Journal of the
Royal Microscopical Society

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS

AND

A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia)

MICROSCOPY, &c.

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

FOR THE YEAR

1910

TO BE OBTAINED AT THE SOCIETY'S ROOMS,
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III.—*An Automatic Aerating Apparatus, suitable for Aquaria, etc.*

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

(*Read December* 15, 1909.)

The Aerator (fig. 1) to be described costs little and is reliable, besides having other advantages which are referred to later. The essential features of the apparatus are: (1) a constant inflow of water into a closed vessel forces the contained air under pressure through the aerating nozzles; (2) the vessel is emptied automatically at regular intervals by siphon action, air being allowed to replace the water siphoned off. During this period, which is relatively short, there is a pause in the output of air.

Explanation of the lettering on the Sketch.

A. Constant inflow of water under 8 feet or more of water pressure. The inflow must be sufficient to insure the advent, at the proper time, of siphon action. If too scanty the water will simply trickle over the summit of the siphon tube. But the inflow should not be so great as to compete effectively with the emptying action of the siphon. In practice the proper rate can be got in a few minutes by manipulating the water-tap, but most water-taps require readjustment for the first few days.

B. A small vessel (the water valve vessel) suspended within the large vessel C. B is kept full by the inflow and it overflows into C. The end of the tube F just dips into the water within B.

C. A large glass bottle (e.g. of $\frac{3}{4}$ gallon size) with moderately wide mouth closed by a rubber bung with perforations for the tubes A, D, E and F. The bung must be quite air-tight, and it should be fixed securely in the neck of the bottle so that it may not be driven out when the pressure rises within the bottle. The constant inflow of water tends to fill the bottle, driving the contained air up the aerating tube D. Sooner or later the bottle C is emptied by the siphon E, and then the filling up process starts anew.

D. Aerating tube of $\frac{7}{16}$ in. internal measurement. The lower end just pierces the rubber bung and is bevelled, while the upper end reaches above the summit of the siphon. From the upper end a small indiarubber tube (K in the sketch) leads to the aerating nozzles, the number of which may be multiplied indefinitely by

means of Y tubes or other simple device. The height of D is greater than that of the siphon in order to insure that under no circumstances will water find its way into the rubber tubing. The width of D and the bevelling of its lower end insure that any

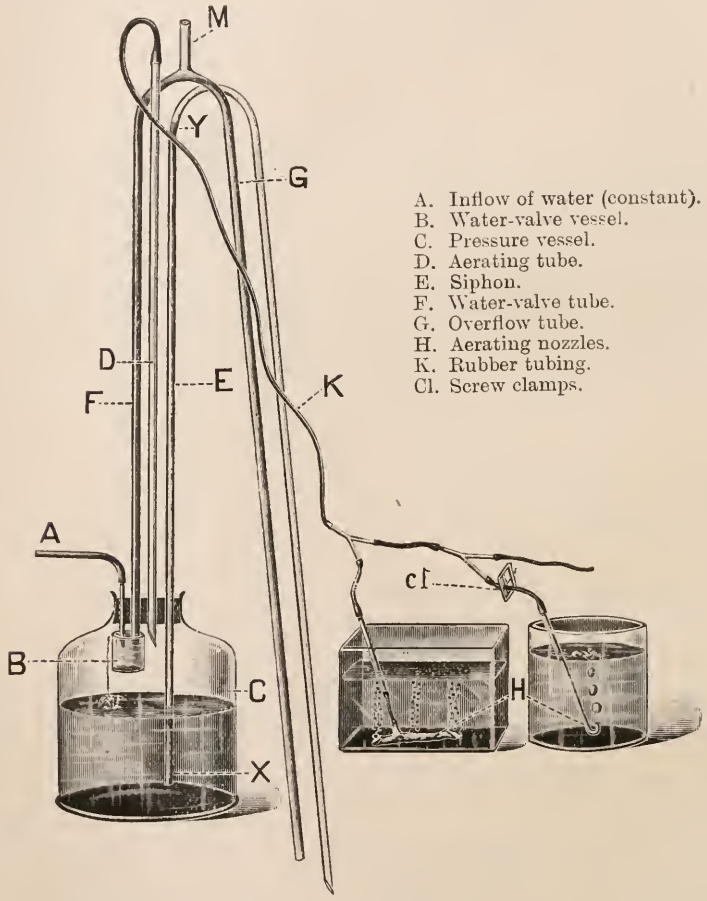


Fig. 1.

water which may have got into it will readily fall back into the vessel C when this vessel is being emptied by the siphon.

E. Siphon. One end passes through the bung almost to the bottom of the vessel C, while the other end goes to an outlet and reaches not less than $1\frac{1}{2}$ to 2 ft. below the level of the first. The

siphon, as well as the tubes F and G, is of ordinary glass, $\frac{3}{8}$ in. internal measurement. A good all-round working height is 7 or $7\frac{1}{2}$ ft. from X to Y. This gives pressure enough to aerate with finely divided air bubbles, but the higher the siphon the better will be the pressure and the finer the streams of bubbles that can be produced. On the other hand, a total height of about $2\frac{1}{2}$ ft. is all that is required for the output of ordinary bubbles and for their distribution over different aquaria the depth of which does not exceed a foot or so. (See also commencement of paragraph under G.)

F. Water valve tube. This is open above at M, and passes into an overflow tube G, the bend being an inch or two above the top of the siphon. The primary purpose of the tube F is to allow the periodic entrance of air into C during the time when the emptying of this chamber by the siphon takes place. Any water which may be in F flows back into C and is followed by air, which bubbles up freely from the lower end of this tube. On the other hand, air is not allowed to escape by F when C is filling up again and the aerating nozzles are working under full pressure. What happens is, that water rises in F, as it does also in the ascending limb of the siphon. The height of the water in the former exceeds that in the latter by exactly the difference of the water levels in B and C. The rise is rapid till overflow from F into G occurs. This does not set up siphon action, because air enters freely at M. But as C fills up, the water level in the siphon creeps higher and higher till its summit is overpassed and siphoning begins. Pressure inside C then becomes negative; the water in F flows back into C, and is followed by air entering at M.

G. Overflow tube, described above. This is hardly required for an apparatus designed only for ordinary bubbles under low pressure. See end of paragraph under E. (Although it is not shown in the sketch, I have lately been using the surplus water which overflows by G, in my apparatus at Glasgow University, to provide a supply of air under low pressure. This is done on the principle of the Sprengel pump, with the help of the Naples Station device, viz. a circular bend in the upper part of the tube.)

H. Aerating nozzles. For ordinary bubbles a bit of glass tubing, slightly turned at the end, will serve. The amount of air which is allowed to escape by such a nozzle has to be regulated, and this can be done with perfect precision by means of a screw clamp on the rubber tubing. Sufficient resistance can thus be applied to insure that the internal pressure will be strong enough to force air also through the kind of nozzles that are required for the production of fine streams of bubbles. For these a dried and partly decayed branch of some suitable wood forms a simple outlet. Attach a rubber tube to a side branch and make some notches along the main one. From each of these notches as well as from

the cut ends, streams of bubbles will emerge when the apparatus is working. A bit of dried hawthorn as thick as one's little finger, which has been dead and exposed to the weather for a year or more, gives an extremely fine division of the air. But most purposes will be served quite well by woods with coarser vessels. Insufficient previous weathering is apt to give trouble through swelling taking place after immersion. An air valve may with advantage be set in the main stem of the rubber tubing in order to obviate all tendency to reflux, or better still, a valved extensible air reservoir with suitable recoil may be interposed, thus eliminating altogether intermittence of aeration. It goes without saying, also, that special arrangements may be added, such as those which Browne * has so successfully devised for the growth of hydroids.

To sum up, the influx of water through A is constant, and the sequence of events is as follows:—Rise of pressure in C; rise of water in E and F; forcing of air through the aerating nozzles; overflow of surplus water through G; filling up of C; commencement of siphon action; flowing back of water from F into C; entrance of air into C; emptying of water into C; cessation of siphon action; recommencement of rise of pressure in C.

The apparatus can be fitted up wherever there is a constant water supply fresh or salt, under even a slight degree of pressure. It works quite automatically, and after being properly adjusted requires no attention except in arranging the nozzles from time to time to suit new aquaria, or the varying requirements of aquaria already established. No active damage can be done to the aquaria even though the siphon action from any cause (e.g. leakage or slackening of inflow) should temporarily cease.

The air used is freed from most of its soluble and suspended impurities through entering by the long wet tube F, bubbling up through the water in B, and remaining for a time within C, into which there is a constant inflow of water. By way of further precaution, the air entering at M may be filtered through cotton wool. Thus the atmosphere even of a city laboratory, may be rendered practically harmless.

The intervals of pause and of active aeration can be varied within wide limits, as also can the periodic time of both. Or the whole apparatus can be stopped and re-started after a time (e.g. to imitate tidal conditions) by turning the water-tap.

A single aerator on the scale indicated above will provide continuous and efficient aeration for as many as thirty small aquaria. Increase in the sizes of the parts gives an increased supply of air, while by heightening the various tubes the internal pressure can be brought up almost to the limit of pressure of the water supply.

* Journ. Marine Biol. Assoc. United Kingdom, n.s. viii. No. 1, pp. 37–43.

The aerator has been fully tested in the Embryology Laboratory at Glasgow University during the eight months that have elapsed since the author first employed it there in its present form. A similar instrument fitted up by him at the Millport Marine Station in the beginning of September last has also worked with regularity. It was at the latter Institution, several years ago, that his first experiments directed towards designing such an aerator were made.

NOTE.

Convenient Form of Stand for Use as a Micro-Colorimeter and with the Micro-Spectroscope.

By Marshall D. Ewell, M.D., F.R.M.S.

The apparatus shown in fig. 2 was constructed for use with Lovibond's standard coloured glass slides, or with the micro-spectroscope. It will be seen that the apparatus consists of two objectives carried by tubes screwed into a prism-box. The 12 mm.

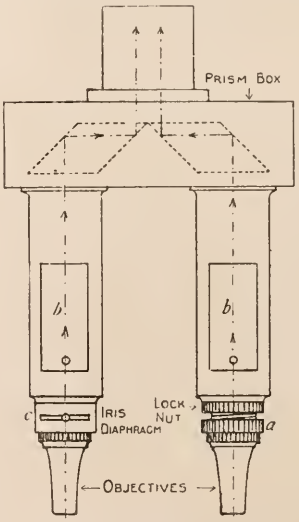


Fig. 2.

Spencer objectives are matched, and in order to absolutely secure equality of working distance, one of them (the right-hand one) is fitted with an adapter with the Society's thread, male at the upper end, and female at the lower. When the matching has been satisfactorily attained a lock-nut clamps the objective, and the two par-focal objectives can then be simultaneously focused by the ordinary slow motion. The Lovibond tinted glasses are inserted

in the openings *b*, *b*, closed by tubes sliding within the larger Microscope tubes. In order to regulate the intensity of the light, an iris diaphragm is interposed in the left-hand tube at *c*. The prism-box contains a pair of reflecting rhombs, and the course of the rays is shown by the dotted lines. Thus the effect is to

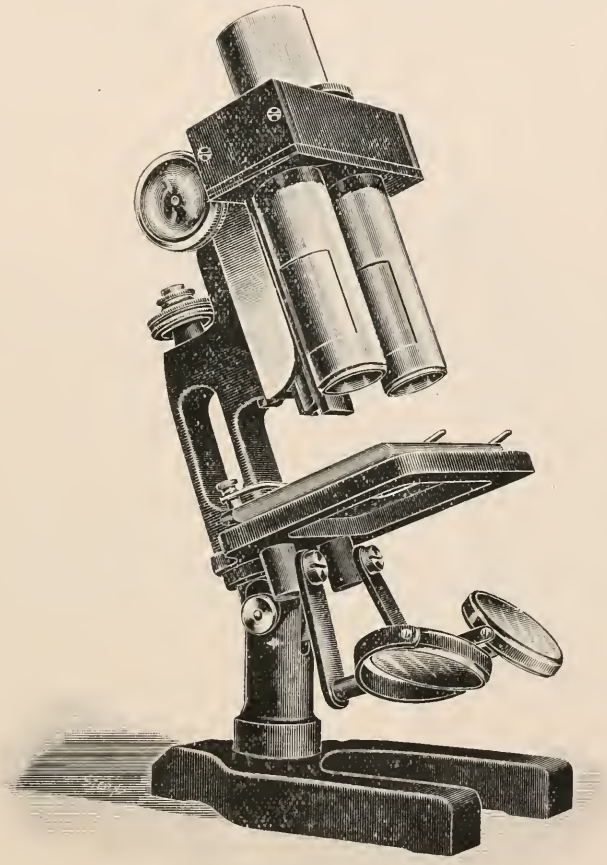


Fig. 3.

appose two images which readily lend themselves to comparison. Fig. 3 shows the apparatus fitted to a Spencer Lens Co.'s stand. With the exception of the stand, the residue of the outfit was made by Dr. Ewell in his amateur shop.

The general idea recalls Inostranzeff's comparison chamber or

microscopic comparer,* in which a prism chamber (see fig. 3) consisted of a horizontal tube with two vertical arms. These arms fitted into the tubes of two Microscopes, and the horizontal chamber contained four prisms. Two images, conveniently apposed for comparison, appeared in the eye-piece chamber. This idea was somewhat improved upon by van Heurck.†

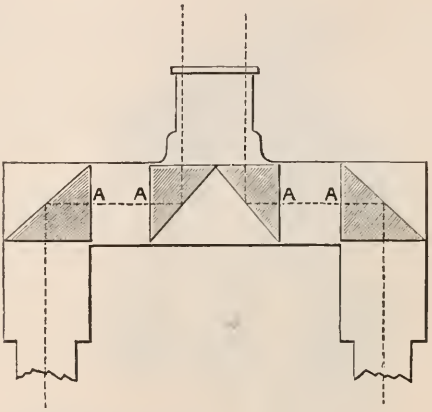


Fig. 4.

It will be noticed that Dr. Ewell's design, which has been independently evolved, is an advance in several respects. It requires only one Microscope ; it secures par-focality of objectives, and, owing to the use of only two prisms, the loss of light at A, A (fig. 4) is avoided.

* See this Journal, 1886, p. 507.

† Op. cit., 1887, p. 463.

MICROSCOPY.

A. Instruments, Accessories, etc.*

(1) Stands.

Zeiss' Microscope for Investigating Ultra-microscopical Particles.† This instrument is clamped to the foot-plate or board on which the rest

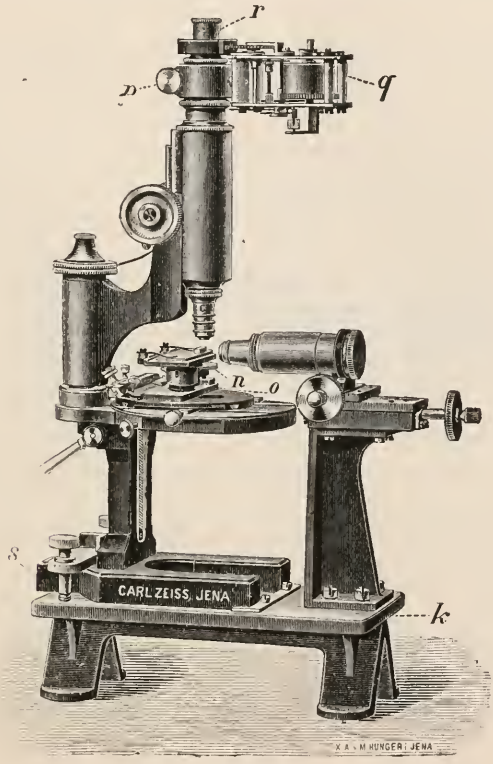


Fig. 5.

of the apparatus for demonstrating ultra-microscopic particles are placed. The microscope has a large mechanical stage and a special object-stage *o*, which can be elevated. It is provided at the back with a beading for

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

† Zeiss' Catalogue, Ultra-microscopy and Dark-ground Illumination, 3rd ed., 1907, pp. 15–19, fig. 11.

sliding into the groove of the large mechanical stage after the springs have been withdrawn. The object-stage can be elevated by means of the screw n_1; it terminates at the top in a plate, on which the specimen to be examined is placed. The Microscope, as shown in the illustration (fig. 5), is fitted with dissecting-stage and rotating-analyser on the sole-plate with cross slides.

Some of the accessory apparatus used with this Microscope have been described already.*

ELEIZEGUI, A.—**Un nuevo modelo de microscopio para la enseñanza** (1 fig.). *Bol. de la R. Soc. española de Hist. Nat.*, viii. (1908) pp. 442–4.

(3) Illuminating and other Apparatus.

Beck-Gordon Speculum Lamp.†—This lamp (fig. 6) is made for use with the incandescent electric light or the incandescent pendent gas mantle. The lamp depends for its action on a polished glass cylinder

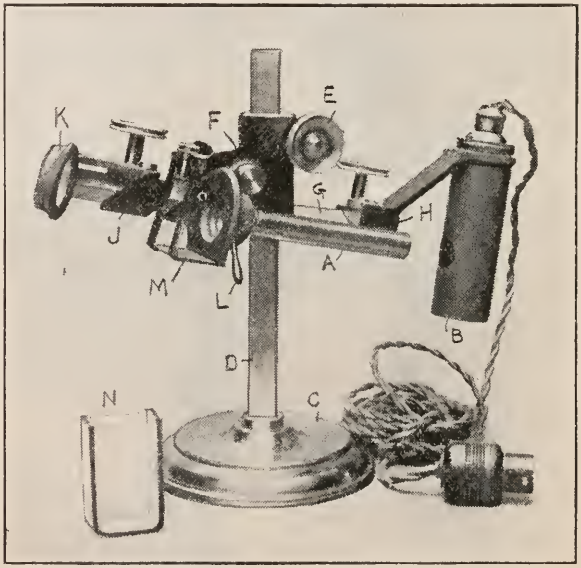


FIG. 6.

A several inches long, into one end of which light from the lamp B enters. The light so entering is totally reflected along the sides of the cylinder in such a manner that when it leaves the other end it emerges in all directions not exceeding a moderate angle, so that this end becomes a radiant surface, and behaves as if it were a practically homogeneous disk source of light. In order to secure the best "critical" illumination with powers this surface is focused on to the object instead of the actual

* See this Journal, 1907, p. 615, and 1906, p. 369.
† Special Catalogue, 1909, R. and J. Beck, Ltd.

illuminant by the substage condenser. The instrument consists of a heavy stand C with an upright rod D, up and down which the lamp can be moved with a rack-and-pinion E. The glass rod A is fixed to a block F, which can be pivoted at an angle so that the light may be directed either up or down, rendering the lamp useful for every kind of illumination for either high or low powers. The block F carries a bar G which carries the fitting H of the electric light B, and also the fitting J of the bull's-eye K. The bar G can be moved and clamped in the block F, thus giving a rough adjustment for moving the lamp B, or the bull's-eye K, nearer to or further from the glass rod A. The lamp B and the bull's-eye K can also be both moved by rack-and-pinion motions along the bar G. The lamp B when placed close to the end of the glass rod A gives a very intense illumination, as a large proportion of light enters the glass rod; but as it is moved away by the rack-and-pinion the intensity of the light is reduced rapidly, varying according to the square of the distance of the lamp B from the end of the glass rod A. The condenser K can be swung out of the way when not required, and can be focused by means of the rack-and-pinion so as to give parallel light or to focus the light to a small area for the illumination of opaque objects. In front of the illuminated disk end of the glass rod an iris-diaphragm moved by a lever L is placed, which enables the illuminated disk to be reduced in size, and which forms when closed down the best object by which to focus the disk upon the microscopic object with the substage condenser for producing critical illumination. In front of the iris-diaphragm is a stage M which carries a trough N for acetate of copper, or other monochromatic solution, and by means of clips, glass colour filters, patch stops, or other appliances, can be attached to this stage.

New Form of Polarimeter for the Measurement of the Refractive Index of Opaque Bodies.*—W. T. Barrett's instrument for the above purpose depends upon Brewster's well-known principle that the index of refraction of any substance is the tangent of the angle of maximum polarisation for that substance, and that, hence, when a ray of light incident on a transparent body is polarised by reflection, the refracted ray forms a right angle with the reflected ray. By means of Brewster's Law the indices of refraction of various opaque non-metallic reflecting surfaces have been obtained. As every different colour has a different index of refraction, the law shows that the polarising angle correspondingly varies with the different rays of the spectrum, being, for a given substance, smallest in the red and largest in the violet. In bodies of low dispersive power the angle of maximum polarisation is nearly the same for all colours, and white light can be used as the source. In other cases monochromatic light must be employed—either a sodium flame or suitably coloured glass in front of the source described below. The amount of light reflected from some opaque bodies is small, and hence the determination of the polarising angle is difficult, unless we can always keep the analyser placed in the reflected beam at the same angle as the ray incident on the opaque surface under examination. To secure this, the

* Sci. Proc. Roy. Dublin Soc., xii. (1909) pp. 98–901 (2 figs.).

author has devised the following instrument (fig. 7), whereby with a rack-work and simple link-motion, the collimator, which renders the

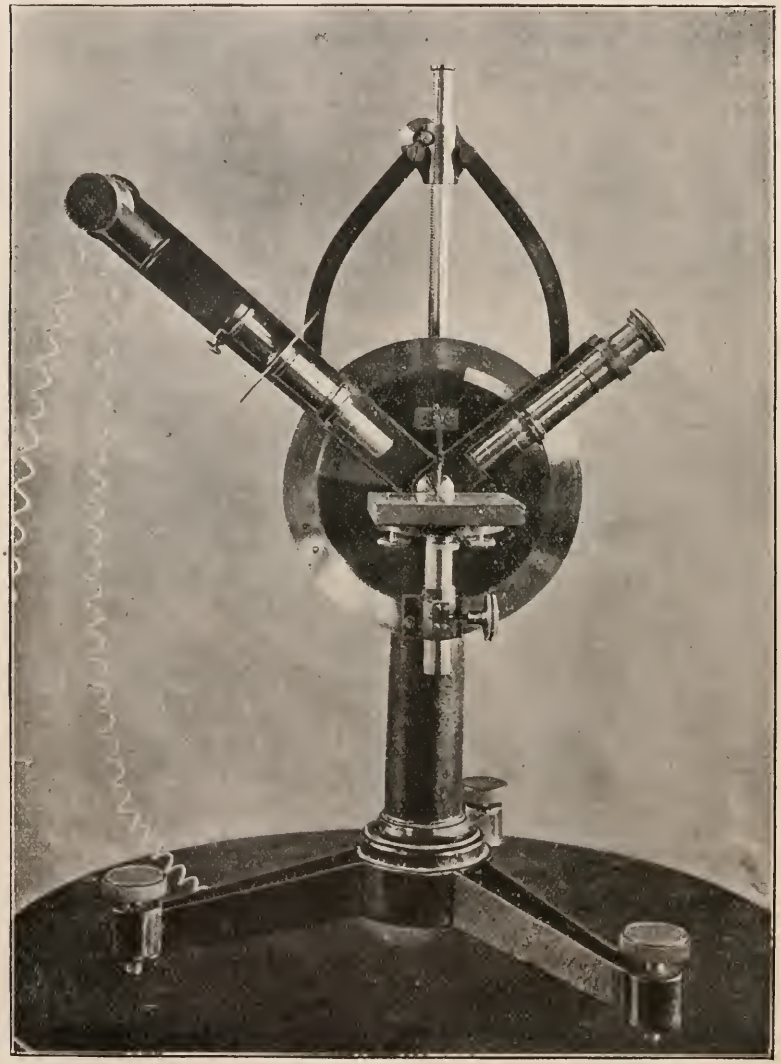


Fig. 7.

incident rays parallel, and the telescope, in which is placed the analysing Nicol's prism, are simultaneously moved through equal angles. The opaque body is placed on a movable table with levelling screws, which

are adjusted until the reflecting surface is level, and at the centre of the graduated circle round which travel the telescope and collimator. A small but brilliant source of light is employed, such as a Nernst or a 10-volt electric glow-lamp; a small lens throws a brilliant image of the light on to the adjustable slit of the collimator. This latter contains a lens in a draw-tube, so that a parallel beam falls on the opaque reflecting surface: and a sharp image of the slit is obtained by the lens in the telescope, which also contains a small Nicol's prism. Upon turning the rack-work handle the source of light and collimator move together, and through the same angle as the telescope. The observer now turns the polarising plane of the Nicol at right angles to the plane of the reflected

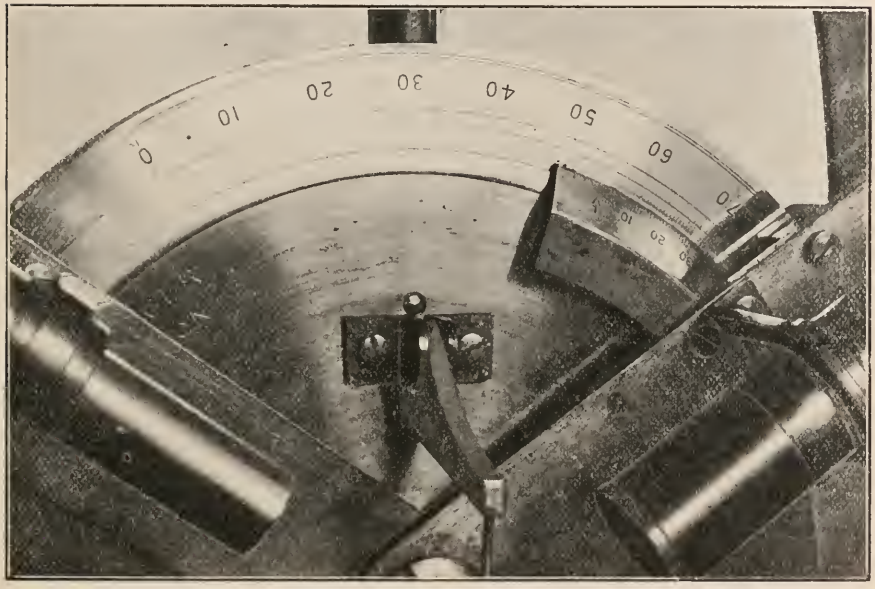


Fig. 8.

polarised ray, and watches the gradual extinction of the light as the polarising angle is approached. At the angle of maximum polarisation the light is extinguished (reappearing as the angle is passed), the clamping-screw is then turned, and, by means of the vernier, the angle is read off in degrees and minutes. As the polarising angle of nearly all substances lies between 48° and 68°, the circle need not be finely graduated for more than 20°. An enlarged view of scale and vernier is shown in fig. 8. It is, of course, essential that the light incident on the opaque surface be strictly parallel; and careful adjustment of the collimator must be made beforehand for this purpose. Provision is also made in the instrument for two other adjustments, namely (1) the coincidence of the axis of collimation and the zero of

the scale, and (2) of the reflecting surface to be tested with the centre of the graduated circle. This latter is accomplished by a small projecting arm with a platinum point.

Liquids are placed in a little glass capsule on the levelling table, which is adjusted until the platinum point, indicating the centre of the circle, just touches the liquid surface. Bodies having an irregular, granular, or crystalline surface, if fusible, are melted. This is accomplished by placing them in a small capsule of metal or porcelain, which is heated by a current of steam or an electric current traversing a platinum wire coiled round the capsule. In practice a difficulty occurs in determining the precise angle of maximum polarisation; for the extinction of the reflected ray seems to spread over a narrow region rather than to occur at a definite point. This error, however, can be lessened by careful attention to the parallelism of the incident rays and homogeneity and intensity of the light. The author employed a small direct vision-prism spectroscope in the collimator and obtained a sharp spectrum, using, of course, a very brilliant source of white light. In this way he hoped to obtain the angle of extinction for a definite colour and thus see a dark band pass across the spectrum, as the polarising angle for such colour was reached. In the case of bodies of very high dispersion, such as nitroso-dimethyl-aniline, the dark band is sharp and well-defined. But in the case of bodies of low-dispersive power, a faint broad shadow is observed to move across the spectrum, the best position to read being when the shadow is in the green or greenish-blue; results can then be obtained within 20′ to 30′, even with this preliminary apparatus.

Pringsheim's Yellow Filters.*—E. Pringsheim, jun., constructs his filters in the following manner: White glass plates (e.g. old photographic plates) are thoroughly cleaned by a solution of potassium bichromate in concentrated sulphuric acid, rinsed in running water, and, the future disk-side downwards, dried by being placed obliquely on blotting-paper. This cleaning facilitates the future adhesion of the gelatin layer. Every speck of dust is to be avoided. A deep reddish-brown solution in distilled water to which 20 p.c. gelatin has been added is filtered in a steam chamber, and a little glycerine at the rate of a single drop per 100 c.cm., is added to prevent undue brittleness to the layer. Some boric acid is also added to prevent growth of moulds. Boric acid is too weak to influence the colour, but must be added sparingly as it is apt to crystallise out in drying. The cleaned glass plates are set out on a larger glass plate accurately levelled. The gelatin solution is poured on to the middle of the plates, and must be hot, so that the application may be uniform in thickness. Any want of success may usually be made good by heating up the unsuccessful part on an asbestos layer. When the gelatin has solidified the plates are kept obliquely in a dry place as dustless as possible. With rare exceptions the gelatin layer will be found so uniformly applied, that, when held between the eye and a newspaper, the printing seems scarcely affected. Two such plates may be turned inwards and cemented by Canada balsam.

The author not only uses his filters for the windows of a box for studying the heliotropism of plants, but applies them to the study of

* Ber. Deutsch. Bot. Gesell., xxvia. (1908) pp. 556-65 (4 figs.).

microscopic organisms (e.g. algæ-swarms, *Euglenæ*, *Volvox* colonies, etc.) sensitive to light. The apparatus is shown in fig. 9, where the filter

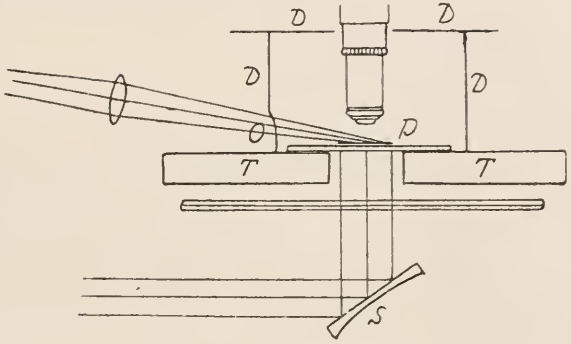
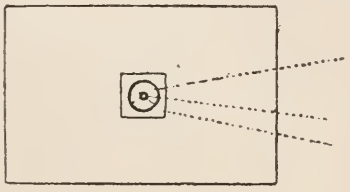
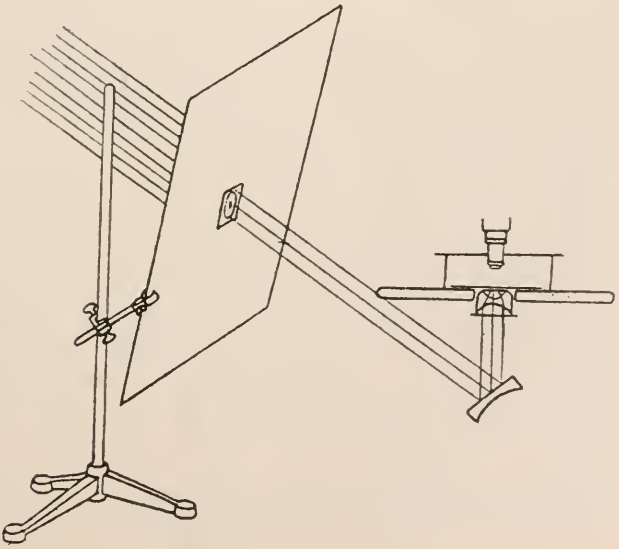


FIG. 9.





FIGS. 10, 11.

will be observed underneath the stage T. the light passing through it after reflection at the mirror S. On the stage itself a black cardboard

tube, D, with a lid perforated for the objective, completely surrounds and incloses the object P. Through an aperture, O, ordinary light concentrated by a lens can be concentrated on the object. The influence of the yellow light upon such organisms as are sensitive to bright ordinary light can then be studied.

It is well known that Engelmann has shown, by arranging a spot of light in a dark ground, that many organisms lose their activity when no longer in the light spot. The author varies this experiment by introducing a light flicker in a yellow field, and his apparatus is shown in figs. 10 and 11. A simple small gelatin disk containing a small colourless circle of 5 mm. diameter is projected into the plane of the preparation. Racking of the illuminating apparatus will secure sharp definition of the circumference of the circle in the image of the organisms. A cover-glass acts as the glass disk, and the colourless circle is obtained by application of a drop of hydrochloric acid and subsequent treatment by a moist camel's-hair pencil. Any slight reddening due to the acid is made good by ammonia. The cover-glass is fastened with strips of paper pasted on to a large sheet of cardboard, whose plane is arranged normally to the incident light-rays. A very slight displacement of the mirror shifts the bright spot, so that organisms which had previously clustered in the white light come now under the influence of the yellow light.

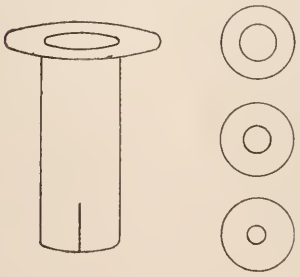


Fig. 12.

Dark-ground Illumination.*—S. C. A. describes how he successfully obtained good dark-ground illumination with a Zeiss DD_1 N.A. ·85 one-sixth Reichert 7A N.A. ·87 one-seventh, using Baker's achromatic condenser N.A. 1·0. "All that is necessary is to insert a metal tube in back of objective, one end of which comes in close contact with the back lens of the objective. This end is split to enable a small metal disk to be sprung into it; the other end has a collar, which sits on the top of objective. Two or three metal disks are necessary, each having the centre punched out, giving varying apertures, a large or a small aperture being used according to the amount of light to be stopped out. I generally leave the tube in my $\frac{1}{4}$ in., in which case all that is necessary to obtain dark ground is to place expanding spot in condenser carrier. This extra amount of work to be readily obtained from an objective will be appreciated. Diaphragms, or a Davis shutter, are of no use for dark ground illumination with high powers, as they work too far away from back lens of objective." (fig. 12).

Use of the Polariscope in Testing High-tension Insulators.† C. F. Harding shows that with the aid of the polariscope it is not only possible to determine some of the causes for the unsatisfactory service

* English Mechanic, xc. (1909) p. 311 (1 fig.).

† Proc. Indiana Acad. Sci., 1908 (issued 1909) pp. 147-9.

given by certain glass insulators, but it is also possible to make preliminary acceptance tests upon new insulators, and to eliminate all of those which show signs of improper annealing.

Evatt, Ev. J.—**The Cameragraph: a Drawing Apparatus.** *Journ. Anat. and Physiol.*, iii. (1908) pp. 335–6.

(4) Photomicrography.

Cheap non-vibrating Suspension for Microphotography.*—R. G. Perkins takes a 2-in. plank 14 in. wide and fixes on it in optical alignment the various parts of the apparatus. It is of course necessary to have some arrangement so that the light and the collecting lens may be adjusted, though to save expense, a median fixed position may be secured with good results for all powers. The bellows should slide in the focal plane, so as to admit of looking in the eyepiece of the Microscope for the area to be photographed. Two cleats of hard wood were screwed to the bottom of the plank near the ends, and through these four screw-eyes were bolted. Four pulleys were fastened on the ceiling with window cord passing from the cleats on the wall through the pulleys and down to the screw-eyes in the plank. At any point between the ceiling pulleys and the screw-eyes were interposed extension springs of such a tension that the rings would be separated about an eighth of an inch when the whole weight of the apparatus came upon them. The plank and its fixtures were then raised by its cords to a convenient height, the light connected with its source, and the machine was complete. The advantages which have been found in this arrangement are, in the first place, the absolute removal of building vibration, exposures of one second or one hour being equally clear, even with the whole affair swinging to and fro and up and down. In the second place, there are no legs underneath to be kicked or to get in the way, and the plank can be pulled up to the ceiling if desired to give more space in the dark room. In the third place, the plank and the suspension cost only three dollars, besides the time necessary for installation.

Resolving Power of Photographic Plates.†—C. E. Kenneth Mees points out that, while great attention has been paid to the resolving power of lenses, very little has been done for the resolving power of the photographic plates which are largely used in recording instruments. He considers that the resolving power may be defined as the distance which must separate two lines of light falling upon the plate in order that the developed image may be recognised to be that of two separate lines. It is clearly of no use to obtain a higher resolving power in an instrument than the plate used in that instrument will possess. The only attempt to state this resolving power appears to be that of Wadsworth,‡ who lays down that two lines can be separated if between the particles in the maxima of the lines there are one silver particle and two spaces, that is to say, the linear distance between the two maxima or centres of the line is equal to four times the diameter of a particle.

* Johns Hopkins Hosp. Bull., xx. (1909) p. 325.
† Proc. Roy. Soc., lxxxiii. (1909) pp. 810–18 (8 figs.).
‡ Astrophys. Journ., iii. (1896) pp. 188, 321.

If the diameter of a particle be called e, then we may assume that for photographic resolution it is necessary that the linear distance between the centres of the lines be equal to $4e$. E. C. C. Baly * states that e may be taken as lying between 0·005 to 0·025 mm. ;I this statement is not confirmed, however, by other workers. It is not difficult to make slow plates in which the grain does not exceed a diameter of 0·0005 mm. According to Wadsworth, these plates should therefore resolve lines which are not much more than $\frac{2}{1000}$ mm. apart. As rough experiments showed at once that the resolving power of such plates did not exceed about $\frac{1}{20}$ to $\frac{1}{40}$ mm., the author undertook to thoroughly investigate the subject. After numerous experiments, he concluded that: 1. The resolution of a photographic plate is dependent on the amount of irradiation displayed by that plate. 2. That irradiation is not directly proportional to the size of grain, but is caused by two different forms of scatters arising from (*a*) reflection and (*b*) diffraction. 3. That the resolving power is likely to be much smaller than that indicated by the theory of Wadsworth.

In order to experimentally determine the resolving power, a series of black and white line gratings were constructed having alternate black and clear lines of equal width, the width of the clear glass ranging from 0·88 to 0·14 mm. Experiments showed that the limit of resolutions possessed by dry plates chemically developed were: For an ordinary fine grained plate, lines will be just resolved if they are separated by 0·018 mm. (For a coarser grain, as in all fast plates, about 0·030 mm. is necessary.) For very fine-grained plates for violet light, 0·018 mm. will be resolved; with red light, 0·008 mm. may be discerned. The resolution on the surface of a fine-grained plate will obviously be much greater than this, as is shown by the very high resolving power possessed by the fine-grained "albumen" plates which are developed by the deposition of silver from an acid silver solution.

Specially prepared gelatin plates of extreme thinness were also prepared, and were found to be more sensitive to red than to blue. The separation with violet light was 0·008 mm.; while with red light lines of 0·004 mm. separation were resolved.

[Photomicrographers will readily appreciate the superiority apparently possessed by red light and medium grains over violet light and fine grain plates. In resolving line tests the former go nearly twice as far as the latter.—Ed.]

Ultramicroscopic Cinematography of Living Microbes and of Moving Particles.†—For carrying out the above purpose, J. Comandon used as light-source an arc lamp of 30 amperes with automatic regulator, the luminous rays being condensed by a thin glass lens in such a way that the image of the positive crater of the arc covered the diaphragm of the Microscope condenser. The Microscope (a Zeiss) was provided with Siedentopf's parabolic condenser giving lateral illumination and thus forming the ultramicroscope. The cinematograph was Pathé's apparatus modified for the purpose, and adapted to the Microscope by the help of a bellows (soufflet). The movement of the film was

* Spectroscopy, p. 339.

† Comptes Rendus, cxlix. (1909) pp. 938-41 (1 pl.).

arranged so that the operator could focus directly on to the sensitive layer. The stop apparatus was synchronous with the descent of the film, and was placed in the luminous beam before the beam reached the preparation. Thus in the intervals of rest the moving particles were no longer submitted to the action of the light and heat of the electric arc. The whole apparatus was operated on an optical bench whose very massive support eliminated vibrations as much as possible. Moreover the apparatus could be arranged at a variable distance from the Microscope.

In order to get exactly the illusion of movement seen in the ultramicroscope, the cinematographic views must be taken at normal rate, that is to say at the rate of sixteen photographs per second, thus giving a pose of $\frac{1}{32}$ sec. for each image. The quantity of maximum light, the film-sensitiveness, the pose time, being quantities almost fixed, the magnification must be varied in order to get the images with optimum illumination. The best results for photographs of blood and its parasites were obtained with a Zeiss 4 mm. apochromat, No. 4 projection ocular, and a film at 0·28 metre from the ocular (plate II.). A magnification of about 280 diameters was thus obtained. In order to get a quantitative measure of the movements of the particles, a rod beating seconds intercepted the luminous ray and thus provided a scale of observation. The author made some very interesting comparative studies of those small mobile blood particles known as Müller's hæmokonies, which were easily counted by this method.

CRABTREE, J. H.—**Formation and Photomicrography of Crystals.**

[A useful article on the method of production, of illumination, and photomicrography of crystals; is well illustrated.]

Knowledge, vi. (1909) pp. 411–14 (10 figs.).

(5) Microscopical Optics and Manipulation.

Methods of Determining the Amount of Light Scattered from Rough Surfaces.*—W. F. Barrett, having been consulted in connection with a case of "ancient lights," found it desirable to devise some trustworthy methods for determining the amount of light scattered from large rough surfaces such as the wall of a house. The word "scattered" is to be taken in the sense of "irregularly reflected." Ordinary photometric methods are inapplicable in the case of large surfaces. The author devised the two following methods.

Method A.—This consists of a rapidly revolving opaque disk with a transparent sector which can be altered in size, and whose angular magnitude can be measured (fig. 13). It can be driven by hand, a simple speed-gear being all that is necessary. It is placed at a given distance between the reflecting surface, which is illuminated by the sun or strong artificial light, and the photometer. The width of the sector is altered until equality of illumination between the reflecting surface and a standard source of light is obtained, as shown by some transmission photometer such as Bunsen's, Joly's, or Lummer and Brodhun's. If the scattered light is coloured, as from a brick building, a wedge of suitably coloured glass, or a coloured gelatin film of increasing thickness is gradually interposed in front of the standard light until a similar tint is obtained.

* Sci. Proc. Roy. Dublin Soc., xii. (1909) pp. 190–7 (3 figs.).

Method B.—This consists in reducing the intensity of the stronger light by an absorbing medium. For this purpose the following

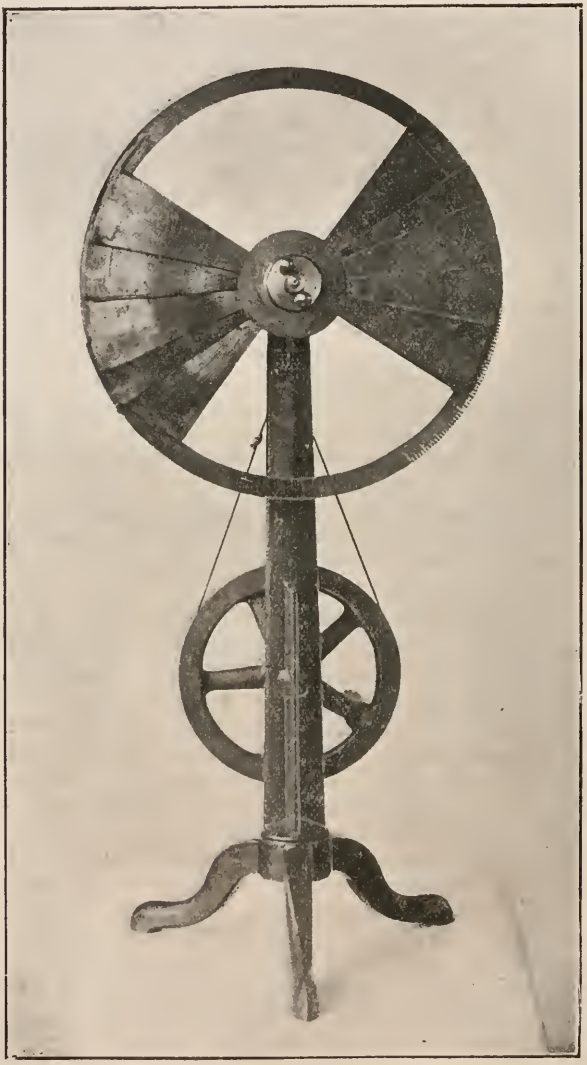


FIG. 13.

arrangement is adopted. It is in principle somewhat similar to the "colorimeter" often used in chemical analysis, and is an adaptation of the method the author recently patented for determining the "light-

threshold" of the eye. The absorbing medium is a liquid of neutral tint, best formed from fine China or Indian ink mixed with water, and

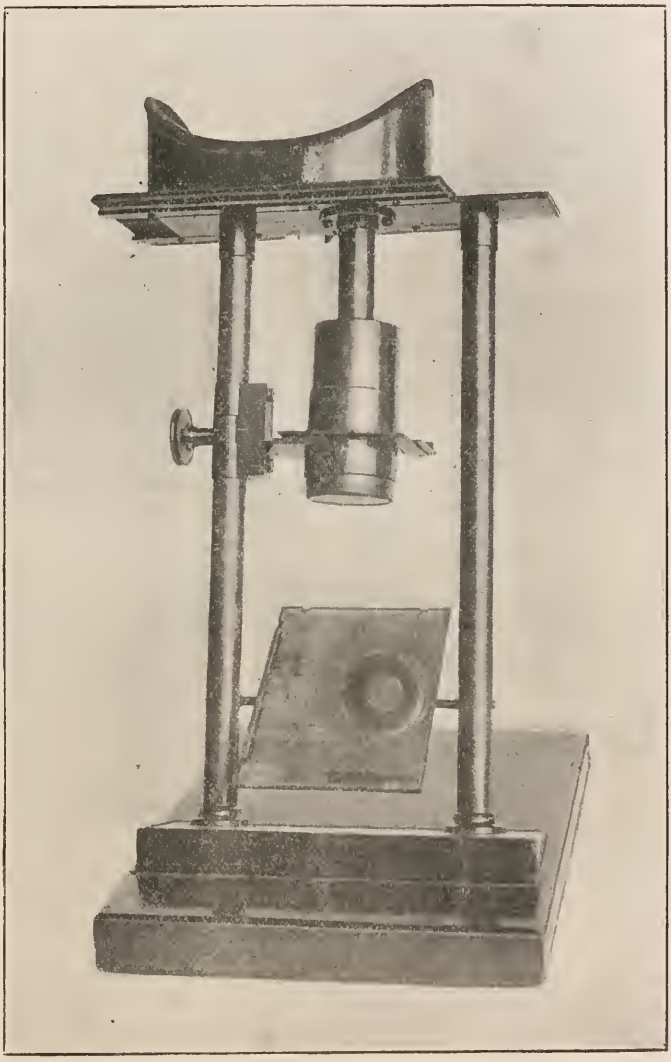


Fig. 14.

allowed to stand for 48 hours; the coarser particles are then deposited, and the supernatant liquid is employed. The apparatus is shown in fig. 14, and, in section, in fig. 15. A variable depth of the liquid is

obtained by the movement of a plunger with glass bottom H (fig. 15) which can be gradually immersed within a cylinder or cistern I, also with a glass bottom, containing the absorbing liquid. Light is reflected upwards through the cylinder by means of a mirror, M, at 45°. The amount of light scattered from various large surfaces can thus be very

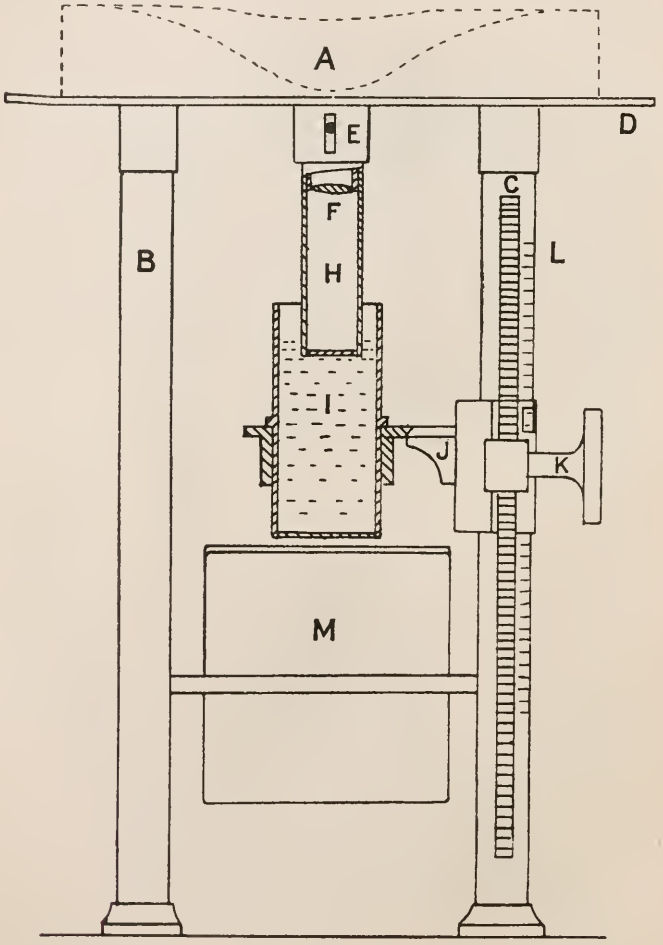


Fig. 15.

easily compared by the relative depths of liquid required to produce extinction. The pillar L is graduated, and the cistern I raised or lowered by the rack-and-pinion K. In order to exclude extraneous light the observer rests his forehead in a shaped head-rest A, and a black cloth covers the head. After one minute the eye attains a fairly steady state, and either eye can be used at pleasure by sliding the head-

rest to and fro. On the glass bottom of H is a minute photograph of the graduated test type used by oculists. This is viewed through a small lens F, adjustable at E, until a sharp image is seen by the observer. When the cistern I is raised until the glass bottom of H and I touch, the scale-reading on L then indicates zero. The depth of the liquid (as indicated on the scale) required to produce complete extinction of the light measures the intrinsic brightness of the source. Or with a constant source of light the depth measures the "light threshold," or the sensibility of the observer's eye to light. This sensibility rapidly rises during the first minute of observation, and becomes nearly constant after two or three minutes. The form sense, or "visual ocuity," of the eye is measured by the depth of liquid required to obscure and produce illegibility of the test type, and this also measures the illuminating power of the source of light. The illuminating power of the source may be reduced to any given fraction by means of the adjustable and rapidly revolving sector, or by other means; and it will be found that the depth of liquid required to produce extinctiou of the light is practically the same, even when the illumination from the source is reduced to a very minute amount; in other words, the intrinsic brightness remains the same. On the other hand, the legibility of the test type varies with the amount of illumination, and it is this we require to measure in the case of light irregularly reflected from rough surfaces. Hence this arrangement affords an accurate method of testing the illuminating power of any surface that scatters light, whether large or small. It is only necessary to use a steady source of artificial light, and note the depth of immersion of the plunger H which is required to produce illegibility when a silvered mirror is employed; then replace or cover the mirror by a similar sized piece of the reflecting surface to be tested, and note the depth now required for extinction, the distance and intensity of the source of light remaining unchanged. The author quotes the following as specimens of his results:—Silvered glass, 100; plane glass surface, 65; ground glass, 45; white card, 45; grey card, 35; dark grey card, 21; smooth black paper, 20; black cotton cloth, 16; dull black woollen cloth, 5.

An Adjustment for the Plane Grating similar to Rowland's Method for the Concave Grating.*—C. Barus states that the remarkable refinement which has been attained (notably by Ives and others) in the construction of celluloid replicas of the plane grating, makes it desirable to construct a simple apparatus whereby the spectrum may be shown, and the measurement of wave-length made in a way that does justice to the astonishing performance of the grating. He has therefore devised an inexpensive contrivance in which the wave-length is strictly proportional to the shift of the carriage at the eye-piece: which for the case of a good 2-metre scale divided into centimetres admits of a measurement of wave-length to a few Ångström units, and with a millimetre scale should go much further. Observations are throughout made on both sides of the incident rays, and from the mean result most of the usual errors should be eliminated by symmetry.

* Proc. Amer. Phil. Soc., xlviii. (1909) pp. 166–76 (5 figs.).

Fig. 16 shows two double slides A, B, like a lathe-bed, 155 cm. long and 11 cm. apart, which happened to be available in the author's laboratory; but single slides at right angles to each other, similar to Rowlandson's, would have been preferable. The carriages C, D, 30 cm. long, kept at a fixed distance apart by the rod a R b, are in practice a length of $\frac{1}{4}$-in. gas-pipe, swivelled at a and b, 169·4 c.m. apart, and capable of sliding right and left and to and fro, normally to each other.

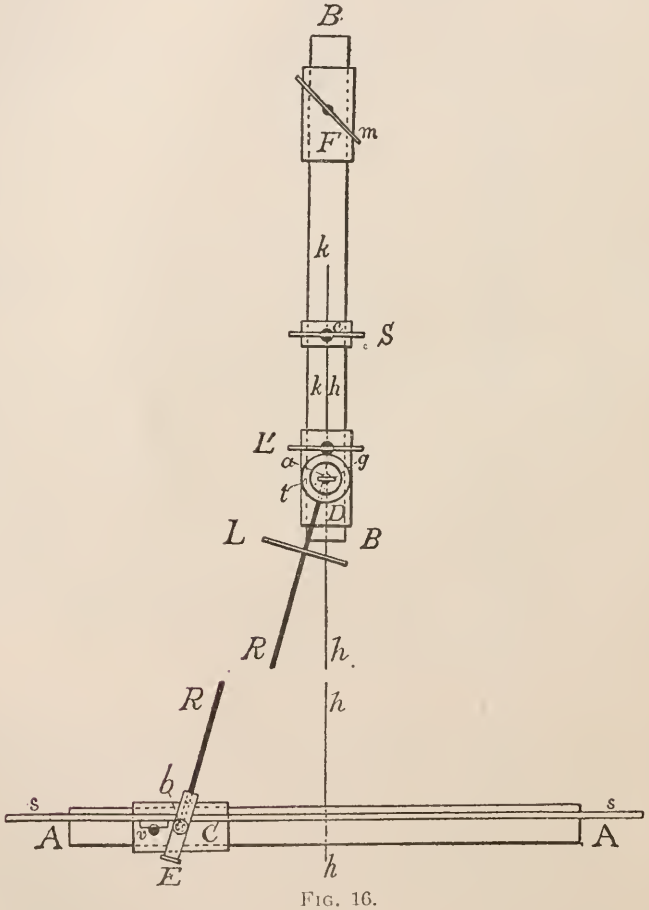


Fig. 16.

The swivelling joint, which functioned excellently, is made very simply of $\frac{1}{4}$-in. gas-pipe T's and nipples. The horizontal rod k fixes the slit standard on the slide S, and is prolonged towards the rear for carrying the flame or Geisler tube apparatus: the rod k also secures the grating standard at t. A large lens at L, of about 56 cm. focal distance, and about 10 cm. in diameter, is placed in front of the grating, and throws an image of the slit S upon the cross-hairs of the eye-piece E. F is a

carriage for the mirror or flame, or other source of light whose spectrum is to be examined. A rod *h h* serves to focus S. The author gives a full account of the adjustment necessary. He also gives some examples of the satisfactory results obtained.

Wave-length Comparator for Standards of Length.*—A. E. H. Tutton, in describing his instrument for comparing standards of length—the Imperial Standard yard, for instance, with official or other copies—states that it is the most perfect instrument yet devised for measurement of wave-lengths in general. The principle of the instrument is an improved form of the author's interferometer described to the Royal Society in 1898. The essential point of the instrument is that one of the two Microscopes, employed to focus the two defining lines on a standard yard bar, actually carries just above the objective one of the two glass plates of the interference apparatus, which reflect the monochromatic light (hydrogen or cadmium red radiation) which is caused to interfere and produce rectilinear dark bands. When the Microscope is moved the plate consequently moves with it, and the amount of movement is absolutely afforded by the movement of the interference bands, being equal to half the wave-length of the light employed for every band which passes the reference spot in the centre of the field of the interferometer telescope. So perfectly has this fine movement been achieved that the Microscope and the bands can be caused to move simultaneously by rotation of the large fine-adjustment wheel, so steadily that each band can be made to pass the reference spot as slowly as one wishes and be arrested instantly, without the slightest tremor, at any fraction of its width, so that the control of the bands and the counting is a perfectly simple matter.

In order to compare two standard bars it is only necessary (1) to place the bar of known length, supported on an elaborate mechanism for the adjustment of the bars, under the two Microscopes, carried on massive yet delicately moving sliders on a 6-foot V-and-plane bed, so that the two defining lines are adjusted between the spider-lines of the micrometer eye-piece in each case; (2) to replace the standard by the copy to be tested, so that the defining line near one end is similarly adjusted under the corresponding Microscope; then, if the other defining mark is not also automatically adjusted under the second Microscope which carries the glass interference plate, as it should be if it is an exact copy, (3) to traverse that Microscope until it is so adjusted; and (4) to observe and count the number of interference bands which move past the reference spot during the process. The difference between the bars is this number multiplied by the half-wave-length of the light in which the bands are produced. The temperature of the whole room is controlled entirely electrically, being maintained constant at the official temperature, 62° F. (A description of the apparatus will appear later.)

Use of Wave-length Rulings as Defining Lines on Standards of Length.†—The delicacy of the method of measurement in wave-lengths described in the preceding abstract calls for a corresponding refinement in the engraved lines, which form the defining lines of the length of a standard yard or metre or other line-measure bar. The defining lines on

* Proc. Roy. Soc., Series A, lxxxiii. (1909) pp. 79–80. † Tom. cit., p. 81.

the Imperial Standard yard are sharp-edged, but contain the equivalent of 40 interference bands of red light in their thickness, and the Benoît defining lines of the platinum-iridium copy made in 1902 are not only very ragged edged but contain 15 interference bands in their thickness. By the help of J. H. Grayson, of Melbourne, it has been found that wonderfully satisfactory rulings on the scale of 40,000 to the inch can be made on polished speculum metal covered with a thin cover-glass. Now the forty-thousandth of an inch is a single wave-length of red light (for Hα = $\frac{1}{38710}$ in., and Cd red = $\frac{1}{39439}$ in.), so that the interval between any adjacent pair of these lines is equivalent to only two interference bands. The thickness of each line, which is absolutely sharp-edged, is less than a single interference band. The author has therefore devised a "Tutton location signal," consisting of five such parallel lines spaced $\frac{1}{40000}$ in. apart, with a pair of strong "finder" lines outside them and parallel to them, and another pair of similar finder lines, perpendicularly transverse to them, to indicate a central part of the lines lines for use. The central line of the five fine Grayson rulings is the defining line.

Pocklington, H. C.—**The Aberrations of a Symmetrical Optical Instrument.** [A mathematical treatment on Lord Rayleigh's article on Hamilton's Principle and the Fine Aberrations of von Seidel.]
Proc. Roy. Soc., Series A, lxxxiii. (1909) pp. 99–106.

(6) Miscellaneous.

Observations on Mammalian Blood with Dark Field Illumination.*—H. Crawley finds that the dark field illumination is a sine quâ non for examining fresh blood. The apparatus used consisted of a substage condenser, arc lamp, and rheostat for cutting down the current to 4 amperes. It was found to be important that the slides used should not exceed 1 mm. in thickness. The work was done with a $\frac{1}{12}$ in. achromatic immersion lens stopped down with a hard rubber funnel and a No. 12 compensating eye-piece, though equally good pictures were obtained with a No. 18 eye-piece. The blood studied was that of the cow, sheep, rabbit, guinea-pig, white rat, and man. The blood of sheep and cow was drawn from the jugular vein, defibrinated and preserved in cultured tubes. The media used were bouillon, citrated salt solution, or simple salt solution. Citrated salt solution appears to have a destructive influence on the blood cells after a certain time. It was also noted that the dark field illumination acted injuriously on living cells, and that trypanosomes perished very quickly under its influence. The phenomena observed are treated under the following heads: (1) Blood dust; (2) beaded threads; (3) flagellated erythrocytes and free flagella; (4) bodies showing pseudopodia; (5) erythrocytes; (6) leucocytes; (7) blood plates.

Quekett Microscopical Club.—The 459th Ordinary Meeting of the Club was held on Tuesday, October 26, 1909, the President, Prof. E. A. Minchin, M.A., F.Z.S., in the Chair. Mr. W. Wesché, F.R.M.S., communicated two papers, one "The Life-history of the Tachinid Fly, *Phorocera serriventris* Rondani," and a "Note on a Quick Method of

* U.S. Dep. Agric., Bull. 119, Washington, 1909, pp. 5–15 (1 fig.).

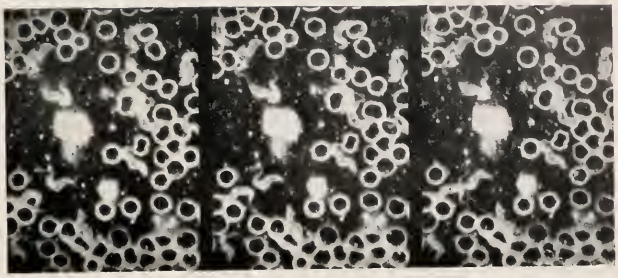


FIG. 1. TRYPANOSOMES IN MOUSE-BLOOD.

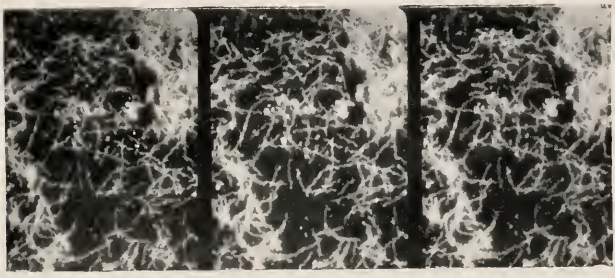


FIG. 2. SPIROCHÆTES OF BALANITIS.

FIG. 3. SPIROCHÆTES IN BLOOD OF FOWL.

Preparing and Staining Pollen." Mr. A. C. Banfield gave a lecture, with lantern illustrations, on "Low-power Photomicrography and Stereo-Photomicrography." Mr. James Murray exhibited some specimens of Rotifers obtained by the 'Nimrod' during Shackleton's Antarctic Expedition.

The 460th Ordinary Meeting was held on Tuesday, November 23. Reference was made to the much-regretted death on November 7 of Dr. W. H. Dallinger, F.R.S., etc., Member and Past President of the Club. The President exhibited and described two preparations of cysticercus of tapeworm, probably *Hymenolepis diminuta*, obtained from rat fleas. Note of a new locality, the second known, for *Zoothamnium geniculatum* was communicated by Mr. J. Stevens, F.R.M.S. Mr. F. P. Smith contributed a "Note on the Mounting of Spider Dissections as Microscopical Objects." Mr. J. S. Dunkerley, B.Sc., gave an interesting résumé of our knowledge of that little-known group of the Protozoa, the Choanoflagellata. J. Clark, in America, was the first to describe the true structure of these forms. A typical Choanoflagellate has an oval, naked, protoplasmic body with nucleus, contractile vacuole, one flagellum, and surrounding the base of the flagellum a protoplasmic membrane—the collar—which is usually basin-shaped. The flagellum arises from a staining granule, the blepharoplast, which apparently was not seen by Saville Kent and other early workers.

B. Technique.*

(1) Collecting Objects, including Culture Processes.

Two New Methods for Growing Azotobacter in large quantities for Chemical Analysis.†—C. Hoffman and B. W. Hammer describe two procedures by which they have obtained good results.

1. For obtaining a large amount of *Azotobacter* cells an adaptation of the old "pinsel" plate culture method has been employed. In large 8 or 11 in. Petri dishes, $\frac{1}{2}$ in. layer of the specific agar medium is placed; the whole is then sterilised and finally cooled. The plates are then inoculated with a heavy suspension of Azotobacter in sterile water, using about 10 c.cm. per plate. This is thoroughly and evenly distributed over the surface of the solidified agar, and the cultures so prepared then incubated. Under these conditions thorough aeration is possible. After the necessary period of incubation the growth, which is very abundant, is carefully scraped off the surface of the agar with a glass slide, removed to an evaporating dish, and prepared for chemical analysis. As much as 1 grm. of dry growth per plate has been obtained in this way.

2. To study the influence of different chemical compounds upon the nitrogen-fixing properties of Azoterbacter, the authors devised their "sand-slope" culture. This consists in using clean washed and heated quartz-

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

† Centralbl. Bakt., 2te Abt., xxiv. (1909) pp. 181–3.

sand as follows: in 150 c.cm. Erlenmeyer's flasks, 10–15 grm. of sand are placed, together with 20 c.cm. of the specific liquid-culture medium. The whole is then sterilised, after which the flasks may be inoculated. For inoculation purposes, 1 c.cm. of a heavy suspension of Azotobacter in sterile water is used. After inoculation the sand is so sloped that a considerable quantity is above the surface of the liquid culture medium. This slope thus furnishes a solid substratum always well saturated with the culture solution due to capillary action. It further affords optimum aerobic conditions essential for the luxuriant growth of Azotobacter.

Cultivation of Spirochæta gracilis and S. balanitidis.* — C. Levaditi and V. Stanesco cultivated these Spirochætes—the one derived from a chancre, the other from the pus of balanitis—by sowing the microbic flora in a large tube containing horse serum, and three days afterwards inoculating the Spirochætes in a collodion sac filled with horse serum placed within the large tube. In this way the nutritive substances prepared by the microbic flora penetrate the sac, and assure the multiplication of the Spirochætes. Another method was to make stab-cultures in horse or human serum coagulated at 75°. Both these methods produced cultures extremely rich in Spirochætes. These organisms are, however, incapable of assimilating the nutritive substances of the serum without the co-operation of the associated microbes, which are essentially proteolytic. It is only on the third or fourth day after liquefaction of the medium has commenced that *Spirochæta gracilis* and *S. balanitidis* begin to multiply. Thus by making use of a liquefying aerobic bacillus the authors obtained mixed cultures, in which *S. gracilis* multiplied in symbiosis with the bacillus. In this connection it may be pointed out that there is a certain analogy between the culture conditions of Spirochætæ and Amœbæ.

Cultivating Meningococcus.†—P. Esch made comparative observations with maltose-ascites-agar, Lœffler's and Buchanan's serums, and with sheep's-blood-maltose-ascites-agar. The last was found to give constant results, and the growth on this medium was very rapid and luxuriant. In from 8 to 12 hours the colonies were evident, and in one instance a vaccine was obtained in 24 hours. The medium consists of 60 c.cm. pepton agar (1 p.c. pepton Witte); to which, after cooling to about 50° C., are added 20 c.cm. sterile defibrinated sheep's-blood, 10 c.cm. ascitic fluid, and 1 grm. maltose dissolved in 3 c.cm. bouillon.

Detection of Bacteria by means of an Electric Current.‡—C. Russ made experiments to ascertain whether bacteria, suspended in an electrolyte, through which a current passes, are transmitted to either electrode, and if so, whether pathogenic organisms could be collected and extracted by such means from pathological fluids. He found that certain bacteria, under the influence of a suitable current, aggregate at one or other electrode. The aggregation varies with the nature of the electrolyte, and is probably due to affinity between the products of electrolysis and the bacteria. The aggregation by electrical

* C.R. Soc. Biol. Paris, lxvii. (1909) pp. 188–90.
† Centralbl. Bakt., 1te Abt. Orig., lii. (1909) pp. 150–4.
‡ Proc. Roy. Soc., Series B., lxxxi. (1909) pp. 314–22 (3 figs.).

currents affords a means of collection and examination. The differences in behaviour of various bacteria are such as to suggest the possibility of utilising the method for purposes of specific discrimination. As an example, the presence of tubercle bacilli in the urine is given. For this, the most suitable electrolyte was ethylamine 5 p.c., 1 part; lactic acid 10 p.c., 4 parts; bromic acid 5 p.c., 2 parts; urine, 1 or 2 parts. The apparatus used (fig. 17), consisted of a modified U-tube, filled with a mixture of tuberculous urine and the electrolyte. In the narrow limb of the vessel a platinum foil strip was submerged. In the broad limb a glass tube, traversed by a platinum wire, was submerged, the lower end of the tube forming a bacterial trap. After

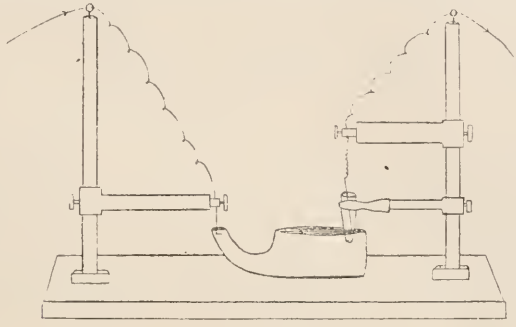


Fig. 17.

passing a current for a sufficient time the contents of the trap were examined in the usual way for tubercle bacilli.

New Method for obtaining Pure Cultures from Whole Organs and Pieces of Tissues.*—A. Feoktistow states that pure cultures of whole organs, e.g. spleen of mouse, or pieces of tissue, may be obtained by immersing the objects in 10 p.c. caustic potash, or soda, for some few seconds, 3 to 8 according to size. The object is then transferred without further preliminary or care to the cultivation medium.

Aerobic Cultures of "Anaerobic" Organisms.†—F. Marino, in a preliminary communication, states that he grows anaerobes in bouillon-serum prepared as follows. Test tubes are filled with a mixture of 5 c.cm. serum and 15 c.cm. bouillon; these are heated for an hour at about 100°. Temperatures much below or much above 100° retard or prevent the development of anaerobes. Any quantity of bouillon-serum may be made provided the relative proportions of 1–3 are maintained.

Cultivating Spirochæta pallida.‡—J. Schereschewsky made cultivations on horse-serum. The medium was inoculated with infected material. The spirochætes were formed on the third day, and from the fifth to the twelfth were very numerous. The best way to examine for

* Centralbl. Bakt., 1te Abt. Orig., lii. (1909) pp. 685–7.

† C.R. Soc. Biol. Paris, lxvii. (1909) pp. 664–5.

‡ Deutsche Med. Wochenschr., 1909, pp. 1260 and 1652, through Centralbl. Bakt., 1te Abt. Ref., xlv. (1909) pp. 107–9.

them was by removing some of the fluid in a capillary pipette, and then using the dark-ground illumination. Films were made by fixing the smear with osmic acid vapour, and staining with Giemsa's mixture (60 c.cm. of 0·5 p.c. glycerin and a few drops of the Giemsa). The mixture is used hot, and re-applied. Morphologically the spirochætes bred in this way are indistinguishable from the typical *Spirochæta pallida*, but they were not pathogenic to animals. Hence these results suggest (1) that the spirochætes bred are not the true *S. pallida*; (2) that they have lost their virulence; or (3) that syphilis is not due to *S. pallida*.

Collecting Cœlenterata, and Observations on the Ova.*—G. T. Hargitt collected *Tubularia crocea* in November and *Pennaria tiurella* in July and August. The male and female colonies were kept in separate dishes. The medusæ became free about 7 o'clock in the evening. When a sufficient number of eggs had been discharged, spermatozoa were introduced by adding a pipetteful of water from the dish containing the male colonies. In this way the desired stages were easily obtained. To secure stages earlier than fertilisation medusæ were removed from the colony before the time of maturation. The medusæ thus artificially set free were at once fixed, some 15 to 12 hours, others 10 hours, and others at still shorter periods, before liberation.

The following fluids were used for killing:—Flemming's stronger mixture, aqueous solution of sublimate and acetic acid, Bouin's picro-formol, Zenker's fluid. For *Tubularia* the corrosive-acetic gave the best results, and for *Pennaria* Bouin's fluid was the most satisfactory. For staining, iron-hæmatoxylin followed by Congo red or orange G: also Conklin's picro-hæmatoxylin, Delafield's and Ehrlich's hæmatoxylin were useful. For purposes of comparison, Mallory's phosphotungstic hæmatoxylin, iron-Brazilin, and Auerbach's and Erlich-Blindi mixtures of acid-fuchsin and methyl-green.

Collecting and Preserving Insects.†—N. Banks, in collaboration with other members of the Bureau of Entomology, U.S.A. National Museum, has compiled a small monograph dealing with the collection and preservation of insects. To those interested in entomology it will be found very useful, as full directions are given for every stage, and these are supplemented with a classification of insects and with special directions for different kinds. The volume is freely illustrated, and a good bibliography is appended.

Modification of the Conradi Medium for Isolating Bacillus typhosus from Excreta.‡—H. B. Fawcus recommends a medium of the following composition. To 900 c.cm. of tap water add 5 grm. sodium taurocholate (commercial from ox-bile); 30 grm. agar (powder); 20 grm. peptone (Witte); 5 grm. common salt. Dissolve in steamer for 3 hours, clean with white of egg, filter through wadding and bring to a reaction of +15 with normal lactic acid or normal soda as required. Dissolve 10 grm. of lactose in 100 c.cm. of distilled water and add it to the melted agar. Mix well and filter through Chardin paper. To

* Bull. Mus. Comp. Zool., liii. (1909) pp. 161–212 (9 pls.).
† Smithsonian Inst., Washington, U.S., Bull. 67 (1909) 135 pp. (188 figs.).
‡ Journ. Roy. Army Med. Corps, xii. (1909) pp. 147–54.

each 100 c.cm. of the clear bile-salt-lactose-agar add 2 c.cm. of 1 in 1000 aqueous solution of brilliant green (extra pure, Grübler) and 2 c.cm. of a 1 p.c. aqueous solution of picric acid. The resulting clear bright green agar is poured into plates 17–20 cm. in diameter. After solidification the plates are dried in an incubator. The bile-salt-lactose agar made in bulk may be distributed into flasks, each containing 150 c.cm. When required for use, one of these is melted and 3 c.cm. of each of the solutions of the dyes added and well mixed. This amount makes three large plates. After inoculation the plates are incubated at 37° upside down. In 24 hours typhoid colonies have a diameter of about 1 mm.; they are quite transparent and clear, while coli have a dark green spot in the centre. These characters are greatly accentuated in 48 hours. Paratyphoid colonies, colonies of the food-poisoning group and of dysentery- are indistinguishable in their growth from those of *B. typhosus*. After 48 hours the typical colonies may be fished out and submitted to further examination.

Rosenthal, G., & P. Chazarain-Wetzel—**La culture du Bacille perfringens dans les cultures sporulées en eau blanc d'œuf du Bacille anaérobie du rhumatisme aigu; moyen de différenciation des deux variétés du bacille d'Achalme.** *C.R. Soc. Biol. Paris*, lxvii. (1909) pp. 677–8.

Sineff, A., & R. Drosdowitsch—**Prof. Dieudonné's Blutkaliagar, ein neuer Nährboden für die bakteriologische Diagnose der Cholera.**
[Confirms the value of this medium for isolating cholera vibrio.
Centralbl. Bakt., 1te Abt. Orig., lii. (1909) pp. 429–31.
See also this Journal, 1909, p. 661.

Thaon, P.—**Symbiose de Levure et Oospora dans un cas de langue noire.**
[Gives results of cultivations of these organisms.]
C.R. Soc. Biol. Paris, lxvii. (1909) pp. 705–7.

(2) Preparing Objects.

Studying the Labyrinth.*—W. Kolmer used monkeys for studying the structure of the internal ear. After the blood had been removed during narcosis the vessels were thoroughly washed out with warm Ringer's fluid. As fixative, Held's fluid was used. This consists of a saturated solution of potassium bichromate, 2 to 3 parts; 10 p.c. formalin, 2 parts; acetic acid, 1 part. In certain instances, trichlor-lactic acid, or trichlor-acetic acid and uranium nitrate, and, for smaller objects, osmic acid, were added. The fixation lasted, according to the size of the object, for from 3 to 10 weeks. Then followed decalcification, with 5 p.c. nitric acid, followed by immersion in lithium sulphate 4 p.c. for one day. After this the pieces were washed in running water, and after passing through upgraded alcohols were transferred in the usual way to celloidin; in this they remained for 8 weeks. The sections were stained with iron-hæmatoxylin, after mordanting with iron-alum; the contrast stain was Rubin.

Studying the Finer Structure of the Labyrinth of Vertebrata.† H. Held, when examining the development of the organ of Corti and of

* Arch. Micr. Anat. u. Entwickl., lxxiv. (1909) pp. 259–310 (4 pls.).
† Abhandl. k. Sächsich. Gesell. Wissensch., xxxi. No. 5 (1909) 294 pp. (18 pls.).

the macula acustica in mammals and birds, fixed the material in a mixture of chromic acid, acetic acid, and formalin; the sections were stained by the molybdan-hæmatoxylin method, and after-stained with erythrosin, with acid rubin or with picro-fuchsin.

Studying Development of Red Blood Cells in the Chick.*—C. Price-Jones prepares films of bone marrow, spleen, liver, and embryonic tissue in the following manner. Small portions of the specimen are transferred to a watch-glass containing a dissociating reagent: in this way an emulsion of cellular elements is obtained. The dissociating solution consists of glycerin, diluted with ammonia-free distilled water to form a 10 p.c. neutral solution, titrating against decinormal sodium hydrate, and using phenol-phthalein as indicator. The initial acid reaction of this solution should vary from +0·1 to +0·5 (Eyre's Scale); the reagent has a specific gravity of 1029 at 15·7° C. A loopful of this glycerin solution is placed on a coverslip, and to this is added a loopful of the emulsion in the watch-glass, and very gently spread over the surface of the slip. The film thus prepared is allowed to dry in the air, without heating, until a uniform ground-glass appearance is produced. The film is then treated as a blood-film; it is stained with Jenner's solution of rosinate of methylen-blue, and then, after washing in ammonia-free distilled water and completely drying in the air, is mounted in balsam.

Demonstrating Motor End-plates.†—J. Boeke in his study of the motor end-plates in the higher Vertebrata, their development, form and connection with muscle fibres, used Bielschowsky's method. Fixation of embryos in alcohol-formalin was preferable to aqueous formalin, and the following mixture was used: formalin 10 parts, alcohol 60 p.c. 90 parts. After fixation the alcohol is removed by immersion in 10 to 12 p.c. formalin, and then the pieces of tissue are placed in 2 p.c. silver solution for 3 to 5 days in the dark. On removal they are washed in distilled water and then transferred to Bielschowsky's fulminate of silver solution for 1 to 2 hours, and subsequently reduced in 20 p.c. formalin. The pieces are afterwards imbedded in paraffin in the usual way.

Researches on Blood and Connective-tissue. — A Maximow examined the embryos of rats, cats, rabbits, mice, and guinea-pigs. The tissue was fixed in formol-Zenker. Small embryos up to 12 mm. in length were immersed in toto in the warm fluid; larger ones were incised to facilitate the entrance of fluid. The fixation lasted from 3 to 5 hours, after which the objects were washed and then placed in upgraded iodine-alcohols, and when dehydrated were imbedded in celloidin. Serial sections were stained with eosin-azur or with Giemsa. Iron-hæmatoxylin was not so useful.

Hardening and Imbedding the Eggs of Temnocephala fasciata.§ The difference in consistence between the eggshell and the contents gives

* Journ. Pathol. and Bacteriol., xiv. (1909) pp. 218–23 (1 pl.).
† Anat. Anzeig., xxxv. (1909) pp. 193–226 (40 figs. in text and 1 pl.).
‡ Arch. Mikrosk. Anat. u. Entwickl., lxxiv. (1909) pp. 525–621 (3 pls.).
§ Quart. Journ. Micr. Sci., liv. (1908) pp. 417–18.

rise to considerable difficulties. If the contents are in the fresh condition, they burst out and become completely disorganised when the thick shell is broken through. If hardened in the ordinary way, the yolk becomes exceedingly hard and brittle. W. A. Haswell has overcome these difficulties in the following way : The eggs are fixed with sublimate alcohol followed by iodised alcohol and 90 p.c. alcohol. After hardening, they are transferred to a solution of hypochlorite of soda. This transference is effected gradually through downwardly graded alcohols. If this be done too rapidly, the shell will split.

When the solvent action of the hypochlorite upon the cells has proceeded far enough, the eggs are washed in distilled water and dehydrated in alcohol. From absolute alcohol, they are transferred to a mixture of equal parts of absolute alcohol and anhydrous ether for twenty-four hours. They then remain for a like period in ½ p.c. solution of photoxylin or celloidin in equal parts of absolute alcohol and ether, followed by a 2½ p.c. solution of the same. The celloidin blocks, hardened in chloroform, are then finally imbedded in the hardest paraffin in the usual way.

(3) Cutting, including Imbedding and Microtomes.

Studying the Development of Amphioxus.*—The material at the disposal of E. W. MacBride for this research consisted of a large number of eggs, embryos at all stages, from the spherical blastula up to the period when the mouth, club-shaped gland, and one gill-slit have been formed, and a number of older larvæ. The material was preserved for the most part in corrosive sublimate and in osmic acid. The author considers that osmic acid is beyond comparison the best reagent for the preservation of histological detail. When yolk is abundant, osmic acid makes the material very brittle, so that for studying the stages of gastrulation, material preserved in picrosulphuric acid and in corrosive sublimate and acetic acid was used. But osmic acid material was exclusively employed in all later stages.

For imbedding the embryos, MacBride used the following modification of the celloidin and paraffin method : The celloidin containing the embryos, after being congealed in chloroform, was transferred to cedar oil. In this oil it became as clear as glass, so that the imbedded embryo could be observed under the Microscope, and its orientation determined. An appropriately shaped piece of celloidin was then cut out and imbedded in paraffin. The sections were stained on the slide.

Demonstrating Peripheral Nerve Terminations.†—R. C. Mullenix, when studying the peripheral termination of the eighth cranial nerve in Vertebrates, adopted Bielschowsky's method of impregnation. The head of a recently killed fish was immersed in 12 p.c. formalin for at least 24 hours; the fixed material was next decalcified in 12 p.c. formalin containing 1 p.c. nitric acid. After about 24 hours the acid was removed by means of running water. The material was then transferred to 2 p.c. silver nitrate for 24 hours or so, after which it was removed to an

* Quart. Journ. Micr. Sci., liv. (1909) pp. 290-1.

† Bull. Mus. Comp. Zool. Harvard, liii. (1909) pp. 215-50 (6 pls.).

ammoniacal solution of silver oxide. This was prepared by adding to 2 p.c. silver nitrate a few drops of 40 p.c. solution of sodium hydroxide, and dissolving the precipitate with ammonium hydroxide. After a period varying with the nature of the material, the pieces were washed, and then transferred to 20 p.c. formalin. After 12 hours the preparation was dehydrated, cleared, imbedded in paraffin, sectioned, and mounted in balsam in the usual way. The foregoing method was found to be superior to all others, such as those of Golgi, Ramón y Cajal, Vom Rath, etc.

New Method of Staining the Connective-tissue Framework of Viscera.*—D. Timofejew makes freehand or frozen sections of organs of freshly killed animals, or of pieces which have been immersed in physiological salt solution for one day. The sections are placed for 15 to 20 minutes in the following solution:—Methylen-blue (Ehrlich rectified) 1 grm., physiological salt solution 2000–4000 c.cm. The sections do not harm if left in the staining fluid for 24 hours. On removal the sections are carefully washed in salt solution, and then transferred for ½ to 1 hour, or even 24 hours, to a very weak solution of ammonium picrate (0·1 grm. ammonium picrate in 800–1200 c.cm. of physiological salt solution). The differentiation takes place in a few minutes, and its progress may be watched under a low power. The sections are mounted in the following fluid:—Saturated aqueous solution of ammonium picrate 35 c.cm., glycerin 50 c.cm., and distilled water 50 c.cm. In case the nuclei are not sufficiently stained, the preparation may be treated with Hoyer's picrocarmin. After-staining with Cajal's mixture of indigo-carmin and picric acid stains the collagen green, the other tissues remaining violet. A lengthy description of the appearances in different organs is given.

(4) Staining and Injecting.

New Method of Demonstrating the Spores in Acid-fast Bacteria.† L. von Betegh makes use of a stain made up as follows: 2 grm. of pure dahlia are dissolved in 20 grm. of 95 p.c. alcohol; to this are added 50 grm. of distilled water and 4 or 5 drops of strong carbolic acid. L. von Betegh's process consists of the following steps: Stain with warm carbol-fuchsin as usual; wash; stain with dahlia two or three minutes at room temperature; wash; stain with iodine solution (iodine 1 grm. potassium iodide 2 grm. distilled water 100 c.cm.) 10 to 15 minutes; wash in alcohol-acetone until no more stain comes away; wash; counterstain with picric acid or malachite-green; wash; dry, and mount. By this method, the author shows that acid-fast bacilli contain spores which are not acid-fast. He considers that some such method should be employed in routine examinations for tubercle bacilli.

Methods of Demonstrating the Flagella and Minute Structure of Spirillum volutans.‡—F. Fuhrmann investigated living spirilla on a dark ground, using Reichert's mirror-condenser. To keep spirilla at rest for this mode of examination, he prepared a fine film of the thin bacterial

* Anat. Anzeig., xxxv. (1909) pp. 295–301.
† Centralbl. Bakt., 1te Abt., lii. (1909) pp. 550–3.
‡ Op. cit., 2te Abt., xxv. (1909) pp. 129–35.

emulsion, dried this quickly in air, added a droplet of water, and applied a coverslip carefully. This was then ringed with paraffin to prevent evaporation.

The author obtained good results by using a solution containing 3 grm. of iodine and 3 grm. of potassium iodide in 20 c.cm. of water. A small drop of the fine emulsion of spirilla was placed on a clean slide, and to this a larger drop of iodine solution was added. A coverslip was then placed in position, and ringed with paraffin.

For demonstrating minute cellular structure and the intracellular connections of flagella, the organisms were fixed in corrosive sublimate, or in weak Flemming's solution. The bacterial emulsion was placed in a filter-paper folded in the usual way in a filter funnel. The fixing fluid caused the organisms to cohere in clumps, so that none passed through the filter-paper. Alcohols of mounting strengths were added, and then xylol and xylol-paraffin. Finally, the organisms were imbedded in paraffin, fine sections (2–4 μ) were cut and stained with methylen-blue or methylen-green.

New Staining Reaction for Tubercle Bacilli.*—D. Gassi stains the fixed smears in a warm solution of eosin for one or two minutes. The solution consists of 1 p.c. eosin solution, to 5 c.cm. of which a crystal of sublimate the size of a lentil has been added. After washing in water the smear is treated with a mixture of 0·5 NaHO, 1 potassium iodide, 100 of 50 p.c. alcohol, until it assumes a pale green hue, after which it is further treated with alcohol and afterwards washed in water. The preparation is next contrast-stained with acid methylen-blue for 2 or 3 seconds (methylen-blue 1, absolute alcohol 10, $\frac{1}{2}$ c.cm. hydrochloric acid and 90 c.cm. distilled water). After a thorough wash it is dried and mounted. The tubercle bacilli are red, the rest blue. By this method tubercle can be distinguished from smegma bacilli, as the latter are not alkali-fast.

Demonstrating the Presence of Lipoids in Cells.†—C. Ciaccio recommends the following procedure :—1. Pieces a few millimetres thick are fixed in Ciaccio's fluid for 24 to 48 hours (5 p.c. bichromate of potash, 100 c.cm. ; formalin, 20 c.cm. ; formic acid, 4 or 5 drops, or acetic acid, 5 c.cm.). 2. Immersion of the pieces in 3 p.c. bichromate for a week. 3. Washing in running water for 24 hours. 4. Upgraded alcohols for 24 hours ; absolute alcohol, 2 hours ; absolute alcohol and sulphide of carbon (or xylol or chloroform), 1 hour ; sulphide of carbon, 1 hour ; paraffin, m.p. 60°, dissolved in sulphide of carbon at 37°, 1 hour ; paraffin, m.p. 55–60°, 1 hour. The sections are stuck on the slide by Henneguy's method (very dilute solution of gelatin in tepid distilled water, with a crystal of potassium bichromate added). The sections are then stained with an alcoholic solution of Sudan iii. for 30 to 45 minutes, or with scarlet R. Excess of stain is then removed with 50 to 60 p.c. alcohol. The sections may then be contrast-stained with hæmatoxylin, water-blue, crystal-violet, etc., and are imbedded in Apáthy's gum and syrup medium. In some cases the following

* Centralbl. Bakt., 1te Abt. Ref., lxiv. (1909) p. 758.
† Anat. Anzeig., xxxv. (1909) pp. 17–31.

procedure is successful: (1) Fix in Ciaccio's fluid; (2) bichromate for about a week; (3) Marchi's fluid for 24 to 48 hours, followed by bichromate for 48 hours; (4) the rest of the procedure is as before. By the first method, ordinary fats are dissolved, while the lipoids (myelin sheath, adrenal, etc.), are picked out in orange-red by Sudan iii. By the second method it is occasionally possible to demonstrate the co-existence of fat and lipoid in the same cells, a black centre with a red or brownish-red margin or halo.

Modification of Gram's Method of Staining.* — S. Stephan describes a modification of the Gram procedure, which is specially useful for staining sections. The alcohol-fixed sections are stained in carbol-water-methyl-violet 6 B solution for 10 minutes to 1 hour or more. On removal they are washed in water, and then immersed in the following mixture, freshly prepared before use: 10 p.c. ferricyanide of potash 1, and 5 p.c. potassium iodide, for 10 minutes. After washing in water, the sections are thoroughly decolorised in absolute alcohol. They may now be contrast-stained with dilute carbol-fuchsin or eosin, and afterwards mounted in balsam.

Staining Eosinophilous Cells.†—L. Martinotti finds that absolute methyl-alcohol is the best fixative for smears, and that ether-alcohol (equal parts) and heat are also very good for the purpose. For fixing pieces the best fluids are sublimate, formalin, and methyl-alcohol. The author's formula for sublimate is as follows:—Sublimate, 21 grm.: alcohol, 95–100 p.c., 150 c.cm.; physiological saline, 279 c.cm.; acetic-acid, 150 c.cm. For staining the granules in sections some of the eosins must be used, and from these are picked out the bluish-eosin, the pure French-eosin, and the extra-eosin Höchst, all obtained from Grübler. The preparations may be contrast-stained with methyl-eosin, safranin, or cochineal. For staining the granules on smears the eosin-methylen-blue mixture of Jenner and of May-Grünwald are recommended. A copious bibliography is appended.

(6) Miscellaneous.

Burri's Indian-ink Method.‡—A. A. Gins finds that this method is very satisfactory for demonstrating micro-organisms, blood-plates, etc. A film is made of a mixture of the ink and the material to be examined just after the manner of a blood-smear. The method is also adapted for enumerating bacteria in a suspension. Eight photographs show organisms clearly depicted on a dark ground. The ink-smears may be after-stained, e.g. with Giemsa's solution. For making the films a smearer like Wright's is used; the author described the procedure for making a smearer out of a slide.

* Centralbl. Bakt. 1te Abt. Orig., li. (1909) pp. 94–6.
† Zeitschr. wiss. Mikrosk., xxvi. (1909) pp. 4–28.
‡ Centralbl. Bakt., 1te Abt. Orig., lii. (1909) pp. 620–5 (4 pls.).

Metallography, etc.

Copper-tin Alloys.*—F. Giolitti and G. Tavanti have re-determined the equilibrium diagram of this system, using thermal and microscopical methods. The diagram is regarded as being composed of two distinct parts, corresponding to alloys of the compound Cu_3Sn with copper and with tin respectively.

Silver Coinage Alloys.†—E. Pannain has investigated microscopically the effect of working upon a coinage alloy containing 83·3 p.c. silver and 16·5 p.c. copper. The alloy, etched with concentrated nitric acid, is observed to consist of white crystals of a solid solution of copper in silver, surrounded by a dark eutectic. The crystals become elongated by rolling; annealing tends to restore the regularity of structure. The actual coining breaks up the crystals and produces a structure sufficiently distinct from that of cast metal to permit of the detection of some false coins by microscopic examination.

Aluminium-copper-tin System.‡—J. H. Andrew and C. A. Edwards have determined the liquidus curves of this ternary system. A diagram of the well-known equilateral triangle type is given, representing the results of freezing point determinations of more than 400 alloys. Each isothermal line passes through points indicating the composition of alloys having the same freezing point. The diagram is held to demonstrate that no ternary compound is deposited from any of the liquid alloys, and that no true ternary phase appears to form above the solidus. The compound Cu_3Al is remarkably stable. Homogeneous solid alloys containing more than 16 p.c. tin and 12 p.c. aluminium could not be obtained, excessive segregation occurring. Some of the alloys separate, in the liquid state, into tin and a copper-aluminium mixture.

Lead and Tin Alloys.§—A. E. Dunstan finds that a wire of lead or tin, or an alloy of these metals, loaded in tension beyond its elastic limit, extends at a steady rate. A "viscous flow" takes place. For any given load a coefficient of viscous traction may be deduced from the rate of flow. While the effect of tin on the mobility of lead is great, the effect of lead on the mobility of tin is small.

Brass and Copper.‖—The effect of cold working and annealing upon the tensile properties and microstructure of brass containing 67 p.c. copper, 33 p.c. zinc, has been exhaustively studied by Grard. A numerical expression of degree of cold working is given by $\frac{100\,(S - s)}{s}$, S being the area of cross-section of the original fully annealed strip, s the area of cross-section of the strip after cold-rolling in the direction of its length. The effect of temperature and time of annealing was determined on strips cold worked to 125 on the above arbitrary scale. Annealing below 275° C. has little effect; between

* Gaz. Chim. Ital., xxxviii. (1908) pp. 209–39, through Journ. Soc. Chem. Ind., xxvii. (1908) p. 1155.

† Atti R. Accad. Lincei, xviii. (1909) pp. 523–5, through Journ. Chem. Soc., xcvi. (1909) p. 731.

‡ Proc. Roy. Soc., Series A, lxxxii. (1909) pp. 568–79 (9 figs.).

§ Phil. Mag., xvii. (1909) pp. 192–201.

‖ Rev. Métallurgie, vi. (1909) pp. 1069–1113 (69 figs.).

275° and 350° C. the elongation greatly increases and tensile strength falls off. The effect of annealing is in the same direction, but is more gradual from 350°–750° C. Little change takes place from 750°–830° C.; at higher temperatures the brass deteriorates. Corresponding changes in microstructure are a rapid recrystallisation between 275° and 350° C., followed by a growth of size of crystal at higher temperatures. Similar investigations were carried out on brass containing 90 p.c. copper, and on pure copper. The etching solutions used were :—

	For 67/33 Brass.	For 90/10 Brass and pure Copper.
Water	100 c.cm.	100 c.cm.
Hydrochloric acid	6 ,,	50 ,,
Ferric chloride	19 grm.	5 grm.

Iron Alloys.*—C. F. Burgess and J. Aston tabulate the forging, welding, and machining properties of alloys of iron with some seventeen other elements. The alloys, which contained so little carbon that its influence might be neglected, were prepared by melting together electrolytic iron containing about 0·03 p.c. of impurities, and the alloying element, in weighed quantities. In the nickel, copper, cobalt, tungsten, molybdenum, chromium, manganese and silicon series there was a general agreement between the weights used and the percentage composition of the resulting alloy. Silver, selenium, aluminium and lead do not alloy at all in the proportions added. Although arsenic and tin vaporise at temperatures much below the melting point of iron, considerable amounts of these elements remained in the alloy.

Iron-manganese Alloys.†—C. F. Burgess and J. Aston give diagrams and tables showing the effect of increasing manganese content upon the permeability and other magnetic properties of iron-manganese alloys prepared from pure electrolytic iron. The tests were made on the material (1) as forged; (2) annealed at 675° C.; (3) annealed at 1000° C.; (4) quenched from 900° C. The permeability falls as the manganese content increases.

Iron-copper Alloys.‡—C. F. Burgess and J. Aston have determined some mechanical properties of a series of alloys, prepared from electrolytic iron and electrolytic copper. An alloy containing 1·5 p.c. copper appears to be a promising material. Segregation was not observed in the alloys containing 0–8 p.c. copper.

Steels for Gears.§—L. Révillon gives, in addition to the results of practical tests of gears, much information as to the thermal critical points, heat-treatment and mechanical tests of 26 steels, most of which contained nickel and chromium in varying proportions.

Special Steels.‖—W. Giesen deals with a variety of subjects related to alloy steels. Great importance is attached to nitrogen content. The critical nitrogen content lies between 0·037 and 0·041 p.c. for carbon steel, that is the point at which no elongation is obtained in tensile

* Electrochem. and Met. Ind., vii. (1909) pp. 436–8.
† Tom. cit., pp. 476–8 (4 figs.). ‡ Tom. cit., pp. 527–9 (2 figs.).
§ Rev. Métallurgie, vi. (1909) pp. 1024–53. Iron and Steel Inst. Carnegie Scholarship Memoirs, i. (1909) pp. 161–218 (12 figs.).
‖ Iron and Steel Inst., Carnegie Scholarship Memoirs, i. (1909) pp. 1–59 (2 figs.).

tests. The thickness of carburised layer obtained by case-hardening at different temperatures for various lengths of time was determined for steels containing as the alloy element, nickel, titanium, silicon, manganese, chromium, tungsten, and molybdenum. The results of much other experimental work are given, but it is difficult to ascertain whether the numerous and varied statements made by the author are conclusions drawn from his own work or are based upon other published investigations.

Special Ternary Steels.*—A. M. Portevin has carried out shearing tests by the Frémont method, and tensile tests, on a large number of alloys of iron and carbon with a third element. The electrical resistance of the steels was also determined, and the relations between electrical resistance, chemical composition, micro-structure and heat-treatment were investigated. The steels used contained as third element manganese, nickel, chromium, tungsten, vanadium, aluminium, silicon, molybdenum, titanium, tantalum and boron, and were the steels of which other properties had been determined by Guillet. It does not appear possible to express the relation between tensile and shearing properties by any general formulæ. For a given series of alloys, the curve showing the relation between proportion of third element and electrical resistance is made up, as a rule, of several rectilinear portions, and the inflections in the curve correspond with changes in micro-structure. The thermal critical points of a number of vanadium and titanium steels were determined. A bibliography is appended.

Iron-carbon Diagram.—F. Wüst† gives an historical account of the development of the equilibrium diagram of the iron-carbon system, and states the experimental evidence on which he founds the following conclusions. Carbon is not dissolved in molten iron as elementary carbon, but as carbide of iron. "Kish" is formed by the decomposition of the carbide which crystallises from the fluid solution. The solidification of iron-carbon alloys does not take place according to the equilibrium curves, which apply only to the stable system. Graphite is formed by the decomposition of separated carbide. Elements present other than iron and carbon have both a direct and an indirect influence on graphite-formations : (*a*) direct, in that they enter into the composition of the carbide, and either increase its rate of decomposition (silicon, nickel, aluminium) or decrease it (manganese, chromium, tungsten) ; (*b*) indirect, in that the solubility curve of iron carbide in solid or liquid iron is displaced, and the quantity of separated free carbide is correspondingly greater or smaller. The carbide is decomposed in solid alloys by the action of heat. The influence of foreign elements on the temperature at which temper carbon is set free has the same explanation as in the case of graphite formation.

P. Goerens‡ deals very fully with ternary systems consisting of iron, carbon, and a third element. As an example to illustrate methods of investigating and representing ternary equilibriums, the lead-tin-bismuth system is selected. A model showing the diagram in solid form may be constructed from sheets of transparent celluloid, each representing a section through the diagram, erected perpendicular to a triangular base

* Iron and Steel Inst., Carnegie Scholarship Memoirs, i. pp. 230–364 (67 figs.).
† Metallurgie, vi. (1909) pp 512–31 (19 figs.).
‡ Tom. cit., pp. 531–6, 537–50 (46 figs).

any point in which represents the composition of an alloy. The diagram of the iron-manganese-carbon system is shown in this manner. The iron-phosphorus-carbon system, considered as a ternary system the components of which are iron, iron phosphide and iron carbide, resembles the lead-tin-bismuth system. Alloys of iron and carbon with a third element follow one of two types:—1. The iron-carbon-manganese system. The third element forms solid solutions with both γ-iron and iron carbide. Systems following this type are Fe–Cr–C, Fe–W–C, Fe–Ni–C, Fe–Si–C. 2. The iron-carbon-phosphorus system. The third element forms a chemical compound with iron, and the compound is insoluble in iron carbide, and insoluble or partly soluble in γ-iron. To this type belong Fe–P–C, Fe–Sn–C, Fe–As–C, Fe–Sb–C.

Useful bibliographies are appended to both these papers.

Cementation by Carbon.*—L. Guillet and C. Griffith have made careful cementation experiments on iron and low-carbon steel. Samples buried in powdered purified sugar-carbon and heated at 1000° C. in a porcelain tube in which a vacuum was maintained showed a small increase in carbon content, but when the metal and carbon were both previously heated separately to expel occluded gases, a similar "cementation" gave no increase in carbon. The effect of pressure, slight or great, was also studied. The chemical analyses were checked by microscopic examination, which gave information as to the distribution of carbon absorbed by the metal. The authors conclude that pure carbon cannot be absorbed by iron when heated in a vacuum, unless contact be assured by mechanical means, or dissolved gases be present. Cementation increases with increase of pressure.

Constituents of Steel.—The definitions adopted by the Copenhagen Congress of the International Association for Testing Materials† are given. A "metaral" is a chemically homogeneous constituent, an "aggregate" is a chemically heterogeneous constituent. The metarals are ferrite, graphite, cementite, austenite, and martensite. Pearlite, and possibly osmondite, are aggregates. Martensite is defined as a solid solution of carbon and iron, not stable at any temperature, distinguishable from austenite by its greater hardness and magnetic permeability.

H. le Chatelier‡ discusses the definitions, and explains the replacement of the name "troostite" by "osmondite," and the omission of "sorbite."

F. Osmond§ does not agree to the abandonment of "sorbite" and the replacement of "troostite" by "osmondite."

Metallography of Iron.‖—H. M. Howe considers that the results obtained by Baykoff ¶ have made possible a simplification of the theory of the iron-carbon system. The needle structure of martensite now appears to be characteristic of β-iron, not of a crystallitic form of γ-iron. The author collects the evidence that the martensite needles represent a stage intermediate between γ- and α-iron. The specific volume, brittleness and hardness corresponding to the needle structure are all greater

* Rev. Métallurgie, vi. (1909) pp. 1013–23 (3 figs.). † Tom. cit., pp. 1122–3.
‡ Tom. cit., pp. 1124–6, 1366. § Tom. cit., pp. 1183–7, 1363–5.
‖ Electrochem. and Met. Ind., vii. (1909) pp. 423–7 (5 figs.).
¶ See this Journal, 1909, p. 669.

than those of γ- or α-iron. It is, therefore, improbable that the martensite needles can be merely a mixture of α- and γ-iron.

Transformations of Iron and Steel.*—Grenet holds that the transformation of iron, and the solution of carbon in iron, are not two separate and distinct phenomena. When carbide of iron goes into solution in iron, the iron changes from the α to the γ condition. The case of pure iron undergoing the change from α to γ is the limiting case, the concentration of carbon in the γ solid solution formed being nil. Assuming the stability of cementite, the only phases occurring in the iron carbon system in the temperature range -180° C. to $+1200^\circ$ C., and the concentration range 0 to 1·60 p.c. carbon, are ferrite, cementite, and solid solution.

Hardness of Steel.†—Grenet has sought to determine if the effect of annealing quenched or cold worked steel reaches a limit for any given temperature. Small pieces of a hard carbon steel and a nickel chromium steel were quenched in water from 800° C. and heated for various lengths of time, up to 64 hours, at 300°, 500°, 650°, and 675° C. Hardness was determined by the Brinell method. The annealing effect at 300° C. was practically complete after 15 minutes. At 500°, 650° and 675° C., the effect was not complete after 16 hours, though after four hours the action was very slow. Variation in temperature of annealing has a relatively much greater effect than variation in length of time.

Use of Metallic Deposits in Metallography.‡—F. Giolitti has applied the method of depositing thin layers of metal on the polished surface of an alloy by immersion in a solution of a metallic salt, to the study of solid solutions. Indications of the heterogeneity of solid solutions may thus be obtained. The method has been employed in the study of bronzes.

Rate of Change in Alloys.§—G. D. Bengough describes a method of determining the rate of change in metastable solid alloys when heated. Portions of the alloy are heated at a selected temperature for various lengths of time, and quenched in water. Photomicrographs are taken and enlargements on bromide paper are made. The relative proportions of the phases present are determined by cutting them out and weighing the paper.

Surface-flow in Calcite.‖—By a development of the method of step-by-step etching, G. T. Beilby has shown that the disturbance of the surface of calcite by polishing penetrates to a depth of 500 to 1000 $\mu\mu$. The method of etching consists in placing on the polished surface a drop of water containing a minute and known quantity of hydrochloric acid. A known quantity of calcium-carbonate is thus dissolved, and the depth removed by a number of successive etchings is calculated. By illuminating by the nearly critical image of the sun, the author detected a roughen-

* Bull. Soc. Chim., v. (1909) pp. 758-64 (4 figs.).
† Rev. Métallurgie, vi. (1909) pp. 1054-9 (3 figs.).
‡ Gaz. Chim. Ital., xxxviii. (1908) pp. 352-7, through Journ. Chem. Soc., xciv. (1908) pt. 2, p. 945. § Journ. Soc. Chem. Ind., xxvii. (1908) pp. 752-3.
‖ Proc. Roy. Soc., Series A, lxxxii (1909) pp. 599-605.

ing of the surface, caused by etching, calculated to be not more than 2 molecules in depth. The unetched polished surface shows no trace of disturbance, and the presence of a disturbed surface layer is revealed only by etching. The disturbed layer seems to have a different molecular structure, and is harder than the original crystal. The presence of this protective skin does not interfere with the parallel growth of crystals of sodium nitrate on the polished surface.

Testing of Galvanised Metals.* — W. H. Walker, in discussing methods of determining the resistance to corrosion of zinc-coated metals, describes their microscopic structure. Between the outer coating of zinc and the iron base are a number of zinc-iron alloys.

Magnetic Transformation of Nickel and Cobalt.†—I. I. Shukoff finds that sudden changes occur in magnetic properties, electrical conductivity and thermo-electric properties, at about 340° C. for nickel and 1000° C. for cobalt. A heat effect was observed with cobalt at 985° C. by the differential method of taking cooling curves, but no such effect was observed with nickel between 600° and 180° C. The author concludes that the transformation observed in nickel depends on some change occurring in the internal structure of the atom.

Testing by Alternating Stress.‡ — H. le Chatelier discusses the relation between the behaviour of a metal under A. Guillet's vibratory test§ and its resistance to alternating stresses. Perfect elasticity is unknown. However small the deformation, a piece of metal, when the stress is removed, does not return completely to its original form, but remains deformed to a slight degree. A part of this slight remaining distortion disappears slowly, but an exceedingly small permanent deformation remains. In the slow recovery towards its original form, the metal exhibits viscosity, and this is the property which the Guillet "damping" test appears to reveal.

Gases Occluded in Steel.‖ — T. Baker has determined the composition and volume of the gases evolved by two crucible steels, containing respectively 0·81 and 0·90 p.c. carbon, when heated in vacuo. A little aluminium had been added to the second steel before casting, none to the other. More than 97 p.c. (by volume) of the total gas evolved was hydrogen and carbon monoxide, and the sound steel, to which aluminium had been added, evolved twice as much gas as the steel containing blow-holes.

SANG, A.—**Cementation.**
[Theories of various cementation processes are discussed, and methods described.] *Electrochem. and Met. Ind.*, vii. (1909) pp. 485–7, 532.

VANSTONE, E.—**Miscibility of Solids.**
[The theory of the formation of solid solutions is discussed, and the results of experimental work on various organic bodies are given.] *Journ. Chem. Soc.*, xcv. (1909) pp. 590–604 (3 figs.).

* Electrochem. and Met. Ind., vii. (1909) pp. 440–2.
† Journ. Russ. Phys. Chem. Soc., xl. (1908) pp. 1748–52, through Journ. Chem. Soc., xcvi. (1909) pp. 209–10.
‡ Rev. Métallurgie, vi. (1909) pp. 1156–60 (2 figs.).
§ See this Journal, 1909, p. 675–6.
‖ Iron and Steel Inst., Carnegie Scholarship Memoirs, i. (1909) pp. 219–29 (3 figs.).

MICROSCOPY.

A. Instruments, Accessories, &c.*

(1) Stands.

Watson's Naturalist's Microscope.†—This instrument (figs. 18 and 19) is an inexpensive Microscope, and is intended for students and for

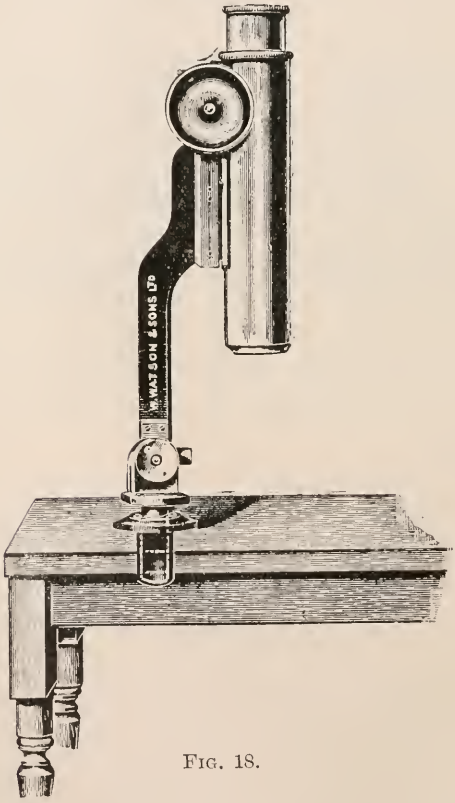


Fig. 18.

biological class work. The base for the Microscope is formed either by the case, or by the bench on which it is to be used. The illustrations show the instrument (1) with stage and mirror removed, fitted in

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

† Watson and Sons' Special Catalogue.

socket and fixed to bench or table (fig. 18) ; and (2) when mounted in socket on side of containing case (fig. 19).

Binocular Loups of Weak and Medium Magnification.*—O. Henker and M. von Rohr discuss the principles which must underlie stereoscopic vision, with especial reference to the image in space. If an object-point be selected, the principal rays proceeding from it must

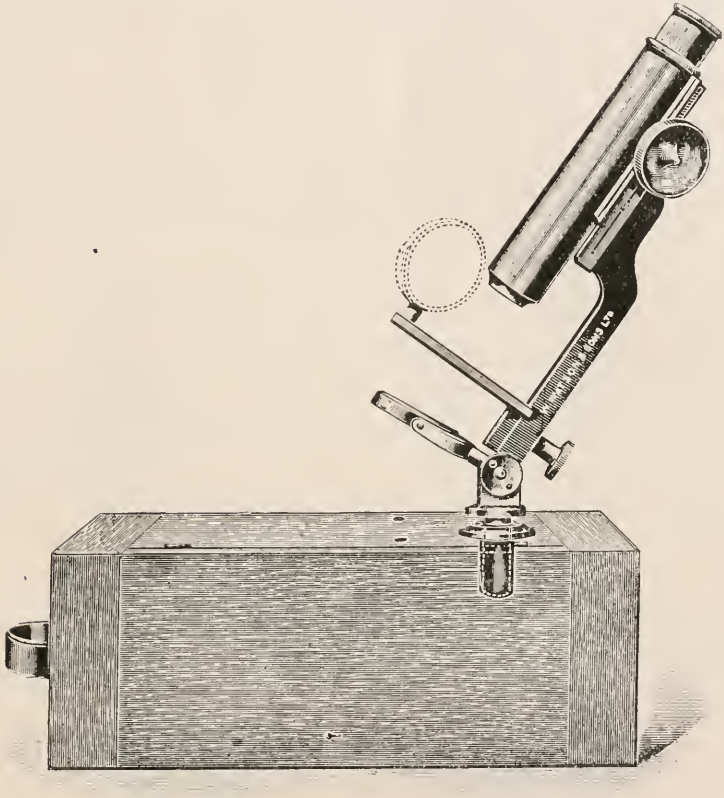


Fig. 19.

first be determined. These principal rays are those which diverge from the object to the centres of the entrance-pupils of the right and of the left instrument. After their passage through the instrument, these rays generally leave the exit-pupils at an increased refraction-angle to their corresponding axes. A space-image, in the sense of geometrical optics, occurs when the directions, produced backwards, of the principal rays pertaining to a selected object-point, intersect in a point of the space-image. The combination of all such space-points will give the true space-image of the whole object. If such a condition, incontestable as a proposition in geometrical optics, be satisfied, it is, furthermore,

* Zeit. f. Instrumentenk., xxiA (1909) pp. 280–6 (7 figs.).

possible to discuss the conditions of the allied subject—viz. the change whereby the perspective arising in the space-object is presented to the eye. That change is closely connected with the above condition. It must at the same time be supposed that the observer's eyes remain accommodated for infinity. Yet it cannot be asserted that these conditions as to accommodation-adaptability of the eyes are ever completely satisfied. But it will be difficult to deny the authors this simplifying assumption if the similar condition be conceded without hesitation in the clearer case of monocular instruments. In any case the conditions should be plainly and clearly laid down on which the consequent explanation depends.

In many instruments intended for binocular use there is no space-image, in the sense of geometrical optics, owing to the fact that in many cases the rays do not intersect, but merely cross one another. But since the observer, even in such instances, not infrequently receives a uniform impression, the explanations must be sought for in physiological rather than in geometrical optics. The result of the authors' view, therefore, is to very much narrow down the ground on which binocular instruments should be treated, and to lay a sure foundation for explaining the construction of selected forms. The space-image, in the strict sense, will only arise when the axes-directions of the system serving both eyes are parallel in both the space-object and in the space-image, and when there is also exact and similar correspondence between the planes of the object and the planes of the images.

Moveover, it is possible to consider systems with a common objective —under these circumstances the space-object possesses only a single position-plane—or with both systems completely separated, and set up parallel to each other.

The authors then discuss the application of their princples to double loups.

(2) Eye-pieces and Objectives.

Watsons' 1/6 and 1/12 Objectives.*—The essential features claimed for these lenses (figs. 20, 21) are the capability of bearing high eye-pieces without breaking down ; the capability of utilising a large solid cone of

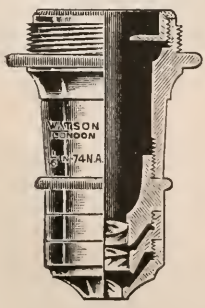


Fig. 20.

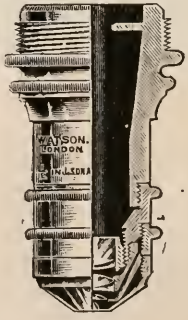


Fig. 21.

illumination ; perfect centring ; a definition which leaves no doubt as to the structure examined.

* Watson and Sons' Special Catalogue.

(3) Illuminating and other Apparatus.

Zehnder's New Half-shadow Polarimeter.*—L. Zehnder reports that this half-shadow polarimeter has proved itself very useful for the examination of elliptically polarised light. The chief parts are shown in fig. 22. The goniometer used in its construction was von Lang's. The parallelised rays, proceeding from the objective O of the slit-tube C, pass through the polariser P. They then traverse the Soleil-Babinet compensator K, and the new half-shadow analysing arrangement A. All these parts are in front of the telescope objective. The polariser P is rotatory about the slit-tube axis, and a finely divided circle T_1 is closely connected with it. This circle is coarsely adjustable, and also, by means of the screw S_1, finely adjustable ; the rotation is read off in degrees and minutes by a vernier. The compensator K is intended to convert into a directly polarised beam the light reflected at the surface under examination, and more or less elliptically polarised, of the body set on the goniometer. The compensator consists (i.) of a plane-parallel

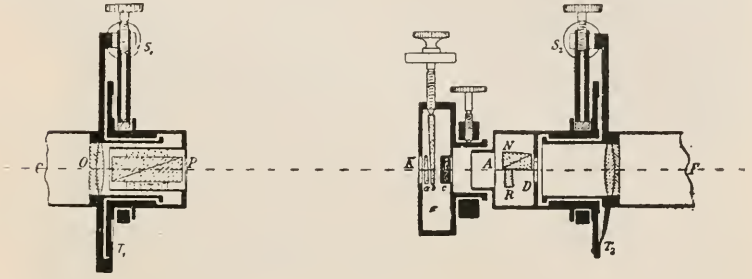


Fig. 22.

quartz plate *c* of uniform thickness, and (ii.) of two quartz wedges *a* and *b*, which together form a plane-parallel plate of variable thickness. The optical axes of *a* and *b*, on the one hand, and of *c* on the other, are orientated in the well-known manner, perpendicular to each other. The half-shadow analysing arrangement A consists of the half-prism N and of the plane-parallel dark glass R, which together half cover up the field of view defined by the circular diaphragm D. The divided circle T_2 is closely connected with this analysing arrangement, and can be rotated about the telescope axis ; the movement is partly coarse and partly, by means of the screw S_2, fine ; the vernier reads to degrees and minutes. The opacity of the dark glass plate is so selected that the diaphragm D under the light used is perfectly visible, and for this reason the ocular lens of the telescope F is made of variable width by means of an ocular slit. The well-known conditions of the Lippich half-shadow polarising apparatus are made use of in adjusting the half-prism and the dark glass. As the dark glass in each rotation of the analyser about the telescope axis transmits a uniform quantity of light, there occurs on each side of every dark adjustment of the half-prism an adjustment for half-shadow equality—that is, for uniform brightness

* Ann. d. Physik., xxvi. (1908) p. 985. See also Zeit. f. Instrumentenk., xxix. 1909) pp. 296–8 (1 fig.).

of the whole field ; between these positions the position of maximum darkness of the half-prism lies midway. As the adjustment for uniform illumination admits of greater precision than that for maximum darkness, this analysing arrangement is more accurate than a single nicol. It is, moreover, especially advantageous to have two positions of adjustment, and to take their mean.

The reflecting plane of the glass body is, by means of an auto-

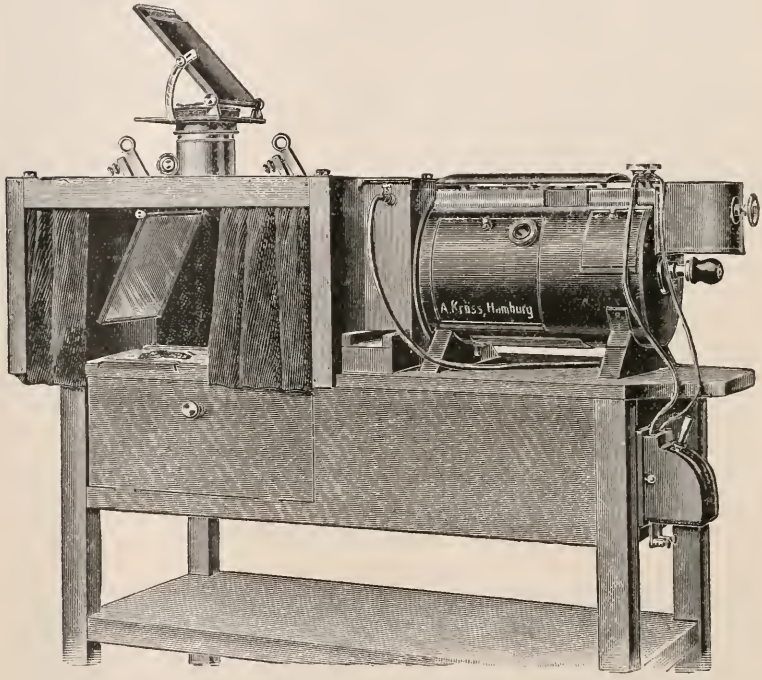


Fig. 23.

collimation ocular, provided with cross-threads, set parallel to the rotation axis of the goniometer, whereby the polarising planes of the analyser and polariser are parallelised with great accuracy, being perpendicular to the goniometer rotation axis. Consequently, it is likewise possible, with great accuracy, to calibrate the drum divisions of the compensator, and to so adjust the rotatory compensator about the telescope axis that the optical axes of its quartz plates lie parallel, being both perpendicular to the goniometer axis.

In adjustments with the compensator, the movable quartz wedge is first pushed far enough to make the half-prism show dark ; it is then further pushed, first in one, afterwards in the other direction, until the field shows equal illumination. The mean of these two adjustments of the wedge gives the position of dark adjustment more accurately than if one attempted to get it by one position of the nicol.

Krüss Epidiascope.* — This instrument, which was described in this Journal,† and was invented rather more than a year ago, has lately been improved in certain details and adapted by A. Krüss to a greater range of purposes. Figs. 57 and 58 of the former abstract illustrate the principle, while the accompanying figs., 23, 24, show the new applications. Fig. 23 shows the epidiascope in normal adjustment. A self-regulating lamp for 30–50 amperes acts as the light-source. Transition from diascopic to epidiascopic projection is effected by pressure on one of

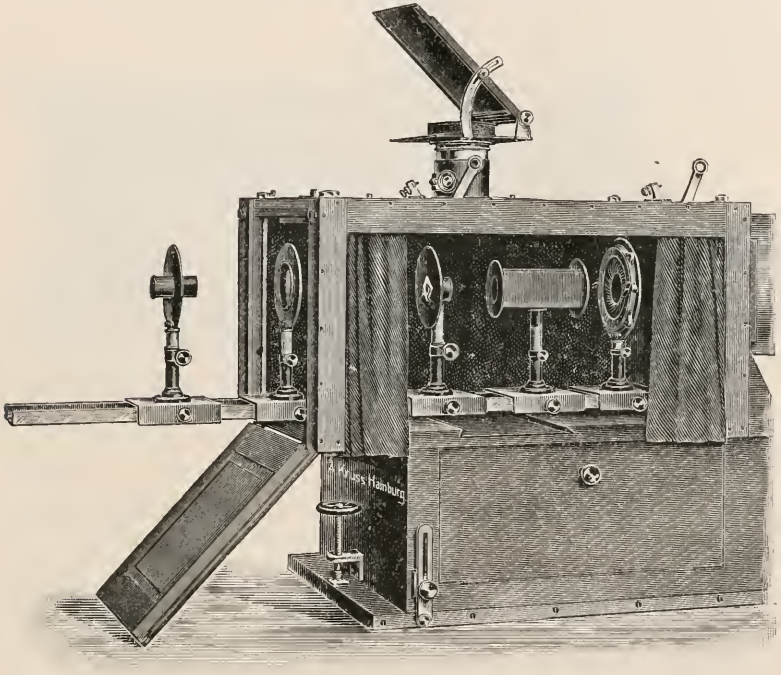


Fig. 24.

the levers seen in the figure. If both mirrors (S_1 S_4 original fig. 57) are thus put out of action and the front wall let down (fig. 24), the light-rays may then pass axially through the apparatus, and an optical bench may be inserted. Fig. 24 also shows the optical bench adapted for polarisation demonstrations. Suitable arrangements may be similarly made for exhibition of spectral, interference, and diffractive phenomena. A projection Microscope can be applied to the bench. Sometimes this Microscope objective would be equally suitable for the projection of opaque objects or of diapositives. But when considerable magnification is required, and increased distance from the screen is unattainable, the

* Deutsch Mech.-Zeit., 1909, pp. 230–2 (3 figs.).
† See this Journal, 1909 p. 251.

arrangement shown in fig. 25 may be used with diapositives. This arrangement may, moreover, be used for the simultaneous projection of two diapositives, the front part being fitted with a specially large illuminating lens, which equally illuminates two adjacent diapositives adjustable in two mutually perpendicular directions. The diapositives may be independently exchanged.

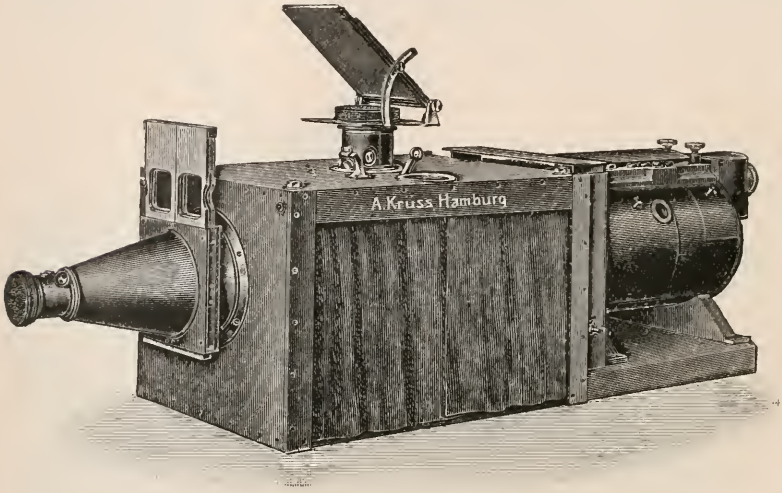


Fig. 25.

Application of Edinger's Drawing and Projection Apparatus to Macroscopic Photography.*—P. Martin has devised a stand which very much increases the usefulness of Edinger's apparatus.†. The stand is manufactured by the firm of Leitz, and consists of a convenient framework in which a camera can be placed and clamped at any angle. This camera replaces the usual optical parts, and is capable, when adjusted at a suitable distance, of projecting into the ordinary photographic part images of very large objects. By this means the author has secured photographs of the pelvis of a horse, or even of an entire horse carcass. In the latter case the carcass was on the floor of a hall, and the frame was conveniently arranged in a gallery over. The frame is mounted on castors, and is therefore easily transferred to any desired spot, e.g. a patient's bedside. With an horizontal adjustment, an object on a wall, or vertical screen may be photographed.

Ocular Micrometer with Interior Vernier.‡—The firm of Nachet, under the instruction of F. Vlès, has manufactured an ocular micrometer which is intended to possess a precision equal to that of the best divided drum-micrometers, but with a less complicated mechanism. The read-

* Zeitschr. wiss. Mikrosk., xxvi. (1909) pp. 219–22 (2 figs.).
† See this Journal, 1905, p. 650, and 1891, p. 811.
‡ C.R. Soc. Biol. Paris, lxvii. (1909) pp. 537–8.

ing, moreover, is within the Microscope, and therefore the time and inconvenience usually spent in reading an external graduation will be saved. The ocular has in its focal plane a scale divided on glass similar to ordinary micrometric oculars. In contact with this scale, and also in the ocular field, is a vernier divided into tenths, on the lower face of another glass slip gliding on that of the fixed scale. A simple metallic slide, a push-screw, and a back-spring suffice to move the vernier. The process of measurement will be easily understood, and takes place in the field of view. There are no special precautions to be taken, such as are usually necessary, with regard to errors of screw, of springs, or of carriers, in the case of external scales. Moreover, the measurement is made without taking one's eye from the ocular, and it is possible, in case of need, to dictate the readings to an assistant without the observer abandoning the observation of a fugitive phenomenon.

Watson and Sons' Holos Immersion Paraboloid.* — This apparatus (fig. 26) gives an intensely black background, with a brilliantly illuminated object, with high-power objectives up to 0·95 N.A., and is specially suited for showing unstained living bacteria. The makers supply full directions for the successful working of the apparatus.

FIG. 26.

Enumeration of Blood-corpuscles.†—R. Samut advocates the use of the following simplified methods for counting blood-corpuscles.

The enumeration of the formed elements of the blood, although admittedly of paramount importance in the diagnosis of disease, is not as frequently carried out as its value would call for. This is undoubtedly due to the fact that, in enumerating blood-corpuscles by means of Gowers's or the Thoma-Zeiss hæmocytometer, the chief difficulty encountered is the necessity of counting the large number of corpuscles in each of the sixteen small squares which make up one of the large squares, since at least eight sets of sixteen small squares should be counted before a fairly accurate result can be expected. Moreover, corpuscles often overlap the lines which form the squares, and great care is required and time lost to avoid counting them twice over.

By means of the Blenden ocular "Ehrlich" these difficulties are avoided. The construction of the ocular is as follows. An ordinary No. 2 ocular is provided with a screen which cuts out a square from the field of vision of the ocular. By means of the little knob (fig. 27) this square can be narrowed, and by means of notches, which divide one side of the square into four equal parts, the reduction may be effected in exact proportion (fig. 28).

Enumeration.—With this instrument enumeration of corpuscles is done as follows. The drop of blood is obtained and diluted in the Thoma-Zeiss pipette and blown out on to the Thoma-Zeiss ruled slide in the usual way. When this has been placed on the Microscope, allow 5 minutes to elapse. Use a No. 9 Leitz objective and a Blenden ocular,

* Watson and Sons' Special Catalogue, 1910.
† Lancet (1909) ii. pp. 1424 (2 figs.).

the slit being so adjusted by means of the little knob that four squares of the central platform of the counting chamber just coincide with it. The number of red corpuscles are counted, and the preparation may now be shifted as many times as desired, each count representing the number of corpuscles in four squares, since the slit corresponds exactly to four of the squares. The total number obtained after several such counts being divided by the number of counts, gives the number of red corpuscles per

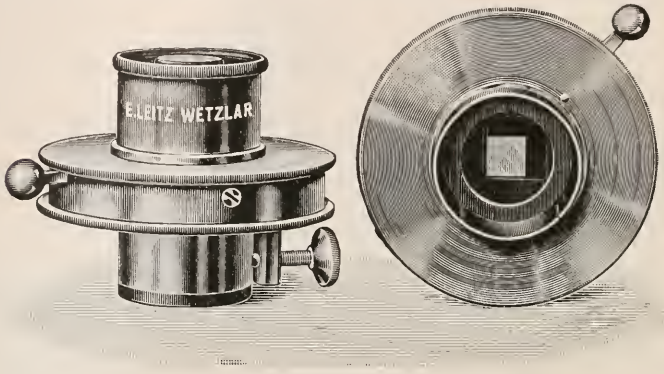


Fig. 27.

field of four squares; hence division by four gives the number per square. This number multiplied by 4000 would represent the number of corpuscles per cubic millimetre were it not that the dilution has to be taken into account, and accordingly the result must be multiplied by 100 or 200.

Example : Average number of red corpuscles per square = 10. Then $10 \times 4000 \times 100 = 4{,}000{,}000$ per cubic millimetre.

The method is quicker and more accurate than that usually employed,

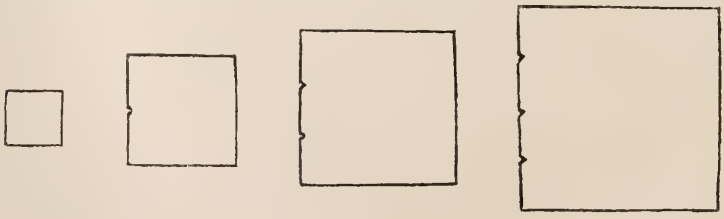


Fig. 28.

since it enables a much larger number of squares to be counted irrespective of the lines of the counting chamber, which constitute an element of confusion in the process of counting.

Again, the Blenden ocular may be used for the purpose of counting the leucocytes in the following manner. A dry-film preparation of the blood to be examined is fixed and stained by Leishman's or Jenner's stain. Using a No. 9 Leitz objective and a Blenden ocular, the number of red

and white corpuscles are counted, the shutter of the ocular being at one-half or one-quarter of the total field of vision. The count is made several times through the same slit, and an average of corpuscles per field is obtained.

Now $\quad L : R :: l : r \quad \therefore L = \frac{Rl}{r}$

where L represents the unknown number of leucocytes, R the known number of red corpuscles per cubic millimetre, and l and r represent the average of leucocytes and red corpuccles respectively per field of vision.

Pulfrich's Stereo-Komparator.—C. Pulfrich* has introduced an improvement into the above instrument, designed a few years ago,† which not only makes it better fitted for its original purpose, but also adapts it for photometric and spectrographic measurements, as well as for estimation of star magnitudes. In the earlier design the ray of light impinged on an inclined and semi-opaque film of silver (fig. 29),

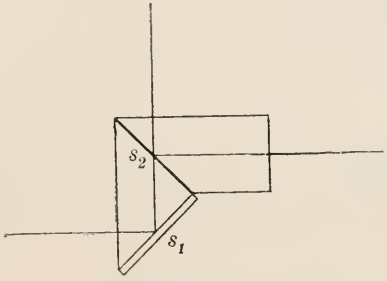


FIG. 29.

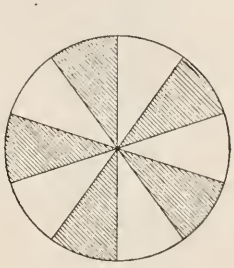


FIG. 30.

and was thus partly reflected and partly transmitted. It was found that the two images thus obtained, differed in intensity, thereby causing difficulties in experiments of comparison. The author has now replaced this silver film by a disk divided into ten sectors (fig. 30), five of which are opaque and five are transparent. He gives full details of the application of his design, which seems to have been highly successful.

ULBRICHT, R.—**Zur Anwendung des Kugelphotometers und Zur Lichtschwerpunkt-Bestimmung.** *Electrotech. Zeitschr.*, xxviii. (1907) p. 777; *Op. cit.*, xxx. (1909) p. 322.
See also *Zeit. f. Instrumentenk.*, xxix. (1909) pp. 353–6 (3 figs.).

(4) Photomicrography.

Method of Preparing Stereo-photomicrographs.‡—A. C. Banfield describes a method by which he has met with considerable success.

* Zeit. f. Instrumentenk., xxx. (1910) pp. 1–6 (8 figs.).
† Tom. cit., xxiv. (1904) pp. 161–6. See also this Journal (1904) p. 578.
‡ Journ. Quekett Micr. Club, 1909, pp. 459–64 (4 pls.).

The mathematical principle involved is that the interocular distance, normally 62 mm., has to be divided by the required magnification in order to give the angular separation through which the objective must be moved. Thus, for 32 diameters, the separation would be 2 mm.; and for 1000 diameters, 62 micra. In practice the photographic objective is kept still, and the object moved. The author uses two of Zeiss' optical benches, mounted on trestles. For very low magnifications (to about × 10) one only is used; for higher magnifications they are placed end to end. At one end of the bench, fig. 31 (pl. III.), is fixed the lamp casing, the bench itself carrying the condensers, object-stage, lens and camera, all of them adjustable in any position on the bench. The camera itself is a very simple affair, adapted for the English standard stereoscopic size, $6\frac{3}{4} \times 3\frac{1}{4}$ inches. The formula regarding objective separation resolves itself in practice into two parallel lines drawn on the focusing-screen, 62 mm. apart, by means of the stage. The object is moved until one of the lines cuts the image centrally: the first exposure is then made; the object is next transferred to the other line, when a second exposure will give the truly stereoscopic pair. The author uses Zeiss' "planar" photo-objectives, their very flat field making them especially suitable for this work; their aperture is, however, too low for high magnifications. Incident light seems to be more satisfactory than transmitted light. The Nernst electric lamp, with a one-ampere filament, makes an excellent light-source. Incandescent gas is also good, but requires long exposures. It is essential that each picture should have identical exposure. Arc-light involves a risk of burning a specimen, but only requires short exposures; it is a great help when dealing with autochromes, which have, however, special difficulties.

In the figure, B parallelises the rays; D is a long-focus lens for converging the parallel rays, after reflexion from mirror H, on the object O; E is a short-focus lens; F a plano-concave lens to parallelise the converging rays from E (this gives a parallel beam of small diameter, but of great intensity); G, object-stage, laterally adjustable by means of

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EXPLANATION OF PLATE III.

A. Lamp casing containing hand-feed arc lamp.
B. Lens to parallelise rays from arc.
C. Water-cooling chamber.
D. Long-focus lens, converging the parallel rays, after reflecting from mirror H, on the object O.
E. Short-focus lens.
F. Plano-concave lens to parallelise the converging rays from E. This gives a parallel beam of small diameter, but of great intensity.
G. Object stage laterally adjustable by means of the vertical pinion.
H. Small mirror universally adjustable.
I. 35 mm. lens (Zeiss Planar).
J. Focusing pinion.
K. Camera.
L. Optical bench, on which the whole of the above is adjustable. The optical axis of the condensing system is 52 mm. above that of the camera. The horizontal line shows the course of the central ray of light. The condensers D and E are mounted on a hinged fitting, the one not in use being folded down out of the path of the rays.

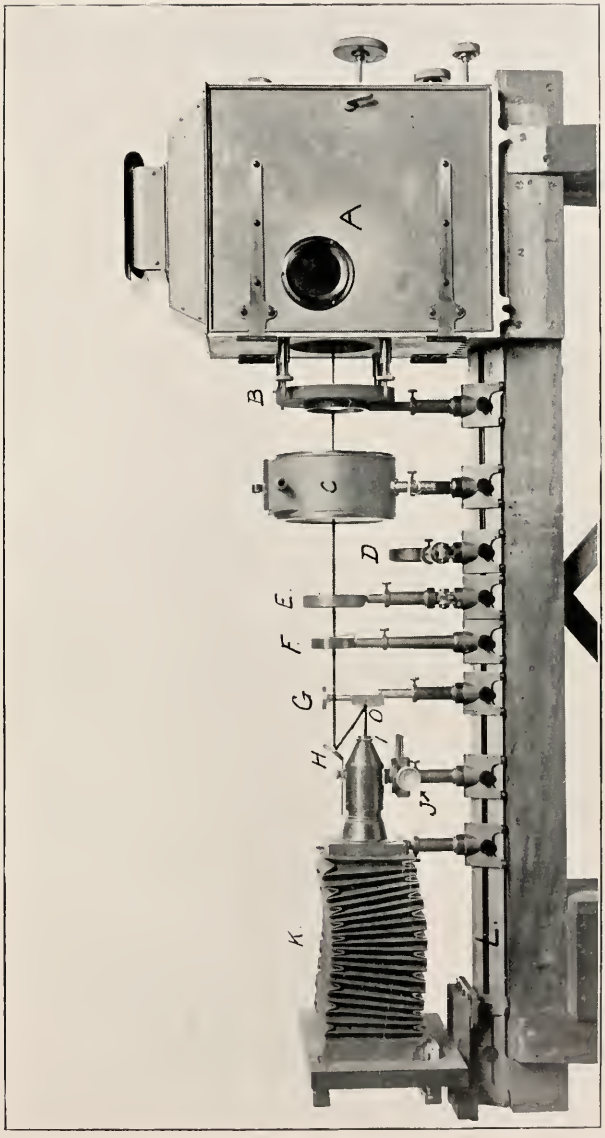

FIG. 31.—APPARATUS FOR STEREO-PHOTOMICROGRAPHY.

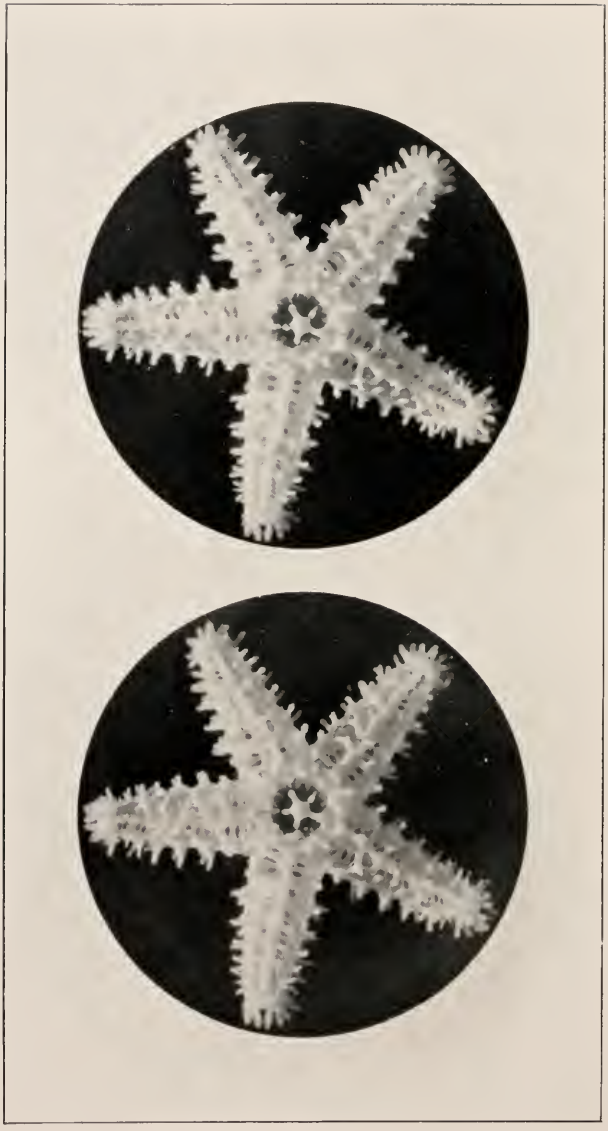

FIG. 32.—SKELETON OF YOUNG STARFISH (*Asterias glacialis*), × 7.

the vertical pinion ; H, small mirror, universally adjustable ; I, 35 mm. lens (Zeiss planar).

The author gives several examples of his results, one of which is shown in fig. 32 (pl. IV.).

(5) Microscopical Optics and Manipulation.

Standard Measurement in Wave-lengths of Light.* — The principles underlying A. E. Tutton's method of interference measurements were described in the February number of this Journal, and a later description of the apparatus was promised.†

A general view of the interferometer and one of the duplicate Microscopes of the comparator, together with sufficient of the bar-carriage to enable some idea of the whole apparatus to be gained, is now given in the accompanying illustration (fig. 33), together with the author's description.

The whole instrument is mounted on a large stone block, resting on isolated concrete foundations. On a small stone pedestal, similarly isolated, in front of the large block, rests the pedestal of the auto-collimating telescope and attached Geissler tube of the interferometer. In the common focal plane of the telescope objective and eye-piece, opposite the junction of this main optical tube with the rectangularly attached side-tube carrying the Geissler tube, a small totally reflecting prism is arranged, half covering the focal aperture. A still smaller rectangular stop or opening in a plate in front of, and almost touching, that one of the perpendicular prism faces which is directed towards the objective, and lies in the focal plane very close to the edge, dividing the closed half from the open half, is the effective source of the interfering light ; the rays from the Geissler tube, received on the other face of the right-angled prism, are arranged to fill this stop after reflection from the hypotenuse of the prism. The rays proceed from the stop to the objective, which they are arranged to fill with light, and thence pass out of the telescope as parallel rays, in the path of which the dispersion and interference apparatus is placed. The rays return to the telescope from the latter along practically the same path, but after re-entering the telescope, instead of returning to the little rectangular stop, their origin, they are deflected just sufficiently to one side to form an image of the stop, the same size as the original, in the open semicircular aperture of the focal plane, within a couple of millimetres of the real stop. This closeness to identity of path of the outgoing and incoming rays, and consequently normal incidence on the reflecting glass surfaces of the interference apparatus, is largely responsible for the magnificent field of parallel straight-lined interference bands which the author's interferometer affords, for it fulfils an essential condition for perfect interference.

With the ordinary eye-piece in position, the images of the stop reflected from the various surfaces of the interference apparatus can be focused, adequately magnified, and viewed during their adjustment to

* See this Journal, 1910, pp. 107–8.

† Tom. cit., p. 107 ; Phil. Trans. A, ccx. (1910) p. 1 ; Nature, lxxxii. (1910) pp. 338–41 (1 fig.).

the theoretically ideal positions. But when this eye-piece is replaced by a special one consisting of a Ramsden micrometer, combined with an

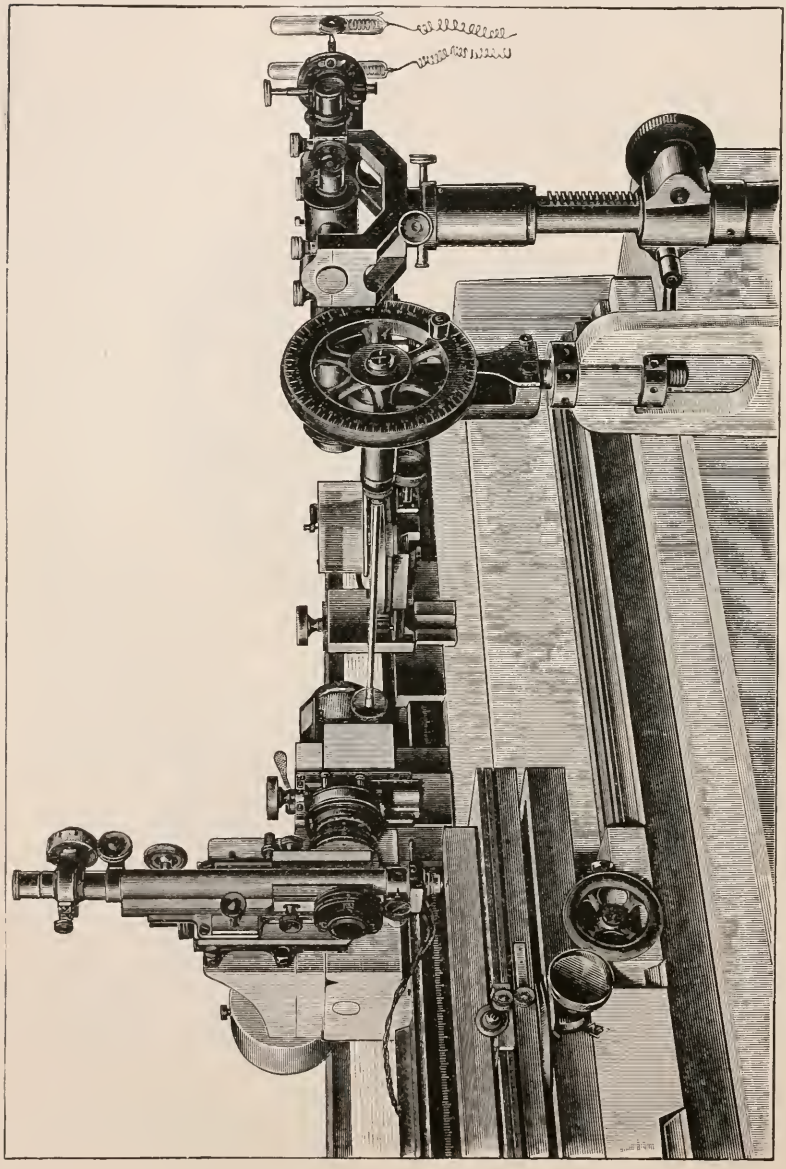

Fig. 33.

additional lens between the latter and the focal plane, the telescope is converted into a low-power Microscope, which focuses simultaneously

the interference bands, a little silvered reference ring in the centre of one of the two surfaces reflecting the interfering light, and the micrometer spider-lines. There are two parallel vertical spider-lines ; one is adjustable by the left drum-head of the micrometer, so as to be able to set it at any convenient distance from the other in order to include a single band and most of the reference ring between them ; and both are moved together by the other (right) measuring drum, in order to be able to determine the band-width and any fraction of a band which may have passed the reference centre.

The dispersion apparatus consists of a Hilger constant-deviation prism, which enables the desired spectrum ray to be isolated from all others, and that alone delivered to the interference apparatus. The rays are deviated exactly at right angles by this prism towards the interference apparatus, the surfaces of which they strike at normal incidence, after which they return through the constant-deviation prism (thus securing double dispersion) to the telescope. The prism is mounted on a divided circle, so that it may be calibrated for the delivery of light of any desired wave-length, if desired, and has numerous adjustments. Such calibration is not essential, however, as the particular image of the origin-stop in the colour corresponding to the spectrum bright line of cadmium or hydrogen can be adjusted visually on removal of the front lenses of the Ramsden eye-piece.

The interference apparatus consists of three circular and thick glass disks, the third of which is of black glass polished an absolutely true plane on its outer surface, which is one of the two important surfaces concerned in the production of the interfering light. It is ground on the back surface, by which it is attached in an adjustable manner to the right Microscope of the comparator, the movement of which it is to record. The outer two are larger disks of colourless glass, identically similar, the two truly plane surfaces of each disk not being strictly parallel, but inclined at the minute angle of 35′. The left surface of that one nearest to the black glass disk is the second surface concerned in the interference, and approaches the black glass within a millimetre ; the second is a duplicate one, merely introduced on the right of it to correct for the slight dispersion produced by the 35′ of inclination, the two being set oppositely as regards the direction of the wedge. The 35′ inclination is just adequate to deflect out of the field of the telescope the reflection from the other (right) surface of the left colourless disk, and both images from the countervailing disk are got rid of by a slight tilt in the rectangular direction. All the many adjustments required are provided for in the mounting of the two colourless disks on a separate carrier sliding along the face of the upper V-and-plane bed of the comparator.

The apparatus, as described up to this point, is the interferometer.

The comparator consists of two V-and-plane beds, nearly 7 ft. long, of specially homogeneous cast-iron, and worked truly plane with consummate care, together with their contents ; they are arranged stepwise, one on the top of the stone block, and the other $7\frac{1}{2}$ in. below and in front. On the upper one slide the two duplicate Microscopes, and on the lower one the standard-bar carriage and accessory fine-adjustment fittings. The carriage is given a longitudinal motion, a transverse

motion adequate to bring either of the two bars to be compared under the Microscopes, as well as fine-adjustments for azimuth, height, and level, thus enabling the defining marks on the bars to be readily focused without touching the Microscopes if it is so desired.

Each Microscope is carried on a solidly constructed slider on the V-and-plane bed, by which its coarse-adjustment for position is effected. The microscope-bearing bracket is not, however, fixed directly to this slider, but to a second one sliding over the first, also with V-and-plane contact, and with the further control of the movement of a cylinder within a cylindrical boring. The fine-sliding is effected by means of a most carefully made screw of fifty threads to the inch, on which the success of the instrument depends, and which carries at its outer end a large milled head for hand rotation, and a worm-wheel of 100 teeth gearing with an endless screw, which can either be rotated by hand by means of a milled head or by means of a shaft and a large wheel, seen in front in the illustration. One complete rotation of the latter corresponds to the movement of the Microscope and the black glass interference disk to an extent which causes the passage of fifteen interference bands past the reference centre. More than an inch of movement of the circumference of the wheel is necessary to effect the passage of a single band. Two-thirds of the dead-weight of the Microscope and slider are taken up by four spring pistons, and the movement of the slider by the screw is only a push in either direction against the walls of a recess in the free slider, there being absolutely no strain anywhere. Hence this movement of the Microscope is not only an excessively fine one, but also so steady that the bands pass with a precision which leaves nothing to be desired, and each band may be held for any length of time for counting purposes.

Each Microscope is provided with a micrometer eye-piece, with spider-lines arranged as in the interferometer. The fine-adjustment is made exceptionally steady and regular. Two sets of objectives are provided, one pair for observing the defining lines in the countersunk wells near the ends of standard bars, with a magnification of 150 diameters, and without penetration of the well by the objective, and the other set for use with the wave-length rulings.

The defining lines, of whatever character, are illuminated (with "critical illumination") by the brilliant image of a distant Nernst lamp, with the aid in each case of a little reflecting prism, a collimating lens, an iris diaphragm, and a glass-plate mirror above the objective, all provided with fine-adjustments. This avoids all heating effect on the bars, and the last traces of heat rays are filtered out by a thick water-jacket in front of the lamp and its beam-parallelising lenses. The illumination of the wave-length rulings $\frac{1}{40000}$ in. apart is excellent with the $\frac{1}{2}$ in. dry objectives employed, and the definition truly surprising.

The temperature of the whole comparator room is maintained at the official temperature, 62° F., entirely electrically, both as regards artificial heating and the thermostat, which is original. So sensitive is the latter that the entrance of a person into the room is immediately followed by the extinction of one of the heating lamps to compensate for the extra warmth introduced.

The finest defining lines yet employed on any line-measure bars are

those on the platinum-iridium copy of the imperial standard yard. Yet even each of these has a thickness equivalent to fifteen interference bands. The defining lines on the imperial yard itself are three times as coarse. Hence we have now arrived at that stage in the competition between defining lines and refinement of measurement when the latter has far surpassed the former. It was for this reason that the author took up the investigation of wave-length rulings, with the idea of their possible use as defining lines commensurable with the increased refinement of measurement. Mr. H. J. Grayson, of Melbourne, whose wonderfully fine rulings have recently been much discussed in microscopic circles, has kindly made a number of rulings of $\frac{1}{40000}$ in. fineness, which preliminary experiments indicated as feasible for the required purpose, on polished speculum-metal and platinum-iridium, which appear, particularly the former, perfectly satisfactory. The $\frac{1}{40000}$ in. being the wave-length of red hydrogen or cadmium light, the distance between two lines ruled at this interval corresponds to only two interference bands. With the $\frac{1}{12}$ in. dry objectives, the lines, moreover, are as cleanly cut as spider-lines, and the thickness of a line is less than half a wave-length. Five such lines are ruled in succession, the central one being considered as *the* defining line. A strong finder-line is ruled on each side of the five, and two other strong ones at right angles in order to localise a central part of such a system. It appears perfectly feasible to carry out a stepping-off process for the counting of the total number of wave-lengths of cadmium red light in the British yard, in which such rulings would take the place of the glass plates of the Michelson or Fabry and Perot *étalons*, a base line of the thirty-second part of an inch being first actually counted in bands with the aid of the interferometer, between limits defined by two such systems of rulings. The final fraction of every stage in such a process could be absolutely checked by the interferometer in all cases where Michelson found it possible to do so, that is, so far as interference bands are still visible, about 4 in.; and, as it has already been proved that the accuracy with the rulings is almost as great as with interference bands, this checking ceases to be as imperative as when only the coarse existing defining lines are available. Hence, the future before these rulings appears likely to be both interesting and important.

On the Production of Micrometric and Diffraction Rulings.* Henry J. Grayson says: Some years ago I had occasion to use some finely-ruled glass plates, not exceeding 0·01 in. thickness, the lines upon them ranging from 0·02 in. to 0·004 in. apart. These, I found, were not readily obtainable commercially, so that I had to devise some method of producing them for myself. After a few experiments, I soon found I had no difficulty in ruling lines greatly exceeding in fineness and accuracy any of the kind I had hitherto seen, and, as the matter was interesting to me from a microscopical standpoint, I pursued it apart from my immediate requirements.

The apparatus I first devised and used was exceedingly simple in principle, and consisted essentially of a fine steel screw and wedge of glass, the incline of the latter bearing some definite ratio to the pitch of

* The Microscope, i. (1909) pp. 4–11.

the former. This glass wedge travelled along a bed, or base-plate, also of glass, being kept in position by means of a slot cut along its surface. As the wedge was propelled forward by the screw it raised a vertical plate, accurately adjusted at right angles to the base-plate, and as free as possible from movement other than that imparted to it by the wedge. To this vertical plate, the slide, or disk to be ruled upon, was attached by means of a suitable cement. A platform, for the support of a sliding diamond carriage, bridged the base-plate and wedge at a suitable height, being, of course, arranged transversely to and in front of the vertical slide.

With this roughly constructed apparatus I was able to produce ruled bands, or groups of lines, ranging from 5000 up to 50,000 lines per inch. The apparatus has since been completely rebuilt, being variously modified and altered in accordance with experience gained, and the greater precision demanded by the class of work subsequently undertaken.

My work has tended mainly in the direction of perfecting rulings for micrometric measurements, and for test purposes. To accomplish this, I have had so to modify and improve the apparatus with which I first commenced work, as to render it capable of precise and accurate movements much less than 0·00001 in.; also to select and mount diamonds with knife edges of a fineness or keenness equal to the grouping together of lines less than 0·00001 in. apart, and yet of such strength and durability as to be capable of producing many thousands of such lines without material alteration in character; and, last, but by no means least, so to mount these rulings as to exhibit them in the best possible manner, while at the same time insuring their permanence as microscopical preparations.

The selection, setting and cutting action of the diamond are of the utmost importance. Nearly all the stones I have used have been obtained from Bingara, N.S.W.

I have tried Brazilian and West Indian diamonds, also the black diamond or carbonado, none of which appear to possess any advantage over those obtained from New South Wales. Some little time ago I received from Dr. van Heurck, of Antwerp, two stones which had been specially prepared after the method of Nobert, by one of the most skilful diamond workers in that city, neither of which was of any value, the cutting edges being much too blunt for fine work. My own method of preparation is to carefully break the stones so as to insure fracture parallel with some of the numerous cleavage planes. The fragments so obtained are examined under the Microscope as to the perfection or otherwise of the angles or edges and faces forming them, the promising pieces being put aside for trial. Good results have also been obtained with stones upon which large facets had been ground on the outer or natural face and afterwards broken so that one face of the knife edge was artificially formed, while the other followed the line of cleavage. Excellent cutting angles have been obtained, too, in the case of stones one face of which forms the outer coating, or skin as it is termed, of the uncut gem.

I always set or mount the diamond so that its cutting edge is perfectly parallel with the line to be cut, and slightly raised in the

direction in which it is to travel. This is contrary to what one would expect, comparing the action of a diamond with a steel graver or other cutting instrument for like purposes, but when it is remembered that the faces, the junction of which form the cutting edge, wear more rapidly than the edge itself, one sees the analogy no longer holds good. In the setting and adjustment of the diamonds it is important to remember that, in the case of test rulings at any rate, the lines after being ruled must on no account be rubbed or polished, consequently, the material removed must be deposited on one side or the other of the groove formed, and this involves the utmost nicety of adjustment of the cutting edge, and not infrequently is a considerable tax upon one's time and patience. The finer the ruling, the greater is the importance to be attached to this particular feature. The length of the cutting edge is also of moment. The longer the edge within certain limits, soon ascertained by experience, and providing it is perfectly straight, the longer will it endure, but as depth and breadth of line are important factors, too long an edge implies too great a pressure strain to produce a line of given depth and width. The pressure upon the diamond to produce a line of a certain depth and breadth, I apply, in the case of micrometric rulings, by means of a spring controlled by a screw; this gives good results up to a rate of 20,000 lines per inch, but beyond this the friction involved is detrimental. The variation of pressure requisite in test plate ruling is obtained by means of a series of weights ranging from 20 grm. or more down to a fraction of 1 grm.

In the matter of spacing, it is of the utmost importance that a correct standard should be obtained as a basis for all micrometric measurements. At the outset, I obtained copies of portions of the standards in use at the Melbourne Observatory, both metrical and English inch values. On carefully examining these I found a slight discrepancy between the inch scale, as copied directly from the standard, and the same values obtained by computation and ruling from the metrical standard. As I had no means of determining which of the two scales was more likely to be correct, I adopted the metrical scale as it stood as my standard for metrical values, and the inch values, as copied from the standard inch scale, as a standard for fractional values of an inch. At a later date I submitted several micrometer rulings to Mr. E. M. Nelson, a recognised authority upon all matters connected with measurements of this character, with the result that it was found that the ratio of inch to millimetre was, in the case of my inch rulings, 25·3821 instead of 25·39997; but as the metrical values proved to be correct, in comparison with the best standards, I have since adopted this scale as a basis for both systems. It may be of interest to know how I determine that lines stated to be ruled, say, at the rate of 90,000 per inch, are really of that value. For this it is only necessary to adjust the relationship of the wedge to the screw once for all, so that forty revolutions of the latter give a movement equal to 0·02 in., in which case one revolution will equal 0·0005 in. As the error in forty revolutions can easily be brought within $\frac{1}{500000}$ in., the error in $\frac{1}{40}$ of this is a negligible quantity. The screw-head being divided into 360 degrees reading by a vernier to $\frac{1}{10}$ of a degree, 8 degrees of movement of the screw-head advance the plate being ruled the $\frac{1}{90000}$ part of an inch,

and so, proportionately, for other values up to 120,000 lines per inch, the finest I have ruled which have so far been resolved. In passing, I may state that the finest lines it has been possible to resolve or separate, by means of the most perfect microscopical appliances hitherto constructed by the best makers, have not exceeded 120,000 per inch.

I have yet said nothing concerning the glass most suitable for ruling upon. Ordinarily the outer crust or surface of the glass as it leaves the makers' hands is much too hard and brittle for the purpose, and speedily ruins the hardest diamonds. This is especially so in the case of thin unannealed microscopical cover-glass, which it is essential to use for many purposes. Hence it occurred to me that it might be possible to so modify and alter the surface of this glass by a process of annealing that better results would be obtained. After some few trials I found that by inclosing a carefully cleaned cover-glass in a metal capsule, and slowly heating to a certain point, short of actual softening, and allowing the cooling process to extend over as long a period as possible, the glass proved to be both softer and tougher, and at the same time far less liable to any alteration due to changes in temperature, or the relief of certain surface strains inherent to the glass in its unannealed condition.

I pass on now to a matter of equal importance with any hitherto dealt with, viz., the preservation of the completed rulings. Ordinarily in the case of micrometer rulings varying from 1 mm. to 0·01 mm. all that is necessary is to fill the lines with graphite, and mount the cover on a slip with Canada balsam. But this method is not suited to the finer rulings, or where it is desirable to preserve the lines without the graphite filling, as in the case of test plates. Nor is it possible to preserve them by attaching the cover-glass to a cell wall or ring of cement or wax, as is frequently done with other microscopical preparations. I myself tried every, or almost every, known cement and wax cell at all suited to the purpose, and in every instance it was only a question of time, probably a year or more, and the cover-glass became coated or covered with minute crystals in some instances, or microscopical beads of moisture in others, to such an extent as to detract greatly from the beauty and perfection of the lines, and in some cases to partially obliterate the finer bands altogether. It therefore remained for me to endeavour to mount the ruled plates in a medium possessing a refractive index differing from glass by an amount equal to the difference between glass and air. Several such media existed, and had been used for other purposes, but with only partial success. These were phosphorus, sulphur, and realgar, or arsenic disulphide. The latter appeared to me the most promising substance to work with, seeing it possesses a refractive index equal to 2·549, but its use is attended with many difficulties, and I worked with it for nearly a year with only partial success. I soon abandoned all attempts to use it in a liquid form dissolved in the usual solvent, bromine, which I found both uncertain and dangerous to use, and turned my attention to the production of thin films, by sublimation. With these I was more successful, and after a time was able to produce exceedingly thin films, which have so far proved quite permanent. Some of the films here shown have been mounted over two years, while those sent to London some little time ago withstood all the

changes of temperature to which they were subjected on the journey without showing any signs of depreciation.

Measurement of the Refraction Index of Liquids by the Microscope.*—M. L. Décombe's method is based on that of Brewster, but is much more precise. The method requires a glass plate with parallel faces L, and a plano-convex lens resting on the plate (fig. 34). A drop of the liquid to be studied is placed at O, between the plate and the lens. A is a luminous point. By the help of a Microscope, the positions of the images O′ and A′ are determined, being (1) the distance from O the point of contact of plate and lens; and (2), the distance from the luminous point A. If Δ be the displacement of the Microscope, and ν the index of the liquid, it follows that

$$\nu = A - \frac{B}{\Delta}$$

where A and B are two positive constants which, in the special case when A is at infinity, have for their respective values A = N, B = R; N and R expressing respectively the index and the curvature-radius of the lens. The coefficient A = N must be previously determined by goniometric methods; then B can be calculated, if ν for a known liquid be taken.

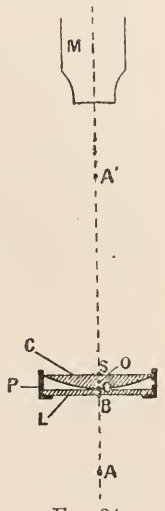

Fig. 34.

The point O′, being independent of the imperfections of the plate L, of the aberrations of the curved surface and of the nature and opacity of the liquid, can be determined with great accuracy, and can be ascertained, once for all, at the outset of each series of observations. Precision depends particularly on B; but the author's experiments show that in monochromatic light the error can be easily rendered less than 0·001. To get the second point as accurately as possible, a liquid biconcave meniscus should be employed—i.e. the liquid should be interposed between two convex glasses in contact at their summits, the radii of curvature being chosen in such a manner as to reduce to a minimum the mean spherical aberrations.

In the author's experiments a cross lightly traced with a diamond on the plate L served as a net for the first point. Various precautions had to be taken, and these are described in the treatise. A Monpillard screen giving green light sensibly monochromatic, was used. When the adjustments have been made, and the constants obtained, it will be noticed that the method requires only a single drop of the liquid; and that also the extreme tenuity of the layer is serviceable for translucid fluids; and that the small volume removes difficulties as to temperature.

Pleochroic Halos.†—F. P. Mennell draws attention to the special interest attaching to this subject, since Professor Joly's suggestion that they are due to the radio-activity of the inclusions round which they

* Comptes Rendus, cl. (1910) pp. 389-91 (1 fig.).
† Geolog. Mag., vii. (1910) pp, 15-19 (1 pl.).

occur. The usual type of halo, as seen in rock sections, is a dark spot of roughly circular outline surrounding a small centrally situated inclosure in another mineral which itself may, or may not, also be pleochroic. The author has found that the following minerals usually show halos :— Beotite, augite, hornblende, muscovite, chlorite, tourmaline, cordierite, staurolite, and andalusite. There is sometimes a difficulty in the identification of the mineral producing the halo, but the author has detected zircon, sphene, apatite, orthite (allanite), and epidote. All these latter minerals (except, perhaps, epidote) are well known to be, comparatively speaking, strongly radio-active. As far as the rocks are concerned, halos are far more common in those of igneous origin than in the other classes, and are especially noticeable in the plutonic types, particularly the granites. The halos are usually spherical in shape, but irregular grains, or granular aggregates, produce halos of corresponding shape, the coloured margins being, however, of uniform width. This uniformity of width is a remarkable feature, the measurement of a large number of cases giving few variations from 0·03 mm. Professor Joly has pointed out that the penetration of the α rays emitted by radium compounds is about 0·04 mm. in the case of aluminium, and, having regard to the slightly greater density of the minerals examined, the results are in close agreement with the theory that the halos are due to the alteration of the surrounding minerals by these rays.

(6) Miscellaneous.

Homogeneity of Optical Glass.*—W. Zschokke points out the difficulties in producing homogeneous glass. The importance of the subject needs no demonstration, but the attainment of homogeneity seems impossible. Even the best compounded and cooled glass-meltings vary considerably in their refractive index. The variation would be less important if the manufacturer had only to make a single lens, but his task is more frequently the manufacture of compound lenses and of reproductions. As a means of testing want of homogeneity, the author suggests the cutting of a right-angled prism from a given slab. By telescopic observations on an "infinitely" distant object seen through the prism, the refractive index can be calculated for different parts of the prism. The knowledge thus obtained may be useful in selecting a suitable part for lens manufacture.

Spiers' "Nature through the Microscope." †—This work, the subtitle of which is "The Rambles and Studies of a Microscopist," is a popular account of some of the better-known "Marvels of the Microscope." It is written in language as simple as the subject-matter permits, and the descriptions convey as much information as a quite uninstructed observer may be expected to assimilate. It is designed primarily to interest such an observer in the Microscope and its revelations, and also to assist a beginner in the choice and use of an instrument. The volume is copiously and satisfactorily illustrated.

* Zeit. f. Instrumentenk., xxix. (1909) pp. 286-9 (1 fig.).
† London: Culley (undated) 335 pp. (10 col. pls. and about 300 drawings).

Quekett Microscopical Club.—The 461st Ordinary Meeting of the Club was held on December 28, 1909, the President, Professor E. A. Minchin, M.A. F.Z.S., in the Chair. Mr. R. T. Lewis, F.R.M.S., gave an interesting account of "The Pollination of the Asclepiads." His attention had been drawn to the subject by the finding of dried pollen-sacs of one of this genus firmly attached to the feet of some insect specimens received from Lindley, O.R.C. A reference to Kerner and Oliver's "Vegetable Kingdom, ii. pp. 257–9, was given.

The 462nd Ordinary Meeting was held on January 25, 1910, the President in the Chair. Mr. James Murray, one of the scientific staff on board the 'Nimrod,' gave an interesting account of the aquatic organisms taken in the Antarctic by Lieut. Shackleton's expedition. Preparations by Mr. Rousselet from material brought home by the expedition were shown of *Philodina gregaria*, which occurred in great abundance; *P. alata*, remarkable for its large lateral processes; *Adineta grandis* sp. n., from Ross Island; and *Hydatina senta*.

At the 44th Annual General Meeting, held on February 22, the President, Professor E. A. Minchin, M.A. F.Z.S., delivered the annual address, taking for his subject, "Some Considerations on the Phenomena of Parasitism amongst Protozoa." In the sense under discussion a Protozoan is a parasite when it lives at the expense of another animal, called its "host." Such parasites may live on the host (epizoic) or in it (entozoic). Both these classes may be further divided into non-lethal (harmless) and lethal, or disease-producing, species. The lethal powers of the latter class are most probably due to specific toxic effects produced by them. Lethal species may be regarded as exceptional and aberrant forms, the majority of Protozoan parasites being harmless. After dealing briefly with the few known cases of active migration of parasites to infect a new host, the special methods of dissemination, of which at least six are known, where the escape of the parasite by anatomical channels is not possible, were described at some length. Sir E. Ray Lankester had suggested that the extinction of animals seen in past geological periods may have been due, in some cases, to their extirpation by some species of parasite new to them, and consequently very deadly. In proposing a vote of thanks to the President, the Chairman, Mr. C. F. Rousselet, F.R.M.S., said that when recently in Canada he had heard it suggested that the extinction of the vast herds of buffalo was caused by some peculiar parasitic malady.

B. Technique.*

(1) Collecting Objects, including Culture Processes.

Cultivation of Leishmania Donovani in Fluid Media.† — A. Laveran and A. Pettit use a peptone-salt medium, which is distributed in Roux's flasks and then sterilised. Into each is poured an equal quantity of defibrinated rabbit-blood. As the cultures are only successful when there is a thin layer of liquid, the flasks are laid flat in the incubator, which is regulated for 21–22° C. The quantity of

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

† C.R. Soc. Biol. Paris, lxviii. (1910) pp. 114–15.

liquid should not exceed one-tenth of the total capacity of the flask. In three or four days growth is evident; in a week the colonies are visible to the naked eye.

Use of Magnesium in Stupefying Marine Animals.* — A. G. Mayer finds that marine animals can be anæsthetized much more rapidly if placed in an aqueous solution of $MgSO_4$ or $MgCl_2$ of three-eighths molecular concentration. They then subside into complete relaxation, and after an hour or two may be killed in any way without becoming distorted through contraction. The method has been tried with marked success, and seems specially suitable for stupefying highly sensitive and contractile animals.

Method of Examining Embryos from the Maternal Tissues of the Rat.†—V. Widakowich, in a contribution to the study of the embryology of the rat, gives an account of his method of obtaining embryos and ova from the uterus and Fallopian tubes of the female rat. In some cases he examined specimens extracted from the maternal organs; in other cases, he prepared specimens of the tubes or the uterus with the contained embryo and examined the tissues by means of serial sections. Zenker's fluid and Schaffer's formalin-alcohol were the most satisfactory fixing fluids. Sublimate-alcohol was tried, but made the specimens very brittle.

For imbedding such objects as Fallopian tubes containing ova, or the uterus containing an embryo, the ordinary celloidin and paraffin-methods were unsatisfactory. A combined celloidin-paraffin method gave good results. The material was soaked in 4 p.c. celloidin and then exposed to chloroform vapour. When the celloidin became solid, the block was immersed in benzol and then imbedded in paraffin with a melting-point of 58° C.

Studying New Sporozoon in Rat-fever.‡—From the blood and lymphatic glands of two individuals suffering from rat-fever—rat-bite disease—M. Ogata has obtained sporozoa, to which he has given the name *Sporozoa Muris*. They appear to belong to the Neosporidia. Inoculation of material from the ulcers, blood, or lymphatic glands of the patient into rabbits and guinea-pigs causes the death of these animals in from one to three months. From their blood, sporozoa in various stages of development may be recovered.

New Hot-water Funnel.§—Many of the present funnels for filtering agar and other fluids at a high temperature, prove unsatisfactory in use. V. Brudny describes an improved apparatus (fig. 35), free from the disadvantages of the older types. It consists of a copper vessel in the shape of an hour-glass. The lower truncated cone contains water, maintained at a constant level by means of the small side-chamber provided with supply and overflow tubes. The water is heated by means of a Bunsen ring, which is fixed to one leg of the tripod stand

* Biol. Bull., xvii. (1909) pp. 341–2.
† Zeitschr. wiss. Zool., xciv. (1909) pp. 242–7.
‡ Mitt. Med. Fakul. K.-Jap. Univ., viii. 3 (1909) pp. 287–318.
§ Zeitschr. wiss. Mikrosk., xxvi. (1909) pp. 418–21.

on which the apparatus rests. The steam rises into the upper inverted cone, in the hollow of which rests the glass filter funnel. The inner wall of this hollow cone is perforated to permit of the escape of the steam and its access to the outside of the glass funnel. Any condensation water trickles down into the receptacle below, seen in the hollow of the Bunsen ring.

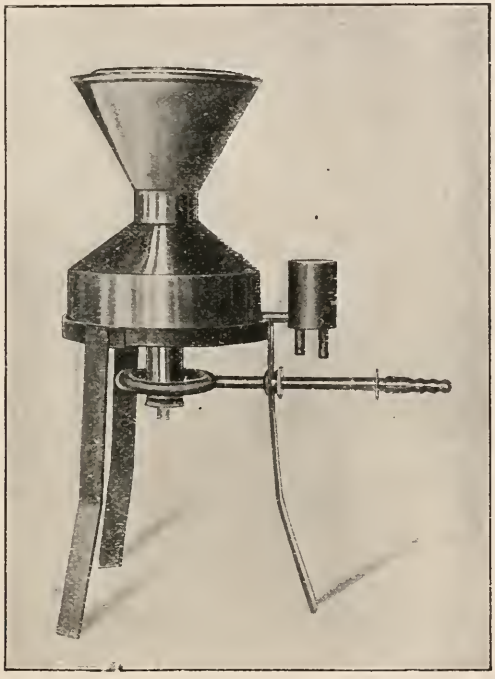

Fig. 35.

Examination of the Blood for Trypanosomes, etc.*—C. Levaditi and V. Stanesco have utilised the hæmagglutinating property of ricin to facilitate searching in the blood for trypanosomes, spirilla, and the like. They take small centrifuge tubes and place 4 c.cm. of the solution of ricin in each tube. The tubes are then sealed and sterilised. When required for use, a tube is opened and 20–30 drops of blood introduced. Agglutination begins at once, and is completed in a few minutes. When all the globules have fallen to the bottom, the supernatant fluid is decanted and centrifugalised. The supernatant fluid is again centrifugalised, leaving a drop to dilute the sediment. This is then pipetted off, and may be examined fresh or stained with Giemsa. In the

* C.R. Soc. Biol. Paris, lxvii. (1909) (1909) pp. 594–6.

authors' hands this method has greatly simplified the detection of these parasites.

Glycerin-agar in Fifty Minutes.* — R. G. Perkins describes the following method for the easy and rapid making of glycerin-agar. The materials used are agar 12 grm., peptone 10 grm., salt 5 grm., and Liebig's extract 2½ grm. Witte's peptone and Liebig's extract appear to be necessary, as the results are less good with others.

Weigh an enamelled pan, preferably one with a double copper bottom, as this reduces the chances of burning, with 1200 c.cm. of distilled water, and record the weight. Place on the gas stove while weighing the other materials, with about 150 c.cm. of additional water to allow for evaporation. This is an important part of the process, as it makes a greater dilution for the first solution of the materials. Add all the materials at once and boil till the whole is in solution, which should be in less than 15 minutes. Cool to 60° C. by the addition of enough cold distilled water to keep the total weight up to about 150 grm. over the sum of the pan, 1200 c.cm. water and the agar, etc. Make faintly alkaline to litmus, and add the whites only of two *absolutely fresh* eggs, beaten up in a little water. Boil, not too vigorously, until the medium boils up clear, and the egg is completely coagulated. The weight at this point should be the sum of the pan, the 1200 c.cm. of water, and about 50 grm. for the added materials. Skim and pour into wire funnels with filters of Schleicher and Schull No. 580, which have just had boiling water poured over them. The funnels are of the type which can be bought with a rubber ring at the top for compression, but I have found them more satisfactory when the top ring is of wire with the rays soldered to it. The filter paper need not be creased, nor an outside funnel used, accidents being very rare. If the room is moderately warm, filtration takes place in a few minutes, usually not requiring more than one sheet of paper divided into fourths. As soon as the filtration becomes slow repeat with a fresh piece of paper, the residual medium being reheated to the boiling point, and boiling water being poured into the paper before the introduction of the agar. As soon as the first 500 c.cm. have come through, it is the custom for the students to add the glycerin or dextrose, etc., and to tube the media while the rest is coming through. From the time that the first weighing is begun until the time when the filled tubes are placed in the sterilizer need not be over 50 minutes, and the students, even the first time, accomplish it in an hour and a half.

The resultant medium is transparent, almost colourless, unless it has been burnt, when it will have a yellow colour. No difficulty has been found in growing the ordinary strains of streptococcus, diphtheria or tuberculosis, and a large proportion of pneumococcus cultures show good development. The medium is firm enough for satisfactory plating, and has adequate water of condensation.

The use of distilled water is important, as also the special grade of filter paper, but the most essential points are the excess of water during the process, the absolute freshness of the eggs, and the preservation of filter paper and media at the boiling point until they meet.

* Johns Hopkins Hosp. Bull. xx. pp, 324–5.

(2) Preparing Objects.

Improved Method of Dehydration.*—B. Suzuki considers that the ordinary method of dehydration, by which objects are placed successively in 50, 70, and 90 p.c. alcohols, is unsuitable for delicate objects, and describes an apparatus (fig. 36) by which the concentration of alcohol is increased gradually. G_1 and G_2 are filled with distilled water; the inverted flask K is filled with 50 p.c. alcohol. The material M is placed in G_2, resting on washed sand S. The junction tube W is filled with glass-wool. As water trickles away through the capillary tube A, an alteration of level in G_1 causes alcohol to enter slowly from the inverted flask, and so the concentration process proceeds automatically. It is only necessary to re-fill the flask, when it become empty, first with 70 p c., then with 90 p.c., and finally with absolute alcohol. The same apparatus, with slight modifications, may be used for hardening and washing processes.

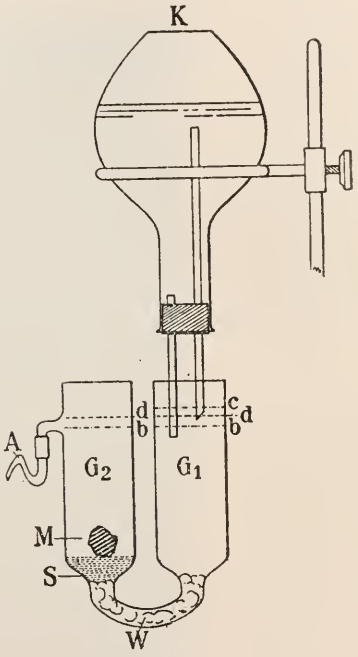

Fig. 36.

New Methods of Investigating the Central Nervous Systems of Vertebrates.†—Under this title B. Rawitz describes new methods of fixing and staining portions of brain and spinal cord. Material, which has been preserved in 10 p.c. formalin, is transferred to a 10 p.c. solution of tincture of iodine in 95 p.c. alcohol. After 5 days the material is removed to a saturated watery solution of potassium bichromate. This solution is changed after 24 hours, and in this second bichromate bath the tissues remain for 7 to 10 days, according to the size of the pieces. They are then removed, dried with filter paper, and put into 95 p.c. alcohol for 3 days, absolute alcohol for 2 days, and chloroform for 2 days. Then after 24 hours in chloroform-paraffin, the material is imbedded in paraffin.

The author gives accounts of a number of new stains, namely indulin, indamin-blue, and azo-acid-blue. The last-named stain, made up in the following combination—azo acid-blue B (Höchst), 2 grm.; tartar emetic, 1 grm.; oxalic acid, 4 grm.; distilled water, 200 c.cm.—gave good results. The ganglion-cells and neuroglia are coloured purple, the axis-cylinders light blue. With this stain made up in some other combinations, the author could not obtain this amphichromatic effect. He ends his paper with illustrations of the application of his methods.

* Zeitschr. wiss. Mikrosk., xxvi. (1909) pp. 211–19.
† Tom. cit., pp. 337–52.

Washing Apparatus for Fixed Material.*—R. Kowler describes an apparatus (figs. 37, 38) by means of which tissues can with safety be washed in a stream of water. The apparatus is made of glass, of the form shown in the diagram. The rubber tube is connected with a water supply. The expanded chamber is at each end separated from the narrow part of the glass tube by a sieve of glass (Glassieb). The material is introduced into the chamber, which is then closed, and the water is turned on slowly at first, until the air is driven out. Then the current of water

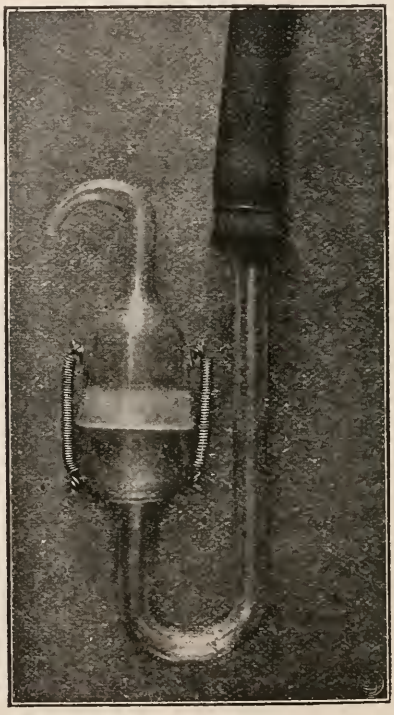

Fig. 37.

is so adjusted that the material remains on or near the bottom of the chamber.

Methylated Spirits for Histological Purposes.†—In the German Empire spirits of wine for commercial purposes consists of 90 p.c. ethyl-alcohol, to which have been added small quantities of methyl-alcohol, acetone and pyridine bases. C. Kittsteiner finds that, as a fixing reagent, this fluid is for ordinary purposes almost as good as ethyl-alcohol. Material must, however, only remain in it for three days, and must then

* Zeitschr. wiss. Mikrosk., xxvi. (1910) pp. 259-60.
† Tom. cit., pp. 191-203.

be removed to uncontaminated alcohol. Treatment of nervous tissues with methylated spirits gives extremely bad results, and with unstriated muscle also the results are most unsatisfactory. For hardening and staining purposes, this reagent is quite as good as the ordinary 90 p.c. alcohol.

Preparing Delicate Embryonic Tissues for Histological Examination.*—For cytological and histogenetic investigations of Vertebrate

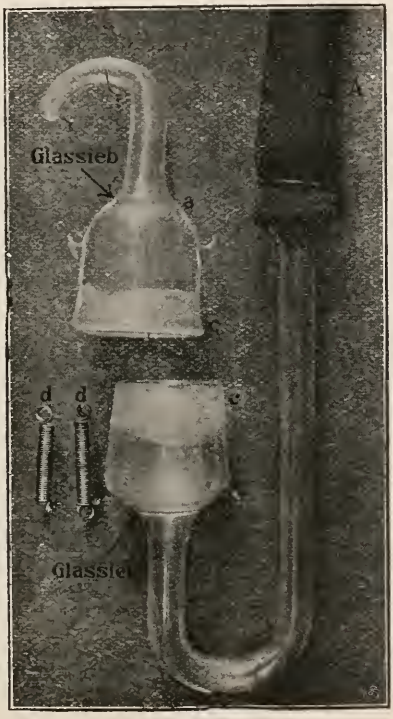

Fig. 38.

embryos, A. Maximow has devised modified methods of fixation and imbedding suitable for such easily damaged material. As fixing re-agent, he uses a modified Zenker's fluid of the following composition:—Formalin 10 c.cm., sodium sulphate 10 grm., potassium bichromate 25 grm., corrosive sublimate 50 grm., distilled water 1000 c.cm. For some purposes he adds 10 c.cm. of 2 p.c. osmic acid to this solution. In the case of larger embryos the specimen must be so prepared by incision, or otherwise, that the fixing fluid can readily gain access to all parts. After careful dehydration the specimens are imbedded in celloidin and cut by

* Zeitschr. wiss. Mikrosk., xxvi. (1909) pp. 177–90.

means of a sliding microtome. The block is kept moistened with 65 p.c. alcohol. Each section, as it is cut, is transferred to a slide, cleared with oil of cloves, and washed free of celloidin with absolute alcohol and mixed alcohol and ether. Maximow uses a large number of staining methods, of which he recommends particularly the iron-alum-hæmatoxylin method, Giemsa stain and Dominici's eosin-orange-toluidin-blue process.

Examining the Structure of Human Heart-muscle.*—Irene von Palschewska fixed the material mostly in a mixture of absolute alcohol 90, and pure 25 p.c. nitric acid 10. The pieces used, about 8 mm. thick, were left in the fluid for about 24 hours, and when removed were transferred to faintly alkaline 94 p.c. alcohol, and this was renewed daily. After a few days, ammonia-free alcohol was used. The alcohol was afterwards downgraded to water for staining purposes, and the staining was effected with hæmalum.

Marie Werner† fixed her material in the 10 p.c. nitric acid and absolute alcohol 90 p.c. mixture, and then washed out with 94 p.c. alcohol, until litmus paper was no longer reddened. She found that neutralisation with ammoniated alcohol impaired the picture. The preparations were stained with hæmalum (1 part to 5–10 water). The pieces remained in the stain for 8 days.

New Methods for Examining Sputum.‡—P. Uhlenhuth recommends his antiformin method for demonstrating the presence of tubercle bacilli. By means of a 20–25 p.c. solution, the sputum is rendered quite homogeneous. It is then centrifuged, and the deposit washed with saline. As the antiformin kills off the associated bacteria, it may be used for obtaining pure cultures of human tubercle bacilli.

H. Haserodt is of opinion that the foregoing antiformin method has a great disadvantage: the film does not fix well to the slide; and recommends the following modification. The sputum should first be rendered homogeneous by means of caustic potash, and then shaken up with ligroin. A combination of the antiformin and ligroin methods gives good results.

G. Bernhardt proceeds as follows: About 5 c.cm. of sputum and 20 c.cm. of a 20 p.c. solution of commercial antiformin are placed in a stoppered bottle. When quite homogeneous, ligroin, to form a layer 3–5 mm. thick, is poured in. The bottle is then vigorously shaken, until a thick suspension forms; it is then left at room temperature for about half an hour, and afterwards loopfuls of the layer immediately underneath the ligroin are removed. Films are fixed and stored in the usual way.

H. Hammerl uses a solution composed of 99 parts ammonia and 1 part caustic potash. A mixture of 5 parts of the solution to 1 of sputum is then vigorously shaken. In a few minutes it is quite homogeneous. To 15 c.cm. of the mixture are added 5 c.cm. acetone. This

* Arch. Mikr. Anat. u. Entwickl., lxxv. (1910) pp. 41–100 (18 figs.).
† Tom. cit., pp. 101–48 (53 figs.).
‡ Centralbl. Bakt., 1te Abt. Ref., xlv. (1909) pp. 282–4.

is centrifuged for half an hour. Films are made from the deposit, and stained in the usual way.

Glaeser, K.— **Untersuchungen über die Herkumft des knorpels an regeneri. erenden Amphibienextremitäten.**
Arch. f. Mikr. Anat. u. Entwikl., lxxv. (1910) pp. 1–39 (1 pl. and 16 figs.).

(3) Cutting, including Imbedding and Microtomes.

Cutting Thin Parallel Slices of Brain Substance.*—K. Berliner describes an apparatus (fig. 39) which has been in use at the hospital in Giessen for a number of years. The material to be cut is fixed on a sliding base (Sch) which moves along grooves in the bars L, L, one of which is provided with a scale. The vertical rods, F, F, guide the

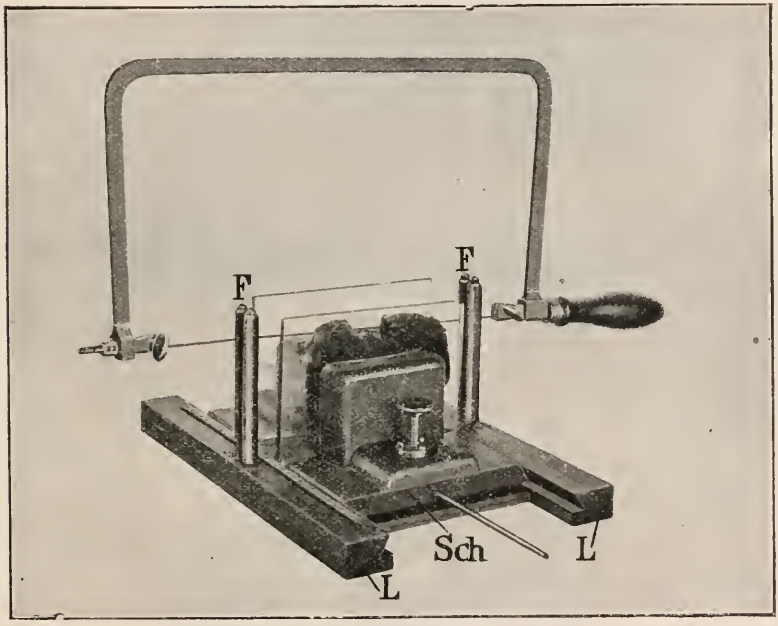

Fig. 39.

movements of the knife or fretsaw, and so vertical slides of equal thickness can be made. For fresh material a knife is used, but in the case of brains hardened in Müller's fluid or in bichromate it is found that a fine fretsaw is more suitable.

Apparatus for Whetting a Microtome Knife.— J. Lendvai has found Apáthy's method of whetting the best. This consists in the application of emery, Vienna chalk, iron-oxide, or diamantin powder, on three mirror-glass plates. For this purpose the author has devised a special apparatus, which has been constructed for him by the firm of C. Reichert. The three plates are necessary because the materials are of

* Zeitschr. wiss. Mikrosk., xxvi. (1909) pp. 382–4.
† Tom. cit., pp. 203–5 (5 figs.).

different degrees of hardness. One plate is for emery, the second for Vienna chalk, and the third for iron oxide or diamentin. These three

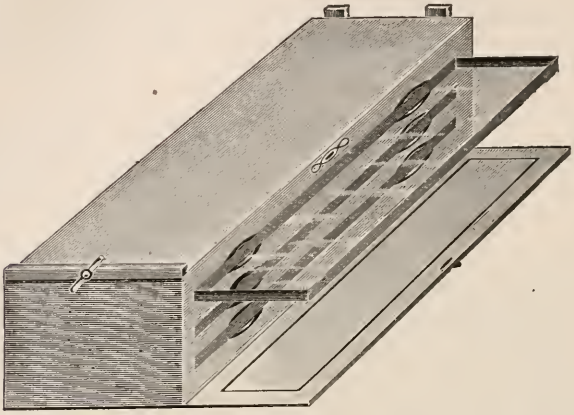

Fig. 40.

Fig. 41.

Fig. 42.

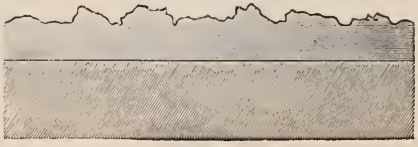

Fig. 43.

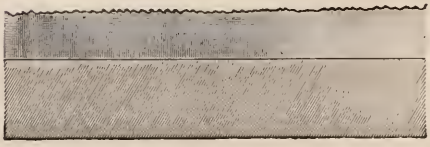

Fig. 44.

glass plates are kept in a wooden block, each in a separate compartment, the compartments being lined with cloth (fig. 40); the intention being to prevent soiling the plates with dust or with foreign material, which

might possibly notch the knife. When in use, the glass plate is laid on the upper face of the block and is fastened down with screws. It is then smeared with a fine emery paper moistened with distilled water ; or with Vienna chalk paper moistened with distilled water ; or with iron oxide. The knife is then drawn rather frequently over the plate (60 or 70 times), and the edge is held forward, in such a position that it is perpendicular to the direction of movement. The knife-edge as it appears under a magnification of 100 diameters is shown in fig. 43. A special facet of 20° to 25° is ground on the knife by placing the back of the knife in a laterally-open iron tube, and clamping it with screws (fig. 41). From the diameter d of the tube and the breadth a of the knife the angle $(\alpha_1 + \alpha_2)$ can be calculated. Thus

$$\frac{d}{2a} = \tan \alpha_1 \pm \tan \alpha_2$$

(fig. 41). The facet, which has been roughly fashioned with emery, is perfected with Vienna chalk, the teeth on the edge now becoming very fine (fig. 44) under the same magnification as before. The iron-oxide is only used for whetting that side of the facet which glides, when in action, on the paraffin or celloidin.

Rotatory Method in Microscopy.*—H. Lebrun, after three years' experience of his method of diskal arrangement,† sees his way to several improvements, the first of which is concerned with the microtome. It was found that in cutting very thin sections tremor of the machine caused much irregularity in the sections themselves. This difficulty the author remedies by attaching the knife-carrier to parts of the microtome not liable to agitation. The paraffin block, instead of being truly rectangular, is now made with sloping slides according to the size of the disk on which the serial sections are to be received. Full directions are given for accurately obtaining the proper shape of block. There are several other improvements in the mechanism and manipulation of the microtome. As above-mentioned, the object-carrier is disc-shaped, the rectangular form being abandoned. An ingenious combination of hand and screw-work brings every part of the object, in spiral fashion, successively under the objective. This arrangement is also particularly convenient in the case of such an object as a tapeworm. The author recommends his method as tending to great economy both in materials and in time. His ideas have been satisfactorily worked out for him by the firm of Seibert, of Wetzlar.

Simple Method of Paraffin Imbedding in Vacuo.‡—W. Berg describes a method which is applicable to any ordinary paraffin oven. The paraffin is contained in a glass flask, firmly stoppered, which communicates by means of stout rubber tubing with an ordinary water suction apparatus. The rubber tube passes through the hole in the top of the oven, which normally holds a thermometer. It is advisable that the paraffin should fill only the lowest portion of the flask, as it foams somewhat, when the exhausting process is commenced. This procedure does not interfere with the ordinary use of the oven.

* Zeitschr. wiss. Mikrosk., xxvi. (1909) pp. 223-41 (13 figs.).
† See this Journal, 1906, p. 725.
‡ Zeitschr. wiss. Mikrosk., xxvi. (1909) pp. 209-10.

(4) Staining and Injecting.

Method of Staining Peripheral Nerves.*—T. Maruyama discusses the method devised by Yamagiwa and its applicability to pathological tissues, more particularly in connection with the study of beri-beri. The process is as follows :—After hardening in Müller's fluid in the ordinary way and imbedding in celloidin, sections are cut. They are stained in concentrated alcoholic eosin for a period of from 1 to 12 hours. Next, after prolonged staining with concentrated watery anilin-blue, they are placed in a differentiating fluid—weak alcohol make slightly alkaline by the addition of liquor potassæ—and washed in distilled water. The sections are then put into weak alcohol to remove excess of anilin-blue, dehydrated in absolute alcohol, cleared in oil, and mounted in balsam. In sections stained thus, the axis-cylinders appear deep blue, medullary sheaths red, connective-tissues and cell-nuclei bright blue, red blood-cells pink, and unstriped muscle pale violet. The preparations lose their stain usually in a few months.

Fluoride of Silver in Golgi's Method.†—E. Saragnone describes a new procedure for demonstrating the intracellular network. It is really a modification of Golgi's method, fluoride of silver being substituted for the nitrate. The preparation used is known as "tachiolo Paternó," and is a 10 p.c. solution of silver fluoride, which is not reduced by the action of light. The full procedure is as follows : 1. The pieces are fixed in a solution consisting of formalin (20 p.c.) 30 grm. ; saturated solution of arsenious acid, 30 grm. ; alcohol (96 p.c.) 30 grm. Time, 10 to 12 hours. 2. The pieces are then transferred to tachiolo Paternó, 30 c.cm. ; distilled water, 100 c.cm., for one or two hours. 3. They are next washed quickly in distilled water, after which they are immersed for a few minutes to an hour in hydroquinone, 30 grm. ; sulphite of soda, 5 grm. ; formalin, 50 grm. ; water, 1000 c.cm. 4. After-washing in distilled water the pieces are passed through upgraded alcohols to xylol and imbedding. 5. The sections are treated with the following solutions mixed immediately before use : (*a*) hyposulphite, 30 grm. ; sulphocyanide of ammonium, 30 grm. ; water, 1000 grm. ; (*b*) chloride of gold, 1 grm. ; water, 100 grm. The reaction is watched and suspended when the sections have assumed a definite grey tint. 6. Wash in distilled water and pass rapidly through permanganate of potassium, 0·5 grm. ; sulphuric acid. 1 grm. ; distilled water, 1000 grm. 7. Wash rapidly in 1 p.c. solution of oxalic acid, and afterwards in distilled water. 8. Stain with carmalum. Wash again. 9. Pass through alcohol and mount in balsam.

Studying the Development of Crucifera.‡—R. Vandendries fixed the material for a day or so in Bouin's fluid, then washed it till it was white in one-third alcohol, and afterwards preserved it in 80 p.c. alcohol. Sections, 8–12 μ, were stained preferably by Heidenhain's method. As the slow method was found not to be particularly suitable for

* Mitt. Med. Fakul. K.-Jap. Univ., viii. 3 (1909) pp. 368–70.
† Pathologica, i. (1909) pp. 536–8.
‡ Zeitschr. wiss. Mikrosk., xxvi. (1909) pp. 422–4.

studying the phenomena of fertilisation, a more rapid procedure was adopted. In this the alum mordant was used for 15 to 30 minutes; this was followed by hæmatoxylin staining for 1 to 3 hours. Differentiation was effected with great care and constant inspection under the Microscope. Congo-red was used in contrast stain and gave excellent results.

Device for Protecting Mounted Sections during Dehydration.*— It is a common experience that when a number of slides bearing sections are put in a flask of alcohol, or other fluid, specimens may be spoilt by movements of the slides against each other. C. Funck suggests a simple plan for remedying this (fig. 45). A grid, preferably of nickel-plated brass, of the form shown in the figure, is placed inside the flask, resting on the bottom. The lower ends of the slides rest in the

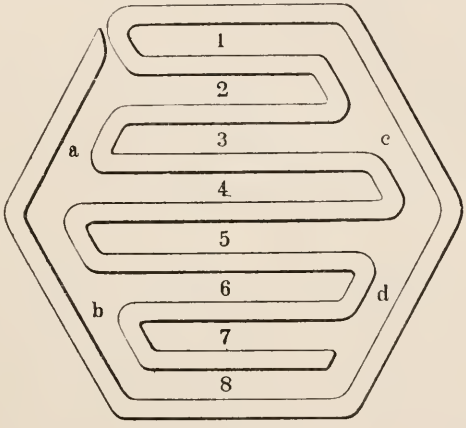

Fig. 45.

numbered spaces. The slides thus remain, touching only at the top edges. The portion of the slide which bears the section is kept free from all contact with its neighbours.

Injection Methods applied to certain Mollusca.†— B. Možejko describes a method of gelatin injection for the anatomical investigation of *Anodon*, *Mytilus edulis*, and some other Mollusca. For the greater part of his work, the author used a 4–6 p.c. solution of gelatin. By the use of finely powdered insoluble mineral dyes, he was able to tint the gelatin variously, and thus differentiate the separate systems or vessels injected. For example, in the case of *Anodon*, it is possible to inject the arteries, veins, intestine, genital ducts, and the cavities of the organs of Bojanus separately, and thus get a specimen injected in five colours. Specimens so injected can be fixed in formalin, and imbedded in paraffin for the purpose of cutting sections.

* La Cellule, xxv. (1909) pp. 415–60 (1 pl. and 54 figs).
† Zeitschr. wiss. Mikrosk., xxvi. (1909) pp. 353–77.

Different Methods of Staining Tubercle Bacilli.*—Karl Bergen gives a critical review of the literature of this subject, describing the staining methods employed by various authorities, and dwelling particularly upon the granules (sc. spores) which are brought out by some methods. For his own research, he selected Much's modification of Gram, Ziehl-Neelsen, and Gasis' methods as the three most promising. Gasis' plan is a reversal of the Ziehl-Neelsen procedure. After staining in an acid stain, the film is decolorised by alkali. Gasis maintained that the alkali-fast property of tubercle bacilli is possessed by organisms in very young and very old cultures, organisms not often acid-fast, as well as by bacilli of the average period.

Bergen found that the advantage of the Ziehl-Neelsen method lay in its ease and certainty. On the other hand, the granular form of the tubercle bacillus was hardly stained at all, and some young forms did not retain the stain. Modified Gram staining is not suitable for differential diagnosis, and in preparations from pure cultures a clear picture is not obtained. The method of Gasis is peculiarly suitable for investigation of minute structure. It gives beautiful films. On the other hand, the technique is difficult, and the results therefore may be inconclusive in cases of differential diagnosis. This method is perhaps the most suitable for making permanent preparations.

Further, Bergen gives an interesting account of the effects obtained by him as a result of combinations of these methods.

Studying the Development of Dentine in Mammalia.†—For the histological investigations in this research, G. Heinrich used a variety of reagents such as formalin, alcohol, Zenker's fluid, osmic acid, and others for fixing his material. Formalin gave the best results, especially when used in connection with the silver-staining process.

By staining sections successively with iron-alum-hæmatoxylin, dilute rubin S and Heidenhain's connective-tissue stain, good contrasts were obtained. Connective-tissue fibres and the uncalcified ground substance were stained deep red, calcified areas black, and tooth-fibres pale grey. The odontoblasts are stained more deeply than the connective-tissue cells.

In the silver process, the paraffin sections, after prolonged soaking in 2 p.c. silver nitrate, are treated with an ammoniacal silver solution. The stain is developed in a formalin bath, and treatment with gold chloride, followed by hyposulphite, completes the silver staining. The sections are then mounted on slides and washed with xylol to remove paraffin, and then with alcohol. Alcoholic solution of light-green is used as counterstain, and the section is then dehydrated and mounted in Canada balsam. These preparations are well adapted for microphotographic purposes.

(6) Miscellaneous.

Experimental Study of Development during the past decade.‡ The advances in this branch of investigation are surveyed by O. Levy.

* Centralbl. Bakt., 1te Abt., liii. (1910) pp. 174–208.
† Arch. Mikr. Anat., lxxiv. (1909) pp. 783–8.
‡ Zeitschr. wiss. Mikrosk., xxvi. (1909) pp. 426–73.

He deals first with artificial parthenogenesis. J. Loeb's experiments upon the ova of Echinoderms showed that it was possible by the use of saline solutions of various strengths to initiate developmental changes. The most successful and suggestive chemical excitant was a dilute cyanide solution, in which 90 p.c. of unfertilised ova developed into larvæ.

Roux, Herbst, and others have directed their attention to the medium in which development takes place, and to the importance of its constituents. By altering the quantities of oxygen, water, and salts in this medium, development was variously influenced.

Injury to the ovum in its earliest stages, deprivation of chromatin, shaking apart of blastomeres, amputation of blastomeres, artificial fusion of ova, and the effects of such mechanical interferences, form the subject of the next series of researches here reviewed. Others have studied the abnormalities of development caused by interference at a later stage with the primitive layers and organ-rudiments by mechanical and other means.

In the remainder of the paper the recent work upon regeneration, transplantation, and functional correlation are reviewed. Full references are given throughout, rendering the article a valuable guide to the subject.

Simple Method of Counting Leucocytes.*—This method, devised by V. T. Carruthers, depends upon the fact that when equal-sized drops of diluted blood are placed on a clean slide, they should cover equal areas and contain equal numbers of cells. Drops of blood, well diluted, are placed on a grease-free slide by means of a grease-free glass rod, and allowed to dry. The blood-pigment is washed off with water and the slide is stained with watery methylene-blue. A number of fields in each film are counted. By means of an obturator inserted in the eye-piece of the Microscope, the author has simplified the enumeration process. By comparing a few counts with the numbers obtained with a Thoma-Zeiss hæmatocytometer, a standard is obtained, so that from the average number of leucocytes in a field, the degree of leucocytosis can be calculated. For all counts, the degree of dilution must, of course, be the same, and the same glass rod and obturator must be used. The successful application of this method depends upon careful observation of a number of trivial details, for an account of which the original paper should be consulted.

Method of Estimating the Hardness of Minerals.†—B. Halle claims that this method of estimating hardness by grinding, devised by him, is superior to the scratching methods. By the latter method it is difficult to get constant results owing to variations in the quality of the diamond point used, and to the difficulty of maintaining even pressure during the scratching process. In Halle's method the mineral is ground on a revolving brass plate for a definite time, and the loss of weight is observed. The specific weight of the mineral is known. All the other factors—time, pace and pressure of grinding, grinding material—are constant, and therefore the only variable, proportional loss of weight, gives the relative hardness. By this method very fine differences in degree of hardness can be estimated.

* Brit. Med. Journ., (1909) ii. p. 1749.
† Zeitschr. wiss. Mikrosk., xxvi. (1909) pp. 424–5.

Metallography, etc.

Microstructure of Copper.*—W. Stahl gives photomicrographs of samples of copper taken from the molten bath at different stages in the final refining operation. At the beginning the copper contained 0·8–0·9 p.c. oxygen ; the photomicrograph shows crystallites of cuprous oxide in a ground mass of eutectic. There is a continuous diminution in amount of oxide present till in the refined copper a thin network of eutectic surrounds the grains of copper.

Physical Properties of Alloys.†—E. Pannain finds that the specific gravity of coinage alloys (bronze and silver-copper alloy) is raised considerably by the mechanical treatment involved in the manufacture of the coins. Most of the increase in density occurs in the first rolling.

Some Zinc Alloys.‡—B. E. Curry has determined the equilibrium diagram of the antimony-zinc system by taking heating curves of 27 previously annealed alloys. The diagram thus obtained differs in important respects from that given by Mönkemeyer, and to a smaller extent from that given by Zemczuzny. Six solid phases occur in the diagram : pure antimony, pure zinc, the compound ZnSb, and three series of solid solutions, α, β, and γ. The α and β phases are instable below 437° and 405° C. respectively. The γ phase is stable only below the solidus. The results demonstrate the inadequacy of cooling curve determinations. The two phases in the zinc-tin diagram are pure zinc and a solution of zinc in tin, having a maximum concentration of about 7 p.c. at 180° C. In the zinc-cadmium diagram the two phases are two solid solutions, zinc in cadmium (maximum concentration 4 p.c. at 217° C.), cadmium in zinc (maximum concentration 5 p.c. at 217° C.). The liquid melt separates into two layers in the zinc-lead and zinc-bismuth systems. Particulars of suitable etching reagents are given.

Alloys of Silver with Zinc.§—N. A. Pushin and M. S. Maximenko have determined the specific resistances, the temperature-coefficients of the specific resistances, and the thermo-electric forces of alloys of silver and zinc. The existence of the following compounds is inferred : Zn_6Ag, Zn_4Ag, Zn_3Ag_2, $ZnAg$, $ZnAg_2$ (?), Zn_2Ag (?) and $Zn_{10}Ag$ (?). Several series of solid solutions are formed.

Alloys of Tin and Lead.‖—The linear relation between composition and electrical conductivity of tin-lead alloys appears to indicate that neither compounds nor mixed crystals are formed. On the other hand, the thermal evidence points to the existence of mixed crystals at both

* Metallurgie, vi. (1909) pp. 609–10 (8 figs.).

† Atti R. Accad. Lincei, xviii. (1909) pp. 700–1, through Journ. Soc. Chem. Ind., xxviii. (1909) p. 1089.

‡ Journ. Phys. Chem., xiii. (1909) pp. 589–605 (7 figs.).

§ Journ. Russ. Phys. Chem. Soc., xli. (1909) pp. 500–24, through Journ. Chem. Soc., xcvi. (1909) pp. 539–40.

‖ Zeitschr. Elektrochem., xv. (1909) pp. 125–9, through Journ. Chem. Soc., xcvi. (1909) p. 319.

ends of the diagram. W. Guertler suggests as an explanation of this discrepancy that the mixed crystals formed during solidification decompose at lower temperatures into tin and lead.

Alloys of Lead with Indium and Thallium.*—N. S. Kurnakow and S. Zemczuzny have determined the electrical conductivity curve of the lead-indium and lead-thallium systems. The plasticity of the alloys was also studied by determining the pressure required to produce flow through an aperture of given size. The flow-pressure curve was found to follow closely the Brinell hardness curve, and was the reverse of the conductivity curve. The authors conclude that lead and indium form a continuous series of mixed crystals. Lead and thallium form three series of mixed crystals. No compounds occur in either system.

Aurides of Magnesium.†—G. G. Urasow has made a careful determination of the equilibrium diagram of the gold-magnesium system. The cooling curves of 109 alloys were taken. In some regions of the diagram inoculation was necessary to prevent supercooling. The compounds occurring and their melting points (dystectic points or maxima in the diagram) are Mg_3Au 818° C., Mg_2Au 788° C., MgAu 1150° C.; the compound Mg_5Au_2 is formed at 796° C. by a reaction taking place between Mg_3Au and the liquid. Mg_5Au_2 exists in two forms, the transformation temperature being 721° C. The microstructure of alloys rich is magnesium was sufficiently developed by polishing on wet chamois leather. Sections of the other alloys were etched with hydrochloric acid and bromine.

Phosphorus Compounds of Cobalt.‡—S. Zemczuzny and J. Schepelew have studied the range 0–33·7 atomic p.c. phosphorus of the cobalt-phosphorus system by thermal and microscopical methods. A dystectic point at 33·33 atomic p.c. phosphorus indicates the compound Co_2P, melting at 1386° C.; this compound has a transformation point at 920° C. The eutectic contains 19·85 atomic p.c. phosphorus and melts at 1022° C. The hardness of the alloy was measured. Co_2P was observed as well-defined crystals in sections polished and etched with ferric chloride solution in hydrochloric acid.

Systems: Tin-sulphur, Tin-selenium, Tin-tellurium.§—W. Biltz and W. Mecklenburg have determined the equilibrium diagrams. The volatility of sulphur restricted the range of the tin-sulphur system investigated to 0–23·4 p.c. sulphur. The compounds occurring and their melting points are SnS, 882° C.; SnSe, 861° C.; Sn_2Se_3 or $SnSe_2$, about 650° C.; SnTe, 800° C. The compounds SnS, SnSe, and SnTe were observed microscopically in sections of the alloys.

The System Cu_2S–FeS.‖—K. Bornemann and F. Schreyer have determined the equilibrium diagram by thermal methods and confirmed it by microscopical examination of the melts after solidification. The

* Zeitschr. Anorg. Chem., lxiv. (1909) pp. 149–83 (5 figs.).
† Tom. cit., pp. 375–96 (16 figs.). ‡ Tom. cit., pp. 245–57 (7 figs.).
§ Tom. cit., pp. 226–35 (7 figs.).
‖ Metallurgie, vi. (1909) pp. 619–30 (22 figs.).

diagram is too complex for brief summarising, and in some regions is insufficiently established. The compounds $(Cu_2S)_2(FeS)$, $(Cu_2S)_3(FeS)_2$ and probably $(Cu_2S)_2(FeS)_5$, or $(Cu_2S)(FeS)_2$, are indicated by the diagram. Concentrated nitric acid was used for etching those sections which required etching.

Mixed Crystals of Sulphur and Tellurium.*—G. Pellini finds that sulphur and tellurium do not form a compound, but form a series of mixed crystals. A solid amorphous solution of tellurium and sulphur was also obtained.

Influence of Arsenic and Tin upon Iron.†—C. F. Burgess and J. Aston have studied the magnetic properties of alloys prepared from electrolytic iron, one series containing 0·29–4·14 p.c. arsenic, the other series containing 0·29–2·06 p.c. tin. Compared with approximately pure iron, the alloys give materially lower hysteresis losses and have a higher permeability.

Phosphides of Iron.‡—H. le Chatelier and S. Wologdine point out that many metallic compounds, which have been described from time to time, are imaginary. Until these supposed compounds are eliminated, by the application of modern metallographic methods of investigation, it is not possible to arrive at any laws governing the formulæ of metallic compounds. An examination of the compounds of iron and phosphorus reduces their number from nine to four. The existence of Fe_3P and Fe_2P is undoubted, that of FeP and Fe_2P_3 is very probable, but their formulæ are not so well established as those of Fe_3P and Fe_2P.

Alloys of Iron.§—P. Oberhoffer briefly summarises published work on the binary and ternary alloys of iron. Our knowledge of the equilibrium diagrams is incomplete for the binary systems, and is still less advanced for the ternary systems.

Heat-treatment of Iron and Steel.‖—Methods of heat-treatment suitable for various descriptions of carbon steel are specified. The position of $Ac\,3$, in steels containing not more than 0·90 p.c. carbon, may be calculated approximately from the formula

$$Ac\,3 = (900 - 200\,c)\,^{\circ}C,$$

c being the percentage of carbon in the steel.

W. Campbell† has made further experiments on the removal of "ingotism" by annealing. In a previous investigation he had found that in a steel casting containing 0·43 p.c. carbon, the coarse ferrite network was not completely removed at 1180°C., but could not be detected after heating to 1195°C. The present work was done on two pieces of steel castings (a) and (b) containing 0·35 and 0·5 p.c. carbon

* Atti R. Accad. Lincei, xviii. (1909) pp. 19-24, through Journ. Chem. Soc., xcvi. (1909) p. 805.

† Electrochem. and Met. Ind., vii.(1909) pp. 403-5 (3 figs.).

‡ Comptes Rendus, cxlix. (1909) pp. 709-14.

§ Metallurgie, vi. (1909) pp. 612-18.

‖ Amer. Soc. for Testing Materials, Proc. ix. (1909) pp. 214-18. (Report of Committee on heat-treatment of steel.) † Tom. cit., pp. 370-7 (12 figs.).

respectively. The manganese sulphide and slag occurred as strings or veins in (*b*), but were evenly distributed as small globules in (*a*). Heating a little above Ac 2 – 3 completely refined the structure of (*a*), but did not altogether remove the ferrite network of (*b*). A network of manganese sulphide or slag appears to prevent complete refining by acting as nuclei on which the ferrite precipitates.

Defects in Steel Rails.—H. Fay and R. W. G. Wint* describe the various ways in which the presence of slag (manganese sulphide, manganese silicate, and possibly other substances) may cause the failure of rails. In many sections examined the sulphide was seen to be broken at right angles to its length, its extreme brittleness causing it to break during preparation for microscopic examination. Cracks invariably begin in and follow from one slag area to another. Flow of metal in many cases appears to be due to the presence of internal cracks originating in slag inclusions. Hard spots in rails are due to (1) imperfect solution of ferro-manganese; (2) surface hardening through friction of the wheels; (3) segregation. The authors believe that some hard areas containing martensite and troostite, found in a nickel steel rail, were caused by segregation of nickel.

R. Job† has investigated some defective open-hearth steel rails, and has found that failure was the result of segregation, piping, and unsoundness.

P. H. Dudley‡ has found that in numerous cases of splitting of heads of rails, etched sections of the rail show dark streaks, found to be harder and to have a higher carbon content than the rest of the rail. The presence of these dark streaks is ascribed to the inclusion in the steel of metal washed away from the cast-iron base of the ingot mould, by the impinging of the stream of molten metal when the ingot was cast.

Tests of Ingots.§—J. E. Howard has examined with the unaided eye and microscopically, sections of ingots, and of the various forms derived from them during their manufacture into rails. In this way the effect of reduction by rolling upon size and shape of grain, gas or shrinkage cavities, and slag inclusions, was followed step by step.

Closing of Blowholes in Steel Ingots.‖—H. M. Howe found that, while comparatively great variations in density occurred in a steel ingot due to the presence of blowholes, the plates rolled from the same ingot were of uniformly high density. Contrary to the generally accepted view, it would appear that the gas is driven out of the blowholes during rolling. It should, therefore, be possible to close and weld up blowholes by rolling.

Structure of Cast Iron.¶—F. J. Cook and G. Hailstone explain variations occurring in the mechanical properties of a series of cast irons of identical chemical composition, by differences which they found in

* Amer. Soc. for Testing Materials, Proc. ix. (1909) pp. 77-89 (14 figs.).
† Tom. cit., pp 90-97 (12 figs.).
‡ Tom. cit., pp. 98-105 (9 figs.).
§ Tom. cit., pp. 319-26 (10 figs.).
‖ Tom. cit., pp. 327-47 (7 figs.).
¶ Foundry, xxxv. (1909) pp. 21-3 (13 figs.).

microstructure. High tensile strength appeared to be associated with a comparatively fine state of division of the graphite, and a net-like formation of the phosphorus eutectic.

Magnetic Properties of Alloys of Ferro-magnetic Metals.* — G. Tammann deduces some general rules from the experimental data previously published by himself and others, relating to the magnetic properties of alloys containing iron, cobalt, and nickel. A solid solution of a non-magnetic in a ferro-magnetic metal is magnetic, while a solid solution of a ferro-magnetic in a non-magnetic metal is non-magnetic. Chemical compounds are practically non-magnetic. The depression of the temperature at which magnetic properties disappear on heating, by the presence of other elements, is discussed.

Magnetic Character of Compounds of Non-magnetic Elements.† E. Wedekind has studied the magnetic properties of the compounds MnB, MnSb, Mn_2Sb, and MnP. The greatest temporary magnetism was shown by MnSb, the least by MnP.

Metallographic Observations at High Temperatures.‡—P. Oberhoffer has attacked the problem of direct microscopic examination of easily oxidised metals at temperatures up to 1000° C. The le Chatelier stand with horizontal stage above the Microscope tube is used. The section is held, polished face down, at the lower end of a vertical quartz tube on which a heating coil of platinum wire is wound. The quartz tube is contained within a glass vessel with flat bottom, through which the specimen is observed, surrounded by a brass cooling vessel, through which water circulates. A vacuum is maintained in the glass vessel by means of an air-pump. Gases can be introduced for etching the hot specimen ; chlorine and hydrogen were tried. A diaphragm of sheet platinum resting on the flat bottom of the glass vessel, reflects upwards heat which would otherwise be radiated downwards to the Microscope objective, but permits observation through a central opening. A thermo-couple in contact with the specimen enables its temperature to be followed. During the heating the specimen was observed, usually with a 16 mm. objective and Zeiss No. 18 compensating eye-piece, till the beginning of a change was noted. The heating current was cut off, and the specimen, when cool, was photographed without being disturbed. Heating was then resumed, and when the change had proceeded further, the specimen was cooled and photographed again. These operations were repeated as required. In this way the transformation from austenite to pearlite was followed, but more definite results were secured in the observation of the formation of temper carbon in cast iron. The results obtained are of value chiefly as indicating the possibilities of the method.

Determination of Melting-points.§—W. P. White discusses methods of determining melting and freezing points, and the sources of error in the results obtained. The prime cause of obliquity in melting curves is the presence of impurities, which cause the melting to occupy a certain temperature interval.

* Zeitschr. Phys. Chem., lxv. (1908) pp. 73–83.
† Op. cit., lxvi. (1909) pp. 614–32 (4 figs.).
‡ Metallurgie, vi. (1909) pp. 554–67 (41 figs.).
§ Amer. Journ. Sci., xxviii. (1909) pp. 453–73, 474–89, through Journ. Chem. Soc., xcvi. (1909) pp. 970–1.

Nitrogen Thermometer.*—A. L. Day and R. B. Sosman have completed the work of extending the gas scale of absolute temperature to 1550° C. The errors in temperature measurement with the nitrogen thermometer have been reduced to about one-fourth of their former magnitude. Much information is given as to the use of melting and freezing points of metals as fixed points. 1755° C. is arrived at by an indirect method as the melting-point of platinum. A table of melting-points of metals, etc., is given.

BAUER, O.—**Appearance of Fractures and Quality of Materials.**
Stahl und Eisen, xxix. (1909) pp. 1338–40 (3 figs.).

BELLOC, G.—**Emission of Gas by Heated Metals.**
Comptes Rendus, cxlix. (1909) pp. 672–3.

BENEDICKS, C.—**A New Form of Pearlite.**
Metallurgie, vi. (1909) pp. 567–8 (4 figs.).
See also this Journal 1909, p. 407.

COSTE, M.—**Transformations of Selenium.**
Comptes Rendus, cxlix. (1909) pp. 674–6.

FROITZHEIM, C.—**Influence of Light on the Texture of Iron and Steel.**
Stahl und Eisen, xxix. (1909) p. 2022.

GULLIVER, G. H.—**A New Experimental Method of Investigating certain Systems of Stress.** *Proc. Roy. Soc. Edin.*, xxx. (1909) pp. 38–45 (1 fig.).

JÄNECKE, E.—**Isomorphous Ternary Mixtures.**
Zeitschr. Phys. Chem., lxvii. (1909) pp. 641–88 (70 figs.).

HEYN, E. & OTHERS.—**Copper-ammonium Chloride Etching Method of Macroscopic Testing.**
[The practical application of the method is discussed by E. Heyn, A. v. Dormus, L. Kruft and M. Widemann.]
Stahl und Eisen, xxviii. (1908) p. 1827; xxix. (1909) pp. 356–8, 517–8, 907–8, 1823–4.

NEUMANN, O.—**Diamonds in Iron.**
Zeitschr. Elektrochem., xv. (1909) pp. 817–20.

PAWLOW, P.—**Dependence of Melting-point on the Surface-energy of a Solid Body.**
Zeitschr. Phys. Chem., lxv. (1908) pp. 1–35, 545–8 (11 figs.).

PÉLABON, H.—**Mixtures of Sulphur, Selenium, and Tellurium with Metals.**
Ann. Chim. Phys., xvii. (1909) pp. 526–66.

ROSS, A. D. & R. C. GRAY AND F. HEUSLER & F. RICHARZ.—**Magnetic Properties of Alloys of Manganese, Aluminium, and Copper.**
Zeitschr. Anorg. Chem., lxiii. (1909) pp. 349–52; lxv. (1909) pp. 110–12.

RUER, R.—**Ternary Systems.**
Zeitschr. Phys. Chem., lxviii. (1909) pp. 1–31 (4 figs.).

SCHENCK, R.—**Departure from Wiedemann-Franz Law in Solid Metal Solutions.**
Metallurgie, vi. (1909) pp. 550–3 (3 figs.).

STERN, E.—**Microstructure of Portland Cement.**
Zeitschr. Anorg. Chem., lxiii. (1909) pp. 160–7 (17 figs.).

TAMMANN, G.—**Chemical Relationship of Metals and the Constitution of Alloys.**
Stahl und Eisen, xxix. (1909) pp. 1084–5 (1 fig.).

* Amer. Journ. Sci., xxix. (1910) pp. 93–161 (6 figs.).

MICROSCOPY.

A. Instruments, Accessories, etc.*

(1) Stands.

New Heat Microscope.†—This instrument, designed by C. Doelter, is intended for the photography of melting and crystallising processes and for observation in various gases. The heating is electrical, as gas-heating is not sufficiently constant; the Microscope can be used for ordinary purposes if the heating chamber be removed and a special tube substituted. The instrument is meant to be more particularly applicable to :—1. Examinations of crystal plates, slides, etc., at temperatures not exceeding 1000° C., and in which polarised light should be serviceable. 2. Examinations of melting and crystallising processes up to about 1600° C., especially to the determination of melting points, solidification and reversal points; in these cases polarised light could be usefully applied up to about 1200° C. The principal distinction between these two classes is that sunlight or some strong artificial light (arc light) is used for the first; and that, for the second, the light from the incandescent chamber or object acts as the light-source. Even at temperatures from 700° to 1000° C. the incandescence might be used as a light-source, especially if the magnification required is not high. An electric arc-lamp with continuous current and automatic carbon regulators is used for the heating. The polariser is a nicol, set as is usual in mineralogical Microscopes. The stage is rotatory and has a circular form. In addition to an adjustable nicol the tube contains an upper rotatory nicol, and the ordinary gypsum or quartz wedges can be inserted. The stage is adjustable by means of two screws and the tube for centring purposes is also fitted with two screws. The tube is extensible for attaining higher magnification, and there is an insertion for replacing the stove (or heating chamber) by one of another size. The low and high temperature stoves have heights of 55 and 100 mm. respectively, with inner clear spaces of 12 and 10 mm. broad. The object-holder takes the form of a small platinum tripod or ring; for melting and crystallising observations a small quartz glass plate is used.

The interior of the stove is asbestos lined, and special pains are taken to exclude air currents, the top and bottom of the stove being protected with close fitting quartz glass plates. The electric current is taken from the domestic supply, or from a small battery of accumulators. The currents have respectively 3 amperes and 80 volts, and 5 amperes and 120 volts. Regulating is accomplished by suitable resistance methods, of which the author gives full particulars. The objective is made of

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

† SB. k. Akad. wiss. Wien., cxviii. (1909) pp. 489–9 (3 figs.).

uncemented chromium glass and flint glass, and is embedded in a water reservoir through which a current constantly circulates.

Fig. 47 shows the complete installation. A small chamber containing a prism is placed over the tube, thus affording direct observation downwards and photographic observation laterally. In order to get sharp images one of the nicols has an arrangement for the insertion of a red or orange disk to act as a filter.

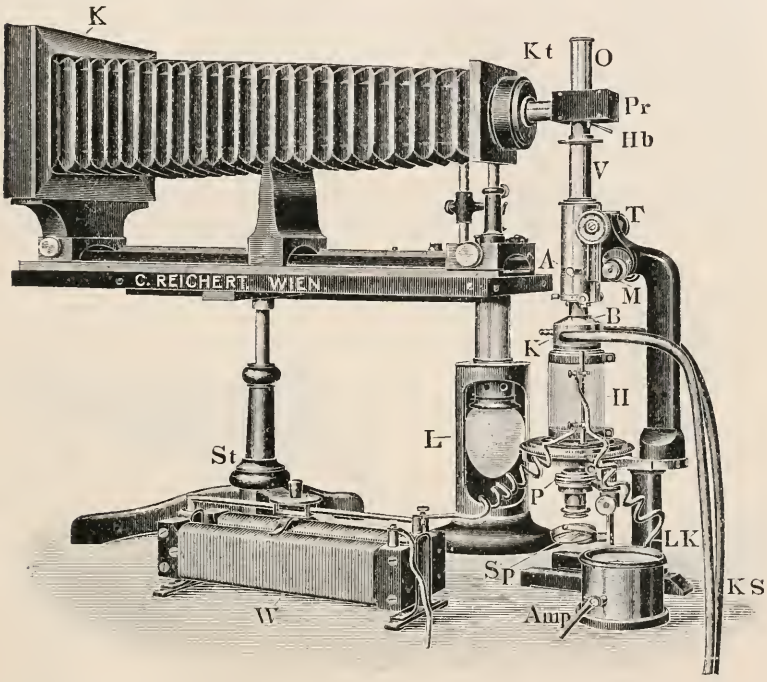

Fig. 47.

For observations in a gas atmosphere a gas current is made to circulate through the interior of the stove, the top being shut down with a quartz glass plate.

(3) Illuminating and other Apparatus.

Dark-field Illumination and Ultramicroscopy in Biology and in Medicine.*—N. Gaidukov's treatise under the above title gives what appears to be a very complete account of the present state of ultramicroscopy. It contains 74 pages of text, 9 pages of bibliography, and 5 plates with descriptive notes. There is also a preface in which the author reminds us that Ultramicroscopy has not been recognised as a distinct branch of science for more than seven years. The work

* Dunkelfeldbeleuchtung und Ultramikroskopie in der Biologie und in der Medizin. Von N. Gaidukov. Mit 13 Abbildungen im text, 3 Lichtdruck-und 2 Chromolithographischen Tafeln. Published by G. Fischer, Jena, 1910.

is divided into ten chapters. Chapters i. and ii. (pp. 1–15) discuss apparatus and the structure of colloids. Chapter iii. (pp. 16–25) deals with the ultramicroscopic examination of liquid colloids, specially interesting to the biologist and the physician. Chapters iv. and v. (pp. 25–48) are occupied with blood, bacteria, and other such microscopic objects. Chapter vi. (pp. 49–59) describes the author's own researches on certain botanical objects (e.g. spirogyra, desmids, etc.). Chapters vii. and viii. (pp. 60–67), plant cells, colloids, and textile fibres. Chapter ix. (p. 73) is a summary; and Chapter x. (pp. 74–83) is bibliographical.

The bibliography includes some 202 items. The plates include some well-known objects (e.g. desmids, spermatozoids, etc.), as seen by bright-ground and by dark-ground methods. The difference in appearance is sometimes very remarkable.

Micrometric Measurements by a Projected Scale.*—F. J. Clendinnen gives the following description of the method devised by him.

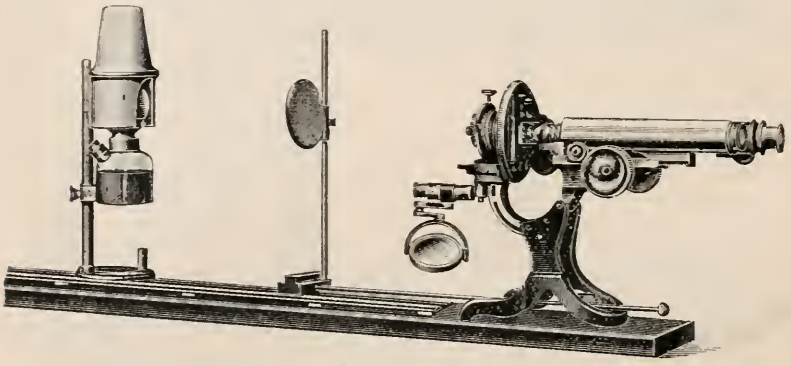

Fig. 48.

The apparatus (fig. 48) consists of a wooden base 3 ft. in length and 8 in. wide, which carries the Microscope; and a pair of steel rails, $2\frac{1}{2}$ in. apart, parallel with which is placed a scale graduated in centimetres and millimetres. The tripod of the Microscope is fitted into slots on the wooden base, so that its position is fixed while in use, but the Microscope can be easily removed. The metal rails are projected forward from the base of the tripod, and upon them runs an upright metal rod carrying the screen, which may be lowered or raised by means of a small set screw. Behind the screen, the rails also carry the lamp, which may thus be adjusted to any requisite distance. A micrometer of known value being in position in the Microscope stage, the reticule upon the screen may now be compared at various distances. These distances being read off by means of the scale placed between the rails, the value of the screen reticule becomes accurately known, and the stage micrometer may now be dispensed with, as it is used merely to determine an exact calibration.

* Trans-Australasian Med. Congress, 1908, ii. (1909) pp. 377–8 (1 pl.).

The Screen.—The screen consists of a disk of glass on which are photographed rulings forming a reticule of five divisions to the square. It is thus apparent that, by adjusting the screen at various distances, a micrometer of various known dimensions is obtained. In the perpendicular position, the screen is reflected by the illuminating mirror through the condenser, by which an image of the reticule is formed on the object. In the horizontal position, the micrometric image is transmitted direct through the condenser, and an image of the reticule is formed on the object. The screen may be readily swung in or out of the field as desired.

The Direct Method.—The Microscope is placed horizontally. The screen is centred by focusing with the condenser a small spot in the centre of the ground glass. The ground glass is now removed, and the screen is placed in the carrier in its stead. The object to be measured is focused in the ordinary way, and then the scale is focused by the condenser, an image of the scale is thrown on the object, the scale which has been previously calibrated on the rails is read off, and the size of the object determined.

The Indirect Method.—This is used when it is necessary to have the Microscope in an upright position. The same applies here as regards the scale, only in this method the plane mirror is used to reflect the parallel rays up through the condenser. First centre the light with the mirror (plane side), focus the stage micrometer as before, place your screen in situ, and focus it on to the stage micrometer, compare with it, and calibrate your rails accordingly.

Advantages over other Micrometers. — 1. The micrometer is easily placed in or out of the field whilst examining an object. 2. The whole field is divided into squares. 3. It can readily be adjusted to various known measurements by simply sliding the carrier on the calibrated rails. 4. It has advantage over the eye-piece micrometer in so much as it is not always in the field of vision, and moreover it has a greater range of measurements. 5. It measures areas instead of lines. 6. By using the camera lucida, the object may not only be easily drawn, but accurately measured.

This ghost micrometer is not new and has been repeatedly re-invented : e.g. by Goring circa 1820 ; Royston Pigott, circa 1870, A. E. Wright, 1890, and others.

(4) Photomicrography.

Method of Estimating the Exposure in Photomicrography, with Axial Cone Illumination.*—Duncan J. Reid remarked that it is generally admitted that to obtain good results in photomicrography, it is necessary that the exposure should be correct. One important feature of this method is that it enables one to record the conditions under which a photograph had been taken, and that with such accuracy as to make it possible to repeat it on any future occasion. It is based on the method of calculating the "working aperture," by the measurement of the Ramsden disk of the eye-piece, described by Sir A. E. Wright in his book on the "Principles of the Microscope." It presupposes carefully centred axial cone illumination, from a source of light at a fixed distance,

* Journ. Quekett Micr. Club, 1909, pp. 486–9.

and, with the help of a Nelson or other collecting lens and a substage condenser of a power suited to the objective in use, so arranged as to just fill the back combination of the objective with a uniform solid cone of light, at full aperture, and so as to give critical illumination and a uniformly illuminated field on the ground glass of the camera. To obtain these results it might be necessary, with objectives below $\frac{1}{2}$ in. (12 mm.) to employ a supplementary collecting lens, in the course of the beam from the Nelson lens. The factors to be taken into consideration in estimating the exposure, were :—1. *The magnification*, which increases the exposure in the direct ratio to the square. 2. *The light:* Exposure tables were shown, based on a standard obtained with the edge of the flame from a $\frac{3}{4}$ in. wick kerosene lamp as a source of illumination. A single 1 ampere filament Nernst lamp, working from 100 volt current, required $\frac{1}{15}$ of those exposures. 3. *The plate:* The photographic plate on which the tables were based was the Ilford chromatic—a colour-sensitive plate of medium rapidity. A standard was found by making a series of strip exposures on such a plate, at a given magnification and aperture (250 diameters, and 0·50 N.A.), from which a table of exposures at that aperture could be calculated for all other magnifications. 4. *Numerical aperture:* It was a very common custom in recording the conditions under which a photograph had been taken, to say that a lens of 1·20 or 1·30 N.A., i.e. its full numerical aperture, had been employed. What was, however, really required was the aperture at which the lens had been worked—the working aperture—which affects the exposure in the inverse ratio to its square. A second table was therefore shown, giving the factors by which the exposures found from the first table should be multiplied or divided, so as to give the exposure required at varying working apertures. To use this second table it was necessary to be able to estimate the working aperture which had been found to give the result desired. If we take a finely divided glass measure, giving say millimetres and tenths of a millimetre, and hold it exactly in the position of the Ramsden disk of the eye-piece, and focus both it and the Ramsden disk simultaneously with a focusing glass, so adjusted that it is in focus when its mount rests on the surface of the measure, it is possible to estimate the diameter of the Ramsden disk of the ocular. Multiplying that diameter by the number of the ocular (giving the number of times it magnifies the result obtainable by the objective alone) we obtain the diameter of the cone of light emergent from the back combination of the objective. If we now divide the semi-diameter of that cone by the equivalent focal length of the objective, in millimetres (usually marked on objectives, now-a-days), we obtain as a result the "working aperture" of the lens.

For instance, if a 4 mm. apochromat be used, the full N.A. of which is 0·95, and a No. 4 ocular, the diameter of the Ramsden disk of the eye-piece may have been found to be 1 mm. This multiplied by the power of the ocular (4), gives us 4 mm. as the diameter of the emergent beam from the back of the objective; the half of that (2 mm.) is the semi-diameter of that beam, which divided by 4, the equivalent focal length of the objective, gives us 0·50 as the working aperture of the lens.

We have therefore all the information required to make use of the following table :—

TABLE OF EXPOSURES FOR MEDIUM AND HIGH MAGNIFICATIONS.

Using edge of $\frac{3}{4}$-in. flame of Kerosene lamp, Nelson paralleliser, and condenser at its critical focus.

For Ilford Chromatic Plates.

At N.A. of 0·50.		Multiplying and Dividing Factors for calculating Exposures at different N.A.	
Diameters.	Exposures.	N.A.	Factors.
100	1″ to 1·3″	0·10	× 25·0
150	2″ ,, 3″	0·15	× 11·0
200	4″ ,, 5″	0·20	× 6·0
250	6″ ,, 8″	0·25	× 4·0
300	9″ ,, 11″	0·30	× 3·0
350	12″ ,, 16″	0·35	× 2·0
400	16″ ,, 20″	0·40	× 1·5
450	20″ ,, 26″	0·45	× 1·2
500	24″ ,, 32″	0·50	Standard
600	35″ ,, 46″	0·55	÷ 1·2
700	47″ ,, 65″	0·60	÷ 1·4
750	54″ ,, 70″	0·65	÷ 1·6
800	62″ ,, 80″	0·70	÷ 2·0
900	1′ 20″ ,, 1′ 45″	0·75	÷ 2·2
1000	1′ 40″ ,, 2′ 10″	0·80	÷ 2·5
1500	4′ ,, 4′ 50″	0·85	÷ 3·0
2000	7′ ,, 8′ 30″	0·90	÷ 3·2
3000	15′ ,, 19′	0·95	÷ 3·5
4000	26′ ,, 34′	1·00	÷ 4·0
..	..	1·05	÷ 4·4
..	..	1·10	÷ 5·0
..	..	1·15	÷ 5·3
..	..	1·20	÷ 5·8
..	..	1·25	÷ 6·2
..	..	1·30	÷ 6·8

Note.—The higher exposures are for fully exposed negatives. Nernst 1-ampere filament lamps require $\frac{1}{15}$ of these exposures.

A table of exposures for low magnifications, at low working apertures, based on the same principles, is also given. The following practical points in connection with making the measurement of the Ramsden disk are mentioned : (1) It is easier to make it with a low-powered eye-piece, which can then be changed for the one with which the photograph is to be taken ; (2) it is generally better to move the object to be photographed to one side, whilst it is being done : (3) it is necessary to interpose a screen of smoked or dark green glass between the eye and the light, which should then be removed before the exposure is made ; (4) the markings on the millimetre measure should be coarse. Anyone who intends to use this method of estimating exposures should work out a standard for himself, as the intensity of the illumination depends so much on the arrangement of the collecting and condensing lenses, and on the source of light. If found to be the same as in the table, well and good ; if not, a magnifying or dividing factor could be found to be used with this table, or, if preferred, a new table could be worked out. If yellow or other coloured screens are employed, they ought to

be standardised by making test exposures on the make of plate to be used, with and without them. Those who wish to read the method in more detail may refer to the full report to be found in the Transactions of the Royal Photographic Society for January 1909.

(6) Miscellaneous.

Refractive Index of Canada Balsam.*—The refractive index of Canada balsam, says W. T. Schaller, as it occurs in the thin sections made for the U.S. Geological Survey, was determined on the request of F. C Calkins, who had found † that the index, or n, was not absolutely constant, but varied between two extremes. By the examination of 300 slides, he found n to reach and even slightly exceed ω of quartz (1·544), though n was found greater than 1·544 only in the proportion of one slide in a hundred. The excess was very small and the balsam was decidedly yellow. The lowest value found by him was about $1·535 \pm ·002$.

The value of n for sodium light was determined on an Abbe-Zeiss refractometer by total reflection on three kinds of slides, which were (1) not cooked as much as usual, (2) cooked as ordinarily done, and (3) over-cooked. The differences found between (1) and (2) are very slight, and, in fact, the individual values show almost as much variation as between the different groups. The values obtained are :

(1)	(2)	(3)
$n = \begin{cases} 1·539 \\ 1·538 \\ 1·539 \end{cases}$	$n = \begin{cases} 1·536 \\ 1·538 \\ 1·539 \end{cases}$	$n = \begin{cases} 1·543 \\ 1·540 \\ 1·540 \\ 1·542 \\ 1·541 \end{cases}$

The average values are for (1), 1·5387 ; for (2), 1·5377 ; for (3), 1·5412, or, as the average of all, 1·5395, which is almost identical with the value (1·5393) given by Becker ‡ in 1898. A determination of n in a slide six years old gave the value 1·5390. These values show that, in general, n lies very close to 1·539, and that this value may well be used in a study of a thin section, while the actual possible variation was found by Calkins to be from 1·535 to 1·545, though the extreme values are but seldom reached. The uncooked liquid balsam has a refractive index of 1·524, which, after cooking, rises to 1·54. The older a slide, the higher the index of the balsam becomes, which after a time, especially if the air has access, reaches towards the highest value, or 1·545.

B. Technique.§

(1) Collecting Objects, including Culture Processes.

Solmedia.—At the meeting of the Society held April 20, F. R. Chopping, assistant in the Clinical Laboratory at the Westminster

* Amer. Journ. Sci., xxix. (1910) p. 324.
† Science, xxx. (1909) p. 973.
‡ Amer. Journ. Sci., v. No. 4, p. 349.
§ This subdivision contains (1) Collecting Objects, including Culture Processes ; (2) Preparing Objects ; (3) Cutting, including Imbedding and Microtomes ; (4) Staining and Injecting ; (5) Mounting, including slides, preservative fluids, etc. ; (6) Miscellaneous.

Hospital, exhibited specimens of bacteriological culture media in dry concentrated form (provisional name, "Solmedia" = solid media). As they are light and of small bulk, they can be sent by post at cheap rate. They do not deteriorate, have hitherto kept extremely well, and will probably do so for quite a long time ; hence they will be invaluable for work in warm climates, especially tropical. The method of using the media, which is quite simple, is as follows : 5 c.cm. of water are to be added to a given weight of solmedium in a test-tube ; the test-tube is then placed in a waterbath for about 30 to 45 minutes, and afterwards allowed to set in the required position. In this way a tube of sterile media is cheaply and easily prepared. Samples of unused "solmedia" culture tubes were exhibited and also cultures of various organisms in various media, as well as uninoculated tubes of media. This method of producing dry concentrated media, which took the inventor about two years to elaborate, will be found to be extremely useful both for persons who require small quantities of cultivation media and also for institutions where many tubes are used daily. A list of the tubes shown will be found in the Proceedings of the Society for April, p. 397.

Solmedia are put up in tubes containing sufficient to make 12, 50 and 100 5-c.cm. tubes. They are also supplied in sterile test-tubes plugged with sterile cotton wool. Each tube contains sufficient solmedia to make a tube of media on the addition of about 5 c.cm. of water. The solmedium is firmly adherent to the bottom of the tube, so that the tubes will stand any amount of transport, and can be stored in any position.

Collecting and Examining Ganymedes anaspidis.*—J. S. Huxley obtained specimens of *Ganymedes anaspidis* g. et sp. n., a Gregarine from the digestive tract of *Anaspidis tasmaniæ*. Some of the hosts had been pickled in formalin, others in sublimate. Preparations were made by staining gut and liver tubes whole in para-carmine for 2 hours, and eventually teasing out on a slide in balsam, removing as much débris as possible and leaving the parasites behind. When *Anaspidis* were fixed quite fresh, their guts were found to be filled with sand ; in such case the *Ganymedes* had to be picked out under a dissecting Microscope. They were then passed from 90 p.c. alcohol to a slide previously smeared with egg-albumen. They were then stained with iron hæmatoxylin, or with Ehrlich's hæmatoxylin and eosin, or with methyl blue-eosin by Mann's method.

Testing for Indol in Microbic Cultures.†—C. Porcher and L. Panisset find that as a rule the quantity is small, and the extract must be concentrated to give a proper reaction. They first obtain the extract by shaking up with ether, then add a few drops of alcohol, and afterwards reduce the extract to $\frac{1}{10}$ of its original bulk. To about 5 c.cm. is added $\frac{1}{2}$ c.cm. of a 5 p.c. alcoholic solution of p.-dimethylaminobenzaldehyde. Then 1 c.cm. of strong HCl is poured down the tube ; a ruby-red ring appears at the junction.

* Quart. Journ. Micr. Sci., lv. (1910) pp. 156–7.
† C.R. Soc. Biol. Paris, lxviii. (1900) pp. 653–5.

Artificial Culture of Marine Plankton Organisms.*—E. J. Allan and E. W. Nelson give an account of an extended research into methods of cultivating plankton diatoms in sea-water media. In their paper they call any diatom culture which can be carried on practically indefinitely by inoculating fresh supplies of prepared water, a "persistent" culture. Strictly "pure" cultures have not been obtained, but most of the "persistent" cultures contain only one species of diatom, and are free from all organisms larger than small flagellates.

As culture media, the authors used sea-water ("outside" water or "tank" water), sterilised and unsterilised, prepared either by the addition of Miquel's saline solutions or the authors' modifications of these solutions, or in other cases by treatment with animal charcoal or peroxide of hydrogen. It was found unnecessary to add the organic infusion recommended by Miquel. The best medium was found to be sterilised "outside" water (i.e. water from the English Channel) treated with Miquel's solutions, and the next best was sterilised tank water treated with animal charcoal.

In order to discover the conditions which underlie the successful cultivation of diatoms, they exposed a number of cultures to varying conditions of salinity and alkalinity as well as to varying degrees of light and temperature. It seems necessary to raise the concentration of nitrates, or possibly of phosphates, above that found in ordinary sea-water. The influence of hydrogen peroxide or animal charcoal appears partly nutritive, partly protective, effecting the removal of toxic substances. Light is the most important physical factor, the rate of growth in a suitable medium depending directly upon its intensity.

A number of flasks were inoculated with mixed cultures by taking plankton fresh from the sea. In general, the true plankton diatoms are the first to develop in considerable numbers. After two or three weeks, infusoria, algæ, and the bottom diatoms, gain the upper hand, and the true plankton forms die out.

The remainder of the paper is devoted to the study of the life-history of certain species of diatoms, and to the methods of rearing marine larvæ in sterile sea-water with a pure culture of a suitable food.

Simple Anaerobic Methods.†—A. Tedeschi gives an account of his application of Marino's methods. For the isolation of anaerobes he uses a culture medium pressed between two sterile-glass surfaces. The medium is inoculated and kept at a temperature of 42° C. for half an hour. It is then poured into the inverted cover of a Petri dish, and then the Petri dish itself is placed with its outer surface upon the surface of the nutrient medium. If the surface of the glass is even, access of air is thus excluded.

The author is also able to cultivate anaerobes in deep culture in ordinary agar. The medium is melted and cooled to 42° C., at which temperature it remains liquid. Sterile glass beads are dipped in broth —to remove adherent air—inoculated with the culture material, and dropped into the agar. They fall to the bottom of the tube, carrying the inoculum with them.

* Journ. Marine Biol. Assoc., Plymouth, viii. (1910) pp. 421–74.
† Centralbl. Bakt., 1te Abt. Orig., liv. (1910) pp. 105–8.

Cultivation of the Tubercle Bacillus upon Animal Tissues.†—C. Frugoni found that portions of the organs of animals, suitably prepared, form an excellent medium for the cultivation of tubercle. Prismatic pieces of the lungs of rabbits and dogs were heated for 45 minutes in an autoclave, and then placed for two hours in 6 to 8 p.c. glycerinated water. They were then put in sterilised tubes, containing a small quantity of glycerin and water to prevent drying. The tissue is kept away from the glycerin bath by means of a constriction of the tube upon which it rests. Upon such a medium the growth of *Bacillus tuberculosis* takes place very rapidly, and the culture possesses great vitality. This method is likely to be of great use for the isolation of the bacillus from tuberculous tissues.

Comparative Value of recent Typhoid Culture-media.‡—W. Gaehtgens and G. Brückner, in the examination of a hundred stools, mostly from typhoid patients, employed the following media : Conradi's brilliant-green picric acid agar, Padlewsky's sodium sulphite malachite-green agar, Endo's fuchsin agar, Werbitzki's china-green agar, Gaehtgen's caffein-fuchsin agar, and the malachite-green agar of Lentz and Tietz. They found that the medium of Lentz and Tietz was the most satisfactory, and for rapid differentiation of the *Bacillus typhosus* fuchsin agar most suitable. By means of these new media it was possible to isolate the bacillus in 50 p.c. of cases in the first fortnight of the disease, and in 75 p.c. of cases in the first three weeks. This shows that examination of the fæces in the diagnosis of typhoid is no less valuable than agglutination tests or blood culture.

Cultivation of Oidium albicans from Throats.*—From swabbings of the throats of 300 cases of suspected diphtheria, Heidsieck was able to isolate *Oidium albicans* in thirteen. The organism was encountered, also, in a number of other cases where the overgrowth of bacteria made isolation impossible. From blood serum, the dull white colonies of *O. albicans* were transplanted on to beet-wort gelatin. On this medium the colonies were at first round, sharply defined, and of a brownish colour. After a few days, thread-like processes were found projecting from the colony, some radially, some tangentially. The author compares the cultural characters of this organism with those of *Saccharomyces cerevisiæ* and *S. ellipsoideus*. Experiments were also carried out with a view to ascertaining the pathogenicity of this yeast, and comparing it with that of other yeasts and moulds.

(2) Preparing Objects.

New Method of Fixing Plankton.†—L. Meunier and C. Vaney have used for two years a 2–4 per thousand solution of quinone for fixing plankton. The compounds formed by the reagent with albuminous substances are more stable than those obtained by means of formalin or the chromic acid salts. After a lapse of time certain structures stain brown ; this browning facilitates the identification of the parts affected,

* Centralbl. Bakt., 1te Abt. Orig., liii. (1910) pp. 553-7.
† Tom. cit., pp. 559-76.
‡ Op. cit., liv. (1910) pp. 108-14.
§ C.R. Soc. Biol. Paris, lxviii. (1910) pp. 727-9.

such as nuclei, muscular fibres and glands. The plankton, either salt or fresh-water, is allowed to remain for 24 hours in the quinone solution, which must be freshly prepared as it decomposes under the influence of air, water and light. After an immersion of 24 hours the quinone is replaced by 70 p.c. alcohol. When it is desired to mount the animals in toto, they are passed through upgraded to absolute alcohol, to which last is gradually added either oil of bergamot or oil of cloves; after a stay of some hours in the pure oil, the animals are mounted in balsam. For histological examination the quinone may be combined with perchloride of mercury, picric and acetic acids. As the reaction of quinone is neutral it does not interfere with staining reactions, and, indeed, may act as a mordant.

Studying Metamorphosis of Muscidæ.*—C. Pérez in his research used *Calliphora erythrocephala*: specimens at every stage of development were examined, and the methods of fixation and staining were very varied. The chief fixatives were acetic-acid-sublimate and the picro-formalin of Bruin. As a nuclear stain Mayer's hæmalum was mostly used, the plasma being contrast stained with eosin and aurantia. Often the iron-hæmotoxylin method was substituted for the hæmalum. Occasionally the preparations were contrast stained with carmine hydrochloride, and then differentiated with picro-indigo-carmine. For osmic acid fixation, Borrel's formula was adopted (osmic acid 2, platinum chloride 2, chromic acid 3, glacial acetic acid 20, water 350). After 24 hours the preparations were washed in running water. The sections were contrast stained with 1 p.c. magenta red, and afterwards for 10 to 20 minutes in picro-indigo-carmine (saturated aqueous solution of picric acid 1 vol., saturated aqueous solution of indigo-carmine 2 vols.). The preparations were differentiated with absolute alcohol and oil of cloves. The author points out that osmic acid penetrates feebly, and therefore this reagent should not be adopted as the chief fixative.

Studying the Neurofibrils in Lumbricus.†—J. Kowalski finds that in order to successfully demonstrate the neurofibrils in *Lumbricus*, the silver impregnation should be effected by means of an acid medium, and the fluid used by him which gave the best results was composed of formol 25 c.cm., glacial acetic acid 5 c.cm., distilled water 100 c.cm.

Two other fixatives recommended by Bouin were as follows:—1. Distilled water 100 c.cm., formol 25 c.cm., glacial acetic acid 5 c.cm., ammonia 0·5 c.cm. 2. Alcohol 94 p.c. 100 c.cm., formol 75 c.cm., glacial acetic acid 5 c.cm., ammonia 0·5 c.cm.

(3) Cutting, including Imbedding and Microtomes.

Studying Eye of Pecten.‡—W. J. Dakin carried out his investigations on the eye of *Pecten* by means of paraffin and paraffin-celloidin sections, by maceration preparations, and by teased out specimens of fixed material. Maceration was found to give important results, and it was noted that different reagents were requisite for maceration and fixation purposes. The best fixatives were Zenker's fluid and Carnoy's

* Archiv Zool. Expér. et Gén., xliv. (1910) pp. 1–274 (16 pls. and 162 text figs.).
† La Cellule, xxv. (1909) pp. 291–347 (4 pls.).
‡ Quart. Journ. Micr. Sci., lv. (1910) pp. 53–6.

mixture. After Zenker the preparations were stained with Mallory's fluid (anilin-blue 0·5, orange G 2, oxalic acid 2, H_2O 100), Heidenhain's iron-hæmatoxylin, Weigert's and Van Gieson's methods. When Carnoy's fluid (chloroform 10, acetic acid 30, absolute alcohol 60) was used for fixing, the preparations (retina) were stained with iron-hæmatoxylin and Bethe's toluidin-blue. Several other methods were adopted, but the foregoing seem to have given satisfactory results. In reference to maceration, it is stated that the lens-cells were easily isolated after immersion of the eyes in 3 p.c. solution of chloral hydrate in sea-water for about 4 hours. The same solution was used for the retinal cells. After two hours the retina was dissected out, placed in a drop of water on a slide, and a cover-glass supported by wax feet placed over it. Gentle tapping on the cover-glass separated the elements. Chromic acid, ·02 p.c. in sea-water, gave good maceration results for rod-cells and rods. Maceration preparations were examined transformed and stained with picro-carmine.

Improved Brain Microtome.*—K. Berliner describes a new type of microtome with a large stage (fig. 49) suitable for cutting sections of

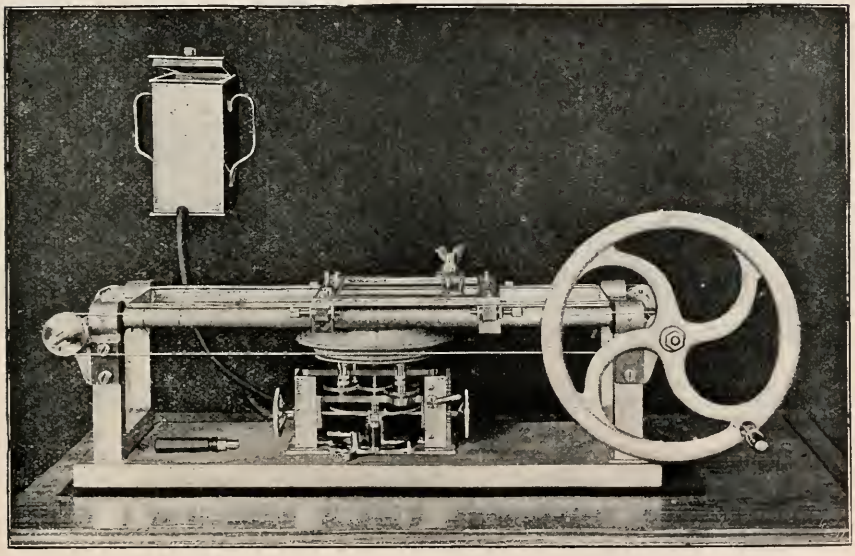

Fig. 49.

large objects, such as the brain. The knife is firmly fixed at each end, and its handles move along rigid cylindrical guide-bars. By means of an accessory apparatus, it is possible to cut sections under alcohol. The mechanism for adjusting and raising the stage is of a new type, fully described in the original paper.

* Zeitschr. wiss. Mikrosk., xxvi. (1909) pp. 378–81.

Injecting Kidney of Teleostean Fish.*—J. Andigé anæsthetised the fish by putting chloroform into the water in which the animals were contained ; the fish were then bled by means of a transverse cut made through the body behind the abdominal cavity. When devoid of blood the arterial system was injected by means of the following procedure. A 1 p.c. solution of nitrite of amyl in distilled water is syringed into the caudal vein ; this done, the caudal vein is ligatured and the syringe inserted into the aortic orifice and the procedure repeated. The canula is left in the artery, and through it is passed the injection mass. That which gave the best results was gelatin coloured with Ranvier's soluble blue ; Fol's metagelatin with Prussian blue was also successful. Injections of the venous system were made through the caudal vein or through the posterior cardinal veins, after bleeding, and previously washing out with nitrite of amyl solution. These venous injections were not invariably successful, and the author found that Retteser's procedure could be relied on. This process consists in immersing the whole animal, with the abdominal cavity freely open, in Müller's fluid. The vessels naturally injected are distinguished with facility, and their dissection is quite easy. Injections of the renal tubules were also tried by the methods of Guitel and Altmann. Altmann's method, which consists in injecting olive oil through the ureters and then treating the injected organ for 24 hours with 1 p.c. osmic acid, gave the better results. Though rendering useful service, neither was entirely satisfactory.

Method of Preparing Frozen Sections of Brain-substance.†—Y. Nageotte gives an instructive account of difficulties met with in such work, and devices for overcoming them. He commences by cutting the hemispheres into slices of about 1 cm. thick. The anterior and posterior portions are cut vertically and the intermediate, horizontally, so that the principal bundles are cut at right angles. The slices must be divided into several portions suitable for the microtome plate. If a disc of liver be first frozen on to the plate, and the block of brain frozen on to this liver bed, the usual waste of the last portion of each block is avoided.

To avoid the deleterious effect of ice-crystals upon the grey matter, the block is immersed first in 3 p.c. formalin. It is then sprayed with methyl chloride on all its sides, and thus the surface is rapidly frozen. It is then gummed to the microtome plate. This can be maintained at a temperature of $-10°$ C. The sections are carefully removed with fingers or forceps, and washed in water. Sections can be cut at a thickness of 40–80 μ.

Before staining, the sections are placed in 90 p.c. alcohol for a few minutes. The addition of 30 p.c. glacial acetic acid to this bath prevents shrivelling. The section is then spread on a glass plate, and stained with hæmalum (Mayer's hæmalum 2 parts, absolute alcohol 1 part) for half an hour in a warm stove. It is then washed with water and placed in a modification of Weigert's decolorising fluid, washed, passed through alcohols, cleared in xylol, and mounted in balsam.

* Arch. Zool. Expér. et Gén., xliv. (1910) pp. 275–624 (104 figs.).
† C.R. Soc. Biol. Paris, lxvii. (1909) pp. 542–5.

Microscopical Sections through both Cerebral Hemispheres.*—G. Bonvicini prepares his material by putting it into solution containing a potassium chromate (4 p.c.) and chromium sulphate (2·5 p.c.) for a period varying from a fortnight to two months, according to the size of the pieces. At first the solution is changed weekly. If the whole cerebrum is to be so treated, the ventricles are injected with 10 p.c. formalin by means of a serum syringe. After the chromate stage, the brain is slung for six or eight days in a large vessel containing formalin. The brain so prepared is then cut into slices by means of a macrotome devised by the author (fig. 50). This instrument consists of a wooden base H_1, upon which a wooden platform H can be moved by a screw,

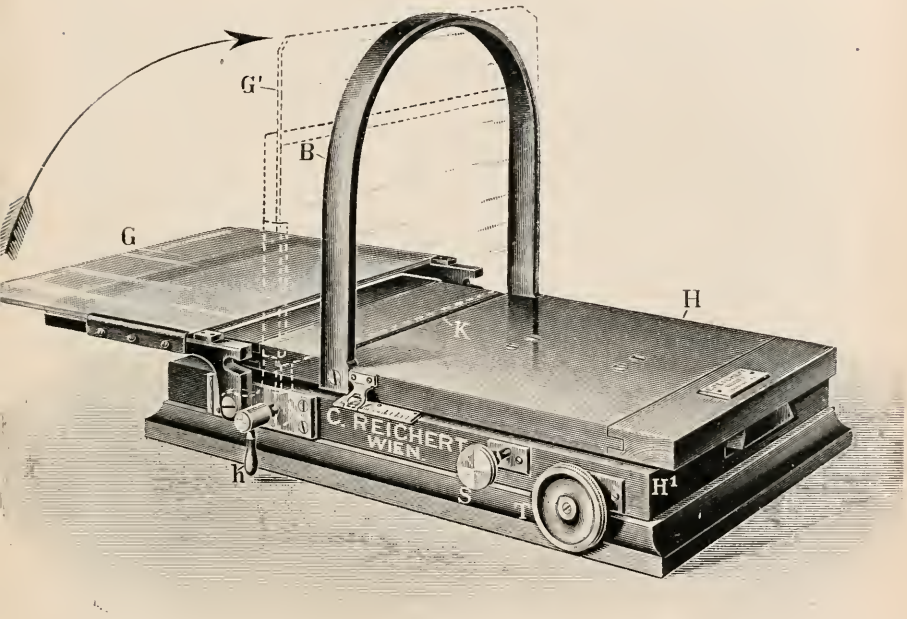

Fig. 50.

controlled by the milled head T. To the base is hinged a glass plate G, which can be moved through 90° into the position G^1. The platform H carries a stout vertical metal bow B, which guides the knife. At K, where the knife would strike the platform H, a strip of cork is inserted to prevent injuring the blade. The brain is placed on the board H, and pushed through the bow B, as far as the glass plate G in its vertical position will allow. The distance of the plate G from the bow B, and consequently the thickness of the slice cut, is controlled by the screw-head T. The surface of these slices may be stained and examined, or fine sections may be cut by means of a microtome.

* Zeitschr. wiss. Mikrosk., xxvi. (1909) pp. 410–18.

Cooling of Paraffin Blocks.*—D. Carazzi made observations upon the effect of different methods of cooling paraffin blocks. Some blocks were allowed to cool slowly at room temperature, others still more slowly in a paraffin oven from which the source of heat had recently been removed. Other blocks were cooled by means of water at different temperatures. The most satisfactory blocks were those which had been cooled by the addition of water at room temperature. The block should remain in this water until solidification is complete. Slow cooling makes the block unsatisfactory from a lack of homogeneity. Too rapid solidification is also unfavourable

(4) Staining and Injecting.

Quick Method of Preparing and Staining Pollen.†—After trying staining the grains and clearing them in phenol and xylol, which failed to remove the stain and also presented great difficulties in manipulation, W. Wesché tried the following quick method, which answered admirably. The flowers were collected during the period August 1 to 15 ; they were kept in pill-boxes till October 2, when the experiment was made. (Later on perfectly fresh pollen was experimented with, and found to be equally good, so that it appears unnecessary to dry it. One of the Compositæ was used, stained with fuchsin—a granule in methylated spirit.) They were shaken on to a slip and scraped with a needle to free the pollen ; the debris other than pollen was removed with forceps, using the dissecting Microscope. The pollen was scraped into a heap on the centre of the slip and stained with methylated spirit, in which a few granules of methyl-violet had been dissolved. This stain must not be too dark ; it should be quite transparent, though violet in colour. This process lasts about a minute, several drops being added at intervals, and the slip is then placed on the hot-plate. In the next process watch carefully to see that the liquid is in every case not completely evaporated. At the psychological moment add a drop of unstained spirit ; repeat this, then add a drop of turpentine ; repeat this three times, add a drop of balsam and xylol, and cover with the thin glass. The cover-glass should be placed on the edge of the slip, so as to be at the same temperature when it is placed on the balsam, and it is then less likely to hold air-bubbles. The slip will be dirty with stain and turpentine ; this can be removed when the slide is cold with a rag dipped in spirit. When the cover-glass is on, extinguish the lamp, and let the slide cool with the hot-plate.

Bleaching Methods.‡—D. Carazzi considers that none of the bleaching methods associated with osmic staining are free from disadvantage. The chief drawback being the difficulty of counterstaining. Altmann's method is the simplest, and therefore the best. The slides with the blackened sections are placed over night in a 2 p.c. gold chloride bath. After washing and drying, the section is placed in a formic acid bath and exposed to direct sunlight. The reduced gold gives the section a purple colour, and the black colour has disappeared. The gold can now be removed by means of iodised alcohol.

* Zeitschr. wiss. Mikrosk., xxvi. (1910) pp. 530–2.
† Journ. Quekett Micr. Club, **x.** (1909) p. 471.
‡ Zeitschr. wiss. Mikrosk., xxvi. (1910) pp. 527-9.

Hydrogen peroxide as a bleaching agent has the disadvantage that it does not keep well. Potassium permanganate and oxalic acid are apt to injure the section unless carefully watched. Sodium perborate—commercially "oxylithe"—has been used by the author with good results. A saturated solution of this salt, to which has been added a small quantity of citric acid will bleach a section rapidly and without injury. Counterstaining is not attended with difficulty.

Chemical Basis of Gram's Method of Staining.* —M. Guerbet, A. Mayer, and G. Schaeffer consider that this staining reaction depends upon changes partly physical, partly chemical, which occur when an aniline dye is allowed to act upon a fatty acid. In a series of experiments they took fatty acids, saturated and unsaturated, simple and combined. They found that unsaturated acids and the lower saturated acids took the stain, but the higher saturated acids did not combine with the dye or with the halogen. Complex bodies, such as the cerebrosides, took the stain unequally. They consider that, in the case of the unsaturated acids, an additional product is formed which is imperfectly soluble in alcohol. In the case of saturated acids, a precipitation of colouring matter (modified, perhaps, by the halogen) takes place in the interior of the substance which has dissolved it.

It has been shown that microbes contain fatty granules, and the application of specific stains for fat show granules identical with those demonstrated by Gram's method. The authors further prove by their experiments that if bacteria normally Gram-stained are exposed to the action of a strong oxidising solution, the double bonds are chemically satisfied and the organisms are rendered Gram-negative. Also, if the procedure of Gram's method be reversed, the halogen stage preceding the aniline dye, no alcohol-fast product is formed.

Nile-blue Staining for the Demonstration of Metachromatic Granules.†—P. Eisenberg discusses the action of this stain upon the metachromatic granules of the *Bacillus pestis* and other micro-organisms. If the bacillus be stained with watery nile-blue, the granules stand out as dark-blue spots on a lighter ground. On the addition of dilute soda, the granules become brownish-red, while the rest of the bacillus is usually pale orange. Fatty granules, on the other hand, usually take a pure orange-red colour, the tint of the pure nile-blue base. The author believes that the brownish-red granules of the plague bacillus, like the metachromatic granules of the diphtheria bacillus, are hyperchromatic structures of the Babes-Ernst type. He points out, also, that granular appearances are often artificially produced by basic precipitation during the staining process.

Methods of Staining Glycogen.‡—P. Mayer describes a new method of glycogen-staining, and gives a comparative account of some other processes. Vastarini uses a mixture of 2 p.c. fuchsin and 4 p.c. resorcin in 94 p.c. alcohol. To this is added 4 p.c. hydrochloric acid. In some

* C.R. Soc. Biol. Paris, lxviii. (1910) pp. 353-6.
† Centralbl. Bakt., 1te Abt. Orig., liii. (1910) pp. 551-2.
‡ Zeitschr. wiss. Mikrosk., xxvi. (1910) pp. 513-22.

cases it is necessary to stain for 48 hours, but gentle warming will shorten the time required. This method is applicable to paraffin as well as to celloidin sections, but they must not be fixed to the slide with albumin or even with alcohol after Gaule's method. As a counterstain, light green or indigo-carmine may be used. As an alternative method Vastarini uses a creso-fuchsin and hæmatoxylin mixture. The author finds that by Vastarini's methods, glycogen is well and sharply stained, and the preparations do not fade quickly. On the other hand it may fail unaccountably.

Best's method is complicated, and the stock solution is difficult to prepare. It is also unstable. Gage stains the tissue with a fairly strong alcoholic solution of iodine, and by this means demonstrates glycogen as a homogeneous and not a granular substance. This is probably due to solution of glycogen by the iodine solution, and points to a defect in the method.

The author uses a ferric chloride and gallic acid ink, prepared according to a formula of Silbermann and Ozorovitz. Sections may be stained either after fixation to the slide or by immersion in the stain. To counteract simultaneous staining of the tissues, sections may be stained first in para-carmine. It is in this case necessary thoroughly to wash out the acid after this stain, in order to prevent subsequent precipitation of ink. Sections so stained have kept well for several months. The author claims for this method the advantage of simplicity over others described.

Further Note upon Injection Methods.*—B. Možejko, in a postscript to his previous account of the application of injection methods to the study of anatomical detail, points out that, for the demonstration of the circulatory system in certain classes of animals, it is advantageous to postpone injection almost until decomposition commences. This is the case in Vermes, Gastropoda and Crustacea among the Invertebrates. In Vertebrates the problem is complicated by the elasticity of the arterial walls, and the coagulation of the blood which accumulates in the venous system. In dealing with the former difficulty the author first of all made trial of amyl-nitrite, according to the method of Oviatt and Sergent, but found it unsatisfactory. He now uses a peptone solution, with better effect.

For the injection of arteries the best time is just the moment when rigor mortis has passed off; the tissues are still fresh but the arterial walls no longer resist the passage of the injection material. It is, however, well to delay injection of the venous system until decomposition has commenced. The blood clots are then partly or wholly liquefied. The author obtained some of his best results by injecting reptiles (lizards and crocodiles) two or three days after death.

Staining Embryonic Nerve-tissues.†—In an investigation of the development of the autonomic nervous mechanism of the alimentary canal of the bird, Williamina Abel made use of Ramon y Cajal's silver-nitrate method. This method consists in impregnating the tissue with

* Zeitschr. wiss. Mikrosk., xxvi. (1910) pp. 542–7.
† Proc. Roy. Soc. Edin., xxx. (1910) pp. 334–6.

a silver salt and subsequently exposing it to the action of a reducing agent. After a number of experiments, it was found that while, in the case of chicks of two or three days' incubation, the best results were obtained with perfectly fresh tissue, a certain amount of post-mortem change was an advantage in older embryos, the optimum period varying from 12 hours in the case of a four-day chick to 24 or 36 hours in the case of adult animals.

By this method fully-developed nerves are stained dark brown, almost black, while the rest of the tissues are golden yellow. Nerve-fibres stain better than nerve-cells. In embryonic tissues, developing nerves are stained in accordance with their degree of development. In preparations stained by this method, nervous tissue, in addition to its dark tint, shows a peculiar sheen which differentiates it from deeply stained portions of non-nervous tissue. Many sections show signs of deterioration after a lapse of about two years.

Studying the Morphology of the Blood of Amphibia.*—F. Freidsohn exposed the slides to be used to the vapour of pure formalin for 2 minutes, then made a smear in the usual way, and again exposed to formalin vapor, this time for about 1 minute. Osmic acid vapor did not yield good results. The fixed smears were air-dried and stained as follows: To 50 c.cm. of distilled water were added fifteen drops of Giemsa stain and five drops of 2 p.c. aqueous eosin solution (extra B.A.)—this was allowed to act for from 1 to 2 hours. The preparations were then washed with water, dried and mounted. The author's observations are confirmatory of the view that the red and white corpuscles develop from lymphoid cells; the illustrations in regard to the polymorph leucocytes are specially convincing.

Studying the Varicosities on Non-medullated Nerve-fibres.†—A. Nemiloff first treated the fresh material in $\frac{1}{8}$ to $\frac{1}{10}$ p.c. solution in 1·6 p.c. saline; after allowing the stain to act for $\frac{1}{2}$ to $1\frac{1}{2}$ hours the preparations were fixed in 8 to 10 p.c. molybdate of ammonium, to which a few drops of formalin or of osmic acid solution were sometimes added. After fixation the preparations were washed in water, rapidly dehydrated in absolute alcohol, cleaned in xylol, and mounted in Damara.

Cell Inclusions in Rabbit's Liver.‡—L. Launoy observed certain protoplasmic inclusions in the liver of the normal rabbit by means of the following procedure: When the liver-cells are dissociated in a solution of brilliant cresyl-blue ($\frac{1}{1000}$ to $\frac{1}{2000}$), the presence of certain inclusions may be seen, and also at the periphery some hard, highly-refracting, often pigmented, yellow or yellowish-brown bodies, which stain blue. Treated with the sulphate of nile blue ($\frac{1}{1000}$ to $\frac{1}{5000}$) and naphthol blue ($\frac{1}{2500}$), these granules stain blue or reddish violet respectively. The staining is selective, as no other intracellular granules are stained under the same conditions. The granules are insoluble in alcohol and chloroform in presence of acetic acid; osmic acid is feebly

* Arch. Mikrosk. Anat. u. Entwickl., lxxv. (1910) pp. 136–72 (1 pl.).
‡ Tom. cit., pp. 567–9 (1 pl.).
† Comptes Rendus, cl. (1910) pp. 145–8 (2 figs.).

reduced, and only at their periphery. The sections depicted in the illustrations were stained by the iron-alum method. The author arrives at the conclusion that the granules are neither fatty nor mitochondria, and calls them pigmented liquid bodies.

Vital Staining of Trypanosomes.* — A. Policard places between slide and slip a drop of infected blood, and then applies to the edge a drop of strong neutral red, dissolved in saline solution. By this method certain granules are stained a brick red. The chemical nature of these formations is doubtful, but they are not acid and are not degeneration products.

Golgi's Method for Examining the Internal Network of Spinal Marrow Cells.†—R. Legendre found that Golgi's method for examining the cells of the spinal cord could be advantageously modified by the following technique : The material was fixed in Golgi's fluid—i.e. formol (20 p.c.) 30, saturated solution of arsenious acid 30, alcohol (96 p.c.) 30, for 6 to 24 hours. Then nitrate of silver (1 p.c.) for one to several days. After a rapid wash in distilled water, the preparations were placed for 1 hour in the reducer (hydroquinine 20, sulphite of soda 5, formalin 50, distilled water 1000). This was followed by washing in distilled water, alcohols, paraffin sections. In this procedure all the later reactions suggested by Golgi are suppressed, as it was found that the foregoing method gave better results and clearer pictures of the network.

Staining Sections by the Romanowsky Method.‡—F. A. McJunkin describes a procedure by which the Romanowsky stain and its modifications may be used for staining sections. The sections are placed in the solution and incubated at 35° for 80 minutes, the solution being renewed at the end of 40 minutes. They are then washed in water, and, if quite blue, in 1 : 1000 acetic acid until pink ; after this they are immersed in 2 p.c. tannin solution for 10 to 40 minutes. The tannin is washed off in water, the excess of water removed with blotting-paper, and then the preparation is hurriedly passed through absolute alcohol to xylol, and mounted in balsam.

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

Fixation of Celloidin Sections.§—D. Carazzi points out that the fixation of thin celloidin sections, of a thickness of 10 μ or less, to the slide, is a matter of difficulty, and one that requires strict observance of technical details. He gives an account of the Italian method of Brazzola and others, and of the Russian method of Rubaschkin.

The technique of the Italian method is as follows : The knife is kept moist with 70 p.c. alcohol. The sections as they are cut are transferred to a square piece of thin unglazed paper. They are dried with Swedish filter paper, and then the slide, coated with albumin-glycerin, is applied with gentle pressure. Paper and glass are reversed, douched with 95 p.c.

* C.R. Soc. Biol. Paris, lxviii. (1910) pp. 505–7.
† Anat. Anzeig., xxxvi. (1910) pp. 207–17 (6 figs.).
‡ Michigan Acad. Sci., 11th Rep., 1909, pp. 110–11.
§ Zeitschr. wiss. Mikrosk., pp. 533–41.

alcohol, and then the paper is removed carefully. If the right conditions of moisture are present, the sections should now adhere to the glass. If the block is already stained, the sections may now be cleared with creosote, treated with xylol and mounted in balsam. Otherwise it it is necessary to apply descending alcohols, stain, dehydrate, and mount as usual.

Rubaschkin's method consists essentially in removing the section straight from the razor to a slide prepared with albumin glycerin. He lays stress on the importance of arranging the section smoothly upon the slide. The section is then cleared with a mixture of equal parts of clove oil and aniline oil.

The author has made a comparison of the two methods, and considers the former to be more suitable when a large number of sections are to be dealt with, the latter more suitable for a small number. When it is necessary to stain the sections, he considers it likely that Favaro's modification of the Italian method would be satisfactory, but disclaims personal experience of it. In this process the sections are stained while still on the unglazed paper and before fixation to the slide.

Mounting Spider Dissections as Microscopical Objects.*—The following method of sealing a mixture of equal parts of glycerin and spirit, a medium of great value in the mounting of the palpi of spiders, can be strongly recommended. Slides so prepared have stood the test of hard wear for more than two years, and show no signs of deterioration.

A tin cell is smoothed on both sides with fine emery cloth. It is cemented to a perfectly clean slip with good gold size and set aside until hard. The edge of the cell is painted with Miller's caoutchouc cement, which is allowed to become "tacky" but not dry. The medium and object are introduced, a cover placed in position, and a clip added. The whole is now *well* washed to remove all glycerin, and the clip is then removed under water. A little water will enter the cell, but this is no disadvantage. The slide is then wiped dry as far as possible, the remaining moisture allowed to evaporate, and a ring of gold-size painted on. In a day or so a ring of club-black is added, which completes the process.

Since this method was published, F. P. Smith says he has had several complaints as to the difficulty of obtaining Miller's cement, and that "C. R. Percival, the well-known mounter, to whom I communicated this method some years ago, tells me that he has used as a substitute an india-rubber cement supplied by Grübler, with complete success."

(6) Miscellaneous.

Filtration of Immune Sera.†—E. H. Ruediger finds that serum, after being centrifuged for 30 minutes at a speed of 3000 revolutions per minute, will pass without clogging through a Berkefeld filter, N or W. If, however, the serum be not quite cleared by the centrifugalising, it is well to pass it first through the coarser Berkefeld V filter. The centrifuge removes blood corpuscles, precipitates, and other extraneous matter.

By experiments with anti-tetanic and typhoid agglutinating sera, the author found that no appreciable loss in potency was caused by filtering.

* Journ. Quekett Micr. Club, x. (1909) pp. 473–6.
† Philippine Journ. Sci. Manila, iv. (1909) pp. 333–40.

He found, also, that the fine Berkefeld W filter stopped all bacteria, when subject to a pressure of not more than two atmospheres.

The author emphasizes the importance of washing, scrubbing, and boiling the filter after use in order to prevent subsequent clogging.

Indian-ink Method of Demonstrating Spirochæta pallida.*—Frühwald used the following technique: the surface of the lesion is scraped until a drop of serum is obtained; a loopful of this is mixed on a slide with a drop of commercial indian ink (Günther and Wagner's). The mixture is then spread with the edge of a coverslip, after the manner of a blood-film. When dry the smear is examined with an oil-immersion. The spirochætes are seen as bright spirals on a dark brown field, and *pallida* can be distinguished from other spirochætes by its form. By this method the author claims that *Spirochæta pallida* can be demonstrated more quickly than by any other procedure.

New Drop Bottle.—F. R. Chopping showed at the Meeting held on April 20 a drop bottle which has been designed to hold staining reagents.

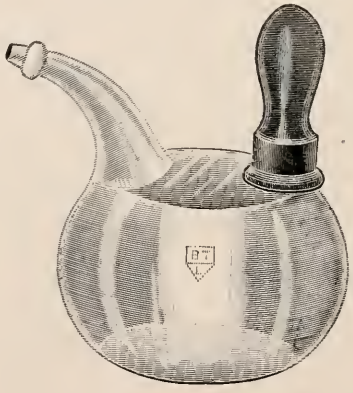

Fig. 51.

It is a modification of "Schuster's Alkalimeter"; the glass stopper is replaced by an indiarubber teat; manipulation of this produces anything from a fine steady stream for washing over slides to a single drop for staining purposes. The bottle holds rather more than the alkalimeter, and has been made in squat form with a wide base, giving it great stability, which experience has shown to be very desirable. A special advantage is that it can be used with equal facility with either hand (fig. 51).

The appearance is neat and the price moderate: the bottles shown were made by Messrs. Baird and Tatlock (see post, p. 397).

* Münch. Med. Wochenschr., No. 49 (1909).

Metallography, etc.

Properties of Gold Leaf at High Temperatures.*—J. C. Chapman and H. L. Porter have found that gold leaf does not become transparent when heated alone. When gold leaf, suspended from a horizontal wire and maintained in tension by means of a small weight hung on it, was heated, a gradual increase of length took place up to about 170° C. From 170° to 340° C. the length remained constant, and at 340° C. a rapid contraction began and continued through a considerable temperature interval. Gold leaf fixed to glass remained unchanged when heated a few degrees below 340° C., but when heated a little above 340° C. it became transparent. Microscopic examination showed that the gold itself was still opaque, but had aggregated, leaving clear spaces, as observed by Turner.† The contraction appears to be the cause of the transparency.

Microstructure of Copper.‡—A metallographical study of copper containing various amounts of impurities forms part of an investigation of the oxidation refining process by W. Wanjukoff. The samples were taken at different stages in the refining operation. Four etching reagents were used: (1) Ammonia solution; (2) ammoniacal solution of copper chloride; (3) nitric acid of 1·2 sp. gr.; (4) copper sulphate solution, acidified with sulphuric acid, in which the section was made the anode of a weak electric current. Numerous photomicrographs illustrate the paper.

Copper-aluminium Alloys.§—M. Barrée has determined the transformation points of the alloys in the range 8 to 15·5 p.c. aluminium, by measuring the variation of electrical resistance with temperature. Critical points were found in the neighbourhood of 500° and 750° C., sufficiently near to those found by L. Guillet. In addition, a new critical point was observed at about 200° C. In those cases in which the transformation did not occur at exactly the same temperature on heating and on cooling, the critical point on cooling was the lower. Successive heatings did not affect the position of the critical temperatures.

W. Broniewski‖ has determined the specific conductivity, the temperature-coefficient of the resistance, the thermo-electric properties and the solution E.M.F. of the complete series of alloys of aluminium with copper. The curves embodying the results obtained point to the existence of the compounds Al_2Cu, AlCu, Al_2Cu_3, and $AlCu_3$. Of these, Al_2Cu_3 is new, while the existence of AlCu has been disputed.

Alloys of Nickel and Copper.¶—E. Vigouroux has not succeeded in isolating any definite compounds by the chemical treatment of nickel-copper alloys. An investigation of the E.M.F. of solution of these alloys leads to the same conclusion, that no compounds exist.

* Proc. Roy. Soc., Series A, lxxxiii. (1909) pp. 65–8 (2 figs.).
† See this Journal, 1909, p. 117.
‡ Metallurgie, vi. (1909) pp. 749–59, 792–801 (55 figs.).
§ Rev. Métallurgie, vii. (1910) pp. 16–33 (8 figs.).
‖ Comptes Rendus, cxlix. (1909) pp. 853–5. ¶ Tom. cit., pp. 1378–80.

Alloys of Cobalt.*—F. Ducelliez has determined the E.M.F. given by binary alloys of cobalt with tin, antimony, bismuth, lead, and copper, in a solution of cobalt sulphate, against cobalt, and also against the other metal of the alloy. The compounds CoSn, CoSb, and $CoSb_2$ (?) are indicated by the curves given. Compounds do not occur in the other systems.

Phosphides of Tin.†—P. Jolibois has made a microscopical and chemical examination of alloys of tin and phosphorus containing 1 to 40 p.c. phosphorus. To obtain alloys containing more than 13 p.c. it was necessary to heat tin and phosphorus together under pressure. The mixtures were heated in sealed tubes at 620° C. Sn_4P_3, microscopically observed as large hard needles in the alloys of lower phosphorus content, and SnP_3, were the only compounds found. The numerous compounds of different formulæ described by other workers do not exist.

Phosphides of Nickel.‡—P. Jolibois, by dissolving nickel in a mixture of tin with Sn_4P_3, has obtained the compound NiP_2. When nickel was dissolved in a mixture of Sn_4P_3 with SnP_3, the compound NiP_3 was obtained.

Effect of Compressing Mixtures of Metals.§—G. Tammann has compressed mixtures of filings of two metals at a pressure of 5000 atmospheres. The blocks obtained were examined microscopically, and their behaviour on heating and their electrical conductivity investigated. It was found that the formation of solid solutions or compounds could not be brought about by pressure alone, for the blocks, immediately after compression, consisted of the unchanged metals lying side by side. Diffusion may go on in the cold, and is accelerated by raising the temperature. In a compressed mixture of bismuth and thallium, mixed crystals as a blue fringe between the metals can be seen after 5 hours at 120° C. The compound Bi_3Tl_2 is formed at higher temperatures.

Shrinkage of Metals and Alloys.‖—F. Wüst has devised an accurate method of determining the alteration in length of a cast bar as its temperature falls from the solidifying point. An iron rod projected into each end of the mould in which the bar was cast. These rods, co-axial with the bar, were attached to small hydraulic cylinders, arranged in such a manner that variation in length of the bar caused an alteration in level of water in a capillary tube. From the time of casting of the bar, observations of time, temperature and length were taken, and plotted as time-temperature and time-length curves. The temperature-shrinkage curve was obtained from these. A description of the microscopical structure of each casting is given. The shrinkage of lead, tin, zinc, aluminium, copper, bismuth and antimony, and of a number of alloys of these metals and of nickel, was determined. The shrinkage coefficients experimentally obtained were found to differ notably from those calculated from

* Comptes Rendus, cl. (1910) pp. 98–101 (5 figs.).
† Op. cit., cxlviii. (1909) pp. 636–8. ‡ Op. cit., cl. (1910) pp. 106–8.
§ Zeitschr. Elektrochem., xv. (1909) pp. 447–50; through Journ. Chem. Soc., xcvi. (1909) p. 669.
‖ Metallurgie, vi. (1909) pp. 769–92 (82 figs.).

published coefficients of expansion. An alloy of components completely insoluble in each other in the solid state contracts less than either of its components; the eutectic alloy having the smallest shrinkage-coefficient. An alloy consisting of one or more solid solutions contracts more than either of its components. Neither in metals nor alloys could a definite relationship between shrinkage and melting point be discerned.

Metastability of Metals.*—E. Cohen and K. Inouye find that other metals exhibit phenomena resembling those observed in connection with the "strain-disease" of tin. Pieces of hard-rolled thin sheet of the metals (lead, copper, zinc, nickel, bismuth, brass) were etched with some figure, such as a cross, placed in contact with similar but unetched pieces between two iron plates, and heated for a number of hours at constant temperatures, for instance, 100° C. or 180° C. In many cases the unetched strip was "infected," and showed a figure similar to that etched on the piece with which it was in contact. The inoculation did not occur in the cold. From these and other observations the authors infer that the common metals, as usually employed in a mechanically strained condition, are metastable, and may pass into a more stable form through inoculation as well as by heating.

Crystalline Structure of Iron at High Temperatures.†—W. Rosenhain and J. C. W. Humfrey have made some preliminary experiments on the microscopical effects of strain in iron at high temperatures. A polished strip of sheet iron was heated in a high vacuum; it was held in such a manner that the release of a strong spiral spring, by electrical means, caused a pull on the specimen sufficient to deform it. The iron strip was strained when the temperature at its centre exceeded 1000° C., the ends not being visibly red. When cold, the specimen was examined microscopically. In a similarly heated but unstrained specimen, three regions of different appearance were noted. At the ends the surface was unchanged. Where the temperature approached redness, a system of interlacing black lines was seen, and in the central (hottest) part, a faint tinting, apparently caused by slight oxidation, revealed a new crystallisation, of coarser and more regular structure, characterised by numerous examples of twinning. Upon these appearances were superposed, in the strained specimen, the effects of deformation. While the area of medium temperature, characterised by the interlacing black lines, showed no signs of plastic deformation, the neighbouring regions, both cooler and hotter, showed slip-bands and other clearly marked strain effects. The authors identify the three regions with the α, β, and γ forms of iron, and consider that the absence of strain effects in the region corresponding to the β form, indicates the greater hardness of this allotropic modification. The interlacing black lines noted in this region are held to be caused by a volume change occurring when α changes to β and β to α, this volume change producing relative movement of the crystals. An approximate measurement of the temperature of different points in a heated and strained specimen was made by

* Zeitschr. Phys. Chem., lxxi. (1910) pp. 301–11 (3 figs.).
† Proc. Roy. Soc., Series A, lxxxiii. (1910) pp. 200–9 (5 figs.).

previously placing particles of salts of known melting points on the rear surface of the specimen. An examination of the particles when cold, revealed whether they had melted or not.

"Growth" of Cast Irons after repeated Heatings.*—H. F. Rugan and H. C. H. Carpenter have made extensive experiments on different commercial cast irons and on numerous alloys containing varying amounts of carbon and silicon, to ascertain the cause of the familiar phenomenon of growth. Long continued heating is not accompanied by continuous growth ; successive heatings and coolings are necessary for growth to take place. White irons of low silicon content altered in volume very little in repeated heating and cooling, while cast irons containing notable amounts of silicon, and accordingly grey, increased in volume in some cases more than 60 p.c. The exclusion of gases, by carrying out the repeated heatings in a vacuum, prevented the growth of some specimens, but others still gave some increase of volume. In these cases the growth is ascribed to the effects of the gases originally present in the metal. A theory of the mechanism of growth is outlined ; the following are the chief points : Commercial grey iron consists essentially of a solid solution of iron silicide in iron, intermingled with which is a quantity of graphite. Heating in air or in flame gases, leads to a penetration of gases, which, probably on cooling, are absorbed by the solid solution and oxidise the silicide of iron. This oxidation is accompanied by an increase of volume, causing incipient disintegration and probably driving the graphite into holes originally present in the metal. A second heating brings about further gas absorption, and the reaction proceeds through numerous heatings until the whole of the silicon and some of the iron are oxidised. The metal has now lost the mechanical strength of cast iron, and can be sawn like chalk ; its microstructure has been revolutionised.

Iron-carbon Alloys.†—N. Gutowsky has sought to determine accurately the solidus curve of this system—the temperatures at which solidification is complete on cooling, or at which melting begins on heating. While the temperatures of commencing solidification and the eutectic temperatures were clearly indicated in cooling curves taken by the author, the points of final solidification could not be discerned in alloys not containing eutectic. For this reason, and also because of the difficulty of ensuring complete equilibrium in a solidifying alloy, the cooling-curve method was abandoned in favour of the method of examining microscopically alloys after quenching at known temperatures, the samples being previously annealed to bring them into a condition of equilibrium. The solidus curve thus obtained for the range, 0 to 2 p.c. carbon, is considerably more concave than that given by Heyn and others, the temperatures at which melting begins, in intermediate compositions, being lower than the temperatures formerly assumed. A series of cementation experiments, and a study of the phenomena of melting and solidification of white and grey iron, were also carried out.

* Journ. Iron and Steel Inst., lxxx. (1909) pp. 29–143 (15 figs.).
† Metallurgie, vi. (1909) pp. 731–6, 737–43 (35 figs.).

Hardness of Quenched Steels.*—A. Portevin and H. Berjot have employed the Shore scleroscope and to a smaller extent the Brinell ball, to determine the hardness of two steels containing 0·32 and 1·46 p.c. carbon, a steel containing 0·56 p.c. carbon, 1·46 p.c. silicon, and two case-hardened steels originally containing, the one 0·13 p.c. carbon, the other 0·09 p.c. carbon, 2·54 p.c. nickel. Specimens were tested after hardening at different temperatures, and after hardening and reheating to different temperatures for various lengths of time. The indications of the scleroscope are rendered worthless by the presence of hardening cracks or of a superficial decarbonised layer. If proper precautions are taken, the scleroscope may safely be used for measuring the hardness of quenched steels, and is especially suitable for testing case-hardened steels, giving as it does the superficial hardness which cannot be determined by the Brinell method. The measurement of depth of cementation by the appearance of the fracture, is less reliable than measurement by microscopic examination of a polished and etched section.

Cementation of Silicon Steels.†—L. Grenet has made comparative cementation tests on a mild case-hardening steel and a steel containing 3·2 p.c. silicon, 0·05 p.c. carbon. No cementation of the silicon steel took place in wood charcoal, but in potassium ferrocyanide 1 p.c. carbon was absorbed by the outer layer 0·5 mm. thick, during a 6 hours' heating at 950° to 1000° C. No graphite was found in the cemented silicon steel after slow cooling.

Carbon-tungsten Steels.‡—T. Swinden has studied the microstructure of three steels containing 0·57, 0·89 and 1·24 p.c. carbon, and about 3 p.c. tungsten, quenched and air-cooled from different temperatures. Some measurements of electrical resistance were made. Conclusions drawn from earlier work § were confirmed. The lowering of the Ar_1 point by high initial temperature does not appear to be due to the formation of a carbide of tungsten, or a double carbide. Possibly a compound Fe_3W goes into solution at the "lowering temperature," and is reprecipitated at the low point on cooling.

Magnetic Properties of Alloys of Iron.‖—C. F. Burgess and J. Aston have made magnetic and electrical tests of two series of alloys, iron-nickel and iron-copper, prepared from electrolytic iron, and containing very small percentages of impurities. The possible occurrence of the compound Fe_2Ni is indicated.

Effect upon Steel of Sudden Changes of Temperature.¶—B. Zschokke ascribes the cracking of a tank, constructed of mild steel plate, to the frequent rapid heating of the internal surface when the tank was used for the preparation of a solution of caustic soda. Numerous experiments

* Rev. Métallurgie, vii. (1910) pp. 61–75 (4 figs.).
† Comptes Rendus, cl. (1910) pp. 921–2.
‡ Journ. Iron and Steel Inst., lxxx. (1909) pp. 223–56 (41 figs.).
§ See this Journal, 1907, p. 640.
‖ Met. and Chem. Engineering (formerly Electrochem. and Met. Ind.), viii. (1910) pp. 23–26, 79–81 (11 figs.).
¶ Rev. Métallurgie, vii. (1910) pp. 165–82 (24 figs.).

on the effect of rapid heating and cooling of various metals are described. Quenching lines were produced on the surface of mild steel specimens by a rapid cooling from temperatures below 400° C. Cracks were not obtained either by quenching or rapid heating.

Importance of Metallography in the Iron Industry.*—P. Oberhoffer indicates the various directions in which the Microscope may be applied to practical advantage in the iron and steel industry. Photo-micrographs illustrating the effect of silicon, phosphorus, and manganese upon size of grain, the changes in structure brought about by heat treatment, the effects of segregation, and other structural features, are given. Further examples are given by E. Heyn,† who also reviews briefly the progress of metallography in Germany.

Cementation by Solid Carbon.‡—G. Charpy and S. Bonnerot have obtained purely negative results in attempting the cementation of a mild steel with sugar carbon, graphite, and diamond, in the total absence of gas. The metal and the carbon were first heated to 1000° C. in separate tubes, in a vacuum continuously maintained, and were placed in contact after cooling. The temperature was raised to and maintained at 700° C. in a vacuum, till no more gas could be extracted, and was then kept at 1000° C. for several hours. Microscopic examination of the surface of the steel showed that not the least trace of carbon had been absorbed. The presence of traces of gas was found to bring about cementation with each of the three forms of carbon.

It now becomes necessary to ascertain if the diffusion of carbon in the interior of cast iron and steel is in any way connected with the presence of occluded gas.

Composition of Mixed Crystals in Alloys.§—D. Mazzotto describes a new method for determining the composition of mixed crystals deposited by alloys at different temperatures, based on a knowledge of the heats of fusion of the mixed crystals. The method is applied to the following binary systems :—lead-tin, tin-zinc, tin-bismuth, bismuth-lead.

Sintering-point Curve.‖—The sintering-point of a binary mixture is the temperature at which the eutectic begins to melt, and is readily observed. A. Stock points out that the sintering-point curve of a binary system may be used to determine the composition of any chemical compounds formed. The curve shows a sharp cusp directed upwards at the composition corresponding with a compound.

* Stahl und Eisen, xxx. (1910) pp. 239-43 (27 figs.).
† Tom. cit., pp. 243-6 (3 figs.).
‡ Comptes Rendus, cl. (1910) pp. 173-5.
§ Nuovo Cim., xviii. (1909) pp. 180-96, through Journ. Chem. Soc., xcvi. (1909) pp. 1008-9.
‖ Ber. Deutsch. Chem. Ges., xlii. (1909) pp. 2059-61.

MICROSCOPY.

A. Instruments, Accessories, &c.*

(1) Stands.

F. E. Wright's New Petrographic Microscope.†—In the design of this instrument the author adopted the Zeiss No. 1 C as his base. This particular model was chosen chiefly because of its wide upper barrel,

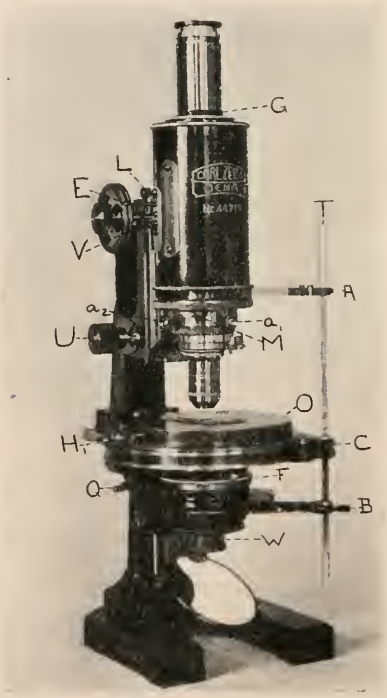

Fig. 53.

which was well adapted for the introduction of diaphragms and the movable Bertrand lens. The general view of the new Microscope is

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

† Amer. Journ. Sci., xxix. (1910) pp. 407–14 (5 figs.).

shown in fig. 53, fig. 54 being a cross section. The chief changes which have been introduced are as follows.

1. The nicols are revolvable simultaneously about the optic axis of the Microscope. They are connected rigidly by the bar T, and their angle of revolution can be read off directly by the stage-vernier. This method obviates the errors introduced by the usual system of gear-wheels, with accompanying lost motion in the moving parts. The details of construc-

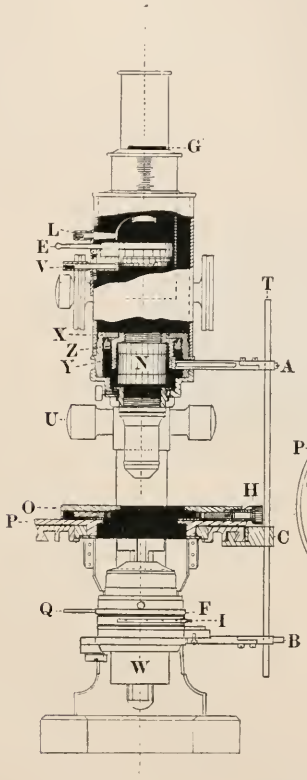

Fig. 54.

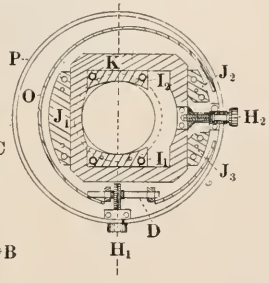

Fig. 55.

tion are shown in fig. 54. By means of the screw and cross bar at B the connecting rod T can be instantly released, and the lower nicol withdrawn or revolved by itself independently of the upper nicol. The total angle through which both nicols can be revolved by this device is 190°. [The author afterwards learned that the device of a connecting rod was not altogether new, having been used by Dick over thirty years ago, but was applied only to the revolution of a cap nicol above the ocular in conjunction with the polariser.]

2. A mechanical stage of new design (fig. 55), practically dust-proof

and mechanically simple in construction. In the figure the vertical edge or rim of the cap O of the stage-plate is indicated by the shaded broken circle, the upper surface of this plate being considered removed, and the working parts as seen from above thus exposed to view. The small plates I_1 and I_2 are attached to the lower stage, and are so constructed that the wedge-shaped edges allow the rectangular plate K to move only in an east-west direction. This movement is effected by means of the screw H_2. The plates J_1, J_2, and J_3 of fig. 55, on the other hand, are attached to the upper movable plate O, and their wedge-shaped edges are so adjusted that they allow the upper plate to move only in a north-south direction with reference to the rectangular piece K. The screw H, which terminates in a block attached to the upper plate, and running in a sliding-pin D, accomplishes these north-south movements. The heads of both screws H_1 and H_2 have divisions reading to 0·01 mm. movement. Springs, not indicated in the figure, have been introduced, and oppose the forward motion of the screws H_1 and H_2, and thus obviate errors due to lost motion in the screws. The total movement of the stage-plate in any direction is 24 mm. Mechanically, it is of simple construction, and consists of few parts.

3. The metal part, containing iris-diaphragm and polarizer, can be withdrawn from the optic axis of the Microscope by means of a release spring, not shown in fig. 54. This part is also revolvable by itself about the axis. This arrangement was adopted in preference to the usual method of inserting and withdrawing the upper nicol, because of the disturbing effect which the introduction of the upper nicol causes, both on the focus and position of the field. With the present disposition, the upper nicol remains permanently in the upper tube, and the optical system—objective, nicol, and ocular—is not disturbed in passing from ordinary to polarized light. In certain Microscopes the effect of the upper nicol on change of focus is compensated by means of a small lens of weak magnification, but even after the introduction of this device some shifting of the field may still be experienced on inserting the upper nicol.

4. An Abbe condenser is used, and with it a large nicol prism, or an Ahrens prism, 15-mm. edge, after the manner of the Fuess Microscope No. 1A. With this arrangement the entire condenser-lens system remains in position, and its upper lens need not be removed when low-power objectives are used. This does away with the devices which have been employed for throwing the upper part of the condenser combination out of the axis of the optic system, and which complicated the construction considerably.

5. The selenite or quartz plate of sensitive tint is inserted in a metal case at Q (fig. 54), just below the condenser. It is revolvable on the carriage F about the optic axis of the Microscope, an arrangement which often facilitates the determination of the ellipsoidal axis of a particular section, because the abrupt rise or fall of interference colours on insertion and rapid revolution of the plate appears more clearly than if the slower moving stage itself were revolved. At M a combination wedge is introduced as in ordinary Microscopes.

6. The Bertrand lens E, fig. 54, is mounted on a sliding arrangement

which, in connection with the sliding ocular tube, permits of different magnifications of the interference figure, an arrangement already adopted on several well-known Microscopes. In the present Microscope the focal length of the Bertrand lens (55 mm.) has been so calculated that the initial magnification of the interference figures can be varied from 0·81 to 1·90 diameters. The ocular itself magnifies this image in turn eight-fold, so that the resulting magnifications range from above 6·5 to 15·2 diameters. The fact that the upper nicol intervenes between the objective and Bertrand lens limits very considerably the range of magnification possible by the Bertrand lens. An iris-diaphragm is introduced directly below the Bertrand lens, and slides up and down simultaneously with it. This diaphragm is opened and closed by means of the pin V (fig. 54), which is connected with the diaphragm itself by means of pin-and-ratchet movement.

7. A second iris-diaphragm is introduced at G (fig. 53), directly below the ocular, and is used in connection with the observation of inter-

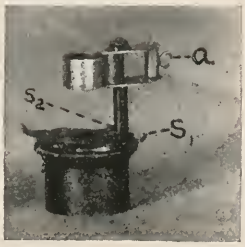

Fig. 56.

ference figures by the Lasaulx method without the Bertrand lens. To be of service in this connexion, the iris-diaphragm should be located precisely in the image-plane from the objective, as was emphasized especially by Czapski in 1891, for in that plane alone can light be excluded from adjacent minerals in the thin section. To realize satisfactorily this condition, the author has heretofore used the cap and stop indicated by fig. 56, with the two sets of slides, S_1 and S_2, at right angles to each other. This cap fits the Microscope tube, and is inserted in place of the ocular. By means of the lens *a* the field is focused in the plane of the slides and any portion singled out for examination. Because of diffraction phenomena the aperture should not be made less than 0·5 mm. in diameter, but even with this restriction, and with the ordinary objectives, 3 or 4 mm. focal length, grains not over 0·01 mm. furnish good interference figures which ordinarily would be completely overshadowed and not discernible if adjacent light were not excluded.

Experience has shown that the effects are still clearly recognizable if the diaphragm is at a distance of not over 5 cm. from the eye, and for convenience sake, therefore, this diaphragm was inserted just below the ocular. The usual round disks with small aperture supplied with Microscopes serve the same purpose, but are less convenient.

Before stopping-down the field by the diaphragm V just below the Bertrand lens, the image-plane from the objective should, on the same principle, be brought to coincide with the plane of this diaphragm, and the desired mineral section isolated by shutting off light from the adjacent grains. To accomplish this readily, a small lens L (fig. 54), 19 mm. focal length, has been introduced in the present Microscope above the Bertrand lens, and, in conjunction with the ocular, serves the purpose of bringing to sharp focus the image-picture in the plane of the Bertrand lens iris-diaphragm, in accord with the principle noted above. In place of this small auxiliary lens, the author has heretofore used a lens of long focal length, and has viewed the Bertrand lens diaphragm directly from the top of the tube. The new arrangement is more convenient, however, and obviates the necessity of removing the ocular before viewing the interference figure. The lens L swings on an axis, and can be instantly thrown out of the field. A small spring with pointer automatically indicates the correct position of the lens when thrown into the field. The Bertrand lens diaphragm ordinarily supplied with Microscopes is of little value in the observation of interference figures by the Lasaulx method without the use of the Bertrand lens, chiefly because of the disturbing effects of diffraction from the small apertures required and the distance of the aperture from the eye of the observer.

Watson and Sons' "Advanced" Petrological Microscope.*— The general design of this instrument is that of the Van Heurck model (fig. 57). It is mounted on a similar type of tripod foot, having a spread of 8½ in., and is fitted with rack-and-pinion coarse-adjustment and standard lever fine-adjustment. The stage has a diameter of 4⅝ in. It is fitted with a sliding bar and centring screws. The edge is divided on a silvered surface to degrees reading by a vernier to one minute. A mechanical stage may be supplied to fit on to the surface of the ordinary rotating stage if desired. The body is of large diameter, 2 in., and is fitted with a rackwork draw-tube divided to millimetres ; the lower end has the universal objective thread, so that a low-power Bertrand lens may be inserted for the examination of large crystals, etc. The draw-tube is slotted to receive a Bertrand lens immediately beneath the eye-piece, and the outer body has a suitable corresponding slot to give latitude for adjustment, the actual focusing being done by means of the rackwork draw-tube. At the lower end of the body a large field analyser is fitted, which can be rotated 90°, the rotation reading against a divided scale. Beneath this is a slot to carry a quartz plate or quartz wedge. A quartz plate is included with the instrument. The eye-piece and analyser prism are combined, the latter having a large field and rotating with a reader against a circle divided to degrees. The eye-piece is slotted and has cross webs. The polariser fits into the substage of standard size, and has an extra large prism, the circle by which it is rotated being divided on a silvered edge, and each quarter circle indicated by a spring catch.

Mounted above the polarizer, but detachable from it at will, is the "lever" high-angle condenser system, either or both of whose lenses can be turned out of the field or brought into position without touching

* Catalogue, 1910–11, pp. 74–5 (2 figs.).

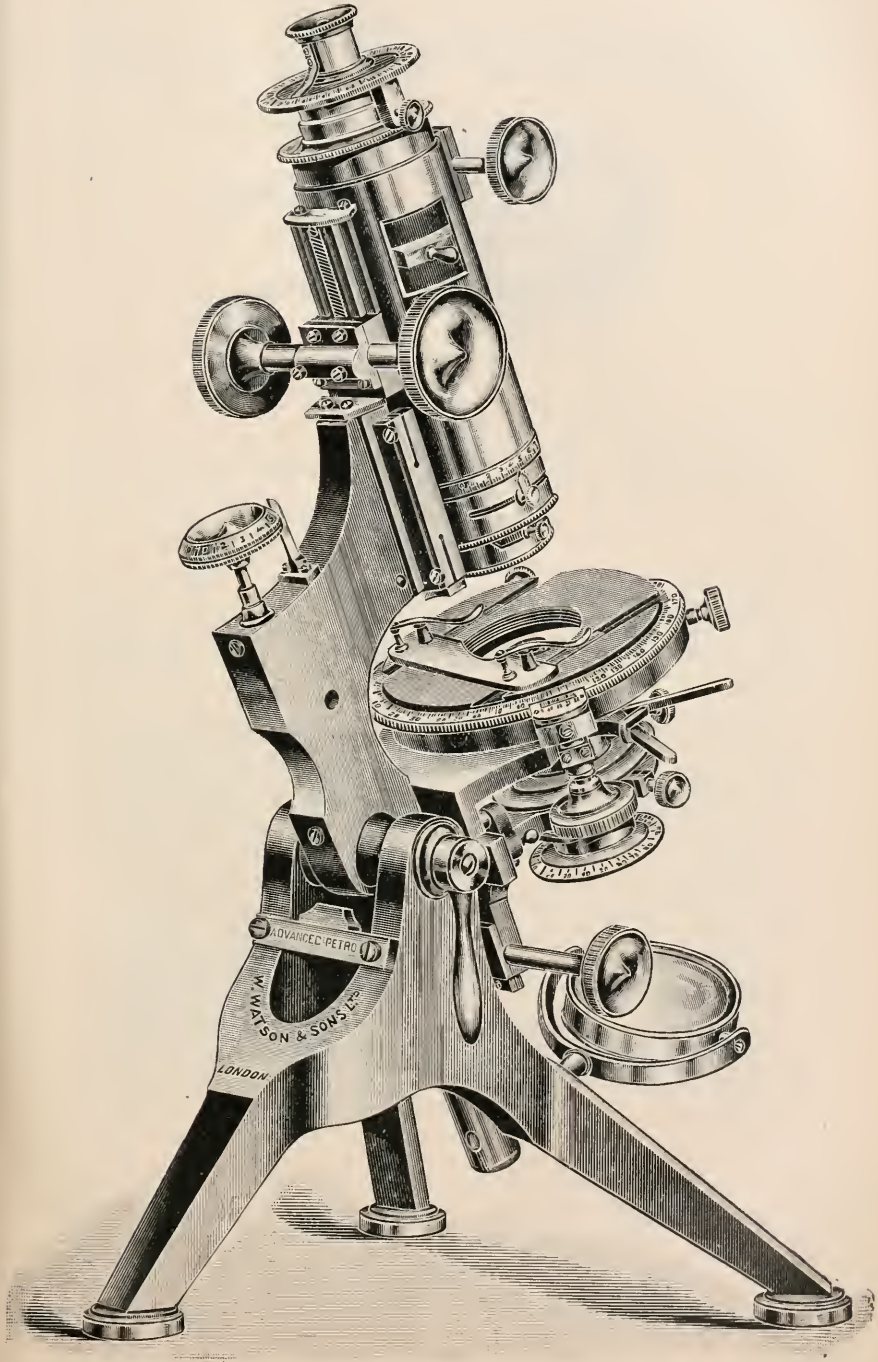

FIG. 57.

the polarizer in any way, as illustrated (fig. 58). It is probably the simplest and most effective arrangement yet devised. The substage is fitted with centring screws, and the whole of the substage apparatus can

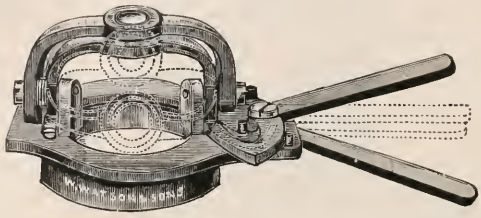

Fig. 58.

be used for ordinary microscopical purposes. It can also be turned out of the optical axis with the apparatus in it.

Nachet—**Microscope pour déterminer les taches de sang, visibles ou invisibles, récentes ou anciennes, sur un corps opaque.**
C.R. Assoc. Anat., 10me réunion, Marseilles, 1908, pp. 201–3.

(2) Eye-pieces and Objectives.

F. E. Wright's New Petrographic Ocular.* — F. E. Wright has designed this ocular for use with the petrographic Microscope, and its purpose is to obtain actual numerical measurement of cleavage angles, ex-

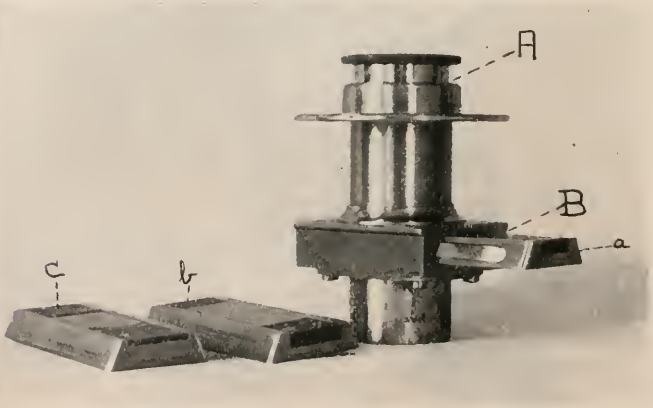

Fig. 59.

tinction angles, optical axial angles, refractive indices, and bi-refringence. In ordinary circumstances these properties are frequently observed, owing to cumbersome methods, in only a very approximate manner. The

* Amer. Journ. Sci., xxix. (1910) pp. 415–26 (12 figs.).

author finds that his ocular successfully determines all the above properties of a thin section. The apparatus is represented in fig. 59, and consists essentially of a metal holder, which is inserted in the Microscope-tube in place of the ordinary ocular, and into which in turn a positive Ramsden ocular is introduced at A, and certain plates mounted in metal carriages, *a*, *b*, *c*, are inserted at B. Cross hairs are attached to the base of the tube A, and are practically in the same plane with the upper

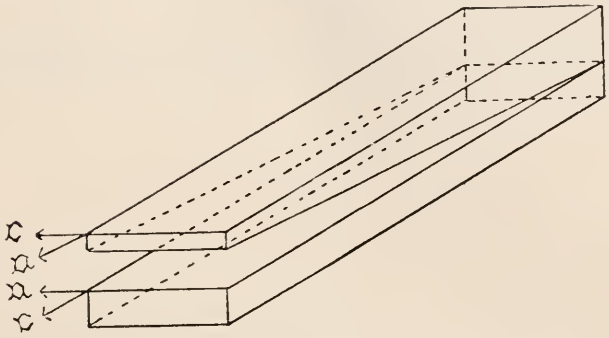

Fig. 60.

surfaces of the sliding plates, *a*, *b*, *c*, with the result that on focusing the Ramsden ocular on the cross-hairs, the divisions marked on the plates, *a*, *b*, *c*, are also in focus, and their relative movements can be read off directly. With the above arrangement the optical constants required can be measured directly by means of the three plates.

Plate *a* (figs. 60, 61) is for measurement of birefringence, and is a combination quartz wedge 35·3 mm. long, and 10 mm. wide. It con-

Fig. 61.

sists (1) of a quartz wedge cut parallel with the principal axis (direction of elongation = *c*) 0·5 mm. thick at the thin end, and 0·89 mm. at the thick end, its pitch being, therefore, about 6° 16′ ; and (2) of a quartz plate with direction of elongation *a* of same length and width, and 0·56 mm. thick. If these dimensions be followed exactly, $\frac{1}{10}$ mm. divisions ruled on the upper surface of the wedge (fig. 61) will give directly the difference in distance in $\mu\mu$ between emergent light waves at a particular point. Thus, for sodium light the distance between successive interference bands will be 5·89 mm. The zero line of the scale must coincide precisely with the black line of exact compensation between wedge and superimposed plate. In the present wedge this is

the case ; the slope of the wedge, however, is not exactly correct, and a slight correction must be applied to the readings obtained, since 22 mm. on the wedge is equivalent to 22·62 $\mu\mu$. For interference colours of the first and second order this error (nearly 3 p.c.) is very slight and can practically be neglected ; but for higher orders it must be taken into account and the readings multiplied by a factor of proportion. In determining the birefringences $(\gamma - \alpha)$, or $(\gamma - \beta$, or $\beta - \alpha)$ of a mineral, the position of the mineral plate (under examination) is ascertained by means of convergent polarized light. In actual work it is not always easy to find a plate cut precisely normal either to the optic normal or to one of the bisectrices, and it is of interest to know the percentage error caused by using sections inclined at low angles with the correct directions.

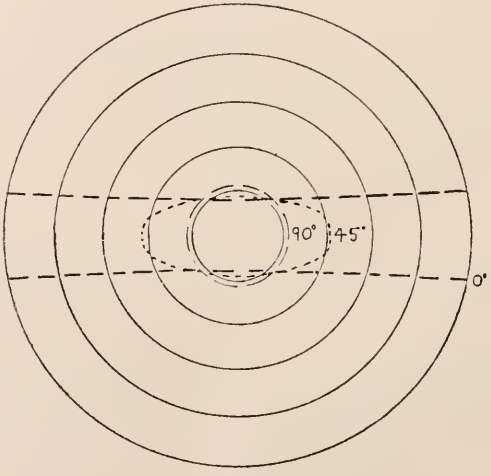

Fig. 62.

For a given plate the birefringence can be calculated approximately from the usual formula

$$(\gamma' - \alpha')\ (\gamma - \alpha) = \sin \mathrm{I}' \sin \mathrm{I},$$

in which I and I′ are the angles which the normal to the plate makes with the two optic axes (or optic binormals) respectively. In figs. 62–67 these relations are shown graphically in stereographic projection. In each figure the angular distance between any two successive concentric circles is 10°. In fig. 62 the positions of the directions in a biaxial crystal whose birefringence $(\gamma' - \alpha')$ is 2 p.c. less than that of the optic normal $(\gamma - \alpha)$, are indicated for the optic axial angles $2\nu = 0°$, 45°, and 90°. The optic normal coincides with the central point of the figure. Fig. 63 shows positions of the directions for which the birefringence $(\gamma' - \alpha')$ is 5 p.c. less than that of the optic normal $(\gamma - \alpha)$ which coincides with the centre of the concentric 10° circles. These curves are drawn corresponding to the optic axial angles $2\nu = 0°$, 45°, and 90°.

Fig. 64 is like fig. 63, except that the directions are indicated whose birefringence is 10 p.c. less than that of the optic normal located at the

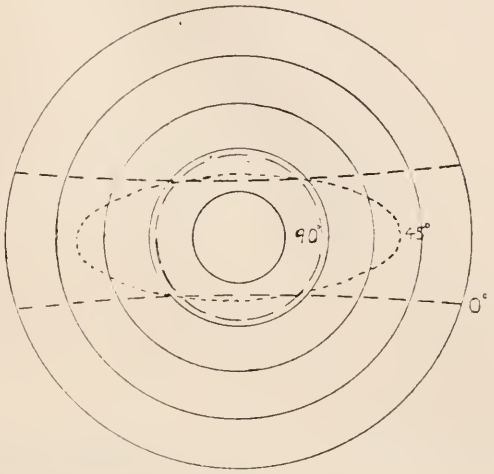

Fig. 63.

centre of the projection plate. The positions of the curves corresponding to optic axial angles $2v = 0°$, 15°, 45°, 60°, 75°, 90° are indicated in the

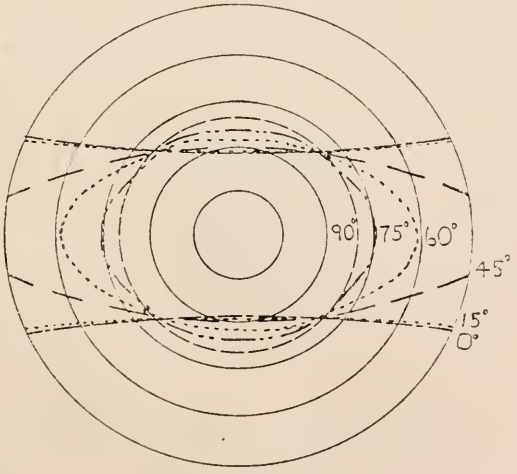

Fig. 64.

figure. In fig. 65 the directions, whose birefringence is 10 p.c. less or greater than that of the acute bisectrix (optic axial angle $2v = 45°$), are

shown by the dotted curves. In this figure the dotted curve which passes through the centre point (acute bisectrix) marks the directions

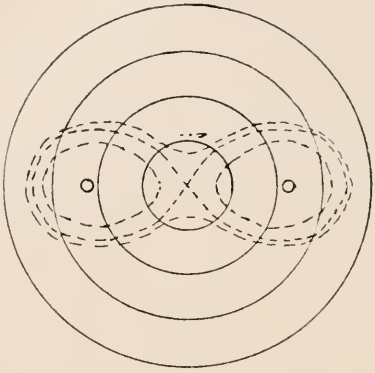

Fig. 65.

whose birefringence is equal to that of the acute bisectrix $(\gamma - \beta)$, or $(\beta - \alpha)$, as the case may be. Fig. 66 is similar to fig. 65, except that the

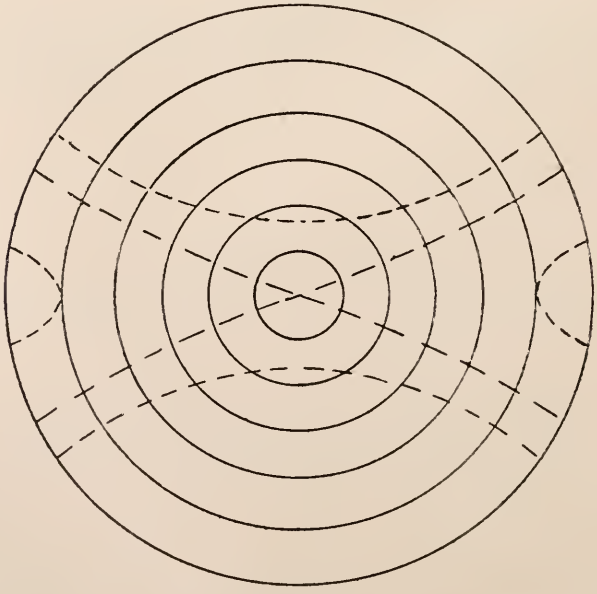

Fig. 66.

centre of the projection plate is the obtuse bisectrix $(2v = 45°)$. As in fig. 65 the directions whose birefringence is 10 p.c. greater or less than

that of the obtuse bisectrix are indicated. Fig. 67 is similar to fig. 65, except that the optic axial angle is $2v = 90°$. The dotted curves again represent the directions for which the birefringence is 10 p.c. greater or less than that of the bisectrix at the centre of the projection plate.

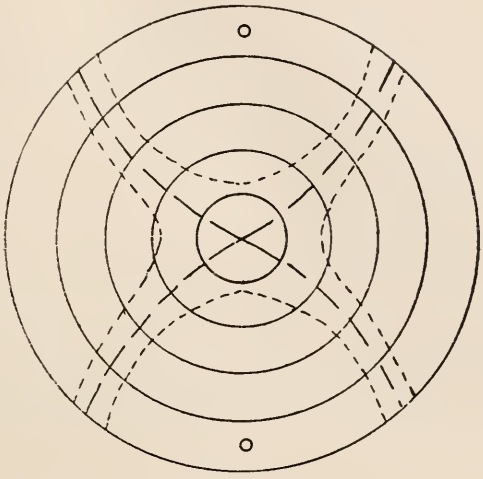

Fig. 67.

Plate *b* (figs. 59 and 68) is for the measurement of the optic axial angle, and is simply a thin glass plate 1·5 mm. wide, on which fine co-ordinate lines 0·1 mm. apart have been ruled. By means of this plate the optic axial angle of a mineral can be measured, provided one or both optic axes appear within the field of vision.

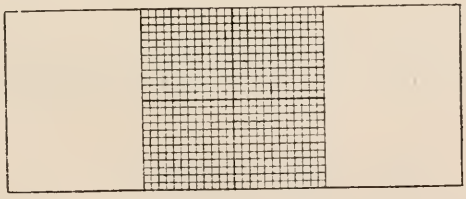

Fig. 68.

Plate *c* (figs. 59, 69, 70) is a bi-quartz wedge plate for the accurate determination of extinction angles. The dimensions are :—Plate of right-handed quartz : length 35·3 mm., width 6 mm., thickness at thin end 35 mm., at thick end 0·85 mm. ; plate of left-handed quartz : length 35·3 mm., width 6 mm., thickness 0·4 mm. The thin plate is cemented on the wedge to a combination plate wedge which gives zero extinction at a distance 3·5 mm. from the thin end (fig. 70). The same specifications are followed with a wedge of left-handed quartz and

a plate of right-handed quartz, likewise superimposed and cemented side by side as indicated in the figure, and in such a way that the line of total extinction in the first combination is the extension of the line of

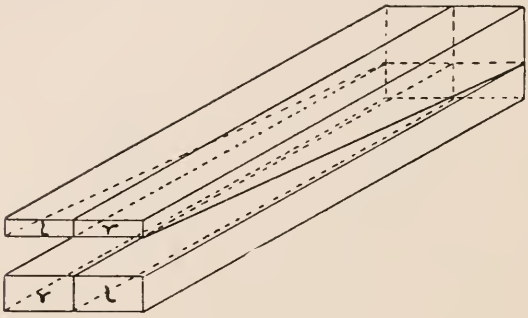

Fig. 69.

zero extinction in the second. This wedge in sodium light gives at the extreme end symmetrical extinction of about ± 10° (fig. 70), while at the thin end it is ± 1°. Fig. 69 gives a view of the bi-quartz wedge showing relative positions of right- and left-handed wedges and under-

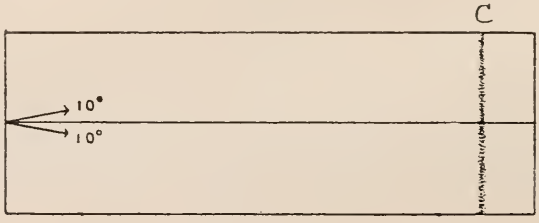

Fig. 70.

lying left- and right-handed quartz plates, all normal to the optic axis. Fig. 70 gives the top view of the bi-quartz wedge plate. The position of the dark line of zero rotation, or exact compensation, is indicated at C.

(3) Illuminating and other Apparatus.

Monochromatic Illumination.* — F. C. Hansen four years ago described a dry yellowish green (light-green, naphthol-yellow) light filter which, interposed between a Nernst light and the reflecting mirror of the Microscope, produced good illumination by means of which sharp images at high magnifications could be observed. The same author now recommends the use of this filter in combination with the mercurial vapour lamp of Schott. This lamp gives out yellow, yellowish-green, and blue rays, and by means of the yellow-green light filter, a clear monochromatic illumination is obtained.

* Zeitschr. wiss. Mikrosk., xxvi. (1910) pp. 525–6.

Ultra-microscopic Image.*—H. Siedentopf, in this treatise, goes very fully into the conditions underlying the formation of the ultra-microscopic image. The scope of his article will be gathered from the following list of its sub-divisions: 1. Limits of applicability of the ultra-microscope. 2. Dark-ground illumination by means of central diaphragms in the objective, and their disadvantages. 3. Dark-ground illumination by unilateral oblique light and the consequent azimuth-errors. 4. Dark-ground illumination by central diaphragms in the condenser, the cardioid condenser. 5. Variation of the diffraction disks by diaphragming the rear focal plane, by wrong use of the Microscope objective, and by obliquely placed cover-glasses. 6. Polarization of the light by diffraction of ultra-microns, and the corresponding appearances in the rear-plane of the Microscope objective. 7. Ultra-microscopic photography by rapid exposures. One of the plates illustrating the paper shows the Brownian movement of fine silver particles of about 20 μ in a colloidal solution, taken with an exposure of $\frac{1}{50}$ of a second. The other plate illustrates (1) the variation of the diffraction-disks by diaphragming the rear focal plane; and (2) gives a valuable criterion for cover-glass correction with dark-ground illumination. A bibliography of 30 references is appended.

Aplanatic or Cardioid Condenser for Dark-ground Illumination.† In section 4 of the article described in the foregoing abstract the author discusses the cardioid curve, and shows that its properties may be advantageously applied to the construction of a new form of dark-ground condenser. The cardioid, which derives its name from its heart-shape, is the curve traced out by a point on the circumference of a circle rolling on another circle of equal radius. It is the caustic curve assumed by rays reflected from a circular surface when the luminous origin is a point on the circumference of the surface. The polar equation to the curve is $R = r(1 + \cos u)$, when r is a constant. If the cardioid be combined with a circle of radius r, the circle being placed in a certain manner, then all rays incident parallel to the axis will, after reflections at the convex surface of the circle and at the concave surface of the cardioid, pass through the cusp of the cardioid. It follows, therefore, that the resulting ray-combination will be free from aberration. This will be understood from fig. 71, where Z Z is the common axis of cardioid and circle. O P is a ray parallel to the axis, reflected at P and P′. M is the centre of the circle.

If the ray is to converge to C, the final branch of the ray will be parallel to the radius P M, and the angle P′ C M will be equal to the angle of incidence u. Now it is a property of the cardioid that the angle i at P′, between the radius vector and normal, is equal to half the angle rotated by the radius vector, i.e., $i = \frac{1}{2}$ P′ C M.

This is proved thus (P′ C M being called u):—

$$\tan i = -\frac{dR}{R} \cdot du = \frac{\sin u}{1 + \cos u} = \tan \frac{u}{2}$$

Therefore

$$i = \frac{u}{2}$$

* Zeitschr. wiss. Mikrosk., xxvi. (1910) pp. 391–410 (2 pls. and 6 figs.). † Loc. cit.

It follows, therefore, that if the circle be suitably placed, the angle of convex reflection at the circle will be equal to the angle of radius vector rotation. The figure assumes that the proper position of the

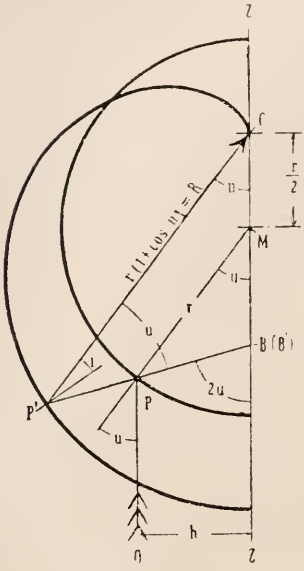

Fig. 71.

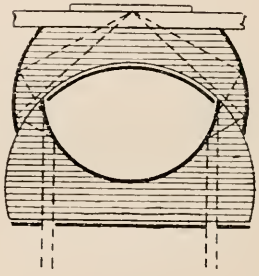

Fig. 72.

circle has been found : it only remains to fix the position of M, its centre. In the isosceles triangle B P' C—

$$2\,\mathrm{B\,C}\cos u = \mathrm{R} = r(1 + \cos u).$$

Again,

$$\mathrm{B\,C} = \mathrm{B\,M} + \mathrm{M\,C} = \frac{r}{2}\sec u + \mathrm{M\,C}$$

whence by substitution and reduction $\mathrm{M\,C} = \frac{r}{2}$. The point C, being the cardioid-cusp, is fixed, and the circle centre is therefore known. It will be noticed that the construction does not depend upon the value of r, which may consequently be chosen to suit the lens-maker's convenience. The radius r may also be expressed by $r = \frac{h}{\sin u}$, and this property makes the ray aplanatic in Abbe's sense of the word.

Fig. 72 shows how the construction is applied by Messrs. Zeiss on their aplanatic or cardioid condenser for dark-ground illumination. Parallel to the axis incident rays pass through a ring-shaped opening in the central diaphragm of the condenser. The diaphragm is set accurately perpendicular to the condenser axis. The shaded part of the figure represents solid glass, and the course of the rays and their emergence and

aplanatic combination at the point corresponding to the cardioid-cusp are easily followed.

For successful use of the apparatus, Microscope objective and condenser, must be accurately centred upon each other, and the strongest available light-source (arc-light or sun-light) is required. For gas or electric incandescent light the paraboloid condenser, with its simpler management, will suffice.

Drawing on a Transparent Drawing-surface.*—H. Tafner points out that certain difficulties attend the use in strong light of such projection apparatus as that of Tandler and Edinger. The strong light throws such intense shadows that it is not altogether easy to trace in the outlines, especially when there is much detail. The author suggests that these difficulties may be overcome by projecting, not on to an opaque surface, but on to a transparent one. He finds that a successful method is to draw by means of an engraver's needle on a gelatin film spread out on a matt-glass sheet. Needles of varying degrees of coarseness may be used to suit the work. By the help of graphite or powdered red chalk the lines may be filled in, and the picture is like a photographic negative ready for copying, and many copies may be struck off by a press. The author describes the details of manipulation, and explains how certain difficulties can be avoided. It is also possible to transfer the gelatin film to a copper-plate.

(4) Photomicrography.

Davis, W. S.—**Photomicrography with Simple Apparatus.**
Photo Era, 1908, p. 20.

Garjeanne, A. J. M.—**A Home-made Photomicrographic Apparatus.**
The Photograph Monthly, xvi., p. 28.

Marktanner-Turneretscher, G.—**Wesentlichere Fortschritte auf dem Gebiete der Mikrophotographie und Projection.**
Jahrb. f. Photogr. u. Reproduckt. für d. Jahr 1909. Published by J. M. Eder.

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

Monpillard, M.—**Nouveau dispositif pour la microphotographie instantanée de M. Briandeau à Nantes.**
Bull. Soc. franç. de Photogr., xxv. p. 73.

Reid, J.—**Photography and the Microscope; more particularly a Method of Calculating the correct Exposure.** *Photog. Journ.*, xlix. p. 33.

(5) Microscopical Optics and Manipulation.

Measurements in the Long-waved Spectrum.†—H. Rubens and H. Hollnagel give the following summary as the result of their investigations: 1. The wave-length and energy distribution of the ultra-rays of rock-salt, sylvine, potassium bromide, and potassium iodide were examined by means of a quartz interferometer. 2. It was found that the ultra-rays of rock-salt, sylvine, and potassium bromide were composed of two series of differing intensity. This is perhaps also the case

* Zeitschr. wiss. Mikrosk., xxvi. (1910) pp. 384–6.
† SB. k. Akad. Wiss., 1910, pp. 26–52 (11 figs.).

with the ultra-rays of potassium iodide. 3. The wave-length of each series is stated in the following table. That of the stronger series is indicated by λ_1, that of the weaker by λ_2, the "medium" being λ_0. The table also gives the molecular weight M of the substances.

Ultra-rays from	λ_1	λ_2	λ_0	M
Rocksalt	53·6 μ	46·9 μ	51·7 μ	58·5
Sylvine	62·0	70·3	63·4	74·6
Potassium bromide	86·5	75·6	82·3	119·0
Potassium iodide	..	..	96·7	166·0

It is to be noticed that the medium wave-lengths increase with the molecular weights—more slowly than the molecular weights, but more rapidly than their square roots. (The "medium" is got by dividing the half-wave length into the distance between two adjacent maxima or minima.) 4. The refractive index of water is about $\lambda = 82{\cdot}3\ \mu$, and is of the same order of magnitude as in the visible spectrum. 5. By examination of the ultra-rays of potassium bromide our knowledge of the spectrum has been increased by about half an octave. The spectrum now comprises ten complete octaves, of which two are in the ultra-violet, one in the visible region, and seven in the ultra-red.

Phenomena of Light-polarization in Solid and Pseudo-liquid Organized Matter.*—P. de Heen points out that, according to present ideas, matter is constituted by ionic fibres traversed by magnetic currents or by currents of ether, and all the phenomena of polarization are the result of the orientation of these magnetic fibres or of the predominant action of certain orientations (polarization by reflection or by refraction). It is interesting to enquire what difference exists between a network of fibres oriented to form a magnetic field and a network of fibres active as regards polarization of the light. The only difference lies in the circumstance that, to obtain an active substance, all the atomic bobbins must be wound in the same sense. The author explains fully his reasons for arriving at this conclusion.

(6) Miscellaneous.

Quekett Microscopical Club.— The 465th Ordinary Meeting was held on April 26, at 20 Hanover Square, W., the President, Professor E. A. Minchin, M.A., F.Z.S., in the Chair. Mr. A. E. Hilton read a paper on "The Life-phases of Mycetozoa." The author gave a detailed description of the life-cycle of this group, which includes less than 300 species, and said that this small group offered exceptional opportunity for studying life-phenomena, as the processes were less obscured than in many other organisms. Mr. Hilton exhibited active living swarm-spores of Mycetozoa × 500. Mr. James Burton read a note on "Two Instances of Breaking of the Meres." The term may be defined as that

* Bull. Classe Sci., Acad. Roy. Belg., 1910, pp. 23–30 (5 figs.).

condition of a body of fresh-water when it is so permeated with one or more species of microscopic algæ as to be visibly affected by their presence. In the two instances observed the phenomenon was due to the presence in large quantity of the alga *Oscillatoria*; one of the species was probably *O. agardhii*, the other is still unidentified.

The 466th Ordinary Meeting was held at the Morley Hall, Hanover Square, on May 24, the President in the Chair. The Hon. Sec., Mr. W. B. Stokes, exhibited and described a specimen of Burche's micrometer. Messrs. Baker exhibited a number of preparations of Crustacea injurious to wooden piers and piles. Two of the most interesting were of the Isopods *Leptochelia sairgnii* and *Arcturus* (?) sp., both very rare.

The 467th Ordinary Meeting was held on June 28 at the Doré Gallery, New Bond Street, Mr. C. F. Rousselet, Vice-President, in the chair. Mr. A. C. Banfield described and exhibited a sliding nose-piece for taking stereophotomicrographs. Referring to his method described before the Club on October 26 last,* when, to obtain the stereoscopic effect, the object is moved, he said that with low powers and strongly lighted opaque objects the shadow of the object floated in space and gave an irritating result. In the fitting exhibited a sliding plate is screwed to carry the objective which is laterally displaceable by rack-and-pinion. In practice the device works exceedingly well. Transparencies were exhibited showing the advantages of the new method. Mr. D. Bryce gave an account of his new "classification of the Bdelloid Rotifera." It is not possible in the space here available to give an abstract of value. The complete paper will be published in the next (November) issue of the Journal of the Quekett Microscopical Club. Mr. E. M. Nelson, F.R.M.S., communicated a paper on "*Navicula rhomboides* and allied forms." The first part of the paper referred to the old question as to the identity of the diatom known as the Amici test. The author concludes that Professor Amici had no one particular test, and that the test as known in America differed from that used here. In the second part the author suggests the use of an "Index Number," to be used when describing the minute differences of similar species or varieties. Such an index, it is suggested, may be found by dividing the number of the transverse striæ by the length-breadth ratio. Examples were given. Mr. A. Earland read a paper on "Arctic types of Foraminifera in the North Sea." The material examined was dredged by the s.s. 'Goldseeker,' employed by the International North Sea Commission. The particular and characteristic boreal forms were described, and many were exhibited. Concluding his remarks, the author said that in the area of the North Sea, as far north as Noss Head, there is a survival of the fauna of the old Arctic North Sea before the submergence of the land. Among the Orkneys and Shetlands there are records of warm water types which are probably gradually spreading outwards and downwards.

* See this Journal, 1910, p. 233.

B. Technique.*

(1) Collecting Objects, including Culture Processes.

New Anaerobic Apparatus.†—O. Lentz describes a simplified method of cultivating anaerobes upon Petri dishes. This consists in an application of the pyrogallic and potash method, and the materials are prepared in the following way. Disks of blotting-paper, of a diameter of 8·7 cm. and thickness of 0·6 cm., are soaked first in a watery and next in an alcoholic pyrogallol solution. Disks so prepared remain serviceable for about a week. To facilitate the subsequent observation of colonies the centre of the disk is cut out, leaving a ring of the "pyrogallic cushion" with an internal diameter of 4·5 cm. Such a ring is placed upon a glass plate of about 12 cm. square, and is then edged with a pencil of plasticine. The plate, gelatin, agar, or the like, is then inoculated and placed for the moment in the Petri cover. Then about 15 c.cm. of 1 p.c.

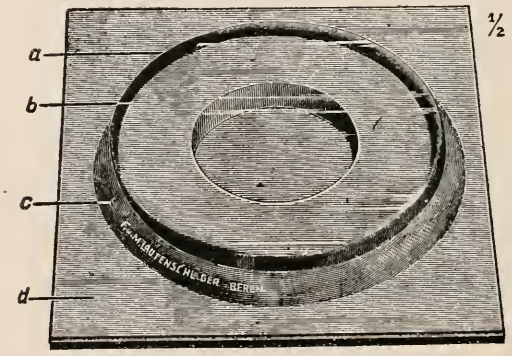

Fig. 73.

watery potash is poured over the pyrogallol pad and the plate is immediately inverted over it (fig. 73). The plasticine is then worked so as to make an efficient air-tight joint. The author tested the excellence of the anaerobic conditions obtained by attempting to cultivate strict aerobes, such as the *Vibrio choleræ*, and by decolorising media stained with methylen-blue. Both tests were most satisfactory. The author has also devised a modification of this method applicable to tubes and flasks.

Method of Obtaining Yeast-spores.‡ — A. Gorodkowa uses the following medium : water 100, agar 1, pepton 1, broth 1, sodium chloride 0·5, glucose 0·25. Slopes are made, and, after inoculating with yeast-cells, are incubated at 28°C. Spores form in two or three days.

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

† Centralbl. Bakt., 1te Abt. Orig., liii. (1910) pp. 358-65.

‡ Bull. Jard. Imp. Bot. Pétersbourg, through Zeitschr. wiss. Mikrosk., xxvi. (1909) p. 583.

Differential Diagnosis of Bacillus typhosus and Bacillus coli by means of Coloured Cultivation Media.*—E. Calandra used the following media: 1. Broth and gelatin stained with litmus. 2. Media stained with picric acid and litmus. 3. Broth and gelatin with brilliant kresyl-blue. 4. Broth with Congo red. 5. Broth with neutral red. 6. Broth with Kuhne's alkali blue. The author claims that there are obvious differences produced in the media by the action of these two organisms: verbal description is inadequate to convey these differences, and ocular demonstration is necessary. They presumably depend on acidifying action of *B. coli*.

Cultivating Bacillus tuberculosis.†—A. Frouin has devised a medium which is said to be specially favourable to the growth of the tubercle bacillus. It is composed of water 1000, sodium chloride 6, chloride of potassium 0·3, disodium phosphate 0·5, magnesium sulphate 0·3, calcium chloride 0·15, glycerin 40, glucosamin 2, sarcosin 2. The solution is neutralised, sterilised, filtered, distributed into flasks and sterilised anew. Though growth for the first fortnight after inoculation is slow, in four weeks it is abundant, and by that time a thick film has formed.

Cultivation of the Leprosy Bacillus.‡—M. T. Clegg gives further details as to the cultivation of the leprosy bacillus.§ Inoculations were made from the spleens and cutaneous nodules of ten lepers. In eight of the ten instances an acid-fast bacillus was obtained in transplants of amœbal cultures, to which the leprous material had been added. By heating such an amœba-cholera-leprosy culture for ½ hour at 60° C. and incubating, colonies of the leprosy bacillus were obtained, which grew readily in pure culture when transplanted to the ordinary laboratory media (e.g. agar, broth, eggs). Guinea-pigs inoculated subcutaneously with the pure culture developed in some instances lesions at the site of inoculation which bore a certain resemblance to the leprous lesions of man, both macroscopically and microscopically. The acid-fast organisms were found at the site of inoculation, and in some instances also in the spleen.

(2) Preparing Objects.

Fixation of Algæ by means of Quinone.‖—When fixing vorticellæ on fresh-water algæ by means of quinone, A. Bonnet made observations as to the effect of the reagent on the algæ. He found that a 4 : 1000 solution gave excellent results. Sea-water may also be used, but the solution turns brown more rapidly than in fresh-water. Once fixed, the algæ are more resistant to contraction and deformity when being dehydrated preparatory to mounting in glycerin-jelly, in glycerin, or in Canada balsam. The chlorophyll stains greenish-brown; spores and eggs brown, the rest of the protoplasm yellow, and the cellulose membranes are unaffected.

* Centralbl. Bakt., 1te Abt. Orig., liv. (1910) pp. 567–75.
† C.R. Soc. Biol. Paris, lxviii. (1910) p. 915.
‡ Philippine Journ. Sci., iv. (1909) pp. 403–14 (2 pls.).
§ See this Journal, 1909, p. 661.
‖ C.R. Soc. Biol. Paris, lxviii.. (1910) pp. 957–8.

(3) Cutting, including Imbedding and Microtomes.

Dissecting Tile and Stand.*—The tile itself (fig. 74), 6 in. square, half black and half white, is well glazed all over to prevent it soaking up stain, etc., the black being put on before glazing. The stand was devised to meet the demand for a cheap and effective arrangement for class use. The jointed lens-holder has a spring clip to take an ordinary pocket lens and is arranged to slide on a pillar for focusing. A slightly more expensive kind has a drawer for dissecting instruments, etc. The tile is made by Flatters and Garnett, Manchester.

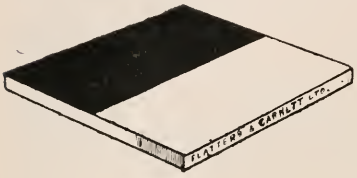

Fig. 74.

(4) Staining and Injecting.

Modification of Neisser's Staining for Diphtheria Bacilli.†—P. Sommerfeld makes films of blood-serum or glycerin-agar cultures and stains them with methylen-blue (alcoholic or aqueous or Loeffler's); washes with water, dries on blotting-paper, and then treats for a few seconds with a mixture of equal parts of alcohol and formalin. When the preparation is almost colourless it is washed and then dried. Smears from diphtheritic membrane require a longer treatment with formalin. The granules are stained dark blue, the bacterial body being pale blue. Contrast staining, though superfluous, may be effected with vesuvin, chrysoidin, or eosin.

New Method of Staining Spores.‡—A. F. S. Kent recommends the following procedure for demonstrating the presence of spores. A film is prepared and fixed in the usual way. It is then treated with a solution of sodium hydrate for some seconds, after which the still wet film is stained with phenol-fuchsin, heated as usual for a few minutes. The next steps are to decolorise with 25 p.c. hydrochloric acid, wash, counterstain with methylen-blue, then wash, dry, and mount.

Staining Moist Preparations and Sections by the Azur-eosin Method.§—G. Giemsa points out some advantages of the application of his staining method to moist preparations. By means of this he can demonstrate the minute structure of the nuclei of trypanosomes and *halteridia*. In dry preparations of amœbæ the karyosome in the centre of the nucleus is indicated in a shadowy manner, while in wet preparations it stands out sharp and distinct. This method is also useful for showing the blepharoplast in *halteridia*, and its relation to the basal portion of the flagellum. The study of sections and of the minute structure of bacteria is also facilitated by this means.

New Colour Reaction for certain Albumins.‖—W. Arnold has applied the sodium-nitroprusside-ammonia reaction to the investigation of different albumins. The details of the method are as follows: To 1 or 2 c.cm. of the albumin solution are added a few drops of a 4 p.c.

* Catalogue B, 1910, p. 28.
† Deutsche Med. Wochenschr., 1910, p. 505. ‡ Lancet, 1910, i. p. 1473.
§ Centralbl. Bakt., 1te Abt. Orig., liv. (1910) pp. 489–90.
‖ Bull. Internat. Acad. Sci. Cracovie, 1910, pp. 56–60.

solution of sodium nitroprusside. Upon the further addition of some drops of an ammonia solution, a deep permanent purple-red colour appears, which is discharged immediately upon the addition of acetic acid. The author found that this reaction was demonstrated to perfection upon the soluble albumins of the crystalline lens. The muscle globulins did not give such a distinct reaction, but a deep purple colour was obtained with myostromin and with acid albumin. After myostromin had been digested by means of pepsin and hydrochloric acid, a carmine-red colour was obtained upon application of the test. Further digestion products, such as the amino-acids, gave no reaction. A negative result was obtained with glutin, and mucin gave only a feeble coloration.

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

Terpineol for Microscopic Purposes.*—According to P. Mayer, fluid terpineol has certain advantages over oil of cloves and other clearing agents. It is colourless and remains so permanently. It has no smell. It is miscible with benzol and xylol in all proportions. Sections can be transferred from 90 p.c., or even if necessary from 80 p.c. alcohol directly into this fluid. It has a lower refractive index than oil of cloves and objects cleared in it can be examined directly, before proceeding to the final stages of washing with xylol and mounting in balsam. It is considerably cheaper than other clearing agents.

(6) Miscellaneous.

Preparation of Osteological Specimens.†—B. Možejko describes a method by means of which specimens suitable for investigation can be prepared in a very short time. For instance, the bones of an animal of the size of a guinea-pig can be obtained in a suitable condition in one day. Soft parts, viscera and muscles, are first of all removed so as to leave skeletal structures roughly free. The material is then treated in a boiling solution, until all the soft parts are thoroughly cooked. For large objects a solution of eau-de-Javelle, for smaller animals a soda solution is used. Small and delicate objects must be boiled in water. From this fluid the material is transferred to alcoholic liquor potassæ. The concentration of this solution should vary with the size of the object. After maceration in this fluid, the specimen is transferred to a water bath. The water is changed daily until it is found no longer to become turbid. If it be desired to disarticulate the skull bones, the specimen should remain longer in the macerating fluid.

Formalin for the Preparation of Museum Specimens.‡—B. Možejko found that animals could be preserved in good condition by injections of 5 to 8 p.c. formalin into the cranial, pleural and peritoneal cavities, and has for some years used this method for studying the anatomical relations of the viscera. He now gives an account of the technique employed for the preparation of museum specimens. Animals anæsthetised with ether were killed by strangulation and injected as above by Kaiserling's formalin-saline mixture. The specimen is then prepared by Kaiserling's process. The author finds that in the case of

* Zeitschr. wiss. Mikrosk., xxvi. (1910) pp. 523–4.
† Anat. Anzeig., xxxvi. (1910) pp. 314–16. ‡ Tom. cit., pp. 317–18.

small animals his method is more satisfactory than vascular injection. In the case of birds and small mammals so injected, he found that the specimen passed into a state of mummification without any decomposition. Such mummified specimens are very suitable for the demonstration of certain anatomical points.

Glycerin Jelly Bath.*—This apparatus consists of a copper box, to contain water, $5\frac{1}{2} \times 2\frac{1}{2} \times 3$ in., on a separate iron stand, as figured (fig. 75). There is a hole at one end to take the bottle of glycerin jelly. In the centre there is a space with movable shelf, for slips and covers. In use, the box is nearly filled with water, and the bottle of jelly, slips, etc., put into position, and a spirit lamp or Bunsen burner placed underneath. When the jelly is melted, the box is removed from the stand and placed on the table (it is a convenient height for mounting upon); a warmed slide or so may then be placed on the top of the box;

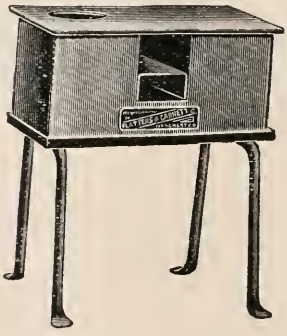

Fig. 75.

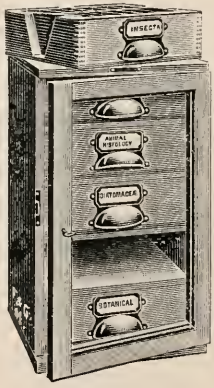

Fig. 76.

the objects can easily be arranged in the liquefied jelly. The lid is removable, and may be placed directly upon the iron stand when a greater heat than that obtainable with the water-bath is required. The apparatus is made by Flatters and Garnett, Manchester.

Microscope Slide Cabinets.†—The new style of cabinet recently introduded by Flatters and Garnett is much more compact than the usual type, e.g. a cabinet, with glass door, to hold 720 slides only measuring ing $18 \times 10 \times 10$ in. They are made in several sizes, and in either mahogany or pine. In the 720 size, there are five drawers, with brass handles at front and space for contents card; the two sides of each drawer are cut away to allow of the removal of the slide trays, of which each drawer holds twelve, each tray in turn holding twelve 3×1 in. slides in separate divisions. Such an arrangement allows of immediate access to any desired slide; slides do not ride on top of one another, and those relating to a particular subject may be kept in the same drawer (fig. 76).

* Catalogue B, 1910, p. 41.

† Tom. cit., p. 59.

Drawer Units of stout card, covered with book-cloth, are made on a somewhat similar plan, except that each drawer is a separate "unit" for 72 slides. They consist of an outer sheath measuring 8 × 4¼ × 3¼ in., with a drawer with cutaway sides, and handle with space for contents

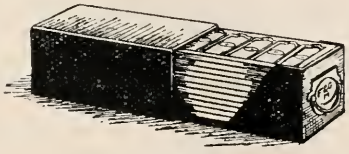

Fig. 77.

card at front, and contain twelve trays, each to hold six 3 × 1 in. slides in separate divisions. They are very durable, and a number may be arranged in any desired manner, as the collection of slides grows. Similar "units" are made without trays, and with drawers not cut down at the sides; they are useful for storing the various oddments incidental to microscopical work (fig. 77).

Metallography, etc.

Cobalt-gold Alloys.*—W. Wahl has determined the equilibrium diagram of this system by thermal and microscopical methods. Observations were also made on magnetic properties and crystalline form. Cobalt and the cobalt-rich alloys exhibited super-cooling to a remarkable degree. The super-cooling of cobalt appeared to increase with greater purity of the metal, and amounted to 200° C. in one experiment. Inoculation was employed in taking cooling curves. No compounds exist in the system, at either end of which mixed crystals, saturated at low concentration, occur. The eutectic melts at 997° C. and contains 90 p.c. gold.

Lead-tin Alloys.†—W. Guertler suggests, in view of the results obtained by Rosenhain and Tucker, and by Degens, that the evolution of heat at about 150° C. may either be due to the decomposition of mixed crystals of lead and tin or to the formation of a compound of about the composition Sn_3Pb_4. The author has calculated the heats of fusion of different lead-tin alloys from published data, and finds them much greater than the means of the heats of fusion of the components. Heat is therefore evolved when molten lead and tin are mixed.

Nickel-carbon Alloys.‡—K. Friedrich and A. Leroux have determined the melting-point diagram of the nickel-carbon system for the range 0 to 2·6 p.c. carbon. The alloys contained 0·2 to 0·6 p.c. iron.

* Zeitschr. Anorg. Chem., lxvi. (1910) pp. 60–72 (3 figs.).

† Zeitschr. Elektrochem., xv. (1909) pp. 953–65, through Journ. Chem. Soc., xcviii. (1910) p. 126.

‡ Metallurgie, vii. (1910) pp. 10–13 (7 figs.).

Up to about 1 p.c. carbon a solid solution only is formed; microscopic examination indicates that the limit of solid solubility lies at about 0·9 p.c. carbon. When more carbon is present a eutectic containing between 2 and 2·5 p.c. carbon, and melting at 1307° to 1318° C., is formed. Alloys containing 2 to 2·5 p.c. carbon appear to consist, microscopically, wholly of eutectic, while a suggestion of primary crystals of the carbon-bearing phase may be observed in the alloy with 2·6 p.c. carbon. No difference in micro-constitution between alloys slowly cooled and those water-quenched from the molten state could be detected.

Lead Bronzes.*—F. Giolitti and M. Marantonio have studied the ternary system copper-tin-lead, in the range 0 to 20 p.c. lead, 0 to 25 p.c. tin. No compounds are formed in the binary system copper-lead, the components are incompletely miscible in the liquid, and immiscible in the solid state, and the eutectic temperature is practically the melting-point of lead. In the ternary alloys the tin exists either as Cu_4Sn or Cu_3Sn. The hardness of the alloys was investigated.

Magnetic Properties of Manganese, Vanadium, and Chromium.† P. Weiss and K. Onnes have found that at the freezing point of hydrogen (14° absolute) the magnetic properties of manganese, vanadium, and chromium are still very feeble. These metals therefore neither become ferro-magnetic nor obey Curie's law of paramagnetism. The magnetic properties of a crystal of ferrous sulphate became enormously stronger at low temperatures. Ferro-magnetic manganese was obtained when very pure reduced manganese in the form of powder was melted in a current of hydrogen.

Magnetic Properties of Iron and Alloys.‡—C. F. Burgess and J. Aston have determined the magnetic and electrical properties of seven iron-silicon alloys, prepared from electrolytic iron, and containing 0·23 to 4·65 p.c. silicon, as forged, annealed at 675° C., annealed at 1000° C., and quenched from 900° C. The addition of silicon does not appear to bring about the same improvement in magnetic properties in electrolytic iron as in commercial mild steels. Electrical resistance increases with increase of silicon content; the resistance of the 4·65 p.c. Si alloy is five times that of electrolytic iron.

The same authors § have made similar tests on electrolytic and other samples of iron, of varying degrees of purity, and also on a number of samples of commercial iron and steel.

Phosphides of Iron.‖—N. Konstantinow has taken cooling curves of thirty alloys, containing 0·5 to 21·0 p.c. phosphorus, and gives an equilibrium diagram, differing in some respects from Saklatwalla's, based on the thermal results and on the microstructure of the alloys. Some of

* Gaz. Chim. Ital., xl. (1910) pp. 51–77, through Journ. Chem. Soc., xcviii. (1910) pp. 504–5. † Comptes Rendus, cl. (1910) pp. 687–9 (1 fig.).
‡ Met. and Chem. Engineering, viii. (1910) pp. 131–3 (6 figs.).
§ Tom. cit., pp. 191–4 (6 figs.).
‖ Zeitschr. Anorg. Chem., lxvi. (1910) pp. 209–28 (10 figs.).

the melts were inoculated during cooling, to prevent supercooling, to which they showed a marked tendency. The existence of Fe_3P and Fe_2P is confirmed. A comparative table of the phosphides, arsenides, and antimonides of manganese, iron, cobalt, nickel, and copper, is given.

O. Kuhn,* in preparing copper phosphide, obtained a product which on solution in nitric acid, left a residue of glistening needles, insoluble in nitric acid, and corresponding approximately to the formula Fe_5P_2. The author considers this to be another definite compound, in addition to the four the existence of which is admitted by Le Chatelier and Wologdine.

Decarburisation of Cast Iron by Gaseous Oxidising Agents.†—H. Becker has studied the action of mixtures of carbon monoxide and carbon dioxide upon cast iron at different temperatures, determining the amount of decarburisation by chemical and microscopical examination. The decarburisation is greater as the proportion of carbon dioxide and the temperature increase. Decarburisation ceases when the proportion of CO_2 falls to 30 p.c. at 800°C. to 12 p.c. at 900°C., and to 2·85 p.c. at 1000°C. White iron appears to decarburise less readily than tempered cast iron at 800°C. A mixture containing 28 p.c. CO_2 will decarburise cast iron at 900°C. without oxidising the iron noticeably. A 24 p.c. CO_2 mixture acts similarly at 1000°C.

Cementation of Steel.—F. Giolitti and L. Astorri‡ find that the addition of a little benzene vapour to carbon monoxide, used as a cementation medium, increases the concentration of carbon in the outer layers of the steel. If the proportion of benzene be increased beyond a certain value, carbon is deposited on the surface of the steel, and the concentration of carbon in the outer layer reaches the value given by solid cementation media. The authors have found cementation to occur when very mild steel and powdered charcoal are heated to 1000°C. in a vacuum, in intimate contact.

F. Giolitti and F. Carnevali § have studied the effect of strongly compressing gases used in cementation.

Improvements in Metallographical Methods.‖—R. Loebe describes the following new devices which he has used in determining cooling curves, standardizing thermocouples and similar work. (1) A clock giving audible signals at definite short equal intervals of time; (2) a modification of the wire method of taking melting points. The melting of a wire of the metal under investigation, fixed across the ends of two platinum wires, causes a bell to ring by breaking an electrical circuit. The temperature is indicated by a thermocouple with its hot junction close to the melting wire. (3) An electric resistance tube furnace; (4) clamps for holding a pyrometer centrally in the same furnace;

* Chemiker Zeitung, xxxiv. (1910) pp. 45-6.

† Metallurgie, vii. (1910) pp. 41–59 (17 figs.).

‡ Gaz. Chim. Ital., xl. (1910) pp. 1–20, through Journ. Chem. Soc., xcviii. (1910) p. 507. § Atti R. Accad. Sci. Torino, xlv. (1910) pp. 337–45.

‖ Metallurgie, vii. (1910) pp. 5–10 (12 figs.).

(5) carbon crucibles for melting ; (6) stirrers for keeping molten metal in motion while a cooling curve is taken.

Invariant Systems and the Composition of Eutectics.*—A. Gorboff discusses the application of the phase rule to the composition of eutectics, and from an examination of the results obtained by numerous investigators, concludes that eutectics follow the law of multiple proportions. Thus the composition of a eutectic may be expressed, like that of a compound, by a chemical formula with rational indices. Some further general rules governing the composition of eutectics are given.

Microscopy and Macroscopy in Workshop Practice.†—J. E. Stead has collected from many manufacturers and investigators opinions as to the value of microscopical study of metals, and quotes a number of typical opinions. He then describes cases in which metallographic methods have proved of great use. A steel casting, before annealing, usually has a skin of somewhat higher carbon content than the interior. This surface layer is decarburised by annealing. Microscopic examination will reveal whether a casting has been annealed or not, and if so, will indicate if a suitable temperature has been employed. Etching the surface of a casting with 20 p.c. nitric acid after rough polishing will show if electric welding has been practised, and whether electrically welded steel has been subsequently annealed or not. The heating by friction of wire ropes sometimes leads to the formation of a dangerously brittle and hard skin in the subsequent rapid cooling. Such a brittle skin can be detected by the Microscope. Many other instances are given.

Formation of Alloys by Pressure.‡—W. Spring agrees with Tammann that the formation of alloys under pressure is a result of diffusion, which is not accelerated by the pressure.

Specific Heat of Metallic Alloys.§—A. V. Saposhnikoff has determined the specific heats at 15° to 100° C. of a number of binary alloys belonging to four typical systems : (1) bismuth-cadmium ; (2) lead-tin ; (3) bismuth-antimony ; (4) zinc-antimony. Regnault's law, which requires that the specific heat of an alloy should be equal to the mean arithmetical specific heat of its components, is confirmed.

Mounting of Metal Sections.‖—E. Preuss describes the following as a new method. The section, which may be quite irregular in shape, is placed on a level surface with the polished face down. A brass ring with parallel ends is placed over it and the spaces between section and ring filled up with plasticine. The ring with the section thus fixed in it is mounted on a slide with the polished face up.

* Journ. Russ. Phys. Chem. Soc., xli. (1909) pp. 1241–1300, through Journ. Chem. Soc., xcviii. (1910) p. 111.

† Proc. Int. Assoc. for Testing Materials, No. 15 (1910) pp. 205–10 (26 figs.).

‡ Zeitschr. Elektrochem., xv. (1909) p. 984, through Journ. Chem. Soc. xcviii. (1910) p. 126.

§ Journ. Russ. Phys. Chem. Soc., xli. (1909) pp. 1708–11, through Journ. Chem. Soc., xcviii. (1910) p. 182.

‖ Stahl und Eisen, xxix. (1909) p. 239 (2 figs.).

C. F. W. Rys * points out that the use of plasticine for mounting is not new, and describes the well-known method, given by J. E. Stead in 1900, in which parallelism of slide and polished face is obtained by means of a brass ring in a much simpler manner than that described by Preuss.

Electron Theory and Solid Solutions of Metals.† — R. Schenck attempts a theoretical explanation of the diminution of electrical conductivity and of the increase of the ratio of the thermal to the electrical conductivity in the case of metallic solid solutions. The decrease in electrical conductivity appears to be due to increased viscosity.

"Damping" Test of Metals.‡—O. Boudouard has devised methods for recording photographically the curve representing the damping of the vibrations set up by means of an electromagnet in a steel bar. A steel containing 0·3 p.c. carbon was tested (1) as rolled, (2) annealed, (3) hardened.

Thermo-electric Properties of Metallic Alloys.§—W. Haken has determined the thermo-electric forces produced at the junctions of copper with alloys belonging to the binary systems tellurium-antimony, tellurium-tin, tellurium-bismuth, tellurium-lead, antimony-silver, copper-phosphorus. The curves representing the relation between composition and thermo-electric properties, and between composition and electrical conductivity, are compared with the equilibrium diagrams obtained by thermal methods. The existence of compounds and of solid solutions is indicated by the thermo-electric method, which may accordingly be employed to check the conclusions drawn from thermal investigations.

Thermo-electric Properties of Alloys.‖—W. Broniewski has collated published data relating to the thermo-electric properties of alloys. By comparing curves representing these properties as a function of the composition of binary systems, with the equilibrium diagrams obtained by thermal and other methods, he arrives at certain general laws. The author's conclusions are too lengthy for reproduction ; he considers that the determination of thermo-electric properties may be a useful auxiliary method for the study of alloys. An extensive bibliography is appended.

Homogeneity of Metals.¶— G. Tagueeff discusses the causes and the effects of non-homogeneity of metals, having regard especially to steel rails. Fracture under shock, and unequal wear, are in general due to non-homogeneity. The presence of manganese sulphide is detrimental.

Change of State in Metals under Mechanical Strain.**—A. Martens discusses in a general manner the behaviour of metals under tension,

* Stahl und Eisen, xxix. (1909) pp. 555–6 (3 figs.).
† Ann. Physik., xxxii. (1910) pp. 261–90, through Journ. Chem. Soc., xcviii. (1910) p. 482. ‡ Comptes Rendus, cl. (1910) pp. 696–8.
§ Ber. Deutsch. Phys. Ges., 1910, pp. 229–39, through Journ. Chem. Soc., xcviii. (1910), p. 387.
‖ Rev. Métallurgie, vii. (1910) pp. 341–67 (15 figs.).
¶ Proc. Int. Assoc. for Testing Materials, No. 15 (1910) 4 pp.
** SB. k. Preuss. Akad. Wiss., 1910, pp. 209–20 (9 figs.).

after different treatments. The effects of cold-working, annealing, etc., are illustrated by particular examples. Time has an important influence on the effects of stress, since, though stress is instantaneous, strain requires an appreciable time for its development, and may continue to increase for months. Thus different stress-strain curves are obtained by different rates of loading. Time effects are much greater in some metals than in others; the breaking-stress of zinc can be raised 50 p.c. by rapid loading. The effects of repetitions of stress, and the work done to produce fracture, are among other points discussed.

Internal Friction of Solids at Low Temperatures.*—C. E. Guye and V. Freedericksz have determined the rate at which torsional vibrations die away in silver, aluminium, gold, magnesium, iron, and quartz, at 100°, 50°, 0°, −80°, and −196°C. For silver, aluminium, and iron, the "coefficient of damping" diminishes with falling temperature, but apparently does not tend to disappear entirely at the absolute zero. The coefficient of elasticity of the metals becomes greater as the temperature is lower.

C. E. Guye and H. Schapper† have made similar determinations on copper, zinc, gold, nickel, palladium, and platinum. The coefficient of damping was found to vary with the amplitude of the vibration. In general, it cannot be said that this coefficient steadily decreases as the temperature falls. It does not seem possible to arrive at any general laws governing the value of the coefficient of damping.

Novel Application of Alloys.‡—Most alloys throughout a certain range of temperature are partially solid and partially liquid. K. Friedrich incorporates with partially solidified alloys in a pasty and workable condition, solid substances in the form of powder. The examples described are (1) an alloy of 90 p.c. tin and 10 p.c. copper heated to 500° C. and allowed to cool to 220° C. Maintained at this temperature the alloy was pasty; a quantity of powdered blue glass was mixed with it, the mixture pressed and allowed to cool, A polished section showed a white metallic ground sprinkled with blue particles. (2) An alloy of 98 p.c. lead and 2 p.c. antimony, mixed at 250° C. with 10 p.c. iron filings. Pressed and cooled it gave a "hard lead." Possible uses for such pseudo-alloys are discussed.

Solubility of Gases in Metals and Alloys.§—A. Sieverts and W. Krumbhaar have determined the amount of various gases dissolved by different metals and alloys, under varying conditions of temperature and pressure. Experiments at very high temperatures were carried out in porcelain tubes heated in a silundum tube resistance furnace. Nitrogen is insoluble in most metals, but forms nitrides with aluminium and with iron. Sulphur dioxide begins to dissolve in copper at the melting point; the solubility increases with the temperature, and is proportional to the square root of the pressure. Numerous other facts are given in the paper.

* Rev. Métallurgie, vii. (1910) pp. 85–6 (1 fig.).
† Comptes Rendus, cl. (1910) pp. 962–4.
‡ Metallurgie, vii. (1910) pp. 97–9.
§ Ber. Deutsch. Chem. Ges., xliii. (1910) pp. 893–900 (2 figs.).

New Method of Coating with Metals.*—U. Schoop describes a process of coating objects with a metallic layer. The metal is melted and projected against the object to be covered, as minute drops or powder, by means of a blast of reducing or inert gas at very high velocity. A remarkably homogeneous and adherent coating is obtained in this way. The process may be used for coating objects with aluminium.

Influence of Pressure on the Boiling-points of Metals.†—H. C. Greenwood has determined the boiling-points of bismuth, copper, lead, silver, and tin, at pressures in the neighbourhood of 100 and 250 mm. mercury. Boiling-points were determined at high pressures as follows :— Lead up to 11·7, bismuth up to 16·5, zinc up to 53 atmospheres. The effect of pressure was found to be very considerable ; at 102 mm. bismuth boils at 1200° C., while at 16·5 atmospheres the boiling-point is 2060° C. For each metal the values of the boiling-points lie on a smooth curve.

F. Henning.—**Über ein Spektralpyrometer und einige optische Konstanten von Metallen.** *Zeitschr. f. Instrumentenk.*, xxx. (1910) pp. 61–75 (2 figs.).

W. Brown.—**Permanent Steel Magnets.**
Sci. Proc. Roy. Dublin Soc., xii. (1910) pp. 312–20 (3 figs.).

,, ,, **Chrome Steel Permanent Magnets.** *Tom. cit.*, pp. 349–53 (1 fig.).

D. Stenquist.—**Alloys of Lead and Tin.**
[A determination of the hardness of twelve alloys.]
Zeitschr. Phys. Chem., lxx. (1910) pp. 536–8 (2 figs.)

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* Comptes Rendus, cl. (1910) pp. 1044–6.
† Proc. Roy. Soc., Series A, lxxxiii. (1910) pp. 483–91 (4 figs.).

Mr. Shillington Scales, in reply to the President, said he had been studying the drawing, but found it incomprehensible without explanatory notes.

Mr. C. L. Curties said he should like to defer giving an opinion on it until it had been made; but, as far as he could understand the drawing, it would be a very costly arrangement, and he did not think anyone could give an opinion on it without seeing it when made.

The President thought that, as in the case of Mr. Nelson's apparatus, it was open to any Fellow of the Society to make it.

The President said he should like to propose a vote of thanks to Messrs. Baker for the loan of the Microscopes to illustrate the subject of his paper. Also to the writers of the other papers and communications and demonstrations.

This was put to the Meeting and carried unanimously.

It was announced that the next Meeting of the Society would take place on October 19, and that the rooms of the Society would be closed from August 12 until September 12.

The following Instruments, Objects, etc., were exhibited:—

The President:—Slides of *Trochodota dunedinensis*: (1) Entire animal, and (2) Calcareous Wheels and Hoops of ditto. Presented by Mr. M. J. Allan, of Geelong.

The following Slides in illustration of his paper: *Alcyonium paessleri*, Spicules; *Ceratoisis delicatula*, Polyps; ditto, Spicules; *C. rosea*, Polyp and various specimens in fluid. Collected by Sir Ernest Shackleton's Expedition at Cape Royds.

Dr. Hebb:—Black and white Tile for Dissecting purposes; Copper Water Bath for Glycerin-jelly Mounting; Cabinet for Slides; Cloth-covered Unit, containing twelve trays holding six slides each. Sent for exhibition by Messrs. Flatters and Garnett.

Photomicrographs of Mr. Grayson's Rulings, taken by himself: Ten bands of 1000 to 10,000 lines to the inch × 300; an enlargement of the 10,000 band × 900, 90,000 × 2000; and enlargements × 6000 and × 8000. Sent for exhibition by Mr. E. M. Nelson.

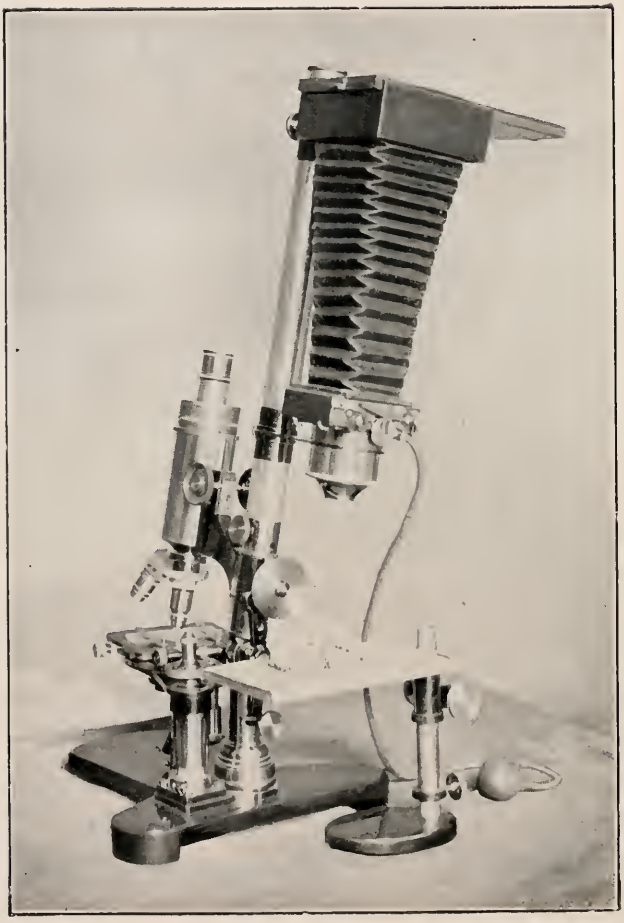
Diagrams illustrating Mr. Nelson's remarks on Mr. Grayson's photomicrographs.

Diagrams illustrating Mr. Nelson's paper.

Drawings of Mr. E. B. Millar-Williams's Fine-adjustment for Body and Substage of Microscopes.

Mr. C. L. Curties:—Calcite, polarized, illuminated by Mercury Vapour Lamp and Nernst Electric Lamp; and Photomicrographs of the appearance under each method of illumination, in illustration of Mr. E. B. Stringer's note.

New Fellows:—The following were elected *Ordinary* Fellows of the Society:—H. C. Gooding, Frank J. Keeley, F. G. Millar, and T. Chalkley Palmer.



MICROSCOPY.

A. Instruments, Accessories, etc.*

(1) Stands.

Old Achromatic Microscope by Trécourt and Georges Oberhaeuser.—This old Microscope, presented by Members of the Council (fig. 78), appears to be one of the early instruments made by Georges

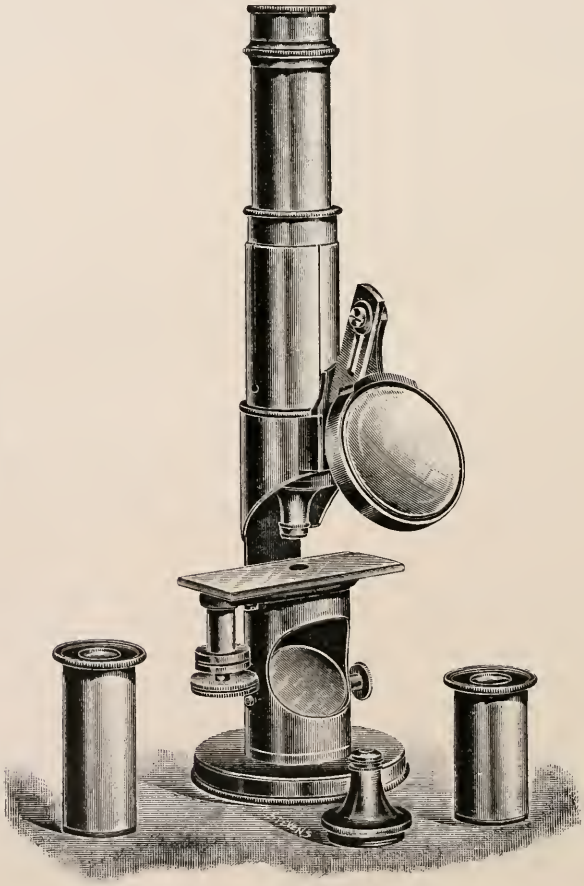


Fig. 78.

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

Oberhaeuser in Paris, when associated with M. Trécourt, about 1830. The model is based on the "Drum" Microscope, the first form of which was produced in 1742, by Benjamin Martin in his "Pocket

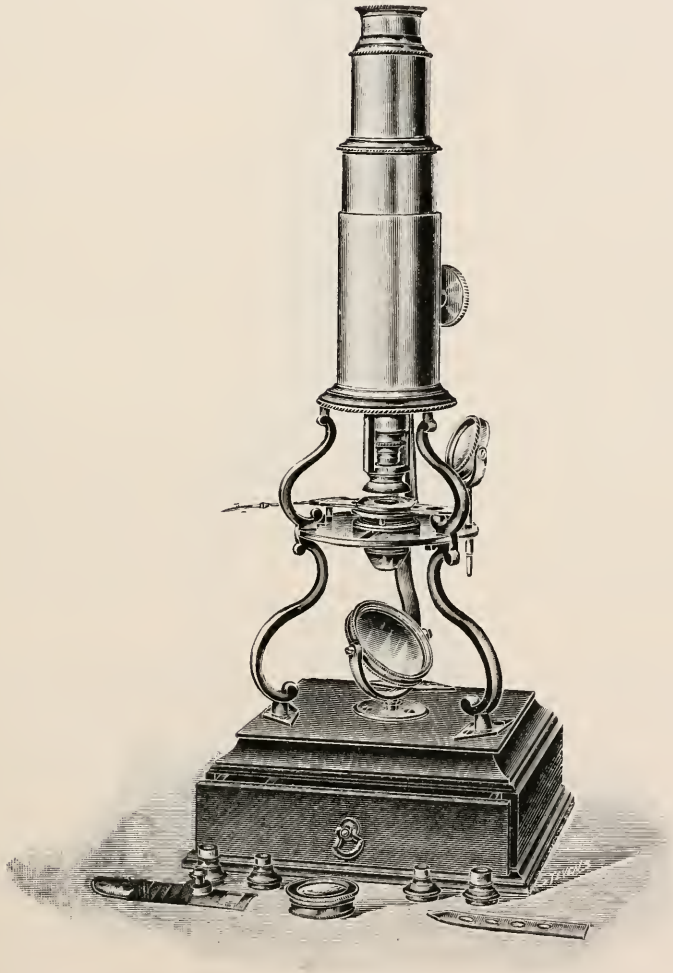


Fig. 79.

Reflecting Microscope." It was afterwards copied with modifications and improvements by Frauenhofer (1811), and many other makers, and has survived to the present day in the cheap form of school Microscopes.

The present instrument is very well finished in brass, mounted on a circular brass base, has a movable concave mirror in the drum, and a bullseye condenser fixed by a dovetailed fitting for the illumination of opaque objects. The coarse-adjustment is effected by sliding tube, and the fine-adjustment by a screw movement to the stage. Nine achromatic objectives are provided, some doublets, and some triplets, ranging in power from 65 mm. to 1·7 mm.; also six eye-pieces (one missing), giving amplifications from 9 to 1790 diameters, according to the table supplied. There is also an eye-piece with needle-points for measuring objects, and two stage micrometers: 1 cm., ruled in 100 parts, and $\frac{1}{5}$ mm., also divided in 100 parts.

Old Microscope presented by Mr. Albert Ash.—This old Microscope (fig. 79) is an improved form of Culpeper and Scarlet's "double reflecting" model, first introduced about 1750, and was called by Adams, in 1798, "the common three-pillared Microscope." It is well made, all in brass, with the three scroll pillars screwed on to the square mahogany box containing the various apparatus; amongst these are a lieberkuhn, concave mirror, bullseye condenser, and six objectives. This model enjoyed great popularity from 1750 onwards on account of its cheapness and handiness, and was extensively copied by all makers of this period. The focusing was effected by sliding the tube carrying the eye-piece and objective up and down the fixed body-tube, but early in the last century, when rack-and-pinion had been generally introduced for the purpose of focusing, this model was further improved by the addition of a rack fixed to the body-tube and working through a slot. This improvement could readily be fixed to the older models, and there is no doubt that this specimen was so altered at some later period, for the colour and lacquer of the brass used for the rack and inner tube are different from that of the rest of the Microscope.

Old Microscope presented by Mr. C. F. Rousselet.—This old Microscope (fig. 80), made entirely of wood and cardboard, is a model which was extensively manufactured at Nürnberg, in Germany, for about a century from 1750 onward. It is a simple and cheap imitation of Culpeper and Scarlet's "three-pillared double reflecting Microscope." The optical part consists of three simple biconvex lenses; two of these, forming the eye-piece, are mounted in a cardboard tube with wooden ends, and are held in position by a wire ring; the third is very much smaller and more convex, is provided with a pin-hole metal diaphragm, and forms the object-glass of about $\frac{1}{2}$-in. focus. The combination, therefore, is that of a chromatic compound Microscope, giving a total magnification of about 45 diameters. The focusing is effected by sliding the cardboard tube carrying the object-glass up and down the fixed body-tube. A movable plane mirror fixed to the centre of the foot-plate serves to illuminate transparent objects; these were mounted on a wooden slider held in position by a wooden clip and spiral wire spring.

The underside of the wooden base shows a mark burned in with red-hot iron, which is understood to be a Nürnberg trademark.

[ ](“The present Microscope formerly belonged to my great-uncle, Charles Garnier, who died in 1869, since when it has been in my possession—it was my first Microscope.”—C.F.R.)

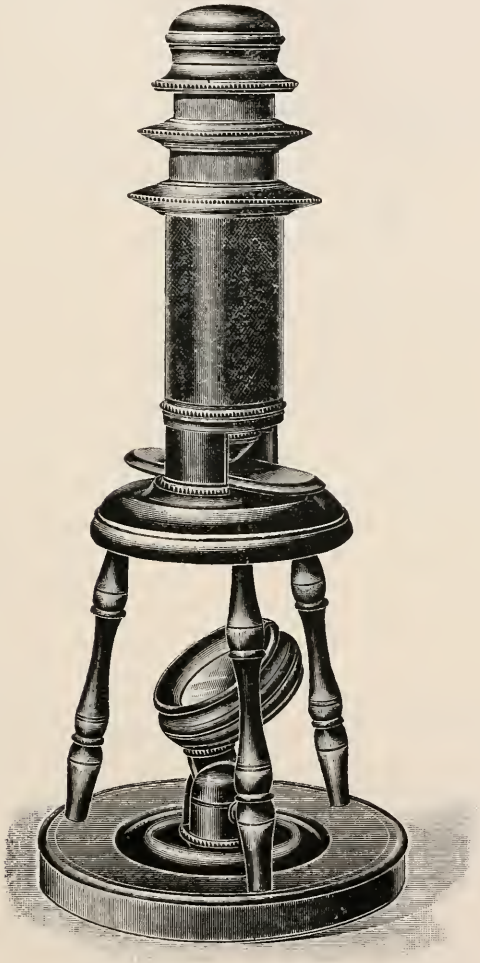


Fig. 80.

Simple Improvements for a Petrographical Microscope.*—Under the above title, A. Johannsen suggests four advantageous improvements.

1. *A rotating upper nicol in which the annoying reflection of light from the surface is overcome.* In examining, between cross nicols, minerals which are rather dark, a small amount of light falling upon the upper

* Amer. Journ. Sci., xxix. (1910) pp. 435–8 (4 figs.).

surface of the nicol produces a hazy appearance of the image. Fig. 81 represents a light-tight modification of the upper nicol of the Fuess IIIa Microscope. A vertical section through the carriage is shown at A. A rotating collar $a\,a'$ is moved by the lever c, and is supported by the flanges $b\,b'$ of the outer tube in which it rotates. A part of the scale d

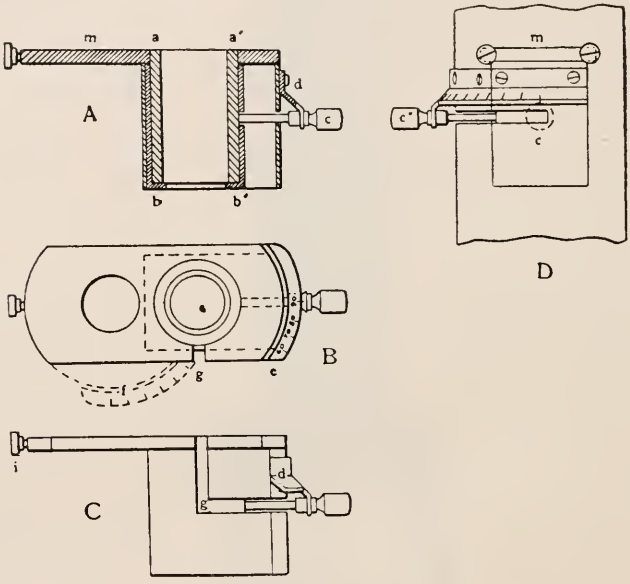


Fig. 81.

is attached to the box and is divided into degrees, although only the 10° divisions are shown at B. B and C are respectively the horizontal and vertical projections. The separation of the scale into two parts, which was made necessary by its lowered position, is shown at e and f. The slot g, which is also shown in C, is for the easy removal of the nicol

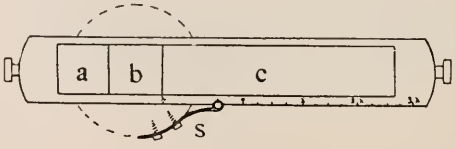


Fig. 82.

from the carriage. The prism is rotated 90° and is lifted out, after the entire carriage is taken from the tube of the Microscope, by the removal of the screw v. D is an end view, showing how the plate m entirely closes the upper part of the opening in the tube and prevents all reflection from the surface of the nicol. The lever c is shown at c' rotated through 90°.

2. *A permanently attached combination wedge.*—A great deal of time is ordinarily lost in picking up the accessories to the Microscope and in hunting for the slot into which they are to be inserted. The author has found that the simple contrivance shown in fig. 82 overcomes all this. A carriage, exactly fitting the slot above the objective, is inserted in the tube of the Microscope, and is kept in place by two end screws like those holding the Bertrand lens bar. At one end is a square of gypsum, *a*, giving red of the first order ; *b* is an opening ; and *c* is a quartz wedge underlain by a mica plate, the two minerals having their directions at right angles to each other, and similar in construction to a Wright

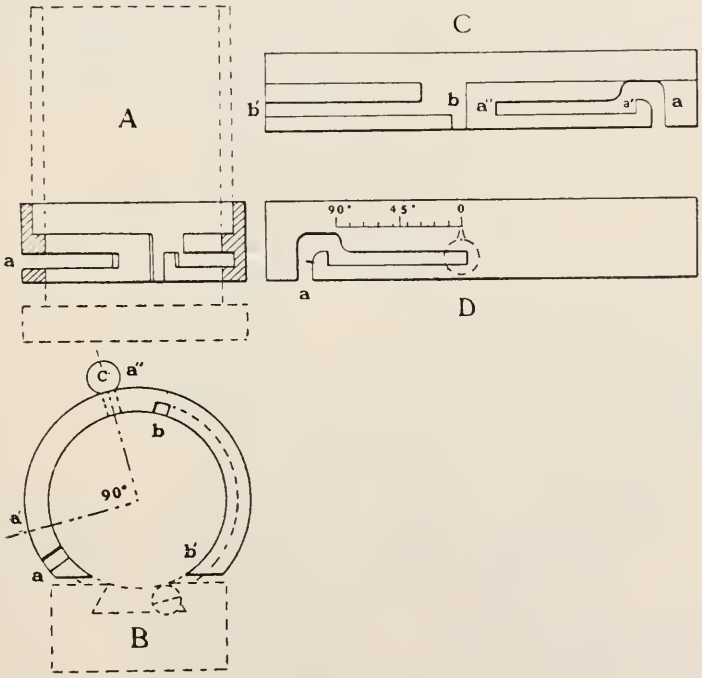


Fig. 83.

quartz gypsum wedge. The thickness of the underlying mica plate is so chosen that it exactly compensates the front end of the quartz wedge, consequently the colours of the combination wedge begin at darkness and gradually increase to the fourth order as the wedge is pushed forward. A spring S, attached to the side of the Microscope tube, presses against the carriage and produces enough friction to hold it wherever it is placed. When the opening *b* is centred, the spring drops in a rounded notch as shown. Upon the upper side of the carriage a scale is engraved, and the end of the spring shows the order of the colour at that time beneath the cross hairs of the Microscope.

3. *A rotating lower nicol for observing very slight pleochroism.*—A

brass collar turned to fit the lower part of the nicol tube is soldered on, as shown in fig. 83. A shows a section through the collar, the nicol tube being here indicated by dotted lines ; B is a view from below ; C a view of the inside of the collar as it would appear if straightened out ; and D, the outside of the collar similarly unrolled. A groove is cut on the inside to receive the head of a screw projecting from the side of the nicol tube *b b'* (B and C). On the opposite side of the tube a lever *c* moves in the slot *a' a''* (B), which is of such length that the distance between centres of the lever, in the position *a' a''*, is just 90°. The screw head and the lever bar thus form the bearings to carry the nicol tube. As the lever is moved from *a'* to *a''*, the screw-head *b* slides in the groove from *b* to *b'*. The nicol tube may be removed or inserted easily by slightly raising and rotating the tube until the lever bar passes over the projection at *a* (D).

4. *Additions to the Hirschwald Stage.*—Fig. 84 shows two scales en-

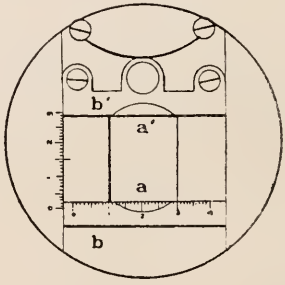


Fig. 84.

graved upon the two parts of the Hirschwald stage. A mark on the sliding portion indicates the distance through which the plate has been moved. Horizontal movement is registered by a small scratch made with a diamond point on the lower margin of the thin section. Any mineral whose position is once registered may again be located by resetting the stage to the former reading. It is necessary to read both the horizontal and the vertical scales.

Watson and Sons' "Royal" Microscope.*—This model has been subjected to revision in several of its structural details, and to enable these to be more clearly understood, illustrations are appended of the principal parts. Reference to the fig. (85) of the Microscope itself will show that it has mechanical movements to stage, a compound substage with screws to centre and rackwork to focus, and a mechanical draw-tube carrying large-sized eye-pieces.

The principal feature in the construction is one which has hitherto prevailed only in this firm's "Van Heurck" instrument. Usually the stage is attached to the lower part of the limb by screwing, but in this instrument a closer and more rigid union is effected. It will be seen by reference to fig. 86 that the limb is continued downwards, so as to form

* Catalogue, 1910–11, pp. 46–9 (3 figs.).

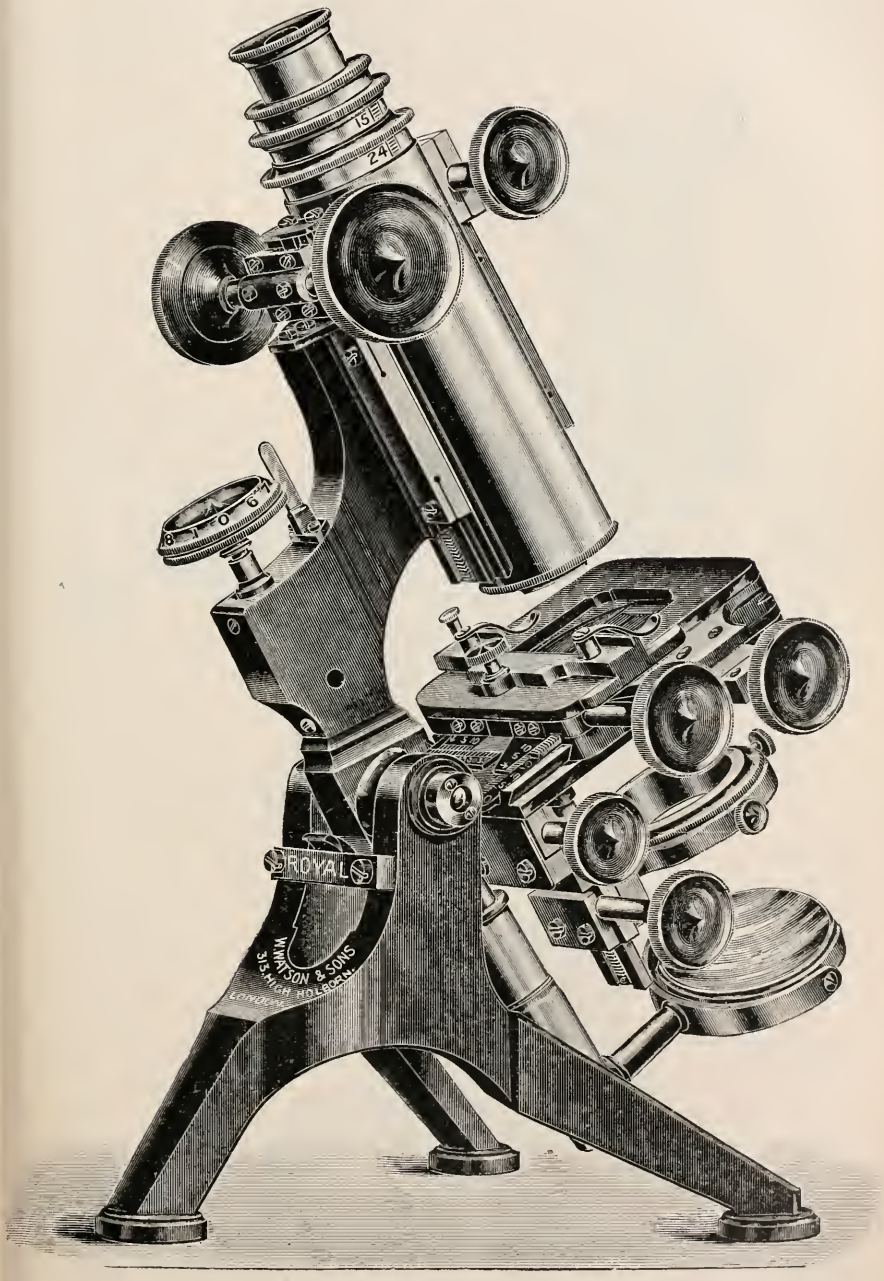


Fig. 85.

an attachment base for the substage, and a shelf and centre for the stage attachment.

The casting of the stage base-plate is continued backwards, so as to

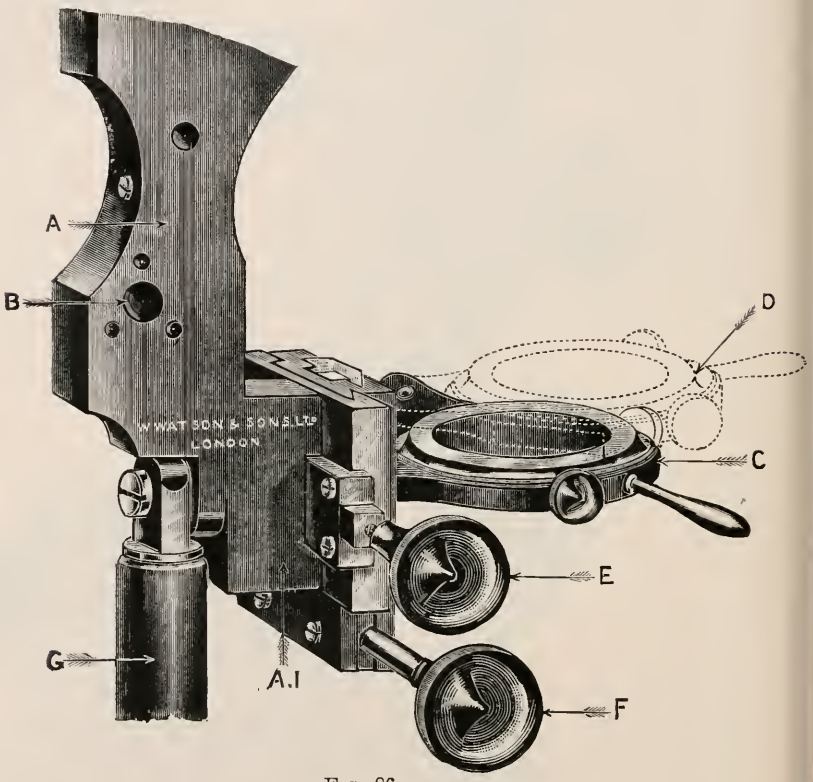


Fig. 86.

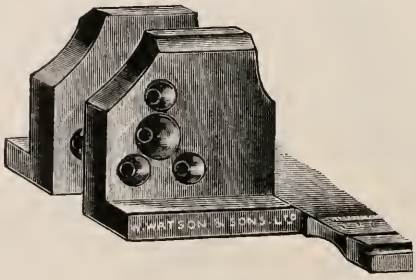


Fig. 87.

form two cheeks (see fig. 87), which embrace either side of the limb. These cheeks are then screwed to the limb, and the axis-bolt, on which the instrument is inclined, passes through the whole.

The substage-fitting is arranged to swing out of the optical axis with the condenser or other apparatus which may be carried in it, and a fine-adjustment is provided to the substage when required.

Quidor-Nachet Microscope.*—The purpose of this instrument is photomicrographic, with especial reference to stereoscopy. The Microscope is described, and has been designed, by A. Quidor. The manufacture is by Nachet. As will be seen from fig. 88 and pl. XII., this instrument differs from the ordinary model by the inclination which the Microscope tube can take to the left and to the right of the vertical, and by the independence of the stage P. An iris-diaphragm placed above the revolver is used with weak objectives, thereby increasing the depth. Inclination is measured by a graduated drum E. A clamp-screw S fixes the apparatus in any desired position. The milled heads F control the rackwork focusing in the usual way. The stage not only has rotatory and rectangular movements, but can also be moved vertically by means of the micrometer-screw L. An index I coincides with a definite point on the stage support when the upper surface of the latter coincides with the axis of rotation. The independence of the stage makes it possible to bring the upper face of the object to the level of this axis, a condition indispensable if the object is to be, and to remain, centred during the angular displacement of the optic axis of the Microscope. The camera is placed above the Microscope-tube, and takes, automatically and successively, on the same plate (8 × 16 cm.) and at two different angles, two views of the same object. The photography is performed with or without the ocular. In fig. 88, AB and A′B′ are two successive positions of the frame for taking a stereoscopic cliché. D is the rod carrying the camera. T is a double tube for preventing all infiltration of diffused light; *b* is one of the buttons controlling the rectangular movement; *c* is the axis of rotation. Fig. 88 also shows the arrangement for magnifications less than 8 diameters and for reductions.

The author gives a table of the magnifications obtainable. They may extend to 680 diameters.

The author also explains and enunciates the two following principles which govern the use of his Microscope:—1. For the same inclination of the optic axis the relief given by stereoscopic views of the same object is independent of the magnification. 2. When an object is photographed under an angle of inclination I_1, its relative relief for a new inclination I_2 is multiplied by the square root of the ratio of the new angle of inclination to the first.

The author adds many practical hints. An aquatic animal should be photographed in water. Small animals between 4 and 40 mm. should be fastened by a drop of gelatin to the bottom of a small dish and then covered with water. The gelatin may be allowed to dry hard, or may be set with a drop of formol. Smaller animals should be fixed with osmic acid and mounted on a slide with formolated water. Animals exceeding 40 mm. should in general be photographed dry. As an illuminant sunlight, when obtainable with a heliostat, is excellent. Nachet's form of the Nernst lamp is the most trustworthy; it can be worked with

* Arch. Zool. Expér. et Gén., v. (1910) p. lxvii–lxxxi (5 figs.).

an alternating or a continuous current. The author gives several examples of stereoscopic views taken by his apparatus.

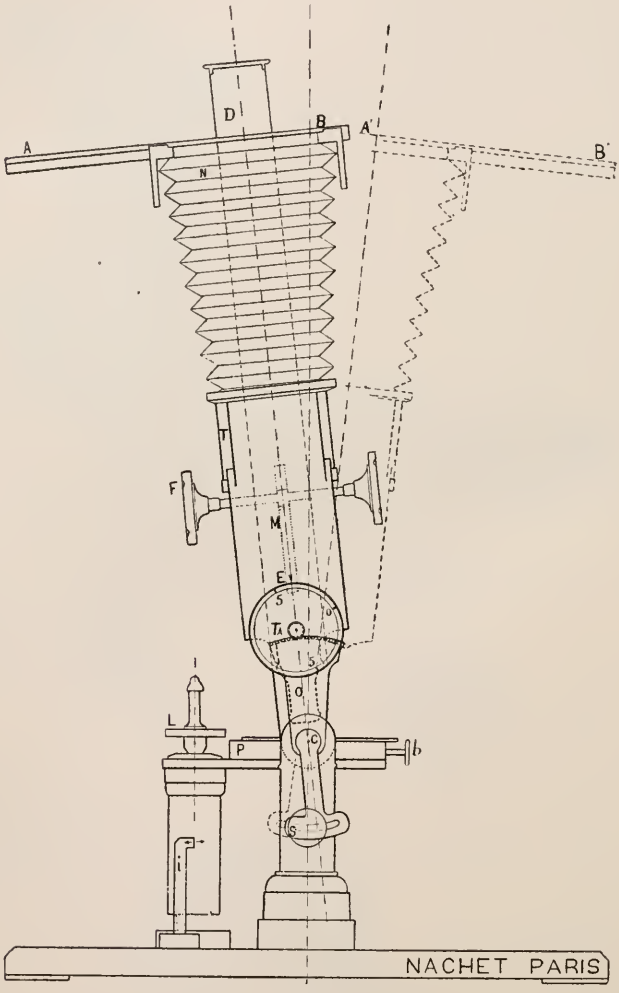


Fig. 88.

BOMAN, H. L.—**Objekttisch-Goniometer für das Dick-Mikroskop.** *Centralbl. f. Mineral., Geolog., u. Paläontog.*, 1910, p. 187.

LEISS, C. — **Verbessertes Kristallisations-Mikroskop mit Erhitzungs und Kühlverrichtung für projection.** *Zeitschr. f. Kristallograph.*, xlvi. (1909) 280 pp.

SOUZA-BRANDAO, V. DE — **O novo Microscopio da commissao do Serviço Geologico.** *Communicações do Serviço Geologico de Portugal.* Lisboa : (1903) v. pp. 118–250.

(2) Eye-pieces and Objectives.

Watson and Sons' Parachromatic Objectives.*—Fig. 89 shows the construction of the low-power objective of this series. The construction of the $\frac{1}{6}$-in. and $\frac{1}{12}$-in. has been given.† The working distance of these objectives is greater than usual, for example, the distance between the front lens of the 1-in. and $\frac{2}{3}$-in. objectives and the object is about the same as their focal length, and the $\frac{1}{6}$-in. has a working distance of more than 1 mm. This working distance permits the $\frac{1}{6}$-in. objective to be used in connexion with the hæmocytometer, a great boon for clinical laboratory work, as those who are given to blood counting know. The immersion objective has been specially designed and entirely re-computed for laboratory work, and is particularly adapted for the examination of stained specimens.

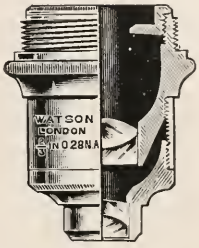


Fig. 89.

(3) Illuminating and other Apparatus.

Drawing with the Camera-lucida.‡—F. Brocher discusses the causes of eye-fatigue frequently experienced in the use of the camera-lucida. He shows that the cause lies in the difficulty of seeing at the

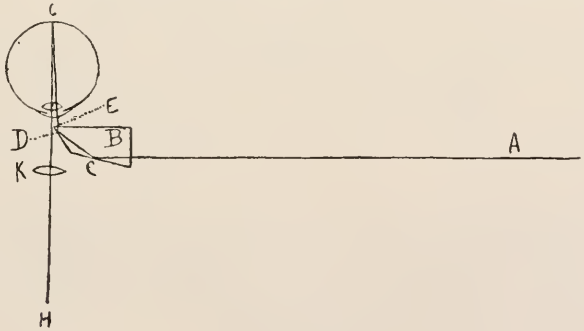


Fig. 90.

same time two objects at different optical distances. Thus if the object to be drawn is at A, at a distance of 1 m., and the paper and pencil are at H, at a distance of 30 cm. (fig. 90), the eye has to exert two different degrees of accommodation. To see A distinctly the surface of the crystalline lens must modify its curvature by one dioptrie, while to see H it must modify it by 3·33 dioptries. It is impossible that the crystalline lens can exert these two different radii of curvature at the same time. Hence the sense of eye-fatigue. If A is to be seen distinctly,

* Catalogue, 1910–11, pp. 86–9 (3 figs.).
† See this Journal, ante, p. 226.
‡ Bull. Soc. Zool. de Genève, 1908, pp. 105–14 (7 figs.).

then H will be invisible, and vice-versâ. The remedy is to bring both A and H to the same optical distance from the eye, and this may be done by inserting a convergent lens of 2·33 dioptries (i.e., 3·33 – 1·0) between the eye and the paper. The author discusses many of the possible cases, and gives tables of the lenses required under various circumstances.

New Nicol for Projection Purposes.*—W. von Ignatowsky points out that for the projection of crystalloptic examination it is usually necessary to have a parallel beam of polarized light, and that the diameter of this beam must be as great as possible. The polarization of the beam is effected in two ways, either by bringing the polarizer directly into the beam, or into the place where the image of the light-source is formed. In the latter case, it is necessary to apply a lens behind the polarizer (in the sense of the light-course) in order to parallelize the beam. This is, indeed, the method usually adopted, because it requires a smaller nicol. In the former case, the free aperture of the nicol must be very great,

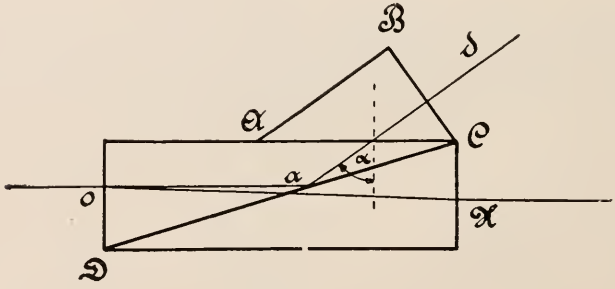


Fig. 91.

and the method is, owing to the high price of calcite, expensive. But both methods have the following disadvantage. As 50 p.c. of the incident radiation remains behind at the nicol, the nicol itself becomes so heated within a very short time that the cement layer is injured, and the nicol is useless for further investigation.

The author describes a method by which the above inconvenience is avoided in a very simple way; it even allows an hour's projection with arc lamp and a current up to 30 amperes without the least injury to the nicol. The cause of the heating lies, doubtless, in the absorptive properties of the black layer which reflects the ordinary ray. It therefore becomes necessary to avoid this cause. Fig. 91, representing a nicol with perpendicular end-planes, shows how the author gets over the difficulty. The extraordinary ray *o* X goes right through the nicol, and the ordinary ray *o a* is reflected at the cement layer D C. The plane A C of the nicol is polished. But as the angle α is greater than the angle of total reflexion, a glass prism A B C is cemented on, thereby permitting the free exit of the ordinary ray *o a d* out of the nicol. In the applica-

* Zeitschr. f. Instrumentenk., xxx. (1910) pp. 217–18 (1 fig.).

tion, for example, of a Glans prism (involving an air-layer) it is of great advantage to avoid heating, because the cement is apt to fly into the air-layer. In such a case a lateral plane should be polished on to the nicol; the glass prism is not necessary because the angle α is less than the angle of total reflexion.

Allotropic Conversion of Phosphorus in the Cardioid-Ultramicroscope.*—H. Siedentopf describes how the actual conversion of white phosphorus into its allotrope, red phosphorus, can be watched. For this purpose it is necessary to introduce a small piece of the white variety into the quartz-chamber of the cardioid-ultramicroscope and to use a magnification of 1500 diameters. The agent of conversion is the light of the visible spectrum. The long-waved rays are kept off by long water chambers and the short-waved are absorbed through the glass of the illuminating lenses. The sharply defined circular field of the cardioid-condenser is controlled by the image of the illuminating lens projected through the condenser and only a very small field at first obtained. An arc-lamp is the light-source. Almost immediately after the admission of light into parts which were previously optically empty, there appear white sub-microscopic specks at a distance apart of perhaps half a micron. The brightness of these specks (? luminiscence) increases rapidly, so that further observation on account of excessive brightness is impossible. If a cobalt glass disk, which cuts off the yellow rays and transmits the red and blue, be laid on the ocular, the change can be further followed and the complete conversion into red seen. The first step in this conversion seems to be a colloidal phase. Before using the cobalt glass place a matt disk immediately under the condenser. Gradually larger and less approximate particles make their appearance. They continue to increase in brightness, but are no longer round; they emit whitish prolongations, partly rectilinear, partly slightly curved, on three or more sides. These prolongations are unpolarized, so that nothing can be said as to a possible crystalline nature. If the matt disk be now removed and strong light allowed to enter freely, these particles with their prolongations develop in a few seconds an intensive light-emission; with the cobalt-glass disk their red tint may be recognized. More central particles and prolongations reveal themselves, and gradually the whole field is filled with the gleam of a reddish meshwork. This new state of the phosphorus remains permanent in darkness. Similar demonstrations may be made successively of different parts of the field.

If solution of phosphorus in carbon disulphide be used, instead of pure phosphorus, the effects are similar. There is, however, also an earlier phase. If the light be darted, lightning-like, into areas which were previously optically empty, white sub-microns are seen in active molecular movement; but they are quickly absorbed, and remain clinging to the walls of the quartz-chamber. In gold solutions this molecular movement may last three days before absorption. The author has experimented with arsenic and selenium with a similar series of results. He has also observed the reduction of potassium bichromate, which under the influence of light takes place in a few seconds.

* Ber. Deutsch. Chem. Gesell., xxxiii. (1910) pp. 692–4.

Recent Progress in Ultramicroscopy.*—Under this title H. Siedentopf describes the cardioid condenser and many of its results. He also discusses various technical difficulties in the application of the apparatus. These have already been noticed in our pages. He draws attention, however, to a new and convenient form of special chamber,† which is illustrated in fig. 92. A small circular quartz plate of about 2 cm. diameter and 1·2 mm. thick is provided on its upper face with a circular groove. The area within this groove forms a sort of plinth and is polished down about 1–2 μ deeper than the peripheral ring. If now a dust-free cover-glass of uniform thickness is laid on this external ring there is a formation of Newton's colours, but an air-layer of 1–2 μ in thickness is superposed above the plinth. If a small drop of any fluid had been previously introduced by means of a platinum loop, the liquid would have spread itself out and any excess would have found its way into the circular groove. In this way the operator can easily obtain a fluid layer of 1–2 μ thick. It is found that ordinary cover-glasses of

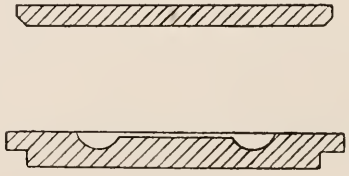


Fig. 92.

0·16 mm., as generally used, are unsuitable. They reveal curvature and exhibit a tendency to cleave to the plinth, with the effect of squeezing out the fluid. It is necessary to use stouter cover-glasses of $\frac{3}{4}$ mm. thickness.

Interferometer, with Inverse Superposed Luminous Rays, giving in White Polarized Light a Narrow Central Fringe of Sensible Tint and Narrow Coloured Fringes at White Intervals.‡ — G. Sagnac describes (fig. 93) an interferential apparatus, by means of which he combines rays differing by small velocities of propagation.

Two isosceles triangular prisms, P_1, P_2, cut out of the same piece of glass ($n = 1{\cdot}514$ for the radiation $\lambda_s = 0{\cdot}56\,\mu$), with angles α identical to a few seconds, are placed with their faces, $l\,l'$, very close together so that a rhombic prism is formed. The layer of air, $l\,l'$, acts as a transparent silvered surface. Hence the light issuing from the collimator C divides at the air-layer into transmitted vibrations (relative amplitude T) and reflected vibrations (relative amplitude R), which are propagated in opposite directions along the same triangular circuit I M_1 M_2. The lens L receives together the vibration T, a second time transmitted by the air-layer (amplitude T_2) and the vibrations R, a second time reflected by the same layer (amplitude R_2). A polarizer, not represented

* Ver. Deutsch. Phys. Gesell., xii. (1910) pp. 1–42 (many figs.).
† Tom. cit., p. 13. ‡ Comptes Rendus, cl. (1910) pp. 1676–9 (1 fig.).

in the figure, defines a vibration of Fresnel's perpendicular to the plane of circuit.

This apparatus is found to give fringes. The author describes the conditions under which an image with black centre is obtained, and how it gives place to a clear centre. If the appropriate condition is realized for a yellow-green radiation, the interferences in white light yield pure sensible tints.

In monochromatic light the fringes are black and with a black centre for the yellow-green ; dark without being rigorously black for red

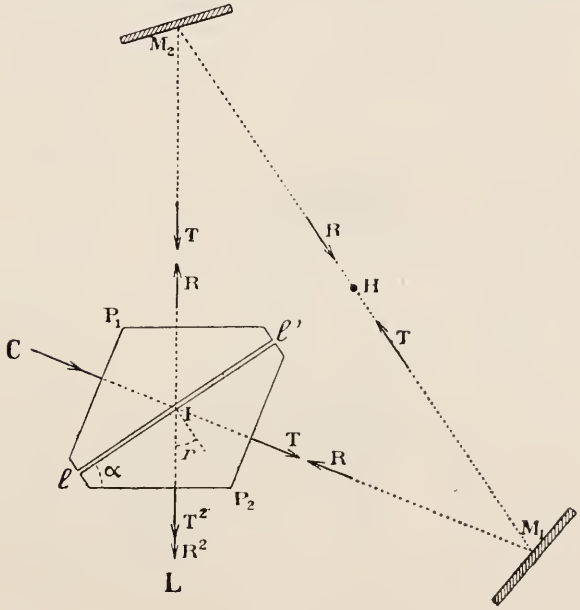


Fig. 93.

and violet. Their centres always correspond exactly to the differences of the series 0, λ, 2λ . . . $m\lambda$.

The author usually employs white light (Nernst filament). The fringes are then coloured, the central one having a sensible tint : they are separated from one another by intervals almost entirely white.

KIRNER, J.—**Optischer Interferenzindikator.**

[The author describes how photography of the Newton's rings, produced by the deformation of a lens exposed to great and rapidly produced pressures, may be made useful in measuring such pressures (e.g. of explosives).]

Zeit. d. Ver. Deutsch. Ing., liii. (1909) p. 53.

See also *Zeit. f. Instrumentenk.*, xxx. (1910) pp. 219–22 (5 figs.).

NAGEOTTE, J.—**Nouveau microtome universel. Appareil à congélation pour les grandes coupes.** *C.R. Soc. Biol. Paris*, lxvii. (1909) pp. 503–5.

(4) Photomicrography.

Practical Photomicrography.*—Fig. 94 shows a simple and very inexpensive apparatus which J. Jullien has found very satisfactory, and which any deft amateur can adapt to his Microscope. The apparatus is essentially composed of a rectangular wooden box of exterior dimensions 27 × 27 × 62 cm. One of the larger sides forms the door, accurately closing by means of two pins. The bottom is pierced with a round hole 12 cm. in diameter, to which is fastened a sleeve of black stuff, supple and light-tight. The Microscope tube fits into this sleeve and is secured by a running string. The interior of the box is completely varnished in

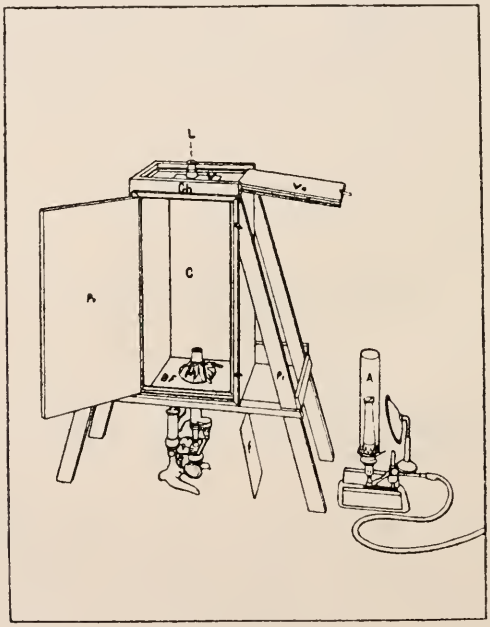


Fig. 94.

dull black. Any ordinary strong double shutter can be used—with a certain modification, however, viz. that the dividing partition is to be done away with, and the ground glass put in exactly the place which the sensitive plate will afterwards occupy. In this manner any difficulty as to difference of focus between the surface of the matt-glass and the sensitive plate will be avoided. The light-source (gas, incandescent lamp) is set about 40 cm. from the Microscope mirror, and a monochromatic filter is placed between the light-source and the mirror.

As an economical method of making a monochromatic filter, the author recommends an unexposed sensitive plate which should be first fixed in hyposulphite and washed as a negative. It should afterwards

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

be immersed some minutes in a solution of 70 p.c. alcohol 200 c.cm., Mars' yellow (aniline) 1 grm. When the plate has been dried in a dustless atmosphere it will be found to have a tint approaching the ideal yellow. Other aniline colours after comparative trials with the spectroscope will give by this process excellent screens of other tints.

(5) Microscopical Optics and Manipulation.

Behaviour of Crystals in Light Parallel to an Optic Axis.*— If a section of a biaxial crystal be cut normal to an optic axis, and this section be examined in parallel light between crossed nicols, it appears uniformly bright in all positions when rotated about the axis. C. Travis points out that this phenomenon is commonly ascribed to interior conical refraction ; but he considers that, owing to the neglect of certain important factors, this conclusion is untenable. The object of his paper is, therefore, to present a discussion of the behaviour of crystals in light that is approximately parallel to an optic axis, and to explain the observed differences between uniaxial and biaxial crystals under these conditions. His conclusions are : 1. That interior conical refraction, in a strict sense, plays no part whatever as a cause of the phenomenon. 2. That the cause is to be found in the fact that so-called parallel light has commonly a considerable divergence. 3. In any given case, the observed intensity of illumination is equal to the average intensity of that portion of the interference figure bounded by the limits of the pencil of light used. The general configuration of the interference figure is dependent upon the optical constants of the crystal, and upon the thickness of section ; these, as well as the amount of divergence of the light, are the determining factors. 4. That the reason why the same phenomenon is not commonly observed in uniaxial crystals is that in the uniaxial figure the first bright ring about the axis is in general much larger than that in the biaxial figure. Under proper conditions, however, the phenomenon may be also shown by a uniaxial crystal.

In the course of his paper he gives the demonstration illustrated in figs. 95 and 96. A ray S A (fig. 95), from a source S, is divided upon entering a biaxial crystal, into the rays A B and A C, which vibrate at right angles. From the same source another ray, S D, may be found which will divide into D C and D E ; C is then the common point of emergence of one ray from each of the points A and D. These rays are polarized at right angles. If the crystal is between crossed nicols, interference takes place between the components of A C and A D parallel to the plane of the upper nicol. The effect produced is dependent upon the difference in phase at C, and this is due to the difference in the optical length of the paths S A C and S D C. If the wave-front of the two rays is essentially normal to the optic axis, it can be shown that the path S A C (S A being great) is optically equivalent to S D C. If, then, S is at a great distance the two rays at C will be in phase ; their vibrations will give a resultant which is parallel to the plane of the lower nicol, and this resultant will be extinguished by the upper nicol.

* Amer. Journ. Sci., xxix. (1910) pp. 427–34 (2 figs.).

In fig. 96 the source is supposed to be at a finite distance and the section normal to the axis. The maximum phase-difference is that between the two rays that lie in the plane of the optic axes; in the figure, this plane is taken as the plane of the paper. It can be shown that the phase-difference at the point of interference is constant if the rays are so nearly parallel to the axis that their front velocity in the crystal may be considered constant. When the section is not cut normal to the optic axis (as in fig. 95) the same result holds if the thickness parallel to the axis be considered instead of the section thickness. From certain experimental data the author concludes that the behaviour of the crystal in light that is approximately parallel to an optic axis, must

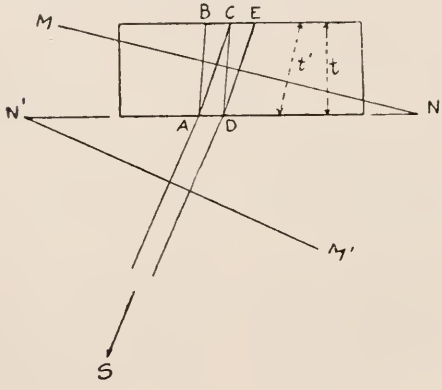


Fig. 95.

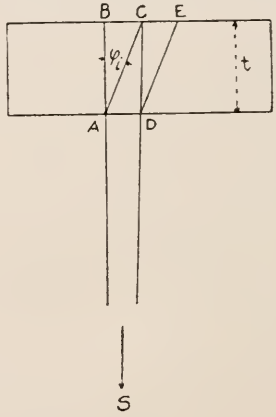


Fig. 96.

be referred to interference effects of exactly the same nature as those observed in any general section with the light falling at any inclination to the axis.

Axial Images of Fluid Crystals.*—D. Vorländer and H. Handswaldt have published the results of their investigations on the above subject. These results are illustrated by 19 plates containing about 80 beautiful photographs of interference figures which have been all obtained by examination with polarized light of thin layers of certain fluids. These figures seem a proof of the crystalline composition of fluids, and they suggest an insight into the structure of fluids and of molecules. They are met with not only in simple forms, but in complicated designs identical with those of solid crystals. At present, however, only uniaxial varieties have been detected.

Ultramicroscopic Examination of Liquids during Electrolysis.† J. J. Kossogonoff (of the University of Kieff) has thought of using the ultramicroscope invented by Siedentopf and Zsigmondy for the investigation of the phenomena of electrolysis, with extremely good

* Abhand. der Kais. Leopold-Carolin. Deutsch. Akad. der Naturf., xc. pp. 105–17 (19 pls.).

† Athenæum (1910) ii. p. 73.

results. According to the Revue Générale des Sciences for June 15, in which a well-illustrated account of his experiments appears, on focusing the instrument on the electrolyte when no current is passing, the observer sees many luminous points which appear to be executing the Brownian movements. On the closing of the circuit, these luminous points string themselves out into a chain, which progresses towards the negative electrode; and on reversing the current, the direction of the stream is also reversed. Kossogonoff does not go so far as to assert that these luminous points are the actual ions, although he shows, by reference to certain calculations of Kohlrausch, that they probably have about the same velocity; but he suggests that, if they are not the ions themselves, they are at least groups of ions, and this may be provisionally accepted. A control experiment, in which the stream of luminous points was exposed to a magnetic field at right angles to its normal direction, seemed to show a dark place near the cathode such as occurs in a Geissler tube in similar circumstances, followed by a layer in which the luminous points are extremely numerous; and the use of sulphate of copper as the electrolyte is said to produce some very beautiful effects. This method of investigation seems capable of extension, and should produce further notable results.

ZSCHOKKE, W. — **Anschauliche Darstellung der Entstehung und Hebung der sphärichen und astigmatischen Bilder.**
Deutsche Mechan. Zeit., Heft 9, 10 (1910) pp. 81–7, 93–7 (17 figs.).

(6) Miscellaneous.

Diagnosis of Natural and Artificial Silks.*—A. Herzog's monograph is a practical introduction to the methods for determining the nature of fabrics, known to the textile trade as silk, by microscopical and chemical means. The booklet is divided into four parts, which deal respectively with the microscopical examination of the fibres; chemical tests, in which are included the most important micro- and macro-chemical reactions; optical examination, which deals with the behaviour of the fibres to polarized light and with refrangibility; while the fourth part is concerned with their ultra-microscopic appearances. Two useful tables are given, one for determining the nature of silks by optical means, the other by microscopico-chemical procedure.

B. Technique.†

(1) Collecting Objects, including Culture Processes.

Observations on a New Gregarine, Metamera schubergi g. et sp. n.‡—H. L. Duke obtained his material, *Glossosiphonia complanata* Linn., a leech which serves as host to *Metamera schubergi*, from water in the neighbourhood of Heidelberg. The leeches can be kept for an in-

* Dresden: Theodore Steinkopff (1910) 78 pp. (50 figs.).

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

‡ Quart. Journ. Micr. Sci., lv. (1910) pp. 261–86 (2 pls.).

definite time in water, provided it be constantly aerated; food is not necessary, though water-snails are appreciated. Owing to the transparent integument, the parasites are visible in the living leech, and may be observed in the stomach diverticula and intestine; the cysts are found in the same situation, but are especially numerous in the intestine.

The Gregarines were obtained by making two incisions parallel to the margins of the leech, and one at right angles to the long axis at about the junction of the middle and anterior thirds. The gut contents were then emptied into normal saline, from which the Gregarines were pipetted on to slides for examination. Preparations in toto were made under a cover-slip supported on wax feet, the various reagents being drawn through with blotting-paper. The stains used were Grenacher's alcoholic carmin solution and Schuberg's modification of Mayer's acid carmin. Leeches destined for sections were fixed in Gilson's fluid. As stains, Delafield's hæmatoxylin with eosin, safranin, and Heidenhain's iron-hæmatoxylin were employed. To obtain the ripe spores, the cysts were placed in a moist chamber, where the spores developed in 7 or 8 days. The cysts were either placed on a slide in a drop of Neckar water, or under a coverslip supported on wax feet.

Observations on a Flagellate of the Genus Cercomonas.*—C. M. Wenyon describes a Flagellate of the genus *Cercomonas*, which was found in the fæces of a patient infected with *Entamœba coli*. Cultivations were made in hay infusion to which a small quantity of fæces was added. Agar used for the culture of amœbæ was also most useful. A film of this medium was placed in a well formed by means of Czokor's wax, arranged in ridges about $\frac{1}{8}$ in. high. The medium was inoculated with material from a previous culture and a long cover-glass ($1\frac{1}{2}$ in.) placed on the well. By means of a hot wire and more wax the well is sealed up. In this way the multiplication of the Flagellates is easily followed with a $\frac{1}{6}$-in. objective, and if the film of the medium be sufficiently thin with a $\frac{1}{12}$-in.

For studying the Flagellates in the fixed and stained condition the cover-glass method was mostly used. The best fixative was two-thirds sublimate and one-third alcohol slightly acidified with acetic acid. Iron-hæmatoxylin was the best stain.

Simple Anaerobic Method.†—For this method, described by Crendiropoulo, the only apparatus required consists of culture tubes, small wide-necked flasks, and a hydrogen apparatus. Agar slopes are inoculated by Veillon's method. The platinum loop is introduced into the condensation water and withdrawn carefully, so as not to touch the surface of the medium. The tube is then inclined so as to distribute the inoculated condensation water over the surface of the medium. Then a half-turn allows the water to trickle back to the bottom of the tube. Then, by means of a capillary pipette, the water is drawn off as completely as possible. The cotton-wool plug is flamed and pushed down the tube to within a few millimetres of the top of the agar slope. A tube from the hydrogen apparatus is introduced into the open end of the

* Quart. Journ. Micr. Sci., lv. (1910) pp. 241–60 (19 figs.).
† Centralbl. Bakt., 1te Abt. Orig., lv. (1910) pp. 247–8.

culture tube, which is now reversed and introduced into a wide-necked flask half-full of a concentrated pyrogallic acid solution. The surface of the pyrogallic is covered with a layer of oil which, while it permits the escape of superfluous gas, prevents access of air. After a few moments the hydrogen has displaced most of the air. The hydrogen tube is now withdrawn, and, by means of a pipette, concentrated caustic soda is added to the pyrogallic acid. Any remaining oxygen is thus absorbed.

Collecting Living Foraminifera.*—E. Heron-Allen and A. Earland point out that living Foraminifera are easy to obtain and no harder to preserve alive than other Microzoa : they give the result of their experience based on more than twenty years' collecting. The apparatus required is of the simplest description : a pail, a coarse sieve with meshes $\frac{1}{8}$ in. in diameter, and a jar or tank in which to preserve the specimens when caught. The horsehair sieves used by cooks are best as they do not corrode, but a metal sieve will do if it is carefully washed and dried after use. The writers use an enamel pail with a diaphragm of galvanized iron wire net. If preferred a second sieve of fine bolting silk may be substituted for the pail, and this is the method recommended and used by J. J. Lister, but the writers use a pail for the collecting, as it retains the diatoms and other microscopic organisms on which the Foraminifera feed, the bulk of which pass readily through the meshes of a silk sieve.

Foraminifera are to be found in abundance in the shore-sands of nearly every coast. To obtain living specimens in any numbers without the use of a dredge we must have recourse to a shore on which rock pools or weed-grown patches can be found between tide marks, although a certain abundance can be obtained on any muddy foreshore. The pail should be half filled with sea water and the sieve rested in it so that the upper rim is not submerged. A handful of small weed, coralline or confervoid preferably, is then torn off, placed in the sieve and thoroughly rinsed with an up and down motion of the sieve in the water. All the small organisms, Foraminifera, Copepoda, and so on, and most of the fine mud and diatoms adherent to the weed will pass through the meshes into the pail. The process is repeated until a sufficient quantity of debris has accumulated in the pail.

For the preservation for observation of the living Foraminifera a suitable tank or aquarium must be prepared. The bottom of the tank must be covered with pebbles or small fragments of rock, on which green seaweed, *Ulva* or *Cladophora*, is in active growth. The tank is then three-parts filled with sea-water and the muddy debris poured in, the surplus water being first syphoned out of the pail after the mud has settled. The mud will settle down in the aquarium and fill up the interstices between the stones. The object of the weed is to oxygenate the sea-water, a method far preferable to the syringing usually recommended, as it can be regulated by the amount of light which is allowed to reach the tank. Moreover, when the weed is in active growth it supplies the Foraminifera with food in the shape of motile zoospores.

Before the muddy debris is placed in the aquarium it is well to empty

* Knowledge, xxxiii. (1910) pp. 285–6.

it into a shallow dish, and remove any undesirable objects, such as worms, large Crustacea, or large fragments of weed, which may have been washed out of the sieve. These would otherwise rot, and set up putrefaction in the water before the aquarium is properly in going order. Once the tank is well started, Nature can generally be trusted to keep the balance of life and death pretty equal, for the presence of a certain proportion of Monads and Infusoria in the water, due to and living on the decay of organisms which have died, seems to be beneficial rather than otherwise to the Foraminifera, serving them as food. If these Microzoa appear to increase too rapidly, which can be seen with the Microscope, or tested by the sense of smell, they can be checked or stopped by increasing the oxygenation of the tank, which is effected by exposing it for a short time to the direct influence of sunlight.

The natural evaporation from the surface of the aquarium would rapidly render the water too saline for life, and this must be remedied by the addition of the necessary quantity of fresh-water as required. The easiest method of preserving the water at its correct salinity is to place a pair of glass specific gravity bulbs in the tank. These can be obtained at a very moderate cost from the dealers in chemical apparatus. They are obtainable in pairs, clear glass and blue glass. The blue bulb sinks to the bottom in normal sea-water, gradually rising as the salinity increases owing to evaporation. The clear glass bulb floats in normal sea-water and sinks if the specific gravity is reduced by the introduction of too much fresh-water. The bulbs require a certain amount of care in their use, as the attachment of any organism to the clear bulb will cause it to sink to the bottom, while the blue bulb often rises under the buoyancy of a bubble of oxygen derived from the weed. It is well, therefore, to examine the bulbs before adding fresh water at random, and the latter must be introduced a few drops at a time and left for some minutes to mix with that in the tank.

When the muddy debris is added to the tank, for many hours, or sometimes days afterwards, few, if any, signs of Foraminifera will be seen. They are all buried under the thin semi-liquid mud. But they will gradually emerge and make their way towards the glass, up which they slowly crawl by means of their pseudopodia, which can be seen surrounding them in an opalescent halo if the tank be examined by oblique light. In the course of a few days the glass sides will be seen to be thickly studded with the tiny shells, prominent among which, owing to its comparatively large size and great abundance, will be the handsome Miliolid, *Massilina secans* d'Orbigny. Any specially interesting species may be removed by means of a pipette to a smaller tank for observation.

For the purpose of examination there is nothing finer than the Greenhow-Smith model of tank Microscope, made by Zeiss. With it specimens can be examined in the tank under a comparatively high power. But the strong light of a Nernst lamp is required to do justice to it, although with the lower powers good results can be obtained with an ordinary Microscope lamp and bullseye condenser. The best results are obtainable with direct light, as the thickness of the tank militates against the use of transmitted light.

For those who have to rely upon the ordinary Microscope and for any work with high powers, the living "foram" must be removed to a cell or excavated slip. After the specimen has been located on the glass side of the aquarium it must be detached with a needle or fine brush with one hand, and as it falls down the side of the tank must be caught with a pipette held in the other. Foraminifera are very sensitive to vibration or shock, and draw in their pseudopodia rapidly, but in most instances they will quickly recover when placed on the stage of the Microscope, and again protrude them. The first sight of a fine *Polystomella* or *Massilina*, with its pseudopodia fully extended, is indeed an experience never to be forgotten.

New Method of Preparing Culture Media.*—C. Gessard is of opinion that the repeated sterilizations required in the preparation of ordinary media, must cause alterations in the constituents, which are undesirable for some purposes. He has, therefore, made use of a method of preparing media without using heat. Three parts of blood, drawn from a vein under aseptic conditions, are received into a vessel containing 1 part of a 20 p.c. salt solution. The strong saline inhibits the process of clotting, but if the mixture be diluted with nine times its volume of water, a clot is formed. Suitable quantities of the concentrated saline mixture are introduced into test tubes, and diluted with sterile distilled water. The tubes are sloped if desired. A clot soon forms, which constitutes the culture medium. As all the manipulations have been conducted so as to avoid contamination, no further sterilization is necessary. The medium may be modified by the addition of sugars, glycerin, or other materials.

Isolation of Cholera Vibrios.†—Finding the stereotyped peptone-water method unsatisfactory for separating the vibrio from *Bacillus pyocyaneus* and certain other organisms, M. Crendiropoulo and A. Panayotatou have discovered a medium upon which these extraneous organisms are more effectively inhibited. A solution of peptone—Witte's for preference—is made alkaline by the addition of soda, so that its reaction is between 0·28 and 0·4 p.c., expressed in terms of soda. When the medium is required for use, 2 parts of this solution are added to 3 parts of neutral peptone agar. The mixture is poured into Petri dishes, and allowed to set. It may then be spread with an emulsion of the suspected material.

The authors also made trial of Dieudonne's alkaline hæmo-agar, but found that the latter did not always restrain *B. pyocyaneus*. Moreover, the colour of this medium made it difficult, in some cases, to distinguish the colonies of the two organisms.

Muller, A.—**Uber den Einfluss des Gehalts der Gelatine an schwefliger Säure auf ihre Verwendbarkeit in der bakteriologischen Technik.**
Arb. Kaiserl. Gesund., xxxiv. (1910) pp. 164–5.

* C.R. Soc. Biol. Paris, lxviii. (1910) pp. 1049–50.
† Centralbl. Bakt. 1te Abt. Orig., lv. (1910) pp. 248–250.

(2) Preparing Objects.

Studying Structure and Life-history of Crithidia melophagia.* Annie Porter examined numerous specimens of *Melophagus ovinus*, in which she found the Flagellate parasite *Crithidia melophagia*. The host, known as the "ked," belongs to the Diptera (Hippoboscidæ), possessing extremely reduced wings ; the keds were obtained from English southern counties. For observations on the living organism two methods of procedure were followed. The alimentary canal was isolated and divided into separate portions ; these were either teased out with needles and examined in saline, or the contents were squeezed out and also examined in saline. Alkaline methylen-blue and neutral-red were occasionally used as intra-vitam stains.

For fresh preparations used in work on hereditary infection, the ovaries and gut were dissected out and mounted in saline. The behaviour of the *Crithidia* and the manner in which they passed out of the gut were carefully watched. In investigations of the stages of *C. melophagia* in the egg and puparia, smear preparations were found to be preferable to sections. The method adopted was to prick the egg or open the young puparian and express the contents on to a slide. The contents were at once fixed, then allowed to flow over the slide ; this procedure obviated distortion and rupture of the parasites. As these preparations contained much fatty matter, the slides were treated with ether, and after washing with absolute alcohol were stained and mounted in the usual manner.

For making permanent preparations the alimentary tract of the Dipteran host was removed and divided into portions, which usually were teased and fixed wet. The vapour of formalin or of osmic acid was mostly used for fixation, but sublimate-acetic-alcohol and Bouin's fluid were also employed. The stains used were Giemsa, thionin, iron-hæmatoxylin, and gentian-violet with Delafield's hæmatoxylin ; the last was particularly useful for the membrane and flagella. Preparations mounted in neutral Canada balsam were superior to dry films or to films mounted in any other manner.

Demonstrating Muscle-spindles.†—P. A. Cilimbaris investigated the muscles of the human eye chiefly, and also those of lower animals ; in the latter case the results were for the most part negative. Frozen sections of fresh muscle were overstained with hæmalum and differentiated with hydrochloric-acid-alcohol, washed in tap-water, and mounted either in lævulose syrup or in balsam. This method was excellent for the sarcoplasm and the interstitial substance ; the contractile elements, however, were unstained.

The fixative used was 10 p.c. formalin, and frozen sections only were used.

Maceration preparations were made by Sihler's method : the muscles were placed in a mixture of 1 vol. acetic acid, 1 vol. glycerin and 6 vol. 1 p.c. aqueous solution chloral hydrate, then for weeks to months in a mixture of 1 vol. Ehrlich's hæmatoxylin, 1 vol. glycerin and 6 vol.

* Quart. Journ. Micr. Sci., lv. (1910) pp. 189–224 (2 pls. and 15 text figs.).
† Arch. Mikroskop. Anat. u Entwickl., lxxv. (1910).

1 p.c. aqueous solution of chloral hydrate ; the teased-out preparations were mounted in glycerin.

Vital methylen-blue staining gave excellent results. The animal (sheep) was washed out through a carotid artery with warm saline or Ringer's fluid. Warm 1 p.c. methylen-blue solution was then injected. The fluid was allowed to set for 20 minutes and then the eyeball-muscles were removed. The muscles were stretched out on a plate and exposed to light in a moist chamber for ¼ to 2 hours. The stain was fixed in 10 p.c. aqueous solution of ammonium molybdate for 24 hours. They were then washed in distilled water for several hours, after which they were dehydrated rapidly in alcohol, cleared up in xylol and mounted in balsam.

The methods of Ramon y Cajal and of Bielschowsky were also tried ; the results were about the same, but not so satisfactory as those already given.

The materials fixed in formalin were imbedded in celloidin, paraffin, or paraffin-celloidin, and the sections stained with hæmalum, iron-hæmatoxylin, and counter-stained with picro-fuchsin or with one of the numerous preparations of carmin.

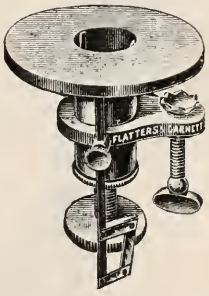


Fig. 97.

(3) Cutting, including Imbedding and Microtomes.

Flatters and Garnett's "Firmax" Microtome.*—This instrument (fig. 97) has been designed in order to meet the demand for a low-priced efficient microtome. It is substantially made with thick brass knife-plate and special arrangements for preventing the wax from turning round. It is provided with table-clamp and thickness register..

Van der Stad's Improved Rocking-microtome.†—The description of this instrument is due to J. Boeke. Fig. 98 gives the general view, which, it will be noticed, differs from the standard type of rocking-microtome rather in elegance and stability than in essentials. The author includes the following among his improvements.

1. One of the four feet of the heavy base-plate A is shorter than the other three, and serves for the reception of a position-screw (*a*, figs. 98 and 102).

2. The instrument can, at desire, be arranged (fig. 99 RMi) for section-thicknesses from 0–25 μ, proceeding by 1 μ ; or for section-thicknesses (RMii) from 0–20 μ, proceeding by 0·5 μ.

3. The object-holder (figs. 98, 100, 101) has some special advantages, in addition to the ordinary movements, in three mutually perpendicular planes for setting the object with any desired orientation. The upper part (figs. 98 and 100) of the holder consists of a strong angle-piece *c*, the shorter side of which carries a strong flattened rounded plug, which

* Catalogue B, 1910, p. 33.

† Zeitschr. wiss. Mikrosk., xxvi. (1909) pp. 242–55 (6 figs.).

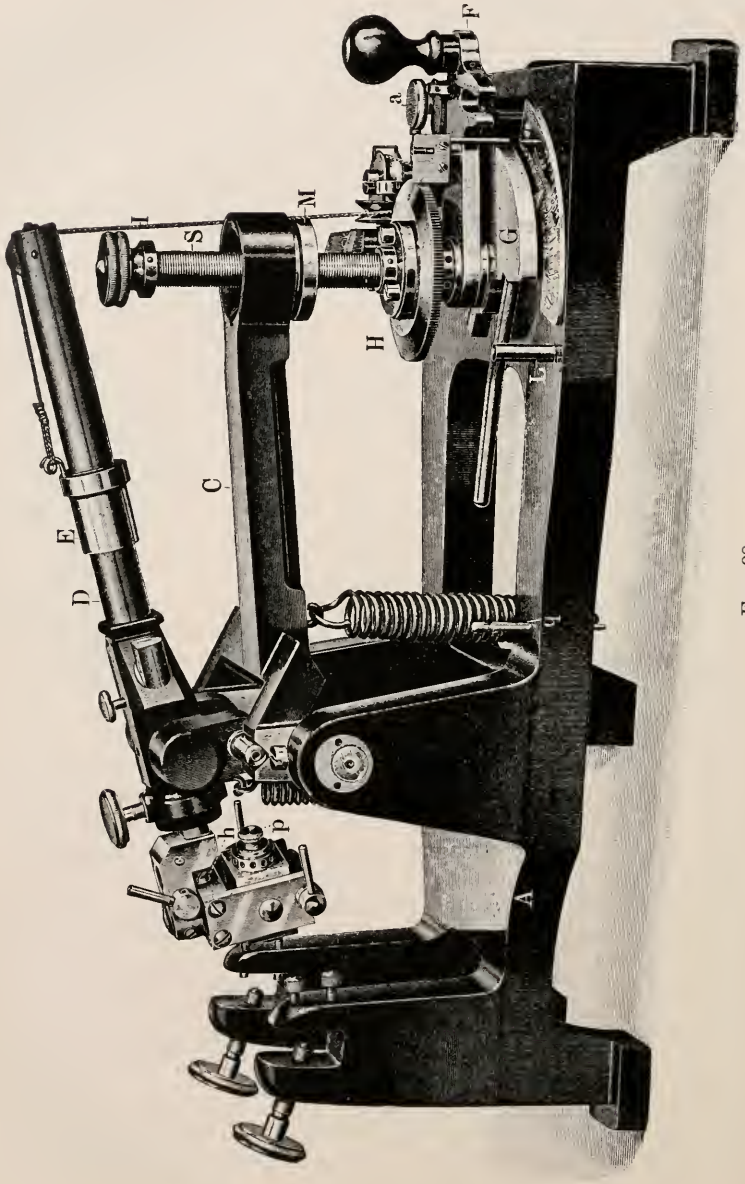


Fig. 98.

fits into a corresponding perforation in the rocking-lever D, and can be securely fixed by two milled-headed screws. To the underside of the angle-piece is applied a four-sided prism *d*, carrying on each of two

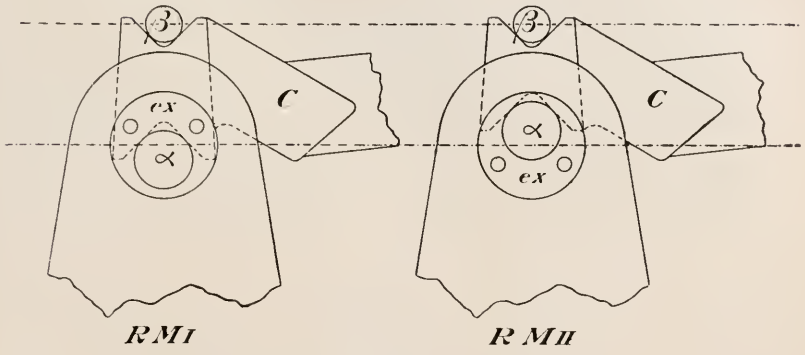


Fig. 99.

opposite sides a wing-shaped plate *e*. These wings *e*, with the prism *f*, form an arrangement for receiving in a suitable insertion the rotatory

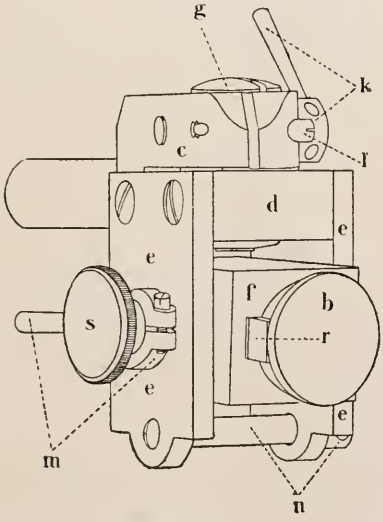


Fig. 100.

object-cylinder *b*. Fig. 101, which is a frontal section, through the vertical rotation-axis *x x*, gives further details, the section being so drawn as to show also the horizontal rotation-axis *y y*, which intersects the vertical axis *x x* in a point of the object cylinder axis. The author

gives full particulars of the details connected with rotation about the vertical axis, rotation about the horizontal axis, and rotation about the object-cylinder-axis.

4. The movement of the lever F is connected, by means of a strongly twisted cord of Chinese silk, with the rocking-lever D, but in a manner differing somewhat from the ordinary mode. One end of this cord is connected with a double eye (fig. 102), the larger eye engaging on one of the two screws v_1 or v_2, of the lever. The cord then runs round the horizontal roller R_1, then round the vertical roller R_2, and finally over the roller R_3 inserted in the back part of the rocking-lever D. The cord, finally, is attached by its other end to the sliding-sleeve E, which is clamped on to D by the screw *w*. German-silver springs, only partly visible in the figure, prevent the cord from slipping out of place. The

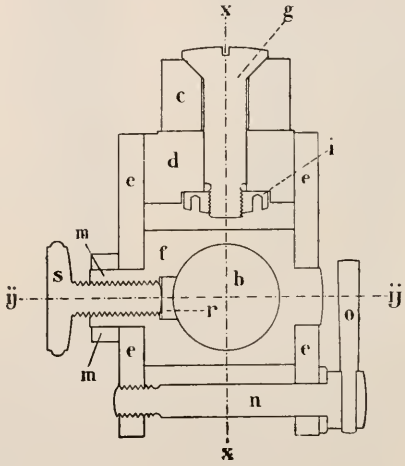


Fig. 101.

application and action of these three rollers distinguishes this microtome from the ordinary form, which introduces only two. The advantage is that the range-movement of the object can be varied by attaching the cord either to v_1 or to v_2. In the last case the range is one-and-a-half times as great as in the first; this would be convenient in the case of cutting a very high object. Fig. 102 shows the working-lever in three positions: F is the rest position; F_2 the extreme position, and F_1 the position at which the forward removal of the object begins, the instrument being adjusted as RMI (fig. 99) and arranged for sections 10 μ thick. It will be easily seen from fig. 102 that the cord at F_2 is longer than at F_1. This means that the removal of the object is carried out only on the small final part of the object-track. With this same arrangement for section thickness, an object 23 mm. high can be dealt with if the cord is hooked on at v_1, or 35 mm. high if the cord is attached to v_2. With adjustment RMII (fig. 99), these figures are respectively 20 and 31 mm.

The scale, with two graduations, is adapted to the operations for either RMi or RMii, or in the case of changing from the one to the other.

5. Each of the knife-rests (fig. 98) has a notch and three screws for receiving and fixing the knife; the small screws are for determining the most favourable obliquity for the knife, and the milled-head acts as a clamp. As efficiency is promoted and wear and tear diminished by choice of proper materials, the author introduces the best cast-steel for the ironwork; instead of soft brass, he uses a hard wear-resisting bronze-alloy.

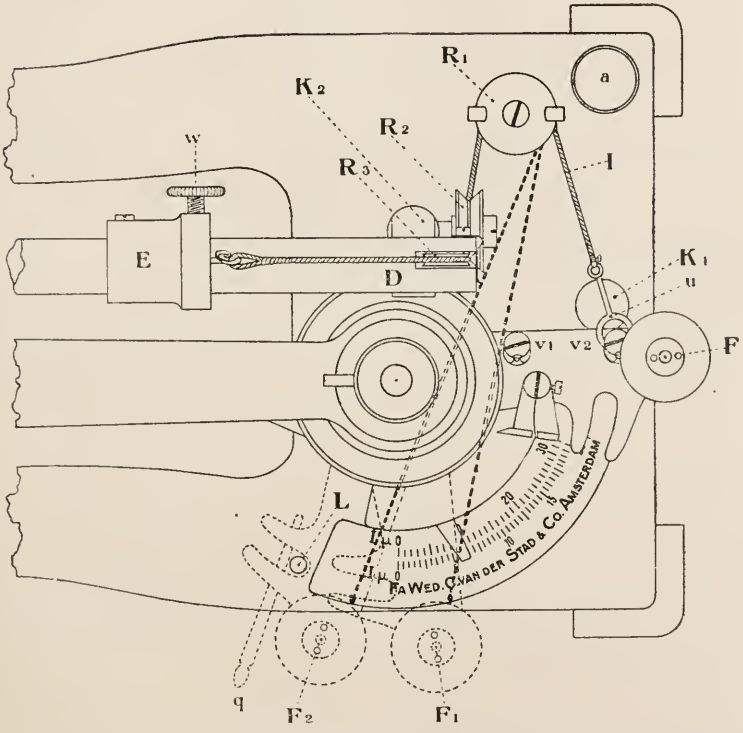


Fig. 102.

Fig. 103 shows an arrangement for ensuring thorough lubrication and for preventing shakiness of the working parts. The figure is a section through the region of the axial bolt T, about which the working-lever F turns. The sector G is not, as usual, directly rotatory about this bolt, but rotates with a long flange, G *b*, about a steel box, U. This box is thickened at its base, and rests on the base-plate. A flange on the bolt T fits on the thickening and keeps U firmly pressed down. The nut T*m* below the base-plate tightens all up. The axis of the bolt T coincides with that of the box U. In this way the working-

lever F is flanged (F*b*) so as to fit into U. The between-space is filled with oil, which finds its way to the rotatory bolt T through perforations in the wall of the box F*b*. The connexion of the micrometer screw S with the rotatory bolt T is effected by means of the hardened steel conical wedge Z. This wedge has a hemispherical base which engages

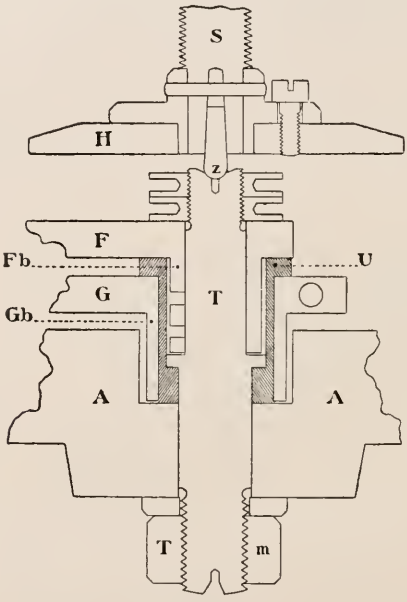


Fig. 103.

in a hemispherical socket in the top of the bolt T. The author considers that this device is superior to rounding off the base of the micrometer screw itself.

(4) Staining and Injecting.

Modification of Bielschowsky's Silver Method.*—P. Snessarew has devised the following modification of Bielschowsky's method for staining connective-tissue fibres. The chief alteration consists in immersing the sections in a solution of crystallized ammonium ferro-sulphuricum cryst. The procedure is as follows: The tissue is fixed in 10 to 15 p.c. formalin for a couple of hours; it is then washed in running water for 30 to 40 minutes, after which it is sectioned by the freezing method. The sections may be washed in a weak solution of formalin or be transferred straight away to 2½ to 10 p.c. solution of ammonium ferro-sulphuricum cryst. In this solution, which must be changed at least once a day, the sections remain at least four days. The solution must be kept in the

* Anat. Anzeig., xxxvi. (1910) pp. 401–11 (7 figs.).

dark, and 5 p.c. formalin may be added, but the addition does not appear to be indispensable. The rest of the technique follows the original lines.*

Diagnostic Value of the Staining Method of Gasis.†—This method depends upon the fact that certain organisms when stained with an acid stain are not decolorized by strong alkalis. Films stained with an eosin solution are treated with sodium hydrate, and counterstained with methylen-blue. It is thus the direct converse of the Ziehl-Neelsen process. It was claimed that, by this method, tubercle bacilli, which are alkali-fast, might be distinguished from other acid-fast organisms, more particularly smegma bacilli, which are decolorized. Levy has made trial of this process, and finds that it yields very satisfactory films, and thus renders easy the routine examinations for tubercle bacilli. On the other hand, the staining solutions are troublesome to prepare, and unstable. Further, he finds that smegma bacilli and other organisms of the acid-fast group are not always decolorized. He considers, therefore, that, as a means of diagnosis, the method is worthless.

Identity of Flemming's and Altmann's Granules.‡—N. Samssonow claims that the filaments found by Flemming in fresh cells are identical with the granules or threads found in fixed preparations made by the chondriosome method or by Altmann's procedure. He describes the methods used and the results of treating cartilage, connective-tissue and epithelial cells; fixation with modified Flemming's solution and staining with iron-hæmatoxylin, or with iron-alizarin and crystal-violet. The ripening of iron-hæmatoxylin (Meves) was accelerated by adding 2·5 c.cm. peroxide of hydrogen to 100 c.cm. of the solution.

Altmann's method consists in fixing very small pieces for 24 hours in a mixture of equal parts of 5 p.c. potassium bichromate and 2 p.c. osmic acid. Paraffin sections are stained in a solution consisting of 100 c.cm. anilin oil water plus 20 grm. acid-fuchsin. When on the slide the stain is heated till it vaporizes, and after cooling it is washed off with picric acid solution, made by mixing one volume of saturated alcoholic solution of picric acid with two volumes of water. The picric acid solution is renewed and the preparation placed in the incubator for 30–60 seconds to differentiate; then alcohol, xylol, balsam. The author prefers to differentiate in the cold.

F. Meves§ pursues the same subject, but in connexion with leucocytes. He contends that his suspicion that the mitochondria and chondriokonts are identical with the granules and threads of Altmann is fully confirmed. In addition to the staining methods used by Samssonow he also adopted Schridde's modification of Altmann's method. This modification consists in placing the blood-films in Orth's mixture (Müller's fluid 9 parts, formalin 1 part) for 12 hours and afterwards for a similar time in Müller's fluid. The preparation is then washed in water, followed by 1 p.c. osmic acid for $\frac{1}{2}$ to 1 hour. The preparation

* See this Journal, 1906, p. 735; and 1908, p. 659.
† Centralbl. Bakt. 1te Abt. Orig., lv. (1910) pp. 253–5.
‡ Arch. f. Mikrosk., Anat. u. Entwickl., lxxv. (1910) pp. 635–41 (1 pl.).
§ Tom. cit., pp. 642–58 (1 pl.).

is again washed and then stained with acid fuchsin-picric acid according to Altmann's procedure. The illustrations seem to bear out the author's contention.

Detection of Tubercle bacilli in Fæces.*—R. W. Philip and Agnes E. Porter advocate the use of antiformin, a mixture of alkali hypochlorite and alkali hydrate for detecting tubercle bacilli in fæces. A piece, a cubic ½ in. in size, is placed in a conical glass and to this about 20 c.cm. antiformin, which has been diluted with water to 15 p.c., is added. After well mixing up, a similar quantity of the dilute antiformin is added and the process repeated. After standing for about an hour a white layer appears. From this white curdy layer a drop is taken and placed on a slide along with a drop of albuminous water. A film made in the usual way is then stained with carbol-fuchsin and methylen-blue and afterwards decolorized with alcohol and acid.

Staining Trypanosoma dimorphon.†—E. Hindle smears a thin layer of albumen on a slide; on this a drop of blood or piece of an organ is smeared in the usual way, and the slide dropped face downwards into a jar of Flemming's strong solution. After 5 minutes or so it is removed and washed with water, and then passed through upgraded alcohols to absolute; after this it is removed to 80 p.c. alcohol containing iodine and potassium iodide; after an immersion of about 10 minutes it is passed into alcohols downgraded to 30 p.c.; it is then stained by either of the following methods:—

1. The film is stained in anilin-safranin for about an hour; after a wash in water it is treated with 1 p.c. aqueous solution of polychrome methylen-blue for one hour. The slide is again washed and then differentiated with Unna's orange-tannin; it is then passed through water, upgraded alcohols to anilin oil, cleared in xylol and mounted in balsam.

2. The film is mordanted for one hour in 3·5 p.c. aqueous solution of iron-alum and then stained for a similar time in 0·5 p.c. aqueous solution of hæmatoxylin, artificially ripened with a few drops of lithium carbonate solution. The preparation is then differentiated in iron-alum and mounted in the usual way.

Method of Staining Deep Colonies in Plate Cultures.‡—E. Dodson cuts out the colony from the agar-plate with a wet chisel and deposits it on a slide. The preparation is then dried at 37° C. and afterwards soaked in methylated spirit for 20 minutes. Surface crystals are now removed by immersion in 5 p.c. acetic acid for about 10 minutes. After this wash and dry in incubator for about 20 minutes. When dry pour on "Stephens' scarlet writing fluid" and allow to act until the colony is well stained, from 10 to 20 minutes. Mop up the superfluous fluid, and then pour on Loeffler's methylen-blue diluted with an equal volume of distilled water. Tilt the slide until the agar turns violet; to attain this end the preparation must be treated twice with blue. Next wash with water and then decolorize with alcohol until no more blue comes

* Brit. Med. Journ. (1910) ii. pp. 184–5.
† Univ. California Publications (Zool.) vi. (1909) pp. 127–42 (3 pls.).
‡ Lancet (1910) ii. pp. 310–11 (3 figs.).

off. Dehydrate with anilin oil, clear in xylol, and mount in balsam. The organisms are stained deep purple and the agar a pale green.

Demonstrating Tubercle Bacilli in the Blood.*—A. Lippmann obtains 10 c.cm. of blood from a vein by means of a syringe. The blood is placed in a flask along with 30 c.cm. of 3 p.c. acetic acid. The mixture is centrifuged for ¼ to ½ hour, and then the supernatant fluid is poured off, while the deposit is treated with water. To the deposit are added 60 c.cm. of 15 p.c. antiformin, and the mixture incubated for ½ to 1 hour. The fluid is again centrifuged, and, after washing the sediment twice with water, smears are made, fixed and stained in the usual way. Examination of the films is toilsome, as only a few bacilli are usually present. The author obtained positive results in 11 out of 25 cases.

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

Polyscopic Cell.†—C. S. Banks describes how to make a new microscopical accessory which will be useful to entomologists and also to general biologists. The polyscopic cell is merely a section of glass tubing of small calibre, made by grinding it to the form of a square prism by means of a rock-grinding apparatus. Lengths of glass tubing say 4–6 mm. in diameter, are cut into pieces from say 15–20 mm. long. Nine to a dozen of these are fastened to a small plate of glass by means of a mixture of 20 parts white shellac and 7 parts Canada balsam. This, in the form of a pencil, is applied to the glass plate held over the gas flame, until a sufficient quantity has melted upon the plate. The short tubes are then placed close together and pressed down upon the plate so that they will all be parallel. The cement having become hard, the tubes are ground down upon the steel wheel of a rock-grinding machine, the operator employing first coarse emery and then finer until their surfaces have become worn to the desired degree and have the velvety appearance of ground glass. A still finer polish may be obtained by next grinding for a short time on a plate glass with pumice and water. The next step is to dry the plate and gently heat it until the tubes become loose enough for removal. The entire mass of adherent tubes may be slipped off, turned completely over, pressed firmly to the glass plate to remove air bubbles and, after cooling, the operation of grinding the faces on the opposite side begun. This being completed, the tubes are now removed as before, set up on edge so that their plane faces are contiguous, re-cemented to the plate and the third face ground. For the fourth face, the mass may be slipped off entire and turned over, the same precautions being taken to press the mass flat to the plate. The cells may now be removed from the plate and, after cleaning off the cement, they are ready for use. They may, however, be polished even more finely if it is so desired, to remove the ground surface and render them perfectly transparent like ordinary glass slides; but this is not absolutely necessary, for the following reasons: After mounting the specimen, the only thing necessary when it is desired to study it under the Microscope is to place a drop of immersion oil on the top of the cell

* Muenchen. Med. Wochenschr., lvi. (1909) pp. 2214.
† Philippine Journ. Sci., v. (1910) pp. 78–83 (2 pls.).

and press over it a tiny piece of cover-glass. This causes a perfect transparence on the top of the cell and makes the enclosed specimen visible. The only special advantage of having the cell polished is to enable one to determine quickly the position of the specimen within. An advantage of leaving the cell with ground sides is that the number and name of the specimen may be written easily upon the surface with India ink.

This slide-cell, though chiefly intended for minute insects and parts of insects, may also be used for Crustacea, Arachnida, Rhizopoda, Vermes, etc.

The method of use is very simple: it is only necessary to select a slide-cell of suitable calibre, fill it with xylol-balsam, and then push it in the preparation. The ends of the tube are then cemented up.

(6) Miscellaneous.

Removing Over-hardening in Anatomical and Histological Preparations, and New Method of Silver Impregnation.* — It is well known, says F. W. Schmidt, that formalin over-hardens, and that consequently preparations become unsuitable for further examination. Noticing that formalin did not harden silver-gelatin emulsions though gelatin alone was rendered very hard, the author ascribed this effect to the action of the silver salts; and working on the basis that animal tissues might behave as gelatin does, he set about experimenting. He immersed *Alburnus bipunctatus* in formalin until it was as hard as a board, and afterwards in 1 p.c. silver nitrate solution. In about 14 days the brittleness was removed. Larger objects, such as *Gadus aeglefinus* L., required a little longer. Of course the objects were stained by the silver, and especially in certain parts. The author then turned his attention to the preventing of this staining, and also to ascertain if any substance would also remove the brittleness. He found that a 1 : 10 solution of citric acid would render the formalin-fixed specimens pliable, but as this was expensive he used ½ p.c. nitric acid. Reverting to his observation that the silver nitrate stained the objects, he goes on to show that formalin-silver nitrate preparations are available not only for macro-, but for microscopical examination, and gives the following procedure:— (1) hardening in 10 p.c. formalin; (2) immersion in 10 p.c. citric acid for 14 days; (3) immersion in 1 p.c. silver nitrate solution for 8 to 14 days. The method is stated to be specially useful for the nervous system.

* Anat. Anzeig., xxxvi. (1910) pp. 652–4.

Metallography, etc.

Aluminium-zinc Alloys.* — W. D. Bancroft has determined the tensile strength of alloys prepared from aluminium and zinc, both of high purity. The alloys were melted in artificial graphite crucibles, and were cast at temperatures 50° C. above their melting points, in graphite moulds. From 0 to 4 p.c. aluminium the tensile strength increases from about 4 to 11 tons per square inch, from 4 to 60 p.c. it increases more gradually to 16 tons, and then decreases to about 6 tons for pure aluminium.

Aluminium-copper-tin Alloys.†—C. A. Edwards and J. H. Andrew have amplified their work on this ternary system,‡ investigating the constitution and determining the properties of numerous alloys. In accordance with the method recommended by Shepherd and Upton, metallographic examinations were relied upon for the location of the boundary lines of the different phases. The original paper, with diagrams and photomicrographs, should be consulted for the details of the constitution of the alloys. No ternary compound is deposited from the liquid alloys, and no ternary eutectic is formed. An alloy containing 10 p.c. tin and 9 p.c. aluminium is a homogeneous solid solution at 900° and at 500° C., but at interjacent temperatures reactions occur in it producing quite different structures showing two phases. The authors suggest that at 900° C. the γ' copper-tin phase is in solution with the β phase, while at 500° C. it is the δ' in solution with β. This implies that the identity of a phase or constituent is not destroyed when in solution.

Copper-zinc Alloys.§—T. Turner and T. M. Murray have determined the changes of length of cast bars of numerous copper-zinc alloys and of some pure metals when cooling from the solidifying temperature. The extensometer used was an improved form of the instrument previously employed for similar work.‖ The temperature of the bar was taken during cooling by a thermojunction; cooling curves were obtained in this way in addition to the volume-change curves. The cold alloys were examined microscopically, and their hardness determined by the Shore scleroscope and the Brinell method. The pure metals, after solidification, contracted in the mould at a uniformly decreasing rate. Most of the brasses expand on solidification, the maximum and minimum expansion corresponding respectively to the greatest and least distances of the "solidus" from the "liquidus" curve in the equilibrium diagram. There is a remarkably large expansion with the alloy containing 14·76 p.c. copper. A maximum total shrinkage, and a maximum hardness at 40 p.c. copper point to the existence of Cu_2Zn_3, supported by microscopical and other evidence.

* Trans. Amer. Brass Founders' Assoc., 1909, pp. 47–54, through Journ. Soc. Chem. Ind., xxix. (1910) p. 159.
† Journ. Inst. Metals, ii. (1909) pp. 29–57 (32 figs.).
‡ See this Journal, 1910, p. 119.
§ Journ. Inst. Metals, ii. (1909) pp. 98–150 (31 figs.).
‖ See this Journal, 1906, p. 743.

Corrosion of Bronzes.*—F. Giolitti and O. Ceccarelli have shown that the rate of corrosion of bronzes bears a relation to their microstructure. Bronzes containing less than 10 p.c. tin were annealed at different temperatures, or cooled rapidly or slowly after casting. After microscopical examination, weighed cylinders were immersed in a dilute solution of hydrochloric acid and ferric chloride for a given time, and the loss of weight determined. The conclusions reached may be briefly expressed as follows. 1. Two bronzes of the same composition, but differing in microstructure, as a result of different thermal treatment, may differ widely in their resistance to corrosion. 2. Corrosion is accelerated by the simultaneous presence of the two solid solutions α and β. 3. The velocity of corrosion increases as the difference of concentration between nucleus and edge of individual crystals is greater. Thus microscopical examination of a bronze may afford data on which to base a conclusion as to its capacity for resisting corrosion.

Zinc Amalgams.†—E. Cohen and K. Inouye have worked out a method of determining the solubility of zinc in mercury, which avoids the considerable errors resulting from previous methods. The solubility curve from 0 to 100° C. has been determined, and shows a regularly increasing solubility with rising temperature.

Copper-arsenic Alloys.‡—G. D. Bengough and B. P. Hill have studied the mechanical properties of five bars of copper containing 0·04 to 1·94 p.c. arsenic, in three states: (1) as rolled; (2) annealed in an oxidizing atmosphere; (3) annealed in a reducing atmosphere. Bars with less than 1 p.c. arsenic were injured by reducing gases at temperatures above 650° C.; the authors suggest, as a cause, the reduction of arsenious oxide with the sudden formation of gases within the metal and insoluble in it. The constitution of the copper-arsenic alloys was investigated by means of thermal and microscopical examination of thirty-six alloys containing 0·9 to 44·4 p.c. arsenic. The existence of Cu_3As and Cu_5As_2 has been confirmed; no evidence of the existence of Cu_2As was found. The authors consider that a true equilibrium diagram of the system cannot be constructed by ordinary methods, for the rates of cooling used appeared to be too rapid to allow the change in the solid to complete itself at the critical temperatures, and too slow to allow of constancy of composition. An alkaline solution of copper-ammonium chloride was used for etching some of the alloys.

Phosphor-bronze.§—O. F. Hudson and E. F. Law state the conclusions they have reached as to the constitution of the copper-tin-phosphorus alloys, illustrating them by a series of remarkably good photomicrographs. The two compounds Cu_4Sn and Cu_3P form a binary eutectic, and together with the tin-copper solid solution α give rise to a ternary eutectic containing 81 p.c. copper, 14·2 p.c. tin, 4·8 p.c. phosphorus. The experimental data on which the authors' conclusions are

* Gazz. Chim. Ital., xxxix. (1909) pp. 557–75, through Journ. Soc. Chem. Ind., xxix. (1910) p. 281.

† Zeitschr. Phys. Chem., lxxi. (1910) pp. 625–35 (2 figs.).

‡ Journ. Inst. Metals, iii. (1910) pp. 34–97 (26 figs.).

§ Tom. cit., pp. 161–86 (27 figs.).

founded are not stated. The sections for microscopical examination were finally polished with Globe polish, by hand. The best etching reagent for these, as for the majority of copper alloys, is a 10 p.c. aqueous solution of ammonium persulphate. This reagent dissolves copper and certain other metals without the evolution of gas, or the formation of a surface film. The surface, previous to etching, should be perfectly freed from grease. The most satisfactory photomicrographs are secured by using colour plates.

Zinc Bronzes.*—L. Guillet and L. Révillon give the first results of an investigation of the effect of other metals on the copper-tin alloys. In cases in which zinc was the third metal, it was observed that the δ-phase existed when the tin content was below the percentage expressing the solubility of tin in copper. The microscopical appearance resembled that of an alloy containing somewhat more tin than the amount present. The effect of the zinc may be expressed by a "coefficient of equivalence," in the same way as the effect of a third metal on the copper-zinc alloys has been expressed. The examination of six alloys containing 13·7 to 4·6 p.c. tin, 1·7 to 10·2 p.c. zinc, and about 85 p.c. copper, has shown that the "coefficient of equivalence" of zinc in bronzes is very nearly 0, the zinc going into solution in the α-phase without seriously altering the limit of solubility of tin. Results of mechanical tests of twenty-one copper-tin-zinc alloys are given.

Ternary System Iron-copper-nickel.†—R. Vogel has employed principally microscopical methods for the determination of the limits of saturation of the ternary mixed crystals occurring in this system. Specimens were submitted to long annealing to obtain equilibrium. Cooling curves of some twenty-five alloys were taken. In the triangular diagram, alloys of compositions lying outside a continuous curve passing through the limits of saturation are, if sufficiently annealed, homogeneous solid solutions.

Light Alloys.‡—W. Rosenhain reviews the progress made in the production of alloys combining great strength with a low specific gravity. Aluminium, which in the pure state is weak, may be strengthened by the addition of copper, alone or with manganese, or of zinc, or of other metals. The effect of such additions upon corrosion is discussed. Alloys of magnesium are beginning to find practical application.

Thermo-electricity of Alloys.§—E. Rudolfi has investigated the relation between constitution and thermo-electric properties of alloys. Ten representative binary systems were examined, the E.M.F. developed by each alloy against copper and against nickel being measured. One junction was kept in molten ice, the other was heated in a paraffin bath. Binary systems are classified in four groups: (1) neither compounds nor solid solutions are formed, the concentration-E.M.F. curve is a straight line; (2) the components form a continuous series of solid

* Rev. Métallurgie, vii. (1910) pp. 429–32 (2 figs.).
† Zeitschr. Anorg. Chem., lxvii. (1910) pp. 1–16 (14 figs.).
‡ Nature, lxxxiii. (1910) pp. 461–2.
§ Zeitschr. Anorg. Chem., lxvii. (1910) pp. 65–96 (12 figs.).

solutions, the curve is U-shaped ; (3) solid solutions of limited concentration are formed, the curve is modified accordingly, showing an inflection at the limit of saturation of the mixed crystals ; (4) a compound is formed, the curve having a maximum at the concentration corresponding to the compound. These rules are compared with those expressing the relation of hardness and electrical conductivity to concentration.

Nitrogen and Metals at High Temperatures.* — I. Shukow has made determinations of the dissociation pressures of metal-nitrogen alloys. The continuous increase of the dissociation pressure with nitrogen content in the case of chromium and manganese proves the alloys to be solid solutions, not compounds. With aluminium the dissociation pressure is constant for a given temperature, and independent of nitrogen content, indicating the presence of an aluminium-nitrogen compound. From these results, and from those obtained in determinations of electrical resistance of metal-nitrogen alloys, the author concludes that nitrogen forms solid solutions but no compounds with manganese, chromium, and titanium.

Effect of Silicon and Sulphur on Cast-iron.†—It is well known that sulphur tends to make cast-iron white by retaining the carbon in the combined state, and that silicon tends in the opposite direction. J. E. Stead reviews the work of previous investigators, and gives the results of a micro-chemical study of the causes of these phenomena. The three pig-irons examined, which illustrate well the effects considered, contained :—

	White	Grey glazed iron	
		No 1.	No. 2
Combined carbon	2·98 p.c.	nil	trace
Graphite	traces	2·65 p.c.	3·30 p.c.
Manganese	0·29 p.c.	0·72 ,,	0·68 ,,
Silicon	1·89 ,,	5·21 ,,	4·32 ,,
Sulphur	0·27 ,,	0·03 ,,	0·025 ,,
Phosphorus	1·62 ,,	1·56 ,,	1·66 ,,

The white iron contained no iron-iron-carbide eutectic, its place being taken by the ternary eutectic of the iron-phosphorus-carbon system. These and other alloys were submitted to various chemical treatments, to separate the carbides, and metallurgical treatments, such as remelting with additions of sulphur or of manganese, and were microscopically examined in their different states. The author concludes that carbide of iron in presence of iron-sulphide crystallizes with an amount of sulphur not exceeding about 0·1 p.c. of the weight of the

* Journ. Russ. Phys. Chem. Ges., xlii. (1910) pp. 40–55, through Journ. Soc. Chem. Ind., xxix. (1910) p. 572.

† British Assoc., 80th Rep., Sheffield, 1910. Chemical Section, President's Address, 13 pp. (9 figs.).

carbide, and that the presence of the sulphur renders the carbide stable. The effect of increasing sufficiently the percentage either of silicon or of carbon in an iron-silicon-carbon alloy containing only moderate amounts of these two elements, is to cause the formation of a carbo-silicide of iron. This carbo-silicide appears to be unstable, readily decomposes into graphite and silico-austenite, and is the cause of the greyness of high-silicon cast-iron.

Ferro-silicon.* — S. R. Bennett reports on the composition and structure of these alloys. Published work is first summarized. Determinations of the specific gravity of numerous alloys indicate the probable existence of Fe_2Si and FeSi, but do not support the existence of $FeSi_2$ or Fe_3Si_2. Several alloys were microscopically examined Up to 20 p.c. Si the alloys consist of solid solutions of Fe and Fe_2Si which are hard, firm masses giving off little or no gas. Alloys from 20 to 21·6 p.c. Si consist of primary crystals of Fe_2Si in a ground of eutectic composed of Fe_2Si and Fe Si ; these alloys begin to get more brittle than the lower grades. From 21·6 to 33·3 p.c. Si the structure shows FeSi surrounded by eutectic Fe_2Si and FeSi ; from 33·3 to 60 p.c. Si there are crystals of FeSi in eutectic FeSi + Si ; and above 60 p.c. Si crystals of Si in a field of eutectic FeSi and Si.

Influence of Antimony and Tin on the Iron-Carbon System.† P. Goerens and K. Ellingen have examined two series of ternary alloys, prepared by the addition at 1350° C. of antimony or tin to molten Swedish pig-iron containing 3·66 p.c. carbon. One series (11 alloys) contained 5·8 to 59·3 p.c. antimony ; the other (12 alloys), 0 to 11·1 p.c. tin. The carbon content in the antimony series was steadily lowered by the antimony additions, falling to 0·3 p.c. in the 59·3 p.c. alloy. The effect of tin on carbon content was in the same direction, but was comparatively slight. Cooling curves, chemical analyses, and microscopical examination were made. The two ternary systems resemble the iron-carbon-phosphorus system in that a ternary eutectic is formed on solidification. In the antimony series this eutectic solidifies at about 950° C. Neither antimony nor tin changes the pearlite-formation temperature. Three constituents were observed in each alloy—pearlite, cementite, and antimonide or stannide of iron. The pearlite is rapidly etched by picric acid and appears dark ; cementite remains white ; antimonide or stannide become light grey after long etching. Cementite may be distinguished from antimonide or stannide by heat-tinting, the cementite colouring more rapidly in each case.

Specific and Latent Heats of Molten Cast-iron.‡—W. Schmidt has determined the total heat evolved when 500 grams of pure cast-iron, containing 4·3 p.c. carbon (about the eutectic composition) cooled to 0° C. from 1375°, 1275°, 1175° and 1130° C., the last temperature being just below the solidification point. The cooling took place in a crucible within an ice calorimeter, the temperature being measured by

* Local Govt. Board Rep., 1908–9. Supplement on nature, uses, and manufacture of ferrosilicon, 1909, pp. 90–96.

† Metallurgie, vii. (1910) pp. 72–9 (10 figs.).

‡ Tom. cit., pp. 164–8 (1 fig.).

means of a thermocouple, and required 16 to 20 hours. The volume of water melted was measured and corrected. The following values were obtained:—Specific heat of molten cast-iron of eutectic composition in the ranges 1175° to 1275° C. = 0·3136; 1275° to 1375° C. = 0·3216; latent heat of solidification of 1 gram = 59 calories.

Effect of Temperature upon the Magnetic Properties of Electrolytic Iron.*—E. M. Terry has determined the magnetic properties of iron at temperatures between −190° and 785° C. Burgess electrolytic iron of remarkable purity was used, 0·07 p.c. of hydrogen and 0·012 p.c. carbon being the principal impurities present. The specimens were examined microscopically after different treatments. The author finds that ferromagnetism reappears on cooling at the same temperature (785° C.) at which it disappears on heating.

ARRIVAUT, G.—**Melting-point Diagram of the Silicon-silver Alloys.**
Procès-verbaux des séances de la Société des Sciences physiques et naturelles de Bordeaux, 1908–9, pp. 9-14 and 20 (1 fig.)
See also this Journal, 1909, p. 264.

BORNEMANN, K.—**Binary Metallic Alloys.**
[A continuation of the summary of published work. (See this Journal, 1909, p. 787.)] Metallurgie, vii. (1910) pp. 103–10 (25 figs.).

DUCELLIEZ, F.—**Chemical Study of the Cobalt-bismuth Alloys.**
[No compound is formed, and cobalt and bismuth are only miscible to a small extent in the molten state.]
Procès-verbaux des séances de la Société des Sciences physiques et naturelles de Bordeaux, 1908–9, pp. 21–4.

„ „ **Cobalt-copper Alloys.**
[No compounds were found.]
Tom. cit., pp. 120–6 (1 fig.).

„ „ **Electromotive Forces of Cobalt-bismuth Alloys.**
Tom. cit., pp. 126–9 (1 fig.).

„ „ **Cobalt-lead Alloys.** *Tom. cit.*, pp. 129–31 (1 fig.).

„ „ **Cobalt-antimony Alloys.** *Tom. cit.*, pp. 131–4 (1 fig.).

„ „ **Cobalt-tin Compounds.** *Tom. cit.*, pp. 134–6 (1 fig.).

FRIEDRICH, K.—**Technical Thermal Analysis of Metallurgical Processes.**
Metallurgie, vii. (1910) pp. 33–9.

GUILLET, L.—**Cementation.**
[The author makes some theoretical and practical observations. A mixture of wood-charcoal (60 p.c.) and barium carbonate is recommended as a cementation agent. For practical purposes a temperature of at least 850° C. is necessary.] *Rev. Métallurgie*, vii. (1910) pp. 496–500.

RENGADE, E.—**Theoretical Form of Cooling Curves of Binary Mixtures.**
[The subject is treated mathematically.] *Tom. cit.*, pp. 89–97 (5 figs.).

VIGOUROUX, E.—**Electromotive Forces of Nickel-copper Alloys.**
[No evidence of the existence of a compound was obtained.]
Procès-verbaux des séances de la Société des Sciences physiques et naturelles de Bordeaux, 1908–9, pp. 114–19 (1 fig.).

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* Physical Review, xxx. (1910) pp. 133–60 (18 figs.).

MICROSCOPY.

A. Instruments, Accessories, etc.*

(1) Stands.

Useful Microscope Device.†—R. Borrow calls attention to a device (fig. 106) by which a difficulty sometimes experienced with a short

Fig. 106.

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives: (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous. † Knowledge (1910) p. 284.

microscope-tube and an objective of long focus may be easily overcome. A small stage of vulcanite or some other material, with an aperture of about 1½-in. diameter, is attached to the top of the substage fitting. By this means an extra 2-in. of space between the objective and the object is secured.

Though the device is worth recalling it is far from new; the last recorded instance being that by Tatham in a paper read at the Quekett in 1895.*

Bacteriological Demonstration Table.†—M. Neisser gives a description of the Mikroskop-Karussel, by means of which microscopic preparations of bacteria may be demonstrated to a seated class. Twelve Microscopes are placed at equal distances from one another, upon an iron table which can revolve round a central axis. Each Microscope is placed at a suitable distance from the edge, and is provided with a separate source of light. A wooden rim, which does not move with the rest of the table, is used as a rest for the elbows of the students. Beside the teacher's seat is a lever by means of which the table may be fixed or released, and a bell, to give signal when the table is about to be moved. The demonstrator places a specimen in focus under the Microscope facing him, releases the table and turns it so that the specimen is suitably placed for examination by his right-hand neighbour, mounts another specimen and moves it on. This continues until each Microscope-stage carries an object, and the whole class is provided. The general idea is simple, but the construction of a satisfactory table requires considerable attention to detail. The chief requirement is stability, but it is also essential that there shall be no jarring in the movement or in the operation of the controlling mechanism.

(3) Illuminating and other Apparatus.

Measuring Inclination of Abbe's Drawing Apparatus.‡ — W. Georgi points out that, if the mirror of the large Abbe drawing apparatus be at its normal inclination of 45° to the vertical, only one-half of the microscopic field can be drawn. In order to bring in the whole field, it is necessary to change the inclination of the mirror. If the drawing board be not similarly adjusted, a distorted picture will be obtained. This board should make with the horizontal an angle twice as great as that which the mirror makes with its normal inclination. The author's device to simplify this adjustment is to affix scales to both drawing board and mirror.

Improvements in the Leitz Mirror Condenser.§—W. von Ignatowsky points out that the hollow space in the Leitz condenser (fig. 107) makes it necessary to construct the apparatus out of two pieces of glass cemented together. In the process of manufacture, however, it is not possible to obtain perfect precision in the application of the plane surfaces and the small irregularities therefore detract from perfect efficiency.

* Journ. Quekett Micr. Club, v. (1894–7) p. 206.
† Umschau., xiv. (1910) pp. 112–13.
‡ Zeitschr. wiss. Mikrosk., xxvii. (1910) pp. 94–114.
§ Op. cit., xxvi. (1910) pp. 387–90 (1 pl. and 3 figs.)

Fig. 108 shows a new pattern in which these defects are remedied. It will be readily seen that the surfaces of i. and ii. in contact are spherical, and these when cemented together function satisfactorily as a whole. Pl. XV. fig. 1 shows a photomicrograph of the rays issuing from the condenser. The scale of enlargement is such that the distance between

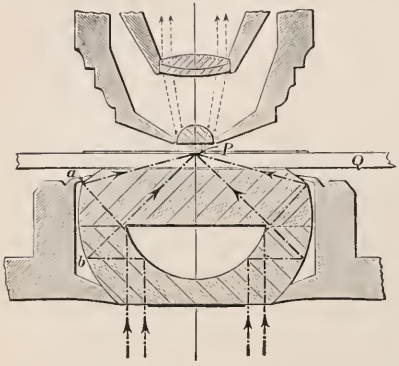


Fig. 107.

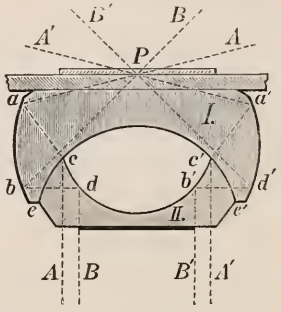


Fig. 108.

the ray-crossing and the lower edge corresponds to the thickness of the object-slide. The photograph was taken by means of a fluorescent uranium glass of corresponding refraction. The uranium glass was placed on the mirror condenser, and by means of a drop of cedar oil

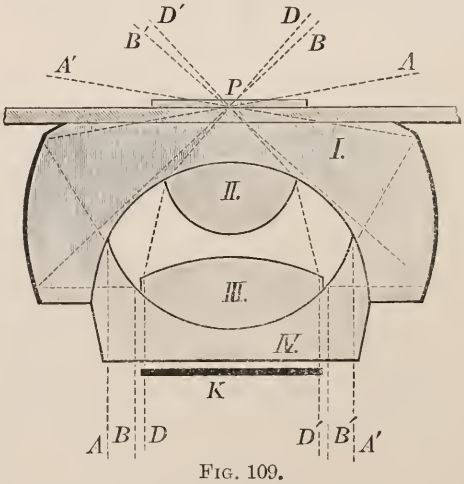


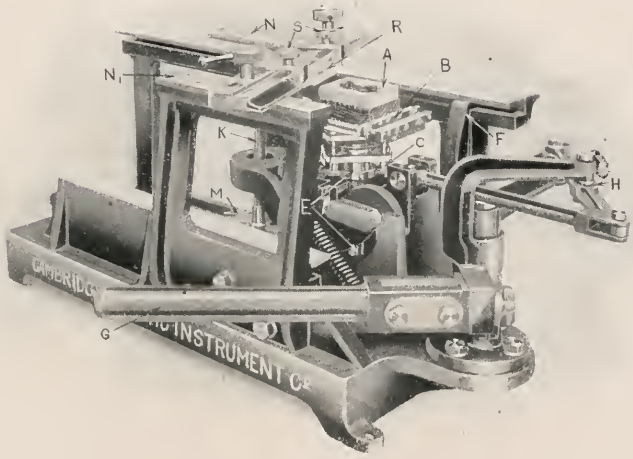
Fig. 109.

optically connected with it. The view of the rays is lateral, and they proceed from a slit, below the condenser, whose length lies in the plane of the paper.

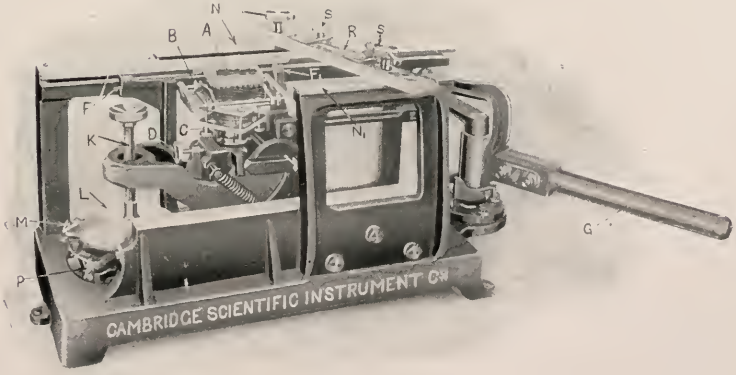
Fig. 109 represents a mirror condenser which may be used for dark-ground or for light-ground illumination. It is somewhat larger than the

1

2



3



Face p. 762]

apparatus in fig. 108, and the hollow space contains two lenses cemented to the spherical surfaces as shown. The condenser gives ordinary light-ground effects when K is swung out, and dark-ground when it is replaced.

The author emphasizes H. Siedentopf's observation that apochromatic immersion systems give much better dark-ground results than are obtained with apochromatic dry systems.

Glass and Metallic Replicas of Gratings.*—J. A. Anderson points out that replicas of gratings were first† made by Thorpe in England, and later, by Wallace and by Ives in America. The method used by Wallace and Ives is to pour upon the grating a solution of gun-cotton in amyl acetate, or some similar substance, and after this is dry to allow it to peel off under water, and then to mount it upon a piece of plane glass. One surface of the film of collodion, the one which was in immediate contact with the surface of the grating, is found to be a fairly accurate copy of the ruled surface of the grating itself, while the other one is more or less perfectly flat. The first will be spoken of simply as

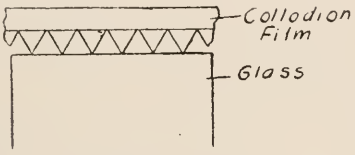


Fig. 110.

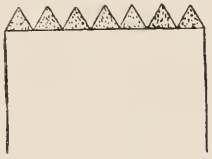


Fig. 111.

the ruled surface, or as the face. Thorpe mounted his replicas with the ruled surface up, while Wallace speaks of mounting the film either ruled surface up or down, preference being given to the latter. It is believed that Ives mounts all of his ruled surface down in contact with the glass. When a replica is mounted face up, it may be transformed into a metallic reflection grating by simply coating it with platinum, by means of cathode disintegration in a vacuum, as has been lately described by E. Gehrke and C. Leithäuser. As a rule, however, this surface is, perhaps, never quite plane owing to the unavoidable differences in the thickness of the film in different places. The author thinks that gratings made in this way will never perform very well when subject to a really severe test. The author, being fortunate enough to have at his disposal a very large number of Rowland gratings, has endeavoured to ascertain "How perfect is it possible to make a replica?"—or, what amounts to the same thing, "How nearly will the resolving power of a replica equal that of the grating from which it was made?" It was found that difficulties arose from the drying of the film, as it had a tendency to shrink. This difficulty increased with the size of the grating. The author found, however, that by mechanically stretching the replica wherever it required it, he was able with practice to correct

* Johns Hopkins Univ. Circular, No. 2 (1910) pp. 19–23 (2 figs.).

† Replicas of gratings in collodion were first made more than half a century ago by the Rev. W. Hodgson.—[Ed. Journ. R.M.S.]

within a small fraction of a fringe, which of course corresponded to the same small fraction of the grating space in the replica itself. A replica corrected in this manner gives the same resolving power as the grating from which it was made within a very few per cent., provided the glass on which it is mounted is optically perfect. In order to transform one of these replicas into a metal grating it is necessary to find a substance which will fill up the grooves (fig. 110) between the replica and the glass surface after the replica has been corrected and dried, and which will adhere to the glass sufficiently to allow the replica to be stripped off. The result will then be similar to fig. 111. This is evidently a fair copy of the grating from which the replica was made. It was accidentally found that certain gums dissolved in the collodion solution will, on gently heating the glass plate upon which the corrected replica is placed, slowly ooze out, filling up the grooves as indicated, and on cooling will harden, and allow the replica to be stripped off. The resulting grating (fig. 111) may now be treated in one of the two following ways:—(1) It may be covered by a thin film of platinum, nickel, or other suitable metal in a vacuum, which coating may be improved by subsequent electroplating, thus producing a durable metallic grating having a perfect optical surface. (2) It may be treated with hydrofluoric acid gas, thus transforming it into a glass or quartz transmission grating with an equally good optical surface, as the gum used is not affected by the acid, while the glass or quartz between the ridges is rapidly attacked. The method is equally applicable to concave gratings. The author has a number of plane platinum, nickel and gold gratings made by the above process, which perform admirably, as well as a number of glass ones made by the hydrofluoric acid process.

Use of the Grating in Interferometry.*—C. Barns points out that, on replacing the symmetrically oblique transparent mirror in Michelson's adjustment by a glass grating, it is possible with ordinary plate glass and a non-silvered grating to produce interferences between pairs of diffracted spectra, if returned by nearly equidistant mirrors to a telescope in the line D. Both of these spectra are very brilliant, and not very unequally so, and the coincidence of spectrum lines, both horizontally and vertically, brings out the phenomenon. This phenomenon is of the ring type, but it occupies the whole field of the spectrum from red to violet. Brilliant large confocal ellipses with horizontal and vertical symmetry are obtained, and the spectrum lines, simultaneously in focus, may serve either as major or minor axes. Their interferometer motion is twofold in character, consisting of radial motion combined with a drift of the figure as a whole in a horizontal direction. Naturally, a fine slit is of advantage, but the experiment succeeds with a wide slit, especially in the red, even after spectrum lines vanish.

Dark-ground Illumination with High Powers.†—R. F. Jones remarks that, "The ability to see living bacteria without the tedious process of preparation and staining, by the use of one of the many dark-ground illuminators that are now obtainable, has to a large extent revived interest

* Amer. Journ Sci., xxx. (1910) pp. 161–71 (2 figs.).
† Knowledge (1910) p. 284.

in microscopy amongst those who deal with such subjects. It is not generally known, however, that a similar effect can be obtained by the means usually at the disposal of the average microscopist. The author has devised a plan whereby the ordinary Abbe illuminator, if suitably arranged, will do all that is required. There are certain essentials, however, and the first of these is that there must be some centring and focusing arrangements for the condenser. This remark holds good with regard to the new dark-ground illuminators; and, in fact, the necessity is becoming intensively obvious with the advance of microscopical technique. The time will come when every worker will recognize that a centring arrangement to his condenser is of vital importance. The first necessity for the condenser, then, is that a centring arrangement must be provided, for the success or failure of the whole attempt is dependent upon accurate centring. A black-patch stop will be used beneath the condenser lenses, and this again must be properly centred. The best way to ensure this is to have a number of disks cut in metal or black paper and fix them to glass disks cut to the size of the stop-carrier of the condenser. The black patch is moved until it is in the right position, and then allowed to dry. The size of the black patch can be ascertained by experiment. It will vary in each case with the numerical aperture of the objective and the condenser.

The detail in bacteria is not such as calls for a large numerical aperture in the objective, and the high magnification that is necessary to disclose the contour can be used, while the numerical aperature of the objective can be reduced by a diaphragm at the back. This is the rule that should be followed when using the Abbe illuminator as here described. It is necessary to use, as nearly as possible, a spot of light as the source of illumination. An incandescent gas lamp with a diaphragm in front is probably the best. To test the centring of the whole system the aerial image of the dark-patch stop should be focused when the condenser is in position, and as the condenser is moved downwards out of focus the spot should gradually become reduced in size, maintaining its centre if set axially."

GAIDUKOV, N.—**Dunkelfeldbeleuchtung und Ultramikroskopie in der Biologie und in der Medizin.**
Jena: G. Fischer (1910) 84 pp. (3 photos., 2 chromolithogr. pls., and 13 figs. in text.

GAMBERA, M.—**Fortschritte auf dem Gebiete mikroskopischer Hilfsapparate im Jahre 1909.**
Bamberg: C. C. Buchner's Verlag, 1910 (9 figs.).
See also *Jahrb. Mikrosk. Jahrg.*, i. (1909).

(4 Photomicrography.

Printing on Sensitized Papers.*—H. Wunderer describes his method of using gas-light photographic papers for the reproduction of diagrams. The diagram is put in a frame with the sensitized paper so that the picture is in contact with the prepared surface. The light travels through the glass plate to the back of the diagram paper, then passes through the paper and through the diagram to the sensitive surface of the paper. The average exposure time is about five seconds. In Breuer's process,

* Zeitschr. wiss. Mikrosk., xxvii. (1910) pp. 50-1.

of which this is a modification, the papers are reversed, so that the light travels through the sensitized paper from the back, and is then reflected back from the diagram to the prepared surface. This latter method is only of use when the diagram shows sharp contrasts, but on the other hand it is of use in cases where Wunderer's method is inapplicable, namely, when the diagram paper is very opaque, and when it bears print or other marks upon the reverse side.

Photography with Ultra-violet Light.*—V. Franz makes use of this method for the study of histological details in the ova of fishes. He considers that by this means it is possible to analyse structures which are beyond the limits of investigation by ordinary microscopic methods. The particular investigation quoted in this contribution shows that the chromophile granules in the plasma of these cells really form part of a network.

Köhler, A.—**Aufnahmen von Diatomeen mit ultravioletten Licht.** *Jahrb. f. Photogr. u. Reprodukt.*, 1909.

Reicher, K.—**Mikrokinematographische Aufnahmen bei Dunkelfeldbeleuchtung am Makrokinematographie.** *Berliner klin. Wochenschr.*, xlvii. (1910) pp. 484–6.

(5) Microscopical Optics and Manipulation.

Additional Refractive Indices of Quartz, Vitreous Silica, Calcite and Fluorite.†—At the suggestion of T. Martin Lowry, J. W. Gifford has increased his previous lists‡ of refractive indices for twenty-six wave-lengths by determining those of seven additional ones. These seven rays are of more recent importance, and several of them, especially those in the spectrum of mercury, promise from their extreme brilliance to be of more than usual value. The method of measurement employed and the instruments used were the same as in the previous experiments. The author gives a table of his numerical results, the wave-lengths examined being 6708 Li, 6438 Cd, 5461 Hg, 5086 Cd, 4800 Cd, 4359 Hg, and 4046 Hg.

Measurements of the Absolute Indices of Refraction in Strained Glass.§—L. N. G. Filon has continued his researches on the above subject, and has applied the method which he first described some three years ago.‖ The method involves measurement of the deviation of a ray of light passing through a slab of glass under flexure. If a slab or beam of glass of rectangular cross-section be bent in a vertical plane under a bending moment M, and if a plane-wave be transmitted through the glass in a direction perpendicular to the plane of flexure, the light is broken up into two components, one polarized horizontally (i.e. perpendicular to the cross-section and along the line of stress), and the other vertically. The variation in the index of refraction of the

* Zeitschr. wiss. Mikrosk. xxvii. (1910) pp. 41–3.
† Proc. Roy. Soc., A. lxxxiv. (1910) p. 193.
‡ Op. cit., Feb. 13, 1902, and March 3, 1904.
§ Op. cit., lxxxiii. (1910) pp. 572–9 (4 figs.).
‖ Op. cit., lxxix. pp. 440–2.

glass, due to the stress, produces in the vertically polarized ray an upwards deflection, $\theta_1 = \frac{C_1 M t}{I}$ radians, and in the horizontally polarized ray a deflection, $\theta_2 = \frac{C_2 M t}{I}$ radians, where t is the thickness of the glass, I the second moment of area of the cross-section about the "neutral axis," and C_1 and C_2 are the stress-optical co-efficients for the vertically and horizontally polarized rays respectively; the stress-optical co-efficient for any ray being the increase in the index of refraction for unit tension, or, what is equivalent, the additional retardation introduced per unit thickness per unit tension. In the above, M is reckoned positive when the slab is bent concave downwards. The author gives full details of his apparatus and of his numerical results.

Southall's Principles and Methods of Geometrical Optics.*—In this work of 626 pages, James P. C. Southall has compiled for the English-speaking student a treatise based largely upon the most recent writings of German investigators. He expressly acknowledges his obligations to Czapski's epoch-making book, Die Theorie der Optischen Instrumente nach Abbe, and to M. von Rohr's Die Theorie der Optischen Instrumente, i. (Berlin, 1904). References to many of the most important contributions to optical literature, French and English, as well as German, of the last fifteen years are freely made. The older writers are also frequently quoted. The author does not hesitate to demonstrate his theorems by the help of modern geometry. Thus in Chapter V. (Reflexion and refraction of paraxial rays at a spherical surface) and Chapter VII. (Geometrical theory of optical images) he makes great use of the properties of harmonic ranges and of conjugate planes. In Chapter XII. he deals with Seidel's extension of Gauss's methods, whereby the inclusion of terms of a higher order in the series-developments made it possible to derive certain elegant and entirely general formulæ in a simple way. These formulæ enable one to perceive almost at a glance how the faults in an image formed by a centred system of spherical refracting surfaces are due partly to the size of the aperture, and partly also to the extent of the field of view. Prism-spectra and the chromatic aberrations of dioptric systems are included under the head of "Colour phenomena" in Chapter XIII.

The work is a very valuable contribution to the study of optics, and should do a great deal to bring an English reader abreast of the latest continental developments.

(6) Miscellaneous.

Method for Testing Screws.†—J. A. Anderson shows how a screw may be tested quite independently of the divided head or end bearings. Consider a screw whose error is a simple periodic one, so that the relation between the distance x advanced by a perfectly fitting nut and the angular rotation θ of the screw is $x = c\theta + b \sin \theta$, where c and b are

* Macmillan Co., Ltd., London and New York, 1910.

† Johns Hopkins Univ. Circular, No. 2 (1910) pp. 14–19 (1 pl.).

constant. If now the screw be rotated with constant angular velocity the velocity of the nut is given by

$$\frac{dx}{dt} = c\frac{d\theta}{dt} + b\cos\theta\frac{d\theta}{dt}$$

or, if k denote the constant

$$\frac{d\theta}{dt}$$

then

$$\frac{dx}{dt} = ck + bk\cos\theta$$

i.e. the velocity of the nut is a maximum when $\theta = 0, 2\pi, 4\pi$, etc. and a minimum when $\theta = \pi, 3\pi, 5\pi$, etc. Let this nut be cut into two parts by a section perpendicular to its axis, and let one of the two nuts so formed be turned through the angle π, say. If now the two nuts be kept from rotating with reference to each other and the screw be rotated with a constant angular velocity as before, the maximum velocity of one nut will take place at the same time that the other nut has its minimum velocity, and hence the motion of one nut with reference to the other will be a to-and-fro motion given by $D = 2b\sin\theta + C$, where D is the distance between the two nuts. This is independent of

$$\frac{d\theta}{dt}$$

and hence the screw may be turned by hand and with any angular velocity, and as D is simply the distance from one nut to the other, which is unaffected by any longitudinal displacement of the screw, it is evident that we are entirely independent of errors in end bearings or divided head. All we need to do, therefore, is to measure D, or rather the variation in D, as the screw is rotated, which can be done by mounting one plate of a Fabry and Perot interferometer on one nut and the other on the second nut, and observe the motion of the fringes when the screw is rotated. The method is very sensitive. The maximum shift of one plate of the interferometer with reference to the other is $4b$, and if we measure to $\frac{1}{10}$ of a fringe of green mercury light the smallest measureable value of D will be $\frac{1}{1000000}$ of an inch, i.e. $b = \frac{1}{4000000}$ of an inch, and this ought to be easily measurable. A much smaller error should be easily detected.

The author also discusses Rowlands' method of "cross-ruling." The method consists in ruling a large number of lines and then turning (through a small angle) the plate upon which the ruling was done, and again ruling the same number of lines so as to be able to observe the loci of the intersections of the two sets of lines. If the error is a simple periodic one the locus of intersection will simply be a sine curve. The author gives a photograph showing cross-rulings with different adjustments of the parts of the 15,000 machine.

Micro-chemical Tests for Identification of Varieties of Glass.* F. Mylius and E. Groschuff give the following scheme for identification of glasses by chemical tests :—

1. Roughly scratch with a file an area on the glass of a few square

* Deutsche Mech. Zeit., v. (1910) pp. 41–5.

millimetres; treat the spot with a drop of etherial iodeosine solution, and then wash with a drop of ether. A reddish tint shows a basic glass in contra-distinction to quartz glass, which remains colourless.

2. Apply a drop of 10 p.c. fluoric acid on the glass. Immediate opacity shows glass rich in earthy or heavy oxides (calcium, barium, lead, zinc, etc.); glasses poor in metal give no opacity.

3. Moisten the end of a platinum wire with the reaction product of No. 2, and carefully bring it into the Bunsen flame. A transient green illumination shows boric acid with certainty; yellow shows sodium. Fairly large quantities of potassium are at the same time recognized by the violet tint transmitted through a cobalt-blue glass held in front of the eye, but better by the characteristic line in the red of a pocket spectroscope.

4. Apply a drop of dilute sulphuric acid to the reaction product of No. 2. A black coloration shows lead (flint-glass), in contrast with leadless glasses which remain colourless. Antimony gives the well-known orange precipitate.

Further investigation on the metallic constituents of glass is performed in vessels. For this purpose reaction No. 2 is repeated, but five minutes are allowed for development. The reaction product is rinsed with 3 c.cm. of water in a porcelain or platinum cruciple, and mixed with just so much (about 0·1 grm.) sodium-bicarbonate that after the effervescence a small residue is left. This is heated for about two minutes, until it coagulates. The completeness of the process is attained when a drop of the alkaline fluid does not decompose methyl-blue solution; should this happen, the heating is to be continued. After the heating, decant, wash the precipitate 3 times with 3–5 c.cm. water, and having treated it in the crucible with 10 drops of dilute hydrochloric acid, reduce it in a steam oven at 100° C. to dryness. The small residue is treated with 3 c.cm. of water, to which 2 drops of dilute hydrochloric acid have been added. The undissolved portion is the silicic acid of the glass, and this must be filtered off. The filtrate is a chloride solution: it must be freed, if necessary, by sulphuric acid from lead (or antimony) in order to be available for further investigations.

5. Place the solution in a test-tube, acidify with a drop of dilute sulphuric acid, and boil up. A heavy white solution is barium.

6. Treat the solution, filtered if necessary, from No. 5 with a drop of potassium ferrocyanide solution. A white slimy precipitate is zinc; if the precipitate is bluish, there is a trace of iron.

7. Treat the solution (filtered if necessary) from No. 6 with 3 drops of ammonia solution, and heat to boiling. A white flocculent precipitate gives aluminium.

8. Treat the solution (filtered if necessary) from No. 7 with 1 drop of dilute oxalic acid, and warm slowly. A white opacity after 2 minutes shows calcium.

9. Treat the solution (filtered if necessary) from No. 8 with 2 drops of sodium phosphate solution. A slowly formed granular precipitate shows magnesium.

The author has, in another article,* studied the decomposability of

* Deutsche Mech. Zeit. (1908) p. 1.

glass under the influence of moist air. He has found this to be easily measurable, and the following table is a classification (by metals, not by oxides) of some important varieties.

Applicability for	Chemical Class	Description	Relative Decomposability
Thermometers; chemical purposes	Sodium-aluminium-boro-silicate	Jena, No. 59iii	3
Optical crown-glass	Ditto	Jena, No. 3917	3
Ditto	Potassium-barium-zinc-boro-silica	Jena, No. 4556	5
Optical flint-glass	Potassium-sodium-lead silicate	Jena, No. 4113	5
Ditto	Potassium-barium-zinc-lead-silicate	Jena, No. 4531	5
Chemical purposes	Sodium-calcium-zinc-boro-silicate	Stutzerbach "Resistance-glass"	8
Plate-glass	Sodium-calcium-silicate	"Rheinish mirror-glass."	20
		Refractive Index	
Optical glass	Sodium-barium-zinc-boro-silicate	$n = 1.518$	60
Ditto	Sodium-aluminium boro-silicate	$n = 1{\cdot}464$	600
Ditto	Ditto	$n = 1{\cdot}461$	1800

Ultramicroscopic Examination of Colours of Textile Fibres.*—J. Schneider and J. Sourek, in continuing the investigations of Schneiden and Kunzl upon the above subject, endeavoured to approach their task from two points of view. 1. From the theoretical standpoint—with the object of discovering whether distinctive appearances could not be found with regard to regular pigment deposits in the case of direct colouring of cocoon silk. 2. From the practical standpoint—with the object of establishing the applicability and trustworthiness of the ultramicroscope in the testing of textile fibre pigments, with the hope of giving a very simple introduction to this testing.

In the case of the first it was hoped that by the use of polarized light distinctive rotations of the plane of polarization might be definitely connected with certain conditions of silk-coloration. The results were, however, unsatisfactory.

In the case of the second point of view, uniformly broad strands of silk from the middle part of the cocoon could be usefully examined. If these furnished only small portions of an absorption spectrum it was found that the colours in the two crossed-nicol positions were complementary. Thus this method of examination might be useful when

* Zeitschr. wiss. Mikr., xxvii. (1910) pp. 219–26.

other methods failed or were, for any reason, not available. The method is, however, complicated by the necessity of paying attention to colour-intensity, fibre-thickness, and orientation. Even in comparison with samples these considerations must be observed. The authors give a long list of their results, their colour-names being made to correspond with those used in G. Schultz' "Tabellarischen Übersicht der im Handel befindlichen Künstlichen organischen Farbstoffe" (Berlin, 1902).

Examination in Microscopy.*—Examination questions upon almost every subject are now in vogue; then why not upon Microscopy? Here are two with which to begin :—

1. With a Ross 4 in. (actually a $2\frac{3}{4}$ of ·085 N.A.) resolve Grayson's 10,000 band, using artificial light from a paraffin lamp with a $\frac{1}{2}$ in. wick.

2. With the same illumination and a Zeiss *aa*, resolve Grayson's 20,000 band.

A light-filter may be used in answering both these questions, and the time allowed for this paper is one week.

Resolutions with low powers sound charmingly simple; but these two resolutions will not be accomplished by anyone who is not well up in microscopy. Those who do not wish to go in for the paper may do worse than occupy some of the coming winter evenings in trying to solve these questions, for facility in microscopical manipulation, as in everything else, can only be acquired by practice.—E. M. Nelson.

Quekett Microscopical Club.—The 468th Ordinary Meeting was held on October 25, at 20 Hanover Square, W., the President, Professor E. A. Minchin, M.A. F.Z.S., in the chair. A paper on "Some New African Species of *Volvox*," by Professor G. S. West, M.A., D.Sc., F.L.S., was read by Mr. C. F. Rousselet, F.R.M.S. The first of the new species, *Volvox Rousseleti* sp. n., was collected by Mr. C. F. Rousselet from a pool near Gwaai station in Rhodesia in 1905. The diagnostic features of this new species are, the enormous number of the cells, from about 25,000 to more than 50,000, constituting the colony, and the density of their arrangement. *V. africanus* sp. n. was obtained by Mr. R. T. Leiper from the Albert Nyanza in 1907. The form is close to *V. aureus*, but differs in the form of the vegetative (asexual) colonies, in the great development and compression of the daughter-colonies before they are set free, and in the fact that three, and often four, generations of colonies always appear to be well marked. A paper on "Two New Species of *Cassidulina*," contributed by Mr. H. Sidebottom, was read by Mr. A. Earland. These are *Cassidulina elegans* sp. n. and *C. decorata* sp. n. Both forms were obtained from H.M.S. 'Waterwitch,' South-west Pacific, station 159, and the second form also at station 256. Mr. C. D. Soar, F.R.M.S., read "A Contribution to the List of Hydrachnidæ found in the East African Lakes." The contents of three tubes had been examined. These had been collected from Victoria Nyanza, Tanganyika, and Nyassa respectively. From the Victoria Nyanza tube only one species was identified, *Unionicula figuralis* Koch. From Lake Tanganyika six forms were

* English Mechanic, xcii. (1910) p. 297.

noted, of which three are new to science: these are *Neumannia papillosa* sp. n., *Mideopsis minuta* sp. n., and *Hygrobates edentipalpis* sp. n. The Lake Nyassa tube only yielded one species, but this is another new one, *Unionicula Cunningtoni* sp. n., very close to *U. figuralis*. The paper includes a list of the seventeen species of Hydrachnids now recorded from the East African lakes. All the new species referred to at this meeting are fully described and figured in the November issue of the Journal of the Quekett Microscopical Club. Mr. A. C. Banfield exhibited living specimens of *Cristatella mucedo* abnormally hatched from statoblasts. The usual time of appearance is about the end of February and beginning of March.

Katalog der Kollektivausstellung der deutschen Präzisionsmechanik und Optik auf der Weltausstellung in Brüssel, 1910.

Deutsche Mechan.-Zeitg., 1910, Heft 12, p. 117.

B. Technique.*

(1) Collecting Objects, including Culture Processes.

'Michael Sars' North Atlantic Deep-sea Expedition, 1910.†—Johan Hjort gives an interesting description of the voyage of the 'Michael Sars,' lent by the Norwegian Government, the expenses of the expedition being defrayed by Sir John Murray. The expedition left Bergen at the end of March 1910, picked up Murray at Plymouth, and then followed the coasts of Europe and Africa down to Cape Bogador, carrying out special investigations in the Bay of Biscay, Bay of Cadiz, and the waters between the Canary Islands and Africa. It then proceeded to the Sargasso sea, and after touching at the Azores it went across the Atlantic to St. John's, Newfoundland. From there it crossed to Ireland, and finally investigated the waters between Scotland and Rockall, and between Scotland and the Faroes, so as to study the influence exerted by the Atlantic Ocean on the Norwegian sea.

Only a sketch of the doings is given, but the preliminary description is full of facts and interest. After alluding to the results of the hydrographical investigations the writer describes the methods of obtaining phytoplankton. Vertical hauls were made at various depths with a fine-meshed Nansen closing-net, the object being to collect material for studying the vertical and horizontal distribution of peridinæ and diatoms in the Atlantic Ocean. A considerable part of the work was directed towards the study of those organisms which pass through the finest silk net; these were collected partly by filtering sea-water through sand filters, and partly by centrifuging. In these ways a large number of new forms were obtained.

For catching zooplankton a vertical closing-net, 1 m. in diameter, made of coarse silk, was used. For reasons given, this was superseded by large nets of 3·25 m. in diameter, made partly of coarser silk and partly of prawn-net, arranged on the principle of Nansen's closing-net.

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

† Nature, lxxxv. (1910) pp. 52–5 (5 figs.).

Though fairly successful, several difficulties arose, but these were surmounted. The chief object was to obtain simultaneous hauls at various depths, and it was found difficult to prevent the long wire-rope from twisting. The difficulty was solved by an arrangement by which a shackle, to which the appliance is fastened, moves freely round the wire. By this means it became possible to have no fewer than ten appliances out simultaneously from two wires.

The material obtained was very large, and quite a number of pelagic deep-sea fish not previously described was discovered. A large trawl was also used; this made twenty hauls. The results were successful, but do not appear to include any new discoveries.

Studying the Relation between Light and Pigment Formation in Crenilabras and Hippolyte.*—The vessels used by F. W. Gamble consisted of large bell-jars, supplied with an air or water current, or stirred by a glass plunger. Seasoned vessels, as well as sterilized ones, were used; filtered "outside" and tank-water were respectively employed; diatoms and algæ were used as food. The vessels were shaded, exposed to diffuse light, and kept in darkness; the backgrounds were translucent, absorbing and reflecting; the incident light used was monochromatic (red and green) as well as white light. The temperature was kept down to 16° C. by a water-jacket, and in other cases allowed to rise to 18° C. or over, but in spite of all these variations the larvæ survived only about ten days. The monochromatic screens used in the case of larvæ consisted of selected pieces of coloured glass (ruby or green) combined with coloured gelatin films. These were placed over the inverted bell-jars, the sides of which were converted into absorbing or reflecting backgrounds. A continuous air-current was led into the water, and the covered screen was cut so that its halves embraced the air tube, which was blackened at this point. The junctions of the screen with the bell-jars consisted of black velveteen, so as to cut out any oblique white rays, but it was found that great care is needed to avoid liquefaction of the gelatin films. In order to observe the prolonged effect of monochromatic light, and to obviate the dominant influence of the background, fluid screens were constructed. To insure a fairly strong light, the screen was made of one cell only. A double glass vessel, consisting of two beakers, or of two large cuvettes, the inner one standing on glass supports, so that its rim just cleared that of the outer vessel, was employed. The inner vessel was then provided with young transparent *Hippolyte* in filtered water, and finely divided Ceramium was used as food. The space between the two was then filled with the colour filter, until the level exceeded that of the water in the inner vessel, the top inch or so of which was rendered opaque. A cover of glass, or of glass and gelatin, was placed over the double vessel, and the whole was then transferred to a shallow aquarium in a strong light. In one case a circulation of tank water was maintained in the inner vessel. The main point of the apparatus is to provide a means of flooding the animals with transmitted coloured light, and thus largely to avoid the effect of light reflected from an absorbent or deflecting back-

* Quart. Journ. Micr. Sci., lv. (1910) pp. 553–5.

ground. The surfaces on which the vessels stood were either slate or dull white brick, but there was always a layer of the fluid some 2 cm. thick between the bottoms as well as between the sides of the two vessels. The coloured solutions employed consisted of the following: for red, a strong solution of erythrosin in distilled water, the strength being increased until a 2 cm. layer cuts out all the orange. Weak lithium carmine solution in a 2 mm. layer was also used. For green, a 60 p.c. solution of copper chloride with a trace ($\frac{1}{20}$ vol. used) of 6 p.c. potassium chromate gave a good result in 1·5 and 2 cm. thickness. For blue, ammoniacal solution of copper sulphate was used, a strong ammonia being added to a concentrated solution until the precipitate thrown down could be filtered off; this screen, owing to the ammonia fumes, is very toxic. The light employed was direct, or direct and diffuse, daylight. In the former case the vessels stood for more than half their depth in a tank placed on the south side of Plymouth laboratory.

Studying the Development of Aplysia punctata.*—A. M. C. Saunders and Margaret Poole obtained *Aplysia punctata* in large numbers until the middle of June. There was no difficulty in keeping them in the aquarium, and they laid eggs in great quantities. Early in the summer the eggs were attacked at times by bacteria, and later in the year by algæ. The rate of development was found to vary with the temperature of the water. In April, about fifteen days elapsed between the deposition of the eggs and the emergence of the free-swimming larvæ. The authors failed to rear the larvæ beyond the free-swimming stage.

Cultivation of Meningococci.†—The examination of fluid from a lumbar puncture for meningococci is a simple process when the organisms are numerous, but in many cases, when they are scarce, the ordinary methods of cultivation upon ascitic or hydrocele agar give negative results. R. Bruynoghe recommends instead the use of the spinal fluid itself. This is added in definite quantities to broth-tubes, and after a few hours incubation a definite pellicle makes its appearance, consisting of meningococci in pure culture. In cases of mixed infection or contamination this method will not be successful. If the fluid be very purulent the fluid is allowed to settle, and the upper clearer fluid is inoculated as above into broth-tubes. Comparative investigations show that this method gives much better results than that which involves the use of ascitic agar.

(2) Preparing Objects.

Automatic Fixing and Imbedding Apparatus.‡—G. Arndt describes a machine (figs. 112–114), the use of which would save a considerable amount of tiresome manipulation in pathological laboratories. It receives portions of fresh tissue, and after due time returns them imbedded in paraffin, ready for cutting. The apparatus consists of three principal parts, a thermostat, a cover *e* carrying a metal cage *k o* and a clock, which controls the automatic mechanism by means of electrical contacts. The inner casing of the thermostat carries a circular series of

* Quart. Journ. Micr. Sci., lv. (1910) pp. 498–9.
† Centralbl. Bakt., 1te Abt. Orig., lvi. (1910) pp. 92–4.
‡ Muench. Med. Wochenschr., lvi. (1909) pp. 2226–7.

eight copper vessels, containing, say, formalin, rising alcohols, clearing fluid, and paraffin. The material to be prepared is placed in the cage *ko*, and the cover *e* is lowered (as in fig. 112) so that the cage and its contents are immersed in the formalin bath. The contact makers around the margin of the clock are set so as to control the length of stay in each

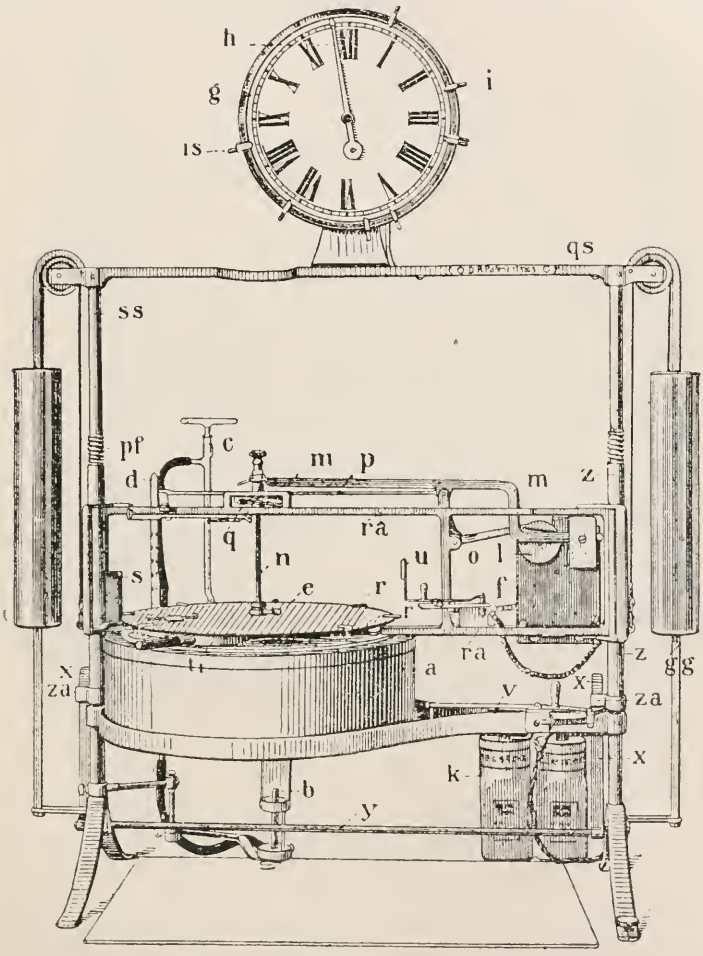


Fig. 112.

bath. When the hand reaches the first stop, a contact is made; this sets in motion a mechanism which raises the carrier and turns it through one-eighth of a circle so that the cage comes to rest above the next bath. This position is shown in fig. 113. After a moment the contact is again broken and the cover again descends. Thus each time the clock-hand reaches a stop, the tissue is transferred to the next bath,

until finally it reaches the paraffin. When the last stop *is* is reached, a special contact is made, which causes the clutches x_1 x_1 to be released. The counterpoises *g g* then descend along their guides, and the whole inner casing, with its ring of copper vessels, is raised out of the thermostat. This position is shown in fig. 114. In this position the paraffin cools and solidifies. The block is now ready for the microtome.

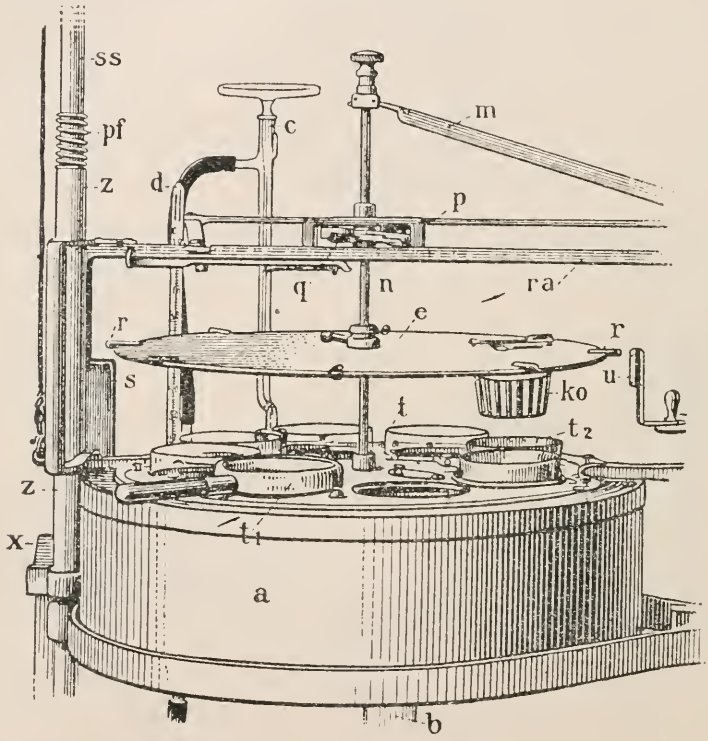


Fig. 113.

Preparation and Staining of Neuroglia.*—H. von Fieandt employs the following method. Small portions of tissue, not larger than 2 c.mm., are taken from the fresh brain and fixed in Heidenhain's sublimate trichloracetic fluid for 24 hours. They are then treated in 96 p.c. alcohol for a week, and in absolute alcohol for two days, the alcohols being changed twice a day. The material is now placed in cedar-wood oil for 24 hours, and then, after a further 24 hours in ligroin, is transferred to a ligroin-paraffin mixture, and finally imbedded in paraffin (melting-point 52°C.). After cutting, the sections are fixed to the slide by the Japanese method, freed from paraffin, washed in alcohol, and then treated for an hour with alcoholic iodine. The preparations are then freed from iodine with sodium thiosulphate, washed in distilled water and stained

* Arch. Mikr. Anat. u. Ent., lxxvi. (1910) pp. 137–41.

with Mallory's hæmatoxylin phospho-tungstic acid solution for 12 to 24 hours. Then, after treatment for an hour with alcoholic ferric chloride, the slide is washed with distilled water, and soaked in absolute alcohol in order to remove the last traces of iron. The differentiating effects of ferric chloride can be controlled by microscopic examination, the reagent

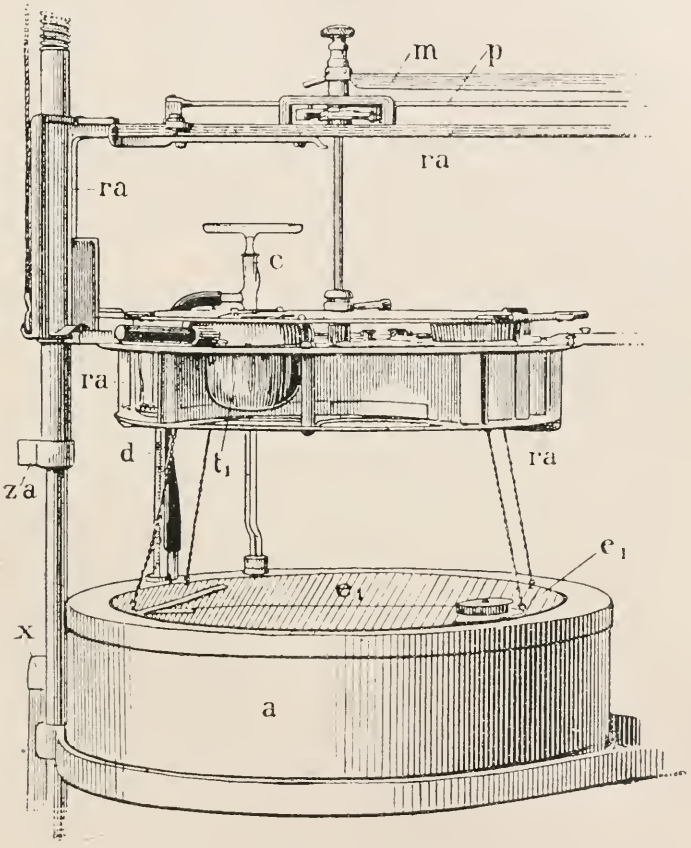


Fig. 114.

being washed off when the process has gone far enough. After 24 hours in absolute alcohol, the sections may be cleared and mounted. The glia fibres are stained deep blue, axis cylinders greyish yellow, elastin yellowish brown, glia protoplasm light blue, and erythrocytes a dirty yellowish grey.

(3) Cutting, including Imbedding and Microtomes.

Theory and Practice of Sharpening Razors.*—C. Fnnck considers in some detail the conditions of razor edges, their imperfections and the

* Zeitschr. Wiss. Mikrosk., xxvii. (1910) pp. 75–91.

methods of sharpening them. Under the first heading he describes the bevels and the effects of notches and striæ upon the sections cut. The fluting and opacity of the free portion of paraffin sections illustrates the effect of these striæ; with a perfect edge the paraffin should cut quite clear. Under the second heading he considers the materials used for sharpening razors, and emphasizes the necessity of using fine impalpable powders of uniformly sized grains. The uniformity of these grains is secured by making timed suspensions in water. He recommends the use of alumina. Finally, he describes apparatus in which the manual labour is replaced by water-driven or electrically-driven sharpening machines.

Large Sliding Microtome.*—The Cambridge Scientific Instrument Company has recently designed a large microtome (Pl. XV. figs. 2, 3) for cutting flat sections up to 150 × 120 mm. (6″ × 4¾″). It is capable of cutting through decalcified bone or cartilage, and is being found extremely useful for cutting sections which are too large to be cut with either of the makers' two rocking microtomes.

The object, embedded in a block A of paraffin wax or celloidin, is fixed to the wood block which is clamped in the object-holder B. This object-holder is fitted with orientating adjustments very similar to those used in the makers' rocking microtomes; being mounted in a cup-shaped socket at the end of a brass pillar E. This pillar can be raised or lowered and clamped at any height by the clamping screw D. The orientating adjustments are made by four screws, one of which is lettered C.

The sliding carriage, which supports the object-holder and feeding mechanism, rests at three points on two guides in the frame of the instrument. The whole carriage can be moved backwards and forwards on these guides by means of the handle G, working through the levers H. The design is such that all wear is automatically compensated for. After the cutting stroke, and when the carriage has nearly reached the extreme position as in fig. 1, a stop-pin, operating through the ratchet M, turns the toothed wheel L and screw K, so feeding the object-holder upwards. The amount of the feed is regulated and indicated by the index P. On the return stroke the mechanism causes that part of the sliding carriage which holds the object-holder to drop just before it reaches the knife R, in order to avoid fouling the same, and to rise after passing the knife to its former position in preparation for the next cutting stroke.

The construction of the sliding carriage is such as to convert the feed into a parallel motion, and so give sections of a uniform thickness; and, further, since the carriage slides on plane guides, the sections are also from a plane surface. The knife R is clamped in two heavy brass clamps by the screws SS. The position of these clamps can be moved so as to set the knife obliquely to the direction of movement of the object. The clamping screws TT hold the clamps firmly in position. The angle the cutting edge makes with the horizontal plane is also readily adjustable, and a small angular scale is divided on the knife-holders so that the same angle can be easily repeated.

Two knives, each measuring 30 cm. long by 5 cm. wide, are supplied. The first one "A" is ground to a very fine angle, and is used for delicate

* Cambridge Scientific Instrument Co., List No. 57A (1910) pp. 8–10 (3 figs.).

work, as, for instance, with soft celloidin, fresh, or alcohol-hardened preparations. The second knife "B" is the most generally useful knife. It is not ground to such a fine angle, and is used with the majority of paraffin preparations and also with hard celloidin.

The microtome will cut sections measuring up to 150 × 120 mm. (6″ × 4¾″) in either paraffin or celloidin. The thickness of the sections can be varied from 0 to 0·06 mm., each division on the scale being equal to 0·002 mm. The total distance through which the microtome will automatically feed the object-holder is 21 mm.

Pl. XV. fig. 2 shows the instrument with the knife in position for cutting celloidin section. In fig. 3 the knife is seen in position for cutting paraffin.

An Eighteenth Century Microtome.*—Description of an instrument for cutting transverse slices of wood for microscopical objects.

A A, in No. 1 (fig. 115†), represents a cylinder of ivory, 3½-in. long and 2-in. in diameter, to the one end of which is fitted B B, a plate of bell-metal, the section of which with the manner of fitting it to the ivory, may be seen in 2, in which the several parts are marked with the same letters as in 1.

C is a plate of brass, fitted to the other end of the cylinder, through which and the ivory there pass two long screws, which take into the thick part of the bell-metal B B, so as to fix both plates strongly to the ivory, into which they are also indented, so as to prevent such shaking as might otherwise happen after swelling or shrinking.

D D. The cutter, whose edge is a spiral, and the difference of whose longest and shortest radii is equal to the thickness of the largest piece of wood that the instrument would take in. The lowest side of this cutter must be ground extremely flat and true, in order that all the parts of its edge may be exactly in the same plane, and that the middle part of it may be applied closely to the flat circular plane left at the centre of the plate B B, to preserve it in the proper direction when carried round by the handle.

All that part of the bell-metal which the edge of the cutter traverses is turned so low as not to touch it (see the section), the middle of the cutter is about ⅛-in. thick and has in it a square hole that fits on the end of a steel axis P P, one end of which turns on a pivot in the plate C, the other end in the plate B B. This end has a conical shoulder which fits into a hole of the same shape in the under side of the plate, as represented in the section.

e e. A piece of brass somewhat in the form of an index, which is also put on the axis P P; this piece has a round hole in its centre, so large as to admit of its being turned into any position with regard to the cutter; and in order to keep it concentric thereto there is left on it a circular projection, which fits into a cavity made in the lower side of the handle where it fits on the axis (see the section).

* The Construction of Timber from its early Growth; explained by the Microscope and proved from Experiments, in a great variety of kinds. By John Hill, M.D., Member of the Imperial Academy. London, 1774, 2nd ed., 64 pp. folio (44 pls.).

† The block for this illustration was kindly presented by Mr. C. Lees Curties.

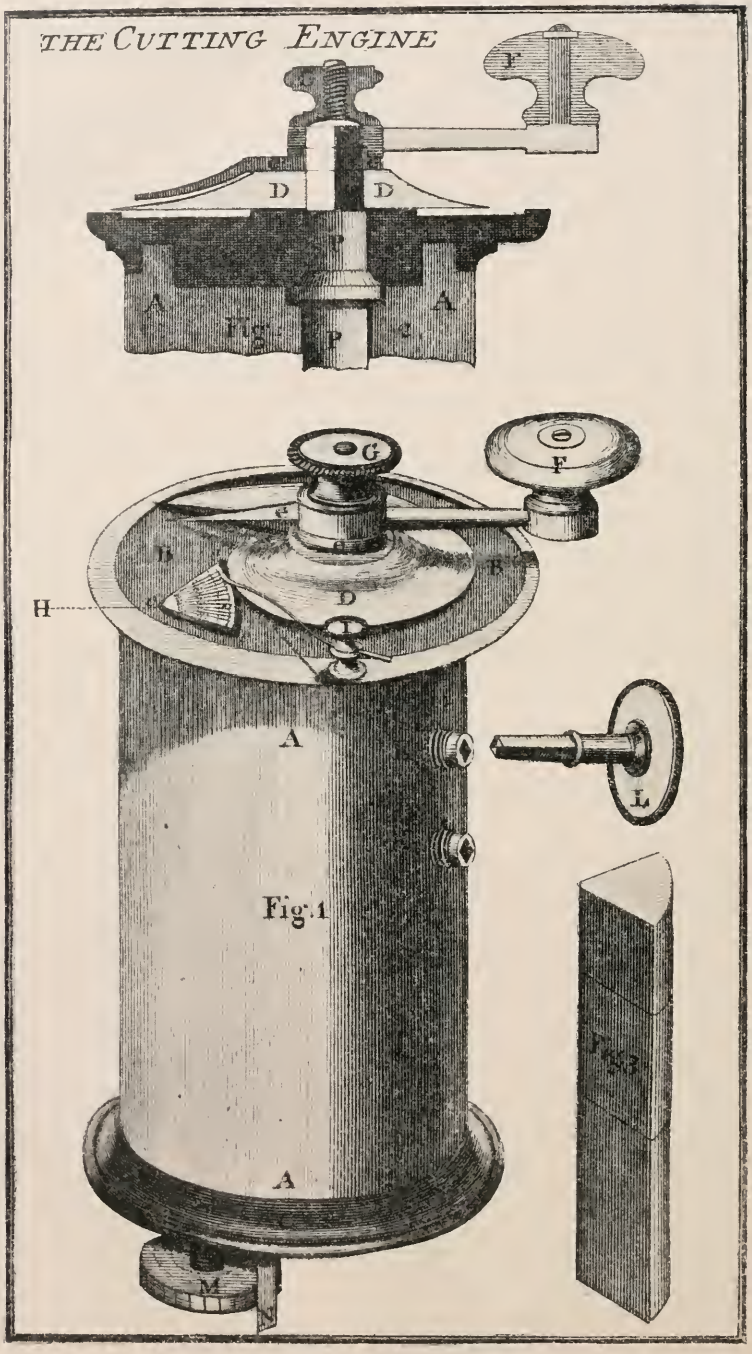


FIG. 115.

F. The handle, which is so fitted on the axis P P that it carries the cutter and the piece *e e* round with it.

G. A nut that screws the handle on its axis and keeps the cutter flat to the bell-metal B B when carried round by the handle.

o o o is a hole, nearly in shape of the sector of circle, pierced through that part of the bell-metal which the edge of the cutter traverses, and continued through the whole length of the cylinder, truly parallel to its axis and of an exact equal width throughout, till it terminates in the plate C.

H represents the end of a piece of wood of which slices are to be cut, and which is put into the cavity *o o o*, into the angular part of which it is gently pressed by means of K K, two brass screws, which pass through the ivory into the cavity *o o o*, and are made to press on the wood *h* by means of L, a key that fits into hollow squares made in the screws K K.

M. A screw that passes through the brass plate C, opposite the middle of the cavity *o o o*, and by means of which the wood *h* is raised to the cutter. This screw has forty threads to an inch, and its head, being divided into twenty-five equal spaces, it is evident that the moving one of these divisions or spaces will make the screw advance, and raise the wood *h* just $\frac{1}{1000}$ of an inch.

N. An index that points the divisions on the head of the screw M. The breadth of this index, from the one fiducial edge to the other, subtends a division and a half on the head of the screw, by which means half divisions as well as whole ones may be accurately shifted, and the $\frac{1}{2000}$, $\frac{1}{1500}$, $\frac{1}{1000}$, $\frac{1}{750}$, etc., parts of an inch, truly estimated. To render the effect of this screw the more certain, its point is turned round so as to act very near the centre, and a piece of ivory (see 3) is carefully fitted into the cavity *o o o* so as to move freely therein without any lateral shake, and to rest on the end of the screw M. This piece of ivory acting equally on every part of the under surface of the wood, will raise it towards the cutter with much more certainty than if the screw acted immediately on it. Several such pieces of ivory, of different lengths (as represented by 3), ought to be fitted to the instrument, so as readily to suit the length of any given piece of wood. One piece, of the full length of 3, must have one end left rough from the file, that pieces of cork, agaric, the pith of wood, and such other soft substances, may be cemented on it with sealing wax, in which case they can be cut into slices of a determinate thickness, as well as wood.

Now if a piece of wood, whether round or of the shape represented in the instrument at *h*, and of whatever size, be put into the cavity *o o o*, and gently pressed into the angular part thereof by the screws K K, let it be raised towards the cutter by means of the screw M. If the handle be turned to the right, the edge of the cutter will advance on the wood, and cut off such part as lies above the plane in which the edge of the cutter moves, and when the upper surface of the wood is thus rendered flat, slices may be cut of any required thickness, according to the number of divisions that the screw M is made to advance. If the machine be made with due care, it will readily cut a thousand slices in an inch, and if the edge be good and very well set, slices may be cut

that are no thicker than the $\frac{1}{1500}$ or even the $\frac{1}{2000}$ part of an inch; but this requires management, much depending on the force with which the screws K K pinch the wood.

It is not an easy matter to procure an edge sufficiently fine for the above purpose, but, with the very best possible, thin slices have a tendency to curl up into rolls, so as to be unfit for the Microscope: to prevent which a very slender spring is made to press gently on that extremity of the slice where the incision begins, so as to keep it flat to the cutter; when this spring is set to its proper position, it is fixed to it by the small finger-screw I. And, lest the action of this spring should destroy the slice after it is wholly cut, and in passing over the extremity of the cutter, the piece *e e* (which turns with the cutter) is fixed by the nut G into such a position that in passing under the spring it raises it, and relieves the slice at the very instant that the cutter has wholly done its office; and thus the slices are made to fall into spirits of wine, in which they are preserved for use.

In some woods the pith shrinks so very fast, that it is extremely difficult to keep it entire in slices that are thinner than 750 to an inch; to remove which imperfection an instrument of the nature above described was made to shift its own screw at every revolution of the handle, so that very little time was left to the pith to shrink, as a hundred slices could easily be cut in a minute, and the pith was as entire as the wood. This instrument had an index which, being set to the numbers 500, 750, 1000, made it cut so many slices to an inch. It performed extremely well, but was judged less fit for general use than that which has already been described, it being more complex and liable to disorder, as well as more difficult to manage.

The cutting engine is an invention of the ingenious Mr. Cummings. The two or three first were perfected under his own hand, and they are now made for general use by Mr. Ramsden.

Numbering Celloidin Sections.*—A. Yurisch gives an account of his experiences with Suzuki's method of numbering serial celloidin sections. This consists, briefly, in numbering the sections in order as they are cut, by marking with Indian ink, so that although mixed during subsequent manipulations, they may be mounted in the correct order. The author finds that such Indian ink marks resist most of the ordinary stains and reagents, and are still legible after sections have been kept for several months. If the numbers are made too large the excess of pigment may be deposited over the surface of the section in small black indelible granules. On the whole, the method is to be commended for its rapidity, simplicity, certainty, and cheapness.

FISCHER, OTTO—**Uber Ferienkwise für Wissenschaftlche Mikroskopie.** *Zeitschr. wiss. Mikrosk.*, xxvii. (1910) pp. 94–114.

(4) Staining and Injecting.

Detection of Tubercle Bacilli in Milk and Fæces.† — E. H. R. Harries recommends the following method. The smear is first stained

* Zeitschr. wiss. Mikrosk., xxvii. (1910) pp. 63–6.
† British Med. Journ. (1910) ii. p. 1295.

with carbol-fuchsin for 15 to 20 minutes in the cold, and then the superfluous fluid is drained off. Pappenheim's stain is then applied until the preparation is blue; the slide is then washed, dried, and mounted in balsam. Pappenheim's stain consists of 1 p.c. rosalic acid in absolute alcohol, to which is added methylen-blue to saturation and a small quantity of glycerin. The smears from fæces should be thin; milk should be centrifuged, and the fat removed by means of ether.

Staining Blood Platelets.*—J. Homer Wright demonstrated the histogenesis of the blood platelets by the following procedure. The material should be obtained immediately after death or taken from the living animal. For fixation methyl-alcohol, formaldehyde, or a saturated solution of mercuric chloride in a 0·9 p.c. solution of sodium chloride, may be used. Methyl-alcohol is not now recommended for fixation. Formaldehyde should not be allowed to act longer than 48 hours. The method is not applicable to material fixed in Zenker's fluid. The tissue is dehydrated by alcohol followed by acetone, cleared in thick oil of cedar followed by xylol, and imbedded in paraffin. The sections should not be more than 4μ in thickness. Crystals of corrosive sublimate in the sections are to be removed by treatment with Gram's solution of iodine and alcohol. The sections are stained while affixed to the slide by Meyer's glycerin-albumin mixture. The staining fluid and the mode of its preparation are described below.

The staining, clearing and mounting is carried out as follows:—

1. Equal parts of the staining fluid and distilled water are mixed in a small wine glass and immediately poured on to the slide. The measuring is conveniently done by means of a small pipette provided with a rubber bulb. At least 2 c.cm. of the freshly diluted staining fluid are thus spread out over the slide, which should be supported upon some object in such a way as to prevent the fluid from running off. The spreading out of the fluid in a layer is important, because it facilitates the evaporation of the alcohol whereby the staining elements slowly precipitate out of solution and, while doing so, stain the tissue elements. This precipitate appears as a yellowish metallic scum which slowly forms on the surface of the mixture. The diluted staining fluid is allowed to act for about 10 minutes, when the preparation is immediately washed in water. The exact time required for the best results has to be determined for each batch of the staining fluid. The proper staining of the preparation may be judged by examining it by a yellowish artificial light under a low magnifying power, after pouring back the diluted staining fluid into the wine glass. The stain is to be regarded as sufficiently intense and the staining process stopped by washing the preparation in water when the cytoplasm of the giant cells has acquired a bright red colour and the fibrils of the reticulum begin to take on a red colour also. If the staining is found not sufficiently intense the diluted staining fluid is poured back on the preparation and allowed to act longer. Over-staining and the formation of a black-red granular precipitate on the preparation occur if the diluted staining fluid is allowed to act longer than a certain time.

* Publications of the Massachusetts General Hospital, iii. (1910) pp. 1–16 (2 pls.).

2. Dehydrate in pure acetone. On account of the great volatility of acetone some care is necessary to prevent the drying of the preparation, which should be avoided.

3. Clear in pure oil of turpentine.

4. Mount in a thick solution of colophonium in pure oil of turpentine. Before mounting the preparation, the superfluous turpentine should be carefully removed because this reagent rapidly takes up water from the air, and thus may cause the clouding of the preparation or the fading of the stain.

The solution of colophonium is made by saturating a quantity of turpentine with powdered colophonium, and keeping the filtered solution in the paraffin imbedding oven until it has evaporated to the required consistence.

The use of acetone for dehydrating and of oil turpentine for clearing and mounting is an important feature of the method, for these do not destroy the characteristic staining of the granules in the giant cells and platelets as do other similar reagents that have been tested.

The staining fluid is composed of a mixture of 3 parts of a solution of modified or polychromatized methylen-blue and 10 parts of a 0·2 solution of eosin, "w.g." (Grübler) in pure methyl-alcohol. It is permanent if kept in a well-stoppered bottle so that evaporation is prevented.

The solution of methylen-blue is prepared as follows: One gram of methylen-blue, B.X. (Grübler), is dissolved as thoroughly as possible in 100 c.cm. of a 0·5 p.c. aqueous solution of sodium bi-carbonate in an Ehrlenmeyer flask. The flask and its contents are then placed in an ordinary steam sterilizer and kept at 100°C. for one hour and a half, counting the time after the steaming has become vigorous. When cool, the mixture is filtered, and the filtrate is the modified blue solution. It must be of a well-marked purple colour when viewed in a thin layer by the yellow transmitted light of an ordinary incandescent electric bulb. This colour appears only after cooling.

It is important that the quantities mentioned should be accurately weighed or measured. An excess of eosin delays the appearance of the scum on the surface of the diluted staining fluid, and the time required for staining will be longer than ten minutes. On the other hand, an excess of the modified blue component hastens the appearance of the scum, and the staining may in ten minutes cause over-staining and the granular precipitate to form on the preparation.

The preparations should be viewed by the light from an incandescent electric bulb which has a yellowish tint. This brings out more strongly the characteristic colour of the granules in the megakaryocytes and in the blood platelets.

Staining Wet Films by Giemsa's Azur-eosin Method.*—G. Giemsa fixes thin smears (malaria, trypanosomes, spirochætes, and such like) in sublimate-alcohol (2 parts saturated aqueous sublimate solution and 1 part absolute alcohol) for 12 to 24 hours or longer, and then after a short wash in water treats the preparation for 5 to 10 minutes in an iodine solution (iodide of potassium 2 grm., distilled water 100 c.cm.,

* Deutsche Med. Wochenschr. (1909) p. 1751.

Lugol's solution 3 c.cm.). The film is then washed with water and then immersed for 10 minutes in a 0·5 p.c. aqueous solution of sodium thiosulphate. After removal it is again washed with water and then stained with fresh Giemsa solution (1 drop to 1 c.cm. of water, or 2 c.cm. for longer staining) for 1 to 12 hours or longer; after the first half-hour it is necessary to pour off the stain and replace with a fresh lot. After staining, the preparation is treated to the following series: (*a*) aceton 95, xylol 5; (*b*) aceton 70, xylol 30; (*c*) aceton 70, xylol 30; (*d*) pure xylol. Mount in cedar-wood oil.

Staining Blood Smears.*—Hayhurst stains films of blood with the following solutions. (*a*) Water soluble eosin 1, methyl-alcohol abs. 100. (*b*) Medicinal methylen-blue 1, methyl-alcohol abs. 100. Solution *a* is allowed to act for ½ to 1 minute, and then the preparation is at once and without further treatment immersed in solution *b* for ½ to 1 minute. After washing in water for ½ to 1 minute the preparation is dried with blotting-paper and mounted in cedar-wood oil. During manipulation the film should be covered in order to prevent evaporation.

Detection of Tubercle Bacilli in the Placenta.†—J. Novak and F. Ranzel, by means of the antiformin method, have demonstrated in four cases out of six the presence of tubercle bacilli in the placenta of tuberculous women. Pieces of placenta were finely divided and washed until free from blood. Part was then treated with 20 p.c. antiformin, while another portion was fixed in alcohol for 24 hours, dried and ground in a mortar to a fine powder, and then treated with antiformin. By this means the tissue and non-acid-fast bacteria are dissolved. The second method gave the better results, solution being effected in 4 to 5 hours. Alcohol in the proportion of 3 to 2 was added in order to reduce the specific gravity and facilitate sedimentation. The sediment was washed and stained for tubercle bacilli.

Indian-ink Method in Parasitology.‡—B. Galli-Valerio has used the Chinese ink method of Burri in studying spirochætes, sarcinæ and bacteria. This ink he uses in dilutions of 1 in 9, or 1 in 3, in distilled water. The solutions are sterilized, and keep well. A few drops of formalin are added. Excellent preparations of these parasites, white upon a dark ground, are thus obtained, and continued investigations are not accompanied with fatigue.

Staining Nervous Tissues with Methylen-blue.§—After giving an account of the methods employed by Ehrlich and others for the demonstration of nerve-cells and nerve-fibres by means of this stain, S. Michailow describes his own technique as applied to the study of these structures in the mammalian heart. After the animal has been killed, the heart is removed and then left untouched for two hours. After this interval, it is washed in Ringer-Locke's saline solution at body temperature until the washings are no longer discoloured. The

* Journ. American Med. Assoc., lii. (1909) No. 14.
† British Med. Journ. (1910) ii. epit. 125.
‡ Centralbl. Bakt., 1te Abt. Orig., lvi. (1910) pp. 46–7.
§ Zeitschr. wiss. Mikrosk., xxvii. (1910) pp. 1–21.

organ is then suitably sliced with a sharp razor, and the slices are transferred to glass dishes for staining. The bottom of these dishes is covered with two or three layers of filter paper. The stain is prepared as a stock solution of 1 grm. of Grübler's methylen-blue in 200 c.cm. of a saline fluid, and from this suitable dilutions are made. For nervous tissues, $\frac{1}{24}$ or $\frac{1}{32}$ p.c. solutions are used. The warmed stain is poured over the material from a pipette, and staining proceeds at a temperature of 37° C. At intervals the material is examined, to see whether the process has gone far enough. As fixing fluid, a solution is used which contains 8 grm. of ammonium molybdate, and 0·5 c.cm. of formalin in 100 c.cm. of distilled water. The material is transferred to this fluid, suitably warmed, and left for 24 hours. Then it is well washed in warm water, dehydrated in alcohols, cleared in oil of bergamot and xylol, and finally mounted in damar-xylol.

Preparation of Ammoniacal Silver Solution. * — A. Schlenmer describes an improved method for the preparation of this fluid, which is used in Bielschowsky's process for demonstrating connective-tissue fibres in bone, dentine, and elsewhere. To a 10 p.c. solution of silver nitrate is added 40 p.c. sodium hydrate in excess, and the precipitate which forms is washed free of alkali. This precipitate is then dissolved in as little ammonia as possible, and the solution is filtered through glass wool. This solution is diluted with 9 parts of water, and is then ready for use.

Toluidin-blue. † — L. Martinotti calls attention to a solution of toluidin-blue with which he has got results as good as those obtained with polychrome-blue. It has the following composition :—Toluidin-blue 1 grm., lithium carbonate 0·5 grm., distilled water 75 grm., glycerin 20 grm., alcohol (95 p.c.) 5 grm. The first two ingredients are dissolved completely in the water, before adding glycerin and alcohol. The method of staining is precisely the same as with polychrome-blue. The solution is readily prepared.

Hæmatin Stains. ‡—L. Martinotti gives three formulæ for hæmatin solutions, of which the first two are based respectively upon Delafield's and Unna's hæmatoxylins. They contain 0·2–0·5 p.c. of hæmatin, and varying proportions of methyl-alcohol, alum, glycerin, and hydrogen peroxide. The results are constant and satisfactory ; the solutions are easily prepared, and keep well.

Chemistry of Vegetable Pigments. § —L. E. Cavazza gives an account of his microchemical researches upon the colouring matters of certain flowers, fruits and leaves. He classifies these substances into fifteen groups, and gives in tabular form the effects of certain chemical reagents upon the members of the different groups.

New Dahlia Stain. ‖—Ballenger describes a new stain for motile organisms, renal tube casts, and fixed smears of *Spirochæta pallida*.

* Zeitschr. wiss. Mikrosk., xxvii. pp. 22–3.
† Tom. cit., pp. 24–9.
‡ Tom. cit., pp. 30–3.
§ Tom. cit., pp. 34–40.
‖ Centralbl. Bakt., 1te Abt. Ref., xlvii. (1910) p. 407.

Dahlia is made up with 90 p.c. alcohol in 10 p.c. solution. One drop of a 10 p.c. solution of this fluid in water is mixed with the suspension of casts or bacilli, and covered with a cover-slip. The slide is then examined directly without removing the excess of stain. For examining fixed smears a 5–6 p.c. watery solution of dahlia is used.

Stable Solution of Gentian-violet.*— Kilduffe recommends the following as a stable solution of this stain for use in Gram's process :— Saturated gentian-violet solution, 25 p.c. ; 5 p.c. formalin, 75 p.c.

Staining Prowazek's Bodies.†—K. Lindner describes a method of staining by means of which these cell-inclusions—the causal agents of trachoma—may be demonstrated and readily distinguished from artefacts. A film is made upon a cover-slip, dried in air, and fixed in absolute alcohol. It is then left for 1 hour in a solution containing five drops of Giemsa and one drop of 1 p.c. acetic acid in 10 c.cm. of distilled water. Then it is dried and mounted. On a film so stained, these bodies appear dark blue or pale blue, the early stages being strongly basophil, the later stages less markedly so. The films show contrast-staining of such a type that it is a relatively easy matter to pick out these bodies during rapid examinations of microscopic fields.

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

Mounting Serial Celloidin Sections.‡—N. Anitschow makes use of the following method. The sections as they are cut are placed in 65 p.c. alcohol and transferred by means of a spatula to albuminized slides. By means of a small forceps, they are carefully spread upon the slide. This process may be facilitated by the use of 98 p.c. alcohol, which softens the celloidin. When quite flat, the sections are pressed firmly down with filter paper. Then a mixture of anilin and clove-oil, or of alcohol and formalin, is poured over the slide, and pressure is again applied. The sections are then washed thoroughly with acetone, to remove all traces of celloidin. The acetone is washed off with water, but in the case of delicate tissues an intermediate treatment with 70 p.c. alcohol is advisable.

Mounting Frozen Sections.§—N. Anitschow describes his method as follows. By means of a spatula the sections are removed from the microtome to a dish containing 50 p.c. alcohol, and from this to albuminised slides. The sections are spread out carefully, and pressed down carefully with filter paper. The slide is then placed in 98 p.c. alcohol for half a minute, transferred to 70 p.c. alcohol, and finally to water. If, however, it is proposed to stain the sections for fat, the slide is placed instead in 50 p.c. alcohol-formalin, and then transferred direct to water.

(6) Miscellaneous.

Gelatin Plates for Graphic Reconstruction.‖—A. Pensa gives a brief account of his method of using sheets of compressed gelatin for

* Centralbl. Bakt., 1te Abt. Ref., xlvii. (1910) pp. 407–8.
† Op. cit., 1te Abt. Orig., xlvii. (1910) pp. 429–32.
‡ Zeitschr. wiss. Mikrosk., xxvii. (1910) pp. 67–70.
§ Tom. cit., pp. 71–4. ‖ Tom. cit., pp. 48–50.

the graphic reconstruction of organs or anatomical structures. Outline sketches representing successive sections through the region under investigation are made upon a series of these sheets and suitably coloured. They are then built up in order, the correct centring of each diagram being secured by bringing salient points into apposition. The sheets are then stuck together by means of a hot iron applied to a corner at a safe distance from the diagram. This method is peculiarly suitable for the study of regions that are not unduly complex, and where the number of sheets required is not so great as to interfere with transparency or clearness.

Morphological Demonstration of Methæmoglobin in Blood.*—G. Krönig has studied dried films of blood from cases of methæmoglobinæmia, with a view to finding out the details of the process of formation of methæmoglobin. After slow and careful heat fixation, films were stained either by the methylen-blue-eosin or hæmatoxylin-eosin method. From cases of poisoning with maretin and potassium chlorate, he obtained films which showed distorted erythrocytes, hæmoglobin and methæmoglobin debris. Granules of pigment ingested by leucocytes were observed. In films treated with an acid stain, small portions of protoplasm were seen adherent to the pigment clumps. By this method, it is possible to demonstrate methæmoglobin even when a negative result is obtained with the spectroscope.

Shaw, E. H.—**The Immediate Microscopic Diagnosis of Tumours at the time of Operation.** *Lancet* (1910) ii. p. 939. See also this Journal, 1907, p. 244.

Metallography, etc.

Metallography of Zinc.†—The impurities which may occur in commercial zinc are lead, iron, cadmium, arsenic, antimony, tin, bismuth, and copper. With the intention of applying the results to the examination of commercial zinc, P. T. Arnemann has studied the zinc-rich binary alloys of zinc with the metals mentioned. The method adopted was to construct the equilibrium diagram for the desired range from cooling curves of the alloys prepared and from published data, and to examine micro-sections. The softness of many of the alloys rendered the polishing of sections very difficult; surfaces for examination were therefore obtained by casting on smooth surfaces. Glass, mica, quartz, and steel were found to be unsatisfactory for this purpose, but good preparations were obtained by allowing the molten alloy to solidify slowly in a small wooden ring placed on the bottom of an inverted carbon crucible heated by a gas burner. The lower face of the small ingot obtained did not show the markings of the carbon surface in contact with which it had solidified, but had the crystalline structure of the alloy. Alloys which could not be prepared in this way were cut and polished. Among the etching reagents used were dilute nitric acid, hydrochloric acid in alcohol, and dilute copper-ammonium chloride solution. The thermal and micro-

* SB. der k. Preuss. Akad. Wiss. (1910) pp. 539–47.
† Metallurgie, vii. (1910) pp. 201–11 (65 figs.).

scopical results are too lengthy for reproduction. The data obtained permitted the identification of some impurities in samples of zinc examined.

Bearing-metals and Stamped Alloys.*—By a process somewhat resembling that described by Friedrich,† W. Guertler has made bearing-metals consisting of grains of a hard metal imbedded in a plastic matrix. An intimate mixture of iron and lead in fine powder was heated to 250° to 300° C. and stamped in moulds. The properties of the product appeared to be satisfactory.

Copper-aluminium-manganese Alloys.‡—W. Rosenhain and F. C. A. H. Lantsberry have made a lengthy investigation of a number of alloys belonging to this ternary system. The alloys studied fall into two classes : (1) heavy alloys, containing 0 to 11 p.c. aluminium, 0 to 10 p.c. manganese, rest copper ; (2) light alloys, containing copper and manganese, not more than 4 p.c. of either, rest aluminium. Mechanical tests, static, impact, and alternating-stress, were carried out on the alloys in different states—sand-castings, chill-castings, bars, as rolled, annealed, or quenched, etc. Cooling curves were taken, and the alloys were microscopically examined. The complexity of the ternary system renders the determination of its equilibrium diagram a matter of great difficulty, and a complete explanation of the results obtained in the limited regions of the diagram which include the alloys investigated is not attempted. The constitution of the heavy ternary alloys closely resembles that of the copper-aluminium alloys : in no case does manganese give rise to the formation of a third phase, so that all the alloys consist of either a single solid solution (the α body) or of two phases, in each of which manganese exists in a solid solution. The compound Cu_3Al appears to be capable of dissolving manganese, and there is no evidence of the formation of a ternary compound. In the light alloys, three distinct phases are found : (1) a solid solution, which is aluminium containing some copper but practically no manganese ; (2) the compound $CuAl_2$; (3) the compound Al_3Mn. A ternary eutectic of these three phases, freezing at 522° C., is probably present in most of the light alloys. No thermal changes were found below the point of final solidification of the aluminium-rich alloys. Corrosion tests were made on the alloys, and in some cases magnetic properties were studied.

Action of Hydrogen and Nitrogen on Temper-carbon in Iron.§ It has been stated by Forquignon and by Charpy that temper-carbon in iron is volatilized, as hydrocarbons when heated in hydrogen, as cyanogen when heated in nitrogen. This has been disputed by Wüst and Geiger. F. Wüst and E. Sudhoff have now carried out a fresh series of experiments, samples of cast iron, containing about 1·5 p.c. temper-carbon and about 1·1 p.c. combined carbon, being heated, at temperatures 880° to 1080° C., in carefully purified hydrogen and nitrogen. No loss of total carbon occurred in either case, but while the carbon condition was un-

* Metallurgie, vii. (1910) pp. 264–8. † See this Journal, 1910, p. 530.

‡ Proc. Inst. Mech. Eng. (1910) i. pp. 119–339 (141 figs.). (Ninth report to Alloys Research Committee.)

§ Metallurgie, vii. (1910) pp. 261–4 (4 figs.).

affected by heating in nitrogen, some 0·7 p.c. temper-carbon was changed to combined carbon by heating in hydrogen. Microscopical examination of the specimens confirmed the chemical analyses.

A_2 Point in Chromium Steel.*—H. Moore has observed that in a series of steels containing up to 6·4 p.c. chromium, the position of Ac_1 was progressively raised by increase of chromium-content. When more than 3 p.c. chromium was present, a critical point occurring below Ac_1 was observed. After rejecting several possible explanations, the author concluded that this apparently new critical point was Ac_2, and, to test this conclusion, devised a method for determining accurately the temperature at which steel loses or regains its magnetic properties on heating or cooling. The identity of the critical point in question with the magnetic change-point proved it to be Ac_2. The addition of chromium to steel, raising Ac_1 while not affecting the position of Ac_2, causes a reversal in the relative positions of Ac_1 and Ac_2 when 3 p.c. or more chromium is present. The author holds that the occurrence of Ac_2 below Ac_1 demonstrates the insolubility of carbide of iron in β-iron.

Chromium Steel.†—A. McWilliam and E. J. Barnes have made tensile and alternating-stress tests upon six steels containing 2 p.c. chromium, about 0·2 p.c. manganese, the carbon varying from 0·2 to 0·85 p.c. The steels were tested after treatments similar to those given in a previous investigation.‡ Heating curves showed a critical point, assumed to be Ac_2, below Ac_1. Cooling curves were also taken. The thermal analysis, and microscopical examination of the steels after different heat-treatments, would indicate that the carbon content of pearlite, when 2 p.c. chromium is present, is decidedly lower than that of pearlite in steels containing no chromium.

Case-hardening.§—S. A. Grayson has investigated the case-hardening efficiency of four commercial materials. Turned test-pieces of mild steel were heated in these materials, at different temperatures, and for varying lengths of time. Carbon was then estimated in thin layers successively turned off, and sections, the edges of which were protected from rounding in polishing by electro-deposited copper, were examined microscopically. The best temperature appears to be 950° to 1000° C. Sulphur may be absorbed by the steel from case-hardening compositions, with deleterious effects. Large quantities of the sulphides of manganese and iron were observed at the edges of sections which had been case-hardened in compositions containing notable amounts of sulphur.

Constitution of Cast Irons and Carbon Steels.‖—D. M. Levy suggests, as a simplified view of the iron-carbon system, that the alloys may be considered as a series of alloys of iron with iron-carbide. A "constitutional diagram" based on this view is given, and the changes which occur in the solidification and cooling of alloys of different carbon content are discussed in detail, being regarded as the separation of carbide of iron

* Journ. Iron and Steel Inst., lxxxi. (1910) pp. 268–75 (2 figs.).
† Tom. cit., pp. 246–67 (15 figs.). ‡ See this Journal, 1909, p. 787.
§ Journ. Iron and Steel Inst., lxxxi. (1910) pp. 287–303 (17 figs.).
‖ Tom. cit., pp. 403–30 (2 figs.).

from either liquid or solid solution in iron. The metastable iron-carbide always tends to decompose into carbon and iron. The effect of foreign elements upon the diagram is considered.

Effect of Low Temperature on Iron-carbon Alloys.*—C. W. Waggoner has determined the magnetic permeability and the magnetic hysteresis of seven iron-carbon alloys containing 0·6 to 1·37 p.c. carbon, and of iron containing 0·06 p.c. carbon, at liquid air temperature and at 20° C. The mean coefficient of linear expansion was determined from room temperature to liquid air temperature, and was found to decrease with increase of carbon.

Cementation by Gases.†—J. C. Olsen and J. S. Weissenbach have determined the depth and intensity of cementation of iron rods heated in illuminating gas, methane, carbon monoxide, and acetylene. In one series of experiments ammonia gas was added to the gaseous cementation medium, and was found to facilitate the absorption of carbon by the steel except in the case of carbon monoxide. Of the three pure gases, carbon monoxide is the most efficient in cementation.

Heat Treatment of Special Steels.‡—L. Guillet classifies alloy-steels, and gives some generalizations as to their treatment. In nickel- and silicon-steels, the carbide goes into solution less readily than in other steels, while annealing at high temperatures appears to have a much less injurious effect than in the case of carbon steels. Other special steels are more sensitive to such annealing. The quenching of polyhedric steels at 1000° C., so frequently practised, appears to be highly injurious. The author has found in steels so treated a coarse network resembling that observed in "burnt" steels.

Thermal Treatment of Cemented Steel.§—L. Guillet recommends the double quenching of cemented articles, the first from a high temperature (up to 1000° C.) to restore the structure and qualities of the body of the steel, the second quenching from 750° C., or thereabouts, to harden, and produce a fine structure in the carbonized layer on the surface. The tempering of hardened cemented steel at about 200° C. has been found to improve its qualities.

Artificial Reproduction of Widmanstätten Figures.‖—N. Belaiew has obtained meteorite-like structures in medium carbon steels by heating the molten metal to a high temperature and cooling it very slowly. The Widmanstätten structure was sufficiently coarse to be perceived by the unaided eye. The author attempts a theoretical explanation of the formation of this structure in meteorites, which are natural iron-nickel alloys.

"Strain-disease" in Steel.¶—After referring to Cohen's investigation of the effect of cold-working upon tin, G. Charpy points out that the growth of the ferrite grains in annealing is much more rapid in steel

* Physical Review, xxviii. (1909) pp. 393–404 (6 figs.).
† American Machinist, xxxii. (1909) pt. 2, pp. 156–8 (1 fig.).
‡ Rev. Métallurgie, vii. (1910) pp. 489–95.
§ Tom. cit., pp. 501–9 (16 figs.). ‖ Tom. cit., pp. 510–21 (15 figs.).
¶ Tom. cit., pp. 655–6.

that has been cold-worked than in the same steel not submitted to such mechanical treatment. The phenomenon is most strongly marked in steels containing very little carbon and at the same time somewhat phosphoric. The linear dimensions of crystalline grain after annealing, in such a steel, in a part previously cold-worked, may be as much as ten times the dimensions of grain in a part which has not undergone cold-work. Annealing temperatures of 650° to 800° C. bring out these differences well.

Application of Titanium Alloys in the Steel Industry.* — W. Venator has divided three charges of basic open-hearth steel each into two portions, to one of which was added titanium, none being added to the other; 0·038, 0·092 and 0·14 p.c. titanium were added, but only traces were found in the steel. The author considers that the mechanical properties of the steel were distinctly improved by the titanium addition. The titanium appears to have a reducing and purifying action, possibly removing traces of nitrogen also.

Effects Produced by Rolling.†—H. Meissner and H. Felser have examined, chemically and microscopically, specimens taken from various descriptions of mild steel and puddled iron at different stages in the process of rolling. While no alteration in chemical composition took place in the mild steel, a considerable reduction in the amount of slag imprisoned in the puddled iron occurred during the rolling, as much as 80 p.c. of the slag being removed. The size of the ferrite grains diminished, and curves are given showing the gradual reduction in grain size during rolling. Mechanical tests were taken at various stages.

Apparatus for Metallographic Work.‡—S. S. Knight describes a metallographical equipment which he finds satisfactory, after discarding four complete outfits in turn. The camera is vertical, and may be swung back out of the way for visual examination. The illuminating apparatus, comprising an acetylene burner enclosed in a sheet-iron chimney, and a condenser, is clamped to the Microscope tube, and thus follows the movement of the lens. Very little light escapes into the room. A cover-glass illuminator is preferable to one of the prism type. As the two influences controlling the quality of iron and steel are composition and heat-treatment, the author considers that metallographical examination almost completely supplements chemical analysis.

Metallography in German and Belgian Laboratories.§—G. Arnou reports on his visit to various German and Belgian iron and steel works, undertaken to study the organization and equipment of their laboratories. At the Krupp establishment, levigated emery-powder is used for the final polishing of sections; alumina is more commonly used elsewhere. Hydrochloric acid is frequently preferred to picric or nitric acid for etching, while etching for macroscopic examination, which is widely practised, is usually performed by means of Heyn's copper-ammonium-chloride reagent. For the detection of sulphides the

* Stahl und Eisen, xxx. (1910) pp. 650–4 (14 figs.).
† Tom. cit., pp. 287–90 (9 figs.).
‡ Iron Age, lxxxv. (1910) p. 279 (1 fig.).
§ Rev. Métallurgie, vii. (1910) pp. 405–28 (16 figs.).

Baumann sulphur-printing method is commonly used; but Heyn declares that sulphides are not distinguished from phosphides by this method, and recommends the use of silk soaked in a solution of hydrochloric acid and mercuric cloride. The Le Chatelier Microscope is generally employed in works laboratories, while the Martens outfit is more frequently installed in scientific establishments. An arc-lamp, with its carbons set at right angles to each other, by the Düsseldorf firm of Dujardin, is frequently used for photomicrography. The same firm also supplies several types of Microscope stand, polishing apparatus, etc. The Stead workshop Microscope is used in cases where more costly outfits are unsuitable or not considered necessary. Instances of the practical application of metallographical results and examples of the mode of reporting them are given. Numerous details relating to mechanical testing, pyrometry, and heat-treatment are furnished.

Testing Steel by Corrosion.*—F. Cloup gives some information about the application of macroscopic etching, which he terms "testing by corrosion," to steel. He has used picric acid as an etching reagent, but recommends a 10 p.c. iodine in potassium iodide solution. A specular polish is unnecessary, but it is advisable to carry the polishing as far as may be practicable. Suitably etched specimens give clear indications of the manner of flow of the metal in the mechanical treatment (forging, stamping, etc.) which it has undergone, and the position and extent of segregation, piping, blowholes, and other defects are revealed. With steel of good quality, free from defects, prolonged etching is necessary to develop the flow-lines.

Heat-capacity of Metals and Compounds.†—H. Schimpff has determined the heat-capacity of fifteen metals and twenty-nine binary compounds of the metals with each other, for the temperature intervals 17° to 100° C., 17° to −79° C., 17° to −190° C. The molecular heats of about one-half the compounds are equal to the sum of the atomic heats of the component metals, within 2 p.c., the limit of experimental error. In the remaining cases the deviations from Kopp's law are usually within 4 p.c. Specific heat increases with temperature, but the value of the temperature-coefficient diminishes as the temperature rises, except for bismuth and lead.

Resistance of Alloys free from Solid Solutions.‡—K. Lichtenecker has deduced a simple formula for the calculation of the electrical resistance of alloys containing no solid solutions. A satisfactory agreement was obtained between observed values and values calculated from this formula.

Spark Spectra of the Metals.§—C. E. Gissing gives good reproductions of photographs of the spark spectra of most of the metals and a few alloys. Containing, in addition, numerous manipulative details, the book should be useful to those who use a prism spectroscope for the

* Rev. Métallurgie, vii. (1910) pp. 605–11 (9 figs.).
† Zeitschr. Phys. Chem., lxxi. (1910) pp. 257–300 (8 figs.).
‡ Phys. Zeitschr., x. (1909) pp. 1005–8, through Science Abstracts, xiii. (1910) Section A, p. 150.
§ London: Baillière, Tindall and Cox, 21 pp. (50 figs.).

qualitative analysis of metal-bearing substances. The lines characteristic of each component, can usually be detected in the spark spectrum of an alloy.

National Physical Laboratory.* — An investigation of the aluminium-zinc alloys has revealed certain inaccuracies in Shepherd's equilibrium diagram, the true diagram being more complex. The eutectics research was continued in several directions. Autographic cooling curves, taken with extremely sensitive apparatus, did not give any indication of two separate stages in the solidification. Various eutectic alloys were made to cool very slowly through their solidifying points, and were submitted throughout this cooling to the action of a centrifuge. Speeds of rotation up to 2500 per minute were used. The lead-tin eutectic after this treatment did not show any signs of separation into the two metals, but in the lead-bismuth and tin-bismuth eutectics a considerable amount of separation took place. Various improvements have been introduced into the methods for determining temperature-density curves. A more complete apparatus has been designed for studying the effects of strain at high temperatures; this consists of an instrument for applying accurately measured stresses to thin strips of metal heated in a small electric tube furnace in a high vacuum. The plastic extension of the specimens may be measured with some accuracy. A new Leitz arc lamp, having the carbons set at right angles, has been installed for use with the photo-micrographic apparatus. For the microscopical study of transverse sections of tin plate, imbedding in electrolytic iron has been tried with success.

Properties of Non-ferrous Metals.† — An extended study of the elastic breakdown of copper, aluminium, Muntz metal and other brasses has led C. A. M. Smith to conclude that any one of these materials has either a very indefinite yield-point, or else varies considerably in its elastic properties. The effects of overstrain, and of heating overstrained metals at 100° C. by placing in boiling water, were studied. Very delicate measurements of strain were made by means of the sphingometer. The mild steel tested appeared to be more homogeneous than any of the other metals.

Mixed Crystals or Solid Solutions? ‡ — St. Ruzicka has made some experiments on organic bodies to test van 't Hoff's theory that mixed crystals (isomorphous mixtures), as well as amorphous mixtures (glasses, alloys), are to be regarded as solid solutions, and that accordingly diffusion should take place in the crystals. The author found that no diffusion occurred in the crystals examined.

Metallographical Study of Slags. — With a view of identifying the various substances which compose the inclusions of slag found in iron and steel, Matweieff has prepared synthetically, and examined microscopically, oxides, sulphides and silicates of iron and of manganese. Each compound was melted, as a rule, in contact with iron. Of several

* Nat. Phys. Laboratory, Rep. for 1909, pp. 79–88.
† Journ. Inst. Metals, ii. (1909) pp. 151–230 (44 figs.).
‡ Zeitschr. Phys. Chem., lxxii. (1910) pp. 381–2.
§ Rev. Metallurgie, vii. (1910) pp. 447–55 (18 figs.).

etching reagents tried, three were found to be specially useful—hydrogen, water vapour, and an organic acid (such as tartaric acid) in the form of a solution in water. The two gaseous reagents were applied by passing them over the heated section. The constituents of ferruginous slags may be classified into three groups:—1. Bodies not attacked by any of the three etching reagents; these are silicates of iron and silicates of manganese. 2. Bodies attacked by hydrogen and water vapour, but not by organic acids; these are the oxides. 3. Bodies attacked by organic acids, but not by the two gaseous reagents; these are the sulphides of iron and of manganese. Methods of distinguishing iron from manganese in the various compounds are given.

Guye, C. E., & H. Schapper—**Internal Friction of some Metals at Low Temperatures.** *Archives des Sciences physiques et naturelles (Geneva)* xxx. (1910) pp. 133–51 (23 figs.).

Hegg, F.—**Thermomagnetic Study of Ferro-nickels** *Tom. cit.*, pp. 15–45 (17 figs.).

Turner, L. B. — **Stresses in a thick hollow Cylinder subjected to Internal Pressure.** *Trans. Cambridge Phil. Soc.*, xxi. (1910) pp. 377–96 (8 figs.).

Arnold, J. O.—**Uniform Nomenclature of Iron and Steel.** *Journ. Iron and Steel Inst.*, lxxxi. (1910) pp. 185–205 (2 figs.).

Arnold, J. O., & A. A. Read — **Chemical and Mechanical Relations of Iron, Manganese, and Carbon.** *Tom. cit.*, pp. 169–84 (7 figs.).

Smith, C. A. M.—**Elastic Breakdown of Certain Steels.** *Tom. cit.*, pp. 431–66 (31 figs.).

Tagueeff, G.—**Homogeneity of Metals.** *Tom. cit.*, pp. 467–89 (10 figs.).