade (fig. 172), to obscure the unemployed eye in monocular Microscopes, is specially adapted for Beck's instruments.

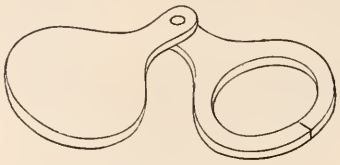

Fig. 172.

Abbe Camera Lucida.—This camera lucida (fig. 173) is a cheap form of the Abbe Camera Lucida, and has a cubical prism which is

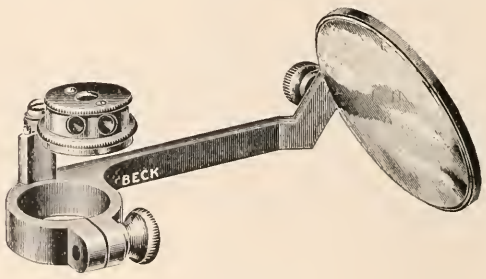

Fig. 173.

provided with a series of rotating tinted glasses. The holder carrying the prism and tinted glasses can be thrown on one side on a pivoted

joint. The instrument, which is made by the firm of R. and J. Beck, is used in the vertical position.

Beck's Parabolic Illuminator.—This apparatus (fig. 174) consists of a mirror made of glass, silvered at the back. The construction was suggested by Mr. Stead as being preferable to a solid silver reflector, which becomes tarnished when used in the presence of chemicals. The apparatus slides on the barrel of the objective, and is thus kept central, and the focusing is effected by moving it up or down. The light should

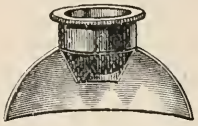

Fig. 174.

be thrown upon it from one side by means of a condensing lens, or otherwise from a lamp on the same level. The light is then converged upon the object in an oblique cone. When in use the lower edge almost touches the object. It is provided with an extra sleeve for fitting it to two object-glasses. It is only suitable for low powers.

Beck's Parabolic Illuminator with Sorby's Reflector.—This (fig. 175) is similar to the preceding, but has the addition of a silver mirror at 45° on a swinging fitting, which can be placed over half the front of

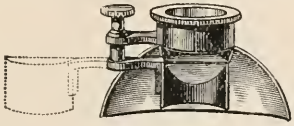

Fig. 175.

the object-glass, and throws a direct beam of light upon the object. With this apparatus the effects of oblique and direct light can be rapidly contrasted. It is only suitable for low-power lenses having a long working distance. This has both reflectors made of silvered glass as in the preceding illuminator.

Strehl, K.—**Beleuchtungsprincipien.** *Central.-Zeit. f. Opt. u. Mech.* (1905) pp. 227–8.

(4) Photomicrography.

Vertical and Horizontal Photo-micrographic Camera.—This consists of a strong metal base, which carries by means of a hinged bracket a solid circular bar. This rod has sliding upon it two strong brackets, the upper one of which carries a frame with folding ground glass and runners to take a double dark slide for photographic plates $6\frac{1}{2}$ in. by $4\frac{3}{4}$ in.; the lower bracket carries a tubular sleeve which fits loosely but in a light-tight manner over a tube which may be attached to the eye-

piece end of a microscope (fig. 176). The two brackets are each attached to bellows, and are capable of an extension of about 30 in. The two brackets slide easily up and down the circular bar in a slot or key-way, which prevents their turning round. They are provided with clamp screws to hold them rigidly at any position on the bar.

The whole camera may be used in a vertical position over the

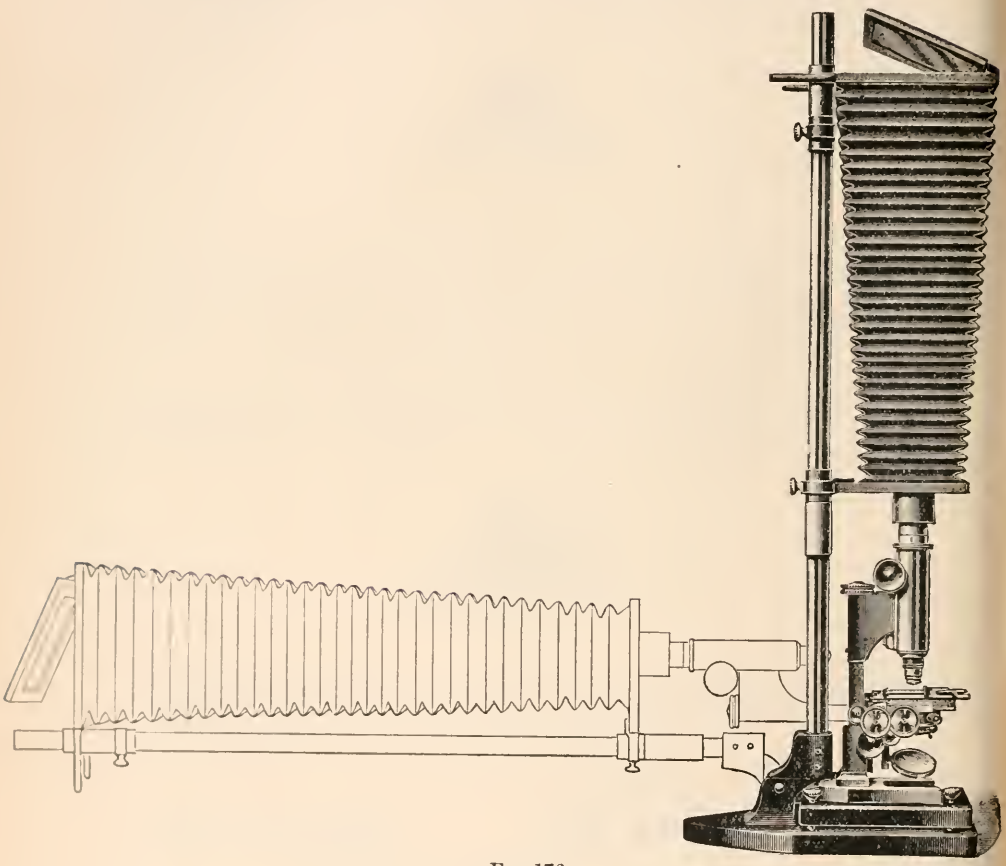

Fig. 176.

Microscope, or in a horizontal position as shown by the outline in figure, in which case the extreme end stands upon two firm feet on the table.

A small table with three levelling screws is supplied upon which the Microscope stands, and may be adjusted for centring the picture.

The apparatus, which is made by the firm of R. and J. Beck, also includes a one $\frac{1}{2}$-plate double plate-holder, carriers for $\frac{1}{4}$-plates, and light-tight connection for Microscope.

Focusing Magnifier.*—This instrument (fig. 177), made by Taylor, Taylor and Hobson, of Leicester, is intended for examining the definition of an image on the camera screen, and is arranged to close like a tele-

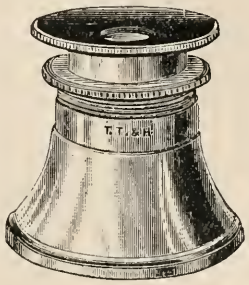

Fig. 177.

scope for compactness. The screw-ring forms an adjustable stop to limit the withdrawal of the eye-piece to suit the sight of the user.

Leadbeater, L.—**Photographing Crystals.**
[Lecture at Rotherham Photographic Society.]
English Mechanic, lxxxii. (1905) pp. 152–3.

Marktanner-Turneretscher, G.—**Wichtigere Fortschritte auf dem Gebiete der Mikrophotographie und des projektionswesens.**
Separat-Abdruck aus Jahrbuch f. Photog. und Reproduktionstechnik f. das Jahr 1905. Halle a. S., Wilhelm Knapp.

(5) Microscopical Optics and Manipulation.

Braun's Methods of Identifying Sub-microscopic Structures Allied Investigations on Double Refraction.†—F. Braun has found that certain substances—e. g. electrically pulverised metals, produce a grating-like structure when viewed with polarised light. This effect is in full agreement with the electro-magnetic theory of light. It has also been found that certain organic substances specially treated with gold solutions give similar effects. Hence it would seem that, either the finely-divided gold, or some compound of the gold and the organic substance, must be anisotropic. Braun's experiments were all made with transparent light, but similar results have now been attained with reflected light. It appears from these later experiments that the light which vibrates parallel to the grating-bars is reflected more intensely than that in the perpendicular direction. This, again, is in accordance with theory and with the behaviour (only reversed) of the transparent light. The method of observation is to place the object on the stage in the usual way, and to arrange above it a cover-glass inclined at 45° to the horizontal. The plane is set horizontally, and polarised light is then made to impinge on the cover-glass; it is then reflected downwards through the object to the mirror; is again reflected, and passes

* Catalogue, 1905, p. 23.
† Central-Zeit. f. Opt. u. Mech., xxvi. (1905) p. 188.

through the inclined coverslip into the objective. By means of a Zeiss vertical illuminator, high magnifications and oil immersions could be applied. It was found that palladium dust gave the best results.

The examination of organic preparations involved greater experimental difficulties. The light from an electric arc projection lantern was passed through a diaphragm and focused by a lens through another diaphragm and a ground glass screen on to a Zeiss vertical illuminator, which reflected it down through the Microscope tube and the objective on to the mirror, which again reflected it upwards through the preparation on to the Nicol eye-piece. An arrangement was also made so that the mirror might reflect directly upwards, thereby enabling a comparison observation with transmitted light to be made. Braun succeeded in accurately identifying by this means the composition of a substance previously unknown to him. The arrangement of apparatus for examination by reflected polarised light is more difficult and elaborate than in the case of transmitted polarised light, but the results give a useful criterion for detecting how far the images are due to any double refraction possessed by the substance itself. The author describes several of his methods for obtaining polarised light.

Microscopical Determination of the Position of a Reflecting Surface during Optical Contact.*—K. Prytz-Kopenhagen, when the surface is a plane reflecting solid, sets on the plane a suitable object (e.g. a grating on a glass plate) appropriately illuminated. This is then viewed through a Microscope whose axis is perpendicular to the plane. The position of sharp definition will be the position of optical contact. In the case of a reflecting liquid, its surface is, of course, plane, and the Microscope is arranged as before. But into the body of the Microscope near the eye-piece focus is introduced a horizontal solid glass rod, whose outer end is opposite a light source, and the inner (i.e. inside the tube) is bent vertically in the axis of the Microscope. The end of this vertical portion is accurately plane and horizontal, and bears two fine diamond scratches $\frac{1}{40}$ mm. apart. These scratches project an image through the objective towards the reflecting surface, and when adjusted the image will be in the reflecting surface, and will be the conjugate point of the glass rod end. In this position the image on the reflecting plane may now be regarded as origin. Just above the objective is a prism of very obtuse angle, the edge being uppermost. The effect of the prism is to throw the ray proceeding from the origin on to the reflecting surface slightly out of the microscopic axis, so that it reaches the eye-piece without being blocked out by the glass rod. Thus, the position of clear definition of the scratches will again be the position of optical contact. Descriptions are given of the application of the method to the measurement of Newton's rings and of other physical quantities.

Brass, A.—**Grundgesetzeder Optik.**
[Deals largely with interference.]
Central.-Zeit. f. Opt. u. Mech., xxvi. (1905) Nos. 15–20.

* Central-Zeit. f. Opt u. Mech., pp. 242–4 (3 figs.).

B. Technique.*

(1) Collecting Objects, including Culture Processes.

Cultivating Trypanosomes.† — Thiroux cultivated *Trypanosoma duttoni* in the following medium : beef or rabbit broth, 1000 grm. (125 grm. of meat macerated in 1 litre of distilled water), Witte's pepton 20 grm., salt 5 grm., agar 20 grm., carbonate of soda solution (53 grm. to the litre) 10 c.cm.

The materials are prepared and mixed in the customary way, except that the medium is not clarified with white of egg. When made, it is sterilised in the autoclave for 20 minutes at 110°, and preserved in tubes covered with caoutchouc caps.

When required for use the necessary quantity is melted in a water bath and when cooled down to 45°, two volumes of defibrinated rabbit's blood are added. It is then made into slopes, and next day the inoculations are made in the condensation water, the blood being taken from the heart of a mouse. The first cultures develop in from 10–15 days ; from these sub-cultures are made, and so on until development occurs on the 4th day.

In order to stain the Trypanosomes, thin films are necessary. The preparations are fixed in absolute alcohol and stained by Laveran's method.‡

Cultivation of Amœbæ.§—A. Lesage inoculated gelose with mucus from dysenteric stools. The gelose, which had been washed in running water for 8 days and afterwards sterilised, was placed in Petri's capsules or in tubes. The temperature ranged from 18°–25°. In a few days amœbæ, often motionless, were found buried among the bacteria. Cultivations were also made on plates on which paracolon bacilli were growing. By this method living amœbæ were obtained from the human intestine without passing through the encysted stage.

Another method was to allow the amœbæ to become encysted, and to cultivate the cysts thus obtained. For this purpose some mucus and a little sterilised water were placed in a covered capsule. The mucus dried slowly at a temperature of 18°–25°. After a few days the dried mucus was sown on gelose plates. In this way about one vessel out of ten was found to contain amœbæ. Each successful plate served to obtain fresh cultures of the pure mixed cultures. Each time the plates were inoculated the amœbæ were sown at the bottom of the plate while held vertically, the upper end being inoculated with the food bacterium. The plates were incubated at 20°. After a few days the amœbæ reached the upper end, and from this part fresh plates were inoculated, and so on.

* 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, &c.; (6) Miscellaneous.

† Ann. Inst. Pasteur, xix. (1905) pp. 566–9 (1 pl.).

‡ See this Journal, 1903, p. 117, and 1904, p. 120.

§ Ann. Inst. Pasteur, xix. (1905) pp. 10–16 (2 pls.); Comptes Rendus, cxxxix. (1904) pp. 1237–9.

All stages in the evolution of the amœbæ were able to be followed out in the cultivation plates.

For staining purposes the methods of Laveran and of Marino were used.

New Bacteria Filter.*—F. Kern describes a new bacterial filter. As seen from the accompanying illustration (fig. 178) it consists of a porcelain cup, the bottom of which is perforated and holds the filter candle, with the blind end upwards and the open end fixed into the hole in the bottom of the cup; beneath this there is a connecting pipe that leads into the lumen of the candle; the cup, candle and connecting pipe are made out of one piece of porcelain; the cup and pipe are glazed; by means of a rubber cork the connecting pipe can be attached to a vacuum flask. When the cup is full of the fluid to be filtered, the candle is covered by a glass bell, shaped like the candle but rather larger; by this means the action of the vacuum is not hindered by the air that would otherwise be drawn in above the filtering level of the candle, and it is not essential that the cup should be completely full of fluid. The author claims that it is a simple contrivance, being composed only of one piece of porcelain and a glass globe, both of which can be readily cleaned and sterilised; that it will filter relatively small quantities of fluid; that it is inexpensive.

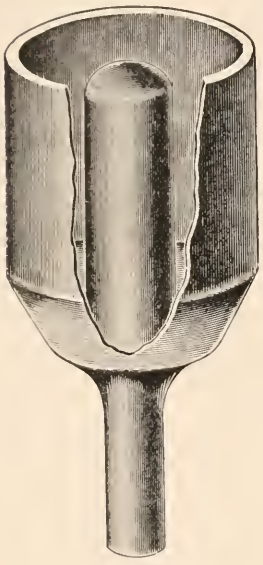

Fig. 178.

Pure Culture from Cells Isolated under the Microscope.†—S. L. Schouten obtained pure cultures from single cells isolated under the highest powers of the Microscope, by means of fine glass needles controlled by a special mechanism. The apparatus employed is represented in fig. 179 as ¼ natural size. It consists of A an iron plate standing on four feet; the Microscope is fixed by a ring to the square copper plate B, and can be moved by means of a screw to the right or left or backwards or forwards. Of the Microscope there is shown the stage F, the Abbe condenser G, the iris diaphragm H, the mirror I, the foot J, and the objective K; on the stage is a moist chamber, the "isolation chamber," which has a special construction, the right and left sides being provided with horizontal clefts, which can be closed by thick oil; through these clefts are passed two needles M, to be described below. On to the moist chamber, which can be moved by means of a mechanical stage, is brought the cover-slip, on the under side of which the isolation will take place. The needles are provided with handles N, resting on the copper bar O, which can turn about a pivot P, and at the

* Centralbl. Bakt., 1te Abt., xxxix. (1905) p. 214.
† Zeitschr. wiss. Mikrosk., xxii. (1905) p. 10.

ends of these bars are small steel disks, by means of which they rest on the vertical rods R ; by means of the spring S, R can be screwed up or down, the point of M in the moist chamber falling if R is screwed up, and conversely ; the screw on R has a very fine adjustment, and the arm of the lever O is about twice as long as the distance of P to the point of the glass needle, so that very minute changes in position can be made ; the pivot P is carried by a copper bar V, which is fixed in the upright T. The glass needles have a stouter portion over the position of the rod O of about 3–4 mm. thick, opposite the pivot P about $\frac{1}{2}$ mm., and the fine ends are formed into points and loops, and vary in stoutness according to the nature of the organism to be isolated. The Microscope being placed in position, the needles are laid in cement on the holders, and are so arranged that the looped ends are directed upwards, resting almost in the middle of the objective, but rather deeper than the upper margin of the isolating chamber ; the side clefts are closed, the cover-glass laid on top of the chamber, and the needles are now pressed so deeply into the cement, that by moving the screw S the ends can be made to rest on the under side of the cover-glass ; the

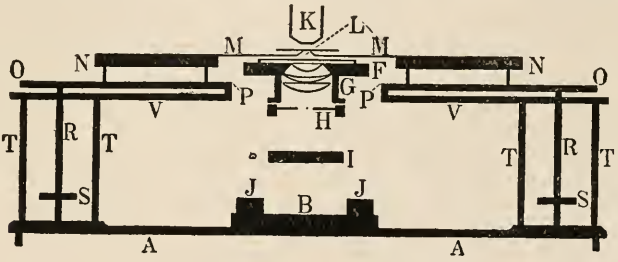

Fig. 179.

ends of the needles should not be separated more than 300 μ, and should not be exactly opposite each other. It is most important that the whole circumference of the loop should rest against the cover-slip. The cover-slips recommended are 18 by 18 mm., thoroughly cleaned and lightly spread with vaselin ; the moist chamber is a square glass frame, the side walls being 2–3 mm. high and 5 mm. broad, making a capacity of about 14 by 14 mm.

Before proceeding to the isolation of the cell, it is necessary to ascertain how much of the material from which the isolation is to be made must be added to a drop of $\frac{3}{4}$ p.c. salt solution, so that there are not too many cells at the margin of the drop ; the author gives details of the method he employs to determine this suitable dilution.

The suitable dilution being decided on and prepared in the specially devised mixing chamber, the cover-slip on which the isolation is to be made, is flamed and laid on the mixing chamber ; then with a sterilised platinum needle are placed near to each other and equally distant from the middle of the slip and rather to its left side, three drops of the sterilised fluid in which the culture is to be made ; these are known as the "culture drops" ; to the right of the middle and about 2 mm. dis-

tant from each other, are placed two drops of a ¾ p.c. salt solution containing the material in the desired state of dilution; these are known as the "material drops"; besides these is also placed one drop of sterilised ¾ p.c. salt solution. The isolating glass needles are now sterilised; this is done by taking away the loose side pieces of the isolation chamber, and by turning off the screw with which N is fixed into O; N is drawn carefully away from the apparatus; the points of the glass needles are then held in a flask of strong sulphuric acid, and afterwards in a flask of ammonia; they are then returned to the plate, the movable side pieces replaced, and the side slits closed with thick olive oil. A drop of water has been previously placed on the floor of the isolation chamber. The cover-glass is seen to be studded with small rounded drops, indicating that the chamber is saturated with steam.

Under a low power the points of the needles are dipped into the drop of sterile ¾ p.c. salt solution. By a movement of the Microscope, the loop of the left-hand needle, now full of salt solution, is brought, under a high power, exactly into the middle of the field; the right-hand needle being about three screw-turns beneath it. By means of the movable stage and a low power the isolation chamber is so placed that the left-hand loop rests almost on the margin of a material drop, that is on the margin that lies nearest to the culture drops. With a high power the margin of the drop is searched for a bacterium to isolate, a part of the margin being chosen where there are not many other bacteria; then the outer end of the loop of the needle is brought into contact with the margin, whereby a little fluid will be withdrawn from the drop; the isolation chamber is then moved a little, so that the small drop of fluid containing the bacterium is separated from the material drop. The isolated bacterium has now to be transferred to one of the culture drops. Using a low power, the chamber is moved so far to the right, that the loop of the left-hand needle when raised, arrives between two culture drops and near to the margin of one of them; then under a high power, the loop is brought against the cover-slip, where it deposits a drop that probably contains the isolated bacterium; several drops are deposited until this is made certain. To bring the isolated bacterium into the culture drop, the pointed end of the right-hand needle is used; under a low power the left hand needle is drawn three screws'-rings down, and the right hand needle is raised and brought by the sliding arrangement of B, exactly under one of the drops in which there is an isolated bacterium; then under a high power the point of the right-hand needle is made to rest on the cover-slip in the drop, and by moving the isolation chamber the point of the needle carries the drop with the bacterium into the culture drop, the bacterium being kept in sight during the process. Diagrams illustrating the stages of this manipulation accompany the description. The author gives minute details for carrying out these processes, for correcting errors, and for avoiding possible difficulties, and refers to the modifications required when dealing with various micro-organisms, and especially when the method is employed for testing the favourableness of any particular medium. He considers that the method is especially useful for studying variability and pleomorphism.

Method for Collecting the Gas of Fermentation.* — A. Cache recommends the following method : Having poured the fluid medium into an ordinary test-tube, he places in it a small short test-glass inverted, and brings the whole into the autoclave ; during the process of sterilisation, all the air in the small tube has escaped, and, after cooling, it is seen to be full of medium. On testing sugar bouillon inoculated with an organism capable of causing fermentation, the gas produced will collect in the inverted tube.

(2) Preparing Objects.

Examination of the Spermatozoa of Ascaris megalocephala.† — L. Scheben gives the following details of the method employed by him in the examination of the male genital organs of *Ascaris megalocephala* : The specimen is obtained as fresh as possible, and put into the fixing solution, a mixture of 50 parts of absolute alcohol, 50 parts of mercuric chloride, and 2 parts of acetic acid, or picric acid as used by Boveri ; or Zenker's solution may be used. The material is cut up into small pieces, and left in the fixing solution for 12 hours, and after removal of the mercury by means of iodine solution, it is placed in 60 p.c. alcohol, and from this it is transferred to alcohols of progressively higher percentages up to absolute alcohol, in which it should not be allowed to remain too long when once the desired hardness has been reached. The object is now placed in xylol, or better, in pure chloroform, covered by a layer of absolute alcohol, to protect the specimen that floats on the surface of the chloroform, from the air ; when the object is sufficiently penetrated, the alcohol can be pipetted off, and the specimen is transferred to a mixture of xylol, or chloroform and paraffin, and after about half an hour it is imbedded in pure paraffin. The imbedding process lasts about 4 hours at 60° C. Sections were then made ranging from 4 μ to 10 μ. Good staining was obtained by Heidenhain's hæmatoxylin method, and counterstaining with a light green ; simple picrocarmine staining also answered well ; the author also stained with anilin dyes, using the double stain of Heidenhain's hæmatoxylin and Bordeaux red. Besides making sections, he also examined the contents of fresh genital glands from the living animal, by means of a warm stage, in albumen-glycerin or in a weak solution of sugar ; or he fixed the contents expressed on to a cover-slip, in osmic acid vapour, or by the method suggested by Van Beneden and Boveri, and mounted in glycerin.

Methods of Examining the Eyes and Frontal Organs of Branchiopods.‡—M. Nowikoff finds that Gilson's fluid is the best for fixing these objects, but he also got good results with sublimate acetic, or with 96 p.c. alcohol. For the thicker sections, that served to show the topographical relations, he stained with borax-carmine and ½ p.c. Lyons blue, or borax-carmine, osmic acid, and wood vinegar, after Schuberg, or with Delafield's hæmatoxylin and picric acid fuchsin, according to Van Gieson. This last is also very good for fine sections ; but he found that for these, in order to show the plasma structure, Bütschli's or M. Heidenhain's

* Centralbl. Bakt. Ref., 1te Abt., xxxvii. (1905) p. 49.
† Zeitschr. wiss. Zool., lxxix. (1905) p. 400. ‡ Tom. cit., p. 433.

hæmatoxylin, or R. Heidenhain's hæmatoxylin potassium chromate is especially useful. Referring to the borax-carmine stain, he notes that the nuclei of the Branchiopods have very little stainable substance, so that he stained the object for about 48 hours at 35°–40° C.

For decolorising the eyes he uses free chlorine by a modification of Mayer's method; he fills a test-tube with 96 p.c. alcohol, adds a few drops of nitric acid, and puts a couple of crystals of potassium chlorate into the mixture; into the lower half of the tube he dips a thin layer of wool, and lays it on the head of the animal, which had been previously kept in 70 p.c. alcohol; in this way the object does not rest on the potassium chlorate; in 12–24 hours at room temperature, the pigment will be completely removed from the tissue, which has not suffered any marked alteration from the treatment.

Investigating the Anatomy and Development of the Venous System of Chelonia.*—F. A. Stromson killed the turtles with chloral hydrate, and injected through the left abdominal vein. The best results were obtained when the animals were killed several days before injecting them. The mass used was mostly gelatin, and in order to prevent it cooling before all the veins were filled, the specimens were previously placed in warm water. If, however, iodide of potassium is used to lower the melting-point of the gelatin, this is not necessary. Some of the turtles were injected with Huntington's wax-mass, and corroded with strong hydrochloric acid.

The material used for studying the development of the veins of embryos was fixed in picro-sublimate. The embryos were dehydrated, cleared, and imbedded in paraffin, and serial sections were cut about 20 μ thick. The best staining results were obtained from Delafield's hæmatoxylin and picric acid. Reconstruction methods were freely used.

Demonstrating the Structure of Gutta-percha Plants.†—A. Charlier, when investigating the anatomy of gutta-percha plants, used collodion sections of the leaf, and stained them with acetic orcanette, with orcanette and chloral, or with sudan, in order to demonstrate the lacticiferous network. It was found easy to macerate little bits of leaf in eau-de-javelle, and, after carefully washing in dilute acetic acid, to stain the tissue *en masse*. The maceration in the hypochlorite varied according to the thickness of the leaf, from 24 hours to several days. These preparations were mounted in glycerin-gelatin.

In order to study the walls of the lacticiferous vessels, the latex was got rid of by immersing the sections in chloroform. The sections were then cleared up in hypochlorite and afterwards stained with iodine-green and alum-carmine. Bismarck brown and Delafield's hæmatoxylin gave equally good results.

Demonstrating the Structure of the Respiratory Tract of Birds.‡ For demonstrating the bronchial ramifications of birds, G. Fischer made corrosive preparations by the aid of wax-masses, celloidin, photoxylin, and celluloid solutions.

* Amer. Journ. Anat., iv. (1905) pp. 453-4.
† Journ. Bot., xix. (1905) pp. 133–4.
‡ Zoologica, xix. (1905) 45 pp., 5 pls. and 2 figs in text.

The wax mass consisted of 3 parts white wax, 2 parts powdered colophonium, 1 part Venetian turpentine. The mass was stained with Berlin blue or with cinnabar. The mass was injected while the body of the bird was still warm, and when the operation was completed the body was cooled down in cold water, and then, after the lapse of a few hours, was transferred to pure hydrochloric acid for maceration. When the maceration was complete, the preparation was cleansed in running water.

The photoxylin and celloidin injections are made by dissolving the commercial article in equal parts of absolute alcohol and sulphuric ether, and mixing the mass with zinc-white or cinnabar.

The solution injected is at first of a thin, syrupy consistence, afterwards followed by a thicker. As the solvents evaporate quickly, it is necessary to give a few turns of the piston-screw from time to time so as to keep the tension up. According to the size of the animal, it takes hours or days for the injection mass to set properly. After having been macerated in pure hydrochloric acid, the preparation is washed in running water, and afterwards preserved in a mixture of alcohol, glycerin, and water.

As hydrochloric acid did not always act satisfactorily, the following corrosive menstruum was substituted : oxalic acid 6, pepsin 1·5, distilled water 200. This medium was used, after preliminary treatment, with hydrochloric acid, and the digestion was effected in a thermostat at 40° C.

Celluloid injection masses were chiefly used for blood-vessels. Celluloid shavings were dissolved in pure acetone, and the solution mixed with cinnabar or zinc-white.

For microscopical sections, the thoracic viscera (trachea, lungs, and heart) were placed within a bell jar, from which the air could be exhausted below and gelatin solution made to flow in above.

For fixing the material for microscopical purposes, five methods were tried : absolute alcohol ; formalin, alone and with the addition of 5 p.c. acetic acid, and of saturated solution of sublimate ; Zenker's and Müller's fluids. The sections were stained by Van Gieson's and by Weigert's methods, and with kresofuchsin.

Creosote as a Dehydrating Medium for Imbedding in Paraffin.* W. Pavlow recommends the following procedure, which he finds has advantages over the usual method of dehydrating with alcohol. The objects, fixed in any kind of fluid, are transferred without previous dehydration to creosotum fagi for 4–24 hours, according to size, and then immersed in pure creosote for 2–3 hours more. On removal, the superfluous creosote is mopped off with blotting paper, and then the objects are placed in xylol or toluol for one hour, after which they are imbedded in paraffin in the usual way.

Injection of Fine Vessels.†—P. Konascko successfully and easily injects the organs of small animals by the following procedure. When it is desired to inject, say, the portal system of the kidney of the frog, a canula is introduced into the vena cava inferior or the vena abdominalis anterior. These large vessels are then injected with warm colourless

* Zeitschr. wiss. Mikrosk., xxii. (1905) pp. 186–7.
† Tom. cit., pp. 179–80.

gelatin. The organ is, of course, placed in a water-bath during the injection. When the operation is completed, the preparation is removed and allowed to cool. It is now easy to insert a canula into the finer vessels, which are distended by the injection-mass. When the canula is fastened, the preparation is placed in warm water again. After an immersion of a few minutes the gelatin is liquefied, and then the injection-mass is easily syringed in.

Demonstrating the Spermatogenesis of Hydra.*—E. B. Downing used a variety of fixatives, including osmic-Merkel, Hermann's, Perenyi's chromacetic, Flemming's, Gilson's mercuro-nitric, Carnoy's acetic-alcohol, Kleinenberg's picro-sulphuric, Graf's chromoxalic, varying strengths of picro-acetic, and hot corrosive. The first three were the best, the osmic-Merkel working especially well. A ½ p.c. solution of osmic acid was used to kill the animals. The hydra was placed in a watch-glass, in as small a drop of water as would allow the animal to expand well. When expanded, about 10 c.cm. of the osmic-acid solution was poured over it, death mostly occurring without any contraction. After about a minute the animal was transferred to Merkel for 24 hours. It was then dehydrated in graded alcohols, cleared in xylol, and imbedded in paraffin. A variety of stains was used, the best being iron-hæmatoxylin, Bordeaux red, orange G, and safranin-gentian-violet.

The preparations were cleared with oil-of-bergamot or cedar-oil, and the sections mounted in balsam or in thick cedar-oil.

The best results were obtained from the osmic-Merkel or the Perenyi, followed by iron-hæmatoxylin and Bordeaux-red, or for count of chromomeres, by safranin. Gentian-violet was the best stain to differentiate the gland-cells of the endoderm, and was used after iron-hæmatoxylin.

Decalcification of Dental Enamel.†—C. F. Bödecker remarks that by the ordinary methods of decalcification, the protoplasmic constituent of the enamel of teeth is torn off from the dentine and gets washed away. This disaster is avoided by the following procedure : The preparations pass through the usual processes until they come to thin celloidin. From this they are transferred to the decalcifying solution, which consists of thick celloidin solution, to which 6–10 p.c. strong nitric acid has been added. The consistence of the solution must be maintained by the occasional addition of ether and alcohol.

The duration of the decalcifying process depends on the size of the preparation—e. g. slices about 30 μ thick are ready within two weeks, while those 1 mm. thick require about two months.

After the preparation has lain in the acid solution for a couple of days it assumes a chalky appearance, but as decalcification proceeds the enamel becomes transparent, so that at last it is almost imperceptible.

When this stage is reached, the celloidin is allowed to harden.

On account of the difficulty of making thin celloidin sections, it is advisable to imbed the block in paraffin.

* Zool. Jahrb., xxi. (1905) pp. 379–426 (3 pls.).
† Zeitschr. wiss. Mikrosk., xxii. (1905) pp. 190–2 (1 pl.).

Demonstrating the Blastoderm of Polistes pallipes.* — W. S. Marshall and P. H. Dernehl killed the eggs in hot water, and after a few seconds added an equal amount of hot saturated aqueous solution of sublimate. After an immersion of 20–40 minutes the eggs were washed and placed in 70 p.c. alcohol. Another method used consisted in adding to hot sublimate solution an equal bulk of alcohol and pouring the mixture over the eggs, and allowing this to act for 10–20 minutes.

The stains used were iron-hæmtoxylin, generally followed by Bordeaux red, and the safranin-methylen-violet, orange G triple stain.

Preparing Fasciolaria tulipa and its Larval Excretion Organs.† O. C. Glaser found that the best fixative was Kleinenberg's picro-sulphuric acid. The stains used were borax-carmin, hæmalum, Kleinenberg's hæmatoxylin, and Conklin's modification of Delafield's hæmatoxylin. In some cases bleu-de-Lyon and eosin in combination were tried.

There was some difficulty in obtaining thin sections, as dehydration rendered the yolk very brittle. For paraffin sections the best results were obtained by superseding the higher alcohols and xylol with 70–80 p.c. alcohol and creosote. This procedure enabled thin sections of a mass containing some 300 eggs to be easily made.

Demonstrating Neurofibrils.‡—G. A. Jäderholm rejects the existence of an endocellular network in ganglion-cells, and shows that the appearances are due to fixation, his view being that the fibrils pass through the cells without inosculating.

He advocates Bethe's method, which consists in fixing with nitric acid, following this with molybdanate of ammonia and toluidin-blue. This procedure causes little shrinkage, and the appearance of an endocellular network is absent. By Donaggio's method, which consists in substituting pyridin for nitric acid as fixative, the cells become shrunken and the appearance of an inosculating endocellular network is produced.

By combining the two methods, shrinkage and artefacts intermediate in degree were produced.

Demonstrating the Structure of Red Corpuscles.§—Vl. Růžička washes the air-dried films with a mixture of tap and distilled water in order to remove the hæmoglobin. The films are then fixed in saturated aqueous solution of sublimate. After thorough washing in running tap water they are mordanted with 5 p.c. sodium nitrate and then washed again. The films are stained with a mixture of 2 parts of 5 p.c. carbol-fuchsin and 1 part of 1 p.c. aqueous china-blue solution.

After washing in water the preparations are dried and mounted in Balsam or in cedar-oil.

Demonstrating Teeth of Mammalian Embryos.‖—K. von Korff fixed the material, teeth of embryos of ox and pig, in sublimate, sublimate-alcohol-acetic acid, and in Flemming's fluid. The last two have the advantage of not dissolving out the slight deposit of lime. The

* Zeitschr. wiss. Zool., lxxx. (1905) pp. 122–54 (2 pls.).
† Tom. cit., pp. 80–121 (2 pls. and 5 figs.).
‡ Arch. Mikr. Anat., lxvii. (1905) pp. 103–23 (2 pls.).
§ Tom. cit., pp. 82–102 (2 pls.). ‖ Tom. cit., pp. 1–17 (1 pl.).

preparations were stained with solution of acid Rubin and orange G in alcohol and glycerin, or they were first stained with Heidenhain's iron-alum hæmotoxylin.

(3) Cutting, including Imbedding and Microtomes.

Reichert's Microtome with Handle.*—This instrument (fig. 180) is a modification of the microtome working in conical bearings previously

Fig. 180.

described in this Journal.† The new features are the handle and the base, which is sufficiently heavy to insure stability.

Flatters' Microtome.—This microtome‡ (fig. 181) devised by A. Flatters is made of brass; the tube or well is 3 in. deep and the extreme diameter 1 in. The spindle is of the same length, the screw having 28 threads to the inch. The spindle is fitted with a thumb-screw at the lower end to admit of the toothed disks being easily changed. A spring stop, the tension of which can be adjusted, works on the teeth of the disk, thus insuring a series of sections of uniform thickness. The

* Special Catalogue, 1905, p. 9.

† See this Journal, 1899, p. 499. ‡ Exhibited at the October Meeting, 1905.

three disks provided have 72, 54 and 43 teeth, giving sections $\frac{1}{2000}$, $\frac{1}{1500}$ and $\frac{1}{1200}$ in. respectively. The thickness of the sections is ascertained by multiplying the notches in the disk by the number of threads per inch on the spindle.

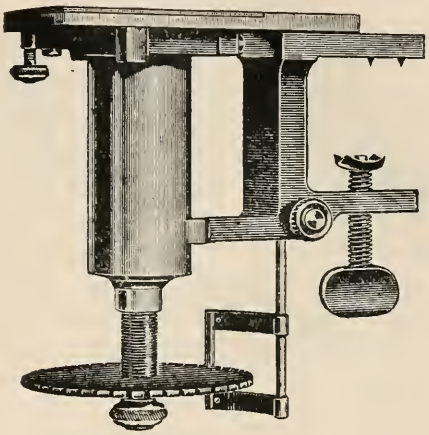

FIG. 181.

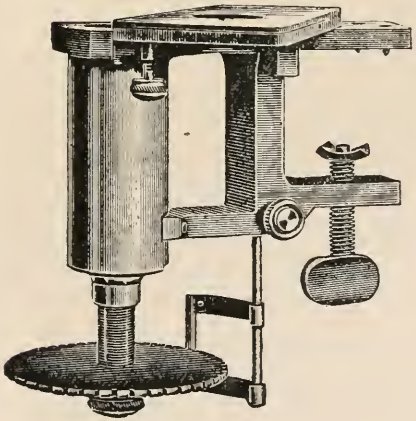

FIG. 181A.

The knife-plate, $2\frac{3}{8}$ in. by $4\frac{3}{4}$ in., is made of hardened brass polished "dead flat," and has an aperture the same diameter as the tube, but tapers slightly to the top in order to prevent the specimen from turning

or rising while the sections are being cut; it is attached at one end to the headstock by a stout screw, and is securely held in position by a reliable screw which is clamped under the headstock. The specimen to be cut is placed in the well of the microtome, and paraffin, m.p. 130° F.,

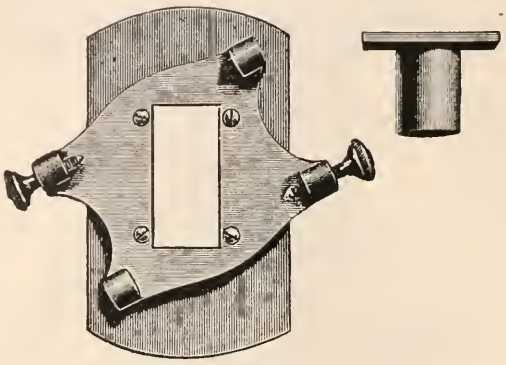

Fig. 181B.

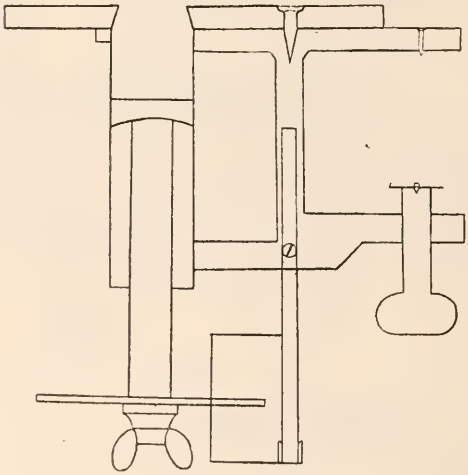

Fig. 181C.

poured in; when set, any superfluous wax is removed. The "candle" so formed is then moved upwards by turning the toothed disk. The sections are cut by passing the knife obliquely over the knife-plate, which is always kept moist with alcohol.

The instrument is fitted with an oblong top for sections too large for the ordinary well; it fits on the top of the microtome and is held in position by a series of clamps; the aperture is $\frac{3}{4}$ in. wide by $\frac{1}{2}$ in. long by $1\frac{1}{8}$ in. deep. The carrier fits into the tube of the microtome, and is actuated by the spindle in the usual way.

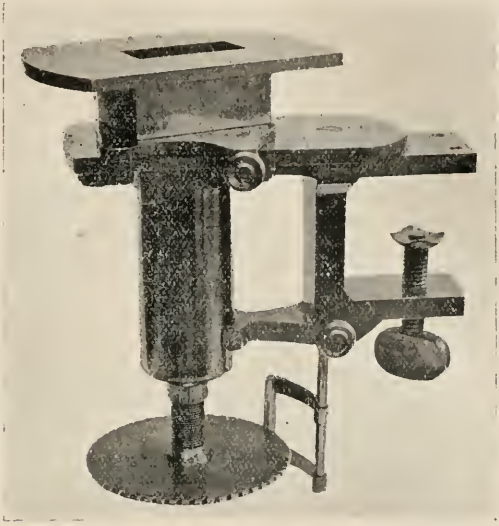

Fig. 181D.

Preventing Rolling of Paraffin Sections.*—In order to prevent the rolling and crumbling of paraffin sections, A. Siding works up a little bit of paraffin with the fingers on to a thin, transparent plate of the same size as the section surface, and presses it on the section surface of the paraffin block. With a little practice the right pressure for obtaining intimate union is attained. When the section is made, this, together with the plate, is easily removed with the finger to a slide already provided with adhesive. For very large sections, just warmed paraffin should be poured over the section surface. The further manipulation is the same as that for ordinary paraffin sections.

(4) Staining and Injecting.

Easy Method of Staining and Mounting Algæ and Fungi.†—J. Burton, in a paper read at the Quekett Microscopical Club, remarked that in exhibiting micro-objects to friends who were not particularly well acquainted with natural history, it was always noticeable that they showed most interest in "common objects." A fly's foot or scales from a butterfly's wing drew more attention and gave more pleasure than rarer objects which were not understood. Among the objects suitable

* Zeitschr. wiss. Mikrosk., xxii. (1905) pp. 177–8.
† English Mechanic, lxxxii. (1905) pp. 272–3.

for popular exhibition, nothing could be more beautiful, when properly displayed, than the very common "moulds," which were universally familiar, and, indeed, only too often more familiar than welcome. But there was considerable difficulty in mounting them, or even in preparing them for exhibition as temporary mounts for transmitted light. This was due partly to the fact that the spores were very readily shed, and the whole plant disorganised, in the dry air of a room, and partly to the difficulty of getting water to penetrate effectually among the hyphæ. Some years ago a friend had sent him a bottle of fluid and some specimens of micro-algæ preserved in dilute spirit, with the directions, "Wash out the spirit and mount in the fluid." The result was very satisfactory, staining and permanent preservation being effected at the same time, with only one medium. The method was found to answer equally well with fungi, the only difficulty lying in the preliminary process. The fluid consisted of glycerin to which an alcoholic solution of Hoffman's blue was added in sufficient quantity to obtain the desired tint. It was essential that the blue should be of the best quality if permanent results were wanted. Methylen-blue could be used as a substitute, but the colour faded quickly.

The method of mounting was as follows:—A drop of alcohol of strength 80 p.c. to 90 p.c. was placed upon a glass slip. A small portion of the fungus was placed with as little disturbance as possible in the alcohol, which at once penetrated the fungus. The alcohol quickly evaporated and another drop was then placed on the object, which was left to soak in it for about a quarter of an hour. Then a drop or two more of dilute spirit, say 25 p.c. strength, was added. When this had penetrated the specimen, the slide was left undisturbed for several hours, care being taken to insure that the fluid did not evaporate altogether. By these processes the initial difficulty of the resistance to wetting was overcome, and at the same time the tissues were fixed and hardened. After some hours (or sooner if convenient) the spirit was washed out with distilled water. This was done on the slide with a camel-hair brush, with which some of the superfluous spores were at the same time removed. While the object was still wet a drop of the coloured glycerin (diluted if the object is a delicate one) was placed on the fungus and allowed to soak in thoroughly. It was a good plan at this stage to put the slip away in the cabinet for a time. Finally, the specimen was arranged under a Microscope, the diluted glycerin withdrawn with a brush, and a drop of glycerin of full strength substituted. The cover-glass was then placed in position and cemented down. Unless the object was thick no cell was required. The algæ could be treated in the same manner, but were much easier to deal with, as they did not require such delicate manipulation in the early stages.

Apparatus for Staining simultaneously Numerous Sections.*—The apparatus devised by L. Neumayer consists of two hoops, *a* and *b*, united by cross-pieces *e*, *e* (fig. 182). The hoops, which are 2·9 cm. high, are 7·9 cm. apart, a distance which easily admits the insertion of the ordinary slide. Upon the cross-pieces rest the two rings *d* and *e*,

* Zeitschr. wiss. Mikrosk., xxii. (1905) pp. 181–5 (1 fig.).

which serve to support the slides. On the inside of *a* are 80 filiets 1·8 cm. high, the space between adjacent pairs being about 0·4 cm. The inner hoop *b* has eight fillets, which are about 2 cm. apart. At the intersection of the cross-pieces is inserted a T-shaped piece, which serves, through the mediation of a hook, for removing the frame from the solutions. The frame is made of cast iron, covered with white enamel, and, when filled with slides, weighs about 400 grm.

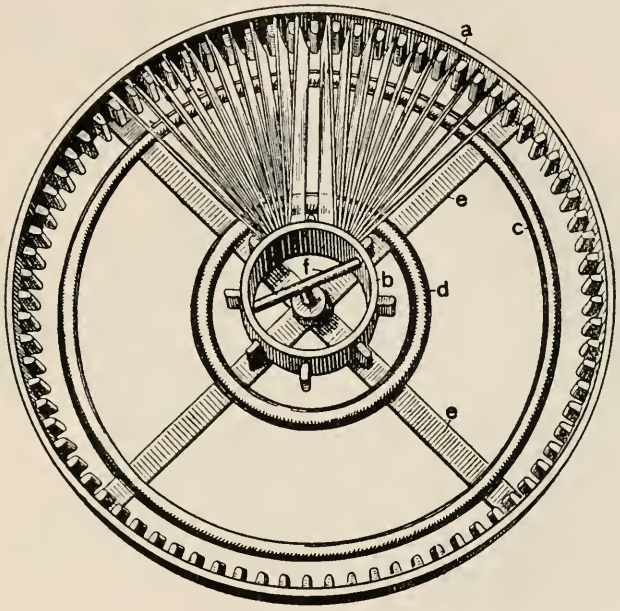

Fig. 182.

Demonstrating the Neurofibrils in Ganglion Cells.*—A. Gemelli places pieces 1 cm. square in a mixture of 3 p.c. bichromate of potash and 1 p.c. osmic acid, in the proportion of 1 : 8 ; a few drops of sulphocyanide of potash are added, and after an immersion of about half-an-hour the pieces are transferred to the customary osmic-bichromate solution. In from 48–72 hours the pieces are passed into the nitrate of silver solution. Sections were made by the celloidin method.

Apparatus for the Simultaneous Staining of Several Sections fixed to Cover-slips or Slides.†—K. Melissinos has devised this apparatus (fig. 183). It consists of a square box K, 80 mm. long, 45 mm. broad and high ; on the inner wall of one side is a plate A, provided with grooves, which is held fast by a small knob *kn*. The

* Anat. Anzeig., xxvii. (1905) pp. 449–62 (6 figs.).
† Zeitschr. wiss. Mikrosk., xxii. (1905) p. 130.

plate A has twenty grooves R, to receive twenty slides and forty coverslips. Parallel to the plate A and inside the box is another plate B provided with the same number of same sized grooves ; by means of the long arm *a r*, this plate is connected with the screw *s*. If the screw is turned the plate B can be brought nearer or farther away from the fixed plate A. One of the grooved plates carries at its lower margin and on the inner surface a fine thread which projects 5 mm. over the surface, and so serves to prevent the plate from falling down into the deposit of stain at the bottom of the vessel. The movable plate B has at either side two notches, to facilitate the circulation of the staining solution, washing fluid, etc. Various sized and shaped glasses can be placed

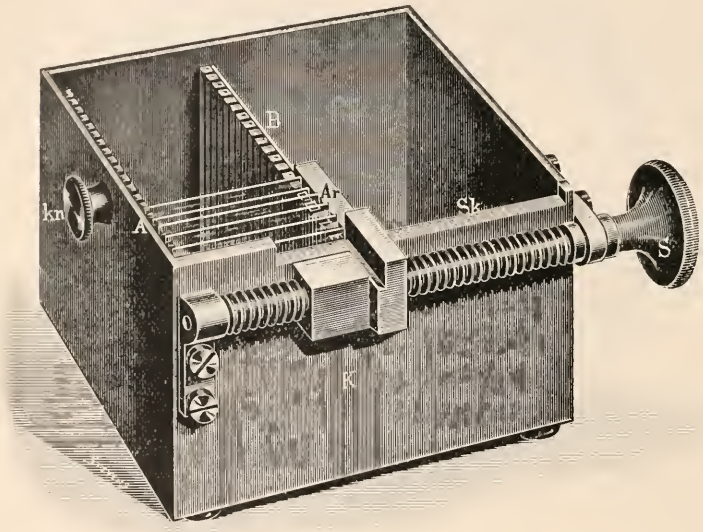

Fig. 183.

upright in the box ; the size of the slide for which it is to be adjusted being engraved on a scale *sk* in mm.

The advantages claimed for this apparatus are that it can be used for slides or coverslips ; that, by adjusting the screw, the slides and slips can be held fast in the grooves, and do not fall out when the various stain fluids are poured off ; and also with one apparatus a quantity of material fixed to slides can be treated in a short space of time.

Examination of the Retina of the Nautilus and certain Dibranchiate Cephalopods.*—H. Merton found that retinæ of these animals did not stain by the usual nuclear and plasma dyes ; with Delafield's hæmatoxylin he obtained only a diffuse staining, and with borax-carmine he had no result, but he was more fortunate with the stronger staining

* Zeitschr. wiss. Zool., lxxix. (1905) p. 326.

anilin dyes, such as toluidin blue and Unna's polychrome methylen-blue With toluidin blue he applied a mordant, using either ammonium molybdate, after Bethe, or antimonium tartrate (tartar emetic) according to Schuberg. With this method he could demonstrate the nerve fibrillæ; he used as a control stain the iron-hæmatoxylin method of M. Heidenhain, after which he stained with a 1 p.c. aqueous solution of acid fuchsin, and obtained a most useful appearance; also R. Heidenhain's stain with aqueous hæmatoxylin and a subsequent mordant of chromate of potash gave good results; he also obtained good preparations of very thin sections with the iron-hæmatoxylin method of Butschli —acetate, iron oxide, and aqueous hæmatoxylin. Sections of 3 μ or less were only obtained if the retina had been separated from the underlying thick layer of connective tissue before imbedding. To obtain thin sections of the retina in conjunction with the connective tissue he employed Mastix collodion after Heider.

To bleach the pigments he used a mixture of 85 parts of 96 p.c. alcohol and 15 parts of nitric acid, and a knife's-pointful of KCl or $KClO_3$, care being taken that the object does not remain for long in contact with the KCl or $KClO_3$, lest the tissue be destroyed.

For fixing the eyes of the Dibranchiates he found Zenker's mixture was especially good. For staining he used Heidenhain's iron-hæmatoxylin combined with acid fuchsin or orange; and besides these he used Blockmann's fluid that stains the nerve fibres pale yellow, the other constituents staining blue, and he obtained excellent results by combining this reagent with borax-carmine, osmium, and wood-vinegar.

Theory of Vital Staining.*—V. Růžička, as the result of extended research, has elicited a difference in the staining relations of living and dead protoplasm, living protoplasm staining red, dead protoplasm staining blue, when treated with an equimolecular mixture of neutral red and methylen-blue. The method consists of mixing equal parts of 0·05 p.c. solution of neutral red and methylen-blue in distilled water; some of the mixture is dropped on a clean slide and allowed to evaporate at 35° C. in the incubator; on to the dried layer of stain is brought the object in the same isotonic medium, which serves equally as a solvent for the stain mixture. In seeking to explain his results the author considers that living substances exist in a more or less fluid condition, and consist of two layers of different densities, an outer denser and an inner more fluid; and he conceives that when such a cell is surrounded by fluid its outer layer would behave, in respect to the separate fluids, as a membrane; and, assuming that the staining process proceeds according to the laws of simple diffusion, and will continue until the concentration of the fluids on either side of the membrane are equal, a mixed violet tone would result. But as this does not occur, he concludes that his results do not admit of a simple physical explanation. The author suggests two other explanations: either the methylen-blue cannot penetrate into the living cell because the outer cell layer opposes an insuperable barrier to its molecules (but this is not tenable, for living cells can be stained well by methylen-blue); or it is possible that

* Zeitschr. wiss. Mikrosk., xxii. (1905) p. 91.

both stains penetrate the cell, but that one undergoes changes according as the cell is alive or dead, so that only one stain is represented. The author gives as an example the central nucleus that stains blue in an otherwise only red-stained cell, and to the blue-stained bacteria contained in the nutrient vacuole of a red-stained amœba, and concludes that both the red and the blue stain are to be found in the stained object, and points out that the simultaneous presence of both stains in the cell would be demonstrated by the addition of hydrogen peroxide, a mixed violet stain resulting. The author concludes that with the use of his mixed stain, the methylen-blue is present in the living cell, and that the neutral red is present in the dead cell, but by the chemical influence of the protoplasm they are rendered invisible. And further, that the neutral red staining of the living cell is a chemical process, whilst the methylen-blue staining of a living cell is a vital phenomenon, but has a physical basis.

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

Method for Mounting Celloidin Sections.*—D. Cristina proposes the following method. The sections, being cut and stained, are transferred to alcohol at 94° for a short time; from this reagent they are taken by means of strips of blotting paper and transferred to specially prepared glass slides: these have been spread with glycerinated albumen (egg albumen 5 parts, neutral glycerin 1 part); the paper strip with the sections attached is laid, section side down, on the prepared surface of the slide, other dry strips being laid over it and gentle pressure made with the finger. The sections remain firmly fixed.

Method of Staining and Permanently Preserving Urinary Sediment.†—P. Fiorentini and M. Signer stain the deposit obtained by centrifuging or by sedimentation with the Ehrlich triacid mixture, and then treat the material with glycerin slightly acidulated. Treated in this way permanent and contrast-stained preparations of urinary deposit are easily obtained. The authors are vague as to time and acidity.

(6) Miscellaneous.

Keeping Polyzoa.‡—F. St. John Parker hit upon the idea of taking only a few small colonies and dividing these among several aquaria, thus allowing the groups ample room. He found this plan answered perfectly, and he writes:—"I can keep Polyzoa in captivity for very much longer periods than I found possible before adopting my present plan. Last September I found some specimens of *Fredericella sultana*, some of which were alive in March this year, when an accident unfortunately destroyed them. I have at present a number of small, but flourishing, colonies of both *Fredericella* and *Plumatella repens* in the small square glass tanks which can be bought at Beck's for about 8*s*. each. Small groups of about half-a-dozen or so individuals are all that are needed for the Microscope to make a really fine display, under dark-ground

* Zeitschr. wiss. Mikrosk., xxii. (1904) p. 99.
† Tom. cit., pp. 187–9 (1 pl.).
‡ English Mechanic, lxxxii (1905) p. 187.

illumination. Another advantage of my plan is, the larger colonies are left behind in their natural habitats, and the danger of extermination is reduced to a minimum. My method, as detailed above, I have found equally successful for *Plumatella*, *Lophopus*, *Alcyonella*, *Fredericella*, *Cristatella*, etc. Of course, in the case of such voracious creatures, ample food must be supplied, and, from my own extended observations, I conclude that this is largely vegetable. Where practicable, I invariably keep the specimens supplied with water from the original habitat; but when that could not be done, I have found tap-water, with the addition of some clear river-water, to answer very well. Experiments with tap-water alone have not been so successful."

Metallography, etc.

Etching of High Carbon Steel.*—E. H. Saniter having failed to obtain good etching of high carbon steels, especially in the tempered condition, with iodine, 2 p.c. nitric acid or picric acid, tried Sauveur's method of dipping in strong nitric acid (sp. gr. 1·42) and washing at the tap. This gave better results, but several treatments were required to obtain the desired etching. He then tried dipping the specimen in absolute alcohol, followed by strong nitric acid and washing at the tap. This gave a good etching with only one treatment. The specimen should be held in a pair of forceps and moved about rapidly in the acid. Fresh acid must be used for each etching.

Metallography of Iron and Steel.†—R. A. Hadfield, in his Presidential Address to the Iron and Steel Institute, regrets the tendency to multiply the names of micro-constituents, and suggests the terms "martensitic structure," "sorbitic structure," as being less liable to misconstruction than the terms "martensite," "sorbite." The marked differences of opinion as to the meaning of the currently accepted designations of the constituents of steel should lead to caution in their use. The address deals with a very wide range of topics connected with the metallurgy of iron and steel.

Experiments relating to the Effect on Mechanical and other Properties of Iron and its Alloys produced by Liquid Air Temperatures.‡—R. A. Hadfield, after giving a résumé of previous investigations into the properties of metals at low temperatures, describes his methods of mechanically testing at the temperature of liquid air, and gives the results of mechanical and electrical tests, some 1600 in number, carried out on an extensive series of alloys. At −182° C., commercially pure iron, which is highly ductile at the ordinary temperature, becomes brittle and has a much greater tensile strength. Great increase in tenacity and decrease in ductility also result when carbon steels (0·1 p.c. to 1·5 p.c. carbon) are cooled to −182° C. Brinell hardness tests confirm these conclusions. Nickel on the contrary improves both in tenacity

* Iron and Steel Mag., x. (1905) p. 156.
† Journ. Iron and Steel Inst., lxvii. (1905) pp. 85–7.
‡ Tom. cit., pp. 147–219 (14 figs., 37 diagrams); Discussion, pp. 220–55.

and ductility when submitted to liquid air temperatures, and the effect of nickel upon iron when alloyed with it is to diminish the tendency of the latter metal to become brittle at low temperatures. Microscopic examination of etched specimens at −182° C. did not give any indications of changes in micro-structure caused by the low temperature. An excellent feature of the paper is the comprehensive bibliography appended.

In the discussion on this paper W. F. Barrett gave details of the singular electric, magnetic, and thermo-electric properties of Hadfield's iron-manganese-nickel alloy. H. le Chatelier and L. Dumas advanced hypotheses explaining the great differences in the effect of low temperatures on different iron alloys. F. Osmond disputed Hadfield's conclusions as to the allotropic theory.

The Types of Structure and the Critical Ranges on Heating and Cooling of High Speed Tool Steels under Varying Thermal Treatment.*—H. C. H. Carpenter has obtained cooling and heating curves of 16 specimens of steel, containing one, two, or three of the alloy metals chromium, tungsten, and molybdenum in varying percentages. The carbon varied from 0·25 p.c. to 1·31 p.c. For iron-chromium-carbon alloys the author concludes that (1) the initial temperature from which the metal is cooled is almost without influence on the position of the critical point, and (2) increase of chromium tends to raise the critical point. He also considers that, contrary to the widely accepted belief, the presence of chromium hastens instead of retarding the transformation of hardening carbon into annealing carbon during cooling. The action of tungsten and molybdenum in high-speed steels is to hinder or prevent the changes which result in a softening of the alloy, and to impart a high resistance to tempering. The steels examined, when cooled from temperatures not higher than 900° C., pass through a critical change at about 700° C. If the initial temperature is raised, the same rate of cooling being maintained, the critical change is usually split into two or more parts and spread over a range of temperature from 700° to 300° or 400° C., or even lower. Molybdenum is more active than tungsten in promoting this split. When suitably treated, the alloys useful as high-speed steels have a polyhedral or "austenitic" structure.

Heat Treatment and Fatigue of Steel.†—F. Rogers has carried out a large number of mechanical tests (tensile and fatigue) on samples of three steels containing respectively 0·14 p.c., 0·27 p.c., and 0·32 p.c. carbon, heat treated in different ways. The alternating stress machine was of the Wöhler type, the fatigue tests carried out on it exhibited great irregularities. The author concludes that overheating lowers the elastic limit greatly, while increasing Young's modulus, these two effects both tending to reduce the resilience of the steel enormously. Steel fatigued beyond a certain limit cannot be restored by heat treatment alone. Microscopic examination of polished and strained specimens demonstrated that fatigue cracks tend to select a path through ferrite.

The Elastic Properties of Steel at High Temperatures.‡—B. Hopkinson and F. Rogers have found that with rise of temperature, up

* Journ. Iron and Steel Inst., lxvii. (1905) pp. 433–73 (14 pls.).
† Tom. cit., pp. 486–94.
‡ Proc. Roy. Soc., Ser. A, No. 76 (1905) pp. 419–25 (3 figs.).

to 800° C., the stress strain relations in steel undergo a change, the "time effect" or "creeping" becoming much greater. A test piece 4 in. long, about 0·2 in. diameter, with enlarged ends screwed into steel bars $1\frac{1}{8}$ in. diameter, was heated in a vertical electrical resistance tube furnace. Tension up to $1\frac{1}{2}$ tons per square inch could be rapidly applied. At temperatures of 600°–800° C., the effect of applying the stress was to produce an immediate extension followed by a slow drawing out. On removal of load an immediate shortening occurred, followed by a slow contraction. Young's modulus was found to decrease considerably with rise of temperature.

Metallography Applied to Foundry Practice.*—A. Sauveur describes the microscopical outfit adapted for the examination of cast-iron specimens. Vertical illumination is more generally useful than oblique, which gives a negative image.

Special Steels.†—L. Guillet summarises the results of his well known investigations on alloy steels. He deals chiefly with ternary steels (containing iron, carbon, and a third element), some quaternary steels being also considered. The author is convinced that vanadium steel, containing less than 0·7 p.c. of that element, is likely to increase largely. Titanium steels and cobalt steels are devoid of any practical interest. While the micrographic character of pearlite steels furnishes only very partial indications of their mechanical properties, it may be at once concluded from the martensitic structure of a steel that it has a high tensile strength and elastic limit. A polyhedral steel has a low elastic limit, high elongation, great resistance to shock, and a hardness depending on the alloy element. Graphite steels are useless for practical purposes, the presence of this constituent causing fragility.

Induction Galvanometer for the Study of Freezing and Critical Points.‡—Dejean describes a modified Desprez-d'Arsonval galvanometer, in which the moving frame carries two distinct coils. One of these is connected to a thermo-electric couple inserted in the specimen under observation. Variations of temperature cause rotation of the two coils, thus inducing in the second coil a current which is measured by another sensitive galvanometer. The induced current is proportional to the velocity of rotation of the coils, and therefore depends upon the rate of heating or cooling of the specimen. A method of automatic recording is described, and critical point curves of a number of samples of steel are given.

The Crystallisation of Iron and Steel.§—In this introduction to the study of metallography, a course of six lectures by J. W. Mellor, the subject is dealt with in an elementary manner, controversial matter being touched upon very briefly. Starting with the general phenomena of crystallisation, allotropy, and entexia, the author considers the modes of solidification and subsequent cooling of solutions, taking particular instances of alloys as examples. The formation of the various constituents of iron-carbon alloys by the cooling, slow or rapid, of a homogeneous

* Iron and Steel Mag., x. (1905) pp. 309–13.
† Tom. cit., pp. 314–21 (3 figs.). ‡ Rev. Met., ii. (1905) pp. 701–4 (4 figs.).
§ London: Longmans, Green, and Co., 1905, x. and 144 pp., 65 figs.

liquid solution of carbon in iron, is clearly explained. The law of mass actions and the influence of passive resistance in opposing the change of an unstable condition to one of stability, are fully considered in their great effect upon the final constitution of steel subjected to thermal treatment. The author supplies a real want by a brief statement, intelligible to the student commencing the subject, of the phase doctrine as applied to the study of alloys. The influence of the crystalline structure of iron and steel upon their behaviour when subjected to stress is dealt with on the lines developed by Stead, Ewing, Rosenhain, and others. The slip band theory of the plastic deformation of steel is adopted. Possibly too much importance is attached to intracrystalline weakness in steel, the results obtained by recent workers tending to show that intracrystalline weakness is more serious, and that fracture, in structural iron and steel, usually proceeds through the crystals along cleavage planes. The chapter devoted to the preparation and examination of microscopical specimens gives the approved methods of polishing, etching, mounting, etc. A useful feature is the appended glossary, which closely follows that drawn up by a committee of the Iron and Steel Institute. Throughout the work the standpoint taken is that of the allotropists, though the subcarbide theory of Arnold is stated as an alternative explanation of the hardness of quenched steel. The book may be recommended as a lucid outline of the metallography of iron and steel as this somewhat complex subject stands at the present time.

Beilby, E. T., & H. N.—**The Influence of Phase Changes on the Tenacity of Ductile Metals at the Ordinary Temperature and at the Boiling Point of Liquid Air.**
Proc. Roy. Soc., Ser. A, No. 76 (1905) pp. 462–8 (4 figs.).

Delville, P.—**The Influence of Titanium on Pig Iron and Steel.**
[A résumé of the available information on the subject.]
Iron and Steel Mag. (1905) pp. 230–4.

Dillner, Gunnar, & Eustrom, A. F.—**Magnetic and Electric Properties of Various Kinds of Sheet Steel and Steel Castings.**
Journ. Iron and Steel Inst., lxvii. (1905) pp. 474–80.

Gardner, J. C.—**Effects caused by the Reversal of Stresses in Steel.**
Tom. cit., pp. 481–3.

Houghton, S. A.—**Note on the Failure of an Iron Plate through "fatigue."**
Tom. cit. pp. 383–9 (2 figs.); Discussion, pp. 390–4.

Lecarme, J.—**Cementation of Steel.**
[A reply to H. le Chatelier's criticism of the author's former paper on the subject—see J.R.M.S., 1905, p. 669. It is pointed out that much of the experimental proof of the author's statements was omitted from the article referred to, with the object of condensing it.]
Rev. Met., ii. (1905) pp. 720–1.

Rogers, F.—**Troostite.**
[The author combats Boynton's view of troostite as β iron, and gives evidence to show that it contains carbon.]
Journ. Iron and Steel Inst., lxvii. (1905) pp. 484–6.