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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FELLOWS OF THE SOCIETY.

FOR THE YEAR

1887.

Part 1.

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genus, Spirobacteriaceæ, with subgenera Vibrio and Spirillum. B. Bacteria with formation of arthro-spores (including those the mode of fructification of which is not yet known): 1st genus, Arthro-coccaceæ, with subgenera Arthro-streptococcus, Leuconostoc, Merista, Sarcina, Micrococcus, and Ascococcus; 2nd genus, Arthro-bacteriaceæ, with subgenera Arthro-bacterium and Spirulina; 3rd genus, Arthro-spirobacteriaceæ, with subgenus Spirochæte; 4th genus, Leptothricheæ, with subgenera Leptothrix, Crenothrix, and Phragmidiothrix (?); 5th genus, Cladothricheæ, with subgenus Cladothrix.

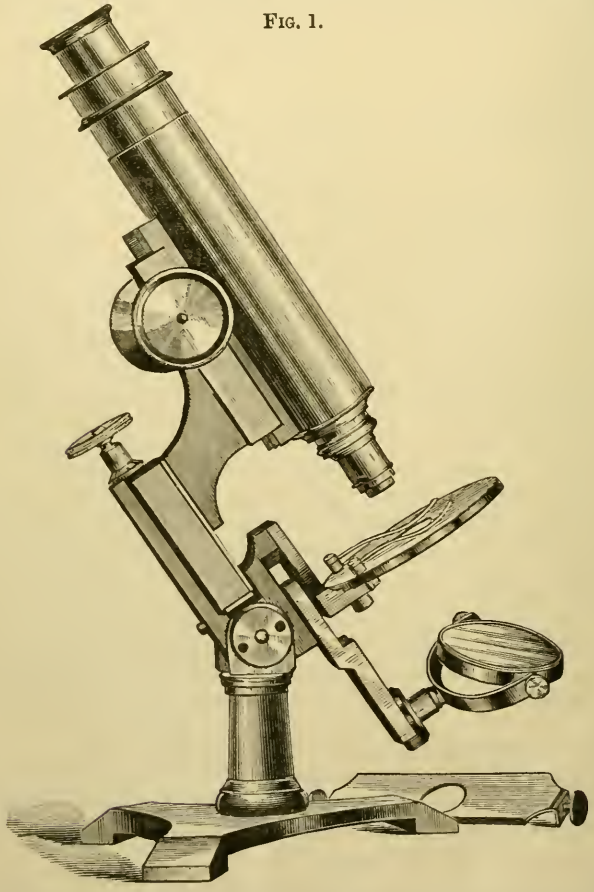
MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Bulloch's Student's Microscope.—In this instrument, by Mr. W. H. Bulloch, of Chicago (fig. 1), the stage is connected with the stem by means

Fig. 1.



* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating Apparatus; (4) Other Accessories; (5) Photo-micrography; (6) Manipulation; (7) Microscopical Optics, Books, and Miscellaneous matters.

of a strong angle-piece, leaving space for the free movement of the radial swinging tail-piece. The arrangement is a modification of the plan adopted some time ago by Mr. Bulloch, to remedy the flexure so commonly found in the Zentmayer mechanism, where the stage is carried by a conical spindle passing through a sheath in the lower end of the stem, the swinging tail-piece fitting by means of a collar outside the sheath.

Bausch & Lomb Optical Co.'s Combined Inverted and Vertical Microscopes ("Laboratory" and "University" Microscopes).—The Inverted Microscope, in the forms issued by M. Nachet, is well known to microscopists. The Bausch & Lomb Optical Co. have now combined it with the ordinary vertical form, the principle involved being, they believe, entirely new. "There is no question that the fact that the inverted could only be used as such, and that it was but incomplete at the best, has precluded its more general use, and we have no doubt that offering them as we do now by combining two instruments in one, and supplying each with such complete adjustments as modern requirements demand, they will be found to fill a necessity in certain branches and prove a great convenience in others. . . . This form of instrument is particularly adapted for chemical investigations, for the reason that crystals may be studied as they lie in their natural position in any depth of fluid, and the head is sufficiently distant from the stage not to inhale any fumes. Further than this, it is valuable in the examination of diatomaceæ and other objects in water which are heavier than it, and therefore sink to the bottom; also in moist histological preparations, as they adhere to the surface of the slide, and are therefore in one plane. It is also an excellent dissecting Microscope, as it is partially erecting, offers no hindrance to manipulation with any power, and makes it convenient to observe the object directly." *

There are two forms, the "Laboratory" and the "University."

The "Laboratory" Microscope when used as an inverted instrument, is shown in fig. 2. The mirror-bar swings on an axis in the plane of the stage to any point above or below it. The mirror and substage are adjustable on the mirror-bar. The substage carries a revolving diaphragm, and is fixed on a pivot so that it will swing in and out of the optic axis, allowing the polarizer to be attached and ready for instant use. On the slide is the arm, to the lower side of which is fastened the prism-box. On the upper horizontal surface of this is the nose-piece, with an extra adapter for high powers, and in the oblique surface is a screw-socket for the body-tube.

To transform the instrument into an ordinary Microscope, fig. 3, the tube is unscrewed, the milled head at the front of the arm loosened, which releases the prism-box, and the arm is swung on its axis from between the pillars into an upright position. The tube is now attached to the opposite side of the nose-piece, and after the stage clips are reversed it is ready for work.

The "University" Microscope (figs. 4 and 5) is in its general construction similar to the preceding, except that the (single) pillar and the arm are not japanned but are of brass, and that the instrument swings on an axis which is the same as that of the mirror-bar. The stage consists of a glass plate mounted in a brass ring.

The prism used for inversion is that suggested by Mr. J. Lawrence Smith

* 'Illustrated Catalogue of Microscopes, Objectives, and Accessories,' 10th ed., 1886, p. 33.

FIG. 2.

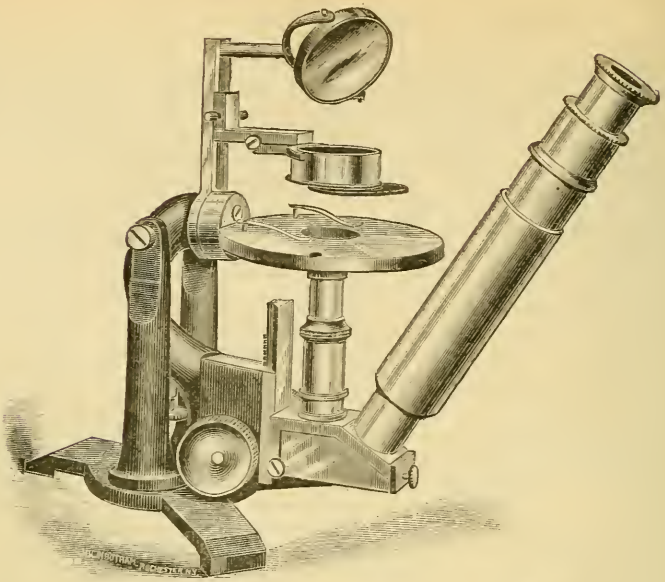


FIG. 3.

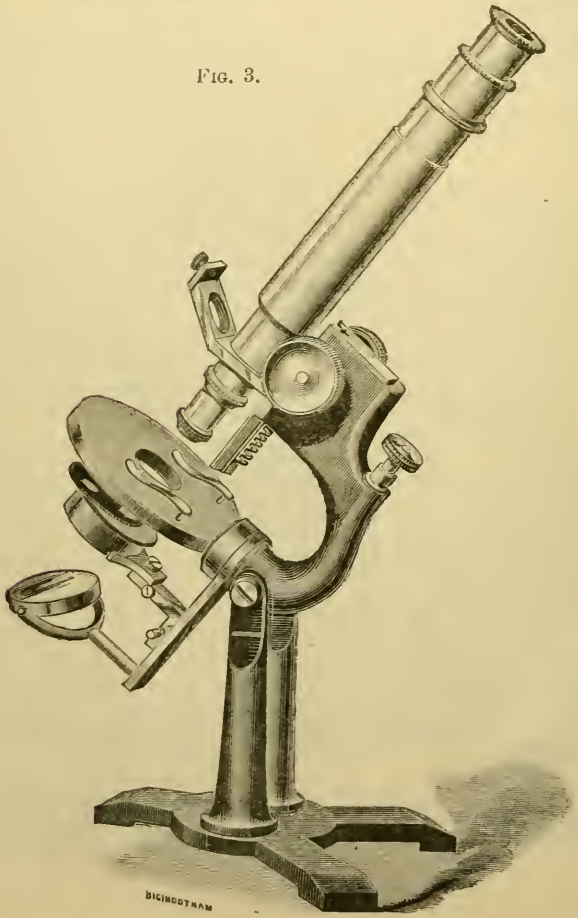


FIG. 4.

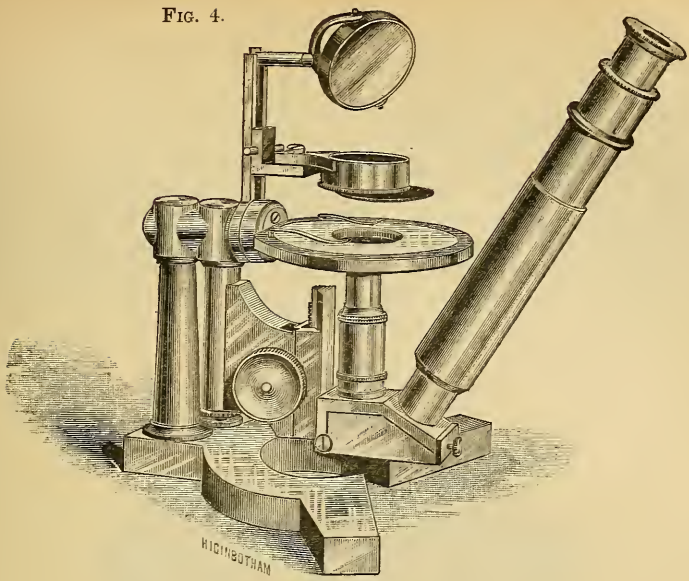
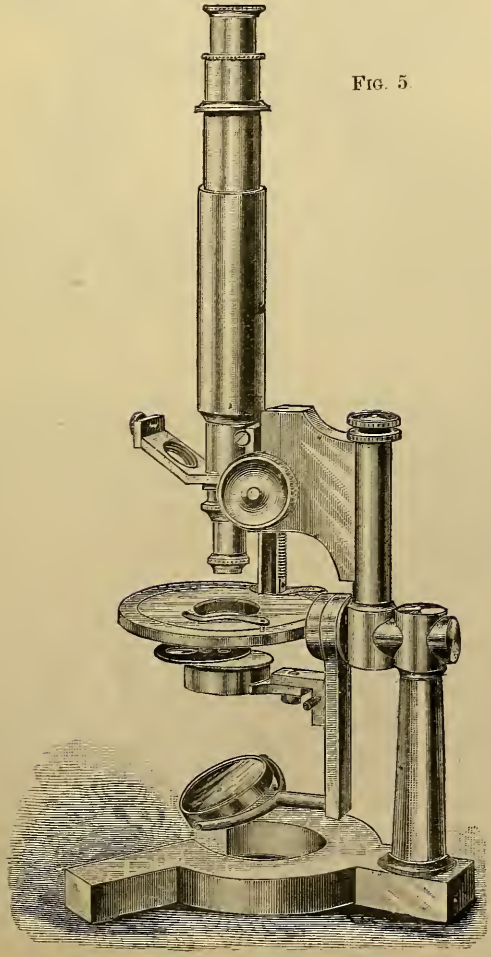


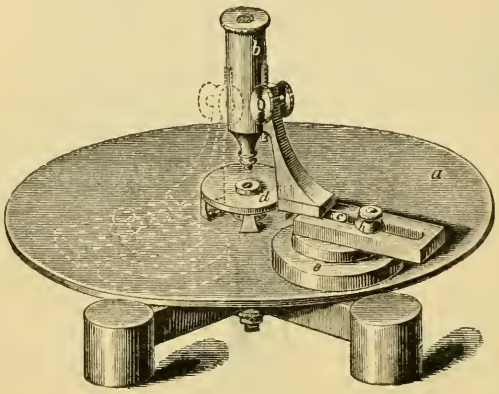
FIG. 5.



in 1851, having four faces, with angles of 57°, 150°, 48°, and 105°, the rays being twice totally reflected.

Berger's Microscope for fixing Spider's Threads.*—Mr. C. L. Berger describes the following Microscope for the adjustment of distance-threads in telescopes for theodolites, &c. To fix the threads in the grooves is used a small apparatus *b* (fig. 6), which stands upon a rotating plate *a*; *b* can be both rotated about the pin *c*, and moved backwards and forwards, and

Fig. 6.



clamped by the screw *h*. The apparatus can also be moved with the stand *e* to different parts of the plate, so that the diaphragm (for the telescope) need not be moved. The latter is held by a spring on the little stage *d* in the centre of the table *a*, and there is a mirror under *d*. With this apparatus he has been able to adjust the distance-threads for use with normal levelling staffs to within 0·001 of their true position, which corresponds to an error of 0·1 foot at a distance of 100 feet. This error, especially with long distances, lies within the limits of the accuracy which can be attained with distance-threads in general, and may in most cases be neglected. By using a micrometer-screw with the Microscope, as is done with dividing machines, the threads may be still more accurately adjusted before they are fixed to the diaphragm, and the error still further reduced.

Koch's Microscope for determining Coefficients of Elasticity.†—The apparatus originally devised by Dr. K. R. Koch for his experiments on the elasticity of crystals, is now made in an improved form by Breithaupt and Son, of Kassel, and is shown one-fourth natural size in fig. 7.

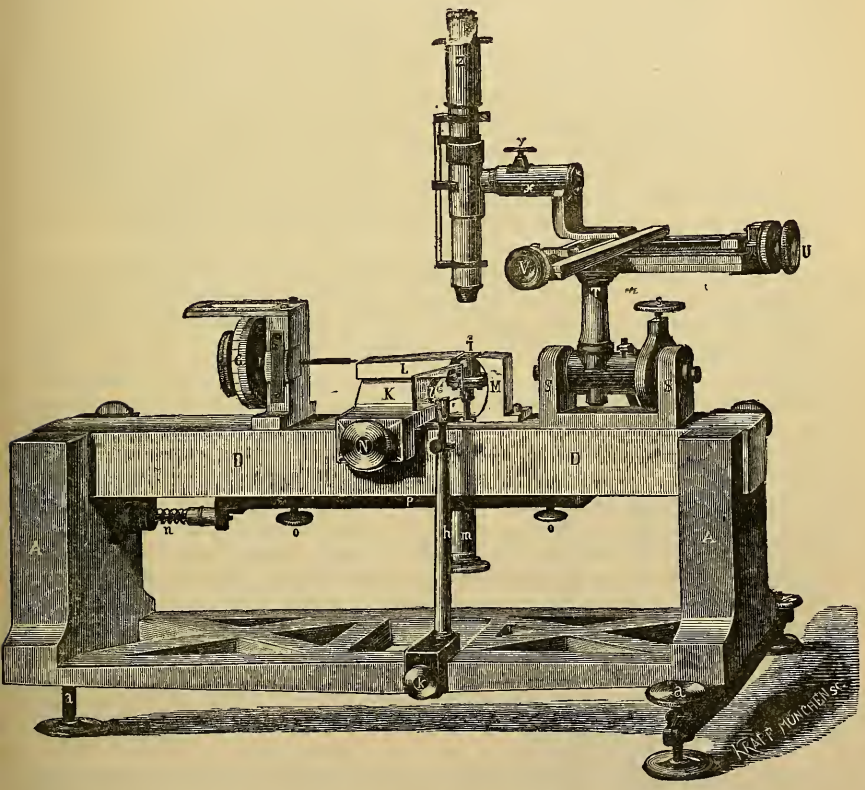
A solid stand A, of lacquered iron, supported on three levelling screws *a*, carries the steel bar D on which is fixed the steel anvil M; the upper surfaces of M and of a similar anvil L are slightly bevelled upwards, so that the plate or bar to be examined, when placed upon M and L, rests upon their inner edges alone as two linear supports; L is, however, not fixed, but is suspended on a knife-edge forming part of K, parallel to the length

* Zeitschr. f. Instrumentenk., vi. (1886) p. 276 (1 fig.).

† Groth, P., 'Physikalische Krystallographie,' 2nd ed., 1885, pp. 660-6, 3 figs.

of D, so that when the plate is in position, and loaded with a weight, L adjusts itself to parallelism with M, and the plate rests evenly upon the two edges. The block K which carries L is not fixed, but is made to slide along the bar D, and is clamped by the screw N; in this way the distance between the inner edges of L and M can be set to any length between 10 and 30 mm. Between L and M and beneath them is a totally reflecting prism *i*, by which the light reflected into it by the glass plate on the rod *h* passes vertically upwards through the upper horizontal face. The prism is fixed on three screws, by which its upper surface may be adjusted to

Fig. 7.



parallelism with the plate, and it is slowly raised or lowered by a milled head at the lower end of *m*. The prism is supported on the plate *p*, and can always be brought into the middle of the space between L and M by the screw *n*, and fixed by the clamps *o o*. The position of L, and consequently the distance between L M, may be measured either by the micrometer-screw and index at G, or more conveniently by the Microscope *z*. S is a horseshoe support, in which turns an axle bearing the pillar T and clamped by *s*. Upon T are the two slides with micrometer-screws U V, by which the Microscope *z* can be moved horizontally through measured distances, either parallel or perpendicular to the length of the bench; *z* turns about the axle *x*, which is clamped by the screw *y*. The Microscope itself

is of small magnifying power, and is roughly focused by raising or depressing the tube, while by turning a grooved ring in the middle of the tube a fine-adjustment is obtained; there is a fixed and a movable thread with graduated circle.

In using the instrument, the Microscope, fixed in the vertical position by a stop on the axle S S which abuts on D, is first adjusted to the inner edges of L and M successively by means of the micrometer-screw V; (U and V have drums divided into 100 parts each, equivalent to a motion of 0·005 mm.); this determines the distance between the edges and the position of the experimental plate upon them. The screw *s* is then loosened and the Microscope is rotated about the axle S S into the horizontal position, where it is held by a second stop and counterbalanced by a weight fixed on the lower end of T. It is then focused upon the upper surface of the prism which is slightly curved; the prism is raised until it just touches the plate with its central point, and the interference rings are seen in the field of view, when monochromatic light is reflected into the prism. If a small space intervenes between the plate and the prism, then when the plate is loaded this space is diminished and the interference rings travel across the microscopic field, a motion through the breadth of one ring being equivalent to a vertical displacement of half a wave-length; in this way the extent to which the plate is bent may be measured in fractions of a wave-length.

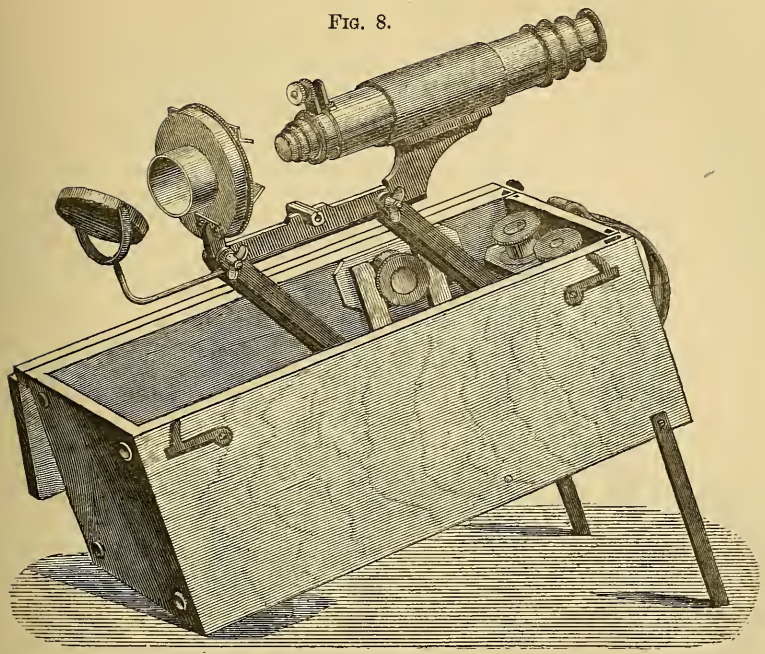
The apparatus above described constitutes a complete micrometer for the measurement of lengths and angles within the space of 4 sq. cm. covered by the motions of the screws U and V, and may therefore be applied to microscopical measurements for a variety of purposes. In this case the object to be measured is placed upon an object stage, which rests upon D above K and M, and is provided with a rotating glass plate mounted in brass, and illuminated either with a lens from above, or from below with the prism or a small mirror. In this form the instrument is especially applicable to the measurement of Senarmont's or Röntgen's ellipse of heat-conductibility, and to the examination of etched figures upon crystal faces; for the latter purpose it is particularly convenient when it is required to measure the angle between the edge of an etched figure and an edge of the crystal which is at some distance from the same, that is to say, when the crystal is so large that a well-defined etched figure and the outline of the crystal face are not visible together in the Microscope; in such a case the movable thread is adjusted to the edge of the etched figure; the Microscope is then shifted by means of the screws U V until the edge of the crystal appears, when its direction may be determined by the movable thread.

Moginie's Travelling Microscope.—This (fig. 8) was designed by the late Mr. W. Moginie, in order to provide an instrument which could be very rapidly set up when travelling, and without the necessity of separating it from its case.

The limb supporting the socket for the body-tube and the stage is attached by thumbscrews to the upper ends of two pairs of parallel bars, the lower ends of which turn on pivots fixed to the bottom of the box. When the bars are depressed the limb, with the body-tube, stage, and mirror, drops into the box. The loss of time in the operation of taking a Microscope out of its box and replacing it again is thus avoided.

At one end of the box are two flat rods or feet, turning on pivots and allowing the box to be inclined, as shown in the fig. On the bottom are two similar feet which also turn on pivots, so as to extend horizontally on

Fig. 8.



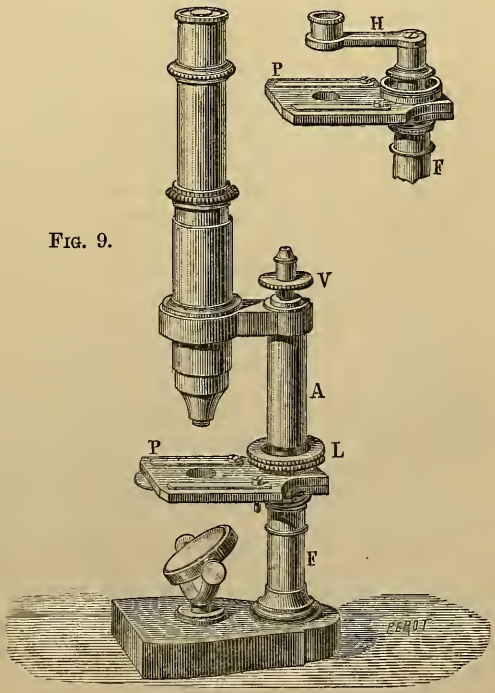
either side of the end of the box, increasing its stability when the Microscope is used in a horizontal position.

The box contains eye-pieces, cameras, animalcule-boxes, and other accessories.

Nachet's Compound and Single Dissecting Microscope.—In this instrument (fig. 9) M. Nachet has applied the arrangement of his Travelling Microscope for readily converting it from a compound to a single Microscope. This is accomplished by unscrewing the milled ring L at the base of the pillar V A, when the latter, with the body-tube, can be removed from the lower part of the instrument P F, and an arm H, carrying dissecting lenses, substituted.

Though the conversion is rapidly effected, the connection does not appear to be in any way wanting in solidity.*

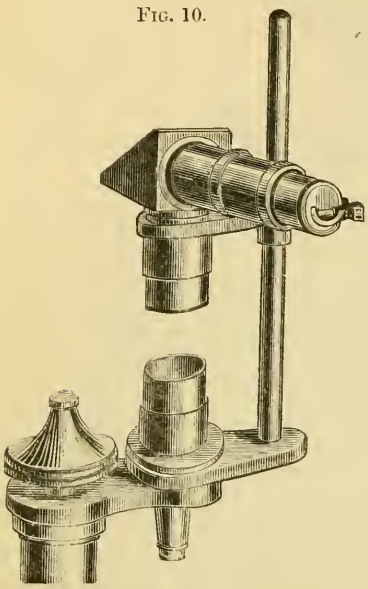
Fig. 9.



* A similar arrangement was adopted in the Nachet Travelling Microscope.

Pfeifer's Embryograph.*—This piece of apparatus, the work of Mr. A. Pfeifer, the instrument-maker of the Biological Laboratory of the Johns-Hopkins University, Baltimore, "renders the Zeiss-Oberhauser camera available for drawing objects under very low magnifying powers." It consists, first, of a collar fitted to the arm of the Microscope, and furnished with a short draw-tube, which can be placed with the objective either above or below the arm; and, second, of a vertical rod, supported on an arm which is clamped under the collar of the draw-tube, and carries a second movable arm resting in a collar to support the camera. This arm is held in place by a thumb-screw, and it may be set at any point on the vertical rod. When the Zeiss *aa* objective is used, and the camera is lowered as much as possible, an image magnified about three diameters is projected on the paper, and any amplification greater than three diameters may be obtained by varying the height of the camera, and by the use of the higher objectives.

Fig. 10.



Schott's Microscopes.—A matter that has long puzzled microscopists has happily found a solution, and although the discovery is not calculated to produce any revolution in microscopy, it is worthy of being recorded in a microscopical journal.

Gaspar Schott, in his 'Magia Universalis,'† figures and describes among others the Microscopes shown in figs. 11, 12, and 13. These Microscopes, as will be seen, are apparently of an exceptional and extraordinary size, and no explanation is furnished by the text or otherwise of the advantages supposed to be obtained by their large dimensions. So far as anything is known of the ideas of Schott's contemporaries, there is nothing that in any way tends to show that the uselessness of mere size was not thoroughly appreciated, so far as Microscopes at any rate, in contradistinction to telescopes, are concerned. Added to this, Schott himself writes of gold and silver dust, small seeds, &c., being viewed by these Microscopes, objects which are obviously unsuited for large instruments. As no reasonable explanation was forthcoming, some microscopists fell back upon the notion that Schott was drawing upon his imagination for the whole thing, and that no such Microscopes had ever in fact been made.

We recently received from Prof. Abbe, Traber's 'Nervus Opticus,'‡ and we happened to open it at the plate containing the three drawings

* Stud. Biol. Laborat. Johns-Hopkins Univ., iii. (1886) pp. 480–1 (1 fig.).

† G. Schott, 'Magia Universalis naturæ et artis. I. Magia Optica.' 4to, Herbipolis, 1657, pp. 533–6, pl. xxv. figs. 5, 7, and 8.

‡ P. Traber, 'Nervus Opticus sive Tractatus Theoricus, in tres libros Opticam, Catoptricam Dioptricam distributus,' xxii. and 226 pp. and 35 pls., fol., Viennæ Austriæ, 1690.

which are reproduced in figs. 14, 15, and 16.* It seems to us that these drawings at once furnish an explanation of the difficulty. It will be seen

Fig. 11.

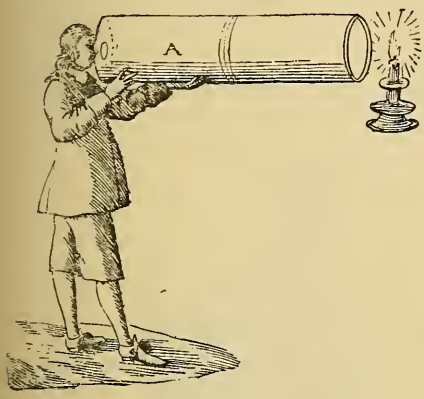


Fig. 12.

Fig. 13.

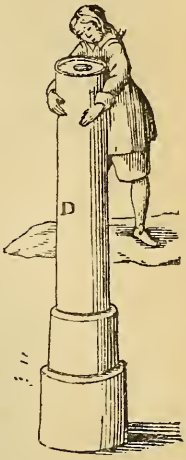


Fig. 14.

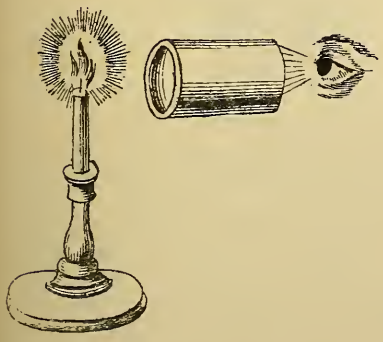
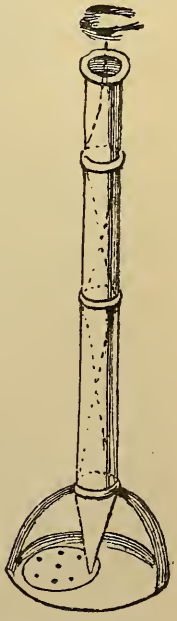


Fig. 15.

Fig. 16.



that in place of a full length of a man being drawn as the observer at each instrument, *an eye* only is given. The change that this makes requires no enforcing. The whole scale is at once altered, and the Microscopes are reduced from their apparent size of 4 or 5 feet to scarcely as many inches. Schott's draughtsman was probably of an artistic turn of mind, and added the full-length figures with the view of enlivening and illuminating what he probably felt to be very inartistic pictures. That he succeeded in making much prettier pictures may be freely admitted, but he little thought to what erroneous deductions his artistic tastes would give rise.

We are not overlooking the fact that Traber's book was not published

* Tom. cit., pp. 66–8, Lib. i. Tab. iv.

until 1690, while Schott wrote in 1657, but this cannot militate against the striking evidence furnished by the three figures. Traber, who lived at Vienna, may well have heard from Schott or otherwise of the mistake that had been made in the drawings, and corrected it accordingly.

Schiefferdecker's Fine-Adjustment Screw.*—Dr. P. Schiefferdecker describes a micrometer-screw made by Winkel of Göttingen, which is so constructed, that lateral movement is altogether prevented, and the action of the screw is very regular and easy.

Fig. 17 shows a section of the apparatus viewed from behind. The casing which carries the tube is fixed by means of an arm to a hollow trilateral

Fig. 17.

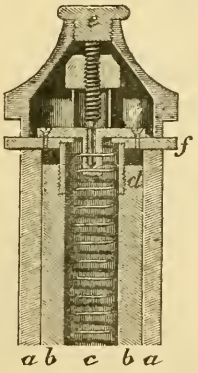
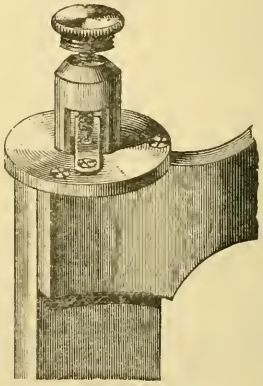


Fig. 18.



"prism" *a*. The sides, i. e. the right and left surfaces of the latter, are with the arm made of one piece; the base, i. e. the hinder surface, is screwed on to the adjacent sides. In *a* is a second trilateral prism *b*, the lower end of which is screwed to the foot of the Microscope. This prism is fitted most accurately into the cavity of the former, so that a relatively large friction resistance exists when the two prisms work against each other. The prism *b* has a cylindrical cavity *c*, beginning at the top and going down a definite distance. Its axis coincides with that of the prisms. It contains a strong spiral spring, the diameter of which coincides with that of the cavity. To the upper end of *c* is screwed a hollow steel tube *d*, the internal diameter of which is equal to that of *c*. It projects above *b*, and enters the circular opening of the brass plate *f*, which lies above *a* and closes it. The steel tube *d* is not uniform throughout its extent. After that portion, about 6 mm., which is immediately above *b*, there follows a part of 11 mm. in length, from which the right and left fourths of its wall have been cut away. On this follows a solid end-piece perforated by the micrometer-screw *e*. Through the openings in *d* passes a small brass plate or bridge *g*, which is fixed at each end to the plate *f* by a screw.

If fig. 17 be compared with fig. 18, the position of this bridge will be understood. The spiral spring presses strongly against the bridge which is firmly united to the plate *f*; this, again, is firmly fixed to *a*, which carries the tube. The spiral spring therefore exerts its pressure on the upper end of *a*, pushes on this and the tube, and presses the bridge firmly against the upper solid part of *d*. The micrometer-screw opposes the tension of the spiral spring. It presses on the bridge, not however directly, but by means

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 1–5 (2 figs.).

of a special arrangement. In the middle of the bridge is screwed a short steel cylinder, which extends into the central hollow of the spring for about 8 mm. It possesses a cylindrical cavity, the longitudinal axis of which coincides with that of the cylinder, and which ends conically. Within the cavity is placed a small steel rod, the diameter of which is somewhat smaller, so that the space is not quite filled. This rests with its lower conical extremity in the conical end just alluded to. To the upper squared off end of the rod, which is flush with the upper surface of the bridge, is fixed a small cap in which the point of the micrometer-screw is adjusted. The cap (fig. 17) is intended to protect the parts inclosed from dust, and also to give a firmer hold to the finger.

The following is the action of this contrivance. The cylinder which extends from beneath the bridge to the central cavity gives a firm hold to the spring. The rod in the steel cylinder forms the direct continuation of the micrometer-screw with the advantage of a movable point, and as the rod is of less diameter than the cavity in which it lies, the screw at its lower end is practically movable on all sides. The arrangement offers the following advantage:—If the point of a micrometer-screw is not quite accurately placed, either in consequence of imperfect work, or from warping in hardening, the screw will exert not only a vertical but also a lateral pressure. This will in turn produce a lateral displacement of the tube. If, however, the screw works on an easily movable point which is firmly united to it, and has only a slight lateral movement, vertical motion only will be communicated. Another advantage is, that the friction of the micrometer-screw is as small as possible, and therefore a very strong spring can be inserted without the screw losing its easy regular action. In consequence also of the power of the spring, the prisms *a* and *b* can be fitted so close as to create a relatively strong degree of friction.

(2) Eye-pieces and Objectives.

Finding the general character of the Components of a Cemented Combination Lens.*—Mr. E. M. Nelson premising that it is very useful to know whether a combination consists of two or three lenses, and if those are biconvex, plano-convex, meniscus, &c., gives directions for obtaining such information without uncementing. The method employed is simply the consideration of the reflected images from the surfaces of the glass.

"Take the plane mirror of your Microscope in your hand, and examine the reflection of a window. Notice that it is an erect image, and that when you move the mirror in a certain way the image appears to come towards you. Now look at the concave side, the image is inverted, and when the mirror is moved in the same direction as before the image goes away from you. A convex mirror behaves as a plane mirror, there being only this difference—that the greater the convexity the smaller is the image, which difference is also true of a concave mirror—viz. the greater the concavity the smaller the image. If you now examine a single biconvex lens, you will see a large erect image from the surface next the window, and a small inverted image from the surface on the other side. It acts precisely as if it were a convex and a concave mirror. In a single biconcave lens you have a large inverted and a small erect image. In a plano-convex, with the convex side towards the window, you will find a small erect image from the convex side, and a large inverted image from the plane side. With the plane side towards the window, you will have a large erect image from the plane side, and a small inverted one from the other side. With

* Engl. Mech., xliv. (1886) pp. 320–1 (3 figs.). Journ. Quek. Micr. Club. iii. (1887) pp. 13–7.

the concave side of a plano-concave towards the window, the concave side will give an inverted image, and the plane side an erect image; but with the plane side to the window, you will get two erect images. Converging and diverging menisci have for their convex sides two erect images, and for their concave sides two inverted. I find, however, that in a converging meniscus, if the concave surface is of very large radius, the reflection from it when viewed from the convex side will be inverted instead of erect; in other words, it will take the form of a plano-convex. I imagine that in a diverging meniscus, which closely approximates the form of a plano-concave, the same result would be found—viz. that the image from the flat side, when seen through the more concave side, would be erect instead of inverted, as one would expect; but of this I have no practical experience, not having a single lens of that form to experiment on.

"Now, if we take a cemented doublet, consisting of a biconvex and a plano-concave, we shall very easily see the two bright reflections from the two exterior surfaces—viz. the plane and the convex. The image from the cemented surfaces, however, will not be so readily apparent. With a little attention it will be discovered as a faint image, with most probably a bluish tinge, though occasionally it may have a reddish tinge. When once seen, it will be easily recognized again. A triple combination will have two faint images as well as two bright ones. I find the following the best method of procedure. First find out by the number of faint reflections if the lens is a doublet or a triplet. Next find out the nature of the external surfaces, and write them down—e. g. plano-convex doublet. This means that the combination is composed of two lenses, and that one of the external surfaces is convex and the other plane. Now write down the reflections as they come, beginning at the side next the window, underlining the reflection from the first surface, and putting the reflection from the cemented surface in (). In writing these down, I use the following abbreviations: *e* for erect, *i* for inverted, *s* for small, *l* for large, and L for very large. It is a good plan to draw the lens by representing, first, the external surfaces only, and then filling in the cemented surfaces, according to the reflections you obtain. It is absolutely necessary that the reflections from both sides of the combinations should be ascertained, as it is impossible to discover the construction of the combination from one set of reflections. When the images are large it is as well to look at the reflection of the bar across a window; the knob of the hasp showing if the image is erect or inverted. The images from small lenses require to be examined by a magnifying glass. One word of caution, and that is, until one is practised in picking up these faint images, the very large faint ones are apt to be overlooked. Until one is familiar with the manner of holding a lens, only a faint blue tinge will be seen over the glass; but after a little practice, a distinct image of the window bar will be obtained."

Some examples with figs. are given.

(3) Illuminating Apparatus.

Ahrens's Polarizing Prism.*—Dr. H. Schröder suggests that this prism† may be improved by using linseed oil for cementing instead of Canada balsam, since the surfaces may then be cut at a more convenient angle. This cement is not very tenacious, so that during the cutting and polishing of the prism the parts must be provisionally fastened with Canada balsam, which is finally removed and replaced by the linseed oil varnish.

* Zeitschr. f. Instrumentenk., vi. (1886) pp. 310–1 (1 fig.).

† See this Journal, 1886, p. 397.

(4) Other Accessories.

Super-stage for the Selection and Arrangement of Diatoms.*—Herr E. Debes's instrument (figs. 19, 20, and 21) for selecting and arranging diatoms consists of a ring A fixed to the stage of a large Zeiss dissecting

Fig. 19.

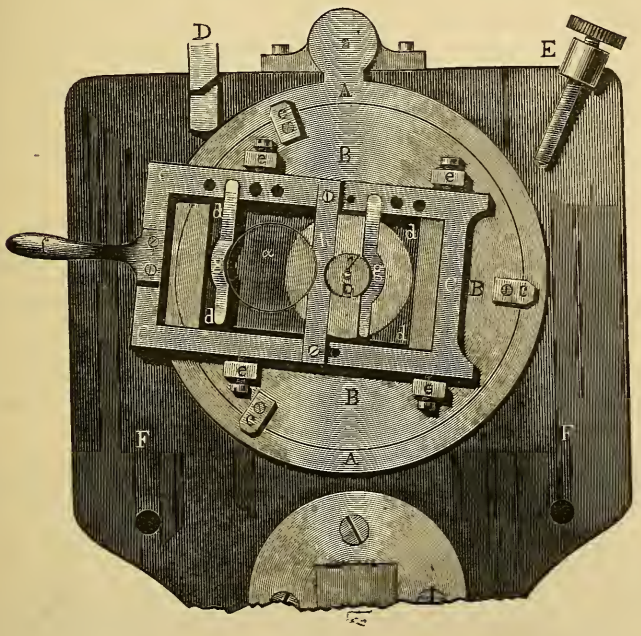


Fig. 20.

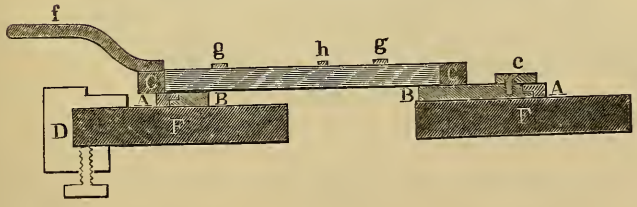
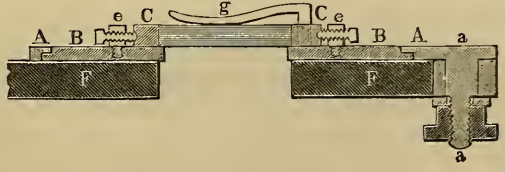


Fig. 21.



Microscope and moving pendulum-wise on the axis *a*. Within the ring is a disc B moving round the middle point *b*; the disc is provided with

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 330-6 (3 figs.).

three small bearing-plates *c c c*. The circle-segment which the middle point *b* describes when the apparatus is moved must accurately intersect the middle of the field of view. The movement of the ring A is limited on the left side by the clamp D, which is movable, and can be fixed in any desired position by a screw. On the right the motion is confined by the adjusting-screw E attached to the stage F. The disc B, perforated by the quadrangular opening *d d d d*, carries the frame C which is fixed to B by the binding-screws *e e e e*. To the left of the frame is the handle *f*, having a slight tilt upwards. In the long sides of the frame C are grooves in which the screws *e* work; if the latter are drawn out, the frame can be moved in the direction of its length. The frame C carries a glass plate, two springs *g g*, and a narrow plate *h*; these last three lie upon the glass so as to leave spaces for the insertion of cover-glasses α and γ of 10 and 6 mm. diameter, the former carrying the specimens from which are selected those to be arranged on the latter.

It follows, therefore, from the construction of the apparatus, that if the centre of the cover-glass γ coincide with the central point *b*, the central point of the field of vision will revolve round its own axis when B is turned, provided that the clamp D is so adjusted that the outer frame A touches it. Similarly, when the frame is properly adjusted to E, the centre of α will remain in the field of view.

The chief advantage of this instrument consists in its automatic precision, the hair used for arranging being always within the field of view and under the control of the preparer.

Hildebrand's Slide-carrier.*—In Dr. H. E. Hildebrand's contrivance (figs. 22–24) the stage is fitted with a circular frame R, in which is inclosed

Fig. 22.

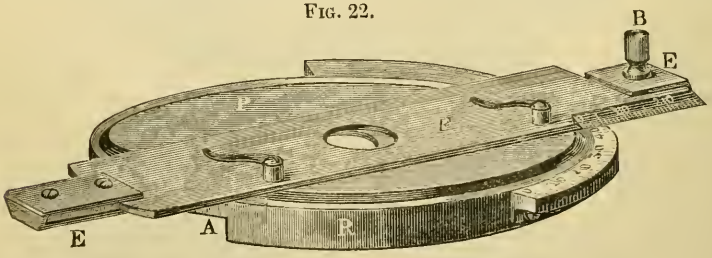
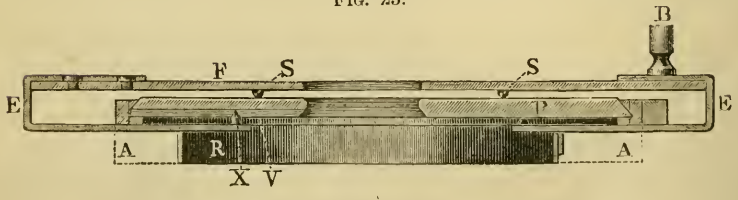


Fig. 23.

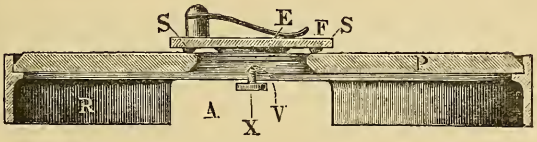


a glass plate P with a central aperture. The slide-carrier proper is a metal plate F, with a circular opening in the middle. This plate moves over

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 386–9 (3 figs.).

the glass on four pegs S, and is kept in position by the square springs E, for the passage of which two sections A of the frame R are removed. Running from the left section A directly inwards as far as the central aperture is a groove V, 1 mm. deep, on the under surface of the glass plate P. In this groove works a short guide-pin X, connected with the end of the left rectangular spring E. When pressure is made on the handle B

Fig. 24.



the carrier is moved to and fro along the groove, or in arcs of which X forms the centre, or in a combination of the two movements. As the figs. show, a finder can be employed.

The apparatus admits of some modifications, such as having the upper surface of the glass plate grooved instead of the lower.

(7) Miscellaneous Matters.

The New Glass.*—In an article widely copied by the American daily press from the 'St. Louis Dispatch' occur some rather startling statements concerning the discoveries of "Prof. Abbey" and "Dr. Scott," of which the following is a very brief extract.

"That a recent wonderful discovery in microscopy has not been even noted in the public press may be cited as proof of the general apathetic tendency as regards scientific matters. The Microscope has always been regarded as a wonderful instrument, but by the discovery of an entire new kind of glass lately, its powers are increased to an incredible degree. . . . With the old glass the full power of the Microscope was the discernment of the one-five-hundred thousandth part of an inch, and with the new glass it is claimed that the one-two-hundred-and-four-million-seven-hundred thousandth part of an inch can be distinguished. This certainly seems incredible, but positive assurance of its truth is given by parties who have tested Prof. Abbey's and Dr. Scott's new instrument."

Errors of observation in reading divided instruments.†—Herr H. F. Dorst has endeavoured to compare the relative accuracy of the three methods by which fractions of the divisions on graduated instruments are determined in making measurements; these are (1) direct estimation, (2) measurement by vernier, (3) measurement with micrometer Microscopes, and the errors corresponding to them may be called respectively estimation-, coincidence-, and adjustment-errors.

To compare these the author made a large number of observations with the naked eye upon various instruments and with sets of lines ruled upon paper, having previously determined that his eye could be regarded as one of normal accuracy and sensitiveness. The observations were made with the graduations both in horizontal and vertical positions, and the probable

* Micr. Bulletin (Queen's), iii. (1886) pp. 35-6.
† Zeitschr. f. Instrumentenk., vi. (1886) pp. 383-7.

errors were calculated by the method of least squares. The following were the results:—

Estimation error, ·015 to ·059 mm.;
Coincidence error, ·002 to ·014 mm.;
Adjustment error, ·0018 to ·034 mm.

The author concludes from his experiments that from an interval of a certain magnitude the relative error of estimation (that is the ratio of the error to the interval) increases as the latter diminishes; this increase of relative error is, however, not rapid enough to involve an increase in the absolute error of the measurement, so that using the naked eye it is possible to measure more accurately with fine than with coarse graduations.

Carlisle Microscopical Society and Dr. Dallinger.—Dr. Dallinger, P.R.M.S., in accepting an invitation to be an Honorary Vice-President of the Carlisle Microscopical Society in place of the late Dr. Carpenter, wrote to Mr. C. S. Hall, the President of the Society,—

"I have delayed writing in detail up to this time, in the earnest hope that I might find time to say something to the Society in my letter that would give direction, or stimulus, to the work it so wisely undertakes. But the pressure upon me by the claims of work, compulsory or self-imposed, is so great, that I fear if I delay until I can do, in relation to my words of direction or help, as I would, I shall do nothing. I therefore write the rather to express my deep anxiety that the members of your Society should first of all keep, individually and collectively, before them the fact, that the *raison d'être* of the modern Microscope is its scientific employment. This can only be the result of a complete mastery of the instrument in all its details. The capacity to bring out what the highest optical skill has put into a lens, is one that in this day, when objectives of the first quality are of such a high order of merit, cannot be overestimated. We may determine on a certain line of delicate investigation, say the working out in persistent continuity of the life-history of some typical form of a group of Infusorians of a relatively large size (and splendid work is waiting to be done in this direction), yet, unless the worker is master of his lenses—able, that is to say, to make them *obey* him without difficulty, yielding precisely the results he wants, and not wanting anything from them that they cannot yield; making the utmost and best use of aperture, collar, and fine-adjustment; and knowing accurately what eye-piecing any given lens will admit of. These and many other things are of the utmost importance. But they imply steady effort and practice: these, with a fair knowledge of the construction of the instrument, are the keys to success, and they can be acquired by any resolute man. But beyond this the management of light and illuminating apparatus is of the first importance. If anything, this is more difficult to fully master than the efficient employment of the lens; for the use of the lens to its utmost capacity depends upon it. But it is equally within the reach of the resolute. It is when a man is master of his Microscope, as the skilful organist is of his organ, that he will enter without hesitancy, and with certainty of result, upon such investigations as, in every department of biology, and indeed of science, invite the interest and effort of the microscopist.

Of course, what I have said applies in increasing ratio to the higher power lenses. But it has also a meaning when applied to *any* power. Relatively very few amateurs have discovered the outside power of their lenses. I can see that by the use of the new achromatic lenses, the difficulty of the use of high powers of great aperture will be lessened; but perfect

mastery of the difficulties and peculiarities of our instrument is the absolutely essential precursor to successful work of any original kind, in any direction we may choose.

I note with great pleasure that several of the provincial societies are making manipulation special, and employing demonstrations in histological methods, microscopical dissections, mounting of various kinds, &c. It would be a great gain, in my judgment, in all such societies, to have similar and progressive demonstrations on the practical use of all lenses and all apparatus employed to secure their highest efficiency, in various kinds of investigation. No doubt it may be said that small societies are not always possessed of such members as could give this desirable information. This is true: but the society exists to secure this end; and since application, with such lenses and apparatus as may be within reach of the members, is all that is required in addition to ordinary intelligence, each member may advance, and the most efficient help and stimulate the rest."

Chérubin d'Orléans' 'La Vision parfaite.'—Père Chérubin d'Orléans was the first known inventor of the Binocular Compound Microscope, which he described and figured in his work, 'La Vision parfaite,' published in Paris in 1677,* the Latin edition, 'De visione perfecta,' translated by himself, being issued at the same time. Numerous references to this work have appeared from time to time in the literature of the Microscope; but hitherto the second volume, which was published in Paris in 1681, was entirely unknown, the first volume giving no indication, either on the title-page or otherwise, of the existence of a second. In a recent visit to Antwerp we were surprised to discover a copy of the work with the two volumes bound together. This second volume † is of special interest in microscopy, from the fact that it contains a full description, with figures, of Chérubin's 'Microscope Universel,' in which is described the first application (so far as we are aware) of a rotating disc of object-lenses. There are eight different powers, applied at the nose-piece of the body-tube, a system practically identical with that adopted in England sixty or seventy years later by B. Martin. This was probably suggested to Chérubin by his rotating object-disc, which he figured (plate 31, fig. 7) and described (p. 262) in his 'Dioptrique Oculaire,' published in Paris in 1671.

Value of the Microscope in Trade.‡—"D." points out of what infinite value the Microscope is in trade; and of trades selects that of brewing, "because it will be apparent to all readers that a brewer without a Microscope is almost analogous to a peacock without a tail."

Since the remarkable revelations of M. Pasteur, the brewing trade has been completely revolutionized, and a man nowadays who does not know how to use the Microscope, and who, in fact, is not an able manipulator of that instrument, does not come within the definition of master brewer. "Science has so beautified the labours of the brewers, that they have been elevated above the level of empiric soup-makers to that of, at least, semi-professional men;" and he doubts not but that "time's effacing fingers will ere long entirely sweep away the old ignorant class of men who perhaps knew well how to wash a barrel, but had no idea of the influence of certain salts and organisms on the character of their malt extract."

After pointing out the value of the Microscope in determining,

* Chérubin d'Orléans, 'La Vision parfaite: ou le concours des deux axes de la vision en un seul point de l'objet,' xxvi. and 187 pp., frontispiece, and 16 pls. and 4 figs., fol., Paris, 1677. See this Journal, 1882, p. 253.

† 'La Vision parfaite: ou la veue distincte par le concours des deux axes en un seul point de l'objet,' tome ii., xxviii. and 239 pp., 12 pls., fol., Paris, 1681.

‡ Engl. Mech., xliv. (1886) p. 391 (3 figs.).

indirectly, the purity of the air in the fermenting rooms, &c., and the important part it plays in the analysis of water, he refers to the determination of the quality of the yeast as by far the most important use of the Microscope to the brewer. "The presence or absence of certain bacteria is of vital importance, as it is these foreign organisms that cause the unhealthy fermentations that used to perplex brewers so much; but which (thanks to such men as Pasteur, Huxley, Tyndall, Lister, Budd, and others) they are now learning to detect and remove. The germs most frequently found contaminating yeast are *Bacterium lactis*, *B. aceti*, and *B. amylobacter*, and it is these three that are familiar—too familiar—to most brewers. We now know that a healthy yeast-cell should not be larger than 1/2000 in. in diameter, and as a micrometer is an indispensable adjunct to every brewer's Microscope, the size is easily measured. We know that the absence of any vacuole in the cell denotes the plant to be too young, and not fit to induce a vigorous fermentation, and that the presence of more than three vacuoles and a shrivelled cell, at once points out the yeast to be too old. We learn from the presence of an undue amount of lactic and other ferments, when it is time a change of yeast was sought, and the 'change' having arrived, we can examine it before using, and determine the age and quality of the purchase."

The author adds that as this is intended for non-professional readers, he will not enter into any lengthy detail. "This is merely to show that, whilst the Microscope affords a most pleasing recreation to many men, and a deep life-study to others, its value to a trader is not the least of its uses. The growing taste for microscopical research amongst men is a sure sign of the intellectual age in which we live; and now that a good instrument can be purchased for such a small outlay, it behoves all men to get as deep an insight as possible into the wonders of the world around us."

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[Recommendation of Washington for the next meeting.]

The Microscope, VI. (1886) p. 273.

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[Angry remonstrances as to his not having been furnished with the earliest information as to the new glass and objectives, instead of having to take his account of them from this Journal.]

Zeitschr. f. Wiss. Mikr., III. (1886) pp. 393–4.

Bolton, Thomas, F.R.M.S.

[Grant of a Civil List pension of 50*l.* per annum.]

Midl. Naturalist, X. (1887) pp. 22–4.

Bostwick, A. E.—**On a means of determining the Limits of Distinct Vision.**

["Let a ruler lean against the shade of a lamp; place the eye so near that the image is necessarily blurred, and, moving the edge of a sheet of paper back and forth before the eye, step slowly backward till apparent motion of the object ceases; continue the backward movement until the object begins to recede slightly from the screen; the space where there was no motion is that in which alone distinct vision is possible. Of course, every effort must be made to accommodate the focus of the eye to the object during the whole experiment. It is a more difficult task than one thinks, to decide by simple judgment whether an object is distinctly seen or not, except it be much blurred. If the image is fairly distinct, most people will suppose it to be perfectly so. The test described above never fails to show whether or not the judgment is correct."]

Science, VIII. (1886) p. 232 (1 fig.).

Burrill, J. T.—**Bacteria and Disease.**

[Presidential Address to the American Society of Microscopists, 1886.]

St. Louis Med. and Surg. Journ., LI. (1886) pp. 131–45.

Christian, T.—**[Slide for testing Astigmatism of the eye.]**

["Mr. Christian exhibited an interesting test slide (his own preparation) ingeniously mounted, with a view to discover any astigmatism of the eye. It consists partially of diatoms of the *Navicula* shape. If the eye of the observer

can see simultaneously all the lines of the objects in the field well defined and resolved, then his eye is practically without astigmatic defect. The object of this important test-slide is very obvious, as incomplete perceptions are often erroneously attributed to the inferiority of the objective used, when in fact they are the result of an astigmatic defect in the observer's eye. Results of observations among microscopists often differ because the operators of instruments are frequently not aware of the astigmatic condition of their eyes."]

Amer. Mon. Micr. Journ., VII. (1886) p. 220.

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[Cf. Journal, 1886, pp. 316 and 849.]

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[Cf. Journal, 1886, pp. 316 and 849.]

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DORST, F. J.—**Ueber die Grösse der Beobachtungsfehler beim Ablesen eingetheilter Instrumente.** (On the extent of the errors of observation in reading-off divided instruments.) [*Supra*, p. 155.]

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Journ. and Trans. Phot. Soc., XI. (1886) pp. 25–9 (1 fig.).

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[1, 2, and 3, see *β*. 4. Paper for cleaning the lenses of objectives and oculars, *post*. 5. See *β*.]

The Microscope, VI. (1886) pp. 265–8 (2 figs.).

Glass, the New. [*Supra*, p. 155.] *Micr. Bulletin* (*Queen's*), III. (1886) pp. 35–6.

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Bull. Soc. Belg. Micr., XIII. (1886) pp. 5–11.

HILDEBRAND, H. E.—**Ueber einen einfachen und sehr gebrauchsfähigen Objectführer.** (On a simple and very useful object-carrier.) [*Supra*, p. 154.]

Zeitschr. f. Wiss. Mikr., III. (1886) pp. 386–9 (3 figs.).

Hillhouse, W.—See *Strasburger, E.*

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[Report of the meeting and editorial comments on the apathy of the Chautauqua people, and on the conduct of a member who at the Soirée exhibited to a mixed assemblage "living" human spermatozoa, under the description of "the germs of life."]

St. Louis Med. and Surg. Journ., LI. (1886) pp. 153–7.

" " Ditto.

["Mr. E. H. Griffith, of Fairport, N.Y., the originator and for several years past the superintendent of the Working Session of the American Society of Microscopists, is very much chagrined at a mistake which occurred at Chautauqua, and which cost him and the Society several valuable books, slides, and instruments. Having received from California some microscopical material for distribution, he announced the fact in open session, and told all who desired specimens to come to his table and help themselves. Quite a number of persons availed themselves of the offer and helped themselves, not only to the unmounted material, but to a large number of rare and costly mounted slides belonging to the Society, and some valuable books which chanced to be on the same table. Similarly, Mr. Griffith's offer to loan any instrument on his table to workers in the session, was taken to mean that the parties could keep what they borrowed —the result being a nett loss of four new and costly Griffith's turntables. No doubt those who took the books and slides did so under a misunderstanding of

Mr. Griffith's words, and they will promptly make reparation. Those who kept the turntables can scarcely be judged so leniently. Still it is possible that they too misunderstood the offer. At any rate, prompt reparation should be made. If it is not done, the matter should be looked into by the Society, and an example made of the persons who so abuse the privileges of membership. The 'nipping' of fine slides has become entirely too frequent to be pleasant to those who have to stand the loss. The writer's cabinet has suffered a greater or less depletion from this source at every meeting that he has attended, and the 'nippers' must henceforth be on their good behaviour or exposure will most certainly follow."]

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Moore, A. Y.—A central-light Objective.
[Report on Spencer objective "1/18 105° B.A."]
The Microscope, VI. (1886) pp. 241–2.

" " Gold-plated Diatoms.
["From A. Y. Moore we have received another novelty, namely, preparations of the diatom *Arachnoidiscus*, plated with gold by electricity. These make very rich and elegant objects, and present some interesting features, among which may be noted the prominence with which the rays or ribs stand out. Dr. Moore states that 'by making the diatom opaque, points of structure may be determined which probably would not otherwise be seen.' Certainly, independent of any scientific value they may have, these slides constitute a very attractive novelty."]
Micr. Bulletin (*Queen's*), III. (1886) p. 35.

N., W. J.—The Two Mirrors (*contd.*) [*Post.*] *Sci.-Gossip*, 1886, pp. 265–8 (2 figs.).

Nelson, E. M.—A method of finding out the general character of the components of a cemented combination.
[*Supra*, p. 151.] *Engl. Mech.*, XLIV. (1886) pp. 320–1 (3 figs.).
Journ. Quek. Micr. Club, III. (1887) pp. 13–7.

Objectives, new Apochromatic.
Journ. Quek. Micr. Club, III. (1887) pp. 22–4 (T. Curties and J. E. Ingpen)—*Micr. Bulletin* (*Queen's*), III. (1886) p. 46 (G. A. Piersol)—*Naturforscher*, XX. (1887) pp. 29–31.

Outerbridge, G. E., Jun.—The Limit of Thinness.
[Gold leaf on glass plates not more than the 1/400,000 mm. thick.]
Scientific Enquirer, II. (1887) pp. 9–10.

Pelletan, J.—See *Mayall, J., Jun.*

Pennetier, G.—De l'enseignement de l'histoire naturelle et de la micrographie commerciale. (On the teaching of natural history and on commercial microscopy.)
[Address to the International and Industrial Congress at Bordeaux, 1886, advocating natural history being placed on the same footing as physics and chemistry in the "Cours de Marchandises" of the Higher Schools, with a laboratory for microscopical technique as applied to commerce and industry.]
Journ. de Microgr., X. (1886) pp. 486–93.

PSCHEIDL, W.—**Bestimmung der Brennweite einer Concavlinse mittelst des zuzammengesetzten Mikroskops.** (Determination of the focus of a concave lens by the compound Microscope.) *SB. K. Akad. Wiss. Wien*, XCIV. (1886) pp. 66–70.

Quimby's (B. T.) Slide-carrier.

[Two thin pieces of wood, rather larger than a slide, with a round hole piercing their centre. Narrow strips of sufficient thickness are fastened between the top and bottom pieces, dividing the interspace into three compartments, into the middle of which a square of blue glass may be inserted, while the end spaces are for the clips. In the upper surface of the carrier behind is a ridge to prevent the slide from slipping down.]

The Microscope, VI. (1886) pp. 269–70.

ROYSTON-PIGOTT, G. W.—**Microscopical Advances. XV.**

[On the circular solar spectrum.] *Engl. Mech.*, XLIV. (1886) p. 337 (9 figs.).

SARGENT, T. L.—See Wells, S.

SCHRÖDER, H.—**Notiz in Bezug auf Korrektion des sekundären Spektrums.** (Note on the correction of the secondary spectrum.)

[Having examined about fifty varieties of glass used by Ross and Co., from Dollond's time, and having determined the constants of each for the seven principal lines of the spectrum, he found three varieties which are suited to secure the absolute coincidence of any three lines in the spectrum; these are dense English flint, a crown glass of high dispersion and relatively low index made exclusively for Ross and Co., and a variety of plate glass containing a high proportion of aluminates which has a mean index as great as that of the crown glass. A good achromatic compound Ross Microscope being used as eye-piece, it was found that (the objective being small) absolutely no secondary colours were to be observed either at the focus or away from it, although the calculations point to the existence of such. By the combination of both sorts of crown with light English flint coincidence of the lines D E G was attained, and a combination of both sorts of crown with dense English flint was made to ensure coincidence of the lines B D G.]

Central-Ztg. f. Opt. u. Mech., VII. (1886) pp. 205–6.

Science Directory. *Sci.-Gossip*, 1886, p. 256.

Science in 1886.

["The new optical glass which has been invented by Abbe, of Jena, is of great interest, especially among microscopists, vastly improving the observing power of the instruments with which they work."]

Times, 6th January, 1887, p. 3.

STEIN, S. T.—**Das Licht im Dienste wissenschaftlicher Forschung.** (Light as an aid to scientific research.) V. Die Photogrammetrie, Militärphotographie und Optische Projektionskunst. (Photogrammetry, military photography, and the art of optical projection.) 2nd ed., viii. and 146 pp. and 170 figs., 8vo, Halle, 1887.

Stenglein's Mikrophotogramme zum Studium der angewandten Naturwissenschaften. Lief. I. 16 pp. and 12 photomicrographs, Berlin, 1886.

Strasburger, E.—**Handbook of Practical Botany for the Botanical Laboratory and Private Student.** Edited from the German by W. Hillhouse. Revised by the author and with many additional notes by author and editor. [*Supra*, p. 120.]

xxiv. and 425 pp., 134 figs., 8vo, London, 1887.

[Also edition in Russian, xiv. and 304 pp., 114 figs., 8vo, Moscow, 1886.]

TASCHENBERG, O.—**Bibliotheca Zoologica II.** Verzeichniss der Schriften über Zoologie welche in den periodischen Werken enthalten und vom Jahre 1861–1880 selbständig erschienen sind. (Index to the zoological papers contained in periodicals and which have appeared separately from 1861–80.)

[Continuation of Carus and Engelmann's Bibliotheca Zoologica, 1846–60. Parts 1 and 2 contain a bibliography of the Microscope and microscopical technique, pp. 279–348, including A. C. Swinburne's 'Under the Microscope'].

8vo, Leipzig, 1886.

TREAT, M.—See Wells, S.

W.—**Ausstellung wissenschaftlicher Instrumente, Apparate und Präparate.** (Exhibition of scientific instruments, apparatus, and preparations.)

[Brief description of the Exhibition at Berlin, which included Microscopes and polarization and photomicrographic apparatus.]

Zeitschr. f. Instrumentenk., VI. (1886) pp. 348–52, 388–91.

WALES, W.—**A Cover-carrier for Immersion and Dry Lenses.** [*Post.*]

Journ. N. York. Micr. Soc., II. (1886) pp. 125–6.

WELLS, S., TREAT, M., and SARGENT, T. L.—**Through a Microscope:** something of the science, together with many curious observations, indoor and out, and directions for a home-made Microscope. iii. and 126 pp., 8vo, Chicago, 1886.

Winkel, R.—**Apparat zum Markiren mikroskopischer Objecttheile.** (Apparatus for marking parts of microscopic objects.)

Title only of German Patent, Kl. 42, No. 4365.

Wood, R. W., Jun.—**A simple Polariscope.**

[Black glass substituted for the mirror for the polarizer. Eighteen circular coverglasses for the analyser.]

The Microscope, VI. (1886) pp. 268–9 (1 fig.).

Zeiss's (C.) Ten Thousandth Microscope.

[He "recently placed in a box with his own hands the ten thousandth Microscope he has made."]

The Microscope, VI. (1886) p. 284.

β. Collecting, Mounting and Examining Objects, &c.*

(2) (*b*) Preparing Special Objects.

Preparing Eyes of Mammals.†—The eyes of certain mammals used by Dr. A. Dostoiewsky were hardened in Müller's fluid for periods varying from a few days to several months. Many of the eyes had previously been placed for 24–48 hours in a 2 or 3 per cent. chromic acid solution. For cutting, the anterior half of the eye was imbedded in celloidin used in three different strengths (thin, medium, and thick). In each of these solutions the preparation was left for at least 24 hours. It was afterwards immersed in a mixture of 2 parts of ordinary spirit and 1 part of water. The direction of the sections was meridional, transverse, and tangential. For staining, Böhmer's hæmatoxylin and eosin were exclusively used. The logwood solution was several months old, and very weak. This device prevented the celloidin from becoming stained.

Preparing Eyes of Birds.‡—Dr. W. B. Canfield, in his researches on the accommodation apparatus of the bird's eye, employed Semper and Frederieq's method for dry preparation, and also the celloidin process. The eyes were fixed in Müller's fluid, and then hardened in spirit. For decalcification, saturated solution of picric and chromic acid, and nitric acid 2 per cent. were used. The eyes were then imbedded in celloidin by Czermak's method, and the sections, stained with hæmatoxylin and eosin, were mounted in balsam.

Preparing Molluscan and Arthropod Eyes.§—In elucidating the structure of molluscan and arthropod eyes, Mr. W. Patten notes the satisfactory results obtained by the following methods:—When sections were not resorted to, the tissues were hardened a very little and then macerated. The use of chromic acid had to be varied in strength and temperature, &c., for different regions; it was found especially useful to shift in half an hour from a one-tenth per cent. to a one-twentieth, in 24 hours back again to one-tenth, in 24 hours to a one-fifth, where it was kept for 48–60 hours. The cornea was best treated with picro-chromic, the lens with picro-sulphuric, the layer of nerve-fibres below the septum with one-fifth per cent. chromic acid for 24 hours, the retinophoræ with chromic, the rods and retinidia with one-fifth per cent. chromic at 50° C. for half an hour. The best preparations, with all the parts in the most natural position, were

* This subdivision contains (1) Collecting Objects; (2) Preparing, (*a*) in general, (*b*) special objects; (3) Processes prior to making sections; (4) Cutting, including Imbedding and Microtomes; (5) Staining and Injecting; (6) Mounting, including slides, cells, preservative fluids, &c.; (7) Examining objects, including Testing; (8) Miscellaneous matters; (9) Bibliography.

† Arch. f. Mikr. Anat., xxviii. (1886) pp. 91–121 (2 pls.).

‡ Ibid., pp. 121–70 (3 pls.). § MT. Zool. Stat. Neapel, vi. (1886) pp. 733–8.

obtained by killing the eyes first with one-tenth per cent. chromic acid for half an hour, allowing them to remain in one-half per cent. for 24 hours, one-tenth per cent. for 24 hours, and finally one-fifth per cent. for 48 hours or more.

Demonstration of Bile-capillaries.*—For the demonstration of the biliary capillaries, Dr. M. Miura used the following methods:—A small piece of liver, after having been in Müller's fluid for 2–5 days, is washed with ordinary water and laid in distilled water for 3–5 hours. It is then transferred for 2–3 hours to a 15 per cent. watery grape-sugar solution. It is next placed for two or three days in a 0·1–0·2 per cent. solution of gold chloride. The gold solution is to be changed two or three times. Finally the preparation is again left for two or three days in the grape-sugar solution, but without access of air, until it assumes a dark violet or black colour. The bile-capillaries are stained a purple red.

Preparing Horse-hoofs.†—In Dr. C. Nörner's investigations, directed chiefly towards the discovery of nerve-fibres, the hard corneous layers were first removed from the hoof, and then small pieces of the softer tissues were cut out and placed in osmic acid and gold chloride. Pieces of tissue were placed in osmic acid (1:100) for 24–48 hours, they were then washed and stained in picro-carmine (*in toto*). In using the gold chloride, the fresh pieces were first rendered sufficiently transparent by soaking for one to five minutes in one-third formic acid. They were then transferred to a gold chloride solution (1:100 or 1:200) for 20 hours. After washing, the gold is reduced by putting the pieces in a weak solution of formic acid for 24 hours in the dark. They were then hardened in absolute alcohol and stained *in toto* in picrocarmine. The sections were first examined in dilute glycerin, and those showing numerous nerves were placed, after staining, in dilute picric acid, then passed through alcohol to oil of cloves, and mounted in balsam.

In preparations thus treated the nerves, stained dark violet to black, show up against the red background. The author does not speak encouragingly of either method, as he found that both were unsatisfactory.

For examining the histological structure of the hoof, pieces of the softer parts were stained *in toto* in Ranvier's picrocarmine, and were then hardened in alcohol. The sections were then placed in water slightly acidulated with picric acid and mounted in balsam or in formic acid glycerin; or the pieces were first cut and then stained.

Showing Mitosis in Brain of Tadpole.‡—Prof. A. Rauber has in his researches found the following methods most successful in displaying the nuclear division in the nervous system of frog embryos. For hardening, 1/3–1/2 per cent. chromic acid, and alcohol, or Flemming's mixture of chromic, osmic, acetic acids and water, were found most satisfactory. For staining, safranin solution or gentian-violet, or picrocarmine and hæmatoxylin, alone or successively, yielded the best results.

Method of Studying Development of Genital Organs of Pulmonata.§—In his account of the development of the generative apparatus of Stylommatophorous Pulmonata, Dr. J. Brock states that *Agriolimax agrestis* is a satisfactory species to cut into sections for the purpose of orientation when

* Virchow's Arch. f. Pathol. Anat., xcix. (1885) pp. 512–21 (1 pl.).
† Arch. f. Mikr. Anat., xxviii. (1886) pp. 171–224 (1 pl.).
‡ Ibid., xxvi. (1886) pp. 622–44 (1 pl.).
§ Zeitschr. f. Wiss. Zool., xliv. (1886) pp. 338–9.

dealing with sections of unknown forms or such as are likely to disturb the disposition of parts by coiling or contraction. The young were killed in 0·1 per cent. chromic acid solution, to which a little (1 drop to a 1 per cent. solution in a watchglass) osmic acid was added; they were then treated with alcohol of increasing strength, coloured *in toto*, carefully dehydrated, and cut by Jung's microtome into sections of 1/120 mm. thick. Staining was effected with alum or borax-carmine; occasionally combinations of the two gave excellent effects. In a footnote the author remarks that the finest and most precise colorations of nuclei are got with alum-carmine, in the case of molluscs and vertebrates; with Arthropods the coloration is less intense and certain, owing to a peculiar swelling of the tissue.

Preparing Sections of Stem and Root.*—In his investigation of the origin of lateral roots in Dicotyledons, M. A. Lemaire found that sections simply hardened in alcohol were not available, owing to the contraction of the protoplasm; and the same objection applies to the use of calcium chloride; the presence of tannin is also a serious obstacle to their examination. M. Lemaire finds the following process produce good results. The section is first placed in the solution of sodium hypochloride known as *eau de Labarraque*, until the colouring matters are entirely destroyed and the nucleus and protoplasm dissolved, the cell-walls being left intact. This requires a submersion of from 15 to 20 minutes; but one to two hours produces no bad effect. The best staining material is then anilin-brown, which he uses as a solution of 3–4 per cent. in absolute alcohol. The preparations after being repeatedly washed in distilled water, are placed in drops of this fluid for some minutes, then immersed in absolute alcohol, and finally in oil of cloves until they attain the desired transparency; and finally mounted in Canada balsam. Sections prepared in this way are remarkably clear, and may be preserved for a long time. Mounting in glycerin does not answer so well. The process will apply to the study of all merismatic tissues.

Preparing the Epidermal Tissues of Pitcher Plants.†—Dr. J. M. Macfarlane states that the difficulty he experienced in getting clean and large pieces of the epidermis from the different surfaces of pitchers induced him to try various methods of preparation. Maceration in caustic potash solution of 2 per cent. strength gave admirable results. The pitchers to be macerated were placed whole in beakers containing the solution, and boiled over a Bunsen flame for from 10 minutes to 2 hours. The pitchers of *Nepenthes*, if young and fresh, had both outer and inner epidermis loosened from the green cellular and fibrovascular systems after about 15 or 20 minutes' boiling; old or dried pitchers required 30 to 60 minutes. By floating them afterwards in clean water both epidermal layers could be detached with great ease. Pitchers of *Cephalotus* were macerated after 10 to 20 minutes' treatment, but those of *Sarracenia*, *Heliamphora*, and *Darlingtonia*, except when young and tender, required boiling for about 2 hours, with subsequent maceration for 2 or 3 weeks in water.

In this way not only could long pieces be obtained for continuous microscopic examination of the surfaces, but bottled hand specimens of the entire inner epidermis of *Nepenthes* could be made, showing clearly to the naked eye the attractive, conducting, and secreting surfaces, with associated glands. Similar treatment of leaves for preparations of hairs, water and air stomata, &c., give equally good results in many cases.

* Ann. Sci. Nat. (Bot.), iii. (1886) pp. 172–4.
† Rep. 55th Meeting (1885) Brit. Assoc. Adv. Sci., 1886, p. 1088.

Preparing Lactarius to show Branched Laticiferous Vessels.*—Dr. A. Weiss finds that pieces of *Lactarius deliciosus* should not be kept too long in spirit, and that sulphuric acid shows the course of the vessels very plainly, the contents of the tubes assuming quickly a blue-black colour. The surrounding tissue being greatly affected by the reagent, the laticiferous vessels appear still more clearly, and slight pressure on the cover-glass serves to separate them for some distance. Iodine water imparts to the tubes and their contents a trace of green, which is rendered more intense by potash, and the juice appears in large dark-orange coloured drops. The colour afterwards passes into brown. Ferrocyanide of potash, sulphocyanide of potash, nitrate of silver, bleach the juice. Platinum chloride, cobalt oxide, chromic acid, and potassium bichromate have no effect; gold chloride stains the vessels blue-black, the hyphæ greenish yellow. Sulphuric acid stains the contents of the vessels yellow, yellowish green, greenish black, and finally blue-black; the contents of the hyphal filaments rose-red. Iodine solution brings out a very dark almost black colour in the vessels.

Solution of Starch in Leaves.†—M. L. Brasse describes the manner in which a diastatic ferment can be extracted from green leaves. The leaves are bruised in a mortar and covered with cold water; after twenty-four hours they are pressed, $1\frac{1}{2}$ volumes of 90° alcohol added, and the juice filtered. The same quantity of alcohol is again added to the filtrate and the precipitate thrown on a filter, and rapidly washed with alcohol of 65°. The diastase is obtained in solution by dissolving the washed precipitate in water and filtering.

New Reagent for Coniferin.‡—Dr. H. Molisch describes the mode of preparation and action of a new reagent for coniferin. We have hitherto been indebted to the reaction with phenol and hydrochloric acid for the identification of coniferin in plant tissues. A section containing coniferin, one of pine-wood for instance, if moistened with this reagent, gives in direct sunlight an intense yellow-green or blue-green or sky-blue. By the aid of this the general diffusion of coniferin in lignified tissues was recognized firstly by F. Tiemann and W. Haarmann, and then by v. Höhnel and Singer; in fact, this glucoside is stated to be always present in woody tissues or in lignin. During the study of two new sugar reactions,§ the observation was made that thymol colours woody tissue a striking blue-green in the presence of concentrated hydrochloric acid.

The observation was carried out as follows:—A 20 per cent. solution of thymol in absolute alcohol was first prepared; with this a section of pine-wood was moistened, and as much hydrochloric acid added as would fill the space between the cover-glass and the glass bearing the object. In a few minutes a green colour developed, which soon turned to blue-green or blue; or, if the above had taken place in direct sunlight, the colour would be almost immediately a deep sky-blue.

The author then quotes from a paper of T. and D. Tommasi, published in 1881, which pointed out the fact that a greater intensity of colour is obtained when working the phenol-hydrochloric acid reaction, if previously some potassium chlorate be added to the acid. Taking advantage of this result, the following reaction is used by the author as being the most

* SB. K. Akad. Wiss. Wien, xci. (1885) pp. 166–202 (4 pls.).

† Ann. Agronom., xii. pp. 200–3. See Journ. Chem. Soc. Lond.—Abstr., l. (1886) p. 827.

‡ Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 301–5.

§ See *infra*, p. 169.

serviceable in detecting coniferin. Water is added to a 20 per cent. solution of thymol in absolute alcohol as long as it remains clear and no thymol is precipitated. Crystals of potassium chlorate are then added in excess, and the solution is allowed to stand several hours, and filtered. Some paper which contained only a trace of coniferin was taken and moistened with this liquid, and a drop of concentrated hydrochloric acid added; in a few minutes, although in complete darkness, the moistened part became bluish green. With this reagent, sections from the stem of over a hundred woody and herbaceous plants were tried, and always with a positive result. In all the sections the lignified portions only became blue; in the first place the walls of the xylem-elements, then those of the pith and the bast-cells.

Finally, the author refers to a paper of Wiesner's, who states that he obtained a red-violet colour when phloroglucin, lignin, and hydrochloric acid are brought together. The presence of phloroglucin in some measure conceals the reaction for coniferin; but not so much so as to make it altogether inapplicable.

Engelmann's Bacterium-method.* — Dr. N. Pringsheim replies to Engelmann's further defence † of the accuracy of this method of determining the intensity of the evolution of oxygen in plants under the influence of sunlight. He reasserts the inadequacy of the method of successive observations, from the inconstancy of the minimum width of the cleft needful for the movement of the bacteria in the different colours. The movement can often be followed up to the disappearance of the object, and it usually ceases in all colours at nearly the same width of cleft, which, in direct sunlight, is about 0·008 mm.; while, on the other hand, the minimum widths for the visibility of the movement in the different colours of the spectrum—red, yellow, green, and blue—do not stand in a constant relationship to one another, as required by Engelmann's theory.

Preparing the Bacillus of Lustgarten.‡—MM. Alvarez and Tavel have modified Lustgarten's method as follows: instead of sulphuric acid they use 2 per cent. oxalic acid; a stay of two hours in the warm solution they find sufficient; and they double stain with eosin, picro-carmine, and safranin. They approve De Giacomi's method if the iron chloride be strongly acid. Against Lustgarten they maintain that the syphilis bacillus, like that of tubercle, strongly resists decolorization by acids (33 per cent. nitric, hydrochloric and sulphuric acids). The authors, however, mention a difference between the two bacilli, which is, that Lustgarten's microbe becomes immediately unstained by alcohol after treatment with acid: the acid must therefore be well washed out in water, if the colour is to be retained.

Method of obtaining Uric Acid Crystals from the Malpighian Tubes of Insects, and from the Nephridium of Pulmonate Mollusca.§—By the method adopted by Dr. C. A. MacMunn, he obtained abundance of crystals of uric acid from the contents of the Malpighian tubes of a single insect, and the method is therefore likely to be useful in determining whether a given organ in an invertebrate animal discharges a renal function or not.

The insect examined was *Periplaneta orientalis*. The Malpighian tubes, after crushing, were boiled in distilled water to dissolve the supposed

* SB. Versamml. Deutsch. Naturf. u. Aerzte, Sept. 20, 1886. See Bot. Centralbl., xxviii. (1886) p. 93.

† See this Journal, 1886, p. 705. ‡ Arch. de Physiol., xvii. (1885) p. 303.

§ Journ. of Physiol., vii. (1886) pp. 128-9.

urate or urates, the extract evaporated to dryness, the residue extracted with boiling absolute alcohol and this extraction twice repeated, the alcoholic solution poured away, the residue again boiled in distilled water and filtered while hot. To the filtrate an excess of acetic acid was added, and after the lapse of some hours crystals were easily found with a 1/5 in. objective. These occur mostly in hexahedral plates, also in the so-called "coffin-shaped" crystals and in prismatic needles crossing each other, also in groups of star-shaped form composed of prismatic and "whetstone" crystals, and in other forms.

Some of the residue, when evaporated to dryness and nitric acid was added, effervesced; on evaporating the acid the residue was reddish. On holding a glass rod wet with ammonia close to it, a fine purple colour was seen, and on adding caustic soda instead of ammonia it showed a beautiful violet colour.

On applying the same methods to the contents of the nephridium of *Helix aspersa* a similar result was obtained, the crystals, however differing in shape and size, but corresponding, nevertheless, to the well-known forms in which uric acid is known to crystallize. Some of the crystals obtained were cubical, some hexahedral, others prismatic with truncated angles, others coffin-shaped, and so on. Both in the case of *Periplaneta* and *Helix* the size of the crystals depends on the method of preparation; for instance, they are smaller when the acetic acid solution is boiled.

The dried residue in the case of *Helix* also gave the murexide reaction distinctly, and the above-mentioned colour changes with caustic potash.

From the nephridium of *Limax flavus* similar crystals were obtained, and in this case too the murexide reaction was equally well marked.

In the juice of the nephridium of *Helix* spherical crystals are found, which have been mistaken by some observers for crystals of the colouring matter of the so-called bile of this mollusc; they probably consist of urate of soda (and calcium), and are at all events the urate of the base which yields uric acid by the above treatment. In their interior needles can be seen radiating from the centre to the periphery. It has been shown by Griffiths that the "green gland" of the crayfish can be made to yield crystals of uric acid, and he has more recently found uric acid in the organ of Bojanus of *Anodon*, but in his experiments caustic potash was used; a method open to the objection that possibly, though not probably, the reagent may have had something to do with the result; but in the present case acetic acid was the only reagent used, which is not open to this objection.

Hence it may be safely concluded that the view held that the Malpighian tubes of insects and the nephridium of the Pulmonate Mollusca function like the kidney of vertebrates is quite correct.

(4) Cutting, including Imbedding and Microtomes.

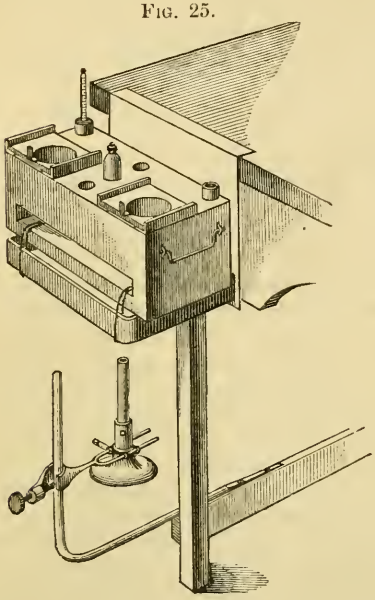
Water-bath Apparatus for Paraffin.*—Mr. E. L. Mark finds it preferable to have a water-bath for each student instead of a common tank for all, a plan which has the advantage of all the materials being close at hand. Moreover, it is more convenient to have the top of the bath nearly level with the top of the table, rather than as a tripod standing on the table. The gas-jet should be adjustable for distance in preference to the bath.

The bath (fig. 25) is a modification of that used at the Naples Zoological Station. It is fixed on a wrought-iron bracket to the end of the work-

* Amer. Natural., xx. (1886) pp. 910-4 (3 figs.).

table, so that a space of 25 to 30 mm. is left between the edge of the table and the bath. The bracket is made of band iron, 25 × 3 mm., bent into a rectangular form. The gas-burner is carried by a movable forked clamp fixed to an iron rod bent at right angles, and which is screwed to the legs of the table.

Fig. 25.



The water-bath itself is made of tin-lined burnished copper, is 18 cm. long, 9 cm. broad, and 8 cm. high, and has an oven 1 cm. high near the bottom for heating slides. The water-space communicates externally by one "chimney" only.

In the top are two large and four small copper-lined wells. One of these is 7 cm. deep, the rest 4 cm. deep. The two larger wells are 6 cm. in diameter, and each receives a copper tank provided with a handle and a nose. On either side of the larger wells copper ledges are fixed for supporting glass plates to protect from dust.

In order to fill the wells with paraffin and to support the object to be imbedded, ladles made by beating out the end of a piece of copper wire are recommended. Of the smaller wells, three are 18 mm. in diameter and are intended for 2-drachm vials. The fourth well has a diameter of 24 mm., and is intended for a mercurial gas-regulator.

Orienting large objects in paraffin.*—Mr. E. L. Mark finds that for large objects all that is necessary is to place the glass plate on which the imbedding is to be performed on the top of an ordinary glass dish (5 cm. deep and 10 cm. in diameter is a convenient size), at the bottom of which a small mirror is so adjusted as to make an angle of a little less than 45° with the horizon. With the mirror turned towards the window the outlines of the object are rendered sufficiently distinct for most purposes of orientation.

Pfeifer's Revolving Automatic Microtome.†—Mr. A. Pfeifer's microtome (fig. 26) was designed to save time and labour in the preparation of series of sections, and to attain at the same time the greatest uniformity in the thickness of the sections.

The mechanism is very simple. The frame B contains a horizontal screw beneath the sliding carriage C. The carriage carries the knife K. This carriage is moved forward by the turning of the screw. Two arms of the frame support the axis J of the revolving wheel E, to which the imbedded object is attached. The knife K is clamped in an upright position on the arms rising from the sliding carriage, so that the edge of the knife is in the same horizontal plane with the centre of the axis J. Thus, as the sliding carriage is moved by the screw, so the knife is moved to or from the revolving object. The carriage slides by means of grooves

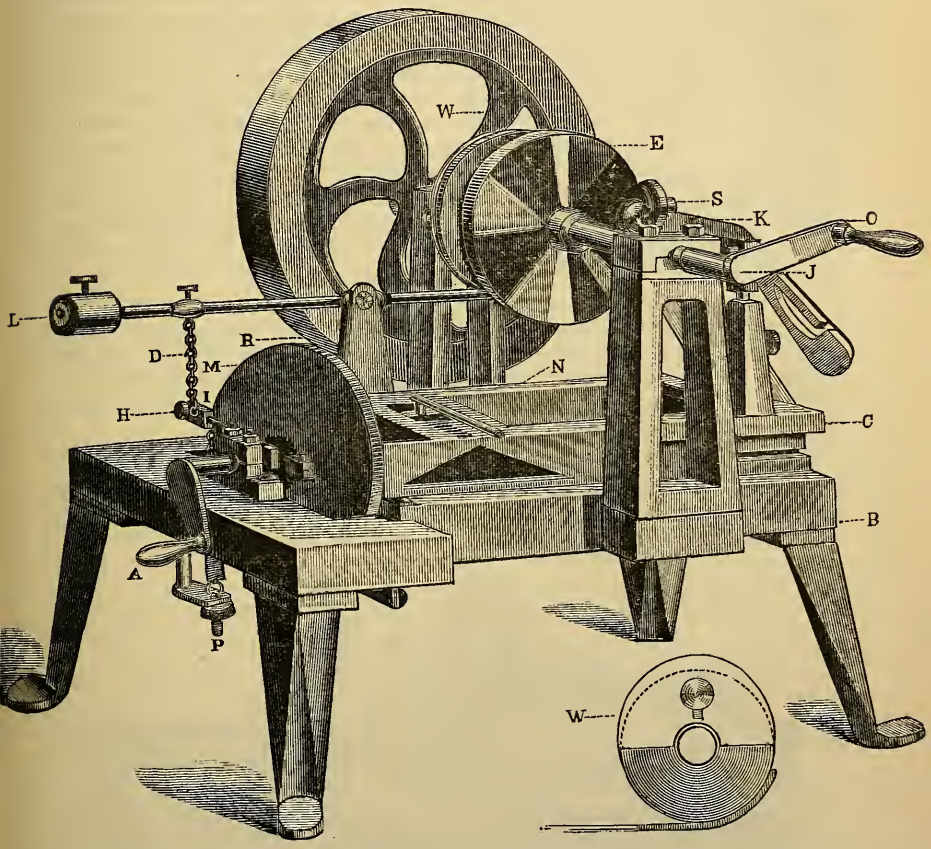
* Amer. Natural., xx. (1886) pp. 914–5.

† Studies from the Biol. Laborat. Johns-Hopkins Univ., iii. (1886) pp. 477–9 (1 fig.).

on raised tracks of the frame, and is not directly connected with the screw, but is simply pushed by the nut N. This arrangement makes it impossible that any slight eccentricity of the screw should cause a jolting of the carriage.

The head of the screw is a solid wheel M at the end of the frame, and has 250 ratchet-teeth on its circumference. The screw has 20 threads

Fig. 26.



to the inch. The knife, therefore, is moved an inch by 20 revolutions of the screw; and as there are 250 teeth to the revolution, each tooth represents $1/20 \times 250 = 1/5000$ inch.

The handle O turns the axis J, to which is attached the wheel E. This wheel is four inches in diameter, and to it is fastened the clamp which holds the object to be cut. The axis also carries a fly-wheel and an adjustable eccentric wheel W (figured separately). This eccentric moves a lever L, the long arm of which is connected with the small chain D. The chain lifts a small lever H, which works by means of a catch I on the teeth of the screw-head, causing the screw to revolve. The small lever is steadied and pulled back to its place by a spiral spring P, while another spring catch underneath the frame prevents the ratchet-wheel from turning back. By properly adjusting the eccentric wheel the levers may be made

to act so that the catch I will take any desired number of teeth by every revolution of the object. The knife moves only during that part of the revolution when the object is not in contact with the knife. The ribbon of sections slides downward from the knife and is caught on a piece of paper placed upon the table. The wheel holding the object, as well as the razor, can be moved so that almost all parts of the edge of the razor can be used.

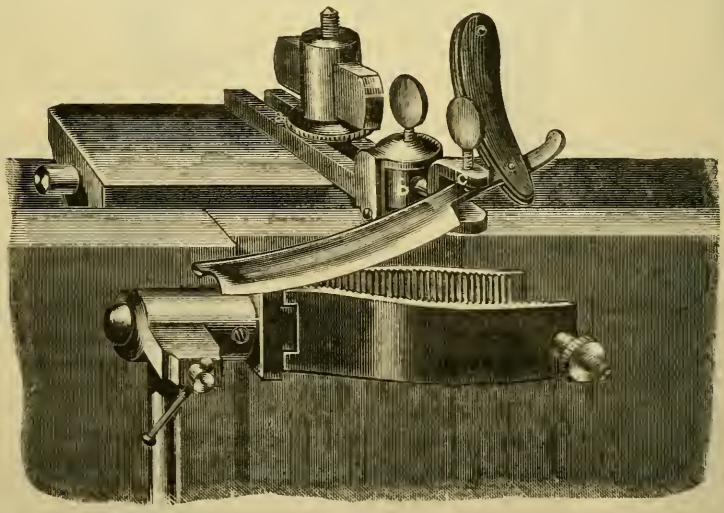
The frame-bed of the microtome is made of iron, the screw of steel, and all the rest is brass. Any ordinary microtome knife or razor may be used.

The machine has been in use at the Johns-Hopkins University at Baltimore, for a year, and gives the greatest satisfaction. It can be used with great rapidity, but so far the best results have been obtained at a rate of not over 100 sections to the minute. The only possible error in a revolving microtome of this kind is theoretical—namely, that owing to the circular motion of the object, each section is part of a hollow cylinder. But in reality, with objects of ordinary size, this error is not apparent, and even under a high magnifying power there is no perceptible difference between sections cut by this microtome and those cut by ordinary slide microtomes.

Hildebrand's Microtome.*—Dr. H. E. Hildebrand has made several improvements to his "Simple and effective Microtome" already described.† On the sides of the object- and knife-carriers excavations with roughish surfaces have been made for the reception of the thumb and first two fingers. The clamp of the knife-carrier is now made of metal and is lighter, and all the metal parts are nickeled.

Martinotti's Knife-holder for Sliding Microtomes.‡—Dr. G. Martinotti has designed a simple clamp (fig. 27) for the purpose of fixing ordinary razors to the carrier of the sliding microtome.

Fig. 27.



The arrangement consists of two clamps *a* and *c*, which are connected by a ball-and-socket joint *b*. The long bars of the clamp *a* are fixed to the

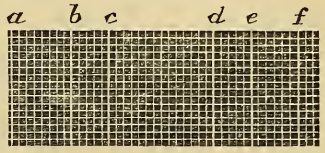
* Zeitschr. f. Wiss. Mikr., iii. (1886) p. 392. † See this Journal, 1886, p. 886.
‡ Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 390–2 (1 fig.).

carrier by a large screw. The short clamp *c* holds the razor (or even a microtome-knife). The ball-and-socket joint allows extensive motion in a horizontal direction, but the vertical movements, although sufficient, are more limited.

This simple accessory is intended chiefly for those microtomists who sharpen their own razors, and the only defect (which is pointed out by the inventor), is that it requires a certain amount of space between the slide and the object-carrier.

Determining the Reciprocal Positions of Object-points.*—For this purpose Prof. H. Strasser uses very thin paper ruled with fine lines as in fig. 28, and further subdivided by coarse vertical lines in such a way that the distances between $a\,b + e\,f = c\,d$ and $b\,c = d\,e$. A quadrilateral case is then formed of the paper thus ruled, by gumming the ends together so that the line *f* coincides with the line *a*. Within this case, supported by a metal box, the specimen is imbedded. Owing to the thinness of the paper no difficulty is experienced in making sections if the mass be cut with a very sharp knife. Each section is thus surrounded by a paper band in which vertical and horizontal marks are present. These marks are intended, *inter alia*, to aid in the recognition of the position of the section to the object.

Fig. 28.



Section-series and a new method for making Wax Modelling-plates.†—Prof. H. Strasser, in an article on the study of section-series, and on a means for facilitating the reconstruction of the dissociated form, describes an improvement and simplification of the plate-model system devised by Born,‡ consisting in the adoption of transparent plates which are also much thinner than any hitherto used.

The apparatus required in the preparation of the new plates are an iron roller, 4 cm. in diameter and 30 cm. in length; a water bath for keeping the wax at a temperature of 60°; some strips of tin and brass from 0·2 to 5·0 mm. thick, and a large smooth lithographic stone.

In preparing the wax plates, a piece of the still warm wax is kneaded out in the hands as flat as possible, and having been placed between two leaves of parchment paper kept moistened with turpentine, is rolled out by means of the roller previously warmed. The thickness of the lamella is regulated by the choice of the metal strips placed along the sides of the paper. When a perfectly flat layer has been thus rolled out, the parchment paper is stripped off and the plate dried between filter papers. To the surface of these wax plates paper is made to adhere by means of gum, for which purpose flour is first rubbed into the plate, or by melting it in by means of a hot roller. The plates thus produced are of fair size, and from 1/3 to 1/4 mm. thick.

In preparing wax-paper plates to which the section-sketch is attached, a very similar procedure is carried out. This method is to be preferred to the former as a rule. One of the leaves of tracing paper is placed on the lithographic stone damped with turpentine. On the other side is laid a strip of metal, then the wax is spread over the surface and the second leaf of tracing paper having been adjusted, a flat lamina is produced by rolling as before with the heated roller. The thickness of these plates, paper and

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 192–5 (1 fig.).
† Ibid., pp. 179–92 (1 fig.)
‡ See this Journal, 1884, p. 634.

all, may not exceed 0·2 mm. Although firm in consistence, they are perfectly flexible, and are cut with sharp knives or scissors quite easily.

The author mentions also a mixture of gum-tragacanth, sugar and flour, as capable of being rolled out into very thin plates, but does not indicate the proportions of the ingredients.

(5) Staining and Injecting.

Rosanilin Nitrate for Goblet and Mucous Cells.*—Dr. J. H. List now uses a 0·0001 per cent. of rosanilin nitrate for goblet and mucous cells. Sections taken from 50 per cent. alcohol are overstained in the above fluid for ten to fifteen minutes. The superfluous stain is then extracted in absolute alcohol. The nuclear structure, as well as the reticulum of the cell, are well shown. After hardening in chrom-osmium-acetic acid, the chromatin of the nucleus comes out extremely well. The karyokinetic figures in epithelium are also well shown.

Absorption of Colouring Matters by Plants.†—Dr. W. Pfeffer, as previously recorded, ‡ has discovered that certain anilin colours are taken up by living cells and eventually assimilated. It is possible, therefore, that these dyes may be used to study the processes of absorption. If, for example, *Trianea bogotensis* is placed in a 0·001 to 0·002 per cent. solution of methylen-blue, the cells of the root-hairs will be found, in a few hours, to be stained a deep blue, while blue granules are discerned in the cells of the root-epidermis. The solution must not be too strong as a poisonous effect is produced on the plant. Assimilation of methylen-blue takes place when plants are left in a solution of one part methylen-blue to ten million parts of water. The pigment may be removed without damage to the plant by a 0·01 per cent. solution of citric acid.

Methyl-violet, cyanin, fuchsin, methyl-green, Bismarck brown, are taken up to some extent, nigrosin and anilin-blue not at all.

Methyl-violet and cyanin stain the cell-protoplasm without damaging the life of the cell, and the blue staining of the protoplasm by cyanin demonstrates also the alkalinity of the protoplasm.

Relation of Fatty Matter to the Receptivity of Staining in Micro-organisms.§—Dr. A. Gottstein after treating sections and cover-glass preparations with fat-dissolving reagents (heating the preparations with caustic potash in alcohol 2–5 per cent.), finds that tubercle bacilli, treated by the Ehrlich method, give the characteristic reaction, while smegma bacilli lose their acid-resisting property when manipulated in a similar manner. The author remarks that while ordinary fats lose their anilin staining after the action of an acid, lanolin, like cholesterin and certain fat-crystals (Celli's and Guarnieri's pseudo-bacilli) presents a similar resistance to acids, as do tubercle bacilli; hence smegma bacilli probably retain their staining capacity from the presence of a body analogous to lanolin.

Phloroglucin Test for Lignin.‖—Herr A. Tschirch finds the application of phloroglucin-hydrochloric acid a very useful test for the degree of lignification in wood; or, since the bark of most Angiosperms contains phloroglucin, hydrochloric acid alone may frequently be used. In this way it is shown that the bracheids are much more strongly lignified than the stereids in a "mixed ring," ¶ the former taking at once a dark-red

* Zeitschr. f. Wiss. Mikr., iii. (1886) p. 393.
† Bot. Ztg., xliv. (1886) pp. 114–25.
‡ See this Journal, 1886, p. 638.
§ Fortschr. d. Med., iv. (1886) p. 252.
‖ Pringsheim's Jahrb. f. Wiss. Bot., xvi. (1885) p. 325.
¶ Cf. this Journal, 1886, p. 1008.

stain, the latter becoming only gradually red. The staining by hydrochloric acid alone was very distinct in all woods examined except those of *Sambucus*, *Juglans*, and *Colutea*, in which it was but slight. In *Syringa* the bracheids were coloured blue-green by this reagent. Instead of hydrochloric acid, concentrated sulphuric acid may also be used, when the lignified cell-walls of plants which contain phloroglucin are coloured cherry-red. The red staining begins on the cambial side of the bast-bundles, showing that the chief seat of the phloroglucin is the leptome.

(6) Mounting, including Slides, Cells, Preservative Fluids, &c.

Medland's Portable Cabinet.—Mr. J. B. Medland's cabinet (figs. 29 and 30) is 11 in. × 5 in. × 3½ in., "only 2½ in. larger than the ordinary case holding one-half the number" of slides. It contains sixteen trays for nine objects each. Each slide is held at its ends by the projecting side-flap of the tray, which is kept down by the succeeding tray, and so on, the lid holding the whole firmly down. When open the lid and front fall

Fig. 29.

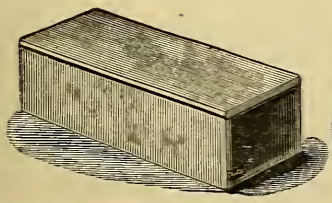
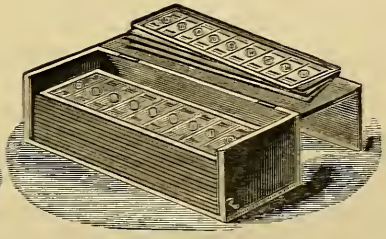


Fig. 30.



back, forming a stand or table upon which to place the trays, which are thus less liable to get displaced or upset than when placed among other apparatus or upon the work-table. The designer considers that the advantages of size, compactness, and the improvements over the ordinary case strongly recommend it to microscopists and others who may require to carry a number of objects in a small space with the least possible risk of damage.*

(8) Miscellaneous Matters.

Dissecting Pans.†—Mr. E. L. Mark recommends beeswax, rendered black with lampblack, as the best filling for dissecting pans, which should be made of glass. The most convenient size is 25 cm. by 15 cm., and about 5 cm. deep. The glass vessels are first heated in water, the temperature of which is gradually raised to near the boiling point; the hot wax is then poured in. If the surface become impaired the whole mass should be remelted, or the flame of a gas-jet be turned on to the surface for a short time.

Alling's Microscopical Records.—This book of forms is modelled after a plan suggested by Prof. S. H. Gage, modified to meet the wants of the general worker as well as the specialist by Mr. C. E. Alling.

* Cf. Engl. Mech., xliv. (1886) p. 363 (2 figs.); Sci.-Gossip, 1886, p. 258 (2 figs.); Nature, xxxv. (1886) p. 158.

† Amer. Natural., xx. (1886) p. 915.

Each page has (three times repeated) the following:—

Common Name	Method of Hardening
Scientific Name	Staining Agent
Locality obtained from	Clearing Agent
Obtained by	Mounting Medium
Mounted by	Date
Special Object of Preparation	Remarks

In addition to numbered spaces for 500 preparations, there are pages ruled for formulæ, so that they can be referred to by number and the repetition of the details with each object avoided. Also an index for cataloguing each preparation.

Gérard's 'Traité pratique de Micrographie.'*—This book, by Prof. R. Gérard, of the *École supérieure de pharmacie* at Paris, and formerly Director of the Microscopical Laboratory there, is one of the most extensive works on practical microscopy that has been published for some years. After a comparatively brief account of the Microscope and accessories, 325 pages are devoted to Botany, 48 to Zoology, and 64 to the application of the Microscope to clinical researches and hygiene. The illustrations include 279 woodcuts and 40 plates. The author gives throughout the work detailed statements of the technical processes which he has found most successful for each subject treated of.

Lee and Henneguy's 'Traité des Méthodes Techniques de l'Anatomie Microscopique.'†—Microscopists will remember the excellent 'Microtomist's Vade-Mecum' of Mr. A. B. Lee,‡ which collected and grouped in a convenient form the numerous and varied technical methods which had previously been scattered through a large number of serial publications. This work, whilst not strictly a translation of the 'Vade-Mecum,' is in the main founded upon it. Some chapters have been rewritten and extended, especially those relating to embryology, the cell, and the nervous centres. M. Henneguy claims that it includes "at once the grammar and the dictionary of microscopical technique." The translation was made by Mr. Lee and revised by M. Henneguy, and there is a commendatory preface by Prof. Ranvier.

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* Gérard, R., 'Traité pratique de Micrographie appliquée à la Botanique, à la Zoologie, à l'Hygiène et aux recherches cliniques,' iv. and 511 pp., 279 figs., and 40 pls., 8vo, Paris, 1887.

† Lee, A. B., and F. Henneguy, 'Traité des Méthodes techniques de l'Anatomie Microscopique, Histologie, Embryologie et Zoologie,' 8vo, Paris, 1887.

‡ See this Journal, 1885, p. 355.

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Sect. II. Animal Histology. No. 5. The Uterus. (Plate V. Uterus of Rabbit × 30.) No. 6. Mammary Glands. (Plate VI. Mammary Gland of Cat during period of lactation × 250).
Sect. III. Pathological Histology. Nos. 5 and 6. Congestion of Kidney. (Plate V. ?) (Plate VI. Parenchymatous Nephritis).
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[XII. Mounting media. XIII. Mounting in balsamic media. XIV. Mounting in aqueous media.]

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St. Louis Med. and Surg. Journ., LI. (1886) pp. 154–5, 281–2.

Rocellin.
["Rocellin colours bone, connective tissue, glands, and epithelium cherry-red; gold or orange serves for fresh or alcoholic or chromic acid preparations. Bone is stained deep orange-red, cartilage, gold, connective tissue, reddish; especially valuable for glandular tissue; it gives a splendid appearance to liver injected with Berlin blue, the blue vessels show on a gold ground; sections of skin give fine results. Preparations after washing and cleaning are best mounted in Canada balsam; oil of cloves is mostly used for clearing, but where the colours are very delicate, use oil of lavender or quite colourless oil of aniseed, as the yellow colour of the oil of cloves injures them."]
The Microscope, VI. (1886) p. 95.

STÖHR, P.—**Lehrbuch der Histologie und mikroskopischen Anatomie des Menschen mit Einschluss der mikroskopischen Technik.** (Guide to human histology and microscopical anatomy, including microscopical technique.)
viii. and 255 pp., 199 figs., 8vo, Jena, 1887.

STRASSER, H.—**Ueber die Nachbehandlung von Serienschnitten bei Paraffineinbettung.** (On the after-treatment of series sections with paraffin imbedding,) [*Post.*]
Zeitschr. f. Wiss. Mikr., III. (1886) pp. 346–50.

TAYLOR, T.—**Butter and Fats.**
[Reply to criticisms of editor of 'Science.'] *Science*, VIII. (1886) pp. 455–8.
Amer. Mon. Micr. Journ., VII. (1886) p. 211–13.
Photo-micrographs of Butter and Fats.
Cf. *Micr. Bulletin* (*Queen's*), III. (1886) pp. 47–8.

THANHOFFER, L. v.—**Beitrag zur Untersuchungstechnik des Centralnervensystems.** (Contribution to the investigation-technique of the central nervous system.) [*Post.*]
Math. u. Naturwiss. Berichte aus Ungarn, III. (1886) p. 79.

Tötungsmethoden für wirbellose Tiere. (Methods of killing Invertebrata.) [*Post.*]
Tageblatt d. 59 Versamml. Deutsch. Naturforscher u. Aerzte, 1886, pp. 411–4.
Naturforscher, XIX. (1886) pp. 517–8.

VRIES, H. DE—**How to make colourless specimens of plants to be preserved in alcohol.**
[Cf. 1886, p. 1075.] *Nature*, XXXV. (1886) p. 149.

Water-bath for use in Imbedding. [*Post.*]
Amer. Mon. Micr. Journ., VII. (1886) pp. 203–4.

WHELPLEY, H. M.—**The Microscope in Pharmacy.** [*Post.*]
The Microscope, VI. (1886) p. 280.

WHITELEGGE, T.—**List of the Fresh-water Rhizopoda of N. S. Wales. I.**
["When gathering aquatic plants in search of any of the *unattached* forms of microscopic life, they should never be lifted entirely out of the water, but floated or pushed into a bottle with as little disturbance as possible. By adopting this method many more living forms will be obtained than would be the case if the plants were lifted altogether out of water." Also directions for preparing and mounting rotifers, infusoria, diatoms, desmids, &c., using 1 per cent. osmic acid.]
Journ. Linn. Soc. N. S. Wales, I. (1886) pp. 497–504.

MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Grunow's Physician's Microscope.†—In this instrument, designed by Mr. J. Grunow (figs. 35 and 36), the whole stand is of brass, with

Fig. 35.

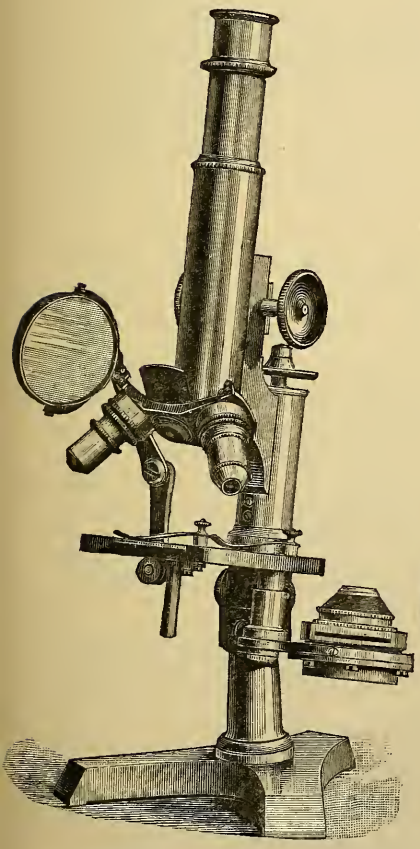
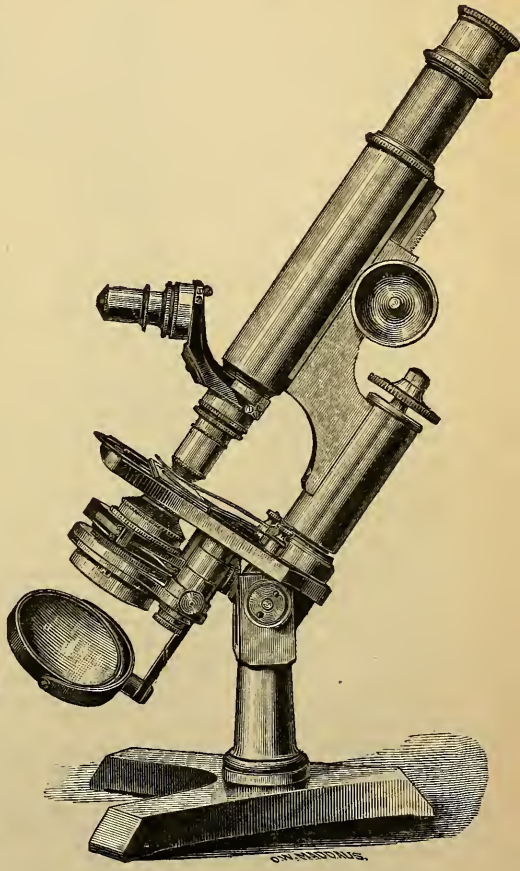


Fig. 36.



rack-and-pinion coarse, and micrometer-screw fine-adjustments. The stand can be inclined to any angle. The mirror is mounted on a double arm, so that it can be swung above the stage for the illumination of opaque objects. The substage is on a pillar attached to the base of the Microscope, and may be turned aside, thus facilitating the exchange of accessories without disturbing the object in the field.

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating Apparatus; (4) Other Accessories; (5) Photo-micrography; (6) Microscopical Optics and Manipulation; (7) Miscellaneous.

† The Microscope, vi. (1886) p. 245 (1 fig.).

Burch's Perspective Microscope.*—Mr. G. J. Burch, in 1874, while trying to devise means whereby the different planes of an object should be visible under the Microscope without the adjustment of the focus to each, discovered that, when two lenses are separated by a distance equal to the sum of their focal lengths, the optical conditions are such that the magnitude of the image bears a constant ratio to that of the object, no matter where upon the optic axis it is situated—the ratio being that of the focal lengths of the two lenses; that a given displacement of the object along the axis causes a displacement of the image in the same direction, but in the square of the ratio.

Further, that a picture drawn with the camera lucida under these conditions has the perspective of an object magnified in the square of the ratio, when it is brought within the proper distance of the eye.

The field of view of the perspective Microscope is small, but may be increased by using more than two lenses, and the author's researches gave him reason to believe that, with glasses of wide angle specially constructed, a high power, with sufficiently large field, might be obtained. Several uses other than microscopic were indicated, to which the instrument can be applied.

The paper, as read to the Royal Society, was accompanied by diagrams, showing, in two different ways, the changes of position of the principal foci and principal points, &c., of a system of two lenses, as the distance between them is varied, and a piece of moss was shown under the instrument, in magnified perspective.

Entomological Microscope.†—M. J. L. Weyers discusses the proper form, &c., of a Microscope suitable for entomologists, which we read with attention until nearly its conclusion, without clearly appreciating what the author proposed in the way of an improvement upon the existing forms. The last paragraph, however, dispensed with any necessity for again reading the paper to supply the missing clue. That paragraph runs as follows:—"In fine, the compound entomological Microscope requires no novel arrangement; no unknown accessory. It simply aims at uniting in one and the same instrument the different arrangements applied hitherto separately to the usual compound Microscopes."

Lehmann's Crystallization Microscopes.‡—Dr. O. Lehmann has now found it possible to construct a smaller, more portable, and cheaper form of the Microscope, with which his observations on the growth of crystals were made.§

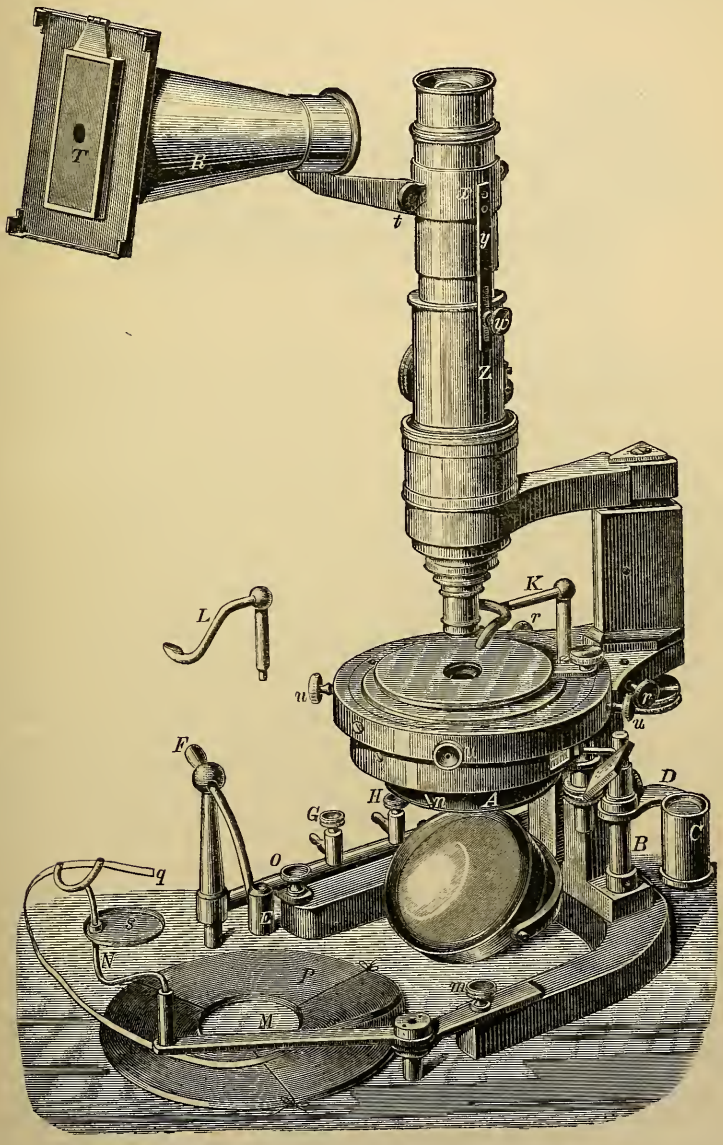
The new instrument, as described by him under the name of the "*Small Crystallization Microscope*," is shown in fig. 37, from which it will be seen that it is not so much a Microscope of special construction (in fact it is a Merz 1866 instrument) as an ordinary instrument adapted by the addition of certain supplementary parts.

The form of the stage is shown in fig. 38; the hollow rotating centre *b* carries the platinum covered stage *a* supported on a cylindrical ring which is pierced with numerous holes to allow the products of combustion to escape as indicated by the arrows, while to its lower side is fixed the graduated circle *c*; *d* is a handle by which the stage is turned, and which abuts against a stop for the zero point of the scale; the tube *e* in which the stage rotates is centered by the four screws *n*; the index is fixed to this

* Nature, xxxv. (1887) p. 358.
† Comptes Rendus Soc. Entomol. Belg., 1886, pp. xc.-iii.
‡ Zeitschr. f. Instrumentenk., vi. (1886) pp. 325-34 (3 figs.).
§ See this Journal, 1885, p. 117.

piece so that it is not disturbed by the centering of the stage, and at *f* is a small aperture through which the observer reads the scale from a vertical position by means of the inclined mirror shown in fig. 37. The rotation of the upper part of the Microscope is confined within very narrow limits by

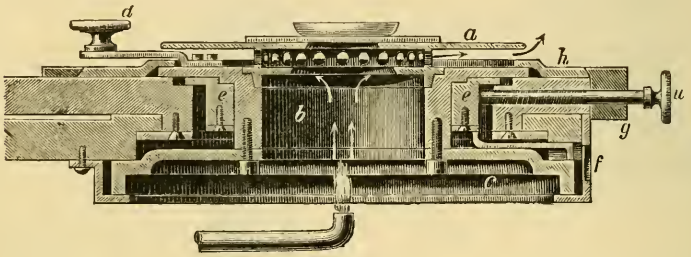
Fig. 37.



the two screws *r r* of fig. 37, and is only employed to bring the index and zero point of the scale into coincidence after centering. The cover *h* and circular band *g* serve as protections for this part of the instrument.

A (fig. 37) is the frame of a diaphragm of the ordinary form, except that the smallest opening has been replaced by a large one, which can be partially closed with a crescent-shaped screen by means of the handle *n*. C is the polarizer attached to the arm D, which slides on and revolves round the column B, so that it can be rapidly introduced and withdrawn while the object is being heated. The heating apparatus consists of the

Fig. 38.

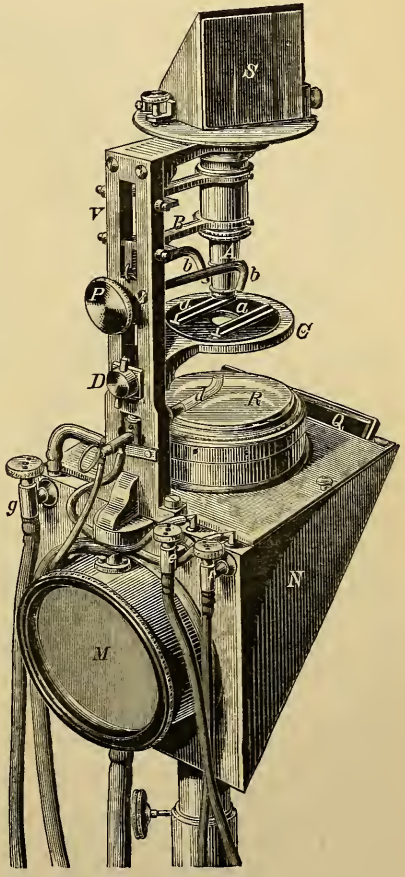


burner E which is supplied with gas and air through the taps G and H; it is fixed to a movable arm, and is adjusted by the handle F, and clamped by two screws, of which one is seen at O; the tube which conveys air is continued inside the gas-tube until it almost reaches the beginning of the arm; the burner is closed at the bottom by a plate of mica, so that the object may be partly illuminated from below through the flame. K is a tube with double orifice which is used for cooling the object by means of a current of air transmitted through a passage in the foot of the instrument and regulated by a screw tap, so that the temperature is completely under control, and may be varied at will. M is a movable arm with stop, which is attached by the screw *m* to the other foot of the instrument and carries a holder N; this serves to support the end of a magnesium band P over the tray *s*, and it is pivoted so that the projecting portion of the band at *q* may be directed towards the mirror; in this way the field remains brilliantly illuminated as the metal burns; the same burner E which is used for heating purposes may be also employed to ignite the wire. The magnesium flame is used for photographing the object, and for this purpose the upper part of the tube Z is provided with a movable ring *x*, to which is attached by the hinge *t* the camera R. The Microscope may then be rapidly converted into a photographic apparatus by swinging R into the vertical position. T is a hinged frame carrying a ground-glass plate by which the image is roughly focused, the final adjustment being made upon a small spot of smooth glass which occupies the centre of the ground-glass plate by means of a lens hinged to T; the camera is clamped in position by the screw *w* which passes through a slot in the bar *y* firmly attached to *x*, and finally the focusing plate is replaced by an aluminium slide containing the sensitive dry plate. The dry plates used are of small size (6·5 × 9 cm.), and may be developed and fixed by the light of a petroleum or gas lamp with red chimney.

In place of K the tube L (shown at the side of the figure) may be mounted on the stage; this tube is used to direct a current of air upon the objective, so as to protect the lenses against the heat of the stage and to carry away the products of combustion which would otherwise condense upon them; if a greater degree of cold is required, this current of air may be first passed through a freezing mixture and drying tube.

The chief object which this instrument seeks to attain is the rapid change of certain parts; the heating apparatus, the magnesium-light, the camera, the cooling apparatus, and the polarizer, are all so constructed that they may be introduced and withdrawn without loss of time, since the operations have to be conducted with great rapidity during the growth of the crystals. The author suggests other additions and improvements which might be made; for instance, a water cooling-apparatus for fusion experiments; a roll of sensitive paper to be used for a continuous series of photographs in place of a set of dry plates, &c., and promises an account of observations which he has recently made with the Microscope upon bodies under high pressures, in small capillaries, and in vacuum.

Fig. 39.



The *Crystallization Microscope for projection* is shown in fig. 39. A is the objective which is adjusted by a parallelogram movement B by means of the screw P. The stage C is movable along a vertical slot in the upright V, and is clamped by the screw D. The object lies upon the two edges *a*, which allow a free passage of the air, and *b b* are as before the two tubes by which the object is cooled; *d* is a glass burner which receives its supply of gas and air through the two screw-taps *e* and *f*; the current of air in *b* being regulated by the screw-tap *g*.

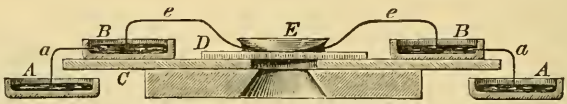
The light from an electric lamp enters the apparatus at M through two parallel plates of glass through which circulates a current of water free from lime, such as rain-water; ordinary water soon leaves a deposit of carbonate of lime upon the glass, and cannot be used for the purpose. N is a water-tight chamber filled with concentrated solution of alum containing also a few loose crystals of alum, which are dissolved when the temperature rises; the hypothenuse of this triangular chamber is occupied by the plane mirror Q, which reflects the light upwards through the plano-convex condensing lens R of short focal length, which illuminates the object with a convergent beam of light from the electric lamp. After the rays have traversed the objective they enter a rectangular prism S, by which they are reflected in a horizontal direction and throw an image upon the screen; the prism S being adjusted by means of a screw and hinge.

This instrument may conveniently be used not only for demonstration, but also for photographing, by allowing the rays to enter an ordinary

camera from which the objective has been removed; and the author suggests its employment to demonstrate the phenomena of electrolysis (fig. 40).

A A are mercury connections which receive the wires from a battery of six small Grove's cells; a rheostat, contact-breaker, and commutator being included in the circuit. The current is conveyed from A A by *a a* to B B, two

Fig. 40.



vessels of mercury, which are insulated and fixed upon C a plate with a hole in its centre, which rests upon the stage. D is the object-carrier, on which a drop of the solution is placed, being then covered with a flat watch-glass E, having its convex side downwards; the electrodes are formed by the wires *e e*, terminating in arrow-shaped platinum points, which are brought into contact with the drop. Any desired movement is given to the object by the motion, not of D, but of the plate C. The mercury connections obviate the pressure or elasticity which would be introduced by solid connections.

Nelson's "New Student's Microscope."—Mr. E. M. Nelson claims * that this instrument "begins a new era in the progress of 'microscopy,'" and that for the "first time in the history of the Microscope a thoroughly sound full-sized instrument" can be supplied at the same price as a student's Microscope.

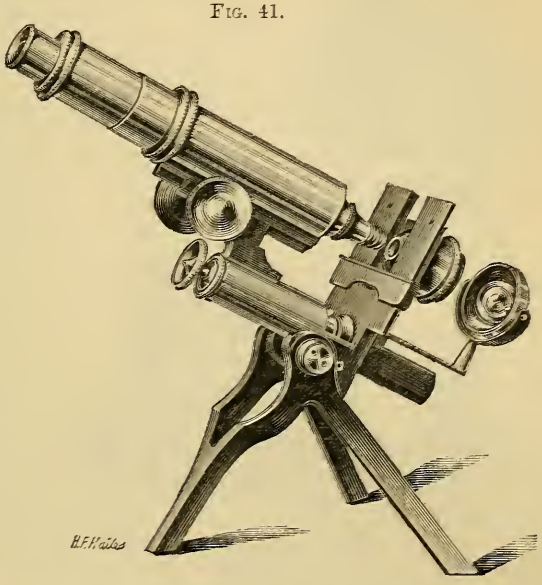
Referring to some of the points adopted in this new Microscope—points where there must of necessity be much that is old in design—Mr. Nelson divides Microscope feet into four classes:—1st. The simple tripod, illustrated by the Powell form. 2nd. The plate and uprights. A flat plate with pillar or pillars, as in the Beck model; and a plate with flat uprights, as in the Andrew Ross. 3rd. The bent claw, a very common and bad form, used by many makers. 4th. The heavy horseshoe, the usual Continental model. The plate and uprights, though a good form, was not adopted because it was too heavy and expensive. The bent claw is a bad form: it is heavy, easily capsized, and while seemingly a tripod, often rocks on four points. The heavy horseshoe which, until lately, was always fitted to students' Microscopes, has nothing to recommend it. A designer, Mr. Nelson considers, "must indeed be hard up for resources who can only obtain steadiness by weight. There can be no question but that the tripod in its simplest form is the best. Of all the ways of utilizing it, that adopted by Messrs. Powell and Lealand is the most efficient, viz. of hanging the Microscope in a horseshoe, supported by three legs; but that for this class of instrument was quite out of the question, for cost immediately puts it outside the category of students' Microscopes.

There is a great difference between the steadiness of a Microscope perched up on the top of its trunnions, and one that is hung in a tripod. The new Microscope (fig. 41) is placed in a kind of stirrup hanging from the trunnions. . . . The body is large enough to take Zeiss's full-sized eyepiece, viz. $1\frac{3}{8}$ in., and is 10 in. long when the draw-tube is pulled out to a mark. When the draw-tube is pushed home, the length is 6·3 in., or Continental gauge. It, therefore, will suit both kinds of apochromatics. The optic axis of the instrument, when in a horizontal position, is $8\frac{1}{2}$ in. from the table. It has rackwork coarse-adjustment, and Campbell's fine-

* Cf. Eng. Mech., xliv. (1887) p. 497.

adjustment. It is to this fine-adjustment that the instrument owes its origin. The moment Mr. Campbell explained to me the principle of his fine-adjustment, I foresaw the construction of an efficient student's Microscope. The direct-acting screw is only suitable for low powers and small apertures. I will put it even stronger: delicate work with high powers and wide apertures is not possible with any Microscope having a direct-acting screw fine-adjustment.

Fig. 41.



The stage is of the cut horseshoe form. . . . The principal object of it is to enable you to feel your working distance. Let me point out a great improvement in the sliding bar. Its guiding lugs are stowed away underneath the stage; I have no hesitation in saying that next to a perfect mechanical stage this is the best. Most of the mechanical stages are so defective in design, and so scamped in their workmanship, as to be worse than useless.

The substage is fitted with a tube, having a spiral slot for focusing. . . . There is a novel feature about the stops for dark-ground illumination, viz. there is a three-legged carrier which holds them all. This carrier has a pin in the centre of it on which the various sized discs fit. The stops, diaphragms, &c., have a separate tube-fitting for them, so that it is unnecessary to move your condenser when changing either a stop or a diaphragm. This substage will carry either of Prof. Abbe's condensers, or a cheap condenser made especially for this Microscope. The weight of the Microscope is 7 lbs. complete."

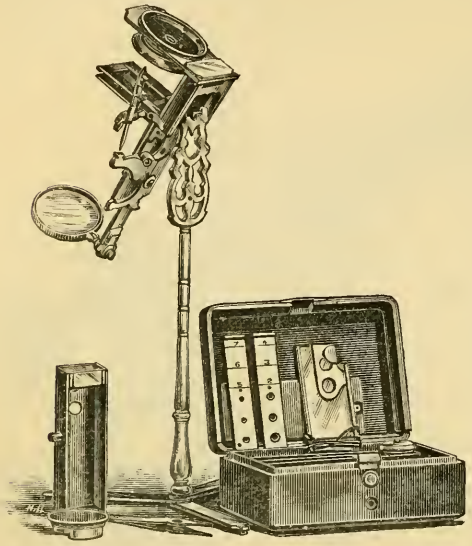
The instrument is made by Mr. C. Baker, of High Holborn, and has been brought out under the personal superintendence of Mr. C. L. Curties. Since the original issue, Mr. Baker has added to the completeness of the design by the application of a rack and centering movements to the substage, and also Mayall's removable mechanical stage.

Lindsay's Simple Microscope.—In the Journal for 1883, p. 708, we reproduced from a German publication two figures of Lindsay's Microscope, which we have since found were probably taken from the specification of the patent granted to George Lindsay in 1742, the first patent known in England relating to a Microscope. As the general design of the instrument is not readily understood by inspection of those figures, we here give a perspective view (fig. 42) of a highly finished model in silver by Lindsay, which we met with in our recent visit to Italy.

The optical arrangement consists (1) of a low-power lens provided with a Lieberkühn (one of the earliest applications of this device after its

introduction by Dr. N. Lieberkühn, in 1738), which slides beneath the cross-arm on the top of the instrument; (2) of two sliding plates each provided with three different powers, numbered from 2 to 7, also sliding beneath the cross-arm; (3) a perforated conical reflector, acting after the manner of a Lieberkühn, which can be applied in conjunction with the low-powers in one of the sliding plates. The mirror is concave, and is hinged on a pivot applied in a socket at the end of the sliding tail-piece. The focusing is by means of a bent lever at the back moving the stage up or down. The limb is hinged at the back to incline on an ornamental support fitted to rotate on the pillar and tripod. A fish-plate, a silver box with perforated sliding lid, articulated stage-forceps, hand-forceps, ivory box for talcs and rings, and six object-slides, together with the whole Microscope, pack neatly in a box about $3\frac{1}{2} \times 2\frac{1}{2} \times 1\frac{1}{2}$ in.*

Fig. 42.



Garrison, F. L.—See *infra*, β (2).

Howland, E. P.—[**Microscopic Projection.**]

["My experience leads me to believe that the direct projection of microscopic objects can only be successfully accomplished in small rooms. For public exhibitions and for projection generally photographs are to be preferred. The use of a projecting Microscope is quite satisfactory with low powers, but it is difficult to concentrate the light sufficiently to admit the use of high powers. These remarks refer to the use of calcium light. With the electric light better results may be obtained."]

Amer. Mon. Micr. Journ., VIII. (1887) pp. 38–9.

Pe.—**Ausstellung wissenschaftlicher Apparate, Instrumente, und Präparate.** (Exhibition of Scientific Apparatus, Instruments, and Preparations.) II.

[Exhibition at Berlin. Includes an Electrical Arc Lamp with Microscope—Stricker's Electrical Projection Microscope—Nehmer's Incandescence Lamps—Microscopes by Schieck & Wannbrunn and Quilitz & Co.]

Zeitschr. f. Instrumentenk., VI. (1886) pp. 425–31.

Cf. "W.," *ante*, p. 161.

Pfeffer, W.—**Bezugsquelle und Preis einiger Apparate.** (Place to obtain and price of some apparatus.)

[Includes Microscopes.] *Bot. Ztg.*, XLV. (1887) pp. 27–31.

(2) Eye-pieces and Objectives.

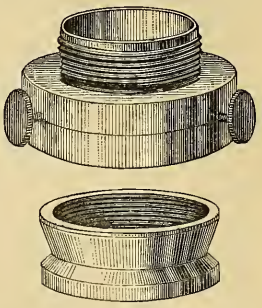
Frazer's Centering Nose-piece for use with Double Nose-pieces.†—"When the nose-piece is moved in the usual way, and one objective put in place of another," writes Mr. A. Frazer, "it seldom happens that an object which was in the focus of one power is also in the focus of the other; and, as a consequence, the operation of focusing must be performed. This

* Cf. Society of Arts Cantor Lectures on the Microscope, by J. Mayall, junr. (reprint in collected form), 1886, p. 43 (1 fig.).

† Trans. Edinburgh Naturalists' Field Club, i. (1885-6) pp. 333–5.

defect may be remedied by making the sides of the nose-piece which hold the objectives of unequal lengths, or by putting an adapter in either side and so correcting for the difference of adjustment for focus. When this correction has been made the convenience of the nose-piece is much increased; but the error of want of concentricity may still remain, i. e. a particular point in the middle part of the field of the lower power may not also be in the centre of the field of the higher. The appliance now described has been designed to remedy the defects both of want of centre and error of focus. It consists of an outer brass collar, which in its upper part is provided with a screw which fits one of the screwed ends of the nose-piece, and in its lower part consists of a brass collar, which is provided with three mill-headed steel screws, placed at regular intervals in its circumference. These screws control an inner ring, into which the objective is screwed, and which may be moved laterally by means of the steel screws. This inner ring, and also the outer ring which supports it, may be made of any suitable length, and by this means the accurate adjustment for focus is effected; while the inner ring being, as already mentioned, capable of a lateral movement, the adjustment for 'centre' may also be accurately made."

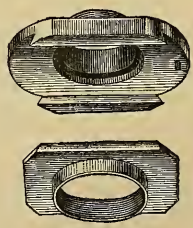
Fig. 43.



Turnbull's Improved Sliding Nose-piece and Adapter.*—The Royal Scottish Society of Arts has awarded a silver medal to Mr. J. M. Turnbull for this apparatus, which he thus describes:—

"It consists essentially of a small face-plate or 'chuck,' which screws into the ordinary 'nose' of the Microscope, fig. 44. On its face this has a slide, which has fitted into it another sliding-piece, and into which the objective is screwed. As many of the other objectives as belong to the instrument are fitted with similar sliding-pieces, which also fit into the first. Once, therefore, an objective is fitted and centered with one of these sliding-pieces, having a sufficient length of tube to bring it very nearly into focus, it can be substituted in a moment for one of lower or higher power, as the case may be; and if an object has been previously centered on the stage with a low power, it will be found accurately centered in the field of that of the higher. I also wish to draw your attention to the fact that all the face parts of this appliance are finished on the lathe, which enables the optical axis of the eye-piece, instrument, and objective to be truly maintained, and does away with the failings of the ordinary double nose-piece in this respect. Another form of this adapter is to have two, three, or more objectives mounted together on one of the sliding-pieces, having on each objective a sufficient length of tube to bring it accurately into focus, and sliding one objective on another, as may be wished, central with the tube of the instrument, a small spring-point retaining it in that position. It is a matter of choice, however, as to which is the better form—whether it will be more convenient to have two or three objectives mounted together, or to have them separate.

Fig. 44.



Having thus described the appliance, I think I may fairly claim for it that it will change the objective of a Microscope with great rapidity, with

* Trans. Edinburgh Naturalists' Field Club, i. (1885-6) pp. 335-6.

very accurate centering, and very close approximate focusing. Having made these claims for it, I commend the apparatus to the attention of all workers with the Microscope, whose time is generally too valuable to waste on matters such as this."

Wales's Cover-carrier for Immersion and Dry Lenses.* — Mr. W. Wales, in exhibiting a non-adjustable 1/5 in. objective with a cover-carrier or cap, said that the idea of affixing a cover-carrier to a lens occurred to him because of the fact that opticians are frequently held responsible for errors of the manipulator in the use of non-adjustable lenses—that a non-adjustable lens corrected for a 10 in. tube would sometimes be used on an 8 in. tube, and this failing to produce good results, the optician would get the credit for making a poor lens. Hence he had fitted a cover-glass to a cap made to screw on to the front cell, or fitting over the objective, and had adjusted and corrected the lens for that particular cover-glass, so that the objective could be plunged down into any fluid without injuring it, and would always be correct for a 10 in. tube without adjustment.

In using an oil-immersion lens with the cover-cap, a drop of oil is placed on the inside of the cover-glass, and the lens can be used in urine, blood, or other liquids. The oil can be allowed to remain there if the lens is perfectly tight, saving time and trouble in repeated examinations of this kind. The cap also serves as a protection to the lens. It can be easily removed and cleansed at any time, and the cover-glass can be replaced if broken.

Paper for Cleaning the Lenses of Objectives and Oculars.†—Prof. S. H. Gage for the last two years has used the so-called Japanese filter paper (the bibulous paper often used by dentists when filling teeth) for cleaning the lenses of oculars and objectives, and especially for removing the fluid used with immersion objectives. Whenever a piece is used once it is thrown away. It has proved more satisfactory than cloth or chamois, because dust and sand are not present, and from its bibulous character it is very efficient in removing liquid or semi-liquid substances. At the author's suggestion it was tried in the Bureau of Animal Industry at Washington, and is now used there almost exclusively.

DALLINGER, W. H.—**The value of the new Apochromatic Lenses.**
[Extract from Presidential Address, *supra*, p. 185.]
Nature, xxxv. (1887) pp. 467–9.

FORGAN, W.—**Notes on Microscope Objectives.**
Trans. Edinburgh Naturalists' Field Club, I. (1885–6) pp. 326–9.

LAURENT, L.—**Sur l'exécution des objectifs pour instruments de précision.** (On making objectives for instruments of precision.)
Comptes Rendus, CII. (1886) pp. 545–8 (2 figs.).

NELSON, E. M.—**Object-glasses.**
["For bacteriological work two lenses are absolutely necessary, and a Microscope fitted with a condenser. I consider the condenser so important that I would rather have an indifferent lens with a condenser than a first-rate lens without. A cheap and excellent combination is Seibert Nos. 3 and 7, viz. a 1/2 N.A. 0·32 and water-immersion 1/16 N.A. 1·07. These two glasses cost a little under 5*l.*, and if you know how to test them you can get two first-rate lenses. A third lens is very useful, as the interval between a 1/2 and 1/16 is rather wide. The best lens to put in is a Reichert No. 7*a*; this is a 1/7 of N.A. 0·84. I think its price is about 2*l.* The next series of three, costing about 9*l.*, would be Zeiss A.A., D.D., and G. These are a 2/3 of N.A. 0·31, a 1/6 N.A. 0·82, and a 1/9 N.A. 1·16. These also require selecting."]
Engl. Mech., XLIV. (1887) pp. 562–3.

SCHULZE, A.—**On Abbe's Apochromatic Micro-objectives** and compensating eye-pieces made of the new optical glasses in the works of Dr. Carl Zeiss in Jena, with some general remarks on object-glasses.
Paper read to Glasgow Phil. Soc., 17th Nov., 1886, 13 pp.

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* Journ. New York Micr. Soc., ii. (1886) pp. 125–6.
† The Microscope, vi. (1886) p. 267.

(3) Illuminating Apparatus.

Jones's Radial Swinging Tail-piece.*—The principle of causing the illumination to move radially upon the object from the axis to near the horizon and above, as illustrated in Grubb's Sector Microscope,† and subsequently by Nachet (Thury), Zentmayer, Tolles, Bulloch, and others, appears to have been anticipated in the last century in a Lucernal Microscope, designed by "the Rev. John Prince, LL.D., now of Salem, Massachuset's States, North America," and constructed by W. and S. Jones, the application of the lamp being suggested by "Mr. John Hill, Wells, in Norfolk." ‡

Fig. 45.

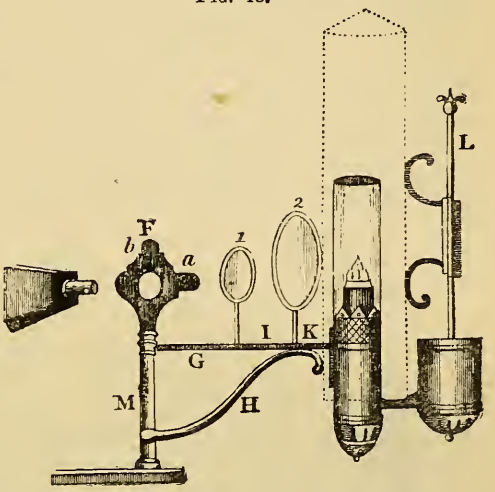


Fig. 45 shows the tail-piece as figured by Adams in plate ix. fig. 5 of the second edition of his 'Essays on the Microscope.' The stage F is supported by a rod passing through a socket M, and attached to a bar, forming a continuation of the limb carrying the projection-box or camera of the Microscope; G I K is the tail-piece connected with the socket M, and strengthened by the bracket H, carrying condensers 1 and 2, and the lamp L. The tail-piece swings laterally round the axis of F, and thus gives radial illumination upon the object on the surface *b a* of the stage.

In what appears to have been an original form of the apparatus which we have seen, a mirror was fitted to slide upon the tail-piece, but no lamp was applied. To the apparatus furnished with a lamp a tablet is attached, notifying that Mr. John Hill had devised the arrangement.

Bausch & Lomb Condenser and Substage. [*Post.*]
The Microscope, VII. (1887) p. 16 (1 fig.).

N., W. J.—**The Two Mirrors. IV.** [*Post.*]
Sci.-Gossip, 1887, pp. 25–7, 52–4 (3 figs.) (*contd.*).

Stricker's Electric Lamp.
["In lecturing before the Society of Natural History at Berlin, Prof. Stricker has employed with much success an electric lamp of 4000 candle power for the projection of microscopic sections upon a screen, employing a magnifying power of 6000 to 8000 diameters. It is stated that the definition obtained is very satisfactory." Cf. Journal, 1886, p. 502.]
Science, IX. (1887) p. 55, and see Pe, *supra* (1).

(4) Other Accessories.

Haswell's Rotating Stage and Circular Slides for large Series of Sections.—This apparatus was more especially designed by Mr. W. A. Haswell for the purpose of enabling students conveniently to examine series of sections of objects which they have not the opportunity of sectioning for themselves. It is thus more particularly intended for special

* Society of Arts Cantor Lectures on the Microscope, by J. Mayall, junr. (reprint in collected form), 1886, p. 58 (1 fig.).
† See this Journal, 1880, p. 1056.
‡ See Adams's 'Essays on the Microscope,' 2nd ed., 1798, p. 84.

type-series of sections of such objects as, when cut into thin sections, would occupy a very large number of slides of the ordinary form,—such as the earthworm, leech, fluke, *Amphioxus*, chick, mammalian embryos, and the like: but besides its use for demonstration purposes it is also claimed to be of the greatest service in investigation.

The sections are mounted on circular discs of glass *a*, figs. 46 and 47, 9 in. to 11 in. in diameter, with a circular aperture of 3 or 4 inches in the centre. The method of procedure is as follows:—The glass disc after being carefully cleaned is smeared over thinly with a very thick solution of shellac in creosote. It is then laid on a sheet of white paper on which concentric circles a quarter of an inch or thereabouts apart, from the size of the disc downwards, have been ruled. The sections, cut by an automatic microtome, are laid round the outer edge of the disc in concentric circles, their position being regulated by the concentric lines on the paper. To facilitate the arrangement of the section it is advisable in paring down the block of paraffin to leave the sides not quite parallel, but inclined to one another at

Fig. 46.

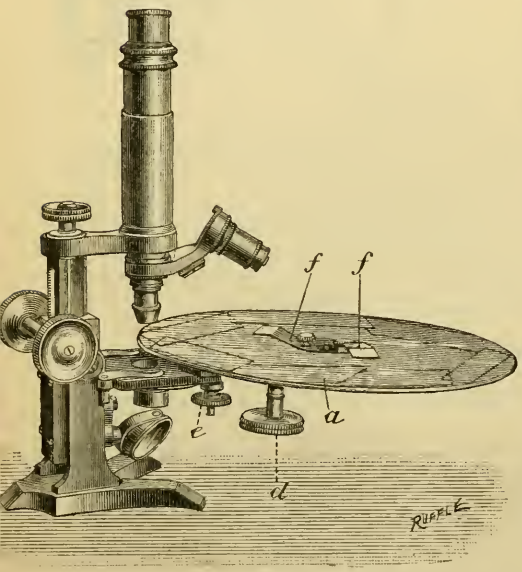
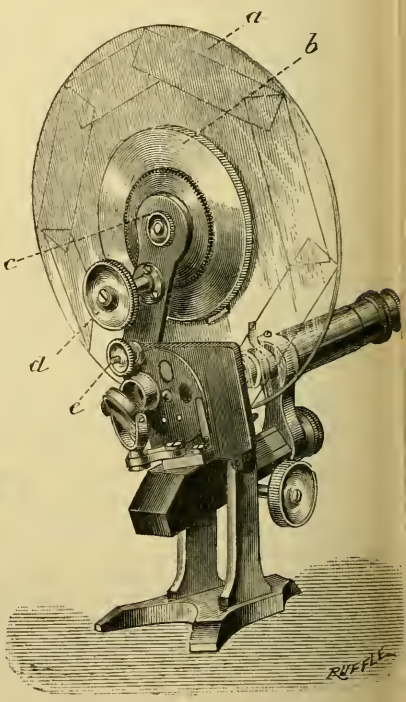


Fig. 47.



about the angle between two radii of the disc separated near the circumference by the thickness of the block; by this means is produced a ribbon of sections which is not straight but curved, with about the curvature required. The disc is then warmed in the usual way to dry the creosote and melt the paraffin, and is flooded with turpentine to dissolve out the latter: balsam is poured on and the sections are covered with oblong strips of thin cover-glass. In this way may be regularly arranged on the disc a series containing thousands of sections.

The apparatus for enabling the series to be examined is a brass revolving

table *b* carried on a horizontal arm *c*, which is fastened to the right-hand corner of the stage of the Microscope by a screw passing through a hole in the stage and provided with a nut *e*. The glass disc is centered on the circular table and fastened with a pair of spring clips *f f* placed near the centre. The table, carrying with it the disc, is rotated by a rack and pinion or rather cog-wheel movement, worked with the right hand by means of a milled head *d* placed underneath. The concentric circles of sections are brought under the tube by the movement of the horizontal arm, by means of which the centre of the revolving table is brought nearer to or carried further away from the centre of the stage.

Warm and Cold "Stages."—In studying the anatomical elements of a warm-blooded animal, and other phenomena which naturally occur under the influence of a temperature considerably above that of the surrounding air, it is necessary to have some means of maintaining a condition as to temperature resembling that of the living organisms, or even, as in the experiments of Dr. Dallinger, described *supra*, p. 185, of raising the temperature to an abnormal point. We summarize here some of the principal suggestions that have been made for this purpose (as well as for producing cold), excluding such as have previously been recorded in this Journal.

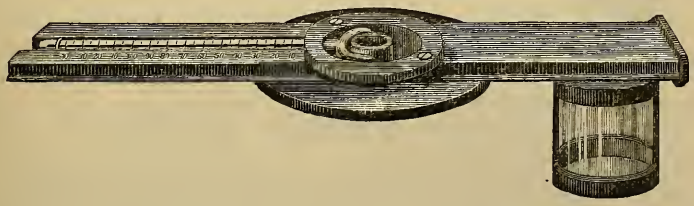
A very crude process described by Raspail * was to put the object in water in a watch-glass on the stage, a spirit-lamp being placed beneath it, which served both for heating the water and giving light to the object. The objective was covered by the globular end of a thin glass tube, which dipping into the water, prevented the obscuration of the object by vapour and protected the objective. Harting,† following, but not quoting, Goring and Pritchard ‡ proposed to substitute for the glass tube a brass one, closed by a plane plate of glass. Schacht § also heated the slide direct by a minute wax taper placed (for short periods) below the opening in the stage.

Apart from these methods, four different principles have been adopted for heating microscopic objects: (1) by hot air; (2) by electricity; (3) by conduction through metal plates; and (4) by water.

1. *Air.*—This is perhaps the least convenient medium of all for heating microscopic objects.

Prof. G. Fritsch commends *Dr. Senarmont's* ‖ apparatus as a very simple and handy stage, which "in its arrangement is to be preferred to those of Max Schultze and Stricker." It consists (figs. 48 and 49) of a hollow

Fig. 48.

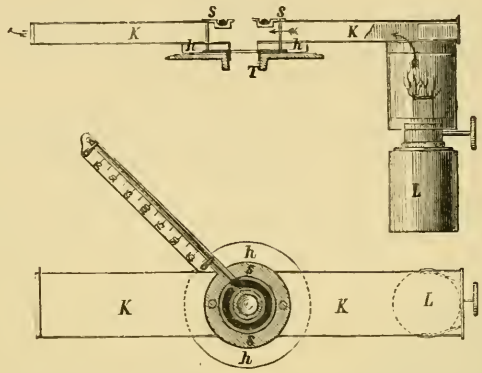


box of tin K, open at one end, and having at the other an aperture in the lower surface, to which is attached a cylindrical tube of mica. The box is

* Raspail, L. V., 'Nouveau Système du Chimie Organique,' 2nd ed., i., 1838, pp. 222–3 (1 fig.).
† Harting, P., 'Das Mikroskop,' 2nd ed., ii., 1866, pp. 146–7 (1 fig.).
‡ Goring, C. R., and Pritchard, A., 'Microscopic Illustrations,' 1830, pp. 55–6 (2 figs.).
§ Schacht, H., 'Das Mikroskop,' 3rd ed., 1862, p. 79.
‖ Bericht u. d. Wiss. Instrumente a. d. Berliner Gewerbeausstellung im Jahre 1879 (Löwenherz), pp. 305–6 (1 fig.), and pp. 355–6 (1 fig.).

pierced with a circular aperture in the centre, that in the upper surface being open, and that in the lower closed by a plate of glass. On the top is screwed a plate *s*, with a deep annular groove to hold the thermometer-bulb, the tube of which lies in a groove along the upper surface of the box to the left. A lamp L is placed under the mica cylinder, and thereby warm

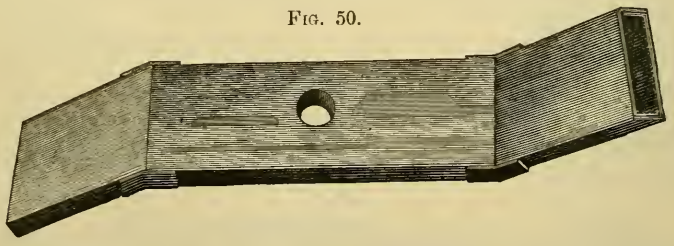
Fig. 49.



air is made to pass through the box, the heat being transmitted from the centre plate into the object laid upon it. It is isolated from the stage T by means of an ebonite ring *h*.

Dr. Beale also in 1865 * described and figured a simple plan (fig. 50) of heating objects by hot air. It consists of a long copper box, open at both ends, the middle part of which lies flat on the stage One end is bent down obliquely so as to project over the side of the stage, while the other is similarly bent up. A spirit-lamp being placed at the lower end a current

Fig. 50.



of hot air passes through the box and escapes at the upper end. The centre of the box has its lower wall composed of glass, while at the upper part is an opening to allow of the hot air reaching the slide.

Valentin's stage described under (4) Water *infra*, can also be used as a hot air stage.

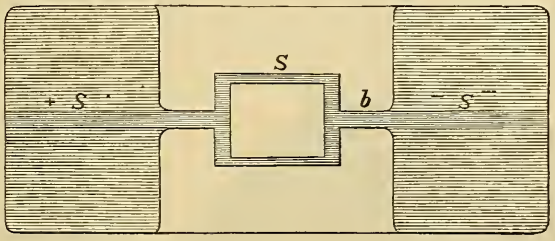
2. *Electricity.—Prof. S. Stricker* recommends † the use of electricity as a means of heating a stage, thus describing it:—A better method than any consists in the conversion of a constant current of electricity into heat. In microscopical investigation only a very small absolute quantity of heat is required, and indeed it is not necessary to warm the stage in its whole extent, but only its centre, or what is still better, the cover-glass placed on

* 'How to work with the Microscope,' 3rd ed., 1865, p. 129 (1 fig.). See also 5th ed., 1880, p. 189 (1 fig.).

† Stricker, S., 'Manual of Human and Comparative Histology.' Transl. by H. Power, 1870, pp. xii.-xvii. (3 figs.)

a slip of caoutchouc. An amount of heat so small as this we may reasonably expect to obtain from the interruption of even feeble currents of electricity. It is well known that the heating of a wire introduced into the arc of a constant current increases with the diminution in diameter of the wire. For this purpose, therefore, we employ a proportionately thin wire attached to the centre of a glass plate, the ends being in connection with the electrodes of a constant battery. When the current is closed the temperature of the centre of the glass plate is raised. The attachment of the wire presents, however, certain inconveniences, and we possess in tin-foil a more appropriate means at our disposal. The tin-foil should be cut into the form represented by S in fig. 51, and then glued to a glass slide; the

Fig. 51.

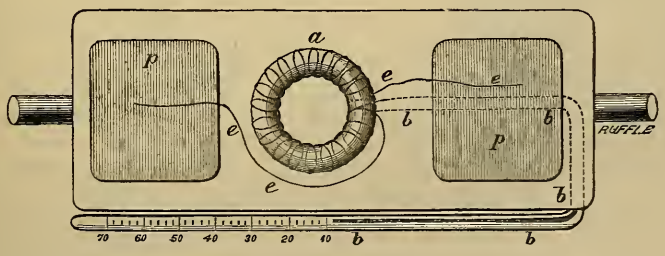


extremities of the tin-foil being introduced into the arc of a constant current. A second strip of tin-foil of the same breadth as that attached to the slide *b*, is wound round the bulb of a thermometer and introduced into the circuit at any convenient point. This furnishes the means of correctly estimating the temperature attained by the centre of the slide when all the secondary conditions are uniform. These latter can, however, be estimated by comparison and the due employment of a thermometer—a proceeding that is always requisite whatever may be the mode of heating employed. In order to accomplish this, a fatty substance, the melting point of which is known, should be placed at the point where the object is situate, and the reading of the mercury should be taken at the moment that the fat begins to melt.

As the temperature diminishes as the square of the strength of the current, this decrease can to a certain extent be covered by diminishing the transverse section of the tin-foil, so that if a weak current be in use the strip of tin-foil must be made proportionately narrow.

In order to exercise a direct control over the temperature of the cover-glass, a thermometer should be attached to the slide itself. In fig. 52, *a* is

Fig. 52.

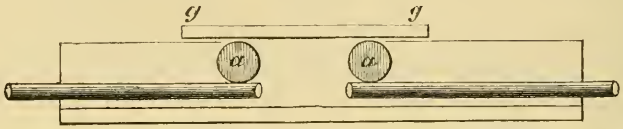


the bulb of the thermometer, the dotted line *b* indicating the direction of the tube. Both the tubes and the bulb lie in a groove made in a hard caoutchouc slide. A coil of very fine copper or platinum wire *e* is wound

round the bulb and the ends lie on the metal plates *p p*, which are also connected with the electrodes.

Fig. 53 also gives a longitudinal section of the stage; *g g* is the cover-glass upon or to the under surface of which the object to be examined is fixed. The cover-glass is in contact not only with the surface of the

Fig. 53.



slide, but also with the coil of wire surrounding the bulb of the thermometer the transverse section of which is seen at *a a*. When the circuit is closed the wire becomes heated and acts on the one hand upon the mercury, and on the other upon the cover. The hard caoutchouc is a bad conductor of heat, and hence the cover-glass receives the greater part of the heat.

Fig. 54.

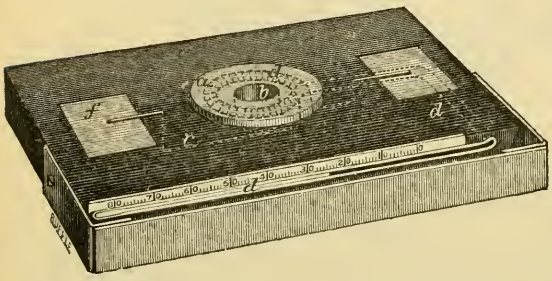


Fig. 54 shows the Stricker stage as figured in the 'Handbook for the Physiological Laboratory,'* *b* being the central chamber (surrounded by a copper disc *a*) warmed by the current, *f* a copper plate with a corresponding one on the other side to which the electrodes are applied, *c* a platinum wire by which the two plates are in communication and which is coiled round the bulb of the thermometer *d*.

Dr. S. T. Stein † also uses a platinum spiral (fig. 55) inserted between

Fig. 55.

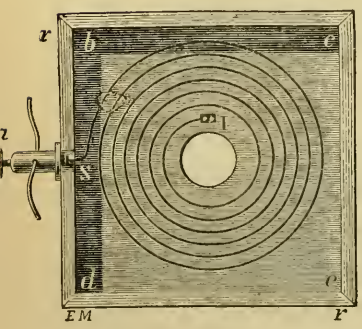
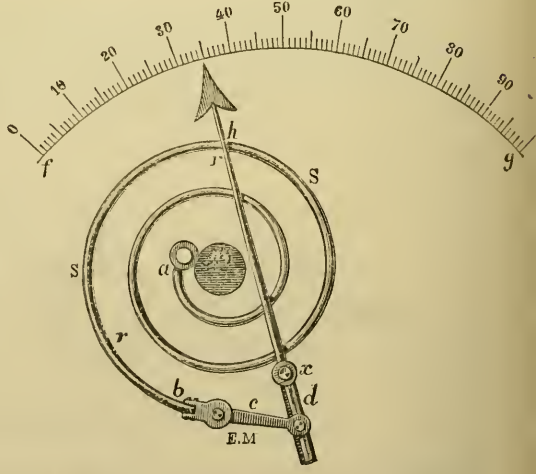


Fig. 56.

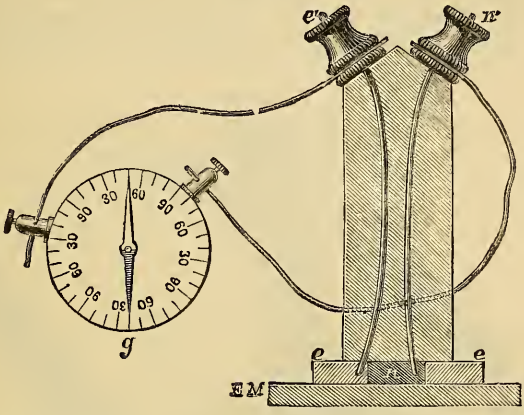


* Burdon-Sanderson, J., E. Klein, M. Foster, and T. L. Brunton, 'Handbook for the Physiological Laboratory,' 1873, fig. 14.

† Zeitschr. f. Wiss. Mikr., i. (1884) p. 161.

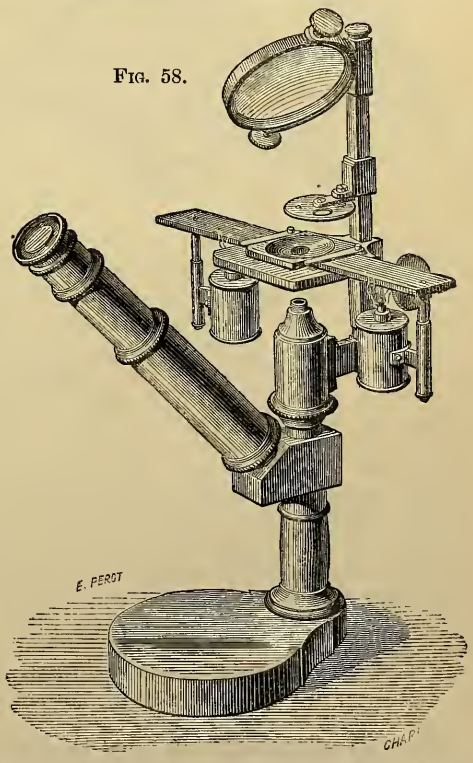
the upper and lower plates of the stage of a Microscope, and heats it by the electric current. To measure the degree of heat, he employs the bi-metallic thermometer (fig. 56). The spiral is made of brass S and iron *r*

Fig. 57.



soldered together, and by the difference of expansion in the two metals the spiral contracts or opens. The inner end *a* is attached to the stage close to its opening, while the free end *b* acts, through an arm *c*, on an index *d* which is pivoted at *x*, and whose point *h* moves along the scale *f g*. Or the thermo-electric apparatus (fig. 57) may be used, where *e e* is iron and *n* German silver, two wires *e'* and *n'* leading to the galvanometer *g*, the needle of which is deflected more or less, according to the temperature of the stage.

Fig. 58.



3. *Hot Plates.—M. C. Chevalier's* * is shown in fig. 58. It consists of a metal plate with a central aperture, beneath the two ends of which are placed spirit-lamps which slide up and down on the projecting stems. This apparatus was intended for use with Chevalier's Universal or Chemical Microscope (a modified form of the latter shown in fig. 58), in which the objective is beneath the object. One or

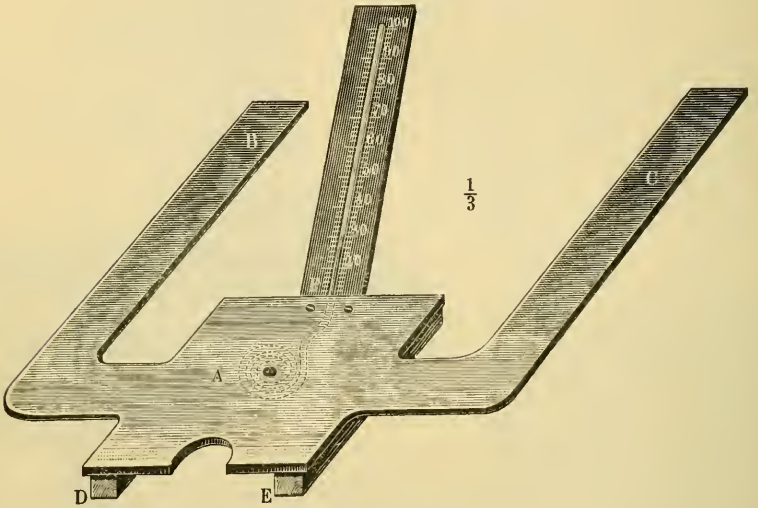
* Chevalier, C., 'Des Microscopes et de leur usage,' 1839, p. 97 (1 pl.).

both of the lamps can be used according to the degree of heat required, and a thermometer can be applied if desired.

Prof. Max Schultze's * (fig. 59) is figured in most foreign treatises, and was the first fairly successful hot stage.

It consists of a brass plate A, 1–2 mm. thick, notched behind so as to fit to the pillar of the Microscope, and attached to the stage by clamps. It has two arms B C, 170–200 mm. long and 30 mm. broad, bent forwards at

Fig. 59.



right angles. Spirit-lamps are placed under the ends of these arms and an object on the plate (then elevated 10 mm. above the stage) can be readily raised to a temperature of 35°–45° C. A small hole at A allows light from the mirror to pass to the object, the temperature of which is recorded † by a thermometer F, rising obliquely above the stage, the bulb being wound twice round the aperture at A. The upper part of this bulb is flat, so as to lie close to the central plate, and the bulb is inclosed in a box or cover to protect it from changes in the external temperature. Two wooden ledges D E at each side of the box, support the apparatus on the stage and retard the abstraction of heat through the stage. This apparatus has a special defect according to Engelmann. The temperature of the object is occasionally reduced very considerably by the metallic setting of the lens and the body-tube, so that the focal distance of the objective exerts a marked influence on the observations. The insertion of a bad conductor of heat between the lens and the body-tube has been proposed. An ivory tube 30 mm. in height applied in this manner lessens the defect very materially.‡

Dr. Ransom in order to employ the stage for cold also, suggests making it of copper instead of brass, the former metal being so much better a

* Arch. f. Mikr. Anat., i., 1865, p. 1; Frey, H., 'Das Mikroskop,' &c. Transl. by Cutter, 1880, pp. 101–2 (1 fig.); Harting, op. cit. pp. 147–8 (1 fig.); Dippel, L., 'Das Mikroskop,' 2nd ed., 1882, pp. 653–5 (1 fig.); Robin, C., 'Traité du Microscope,' 1877, pp. 161–2 (1 fig.).

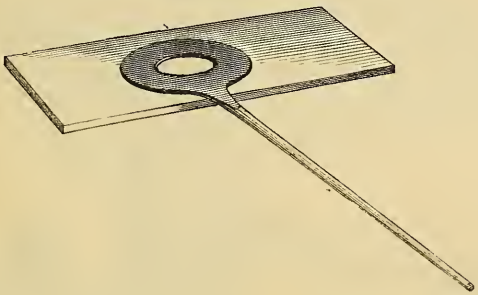
† Frey says "wirklich" and Ranvier "approximativement."

‡ See Frey, op. cit., pp. 101–2.

conductor,* while *Sig. Koritska* of Milan makes the ends of the arms B C terminate in discs, to give an extended heating surface.

Prof. Stricker's first form † consisted of a copper ring or rod inserted into a glass slide so as not to project beyond the surface. A second rod with a spiral coil is slipped over the free end of the first rod, and its extremity heated by a spirit-lamp. This has been further simplified ‡ by making the ring and rod in one piece, as shown in fig. 60.

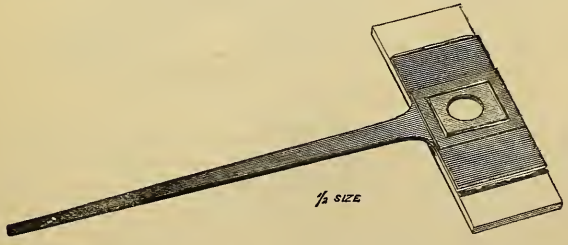
Fig. 60.



Two simple modifications of this form are also shown in figs. 61, 62, and 63.

The first § (figs. 61 and 62) has an oblong copper plate 2 × 1 in., from one side of which projects an arm of the same metal 4 or 5 in. long. The plate has a round aperture in the centre 1/2 in. in diameter, and is fastened to an ordinary slide by sealing-wax. The rod is heated near

Fig. 61.



its end by a small spirit-lamp as shown in fig. 62, and the heat is conducted by the rod to the copper plate, and from this to the preparation. If an object is under examination, such as white blood-corpuscles, which it is desired to warm to about the temperature of the body, a small fragment of a mixture of white wax and cacao-butter melted at about 30° C., should be placed upon the copper (fig. 62). The lamp is now gradually approached along the rod until it arrives at a point, the heat transmitted from which is just sufficient to partially melt the fragment, and it is then left burning at that spot.

The other form (fig. 63) consists of a square copper plate *b* with a central opening *c*. A rod *e* projects from its under surface (upper as

* Beale's 'How to work with the Microscope,' 5th ed., 1880, p. 189.
† Op. cit., pp. xvii.–xviii. (1 fig.). ‡ Burdon-Sanderson, op. cit., pp. 6–7 (1 fig.).
§ Schäfer, E. A., 'A Course of Practical Histology,' 1877, pp. 18–20 (2 figs.).

seen in the drawing), and fits into a groove in the glass slide *a*. A pin *d* also fits into a hole at the end of the groove. The rod is heated by a spirit-lamp.*

Fig. 62.

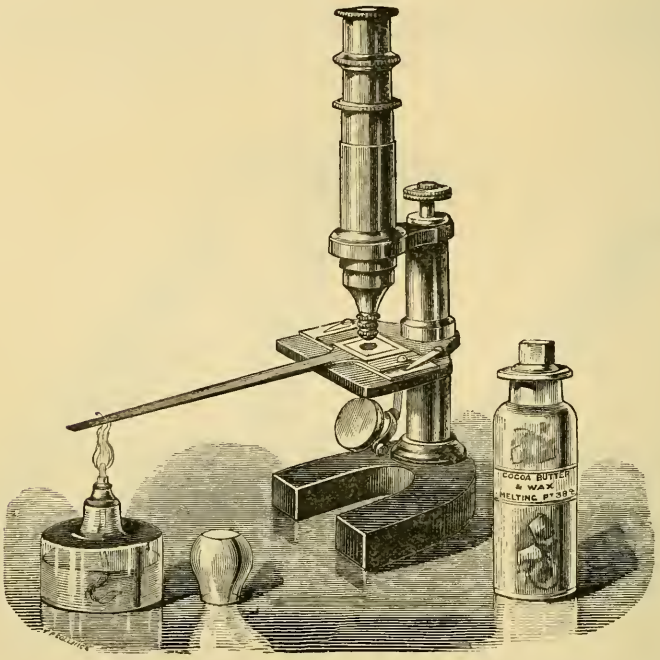
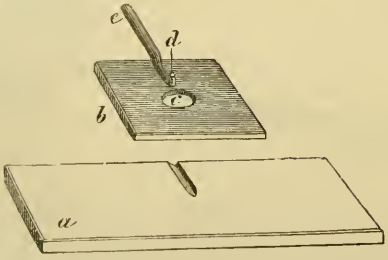


Fig. 63.



Prof. Stricker's more complete form † is shown in fig. 64. It consists of a block of black vulcanite 3 × 1½ × 1/4 in. The central cylindrical chamber *b* is closed below by a glass plate and surrounded at the top by a copper disc *a*. The bulb of the thermometer passes round the chamber, as shown by the dotted line *d*. Its capillary tube lies in a trough, one side of which is formed by the back of the block and the other by a metal plate screwed to it, the form of which is shown in the fig. The tube *c* (for gases) leads into the chamber, and a second tube leads from it through the projecting metallic arm shown at the top. This arm, which is

* Burdon-Sanderson, op. cit., fig. 12.

† Stricker, op. cit., pp. xvii.–xviii. (1 fig.). Burdon-Sanderson, op. cit., p. 7 (fig. 2).

in one piece with the disc *a* is of such a size that the rod *g*, fig. 65, fits in it by means of the spiral *f*, and by this rod the chamber is heated.*

Fig. 64.

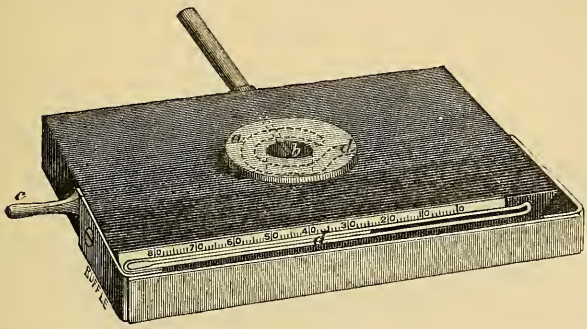
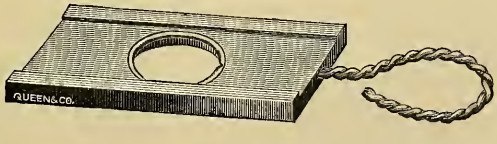


Fig. 65.

Mr. J. S. B. Bell also recently suggested † a modified arrangement for maintaining the preparation at any temperature from that of the room up to 100°. It consists (fig. 66) of a mahogany slide 3 × 1½ × 1/4 in., with a flat groove 1/16 in. deep for the ordinary glass slide to lie in. In the

Fig. 66.



centre is a round hole 1 in. in diameter, which incloses a copper ring, made by bending No. 16 wire into a ring slightly less than the hole. The two ends pass longitudinally through the stage and are twisted together and curled round. The stage is heated by a spirit-lamp held to the twisted wire, and when the required temperature is reached the lamp is moved back along the wire to a point that will just maintain the temperature. At the time the stage was exhibited, the room was 62° F.; the slide was heated to 82°, and the temperature kept stationary. It was then heated to 100°, and kept stationary for half an hour. In this arrangement the heated wire is isolated from the stage and from the glass slide by means of the wood in which it is placed.

Mr. W. H. Symons' first form of stage ‡ for steam, water, a saturated

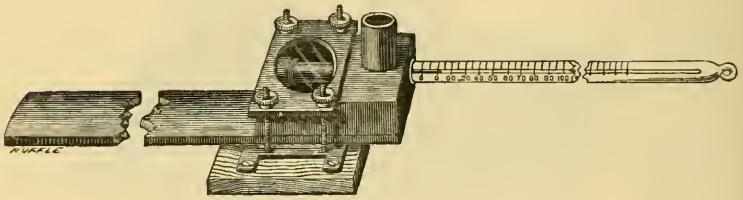
* Dr. C. H. Golding-Bird in 1875 suggested (Quart. Journ. Micr. Sci., xv., 1875, pp. 373–4) a "differential" warm stage made with copper and iron wire, and intended to correct the error which he considered the preceding forms of stage to give rise to, by reason of the difference of temperature between the copper and the centre of the glass slide.

† Micr. News, iv. (1884) pp. 19–20; and cf. Queen's Micr. Bulletin, ii. (1885) p. 4, and iii. (1886) p. 13 (1 fig.).

‡ See this Journal, 1882 p. 21.

solution of chloride of calcium, or glycerin, was intended for comparatively low temperatures, being furnished with a special form of thermometer graduated to 150° C., and as it was somewhat expensive and liable to get out of order, he devised a second form * (fig. 67) which "can be obtained

Fig. 67.



for a nominal sum, is capable of being used with an ordinary thermometer, and is available for all temperatures within the range of that instrument."

A block of copper 6 cm. by 4 cm. by 2 cm., has an aperture 2·5 cm. in diameter passing quite through it, but closed on both sides by thin glass or mica held between thin pieces of cork by means of plates screwed down, as shown in the fig., sufficiently tightly to prevent leakage. A slightly tapering canal is drilled through the block lengthways from one end, meeting and extending a little beyond the aperture. This is for a thermometer 33 cm. long, the bulb of which passes across the aperture. The tube is graduated to 600° F.† An open tube of one piece with the rest communicates with the canal. A piece of copper 3 mm. thick brazed on the block before the aperture is drilled, extends about 15 cm. beyond the end opposite to the thermometer. The part placed on the stage is mounted on some nonconducting substance, such as a piece of well-seasoned mahogany.

The thin glasses or mica having been firmly packed in their places, and the thermometer put in position, taking care that it does not come into contact with any portion of the metal, perfumed oil is carefully poured into the open tube, until when in a horizontal position it completely fills the aperture in the block; the whole arrangement is then placed on the stage so that the aperture shall correspond with the optic axis. The object to be examined is placed on the upper thin glass.

4. *Water.*—This furnishes by far the best means of heating objects, a constant temperature being more readily maintained than with any other method. Changes of temperature can also be rapidly effected.

Dr. Polaillon ‡ suggested a flat box 1·0–1·5 cm. deep and of the same form as the stage. The upper and lower faces were of glass. There were two indiarubber tubes, one leading from a vessel of hot or cold water placed on a higher level, and the other leading into a lower vessel to catch the waste water.

Prof. Stricker's § original idea is shown in fig. 68, when the two tubes and rod at the upper side are removed. It consists of a metal box with a central perforation for light, the preparation being either placed upon a cover-glass cemented down, or so arranged that the central aperture serves as a cell. At opposite points of the box two tubes are inserted for the passage of water.

* Pharmaceutical Journal, xiii. (1882) pp. 1–4 (3 figs.), 21–2.

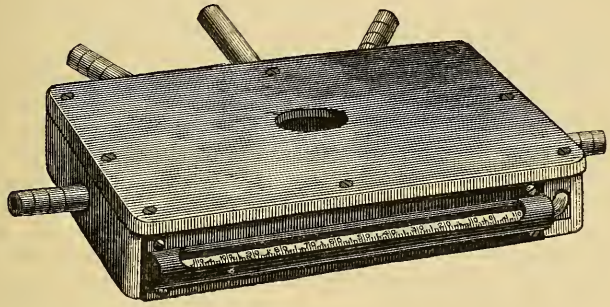
† The thermometer was described as fitted by means of a cork, but Mr. Symons found this got dry and leaked, and subsequently tried cement (sulphur and iron).

‡ Journ. de l'Anat. et Physiol., 1866, p. 133.

§ Op. cit., p. xix.

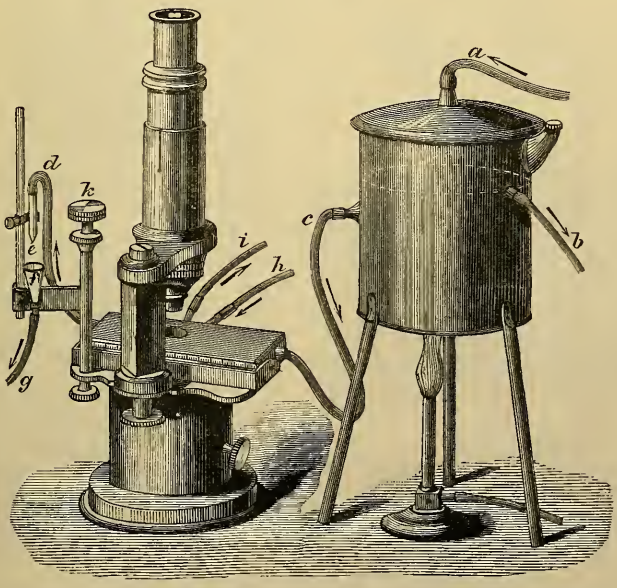
Dr. Burdon-Sanderson * modified Stricker's stage by the addition of two pipes for passing gas into the central chamber, and a rod for heating the stage by that method if desired. As modified it is shown in fig. 68, and

Fig. 68.



in use in fig. 69. In the vessel the water is maintained at a constant level, indicated by the dotted line, and at boiling temperature. *a* is the supply tube, *b* the waste tube, *c* the tube leading to the stage, and *d* a tube by which the hot water leaves the stage, terminating in a conical

Fig. 69.



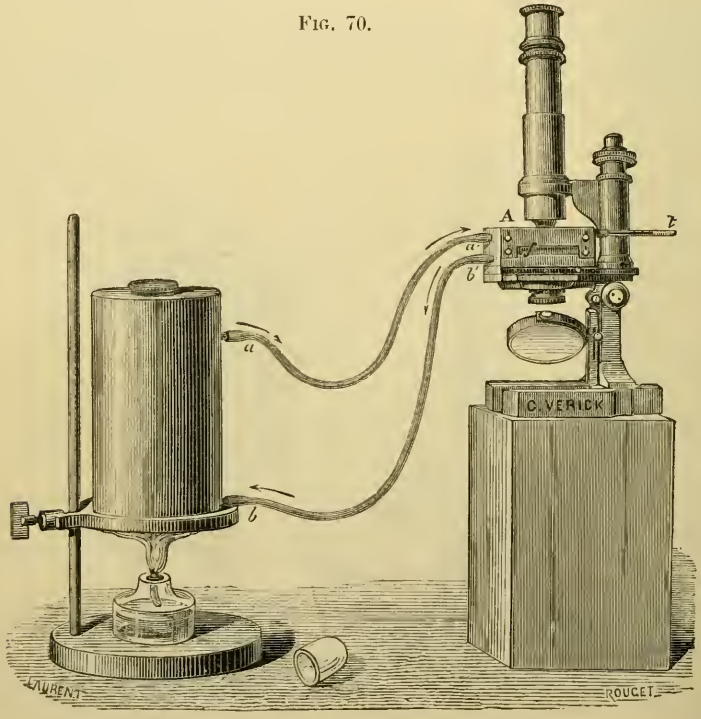
dropper *e*. A funnel *f* collects the drops which fall from *e*, and *g* is the waste. The rate of flow is determined by varying the height of *e* by means of the sliding screw on which it is supported. It admits of more exact adjustment by means of a fine screw which works in the axis of the

* Burdon-Sanderson, op. cit., pp. 15–6, fig. 3; Quart. Journ. Micr. Sci., x. (1870) pp. 366–7 (2 figs.).

vertical column on which the escape tube is supported. This column is firmly fixed in the stage of the Microscope, its axial screw terminating above in a milled head *k*. *h* and *i* are tubes for gas.*

Dr. Klein says† that in the employment of this apparatus several difficulties are encountered. For instance, the temperature of the water receptacle is only in part controlled by the regulator, and the temperature of the stage is subject to variation according to the rate at which the water flows into and escapes from it, so that unless great care is taken in the adjustment constancy cannot be relied on. Another practical difficulty lies in the fact that the temperature of the water in the receptacle is different from that in the stage, the rate of flow being so inconsiderable that there is necessarily a great loss of heat by radiation from the metal surface. If the stage is not fitted with a thermometer this difference of temperature may be determined once for all by comparative measurements, so that the true temperature of the stage can then be known at any time by deducting the ascertained loss of heat, i. e. the ascertained difference above referred to, from the temperature to which the regulator is adjusted.

Fig. 70.



Prof. Ranvier‡ has modified the preceding apparatus as shown in figs. 70 and 71. In the centre of the stage A (fig. 70) is a horizontal slit *f*, in

* In the apparatus described in the Quart. Journ. Micr. Sci. the water was in the first instance conveyed to a loop-shaped metal tube surrounding the upper part of the objective for the purpose of keeping it warm, a vulcanite ring preventing the heating of the Microscope-tube. From the loop the water passed to the stage.

† Burdon-Sanderson, op. cit., p. 7.

‡ Ranvier, L., 'Traité technique d'Histologie,' 1875, pp. 41–2 (1 fig.)

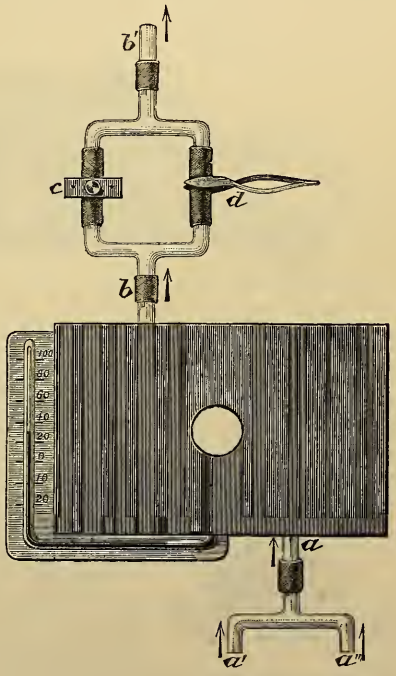
which the slide O (fig. 71) with the object can be placed. Above and below this are other vertical openings *c* and *d*, communicating with it, the upper one *d* receiving the objective, and the lower one *c* a diaphragm of glass. To prevent cooling, the space between the objective and the sides of the upper opening can be stopped with cotton wool. A thermometer *t* is inserted in a tube at one side of the apparatus, as shown in both figures.

Fig. 71.

It is essential, in order to insure the same temperature of the water in the reservoir and stage, which communicate by the circulating tubes *a a'* and *b b'*, that the stage should be above the level of the water in the vessel, and therefore that the Microscope itself should be elevated as shown in fig. 52.

Professor Ranvier describes the great advantage of the apparatus to consist in the fact that a constant temperature can be readily maintained for several hours. When the temperature of the water has been raised to 40° C., an observation can be continued for a quarter of an hour without any reheating, as the cooling proceeds so very slowly. The preparation is at the very centre of the stage, and the aperture below being closed by a glass diaphragm and that above by cotton-wool, the object is protected against all the usual causes of cooling, and its temperature is very nearly that indicated by the thermometer.*

Fig. 72.



Dr. M. Flesch † suggests a form of stage available for both high and low temperatures, and especially for rapid changes of temperature, also allowing the Abbe condenser to be used for illumination as well as the ordinary polarizing apparatus.

The author discusses some of the preceding stages, condemning Max Schultze's. He considers Ranvier's to come the nearest to fulfilling the conditions which he laid down for himself. Bartley's ‡ and Symons' § he considers to each present important advantages; the former does not, however, allow the temperature to be determined with exactness; the latter he fears would not admit of very rapid changes, and the cover-glass on which the object is placed would be liable to be broken or displaced by quick cooling.

The stage (fig. 72) is a shallow box, into which pass the tube *a* for

* To prevent the cooling of the object by the objective, especially when the focus is short, it has been suggested to place an ivory tube 30 mm. long over the objective. Dippel, tom. cit., 1882, p. 655. † Zeitschr. f Wiss. Mikr., i. (1884) pp. 33–8 (1 fig.).

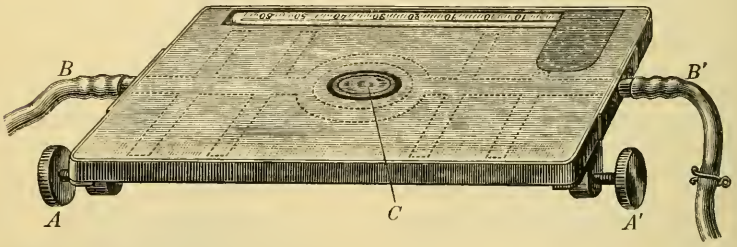
‡ See this Journal, 1881, p. 672. § See this Journal, 1882, p. 21.

introducing hot or cold water and the tube *b* for carrying it away. The former is attached to a T tube—one branch *a'* being connected with a vessel of hot water, and the other *a''* with cold water, a pinchcock closing the one not in use. A double T tube is in connection with *b*, through one branch of which the water ordinarily flows in drops controlled by the screw *c*. The object of the double tube is to facilitate an almost instantaneous change of temperature. If the pinchcock *d* on the second branch is opened at the same time as the cold-water vessel is placed in connection with the stage the water will rapidly circulate, and the stage will be filled with cold water only, so that in a few seconds the temperature may be lowered 30°.

Dr. Flesch at the time his paper was written was not wholly satisfied with his apparatus, and expected to improve it.

*Löwit's Hot Stage for High Powers.**—The thickness of the ordinary hot stage does not allow the condenser to be brought close to the under side of the slide, so that the object is not in the focus of the illuminating beam, and the use of high powers is obstructed. Dr. Löwit's hot stage (fig. 73) is intended to remedy this difficulty.

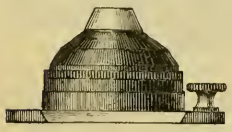
Fig. 73.



In general form the stage is like that of Stricker but thinner; the water circulates by means of the two tubes B B' and the internal tubing shown by dotted lines. The screws A A' are for centering.

Into the central opening C can be introduced the upper of the two lenses of a condenser, the upper lens, as shown in fig. 74, being much coned away, so that the top surface lies flush with the stage. The object can thus be placed in the focus of illumination, and the full effect obtained even with homogeneous-immersion lenses.

Fig. 74.



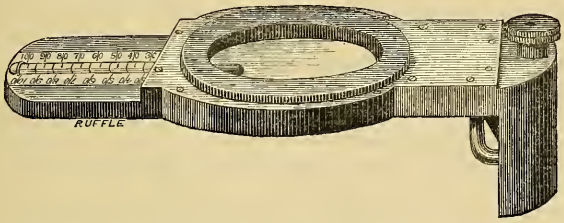
To maintain a constant temperature the author finds it better to admit the water from a vessel in which it is kept at boiling-point, and as soon as the temperature in the stage has risen to 30°–40° C. to check the flow by closing the outflow tube until the water can only issue in drops; by regulating the outflow the chamber can be maintained at any desired temperature. With a slow circulation, however, the thermometer will not indicate the temperature of the object, but only that of the water in the neighbourhood of the bulb, which will differ according to the side at which the water enters, the water of course being colder towards the exit side. Thus the thermometer might register 50° C. when the hot water enters at B' and 40° C. when it is admitted at B, so that in the

* Zeitschr f. Wiss. Mikr., ii. (1885) pp. 43–6 (1 fig.).

former case the object will be at a lower and in the latter at a higher temperature than the thermometer. If it is desired to know exactly the temperature of the object a rapid circulation must be maintained, and a thermo-regulator used.

*Dr. G. Valentin's** (fig. 75) is intended not only for heating and

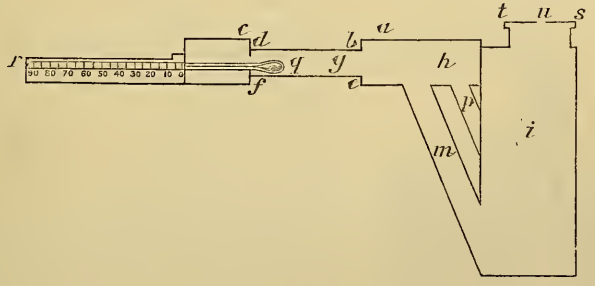
Fig. 75.



cooling by water, but also by air, and for a great variety of microscopica observations which require a closed chamber.

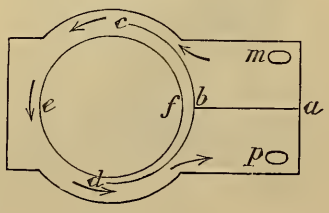
It consists of a vessel *i* (fig. 76), projecting over the side of the stage, and communicating with the chamber *h g* by the two pipes *p* and *m*. The

Fig. 76.



centre is formed of two glass discs *b d* and *e f*, *b d* being sunk below the level of *a c* to form an outer chamber, which can be closed with cover-glass when required. It is removable, so as to give access to the interior. (A section of the interior of *h g* is shown in fig. 77, where *e f* is the bottom plate of fig. 76 and *m p* the openings of the two pipes; *a b* and *c d* are two metal partitions which serve to regulate the flow of the fluid, as shown by the arrows.) A thermometer *q r* also passes into the chamber, which terminates at this end at *d f*.

Fig. 77.



To use it for heating with water the top *s t* is removed and water poured into *i* until full, and a spirit-lamp placed beneath it. The steam escapes at the small hole at *u*, or, if the water is required to boil, the top is removed and a pipe of larger opening put on. For heating with air the spirit-lamp is placed as before, or the vessel *i* is plunged in hot water.

* Valentin, G., 'Die physikalische Untersuchung der Gewebe,' 1867, pp. 421–8 (4 figs.).

If it is desired to cool the object the end of the vessel *i* can be placed in cold water, or for low temperatures in ice and salt, the chamber being then filled with pure alcohol instead of water.

The apparatus can also be used as a moist chamber or for steaming objects. In this case only a little water is placed in *i*, *u* being closed with wax and the object placed at *g*. If the glass *b d* is too thick one or other of the following plans may be adopted. The object may be placed on *b d* and covered, and a communication made between the interior (filled with water) by a piece of cotton. Or *b d* may be removed and a brass plate substituted with a square aperture, over which the object is suspended on a cover-glass.

For a dry chamber it is only necessary to introduce sulphuric acid or potash sticks into the vessel *i*.

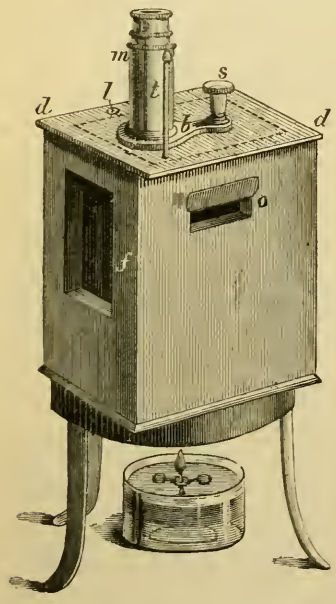
Gases can be introduced through *s t*, the object being suspended over the aperture in the brass plate as before, or the action of the vapour of ether, chloroform, &c., upon different objects may be investigated.

It is also adapted for all kinds of observations (spectroscopic, fluorescent, or otherwise) on fluids, especially where a constant thickness is required.

Prof. J. Sachs encloses the Microscope itself in a special chamber which he describes as follows:*—

"Convenient contrivances for observing the action of particular higher or lower temperatures on plants or parts of plants of considerable size are easily arranged. It is more difficult to expose microscopic objects to a particular higher or lower temperature in such a manner that it can easily and certainly be observed, and that the temperature of the object is also that indicated by the thermometer, or nearly so. All these requirements are fulfilled by the very cheap heating apparatus for the Microscope represented in fig. 78.

Fig. 78.



The size of the heating apparatus must vary with that of the Microscope; mine is constructed for one of Hartnack's ordinary instruments. The box is nearly cubical, and has double walls of sheet zinc at the bottom and sides, inclosing a space 25 mm. thick, which is filled with water through the hole *l* (fig. 78). It is quite open above, but in the front side-wall is an opening *f*, which is closed by a glass plate well fitted but not otherwise fixed. This window is sufficiently large, and is so placed that it allows enough light to fall on the mirror of the Microscope which stands in the box. The height of the box is so arranged that the upper rim of the double wall is on a level with the arm *b* of the Microscope. The opening of the box is closed by a thick cardboard cover *d d*, in which an opening is cut exactly to fit the arm *b*. By the side of the tube of the Microscope a round hole is cut in the cover through which a closely fitted small thermometer *t* passes, so that its bulb hangs

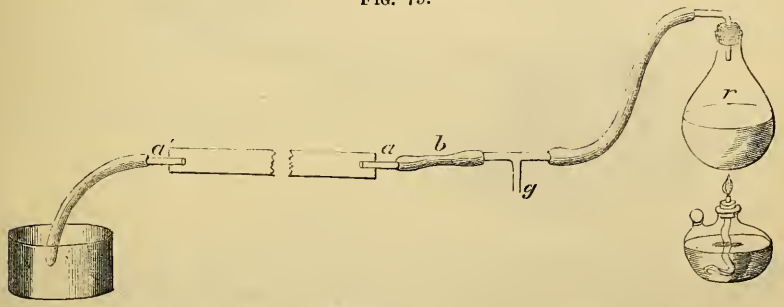
* Sachs, J., 'Text-book of Botany,' 2nd ed., 1882, pp. 735–7 (1 fig.).

near the object. The box is painted on the inside with black varnish, and a piece of cardboard moistened with water lies beneath the foot of the Microscope in order to prevent its moving and to keep the air within moist. The focus is easily adjusted to the object by means of the fine-adjustment *s* which projects above the cover; two openings in the side, one of which is shown at *o*, enable the slide bearing the object to be moved, when necessary, by a pair of forceps. It is still more convenient to fix the slide on a wire which goes through a cork fitted to the opening *o*.

It is easy by means of this heating apparatus to observe and demonstrate the influence of temperature on protoplasm-currents. To take observations at low temperatures it is sufficient to enlarge the hole *l*, in order from time to time to place pieces of ice in the cold water.*

Maintaining a constant temperature and varying the temperature.—For varying the temperature with rapidity, *Prof. Stricker* suggested† the arrangement shown in fig. 79 (centre of stage omitted). To the tube *a*, com-

Fig. 79.



municating with the stage, is attached an indiarubber tube *b*, which leads to a flask *r* for generating steam. The steam escapes through the perpendicular limb *g* of the T-shaped tube which is interposed between the flask and *b*, because it here meets with the least resistance. When this is prevented by means of a caoutchouc tube and a clip, the steam will pass through the slide and heat it. If the lamp is removed, the flask in cooling will act by way of suction on the vapour in the slide and air will enter, or iced water may sucked up through the tube *a'* and rapid cooling effected.

A preparation may also be subjected to sudden alterations of temperature by the apparatus shown in fig. 69.‡ A clip is placed on the tube *c*, leading from the water receptacle by means of which the access of the warm water to the stage may be interrupted. The end of the escape tube *d* is then allowed to dip into a vessel of cold water. This done, cold water may be readily introduced into the stage so as to cool it suddenly, by suction through the tube *c*, which must be provided with a branch (not shown in the fig.) between the clip and the stage for the purpose. To effect a sudden rise, all that is necessary is to open the clip.

An excellent contrivance for maintaining a constant temperature with a hot stage, is that devised by *Prof. E. A. Schäfer*,§ on the model of the

* Panum is also stated (Thanhoffer, tom. cit., p. 89) to have adopted the same plan as Sachs of enclosing the whole Microscope, but we have not been able to find the reference to his description.

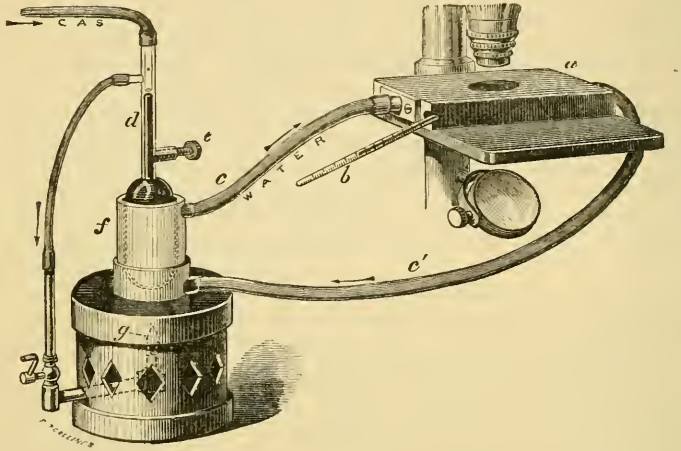
† Op. cit., pp. xx.–xxi.

‡ Burdon-Sanderson, op. cit., pp. 7–8.

§ Op. cit., pp. 22–3 (1 fig.).

ordinary gas Thermo-regulator. The object (fig. 80) is placed upon the warm stage *a*, which consists simply of a brass box resting upon the stage of the Microscope, and with a tubular aperture in the centre to admit light to the object. The box is connected by indiarubber tubes with a hollow metal jacket *f*, and the whole system thus constituted is completely filled with water previously boiled to the exclusion of air. The water is warmed at *g* by a small gas-flame and rising through the tube *c* communicates its

Fig. 80.



heat to the box *a*, the temperature of which is measured by a small thermometer *b* inserted through an obliquely placed tube quite into the central opening and immediately under the preparation. The cooled water from the stage passes down the tube *c'*, and so to the flame again, and in this way a constant circulation is kept up.

The bulbed tube *d* filled with mercury serves to regulate the flow of gas so as to keep the temperature constant at any desired point. This is effected by turning the steel screw *e* when this point, whatever it may be, is reached, so as to raise the mercury in the glass tube, and almost block up the lower end of a small steel or glass tube which is fixed into the upper end of the tube *d*. The gas used for heating passes through the small tube and then above the mercury and between the two tubes to be conducted by the side-piece to the burner below. If now the temperature rises higher in the reservoir *f* surrounding the mercury the latter will expand and rising in the tube will cut off more of the gas, and thus reduce the flame, on which the mercury will again contract and the flame increase in consequence, and so on. It is found that an equilibrium soon becomes established, and the temperature of the water and stage remains almost absolutely constant. To raise or lower the temperature all that is required is to screw *e* out or in. The smaller tube enclosed in *d* is pierced with a minute aperture to allow a constant passage of gas, so as to prevent the flame from being extinguished in the event of the mercury completely blocking up the lower end of the tube.*

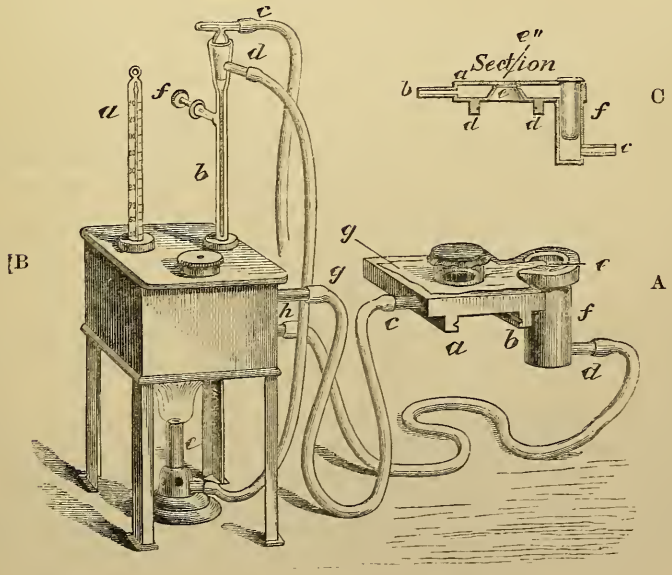
* To provide against the danger resulting from accidental extinction of the gas, Prof. Koch devised a self-acting apparatus, which, simultaneously with the extinction of the flame of the burner, shuts off the supply of gas. Cf. Crookshank's 'Practical Bacteriology,' 1886, p. 36 (1 fig.).

Dr. Dallinger's Thermostatic continuous Stage is constructed on the same principle as the preceding. It was devised for the continuous observation under high powers of the minutest living organisms, and was used by Dr. Dallinger and Dr. Drysdale for the continuous watching of monads as described in 'The Monthly Microscopical Journal,' 1869, pp. 97 *et seq.* The primary object was to arrange the field of observation, consisting of a minute drop of a septic fluid containing a given organism under observation, so that it might be observed with the highest powers, uninterruptedly, and yet that the drop of fluid should not be suffered to evaporate. The details of explanation as to how this was accomplished are given in the paper above referred to. It will suffice here to point out that the non-evaporation was accomplished by causing the objective and the covered drop to work in an air-tight chamber kept by capillary action constantly so saturated with aqueous vapour that the air within that chamber had, as it were, no room to receive the vapour from the covered drop on which observations were being made.

The present piece of apparatus aims at precisely the same thing, with the additional aim that the covered drop and all surrounding it shall be, and shall be static at, any temperature required. It was employed specially to investigate the life-history of a septic organism whose normal fluid was from 90° to 95° F.

The stage was made as described in the above paper, but it was made hollow and water-tight. The whole stage is seen in perspective in fig. 81.

Fig. 81.



At A, *a b* are two grooved pieces of solid metal which permit the stage to slide on to the stage of an ordinary Microscope and partake of the mechanical movements effected by the milled heads.

B is a vessel for water with a thermometer *a* of sufficient delicacy for indicating the temperature. *b* is a mercurial regulator, carefully made, but of the usual pattern; *c* brings the gas from the main; *d* conveys as

much of the gas as is allowed to escape from between the top of the mercury and the bottom of the gas delivery tube to the burner *e*. The regulation of this apparatus so as to obtain a static temperature, as is well known, is a matter of detail depending chiefly on the careful use of the mercurial screw-plug *f* and the height and intensity of the burner *e*. A temperature quite as accurate as is needed can be obtained for the purpose required.

The stage (A) is placed in position on the instrument; and two openings in this hollow stage at *c d* (A) are connected with two similar openings in the water-vessel, viz. *g h* (B). The whole is carefully filled with water and raised to the required temperature and regulated.

The manner in which it accomplishes the end desired is as follows. On the centre of the stage (A) will be seen a small cylinder of glass: this is ground at the end placed on the stage, and covered with a sort of drum-head of indiarubber at the upper end. By examining C with a lens it will be seen that a cell is countersunk into the upper plate of the hollow stage at *e''*, and a thin plate of glass is cemented on to this (seen also in section in the same figure). At *e* another disc of glass is cemented watertight, so that a film of warm water circulates between the upper and under surfaces of this glass aperture. A glass cup is placed in the jacketed receptacle *f* (A and C), and this also is filled with water. A piece of linen is now laid on the stage (A, *g*), with an aperture cut in its centre slightly less than the countersunk cell in which the glass disc *e''* is fixed, and a flap from it is allowed to fall over into the glass vessel *f* (A and C). Thus by capillarity the water is carried constantly over the entire face of the linen. But the glass cylinder seen in A is made of a much larger aperture than the cell and the opening in the linen, and consequently a large annulus of the linen is inclosed within the cylinder. The drop of fluid to be examined is placed on the small circular glass plate and covered with the thinnest glass, the drum-head cylinder is placed in position, the point of a high-power lens is gently forced upon the top of the indiarubber through a small aperture, thus forcing the lower ground surface of the cylinder upon the linen, and making the space within the closed cylinder practically air-tight, but still admitting of capillary action in the linen. Thus the enclosed air becomes saturated.

By complete circulation the water in the vessel *e* (A) is but slightly below that within the jacket of the stage, and thus the vapour as well as the stage are near the same thermal point.

For aiding in illumination and admitting various illuminating apparatus, a large bevelled aperture *e* (A) is made between the lower and upper plates of the stage jacket which is found to supply all the accommodation needed.

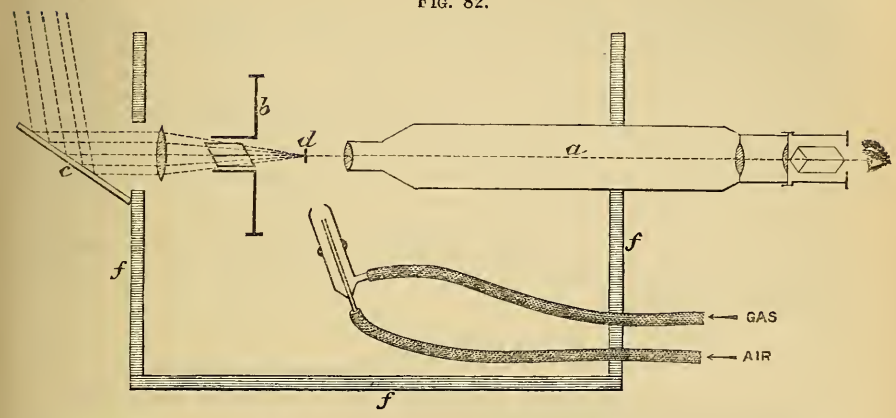
Merian's Arrangement for Heating Minerals.*—Herr A. Merian, following the researches of Mallard and Klein on the influence of heat on boracit, has studied other mimetic minerals in a similar manner. In tridymit no change of its optical relations could be perceived when the ordinary hot stage was used, and for the purpose of observing its behaviour at still higher temperatures the following arrangement was adopted.

A Microscope *a* (fig. 82) was so fixed in a box *f* that daylight could be made to pass from a plane mirror *c* through a convex lens to the nicol on the stage *b*, the Microscope being horizontal. The space between the stage and the objective was sufficiently large to allow the introduction of the preparation *d* and the heating apparatus.

* Neues Jahrb. f. Mineral., Geol., u. Palæontol., 1884, pp. 193–5 (2 figs.).

The mineral chips were supported on platinum-pointed pincers fastened to a stand, and in this way brought within the focus of a low-power

Fig. 82.



objective. By means of a small gas-jet the mineral could be brought to a white heat in a very short time, "without perceptibly warming the objective and nicol."

Capillary Tube Slide and Perforator of Cell-elements.*—One of the principal drawbacks in the microscopical examination of small objects consists in the difficulty of suitably orienting them on the slide in order to observe successively all their aspects. In observing, for instance, the segmentation of an ascidian ovum, the vitellus of which measures scarcely more than 0·1 mm., the turning round of such a delicate object demands much patience, and leads only too often to its destruction. M. L. Chabry therefore proposes the following apparatus:—

The egg is sucked into a capillary glass tube having very thin walls, and an internal diameter exactly equal to that of the egg, and measuring 8–10 cm. in length. A drop of sea-water introduced at the upper end of the tube, held vertically above the liquid, induces an internal current which drives the egg towards the middle of the tube. There is also required an ordinary slide, to which are fixed with wax two small glass sockets, at a distance sufficient to admit a cover-glass between them. These two sockets, which lie in a line following the long diameter of the slide, so exactly admit the capillary tube, that they permit no other movements than of rotation and of sliding longitudinally. That part of the tube lying between the two sockets, and containing the egg, is covered with a thin cover-glass, beneath which a drop of water is introduced. Thus submitted to microscopical examination, the object presents a clear image and its rotation is determined, even beneath the observer's eye, by the rotation imparted to the capillary tube. In order to have the latter under perfect control, one of the ends projecting over the edge of the stage is bent like the letter L.

To make it serve as a pricking, perforating, and injecting instrument, there is introduced into the capillary tube a very fine glass thread, terminated by a short, sharp point. If the end opposite that through which the stylet has been introduced be closed in such a manner as to prevent any

* Comptes Rendus Soc. Biol., iii. (1886) pp. 322–3.

escape of the liquid and of the object enclosed within the tube, the object may be pricked or perforated at any selected point by a sharp tap. If manipulated with more caution, the stylet also serves to turn the object round within the tube, and the combination of this movement with that of turning the tube permits examination in any position whatever. A lever serves to control the sliding of the stylet by reducing by five to ten times the extent of the movement imparted by the hand. This lever is a blade of straw, through the fixed end of which passes a pin fastened vertically to one of the corners of the flat slide. Its direction is perpendicular to the stylet, with which it is connected at about 1·5 cm. from its fixed end. This lever moves in the plane of the flat slide, beyond which it projects, as it is much longer than the slide is broad.

By the aid of this perforator the author has been able to pierce and kill, at will, *any* cell of an ascidian egg in segmentation, and to obtain experimentally the "monstres" called "fractions d'individu," the existence of which he discovered.

Bausch & Lomb Condenser and Substage. [*Post.*]
The Microscope, VII. (1887) p. 16 (1 fig).

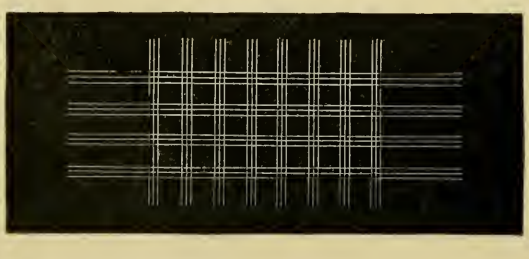
Heurck, H. van.—**Comparateur à employer dans les recherches microscopiques.** (Comparator for microscopical researches.) [*Post.*]
Bull. Soc. Belg. Micr., XIII. (1887) pp. 76–8 (2 figs.).

Rohrbeck.—**Ueber Thermostaten, Thermoregulatoren, und das Constanthalten von Temperaturen.** (On Thermostats, Thermoregulators, and the maintenance of Constant Temperatures.) *Deutsche Medicinalztg.*, 1886, and *Deutsche Chemikerztg.*, 1886.
Cf. *Centralbl. f. Bacteriol. u. Parasitenk.*, I. (1887) pp. 247–8.

(5) Photomicrography.

Evans's Focusing Screen for Photomicrography.*—Mr. F. H. Evans refers to the difficulty which exists in focusing, by means of an ordinary focusing lens, the microscopic image projected on a screen of patent plate glass. This is due to the power of accommodation of the eye, in consequence of which the focal plane of the image is frequently assumed to be on the outer instead of the inner surface of the screen. He suggests that this difficulty may be readily overcome by ruling on the inner surface of the glass screen (i. e. the surface towards the Microscope) a series of fine lines similar to those shown in fig. 83; the eye has then before it a definite

Fig. 83.



object in the focal plane upon which the focusing lens is adjusted, so that the almost involuntary movement of accommodation is practically arrested thereon, and the focusing of the microscopic image on that plane is thus greatly facilitated.

* Journ. and Trans. Phot. Soc., xi. (1886) pp. 25–8 (1 fig.).

Bray, A., and R. Sulzberger.—**La Photomicrographie.** Rapport sur la Conférence pratique de M. le Prof. Francotte. (Photomicrography. Report on the practical demonstration of Prof. Francotte.)
Bull. Soc. Belg. Micr., XIII. (1887) pp. 59–69.

Francotte, P.—**Résumé d'une Conférence sur la Microphotographie appliquée à l'histologie, l'anatomie comparée et l'embryologie.** (Summary of a lecture on photomicrography applied to histology, comparative anatomy, and embryology.)
Bull. Soc. Belg. Micr., XIII. (1886) pp. 24–56 (5 figs.).

Garrison, F. L.—See *infra*, β (2).

Heurck, H. van.—**Application du petit appareil photographique aux Microscopes continentaux.** (Application of the small photographic apparatus to Continental Microscopes.) *Bull. Soc. Belg. Micr.*, XIII. (1887) pp. 82–3.

Israel, O.—**Ueber Mikrophotographie mit starken Objectivsystemen.** (On photomicrography with high powers.)
Arch. f. pathol. Anat. u. Physiol., CVI. (1886) pp. 502–14.

Mercer, A. C.—**The Indebtedness of Photography to Microscopy.**
Rep. from *Phot. Times Almanac*, New York, 1887, 7 pp.

Stenglein, M., and Schultz-Hencke.—**Anleitung zur Ausführung mikrophotographischer Arbeiten.** (Introduction to practical photomicrography.)
viii. and 131 pp., 5 figs. and 2 phot., 8vo, Berlin, 1887.

Sulzberger, R.—See Bray, A.

(6) Microscopical Optics and Manipulation.

Ewell, M. D.—**Micrometric Measurements.**
[Results of measurements by six observers, showing considerable discrepancies.]
The Microscope, VII. (1887) pp. 10–2.

Glass, a New.
[Similar to the ludicrous paragraph referred to *ante*, p. 155, and contains in addition the statement that "the difference between the new and the old glass consists in the refraction of light!"]
Scientif. Enquirer, II. (1887) p. 47, from *Boston Journ. of Commerce.*

Glass, New Optical.
["The invention of a new optical glass is said to be creating a sensation in the German scientific world. The glass, owing to its great refractory power, promises to be of marked influence in practical optics, inasmuch as it will admit of the production of lenses of short focal width, such as it has hitherto been impossible to obtain. For microscopic photography it will be of the greatest importance"!]
Echo, 7th March, 1887.

H.—**Measuring Refractive Index.**
[G. Thompson's method. See Journal, 1886, p. 698.]
Amer. Mon. Micr. Journ., VIII. (1887) pp. 12–3.

Höegh, E. v.—**Eigenschaften der Jenenser Glassorten.** (Properties of the Jena glass.)
[Refractive indices and dispersive powers of forty-four kinds of glass.]
Central-Ztg. f. Optik. u. Mech., VIII. (1887) pp. 13–4.

Mayall, J., Jun.—See Taylor, J. T.

Measurement, Minute.
[Micrometer Microscopes.] *Knowledge*, X. (1887) pp. 109–12 (3 figs.) (*contd.*)

Nelson, E. M.—**Numerical Aperture.**
[Reply to T. F. S. (p. 435), as to why an oil-immersion objective performs better than a water-immersion of the same aperture. "Accounted for by slip (loss of light by reflection, &c.) and unavoidable errors in construction."]
Engl. Mech., XLIV. (1887) p. 480.

"Orderic Vital."—**Schott & Co.'s New Optical Glass.**
[Contains a translation of the list of glasses. Cf. Journal, 1886, p. 856.]
Engl. Mech., XLIV. (1887) pp. 523 and 563.

Pscheidl, W.—**Bestimmung der Brennweite einer Concavlinse mittels des zusammengesetzten Mikroskopes.** (Determination of the focal length of a concave lens by the compound Microscope.)
[Find the position of an object in which the given concave lens produces an image half the size of the object itself; the distance between the image and object is then equal to one-half the focal length, if the thickness of the lens be neglected.]
SB. K. Akad. Wiss. Wien, XCIV. (1886) p. 66.

Royston-Pigott, G. W.—**Microscopical Advances. XVI.**
[Ancient and modern diffraction lines.] *Engl. Mech.*, XLV. (1887) p. 1.
S., T. F.—See Nelson, E. M.
Taylor, J. T.—**Photographic Lenses.**
[Contains remarks on the new glass by the author, J. Mayall, jun., and others.]
Journ. Soc. of Arts, XXXV. (1887) pp. 192-201, 268-9.

(7) Miscellaneous.

A Visit to Jena.—At the January meeting of the Society, Mr. J. Mayall, jun., gave an account of his recent visit to Jena, where during about a fortnight he had been the guest of Prof. Abbe. Every facility had been given him for following the technical processes employed in the manufacture of Microscopes in Messrs. Zeiss's optical and mechanical workshops, and in the production of optical glass in the Jena Optical Glass Works, and his impression was that it would be hardly possible to overrate the skill in organization there displayed for the purposes in view. Messrs. Zeiss employed upwards of three hundred assistants in a series of workshops so arranged that those departments where delicate work was being produced —where the vibration of steam machinery would be a serious drawback— were quite separate from the departments where steam-power was employed.

Messrs. Zeiss had found it advantageous to make their own brass castings, and hence had established a foundry on their premises. He had seen the various heavy kinds of lathe-work and fraising in full operation with steam-power. The parts of the Microscope-stands where this and other mechanical work was being executed were usually given out in sets of ten, and in general the system of piecework was in vogue throughout the workshops. With regard to the optical work, only a very small portion was produced by the aid of steam-power; for instance, the plane surfaces of eye-piece lenses, which were worked together in large sets, and the glass-slitting by means of rapidly-revolving iron discs charged on the edges with diamond fragments. The glass-slitting machine was largely employed in the preparation of prisms of the different samples of glass for the determination of the refractive and dispersive indices. By means of the glass-slitter, the plates of optical glass, as received from the glass works, were cut to the various thicknesses required, and then, by means of ordinary American wheel-cutters, the thin strips were cut into squares of the sizes required. The squares were placed in suitable trays in the storeroom, whence they were given out to the glass-grinders, together with the necessary tools and the gauges belonging to them. The glass-grinders snipped the squares to approximately the disc shape, and then cemented them each on a suitable block, and ground and polished the surfaces, the metal tools being attached to foot-lathes with vertical spindles passing through deep horizontal trays, in which the refuse emery, &c., was caught, and the workmen were generally seated.

For testing the accuracy of the finished surfaces, Fraunhofer's method was employed, which consisted in providing for each curvature required a pair of highly-finished standard convex and concave surfaces worked in rock-crystal, of which the radii had been accurately determined by means of a spherometer of great precision, the perfection of the curvatures being shown by the symmetrical formation of Newton's rings when the surfaces were pressed in contact. Each surface, as finished, was tested by contact with the corresponding standard surface of rock-crystal, and the polishing was continued until the required degree of accuracy was reached. He was previously aware that Fraunhofer had employed this method of testing the accuracy of spherical surfaces for telescopes, using standards made of glass. Prof. Abbe informed him that Dr. Hugo Schröder had

suggested the advisability of making the standards of rock-crystal, instead of glass, for testing Microscope lenses, on the ground of its much greater durability where required to be in such constant use. Each workman was also provided with a contact-measurer, by which he was able to determine the thickness of the lenses, and thus approximate to the required thickness within a small fraction of error. An experienced foreman superintended this department, and was responsible for the accuracy of all gauges, &c. Mr. Mayall said he had been much interested to see these methods of precision in regular daily use in Messrs. Zeiss's workshops, the more so from the fact that for much of the optical work lads were employed, who thus obtained admirable training for the more difficult branches on which they entered later on. He had also witnessed the processes of centering the separate lenses, and reducing them to the required diameters; then the cementing into combinations and the mounting in metal cells, with its attendant further process of centering. He had also watched the whole process of manufacturing a front lens for an apochromatic 1/8 homogeneous-immersion, from the grinding to the complete mounting in its cell, centering, &c., the lens being somewhat greater than a hemisphere, and the figure being tested in the standard concave of rock-crystal as he had previously described. The rapidity and dexterity shown throughout the execution of this delicate work had most favourably impressed him as to the high character of the training in Messrs. Zeiss's workshop, for it should be noted that the production of such work was not confined to one pair of hands, as generally obtained in England, but was being executed by several—workmen of special aptitude, doubtless, but still such as the system of training there adopted brought to the fore in sufficient number to meet the demand, even in so large an establishment. He had also observed with special attention the methods employed for testing the finished objectives; but there, of course, so much depended on the education of the eye and judgment, that he could not venture to criticize, not having himself practised with Prof. Abbe's silvered plate method. He understood, however, from Prof. Abbe that the method enabled the director of that department to give precise instructions as to alterations needed to reach a certain standard of excellence.

He must not omit to refer to the photomicrographic department, to which Dr. Roderick Zeiss had given special attention. A separate building had been erected for this purpose, and massive concrete blocks supported the installation of the electric light, projection apparatus, &c., as free as possible from vibration. Here he had seen a number of images of test objects, &c., projected on a screen by means of an arc lamp of 1200 c.p., using various objectives, from 1 in. to 1/20 in. focus. In some instances the higher degree of achromatism attained in the new apochromatic objectives was unquestionably shown, and he had no difficulty in admitting that on the whole the projection images were the best he had ever seen by artificial light. In view, however, of the extreme difficulty—impossibility he might say—of controlling the arc lamp, of maintaining a steady and equal light even for a space of one or two minutes, he thought for purposes of photomicrography it could not be commended, especially not for producing large negatives by direct projection. He had long held the opinion that the best photomicrographs were obtained by making small negatives by direct projection, negatives just large enough to exhibit the points sought to be demonstrated; if, then, it were desirable to produce a further enlargement, the small negative could be magnified by an ordinary photographic process. In this way the best photomicrographs by Dr. Van Heurck, of Antwerp, were produced, and the most difficult results, such as photographing the

higher bands of Nobert's 19-band test plate, were obtained by using sunlight.

The main purpose of his visit to Jena, however, was to submit to Prof. Abbe's examination a number of the best English objectives, whence he could accurately estimate the standpoint of excellence from which English microscopists would criticize the new apochromatics produced at Jena. In furtherance of this purpose the President of the Society and Mr. Frank Crisp had placed at his disposal the best objectives in their collections. Mr. Nelson had also requested him to select from his fine collection any objectives which he thought would worthily represent English optical work. From these collections, and sundry examples from his own, Mr. Mayall said he believed he had been able to carry out the intention of his visit to Jena; and he thought Prof. Abbe was now as vividly aware of what was meant in England by "critically good images" as possibly could obtain under the circumstances. He must, of course, mention the fact that he took with him to Jena his large Powell and Lealand Microscope and accessory apparatus. If his visit to Jena resulted in inducing Prof. Abbe to withdraw his frequently-expressed depreciation of the value of the achromatic condenser—and he had reason to believe this would be one of the practical results following upon his visit—he (Mr. Mayall) should consider his journey not wholly fruitless in advancing practical Microscopy.

Referring to the Jena Optical Glass Works, Mr. Mayall said they were under the management of Dr. Otto Schott, who appeared to have thrown his energy thoroughly into every detail of their organization, which had so favourably impressed the German Government that large official grants of money had been made in aid of the experiments suggested by him. The aim of the series of experiments had been to arrive at a knowledge of the conditions necessary for regulating the refractive and dispersive indices as far as possible with the various known substances capable of vitrification. He understood Dr. Schott to say the experience he had gained in the experiments made with the assistance of the Government—experiments which had all been carefully classified and recorded—enabled him now to undertake to furnish any kind of optical glass according to sample supplied to him. On receiving such a sample, he proceeded to analyse it both optically and chemically, and then, from his registrations of experiments already made, he was able at once to select the elements and conditions required to arrive at the same result. Moreover, the exhaustive series of experiments he had made, enabled him, within certain limits, to control the ratio of the refraction to the dispersion, so that he had not only succeeded in increasing the range between the limits beyond what had been reached previously by makers of optical glass, but was also in a position to manufacture glass of any given refraction and dispersion for special purposes. The skilful optician was thus provided with new optical means which would certainly lead to general improvements in the construction of telescopes, field-glasses, &c. The new kinds of glass employed in Prof. Abbe's apochromatic objectives were produced at these Glass Works, as also the glass employed by Messrs. Powell and Lealand for their new apochromatics. Dr. Schott expressed his conviction that several of his new kinds of glass would be found of great importance in the construction of photographic lenses; he also said that Steinheil, the well-known optician of Munich, had already adopted its use largely. Such a fact ought not in his (Mr. Mayall's) opinion to be neglected by our makers of photographic lenses; for, assuredly, if one of them could succeed in producing lenses with a given ratio of aperture to focal length, but with a larger and flatter field than

had hitherto been seen—and the apochromatic Microscope-objectives showed how advance in that direction had been made by means of the new glass—the demand for such improved lenses would be practically unlimited.

Microscopic Justice.—Under this heading the 'Evening News' of 16th March says:—"Mr. Justice Chitty's Court presents a curious scene to-day. The judge is trying a patent case relating to waterproof fabrics. The Attorney-General, Mr. Moulton, Q.C., and Mr. Finlay, Q.C., are engaged in the case, and the learned counsel are provided with Microscopes to examine the materials. Another Microscope is placed upon the judge's desk, and during the morning witnesses have been seated beside Mr. Justice Chitty peering through the Microscope to detect differences of manufacture in the fabrics."

Loewenherz, L.—**Zur Geschichte der Entwicklung der mechanischen Kunst.** (On the history of the development of mechanical art.)
[Includes G. F. Brander (Glass Micrometers) and Fraunhofer (Achromatic Lenses and Microscope).]
Zeitschr. f. Instrumentenk., VI. (1886) pp. 405-19.

Macfarlane, J. M.—**On the Progress of Microscopical Research.**
[Presidential Address to the Microscopic Section.]
Trans. Edinburgh Naturalists' Field Club, I. (1885-6) pp. 319-26.

Matthiessen, L.—**Ueber eine neue Etagenloupe.** (On a new "tier" lens.)
[Discusses the lenses described in this Journal, 1886, p. 1065.]
Central-Ztg. f. Opt. u. Mech., VII. (1886) pp. 109-10.
See also *Nature*, XXXV. (1887) p. 331.

Mayall, J., Jun.—**Cantor Lectures on the Microscope.**
[Reprint in a collected form of the lectures noted in Journal, 1886, p. 869.]
97 pp., 103 figs., 8vo, London, 1886.

Pouchet, C.—**Prof. C. Robin, Sa Vie et son Œuvre.** (Life and work of Prof. C. Robin, Hon. F.R.M.S.) (*Concld.*)
Journ. de l'Anat. et de la Physiol., XXII. (1886) pp. xlix.-clxxxiv.

Scientific Directory. *Sci.-Gossip*, 1887, pp. 40, 65.

Western Microscopical Club.
[Report of meeting on 7th February, 1887, with system of classification of Mr. Crisp's Collection of Microscopes, &c.]
Engl. Mech., XLIV. (1887) p. 539.

β. Technique.*

(1) Collecting Objects, including Culture Processes.

Esmarch, E.—**Ueber die Reincultur eines Spirillum.** (On the pure culture of a *Spirillum*.) [*Post.*] *Centralbl. f. Bacteriol. u. Parasitenk.*, I. (1887) pp. 225-30.

Petri, R. J.—**Eine kleine Modification des Koch'schen Plattenverfahrens.** (A small modification of the Koch plate process.) [*Post.*]
Centralbl. f. Bacteriol. u. Parasitenk., I. (1887) pp. 279-80.

Smith, T.—**The relative value of cultures in liquid and solid media in the diagnosis of bacteria.** *Med. News*, 1886, II. pp. 571-3.

(2) Preparing Objects.

Preparing Goblet-cells.†—Dr. J. H. List examines goblet-cells, if possible, in aqueous humour, iodized serum, and 0·5 per cent. salt solution.

As isolation media, excellent results were obtained from Müller's fluid after acting for several weeks, from 0·5 per cent. osmic acid in 24 hours, followed by teasing out in distilled water or dilute glycerin (equal volumes of glycerin and distilled water), and from 0·1 per cent. chromic acid in

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

† Arch. f. Mikr. Anat., xxvii. (1886) pp. 481-588 (6 pls.).

one or two weeks. He also used one-third alcohol for 24 hours, followed by staining with rosanilin nitrate or dilute Renaut's hæmatoxylin-glycerin, to show the granular circle round the nucleolus of the goblet-cell nuclei in the bladder of various amphibia. The best results were obtained from sections. The objects were either placed for some days in Müller's fluid and then hardened successively in 50, 70, 90, and 100 per cent. alcohol, or were left in 0·5 per cent. osmic acid for 24 hours and then hardened gradually in spirit. But excellent results were also given by 2 to 3 days' hardening in 0·25 per cent. chromic acid, followed by washing in water for 24 hours, and this by gradual hardening in spirit, or by a 24 hours' action of Flemming's chrom-osmium-acetic acid, and after hardening in spirit. The objects were imbedded in celloidin, then cut and stained in the manner previously described,* although it may be mentioned that rosanilin nitrate and Weigert's Bismarck brown are excellent for the purpose. The sections were overstained, and the excess of colouring matter extracted in absolute alcohol, and then after dehydration and clearing up in bergamot oil, were mounted in balsam or dilute glycerin. For the connections between the goblet-cells and nerve-terminations, a 0·5 per cent. gold chloride solution was used after Ranvier's method.

Preventing Cartilage-cells shrinking away from Matrix.†—Mr. B. L. Oviatt states that Prof. Gage finds that the following mixture is superior to the saturated solution of picric acid, recommended by Ranvier for preventing cells shrinking away from the matrix: Picric acid, 7·5 grns.; alcohol (95 per cent.), 250 c.c.; water, 250 c.c. After 24 hours the sections are transferred to water, wherein they remain for 6 to 12 hours.

Demonstrating the Nuclei of Mammary Gland-cells in Lactation.‡—Dr. F. Nissen used as his material the glands of suckling bitches, rabbits, and cats. The animals having been killed by cutting their throats, the glands were quickly removed and cut into small pieces, some of which were placed in a concentrated sublimate solution heated to 40° C., and others in Flemming's chrom-osmic-acetic acid mixture. After twelve hours the pieces from the sublimate solution were washed in flowing water for twenty-four hours, and then hardened in alcohol. When sufficiently hard they were passed for twenty-four hours into a one per cent. watery solution of logwood, and thereupon for another twenty-four hours into a one per cent. alum solution (changed five or six times). In order to obtain a pure nuclear stain, the colour must be extracted with the alum solution until the extraction fluid is but little tinged. The protoplasm is either unstained or has merely a faint bluish reflex, the chromatin of the nucleus alone is stained; the connective tissue is unaltered, but the lymph corpuscles are deeply dyed, so that by the degree of stain they are easily discriminated from the nuclei of the alveolar epithelium. The coloured pieces were dehydrated with absolute alcohol saturated with turpentine oil, imbedded in paraffin and cut with a microtome. The pieces kept in Flemming's mixture were after two or three days washed for twenty-four hours, hardened in absolute alcohol, and imbedded unstained in paraffin. The sections were freed from paraffin by means of turpentine, and the turpentine removed by alcohol.

Gram's method was used for staining. The staining fluid is a solution of 3 grms. anilin, 1 grm. gentian violet, in 15 absolute alcohol, with addition of 100 grms. of aq. dest. When removed from alcohol the sections are

* See this Journal, 1885, p. 902.
† St. Louis Med. and Surg. Journ., li. (1886) p. 209.
‡ Arch. f. Mikr. Anat., xxvi. (1886) pp. 337–42 (1 pl.).

placed from 3–5 minutes in this solution, then washed for a few seconds in absolute alcohol, and then transferred to the iodide solution, which is—1 part iodine, 2 parts iodide of potassium, and 300 parts water. They are finally decolourized in absolute alcohol, cleared up in oil of cloves, and mounted in Canada balsam.

Artificial Distortions of the Nucleus.*—Dr. C. Van Bambeke employed principally the intestinal canal and Malpighian vessels of Arthropoda in his researches. The organs or their parts taken from the living animal were teased or spread out. Organs of tubular form, like the intestinal canal, were first of all split up and their contents evacuated. The blood of the animals could be examined without the aid of reagents; yet it was more advantageous to add a fixative and a staining medium. The author preferred acid methyl-green, under the influence of which reagent the nuclei of the eyes and their alterations could be easily studied. For permanent preparations, fixation with osmic acid, staining with methyl-green, and mounting in dilute glycerin were employed.

The manipulation to which the organs were exposed produced alterations in a large number of nuclei, and this alteration occurred also in various proportions, according to the species examined.

Demonstration of the Fibrillæ of Unstriated Muscular Fibres.†—For demonstrating the longitudinal fibrillation of unstriated muscular fibres the following method has proved very satisfactory according to Prof. S. H. Gage: Ten to fifteen cm. of perfectly fresh small intestine from a cat or other animal is tied at one end, and into the other is injected the following mixture: 95 per cent. alcohol 25 c.c., water 75 c.c., picric acid crystals 3/4 gram. When the intestine is moderately distended, the end in which the injection is made is tied, and the piece of intestine placed in a glass dish and covered with the mixture. After one or two days the muscular coats may be torn off in shreds. If one of the shreds is teased well with needles, unstriated muscular fibres may be partly or wholly isolated. They may be mounted in 75 per cent. glycerin. The picric acid stains the fibres yellow, and with a homogeneous-immersion (1/12 or 1/18) the longitudinal fibrillation shows with the greatest clearness. In some cases the ends of the fibres will be frayed, and show the fibrillæ something like a brush.

Preparation of the Organs of the Nervous System.‡—Prof. G. Golgi's improved method is as follows:—

1. Combined use of bichromate of potash and nitrate of silver. This depends on the gradual removal of the bichromate from the hardened pieces by means of a half to 1 per cent. solution of silver nitrate. The reaction is completed in 20 to 30 hours. This method is somewhat uncertain. 2. Successive use of bichromate of potash, osmic acid, and silver nitrate. Hardening is effected in a mixture of a 2 per cent. solution of bichromate, 8 parts, and 1 per cent. solution of osmic acid, 1 part. The pieces, which must be very small, are then immersed in the silver nitrate solution. 3. Successive action of potassium bichromate and perchloride of mercury. This method requires from one month to a year (according to the size of the pieces) for its full development, but a whole brain may be stained through at once.

Preparation of Amphibian Embryos.§—Dr. C. Rabl recommends that the embryos of *Salamandra maculosa* and *atra* and *Triton tæniatus* should

* Arch. de Biol., vii. (1886) 3 pls. † The Microscope, vi. (1886) pp. 267–8.
‡ Milano, 1886. Cf. Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 409–10.
§ Morphol. Jahrb., xii. (1886) pp. 252–7 (2 pls. and 2 figs.).

be fixed in 1/4 to 1/3 per cent. platinum chloride solution for from 3 to 24 hours, according to size. Then, having been carefully washed in water, they should be transferred to weak spirit and afterwards to stronger alcohols. Sections should be stained on the slide.

Preparation of Eggs of Osseous Fishes.*—Dr. M. v. Kowalewsky hardens eggs of *Carassius auratus* L., *Polycanthus viridiauratus* L., and *C. auratus* L. var. for 1¼ hours in a mixture of picro-sulphuric acid 8 vols., 1 per cent. chromic acid 1 vol. The eggs of *Carassius* were placed in the foregoing along with the pieces of plants to which they adhered, because they could not be separated therefrom without damage. The hardened eggs were then transferred to 20 per cent. spirit, frequently changed, for about 12 hours, and then in the course of 10 hours passed through 20, 28, 35, 43, 50, 60, and 70 per cent. spirit, in the last of which they were preserved. Before staining, the egg-sac was ruptured under a dissecting Microscope. The stain was either Grenacher's borax-carmine, or hæmatoxylin, then toluol and paraffin.

Preparation of Heart-muscle in Cardium edule.†—Dr. K. Drost used the following maceration medium introduced by Möbius:—Chromic acid 0·25 per cent., osmic acid 0·1 per cent., acetic acid 0·1 per cent., in sea water. In this fluid the objects remained for some days; acids by themselves gave no results.

For *Montacuta bidentata* 1 part sea-water to 0·5 per cent. bichromate of potash 4 or 6 parts were used; but the hairs of the sense-organs were found to be macerated.

Preparation of Eggs of Arthropoda.‡—Dr. F. Stuhlman in the examination of the eggs of insects, spiders, Myriopods, and *Peripatus*, examined fresh objects in 0·75 per cent. salt solution, to which is sometimes added weak acetic and methyl-green acetic acid. The foregoing was only suitable for young eggs, as older ones are too opaque. As fixative, cold concentrated sublimate solution proved the best. Water, 33 per cent. alcohol, and hot sublimate solution were not so useful. The cold sublimate fixed in 5 to 10 minutes. The preparations are then thoroughly washed; a few drops of tincture of iodine hastened the process. Then 60 per cent. spirit and finally absolute alcohol. The chorion is perforated with a fine needle, but the upper-pole is to be avoided. Ovaries are placed for several hours in chloroform, then from one to three days (according to size) in paraffin at about 55° C. The imbedding mass is rapidly cooled. The sections are stuck on with a thin layer of Mayer's fluid. The author states that fresh albumen mass stains less easily than the older. The stains used were Grenacher's borax-carmin, Weigert and Ranvier's picro-carmin, and Flemming's hæmatoxylin. The author recommends double staining with picrocarmin and hæmatoxylin; weak staining first with picrocarmin and afterwards with the logwood. The dye is then extracted with acidulated alcohol until a red hue appears, the sections are then transferred to ammoniacal alcohol until the blue colour reappears. In order to obtain various shades of colour the author advises to stain about 3/4 of the sections (*sic*) with picrocarmin and then to draw out the slides from the fluid so that the upper part is more deeply stained than the lower. The slide is then turned round and the process reversed with hæmatoxylin. Afterwards absolute alcohol, bergamot oil, xylol balsam,

* Zeitschr. f. Wiss. Zool., xliii. (1886) pp. 434–80 (1 pl.).
† Morphol. Jahrb., xii. (1886) pp. 163–201 (1 pl.).
‡ Ber. Naturf. Gesell. Freiburg i. B., i. (1886).

Flemming's chrom-osmium-acetic acid, and safranin staining give good results. Fixation with 3 per cent. nitric acid produced vacuoles in the yolk, and was, therefore, of but little use.

Preparation of the Embryo of the Fresh-water Crayfish.*—Dr. H. Reichenbach hardens the eggs by placing them in water, which is gradually heated up to 60° or 70° C. (rupture of the chorion does not damage the embryo); they are then hardened in a 1 to 2 per cent. bichromate or 0·5 per cent. chromic acid for 24 hours; next washed for a similar period, and then transferred first to 70 per cent. spirit and lastly to absolute alcohol. The chorion is then opened, and the embryo separated from the yolk by means of a sharp knife, and stained with picrocarmin. The yolk stains yellow, the plasma and nuclei red; then water, alcohol, cloves, and balsam.

Preparation of Copepoda.† — Dr. J. Vosseler recommends as the simplest method for killing, hardening, and staining Copepoda, to place them for about 12 hours in a mixture of Flemming's solution 1 part, water 2 parts, and then, after washing, to harden in spirit; mount in Venice turpentine. The animals also may be killed by the gradual addition of alcohol to the water in which they are contained. After having been placed in a mixture of equal parts of glycerin and water from 10 to 14 days they may be examined. Permanent preparations should be afterwards placed in absolute alcohol and mounted in Venice turpentine.

Preparation of Lumbricida.‡—Dr. H. Ude, in order to demonstrate the anatomy of the pores and the histology of the body-wall, employed the following methods:—

1. Living earthworms were placed in 0·5 per cent. chromic acid and hardened therein for eight to ten hours, washed in water, and transferred to 70 per cent. alcohol, then stained with Hamann's neutral acetic carmine, 70, 80, 90, 100 per cent. spirit, chloroform, chloroform-paraffin, pure paraffin. Results: Hypodermis good; longitudinal muscles destroyed.

2. The worms were killed in boiling water and the bodies, stretched on cork, were then treated for eight hours with 1 part concentrated picro-sulphuric acid to 3 parts distilled water. After washing they were stained with Grenacher's borax-carmine. Results excellent, but if the colour be withdrawn with hydrochloric acid alcohol the cuticula and hypodermis are damaged.

3. If the animals are to be preserved in spirit they are previously narcotized with chloroform vapour, in order to prevent too great contraction. Stain with borax-carmine.

Preparation of Rhabdocœlous Turbellaria.§—Dr. M. Braun prepares whole specimens on a slide by running under the cover-glass a mixture of 3 parts Lang's fluid and 1 part of a 1 per cent. osmic acid solution. Directly the animals become opaque the superfluous fluid is removed with blotting-paper, and then replaced by 45 per cent. spirit and afterwards by 70 per cent. alcohol. The cover-glass is then removed, and 96 per cent. alcohol applied. In a few minutes the latter is replaced by 1 or 2 drops of alum-carmine which stains in 2 or 3 minutes. Wash in water, transfer to alcohols of gradually increased strength up to absolute; clear up in oil of cloves or creosote, and mount in balsam.

* Abh. Senckenb. Naturf. Gesell., xiv. (1886) 137 pp., 14 pls.
† Inaug.-Diss. Stuttgart, 1886. Cf. Zeitschr. f. Wiss. Mikr., iii. (1886) p. 400.
‡ Zeitschr. f. Wiss. Zool., xliii. (1886) pp. 87–143 (1 pl.).
§ Arch. Naturk. Liv.-Esth. u. Kurlands, x. (1885). Cf. Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 398–9.

If the animals are to be sectioned the author uses Lang's fluid boiling, or the before-mentioned mixture of Lang's fluid and osmic acid. After 5 minutes the fixative is removed, the object washed with water and treated with alcohol. In two days the staining may be done. Imbedding is made in a mixture of ordinary paraffin, tallow, and hard paraffin (about 1/10 of the mass). The latter imparts a consistence suitable for riband sections.

Preparing Diatoms in Cementstein.*—Mr. H. Morland recommends the following plan for preparing and isolating the diatoms in Jutland "cementstein":—

Slices about 1/25 in. in diameter are first of all prepared with "Wellington knife-powder." When the slice is finished on one side, it is attached with balsam, prepared slide downwards, to the slip on which it is finally mounted. The balsam for this purpose must be hard, and it is necessary to avoid bubbles under the section. The slices are fixed with balsam slightly hardened, and then hardened off gradually by placing the slips in a very cool oven for a week or ten days; the balsam is thus hardened throughout without bubbles. The second side of the slice can now be rubbed down in the same way as the first side with "Wellington knife-powder" and water on glass. As the section approaches completion, care and very light pressure must be employed, the grinding being continued until the section begins to break away at its edges. The slip with section attached is now washed with clean water, wiped, and dried off with a very gentle heat, not sufficient to soften the balsam. A very small quantity of balsam is now put on the section, the cover placed on, and pressed down hard. The slide is now placed in a cool oven for a few days. A ring of Bell's cement will enable it to be examined under an oil-immersion lens without fear of the oil attacking and softening the balsam.

In order to isolate the diatom sections, after preparing one side of the slice, it is attached to a piece of glass about $1\frac{1}{4}$ in. by 1 in. instead of the ordinary 3 in. by 1 in. It is then immersed, still attached to the glass, in benzol. After about half an hour it can be brushed off with a camel's-hair pencil on to a glass slip, and cleaned of all balsam by brushing with the camel's-hair pencil dipped in benzol. The slide is then transferred to methylated spirit to get rid of the residue of benzol, and, after a short time, to clean water in a watchglass. The water is poured off and a few drops of hydrochloric acid added, which at once separates the diatoms contained in the section. The watchglass is now filled up with distilled or filtered rain-water, allowed to settle, the liquid drawn off closely by means of a fine pipette, and filled up with water again; the process being repeated until the whole of the hydrochloric acid has been got rid of. The diatoms in the watchglass are now boiled in sulphuric acid; and after washing away the acid, the clean diatom sections are ready for selecting and mounting. Mr. Morland states that some of his sections prepared in this way are not more than 1/3000 in. thick.

Preparing Tubercle Bacilli.†—Herr Biedert dilutes 1 tablespoonful of sputum with 2 of water and 15 drops liquor sodæ, and then boils to fluidity; 4 spoonfuls of water are again added, and the fluid reboiled until it is of uniform density. If on cooling it does not run well, more water is added; the fluid is kept bottled for two days, and then the supernatant liquid poured off so as to leave a quantity 5–8 mm. high in the flask. To this some fresh egg-albumen is added, and after having been well shaken together the fluid is used for cover-glass preparations.

This method was found to give considerable increase to the number of

* Journ. Quek. Micr. Club, ii. (1886) pp. 299–301.

† Berliner Klin. Wochenschrift, 1886, Nos. 42–3.

bacilli over those found in the original sputum. The Ehrlich and the Neelsen-Johne methods of staining were used.

If the alkalized fluid were allowed to stand longer than two days, and if more than fifteen drops of caustic soda were added, the number of bacilli diminished. From these facts, it is naturally concluded that the non-staining is due to the alkali, and the author recommends for his procedure the Neelsen-Johne method, as he found that Ehrlich's stain was less reliable. The foregoing method is inapplicable for the demonstration of *Bacillus tuberculosis* in tissues.

BRYAN, G. H.—**On mounting selected Diatomaceæ.**
Scientif. Enquirer, II. (1887) pp. 48–50.

CERTES.—**Procédé de M. Tempère pour le montage dans le baume des organismes microscopiques délicats et pour fixer directement des Infusoires par certaines couleurs d'aniline.** (Tempère's process for mounting in balsam delicate microscopic organisms and for immediately fixing Infusoria by certain anilin colours.) [*Post.*]
Bull. Soc. Zool. France, XI. (1886) pp. xix.–xx.

Fraenkel, E., and Simmonds, M.—**Preparing Sections containing Typhoid Bacillus.**
Scientif. Enquirer, II. (1887) p. 32. *Transl.* from 'Die Ætiologische Bedeutung des Typhus Bacillus,' Hamburg and Leipzig, 1886.

GAGE, S. H.—**Notes on Microscopical Methods.**
iv. and 32 and 4 pp., 11 and 2 figs., 8vo, Ithaca, N.Y., 1886–7.

GARRISON, F. L.—**The Microscopic Structure of Iron and Steel.**
[Methods used in preparing the specimens. Microscopes. Use of photography.]
Journ. Franklin Institute, CXXIII. (1887) pp. 181–95 (2 pls. and 1 fig.).

GOODALE, G. L.—**A Method for subjecting living Protoplasm to the action of different liquids.** [*Post.*]
Amer. Journ. Sci., XXXIII. (1887) pp. 144–5.

L[ATHAM], V. A.—**Preparation of Diatoms.**
[Prof. Brun's process.] *Scientif. Enquirer*, II. (1887) p. 31.

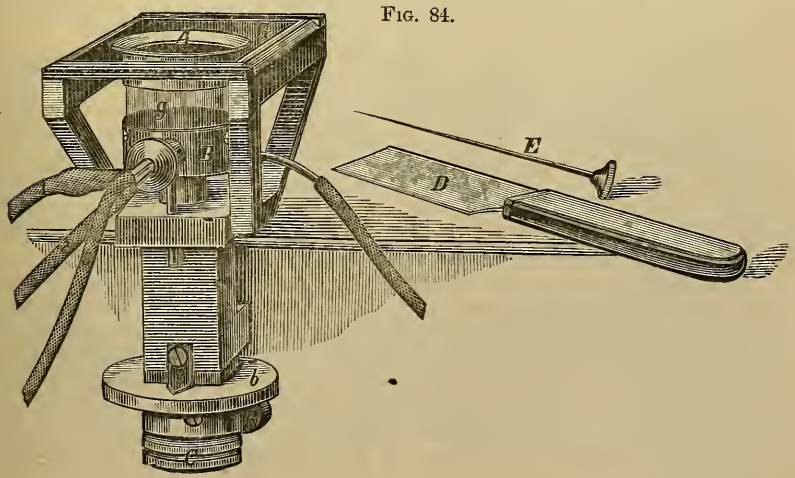
MOORE, A. Y.—**Mounting whole Insects.** *The Microscope*, VII. (1887) pp. 13–5.

SCHULZE, F. E.—**Ueber die Mittel welche zur Lähmung von Tieren dienen können, um dieselben im erschlafften ausgedehnten Zustande erhärten oder anderweitig konservieren zu können.** (On the means of paralysing animals in order to harden or otherwise preserve them in a relaxed and extended condition.) [*Post.*]
Biol. Centralbl. VI. (1887) pp. 760–4 (*Ber.* 59 *Versamml. Deutsch. Naturf. u. Aerzte*, Berlin, 1886).

(3) Cutting, including Imbedding and Microtomes.

Jung's Freezing Microtome.—This instrument (figs. 84 and 85) is constructed on the lines of the apparatus devised by Hughes and Lewis.

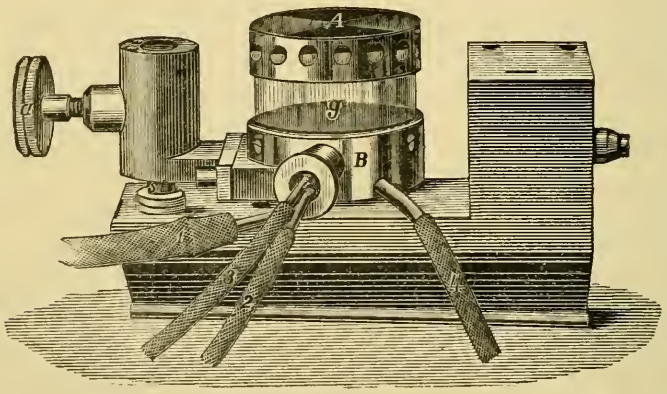
FIG. 84.



By making the tube *g* of mica, the object is found to retain the cold much longer than is the case with other constructions. A is the plate on which the preparation is laid; *g*, the mica cylinder; B, the lower part in which the ether spray tubes are fixed. No. 1 tube is from the bellows; No. 2 takes the air to the ether bottle; No. 3, the ether bottle spray point; and No. 4 is the overflow pipe for the excess ether.

The glass plate G serves as a support for the knife; *b* is divided in order to determine the thickness of the sections (1 division = 1/200 mm.);

Fig. 85.



C is the micrometer-screw which raises the object; R is the screw which fastens the instrument to the table; D is the ordinary form of knife, and E a stilet for clearing the spray points without enlarging their openings.

Fig. 85 shows a similar contrivance adapted for use with a slide microtome.

Jung's Sliding Microtome for very large objects.—As this microtome of Herr R. Jung (fig. 86) corresponds in the construction and use to the smaller instruments, it is only necessary to describe the provision for cutting large objects.

The knife is to be placed considerably higher in front than behind, in order to lessen the pressure on the objects. In order to satisfy all demands, the knife-rest is adjustable. The knife is so arranged that the whole length of blade can be used, and then the screw *c* is fairly tightly screwed down. As strong knives, even of a length of 36 cm., easily give, a knife-support has been constructed; this is fastened by the screw *c'* to the carrier. The support is arranged parallel with the back of the knife M; if the extremity *n* be slightly pressed backwards so that it touches the knife, it is then fixed in this position by the screw *o* (scarcely evident in the illustration).

This done, the spirit-vessel *Sp* can be arranged in a position which will not interfere with the free movement of the knife. In order that a stream of spirit may follow the knife over the object, the following arrangement is adopted. The spirit-vessel *Sp* turns round an axis on the column *h*; to it is joined the arm L, which carries in front the fine tube *r* (connected with *t t'*), and also the rod *p*; the latter is movable perpendicularly, and to its lower end a bridge or grip with two small rollers *i* and *i'* is fastened. The rod *p* is so placed that on each side of the metal strip *b*, screwed on to the

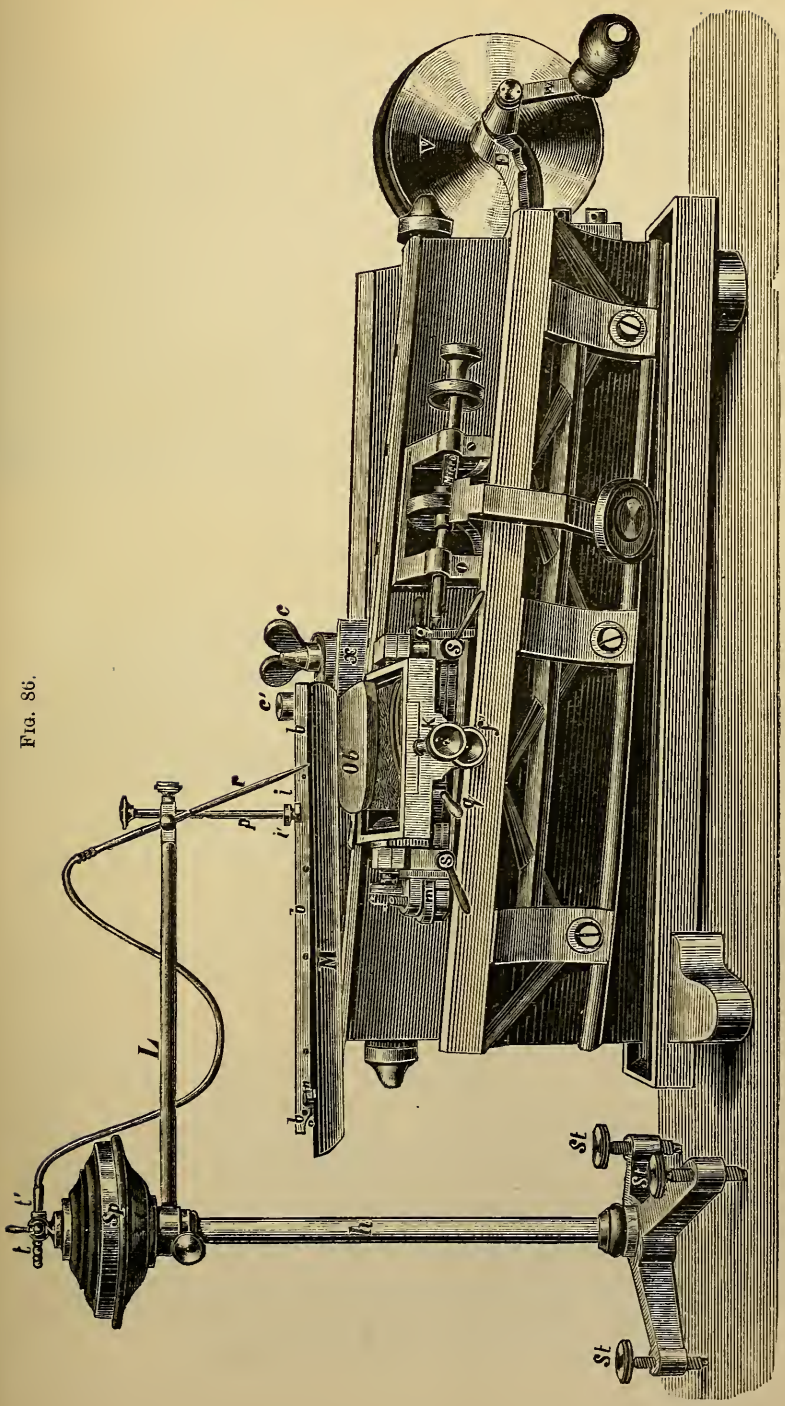


Fig. 86.

Jung's Sliding Microtome for very large objects

knife-support, there is one of the rollers. By the adjusting-screws *St* the whole apparatus is so arranged that, when the knife-carrier is in motion, no other friction occurs than that of the rollers on the strip *b b b*.

The vessel is filled by screwing off the head Z. As the tube *r* acts as a siphon, it is necessary when the cock is turned on to blow down the tube. The stream of spirit should be directed at a right angle to the knife, and about the middle of the object. This done, the object *Ob* by means of the screw *k* is firmly grasped in the fangs of the object-carrier; the correct direction for the position of the knife is given to its surface by the screws at *f* and f_1, and then the axes of the fangs are tightened up by the levers *q* and *q'*. If the height of the object is not quite correct, adjustment is made by the screw *m*. By turning the screws *s s* the holder is fixed.

V is a wheel with cranked axle *Ew*, and this by means of a catgut band moves the knife.

Microtome used at the Naples Zoological Station.—This instrument in its improved form (figs. 87, 88, and 89), is described by Herr R. Jung.*

(1) *The knife and its carrier.*—The knife, which is plano-concave, is pushed into its holder *a* (fig. 88), and fixed by means of the two screws *b* at both points. The holder is in its turn fastened to the carrier by means of two bolts *c*, and these are screwed up by inserting the rod *d* in one of the five holes (cf. fig. 87). If the knife is to rest on the carrier directly, the shorter bolt is used; if, on the contrary, the object to be cut is very long, it becomes necessary to raise the knife, and one, two, or three metal plates having been placed underneath, the long bolt is used. The choice of the screw depends on the form of the object and the position of the knife. The latter, in virtue of the construction of the holder, can be used in any position, and along its whole length. For large objects of unequal texture, it is recommended to place the knife as far as possible in an almost parallel position (cf. fig. 88), and to move the carrier slowly and carefully. In this way such objects are cut to the best advantage. If, however, the object be small and of similar consistence throughout, the knife may be placed in front and the section made by a planing motion. The paraffin block which incloses the object must be so arranged that the anterior and posterior edges of the section are parallel, and also at right angles to the middle vertical plate of the instrument; in this way, with quick planing, the sections stick together, forming large bands.

Before the knife is sharpened or stropped it is fastened to the handle, and a steel case is pushed up over its back and screwed up. In most instances one turn on a good strop suffices, and this should be done without any force.

(2) *The section-stretcher.*—In its new form this can be used for any position of the knife, and is easily applied thereto. The long rod *e* (fig. 88), partly with the hand, partly by means of the two screws *f*, is accurately adapted, parallel to the surface, and in such a way that it projects over the edge; it is then lowered by the front screw *g*, until almost in contact with the knife-surface. For small objects the slender, for large, the thick rod is used. If the sections are very bulky, the tendency to turn up must be prevented by pressing lightly on the section with a spatula, &c., as it appears between the rod and the blade. If the section-stretcher be properly arranged it works perfectly trustworthily, provided the sections have no tendency to crumble. When the knife is placed obliquely, the paraffin block is best shaped as a right-angled triangle, so disposed that the knife-

* Preis-Verzeichniss, 1886, pp. 16–9 (3 figs.).

Fig 87.

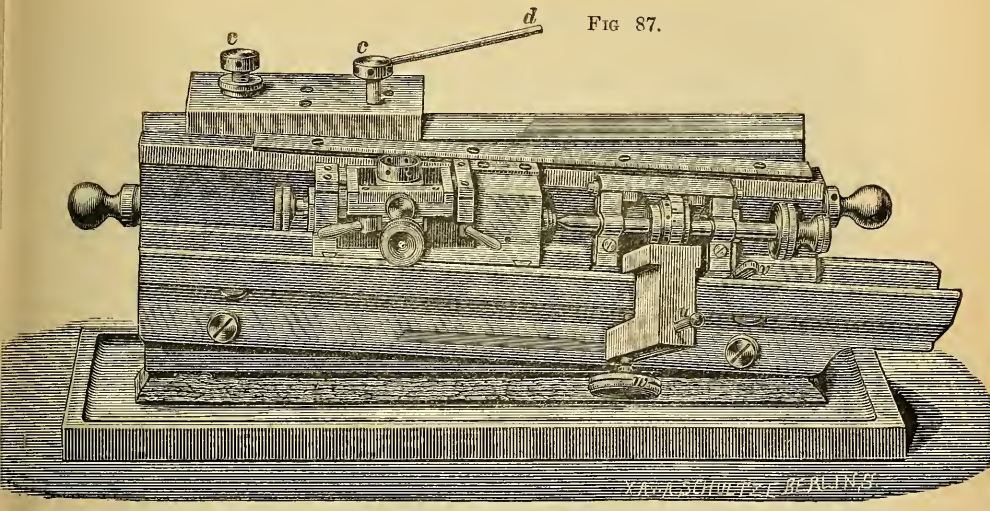


Fig. 88.

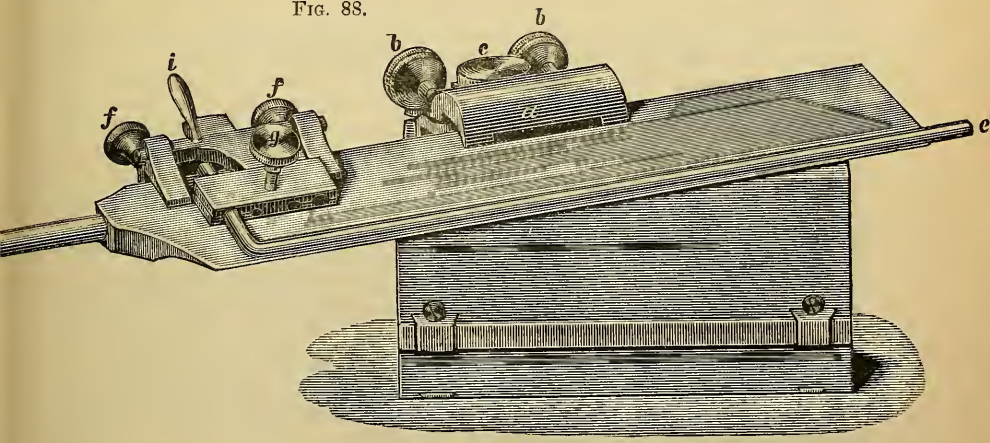
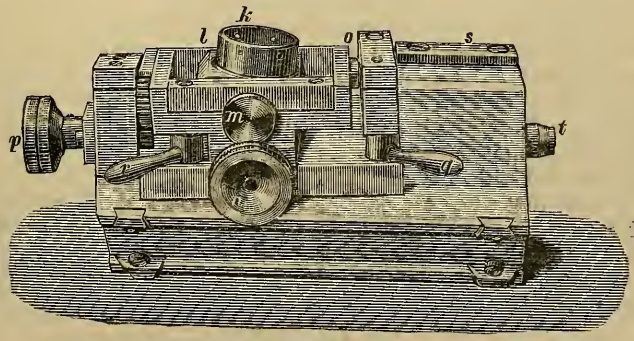


Fig. 89.



Microtome used at the Naples Zoological Station.

blade touches upon one of the two tangential sides and finally reaches the opposing angle. When the knife is placed across or in front the section-stretcher is usually superfluous, and the block must have the shape given above (under No. 1). The handle *i* serves to remove the rod for cleaning it or the knife-surface.

(3) *The object-carrier.*—The hollow cylinder (*k*, fig. 89) serves for the reception of the object to be cut. For this purpose it is filled with hard paraffin; in this last the paraffin block, in which the object is imbedded in the usual way, is melted with hot needles. The cylinder, by the aid of the small pin *u* (fig. 87), which fits the holes, is capable of vertical and horizontal movement, and is fixed by means of the screw *m*; by the milled head *n* the direction may be altered to the extent of 90°, and the metal frame can receive through the milled head *n* a similar inclination to the plane standing vertically to it. In this way the object may be placed in any desired direction to the knife-edge. The two levers *q* and *r* serve to fix it. Too strong pressure should be avoided, as the plates may be bent thereby.

(4) *The micrometer-screw.*—The object-carrier can be moved along by the hand, and for the accurate estimation of the amount of movement there is a vernier which corresponds with the millimetre scale on the vertical upright of the microtome. It is, however, safer to use the micrometer-screw (fig. 87) the point of which works against an agate. The screw is so threaded that one turn moves the carrier up 0·3 mm., consequently an upward movement of 1:20 produces an ascent of the object of about 0·015 mm. The screw-head is divided into fifteen parts, and therefore the interspace between any two divisions corresponds to an elevation of 0·001 mm. If by means of the pin *u* the movable half of the cylinder be shifted so that the numbers V, X, XV can be read, a click, produced by a spring, will be heard fifteen times at every revolution of the screw. If the two numbers 3 on the side of the cylinder be approximated, the clicking only occurs thrice; therefore each one corresponds to a raising of the object 0·005 mm. Similarly for 2 and 2 or 1 and 1, the values 0·0075 and 0·015 mm. are obtained. The spring-catch arrangement may be dispensed with by raising the handle *v*. The screw-carrier is fixed to the groove by the milled-head *w*.

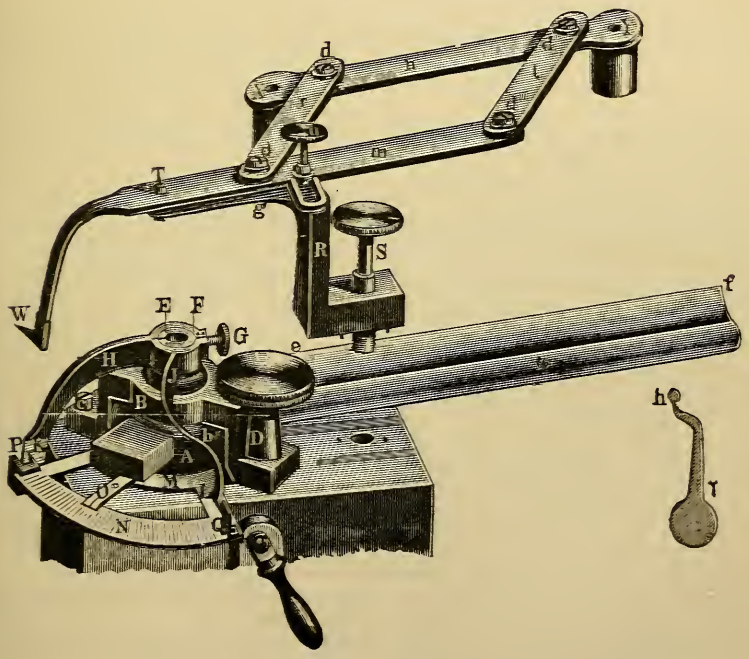
Apparatus for controlling the position of the Microtome Knife.*—Dr. T. v. Dembowski's contrivance consists of two distinct parts. In the first of these the knife *a* (fig. 90) is fixed by the ball-and-socket joint A, the ball of which lies in a hollow excavated in the upper surface of the slide. The arch B covering the ball is fixed by the screws *c* and D. From above B projects a short tube E, which forms part of the ball. Inside the tube E is a binding-screw, accessible through the opening; another, *b*, is seen at the side. Fitting over E, and fixed by the screw G, is another tube F, with two arms H and J. At the end of H is a scale K, and at the end of J a pointer L; the latter is at right angles to K. Encircling the excavation in the slide is a wall-like ring, about which the plate M turns; at the end of this plate is a pointer P. The other end of M carries a vertically placed plate Q, provided with a scale. The end of the pointer P is distant about 90° from Q, so that when the pointer P touches the scale K the point L is brought into contact with the plate Q. The pointer O indicates on the scale N what angle the edge must form with the middle plane of the microtome in order to be able to cut objects of given size when using the whole length of the blade.

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 337–45 (2 figs.).

The second part of the apparatus (which in fig. 90 is raised above its ordinary position for the purpose of rendering its parts more conspicuous), consists of a plate R, fixed to the slide by the screw S and two pegs. From R projects, over the ball-joint, the piece *g*, to which is applied the bar *m*, fixed by a screw *u*. Through *m* and *g* the screw-peg T passes to be inserted in the centre of the ball-joint. The left end of *m* terminates in the pointer W, and this is so situated that it points to the same division of the scale K as P does.

The pieces *r n t m* form a parallelogram, with movable joints at *d d' d'' d'''*. At the ends of *n* are the diopters X and Y, and the plane in which they lie is parallel to the plane which passes through the centre of the ball, the peg T, and the pointer W.

Fig. 90.



To the right of the lower part of the illustration is the piece γ, which is fixed to the object-carrier, and bears at its free end the knob *h*. This piece and the knife are so arranged that the ball *h* touches the under surface of the knife near its edge, throughout its length; and when this has been accurately effected, the division of the scale K, which the pointer P indicates, is noted.

A definite position or line is thereby obtained, so that the knife can be raised or lowered without deviating from its correct position, and, in other words, it may be said that the purpose of the foregoing apparatus is to enable the microtomist to put the section line of the knife in a plane parallel to the course of the slide, and also to render it possible to lower the edge and raise the back without the plane which the knife-edge

describes ceasing to be parallel to the course of the slide. We cannot pretend, however, to have very clearly understood the author's views.

Sectioning fresh Cartilage by partial Imbedding.*—Mr. B. L. Oviatt first removes the end of the bone by cutting through it at 2 or 3 centimetres from the joint. The well of the microtome is then filled with paraffin to within about one centimetre of the top, and as soon as it begins to turn white from cooling the bone is inserted until the cartilage is in the plane of the microtome or a little below it. While the paraffin is cooling the cartilage is prevented from drying by placing on it a little cotton wool wet with artificial serum or salt solution. By this method sections may be obtained of uniform thickness, and more rapidly than by the old method. It is also applicable for sectioning injected tissue if care be taken to cut very slowly and with a drawing motion, and at the same time to keep the tissue and knife wet with 25 per cent. spirit.

Cutting Sections of delicate Vegetable Structures.†—Mr. W. A. Haswell considers there is a difficulty in obtaining by the means ordinarily recommended, with considerable pains and loss of time, a number of fine sections of such delicate vegetable structures as the prothallium of a fern, fronds of delicate seaweeds, or thin and flexible leaves of land plants; and that the following method, which he has found of service, will recommend itself by its simplicity.

The specimens to be cut, if they have been in alcohol, are placed in water for a few hours, and then for a day in a thick solution of gum arabic; if fresh they may be placed at once in the gum. Small pieces of carrot are placed in the gum for the same length of time. The specimens to be cut and the carrot which is to form the imbedding material are now thoroughly saturated with strong gum solution. Slits are made in the pieces of carrot, and the thin structures to be cut are inserted in the slits, any interstices being filled up with gum. The blocks of carrot, with the imbedded specimens, are then frozen and cut in the usual manner with the freezing microtome. When the sections are placed in water there is little difficulty in picking out the sections of the imbedded objects from the light-coloured and flocculent sections of the carrot—an operation which is facilitated by agitation of the water, when most of the narrow needle-like sections of the thin objects will find their way to the bottom of the vessel.

Kühne, H.—**Dr. R. Long's neues Mikrotom.** (Dr. R. Long's new microtome.)
Breslauer ärztl. Zeitschr., 1886, pp. 284–5.

[Osborn, H. L.]—**On treating Chicks for Section-cutting.**
Amer. Mon. Micr. Journ., VIII. (1887) pp. 29–31.

Queen & Co.'s (J. W.) New Model Microtome. [*Post.*]
The Microscope, VII. (1887) p. 17 (1 fig.).

Reeves, J. E.—**Cutting Sections of Animal Tissues.**
Amer. Mon. Micr. Journ., VIII. (1887) pp. 12, 14–5,
St. Louis Med. and Surg. Journ., li. (1886) pp. 340–4, lii. pp. 159–60.

Smith, J. L.—**[Making Sections of Embryo Chicks.]**
Amer. Mon. Micr. Journ., VIII. (1887) pp. 37–8.

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* St. Louis Med. and Surg. Journ., li. (1886) pp. 208–9.
† Proc. Linn. Soc. N. S. Wales, l. (1886) p. 489.

(4) Staining and Injecting.

Staining the Retina by Weigert's Method.*—Dr. R. Lennox hardens the retina of man and of the cat in Müller's fluid and alcohol, and imbeds in celloidin. The sections are placed for about twenty-four hours in a 1/2 to 1 per cent. chromic acid solution, and then, after having been washed in water, in Weigert's hæmatoxylin (1 part hæmatox., 10 parts alcohol, 90 parts water). If kept at a temperature of 40° C. they remained in the logwood solution for two hours; if at ordinary temperature, a longer time. The sections were then decolorized by the cyanide solution (ferrocyanide of potash 2·5, borax 2, water 100). When they became yellowish (about half an hour) they were washed, dehydrated, and mounted in balsam. Nerve-fibres (cat) came out as dark varicose threads. Two kinds of ganglion cells were distinguished:—(1) large yellowish elements with bright nuclei and black nucleoli; (2) dark cells with perfectly black nuclei. In the internal granular and epithelial layers (man) this difference of the nuclei also occurs. The nuclei of the cones are usually black, those of the rods bright with black nucleoli. Of these differences the author offers no explanation.

Staining Tubercle Bacillus.†—Herr Gottstein attacks Ehrlich's explanation of the Ehrlich staining process, i. e. the investment theory which supposes a qualitative difference, while Gottstein and others only accept the presence of a quantitative difference. The author calls attention to the fact that a property of certain constituents of the formula used for staining renders it possible to dissolve twice as much of the dye as distilled water would take up. Consequently the solution acts from concentration and not by any specific virtue. Then as regards resistance to mineral acids, treatment with decolorizing agents shows that the more lightly a dye is bound up to the tissue the more easily is it disassociated therefrom, a confirmation of Gierke's dictum that staining in general is not a chemical but a physical process, and depends on diffusion and imbibition. The resistance of the tubercle bacillus to decolorizing agents is to be explained, according to the author, by supposing that it has a quantitatively slight disposition for imbibition of solutions.

Phenomenon in Anilin Staining.‡—Mr. E. H. Wagstaff in the summer of 1884 mounted several slides of desmids, *Spirogyra*, and other algæ, the mounting substance being the article commonly known as "French polish," coloured with the addition of a little anilin-green and well mixed together. The slides were spun in the usual manner on the turntable, the cells being finally finished off with a last touching-up with the "French polish." About six months after he found the specimens had become stained a beautiful and vivid green, of course rather too vivid, but nevertheless quite a surprise. The specimens stained were *Spirogyra inflata*, *S. Weberii*, *S. quinina*, *Staurospermum gracile*, and *S. viride*. The desmids so treated were *Closterium rostratum* in conjugation, and *C. Leiblorii*, &c.

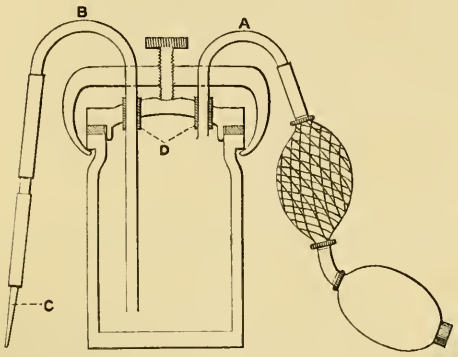
Congo Red.§—Dr. F. Nissl gives the following (provisionally) as a staining method for axis cylinders:—Chromate of potash; alcohol, 95 per cent.; watery solution of Congo red, 5 to 400; alcohol, 95 per cent., three

* Arch. f. Ophthalm., xxxii. (1886) 8 pp. and 1 pl.
† Deutsche Med. Wochenschr., 1886, No. 42.
‡ Sci.-Gossip, 1887, p. 41. § Münchener Med. Wochenschr., 1886, p. 528.

to ten minutes; nitric-acid-alcohol ($3HNO^3$ to 100 C^2H^6O), about six hours; alcohol, one to five minutes; oil of cloves or origanum; balsam.

Gage's Injecting Jar.*—Prof. S. H. Gage's injecting jar (fig. 91) grew out of the necessity for some simple and efficient apparatus for injecting liquids (chloride of gold, nitrate of silver, nitric, chromic, osmic, and picric acids) which would be injured by or injure an ordinary syringe. As will be seen, it is made on the principle of an ordinary wash-bottle. It is prepared by boring two holes in the glass cover of a fruit-jar or of an anatomical specimen jar, and inserting glass tubes, the pressure-tube A just penetrating the cover and the delivery-tube B extending nearly to the bottom of the jar. Where the glass tubes penetrate the cover they are surrounded by rubber tubing D, to render the joints air-tight. The pressure is obtained by the use of an atomizer bulb, or, in order that it may be constant, two bulbs are used, the second one being covered with a net to prevent undue distention. The delivery-tube and the cannula C are of glass, only enough rubber tubing being used to make the delivery-tube outside the jar flexible.

Fig. 91.



While this jar was designed for special liquids, it has been found excellent for making fine injections with gelatin mass. With two bulbs, as in the figure, a pressure of 40 mm. of mercury may be obtained; this is sufficient for most purposes. While water or mercury might be used to obtain the pressure, as in the various forms of constant pressure apparatus, the atomizer bulbs are preferred, as it is easier for the operator to control the pressure and adapt it to the individual cases.

Stein's Injection Apparatus.†—The injection apparatus used by Dr. S. T. Stein is shown in fig. 92. In this instrument the required force is derived from the action of compressed air upon a column of liquid, and it consists accordingly of two parts—A the compression-pump, and B the vessel which holds the liquid. The pump A, made of guttapercha, consists of an air-bag *m* into which air is forced by means of a collapsible ball and the two valves *a* and *b*. From *m* the air passes by the tube *c f* into B through the rubber-stopper *d*, which admits by air-tight openings that and another tube *g h*. The end *f* of the first tube does not penetrate far into the vessel, but the second tube *h g* extends into the injection-fluid, while its other end *i* is closed by the stop-cock *k*. When the stop-cock is open the apparatus yields a continuous stream from 2½–3 metres in height, which by closing *k* may be reduced to a slow succession of drops. B stands upon the support *e*, and is immersed in a water-bath *w*, which is heated by the spirit-lamp *t* in the chamber *s*.

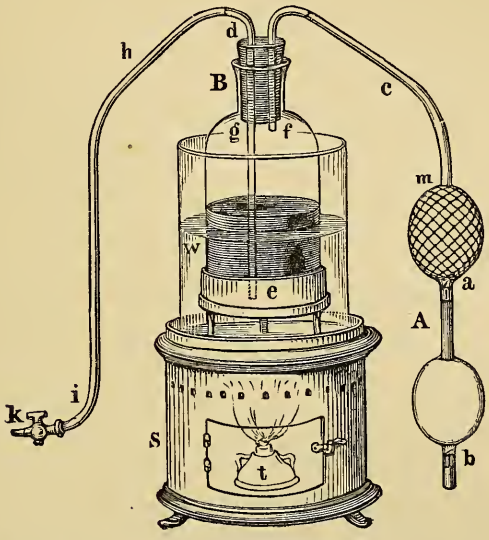
For this apparatus the author claims the advantages that it is completely under the control of the operator, whose hands are moreover left free; it may be used for all sorts of cold and warm injections, including chemical

* The Microscope, vi. (1886) pp. 265-6 (1 fig.).

† Stein, S. T., 'Das Licht,' 8vo, Halle, 1884, pp. 307-10 (1 fig.).

solutions such as nitrate of silver, and none of the liquid is lost, while the whole apparatus is easily cleaned by pumping a stream of warm water through it.

Fig. 92.



Nitrite of Amyl for Fine Injections.*—Messrs. B. L. Oviatt and E. H. Sargent suggest the employment of amyl nitrite for fine injections, and point out three methods for its exhibition. 1. A mixture of ether and amyl nitrite may be poured into the box in which the animal is killed, and when quite anæsthetized a sponge moistened with pure nitrite may be held over the animal's nose until it is quite dead. This procedure is not recommended. 2. After being anæsthetized with ether, the nitrite may be held over the nose, or the animal may be removed from the box, and after the sponge is applied the head wrapped up in a rubber sheet. 3. Injection of a small amount of nitrite in salt solution into the vessels directly after death by either of the foregoing methods. In any case it is advisable to add a little nitrite to the mass just before using. The relaxing power is so great, that the largest arteries will be found collapsed.

Dekhuyzen, M. C.—**De aard van het proces der Kleuring van mikroskopische praeparaten.** (The nature of the process of staining microscopical preparations.) *Nederl. Tijdschr. v. Geneesk.*, 1886, pp. 585–8.

Gray, N. M.—**A Modification of Weigert's Method of staining Tissues of the Central Nervous System.** [*Post.*] *Amer. Mon. Micr. Journ.*, VIII. (1887) pp. 31–2, from *Med. News*, 1886, Nov. 6.

Grigorjew, A.—**[On Ehrlich's Staining of Micro-organisms.]** [In Russian.] *Russkaja Medecina*, 1886, No. 42.

Hankin, E. H.—**Some new Methods of using the Aniline Dyes for staining Bacteria.** [*Post.*] *Quart. Journ. Micr. Sci.*, XXVII. (1887) pp. 401–11.

Kühne, H.—**Zur Färbetechnik.** (On staining technique.) *Zeitschr. f. Hygeine*, I. (1887) pp. 553–6.

S., R. J.—**Staining Fluid.**
[Carmine, 10 grns.; strong liquid ammonia, 1/2 drachm; Price's glycerin, 2 oz.; distilled water, 2 oz.; alcohol, 1/2 oz.].
Scientif. Enquirer, II. (1887) p. 30.

* St. Louis Med. and Surg. Journ., li. (1886) pp. 207–8.

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

Thymol in Microscopical Technique.*—Dr. G. Martinotti concludes from his own experiments and the researches of others that although thymol may have a useful application in microscopy as an antiseptic, it should not be employed when the tissues to be examined have been or are to come in contact with chromic acid or its salts.

If to a watery solution of chromic acid a watery solution of thymic acid be added, a precipitate forms, even when not exposed to light, and this precipitate is devoid of the characteristic smell of thymol. After washing the precipitate, the filtrate is found to be a yellow odourless powder, which examined microscopically consists of amorphous granules and a few small prismatic crystals. This precipitate is insoluble in water, insoluble or nearly so in alcohol, ether, chloroform, benzine, in water acidulated with sulphuric, hydrochloric, nitric, acetic, formic, and oxalic acids, in ammonia, in anilin diluted with alcohol. If an alcoholic solution of thymol be added to the watery solution of chromic acid the action is so energetic that the temperature rises from 70° to 80° C. The precipitate is produced as before, but the mass assumes a blackish colour, as if mixed with some carbonaceous matter.

Again, if thymol crystals be thrown into the chromic acid solution they become invested by a precipitate, while their central parts retain their usual character. With solution of potassium bichromate similar results follow, but more slowly.

Hence a chemical action takes place between thymol and chromic acid, and this action is a process of oxidation. So the writer assumes from the researches of Lallemand, Carstanien, and others who have examined the relations and composition of thymol.

As remarked above, the conclusion arrived at is that thymol is unsuitable as a microscopical reagent in conjunction with chromic acid or its salts. With other reagents, such as picric acid, carmine, gum, and gelatin, thymol works well.

Hilgendorf's Apparatus for Dehydrating Microscopical Preparations.†—Herr F. Hilgendorf's apparatus consists of a test-tube (for small objects, about 50 mm. long and 6 mm. broad) into which is filed, about 5–10 mm. above the bottom, a small hole. The aperture may, if necessary, be lessened by means of a wood-splinter. The object is then placed in this tube, *partially* filled with weak spirit, and the upper end closed with a cork. Thus prepared, the tube is inserted into a closed vessel filled with absolute alcohol. Through the small hole the latter finds its way into the tube, and continues to do so for a half to one hour. At a height of 1 cm. diosmosis was found to require several days, but the rapidity of the action can be proportionately increased by filing the hole lower down. Several tubes, and this is a great advantage, can be placed in the outer vessel at the same time. It is recommended to use some hygroscopic substance, as burnt copper sulphate, &c., to keep the dehydrating fluid as concentrated as possible.

Method for treating Serial Sections imbedded in paraffin by Weigert's method.‡—Weigert's method of making serial sections of celloidin preparations was described in this Journal, 1886, p. 349.

Prof. H. Strasser describes the following improved method, in which

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 351–8.
† SB. Gesell. Naturf. Freunde zu Berlin, 1886, pp. 133–5.
‡ Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 346–50.

the stiff glass plates are replaced by a pliant medium that allows fluids to penetrate from both sides, the paraffin-imbedded sections being attached to gummed paper by means of collodion.

The gum-collodion plates are made by covering one side of a smooth piece of writing-paper, duodecimo size, with a thick layer of gum arabic. As soon as the gum ceases to be sticky, the paper is flattened out smooth in a hand-press, care being taken that there are no unevennesses. Thick-flowing collodion is now passed over the gummy side, and a smooth layer having been obtained, the plate is again pressed out between two firm, smooth surfaces in the hand-press. Upon the plate thus obtained the sections are then fixed by means of a mixture of 2 parts collodion and 1 part oil of cloves. For large and thin sections it is necessary to use a section-stretcher of special construction. This, however, remains to be described. Over the whole a thin layer of the collodion clove-oil mixture is then brushed with a camel's-hair pencil.

The paraffin is next dissolved out by laying the plate in a dishful of benzin for 15–30 minutes. The plate is then dried with blotting-paper, and at once transferred for a few minutes to 95 per cent. alcohol. It is then dried again, and to keep up a perfectly smooth surface the sections must be brushed over, if need be, with the collodion clove-oil mixture. It is next transferred to 80 per cent. alcohol, wherein it remains for a quarter of an hour or more. When sufficiently hard, these plates may be treated in any watery or water-and-spirit solution. The watery solutions of course set free the collodion plate by dissolving the gum. Clearing up and mounting are performed in the usual way with creosote and Canada balsam.

Permanent Caustic Potash Preparations.*—It is usually stated that specimens treated with caustic potash cannot be permanently preserved. During the past summer an aqueous solution of caustic potash of 35 to 40 per cent. was used by Prof. S. H. Gage for isolating cardiac muscle from many different animals; as some of the preparations were drawn it seemed unfortunate not to be able to render them permanent as vouchers for the drawings. This was accomplished by adding glacial acetic acid to the isolated cells. The acid combines with the caustic potash to form acetate of potash, which is often used for permanent mounting; finally a mixture of glycerin 75 parts and an aqueous solution of picrocarmine (1 per cent.) 25 parts was added as a permanent mounting medium. These specimens after three months show no signs of deterioration. If the specimens were already under the cover-glass, a drop of glacial acetic acid was drawn under it and afterwards a drop of the glycerin and picrocarmine mixture.

How Alcohol drives out Air-bubbles.†—M. L. Errera remarks that that which renders air-bubbles so persistent in organic tissues is, in the first place, their extreme minuteness; then the thin layer of water which encompasses them holds in solution a certain quantity of organic matter; whence arise an increase of the superficial viscosity, and a diminution of the tension, both favourable to persistence.

But the air-bubbles should disappear if for water be substituted a liquid endowed with the three following properties:—(1) It must be perfectly miscible with water. (2) Its superficial tension must be weak. (3) Its superficial viscosity must be weak. Now, of all the liquids indicated by Plateau, who has made some very original observations on the superficial and internal viscosity and tension of fluids, only two fulfil both conditions. These are ether and alcohol, both of which ought to rapidly drive out air-

* The Microscope, vi. (1886) p. 267.
† Bull. Soc. Belg. Micr., xiii. (1886) pp. 69–75.

bubbles from microscopical preparations. As the superficial viscosity of ether is very feeble, and its tension less than that of alcohol, it should be preferable for the purpose to the latter, though it must be borne in mind that ether is not miscible with water, like alcohol, in all proportions. But, as a matter of fact, experience shows that ether does cause to disappear, just as alcohol does, the air-bubbles adhering to organic tissues.

Krönig's Cement.*—Dr. Krönig calls attention to the convenience of a sealing cement composed of two parts of wax and seven to nine parts of colophonium. The colophonium is added piecemeal to the melted wax, the result is filtered, and the mass left to cool. Solid at ordinary temperatures, it is readily melted by placing the containing vessel in hot water. As it hardens rapidly, the preparation can be finished at once. It is insoluble in water, glycerin, and caustic potash; its consistence is good; its composition is cheap and simple.

Aylward's (H. P.) Opaque Wood Slide.

["Parallel-sided, sunk cell, beyond which is a parallel-sided groove to hold a brass-flanged ring. The object is put into the cell, a thin cover-glass laid on the top of it, and the brass ring dropped into position holds all perfectly secure, and if pressed tightly down, we believe, air-tight also. The special qualifications Mr. Aylward claims for this slide are its simplicity, and also that owing to the dryness of the wood botanical objects need not be thoroughly dried before mounting. The wood will absorb all dampness that may be left, and in so gradual a manner that all shrinking or curling of the specimen will be avoided."]

Scientif. Enquirer, II. (1887) p. 39.

Gage, S. H.—**Centering Card.**

[The card is prepared by making upon it several concentric circles, and then cementing to it pieces of glass or Bristol board, so that when the slide is placed in position the centre will be over the centre of the circles.]

The Microscope, VI. (1886) pp. 266–7 (1 fig.).

Guardia, J.—**Hints for Microscopists.**

[To view preparations from both sides with high powers:—Two thin strips of wood, brass, cardboard, &c., 3 in. × 1½ in. From the centre of one cut out a square 3/4 in. side, and from the other a square slightly larger than 7/8 in. side. Glue the two strips together, and there is a ledge 1/16 in. for the preparations to rest on. The specimens are mounted between two 7/8 in. cover-glasses and put in the frame or carrier.]

Engl. Mech., XLV. (1887) p. 11.

Heurck, H. van.—**Nouvelle préparation du Médium à haut indice (2·4) et note sur le liquidambar.** (New preparation of the medium of high index (2·4), and note on liquidambar. [*Post.*] *Bull. Soc. Belg. Micr.*, XIII. (1886) pp. 20–4.

Morris, W.—**Notes on experiments in mounting the Amphipleura pellucida in media having a higher refractive index than Canada balsam.** [*Post.*]

Journ. and Proc. R. Soc. N. S. Wales, XIX. (1886) pp. 121–33.

Vries, H. de.—**Over het bewaren van plantendeelen in spiritus.** (On the preservation of parts of plants in spirit.) [*Post.*] *Maanbl. v. Natuurwet.*, 1886, No. 5.

(6) Miscellaneous.

Two new Sugar Reactions.†—Dr. H. Molisch found that sugar solutions, with the exception of inosite, immediately assume a deep violet colour on the addition of some drops of a 15–20 per cent. α naphthol solution and sulphuric acid in excess, and that the addition of water then produced a deep violet precipitate. If thymol be added to the α naphthol the colour becomes a bright ruby red, and the precipitate, from water, is carmine red. In this way 0·00001 per cent. of sugar can be demonstrated. Carbohydrates and glucosides also give these reactions, but more slowly, and after the action of sulphuric acid.

* Arch. f. Mikr. Anat., xxvii. (1886) pp. 657–8.

† SB. K. Akad. Wiss. Wien, xcii. (1886) pp. 912–23.

From the foregoing considerations Molisch bases the following method for demonstrating sugar in plant sections:—A not too thin section laid on a slide is treated with a drop of 15–20 per cent. alcoholic α naphthol solution, then two or three drops of concentrated H_2SO_4 are added. If the section contains sugar the violet coloration appears in less than two minutes. In other carbohydrates the colour appears in a quarter to half an hour. In practice two sections are used; one of these is boiled for a few minutes in water, whereby sugar, dextrin, gum, and glucosides are dissolved. The two sections are then submitted to the same test, and if sugar is present in the unboiled section the coloration immediately appears. As dextrin, gum, and glucosides may be usually disregarded, the appearance of the violet, &c., staining indicates with great probability the presence of sugar.

The foregoing test may be used to demonstrate the presence of inulin, which by Sachs's method is liable to be confounded with sphæro-crystals, for these become immediately stained deep violet with α naphthol and sulphuric acid, and on the addition of thymol are dissolved with the production of a red colour.

These reactions may be used for the detection of sugar in urine. Without any preparation normal human urine exhibits them distinctly, even when it is diluted from 100 to 300 times; and the presence of grape-sugar is therefore absolutely determined in the urine of man in a normal condition. A simple method, based on these reactions, is given for the distinction of diabetic from normal urine.

Discrimination of Butter and Fats.—Prof. H. A. Weber * has made further experiments upon the microscopic methods of distinguishing butter from other fats proposed by Dr. T. Taylor. †

Dr. Taylor's first claim was that butter, cooled slowly under certain conditions, formed "globules," which, when viewed by polarized light, showed a well-defined St. Andrew's cross. Prof. Weber having shown that this appearance was not characteristic of genuine butter, but might be produced in any common fat by treatment similar to that applied to the butter, Dr. Taylor then called attention to another test as being characteristic. According to this, if a sample of butter is viewed by polarized light, a plain selenite being placed between polarizer and analyser, a uniform colour is observed; if any solid fat, like lard or tallow, be thus viewed, the fat will exhibit prismatic colours. Prof. Weber finds this test as fallacious as the former. Any of the fats under consideration, if melted, and cooled slowly, and then submitted to Dr. Taylor's test, will show the prismatic colours, due to the action of the comparatively large crystals formed upon the polarized light. On the other hand, the same fats, if cooled quickly, so as to prevent the formation of large crystals, present the uniform tint claimed by Dr. Taylor as characteristic of butter fat.

Dr. Taylor in reply contends ‡ that Prof. Weber's experiments were erroneously carried out, and his views are defended against those of Prof. Weber by Mr. R. Hitchcock. § Mr. C. M. Vorce also corroborates ‖ Dr. Taylor, and describes a modified method of his own.

Dr. J. H. Long, ¶ on the other hand, considers that we have no abso-

* Science, vii. (1886) p. 524, from Bulletin No. 15 Ohio Agricultural Experiment-Station.

† See this Journal, 1885, pp. 356 and 918. It would seem from the above that these two extracts, though given in the order of date of the sources from which they were taken, were chronologically reversed. See also this Journal, 1886, p. 174.

‡ The Microscope, vi. (1885) pp. 78–9, and see pp. 85–6. Amer. Mon. Micr. Journ., vii. (1886) pp. 169–70.

§ Amer. Mon. Micr. Journ., vii. (1886) pp. 119, 135–7. ‖ Ibid., pp. 156–7.

¶ Bull. Illinois State Micr. Soc., May 14, 1886, 5 pp. and 1 pl.

lutely certain method of distinguishing between butter and some of its substitutes, and that of all methods proposed, the microscopic are perhaps the least reliable.

Microscopic Structure of an Armour-plate.* — Dr. H. Wedding describes the microscopical examination of a compound armour-plate, from which it appears that the different varieties of iron and steel used in the construction of such a plate can be recognized without difficulty by means of the Microscope. The plate examined, which was one of the largest used (300 mm. thick) consisted of a base composed of a series of hammered plates of puddled iron 35 mm. in thickness, welded together into a plate of 215 mm. thickness; a face of cast iron (containing 0·45 per cent. of carbon) rolled into a plate 15 mm. thick; and an intermediate layer of steel which had been run in between these two plates and allowed to solidify; the whole being finally rolled at a red heat.

A transverse section was polished, cleaned with water, alcohol, and ether, etched with a weak solution of hydrochloric acid (one drop of acid in a litre of water), cleaned a second time, and then tempered to a yellow tint, when the etched figures stood out in orange upon a yellow ground.

The section was then submitted to microscopical examination and the following features were observed. The surface-plate displays the characteristics of cast iron poor in carbon, namely homogeneous iron with uniform inclusions of angular flakes and crystals of iron; in the steel plate the homogeneous iron is reduced to a network enclosing large masses of crystallized iron and small pores; while the base-plate is characterized by welding joints in the form of pores permeating stringy iron in which the crystalline structure is developed parallel with the joints. The quantity of crystals present may be regarded as an indication of the percentage of carbon, and they are seen to diminish in number where the otherwise homogeneous iron of the surface-plate comes into contact with the steel. Other changes of character observed near the point of contact of the different materials are detailed by the author and suggest that the Microscope may perhaps be used not only to determine the nature of the metal, but also to estimate its homogeneity, purity, &c.

Microscopist's Working Table.†—In a series of articles on "The Naturalist's Laboratory" by an anonymous writer, a microscopist's working table is thus described:—"As a very large part of the naturalist's work nowadays calls into use that most useful of modern inventions, the compound Microscope, a special table designed to facilitate research must here be looked upon as something indispensable. The objects of the design, now submitted to the notice of students of nature for the first time, are to afford general convenience during study, and to enable one to record observations graphically on the spot. To accomplish these the table is divided into two parts, the microscopist's, M (figs. 93 and 94), and the artist's portion, D. The dimensions of the table are clearly indicated on the figures. Fig. 93 is a working plan to show the end elevation of the structure; fig. 94 gives a good idea of the shape of the table-top. Each part is furnished with two drawers as shown in fig. 93; the drawers under D afford space for the storage of colour-boxes, pencils, paper, &c.; those beneath M are intended to receive microscopical accessories, such as glass slips, instruments, live-boxes, troughs, and the hundred and one odds and ends that may be required from time to time by the worker in Nature's unseen universe.

* Verh. Ver. zur Bef. d. Gewerbfleisses, 1886, p. 293. Cf. Naturforscher, xx. (1887) pp. 18–9.

† Knowledge, x. (1887) pp. 80–1 (2 figs.).

"The longest end of the table ought to face a window approximately looking northwards. The worker seated on the bench T can thus employ direct or reflected light according to the position, inclined, upright or horizontal, in which he places his Microscope. To his right there is fixed a reagent stand, R. As soon as he has completed his observation, or adjusted an object which he deems worthy of delineation, he should shift his instrument to the position D and take his seat upon the chair S. By so doing, he will gain the inestimable advantage of working in a clear

FIG. 93

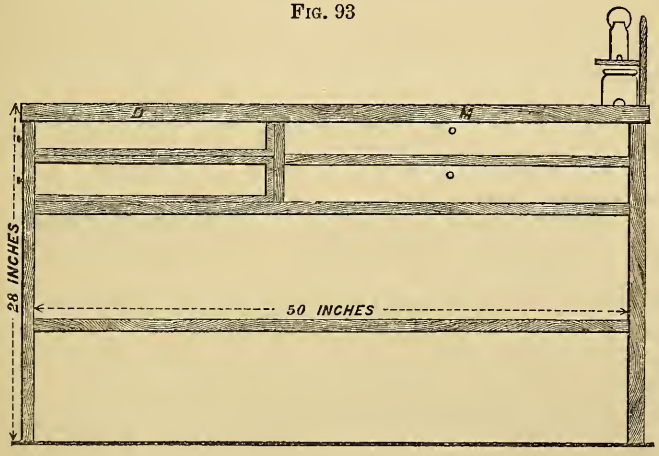
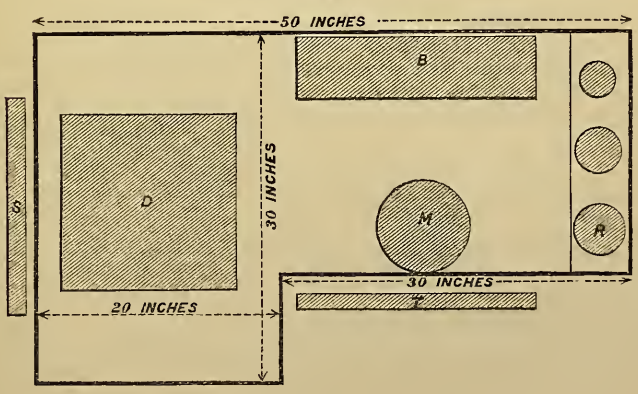


FIG. 94.



transmitted light without the chance of a vitiated result through interference rays, and with absolute security against the evil effects of a more or less intense glare. The value of thus being able to shift one's position from front to side on the table will soon become evident to workers with the Microscope who indulge in prolonged observations. The top plan (fig. 94) shows the position of the Microscope during investigation, or whilst mounting objects; B, place for a dust-proof box, for use whilst preparing specimens for observation, a detailed description of which will be given in the sequel;

D, the position of the Microscope when used with the camera lucida for delineating objects, or when employed with the polariscope, or where pure transmitted light is alone admissible; R, the reagent-stand."

Ward's Catalogue of Microscopical Collections.—Dr. R. H. Ward has prepared a convenient form of catalogue for recording a large number of brief data of objects. Each double page has space for 10 objects and the data are grouped in four columns. Below is a specimen of the heading of a page and one of the 10 spaces; the columns for preparation and mounting are not, however, beneath the other two but run across the right-hand page. Each book contains space for 1000 or 2000 objects as preferred. There is an appendix for long notes, special methods, formulæ, &c., and an alphabetical index.

(*Left-hand Page.*)

	Name.	Source.
Slide No.	c. Common Name. s. Scientific Name. N. Special points shown, Illumination or Powers required, Reference to authorities, &c.	h. Habitat or Locality. c. Collector (Presented, Purchased, Exchanged, &c.)
	c	h
1	s	c
	N	

(*Right-hand Page.*)

Preparation.	Mounting.
p. Preserved (Hardened, Macerated, Decalcified, Injected, &c.). ct. Cut (Imbedded, Frozen, Microtome), Teased, &c. st. Stained. cl. Cleared.	m. Mounting Medium. cc. Cell and Cement. cg. Cover-glass Thickness. | d. Date. | lc. Location in Cabinet. r. Repairs or Disposal (Broken: Cement run in: Air in: Given to or Exchanged with, &c.).
p	m
ct	cc
st	cg d . . lc
cl	r .

Dr. Dallinger's Address.—The following * is a popular appreciation of Dr. Dallinger's last address.

"It is difficult to say whether the wonders that reward the patient servants of science are more attractive in the direction of the infinitely little or of the infinitely great. In both of these fields there are faithful workers, constantly striving to enlarge for us the bounds of human knowledge, albeit

* Daily Telegraph, 19th Feb., 1887, p. 5.

mankind is not grateful enough for their toil. Experimental researches, like those which Mr. Crookes explained last night at the Royal Institution, force the mind to consider matter in its ultimate and minutest forms as analysed by the electric spark and the spectroscope, in atmospheres millionths of our common air in tenuity; and they are not less wonderful than the contemplation of worlds thousands upon thousands of times larger than our own. Our astronomers are engaged at present in photographing the face of the midnight heavens, having discovered that the film which they expose to the sky is far more sensitive to light than the keenest human eye, and more than one observatory is thus registering distant and minute stars previously unknown. The stellar universe has been by such means perceived to be more crowded with life and glory than had been realized; and night after night the astronomer's camera in this silent way prints off accurate pictures of seen and unseen immeasurably distant worlds. Meanwhile, coming from the realms of matter to the sphere of life, the microscopists are quite as busy as the telescopists, and the results which they achieve, although drawn from regions that escape us by minuteness, often shed new rays of truth over those problems of living nature which baffle us by their vastness. The Rev. Dr. Dallinger, President of the Royal Microscopical Society, delivered an address last week which well illustrates this view, while it gives an example of the admirable and unceasing devotion shown by our best scientific men. After dwelling on certain recent improvements in the construction of lenses, the President, on the occasion referred to, proceeded to describe a series of experiments which he has conducted for nearly ten patient and faithful years. Long ago Darwin expressed the opinion that if we would actually observe and demonstrate the manner in which living creatures adapt themselves, by inward and outward modifications, to changed circumstances, and so produce what are called new species, it must be by watching the lowest and least visible organisms. To such a task Dr. Dallinger set himself. His project was to place and keep under his lens several varieties of those minute monads which are incessantly multiplying by fissure or division, and which are nearly at the bottom of animated nature. The generations of these creatures succeed each other about every four minutes; so that, in the course of an hour, we can view the passage of fourteen or fifteen generations, which would answer to something like four hundred and fifty years of human history, while a day of monadic existence would represent more than ten thousand of our years. These monads live in water, and by connecting the drop that serves them for a habitable and roomy ocean with the ingenious apparatus of Prof. Schäfer the temperature of this drop can be either kept constant or raised very slowly and with absolutely steady precision. Here, therefore, were the conditions requisite for gradually altering the climate in which these monads throve; and if it could be proved that such tiny infusoria could indeed be slowly accustomed to changes greater than would be suffered by animals removed from the Equator to the Pole, then bright and trustworthy light would be cast on the modifications of life which we see arrived at on the earth, and Darwin's great law would be largely removed from theory to recorded fact. To carry out so very delicate an investigation, however, it would have to be prolonged for months and even years, in order to imitate the immense deliberation with which Nature herself accomplishes every substantial change in her highest productions. Night and day, winter and summer, the patient gaze must be kept fixed on those merest specks of silvery life which had to be nursed into new conditions of existence. The slightest accident to the apparatus might in one moment render the whole experiment void, and leave the drop of water as lifeless as these islands

would be if another glacial period suddenly arrived. The only reward, on the other hand, for successful and almost inconceivable perseverance would be the discovery of truth, and the reinforcement of Darwin's sublime generalisation. But, for the sake of these, which always satisfy the noble ardour of science, Dr. Dallinger has given as many years of his life as were spent by the Greeks in the siege of Troy, and has apparently won a scientific victory, the value of which is as signal as his ingenuity and devotion are admirable.

We will endeavour very briefly to describe the method and the outcome of his most remarkable experiments. The group of microscopic monads were put under the lens in a well-fitted water-cell at their usual temperature of 60° F., the apartment, the apparatus, and all round being carefully kept in precise unison. The Doctor then spent the first four months of his observation in raising the temperature time after time by stages less than one-sixth of a degree, until his swarm of protozoa had reached the new and advanced reading of 70° F. This change, nevertheless, had no more disturbed them than that experienced by a British family when it migrates from London to Cape Town; the life-history of each group remained unaltered; they moved, gyrated, fed, and split themselves into new individuals in just the same manner and within much the same period as before. When, however, three more degrees had been added to the seventy, the monads showed signs of being decidedly inconvenienced. They were neither as lively nor as productive as formerly; yet, by keeping them exactly at this range during two quiet months they regained their full vigour, and might be compared to emigrants who had become seasoned by surviving the first hot spell in a tropical country. They could now stand—by gradual steps of increase—the enhanced heat of 78°, which was reached at the commencement of the twelfth month. Yet here, again, a long pause was found to be necessary; the new generations of those silver specks of life under the glass were not all alike strong enough to live and thrive. What answers to sunstrokes and fevers with us had caused vacant spaces to appear in the water-drop, and it was only when the monads showed themselves once more lively and prolific by a long era of repose that the careful Doctor administered a further dose of caloric. During eight years and a half did he thus slowly and unweariedly proceed in the same course, augmenting the heat of their surrounding element now and then by slow and slight additions, pausing afterwards for months to give the minute creatures time to accommodate themselves when signs were visible that they were under difficulties, and always going forward to new trials of endurance when they had recovered. In this manner, after all those many years, Dr. Dallinger brought his small patients to the astonishing range of 158° F., at which the latest generation appeared 'as jolly as sand-boys.' It is not possible to say how much farther their tiny constitution could have been trained to defy increasing warmth, because the research was at this point accidentally terminated; but it will be seen that the Doctor had brought the little people of his drop-world to sustain a heat nearly one hundred degrees higher than the flourishing point of their ancestors, any species of which, if taken at the beginning, would have been completely and instantaneously killed in water of one hundred and forty degrees. When we have added that these minute salamanders perished directly they were put back into their ancestral medium of sixty-five degrees, if will be manifest that the indefatigable Doctor had, by the magic of science, effected a miracle of Nature almost as striking as if the *Protococcus nivalis*, which stains the Arctic snow with crimson, had been transformed into the great grasses and feathery bamboos which clothe the burning sides of a mountain under the Equator.

The biological importance of these observations will furthermore be evident to all intelligent minds. There must have passed under the eyes of Dr. Dallinger, during his watch, something like half a million generations of the minute organisms. His augmentation of temperature had meanwhile represented the sudden changes which may have come upon earth-life, while his pauses answered to those periods of steadfast conditions which must have intervened, and given to living things leisure to accommodate their organs to new circumstances. Thus the ages of our planet's history were condensed, so to speak, under the vigilant eye-piece of the Doctor's Microscope, and these seven or eight years of observation furnished an epitome of the earth's entire existence. They proved to demonstration in these low forms what we can only guess at with regard to the higher plants and animals. Darwin constantly insisted upon the slowness of the process of adaptation, and, if we should seek to transpose the advances and the pauses of these seven or eight years into terms proportionate for higher orders of life, the figures would become truly prodigious. Yet no change from sea to land, or from icebergs to tropical forests, could be relatively greater than that triumphantly borne by these infusoria. And, if it be objected that they are of an organism too degraded and too primitive to bear any practical relation to the highest grades of life, the answer is obvious and convincing. Those higher species, whether plants or animals, are mainly built up of vast aggregations of cells; and these cells, though differently endowed in different parts of the frame, are very like the monads in many respects. Thus the patient experiment has, in truth, a clear and most valuable bearing upon the problem of gradual evolution in all its stages and illustrations, and light is cast upon the grandest operations of Nature by the way in which these tiny mere dots of protoplasm 'live and move and have their being.' Nor could better proof be wanted of the way in which the infinitely little illuminates, as we have said, and explains the infinitely great."

BOUDIER, E.—**Considérations générales et pratiques sur l'étude microscopique des Champignons.** (General and practical considerations on the microscopic study of fungi.) *Rev. Mycol.*, VIII. (1886) pp. 215–8.

COLE, A. C.—**Studies in Microscopical Science.** Vol. IV. Secs. I.–IV. No. 7 (each 4 pp.).

Sec. I. Botanical Histology. No. 7. Studies in Vegetable Physiology. VII. Haustoria. (Plate VII. Dodder in parasitic connection with clover.)

Sec. II. Animal Histology. No. 7. The Ovary and Ova in Birds. (Plate VII. Ovary of Bird × 50.)

Sec. III. Pathological Histology. No. 7. Fatty Degeneration of Kidney (Phosphorus poisoning). Waxy disease. (Plate VII. Fibrosis of Kidney.)

Sec. IV. Popular Microscopical Studies. No. 7. Microbes. (Plate VII. Microbes.)

JENNINGS, C. G.—**The Microscopic Examination of Urinary Deposits.** *The Microscope*, VII. (1887) pp. 9–10.

KASTSCHENKO, N.—**Methode zur genauen Reconstruction kleinerer makroskopischer Gegenstände.** (Method for the exact reconstruction of small macroscopic objects.) [*Post.*] *Arch. f. Anat. u. Physiol.* (*Anat. Abtheil.*) 1886, pp. 388–93 (1 pl.).

LONG, R.—**Die Trichine. Eine Anleitung zur Fleischschau.** (The Trichina. A guide to the inspection of meat.) iv. and 31 pp., 20 figs., 8vo, Berlin, 1886.

PELLETAN, J.—**Revue.** (Review.)

[Remarks on the progress of microscopical technique and "diatomologie" in 1886.] *Journ. de Microgr.*, XI. (1887) pp. 2–4.

PENNETIER, G.—**Technique microscopique. Recherche de la farine de blé dans le chocolat.** (Microscopical Technique. Search for flour in chocolate.) *Journ. de Microgr.*, XI. (1887) pp. 35–7.

RAFTER, G. W.—**On the use of the Microscope** in determining the sanitary value of potable water, with special reference to the biology of the water of Hemlock Lake.] *Proc. Rochester (N.Y.) Acad. Sci.*, 1886, 25 pp., 3 pls.

RÜFFERT, F. W.—**Microscopische Fleischbeschau.** (Microscopical inspection of meat.) 2nd ed., xii. and 87 pp., 40 figs., 8vo, Leipzig, 1887.

Seeds for Microscopic Objects.

[Lists of the most suitable by Reymond, Working-Man Botanist, and S. Bottone.]

Engl. Mech., XLIV. (1887) pp. 505–6, 527.

SLACK, H. J.—**Pleasant Hours with the Microscope.**

[Formation of crystals.] *Knowledge*, X. (1887) pp. 107–8 (3 figs.).

VANDERPOEL, F.—**A new Settling Tube for Urinary Deposits.** [*Post.*]

Amer. Mon. Micr. Journ., VIII. (1887) pp. 28–9.

WHELPLEY, H. M.—**The Microscope in Pharmacy.**

["It is undeniable that the Microscope will be one of the important instruments of the drug store of the future. As already referred to, drugs now come into the market in such altered conditions that the naked eye cannot recognize them. This gives great opportunities for adulteration, and microscopy is the most convenient path out of the difficulty. The instrument will grow more and more popular each year, as the profession becomes better educated and the public learns the importance of guarding against inferior or adulterated drugs. Even at the present time the importance to the pharmacist of the study of microscopy is quite generally recognized. The leading colleges of pharmacy have laboratories equipped with facilities for giving the students instruction in this highly interesting and valuable study."]

The Microscope, VI. (1886) p. 280, from *National Druggist*.

WILLIAMS, G. H.—**Modern Petrography**, an account of the application of the Microscope to the study of Geology. 8vo, Boston, 1886.

MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Burch's Perspective Microscope.†—In 1874, Mr. G. J. Burch "discovered a form of Microscope giving constant magnification along the optic axis, so that the objects were shown by it in microscopic perspective."

By writing $(f_1 + f_2 + \mathrm{H})$ for the distance between two thin lenses, he obtained for the formula of the system

$$\frac{f_2(f_2 + \mathrm{H})u - f_1 f_2(f_1 + f_2 + \mathrm{H})}{\mathrm{H}u - f_1(f_1 + \mathrm{H})} = v;$$

u being the distance from the object to the first lens, and v that from the second lens to the image.

Putting H = 0 in this equation, three things result:—

1. du/dv, which represent the longitudinal magnification, becomes constant, namely—$-(f_2/f_1)^2$;

2. The lateral or angular magnification, f_2/f_1, is also constant;

3. A picture of an object so magnified, drawn with the camera lucida, when viewed from a distance f_2/f_1 times less than that at which it was drawn, has the perspective belonging to an object magnified $(f_2/f_1)^2$ times.

The distance at which the eye must be placed is great, but may be reduced by employing three lenses, the distance between the first and second being $(f_1 + f_2 + f_2/m)$, and that between the second and third $(f_2 + f_3 + mf_2)$.

If the lenses are nearly but not quite in the afocal position, greater power and a wider field may be obtained; but it is at the expense of the penetration, which may, however, with advantage be limited to the thickness of the object. The instrument offers great advantages for artistic purposes, but lenses or mirrors of specially wide angle are needed for the farther development of the invention.

The optical conditions of a system of two thin lenses at varying distance apart are shown by diagrams.

In diagram 1 the u and v of the formula employed are set off as abscissæ and ordinates, and the curves (which are rectangular hyperbolas) drawn for several values of H. In the afocal position of the lenses, the curve degrades into a line which is a tangent to all the hyperbolas at the point (f_1, f_2). The locus of vertices and locus of centres of these curves being straight lines, and the hyperbolas all touching the point (f_1, f_2), it is shown that the principal foci, principal points, and equivalent focal length for any given position of the lenses, can be found by rule and compasses, without drawing the curve.

In diagram 2 the actual position of the lenses, their principal foci, separate and combined, and the principal points, positive and negative (answering to the vertices of the curves in diagram 1), are plotted down as abscissæ, the values of H on an enlarged scale being taken as ordinates.

Diagram 3 shows the same for two lenses of equal focal length.

Comparison of these two diagrams suggests the employment of the term "pseudo-principal points" for those positions at which the magnitude

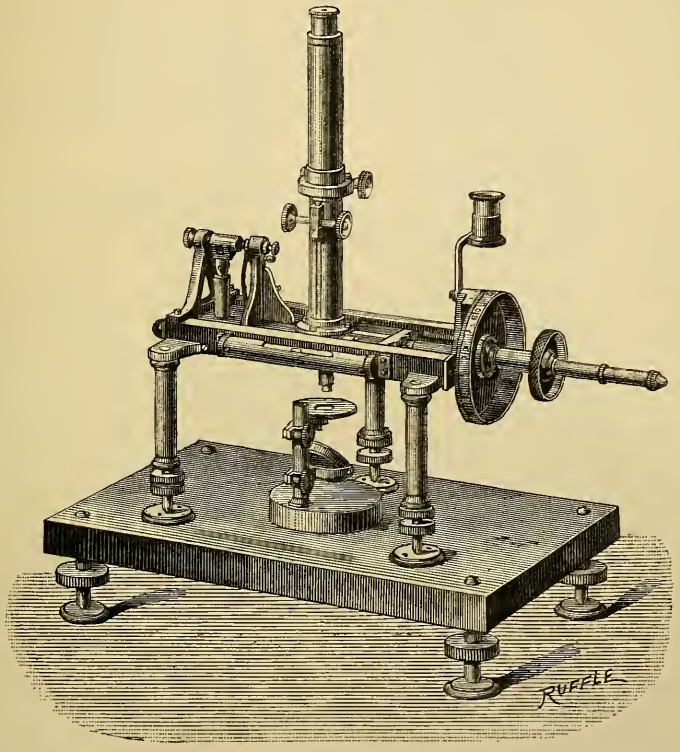
* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photo-micrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† Proc. Roy. Soc., xlii. (1887) pp. 49-50. See also this Journal, *ante*, p. 288.

of the image is in the constant ratio f_2/f_1 to that of the object for every value of H, inasmuch as the distance from these to the principal points gives the measure of the "penetration" of the system.

Campbell's Micrometer-Microscope.—This (fig. 96) was originally devised by Sir Archibald Campbell for measuring photographs of spectra;

Fig. 96.



it has since been improved for measuring diffraction gratings, and special means have been added for recording end-measurements of standard gauges by utilizing electrical contacts. It is made by Mr. A. Hilger.

It consists of a horizontal metal frame, in which a Microscope is applied to slide over a space of $5\frac{1}{2}$ in. actuated by a micrometer-screw. The frame is supported on three pillars, with adjusting screws for levelling with conical ends fitting in V-slots converging to a common centre, and applied on a substantial iron base-plate standing on adjustable screws, also for levelling.

The micrometer-screw has a pitch of 100 threads to the inch; the drum-head connected with the screw is divided into 100 parts on the edge, and by means of a vernier, direct readings can be taken up to 1/100,000 of an inch. For registering entire revolutions of the screw a fixed scale corresponding with the pitch of the screw is engraved on one side of the frame, and an index-pointer travelling with the Microscope gives the readings.

The diffraction gratings, &c., are carried on an adjustable stage with mirror that can be placed as required on the base-plate under the Microscope.

For standard end-measurements, where the difficulty is to determine the precise points of contact, the object is placed in a double V-carrier, one end touching a fixed electrical contact-point, the other end is then presented towards a travelling contact-point, actuated by the micrometer-screw, and the contact is shown by the deflection of a delicate galvanometer needle to an estimated accuracy of about 1/1,000,000 in. For registering temperatures, a thermometer is attached to the micrometer frame.

In practice the stage-plate on which the object is placed is first levelled by means of a spirit-level, then the tripod of the micrometer-frame is adjusted in the V-slots on the base-plate and accurately levelled, for which purpose spirit-levels are applied to the frame at right angles.

For high-power work the Microscope is furnished with Mr. Hilger's tangent-screw fine-adjustment, in which the motion is unusually slow, and which is described *infra*, p. 461.

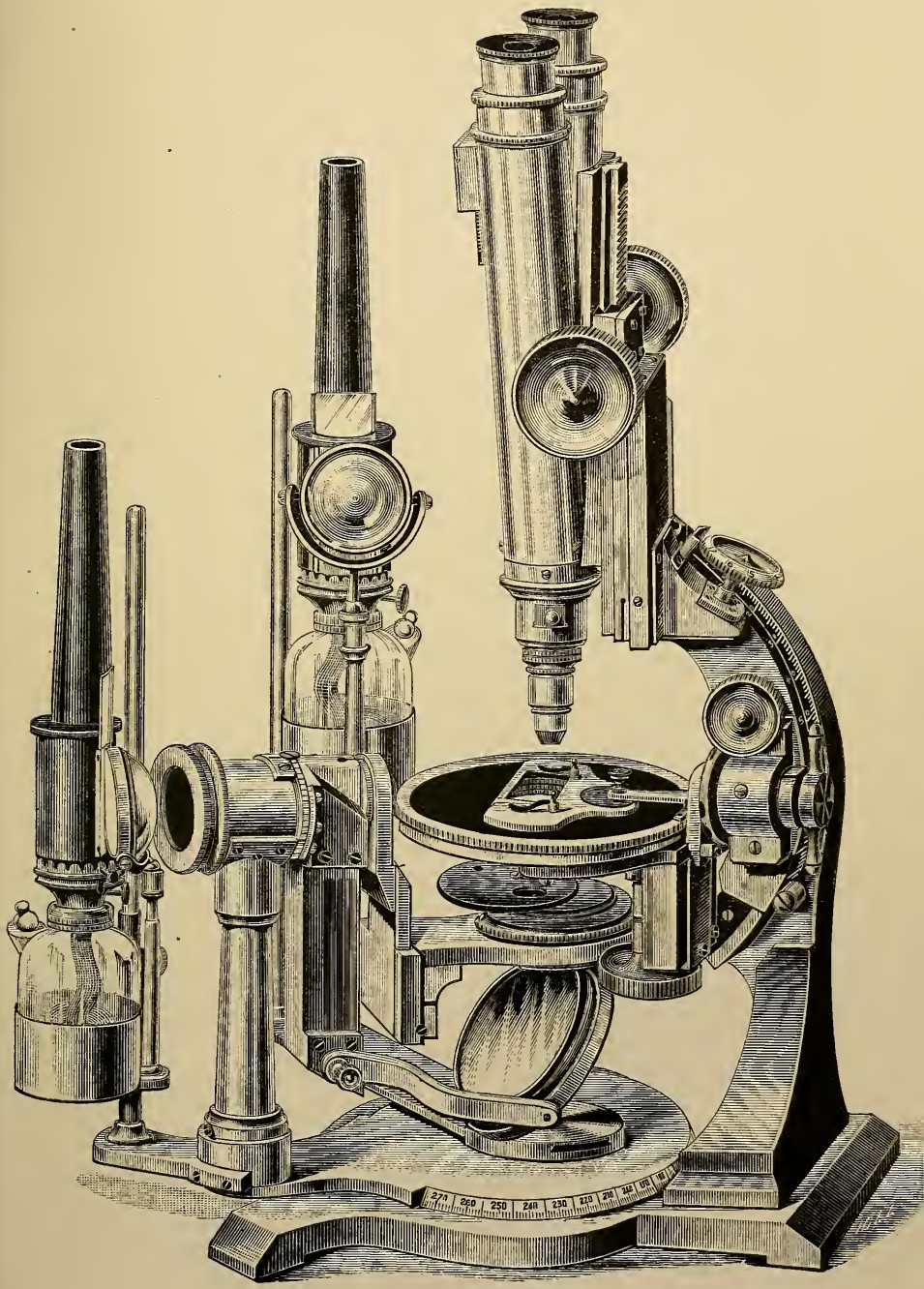
Watson-Draper Microscope.—This Microscope (Plate IX.) made by Messrs. Watson & Sons, after the designs of Mr. E. T. Draper, is an elaboration of the instrument suggested by Mr. E. Crossley.* The following description is furnished by Messrs. Watson:—

The idea in arranging it is, that when the object is on the stage, either it may be made to rotate in any direction, horizontal or vertical, round a fixed beam of light, without the light ever leaving the object, or the stage may be kept fixed while the light is revolving round it in any direction, horizontal or vertical; always, however, remaining upon the object. Of course to do this exactly it is absolutely necessary that the object should be precisely in the centre of all the circles in which the various parts of the instrument are revolving, and to enable this to be done with the utmost precision, there is an adjustment to the stage by means of a micrometer-thread screw below, to raise or lower it according to the requirements of different thicknesses of objects.

The body is mounted on an extremely solid pillar carrying a quadrant of a circle, and in this it may be placed in any position from the horizontal to the vertical, and as the stage is connected and moves with the body, and as this arc of a circle is struck from a radius, the centre of which would be the object on the stage, it follows that when light is thrown from directly underneath the object, by inclining the Microscope through this arc and without touching the mirror, the light becomes more and more oblique, till it arrives at that point where it is impossible for it to enter the objective. Again, the stage being a concentric rotating one, allows the object to be moved horizontally round the same fixed light. The two motions therefore are used when it is desired to place the object in any position with regard to a ray of light.

For those objects, however, which could not be conveniently moved, there is another arrangement for keeping the object stationary, while the light is thrown upon it from any desired angle. This is done by using Mr. Crossley's arrangement of a train of prisms transmitting the light on to the mirror and rotating on an axis in the same plane with the object on the stage. The prisms have also an additional movement which Mr. Crossley's arrangement has not, viz. the pillar supporting them is fixed upon a horizontal rotating base-plate so that by the movement of the base-plate, combined with the swinging motion of the prisms, the light may be thrown through them upon the object from any direction, horizontal or vertical. A lamp is fixed permanently to the pillar carrying the prisms, which moves with it in whatever direction it is placed. There is also a

* See this Journal, 1881, p. 653.



Watson-Draper Microscope.

second lamp supplied for illuminating opaque objects from both sides of the instrument, so as to avoid the influence of shadows. The whole of the circles in which the various parts of the instrument revolve are graduated to degrees so that the observer may be able to tell the angle at which any effect has been produced in order that it may be at once obtained again.

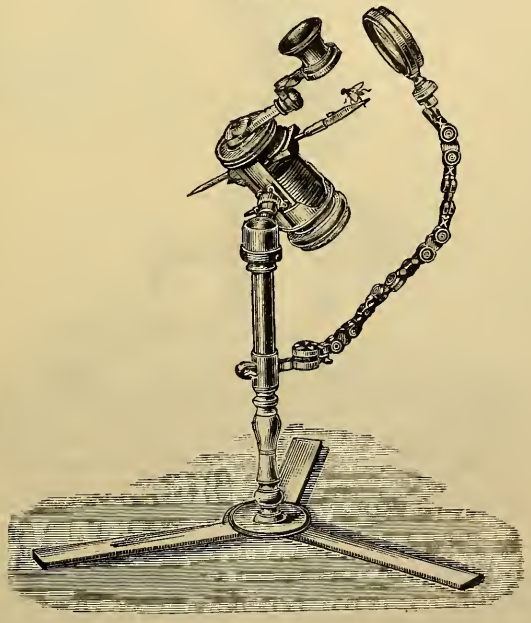
The substage and mirror are attached to the prism-box, and move with it. The mirror can also be detached and applied to the centre of the base.

The stage can be raised and lowered to compensate for the different thicknesses of the slide.

Universal Projection Apparatus for Mineralogical Purposes.* — Dr. F. J. P. van Calker's apparatus is announced under the title of "Universal projection apparatus for the representation of microscopical images of thin slices of rocks with and without polarization, of the phenomena of thick and thin crystal plates in parallel and convergent polarized light, of tension phenomena, of the difference between parallel and oblique extinction, the phenomena of pleochroism and microchemical reactions." It is, however, nothing more than a stand with a brass ring, through which crystallographic, optical, and microscopical apparatus are pushed.

Culpeper's Simple and Compound Microscopes (Wilson's form).—The Microscope shown in fig. 97 (simple) and fig. 98 (compound) would appear

Fig. 97.



to have escaped the notice of the writers who have treated of the history of the construction until quite recently.† It was designed and made by Edmund Culpeper whose name is generally known in connection with the

* Zeitschr. f. Krystallogr., xii. (1886) pp. 55–8 (1 pl.).

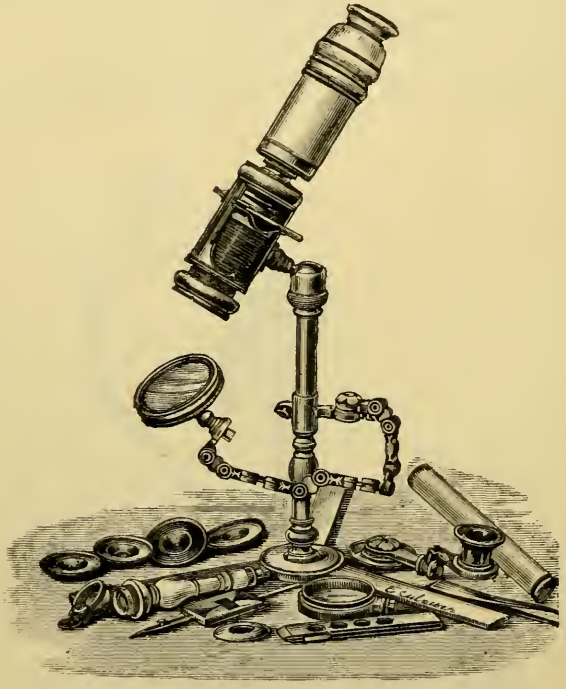
† Society of Arts Cantor Lectures on the Microscope, by J. Mayall, junr. (reprint in collected form), 1886, pp. 34–5 (2 figs.).

vertical tripod form of Microscope that was so popular from 1738 down to the end of the century. From the fact that no example which we have seen of this instrument was furnished with a Lieberkühn, we think it was probably constructed before 1738.

In fig. 97 the peculiarities are (1) the application of a ball-and-socket inclining movement on a pillar and tripod, to Wilson's "Screw-barrel" Microscope, (2) the addition of an articulated arm to carry a condensing lens, for opaque objects (as in fig. 97), or a plane mirror (as in fig. 98). For opaque objects the lens was removed from the body-tube and a disc having a pivoted arm terminating in a ring substituted. A low-power lens in a horn mount was then screwed in the ring and was thus held at some distance from the instrument so that the object could be properly illuminated.

In fig. 98 the compound body of ivory with draw-tube is shown, also the

Fig. 98.



accessory apparatus. On the left are four simple lenses in disc-mounts; the ivory handle for the "Wilson," when unscrewed from the ball-and-socket, having a screw-box at the end for discs of talc and rings; the forceps-carrier; a diaphragm for the condenser (which is a bi-convex lens in a cell at the lower end of the "Wilson"); hinged animalcule cage with four concave discs of glass, mounted in apertures in a plate on which a similar plate with four corresponding apertures and plane discs is hinged to open or close; condensing lens for opaque objects; carrier with horizontal rotating and vertical pivot movements for the low-power lens in horn cell,

&c.; glass tube for aquatic objects, and forceps. In later constructions Culpeper applied the mirror to one of the feet in a line with the optic axis.

Hilger's Tangent-screw Fine-adjustment. — This fine-adjustment, devised by Mr. A. Hilger, is in principle a direct-action screw, controlled by a worm-wheel and tangent-screw. The mechanism is shown in figs. 99, 100, and 101, and it is applied in the middle of the body-tube.

A is a tangent-screw, actuated by the milled head A′, gearing with a worm-wheel collar B B, having an internal thread by which it engages the screw C C at the upper end of a tube sliding within the body-tube D and carrying the objective at the lower end, the metal stop E preventing

Fig. 99.

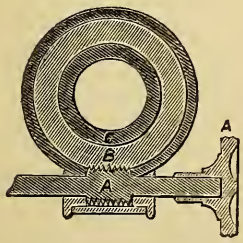


Fig. 100.

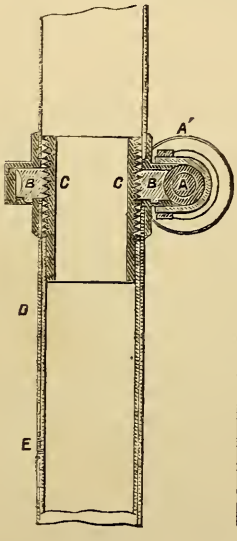
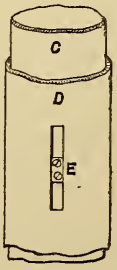


Fig. 101.



lateral movement. B B is fitted in bearings so as to rotate only. The rotation of A moves BB slowly round, causing C C to travel up or down as required in focusing.

Beck & Co.'s Microscopes.

["Apropos of the statement in the December number, that Zeiss had recently issued his 10,000th Microscope, we learn that Beck & Co., London, have manufactured over 14,000."]

The Microscope, VII. (1887) p. 93.

Dippel, L.—**A. Nachet's grosses Mikroskop No. 1 und dessen Objectivform.** (A. Nachet's large Microscope No. 1, and his Objectives.)

[Description of the Microscope described in this Journal, 1886, p. 837.]

Zeitschr. f. Wiss. Mikr., III. (1886) pp. 457–60 (1 fig.).

Dissecting Microscope, how to make a simple.

[Made out of a crayon box (or a similar one having a sliding lid) with corks, a rod, wire, &c.]

Engl. Mech., XLV. (1887) p. 96, from *N. Gleaner*.

Houzeau, J. C.—**Microscope et Télescope.**

Bull. Soc. Belg. Micr., XIII. (1887) pp. 90–110.

Latteux, P.—**Manuel de Technique Microscopique.** (Manual of Microscopical Technique.)

[Cf. *infra*, β (1). In addition to Technique, it contains chapters on Simple and Compound Microscopes, Accessories, Test Objects, Micrometry, Drawing, and Photomicrography.]

3rd ed., xvi. and 820 pp. (385 figs. and 1 pl.), 8vo, Paris, 1887.

Powell's (T.) Microscope and Appendages "made out of odd materials of various kinds." (Mr. Powell is a shoemaker.)

Proc. Lit. and Phil. Soc. Liverpool, No. XXXIX. (1885) p. xlviii.

(2) Eye-pieces and Objectives.

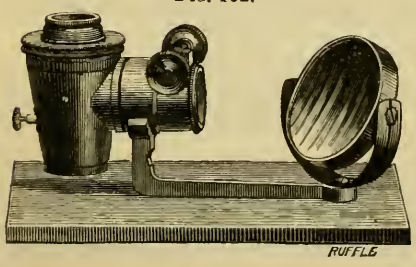
Apochromatic Objectives.*—Dr. M. D. Ewell has examined a Zeiss apochromatic objective, 1/12 in. N.A. 1·40 (with eye-pieces), made from the new optical glass. By oblique light he considers it is a well-corrected objective, but no better than first-class American objectives, except that the images have hardly any perceptible colour. With axial illumination, however, using an Abbe condenser of N.A. 1·40, with no stops or diaphragms whatever, the real superiority of the glass becomes apparent. "I have never before seen so clear and perfect a picture under similar conditions; and it is clearly apparent that the corrections are approximately perfect up to the extreme limit of its aperture. It is not difficult with such axial illumination to resolve a Möller Probe-Platte from end to end, and the images are practically colourless. In the present state of our knowledge, this objective certainly leaves nothing to be desired. The working distance is large, about 1/100 in., and the so-called searcher eye-pieces make even as high a power as a 1/12 very convenient in use. I do not assume to speak for any one but myself; but such, as it seems to me, must be the judgment of any unbiassed observer. For the practical worker with axial illumination, it seems to me that the apochromatic objective is destined to become the objective of the future."

Double Objectives with a common field of view.†—These (made by Herr H. Westien) consist of two lenses or lens-systems, which having been ground away at the edges on one side are placed so near and under such an angle to each other that their optic axes coincide with the axes of the eyes; when this is the case the two fields of view appear united into a single one.

(3) Illuminating and other Apparatus.

Hilger's Opaque Illuminator.—For the illumination of opaque objects to be viewed with Campbell's Micrometer-Microscope, Mr. A. Hilger has devised the apparatus shown in fig. 102, which is a modification of Prof. H. L. Smith's vertical illuminator.

Fig. 102.



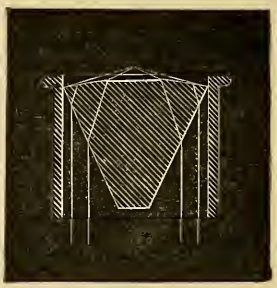
The reflector is concave, of speculum metal, of oval shape, and having a central aperture, through which the rays pass from the objective to the eye-piece. It is mounted in a conical tube, inclined normally 45° to the optic axis, and by means of an adjusting screw this angle may be altered a few degrees, so that the object may be illuminated from one side only if required. A system of condensing lenses with rack-work is applied to direct the light from the external mirror to the speculum, whence it is reflected through the objective and condensed upon the object.

* The Microscope, vii. (1887) p. 63.

† Central-Ztg. f. Opt. u. Mech., viii. (1887) p. 60.

Nachet's Dark-ground Illuminator.—This apparatus (fig. 103) consists of a truncated cone of glass, the base of which has the outer zone ground off to a spherical curve, leaving a central plane disc, which is blackened to exclude light. This cone is mounted in a cylindrical tube, with its base upwards, which is applied in the substage after the manner of the usual Continental cylindrical diaphragms, and racked up close to the transparent object. Parallel rays striking on the conical surface are refracted to the lenticular zone, and thence condensed on the object. M. A. Nachet, by whom the apparatus is constructed, states that "it should be used only with low powers having an angle of aperture less than that of the illuminator."

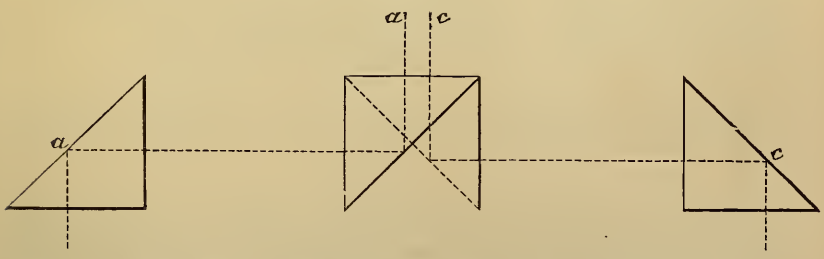
Fig. 103.



Quimby's Lamp-shade.*—Mr. B. F. Quimby's "illuminator" or lamp-shade is intended to be used with the Griffith Club Microscope. It consists of three pasteboard cylinders, accurately fitted one within the other—the external revolving on the middle, the inner being removable. All three cylinders are pierced anteriorly by a round aperture; the middle piece having also a slot. With the inner cylinder removed, the external piece may be twisted one way or the other, the pencil of light coming through the opening thus regulated; or, in the examination of diatoms, the slot may be used. The inner surface of the second cylinder is white, but for the convenience of those who prefer a black background, the inside of the third cylinder is of that colour, and this may be slipped into the illuminator whenever a dark surface is required. The middle cylinder is surrounded at its lower margin with a brass collar, to which a short tube is attached. Into this tube fits the lamp rod, while the illuminator rests on the rod controlling the light.

Van Heurck's Comparator.†—Dr. H. Van Heurck has derived the idea of his comparator from the instrument devised by M. Inostranzeff for comparing the colours of minerals.‡ The latter instrument, though

Fig. 104.

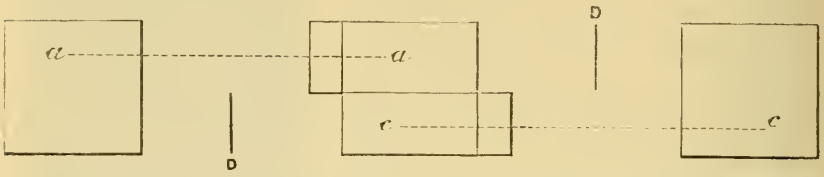


essentially practical, is insufficient for diatoms, as the field is partially intersected and a black band, where the prisms join, prevents perfect approximation. Moreover, it is preferable that the diatoms should be apposed not in their whole length but with half the length of the valve.

* The Microscope, vii. (1887) pp. 56–7.
† Bull. Soc. Belg. Micr., xiii. (1886) pp. 76–8 (2 figs.).
‡ See this Journal, 1886, p. 507.

The new apparatus works perfectly. Instead of two prisms, apposed by their edges, as in Inostranzeff's instrument, there are two prisms of large size, *a*, *c*, figs. 104 and 105, but of slight width and in apposi-

Fig. 105.

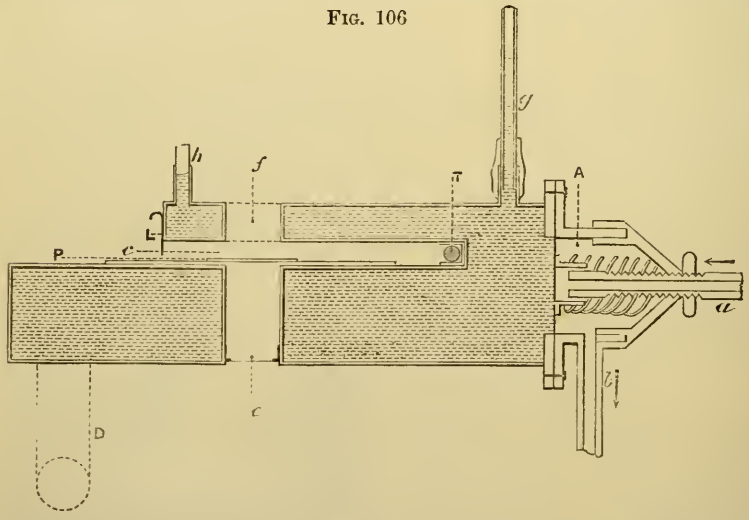


tion by one of their triangular faces. The two images are brought together in the direction of their length: the piece carrying the two prisms is movable, can turn on its axis, and be fixed in any position whatever. By slightly turning it, the line of separation of the two prisms altogether disappears, and so thoroughly, that a perfect valve can be made up of two halves of a valve, each belonging to one of the fields, and the photograph must be examined very attentively to find the place where the valves join.

Thus the comparisons are as complete as possible, and the images so clear that high powers may be used. In each part of the tube the diaphragms D cut off any interfering light coming from the opposite side.

Vignal's Hot Stage with Direct Regulator.*—M. W. Vignal's hot stage (fig. 106) consists of a rectangular brass box open on one side and con-

Fig. 106



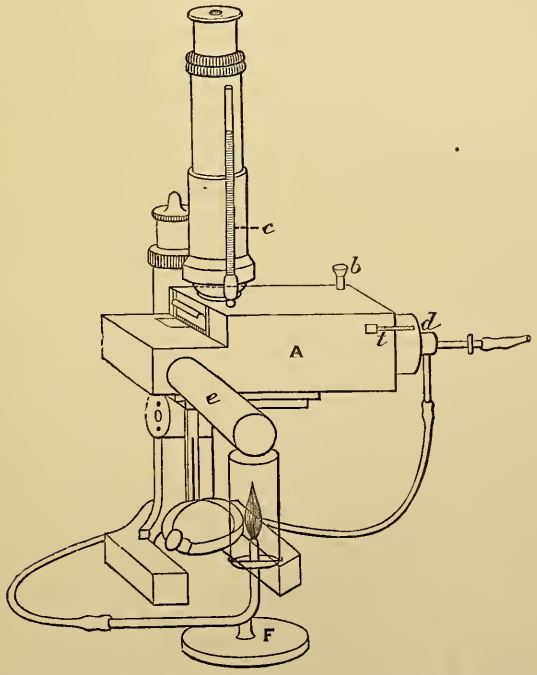
Longitudinal transverse median section of the hot stage. A, D'Arsonval's regulator; *a*, entrance tube for gas; *b*, exit tube for gas; *g*, glass tube fixed with caoutchouc band; *h*, tube for introduction of water; *c*, hot chamber proper, with slide P and thermometer T; L, door closing chamber; *f*, aperture for objective; *c*, glass disc in copper ring for closing the illuminating aperture; D, heating cylinder.

taining a second small rectangular box. These two boxes are perforated by an aperture which allows the light to be reflected upwards from the mirror.

* Arch. de Physiol., vi. (1885) pp. 1–10 (2 figs.).

The lower part of the aperture is closed by a small glass diaphragm, let into a copper ring. On the other side of the large box is fitted D'Arsonval's caoutchouc regulator; on the front side is a cylindrical diverticulum like that of a hot filter. On the upper surface are two brass tubes; to the front one is fixed, by means of a caoutchouc ring, a glass pipe into which the water rises in order to determine the pressure and consequently the regulation of the escape of gas; the other tube, closed by a caoutchouc plug, is that through which the box is filled with water and freed from gas or air. In front another tube passes through the chamber; in this is inserted a thermometer insulated by means of a piece of Bristol board. On the right side of the smaller box is a lateral opening for the insertion of the slide, and as the upper part of the larger box is wanting towards the right,

FIG. 107.



Showing the appearance of the hot stage arranged on the Microscope. A, hot chamber *b*, water tube; *c*, glass pressure tube; *d*, D'Arsonval's regulator; *e*, heating cylinder; F, burner with glass chimney; *t*, thermometer.

the defect serves for the easier manipulation of the slide. The hot stage proper is 5 mm. high, 75 mm. long, and 40 mm. broad, and in order not to lose heat a small door drops down just so far as not to interfere with the slide. The gas burner is inclosed in a glass chimney, in order to keep the flame quite steady.

The apparatus is put in working order as follows: The pressure tube having been arranged, the chamber is filled with boiling water, and is shaken from time to time in order to disengage any inclosed air. The apparatus is then placed on the stage, the gas lighted, and the regulator tap turned down until the flame begins to diminish. The tube is

then screwed up and the gas-jet placed at the end of the heating tube. As the water gets warm its excess escapes from the tube through which it was introduced. In about one hour to an hour and a half, when the thermometer marks 36° to 38° C., the tube is closed with the caoutchouc plug. As the water gets hotter it mounts in the glass tube and causes a pressure on the caoutchouc membrane of the regulator, and this lowers the flame by diminishing the current of gas supplied. If the temperature lowers the water descends and the gas is supplied more freely. Should the apparatus have been regulated for too high a temperature some water is introduced into the tube by means of a fine pipette, and *per contra* some is withdrawn by removing the caoutchouc plug if the temperature has been regulated too low. It is stated that the regularity of this hot stage is such that even under unfavourable conditions it does not vary more than a few tenths of a degree.

Julien's Immersion Heating Apparatus.*—Dr. A. A. Julien's "immersion apparatus" was devised for the special purpose of exactly determining the temperature of expansion of the liquid in the fluid cavities of minerals. He considers that most of the forms hitherto devised are "extremely inaccurate, often complex and untrustworthy, and it may be owing to this cause that Brewster obtained, for the critical temperature of the liquids in quartz, results of the very wide range between 20° and 51° C."

The author in a previous paper thus expressed himself on the subject. "The objection to all these forms of apparatus lies in their irregular application of heat, and its irregular and indefinite loss from currents in the surrounding atmosphere, and from the refrigerating effect of the mass of metal in the stage, and also in the objective, in an amount proportionate to its close approximation, i. e. to its focal distance or high power. Even in the most pretentious apparatus, that of Vogelsang, its inventor admits a variation or error of 10° C., according to the objective employed; from a No. 4 Hartnack of 3 mm. focal distance to a No. 9 of 0·1 mm. Vogelsang suggested the reduction of observations made by means of high-power objectives to the standard of the No. 4, and was even forced to make a plus correction of 1° C. for observations in which the temperature of the air of the room and of the Microscope fell below his normal (20° C.) as far as 12° to 15°. Practically, in use these observations are consequently made almost altogether on large cavities and under low-power objectives, and an accuracy to 1° C. has been accepted as satisfactory. Although wide discrepancies have constantly occurred, even in determinations on the fluid cavities in the same slice of mineral by means of these devices, on the other hand some of the most delicate and important investigations, such as those of Sorby and King on the indication of the degrees of pressure to which certain granites have been subjected during folding and metamorphism, have rested largely upon the accuracy of determinations of this very kind." †

Brewster, Sorby, and Hartley have used the same principle as the author, Hartley adopting the plan of immersing the slide in water of known temperature, removing, wiping it hastily, placing it on the stage, and instantly examining it ‡ Far more accurate results with greater convenience can, however, be obtained by means of an apparatus permitting the slide to remain under observation, immersed in a layer of water on the stage, and continuously warmed by a current of air from the breath of the observer, or, if necessary, by the conduction of heat to the bottom of the

* Journ. N. York Micr. Soc., i. (1885) pp. 137-9. See also this Journal, 1882, p. 266.
† Amer. Mon. Micr. Journ. v. (1884) pp. 189-90.
‡ Journ. Chem. Soc. London, 1876, p. 139.

vessel from a small flame at the side of the stage. By this means an accurate determination of the actual temperature at which a fluid inclusion expands into a gaseous state may be obtained in a few minutes to 0·05 C°.

The simplest form of the apparatus consists of three parts, as follows:—

1. A shallow glass tank, such as may be cut off the bottom of a chemical beaker, of sufficient diameter for the slide to lie within it, just immersed in a thin layer of water, but separated from the bottom by two little blocks of rubber or glass. This tank is placed upon the stage.

2. A chemical thermometer of sufficient delicacy, with a short bulb, or with a long bulb bent at a right angle. This is inserted in the tank, as nearly upright as possible, and the depth of the water is made just enough to cover the bulb. The length of the scale should be such as to bring the degrees between 27° and 32° near the level of the observer's eye when it is at the eye-piece, to facilitate immediate observation without the delay caused by moving the head.

3. A piece of small rubber tubing tied to the body of the stand, with the upper end inserted in the observer's mouth, and with the lower end, which terminates in a short piece of glass tubing drawn to a fine aperture, lying in the water on the bottom of the tank.

An immersion objective may be employed or, if the cavity be large, any objective of lower power may be used, with its front immersed in the water. After the cavity has been brought into sharp focus, a steady but gentle stream of air is blown through the tube, the immersion of the objective preventing interference from the waves on the surface of the agitated water. The cavity is continuously observed, as the bath and the immersed thin section are gradually warmed by the current of the observer's breath, and when the critical point is reached and the liquid contents of the cavity suddenly disappear, a quick observation of the thermometer is made.

Again, as the bath cools—which process may in hot weather be hastened by adding carefully a few drops of cool water, with continual agitation by the air current—the original bubble may be observed to leap back into view, and a second observation of the thermometer is taken as a check to the first.

If a higher temperature be required for other uses of this apparatus, oil or other liquid may be substituted for the water in the bath, and it may be heated by conduction from a taper or lamp burning by the side of the stage, through a stiff slip of copper introduced beneath the glass tank. A small hole, for observation, through this copper slip should be placed immediately over the centre of the aperture of the stage. The apparatus may be further protected from radiation of heat, and more uniform results ensured, by inclosing the tank in a ring of pasteboard or sheet cork, and by inserting plates of cork between the copper plate and the stage.

Unequal Heating of Crystal Sections.*—Dr. W. Klein, for studying the alterations of optical characters in crystals, produced by unequal heating, suggests the use of a plate of copper, resting upon one side of the crystal, the other end of the plate being heated in a spirit-lamp. To accelerate the process, and to obtain the means of rotating the section during heating, it is better to use a pair of copper forceps attached to a wooden ring, so that the points of the forceps in which the section is held come exactly into the centre of the ring; between the ring and the forceps is a layer of asbestos. The whole is laid upon the stage, and the projecting end of the forceps heated by a spirit-lamp. By this method the crystal is heated on one side on both the upper and lower surfaces.

* Zeitschr. f. Krystallogr. u. Mineral., ix. (1884) pp. 38–72.

Culture Glass for examining Micro-organisms.*—The glass invented by Dr. F. Lipez consists of a flat and a round part. The former is for the reception of the nutrient medium; the latter for the cotton-wool plug.

Fig. 108.

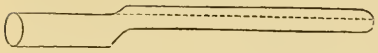


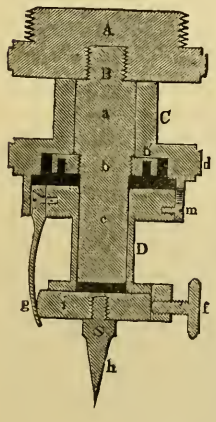
Fig. 109.

Fig. 108 shows the instrument in section; fig. 109 from the surface. One-third the natural size.

The nutrient medium is only spread in a thin layer on the lower surface of the glass. The advantages claimed for this glass over the ordinary plate method are: (1) The simplicity of its application, for it is a storehouse as well as a laboratory; (2) its certainty of preventing ingress of extraneous organisms, &c; (3) it allows the colonies to be examined with low powers, and to be extracted for examination if need be; (4) it allows the action of certain gases in the organisms to be observed with facility—e.g. CO^2 can be poured in and H gas poured up, according to the position of the aperture.

Schiefferdecker's Apparatus for Marking Microscopical Objects.†—Dr. P. Schiefferdecker's apparatus (fig. 110) is essentially a diamond point for scratching circles on the cover-glass, so that any particular spot can be easily found.

Fig. 110.



It consists of the screw-head A, to which is united the piece B, of unequal length and diameter at *a* and *c*. At *b* are a few threads for working in the female screw *b'*, which supports the revolving cylinder C, but without interfering with its movements. C is united to a second revolving cylinder D by means of the screw *m*. A linear aperture at *m* allows free up and down movement of the parts from D to *h*. The horizontal slide *i* is moved by the screw *f* and the spring *g*. At the end of *h* is a diamond point. The apparatus is screwed to the body-tube in place of the objective, and *h* is moved out excentrically to the desired extent, and a circle is scratched on the cover-glass by turning the raised rim *d* round through 360°. By this means circles of 0·25 to 0·20 mm. diameter can be described. Of course it is necessary that the cover-glass should be firmly fixed.

Microscopic Measurement of Indices of Refraction and Axial Angle of Minerals.—M. E. Bertrand ‡ is able to observe the optic axes in a mineral of which the true axial angle is 145°, by increasing the aperture of the condenser and objective, and using a strongly refracting immersion liquid. For this purpose, the condenser consists of three lenses, which are respectively hemispherical of 5 mm. radius, 5 mm. thick with 12 mm. radius, and 19 mm. diameter with 60 mm. focal length; the objective consists of 3 lenses which are respectively hemispherical of $1\frac{1}{2}$ mm. radius,

* Centralbl. f. Bacteriol. u. Parasitenk., i. (1887) pp. 401–2 (2 figs.).
† Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 461–4 (1 fig.).
‡ Bull. Soc. Min. de France, viii. (1885) pp. 29–31, 377–83.

3 mm. thick with 5 mm. radius, 2 mm. thick with 12 mm. radius. The polarizer need not have a field of more than 20°. For sections of from 0·1–0·01 mm. thickness a fourth lens of 13 mm. diameter and 4·5 mm. focal length is added to the objective, and to obviate the difficulty of mounting very small fragments of crystals for the measurement of the axial angle, this fourth lens, together with the eye-piece and analyser, is made to turn about an axis perpendicular to the axis of the Microscope, and passing through the section, the angle of rotation being measurable.

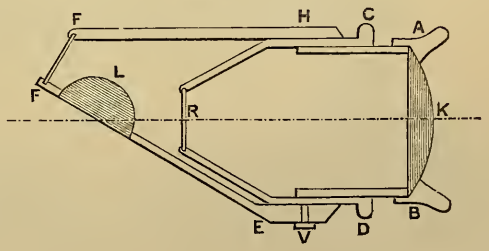
In making the measurement the whole body-tube is depressed until the objective is in contact with the section in the immersion liquid; adjustment to a satisfactory part of the section is then made by the eye-piece tube, and the upper part of the tube is raised until the interference curves are seen; the angle is then measured by rotation about the axis mentioned above. Since a certain rotation of the upper part of the tube corresponds to the angle of total reflection, this disposition of the instrument renders it possible to measure the index of refraction at the same time.

On the same principle M. Bertrand has constructed a new refractometer for rock sections.* The rotation of the upper part of the tube is here replaced by a rotation of the hemispherical lens, which is now fixed to the axis of a small goniometer, carried by a separate pillar mounted on the Microscope-stand. The objective of the Microscope consists of an achromatic lens of 30 mm. focal length, and above it is a diaphragm with a slit 1/4–1/2 mm. in breadth, and 3 mm. in length, parallel to the axis of the goniometer.

The section together with the polarizer is kept in contact with the hemispherical lens by a spring. When the limit of total reflection is reached by a rotation of the goniometer axis, the upper part of the section is bright and the lower part dark, so that the boundary line may be adjusted to the cross wire. The section is illuminated from above by means of a hole in a screen which allows the light to fall only upon the mineral under examination. When the instrument is carefully adjusted, this method will give the refractive index correct to 2 or 3 units in the third decimal place.

Bertrand's Refractometer.†—This instrument, designed by M. E. Bertrand, may be used for solids or liquids, and gives the index correct to two places of decimals by a single reading.

Fig. 111.



A B, fig. 111, is the eye-piece carrying a lens of crown glass of 4 cm. focus; it slides in the tube C D which is conical at the further end, and is provided with a reticule R consisting of a glass disc 8 mm. in diameter engraved with 80 divisions, 1/10 mm. apart and numbered by tens. C D slides in the tube E F F H, the lower face of which is an elliptical section, making an angle of 30° with the axis, and carrying the hemispherical flint-glass lens L of 5 mm. radius fixed in a copper disc. The plane surface of this lens faces outwards, and its centre is in the axis

* Bull. Soc. Min. de France, viii. (1885) pp. 426–8, and ix. (1886) pp. 15–21.

† Op. cit., viii. (1885) pp. 375–7. Cf. Le Génie Civil, and Eng. Mech., xliii. (1886) p. 453 (1 fig.).

of the instrument. F F is a small aperture filled with ground glass which admits light, and V is a screw to fix the tube C D when it is so adjusted that R is at the focus of the lens.

To find the index of a liquid, a drop is placed upon the plane surface of L; of the rays refracted through L, those which have an angle of incidence greater than the critical angle are totally reflected at the surface of the liquid, and illuminate the lower portion of the reticule; the upper part remains dark, and the position of the boundary line depends upon the critical angle, and, therefore, upon the index; if then the value of the graduations is known, the index is read directly from the position of this line upon the scale.

For solids, a polished plane surface is placed against the lens, a liquid of higher index having been interposed between them, two boundary lines are then seen, one of which belongs to the liquid, and the other to the solid; the latter gives the required index directly.

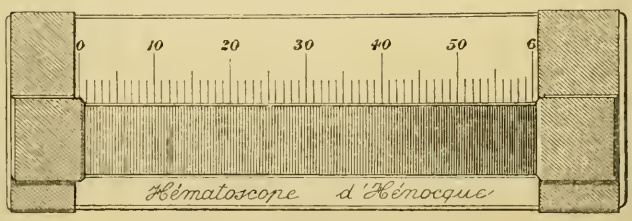
M. Bertrand uses as an immersion liquid, with substances of high refractive index, dibromated naphthyl-phenylacetone, to which a few drops of bromated naphthalene have been added.

The instrument is graduated by determining the position of the boundary line for different solids and liquids of known refractive index.

Hæmatoscopy.* — M. Hénocque under this name indicates a new spectroscopic method of analysing the blood. This method comprises two modes of observation: 1st, the determination of the quantity of oxyhæmoglobin by instruments called *hæmatoscopes* and *hæmatospectroscopes;* 2nd, an estimation of the time of reduction of the oxyhæmoglobin by spectroscopic examination through the thumb-nail. The ratio of these serves to measure the activity of the reduction.

In the estimation of the quantity of active colouring matter by the hæmatoscope an apparatus is used (fig. 112) which consists of two super-

Fig. 112.



posed plates of glass which are in contact at one end and are separated by an interval of 0·03 mm. at the other; a few drops of undiluted blood inserted between the plates form a layer of gradually increasing thickness and intensity of colour, and the thickness is measured by a millimetric scale engraved on the glass. The amount of colouring matter is estimated by observing the point of the scale at which the two characteristic bands of oxyhæmoglobin appear equally dark in a direct vision spectroscope. For example, blood containing 14 per cent. of oxyhæmoglobin examined by daylight will give two bands of equal darkness with a thickness of 0·07 mm., the bands are also of equal breadth and occupy the spaces 530 to 550 and 570 to 590 in the spectrum measured in wave-lengths; the percentages of oxyhæmoglobin corresponding to different points of the scale are given by a comparative table.

* Comptes Rendus, ciii. (1886) pp. 817–20 (3 figs.).

On looking through the thumb-nail with a direct-vision spectroscope the first characteristic band is seen, sometimes accompanied by the second. When a ligature is made round the joint the bands disappear, the yellow at the border of the ray D then slowly reappears, and finally the bands disappear entirely; the time occupied is the *time of reduction*, and varies between 25 and 90 seconds, the normal time being about 60 seconds in health and in a state of rest; it is connected with the quantity of oxyhæmoglobin and the rapidity of exchange between the blood and the tissues.

Fig. 113 represents a hæmatospectroscope with the lateral movements which are required to study the phenomenon of the two bands; it is provided with a micrometric scale divided in wave-lengths. Fig. 114 is a

Fig. 113.

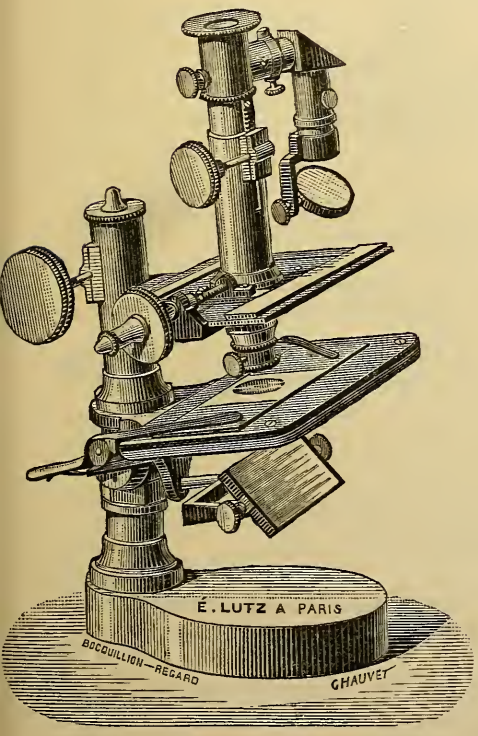
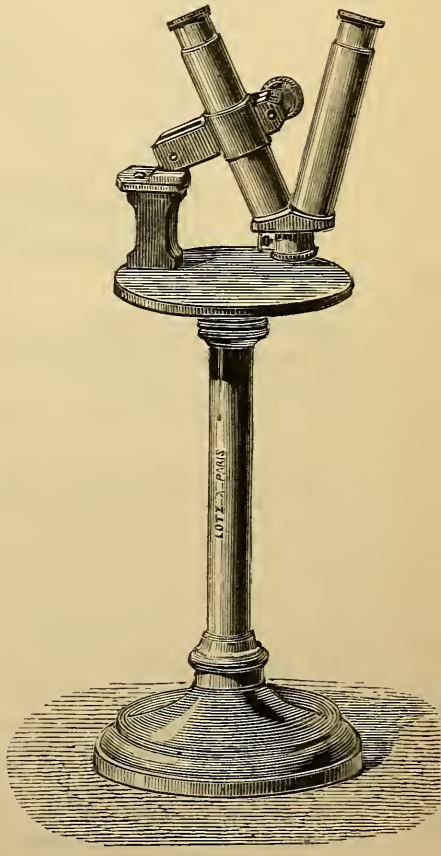


Fig. 114.

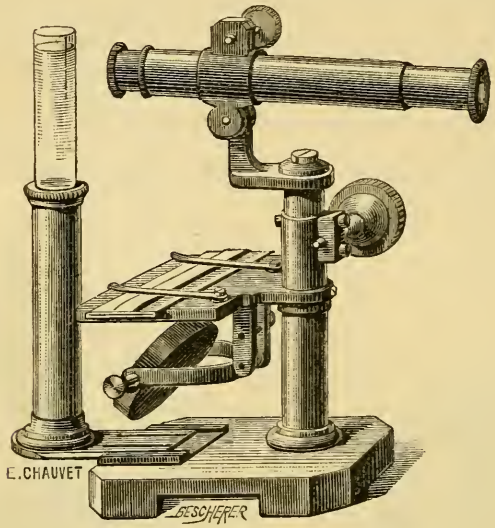


double hæmatospectroscope with a single slit by which two persons can observe the same phenomena simultaneously. The form shown in fig. 115 allows the spectroscope to be placed horizontally.

Experiment having shown that in the normal condition when the blood contains 14 per cent. of oxyhæmoglobin the mean time of reduction is

66 seconds, it may be assumed that the quantity reduced in one second is 0·20 per cent. If this quantity be taken as the unit of activity of reduc-

Fig. 115.



tion, then the following formula gives the activity corresponding to any values of the time of reduction and quantity of oxyhæmoglobin determined by the above methods.

$$\text{Activity of reduction } \epsilon = \frac{\text{quantity of oxyhæmoglobin}}{\text{time of reduction}} \times 5.$$

Hayem's Chromometer.—Prof. G. Hayem's apparatus for measuring the quantity of hæmoglobin in the blood consists of two cells arranged on

Fig. 116.

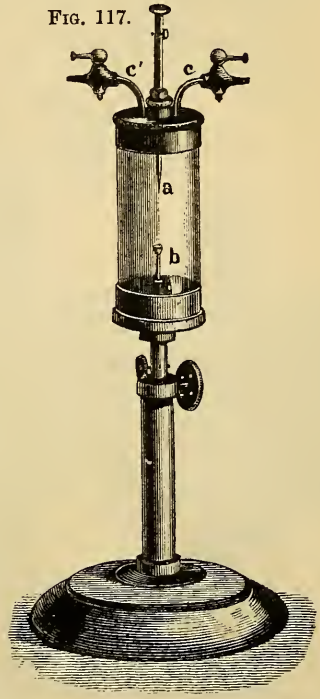
a slide as in fig. 116, one of which is filled with dilute blood and the other with pure water, the slide being placed on a standard colour for comparison.

Spectrum Analysis in Micro-Mineralogy.*—Dr. K. de Kroustchoff believes that he has found a method which, by the aid of spectrum analysis, will allow quantities that are unrecognizable by ordinary means to be easily identified. For this purpose he uses an apparatus which consists of a glass cylinder closed at both ends by a brass cap. In the upper cap is a stuffing-box, through which a brass rod, with a platinum point for an electrode *a*, plays up and down. Through the upper cap also pass two brass tubes,

* Bull. Soc. Mineral. France, vii. (1884) pp. 243–9 (1 pl.).

fitted with taps *c* and *c'*. The lower cap is also provided with a brass rod, upon which, by means of a screw, can be fastened bits of metal or carbon, *b*. This is the second electrode. The small cones of birch-wood charcoal are freed as far as possible from foreign bodies by prolonged treatment with acids and alkalis, followed by prolonged boiling. The carbons can now be used in various ways. If liquid, the carbons are soaked therein. Other matter is first heated in a platinum vessel with dry chlorine gas. The gas with chlorides is then passed through a tube containing some carbons, which become impregnated by the substances. Combinations other than chlorides are deposited on the walls of the tube; these are placed in a hole in the carbon, or in small platinum or aluminium cups soldered to *b*.

Fig. 117.



When the substance to be examined is arranged in the apparatus, the latter is filled with dry hydrogen, and the electrodes united with the poles of a battery. When the current is closed the spectrum is observed.

By this method a thin microlith, 0·02 mm. by 0·001 mm., observed in a piece of Podolsk quartz, was found to consist of aluminium, beryl, and silicon; consequently the microlith was beryl.

Copper.—**Achromatic Condensers.** *Engl. Mech.*, XLV. (1887) p. 300.

Gill, R.—**Camera Lucida.**
[Describes one made of a cover-glass, and costing the fraction of a penny.]
Sci.-Gossip, 1887, p. 116.

Leach, W.—**The Lantern Microscope.**
[Describes his arrangements for illumination.]
Engl. Mech., XLV. (1887) pp. 50–1.

Terry, W. A.—**Notes on Diatom Study.**
[Varnish cell 1/100 in. thick for studying motions of diatoms.]
Amer. Mon. Micr. Journ., VIII. (1887) pp. 44–6.

Trœster, C.—**Hilfsvorrichtung für das Mikroskopiren bei Lampenlicht.** (Contrivance for use with the Microscope by lamplight.)
[Plate of blue-tinted glass, one side of which is dull, placed in the aperture of the stage so that the mirror and condenser form an image of the lamp-flame upon the dull surface. This will be found to obviate the two chief objections to the use of lamplight, namely, the colour, and the parallelism of the rays which gives rise to interference phenomena.]
Zeitschr. f. Instrumentenk., VII. (1887) p. 65.

(4) Photomicrography.

Photographic Apparatus for the Microscope.—The introduction of dry plates has given such an impetus to photomicrography, that in the course of last year we commenced to collect the illustrations for an extended notice of the various forms of photomicrographic apparatus. On reviewing them, however, we fear that many have now scarcely more than an historical

interest, and we have therefore made a limited selection (hardly more than a quarter!) which may serve to give a few hints to any who desire to contrive any variations on the forms hitherto in use.

I. Of those which have now a purely historical interest only, are Prof. *J. Gerlach's* * (fig. 118) and *Möller and Emmerich's* † (fig. 119). These require no description.

Fig. 118.

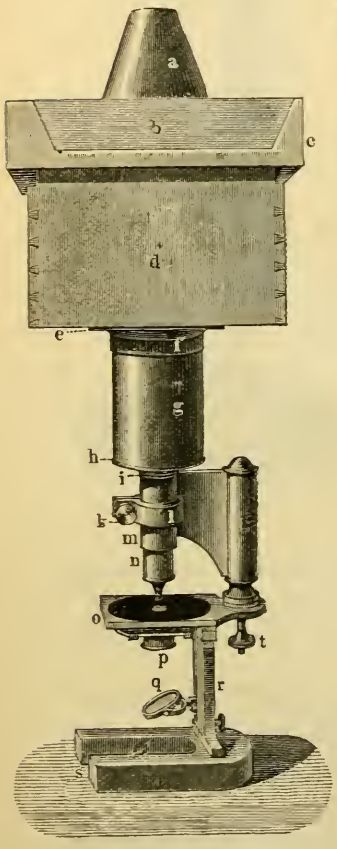
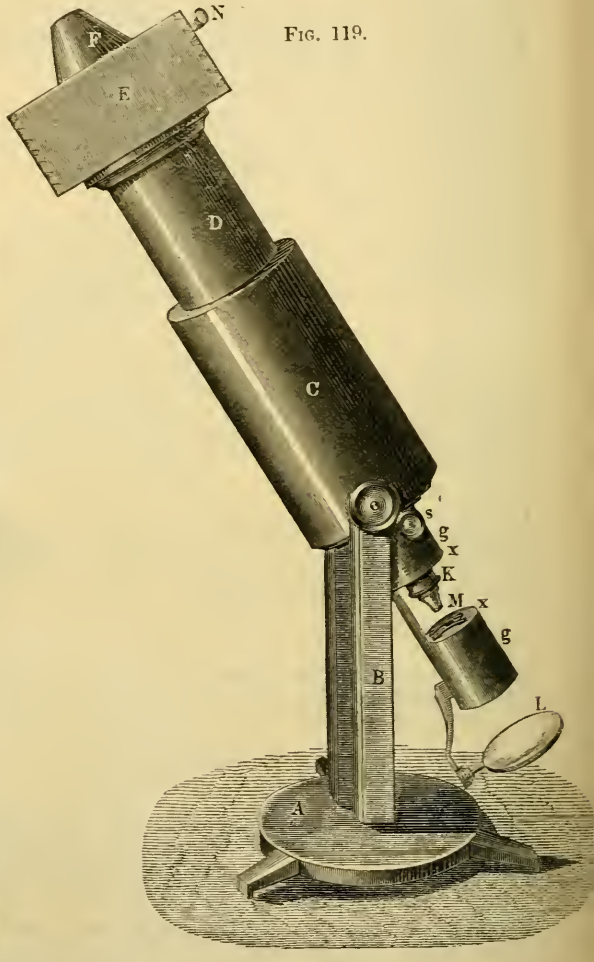


Fig. 119.



Nearly the same remarks apply to the complicated arrangements of *Dr. B. Benecke* ‡ (figs. 120 and 121) intended for use with the highest powers.

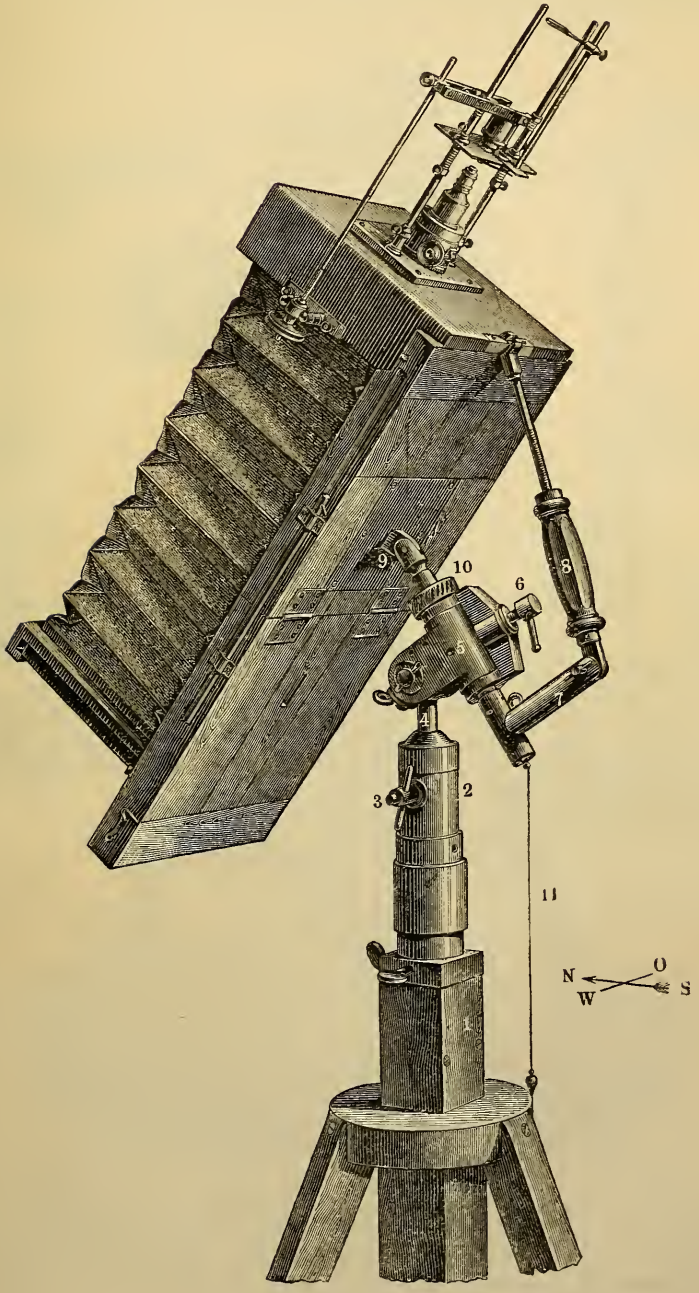
Fig. 120 shows the camera as mounted on a stand for use with direct sunlight and without any mirror. The stand is so contrived that when once

* 'Die Photographie als Hülfsmittel mikroskopischer Forschung,' 1863, viii. and 86 pp., 9 figs. and 4 pls. of photomicrographs.

† Cf. Dippel's 'Das Mikroskop,' 1867, p. 211–3 (2 figs.).

‡ 'Die Photographie als Hilfsmittel mikroskopischer Forschung (nach dem Französisch von Dr. A. Moitessier),' 1868, xiv. and 265 pp., 88 figs. and 2 pls. of photomicrographs.

FIG. 120.



then screwed up and the gas-jet placed at the end of the heating tube. As the water gets warm its excess escapes from the tube through which it was introduced. In about one hour to an hour and a half, when the thermometer marks 36° to 38° C., the tube is closed with the caoutchouc plug. As the water gets hotter it mounts in the glass tube and causes a pressure on the caoutchouc membrane of the regulator, and this lowers the flame by diminishing the current of gas supplied. If the temperature lowers the water descends and the gas is supplied more freely. Should the apparatus have been regulated for too high a temperature some water is introduced into the tube by means of a fine pipette, and *per contra* some is withdrawn by removing the caoutchouc plug if the temperature has been regulated too low. It is stated that the regularity of this hot stage is such that even under unfavourable conditions it does not vary more than a few tenths of a degree.

Julien's Immersion Heating Apparatus.*—Dr. A. A. Julien's "immersion apparatus" was devised for the special purpose of exactly determining the temperature of expansion of the liquid in the fluid cavities of minerals. He considers that most of the forms hitherto devised are "extremely inaccurate, often complex and untrustworthy, and it may be owing to this cause that Brewster obtained, for the critical temperature of the liquids in quartz, results of the very wide range between 20° and 51° C."

The author in a previous paper thus expressed himself on the subject. "The objection to all these forms of apparatus lies in their irregular application of heat, and its irregular and indefinite loss from currents in the surrounding atmosphere, and from the refrigerating effect of the mass of metal in the stage, and also in the objective, in an amount proportionate to its close approximation, i. e. to its focal distance or high power. Even in the most pretentious apparatus, that of Vogelsang, its inventor admits a variation or error of 10° C., according to the objective employed; from a No. 4 Hartnack of 3 mm. focal distance to a No. 9 of 0·1 mm. Vogelsang suggested the reduction of observations made by means of high-power objectives to the standard of the No. 4, and was even forced to make a plus correction of 1° C. for observations in which the temperature of the air of the room and of the Microscope fell below his normal (20° C.) as far as 12° to 15°. Practically, in use these observations are consequently made almost altogether on large cavities and under low-power objectives, and an accuracy to 1° C. has been accepted as satisfactory. Although wide discrepancies have constantly occurred, even in determinations on the fluid cavities in the same slice of mineral by means of these devices, on the other hand some of the most delicate and important investigations, such as those of Sorby and King on the indication of the degrees of pressure to which certain granites have been subjected during folding and metamorphism, have rested largely upon the accuracy of determinations of this very kind." †

Brewster, Sorby, and Hartley have used the same principle as the author, Hartley adopting the plan of immersing the slide in water of known temperature, removing, wiping it hastily, placing it on the stage, and instantly examining it ‡ Far more accurate results with greater convenience can, however, be obtained by means of an apparatus permitting the slide to remain under observation, immersed in a layer of water on the stage, and continuously warmed by a current of air from the breath of the observer, or, if necessary, by the conduction of heat to the bottom of the

* Journ. N. York Micr. Soc., i. (1885) pp. 137-9. See also this Journal, 1882, p. 266.
† Amer. Mon. Micr. Journ. v. (1884) pp. 189-90.
‡ Journ. Chem. Soc. London, 1876, p. 139.

vessel from a small flame at the side of the stage. By this means an accurate determination of the actual temperature at which a fluid inclusion expands into a gaseous state may be obtained in a few minutes to 0·05 C°.

The simplest form of the apparatus consists of three parts, as follows :—

1. A shallow glass tank, such as may be cut off the bottom of a chemical beaker, of sufficient diameter for the slide to lie within it, just immersed in a thin layer of water, but separated from the bottom by two little blocks of rubber or glass. This tank is placed upon the stage.

2. A chemical thermometer of sufficient delicacy, with a short bulb, or with a long bulb bent at a right angle. This is inserted in the tank, as nearly upright as possible, and the depth of the water is made just enough to cover the bulb. The length of the scale should be such as to bring the degrees between 27° and 32° near the level of the observer's eye when it is at the eye-piece, to facilitate immediate observation without the delay caused by moving the head.

3. A piece of small rubber tubing tied to the body of the stand, with the upper end inserted in the observer's mouth, and with the lower end, which terminates in a short piece of glass tubing drawn to a fine aperture, lying in the water on the bottom of the tank.

An immersion objective may be employed or, if the cavity be large, any objective of lower power may be used, with its front immersed in the water. After the cavity has been brought into sharp focus, a steady but gentle stream of air is blown through the tube, the immersion of the objective preventing interference from the waves on the surface of the agitated water. The cavity is continuously observed, as the bath and the immersed thin section are gradually warmed by the current of the observer's breath, and when the critical point is reached and the liquid contents of the cavity suddenly disappear, a quick observation of the thermometer is made.

Again, as the bath cools—which process may in hot weather be hastened by adding carefully a few drops of cool water, with continual agitation by the air current—the original bubble may be observed to leap back into view, and a second observation of the thermometer is taken as a check to the first.

If a higher temperature be required for other uses of this apparatus, oil or other liquid may be substituted for the water in the bath, and it may be heated by conduction from a taper or lamp burning by the side of the stage, through a stiff slip of copper introduced beneath the glass tank. A small hole, for observation, through this copper slip should be placed immediately over the centre of the aperture of the stage. The apparatus may be further protected from radiation of heat, and more uniform results ensured, by inclosing the tank in a ring of pasteboard or sheet cork, and by inserting plates of cork between the copper plate and the stage.

Unequal Heating of Crystal Sections.*—Dr. W. Klein, for studying the alterations of optical characters in crystals, produced by unequal heating, suggests the use of a plate of copper, resting upon one side of the crystal, the other end of the plate being heated in a spirit-lamp. To accelerate the process, and to obtain the means of rotating the section during heating, it is better to use a pair of copper forceps attached to a wooden ring, so that the points of the forceps in which the section is held come exactly into the centre of the ring; between the ring and the forceps is a layer of asbestos. The whole is laid upon the stage, and the projecting end of the forceps heated by a spirit-lamp. By this method the crystal is heated on one side on both the upper and lower surfaces.

* Zeitschr. f. Krystallogr. u. Mineral., ix. (1884) pp. 38–72.

Fig. 126.

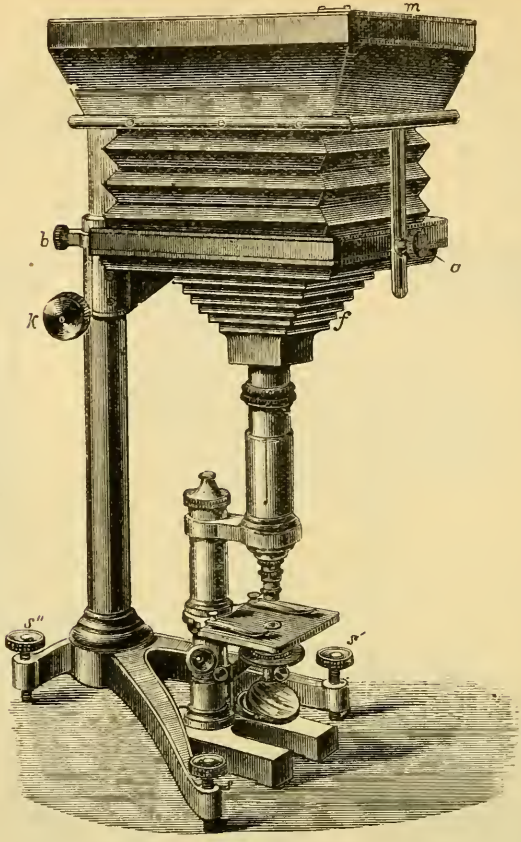
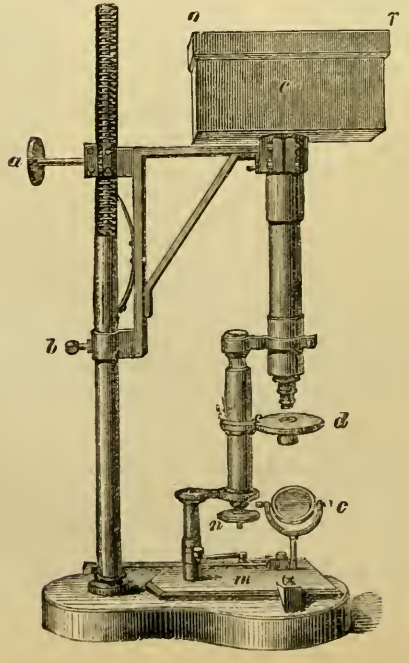


Fig. 127.



Prof. A. Girard's Photomicrographic Camera as made by M. Nachet (fig. 128) allows of the observer remaining seated and conducting all the

Fig. 128.

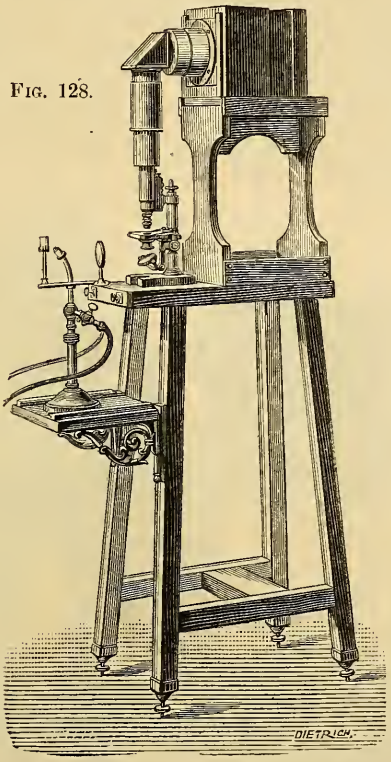
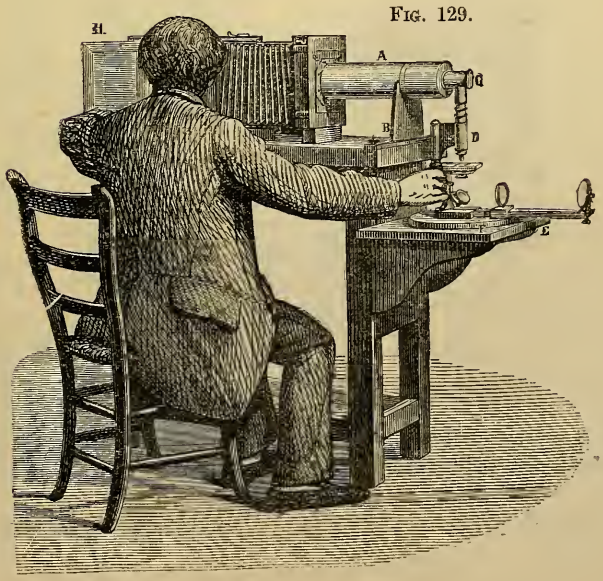


Fig. 129.



necessary manipulations at the length of the arm, and with a vertical Microscope. Focusing, adjustment of illumination, &c., can be done with the hand without moving from the seat, and without having to leave the image. This is accomplished by placing at the end of the tube of the camera a plane silvered mirror at an angle of 45°, which receives the rays from the Microscope and deflects them into the camera. Any Microscope can be used. The stand has a bracket for an oxyhydrogen or electric lamp.

Dr. A. Moitessier earlier described * a somewhat similar arrangement which took the form shown in fig. 129. It has the side door for focusing described in this Journal, 1886, p. 841.

Fig. 130.

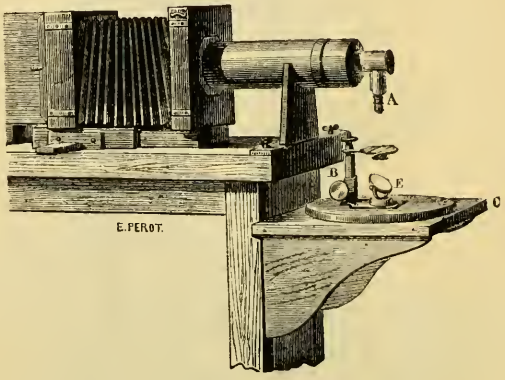
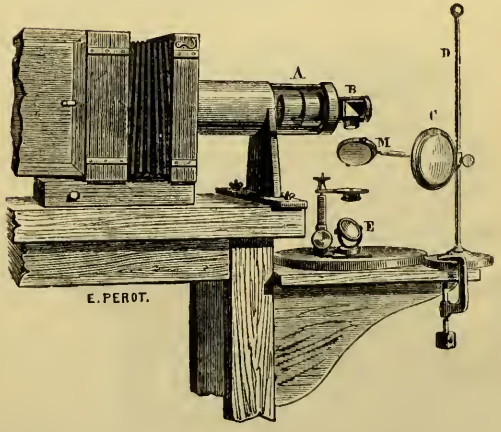


Fig. 131.



The latter form is also readily adapted for cases where small (fig. 130), or very small (fig. 131), enlargements (3-5) are required.† In the latter

* Op. cit., p. 131.

† Ibid., pp. 136 and 138.

case a photographic objective is placed behind the prisms. The adjustment for focus is made by moving the stage. These forms are specially suitable for opaque objects.

In *Nachet's* photomicrographic camera (figs. 132 and 133), M. A. Nachet has provided for its use either in a vertical, inclined, or horizontal position. This is accomplished by attaching it to two upright supports which can be

Fig. 132.

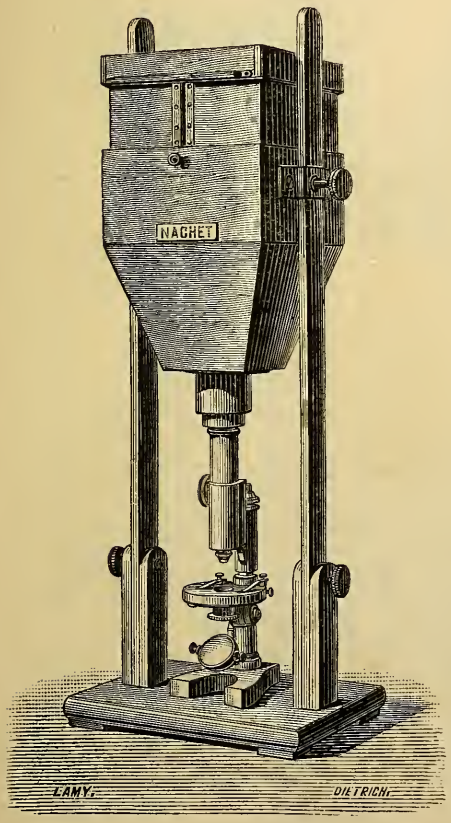
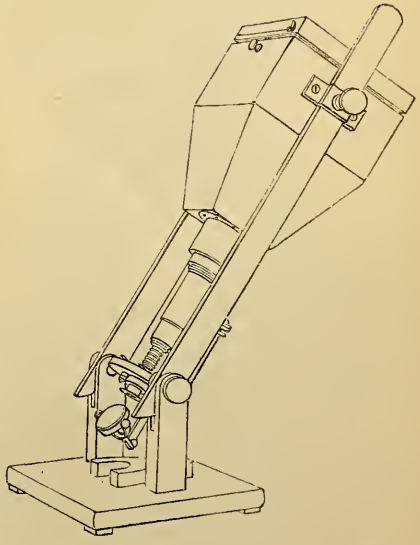


Fig. 133.



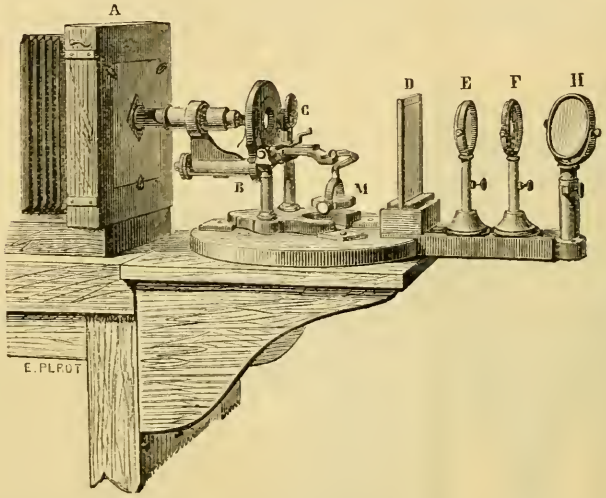
inclined on two short pillars fixed to the wooden base on which the Microscope is placed. The camera is also arranged to slide on the supports so that it can be raised or lowered, and set at different heights. Adapter-tubes of special construction are applied to the body-tube to connect it with the camera, which are so arranged that the focal adjustments of the Microscope are made independent of the adjustment of the camera, and at the same time no extraneous light is allowed to enter at the connection.

III. *Cameras for Horizontal Microscopes.*—Of these there are an endless number :—*Moitessier's* * (fig. 134) makes use of an ordinary Microscope.

* Op. cit., p. 134.

In *Reichert's* apparatus (fig. 135) the camera C slides on a base-board between guides *a* and *b*, a graduated scale and index *z* recording the position. It can be levelled by screws *s* at one end. The lengthening-piece Z is removable when the camera is required to be brought nearer to the Micro-

Fig. 134.



scope. The ground glass is moved by rack and pinion T, or for fine-adjustment by *m*.

The Microscope D is connected with the camera by a light-proof connection at K, and is fastened to the base by a screw at F. The fine-adjustment screw head E is toothed, and is turned by a larger toothed wheel *u* which is actuated by the prism *g* at the end of the rod *Sp*. The other end of the rod reaches to *k* where it is turned by the milled head *h*.

For illumination by transmitted light a mirror P and condensing lens L slide in the groove *l*. There is also a holder B for holding fluids, either for controlling the illumination or for stopping the heat rays. For opaque objects there is a second mirror H on a support *r*.

Seibert's (fig. 136) and *Vérick's* (fig. 137) have each special arrangements for focusing. In the original form of the former the screw head had teeth cut in it in which a toothed wheel worked, the wheel being actuated by a double-jointed rod. This is now modified, as shown in the fig., a system of pulleys and cords being used. In the latter there is a rod and one pulley, the head of the fine-adjustment screw being also grooved to receive the cord.

For photomicrography *Dr. Zeiss* modifies his No. 1 stand as shown in fig. 138. The chief differences are that the body is shorter and of greater diameter, so as to interfere as little as possible with the cone of rays transmitted by the objective, and that there is an extra large (140 × 120 mm.) mechanical stage with circular and rectangular motions. The draw-tube is also tapped at its lower end with the ordinary objective thread, to receive when required a photographic correcting lens, to correct the objective for a picture 1 to 1½ metres distant. The stage and body-tube are fixed and do not revolve round the optic axis.

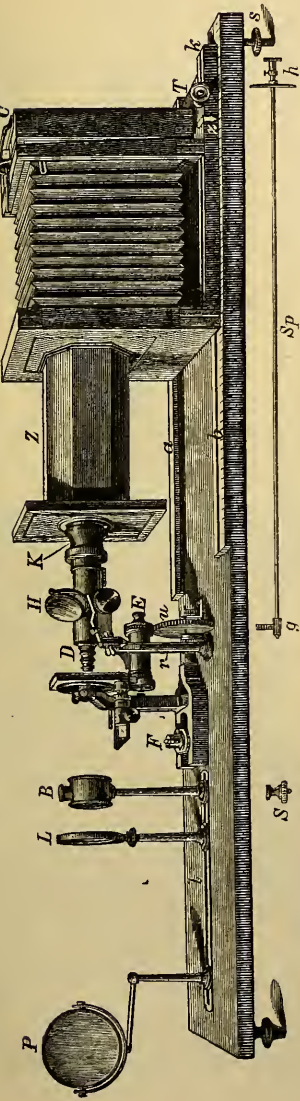


Fig. 135.

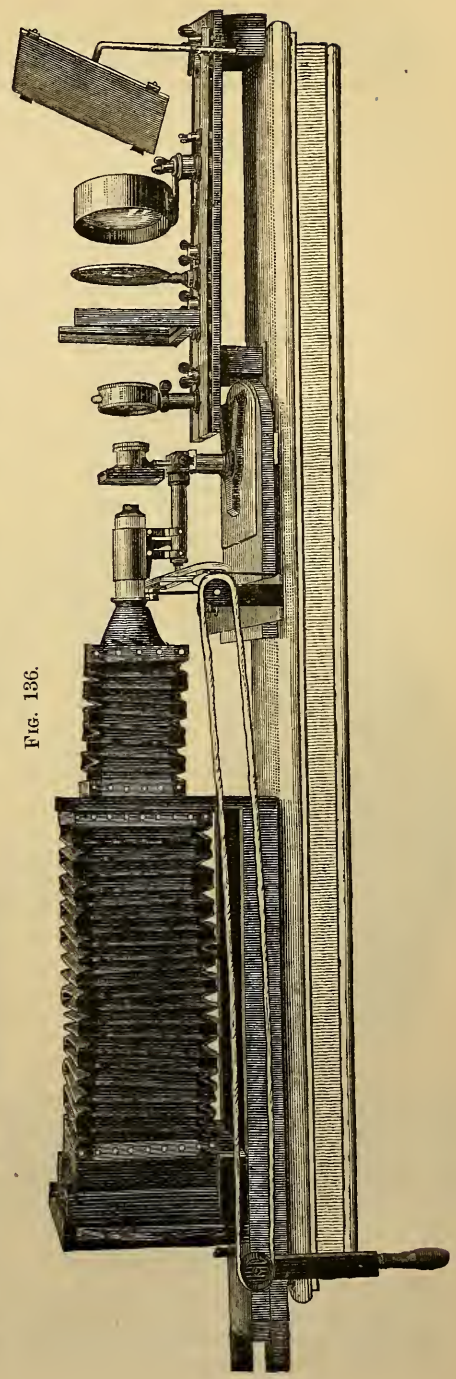


Fig. 136.

The larger form of camera is shown in fig. 138. It consists of an ordinary mahogany photographic camera of medium size, with extending arrangement, lengthening to about one metre, the amount of extension being registered on a scale on the lower part of the camera. There are two

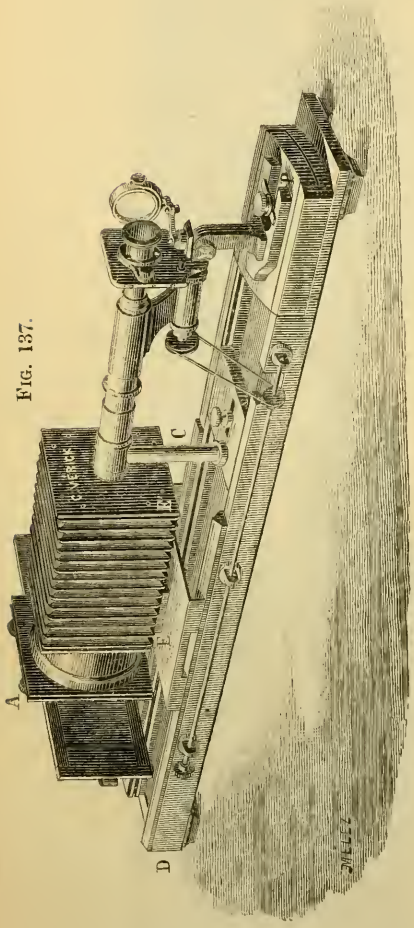


Fig. 137.

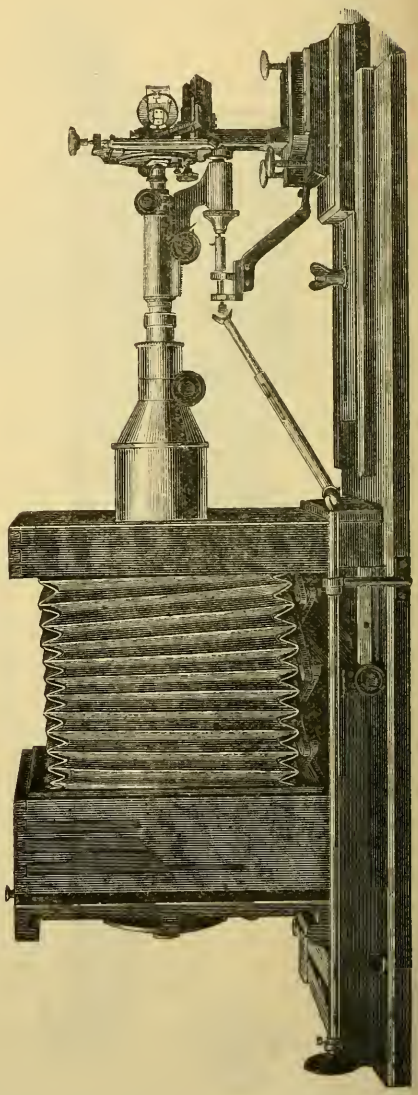


Fig. 138.

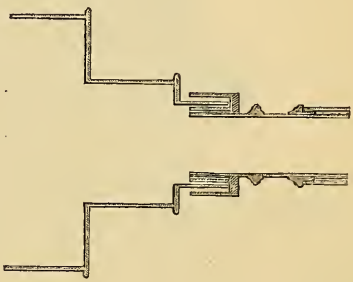
slides for plates, 23 cm. square, with wooden frames for plates of smaller dimensions.

The camera is fastened to a strong wooden base which also carries the Microscope, the fine-adjustment being worked by a long Hooke's joint. The Microscope does not stand directly on the wooden base, but on a heavy

metal plate on a wooden support. The former allows the axis of the Microscope to be brought into line with that of the camera by moving it laterally by hand; it is also adjustable by three screws. The wooden support can be freely moved to and from the camera, between guides on the base.

The end of the camera which is turned to the Microscope has a long brass nozzle, blackened inside, which carries a brass jacket moved by rack and pinion. This jacket is inserted into a double cap fitting on the end of the body-tube as shown in fig. 139. A connection between the camera and the Microscope is thus made which is impervious to light.

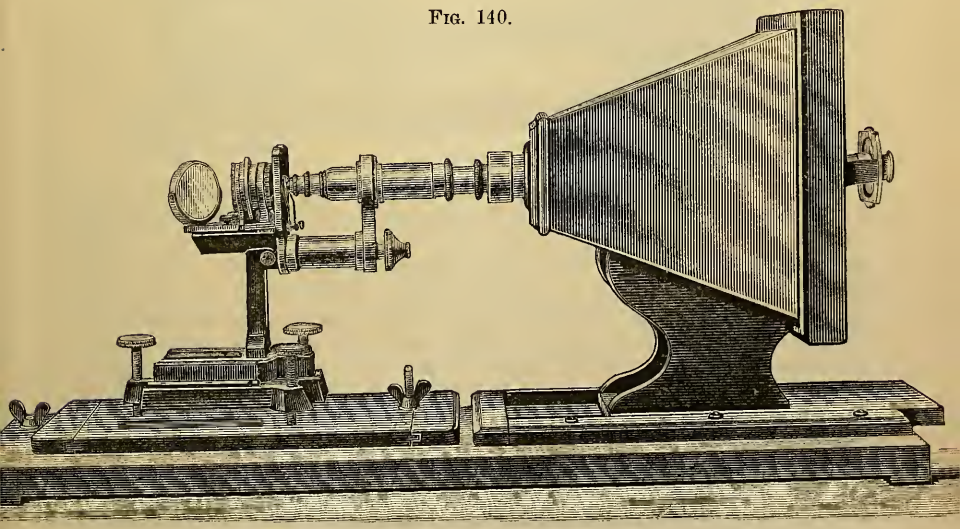
Fig. 139.



For fine-adjustment of the image after a rough focus on the ordinary ground glass, the latter is replaced by a frame with a disc of transparent plate glass having a cross cut with a diamond in its centre. A low power lens is focused on this mark and moved over the plate by a carrier, and the vaguely adjusted picture is then accurately focused.

In the smaller form of camera shown in fig. 140, there is a funnel-shaped non-extending camera which is intended for use with an eye-piece, as without it only small pictures can be obtained; the camera is movable between guides upon the wooden base. The plate-holders are 18 cm. square.

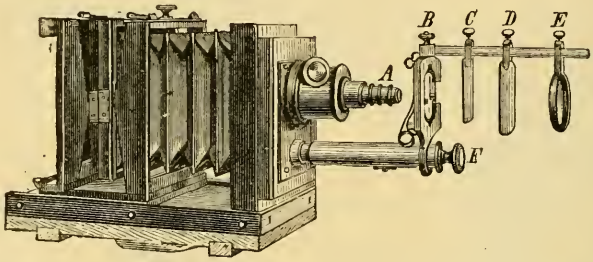
Fig. 140.



For a lamp is used the Siemens gas-burner on an adjustable brass stand and glass globe, described in this Journal, 1886, p. 515; the lamp is said to give an "excellent bright and white light which almost completely supplies the place of good daylight."

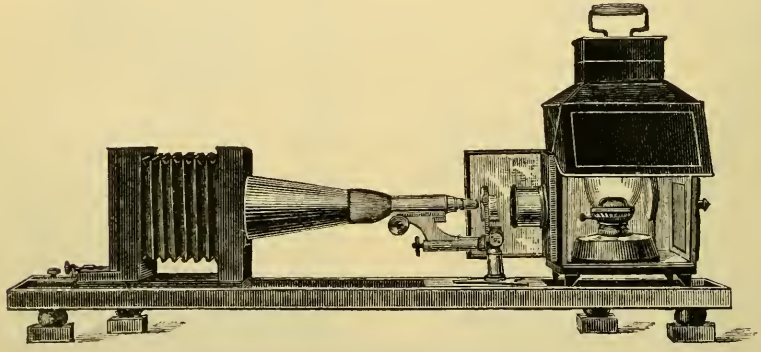
Klönne and Müller attach a standard in front of the camera carrying a stage B which is moved to and from the objective A by the fine-adjustment screw F. The stage has a rod for glass diaphragms C, D, and bull's-eye E.

Fig. 141.



Mr. J. Carbutt combines the camera and Microscope with a lantern in the manner shown in fig. 142.

Fig. 142.

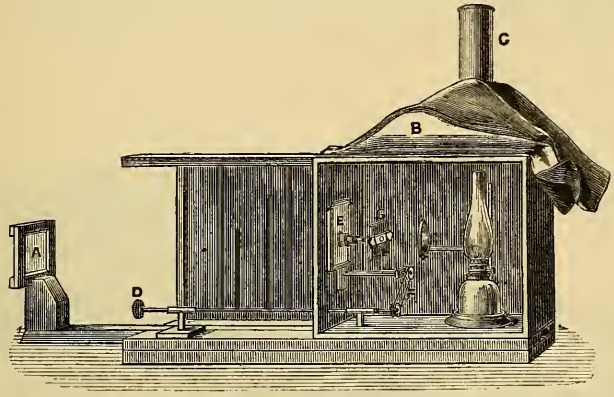


Mr. T. Charters White describes a "simple method of photographing biological subjects without using a Microscope."* The apparatus (fig. 143) consists of an oblong lidless box, laid on its side, and securely screwed to one end of a base-board 2 in. in thickness and 2½ ft. in length. The upper central part of this base-board, about 1 in. in thickness, is made to slide in a dovetailed groove. The end of this sliding part carries the holders A for the plates employed, the holder being an ordinary photographic printing frame. The size of the holder is varied according to the amplification required, and by means of this sliding holder the magnification can be diminished or greatly extended as may be desired. The upper side of the box has an oblong opening cut in it over which a tin chimney C is fixed, thus allowing the lamp to approach or recede from the stage G as may be desirable. Another opening is made in that side of the box which faces the plate-holder, and central with it; this opening is closed by a movable brass plate E, having an adapter with the Society screw soldered into it. Below this plate a support carrying the movable stage is fixed to the side of the box, the stage being moved backwards and forwards by the focusing arrangement D, F. The light is derived from a lamp, burning the purest

* Sep. repr. from Journ. Brit. Dental Assoc., Oct. 1886, 8 pp. and 1 fig.

paraffin oil, in which is dissolved a lump of camphor of the size of a walnut to the ordinary reservoirful; this whitens the flame and renders it more actinic. A plano-convex lens, with the convex side towards the

Fig. 143.

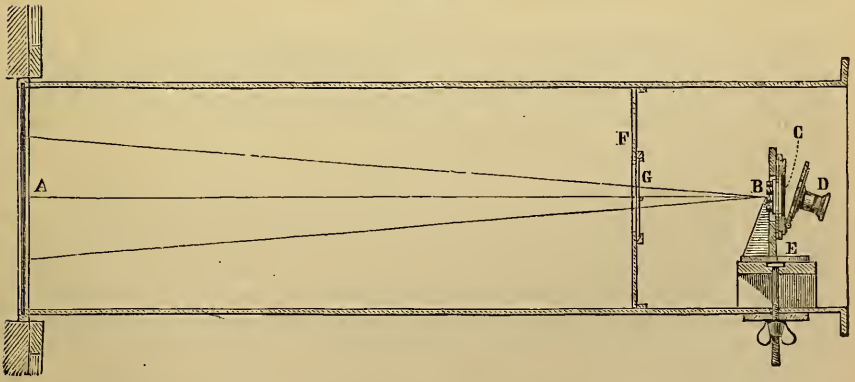


flame, concentrates the light on the object. A curtain of black velvet B falls over the front of the box, shutting all light in, and a shutter cuts off the rays coming through the objective till all is ready for them to fall on the sensitive plate.

Dagron's Microphotographic Apparatus.*—M. Dagron's apparatus for producing microscopic photographs (first used for pigeon despatches during the Franco-German war) is shown in figs. 144 and 145).

It consists of a long rectangular chamber closed at A by ground glass which is brightly illuminated from outside and on the inside of which is

Fig. 144.

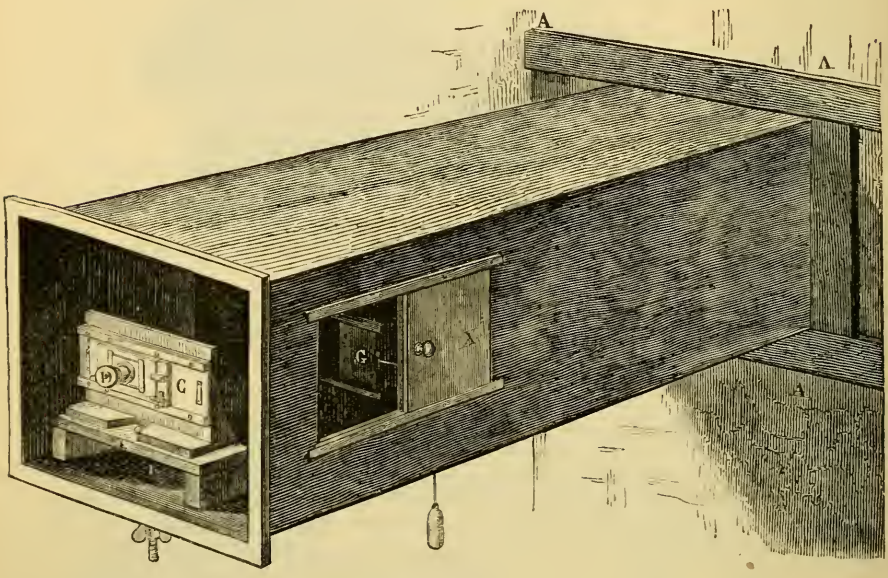


a clamp to hold the negative to be reduced. At the other end of the chamber is the photographic apparatus. At B is a set of 20 microscopic objectives arranged in rows of five, which project images upon a very finely

* S. T. Stein, 'Das Mikroskop und die mikrographische Technik zum Zwecke photographischer Darstellung,' 1884, pp. 315-20 (3 figs.).

ground focusing screen provided with rectangular micrometric divisions; in each of which appears one of the twenty images. At D is hinged a small strongly magnifying Microscope by which the images may be focused, the whole being adjusted by a screw clamp at E. At about a quarter of the length of the chamber from B is a plate F with an opening closed by the sliding screen G held by a counterweight, so that when drawn aside it immediately returns, admitting an instantaneous flash of

Fig. 145.



light. The sensitive plate C receives twenty images at a time and in this way, by five consecutive exposures on adjacent parts, a hundred minute photographs may with ease be taken upon a plate measuring 2 cm. by 15 cm. A lateral opening closed by the sliding door X allows the operator's hand to be passed into the box.

Bousfield's 'Guide to the Science of Photo-micrography.'*—To those who for many years have watched the progress of photomicrography, and who must have often seen brought forward, as novelties and advantages, devices that were adopted years since, it will be very satisfactory to find in Dr. E. C. Bousfield's *brochure* not only a trustworthy guide to the gelatino-bromide process which has been selected, but a real advance in the endeavour to set the principles of the most difficult portion of the subject upon a scientific basis.

The rapid spread of photomicrography amongst microscopists is, doubtless, largely due to the facilities furnished by the use of the dry gelatino-bromide plates, and their sensitiveness to the rays from ordinary artificial

* Bousfield, E. C., 'A Guide to the Science of Photo-micrography; containing Exposure-tables and rules for working,' 69 pp. and Table, 8vo, London, 1887.

light, which enables the microscopist, without very much trouble, to secure at any moment a photomicrograph of the object he is examining, and with only a few minutes' delay; while formerly it was almost necessary to utilize sunlight either with or without an equatorially mounted prism, or some form of heliostat, or the solar Microscope; for the magnesium, oxyhydrogen, and electric lights, though so useful, never obtained more than a temporary claim. Looking to the quality of the results, possibly the palm would be granted to the wet collodion process, as gelatino-bromide negatives often show a fine granulation, absent in the collodion or albumen film, which interferes with enlargement. Still the advantages for general work lie with the dry bromide plate, which is the process the author adopts. All who have endeavoured to obtain the best results with the gelatino-bromide plates have from their great sensitiveness found a difficulty both in the time of exposure and the mode of illumination, and it is to both of these that the author devotes considerable attention, and introduces a more certain way to regulate the exposure according to the non-actinicity of the object, whether due to thickness or colour, to which may be added the difficulty occasioned by alteration in distance between the object and the screen, from a different manufacture of the plates, and from the use of different objectives of the same power. To meet these difficulties the author has constructed a scale or table by which to regulate the time of exposure under these different circumstances. This table of exposures has been ingeniously founded upon the visibility of the figures on Warnerke's sensitometer under the same illumination, and at the same distance of the screen as the gelatino-bromide plate will be placed at, as one of the terms, and used in conjunction with the known scale of the sensitiveness of the plates, either as stated by the maker, or as tested on trial with the same sensitometer, as the other term. These two terms or readings being known, the third, the time of exposure required in seconds for such a plate to be properly exposed, is indicated in the table up to ten minutes. Examples of the use of the scale are given, and every photomicrographer who wishes to work upon this, the most sure method of exposure yet devised, will heartily thank the author for his effort to supply a deficiency, which even long years of experience could not always obviate without the loss of a plate or two.

Dr. Bousfield rightly lays great stress upon the method of illumination when using a paraffin lamp, and points out the correct way of obtaining a brilliant field, or for securing a dark-ground illumination. It may here be noticed, in connection with this latter method of illumination, that stereoscopic photomicrography is passed over in silence, which we should have been glad to see noticed. Part of a chapter is devoted to the use of "orthochromatic" or "isochromatic" plates, with the use of tinted glass between the bull's-eye and condenser, to produce in the negative actinic contrast between the different parts of the object, *inter se*, and the background, and the author furnishes the following rule, "to use such a coloured screen as reduces the colour of the object to a neutral tint," a table being given of the different colours found most useful, and the number of seconds the time of exposure must be increased.

Many years since, Dr. Maddox, instead of using coloured glasses, employed coloured varnishes applied to the back of the slide, thus getting rid of one reflecting surface, and later he tried the use of a small globe filled with various coloured media and placed between the bull's-eye and substage condenser, but nearer the latter, thus obtaining a further concentration of the light.

The author seems to lean to the use of the eye-piece combined with the

objective, though it is still an open question whether better negatives cannot be produced without its use, for the dangers of absolutely correct centering are very great. He also appears rather to prefer the use of the old term microphotography, but he certainly acted wisely in adhering to what is now the standard and well recognised term which, however imperfect, has been admitted since 1864, if not earlier, although the fatherhood has been made somewhat doubtful by the impossibility of finding any printed record of its first use. It has, however, been so generally accepted by the foremost workers since that time, that no other nomenclature can now take its place. Macrophotography was proposed many years since, but never found favour, for it would rather apply to reasonable enlargements, whether from photomicrographs or ordinary negatives, than to the photographic image produced by the Microscope in the first instance.

The photographic use of the new "Apochromatic" objectives with their accompanying "projection" eye-pieces receives a favourable notice, and theory is certainly in their favour.

There are some points in this manual which are a little dogmatic, and others which may be enlarged upon in future editions with advantage to the beginner. The retention of the ordinary brass photographic mount, the lenses being removed, is very questionable unless the screw rims be perfectly blackened, and then if there be a central diaphragm the field may be too much limited. The attempt to photograph different planes by successive focusing, however perfect the fine-adjustment, is open to question, for the different photographed planes when developed must overlie each other and tend to confusion, except with very simple objects. It has been usual to find the most perfect visual focus of whichever plane gives the truest aspect of the whole, and to photograph that, using a rather slow plate, a low angle objective, full exposure, and slow development well restrained.

Hitchcock, R.—**Photomicrography. IX.**
[Sensitizing the paper, printing, mounting, &c.]
Amer. Mon. Micr. Journ., VIII. (1887) pp. 41–4.

(5) Microscopical Optics and Manipulation.

Magnifying Power of Dioptric Instruments.—M. A. Guébhard * has cleared up the disagreement which appeared to exist between theory and practice in regard to magnifying power.

Magnifying power involves a comparison between the apparent size of an object seen with and without the optical instrument, by apparent size being meant the size of the image on the retina. This is proportional to the visual angle (or its tangent), that is to say, it may be measured by $\frac{h}{d}$ where h is the absolute size of an object and d its distance from the first nodal point of the eye. The apparent size may therefore be increased indefinitely by bringing the object near the eye, until the *punctum proximum* or least distance of distinct vision is reached. Defining then the magnifying power as the ratio of the visual angles under which the object is seen, with and without the instrument respectively, when the conditions are as

* Rev. Scientif., 1883, pp. 804–11 (5 figs.). Transl. by G. Fischer, Central-Ztg. Optik u. Mech., v. (1884) pp. 183–8 (6 figs.), 194–7. Cf. also pp. 217–20 (3 figs.).

favourable as possible, we get $P = \frac{H}{D} : \frac{h}{d}$; H being the size of the image and D its distance from the nodal point. Putting $d = 1$, that is, choosing for unit length the distance of distinct vision of the eye under consideration, we may write $P = \frac{H}{h\,D}$. Now if δ = distance between the second principal plane of the instrument and the nodal point, f = distance between the second principal focus and the second principal plane $\frac{H}{h} = \frac{D+\delta}{f}$. Hence $P = \frac{1}{f}\left(1 + \frac{\delta}{D}\right)$.

This is the formula which in different shapes appears as the expression for the magnifying power; but an unjustifiable limitation is generally imposed upon it by rejecting negative values of δ and D. As a matter of fact δ is generally negative. (Supposing the eye at the left-hand side of the page and looking towards the right, the positive direction is here taken as from left to right, negative from right to left, the nodal point being origin.) If δ and D were always positive P would be increased by increasing δ and diminishing D, i. e. by bringing the eye as close as possible to the eye-piece, so that the image is produced at the *punctum proximum*. The fact that this is not done in practice is generally explained on physiological grounds. The eye is withdrawn from the lens, it is said, so as to avoid the prolonged effort of accommodation. M. Guébhard, on the other hand, maintains that accommodation is relaxed simply because in most cases nothing is gained by it. It will be seen that D may have any value between the *punctum proximum* and the *punctum remotum*, i. e. between the greatest and least distances of distinct vision, and the former may be equal to ∞ for emmetropy and even negative for hypermetropy. As regards δ, it is in general physically impossible to bring the nodal point nearer to the instrument than 12 mm., and few instruments have a longer focal length than this, so that δ is generally negative.

The author then discusses the interpretation of the formula in the different cases which may arise according as D is + or −, and greater or less than δ. With the Microscope, for example, where δ is negative, D positive, and δ numerically less than D, δ must be as small and D as large as possible, that is to say, the eye must be brought close to the eye-piece, but accommodation must be relaxed, *so that vision takes place at the greatest, and not, as is generally stated, at the least distance of distinct vision.*

D positive, δ negative, and δ greater than D is the case of the camera obscura, or projection on a screen.

The case of hypermetropy (D negative) is curious; here δ if + must be small, but if negative must be as large as possible, and the instrument will have its greatest power when the eye is withdrawn as far as possible and has the image formed behind it at the greatest distance of distinct vision; the magnifying power continues to increase as the eye is moved farther from the lens, and in this respect hypermetropy is attended with a considerable advantage over every other peculiarity of vision.

The author finally expresses a desire that opticians should determine not only the focal lengths of their instruments, but also the focal positions, so that the actual magnifying power attainable could be calculated from these data and from the physical constants of the eye, instead of assuming, as is generally done, that 250 or 300 mm. represents universally the distance of distinct vision.

Dr. V. Chiusoli points out* that the conclusions of Guébhard can be verified by a simple experiment.

Using the strongest eye-piece and the weakest objective, focus the Microscope upon a coarse object of sharp outline (e.g. hairs). Then, according to Guébhard, the virtual image formed by the eye-piece is at the *punctum remotum* of the eye. Next move the tube suddenly towards the object through a fraction of a millimetre by means of the micrometer-screw; the object at first appears blurred, but after a short effort the details will reappear with their former distinctness. The image in this case has been brought nearer to the eye, and can only be seen clearly again after an effort of accommodation. The movement of the tube must be small, since it will correspond to a large displacement of the image.

In the same way, if the vision be suddenly transferred from one part to another of the same object without any movement of the tube, an effort of accommodation will be necessary, since the different parts of the object do not lie in the same focal plane.

These facts indicate the correctness of Guébhard's conclusions and the error of the impression that the virtual image is always at the least distance of distinct vision.†

Care of the Eyes in Microscopy.‡—Prof. S. H. Gage recommends the microscopist (in addition to keeping both eyes open and using an eye screen if necessary) to "divide the labour between the two eyes, i.e. use one eye for observing the image awhile and then the other."

He considers that "with a Microscope of the best quality and suitable light—that is, light which is steady and not so bright as to dazzle the eyes, nor so dim as to strain them in determining details—microscopic work should improve rather than injure the sight."

KERBER, A.—**Bestimmung der Farbe, für welche die sphärische Aberration zu heben ist.** (Determination of the colour for which the spherical aberration is to be corrected.)

[The author inquires how the aberration should be corrected so that the average spherical aberration of all colours shall equal 0, due regard being had to their different intensities; and concludes that this condition is secured when the correction is made for light of wave-length 0·00055, that is, for a ray lying between D and E. It appears, therefore, that this result is practically realized by the correction as it is ordinarily made.]

Central-Ztg. f. Optik u. Mech., VIII. (1887) pp. 49–51.

NELSON, E. M.—**Microscopical.**

[Reply to queries on optical tube-length; tests for spherical aberration in objectives, with remarks on the fallacy of the American system of testing; stages, &c.]

Engl. Mech., XLV. (1887) p. 221.

ROYSTON-PIGOTT, G. W.—**Microscopical Advances. XVII.**

[Diffraction, Ancient and Modern.] *Engl. Mech.*, XLV. (1887) p. 93 (1 fig.).

ZECH, P.—**Elementare Behandlung von Linsensystemen.** (Elementary treatment of Lens-systems.) 8vo, Tübingen, 1887.

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* Rev. Scientif., 1884, p. 62. Cf. Zeitschr. f. Wiss. Mikr., i. (1884) pp. 558–9.

† Prof. C. M. Gariel (Rev. Scientif., 1883, p. 789; Central-Ztg. f. Optik u. Mech., v. (1884) pp. 218–9, 3 figs.) gives an elementary proof of Guébhard's results, showing that if the focus lies behind the nodal point the magnifying power increases as the image approaches the eye, and is greatest at the *punctum proximum*. If the focus is in front of the nodal point the magnifying power increases as the image recedes, and is greatest at the *punctum remotum*. If the focus coincides with the nodal point the magnifying power remains constant. Cf. on same subject, Monoyer; Comptes Rendus, xevi. (1883) pp. 1785–7; Central-Ztg. f. Optik u. Mech., v. (1884) pp. 217–8.

‡ 'Notes on Microscopical Methods,' 1886–7, pp. 8–9.

(6) Miscellaneous.

Relations between Geology and the Mineralogical Sciences.*—Prof. J. W. Judd in his anniversary address to the Geological Society made the following remarks on the Microscope.

"How is it, we may profitably ask, that the biological sciences have made such prodigious advances, while the mineralogical ones have lagged so far behind? We must ascribe the result, I believe, to two causes:—

In the first place, improvements in the construction of the Microscope, and more especially the perfecting of methods of study by means of thin sections, have immeasurably enlarged the biologist's field of observation; histology and the cell-theory, embryology with all its suggestiveness, and many important branches of physiological research, must have languished, if, indeed, they ever saw the light, but for the aid afforded by the microscopical methods of inquiry.

In the second place, the growth of geological and palæontological knowledge has been the leading factor in that profound revolution in biological ideas which, sweeping before it the superstition of fixity of species, has endowed this branch of natural science with the transforming conception of evolution.

Now these two causes, which have done so much for biology, are already working out the regeneration of mineralogy; and I doubt not that the fruits brought forth by the latter science will be equally satisfactory with those of the former.

The application of the Microscope to the study of minerals has proved less easy than in the case of animal and vegetable structures. . . .

The greatest step in advance in connection with the microscopic study of rocks was undoubtedly made, however, when it was shown that transparent sections of minerals, rocks, and fossils can be prepared, comparable to those so constantly employed by biologists in their researches. . . .

I believe that what geology has already done for biology she is now accomplishing for mineralogy; it may, indeed, be instructive to point out how, in every one of its departments, the employment of microscopic methods and the suggestion of new lines of thought are causing mineralogy to develope in just the same directions as biology has already taken before her. In this way we may perhaps best convince ourselves that mineralogy is once more asserting her position in the family of the natural sciences."

The Microscope in the Legal Profession.†—Under this heading the editors of 'The Microscope' write as follows:—

"The importance and usefulness of this great instrument grows with every year. Its valuable service is by no means restricted to the medical profession, whose especial favourite it is. It has interested itself in the varied fields of manufacture, especially in pharmacy and chemistry, where it has become as indispensable an article of furniture as the mortar and pestle to the apothecary; but its orbit has widened and continues to widen with almost every new moon.

"It is, perhaps, not generally known how very useful it has of late years become in the legal profession. A few years ago, when a question arose as to the authenticity of signatures, or suspected alterations in a written instrument (such as deeds, wills or promissory notes), the only means the court and jury had to settle the vexed question was to call in men reputed to be 'experts' in the matter of handwriting, such as bookkeepers, paying-tellers in banks, scriveners and copyists, and take their opinions

* Quart. Journ. Geol. Soc., xlii. (1887), Proceedings, pp. 60–2.

† The Microscope, vii. (1887) pp. 81–2.

for what they were worth. Oftentimes very shrewd judgments were given by such witnesses; but the best opinion in a delicate case was generally submitted as a mere guess or conjecture, with such reasons as the observer had to offer in its support, and smart lawyers generally managed to introduce as many expert witnesses on one side as were offered on the other, and so the jury, instead of being helped, were only the more perplexed over the question which they were sworn truly and correctly to decide. The rule of law being that any *material* alteration in an instrument rendered the entire document void, it will be seen how large interests of contending parties were often suspended on the correctness of the human eye—unaided, it was as difficult a task in many cases as for the observer to tell by a glance the number of fibres in a leaf, or threads in a fabric offered for inspection. In cases of forgery, the freedom or imprisonment of the suspected party was made to turn on the stumbling judgment of unlettered and unskilled men in the jury-box. But to-day, in all such cases the Microscope is summoned into court, and its silent testimony solves the riddle in almost every case. There is no impeaching this expert witness. Call as many Microscopes to the witness stand as may be desired, they all tell the same story—no conflict between them, and the case is settled beyond the possibility of a doubt. In the matter of counterfeited currency the Microscope has become a *vade-mecum* to every modern bank clerk charged with the responsibilities of a receiving teller. If a glance of his well-trained eye awakens a suspicion as to the genuineness of a Government note, he has but to place it under his Microscope and his doubt is made a certainty. His testimony, therefore, in behalf of the Government against the counterfeiting engraver fixes his destiny at once. The relations which the Microscope sustains to medical jurisprudence are none the less important, indeed, they are still more valuable because there they bear upon human life instead of human liberty merely. The criminal whose garments are stained with human blood can no longer relieve himself of a suspicion by saying they were discoloured by the blood of a slaughtered sheep or calf. The Microscope looks down upon them, searches out the corpuscles and renders its verdict at once as to whether the prisoner wears the badge of murder or whether he should go free. Also in all the variety of criminal cases in which poison is suspected and where felonious miscarriage is charged, the Microscope is now a swift and essential witness in ascertaining and settling the exact facts—indeed, it has become as indispensable to the legal profession as to the medical, as might be yet more conclusively here demonstrated had we space in which to expand this article.

"We leave the subject with the remark, that in the whole realm of science there is no instrument yet discovered that, in practical usefulness, can compare with the Microscope, and therefore it is we who are inspired to promote and expand its sphere of science in the cultured and civilized world."

Captain W. Noble and this Journal.—We once asked a paragraph writer for a periodical how it was that he and his brother professionals so frequently wrote such utterly inane paragraphs, about nothing in particular or on such absurdly minute points that they could be of no interest to any human being. His answer was that no one who had not had practical experience in the matter could realize the shifts and difficulties to which the paragraph writer was put. The day of publication came round with the clock and the inexorable employer with equal regularity demanded the prescribed amount of copy, and allowed no delays and no

excuses, so that vacant space had to be filled with nothings if the somethings were wanting.

It is evidently under this influence that Captain William Noble (F.R.A.S. and one of the Fellows of this Society), who writes paragraphs fortnightly for the 'English Mechanic' under the *nom de plume* of "A Fellow of the Royal Astronomical Society," has published a series of notes on this Journal.

Last year Captain Noble apparently wanted to know why the index was not published in December. The obvious way of obtaining the information he wanted, being a Fellow of the Society, was to apply to one of the officials, who would, of course, at once have given it. This would not, however, have supplied any paragraph to fill a vacant space, and accordingly Captain Noble put his inquiry into print, and published it as one of his paragraphs.*

The officials of the Society very properly paid no attention to such an extraordinary proceeding, and "One Who Knows" somewhat unmercifully criticized † Captain Noble for the absurdity of which he had been guilty, and invited him next time to inquire before rushing into print, a suggestion which (perhaps not unnaturally) considerably irritated Captain Noble, who complained ‡ of the "elephantine chaff" to which he had been subjected.

This criticism, nevertheless, made, as it was intended to do, an impression on the worthy Captain, and when this year the index did not make its appearance, he wisely decided that he would inquire before committing himself as he had done in the previous year, and so avoid again falling under the sarcasm of "One Who Knows." When Captain Noble presented himself at the Library to make his inquiry, as his ill luck would have it, the Librarian was absent. What ought any one to do under such circumstances who was really desirous of obtaining an answer to his inquiry? Obviously, if he could not wait until the Librarian returned, he would leave his inquiry as a message or a note, and request a reply to be sent, as it would have been. He would *not* take the first answer he could get—from no matter whom—the more absurd the better—and rush off with it to the printer. Yet this is just what was done by Captain Noble, who, amongst other statements, said § that the result of his inquiry was that he "was informed by the attendant that 'he *didn't know*, but *perhaps* "Mr. Crisp had been too busy to attend to it!'"

The italics in the above quotation are ours, but it hardly requires such marks of accentuation to call attention to the character of the "explanation" which Captain Noble was content to carry away with him for publication!

No notice being taken of this, Captain Noble indited another paragraph, in which he said ‖: "Verily, if there be any foundation for the quasi-explanation vouchsafed to me at King's College, Mr. Crisp must have been oppressed with an amount of business almost appalling to contemplate."

These paragraphs were again criticized by "One Who Knows," who again pointed out ¶ the childishness of Captain Noble's proceeding, and also stated that he had made personal inquiry at the Library of the Society, and that both officials certified that not only did they not give such an answer as alleged, but that no such inquiry, verbal or written, was addressed to them.

This letter irritated Captain Noble still more than before, and induced him to write in terms ** which it would be unfair to print here, as we are sure he regretted his paragraph as soon as he saw it in print. It is never

* Eng. Mech., xlii. (1886) p. 446.
† Ibid., p. 474.
‡ Ibid., p. 489.
§ Ibid., xliv. (1887) p. 560.
‖ Ibid., xlv. (1887) p. 173.
¶ Ibid., p. 201.
** Ibid., p. 219.

wise to write in anger, and still less to print what is thus written, and Captain Noble's letter is a striking example of this. In addition to charges of "impudence" and a reflection on the Council for which there was no foundation, the letter contained the assertion that the period from the middle of February to the middle of April was *four* months, which sufficiently shows the state of mind in which it was written.

The unkindest cut of all came, however, not from the enemy, but from a friend, Captain Noble's own editor, who after very impartially publishing a further letter* from "One Who Knows," closed the discussion with the following remark:—

> "This ends this matter. Our space is too precious to devote to "the endless discussion of the merits or shortcomings of other "publications of no interest to one in a hundred of our readers."

We are sure every Fellow will agree in the very sensible view of the editor, and it is only left to wonder why when Captain Noble had such a plain course open to him, he should have adopted one which exposed him to the well-deserved criticism we have quoted.

The matter, moreover, does not end with the manifestation of its puerility. Never having troubled to obtain an answer to his inquiry, Captain Noble remained in ignorance of the cause of the delay in issuing the index, and hence was led to deal with the matter in a way which he would otherwise not have done, thus exposing himself to be considered not a little inhumane, though we are sure such a charge would in reality be unjust. Whatever his temperament, we are satisfied he would be among the last to, for instance, dance a *pas des fous* at the funeral of his neighbour. We are gratified to know that we have the sympathy of such of the Fellows as are aware of the cause of the delay, and notwithstanding the justification which Captain Noble has given for supposing the contrary, we are sure that if he had only taken the same trouble to get an answer as he did to ask the question we should have had his sympathies also. We only cite the fact to show how more than ridiculous his proceeding has been, whether looked at from the light of his position of a Fellow of the Society or even as an outsider.

In writing these lines we have had no desire to press harshly upon Captain Noble. Though we cannot flatter ourselves that (at the moment at any rate) he will pay much heed to any remarks from ourselves, we have certainly a hope that the expression of opinion from his own editor will have more weight, so that he may not find himself again in such an undignified position. Our object in writing is similar to that which suggested in olden times the fixing of the heads of misguided persons on Temple Bar. They, poor wretches, were beyond the influence of example. The ghastly display was solely intended *pour encourager les autres*. If others are tempted to enter on such a proceeding as that on which we are now commenting, we invite their perusal of this note and ask them to consider the moral it points before launching on the world in print a discussion "of no "interest to one in a hundred of their readers."

Bernard, J. G.—**Histoire des Microscopes; ce que leur doit la Médecine.** (History of Microscopes; what Medicine owes to them.)

[I. 1. History of simple Microscopes, the solar Microscope, and compound Microscopes, before achromatism. 2. Construction of lenses, achromatism, methods of illumination. 3. Simple and compound Microscopes after achromatism. 4. Accessories. II. 1. What Medicine owed to the Microscope before Schwann. 2. And since Schwann. Recent discoveries, future of medicine.]

iv. and 145 pp. and 1 pl., 8vo, Paris, 1886.

* Eng. Mech., xlv. (1887) p. 242.

Boys, C. V.—**On the production, preparation, and properties of the finest Fibres.**
[Fibres less than the 1/100,000 in. in diameter were obtained from quartz.]
Nature, XXXV. (1887) p. 575.

Fraunhofer, Joseph von, zur Säkularfeier seines Geburtstages.
[Sketch of his life, with portrait. Born 6th March, 1787. Died 7th June, 1826. "Achromatic lenses for Microscopes were made in his workshop; a large Microscope completed in 1816 was furnished with a peculiar measuring apparatus to the screw-micrometer, which allowed the diameter of objects to be determined to the 1/100,000 of an inch."]
Central-Ztg. f. Optik u. Mech., VIII. (1887) pp. 73-5 (portrait).
Cf. *Zeitschr. f. Instrumentenk.*, VII. (1887) pp. 113-28 (portrait).

Glass, the New.—Yet other variations of the ludicrous accounts of this glass.
["Professors Abner and Schott have invented a new optical glass, which will be of great value in microscopic photography. It is said that while the ordinary lenses do not admit of distinct reflections beyond 1/500,000 of an inch, this new glass will render 1/204,700,000th of an inch visible."]
Family Doctor, 1887, p. 66.
["As an instance of how a grain of truth may sometimes be transformed into a mountain of error, the Secretary read an item which has been going the rounds of the interior press, and which announced the discovery of a new glass in Sweden, composed principally of boron and phosphorus, of such extraordinary refractive power that lenses made of it would reveal the 1/204,700,000 in."]
Proc. San Francisco Micr. Soc., 13th April, 1887.

Journal of the Royal Microscopical Society—retrospective and prospective.
[Review of this Journal.] *Nature*, XXXVI. (1887) pp. 78-9.

Mayall, J., Jun.—**Conférences sur le Microscope.** (Lectures on the Microscope.) *Contd.*
[*Transl.* of the Cantor Lectures. See Journal, 1886, p. 869.]
Journ. de Microgr., XI. (1887) pp. 113-24 (12 figs.).

Pelletan, J.—**Nos Maitres.** Charles Chevalier.
[Memoir and portrait.] *Journ. de Microgr.*, XI. (1887) pp. 177-8 (portrait).

Rogers, W. A., Hon. F.R.M.S.—[Sketch of Life.]
The Microscope, VII. (1887) pp. 45-80 (portrait).

V., O.—**Messrs. Schott & Co.'s new Optical Glass.**
[Remarks on the table of optical data referred to in Journal, 1886, p. 856.]
Engl. Mech., XLV. (1887) p. 249 (in part).

Williams, G. H.—**Modern Petrography:**—An account of the application of the Microscope to the study of geology.
[Contains a note upon Petrographical Microscopes.]
35 pp., 8vo, Boston, Mass., 1886.

Williamson, W. C.—**The Microscope and Geology.**
[Abstract of Presidential Address.]
Rep. and Proc. Manchester Sci. Stud. Assoc. for 1886, p. 32.

β. Technique.*

(1) Collecting Objects, including Culture Processes.

Method for Preservation and further Cultivation of Gelatin Cultures.†—Dr. H. C. Plaut preserves gelatin and agar cultivations in the following manner.

If a plate cultivation, the colony is cut out with a fine sterilized knife, and placed on a sterilized slide in a drop of sterilized water to which a trace of glycerin has been added. The slide is then warmed over a spirit-lamp, and a sterilized cover-glass imposed, which is fastened down with some varnish. This procedure will allow the colony to be examined at any time under high powers, and the original condition of the cultivation will be retained for quite a year. If required for cultivation in other media the colony is always available by merely removing the

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

† Fortschr. d. Med, iv. (1886) p. 419.

cover, and if, instead of water, some nutrient medium be used, anaerobic bacteria can be developed in the chamber.

For test-tube cultivations, after the glass has been washed outside with a 2 per cent. sublimate solution, it is scratched round at the level of the gelatin with a file and then broken off. From the gelatin a colony is dug out with a sterilized knife, and treated as above.

In this way tube cultivations become accessible to the Microscope and to photomicrography. Agar cultivations may be treated in a similar manner, but stronger heating is required. A mixture, however, of equal parts of meat-peptone-gelatin and agar-meat-peptone produces a mass which is fluid at 48° C. and can be preserved at 28° C.

Modification of Koch's Plate Method.*—Dr. R. J. Petri recommends flat double vessels of 10–11 cm. in diameter, and 1–1·5 cm. in height. The one used as the cover, of course, is a little larger. The gelatin, prepared in the usual manner, is poured in so as to form a layer of only a few millimetres thick, and then the cover imposed. A level layer is easily obtained by gentle to and fro movement. Except the edge, every part of the gelatin is accessible to the Microscope. The gelatin dries very slowly, and may be kept damp for a long time by putting several of these small vessels within a large one, with a piece of damp filter paper, and then covering with a bell-jar. These vessels answer very well for agar plates. Numbering the colonies is very simple. The cover is replaced by a glass plate marked out in divisions, through which the position and number of the colonies are noted.

Fig. 146.

Fig. 147.

Method for Cultivating Anaerobic Bacteria.†—Dr. M. Gruber uses a tube made of easily fusible glass; it is about 25 cm. in length, and the wider part about 2 cm. in diameter. The neck, about 5 cm. long, is only 3–4 mm. wide (fig. 146). After having been plugged with cotton wool and sterilized in the usual manner, the lower part or body receives 10–12 cm. of gelatin, introduced with the usual precaution, and is then again sterilized at 100°.

After having been inoculated by the aid of a platinum wire, the cotton-wool plug is rammed down tightly and a caoutchouc plug, with a piece of rectangular glass piping, is fitted into the head. The glass piping is connected with an air-pump, and the air exhausted as far as possible; the residual air is removed by immersing the tube in water at 30°–35°, and boiling. The contents of the tube are prevented from bubbling up by gently heating the junction of the neck and body with a Bunsen's burner. The evacuation and boiling occupy about a quarter of an hour.

* Centralbl. f. Bacteriol. u. Parasitenk., i. (1887) pp. 279-80.

† Ibid., pp. 367–72 (2 figs.).

While the boiling is still going on, the neck is heated and melted off (fig. 147). The tube is then laid in a horizontal position and rotated, so as to spread out the gelatin into a regular layer, and care must be taken to allow it to cool gradually. With practice, the whole transaction does not take more than twenty to twenty-five minutes.

The author remarks, that the addition of sugar renders meat-peptone gelatin a more suitable medium for anaerobic bacteria.

The foregoing method is only intended for the cultivation of such bacteria as will thrive at temperatures under 24°–25° C., but the tubes may be filled with agar or fluid media, and used for the examination of the fermentation properties of anaerobic organisms.

New Method for the Cultivation of the Tubercle Bacillus.*—MM. Nocard and Roux advise the use of sterilized serum, which is obtained from the jugular vein of an animal (horse for choice). The blood is passed aseptically into large sterilized bulbs, and then coagulated in fresh water at 10°–12°. The serum is withdrawn with Pasteur's ball-pipettes.

M. Nocard had previously determined that coagulated serum is rendered more suitable for the cultivation of the bacillus by the addition of peptone, soda, and sugar, and the authors now advise the addition of 6–8 per cent. glycerin, which, they state, prevents the formation of the iridescent scum on the surface of the serum from drying and oxidation, and even favours the growth of the bacilli.

Tubercle bacilli were found to grow well in agar-bouillon at 39° if 6 to 8 per cent. glycerin be added to this medium.

The cultivations in media thus prepared grow more luxuriantly and rapidly than by other methods, while they retain the staining and physiological properties characteristic of tubercle bacilli.

Pure Cultivation of a Spirillum.†—Dr. E. Esmarch has succeeded in obtaining a pure cultivation of *Spirillum* from the dried-up remains of a mouse which died of mouse septicæmia. A trace of the remains was inoculated in gelatin, and from this a second tube prepared according to Koch's fractional method.

In the first tube more than 200 colonies of bacteria appeared within a few days. These, which did not liquefy the medium, were of a yellowish-grey colour, and in the course of another fortnight or so assumed a wine-red hue. In the attenuation tube two colonies of bacilli soon showed themselves, and after the lapse of fourteen days four new colonies appeared. These were found to be identical with the red colonies in the first tube. Cover-glass preparations showed that the colonies were a pure cultivation, and consisted of short *Spirilla*.

Cultivated in meat broth, the *Spirilla* were found to flourish best at a temperature of about 37° C., copious development taking place within twenty-four hours. At ordinary temperature eight to ten days were required.

In the original cultivation short *Spirilla* only, with two or three turns, were noticed, but in the broth the number of turns became greater, amounting to thirty, forty, and even fifty. The thickness of curve was always the same, being about double that of the cholera *Spirillum*. The short ones showed lively movements; the larger were either motionless or moved in a slow snake-like way. Cover-glass preparations were stained with the ordinary watery anilin dyes for above five minutes. No flagella were rendered evident.

* Ann. Instit. Pasteur, i. (1887) pp. 19–29.

† Centralbl. f. Bacteriol. u. Parasitenk., i. (1887) pp. 225–30.

In respect of colour this *Spirillum* was found to differ from other pigment-forming micro-organisms, since access of air was not found to be a requisite, for the red pigment appeared in the deeper layers of the gelatin while the superficial were still devoid of colour. Agar, blood-serum, potato and milk also formed favourable surfaces for the development of this organism.

Examined in hollow-ground slides, the cover-glass of which was supplied with gelatin, the *Spirilla* were found, after ten minutes in the incubator, beginning to show signs of division, and in twenty-four to thirty hours the threads were distinctly separated into segments equal to about three-quarters of a turn, and these segments again, in another twenty-four hours, began to grow so luxuriantly that the colony appeared like one vast coil. Solid media seemed to be more favourable to the production of the shorter forms, and in colonies developed on agar or potato, resting forms, or possibly actual spore formations, became evident. Bright uncolourable spaces, like the spores of anthrax, were seen in cover-glass preparations, and though they could not be differentiated from the rest of the body-wall by staining, they may perhaps be regarded as the resting phase of the *Spirillum*. For when the *Spirillum* was dried on silk threads they were found to be dead in 6–8 days, and no growth took place in gelatin. But the spore-like forms, when dried for five weeks, were capable of developing in broth at a temperature of 52° C. within five minutes.

Experiments on animals which were injected with some of the pure cultivation gave negative results.

For this *Spirillum* the author suggests the name of *S. rubrum*.

New Culture Medium.*—Dr. A. Edington says that a jelly derived from Irish moss is much less opaque than agar-agar, and more nutritious, and is therefore to be recommended as a culture medium for micro-organisms capable of withstanding high pressure. He macerates 2 oz. of the finest selected Irish moss in 18 oz. water, and after leaving it for a night, keeps it in the steam sterilizer at about 212° Fahr. for an hour and a half, stirring occasionally. It is then strained through a felt bag two or three times, when the jelly thus obtained will be found on cooling merely to gelatinize, yet able to withstand a temperature of 87° Fahr. before liquefying; but if it is evaporated it is found to be capable of withstanding a temperature between 122° and 131° Fahr. before liquefying. In this state, if a test-tube be filled with it, it is found to present the appearance of water with only a slight degree of haziness. In order to render this more nutritious, and so better fitted for the requirements of the growth of the generality of micro-organisms, the materials recommended by Dr. Klein may be added, namely, beef-peptone and ordinary cane-sugar. Add to the jelly 2 per cent. of the former and 1 per cent. of the latter, and the result is a jelly almost as bright as nutrient gelatin and infinitely more so than agar, while the simple method of preparation and the price have much to recommend it.

Collecting Urinary Sediment for Microscopical Examination.†—Dr. C. W. Dulles uses a straight glass, and not a conical one as usually recommended, and leaves the urine to settle for 24 hours. After this time he perforates the paper cover of the glass with a pipette employed in the ordinary manner, and leaves the pipette, also covered or plugged, for another 24 hours. He then withdraws it, and uses the first two or three drops for examination.

* Engl. Mech., xliv. (1886) p. 151.

† The Microscope, vii. (1887) pp. 85–6, from Med. News.

Abbott, C. A.—An improvement in the method of preparing Blood Serum for use in Bacteriology. *Med. News*, 1887, pp. 207–8.
Bolton, M.—A Method of preparing Potatoes for Bacterial Cultures. *Med. News*, 1887, p. 318.
Lockwood, S.—Raising Diatoms in the Laboratory. *Journ. New York Micr. Soc.*, II. (1886) pp. 153–66 (2 pls.)

(2) Preparing Objects.

Notes on the Technique of Embryology.* — Dr. H. Henking finds that the eggs of Phalangida can be kept through the winter without getting covered with fungi, and so damaged or even destroyed, by placing them in an ordinary oven on sand or earth kept moistened with distilled water. The usual antimycotics, such as carbolic and salicylic acid and alcohol, are quite unreliable.

Ova are best preserved with boiling water and chrome-osmium-acetic acid, and Perenyi's fluid is also useful, but sublimate, chromic acid, picro-sulphuric acid, 20 per cent. nitric acid are less reliable. Eggs of Phalangida being little penetrable by reagents, it is almost indifferent whether boiling water or a boiling 1/2 per cent. solution of chromic acid be used for hardening.

Owing to the difficulty of staining eggs the author prefers to rupture the shell. This is done by means of two very sharp needles under a power of 40 or 50 diameters and in 70 per cent. spirit. The eggs are previously hardened in 90 per cent. alcohol, and when transferred to the weaker spirit are easily lacerated without damage to their contents. The outer casing only of the shell is broken; this, the more brittle, is covered with a uterine secretion to which foreign bodies are frequently attached, so that there is an extra advantage in removing it. The more flaccid inner shell serves to protect the egg contents.

The eggs are stained *in toto* best with Grenacher's borax-carmine or with eosin-hæmatoxylin, or with Hamann's neutral acetic carmine. If eosin-hæmatoxylin be used, the eggs are washed with a weak alum solution and then transferred to alcohol which is faintly stained with eosin in order to prevent loss of colour. Ova treated with borax-carmine are overstained and then decolorized in slightly acidulated 70 per cent. spirit.

After having been stained and dehydrated the eggs are transferred to a mixture of equal parts of bergamot oil and alcohol for some hours, then to pure bergamot oil, and from this to a mixture of bergamot oil and paraffin. They are next saturated in paraffin at a temperature of 55° C., and when ready are fished out with a spoon and allowed to drop into a vessel filled with cold water in order to cool the paraffin rapidly.

Orientation of the ovum is most easily effected by means of a glass ring 2 mm. high. This is placed on a slide and filled with melted paraffin, in which the eggs are immersed. The slide is then placed under a dissecting Microscope with a power of 40 or 50 diameters, and the egg moved into the desired position by means of a needle heated in a spirit-lamp. Though manual dexterity is required for this operation, it is more simple and easier than to employ the apparatus devised for this purpose. The paraffin block when cool is easily removed from the ring, and is then melted on to a cork.

The treatment of brittle sections, more especially in the case of Arthropoda, is always difficult. The usual methods for obviating the tendency to crumbling are to brush the section surface over immediately before cutting with collodion or with collodion thinned down with ether.

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 470–9.

Dr. Henking, however, finds that ether evaporates too rapidly, and instead uses absolute alcohol for dissolving paraffin. A sufficiently strong but delicate layer is deposited on the section surface by the evaporation of the spirit. If, however, the objects should be extremely brittle, e. g. the eggs of Phalangida, a weak solution of shellac in absolute alcohol and saturated with paraffin should be used. The solution is kept in a stoppered bottle, 8 cm. high, and to the cork are fastened coarse hairs reaching to the bottom of the bottle; by these means fluid sufficient is withdrawn for smearing the section surface.

The removal of air-bubbles, said to occur after mounting in chloroform-balsam, especially when rather thin, may be effected by applying a little pure chloroform at the edge of the cover-glass before adding more balsam.

Method for isolating Epithelial Cells.*—Dr. P. Schiefferdecker, who has employed the process successfully for some years, recommends "Pankreatinum siccum" as an isolating agent for the cells of cuticle. It is a brownish powder made from the pancreas without the aid of chemicals. So much of the powder as will dissolve in cold distilled water is used to the extent of some cubic centimetres. After filtering, pieces of skin are placed therein, and the vessel put in an incubator or some warm place, near but not exceeding the body temperature. Maceration is sufficiently advanced in three or four hours. The pieces are then washed and afterwards placed for preservation in a mixture of equal parts of glycerin, alcohol, and water.

The epithelial cells are easily separated, and their characteristics well preserved.

Demonstration of goblet cells in bladder epithelium of Amphibians.† In his study of the unicellular glands or goblet-cells in the bladder epithelium of Amphibians, Dr. J. H. List used the following methods. For demonstration, nitric acid and silver oxide (1 : 300), and 1/2 per cent. osmic acid for 12–24 hours, with subsequent clearing in dilute glycerin. For hardening, besides osmic acid, 1/4 per cent. chromic acid, 90 per cent. alcohol, and Müller's fluid. Imbedding in paraffin or celloidin. Staining with hæmatoxylin and various anilin dyes—eosin, methyl-green, anilin-green, Weigert's Bismarck brown, nitric acid, rosanilin, dilute Renaut's hæmatoxylin glycerin, and double stains. For isolation, Müller's fluid or 1/2 per cent. osmic acid.

Preparing the Liver.‡—For the examination of the finer structure of the liver-cells Prof. L. Ranvier recommends osmic acid (1–100). He takes pieces of liver (2 mm.) of a freshly killed animal, and leaves them in the fluid for twelve to twenty-four hours. By teasing out, the liver-cells are easily isolated. The excavations on the margins of the cells are not rendered visible by this means, so in order to fill the liver capillaries the author injected the portal vein with a gelatin solution at 30°. The isolated liver-cells were stained either with iodized serum (prepared from the amniotic fluid of a ruminant to which iodine had been freely added), or with "iodide of iodine" (aq. dest., 100; iodide of potassium, 1; iodine crystals in excess).

In order to study the glycogen of the liver, the author employed the following method:—In order to collect as much glycogen as possible in

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 483–4.

† Arch. f. Mikr. Anat., xxix. (1887) pp. 147–8.

‡ Journ. de Microgr., ix. (1885) pp. 3–14, 55–63, 103–9, 155–63, 194–201, 240–7, 287–95, 334–43, 389–96, 438–45, 480–2; x. (1886) pp. 5–10, 55–8, 160–6, 211–4. Cf. Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 247–51.

the liver-cells, a dog was fed for two days on boiled potatoes to which fat had been added to make them tasty. The animal was then killed, and pieces of the still warm liver were cut with a freezing microtome. The sections were placed in iodized serum and immediately examined. Glycogen was found by this method to be disposed diffusely in the liver-cells, the contents of which had assumed a brown colour. At first the glycogen collects in small irregular masses, but afterwards appears on the cell-surface as lumps stained by the iodine. In sections exposed for some minutes to the vapour of osmic acid the glycogen is fixed within or without the liver-cells without taking on the characteristic wine-red iodine reaction. This staining of the glycogen is unfortunately not permanent, for it begins to disappear in 24 to 48 hours. After leaving the sections in iodized serum for 24 hours, no more glycogen is found.

As an injection mass for the liver vessels Ranvier used gelatin and prussian blue (gelatin, 1·0; prussian blue, 25·0); and also carmin. The gelatin is softened in water, and all the water not imbibed is poured off. It is then dissolved in a water-bath, and to it is added a carmin solution prepared as follows:—Over some carmin No. 40 is poured water sufficient to saturate it. When after standing some hours it has assumed a pappy consistence, ammonia is added drop by drop until the carmin is dissolved. So much of this carmin solution (a very small quantity) is added to the gelatin as will give it the required colour. This mixture is then neutralized by the addition of some drops of acetic acid (1:2 or 3 parts water). Neutralization is shown by the appearance of the wine-red colour. The mass is then filtered through flannel into the injection syringe. (If the temperature of the animal amounts to 36°, there is no diffusion of the injection mass through the vessels, on account of the large quantity of the gelatin.) After cooling, the liver is cut into small pieces of 1 cm. breadth and placed for 24 hours in ordinary spirit. This suffices to render the pieces of liver sectionable.

In order to examine the intercellular substance of the epithelium, the author used the silver method. He exposed the portal vein of a rat just before its entrance into the liver, and in order to remove the blood, injected through a syringe with a silver needle first distilled water, and then after some seconds a silver solution (3:1000). The liver was then placed in distilled water for one or two hours, and afterwards in spirit. On the second day sections were made, mounted in glycerin, and exposed to daylight. After some days they turned brown, and the intercellular spaces became visible.

Prof. Ranvier demonstrates the interlobular connective tissue by hardening pieces of liver in alcohol and staining the sections with hæmatoxylin and picrocarmin. Preparations of the latter were preserved in glycerin to which formic acid was added.

The bile-ducts were injected with Hering's apparatus. With this a mercurial column of 30–40 mm. is advantageous, as with higher pressure slight lacerations of the biliary capillaries occur. The injection mass is prepared by mixing a concentrated solution of the persulphate of iron with a solution of the yellow prussiate of potash. An insoluble precipitate of prussian blue is obtained, but when moistened with water it gradually becomes soluble. A too strong solution should not be used, as it easily precipitates. The injection should be carried out as quickly as possible, and at a low but constant pressure, 40 mm. The animals (rats, guinea pigs, and rabbits) are killed by decapitation, and injected while the liver is still warm. The injection usually only takes one minute. The sections are afterwards mounted in dammar.

In order to show the biliary passages, Prof. Ranvier injected silver solution (1 : 500) into the hepatic duct (in frogs from the gall-bladder) of a recently killed animal (40 mm. pressure). The duration of the injection was three hours. Small pieces of liver were then placed in osmic acid, others in alcohol, and the sections, made in 24 hours, were mounted in dammar or in formic acid glycerin.

The author also employed the "natural" injection. 60 c.cm. of a cold saturated indigo-carmin solution were injected into the jugular of a live rabbit, 15 c.cm. at a time, with 20 minutes' interval between the injections. Ten minutes after the last the animal was killed, and through the portal vein a solution of potassium was injected in order to fix the colouring matter in the biliary canals. Hardening was done in alcohol. Osmic acid is not advisable, as it destroys the blue colour.

Embryonic livers were treated by hardening small pieces for 15 hours in osmic acid, then, after washing, hardening in 40 per cent. alcohol. They were then set in a mixture of wax and oil, and afterwards in elder pith.

When examining the glands of the hepatic duct these were injected with osmic acid (1 : 100). Small pieces were teased out in a physiological salt solution (7 : 1000 aq.). Sections of the hepatic duct stained with picrocarmin were mounted in formic acid glycerin. The glands of the hepatic duct showed up much better with gold chloride than with osmic acid. Freshly expressed lemon juice was injected into the hepatic duct, and 10 minutes later gold chloride 1–100. To reduce the gold, small pieces were kept for 24 hours in formic acid (1 : 3 aq. dest.). The glands were stained a bright violet.

The author then passes to the examination of the gall-bladder (guinea-pig) the epithelium of which he obtained by maceration in iodized serum. Lastly, it may be mentioned that the muscle-fibres of the gall-bladder were demonstrated by injecting therein freshly expressed lemon juice and leaving it therein for five minutes. The gall-bladder is then placed in osmic acid for some minutes, then washed, and the epithelium removed with a brush. Sections stained with picrocarmin show striped muscular fibres.

The Resorcin derivative Phloroglucin.*—Dr. J. Andeer communicates the following interesting properties of phloroglucin or trioxyhydro-benzol. It prevents the coagulation of the blood and other animal juices, keeping them fluid and undecomposed for a long time. In certain fermentations it acts as a deodorizer, but as an antiseptic and antimycotic it is quite useless.

In conjunction with hydrochloric acid it renders bone sectionable in a few hours. (It has, however, no action on elastin or keratin.) The addition of hydrochloric acid to the saturated watery solution of phloroglucin bears a direct relation to the hardness, i. e. to the amount of phosphate, in bone. The acid must be pure, but not fuming. For bones of Batrachia, 5–10 per cent.; of Reptilia and Aves, 10–20 per cent.; of mammals, 20–40 per cent. additions of hydrochloric acid are recommended. The softening of mammalian bones may be hastened by increasing the quantity of hydrochloric acid. After the desired consistence is attained, all trace of acidity must be removed by frequent washing in water, and the preparation treated by any of the ordinary methods of hardening.

The foregoing process has been further elaborated † as follows:—The

* Centralbl. f. d. Med. Wiss., Nos. 12, 33, pp. 195, 579. Cf. Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 375–6.

† Internat. Monatschr. f. Anat. u. Histol., i. (1886) pp. 350–3.

objects softened by means of phloroglucin and hydrochloric acid are afterwards hardened by one of the recognized methods. As many injection masses are thereby softened, Dr. Andeer recommends, if blood-vessels are in question, impregnating the walls of the vessels with mineral colours instead of injecting their lumen. Injection of solution of ferro or ferridcyanide or sulpho-cyanide of potassium, followed by iron chloride, gives excellent pictures, and the preparations thus obtained are permanent and susceptible of any further treatment.

New Method of Mounting Protozoa in Balsam.*—M. A. Certes describes a new method of mounting Protozoa in balsam, discovered by M. Tempère: the specimens exhibited were of *Ophryoscolex* and *Balantidium* from the paunch of Ruminants. After the organisms have been fixed and coloured they must be passed through alcohol of 36°, 70°, and absolute; the last ought to be renewed at least twice, and should continue to act for about twenty-four hours. The absolute alcohol must then be replaced by pure benzole; a tenth of the alcohol in which the organisms are placed is removed by the pipette, and replaced by the same quantity of benzole; this operation is repeated ten times, at intervals varying from ten to thirty minutes. Care must be taken that the benzole mixes thoroughly; after the last addition it should be decanted, and pure benzole substituted. After twenty-four or forty-eight hours in the benzole, according to the size of the object, a fifth part of Canada balsam dissolved in benzole is added; this is repeated at intervals of from a quarter to half-an-hour; and the organisms may then be preserved in the tubes till wanted, or mounted at once. In mounting care must be taken that each drop holds in suspension a sufficient quantity of organisms.

Microscopical Technique for small Pelagic Objects.†—Prof. J. Brun gets rid of the organic detritus, &c., which accompanies the mud and ooze from which Polycistina, Radiolaria, Globigerina, Foraminifera, and Diatomaceæ are obtained, by heating the dried up mass with weak hydrochloric acid in order to remove the chalk. When the reaction is over the contents of the flask are poured on to a filter and washed. When dry the deposit is treated in a flask with twice its volume of strong sulphuric acid (for guanos 5–6 times this volume of acid is required). After standing some time the upper three-fourths of the acid which dissolves the chitinous débris is decanted off and to the thick black paste is added bichromate of potash in coarse powder until it begins to turn red. By the production of nascent chromic acid the last remnants of organic matter are destroyed; the residuum is then washed at first slowly and afterwards freely and by decantation. The last washings are made with distilled water. The now whitish residue is spread on large cover-glass to dry. Small sea animals may be obtained alive by sweeping them off the surface water in a silk veil fastened to a wire frame. The glairy mass of animals is then at once scraped into a 25 per cent. solution of neutral acetate of potash (solution one quart). The acetate, unlike alcohol, produces no deformity, it prevents decomposition, and is easily removed by washing with water. On the removal of the acetate the mass is treated for several days with cold concentrated hydrochloric acid and the flask frequently agitated. The species are then washed freely and calcined on the cover-glass at a dull red heat. Compact masses of fossil deposit are separated by heating to about 100° and then soaking in a boiling saturated solution of soda sulphate. This salt takes up water as it crystallizes and consequently its dilatation renders the mass

* Bull. Soc. Zool. Fr., xi. (1887), Proc Verb., pp. xix.–xx.
† Arch. Sci. Phys. et Nat., xvii. (1887) pp. 146–54.

friable enough for manipulation after the operation has been repeated once or twice. The mass must never be crushed as a large number of species would be broken.

For sorting and mounting the author uses a low objective (Zeiss *aa* or Seibert No. 1) and a strong ocular. An iron hand-support is fixed to the stage. A pig's or dog's eyelash fixed in a handle is used for picking out. No prism is used as the eye and hand soon become accustomed to the reversed position.

The selected specimens are deposited in a small drop of glycerin-gum lying on the surface of a cover-glass. The gum is made by dissolving 1 grm. of white powdered gum tragacanth in 50 grm. boiling distilled water and then adding to the filtrate an equal volume of pure glycerin. The cover-glasses should be 8–10 mm. in diameter and 1/10 mm. thick.

The selected specimens are arranged on the cover by centering the latter over a circle scratched on a slide. After having been washed with distilled water, the covers are placed in an incubator at 100° (or water-bath) in order to volatilize the glycerin, and hence fix the specimens to the cover.

For mounting diatoms, &c., the author uses balsam of tolu from which cinnamic and benzoic acids have been removed by prolonged boiling in a large quantity of water. It is then dissolved in rectified benzine, filtered, thoroughly dried, and finally dissolved in alcohol or chloroform. When soft the index of this tolu is 1·68, and 1·72 when dry. When the covers are quite dry the tolu thinned with benzine is added and finally a drop of the thicker balsam. The slides are then dried in a stove at a temperature of 60°–70° for an hour or two.

The author decries the artificial (arsenical) media for mounting as the formation of arsenious acid invariably takes place sooner or later and the specimens become useless.

Engelmann's Bacterium-method. — The controversy respecting the value of this method for determining the intensity of the evolution of carbon dioxide is continued by Pringsheim * and Engelmann,† to which Pringsheim ‡ again replies.

Cleaning Diatoms.§—Mr. A. L. Woodward gives the following as an easy and effective method :—

Coarsely powder the diatom-bearing earth, or the dried diatomaceæ, and mix with *bi*-sulphate of potash. Take a porcelain gallipot, about an inch high, and fill it about one-third full of the mixture of diatoms and bi-sulphate ; take the tongs and set it down among the glowing coals in the stove. The bi-sulphate immediately begins to fuse, and boils up as black as pitch. If the gallipot is not too full it will not boil over, but rises up and sinks back again and again until, as the sides of the pot begin to turn red the boiling mass becomes clear, and the bottom of the vessel is seen glowing hot through it. When the boiling ceases, lift out the pot and let it cool. Brush off any dirt or ashes that may be on the outside of the pot, and then put it in clean, hot, *soft* water, and let the contents dissolve, which they will soon do. Pour off the water, and replace with clean, soft water, repeating this several times to get rid of the acid. Then shake up in a test-tube, let the sand settle, and pour off the diatoms, repeating this process, also, if necessary.

In the author's hands this process has given very fine results, and

* Ber. Deutsch. Bot. Gesell., iv. (1886) Gen. Versamml., pp. xc.–xcvi.
† Bot. Ztg., xlv. (1887) pp. 100–10. ‡ Ibid., pp. 200–4.
§ Scientif. Enquirer, ii. (1887) pp. 70-1.

noxious fumes from boiling acids are avoided. The process was originally suggested by Mr. G. C. Morris, of Philadelphia; he, however, suggested the use of a platinum crucible, which is costly. The porcelain gallipot answers every purpose, while the expense is merely nominal.

Preparing Bacterial Material for Transmission by Post.*—Dr. G. Marzi has devised the following method for transmitting specimens of bacterial material by post, &c.

Square pieces of gelatin leaf, about 14 mm. broad by 25 mm. long, are soaked for five minutes in a 1 per cent. solution of sublimate in absolute alcohol. These having been repeatedly washed in alcohol, are placed under a sterilized bell-jar to dry. A small quantity of the bacterial material (a pure cultivation, blood serum or the like) is then spread with a platinum wire on the gelatin leaf near the edge. When the preparation is quite dry it is rolled in sterilized tinfoil, put in a case and labelled. Two specimens should be sent, one for microscopical examination, the other for cultivation.

The receiver, after having unrolled the tinfoil, rubs the gelatin disc on the surface of a cover-glass moistened with sterilized water. To the cover, the greater part of the bacterial material adheres, and can be used at once after staining, for microscopical examination or for cultivation purposes.

If it be certain that the culture be pure and that the microbes are alive, the second specimen can be used for cultivation on gelatin; if not perfectly pure, the isolation method must be adopted.

Technical Method of Diagnosing Gonococci.†—M. G. Roux recommends the following method of determining the absence or presence of the *Gonococcus* of Neisser, which has hitherto been very difficult. When it is attempted to detect micro-organisms in any organic liquid, the method of double coloration of Gram is generally adopted, that is, after the preparation has been dried and stained by methyl-blue or gentian-violet, it must be submitted to the iodized iodine liquid of Gram, which possesses the property of fixing the anilin colours on the microbes exclusively; the preparation is then decolorized by alcohol, treated with distilled water, and re-stained with eosin; although this method generally succeeds with secretions, it always gives a negative result if *Gonococcus* alone is present. In doubtful cases, then, if *Gonococci* have been recognized on staining by gentian-violet or other reagent without the addition of alcohol, it is only necessary to adopt the method of Gram; if, then, all the cocci disappear they are those of Neisser; if, on the contrary, they or any remain, there must be doubt as to the blennorhagic nature of the secretion.

Preparing Crystals of Salicine.‡—Dr. F. L. James writes as follows:—"Some years ago the writer, after finishing a lot of slides of various crystals for examination under the Microscope, poured a few drops of a solution of salicine on a piece of window glass, and left them to crystallize. Some days afterwards, on examining the glass, he was surprised and delighted at the gorgeous beauty of the crystals. Two of the drops had crystallized so that the glass could be cut away into slides and mounted. These two specimens have been shown annually at the meetings of the American Society of Microscopists, and have been seen and admired by thousands, not one of whom had ever seen their equal. Words utterly fail to give any idea of their splendour. 'Nothing,' said a gentleman at Cleveland, 'short of the Pearly Gates can compare with them.'

Although during the past four or five years I and my students

* Riforma Medica, 1886, No. 21.
† Comptes Rendus, ciii. (1887) pp. 899–900.
‡ St. Louis Med. and Chirurg. Journ., li. (1886) pp. 280–1.

have made many hundred and even thousands of attempts to duplicate these results, up to very recently these two slides have remained unique. After the Chautauqua meeting, where they were again the centre of admiring crowds, I commenced a series of systematic experiments, discarding old methods altogether, and can now announce that I have found a method by which I can get slides, even more magnificent, with absolute certainty; and I have now in my cabinet a dozen, any one of which distances in every respect the old preparations, magnificent and beautiful as they were. I am continuing my experiments with other crystallizable materials, and when they are completed will explain the methods by which the results are obtained. I will say, however, that the size and the form and method of growth of all crystals yet experimented with are modified by the temperature at which crystallization takes place; the degree of saturation of the mother liquor or solution; the position in which rests the slip on which crystallization progresses; the medium used for solution; and, finally, by the material used for retardation of crystallization."

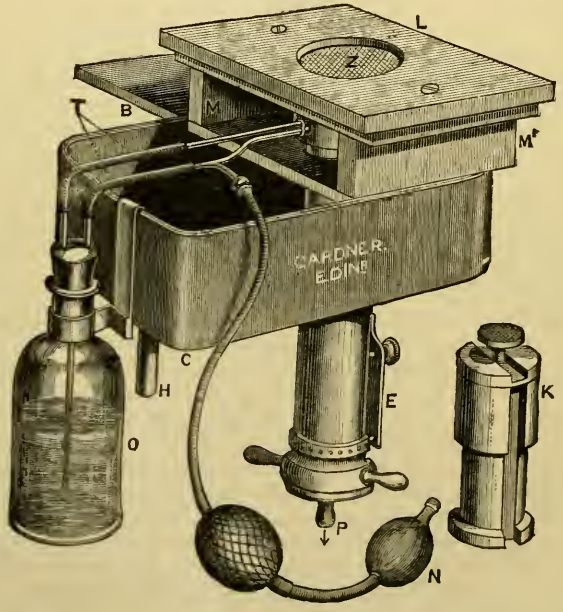
LATHAM, V. A.—**Practical Notes on preparing Palates of Molluscs, Snails, &c.** *Scientif. Enquirer*, II. (1887) pp. 87–9.

TURNER, W. B.—**Desmids.** [Directions for preparing.] *Trans. Leeds Naturalists' Club*, 1886, pp. 16–8.

(3) Cutting, including Imbedding and Microtomes.

Rutherford's Combined Ice and Ether-spray Freezing Microtome.*—Prof. W. Rutherford's well-known microtome is now adapted for freezing

FIG. 148.



by means of an ether-spray apparatus, as well as by the original ice and salt method.

* Lancet, 1885, i. pp. 4–6 (2 figs.).

Fig. 148 shows the instrument as arranged for the spray. The gum-imbedded object placed on the zinc plate Z is frozen by means of a spray of anhydrous ether contained in the vessel O having the tubes T. The superfluous ether runs down through the tube P to a collecting bottle. The spray-tubes are fixed in a slot under Z, so that they are easily removed if required. Instead of the hand-bellows N a pedal pump can be employed. There is an indicator at E. The zinc plate Z is insulated from the surrounding metalwork by means of a vulcanite casing. When used with ice, the glass plate L, the supports M and M′, and the spray apparatus are removed; Z is unscrewed, and replaced by the plug K. The glass plate L is next fitted on the brass plate B, and then the instrument is ready for use. When the box C is filled with the ice and salt mixture the tube H is kept plugged until the box becomes quite full of water. The gum solution is poured into the well and the object immersed therein. The mouth of the well is then closed by means of a guttapercha sheet fixed down by a flat leaden weight, and the whole instrument wrapped up in flannel until the freezing is complete.

A special advantage claimed for this instrument is the facility with which delicate sections are removed from the knife into water, or at once on to the slide.

The knife required for this instrument is of a special construction, and when used is pushed over the glass plate and across the well at a right angle. Hence the knife does not remain sharp very long.

Machine for cutting Rock-sections.*—The machine devised by Dr. H. Rauff does not differ in principle from those which are ordinarily used, but it is provided with adjustments of a new form, by which the rock-specimen may be firmly fixed in any desired position with respect to the cutting-disc. The construction is that of an ordinary turning-lathe, the disc being worked by a treadle and grooved flywheel, while the specimen is held in a support which slides along the horizontal slot of the lathe-bench, and is clamped by a nut from below like the movable rest of a turning-lathe. The rock is held, not by cement as is generally the case, but in a vice capable of holding large fragments: the block which carries this vice is provided with two horizontal rectilinear sliding movements at right angles to one another, one of which is worked by a screw-worm and handle, and the other by a weight acting over a pulley, which keeps the rock in continual contact with the cutting-disc. In addition to these movements the vice-piece can also rotate about a vertical and horizontal axis, and the plate to which it is attached is adjusted and fixed by four levelling-screws. The bearings of the axle and the various parts of the machine are made so massive as to insure greater stability than such machines generally possess.

Sections of Chitinous Organs.†—Herr P. F. Breithaupt, in his investigations into the structure of the bee's tongue, made use of eau de Labaraque (subchloride of potassium), which, after long-continued treatment, dissolves chitin, while it has a preservative action on the neighbouring tissues. The concentrated solution of eau de Labaraque was diluted with three to four parts of water. After washing with water and 35 per cent. alcohol the preparations were hardened by absolute alcohol, cleared up in oil of cloves and imbedded in Canada balsam; those which were adapted for cutting were, after treatment with oil of turpentine, imbedded in a

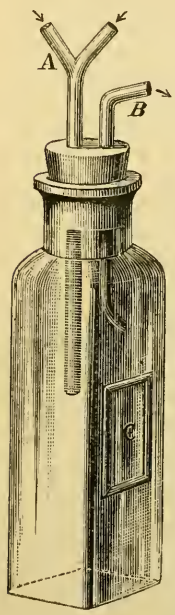
* Verh. Naturhist. Ver. Preuss. Rheinlande, xliii. (1886) Corr. Bl., pp. 130-9 (3 figs.).

† Arch. f. Naturgesch., liii. (1886) pp. 53-5.

paraffin wax mixture, in which were three parts of white wax to one of soft paraffin. The objects were gradually cooled, and sections were made at a temperature of at least 17° R. Schanze's microtome, which is regulated to cut sections from 1/100 to 1/150 mm., was used, and the objects were fixed by Giesbrecht's method. In cutting sections it is important to begin at the hinder end or to follow the direction of the hairs.

Orienting Objects in Paraffin.*—Mr. E. A. Andrews has improved the method of Dr. Selenka† for keeping paraffin melted while the contained small objects are being arranged under the Microscope in any desired position, and then rapidly cooling the paraffin without disturbing the position of the objects.

Fig. 149.



Finding it difficult to make tubes such as Prof. Selenka described, which should be of such shape as to admit of removing the hardened paraffin readily, and at the same time with depressions of sufficient size for any but very minute objects, Mr. Andrews made use of the following simple device, which, though more clumsy than the tube of Selenka, can be used for objects 1 mm. long and much larger, while giving a block of paraffin of very regular shape and with rectangular sides.

A common flat medicine bottle is fitted with a cork through which two tubes pass, or, if the mouth is small, one tube may be fastened into a hole drilled into the bottle. One of these tubes A is connected with hot and cold water; the other B is a discharge-pipe for the water entering the bottle by A, and raising or lowering its temperature as warm or cold water is allowed to flow in. On the smooth flat side of the bottle four pieces of glass rods or strips are cemented fast, so as to inclose a rectangular space C, which forms a receptacle for the melted paraffin. As long as the warm water circulates through the bottle the paraffin remains fluid, and objects in it may be arranged under the Microscope by light from above or below, and can be oriented with reference to the sides of the paraffin-receptacle or with reference to lines drawn upon the surface of the bottle. When the cold water is allowed to enter in place of the warm, the paraffin congeals rapidly, and may be easily removed as one piece. The discharge-pipe should open near the upper surface of the bottle, to draw off any air which may accumulate there.

Orienting Small Objects.‡—It is frequently a very difficult matter to properly orient small objects, especially spherical eggs, so that sections may pass through any desired plane. In working on the embryology of the common shrimp, Mr. J. S. Kingsley found the following process very convenient:—Impregnation with paraffin is accomplished in the usual way, and then the eggs (in numbers) in melted paraffin are placed in a shallow watch-crystal. They immediately sink to the bottom, and then the whole is allowed to cool. The crystal, glass upwards, is now placed on the stage, and the eggs examined under a lens. In this way one can readily see exactly how any egg lies, and then with a knife it may be cut out with the surrounding paraffin, and in such a way that it can readily be fastened to the block in any desired position. After all which have been dropped in a

* Amer. Naturalist, xxi. (1887) pp. 101–2. † See this Journal, 1885, p. 1086.
‡ Ibid., p. 102.

suitable position are thus cut out, the paraffin is again melted, and after stirring the eggs the cutting out is continued as before.

Method for Reconstructing Small Microscopic Objects.*—Dr. N. Kastschenko's method depends on the principle of obtaining two intersecting and perfectly smooth surfaces which he terms definition planes. In respect to the reconstruction of the object, he follows previous methods, especially that of His. He imbeds his object in paraffin and stains the surface of the block with lampblack dissolved in about ten times its bulk of turpentine. The stained block *a* is in its turn imbedded in paraffin (fig. 150). The accuracy of the surfaces is obtained by means of the machine (fig. 151)

Fig. 150.

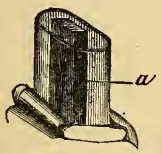
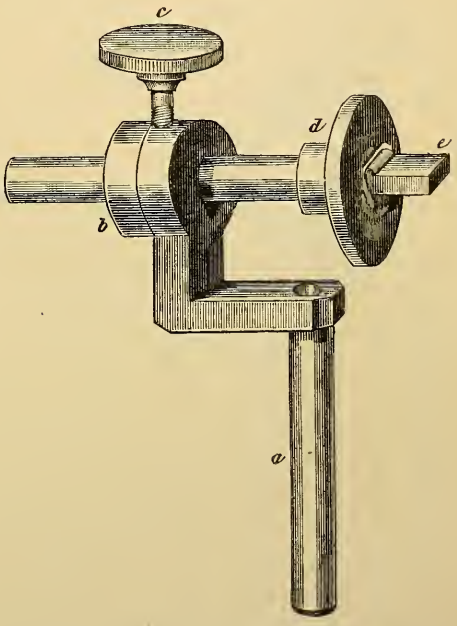


Fig. 151.



invented by the author, and intended to be adjusted to the Schanze microtome. It consists of a bar *a* bent twice at a right angle: through the ring *b* at its upper end runs a bar, terminated by a circular disc *d*, to which the preparation *e* is attached: the horizontal bar is fixed in the desired position by the screw *c*.

The construction of the object is effected in the usual manner, and is divisible into two chief groups, surface construction and serial construction. For the former, transparent material, such as glass, wax-paper, are employed to obtain a figure from the superimposed sections. Under some circumstances the camera lucida may be used to draw successive sections on the same paper. For surface construction, longitudinal sections are the most suitable.

In serial construction the reproduction of the object is easily obtained by the aid of the definition lines, which are made in every drawing of a section in the same position as far as regards the *definition surface*, but which will of course vary in reference to the parts of the object (cf. figs. 152 and 153, *e f*, *g h*). Axial revolution of the object renders reconstruction more complicated; in this case it is unavoidably necessary to draw a circle with the same radius in each section, so that its position in relation to the definition surfaces shall remain the same for every drawing (figs. 152 and 153). Hence the position of the various organs of the object which lie in a

* Arch. f. Anat. u. Physiol.—Anat. Abtheil., 1886, pp. 388–94 (1 pl.).

definite plane is projected upon the corresponding diameter of the described circle.

The employment of definition surfaces renders possible not only accurate reconstruction but also determines the change of form of the whole

Fig. 152.

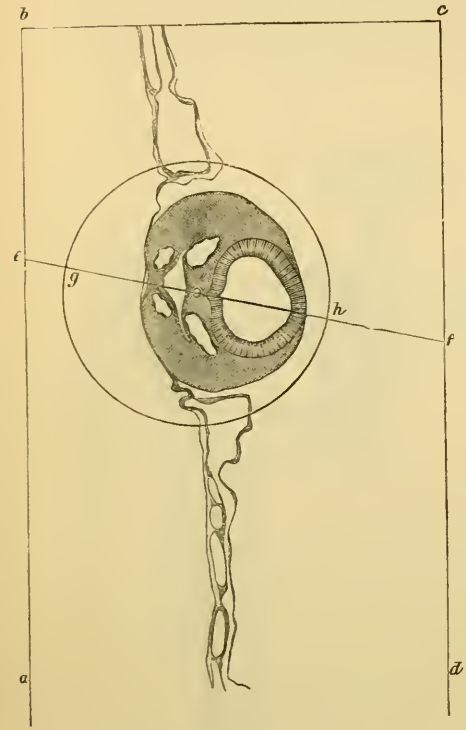
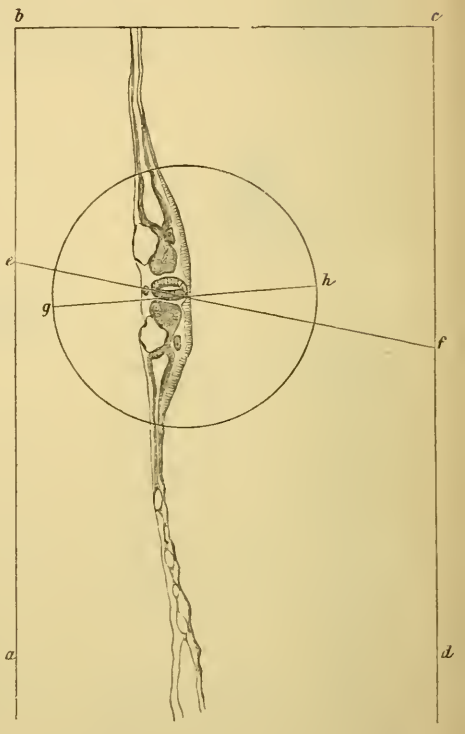


Fig. 153.



object, the position of its various parts in the successive sections, and even allows the size of the angle about which the object has turned to be calculated.

Reeves, J. E.—**How to work with the Bausch and Lomb Optical Co.'s Microtome, and a method of demonstrating the Tubercle Bacillus.**
27 pp., 8vo, Rochester, N.Y., 1886.

(4) Staining and Injecting.

Absorption of Anilin Pigments by living Vegetable Cells.*—Dr. W. Pfeffer continues his researches on this subject, using for his experiments solutions of one part in a million of the pigment, and in the case of methyl-violet, one part in ten millions. If the pigment which enters the cell remains unchanged, the concentration must remain the same inside and outside the cell, and no staining could be detected under the Microscope. Any tinging of any part of the cell must be due to a chemical change in the pigment;

* Unters. Bot. Inst. Tübingen, ii. (1886) pp. 179–331. Cf. this Journal, *ante*, p. 172.

and if the new compound is also coloured, and either not or only slightly diosmotic, a perceptible accumulation of pigment takes place in the cell. The absorption and storing up of the anilin pigments is not connected with the vital activity of the cell. The following are absorbed by the living cell, viz. methyl-blue, methyl-violet, cyanin, Bismarck-brown, fuchsin, saffranin, methyl-orange, tropæolin, methyl-green, iodine-green, Hoffmann's violet, gentian-violet, rosolic acid. No special staining of the cell-nucleus or chromatophores was observed in any case, but a tinging of the protoplasm with all except methyl-blue, and an accumulation in the cell-sap with all except rosolic acid; the microsomes, granules, and vacuoles were also stained. No absorption appeared to take place of nigrosin, anilin-blue, marine blue, anilin-grey, eosin, or Congo-red.

In a subsequent communication,* Dr. Pfeffer states that methyl-blue is largely absorbed by the living cell, a definite chemical compound with tannic acid being formed. The pigment subsequently either remains in the cell or passes out into the surrounding water. This exosmose can also be brought about by the action of citric acid. He suggests that these phenomena may illustrate the analogous phenomena exhibited by the food-materials of plants.

Modification of Weigert's Method of Staining Tissues of the Central Nervous System.†—Dr. N. M. Gray hardens specimens in Müller's or Erlicki's fluids, and then transfers directly to 70 per cent. spirit, and afterwards to absolute alcohol for several days. They are then soaked for one or two days in a mixture of equal parts of ether and absolute alcohol, and next transferred to a solution of celloidin, and eventually imbedded in celloidin on cork. The pieces, still fastened to the cork in the celloidin, are immersed in a solution of neutral acetate of copper (a saturated filtered solution of this salt diluted with an equal volume of water), and allowed to remain in an incubator at 30° or 40° C. for one or two days. The specimens become pea-green after the copper treatment, and the celloidin of a blueish-green. They may now be preserved in 80 per cent. spirit indefinitely. After having made sections, which must still be kept clear of water, they are immersed in the hæmatoxylin solution, the formula for which is as follows:—Hæmatoxylin (Merck's, in crystals) 1 part, absolute alcohol 10 parts, water 90 parts. Boil twenty minutes, cool and filter, and to each 100 parts add 1 part of a cold saturated solution of lithium carbonate. The time for staining varies; in general, the larger, the sooner the result: for cord sections 2–3 hours are enough; for brain sections twenty-four hours are required to colour the very fine fibres of the cortex.

After staining, the sections, now black, are decolorized by immersion in the following fluid:—Borax 2 parts, ferricyanide of potassium 2½ parts, water 100 parts. For cord, half to several hours; for brain sections longer.

From this solution, the sections are transferred to water and well washed, then to 80 per cent. spirit, then absolute alcohol, then cleared up in xylol or creosote, and mounted in xylol- or benzole-balsam.

Modification of Golgi's Method for Staining the Central Nervous System.‡—Signor Tal modifies Golgi's method as follows:—The small pieces of the central nervous system previously prepared by Golgi's method (hardening in bichromate of potash, and subsequent treatment with a 1/2 per

* Ber. Deutsch. Bot. Gesell., iv. (1886) Gen. Versamml., p. xxx.
† Amer. Mon. Micr. Journ., viii. (1887) pp. 31–2, from Med. News, 1886.
‡ Gazz. Ospit., vii. (1886) No. 68.

cent. of corrosive sublimate), are placed in a solution of sulphide of soda. The mercury, already reduced from the sublimate, is changed into sulphide, and the preparations become blackened. The tissue, which has not undergone the influence of the foregoing reaction, is stained with a solution of Magdala red, which gives extremely beautiful pictures. Even Golgi's nitrate of silver method is improved by after-treatment with sulphide of soda.

China-Blue as a Stain for the Funnel-shaped Fibrils in Medullated Nerves.*—Signor C. Galli has succeeded in staining with China-blue the spiral or funnel-shaped fibres of the myeline sheath of peripheral nerves, about the existence of which there was once considerable dispute.

The procedure, which is very simple, is as follows :—The sciatic nerve, carefully cut out from a recently killed animal, is placed in Müller's fluid for eighteen to twenty days. It is then cut up into pieces 5 or 6 mm. long, and these pieces are placed for one or two days in a mixture of one part Müller and two parts water. They are then cut up lengthwise, and immersed in a few drops of glycerin to which glacial acetic acid has been added in the proportion of one or two drops of acid to 1 or 2 c.cm. of glycerin. In this they remain for fifteen to twenty minutes, according to the greater or less acidity of the glycerin. The pieces are then placed in ordinary spirit, where they lose the excess of their colour, and are then coarsely teased out. They are next dehydrated in absolute alcohol, and then cleared up in oil of turpentine. Lastly, a small piece is carefully teased out on a slide and then mounted in dammar.

From the author's description, it would seem that the staining is somewhat diffuse, so that sometimes the funnel-fibres are obscured by the darker stain of the other constituents of the nerve, especially the sheath of Schwann. The blue stain colours the axis-cylinder, the myeline sheath of Schwann's membrane, as well as the funnel-fibres and the primitive sheath nuclei. From the illustrations given by the author, we gather that the axis-cylinder and the nuclei are the less colourable parts.

New Staining Method for Sections.†—Dr. H. Kühne thinks that it is advantageous to pass sections through a concentrated watery solution of oxalic acid and then thoroughly wash them before staining. For this purpose the author uses watery solutions of the dyes which in the case of fuchsin he combines with anilin or thymol water; of methylene blue with a 1 per cent. watery solution of ammonia carbonate; of violet with anilin or thymol + ammonia carbonate. Differentiation is not effected with acids and alcohol, but the sections are first dehydrated in absolute alcohol, to which some of the first used dye has been added.

Differentiation is attained by means of acid stains, of which fluorescin is the most universally applicable. This is dissolved in oil of cloves, and from the mixture the sections are passed through turpentine to xylol and then to xylol balsam.

Double Staining with Orcin.‡—Dr. O. Israel has introduced a new dye, orcin ($C_4H_7NO_6$), to microscopical and especially to bacteriological technique, being suitable for most bacteria as well as for various tissues. It is a vegetable dye which unites in itself the staining properties of the basic and acid stains, and also the combination of two contrast colours.

If sections of actinomycotic tissue be placed in a saturated acetic acid solution, the fungus assumes a dark Bordeaux-red hue, which is the more

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 465–70 (1 pl.).
† Zeitschr. f. Hygiene, i. (1887) p. 553.
‡ Virchow's Arch. f. Path. Anat. u. Physiol., cv. (1886) p. 169.

pronounced if the surrounding tissue be quite decolorized with alcohol. If, however, decoloration be not carried so far, it will be found that in addition to the fungus, the nuclei of the surrounding tissue are blue and the protoplasm red. As glycerin extracts the blue colour, preparations must be mounted in balsam.

As dehydration conducted in the ordinary manner would deprive the sections of colour, it is necessary, after having washed in distilled water, to pass rapidly through absolute alcohol to the slide, where the excess of spirit is to be quickly blotted up. A drop of thick cedar-oil is then added, and as this soon hardens, balsam need not be applied. Thus prepared, specimens have kept well for five years.

Double Staining with Echein-green and Carmine.*—Mr. J. D. Beck states that he has met with splendid results by a combination of echein-green (an acid dye) and carmine. He first stains the sections with the echein-green for five seconds to ten minutes. They are then washed in distilled water from 150° to 212° Fahr. for two to twenty minutes. If time allows, cold water acting for a longer time acts as well. Alcohol first of 60 and then of 95 per cent. hastens the process. The object of the foregoing is to remove all acidity before staining with carmine. The sections are tested for acidity by allowing some water from the slide on which a section is placed to drop on the tongue, or to add some carmine to the slide water and examine under the Microscope to see if any precipitate occurs when ammonia carmine is added. If all traces of acidity be removed, the carmine staining may be proceeded with.

When sections have a feeble affinity for green, the author mounts in the following medium:—White sugar syrup 1 oz., pure glycerin 10 to 30 drops; mix thoroughly. When stained the section is first cleared in pure glycerin, the surplus of which is washed off with water; the latter is evaporated and then the syrup added.

Stained Permanent Preparations of Cover-glass Cultivations.†—Dr. F. Lipež's method for preparing and staining cover-glass preparations suitable for observing under high powers the developmental changes in micro-organisms, consists in first obtaining a thin layer of the nutritive medium previously inoculated to any desired degree with the micro-organism to be examined. The medium is kept in a water-bath at a temperature of 25° or 40° C., according as gelatin or agar is used. With this the surface of the cover-glass is moistened and the superfluous matter drained off with blotting-paper. A film about 0·08 mm. thick is thus obtained. The covers are then placed in a moist chamber or in an incubator, and are then withdrawn at definite intervals. They are dried (best over strong sulphuric acid), stained, decolorized, and mounted in balsam.

The most difficult part of the operation is to decolorize the gelatin or agar without removing the stain from the organisms. The behaviour of the various dyes and of the nutrient layers is very different, but the author mentions, provisionally, that methyl-green is easily removed, and that alcohol and carbonate of potash may in a measure be relied on for decolorizing. Again, some care is necessary to prevent the "fluidifying" bacteria from being washed away, while of other varieties many stick firmly to the cover even after the medium has been removed.

New Methods of using Anilin Dyes for staining Bacteria.‡—Mr. E. H. Hankin premises that in the methods he describes care must be given

* The Microscope, vii. (1887) pp. 69–71.
† Centralbl. f. Bacteriol. u. Parasitenk., i. (1887) pp. 402–3.
‡ Quart. Journ. Micr. Sci., xxvii. (1887) pp. 401–11.

to the hardening of the sections; Müller's fluid must always be used, and the tissues cut into very small pieces.

For the first method the materials required are (1) a strong watery solution of methyl-blue or Weigert's anilin oil solution, (2) a saturated alcoholic solution of eosin, (3) a pipette, (4) absolute alcohol kept as free as possible from water, (5) benzine and clove-oil in equal parts, with an addition of absolute alcohol, sufficient to dissolve the turbidity which appears on shaking these reagents together, (6) fresh and nearly colourless oil of cloves, (7) benzine, xylol, or cedar-oil. The sections, on being taken from spirit, are placed in the methyl-blue solution, and eosin is immediately dropped in from the pipette—about equal parts should be used. The sections should be at once removed to absolute alcohol, and, after a few seconds' shaking, placed in the benzine and clove-oil mixture; as soon as the effects of the eosin begin to be apparent, they should be placed in benzine and mounted. The whole process does not take more than a minute. Sections thus stained show the bacteria and the nuclei blue, the eosin stains the red blood-corpuscles orange, and the background of the tissue is of a rose-red tint.

Successful results were also obtained with watery solutions of Spiller's purple; as soon as the sections are placed in it an equal bulk of alcoholic Spiller's purple must be dropped in from a pipette; the sections are then dehydrated in absolute alcohol as quickly as possible, and removed to the benzine and clove-oil mixture. When cleared, the sections are placed in eosin dissolved in oil of cloves, which stains the background red, and turns out the excess of Spiller's purple; the sections are then washed in oil of cloves, passed through the benzine and clove-oil mixture, placed in benzine and mounted. A somewhat similar method was adopted with fuchsin or gentian-violet as the staining reagent.

In all these methods, advantage is taken of the well-known fact that benzine does not dissolve, and therefore fixes the anilin dyes; one of the advantages of placing sections in benzine before mounting is that any residue of clove-oil is removed. Some of the methods used give results which promise to be very permanent.

Staining Cover-glass Preparations of Tubercle Bacilli.* — Dr. H. L. Tohnan obtains very satisfactory results by the following modification of the Weigert-Ehrlich method.

(1) Anilin oil 30 drops, distilled water 3 oz. Shake vigorously for five minutes and filter.

(2) Saturated solution of fuchsin in 93 per cent. alcohol. Mix together in a watch-glass 2 dr. of No. i. and 15 drops of No. 2. Upon this drop the cover-glass, whereon the sputum has been applied in the usual manner, and allow to stain for twelve hours. Decolorize in 33 per cent. nitric acid until the colour has *almost* gone. By the use of heat the staining may be effected in from 30–60 minutes; but in this case the acid solution is not stronger than from 5 to 15 per cent.

The author recommends the following for preserving, and at the same time staining sputum. The patient puts the sputum first coughed up in the morning into a mixture of anilin oil solution, as above, 2 dr.; fuchsin stain 20 drops, carbolic acid 10 per cent. solution 5 drops.

This mixture is to be prepared fresh, and the sputum left therein for at least twenty-four hours.

This method, as far as time goes, is not to be compared to the Neelsen-

* The Microscope, vii. (1887) pp. 83-4, from 'Medical Record.'

Glorieux method described in this Journal, 1886, p. 537. The latter operation only takes five minutes altogether.

Staining of Syphilis and Tubercle Bacilli.*—Dr. B. Bienstock relying on the assumption that smegma bacilli owe their resistance to decoloration to a coating of fatty matter, bred various kinds of bacilli (of fæces, of green pus, of anthrax, and of typhoid bacillus) in butter-gelatin. According to his expectation, he found that the bacilli thus cultivated show the same resistance to acids as do those of syphilis and tubercle. The material employed was 100 grm. of agar-gelatin mixed with about 20 grm. of boiled butter. The mass having been sterilized is placed in test-tubes and frequently shaken up and the test-tubes put in an oblique position, in order that only a small drop of butter may find its way to the top of the gelatin when it sets. The bacilli grown in the butter-layer were found to possess the staining property alluded to, but not those found in the layers below or above.

The author explains these facts by supposing that the fat-envelope permits the passage of colouring matter but resists the penetration of any decolorizing watery fluid. The staining of tubercle is, according to the author, due to a mantle of fat derived from the necrosed tissues or from the blood-serum; and if this be the cause the diagnostic value of the Ehrlich stain is lowered and ceases to be a characteristic of tubercle bacilli.

Staining Syphilis Bacilli.†—After the ordinary fixative in the flame and staining with fuchsin, Dr. De Giacomi washes the cover-glass with water in which a few drops of iron chloride are dissolved, and then decolorizes in concentrated iron chloride. The bacilli appear red; no other bacilli are stained. The preparation may be contrast-stained if desired.

Staining Micro-organisms in the tissues of children affected with hereditary Syphilis.‡—Drs. M. Kassowitz and C. Hochsinger have found, especially in the blood-vessels of the affected organs, collections of chain-cocci. The authors employed Gram's method. For permanent preparations it was found advisable either to leave the sections in the gentian-violet solution for 12 to 24 hours, or to use a concentrated solution (30 parts alcoholic gentian-violet solution to 70 parts anilin water). Acids completely decolorized the bacteria. Double staining was effected by means of picro-carmine, the solution being afterwards washed in a 1 per cent. hydrochloric acid alcohol, and then neutralized in a half per cent. solution of potash. By the foregoing method the bacteria appear dark blue, and the rest of the tissue a brightish red.

Staining of Lepra Bacilli.§—The well-known rapid disappearance of the stain from lepra bacilli induced Dr. P. G. Unna to ascertain the reason for this phenomenon, in order to be able to meet it by proper rules. The original supposition that the decoloration of the permanent preparations in question depends on an oxidation of the resins and ethereal oils used for clearing up and for mounting, was not confirmed: it rather turned out that if, as there is no doubt from Dr. Unna's experiments, an oxidizing action comes into play in the decolorizing of balsam preparations, this at any rate is to be regarded only as a reduction of the anilin colours. In order to trustworthily demonstrate the affinity for oxygen of the ordinary (i. e. in use) clarifying and mounting materials, Dr. Unna recommends the

* Fortschr. d. Med., iv. (1886) p. 193.
† Correspbl. d. Schweizer Aerzte, 1885, No. 12.
‡ Wiener Med. Blätter, 1886, Nos. 1–3.
§ Monatschr. f. Prakt. Dermatol., Ergänzungsh. 1885, p. 47. Cf. Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 557–9.

following method, communicated to him by Dr. H. Hager. The fluid or its solution in absolute alcohol or benzol is treated with a few drops of mercury nitrate. If the body have any affinity for oxygen a grey metallic deposit is thrown down.

The results which Dr. Unna obtained with this test agree with the long known experience that oil of cloves and oil of turpentine are inimical to the anilin stains; for while, on the one hand, cedar oil as a clarifying agent and the hydrocarbons of the benzol-xylol series as solvents of the resins are superior to the former; yet on the other hand they show that the affinity for oxygen is detrimental to the anilin stains, for glycerin and carbolic acid, which, as is well known, quickly and permanently extract all basic anilin dyes, do not possess according to Hager's test, any reducing power. Together with the influence of oxygen there had been associated as a matter of course the acid nature of the resins which were charged with the decoloration of the preparations. Closer examination of the conditions showed that the acid reaction in itself did not so much represent the baneful factor, as rather the circumstance that the acids entered into new and unstainable combinations with the basic anilin dyes which were fixed in the tissues. In order to obviate as far as possible the latter contingency, the resins must be freed from all traces of ethereal oils by prolonged boiling and thickened to such a degree that they set immediately when applied to the preparation. But the deoxidation and the action of acids are not the only influences which make themselves felt; the remains of the acids (HNO_3HCl, acetic acid) used for the decoloration of sections are probably more dangerous than all the resin acids. Therefore for the removal of these residua the greatest care is required, for though we may avoid, as far as possible, all the mentioned sources of decoloration, there yet clings to the oil and balsam method the inconvenience of over-removal of the stain owing to the use of alcohol unavoidably necessary for dehydration.

Dr. Unna has now contrived a method which renders unnecessary not only the use of alcohol, but also the ethereal oils as clarifying media, preparatory to mounting in balsam—the so-called dry method. Here the stained sections, after decoloration by acid, and after staining with a second dye, are taken directly from water to be placed on the slide, and having next been carefully spread out and freed from superfluous water by pressing them with tissue paper, are heated slowly and carefully over a spirit-lamp to dryness. Upon the dried section and (if possible) warmed slide is poured a drop of the balsam selected. With regard to the permanence of the bacillar stain, the dry method, as far as can be gathered from Dr. Unna's comparative preparations, is not more efficacious than the oil method when carried out with the precautions insisted on by him. Yet the former, according to Dr. Unna's researches, which he reports in another treatise immediately following the one under discussion, and the contents of which cannot here be examined, should have, apart from their simplicity, the economy of material, time, and trouble, a noteworthy advantage for the recognition of micro-organisms and their relations to the tissues.

In a retrospect on the results thus obtained Dr. Unna gives detailed directions for carrying out both the dry and the oil methods, as modified according to the principles of the above-mentioned precautionary measures.

Solution of Hypochlorite of Soda with excess of chlorine as a Decolorizer.*—This solution is prepared by dissolving 8 parts of caustic

* Journ. de Micrographie, xi. (1887) pp. 154-5.

soda to 100 parts of distilled water, and passing chlorine through to saturation. The action is indicated by the following formula:—

$$2NaHO + 2Cl = H^2O + NaCl + NaClO.$$

The solution thus contains 7·45 per cent. of hypochlorite of soda. During the passage of the chlorine it is necessary to surround the solution with a mixture of salt and pounded ice, otherwise the temperature rises, and chloride and chlorate of soda are produced. The more effectual the cold, the greener is the colour of the fluid, but the greenness fades away by exposure to light and with lapse of time. The decolorizing action is proportional to the greenness of the solution, and is due to the presence of chlorine, and also to the hypochlorite of soda, which bodies act in virtue of their property of setting free nascent oxygen.

Experiments made with the foregoing solution by Prof. C. V. Ciaccio and Dr. G. Campari, on animal and vegetable tissues, have demonstrated its perfect efficacy, not only with the colouring matter of leaves and plants, but also with the pigment in the retina, in the chitinous investment of insects, and in melanotic morbid products. Hitherto these last three examples have been held to be unalterable. Specimens to be decolorized must first of all be hardened in alcohol and chromic acid or its salts.

LATHAM, V. A.—**The Microscope and how to use it. X.**
[Injecting—*contd.*]
Journ. of Microscopy, VI. (1887) pp. 102–11 (1 fig. and 1 pl.).

UNNA, P. G.—**Die Rosaniline und Pararosaniline. Eine bakteriologische Farbenstudie.** (Rosanilin and Pararosanilin. A bacteriological staining study.)
73 pp., 8vo, Hamburg, 1887.

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

Medium for clearing up Celloidin Sections.*—Dr. C. Weigert finds that a mixture of xylol and carbolic acid is efficacious for clearing celloidin sections stained with hæmatoxylin or carmine.

Three parts by volume of xylol are mixed with one part pure carbolic acid; and in order to be sure that water is absent from the mixture recently burnt, sulphate of copper is added. The copper sulphate is placed at the bottom of a 250 gram bottle, so as to form a layer about two cm. high. The mixture is passed over it, and the two are shaken up together. After standing, the clear fluid is decanted off.

This mixture is found to clear riband sections taken from 80 per cent. alcohol. It can only be used for carmine and logwood stained preparations, for basic anilin dyes are decolorized or removed from the sections by it. But for bacterial investigations, if the preparation be first stained with carmine, Gram's method, as used by Weigert, can be adopted, provided that anilin oil be substituted for the carbolic acid in the clarifying medium. The last method is, however, said to need improvement.

Reagents for clearing Celloidin Sections for Balsam Mounting.†—Dr. J. van Gieson finds that the only satisfactory reagent for clearing sections imbedded in celloidin is Ol. Origani Cretici, or Spanish hopfencel. This clears rapidly, even in moist weather, after dehydration in 95 per cent. alcohol. It is free from acid, and does not fade the Weigert hæmatoxylin stain if the preparations have been hardened for a long time in Müller, and are mounted in thick balsam. It is also good for Gram's method, the

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 480–81.
† Amer. Mon. Micr. Journ., viii. (1887) pp. 49–51.

simple anilins, logwood, and eosin. When fresh it is of a light amber colour, and does not clear readily, but after having been exposed to the air it becomes darker, and its action more rapid.

The author finds that oil of thyme causes the Weigert hæmatoxylin stain to fade, and that its clarifying property is weak, requiring very thorough dehydration, and that it corrugates the celloidin. An unfavourable opinion is expressed as to the value of Minot and Dunham's clarifier, viz. the mixture of oil of thymol and oil of cloves. Anilin oil clears rapidly, and leaves the celloidin quite pliable, but unless thoroughly (almost an impossibility) removed, the preparation becomes yellowish-brown. Xylol requires very thorough dehydration, and corrugates the celloidin. Bergamot clears well, but damages the stain, especially eosin. Creosote is of very variable composition; some kinds dissolve celloidin. M. Flesch recommends beechwood creosote.

Mounting Sections prepared by Golgi's Method.* — Signor Magini, in order to render permanent preparations obtained by Golgi's method, recommends that the sections when taken from the bichloride of mercury, should be placed in a mixture of equal parts of absolute alcohol, and wetted and shaken up. They are then immersed in creosote for about half an hour, and when on the slide, the creosote is carefully removed with blotting-paper, and the preparations mounted in dammar dissolved in chloroform and ether.

Rapid Method of Dry Mounting.†—Mr. A. W. Stokes takes a mixture of equal parts of paraffin wax and bees'-wax; a piece the size of a pea is placed on a glass or metal slip. This is heated till it melts and forms a thin film; in contact with this are placed the rings intended to form the cells. First one side, then the other side of the rings is brought in contact with the melted wax. The rings are taken off, and in a second or two are cold and hard. One of these is placed on a clean glass slip in the position desired, and heat applied below the slip till the waxed surface of the ring melts and adheres. It is now allowed to cool. The object meanwhile is dried in a desiccator over sulphuric acid or calcic chloride; it is then placed in the cell and fastened in position by a minute fragment of wax. Gum will not do for fixing the object, since if really dry it will not adhere at all. A cover-glass is now taken, one side cleaned and heated; while still hot it is placed on the top of the cell. This top surface having already, as described, been covered with wax, the glass at once adheres, and the object is dry-mounted permanently. There is no liquid to sweat, and no time wasted in waiting for the cell to dry. So strongly does the mixture of waxes adhere, that it is not easy, without applying heat, to detach either cell or cover-glass. Cells can be made out of tissue paper, if required very shallow, or any of the ordinary rings may be used. Vulcanite cells, expanding and contracting very nearly the same as glass with differences of temperature, are preferable. Of course, the cells may be finished off afterwards with any of the usual cements.

The method does not require any turntable, brushes, or other of the usual apparatus; it is claimed to be inexpensive, rapid, effectual, and permanent.

Experiments with Media of High Refractive Index.‡—Mr. W. Morris has made a large number of experiments on mounting media of high refractive index, the object used being *Amphipleura pellucida*. The paper

* Boll. R. Acc. Med. Roma, xi. (1885) No. 7. † Eng. Mech., xliv. (1887) p. 148.
‡ Journ. and Proc. R. Soc. N. S. Wales, xix. (1886) pp. 121–33.

cannot be fully summarized here, and the original must be referred to by those desiring to know the results obtained with the various media.

Success was obtained with sulphur by special manipulation; also with piperine, the alkaloid of pepper, and with "biniodide of mercury, solid," which consists of a saturated solution of the biniodide in piperine. The alkaloids of opium, with few exceptions, are all high-class media; and of the alkaloids generally, the author says "for bacteria mounting, quick work, and splendid definition, giving immensity of light even to the F eye-piece, I am certain they cannot be surpassed, the bacteria being shown like beads of coral when stained with a red dye." Good results were also obtained by holding the prepared cover-glass over the mouth of a vial containing chloro-chromic acid, a highly volatile liquid giving off red fumes when exposed to the air.

Numerous chlorides and iodides were experimented with, of which we select the following:—

Chloride of tin is used thus:—"On placing a small portion on the mica slip and subjecting it to heat, dense fumes mixed with the water of crystallization are given off; and when only a clear liquid is left behind, still giving off white fumes. The cover-glass is held in position with a pair of forceps to intercept the fumes, a white deposit is immediately formed, and the moment a sufficient quantity is deposited, the cover-glass is withdrawn and held over the heated mica until resublimation takes place, leaving a metallic 'scud' on the cover-glass. When mounted in piperine, if properly managed, the diatoms will be found lying in a film of chloride of tin, the striæ beautifully defined, of a steel-grey lustre, and around the edge of the valve a golden-yellow tinge. The author thinks the definition quite up to the phosphorus mounts. Being a deliquescent salt, it must be mounted when hot, if not, moisture will be again absorbed, and the slide will be found to be worthless when mounted."

Iodide of arsenic gives splendid definition to the striæ, and is also of value for mounting bacteria.

Iodide and bromide of silver, with a little manipulation, will rival any of the phosphorus and silver mounts.

Of chloride of tellurium, the author writes, "This preparation, manipulated in the same way as the chloride of tin, is the best medium for showing the *A. pellucida* that I have experimented with. The richness of the colouring is something grand to look at. The beautiful steel-grey striæ, bold and well-defined, with the golden-yellow tinged edge of the valve, makes this the most showy slide that can possibly be exhibited, and in my opinion surpasses Professor Smith's American slide, the medium of which has a refractive index of 2·4."

Of chloride of thallium, he says, "This is a very fine medium; instead of the steel-grey a sea-green colour is given to the striæ; with the golden-yellow tinged edge to the valve, it makes a very pretty exhibit. It has a propensity of causing the piperine to crystallize; this can be got over by using the valerianate of quinine as a substitute for the piperine. I do not think this impairs the resolution, whilst it still keeps up the chromatic appearance. Some of the valves are resolved as well as with the tellurium, others again have got a varnished look, as if the interspaces between the striæ were filled up, and after careful examination minute cracks may be seen in the thin film covering the diatom, as if the thallium had infiltrated itself between the cover-glass and diatom. Those valves found in this state are not so well resolved, giving a more faint look to the striæ."

By mixing chloride of thallium and chloride of tin together, and sub-

liming as usual, the difficulty of crystallization with the piperine is got over, and also the varnished appearance to the diatom, giving a resolution better than any previous medium. The valves may be seen with the central rib jet-black, striæ a greenish steel-grey, hard and crisp, the outer edge either black or yellow tinged, according to the amount of film the diatom is lying in.

The author, who discards ringing, states that he is "prepared to mount, clean, label, and resolve the *A. pellucida* under five minutes' time, in one of the high refractive media, and in no part of the world can the same feat be performed at the present time, so far as our micro information is to hand to date" (November 1885).

New preparation of the medium of high index (2·4) and note on Liquidambar.*—Dr. H. L. Smith's yellow medium consists, as previously noted, of realgar dissolved in bromide of arsenic. It is not, however, the product known in commerce as realgar, that is a brownish-yellow opaque substance with a vitreous fracture, but the realgar of mineralogists, of a beautiful reddish-yellow colour and perfectly transparent. When Dr. Smith published the formula of his medium, the realgar was produced by melting two parts of sulphur with one part of metallic arsenic and keeping the fused mass at a red heat for several hours. After several attempts at making realgar, Dr. H. van Heurck found that it could be more easily and satisfactorily produced by melting together one part of sulphur and 1·7 part arsenious acid in a retort, and raising the temperature to distillation point. Realgar thus obtained by distillation quite resembles the mineral variety. It is then dissolved, by heat in a test-tube, in tribromate of arsenic, also obtained by distillation. The product is a syrupy liquid of a greenish-yellow colour, almost black in large quantity.

The diatoms being fixed to the cover-glass by desiccation, are covered with a drop of the liquid medium. The cover-glass is then placed on the slide, and the latter strongly heated in the flame of a spirit-lamp. Large bubbles are given off and the medium assumes a deep red hue, while at the same time the bromide of arsenic volatilizes. When the ebullition and the volatilization are nearly ended, the heating is ceased, slight pressure is applied to the slide, and it is then allowed to cool slowly. As it cools the medium loses its red colour and finally becomes of a pale yellow hue. During the manipulation, which is not difficult in itself, care must be taken to avoid the dangerous vapours.

Prepared in the manner indicated above, the medium has two disadvantages, first, the liquid alters very quickly, and can only be preserved in tubes hermetically sealed, secondly two-thirds of the preparations are spoilt, often very rapidly, and without any apparent cause. In order to remedy these defects, Dr. H. van Heurck made in the past two years numerous experiments, and at last found a method of preparing a solid substance which can be preserved without undergoing change in the air; and the preparations mounted therein have hitherto kept most perfectly. The author prepares his medium by dissolving in a glass vessel 30 parts by weight of flowers of sulphur in 10 parts of bromine, and thus obtains a solution of sulphur in the bromide of sulphur (S_2Br_2). After perfect combination, 13 parts of metallic arsenic in impalpable powder are added, and the mass heated until the arsenic is perfectly dissolved. The mass is then poured into a porcelain dish and heated over an open fire and constantly stirred with a glass rod until it is found that a small drop is very brittle when cool. The medium is then poured into a cold plate, and when

* Bull. Soc. Belg. de Micr., xiii. (1886-7) pp. 20-4.

quite cold the mass is divided into pieces and preserved in a stoppered bottle. This glassy mass, of a greenish-yellow colour, is what the author calls the first degree, and its index of refraction is = 2·1203 or 2·12 according to calculations made by the firm of M. Zeiss.

On heating for a longer time the mass thickens and the index = 2·2534 or 2·25. During the preparation of the object a part of the sulphur volatilizes and when properly heated the index may be 2·4. The two products may be used indifferently but both, especially the second, are difficult to melt. If so desired they may be dissolved at the time of using in a little bromide of arsenic, but then the same inconveniences may arise as from Smith's original medium.

Liquidambar prepared according to the author's formula is obtainable from M. P. Rousseau of Paris. Samples of the liquidambar show that the mass is hard enough to fix the cover-glass without the aid of cement. It is used either in its firm condition or previously dissolved in a mixture of alcohol and chloroform. Liquidambar, like storax, is unalterable with age; it allows structural details invisible in balsam to be clearly seen, and it may be used for histological objects as well as for diatoms. Bacteria mounted in storax or liquidambar show infinitely better than in Canada-balsam.

Fixing Sections.*—Mr. H. E. Summers writes that the method of fixing sections to the slide, as recently given by him,† has been found to be needlessly complicated when used for celloidin sections. The following simpler method is recommended.

Place the sections in 95 per cent. alcohol for a minute or two, arrange on the slide, and then pour over the sections sulphuric ether *vapour*, from a bottle partly full of liquid ether. The celloidin will immediately soften and become perfectly transparent. Place the slide in 80 per cent. alcohol, or even directly into 95 per cent. if desired. The sections will be found to be firmly fixed and may then be stained, cleared, &c.

Neat method for Rimming Microscopical Preparations.‡—Dr. A. Hansen, after alluding to the difficulty experienced in rimming round the cover-glass of preparations mounted in glycerin with the usual varnishes or lacs, states that the difficulty is easily overcome if the edge of the cover-glass be first run round with glycerin jelly which mixes easily with any superfluous glycerin. When cool the jelly allows a further coat of any varnish: the neatest is dammar.

BROWN, J. F.—**Mounting Opaque Objects.**

[3 × 1 in. strips of heavy cardboard with a central hole 3/8 in. in diameter. "The object to be mounted is placed over the hole of one strip, and then a second strip is placed over the first and secured to it, thus firmly holding the object between them."]

Amer. Mon. Micr. Journ., VIII. (1887) p. 73.

CODLING, W. E.—**Notes on Mounting. 1. Materials.**

Wesley Naturalist, 1887, pp. 81-2.

FRAZER, A.—**On a simple form of Self-centering Turntable for ringing Microscopic Specimens.**

[(1) Much larger and heavier than usual, so that slides which have the specimen mounted *not* in the middle of the slide will not project beyond the edge of the disc when being ringed; (2) the springs are made with a special form of "washer," so that these (the springs) may be turned freely in any direction; (3) the turntable is provided with a simple arrangement, consisting of three screws, which are placed in such positions upon the table that slides either

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* The Microscope, vii. (1887) p. 73. † See this Journal, 1886, p. 544.

‡ Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 482-3.

of 1 in. or 1½ in., if placed against them, will be accurately centered; and the screws are also so arranged that when it is desired to use the turntable as a non-centering one, the screws may be depressed below the surface of the table.]
Trans. Edinburgh Naturalists' Field Club, I. (1885–6) pp. 333–4.

JAMES, F. L.—**Microscopical Technology.** [XV. Finishing the slide.]
St. Louis Med. and Surg. Journ., LII. (1887) pp. 36–41 (2 figs.).

(6) Miscellaneous.

Behrens's Tables for Microscopists.*—Dr. W. Behrens has here collected a series of very useful tables for microscopists and others. They comprise the comparison of the metric and English scales of lengths and weights as well as of thermometer scales; various tables of specific weights, refractive indices and dispersive powers; a numerical aperture table; and tables of hardening, fixing, imbedding, clearing, staining, and other media. There are fifty-four tables in all.

Method for Exhibiting Semi-Microscopical Objects.†—Herr F. Hilgendorf, after alluding to the difficulty of studying carefully small objects in museums, remarks that the exhibition of a large number of Microscopes is frustrated by the great expense and by the clumsiness of the public. The chief difficulty which arises from the differences of vision in different individuals, namely, constant alteration of focus, can be obviated by an ingenious contrivance such as has been employed by Dr. Zenker in the microscopical aquarium. This consists in every observer correcting his focus by means of a suitably chosen lens placed before the ocular, and with this lens traversing the whole series of Microscopes, each of which has been adjusted to the same focus.

The objects should be placed in a frame, the sides of which should be made of glass, and this frame, inclosing the specimens, set up in a vertical position close to a window. A hand-lens which allows a sufficient space between the glass and the eye for the nose and hand, would be necessary for examining purposes. The side plates of the frame must of course be made of smooth, clear, and not too thick glass. It will be found that at least 100 different semi-microscopical objects can be exhibited in each frame. As these frames stand only before the lower part of the window, darkening of the room need not be feared. If it be desirable to increase the number of preparations for examination, a contrivance adopted in some museums is recommended. This is an upright column around which are fixed a certain number of glass frames in such a manner that the latter can be made to revolve round the vertical axis.

The author enumerates certain objects suitable for such exhibition cases. These, beginning with the Protozoa, are chiefly Invertebrata, but many parts of vertebrates, such as fish-scales, otoliths, sclerotic rings, feathers, hairs, &c., are suggested.

Drying and Heating Apparatus for the Histological Laboratory.‡—Herr V. Meyer has had constructed an apparatus which, though intended for chemical work, may be found useful in the histological laboratory, instead of the incubator or hot chamber. In the latter the constancy of the temperature is maintained by means of the thermo-regulator. Meyer's apparatus dispenses with such adjuncts, because the temperature

* Behrens, W., 'Tabellen zum Gebrauch bei mikroskopischen Arbeiten.' (Tables for use in Microscopical Work.) 76 pp., 8vo, Braunschweig, 1887.

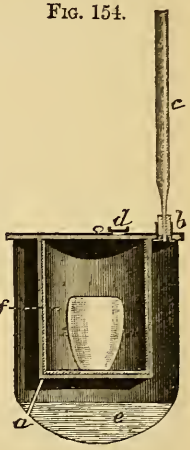
† SB. Gesell. Naturf. Freunde, 1885, pp. 13–6.

‡ Ber. Deutsch. Chem. Gesell., xviii. No. 17, p. 2999. Cf. Zeitschr. f. Wiss. Mikr., iii. (1886) p. 74 (1 fig.).

is kept constant by employing fluids of a definite boiling-point, as regards the required amount of heat, instead of a water-bath.

A double-walled vessel (fig. 154) contains the heating fluid *e* between the two walls, the object to be heated being within the inner chamber *f*. A tubular opening *b* in the top of the vessel carries a glass condensation-tube *c* for cooling the reflux air. Air-tubes *a* enter the dry chamber from below, and the cover has an opening *d*, which is closed by a slide. The apparatus is only intended by the inventor for high temperatures, but it will undoubtedly be easy to adapt it to the wants of microscopists for the use of fluids boiling at lower temperatures. The quantity of gas used is very small, a very small jet only being required to keep the fluid boiling.

Fig. 154.



Drying Apparatus for the Laboratory.*— Herr H. Rohrbeck has devised a drying apparatus which, by taking advantage of the circulating property of hot air, and by the adoption of a chamber for heating the air previously to its admission to the drying closet, is able to preserve an equable temperature in the internal chamber.

The apparatus, apparently, consists of a double walled case, five sides of which are protected by an asbestos layer. The internal chamber is surrounded by an interspace for the circulation of the exit air, while beneath its floor is situated a preliminary heating chamber subdivided into an upper and a lower compartment. The lower compartment is heated directly from beneath by a flame. From here the heated air ascends to the upper compartment, whence it finds its way through fenestrations to the dry chamber, out of which it passes to the interspace. Thus the dry closet is surrounded by warm air. The draught can be regulated by means of valves. The apparatus is closed by a double door and is provided with the usual thermometer and regulator.

Micro-chemical Analysis of Minerals.†—Dr. T. H. Behrens gives a description of methods used for the analysis of small fragments of minerals with the aid of the Microscope, based on the detection of the various constituents by conversion into various compounds, the crystallographic forms or appearance of which are well known.

The mineral is dissolved in hydrofluoric acid, or an acidified solution of ammonium fluoride, and the fluorides converted into sulphates under such conditions that the fluosilicates and fluoaluminates only remain unaltered. Then in the concentrated solution obtained the calcium is detected in the form of sulphate, the potassium as the platinochloride, sodium as a double sulphate of cerium and sodium, lithium as sulphate after separation of the calcium sulphate, and barium and strontium also as sulphates. The double phosphate serves to indicate the presence of magnesium, and an alcoholic solution of alizarin that of aluminium. For the detection of chlorine, mercurous is preferable to silver chloride; for fluorine the best reagent is sodium chloride, the fluoride being previously converted into a silicofluoride. Test analyses are given, which were made with 0·0002 gram of tourmaline, of an apophyllite, a boracite, and other minerals.

* Chem. Ztg., 1885, No. 21. Cf. Bot. Centralbl., xxvi. (1886) pp. 313-5.

† Rec. Trav. Chim., v. (1886) pp. 1-33. See Journ. Chem. Soc. Lond.—Abstr., (1886) p. 917.

Examining Fluid-cavities in Quartz.*—Dr. A. A. Julien, after describing the selection of the material and its preparation (by grinding thin sections or chipping off thin flakes), mounting and examination, points out that the chemical nature of the liquids and gases which occupy the fluid-cavities in quartz can be detected not only by chemical means, but by the use of a few simple microscopical accessories.

The expansion of the carbon dioxide by a slight increase of temperature above 20° C. is so great that advantage can be taken of its peculiar sensitiveness in this respect for its identification, on this minute scale, by very simple means. The simplest of all is a piece of rubber tubing, about 1 ft. long and 1/8 in. in bore. If the peculiar limpidness and delicate outline of the liquid in a fluid-cavity should lead the observer to suspect it to be liquid carbon dioxide, he has but to put this tube to his mouth, and blow a gentle stream of warm air for a minute or two upon the slide, from either above or below the stage. The simple warmth of his breath (about 32° C.) will be sufficient to convert the liquid carbon dioxide into a gas and thus to render its identification at once complete; for that temperature allows at least one degree to spare in reaching the point in the pure substance (31° C.) at which this change of state takes place. If there happens to be a gas-bubble of large size in relation to the layer of liquid in the cavity, the increase of temperature tends at the same time to expand the gas, and to cause the liquid to evaporate into the inner space. These two actions usually so counteract each other that hardly any change is visible. At other times, an appearance of boiling is produced. But when the temperature of 29° to 31° C. is reached, in an instant the liquid layer disappears, and nothing is visible within the cavity except the blurred outlines of its walls. The precise temperature at which liquid carbon dioxide thus passes entirely into the gaseous form within the cavity is termed its "critical point." This is a condition affecting all liquids, that is, all condensed gases; at a certain fixed temperature—which varies with the gas—the liquid flies into the gaseous state when heated in an inclosed cavity the walls of which are strong enough to resist the enormous pressure so resulting. When the slide has cooled back to the critical point (about 31° C.), the inclusion suddenly resumes the visible form it possessed before, or sometimes assumes the form of two or three bubbles, or even occasionally of a cluster or of a shower of bubbles. If the original gas-bubble happens to be much smaller in volume than that of the inclosing liquid, and the slide is warmed gently in the same way, the bubble will be seen to dilate steadily, often rapidly, with a similar sudden disappearance of the liquid layer near the critical point.

In all such experiments, however, the observer must be on his guard as to the temperature of the atmosphere, and of the mineral section at the beginning of the observation. In a warmly heated room, during the winter, and on a warm day, during the summer, the critical point may have been already passed and these transformations have become completed. In these circumstances, no indications of the presence of carbon dioxide will be visible at the first observation, unless care has been taken to keep the slide under examination cool, i. e. below 30° C., which may be done by previously dipping it in cold water. The temperature of the air at midsummer (30° to 33° C.) is often sufficient alone to bring the liquid up to its critical point under the eye of the observer.

In most mineral sections the fluid contents of the cavities consist of water or some saline solution which would usually remain but little

* Journ. N. York Micr. Soc., i. (1885) pp. 129–44.

affected in form or appearance during an experiment like that just described. Occasionally, however, the bubbles in a water-cavity are excited into lively motion and repelled into the farthest side of the cavity by the sudden application of heat. In place of a rubber tube, the application of a warm wire, glass rod, or of the burning end of a cigar, a little below the slide, may be substituted to produce the same effects—or even the direct application of the warm end of one's finger to the bottom of the slide for a few minutes.

The author gives an interesting description of the cavities and their contents, and the phenomena which they present.

Identification of Alkaloids and other Crystalline Bodies by the Microscope.*—Mr. A. P. Smith considers that whilst the number of cases in which a crystalline substance can be identified by the Microscope alone is extremely limited, yet, as a test of purity, microscopical investigation has a very wide application. When we are dealing with a substance that, when pure, crystallizes in a different form from any particular solvent, it is manifest that any departure from that form would lead to the suspicion of adulteration. If we take such a substance as bark, or opium, it is quite possible to distinguish from each other the various alkaloids which it contains. Besides the form assumed by the free base, it is of importance to convert it into a salt, as there is frequently a marked departure in the form of the crystals, e. g. quinidine and quinidine sulphate, cinchonidine and cinchonidine sulphate. There may be cases in which the salt and the base possess the same crystalline form.

Some experience is necessary in selecting the most suitable solvent from which to crystallize an alkaloid, as the duration of the evaporation may have a marked effect upon the form of the crystals. In some cases evaporation may be accelerated by the aid of heat; in others, such a proceeding is fatal to success. The addition of alcohol to ether, and of water to alcohol, appears to be the best means of retarding the process when necessary.

Polarized light should be employed to view the crystals, either with or without a selenite plate. Here, again, the duration of evaporation has a marked effect, also the strength of the solution. If the substance is deposited in a thin film, it may be altogether invisible without polarized light. Thick crystals frequently produce colour without the selenite, and those that are very thick may depolarize without any coloration. This being borne in mind, no difficulty is experienced in practice, as it is easy to compare with an alkaloid of known purity crystallized under the same conditions.

Figures are given of various substances crystallized under the best conditions, with the name of the solvent and the linear magnification, together also with a list of alkaloids and a description of the forms of the crystals.

Carpenè, A.—**Nuovo processo d' analisi delle materie coloranti, introdotte nei vini ed altri liquidi ed in sostanze alimentari solide, fondato sul coloramento dei micro-organismi.** (New process of analysing the colouring matters introduced into wine and other liquids and in solid alimentary substances, founded on the staining of the micro-organisms.) 11 pp. and 1 pl., 8vo, Torino, 1887.

Cole, A. C.—**Studies in Microscopical Science.** Vol. IV. Secs. I.–IV. Nos. 8–9 (each 4 pp.).

Sec. I. Botanical Histology. No. 8. Studies in Vegetable Physiology. VIII. Defoliation (Plate 8. A fallen leaf. Virginia Creeper: *Ampelopsis hederacea.* Long. sec. through the stem and base of petiole.) No. 9. Digestive Glands.

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* Journ. Postal Micr. Soc., v. (1886) pp. 210–8 (2 pls.), from 'The Analyst.'

(Plate 9. Vert. sec. of Leaf of Butterwort showing digestive hairs—slightly diagrammatic.)

Sec. II. Animal Histology. No. 8. Spermatozoa in the Invertebrata. (Plate 9. Spermatozoa of Invertebrata.) No. 9. Reproduction in Lamellibranch Mollusca. (Plate 9. Ovary of Mussel—*Mytilus*.)

Sec. III. Pathological Histology. No. 8. Acute Parenchymatous Nephritis (Acute Bright's Disease.) (Plate 8. Acute Interstitial Nephritis.) No. 9. Chronic Interstitial Nephritis. (Plate 9. Kidney in Leucocythæmia.)

Sec. IV. Popular Microscopical Studies. No. 8. Microbes (*contd.*). (Plate 8. Growing-points of stems.) No. 9. Roots, Stems, Growing-points and Leaves. (Plate 9. V.S. of Leaf of *Eucalyptus globulus* × 50.)

CROOKSHANK, E. M.—**Manual of Bacteriology.**
2nd ed., xxiv. and 439 pp., 137 figs. and 29 pls., 8vo, London, 1887.

Doherty's (A. J.) Histological Slides. *Amer. Mon. Micr. Journ.*, VIII. (1887) p. 52.

Harpe, E., de la.—See *Peyer, A.*

JAMES, F. L.—**Clinical Microscopical Technology.**
[I. Introductory. II., III. Examination of Urine.]
St. Louis Med. and Surg. Journ., LII. (1887) pp. 96–9 (1 fig.) 160–2, 231–3.

" " **Cleaning and drying Containers.**
[Directions for getting rid of minute quantities of water left in bottles after washing them, where the bottles are intended for holding oleaginous or balsamic mounting media or cements.]
St. Louis Med. and Surg. Journ., LII. (1887) p. 230.

LATTEUX, P.—**Manuel de Technique microscopique ou Guide pratique pour l'Étude et le Maniement du Microscope dans ses applications à l'Histologie humaine et comparée, à l'Anatomie végétale et à la Mineralogie. Introduction de M. le Professeur Trélat.** (Manual of microscopical technique, or practical guide to the study and management of the Microscope in its application to human and comparative histology, to vegetable anatomy, and to mineralogy.)
3rd ed., xvi. and 820 pp., 385 figs. and 1 phot., 8vo, Paris, 1887.

[MANTON, W. P., and others.]—**What practical use can the druggist make of the Microscope?** *The Microscope*, VII. (1887) pp. 55–6.
[By testing all crude drugs that come into his possession.]

" " " **Elementary Department. First and Second Lessons.**
"Cleanliness is akin to godliness."
[Lessons based on actual laboratory work, placing "before the beginner, in the most elementary and primer-like manner, the details of microscopical technique."]
The Microscope, VI. (1886) pp. 76–80, 106–10 (2 figs.).

Naturalist's Laboratory. VII. Laboratory Furniture (*concld.*).
[Describes and figures a "Naturalist's Store Case" for Microscopes, dissecting tools, reagents, objects, &c., and so arranged that "the worker can construct his own cabinet piecemeal from time to time with but very little skill and at a very trivial expenditure." Also a "Book box for the storage of microscopical specimens."]
Knowledge, X. (1887) pp. 160–2 (2 figs.).

Peyer, A.—**Atlas de Microscopie Clinique.** (Atlas of Clinical Microscopy.)
Transl. by E. de la Harpe. 2nd ed., 100 pls., 4to, Paris, 1887.

Pharmaceutical Era, a monthly exponent of Pharmacology in all its departments, including Chemistry, Botany, Microscopy, and of the Art of Pharmacy. (A. B. Lyons, M.D., Editor.) Each No. 32 pp. Detroit, Mich., 1887.

QUEEN'S (J. W.) **Needle-holder.**
["It is a sort of universal chuck operated by a concentric screw-collar, and will hold needles of various sizes."]
Micr. Bulletin (*Queen's*), IV. (1887) p. 15 (1 fig.).

SESTINI, F.—**Sopra un nuovo metodo per discernere il burro artificiale.** (On a new method of distinguishing artificial butter.)
Atti Soc. Tosc. Sci. Nat.—Proc. Verb., V. (1887) pp. 218–23.

STOKES, A. C.—**Microscopy for Beginners, or Common Objects from the Ponds and Ditches.** 308 pp., 8vo, New York, 1887.

TRÉLAT, U.—See Latteux, P.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.

Edited by

FRANK CRISP, LL.B., B.A.,

One of the Secretaries of the Society
and a Vice-President and Treasurer of the Linnean Society of London;

WITH THE ASSISTANCE OF THE PUBLICATION COMMITTEE AND

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further experiments with Hesse's tubes, both on the roof of the Science Schools and in the interior of buildings.

To obviate the melting of the tubes in hot weather they were wrapped in bibulous paper saturated with water, and this was surrounded by tissue paper.

In the open air the number of micro-organisms increases with the temperature; thus in January, with temperature of 3·5° C., only four colonies (average) per 10 litres of air were obtained, whilst in August, temperature 18·3°, as many as 105 colonies were found.

In the interior of buildings the same result as in the previous communication was arrived at, viz. that micro-organisms are more numerous when the air is disturbed than when no movement is going on.

A table of results and a table of curves formulating the results conclude the paper.

MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Jaubert's Microscopes, Eye-pieces, Objectives, &c. — One of the most extraordinary patents on the file of the Patent Office† is certainly that of M. Leon Jaubert for "Improvements in Optical Instruments." Five large sheets, 27 by 19 inches, are filled with 189 figs., 125 of which illustrate his ideas of improvements in both Monocular and Binocular Microscopes and describe objectives and eye-pieces of special arrangement made of concentric layers of glass united in groups, multiple objectives, revolvers for eye-pieces and objectives, a rotary micrometer, prisms, and other similar matters. We have selected the following as sufficiently showing the patentee's views, and if more information is desired the specification of the patent is available in the Library.

Universal Microscope.—This is copiously illustrated in all its parts in the Specification, but we give in preference (fig. 155) a modern form of the Microscope, as actually constructed by the patentee and recently exhibited by him. It has an oval base S, supporting two pillars C, which are bent towards each other at the upper ends, so that the trunnion or inclining axis ϕ is much smaller than usual; a spring-catch f engages in a series of holes in the socket A of this axis to fix the various positions of inclination. A second axis is applied in front of A to provide lateral inclination of the stem B, carrying the arm B′, the body-tube T, the stage P, the mirror G, &c.; a spring-catch r fixes the position by means of a series of holes shown on the collar. The stem B has a rack on either side on which acts a screw-collar E, raising or lowering it in the socket A′. A similar mechanism is applied to the body-tube for the coarse-adjustment actuated by the screw-collar E^1 with a slow movement by the screw-collar E^3. A third screw-collar at E^2 focuses the micrometer in the eye-piece. The fine-adjustment has two rates of motion by the milled heads V and V^1. The substage H is provided with a fine-adjustment actuated by the screw-collar e^2.

We have not attempted to give the full description of the patentee, but

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

† 1866, No. 473, 14th February. Cf. also Les Sciences, i. (1883) pp. 55-7 (3 figs.), and pp. 9, 11, 31, 46, 62-3, 78, and 109.

the general features of the construction are sufficiently obvious from the foregoing. The main speciality of the instrument consists in the two axes,

Fig. 155.

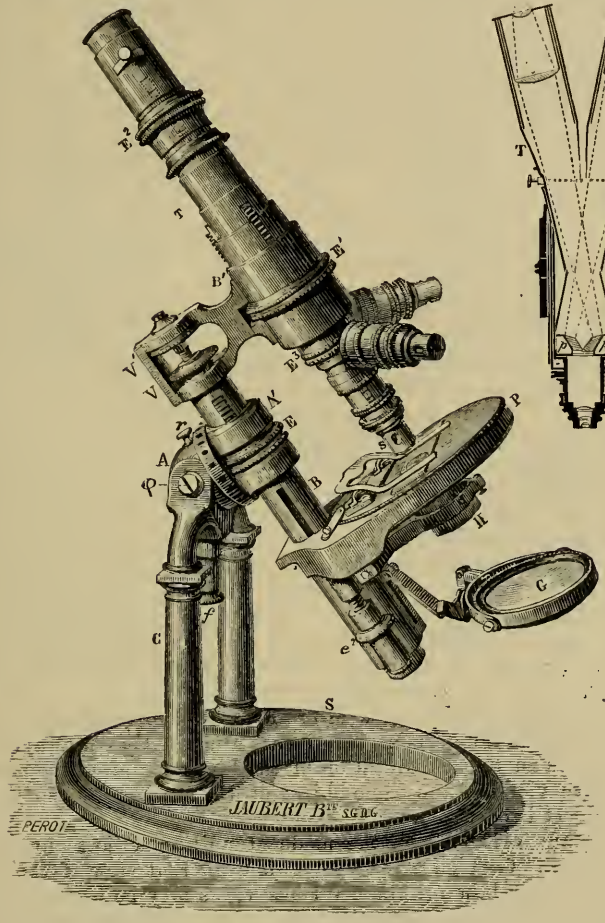


Fig. 156.

so that it can be placed in any position, vertical, horizontal, inclined, "reversed vertical" for chemical purposes, and laterally oblique.

Figs. are given in the specification representing the Microscope converted into a chemical, photographic, and solar Microscope.

Binocular Microscopes.—Of these, several different forms are described.

Fig. 156 "represents a binocular Microscope, with a mode of producing a variable separation of the tubes, and having a single object-glass; adjustment of the focus is effected by means of the screw collar E^1. The tubes T are after crossing again united at their lower extremities by two hinges, and may be separated at their upper extremity by means of the reversely threaded screw at *q*. The two prisms *p p* which divide the rays coming from

the object-glass follow the motion of the tubes upon their hinges. One of the two prisms is placed a little higher than the other, in order that the rays may not pass between their angles, which may in this manner cross each other more or less."

Fig. 1, plate XII., represents a front view of another binocular Microscope. The variable separation of the tubes *t*, *t*, as well as their drawing motion, take place by means of the milled head E^1, and by the pinions *i* taking into racks fixed upon each of the interior tubes. The prism p^1, which is conical, circular, concave, and truncated, reverses the image by causing the rays to pass to the left which it has received from the right, and those to pass to the right which it has received from the left.

Figs. 2, 3, and 4 "show other arrangements of prisms or reflectors either plane or curved, the object of which is to divide into two parts the rays coming from an object-glass of any kind, and to render them binocular; this arrangement allows of the visual angle being preserved and the angle of the two eye-tubes being equalized. Although two of the prisms or reflectors are not placed in the same plane, they have nevertheless no influence upon the extent of the luminous rays and the dimension of the rays which pass through them. A reverse threaded screw allows of the prisms p, p^1, being separated, and another similar screw serves also to move the prisms *p*, *p*, into the positions shown at fig. 5, and which then furnish images of another kind. With reflectors formed by a sector of a cylinder (fig. 4) images" different from the preceding are obtained, and present singular effects, "which with their applications form part of this invention."

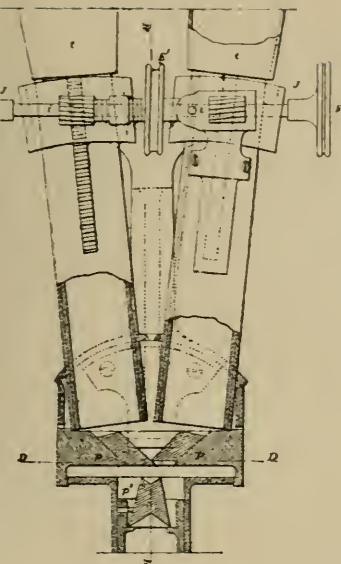
Fig. 6 represents a binocular Microscope with double object-glasses. "The two tubes are made to suit the variable distance of the eyes of the observer by turning the head of the long screw V^3, which acts by means of two different proportioned screw threads upon the arms *b*, *b*, b^1, b^1, so that the tubes *t*, *t*, can be made to recede from each other until the arms *b*, b^1, are parallel in two planes passing through their points of attachment, without the object leaving the focus. Each tube is furnished with revolving object-glass holders having three or four object-glasses; this might also be the case with the eye-pieces." The tubes of the object-glasses are cut away when their focus is very short.

Fig. 7 represents a portion of a Microscope for two persons to inspect the same object at the same time. The lenses are slightly cut away.

"Fig. 8 shows another modification of the binocular Microscope and is intended to give views of the same object at different angles, so that the relief of the object is considerably augmented."

"Fig. 9 (plate XIII.) shows the mode of uniting a large number of object-glasses, each of which gives a somewhat different view of the object. Figs. 10 and 11 show how all these various views may be brought to bear upon the same eye-piece or upon the same point, or upon different points. These object-glasses may be made all to magnify to the same or to different extents."

"These binocular Microscopes having one or more object-glasses, or having several object-glasses and one eye-piece, are also intended for photographing objects, and for reproducing them with forms and reliefs resulting from these arrangements. These views may be superposed completely or partially, and be of equal or different dimensions, or different views of the same object, but of such dimensions that those which reproduce the same plans shall be larger or of greater magnifying power, and the others smaller, or *vice versâ*. They may be combined in such a manner as to reproduce with incomparable perspective and fidelity the object, scene, or landscape photographed or under view, and so that



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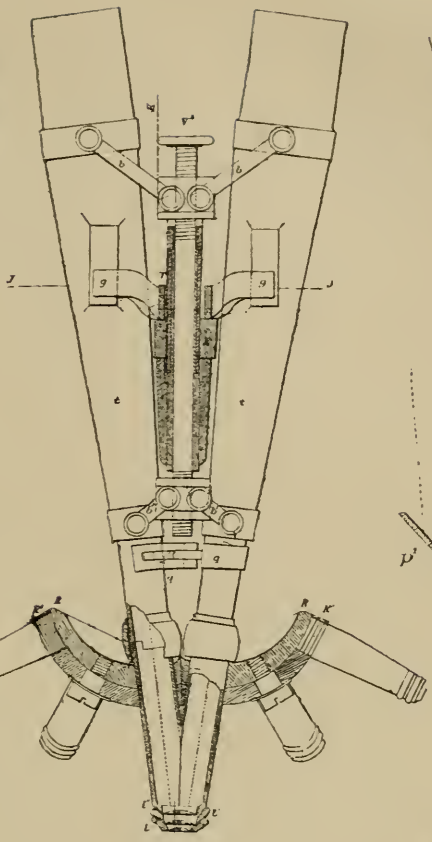

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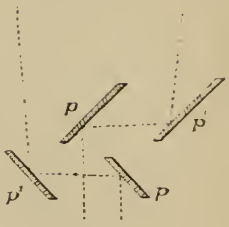

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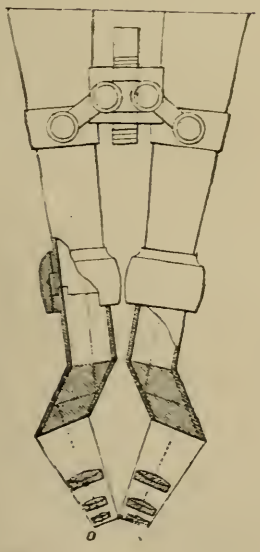

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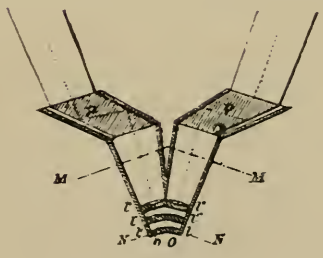

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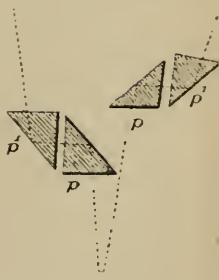

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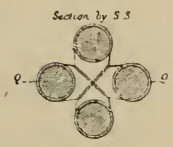
Jaubert's Microscopes, &c.



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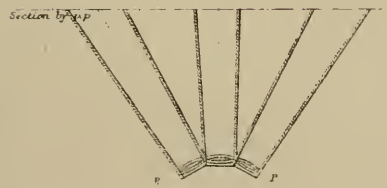

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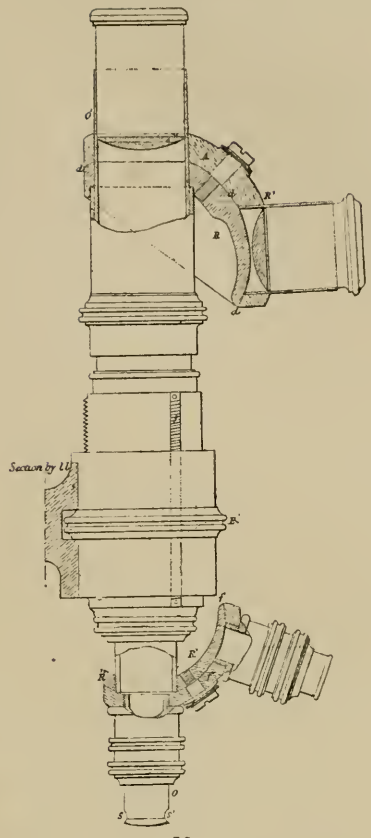

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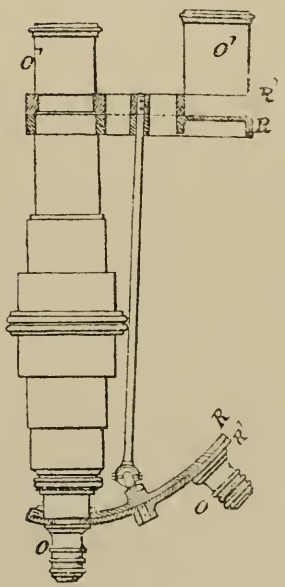

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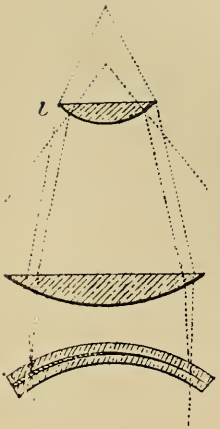
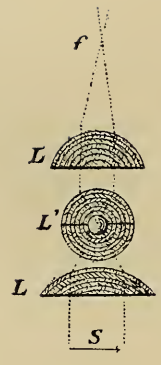
Jaubert's Microscopes, &c.





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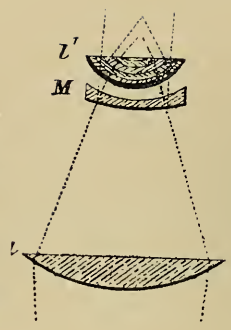

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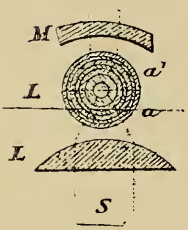

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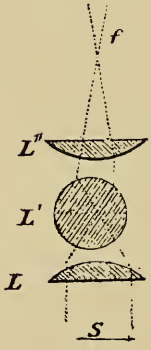

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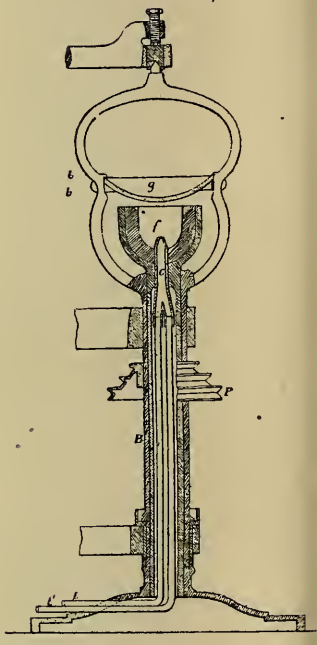

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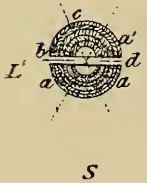

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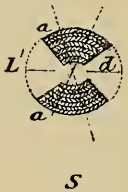

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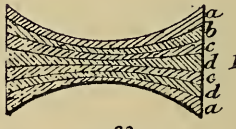

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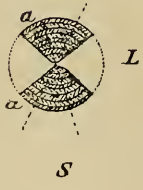

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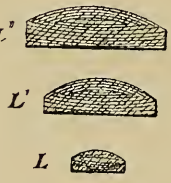


24.


27.

Jaubert's Microscopes, &c.

plane images drawn upon paper shall appear to be in relief as if looked at through a stereoscope."

Hand Binocular magnifying glasses are also described and illustrated.

Objectives and Eye-pieces. — In the settings there are several peculiarities. "Two openings, s s^1 (fig. 12 of plate and fig. 155), made in the outer tube of the objective, allow of the entrance of the light condensed by prisms, mirrors, or reflectors upon an opaque object even with the employment of the greatest magnifying power, even with glasses where the system of immersion is employed. Each of these openings is furnished with a small thin tube of silver or copper in order to prevent the dust from entering between the first and second lenses. This light may be polarized by means of a prism made of Iceland spar or any other polarizer, and coloured or monochromatized by a lens or plate of rock crystal."

Both objectives and eye-pieces are mounted on revolving holders f, with spherical bars R and R′, as shown at fig. 12. The revolving holders may be connected together by a rod, fig. 13, so that the eye-pieces and objectives may be changed simultaneously.

The "optical part" is, however, the most curious of the patentee's suggestions (figs 14–24, plate XIV.). "It is composed of lenses or series of lenses, the arrangement, form, and composition of which are special. The first lens is plano-convex; the second, which may be composed of two parts, is a complete ellipsoid, or formed of two parts of ellipsoid, or hyperboloid, or paraboloid, or even simply a spheroid. In certain cases it may be divided into two parts (fig. 15) plane or cut out at their centre, with such a curve (fig. 16) that the rays which come from the object S shall arrive at the face d, leave it, and after crossing each other shall penetrate the face b, and emerge from the face c after a fresh refraction, which shall render them sensibly parallel. They are rendered divergent by the periscopic lens M, fig. 14. If this lens is replaced by another which is plano-convex or a divergent periscopic meniscus (figs. 17 and 18), the rays will cross each other again at f, and the image will be again turned round. The lens, instead of having its centre cut out, may have it formed of a lump thicker than the rest; it may also be cut or shaped as seen at figs. 19 and 20. The lenses may be neither complete ellipsoids nor hyperboloids, and may be set at variable distances (figs. 16, 19, and 20). The lenses L, L^1, are shown on a scale larger than the real size. This arrangement of object-glass is applied in all its variations to all optical apparatus to which it may be applicable, especially to photographic apparatus, as well to simple as to compound ones, which will be hereafter alluded to."

"The improved eye-piece is composed of a convergent periscopic or non-periscopic meniscus, placed as shown at fig. 14, and of an ordinary eye-piece. Fig. 21 represents an eye-piece in which the divergent periscopic or non-periscopic glass is placed near the eye-piece."

"All the improved lenses are composed of glass in simple concentric layers, or in groups laid one upon the other and rendered adherent or fastened together, and arranged under conditions of thickness, arrangement, curvature, dimensions, and powers of refraction and dispersion even variable from the centre to the edge, such that not only are they completely achromatic, but moreover, whatever may be their form, even spherical, they may be completely deprived of spherical aberration, chromatic aberration, astigmatism, and distortion, and give the chemical focus at the same mathematical point as the optical focus. These layers, either coloured or not, are applied to the glasses of all optical instruments, spectacles, eye-glasses, field-glasses, and telescopes, and not only will these superposed

layers of analogous form and arrangement serve in certain cases like that of the animal crystalline lens, and in other cases simply superposed serving for the production of complete achromatism, but also under certain circumstances arranged in a manner contrary to the preceding arrangements they will serve to produce the maximum of chromatism and the separation of the chemical focus or optical focus, or even of the entire or partial spectrum or the neutral tints, &c., for the production of the effects of polarization and interference."

"Fig. 22 represents a double convex lens formed of concentric layers, the chemical and optic foci of which meet at the same point without aberration of any kind. Fig. 23 is a double concave of the same arrangement. Fig. 24 represents an object-glass composed of a series of three lenses achromatized by concentric layers superposed, and in the form of an ellipsoid, hyperboloid, or paraboloid, or simply a spheroid."

Making the Lenses.—Although somewhat lengthy, we transcribe this part of the patent in full, as it is by far the most "original" portion of the patentee's description. "In order to make the small Microscope lenses, especially for the first or object-glasses as well as the eye-glasses of the others, liquid glass is placed in a small pot or crucible formed as shown in fig. 25. The vitreous matter is passed through a small opening *o*, and by means of a blower it is blown in a state of fusion; by this means it is granulated or divided into round granules, the size of which is in proportion to the size of the opening *o* and of the blower, and to the force with which the air or gas is projected through the fused material. Instead of air or gas high-pressure and superheated steam may be employed, or a stream of water or other liquid at a high pressure and at a suitable temperature. If these granules should be required to be slightly flattened on one side a plate of metal or glass is placed in front and perpendicularly or obliquely to the plane of projection; they are then collected in hot water or any other non-inflammable liquid, or in any other manner, and annealed or fired if need be, and achromatized in the manner hereafter to be described; there may be any number of openings *o* and also of blowers that may be thought desirable.

"The following are the processes for manufacturing the improved lenses with concentric layers having variable refractive and dispersive powers from the centre to the edges, and which process is applicable to the manufacture of lenses of any form and dimensions, spherical, parabolic, elliptical, and hyperbolic, concave, or convex. By means of the apparatus represented at fig. 26 the form and thickness of the lenses from the centre to the edge and their curves may be varied at pleasure according to the degree of density or liquidity of the glass. This apparatus is composed, first, of a hollow fixed foot carrying the bell-shaped vessel made of fire-brick, and having openings for the pipes *t*, t^1, into its interior for conducting hydrogen or other gas and condensed air into the blow-pipe *c*, at the orifice of which they are ignited; second, of a shaft B, which may be driven at a rapid speed by means of the pulley P in communication with friction gearing; it carries a capsule or cup *g*, made of platinum or fire-clay. This cup may be either concave, as in fig. 26, or convex, or of any other form, according to the form of lens required to be produced. A drop or lump of liquid glass is to be placed upon the cup *g*, the apparatus is set in motion, and when one layer has received the required form the fire is moderated and the apparatus stopped, and the second layer of liquid glass of the same or of different density is laid thereon, and the operation is continued as before, and so on until the lens has been brought to the required form, thickness, and density. The various vitreous matters in

fusion may be taken from the pots (placed in the furnace for that purpose) with a platinum brush, the handle of which is hollow, and through which ignited air and gases are caused to pass into the wires of the brush, so that the matter being kept at the required temperature has not time to solidify, and may be laid upon the lens placed upon the preceding apparatus, when stationary, in the same manner as a layer of any other substance, such as paint, would be laid on. Plates of suitable thickness and forms in crown and flint glasses may also be prepared by blowing and moulding, as hereafter described, and caused to adhere together; for this purpose the arrangement of tubes t, t^1 (fig. 26) is employed, fed by air and hydrogen gas or any other combustible giving a flat fan-shaped flame. Pincers having two or three jaws are held in each hand for the purpose of holding the plates to be united; when the faces to be united have been softened they are brought in contact through the flame, the pincers being continually kept turning. In the case of periscopic convex plates, the one which is to take the form of the other must be softened on both faces. The handles of the pincers and also that of the platinum brush have a tube like that of the blow-pipe c for the passage of air and gas which passes through them, the flame impinging upon the back of each plate at the same time that the flame of the intermediate burner impinges upon the two faces; this arrangement allows of one of the plates being sufficiently softened to take the form of the other.

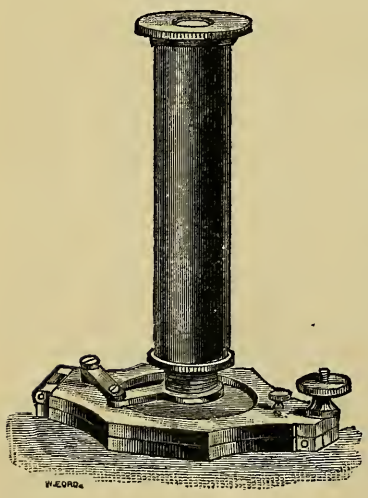
"If the plates are of somewhat large dimensions the pincers are mounted upon a lathe to the mandrils of which a rotary motion of greater or less speed is imparted, and also a reciprocating motion. One of these shafts may advance one of these two plates upon the other; seams and inequalities are caused to disappear by the softening of the glass combined with the motion, but if the lenses to be produced are of large dimensions the preceding processes might be partly insufficient, and in that case plates are employed of the dimensions, forms, thickness, and refractive and dispersive powers suitable for the effect desired to be obtained. They are laid over one another one by one, and set in a mould of polished clay which is introduced into an annealing oven and left there until the plates all adhere. If the lens is to be of any other form than plano-convex the mould has a heavy cover glazed inside, which bearing upon the lens, imparts to it the form (either convex or concave) which it has itself. A greater or less degree of pressure may be employed in order to expedite the adherence and increase the density. If, seeing the various kinds of glass (crown and flint) employed fluid or in plates, and seeing the curves of the lens and the length of focus which might be required, achromatic lenses free from aberrations of any kind could not be obtained, groups might be employed formed of layers superposed and afterwards united as simple plates. If required, fluxes might be interposed between the plates or upon the exterior surfaces of the lenses with the platinum brush. These fluxes may be composed as follows:—One part of white sand, three parts of minium, 0·5 of calcined borax, or three parts of white sand, one part of minium, and five parts of calcined borax, or others, according to the effect desired to be obtained. Instead of these fluxes pulverized glass (either flint or crown) is employed especially upon exterior plates, by means of the fan-shaped burner; this powder is brought into a state of fusion, and the required form is given to it by a suitable movement. Bevelled plates which are partially superposed, or concentric circles and plates, the bevels of which overlap, may be employed, so that the index of refraction shall vary from the centre to the edge. Instead of these circles or plates, or concurrently with them, annular parcels or fagots of glass

threads of flint or crown glass of various densities are placed concentrically one in the other, and superposed or not at their extremities. These circles or parcels of threads are made of any thickness; the threads of glass may also be placed vertically.

"The refraction and dispersive power is also caused to vary in lenses, the density of which is variable from the centre to the edge, by placing tubes formed of glass of different densities, as flint and crown glass, figs. 27, *a*, *b*, *c*, *d*, *e*, one inside the other, which are softened by heating and again blown. Other tubes of greater density *f*, *g*, *h*, *i*, are placed inside them, softened, and again blown. Tubes *j*, *k*, *l* are again put in until the whole and the centre are well filled, they are again softened and drawn, and a cylinder is obtained. If drawn with sufficient rapidity the whole of the concentric cylinders will only form a single cylinder of greater or less thickness, or if the cylinders interposed are sufficiently numerous, a convex lens cut from this cylinder will be deprived of spherical aberration and even of chromatic aberration if the density augments from the edge to the centre, if concave it will be also deprived of aberration, if the density augments from the centre to the edge. These tubes, brought at their extremity to the point of fusion, may be blown, and Microscope lenses will be formed that will be in concentric layers and will be achromatic and without aberration. By bringing them to the point of fusion lenses may in this manner be produced, the outer layers of which will be less dense and have the form and arrangement of layers analogous to those of the crystalline lens of the human eye and will be achromatic.

"Under certain circumstances concurrently with the plates, circles, bundles, and fluxes, silicates in solution in hydrochloric acid or hydrofluoric acid may be employed diluted with water or combined with other transparent substances either to cause the plates to adhere together or to obtain the required degree of refraction or dispersion. Intermediate layers of crystallized boron, sesquichloride of carbon, crystallized or melted silicic acid, bichloride of tin, small crystals, and even powder of any kind, principally powdered glass, either colourless or of many colours, obtained by the method of granulation above described, are applied by means of heat and pressure, currents of electricity, and other mechanical and chemical forces aided by blowing, moulding, and motion. By these means all the required forms and qualities are obtained, so that the refrangibility, dispersion, transparence, malleability, density, hardness, and elasticity of these lenses may be varied."

Fig. 157.



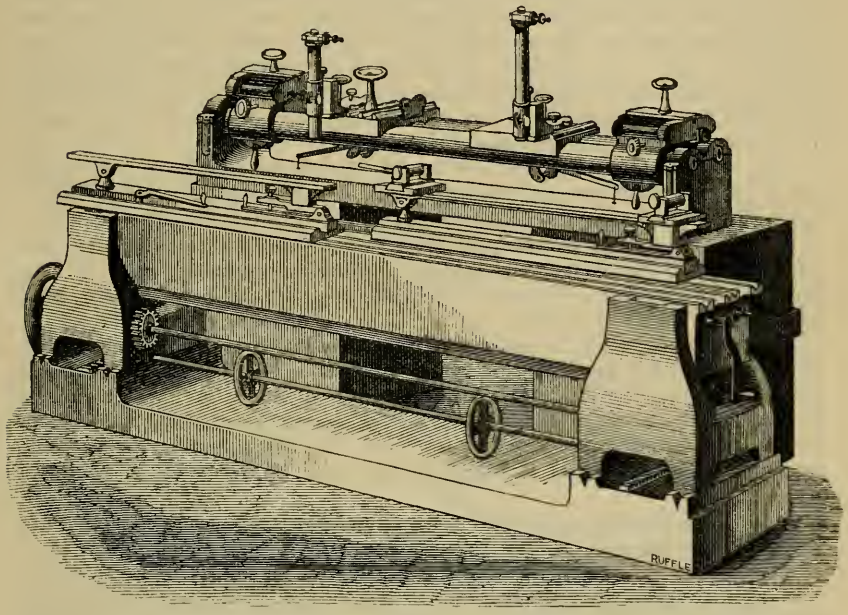
Amongst other matters dealt with are a screw guide for sliding tubes, adjusting screws with differential threads for slow or rapid motion, a universal joint to foot with clamp, improved stages, &c.

Bausch and Lomb Optical Co's Trichinoscope.—Another form of this instrument (described Vol. II., 1882, p. 258) is shown in fig. 157, the doublet being replaced by a compound Microscope which is combined with the compressor (described Vol. III., 1885, p. 714).

The original form with the doublet is on the whole decidedly preferable, and forms a convenient pocket Microscope for field use in collecting Infusoria, algæ, &c.

Rogers-Bond Universal Comparator.*—The special features of the Universal Comparator (fig. 158), devised by Prof. W. A. Rogers and Mr. G. M. Bond, are, as its name implies, the variety of the methods employed and the range of work that can be done in comparing standards of length; each independent method, when carefully carried out, producing similar

Fig. 158.



results which serve to check or prove the comparisons. It includes a method for investigating the subdivisions of the standard by comparing each part of the total length with a constant distance, determined by two adjustable stops.

A heavy cast-iron base is mounted upon stone-capped brick piers, giving a permanent foundation to the apparatus. Upon this base, and reaching from end to end, are two heavy steel tubes 3 in. in diameter, ground perfectly straight, and made "true" by a system of local corrections after they are firmly secured upon the bed-plate of the machine, the object being to get a straight-line motion of the Microscope plate, which slides freely on these true cylinders. Flexure of these cylindrical guides is provided for, by lever supports at the neutral points. Fitted closely to these guides, and outside of the range of motion of the Microscope plate, are two stops, one at each end, as shown in the figure. The stops are arranged to be adjusted at any desired position along the guides, and are

* Description supplied by Prof. Rogers. Cf. also Proc. Amer. Acad. Arts. and Sci., xviii. (1882-3) pp. 287-398 (7 figs.). Journ. Franklin Inst., cxvii. (1884) pp. 361-5 (2 figs.).

securely held by clamping on the under side. These stops are each provided with a pair of electro-magnets, the poles of which do not come in contact with the armature seen at either end of the Microscope plate. The magnets are intended to overcome the unequal pressure due to ordinary contact, a rack and pinion being used to move the plate. The magnets are used to lock the Microscope plate at each end of its traverse between the stops.

Beyond the main base just described, and supported also on brick piers, is an auxiliary cast-iron frame, which is provided with lateral and vertical motion within limits of zero, and 8 in. and 10 in. respectively, for rough or approximate adjustment, and upon the top of this frame are two carriages, which slide from end to end, a distance of about 40 in. Upon these sliding carriages are placed tables provided with means of minute adjustment, for motion lengthwise, sidewise, and for levelling, thus permitting the adjustment of a standard yard bar quickly, and without the necessity of its being touched with the hands after being placed upon the table until the work of comparison is completed.

The tubes of the Microscopes are 12 in. long and $1\frac{1}{4}$ in. diameter with eye-piece micrometers, and the objectives are fitted with Tolles's illuminating prism just above the lower lens.

This method of illumination has proved to be invaluable in the work of comparing line measure standards, especially so in the case of bars having lines ruled on polished gold surfaces at the bottom of wells sunk one-half the depth of the bar.

The first operation in the use of the comparator is to level the main base; then sliding the Microscope plate from end to end of the steel tubular guides—having the Microscope adjusted so as to be in focus upon the surface of the mercury held in a shallow trough, over which the Microscope passes—the curvature due to flexure of the guides is determined, and may be compensated for by counterweights at the various points of support.

In order to test this right-line path of the Microscope plate, the following method is employed. A fine line is traced upon the plane surface of a standard bar, extending throughout its entire length. This is accomplished by means of a cutting-tool attached to the Microscope carriage. Then, reversing the position of the bar, a second line is traced near the first, care being taken to have the distance between the two lines of each end a constant quantity. If the distance between the lines is a constant at every point, it is safe to assume that the horizontal curvature is insensible.

The extent of the effect of any horizontal curvature in the cylindrical ways may also be found by comparing the lengths of two standards placed at varying distances from the centre line between the ways.

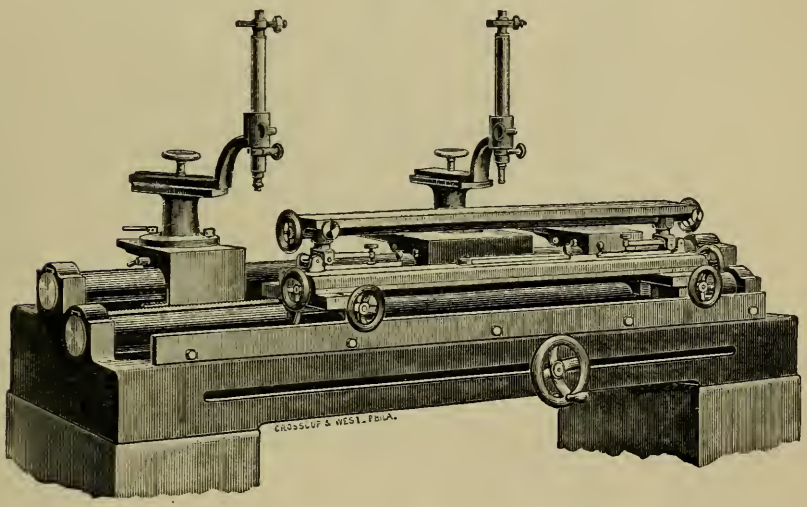
While the comparator has all the conveniences belonging to the ordinary method of comparisons by means of two Microscopes, preference is given to the "stop method." The adjustable "stop plates" are first set approximately at a distance apart equal to the lengths of the standards to be compared. The Microscope plate having been brought into contact with the left stop, the reading of the micrometer is made for coincidence with the initial line of the standard. The carriage is then placed in contact with the second stop and the reading for coincidence with the terminal line is then taken. The bar to be compared now takes the place of the standard, and micrometer readings are made as before. The difference between the results of these micrometer readings gives the difference between the lengths

of the two standards, since the distance between the stops may be considered constant for the short interval of time required to make the comparisons. It is the experience of Prof. Rogers that the precision of the contacts is about four times as great as that of making coincidences between a line of the scale and the micrometer line of the Microscope. The experiment of making one hundred successive contacts and coincidences has been frequently made without observing a single instance in which a variation from constancy under a 1/4 objective could be detected.

In the employment of the "two Microscope method," the comparator has a convenient auxiliary attachment for observing the graduations when the graduated surface is in a vertical plane, according to the method first used by Lane of the U.S. Coast Survey.

A modification of this form of comparator, made by the Ballou Manufacturing Company, of Hartford, Conn., from the plans of Prof. Rogers, for Prof. Anthony, of Cornell University, is shown in fig. 159. The instrument is mounted upon a single heavy base. Though not having the range of motion in the adjustable supports for the standard bars possible with the original comparator, it possesses all of the conveniences for rapid adjustment and accuracy of movement. The right line motion of all moving parts longitudinally is governed by heavy cylindrical guides, and the same

Fig. 159.

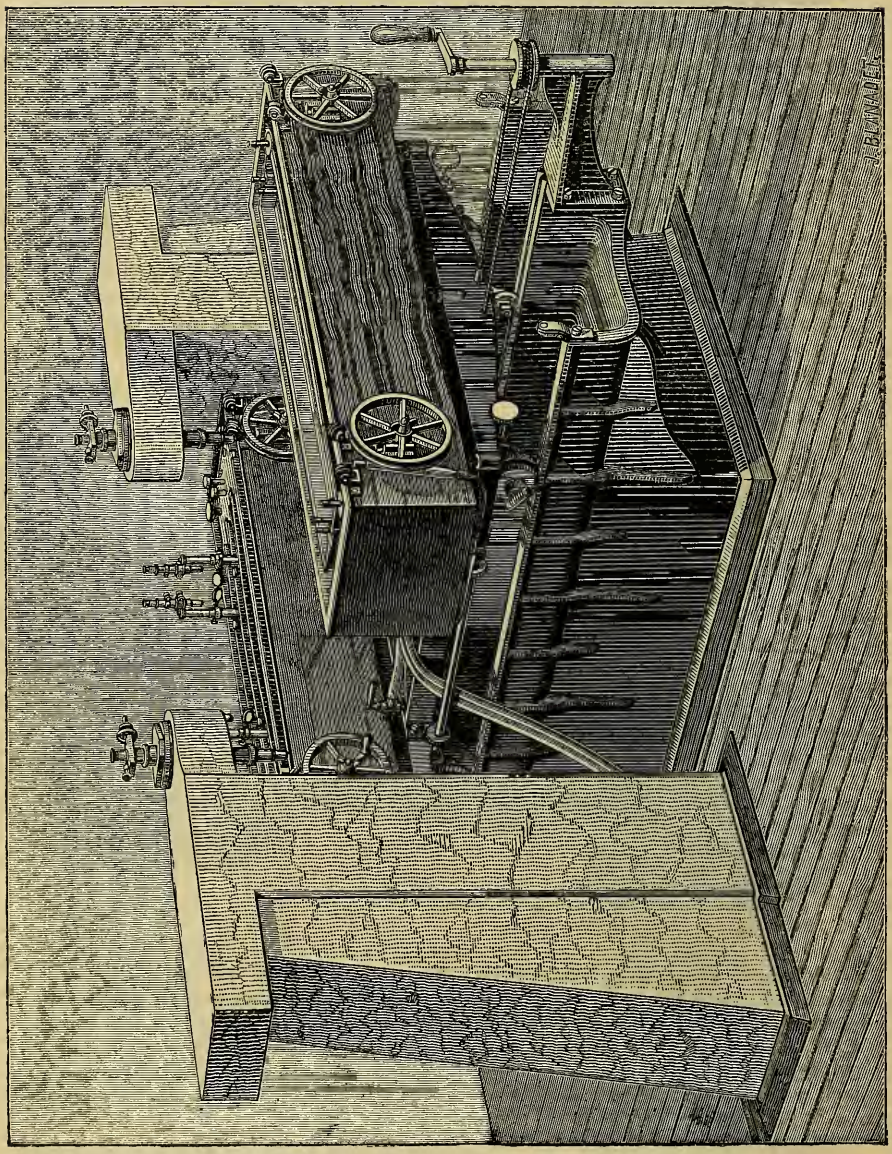


method of the "stops" is used in the comparison of either line or end measure standards of length. In this form of the comparator an effort was made to reduce the cost of construction without impairing the efficiency of the apparatus. The reduction effected in the cost was very considerable. The instrument shown in fig. 158 cost 2500 dollars, while that shown in fig. 159 cost only 800 dollars.*

* Cf. also a paper by Prof. W. C. Unwin, "Measuring-Instruments used in Mechanical Testing," Proc. Phys. Soc. Lond., viii. (1887) pp. 179–84 (3 figs.).

Geneva Co.'s Comparator.—The Geneva Society for the Construction of Physical Instruments constructed for the Bureau International des Poids et Mesures, at Paris, the comparator shown in fig. 160, for determining the co-efficients of dilatation of divided metre scales. In this four Microscopes are made use of.*

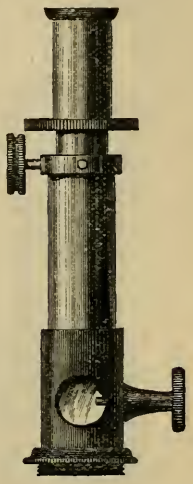
Fig. 160.



* Cf. description in the 'Mémoires du Bureau International des Poids et Mesures.' The two Microscopes on the stone pillars were made by MM. Brunner Frères, of Paris.

Geneva Co's. Reading Microscope.—In this Microscope (fig. 161) designed more particularly for astronomical purposes—the determination of the nadir with a mercury bath—the principle of the "Vertical Illuminator" is made use of for illumination.

Fig. 161.

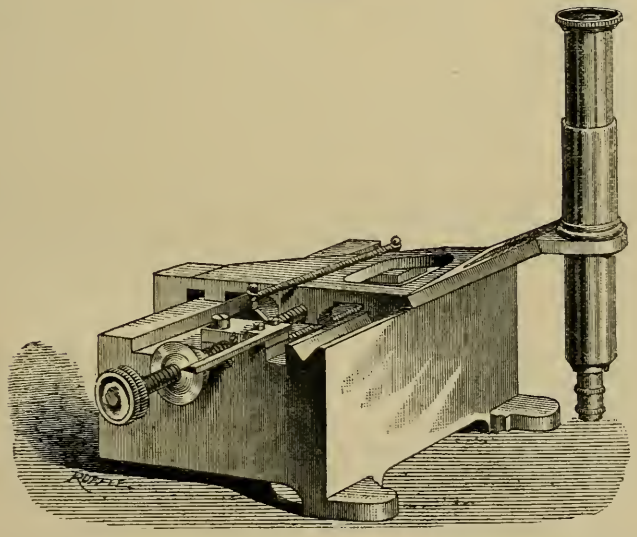


Just below the 1 in. objective is a circular opening which admits light to a piece of thin cover-glass, which is supported on an axis which passes out at one side and terminates in a milled head. On setting the thin glass at the appropriate angle, light is reflected on the object under examination, while at the same time the glass does not obstruct the observer's vision through the eye-piece and objective. The upper milled head clamps the body-tube in the socket when it has been adjusted to the proper focus. The whole instrument is 4 in. high.

Cambridge Scientific Instrument Co.'s Reading Microscope.—This (fig. 162) is also intended for reading off measurements by the aid of a compound Microscope. The one figured has a single Microscope only, but some are supplied with two.

The Microscope slides in a socket attached to a frame which moves in a deep V-shaped groove on the top of a heavy open brass support. A micrometer screw acting against an upper and lower spiral spring moves the Microscope laterally, the extent of movement being indicated on a horizontal graduated bar, the periphery of a coned nut on the screw axis

Fig. 162.



serving as the index. Fractions of divisions are recorded by graduations on the nut itself, the bar, which has a bevelled edge, here acting as the index.

Campani's Compound Microscope.—One of the earliest opticians known to have made a specialty of the construction of Microscopes was

Giuseppe Campani of Rome, who flourished in the latter half of the 17th century, when he was regarded as one of the most skilful makers of telescopes in Europe, outrivalling Eustachio Divini of Bologna, and in technical perfection of optical work not unworthy to rank with Huyghens. His Microscopes have now become so rare that we need hardly plead any other justification for figuring one of them (fig. 163) which we met with during a recent visit to Italy, and which is the first (to our knowledge) that has been figured.*

Fig. 163.

The body-tubes are of wood, and are provided with a double focusing arrangement, one (the lower) for regulating the distance between the object-lens and the object by screwing into the metal ring-socket supported on the tripod, the other for varying the distance of the eye-lens from the object-lens by a screw-motion of the upper tube within the lower one. The base consists of two plates, the upper one being attached to the tripod and the lower one being held to the former by the lateral pressure of a bent spring on either side travelling on rollers, the object-slide being placed between the plates, which are perforated in the centre so that the object may be viewed by transmitted light.

The object-lens is bi-convex, of somewhat yellow glass, and about 1/2 in. focus, and is held in a wood cell by a perforated cap, which serves as a diaphragm. The eye-lens is bi-convex, of about 1 in. focus. There is no field-lens, and hence we think the date of the construction may with some probability be assigned as prior to that of Hooke's compound Microscope (vide his 'Micrographia,' 1665), in which the application of a field lens was claimed as a novelty. In confirmation of this point we may note also that in 1667 Hon. Fabri, in his 'Synopsis optica' (4to, Lugduni), Prop. 46, described a compound Microscope by Divini, in which two pairs of plano-convex lenses were used for the eye-lens and field-lens respectively, so that the application of a field-lens to the eye-piece of a Microscope was known in Italy at that date. Divini's Microscope was also fully described in the 'Giornale de Letterati,' i. (1668) pp. 52–4, which description was partly translated in Phil. Trans., iii. (1668) p. 842, and must have become widely known.

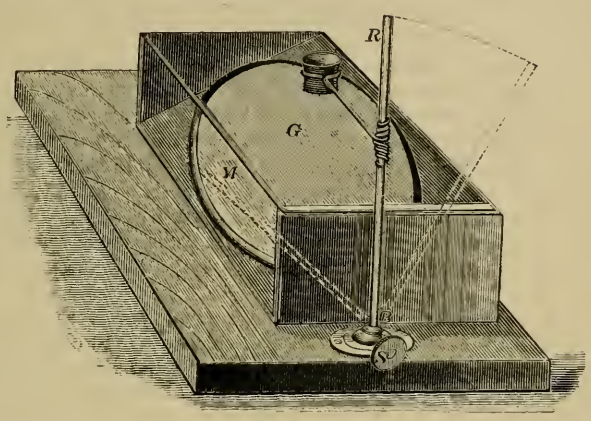
James's Dissecting Microscope.†—Dr. F. L. James uses a cigar-box from which the top and front side have been removed, an old hand-mirror, and a plate-glass cover (fig. 164). In use, this stands on a board which carries an upright rod, provided with a ball-and-socket joint. On this rod slides an arm made of wire, twisted so as to hold a watchmaker's eye-glass. When not in use the ball-and-socket joint permits this rod to be turned down out of the way. The object to be dissected or slide to be arranged is placed on the plate-glass cover. The light is thrown upward by the mirror and through the cover-plate, so as to render visible the minutest detail of

* Society of Arts Cantor Lectures on the Microscope, by J. Mayall, junr. (reprint in collected form) 1886, p. 10 (1 fig.).

† Proc. Amer. Soc. Micr. 9th Ann. Meeting, 1886, pp. 145–6 (1 fig.).

the object to be arranged. In fact the entire combination is a sort of mounting and dissecting Microscope on a large scale.

Fig. 164.



Bausch, E.—**Two new combined inverted and vertical Microscopes.**
[Describes the Microscopes noted *ante*, p. 141.]
Proc. Amer. Soc. Micr., 9th Ann. Meeting, 1886, pp. 148–9 (1 fig.).

Competition for the best Microscope.
["Notes from our London Correspondent." "Certain amateurs of the Microscope in London have been recently discussing the advisability of proposing a competition among opticians: (1) for the best stand for the highest class of work; (2) for the best stand to be supplied for a given sum, say 20*l.*; and (3) the best student's Microscope, costing, say, 5*l.* The suggestion is that a handsome gold medal might be awarded for the best instrument in each class. Special precautions would doubtless have to be taken in the two latter competitions to insure the strict fulfilment of the conditions as to the cost of the instruments. A jury would have to be named comprising microscopists of known skill in the use of the instrument, and one of the principal conditions would be that every Microscope would be put through its paces by one or other of the jury—*not* by the opticians or their nominees. If this matter could be brought to a focus I hope the American opticians will join in the competition. The intention is to arrange the fairest possible conditions, so that the awards may carry the highest possible authority."] [Nothing has been heard of this here!]
Queen's Micr. Bulletin, IV. (1887) p. 17.

Czapski, S.—**Die Mikrometerbewegung an den neueren Zeiss'schen Stativen.** (The fine-adjustment to the new Zeiss stands.)
[Same as Journal, 1886, p. 1051, but different fig.]
Zeitschr. f. Instrumentenk., VII. (1887) pp. 221–2 (1 fig.).

Nagura, O.—**[The Choice of a Microscope.]**
[Japanese.] *Tokio Med. Journ.*, 1886, No. 420.

Nelson, E. M.—**New Microscope.**
[Original description. Cf. this Journal, *ante*, p. 292.]
Journ. Quekett Micr. Club, III. (1887) pp. 85–8 (1 fig.).

Stricker, S.—**Demonstrationen mit dem elektrischen Mikroskop.** (Demonstrations with the electric Microscope.) *Wiener Med. Bl.*, IX. (1886) No. 39.

(2) Eye-pieces and Objectives.

"**New Glycerin Immersion Microscopic Objective.**"—We have been favoured by a firm of Manchester opticians with a copy of a notice under this heading in which the following statement is made:—

"Their experiments and experience prove glycerin to be a much better medium than water or oil. Water necessitates the Microscope being used

almost upright, and soon evaporates. Oil requires great care in manipulation and loss of time in cleaning off after use. *Glycerin is free from these objections.* It will remain three or four days limpid and free from evaporation, and only requires cleaning off with a camel-hair pencil dipped in water, and the lens dried with blotting-paper. This objective has more brilliant definition, deeper penetration, and a greater working distance from the object than any others of its class at much higher prices."

It is not a little surprising that in these days an optician should show such a want of appreciation of elementary optical principles. Glycerin having a lower refractive index than the oil used for immersion the objective is not a homogeneous-immersion objective, with which, therefore, it cannot be compared. Glycerin having a lower refractive index than the fluid used for homogeneous-immersion, the aperture of glycerin objectives, and with it the brilliancy of the definition, is necessarily reduced. The "deeper penetration" is of course simply a function of the reduced aperture. Why a glycerin objective should have a greater working distance it would puzzle an optician to say.

Apart from optical errors, it is equally erroneous to say that glycerin requires less care in manipulation and takes less time to clean off than oil, while its well-known tendency to absorb moisture, and therefore to change in index, is more than a compensation for its alleged freedom from evaporation. It will be news to many that "water necessitates the Microscope being used nearly upright."

Notwithstanding the glowing panegyric on this objective the notice of its virtues, although stating that it is a 1/16 in., omits any mention of its aperture.

Zeiss's Objective-changer, with slide and centering adjustment.—This contrivance (figs. 165 and 166) is designed to provide (1) accurate

Fig. 165.

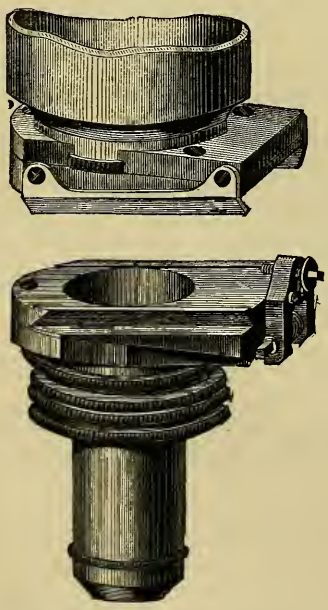
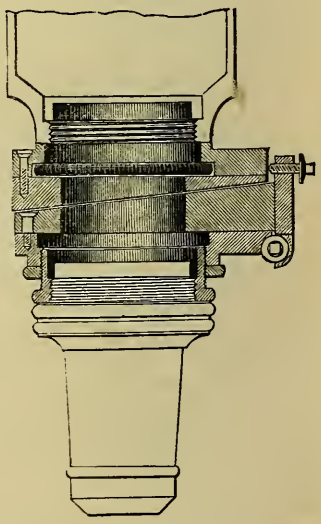


Fig. 166.



centering, and (2) rapid change of the objectives. It consists of two parts, the tube-slide and the objective-slide.

The tube-slide is screwed to the bottom of the body-tube. The plane of the sliding motion is purposely made, not at right angles to the axis of the instrument, but inclined at an angle to it, so that the objective falls and rises as it is inserted or withdrawn. In this way any danger of contact with the object is avoided. The objective is screwed to the objective-slide, and the plane of motion makes with the axis of the objective an angle which is the supplement of that of the tube-slide. At one end is a screw turned by a watch-key, which acts as a stop to bring the objective always back to the same position, and which also serves as a centering adjustment in the direction of the slide, while the adjustment in the transverse direction is effected by a similar screw working at right angles to the first.

Objectives whose settings are approximately compensated for their focal lengths can, by means of the clamp-screw on the objective-slide, be set once for all in their proper position. Any number of objective-slides may be used with one tube-slide. The two pieces fit one another accurately. The objectives always return to the same position, so that the same part of the object occupies the field of view.

HOPKINS, G. M.—**Diminishing the power of an Objective.**

["It is often desirable to diminish the magnifying power of an objective, and at the same time increase its penetration. For example, if one possesses a 1½ in. or 2 in. objective, and desires to examine objects like minerals in the natural state, crystals, seeds, &c., he will find it necessary to focus up and down upon the object to see it in all parts. A 3 in. or 4 in. objective would furnish the desired power, but it is not at hand.

To increase the focal length, and at the same time enlarge the field and deepen the focus, it is only necessary to place a double convex lens of, say, 5 in. focus about half-way down the draw-tube. The action of such a lens is the reverse of that of an amplifier."]

Engl. Mech., XLV. (1887) pp. 310–1, from *Scientific American*.

(3) Illuminating and other Apparatus.

Value of Achromatic Condensers.*—Mr. E. M. Nelson and Mr. G. C. Karop write that an achromatic oil-immersion condenser has been made for them by Mr. T. Powell (Mr. Nelson having, in 1882, suggested to him the necessity for achromatizing the then chromatic oil-condenser) and that this has enabled them to illuminate objects by solid axial cones of larger angle than before; the spherical aberrations of a chromatic condenser being so great that only the rays passing through the centre or through a narrow zone of the condenser could be focused on the object at one time. The result has been a marked increase in resolution. In illustration of this increased resolution they refer to a drawing of an areolation of the same valve of *Isthmia nervosa*, which they figured in their former paper.† The straight bars of silex, by which the central delicate perforated membrane was shown to be attached to the margin of the areolation now have a trabecular appearance; the delicate membrane extends to the edge of the large areolation, and has perforations more difficult to resolve than those in the centre.

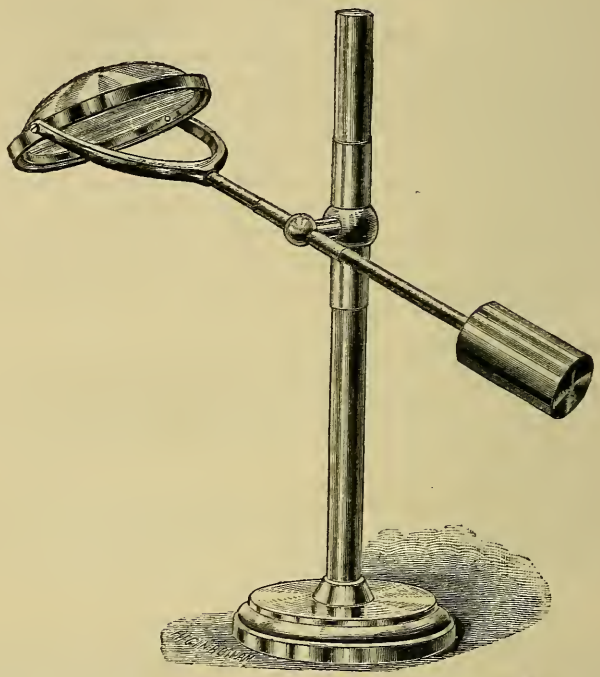
They point out that this is not a correction of misinterpretation of optical images, but a clear case of increased resolution, due to an improvement in optical appliances. Even now they do not wish to lay any claim to finality, but to show that every advance in perfecting instrumental appliances is attended by an increased gain in our knowledge of structure. In addition to the new condenser they have used Professor Abbe's new compensating eye-pieces, which give sharper images than those of the Huyghenian construction.

* Journ. Quek. Micr. Club, iii. (1887) pp. 41–3.

† Ibid., ii. (1886) pp. 269–71 (1 pl.).

Bausch and Lomb Optical Co.'s Condenser.—The speciality of this condenser (fig. 167) is that one end of the cross arm has a weight acting as

Fig. 167.



a counterpoise to the bull's-eye lens at the other end. The lens is 3 in. in diameter.

Miles' "Desideratum" Condenser.*—Mr. J. L. W. Miles' condenser "consists of a plano-convex lens of given dimensions, having a ground spot in the centre; to this can be superadded an adjustable plano-convex lens of short focus. These can be used with or without a system of stops and discs with openings by means of a sliding spindle, which enables any size or character of stop to be placed close under, or at any distance from the lenses.

"The following is a recapitulation of the working capabilities of the condenser:—

"The back lens, used as a simple condenser for all powers, will be found to meet all the requirements of the ordinary microscopist. With a 1/2 in. objective of 70° or 80° aperture, and a C eye-piece, *P. angulatum* can be 'dotted' readily.

"Used as a combined condenser and light-modifier, it possesses advantages superior to the devices in common use.

"As a dark-ground illuminator, it leaves nothing to be desired, working easily with powers from 3 in. to 1/2 in. of 40° inclusive; and also with the 4 in. by increasing the size of the spot-stop.

"It gives binocular vision with 1/4 in. objectives, illuminating both

* Trans. and Ann. Rep. Manchester Micr. Soc., 1886, pp. 31-3.

fields of a binocular Microscope, in use with that power, remarkably well; hence, as may be inferred, there is no difficulty whatever in illuminating both fields with all lower powers.

"In combination with the front lens it has an aperture of 110°, and will, in conjunction with a suitable stop, give dark-ground illumination, with 1/4 in. objectives, up to 100° of aperture, or with any power intermediate between that and the 1 in.

"The combined lenses, having a comparatively large aperture, will be found useful in all cases when a pencil of light of large angular dimensions is desirable, which is very seldom.

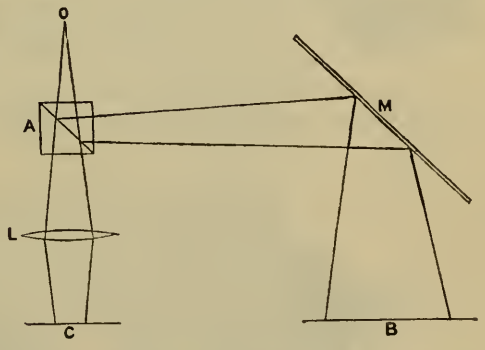
"Used with a stop having one or more side-openings, it will give unilateral or equidistant beams of light of considerable obliquity.

"Generally speaking, the stops, when used, are to be placed close under the lenses, but in practice it will be found that placing a large stop at some distance from the back lens will occasionally disclose structure when every other method fails. A unilateral beam of light, for resolving *P. angulatum* on a dark ground, is best got by placing a suitable stop *on* the back lens before screwing on the front.

"Last, and not least, of the merits of this condenser, is the low price at which it can be supplied, and adapted to nearly any Microscope. It has one fault; it is non-achromatic. This defect is not noticeable with low and medium powers. In using the combined lenses with high powers, the defect may be minimized considerably by careful focusing. Using one lens only, the defect will scarcely ever be noticed. As a matter of fact, only the most costly condensers are really achromatic. To make this into a so-called achromatic condenser would increase its cost, and render it useless for many purposes."

Nachet's Camera Lucida for Magnifiers.*—This apparatus, shown in fig. 168, consists of a glass cube A, formed of two prisms, one of which has an hypothenuse surface gilded on Prof. Govi's method. This is sufficiently transparent to transmit the rays from the object C to the eye at O at the same time as it reflects also to the eye the rays from the paper B and mirror M. The doublet or single lens is at L. The images are of two different tints, the one seen through the gold film being emerald green and that seen by reflection yellow. The difference of colour is said to be of advantage in making clearly visible the point of the pencil.

Fig. 168.

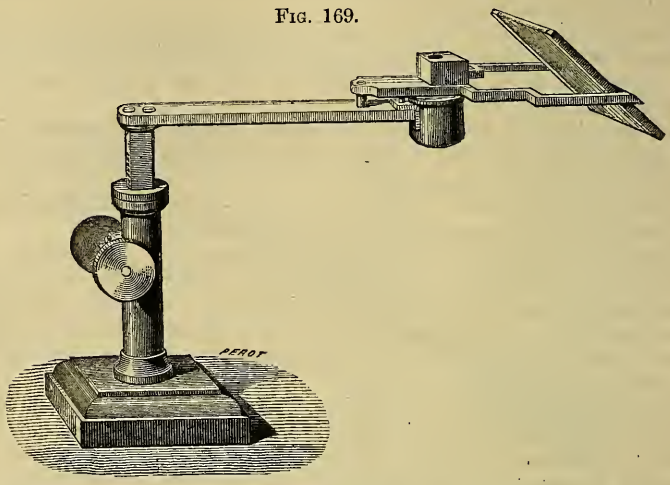


M. Nachet supplies the apparatus in connection with the stand, fig. 169. The instrument can also be used to reduce drawings, which are placed under the mirror M and the paper under the lens L; for this purpose the mirror is made to rotate and an extra low power lens is used. As the smallest movements of the pencil are followed by the lens, these reductions

* Robin's (C.) 'Traité du Microscope,' 2nd ed., 1877, pp. 429–31 (2 figs.).

have, says Prof. Robin, "a character of precision and finish quite remarkable."

Fig. 169.



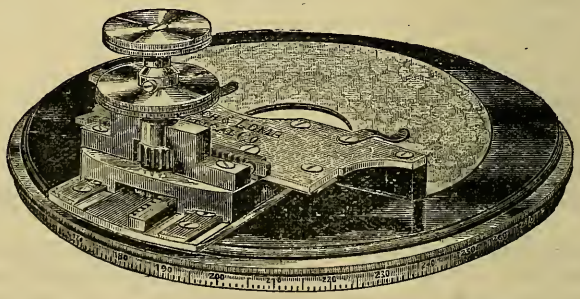
Prism for Drawing.—In accordance with our custom of chronicling microscopic apparatus actually brought to the condition of practical manufacture and use, we note this device of an anonymous designer.

Fig. 170.

It consists of a right-angled prism, not attached above the eye-piece, but placed at the nose-piece over the objective, the image being reflected on paper placed on the table on which the Microscope stands. It cannot, however, be used with ordinary Microscopes where the body-tube is in front of the limb, but only with such forms as the Watson-Moss,* where the body-tube is at the side.

Bausch and Lomb Optical Co's. Mechanical Stages.—These are made in the two forms shown in figs. 171 and 172. Fig. 171 is 4½ in. in diameter,

Fig. 171.



and is intended to be used with the "Concentric" and "Professional" Microscopes. It is thin, to allow great obliquity, but firm. The movements are contained within the circumference of the stage, so that it can make

* See this Journal, 1881, p. 516.

a complete rotation. The rectangular movements are delicate and actuated by two milled heads, placed one above the other (Turrell form). The upper part of the stage is polished black glass; the edge is milled, graduated to degrees and silvered.

Fig. 172.

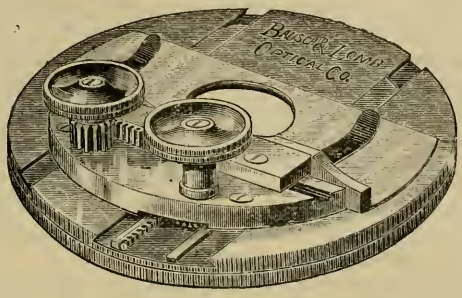
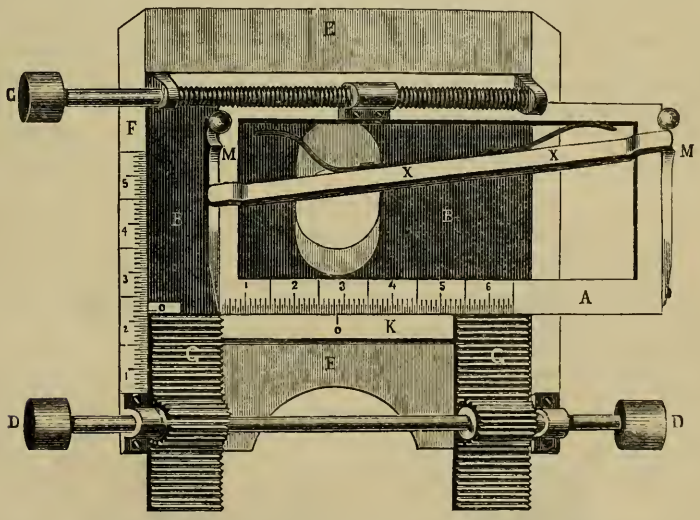


Fig. 172 can be adapted to any Microscope which will admit of a stage 3½ in. in diameter. The movements are all contained on the upper surface of the stage, and it can therefore be completely rotated. It is thin and will admit the use of very oblique light.

Smirnow's Microstat.*—Dr. A. Smirnow describes, under the name of microstat, an apparatus which he has constructed to obviate the great

Fig. 173.



inconvenience of examining the whole of a large object under high powers, or of re-finding minute objects, such as Bacteria, in a large preparation. The purpose of the instrument is much the same, he notes, as that of Klönne and Müller's Bacterium finder.

The principle of the contrivance is based on the fact that any point

* Russ. Med., 1886, No 27 (in Russian). Arch. f. Mikr. Anat., xxix. (1887) pp. 384-8 (1 fig.).

may be determined by its distance from two fixed points or lines on the same plane. The slide is placed in a frame A and kept always in the same position by a rod X. Before the slide is inserted the rod X is pressed forward to the anterior margin of the frame where it is held by two teeth M. By pressing the knobs of the teeth, the rod is released and springs back so as to fix the slide in a given position. The frame is moved from right to left by a micrometer screw C. On an immovable plate K, a permanent point *o* is marked, and the adjacent margin of the movable frame is divided in 0·25 mm. Thus one line on the preparation is defined. But the frame A is fixed to another movable plate B B which is worked by the rack and pinion G, D, on an inferior fixed plate E E, and in an antero-posterior direction. One margin F of this fixed plate is also graduated, and there is another fixed point *o*, so that the desired point in the field can be defined in two directions, and therefore readily determined. The plates B B and E E have apertures for illumination. The attachment to the stage is a simple matter.

The whole field can be systematically observed, a point can be registered and readily found again, the size of large objects can be measured, movements of organisms can be defined, and the comparison of lent preparations greatly facilitated.

Notwithstanding the fulness of the description and the renown of the German periodical in which it appears, it must be said that the "Microstat" is simply a mechanical stage with finders, and in this country at any rate has no feature of novelty.

Darling's Screw-Micrometer.*—Mr. S. Darling has devised two forms of screw micrometer, in which he claims there is "no perceptible play between the threads of the screw and the nut," and in which "the screw will revolve much farther, relative to the motion of the cross-hairs, than in the micrometers heretofore made;" and further, that he has found "a substitute for the common cross-hairs (spider's web), by which measurements can be made with greater accuracy and uniformity."

One form of his micrometer (fig. 174, top view, with top E removed; fig. 175, section of fig. 174 through A B) has a V-thread screw and nut, the nut

Fig. 174.

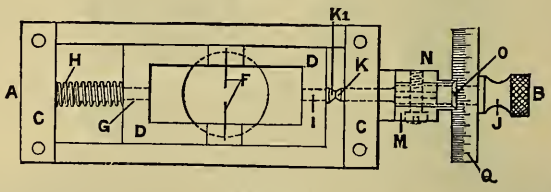
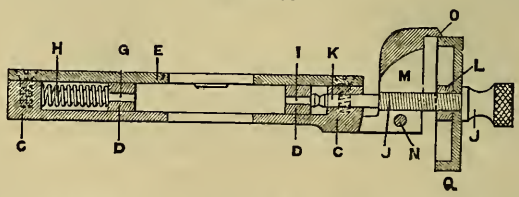


Fig. 175.



being split at one end and a screw tightening the nut. The frame that carries the cross-hairs has a very small hard abutting-piece coming against

* Specification of U.S. Patent, No. 287,420, Oct. 30, 1883.

the end of the screw; the screw also being made hard and preferably small. In another form (fig. 176 top view, with the top E removed; fig. 177, section of fig. 176 through R S), two screws are made on the same piece, each made

Fig. 176.

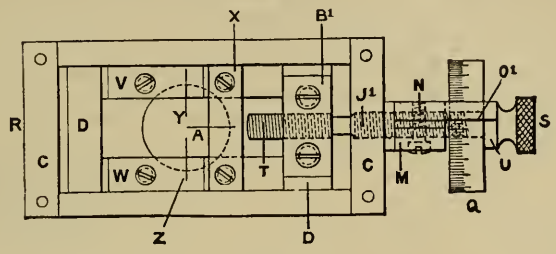
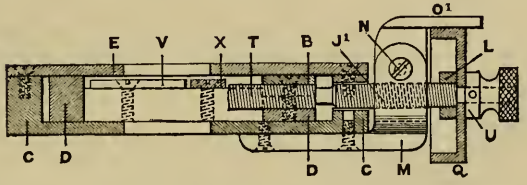


Fig. 177.



of a different pitch, and a whole or split nut for each part of the screw, one nut and the corresponding screw being attached to the frame that carries the cross-hairs.

He proposes to use wires of glass or other suitable material instead of spider-webs, and to apply short cross-wires parallel with and opposite to each other, leaving a space between them and in various positions, so that the operator can have several points to guide him in adjusting the micrometer on the object to be measured. He says,—

"It is well known to mechanics that a screw loose in the nut cannot be depended upon for great accuracy and uniformity in measurements, notwithstanding the slack may be taken up by a spring, as particles of matter are liable to get between the threads and cause errors. That difficulty is avoided in this improved micrometer. From experiments it is believed that the cross-hairs in a micrometer made according to this improvement can be adjusted to a line a number of times—say five, more or less—within an error of 0·00005 of an inch. It greatly facilitates the adjusting of the cross-hairs to a line to have the screw move a considerable part of a revolution for each division of the index-wheel. It is difficult to move the screw made in the ordinary way little enough to adjust the cross-hairs in the most accurate manner, and the difficulty in moving it little enough often influences the operator to accept an adjustment as correct with which he is not fully satisfied.

In the drawings I have illustrated a screw made in two parts on the same piece, one part being 20 pitch and the other 25 pitch, which gives a movement to the cross-hair frame of 1/100 in. each revolution, this being intended for ordinary work; but in a micrometer for very fine measurements I should use a screw from 35 to 40 pitch. 36 and 37·037 pitches would be 3/4000 in. approximately, to each turn of the screw, and the object being magnified fifteen times, and the index-wheel divided into ten parts, one division on the wheel would be 1/200,000 in., and the

index-wheel being about 1·2 in. in diameter, it will be seen that the lines on the screw or index-wheel will be over 0·35 apart, instead of one-tenth (0·035) of that, when the wheel is divided into one hundred parts, in the usual way."

"I have illustrated two methods of making micrometers, which vary from each other in some respects. One method is shown in figs. 174 and 175, and the other in figs. 176 and 177.

In figs. 174 and 175, C is a case with top removed, inclosing the cross-hair frame D. F are wires attached to sliding frame D. These wires may be made of metal or any suitable material, and should be from 1/500 in. to 1/1000 in. in diameter. Glass is a good material to make the wire of, as it can be pulled apart and a square end obtained. The wires can be secured to the frame by wax or any other suitable means. There may be one wire only, or two, as shown in fig. 174, or any number desired, and they may be placed in any position, as shown at A, Z, and Y, fig. 176, or any other preferred. M is a split nut. N is a screw for bringing the two parts of the nut together. J is a screw which passes through nut N, and terminates in a small hardened abutting-end K. O is an index-line. I is a small hardened abutting-piece attached to cross-hair frame D. G is a rod for holding spring H in position. Q is a graduated index-wheel. E is the top to the case C.

V W X, fig. 176, are adjustable pieces, to which the wires are attached; T the part of the screw which is 20 pitch; J_1 the part that is 25 pitch. The screw J_1 passes loosely through the frame C.

It will be seen that by means of the split nut and screws N all play between the nut and the screw can be prevented. Nut B′ may be split at one end, the same as nut M, or made in two parts, with two screws as shown.

It is evident that with the nuts properly adjusted the frame that carries the wires (cross-hairs), fig. 176, must move with the screw without variation. The arrangement shown in figs. 174 and 175 has the advantage of the split nut, and in addition to that very small abutting-surfaces, so that there will be much less liability for dust or oil to get between the abutting-surfaces K and I than in the usual form.

There is a great advantage in having several points to aid in adjusting the cross-hairs to a line. If the operator is in doubt whether one point coincides with the line, the other points will help him to decide directly.

In fig. 174 the nut M may be made in the frame D, as shown at B′, fig. 176, instead of being located outside of case C; but in that case the advantage of the small abutting-surfaces I and K would be lost; but it would be better than the usual form.

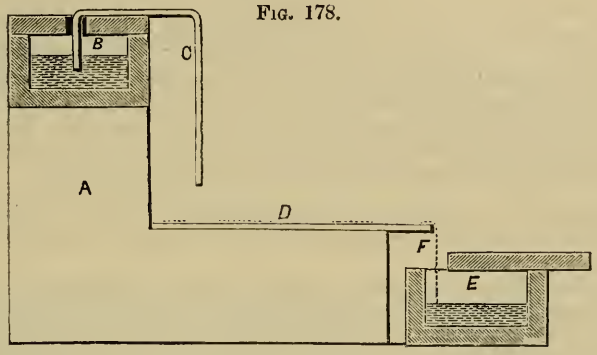
The index-wheel is divided into ten parts and each part into five fractional parts. Now, with the two pitch-screws 36 and 37·037 pitches, as above described, one division of the wheel will read 1/200,000 in., and each fractional part will read 1/1,000,000 in., for with a Microscope that magnifies fifteen times, one turn of the screw being 3/4000 and one division of the wheel being 3/40,000, and this magnified by fifteen times gives 3/600,000 = 1/200,000, and one-fifth (the fractional parts), will give the 1/1,000,000.

The advantage in using the end of a wire instead of the side of a spider-web in the usual way, is that the full size of the line is always in view, and, having the wire nearly the size of the line, it is much easier to judge when the two coincide than when the line is covered by the cross-hairs, as in the common way, and when more wires than one are used each one will serve to correct a mistake that might be made with one alone."

Pagan's Growing Slide.*—The Rev. A. Pagan's slide was designed mainly for the purpose of watching the development of rotifers and other organisms which require a constant change of water. Figs. 178–81 give the essential points of its construction, which is very simple, and so far effective as to have enabled Mr. Pagan to observe the growth of the spores of *Volvox globator* after they had been confined to the slide for six weeks, the actual process of germination taking three days to complete.

Fig. 178 is a longitudinal vertical section of the whole apparatus drawn to a scale of half the actual size. A is a wooden stand supporting a glass

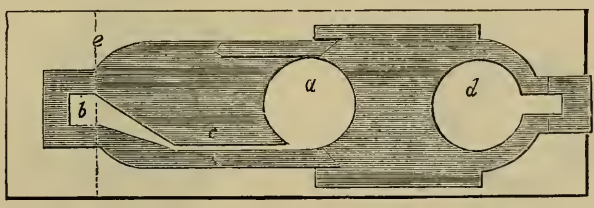
Fig. 178.



trough B, from which a water supply is conveyed to a slide D by a siphon C. This siphon is made from an ordinary capillary vaccine-tube, bent over a minute gas-flame. The water is conveyed from the slide by means of a spout F, made of blotting-paper, to another trough or suitable receptacle E.

Fig. 179 shows in full size an arrangement cut out of blotting-paper, and placed on an ordinary slide, *a* being a circular hole for containing the object under observation. This hole is connected by a narrow channel *c* with another hole *b*, shaped as in the drawing, and so placed beneath the siphon *c* as to receive a drop of water as it falls. It is sufficient, however, if the drop

Fig. 179.



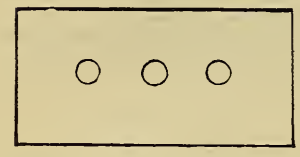
falls on the blotting-paper. A third hole *d* serves to collect the superfluous water, and also acts as a reservoir when the slide is under examination with the Microscope, water being applied there from time to time with a camel's-hair brush.

When it is desired to use the instrument, the blotting-paper is wetted and put on the slide, the drop of water containing the organism placed in the hole *a*, and the whole is covered with thin glass up to the dotted line *e*,

* Journ. Quek. Micr. Club, iii. (1887) pp. 81–3 (4 figs.).

three 3/4 in. square cover-glasses being very suitable for this purpose. The siphon may now be started, the current being regulated to about one drop per minute by means of a linen thread, unravelled, soaked in water to get rid of air-bubbles, and pushed up the shorter limb of the siphon. The water is drawn off at the other end of the slide by three strips of blotting-paper, one broad and the other two less than half the width, placed under the broad slip, thus forming a kind of channel for the water to flow through.

Fig. 180.



After a time the blotting-paper is liable to get clogged, and will not allow the water to filter through; it must therefore be changed. To enable this to be done the part used on the slide is cut in pieces in the manner indicated in fig. 179.

The form of the lid of the trough B is shown in fig. 180. It is provided with three holes drilled 1 in. apart, in order that, when desired, three separate slides can be kept under treatment at the same time.

Apparatus for examining living Myriopoda.*—M. J. Chalande employed the following simple apparatus for microscopical observation of living Myriopoda:—

Two glass slides are fixed, one over the other, by sealing-wax along the two sides, leaving a space of 1–2 mm. between the two slides to allow the myriopod to be introduced. One end of the apparatus is closed by means of a small piece of cardboard. The space between the two slides must vary according to the size of the specimens to be examined, and for very small forms the author substituted a cover-glass (32 by 12 mm. and 1/5 mm. in thickness) for the upper glass slide.

In order to give the myriopod foothold, he gummed some particles of sand to the lower slide at various distances apart. If this is not done, the animal continues to struggle, as it endeavours to find something to hold on to.

Griffith's Mechanical Finger.†—Mr. E. H. Griffith says that a cheap mechanical finger, for those who cannot afford to purchase a better one, may

Fig. 181.

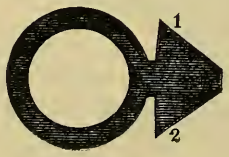
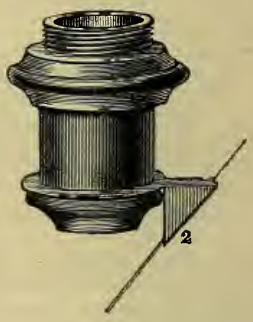


Fig. 182.

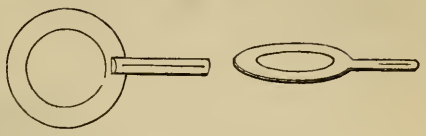


be quickly made as follows:—Procure a strip of sheet brass or other metal, and cut it like fig. 181. Make the aperture just large enough to fit over the

* Bull. Soc. d'Hist. Nat. Toulouse, 1886. See this Journal, *ante*, p. 385.
† Proc. Amer. Soc. Micr. 9th Ann. Meeting, 1886, p. 150 (3 figs.).

screw which fastens the lower system of a low-power objective to the barrel of the objective. Bend the points (1 and 2) down, so that they will meet and serve as a bristle clamp. Remove the lower system of the objective, and put in the thin brass plate as in fig. 182; then draw a cat's whisker between 1 and 2, and the finger will be ready for use as soon as the point of the whisker is in focus and in the centre of the field.

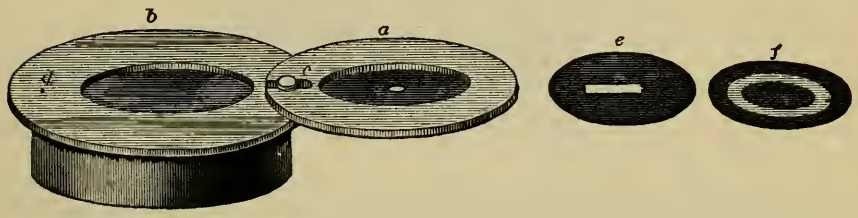
Fig. 183.



A divided wire might be soldered on the ring in fig. 182, and it would answer the same purpose (see fig. 183).

Griffith's Substage Diaphragm-holder and Glass Diaphragms.*—Mr. E. H. Griffith's holder is a metal disc *a* (fig. 184), which is to be fastened to the substage fittings *b*, by means of the screw *c*, which allows it to be turned in any position. An aperture of any desired diameter is made in the holder *a*, and provided with a ledge for the support of diaphragms

Fig. 184.



which may be dropped into position when the holder is turned on one side, as would be indicated in the fig. were the disc turned over. The slot at *c* allows the diaphragm to be placed central with the objective on a decentered stage. The screw-head at *c* should be of sufficient size to retain the holder in any position it is placed. The pin *d* is to indicate a central position when the holder is to be used on a well-centered stage.

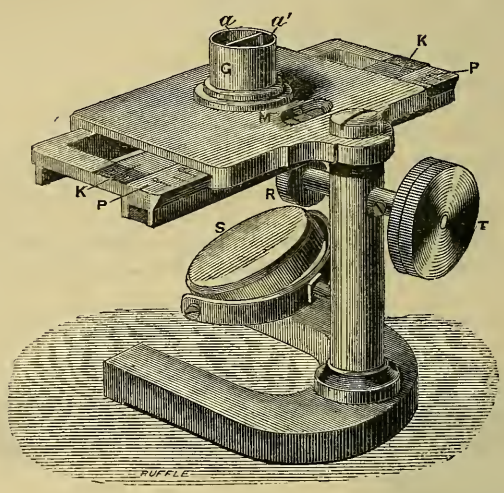
Thin metal discs with various apertures may be used for diaphragms, but much cheaper ones may be made by placing common round cover-glasses *e f* on the turntable, and with a brush quickly covering all but the desired aperture with asphalte or other pigment. In the place of diaphragms, various coloured glasses for the modification of light may be used.

Fleischl's Hæmometer.†—This instrument, fig. 185, devised by Prof. E. v. Fleischl for the estimation of hæmoglobin in the blood, is based on the colorimetric method; that is, it compares the colour of red glass with that of a solution of the blood, and from the thickness of the stratum of the solution or of the glass when the tints are the same the amount of colouring matter present in the blood is determined. Prof. Fleischl finds, however, that although it is easy to prepare a plate of red glass which has exactly the same colour as a certain thickness of a solution of blood, yet if the thickness of the plate be increased *n*-fold it no longer has the same depth of colour as a solution of the same blood concentrated *n*-fold,

* Proc. Amer. Soc. Micr. 9th Ann. Meeting, 1886, pp. 150-1 (1 fig.).
† Med. Jahrb. K.K. Gesell. Aerzte Wien, 1885, 20 pp, and 1 pl.

or as the same solution increased n times in thickness. This peculiarity, which may totally vitiate the colorimetric method if proper precautions are not observed, is due to the fact that though the absorption of light by the glass and the blood-solution respectively are directly comparable so far as red light is concerned, there is no such direct relation for the violet

Fig. 185.



rays; hence it is absolutely necessary to eliminate the violet rays from the source of illumination, and when this is done the relation is complete for all thicknesses of the plate and the solution. For this purpose the comparison must be made not by daylight nor with electric or petroleum light, but either by candle-light or with an oil or gas flame; if this cannot be done, a plate of light-yellow glass must be interposed between the instrument and the source of light. Another feature of Prof. Fleischl's method is that the constant quantities are not, as is usual, the concentration of the solution and its thickness, but the absolute volume of the blood examined and the sectional area of the cylindrical vessel in which the solution is contained, the thickness being immaterial.

The hæmometer consists of a glass tube G, $1\frac{1}{2}$ cm. in length and 15–20 mm. in diameter, closed at the bottom by a glass plate, and divided into two semi-cylinders $a\ a'$ of equal size by a vertical glass plate 0·5 mm. thick. The cylinder is fixed to the stage over a circular aperture, through which light is projected from the mirror S, formed of a plate of fine white gypsum. Beneath one half of the aperture is a wedge of red glass K, movable by the pinion and milled head R T, so that any part of the wedge may be brought under the aperture.

The instrument is used in the following way: the two halves of the glass tube are filled to any height with water; in one is dissolved a unit volume of the blood, and the coloured glass is then shifted until the two semi-cylinders show the same colour. The position of the wedge is then read upon the graduated scale P through the opening M in the stage, the graduations being arranged so as to give direct the percentage of colouring matter as compared with the normal proportion of hæmoglobin contained in healthy blood.

To transfer a fixed quantity of blood to the glass cylinder Prof. Fleischl uses what he calls an "automatic blood-pipette," made by dividing a fine thermometer tube into lengths of equal capacity by sliding a short column of quicksilver from one part to another of the tube and marking the glass at the ends of the column (which is not less than 1 cm. in length) with a diamond. The tube is then cut through at these points, and each length is ground to a conical termination at each end and provided with a short holder of silver wire. If the end of one of these pipettes is immersed in a drop of blood it becomes filled by capillary attraction, and a unit volume of the liquid may thus be transferred to the glass cylinder.

Measurement by Total Reflection of the Refractive Indices of Microscopic Minerals.*—M. J. Thoulet describes a contrivance for measuring the indices of minerals under the Microscope by Kohlrausch's method of total reflection. The only microscopic methods which have been employed with advantage are those of the Duc de Chaulnes and of Mallard, but in both of these it is necessary to have a section of the mineral and to determine the thickness of the section with accuracy; with Kohlrausch's refractometer it is only necessary to have a plane surface of the mineral immersed in a liquid of greater refractive index, so that a natural crystal face may conveniently be employed. In this apparatus, as is well known, the liquid of high refractive index is contained in a cylindrical vessel surrounded by oiled paper, which serves to illuminate the interior with diffused light except at the point occupied by the observing telescope, and the mineral is supported on a rotating axis, which coincides with the axis of the cylinder. When the normal to the crystal surface makes with the axis of the telescope an angle equal to that of total reflection, one-half of the field of view is illuminated by totally reflected rays. The field is consequently divided into two equal parts of very unequal intensity. If the angle between the two positions at which this occurs is $2\,i$, then i is the angle of total reflection, and the index of the mineral is $\mu \sin i$, where μ is the known index of the liquid.

M. Thoulet's contrivance is merely the total refractometer of Kohlrausch applied in a simple form to the stage of Bertrand's Microscope.† A plate of blackened brass fixed to the stage by the screws *d d* carries the graduated semicircle *s* (of which R is the axis) moved independently by the milled head A, and carrying the vernier *t* with it when moved by B. This axis carries not only the object *o*, but also the small cylindrical tube M, into the cork *a* of which it fits closely. This tube contains the bisulphide of carbon or other liquid which surrounds the object, and being completely closed prevents evaporation. M is surrounded by a second cylindrical tube N, open above, but closed below by the cork P. This tube is fixed to the holder D by a point which enters P; and D, being attached to the stand of the Microscope by the spring clip C, may be adjusted by hand to any desired position. The tube N is covered with oiled paper except along a narrow band parallel to its axis, which is brought opposite to the objective E by turning the milled head G.

The tube M having been filled with carbon disulphide, and the object fixed at O with its face parallel to the axis (gum arabic may be used for this purpose, being insoluble in the liquid), the whole apparatus is rapidly centered and adjusted by the stage movements and those at G and C; the angle of total reflection is then determined in monochromatic light by the goniometer, which is divided to tenths of a degree, and which by

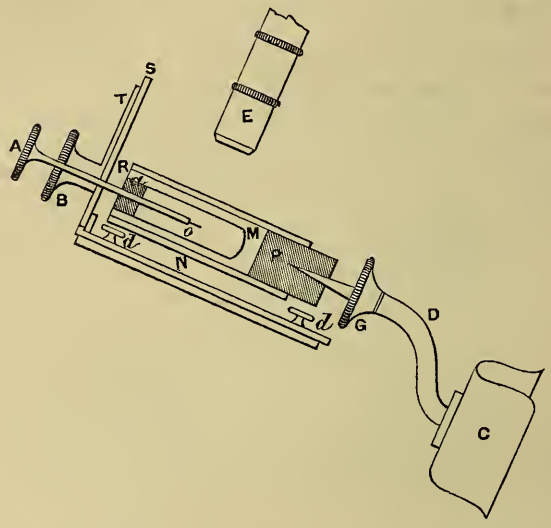
* Bull. Soc. Minéral. France, 1883, pp. 184–91 (1 fig.).

† See this Journal, 1883, p. 413.

repeated measurements gives the angle to about 2 minutes, corresponding to units in the third place of decimals.

In using the instrument the objective is replaced by Bertrand's lens for convergent light, or the objectives 0 or 1 of Nachet may be employed.

Fig. 186.



As regards the liquid, there are many objections to the use of carbon disulphide, and M. Thoulet recommends biniodide of mercury and potassium as more convenient than either naphthaline monobromide or solution of sulphur or phosphorus in carbon disulphide. In any case it will not be possible to determine an index of refraction which is greater than 1·7.

A Microscopic Advantage.

["By inverting a 1/4 in. objective over the eye-piece of the Microscope an arrangement is produced which immediately gives the images in their proper position, and not upside down, as without it. This is a considerable advantage, because it enables a worker to go straight to the object without the mistakes which so frequently occur with beginners."]

Scientif. Enquirer, II. (1887) pp. 106–7.

Hällstén, K.—**Ein Compressorium für microscopische Zwecke.** (A compressorium for microscopical purposes.)

[A brass tube surrounding the objective, at the lower end of which a cover-glass is cemented with shellac. It can be used as a compressorium, and also to prevent the dimming of high powers with water vapour when observing delicate transparent objects in the living condition on the hot stage.]

Zeitschr. f. Biol., XXII. (1886) pp. 404–7 (1 fig.).

Ketchum's (J.) Portable Oxy-calcium Lamp.

["When packed occupied a case only 13 in. long by 6 in. square. The oxygen cylinder was 3 × 12 in. long, and contained four hours' supply. The illumination was very fine."]

Amer. Mon. Micr. Journ., VIII. (1887) p. 97.

Laboratory Notes.

[Usefulness of a simple and inexpensive eye-piece micrometer as a part of the outfit of each Microscope in the laboratory. Culture-cells made of vulcanite rings.]

Amer. Natural., XXI. (1887) pp. 477–9.

N., W. J.—**The Two Mirrors. No. VI.** *Sci.-Gossip*, 1887, pp. 75–6 (1 fig.).

Polariscope, single, for the Toy Microscope.
[Made of sixteen or eighteen cover-glasses.]
Engl. Mech., XLV. (1887) pp. 337–8 (2 figs.), from *Scientific American.*

ROGERS, W. A.—**"Microscopic metal thermometer,** by which the indicated temperature is read off upon the eye-piece micrometer of the Microscope."
Proc. Amer. Soc. Micr., 9th Ann. Meeting, 1886, p. 190.

Schroeder's New Lieberkühns.
[Made of Wolfram steel.] *Journ. Quekett Micr. Club*, III. (1887) p. 92.

SELENKA, E.—**Die elektrische Projections-lampe.** (The electric projection lamp.)
SB. Phys.-med. Soc. Erlangen, 1887, 8 pp.

TATHAM, J.—**Illumination of Objects under the Microscope.**
Trans. and Ann. Rep. Manchester Micr. Soc., 1886, pp. 78–9.

THANHOFFER, L. v.—**Mikroskopische Gaskammer.** (Microscopical gas chamber.)
[Contains only the following abstract—"with which the author investigated under rarefied and compressed air or in different gases the movements of the protoplasm or the circulation of the blood in small transparent animals."]
Math. u. Naturwiss. Ber. Ungarn., IV. (1886) p. 218.

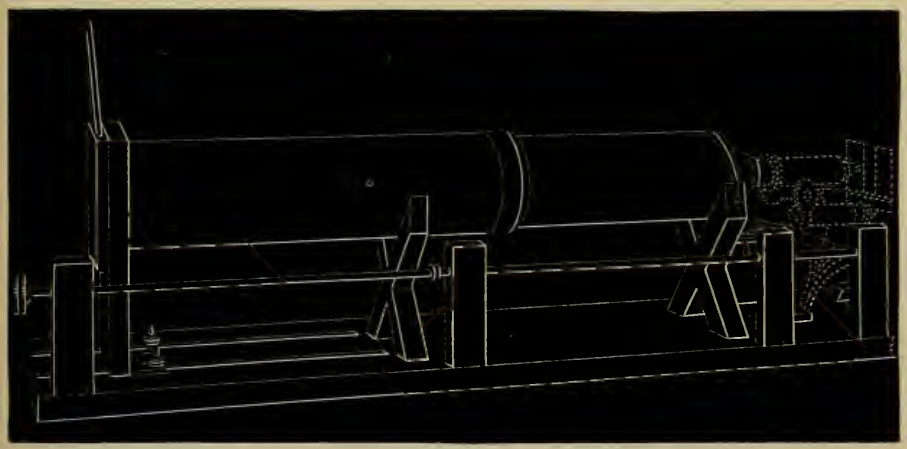
VANDERPOEL, F.—**Improved settling tube for urinary deposits.**
Amer. Mon. Micr. Journ., VIII. (1887) pp. 71–2 (4 figs.) pp. 115–6.

WARD, R. H.—**Micrometer Wires.**
[Recommends the use of platinum wires in preference to spider threads.]
Proc. Amer. Soc. Micr., 9th Ann. Meeting, 1886, pp. 89–93.

(4) Photomicrography.

Nelson's Photomicrographic Camera.—This camera (fig. 187) was designed by Mr. E. M. Nelson in conjunction with Mr. C. L. Curties, especially for use with Prof. Abbe's new 3-power projection eye-piece. The apparatus consists first of a base-board, which is of sufficient length to take the camera when fully extended, the Microscope, and the lamp. The axis of the camera is fixed at the same height above the board as the optic

FIG. 187.



axis of the Nelson Model Microscope, but can be arranged to the height of any stand.

The camera itself consists of two cardboard tubes, which are light but strong, the one sliding into the other like the tube of a telescope; the joint between the two tubes is made light-tight by a velvet flap which is fastened down by an indiarubber band. The joint between the Microscope and camera has the usual light-excluding tubes. The camera when closed and used with the 3-power projection eye-piece is arranged to give a magni-

fication of about five times the initial magnifying power of the objective employed, and when fully extended gives ten times the initial power of the lens. The outer cardboard tube is fastened to an upright piece of wood which is clamped to the baseboard by thumb-screws at any point of its extension. The focusing screens of grey glass and plain glass with ruled lines, slide in grooves at the back of the upright piece of wood. The double back is the well-known Tylar patent metal one, which is cheap and efficient. This back is not a fourth of the cost of the wooden ones, and is free from the objectionable sticking of the slide due to the warping of the wood. The focusing is effected by a rod which runs down the right-hand side of the camera, a string passes round this and over a pulley on the other side of the board, taking a turn round the milled head of the fine-adjustment screw. This string is kept tight by a piece of elastic. The feet of the Microscope fit into blocks fastened on the baseboard.

Mr. Nelson especially recommends the aplanatic lens No. 127 in Zeiss's catalogue, power 6, as a focusing glass, and says that "the whole of the apparatus, viz. camera, Microscope, and lamp, is produced at a cost less than is usually paid for a camera alone. It is not a makeshift which is only capable of doing fairly good work, but it is proved by practical experience to be equal to the highest class of work. The Campbell differential screw fine-adjustment will be found peculiarly serviceable for photomicrographic work, as it is slow and free from spring, which is the bane of every geared-down fine-adjustment." *

Photomicrographic Camera for the Simple or Compound Microscope.† —Dr. P. Francotte's camera is intended specially for Mayer's simple Microscope, but can be used with any instrument in a vertical position. Low powers only are used. In form the camera is merely a pyramidal box with four sides. The topmost side carries a quarter-plate frame (9 × 12). The lower one is fitted with a brass tube by which it is arranged in the Microscope. By means of three screws, exact centering is perfectly obtained. A frame with ground glass serves for the superficial point and the regulation of light, and for the exact point a frame with transparent glass and a single lens of low power is used. The frame for the sensitized plates is double, and is supplied with two intermediate arcs, the one for a glass 6 × 4½ (quarter plate cut in two), the other for a quarter plate cut in four. With Steinheil's lens and monochromatic light, beautiful clichés of entire sections of larvæ of Salamander, &c., 15–18 mm. in length, were obtained. The images were 9–11 cm. long. The sections were stained with picrocarmine and the plates used were those obtained from Attout-Taillefer or those of Monckoven or Beernart sensitized for red rays by quinoline blue (cyanine).

The apparatus also gives good results with the compound Microscope, with or without the ocular.

Focusing in Photomicrography.—The inconvenience of focusing by means of long rods has been attempted to be obviated in several ways. One method, by the substitution of a piece of white paper for the ground glass, viewing the image from an opening at the side, was described in this Journal, 1886, p. 841.

To accomplish the same object, Dr. B. Benecke ‡ inserted a telescope with a right-angled prism in the front part of his camera (fig. 188), by means of which the image on the screen of white paper at the other end of

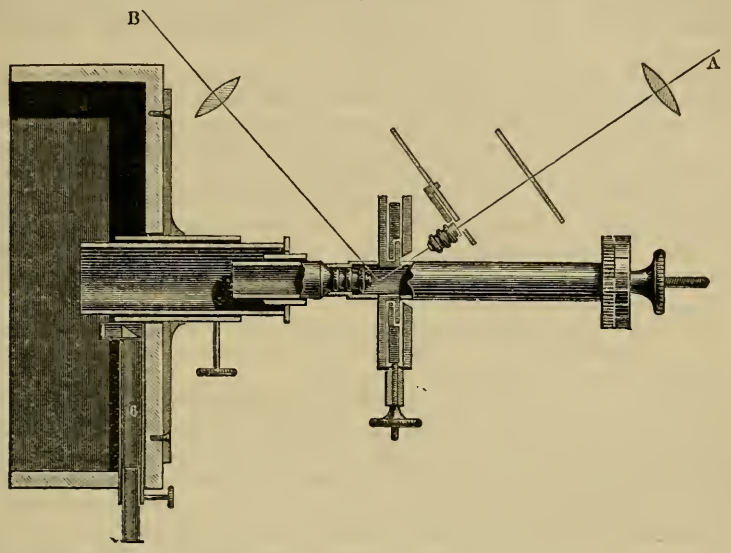
* Cf. Engl. Mech., xlv. (1887) p. 213.

† Bull. Soc. Belg. Micr., xiii. (1887) pp. 149–51.

‡ 'Die Photographie als Hilfsmittel Mikroskopischer Forschung,' 1868, pp. 74–5 (1 fig.).

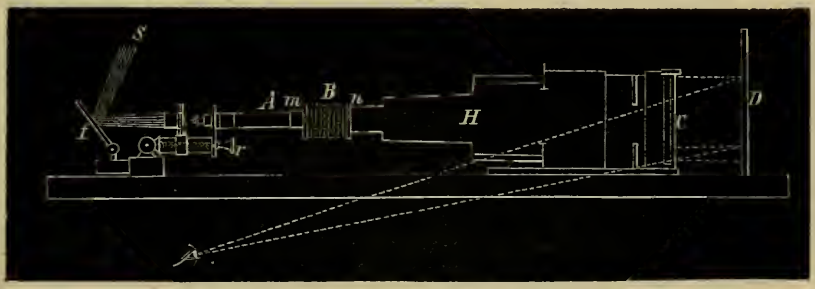
the camera was focused, the observer's head being thus in close proximity to the Microscope. (A and B are intended to show the mode of illuminating an object by oblique transmitted, and by reflected light.)

Fig. 188.



Dr. S. T. Stein* adopts the following method of focusing. The Microscope A (fig. 189) is first adjusted by direct vision until a clear image of the object is obtained; the eye-piece *m* is then removed and the body-tube united with the wooden chamber H by means of the black cloth connection B, which has rubber collars at *m* and *n*, and admits no light; the rays from the mirror *f* throw a blurred image of the object upon the ground-

Fig. 189.



glass plate of the camera C. Behind the camera is the plane mirror D, in which the observer whose eye is near the Microscope sees this image; he is thus in a position to adjust the Microscope until a well-defined image is thrown upon C by the direct use of the micrometer-screw *r* without the

* Stein, S. T., 'Das Licht,' 8vo, Halle, 1884, pp 231–2 (1 fig.). Cf. also J. Girard's 'La Chambre noire et la Microscope,' 2nd ed., 1870, pp. 52–3 (1 fig.).

intervention of any complicated mechanism such as is necessary from the usual position behind the camera. It may be convenient to examine the image with a small telescope or opera-glass.

Photomicrography with High Powers.*—Dr. O. Israel draws attention to the photomicrography of fresh objects, especially of vegetable micro-organisms in their natural condition, by the application of high powers and the use of good bromide gelatin plates.

For most microbes it is necessary to use very narrow diaphragms in order to reproduce the fineness of their lines with sufficient clearness; and as thereby much light is lost, long exposure becomes necessary. Hence also a very stable apparatus is a *sine quâ non*. The duration of the exposure is dependent on the clearness of the microscopic picture, and this in its turn depends on the source of light, the objective, and the size of diaphragm.

Diffuse daylight gives the best light, and for high powers and immersions a condenser is either desirable or necessary. Dry, water, and oil-immersion lenses are all applicable, though the best results were obtained with Hartnack's immersion ii. with correction.

It is of great importance that the object to be photographed should be very thin, in order that the parts above or below the plane in focus should not detract from the clearness of the picture.

For over-exposed pictures the author recommends the addition of a few drops of a concentrated solution of bromide of potassium to the iron developer, and this does not interfere with any subsequent treatment with cyanide of silver. Evidence of the efficacy of the method is given by the prints of negatives of micro-organisms and of other fresh objects, among which may be mentioned striated muscular fibre in salt solution.

Crookshank's 'Photography of Bacteria' and 'Manual of Bacteriology.'—The intention of Dr. E. M. Crookshank's 'Photography of Bacteria'† will be best explained in his own words:—"It might appear ill timed to publish photographs of bacteria when the apochromatic objectives, which promise to be of such great advantage in photomicrography, have just been introduced. I only wish, however, to illustrate results obtained with ordinary objectives, and to demonstrate that photography may be employed with success to represent preparations of bacteria even under conditions unfavourable for photography. There has been no desire to produce a series of feats in photomicrography; but on the other hand, I am anxious to encourage the attempt to make photography subservient to bacteriology. Those who would aim at the former should select difficult test-diatoms as their subject, and endeavour to equal or surpass the photographs taken by Dr. Woodward, of America.

"The preparations to be photographed were selected without any reference to the staining reagents which had been employed, and in some cases photographs are given which were purposely taken of bacteria so faintly stained, as to be demonstrated under the Microscope with difficulty.

"It is hoped that these photographs will be useful as supplementary illustrations to my 'Manual of Bacteriology,' while the accompanying letter-press may serve as an introduction to the methods employed in photo-micrography."

A second edition of the author's 'Manual of Bacteriology'‡ is also

* Virchow's Archiv f. Path. Anat. u. Physiol., cvi. (1886) p. 502.

† Crookshank, E. M., 'Photography of Bacteria,' xx. and 64 pp., 6 figs. and 22 plates of photographs with explanations, 8vo, London, 1887.

‡ Crookshank, E. M., 'Manual of Bacteriology,' 2nd ed., xxiv. and 439 pp., 137 figs. and 29 pls., 8vo, London, 1887.

issued, enlarged and revised, and with additional chapters on the general Morphology and Physiology of Bacteria, &c. There are seventy-three additional illustrations, and a very extensive Bibliography.

FIELD, A. G.—**A new Photomicrographic Apparatus.**
Amer. Mon. Micr. Journ., VIII. (1887) p. 94 (1 fig.).

HITCHCOCK, P.—**Resolution of pearls of Amphipleura.**
[Note on Dr. Van Heurck's photographs.]
Amer. Mon. Micr. Journ., VIII. (1887) pp. 105–6.

MAGINI, G.—**Qualche considerazioni sulla micro-fotografia.** (Some considerations on photomicrography.) *Boll. R. Accad. Med. Roma*, 1886, No. 4.

MERCER, A. C.—**Photomicrograph** *versus* **Microphotograph.**
["A photomicrograph is a macroscopic photograph of a microscopic object; a microphotograph is a microscopic photograph of a macroscopic object." The distinction was originated by Mr. George Shadbolt in 1859 or 1860.]
Proc. Amer. Soc. Micr., 9th Ann. Meeting, 1886, p. 131.

Microphotogrammes du Dr. Van Heurck et du Dr. P. Francotte. (Photomicrographs of Dr. Van Heurck and Dr. P. Francotte.)
[3 of *Amphipleura pellucida* resolved into beads. *Navicula fusca* and Nobert's 18th and 19th band. 4 of zoological subjects.]
Bull. Soc. Belg. Micr., XIII. (1887) pp. 159–60 (1 pl.)

Photomicrography.—See (6) American Society of Microscopists.

(5) Microscopical Optics and Manipulation.

Method of determining the index of refraction when the refracting angle is large.*—The method of minimum deviation can only be employed when the refracting angle of the prism is less than twice the limiting angle; but Signor G. Bartalini shows that indices may be measured in a prism bounded by three planes inclined to one another at two unequal angles, the ray of light being so transmitted as to be refracted at the first and third and internally reflected at the second surface. For the success of this method it is only necessary that the larger angle of the prism added to the complement of the limiting angle should be less than 180°.

The formula is

$$n = \frac{\sin a}{\sin \phi}$$

where

$$\cot \phi = \cot (a - \beta) \cos^2 \theta$$

$$\sin^2 \theta = \frac{\sin b}{\sin a \,.\, \cos (a - \beta)}$$

or

$$\cot \phi = \frac{\sin b}{\sin a \,.\, \sin (a - \beta) \,.\, \cos^2 \theta^1}$$

$$\tan^2 \theta^1 = \frac{\cos (a - \beta) \sin a}{\sin b}.$$

According as the ray after internal reflection makes an acute or an obtuse angle with the third surface.

In the above formulæ a and b are the angles of incidence and emergence, and a and β are the corresponding angles of the prism.

Observations made upon a quartz crystal gave—

By minimum deviation	$n_o = 1{\cdot}5442$	$n_e = 1{\cdot}5537$
By the above method	$n_o = 1{\cdot}5444$	$n_e = 1{\cdot}5535.$

Resolution of 200,000 lines to the inch.—Once again microscopists have been doomed to a bitter disappointment, which is the harder to bear

* Atti Soc. Toscana Sci. Nat., v. (1887) pp. 181–3 (1 fig.).

from its having been so confidently expected that at last the vapourings of microscopical theorists would be exploded and the superior value of a little practical demonstration clearly shown. Theory might attempt to decide that 200,000 lines to the inch could not be resolved with our present resources, but what could that avail against the fact not merely that 200,000 lines to an inch had been *ruled*, but that they had actually been *seen*.

When it was known that Mr. C. Fasoldt, of Albany, New York, who from all accounts is a most able and skilful ruler of lines, intended to show 200,000 lines to an inch at the last meeting of the American Society of Microscopists, expectation was at fever heat, and the feelings of some of our theoretical microscopists can be better imagined than described. It was evident that it was no longer an occasion for such merriment as followed the statement of the belief of a correspondent that "with a little patience" the feat could be accomplished, nor was the offer now only one to "make affidavits" that the lines had been seen* (as if the question was simply one of veracity), but it was declared that a practical demonstration would be given by the author of the lines in the presence of the members of one of the first microscopical societies of the world. This might well excuse, not only excitement but anxiety, on the part of those who had been pinning their faith on the fact that a good many things must happen before 200,000 lines to the inch can be not merely ruled but seen.

The day came, but alas! with the day the man came not—"circumstances prevented that pleasure." In place of the man came only a ruling and a letter. That the ruling was all it claimed to be we have no manner of doubt; what the letter was can be best appreciated by printing it in full.†

"Albany, N.Y., August 2, 1886.

" Secretary American Society Microscopists.

" Dear Sir,—I had intended to be present at your meeting this month, " but circumstances will now prevent that pleasure. With this I send the " Society a fine ruling 5000 to 200,000 lines per inch (23 bands). This " ruling has been resolved by several persons here, with my vertical " illuminator and 1/12 h. im. objective. I had intended to meet with you " and display these lines with my apparatus, but that being impossible, I " send the lines, hoping that some of the members will be able to see them " all as has been done here. I shall always be glad to receive any one " interested in rulings, and will display them to any one who will favour " me with a visit at Albany.

" Yours very truly, Chas. Fasoldt."

The only record consequent on this letter is a vote of thanks for the gift, and we have reluctantly therefore been forced to the conclusion that there (whatever had been done "here"), no one was in fact "able to see them all," so that we have a respite, however brief, from that rude awakening which we must nevertheless consider to be still in store for us.

Boys, C. V.—See "Orderic Vital."

Ewell, M. D.—**A further study of centimeter scale "A."**
Proc. Amer. Soc. Micr., 9th Ann. Meeting, 1886, pp. 75–82.

„ **Comparison of a standard centimeter ruled on glass by Chas. Fasoldt, with centimeter scale "A."** *Ibid.*, p. 83.

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* See this Journal, 1886, p. 868.

† Proc. Amer. Soc. Micr., 9th Ann. Meeting, 1886, p. 206.

GUNDLACH, E.—**Optical Errors and Human Mistakes.**
Proc. Amer. Soc. Micr., 9th Ann. Meeting, 1886, pp. 157-60.

HEATH, R. S.—**A Treatise on Geometrical Optics.**
[Contains sections on the Simple Microscope; Coddington lens, Stanhope lens, and Stanhoscope; Doublets of Wollaston, Pritchard, and Chevalier; sketch of theory of telescopes and Microscopes; the Compound Microscope; magnifying power of the Microscope; on the measure of the aperture of the Microscope, *post*; recent improvements in the Microscope.]
xvii. and 356 pp., figs., 8vo, Cambridge, 1887.

HIMES, C. F.—**The Stereoscope and its Applications.**
[Includes the Binocular Microscope.]
Journ. Franklin Institute, CXXIII. (1887) pp. 398-408, 425-41, 3 pls. and 13 figs.

JAMES, F. L.—
["The Neglected Twin nowhere proves his usefulness more than in microscopy. The observer who has his left hand properly trained has the purely right-handed one at an immense disadvantage. This is especially true in working with high, or comparatively high, powers. Try it, and you will see. With the left hand to manage the stage and the right upon the micrometer adjustment, one can get over a slide in less than half the time occupied when the right hand is constantly leaving the adjustment to regulate the stage."]
St. Louis Med. and Surg. Journ., LII. (1887) p. 348.

KERBER, A.—**Bestimmung der Brechungs-exponenten, für welche die chromatische Abweichung zu heben ist.** (Determination of the refractive exponents for which the chromatic aberration is to be removed.)
Central-Ztg. f. Optik u. Mech., VIII. (1887) p. 97.
„ „ **Ueber die Korrektur von Systemen grösserer Oeffnung.** (On the correction of systems of large aperture.) *Ibid.*, pp. 145-6.

Magnifying-power of Objectives, Measurement of.
[Inquiry by F. R. Brokenshire and replies by R. Gill, G. H. Bryan, F. J. George, and "Gamma Sigma."]
Sci.-Gossip, 1887, pp. 90-1, 116, and 163-4.
Engl. Mech., XLV. (1887) pp. 392 and 437.

"ORDERIC VITAL."—**A lens used both for refraction and reflection,** [and note by C. V. Boys.] *Engl. Mech.*, XLV. (1887) pp. 443-4 (1 fig.), 468.

POLI, A.—[**Recent progress in the Theory of the Microscope.**]
Rivista Scientifico-Industriale, April 30.
Nature, XXXVI. (1887) p. 262.

ROGERS, W. A.—**Methods of dealing with the question of temperature in the comparison of standards of length.**
Proc. Amer. Soc. Micr., 9th Ann. Meeting, 1886, pp. 67-74.

ROYSTON-PIGOTT, G. W.—**Microscopical Advances.** XVIII., XIX., XX., XXI.
[Diffraction, Ancient and Modern.]
Engl. Mech., XLV. (1887) pp. 331-2 (5 figs.), 379 (1 fig.), 427 (4 figs.), 475-6 (6 figs.).

STOKES, A. C.—**Focus Upward.**
["It has been said in a joking way 'that nothing will throw a microscopist into a chill quicker than to see a friend look into his Microscope and focus downward with his coarse-adjustment.' Yet men who ought to know better have been seen to do this reprehensible thing."]
Queen's Micr. Bulletin, IV. (1887) p. 23, from 'Microscopy for Beginners.'

ZECH, P.—**Elementare Behandlung von Linsensystemen.** (Elementary treatment of Lens-systems.) (Sep. Repr.) 16 pp., 8vo, Tübingen, 1887.

(6) Miscellaneous.

Microscopical Society of Calcutta.—A Microscopical Society has, on the suggestion of Mr. W. J. Simmons, been founded at Calcutta,* with an entrance fee and annual subscription of five rupees. It is intended to have two Sessions, one in the cold season and the other in the middle of the year, with a recess after each. Meetings will be held monthly. So far as we know, this is the only Microscopical Society in any part of India. There must be a large and very interesting field for microscopical work in that part of the world, and we wish the new Society every success.

* Indian Daily News, 1887, June 25.

American Society of Microscopists.—The Working Sessions.
[1. The dredging excursion. 2. Photography (discussion and demonstration of photography by lamplight in its application to the Microscope). 3. The General Session (various exhibitions and practical demonstrations).]
Proc. Amer. Soc. Micr., 9th Ann. Meeting, 1886, pp. 174–96.

„ „ „ **Reports of Committees on Micrometry and on Universal Microscope Screw.** *Ibid.*, pp. 197–8, 199–201.

BURRILL, T. J.—**Presidential Address.**
[Bacteria and disease.] *Proc. Amer. Soc. Micr.*, 9th Ann. Meeting, 1886, pp. 5–29.

Dallinger's (Rev. Dr.) Presidential Address.
["Professor Dallinger presents a far more commendable course, as shown in his laborious and conscientious work described in his presidential address before the Royal Microscopical Society. Instead of predetermining that an organism cannot adjust itself to changed environment, because it might follow that species could be evolved from each other, a conclusion at variance with our narrow notion of the way in which an Infinite Creator would proceed in peopling a world with animals and plants, he goes about a series of most delicate experiments, lasting through seven years without a break, to learn if it is a fact that environing conditions may be greatly changed and yet the organism adjust itself to the change. No one can read his account without admiration for such painstaking and intelligent experimentation and for the determination, after the break in the series, to go over the ground again. Such work done by the leaders inspires the rank and file of workers, and it is such work as this which has given us scientific discoveries and their benefits."]
Amer. Mon. Micr. Journ., VIII. (1887) p. 114.

FINK, H. E.—**"The Eleventh Commandment in the eye of a needle."** (Exhibition.)
The Microscope, VII. (1887) pp. 143–4.

GILMER, T. L.—**The Microscope in Dentistry.** *Dental Review*, 1887, May.

JEAFFRESON, C. S.—**Presidential Address to the North of England Microscopical Society.** Eighth Ann. Rep., 27 pp., 8vo, Newcastle-upon-Tyne, 1887.

[MANTON, W. P., AND OTHERS.]—**Making a Microscopist.**
The Microscope, VII. (1887) pp. 176–8.

MICHAEL, A. D.—**Presidential Address to the Quekett Microscopical Club.**
[Darwinism.] *Journ. Quek. Micr. Club*, III. (1887) pp. 44–62.

Microscopist, an enthusiastic.
[Note on Mr. E. H. Griffith.] *Amer. Mon. Micr. Journ.*, VIII. (1887) p. 114.

Moore, A. Y., Death of.
[Memorial resolutions of the Cleveland Microscopical Society.]
Amer. Mon. Micr. Journ., VIII. (1887) p. 97.

„ „ **Obituary notice of.**
The Microscope, VII. (1887) pp. 137–40 (portrait) and p. 149.

Noble, Captain, and this Journal.
[Comment by Editor on note, *ante*, p. 494.] *Eng. Mech.*, XLV. (1887) p. 402.

Pharmacy, the Microscope in.
["The Pharmaceutical Society of Brooklyn, in its lectures to drug clerks, includes a course on the Microscope in Pharmacy."]
The Microscope, VII. (1887) p. 125.

PUMPHREY, W.—**The Microscope in the Lecture- and Class-room.**
[Concludes that when the object is to demonstrate to a class, or to a small company, who can critically examine the image as displayed on the screen, the image, as taken direct from the object, is much to be preferred; but that for large companies, and where the close examination of the image would be impracticable, the photomicrograph is better adapted to the purpose.]
Journ. of Microscopy, VI. (1887) pp. 141–7.

SORBY, H. C.—**The Microscopical Structure of Iron and Steel.**
[Paper laid before the Iron and Steel Institute, May 1887.]
The Ironmonger, 1887, June 4, pp. 391-9.

STRASBURGER, E.—**Das botanische Practicum.** (Practical Botany.)
2nd ed., xxxvi. and 685 pp., 193 figs., 8vo, Jena, 1887.

WARD, R. H.—**Remarks on the methods of making Microscopical Societies successful.**
Proc. Amer. Soc. Micr., 9th Ann. Meeting, 1886, pp. 94–102.

WEST, C. E.—**Forty years' acquaintance with the Microscope and Microscopists.**
Proc. Amer. Soc. Micr., 9th Ann. Meeting, 1886, pp. 161–73.

β. Technique.*

(1) Collecting Objects, including Culture Processes.

Blood-serum Cultivation.†—Dr. F. Hueppe combines the advantages of blood-serum for growing micro-organisms with the advantages of plate cultivation for separating the colonies in the following manner:—Blood-serum is sterilized at a temperature of 58°–60° by the discontinuous method. It may, however, be sterilized at once and with safety by heating to boiling-point, but although its nutritive properties are apparently unaffected, it loses slightly in transparency. The author gives an illustration of a modification of Fol's sterilizer, heated by the same arrangement as the author's own thermostat.‡ The tubes are laid in the oblique position. After sterilization the serum is warmed to 37° C. and inoculated in the usual manner.

Meanwhile, a 2 per cent. agar solution, to which 0·5–1 per cent. grape sugar is added, has been prepared. Having been fluidified, the agar is cooled down to 42°–45°. Equal quantities of the warm inoculated blood-serum and of the warm agar solution are then mixed together, with the usual precautions, and having been well shaken up, are allowed to solidify in plates, bulbs, &c., at the ordinary temperature. When firm the cultivations are removed to the thermostat. By this method the breeding of tubercle-bacilli from sputum succeeds pretty well.

Crosier, R.—**A method of inoculating fluid cultivating media.**
Brit. Med. Journ., 1886, No. 1347, p. 769.

Edington, A.—**A new culture medium for micro-organisms capable of withstanding high pressure.** *Lancet*, 1886, II. p. 704.

Griessmayer.—**Die Reinkultur der Microben mit specieller Rücksicht auf die Hefe.** (The pure culture of microbes with special reference to yeast.)
Allg. Brauer- und Hopfen Ztg., 1887, pp. 591–2, 603–5.

Kolessnikow.—See Tarchanow.

Macé.—**Sur la préparation des milieux à la gélose pour la culture des bactéries.** (On the preparation of gelatin media for the cultivation of bacteria.)
Ann. Instit. Pasteur, 1887, pp. 189–90.

Smith, T.—**The relative value of cultures in liquid and solid media in the diagnosis of bacteria.** *Med. News*, 1886, II. p. 571.

Sternberg, G. M.—**Bacteriological Notes. The liquefaction of gelatin by bacteria.**
Med. News, 1887, pp. 372–3.

Tarchanow and Kolessnikow.—**Die Anwendung des alkalisch gemachten Eiweisses von Hühnereiern als durchsichtiges Substrat zur Kultur der Bacterien.** (The use of alkaline albumen of hens' eggs as a transparent substratum for the culture of bacteria.) *Russkaja Medicina*, 1887, No. 11 (Russian).

Terry, W. A.—**Notes on Diatom study.**
[Dredging for diatoms.] *Amer. Mon. Micr. Journ.*, VIII. (1887) pp. 44–6.

Vignal, W.—**Étuve pour Cultures.** (Culture oven.)
Ann. Instit. Pasteur, 1887, pp. 184–8.

(2) Preparing Objects.

Method for subjecting Living Protoplasm to the action of different liquids.§—Mr. G. L. Goodall, for studying the action of very dilute solutions on living protoplasm, obviates the necessity of transferring the specimen from the litre-flask, as in the methods of Loew, Bokorny, and Pfeffer, to the stage of the Microscope, by using an apparatus consisting

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

† Centralbl. f. Bacteriol. u. Parasitenk, i. (1887) pp. 607–10 (1 fig.).

‡ Med. Wochenschr., 1886, No. 17.

§ Amer. Journ. Sci., xxxiii. (1887) pp. 144–5.

of a small number of "chloride of calcium jars," i.e. tall slender jars with an opening near the base, which are connected by means of "three-way" tubes with a common tube of small size. The latter tube is inserted into the side of a microscopic cell made of soft rubber, firmly cemented to the slide and provided with an inflow and an outflow. The object is held beneath the glass cover either by delicate glass floats or by glass threads fastened by wax. When the object is *in situ* the liquid is made to flow by opening one of the cocks or one of the way tubes. The stream of fluid may be made slow or rapid, and one fluid may be substituted for another.

The same apparatus may be used for differential staining, for plasmolytic investigation, and for the cultivation of organisms under different conditions of nutriment.

Modes of preparing Ova.*—Dr. H. Henking, in his investigations into the development of the Phalangida, adopted various methods of preparing the ova; the animals were sometimes killed with boiling water, and left in it for some time for the albumen to coagulate; they were then hardened in successive strengths of alcohol up to 80 per cent. The ova were never placed direct in alcohol, in consequence of the shrinking caused by such a process. Other specimens were killed with ether, the back laid open, and the animals placed in Flemming's chrom-osmic-acetic acid, or in Kleinenberg's picrosulphuric acid for some hours before removal to alcohol. Eggs that had been deposited were treated with hot water, and with Flemming's fluid, as well as with hot and cold chromic acid, picrosulphuric acid, &c. The best staining reagents were found to be Grenacher's borax-carmine, Hamann's neutral acetic acid carmine, and eosin-hæmatoxylin. Before imbedding, the eggs on being taken from absolute alcohol were placed in a mixture of bergamot oil and absolute alcohol, then in pure bergamot oil, and then in a warmed solution of paraffin in bergamot oil, and finally in quite pure paraffin. By the aid of Spengel's microtome sections from 1/80 to 1/150 mm. thick were prepared.

New Method of distinguishing Vegetable from Animal Fibre.†—Dr. H. Molisch's process depends on the application of the two new reactions for sugar lately discovered by the author:‡—About 0·01 gram of the sample, previously well boiled and washed with water, is mixed first with 1 ccm. of water, then with two drops of an alcoholic solution of *a*-naphthol (15–20 per cent.), and finally with an equal volume of concentrated sulphuric acid. In the case of vegetable fibre the solution assumes, immediately after shaking, a deep violet colour, the fibre being dissolved. If, however, the fibre is of animal origin, the liquid assumes a colour varying from yellow to reddish-brown. By substituting a solution of thymol for *a*-naphthol a fine carmine colour is obtained in the place of the violet.

The author has successfully applied this test to different vegetable fibres, such as cotton, hemp, jute, china-grass, &c.; also to the cellular tissues of wood, cork, and fungi. Moreover, in the case of dyed fabrics the colouring matters do not appear to interfere with the success of the reaction.

Mode of examining Mucous Membranes.§—Prof. L. Ranvier describes the following method of studying the membrane which invests the retro-lingual sac of the edible or the grass-frog. The membrane is detached and then extended on the disc of Ranvier's moist chamber in such a

* Zeitschr. f. Wiss. Zool., xlv. (1887) pp. 88–90.

† Dingler's Polytech. Journ., cclxi. (1886) pp. 135–8. Cf. Journ. Chem. Soc. Lond., Abstr., 1886, p. 1088.

‡ See this Journal, *ante*, p. 344.

§ Comptes Rendus, civ. (1887) pp. 819–20 (1 fig.).

way that its epithelial surface is turned upwards. During this operation desiccation of the tissues is avoided by sprinkling them with aqueous humour, blood-serum, or chloride of sodium in 7/1000 solution; the membrane is maintained in a state of extension by a ring of platinum which is fixed on the disc of the moist chamber; the ring must be of a little longer diameter than that of the disc, in order that the membrane may be held between it and the disc. The membrane is covered by a glass plate, which is fixed with paraffin. In such a preparation the cells with vibratile cilia, sensory or glandular cells, striated muscular fibres, and nerve-fibres and cells may be easily observed in the living state. As the ring keeps the membrane in its place, the glass cover may be removed for the purpose of adding reagents.

Investigating the Termination of Nerves in the Liver.*—Mr. A. B. Macallum adopted the following method for demonstrating nerve-structures in the liver of *Necturus* (= *Menobranchus*). Pieces of the liver were hardened for a week or more in Erlicki's fluid, or for several days in a 1/6–1/5 per cent. solution of chromic acid. After the hardening was sufficiently completed in alcohol, sections of the frozen tissue were made with a Cathcart microtome. When the gum was carefully removed these were put in a 5 per cent. solution of formic acid for an hour, transferred to a 1 per cent. solution of gold chloride for about twenty minutes, then washed in distilled water, and the gold afterwards reduced in the dark with a 10 per cent. solution of formic acid. About thirty hours suffices for this reduction at a temperature of 20° C., and the sections then have a deep red colour, though the tinge was sometimes violet. The chromatin of the nuclei of the hepatic cells took a deep blue-violet tint, the caryoplasm light violet, while the cytoplasm came out very distinctly as a meshwork with a pink or light carmine colour; the nerve-fibres appeared deep violet, but the connective tissue of the interlobular spaces attained a light, or sometimes a deep red colour. When chromic acid was used as a hardening reagent the addition of any organic acid at the same time, such as acetic acid more especially, seemed to have the effect of robbing the nerve-fibres of their selective capacity for gold. Sections of the liver of *Necturus* are of no value when they are less than 0·02 "m" [mm.] in thickness. With the human liver preparations proved to vary very considerably, but were often not successful.

All the sections were cleared in oil of cloves and mounted in balsam. The study of the ultimate terminations of the nerves was made with the Leitz 1/12 in. homogeneous immersion, with special illumination.

The author discusses the value of gold chloride as a reagent for differentiating nerves, which is not admitted by all histologists; he thinks that it has many advantages over other reagents; the substance which fixes the gold in a violet form is not confined to nerves, but appears to be diffused to a small degree in other tissue elements; the failures of some histologists are referred to their not having sufficiently hardened the tissues. Osmic acid, although useful in the case of medullated nerve-fibres, is of no value for demonstrating the finest non-medullated fibrils.

Preparing the Amphibian Egg.†—Prof. O. Schultze has found that for hardening-fluids the following mixtures give perfectly satisfactory preparations when used in the manner described below:—(1) *Chromo-osmio-acetic Acid:* Chromic acid (1 per cent.) 25 parts; osmic acid (1 per cent.)

* Quart. Journ. Micr. Sci., xxvii. (1887) pp. 443–8.

† Zeitschr. f. Wiss. Zool., xlv. (1887) p. 185. Cf. Amer. Naturalist, xxii. (1887) pp. 595–6.

10 parts; water 60 parts; acetic acid (2 per cent.) 5 parts. (2) *Chrom-acetic Acid:* Chromic acid (1 per cent.) 25 parts; acetic acid (2 per cent.) 5 parts; water 70 parts.

The eggs are left in one of these fluids twenty-four hours, then washed in distilled water, which should be often changed. The egg-envelopes are next removed by the aid of needles, and the eggs are then ready for surface-study.

For the purpose of sectioning the eggs are transferred from the water used in washing to 50 per cent. alcohol, then to 70 per cent., 85 per cent., and 95 per cent., leaving them twenty-four hours in each grade. The last grade should be changed several times. The eggs are then clarified in turpentine one to two hours, and then placed in paraffin that melts at 50° C. from one-half to one hour.

Prof. Schultze states that the success of the method depends on following precisely the directions given as to time. If the eggs remain longer, either in alcohol, turpentine, or paraffin, the results may be entirely unsatisfactory. If the conditions are strictly followed the eggs have the consistency of the paraffin, and cut excellently without crumbling in sections 1/200 mm. thick.

For staining, borax-carmine was used, directly after washing, twenty-four hours. The eggs were next placed in acid alcohol of 70 per cent. (five drops of the pure acid to 100 ccm. of the alcohol) to remove a part of the colour.

The first hardening fluid does not penetrate well, and is not well adapted for fixing the central parts of the egg.

Preparing Eyes of Molluscs and Arthropods.*—Mr. W. Patten's methods for preparing the eyes of Molluscs and Arthropods are as follows:—

I. Molluscs (preparation of young *Pectens* from 1–3 mm. long).—(1) Specimens are placed in a mixture of equal parts of sublimate and picrosulphuric acid. After ten or fifteen minutes they are washed in 25 per cent. and 70 per cent. of alcohol.

(2) The shells are then opened, and the mantles dissected out with needles. Thus treated, the shape of the mantle is well preserved, whereas if removed before hardening it becomes much coiled and twisted.

(3) Each mantle edge may be cut, according to its size and curvature, into three or four pieces, and these will then lie sufficiently straight for convenient sectioning.

It is necessary to use a different reagent for nearly every part of the eye.

The Rods.—Chromic acid gives the most varied results according to the strength, time of action, and temperature of the solution, or by various combinations of these three. For instance, 1/20 to 1/5 per cent. for thirty to forty hours failed to give any conception of the structure of the rods, while other parts of the retina, and of the eye itself, were well preserved; but when allowed to act for half an hour at a temperature of from 50° to 55° C., perfectly preserved rods with their nervous networks are obtained, whilst, on the other hand, the remaining tissues become so granular and homogeneous as to be unfit for study. This treatment allows the rods to be removed in flakes, and their ends examined without the aid of sections. It is only in this way that the axial nerve-loops can be observed.

* MT. Zool. Stat. Neapel, vi. (1886) pp. 733-8. Cf. Amer. Natural., xxi. (1887) pp. 401–4, and this Journal, *ante*, pp. 53 and 82.

The Lens.—The lens is best prepared for sections by either sulphuric or picro-sulphuric acid; by the first reagent its shape is best retained, and the lens itself is less liable to be drawn away from the surrounding tissue; the latter reagent, however, brings out more sharply the configuration of the cells, and allows a better stain of the nuclei to take place.

The Retinophoræ.—The retinophoræ are well preserved by nearly all the reagents; but in sublimate, in picric acid, or in their combinations, they become slightly granular, and remain so closely packed that it is difficult to distinguish the cell boundaries. Chromic acid 1/5 per cent. for three or four days, contracts the cells and gives preparations in which the boundaries and general arrangement of the retinophoræ are easily studied.

Section of the Eye.—In order to obtain the best sections of the adult eye with *all* the parts in the most natural position, it is necessary to treat them first with 1/10 per cent. of chromic acid for half an hour, then in 1/20 per cent. for twenty-four hours; 1/10 per cent. for twenty-four hours, and finally 1/5 per cent. for forty-eight hours or more. Next to this method, it appears that solutions of sulphuric acid (twenty drops to fifty grammes of water) give the best preparations (for sectioning) of everything except the rods.

The double layer of the sclerotica and the fibres penetrating it can be seen in sections of eyes treated twenty-four hours in 1/5 per cent. chromic acid.

Maceration and Dissection.—The *pigmented epithelial cells* of *Pectens'* eyes and the cells of the *cornea* are easily isolated by treatment with Müller's fluid or bichromate of potash 1/2 per cent. for two or three days. For the maceration of all other elements weak chromic or sulphuric acid is used. For the outer ganglionic cells, which are very difficult to isolate, maceration in 1/50 per cent. chromic acid gives excellent results, after previously fixing the tissue in 1/5 per cent. for a few minutes.

For the *retinophoræ*, 1/20 per cent. for four or five days proves very useful.

Sulphuric acid 5 drops to 30 grammes of sea-water gives the best results for the nerve-endings in the retinophoræ (not in the rods), and for the nervous inner prolongation of the outer ganglionic cells.

In order to isolate pieces of the cornea with the subjacent *pseudocornea* and the circular fibres on the outer surface of the lens, it is better to macerate the eyes in sulphuric acid as given above. The same treatment retains to perfection the natural shape of the lens, which may then be isolated, and its surface studied to advantage.

It is necessary for the study of the *circular retinal membrane*, the *septum*, and the *retina* itself, to isolate the latter intact. Maceration in chromic acid either makes the retina too brittle or too soft, while the axial nerve-fibres remain so firmly attached to the retina that it is difficult to isolate it without injury. But this may be easily and successfully done by maceration for one or two days in the sulphuric acid solution. By this treatment the *retina*, together with the *septum* and *circular retinal membrane*, may be detached entire.

Surface views of the retina show the peripheral outer ganglionic cells. The *argentea* may be very easily separated in large sheets by macerating for four or five days in bichromate of potash of 1 per cent.

Sulphuric acid is a most valuable macerating as well as *preservative reagent*. In weak solutions (40 drops to 50 grammes) entire molluscs, without the shell, have been kept in a perfect state of preservation for more than six months. For cilia and nerve-endings it is exceptionally good.

The eyes of *Arca* and *Pectunculus* may be macerated either in Müller's

fluid or chromic acid. Undiluted Müller's fluid in twenty-four hours gives more satisfactory preparations than a weak solution which is allowed to act for a longer period. Chromic acid 1/5 per cent. for ten or twelve days gave most of the preparations from which the drawings of the nerve-endings in the author's paper were made. A few drops of acetic and osmic acid added to distilled water gave a very energetic macerating fluid for the epithelium of marine molluscs. Such preparations led to the discovery of the very delicate outward continuations of the pigmented cover-cells in the compound eyes of *Arca*.

II. Arthropods.—In order to demonstrate the presence of the *corneal hypodermis* in the facetted Arthropod eye, and the connection of the so-called "rhabdom" with the crystalline cone cells, it is necessary to resort to maceration. In most cases it is hardly possible to determine the important points by means of sections alone.

The ommateum of fresh eyes, treated for twenty-four hours or more with weak sulphuric or chromic acid, or in Müller's fluid, may be easily removed, leaving the corneal facets with the underlying hypodermis uninjured. Surface views of the cornea prepared in this way show the number and arrangement of the corneal cells on each facet. In macerating the cells of the ommateum it is not possible to give any definite directions, for the results vary greatly with different eyes, and it is also necessary to modify the treatment according to the special point to be determined. It is as essential to isolate the individual cells as it is to study cross and longitudinal sections of the pigmented eyes. In determining the number and arrangement of the cells and the distribution of the pigment, the latter method is indispensable; it should not be replaced by the study of depigmented sections, which should be resorted to in special cases only.

In *fixing* the tissues of the eye, it is not sufficient to place the detached head in the hardening fluid; antennæ and mouth-parts should be cut off as close to the eye as possible, in order to allow free and *immediate* access of the fluids to the eye. When it is possible to do so with safety, the head should be cut open, and all unnecessary tissue and hard parts removed. With abundant material, one often finds individuals in which it is possible to separate, uninjured, the *hardened* tissues of the eye from the cuticula. This is of course a great advantage in cutting sections. The presence of a hard cuticula is often a serious difficulty in sectioning the eyes of Arthropods. This difficulty can be diminished somewhat by the use of the hardest paraffin, and by placing the broad surface of the cuticula at right angles to the edge of the knife when sectioning. Ribbon sections cannot be made with very hard paraffin, but it is often necessary to sacrifice this advantage in order to obtain very good sections.

Killing Polyzoa.*—Mr. T. Whitelegge writes:—"I place a small twig of Polyzoa in about two or three drachms of water; when fully expanded I add about two drops of chloroform, and these should be dropped in so that they sink to the bottom. In from a quarter to half an hour I add spirits, about six drops at a time, and stir up gently, so that it gets mixed with the water. The spirits and chloroform stupefy them, and I try touching one to see if they are in a sleepy condition; then I add more spirits gradually, mixing it and the water each time. When the fluid consists of equal quantities of water and spirit, I let them stand for a time, then add spirit very cautiously till they are in nearly pure spirit. This is necessary, as they contract, even after death, if the water is extracted from them too rapidly. When they are killed they should on no account

* Trans. and Ann. Rep. Manchester Micr. Soc., 1886, pp. 30-1.

be *lifted* out of the vessel, but floated from one vessel to another. If they are lifted out the tentacles become disarranged, and cannot again be put right."

Preparation of Insect Spiracles.*—Mr. F. Dienelt remarks that in most beetles the spiracles are found on the upper part of the abdomen. The insect should be turned on its back and cut across the thorax close to the abdomen; then turn again, and insert a sharp knife into the opening made, and cut round the whole abdomen. As soon as there is room, insert a small stick of soft wood sharpened to a flat point, by means of which the object can be held securely while cutting. All the cutting should be done on the lower side, so that a margin is left on the upper part, which can be trimmed easily after the object has become softened in liquor potassæ. Steeping the insect in this fluid for a couple of hours will destroy all the viscera. Now, hold the part down with the pointed stick, which for this purpose is far superior to mounting-needles, and with a camel-hair pencil remove the viscera and transfer the object to rain-water, removing this two or three times to insure cleansing and to remove the last trace of potash. Keep on brushing until it is certain that the object is clean, and then trim the edges to suit before a final washing. If it be desired to mount the tracheæ *in situ*, greater care is necessary in treating, but they show very well through the skin. Or after most of the viscera have been removed, the tracheæ can be torn by a sawing motion with the back of the knife from the spiracles and mounted separate. In mounting larvæ entire, they should be left in liquor potassæ for a longer time; even a whole day without injury. In cleaning, it is necessary to keep them in the position in which they are to be mounted. Larvæ of the Lepidoptera show best when mounted on the side. In preparing these, hold the larva under water with the pointed stick, and clear out the viscera with a brush through the anal opening by a rolling motion. After a start has been made the process takes but a short time. Larvæ will stand considerable pressure in cleaning, but gentle manipulation of course answers best, especially in those covered with hair. It is best to commence with the largest beetles or larvæ one can find. Larvæ too large to be mounted entire ought to be opened along the back to give the liquor free access.

Twenty-seven grains of potassa fusa to one ounce of water acts but slowly on the chitinous parts of insects, but very promptly on the viscera. It is best kept in a paper-covered bottle, to exclude the light.

Botanical Manipulation.†—M. P. Girod's 'Manipulations de Botanique' treats, in the first place, of the methods of using the Microscope, reagents, &c. The rest of the work consists of a series of original diagrams illustrative of the histology and anatomy of typical plants, from Dicotyledones to Algæ, ending with cell-tissue for purpose of comparison with unicellular organisms. Short notes explaining the methods of preparing sections accompany the plates.

Preparation of Plants in Alcohol.‡—M. H. de Vries explains the great brittleness imparted to fresh parts of plants by plunging them in alcohol in the following way:—The alcohol penetrates first into the outer, and only gradually into the inner, layers of tissue. While the outer cells are killed, the inner cells still retain all their turgidity. These inner still living cells prevent the contraction of the cell-walls in the outer layers, and the latter become, therefore, hardened while still in the stretched condition. While

* The Microscope, vii. (1887) pp. 102–3.

† Girod, P., 'Manipulations de Botanique,' 72 pp. and 22 pls., 8vo, Paris, 1887.

‡ Maandbl. v. Natuurwetensch., 1886. See Bot. Ztg., xlv. (1887) p. 31.

this process is advancing from without inwards, the inner cells also die, and the contraction of their walls is prevented by their connection with the outer layers which have already become stiff; and they also become hard while in the stretched condition. The brittle tissues can be softened by soaking in water for from half an hour to an hour, and do not then again become brittle if again placed in strong alcohol.

Cleaning Diatoms.*—Mr. W. A. Terry recommends the following process for cleaning diatoms. No fumes of any consequence are given off, no artificial heat is required, the process takes only a few minutes, and a much larger proportion of the diatoms are uninjured :—

After washing out the coarse sand and straining out the coarse refuse from the gathering which has not been dried, the material is allowed to settle in the vessel; the water is then poured off rather closely, so that the amount remaining shall be about equal in weight to the weight of the material dry. Finely powdered bichromate of potash is then added in amount equal to the estimated amount of organic matter in the material exclusive of the sand. It is then stirred until mixed; for this purpose a glass slip half an inch wide, with rounded edges, is more convenient than a glass rod. Strong commercial sulphuric acid is then dropped in until brisk effervescence is set up, and continued until the acid produces no effect. The whole mixture is then poured into a vessel containing cold water, and after agitation is allowed to settle. The diatoms will now be found to be nearly clean, and only require the usual alkaline treatment and thorough washing. After the addition of the bichromate, the temperature of the material and of the acid should not be less than 70° F. If the diatoms be not sufficiently cleaned, the operation may be repeated or nitric acid used without much danger. If the material have been dried, it will be well to soak or boil it in water before using acid. Marine muds should be first washed in fresh water to remove the salt, and as they contain more refractory material, the action should be proportionately energetic. Fossil marine earths should be thoroughly softened by long soaking and boiling before being treated with acids, otherwise the gases disengaged would tear and fracture very many of the forms. Boiling in alkalies should be avoided, if possible, as many varieties are softened and distorted by even cold and weak solutions. As first washings, both acid and alkaline, settle very slowly, they should be allowed plenty of time, otherwise the lighter and more delicate varieties would be lost.

The author states that he usually succeeds in getting the diatoms beautifully white and clean at the first operation, but admits that the process is capable of some improvement.

Preparing Silver Crystals.†—Mr. F. T. Chapman says that artificially prepared silver crystals make fine opaque objects, either as permanent mounts, or for observing the process of crystallization. They may be readily prepared, although some care is necessary in order to obtain the best results, especially if the preparation is designed to be permanent.

The deposition of silver from a solution of silver nitrate by means of copper, preferably a copper-wire ring placed in a sufficiently deep cement cell, gives very good results if the wire ring and the thicker mass of crystals at the edge be removed, and the specimen then thoroughly dried and protected by a cover-glass in the usual way. Much better results, however, can be obtained with a brass cell provided with a removable cover or cap (known as the "Pierce cell"), and cemented to a glass slip, the cell being

* Amer. Mon. Micr. Journ., viii. (1887) pp. 69–71. † Ibid., pp. 99–100.

backed by dark-coloured wax. When filled with the solution, the deposition of silver crystals on the inner surface of the cell will immediately commence and proceed slowly toward, but should not be permitted to reach, the centre. When the crystals have approached so near the centre as to leave a clear space of about 1/8 in. in diameter, the solution should be removed by means of a small piece of blotting-paper placed on top of the cell and allowed to remain for a moment. The strength of the solution is not important, but should not be very weak, as the feathery masses of crystals that add greatly to the beauty and depth of the mount do not then appear.

If the crystals, when forming, appear white and brilliant, or darken slightly, or appear to be very fine or small at the sides of the cells, while those at the bottom are spray-like and quite large, the result will usually be successful, although the best conditions are when the bottom of the cell is occupied by several large feathery sprays of crystals, and the sides by shorter sprays or spine-like crystals, the whole being white and brilliant. Sometimes, after the solution has been removed, a deposition of copper on the silver will be found, or crystals of copper salts will intermingle with the silver, and mar its appearance, in which case it is necessary to reprepare the mount. If the silver be permitted to reach the centre, a black precipitate will form and spoil the preparation as a permanent mount, but as the fluid is then filled with a mass of minute sparkling crystals in constant motion, the effect is both interesting and beautiful when viewed with a power of about twenty-five or fifty diameters.

The time usually occupied in preparing a silver mount is about five minutes, the preparation being completed when the solution is removed from the cell by the blotting-paper.

If the crystallization of the silver be unsatisfactory, the cell may be readily cleaned and another layer of wax applied. In order to apply the wax to the cell, a sheet is placed on the cell, pressed slightly with the finger, and a disc of wax forced into the cell by means of a cork that will snugly fit it, sufficient pressure being applied to cause the wax to adhere to the glass slide or to the wax already in the cell.

There seems to be no rule by which the deposition of the crystals can be regulated, as under apparently the same conditions one preparation will be successful and the next one will be a failure. It would seem that a small quantity of gum in the solution would cause the crystals to adhere, and prevent them from breaking or shaking loose when the slide is handled roughly. Gum arabic has been tried without success, as it causes the crystals to turn black. However, the crystals usually adhere firmly enough to the cell and to each other to stand all ordinary usage. A greater mass of crystals may be obtained by repeating the deposition in the same cell, and allowing one mass of crystals to form on the top of the other. When forming in the solution, the crystals seem to almost completely fill the cell, standing out laterally, but when the fluid is removed they fall to the bottom and appear to the eye to form a thin layer, but under the Microscope they stand out in bold relief.

Preparing Crystals of Silicon Fluoride.*—Beautiful objects for polarized light are produced by the action of undiluted fluoric acid on an ordinary glass slide, the results varying with the composition of the glass acted upon. The best results are to be obtained by using slips of thin polished plate and the following process:—Cut a circular hole in a piece of sheet modelling wax; warm the slide slightly, and make the wax adhere

* Scientif. Enquirer, ii. (1887) pp. 128-9, from 'Dental Record.'

well to it, so as to form a fluid-tight cell. Into this put four or five drops of the acid; watch its action closely when the glass has acquired an opaque film, which will be in from three to five minutes; wash it with a stream of warm water; finish with a camel-hair pencil. Remove the wax and dry the slide. The result shows crystals of silicon fluoride, which require no mounting.

Blood, permanent Preparations of.
[Method taught in Heidelberg.] *The Microscope*, VII. (1887) p. 115.

Bramwell, R.—**Process for the detection of micro-organisms in nerve-tissue.**
Edin. Med. Journ., 1886, p. 324.

Castellarnau, J. M. de.—**Procédés pour l'Examen microscopique et la Conservation des Animaux à la Station zoologique de Naples.** (Methods for the microscopical examination and the preservation of animals at the Naples Zoological Station.)
Journ. de Microgr., XI. (1887) pp. 183–6, 215–7, 447–53.

Fellows, C. S.—**Collecting, dissecting, and mounting Entomostraca.**
Proc. Amer. Soc. Micr., 9th Ann. Meeting, 1886, pp. 186–8.

Martin, L. J.—**Petroleum Spirit as a Plant Preservative.**
[Recommends petroleum spirit (boiling from 25°–45° C.) for preserving plants intended for the study of chemical constituents.]
Bot. Gazette, XII. (1887) p. 42.

Miles, J. W. L.—**The capturing, killing, and preservation of Insects for microscopical purposes.** *Trans. and Ann. Rep. Manchester Micr. Soc.*, 1886, pp. 80–1.

Parkes, R.—**The preparation of Foraminifera from common chalk.**
Trans. and Ann. Rep. Manchester Micr. Soc., 1886, p. 21.

(3) Cutting, including Imbedding and Microtomes.

Ryder's Paraffin Imbedding Apparatus.*—Prof. J. A. Ryder describes a new paraffin imbedding apparatus which he has designed.

Those who have had much experience in imbedding in paraffin are aware of the difficulties and risks which attend the imbedding of delicate objects on account of the danger of overheating the imbedding mass. The trouble with thermostats, or heat-regulators, is that they get out of order and give trouble, apart from the difficulty which arises from the variations in the pressure of the gas in the pipes which supply the burners, and which is entirely beyond the control of most forms of the thermostat. To avoid this, Dr. C. S. Dolley, of the Biological Department of the University of Pennsylvania, began a series of experiments with copper bars, which were heated at one end by means of a Bunsen burner, so that the heat conveyed by conduction to the remote end of the bars gradually diminished in intensity, because of its being constantly radiated into the surrounding air, according to well-known laws stated in the text-books on physics. It was found that, with the room at an approximately constant temperature, there was a point along the bar, at a certain constant distance from its heated end, where the temperature of 55° C. could be maintained, and where, if there was placed a copper cup filled with hard paraffin, the latter could be kept just at the point of fusion for a long time without endangering the objects to be imbedded. These results showed that it was possible to utilize an apparatus of this type for imbedding purposes.

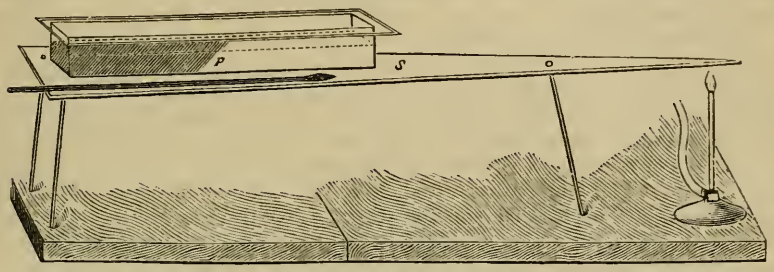
This led the writer to begin a set of experiments with a very simple modification of the foregoing type of apparatus, with the object of getting rid of the usual water-bath entirely in the process of imbedding, and to also use the paraffin itself as a means to indicate how far away from the source of heat it would be safe to allow an object to remain while it was being saturated.

The object was effected in the following manner:—A triangular sheet

* Amer. Naturalist, xxi. (1887) pp. 597–600 (1 fig.).

of copper, slightly less than 1/16 in. thick, 18 in. long, and 10 in. wide at one end and running to a sharp point at the other, as shown at *s* in fig. 190, is supported horizontally upon two legs at the wide end, and at some distance from the pointed end by another leg, these three legs constituting a firm tripod base for the whole device. Under the pointed end of the triangular plate of copper is placed a small Bunsen gas-burner, with an aperture of about 1/8 in., and connected with the gas-supply of the building by means of a rubber tube. If the flame is allowed to burn

Fig. 190.



steadily at about half its full force, and permitted to play upon the copper plate at a distance of about 1 in. from its extreme point, as shown in the figure, the whole plate will soon be heated, but the temperature will be found to gradually diminish towards the wide end. At a distance of about 12 to 13 in. from the point where the flame acts upon the copper plate the temperature will remain steadily at about 56° C., with the temperature of the room at 22° C. As long as the temperature of the room remains nearly the same the temperature of the plate at any given distance from the burner will also remain at the same point. This constancy is due to the fact that the heat which is conducted through the copper plate with constant rapidity from its source—the burner—is radiated into the surrounding air at an equally constant rate, and as one passes towards the wide end of the plate from the burner, trials with the thermometer show that there may be found an infinite number of points in succession at which the temperature is very nearly constant.

In order to use the paraffin itself as an indicator of the proper temperature, and in that way dispense with the thermometer altogether if desirable, it was necessary to use a new type of cup in which to melt the paraffin. The paraffin-cup or trough *p* shown in the figure is made of copper, tin-lined, and is 6 in. long, $1\frac{1}{2}$ in. wide, and $1\frac{1}{4}$ in. deep. In practice the cup is half filled with paraffin and placed lengthwise on the copper plate, with its narrowest side towards the flame, and about 9 in. from it, as shown in the cut. The paraffin-cup may be covered with a slip of glass to exclude dust. If the burner plays upon the plate as directed, and the trough is in the proper position, in about an hour it will be found that the paraffin in the trough has been melted at the end nearest the burner but has remained congealed at the other. Moreover, it will be found that the point where the melted comes in contact with the nearly frozen paraffin is very constant, and it is just at this point where it is safe to place objects which are to be imbedded. The paraffin which remains congealed in the trough is represented in the cut by the shading at the remote end of the trough, the clear space below the dotted lines nearest the flame indicating the portion which remains molten.

It is clear from what has preceded that a shorter cup or trough filled with soft paraffin melting at 36° C. may be placed still farther away from the burner, alongside of the vessel containing hard paraffin fusing at 56° C., while mixtures of turpentine and paraffin, or chloroform and paraffin, would remain molten at a still greater distance from the flame.

The applications and possibilities of this new device will be readily appreciated by histologists and embryologists, since it can be quickly seen if objects are in danger from overheating by simply noting whether the point where the paraffin remains molten in the trough has advanced farther from the flame. This can be easily observed through the transparent cover of the trough.

For large laboratories, where a number of students are engaged in imbedding, a simple modification of this device suggests itself. For such a purpose a horizontal disc of sheet copper, of the same thickness, but 3 ft. in diameter, would afford room for a large number of paraffin imbedding-troughs, which could be arranged in a circle around and some distance from the centre, at which point a larger burner would be applied underneath. The temperature in such a device would diminish from the centre towards the periphery of the disc. The troughs would be placed upon different radii upon the surface of the disc, just as two or three troughs may be placed upon different radii of the triangular plate, which is practically the sector of a disc, as described above.

For imbedding delicate objects, small cups made of tin-foil, pressed into shape in circular tapering moulds, may be satisfactorily employed with this apparatus, in the same way as the troughs.

The device described above can be made by any coppersmith for about two dollars.

Imbedding Objects for the Rocking Microtome.*—Herr S. Schönland advises the following method for imbedding objects in paraffin. It is especially intended for use with the Cambridge rocking microtome, which requires perfect saturation of the object with paraffin. The object, first stained in borax-carmine, is placed in 30 per cent. spirit, to which a trace of acetic acid has been added. It is then transferred to stronger and stronger spirit. From the strongest alcohol it is transferred to a vessel (holding 3–4 ccm.) half filled with oil of cloves and half with spirit. When the specimen has sunk to the bottom, it is placed in pure cloves, and after an hour in turpentine oil, wherein it remains for about six hours. It is next immersed in paraffin for eight to ten hours. The temperature of the paraffin, which has a melting-point of about 45° C., is not allowed to rise above 47°, but just before imbedding it is advisable to heat the paraffin a little more, as air-bubbles are thereby avoided. The ordinary paper boxes are used for imbedding.

Imbedding Eyes in Celloidin.†—Dr. W. B. Canfield recommends that eyes should be hardened in Müller's fluid and then after-hardened in spirit. Schultze's diffusion apparatus is of great use for preventing shrinking of the eye. A small incision is then made tangentially to the sclera and also on the corneal edges, and the eye put in equal parts of absolute alcohol and sulphuric ether. After twenty-four hours it is transferred to pure ether, and the next day to a thin watery solution of celloidin in ether. In order to get rid of air-bubbles, the eye is to be so immersed that the incisions are uppermost. After twenty-four hours the eye is put in thick celloidin, the vessel being left partially uncovered, until the celloidin is hard enough to

* Bot. Centralbl., xxx. (1887) pp. 283–5.
† The Microscope, vii. (1887) pp. 99–101.

be cut. The block is then cut out, softened a few minutes in absolute alcohol, dipped once more in the celloidin solution, and put on a cork.

The block when cut out is better softened in ether and at once transferred to the cork. This procedure is not only more simple but more effective. The preparation on the cork is then exposed to the air until quite stiff and then allowed to float in 84 per cent. spirit until required. By this method sections of the whole or any part of the eye may be made. Anilin colours are to be avoided as they stain the celloidin. Logwood also stains it, but acetic acid (1/2–1 per cent. solution) withdraws it in twenty-four hours, leaving the tissue still coloured. Rosin may be used as a contrast stain. Cedar and origanum oils are the best for clarifying.

Imbedding in Vegetable Wax.*—Dr. P. Francotte who has recently investigated the qualities of vegetable wax as an imbedding medium, finds, that whatever its potentialities may be, it is inferior to paraffin. The method he advises is as follows :—After the object is fixed, hardened, and stained, or not, it is laid in 94° spirit, kept at a temperature of 48° C. in a water-bath. The wax is then added gradually, and in small pieces, until the consistence is that of soup. If the object be small, the heat is continued until all the alcohol has evaporated. If the object be large, the alcoholic mass and the object are poured into a bulb fitted with a straight cooler or tube, about three feet long ; as the spirit condenses, it falls back into the bulb, and when the object is properly saturated it is removed to another vessel and the spirit driven off. The object is then oriented in a metal or cardboard box filled with warm wax. When cool, the mass may be cut with a microtome or by hand. The sections are fixed to the slide with albumen or gum. The slide is then heated in a water-bath to 50° C., and alcohol added until the wax is dissolved. If not coloured *en masse*, the sections may now be stained and then dehydrated, and afterwards cleared up in cloves, cedar, or bergamot oil, or they may be mounted in glycerin.

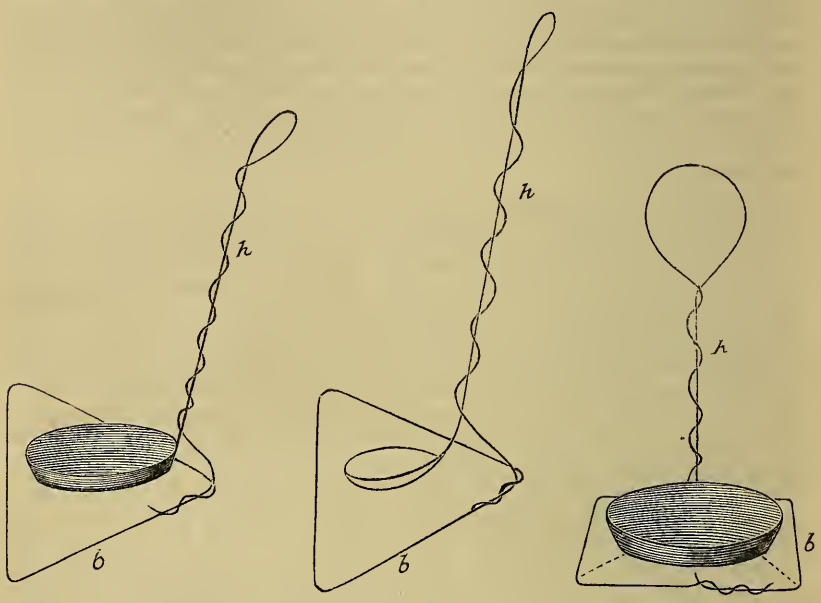
The advantages this medium has over paraffin are, that it dispenses with such fluids as toluol, xylol, benzine, and chloroform, and hence is suitable for animal tissue where these fluids are contra-indicated. It is available also for the examination of micro-organisms in tissues ; in this it is superior to paraffin, for it is always difficult and frequently impossible to discover microbes in tissues impregnated with paraffin. Its most important disadvantages are, that it is difficult to obtain sections thinner than 0·01 mm., and to make out when the object is properly saturated.

Baskets for the suspension of objects in paraffin.†—Mr. H. Garman recommends the use of wire baskets for suspending objects in paraffin. Such a basket is easily made by coiling annealed wire as shown in fig. 191, beginning at the centre of the bottom and working outwards to the margin, then making the handle *h*, and finishing with a triangular base *b*. In use it is placed in the melted paraffin, the triangular base supporting and keeping it from the bottom of the paraffin basin, and it can be removed by means of the projecting handle, which is made of such length that it does not interfere with the glass cover of the basin. For very small objects a hammered wire spoon, like that used by Dr. Mark, is mounted in the same way as the basket (fig. 192). This method of suspending objects in paraffin

* Bull. Soc. Belge Micr., xiii. (1887) pp. 140–4.
† Amer. Naturalist, xxi. (1887) pp. 596–7 (3 figs.).

has resulted from attempts to avoid long handles or other belongings of the baskets, that prevent the close fitting of the plates of glass used to cover the paraffin dishes.

Fig. 191. Fig. 192. Fig. 193.



Francotte's Sliding Microtome.*—Dr. P. Francotte has designed an instrument capable of making most perfectly regular sections of a limited size, 5 mm. at most. The body of the microtome is like Ranvier's, and the object to be cut is placed in a cylinder which slides in the microtome tube. The latter piece does not rub against the metal walls, but is supported in the cylinder by means of pieces of cork. At the base of the tube is a scale for noting the movements of the screw, and at the side is an index for showing in what limits the piece can move.

Upon the circular table of the microtome is fixed by three screws a plate larger than the table. In the centre is an opening in order that the piece may be raised, and at the side a groove with triangular vertical section and sharp edges; within this groove the object-carrier runs. The carrier slides merely on two longitudinal bands so as to lessen the friction as much as possible. The groove maintains a rectilinear and regular movement; the two metal bands keep the knife moving in the same plane. The razor is fixed to the carrier by means of a metal piece and two screws, and in order to obtain the desired stability the instrument is fixed to the work-table by a binding screw. For the rest, the manipulation of the instrument is very simple, and M. Francotte thinks it will suffice for most histological investigations.

Ryder's Automatic Microtome.†—This instrument (figs. 194 and 195) has been devised by Prof. J. A. Ryder, in order to facilitate the preparation

* Bull. Soc. Belge Micr., xiii. (1887) pp. 149-50.

† Amer. Natural., xxi. (1887) pp. 298-302 (2 figs.). Cf. also The Microscope, vii. (1887) pp. 179-83 (2 figs.).

of sections for large classes, and also for the rapid preparation of series of sections in ribbons in embryological work, in which the element of time becomes a serious consideration. One hundred sections per minute can be readily cut with it.

The device is small and compact and is also automatic; the cutting takes place as fast as it is possible to move a vibrating lever up and down through a distance of 3 in. with the right hand. The designer considers that "nearly all other automatic microtomes are costly, unwieldy, large, and heavy, or else very complicated and liable to get out of order. The only exception in part to this rule is the rocking microtome, made in Cambridge, England; but it cuts in an arc, so that the sections are segments of a hollow cylinder, and not parts of a perfect plane; besides, the rocking or vibrating arm admits of only a very limited movement, so that the instrument is suitable only for cutting sections of objects of very limited dimensions; nor is the position of the block adjustable. Moreover, in none of the automatic microtomes now in use is it possible to place the knife at right angles or any other desired angle to the direction in which the block to be cut is moved—a great desideratum in botanical or other work in which an inclined knife is necessary. In order to supply an instrument serviceable especially to teachers, as well as to all classes of students, botanists, pathologists, histologists, and zoologists, the designer has attempted to bring together all the desirable features of previously invented instruments, in as simple, convenient, and compact a form as possible, without sacrificing rapidity and efficiency of action."

Fig. 194.

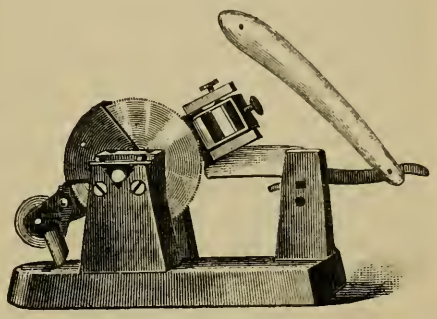
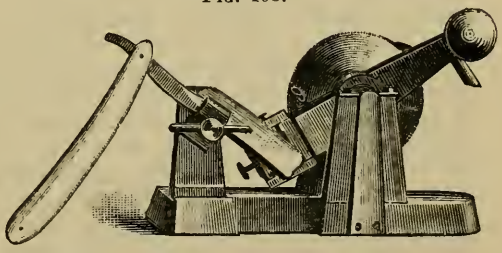


Fig. 195.



The working parts are an oscillating lever, which is provided with a clamp at one end into which paraffin-holders are adjusted, and at the other with a simple handle. This lever rests upon trunnions on either side, and these in turn rest in triangular notches at the top of the two pillars between which the lever oscillates. At the cutting end of the lever a spring pulls the lever down and effects the sectioning and also the adjustment for the next section. The lever is pushed over and adjusted for the successive sections by a hollow screw, through which passes the trunnion on the side away from the knife. This screw is fixed to a toothed wheel, 3 in. in diameter, which revolves close by the side of the oscillating lever. The toothed wheel and screw is actuated by a pawl fixed to the side of the lever near the handle. The number of teeth which this pawl can pass in a single vibration downward is controlled by a fixed stop screwed into the under side of the oscillating lever near the handle; the end of this stop striking on the top of the bed-plate thus brings the lever to rest at a constant point

in its downward excursion. An adjustable sector by the side of the toothed wheel throws the pawl out of gear after a given radius of the wheel has been turned through an arc embracing the desired number of teeth. This adjustment is also effected before the block, containing the object to be cut, reaches the edge of the knife. The adjustment for the next section is therefore effected while the surface of the block is not in contact with the under side of the knife, so that no flattening or scraping effect is produced on the surface of the block in its upward passage past the knife.

The movement of the vibrating lever being arrested at each down stroke at one point and the pawl which catches into the notches in the toothed wheel being released at any desired point by the action of the adjustable sector, it is possible to adjust the apparatus with great accuracy for cutting sections of any desired thickness. If a given radius of the wheel is moved through the arc embraced by a single tooth, sections are cut, having a thickness of only 1/10000 of an inch, or 0·0025 mm.—a thickness which is only practically possible with paraffin imbedding and a very keen razor. If more teeth are taken by the pawl, any thickness of section is possible up to about 1/400 of an inch, or 0·0625 mm. (The screw which adjusts the block for cutting has exactly fifty threads to the inch, and there are two hundred teeth on the periphery of the toothed wheel. The value of a single tooth is, therefore, $1/50 \times 1/200 = 1/10000$ in.).

A freezing attachment, which has lately been appended to the apparatus, shows that frozen sections can be made with as great rapidity and success as those cut from objects imbedded in the paraffin block, and very nearly, if not quite, as thin. Other auxiliary apparatus makes it possible to cut celloidin sections. This is effected by means of alcohol conducted by a tube from a reservoir to the knife, over which the fluid will run and drain into a tray below in such a way as not to come in contact with any other parts of the machine. This tray fits into a recess in the side of the bed-plate of the instrument just below the knife, and into this tray the celloidin sections may be allowed to drop as fast as cut.

The paraffin-holders are square and 7/8 in. in diameter, so that a block of that size may very readily be sectioned. For the botanist, one of these holders is provided with a movable side and screw for clamping objects, so that rather tough stems may be firmly held between blocks of cork, while the more delicate vegetable tissues, or such as must be imbedded in fresh carrot, soaked in gum and hardened in alcohol, may also be firmly held for sectioning by the same device, provided the pieces of carrot are first trimmed into the right shape. The same style of holder is equally applicable for holding the corks—if properly trimmed—upon which tissues are imbedded in celloidin or in gum. This style of holder also enables one to imbed very long objects entire in paraffin—such as earthworms—and to cut them as a single piece, provided the surrounding paraffin is carefully trimmed so as to have two opposite sides parallel. An object 6 in. long and 3/4 in. in diameter, imbedded in this way, may be cut into an absolutely continuous series of sections without losing any essential portions. This is accomplished by slipping the block through the quadrangular clamp for the distance of 1/2 in. every time 1/2 in. of the object has been cut off in the form of sections. 1/2 in. is the length of block which can be cut at one time without readjusting the feed-screw which moves the block and vibrating lever over towards the knife, the whole being kept firmly in place against the face of the hollow screw by a strong spring which presses against the end of the trunnion on the outside of the iron pillar on that side of the instrument where the knife is fastened, so that all the sections are of exactly the same thickness, from

first to last. "Cutting up large objects in the manner above described is not possible with any other form of microtome yet constructed."

Almost any section-knife—wide or narrow-bladed—will fit into and be firmly held by the knife-clamp, which is, however, intended more especially to hold an ordinary razor.

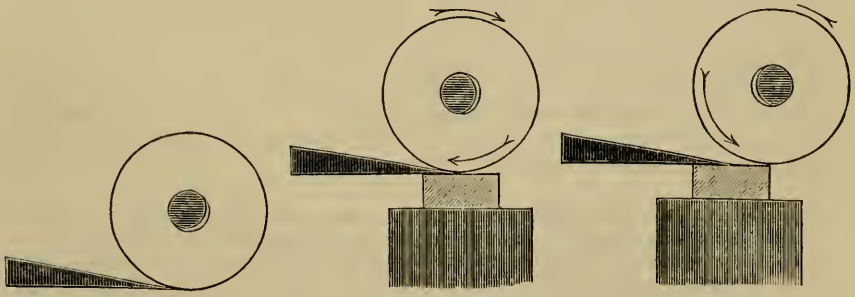
For ribbon-cutting by the paraffin method, the block containing the object, after it is trimmed and soldered to the paraffin with which the holder is filled, by means of a heated wire, is covered with a thin coat of soft paraffin or "paraffin-gum," and of which "chewing-gum" is made. (Chewing-gum may be rendered available for this purpose, if it is melted at a temperature somewhat above boiling, when the sugar which it contains will separate as caramel, leaving the pure paraffin-gum, which may be drained off and used as directed, if the manipulator should find it difficult to get the paraffin-gum of commerce.) This enables one to cut ribbons of any desired length, since the softer paraffin at the edges of the successive sections sticks them together by their margins as fast as they are cut. The ribbons may be allowed to fall upon a slip of paper, which may be drawn out, as fast as the sections are cut, from under the bed-plate of the instrument, beneath which there is a space left for this purpose between the three toes or tripod upon which the whole apparatus rests. The edge of the knife also remains in the same plane, no matter at what angle the cutting edge is placed with reference to the direction in which the block to be cut is moved, just as in the best forms of the sledge microtome.

A section flattener can be attached in the form of a roller of hard rubber which turns loosely on a rod held parallel with the knife-edge. The roller is placed with its centre somewhat in advance of the knife-edge and the rod supporting it may be fastened to the back edge of the knife or be clamped in the position of the support which holds the tube conveying the alcohol to the knife when cutting celloidin sections.

In cutting celloidin or collodion masses, it has been found that the greater the inclination of the knife the better the results, and it may be found expedient to devise a special form of clasp for cutting celloidin.

Mall's Section-smoother.*—Dr. P. F. Mall recommends a section-smoother constructed on the following principle. It consists of a rubber rod about 1¼ cm. in diameter, which rotates *loosely* on a solid axis. The

Fig. 196. Fig. 197. Fig. 198.



rod is so placed that it hangs a little below and in front of the edge of the knife (fig. 196). When the knife passes over the object, the rod is raised

* Arch. f. Anat. u. Physiol.—Anat. Abtheil., 1887, pp. 2-3 (3 figs.). Cf. Amer. Naturalist, xxi. (1887) p. 597 (3 figs.).

to an extent equal to the thickness of the section, and is thrown above and a little behind the edge of the knife (fig. 197), so that the section is prevented from rolling as it slides upon the knife. When the knife is pushed back preparatory to making the next section, the rod rolls over the preparation, and in consequence of the play of its axis, is kept free from the edge of the knife (fig. 198). The section does not stick to the rod as is the case in Jung's section-smoother.

Extemporized Section-smoother.*—Dr. W. C. Borden has invented a device for preventing sections imbedded in paraffin from curling. It consists of a bent glass tube, one end of which is passed through a hole in the table and into the other is fitted a camel's-hair brush. For most sections a round brush with long hairs is the most suitable, but for large sections a flat brush is to be preferred. The brush is to be so arranged that it lies lightly yet closely on the surface of the object to be cut. The thinnest and most delicate sections are not injured by this method and as the harder paraffins allow the thinnest sections to be cut, great success is obtainable by the combination of this flattener and hard paraffin.

Making Sections of Injected Lung.†—Mr. A. J. Doherty injects the lung *in situ* through the right ventricle with a stiff but freely flowing carmine-gelatin mass (Carter's formula), care being taken to throw the mass in slowly and with a uniform pressure, and not to over distend the vessels, either by injecting too rapidly or for too long a time. When properly filled the pulmonary arteries and veins are ligatured, the lungs are removed from the body, and are then distended with 90 per cent. spirit injected through the trachea, which is afterwards to be closed with a clip or bull-nose forceps. The lungs are then weighted with lead and placed in a quantity of 90 per cent. alcohol. In twenty-four hours they are taken out, the clip is removed from the trachea, and as much alcohol as possible is drained from the organs. After this, they are to be redistended with 90 per cent. alcohol and placed in a fresh quantity of spirits of that grade as before. This process is to be repeated on the fifth and tenth days, and at the end of a month the lungs will be found to be hardened without being in the slightest degree collapsed. Cut from one of the lungs, preferably at the root and transversely across a bronchus, a piece, say 1/2 in. square and 1/4 in. thick; transfer it to a glass beaker half filled with methylated chloroform, place the beaker in a water-bath and heat to 100° F. Shake the vessel occasionally to facilitate the saturation of the tissue with the chloroform, and in half-an-hour, add very gradually (i. e. in small pieces, one after the other) about 50 per cent. of paraffin. Keep the lung in this mixture for one hour, and then transfer to a bath of pure paraffin, kept for two hours at 3° F. above its melting-point. The tissue will then be thoroughly infiltrated with the paraffin and beautiful sections can be made with a hand microtome and a sharp razor. The sections are passed through three consecutive changes of warm temperature, and finally are mounted in balsam and benzole.

Groult, P.—**Le nouveau Microtome à levier.** (The new lever microtome—Hansen's.) [Constructed generally on the Thoma plan, its characteristics being the use of a lever and the arrangement for cutting either dry or immersion. The object-holder is connected with the short arm of a lever, the arms of which are as 1 to 5. At each complete turn the micrometer-screw on the right, which acts on the long end of the lever, rises or falls 0·5 mm., so that the object-holder is moved 0·1 mm. Each of the fifty teeth of the head of the screw

* The Microscope, vii. (1887) pp. 97–8 (1 fig.).

† Ibid., pp. 101–2.

therefore represents a movement of the section through 0·002 mm. There is also an automatic arrangement. For wet cutting a fixed tray is added. A second form of the instrument has a movable tray, which can be lowered for dry or raised for wet cutting. In the latter case the object-holder is immersed. It is claimed that this plan of construction obviates the inconveniences of those microtomes which are reversible for immersion.]

Le Naturaliste, VIII. (1886) pp. 241–3 (8 figs.).
Journ. de Microgr., 1886, pp. 507–12 (6 figs.).

HAENSELL, P.—**Le Microtome et ses applications à l'anatomie de l'œil.** (The microtome and its applications to the anatomy of the eye.)
Bull. Clin. Nat. Ophthalm., IV. p. 106.

REDDING, T. B.—**Uses of Celloidin.** *The Microscope*, VII. (1887) pp. 43–5.

ROSENBERG, P.—**Eine neues Microtom.** (A new microtome.)
Anat. Anzeig., 1886, pp. 211–3.

TYAS, W. H.—**Golding-Bird's small Ice Freezing Microtome.**
Trans. and Ann. Rep. Manchester Micr. Soc., 1886, p. 70.

(4) Staining and Injecting.

Fixing and Staining Nuclei.*—Mr. D. H. Campbell writes, that the following methods have been found to give excellent results in the study of nuclei. The observations were chiefly made with the mother-cells of the spermatozoids of various ferns, but the nuclei of vegetative cells also gave very instructive preparations.

In order to fix the nuclei, the prothallia were placed in aqueous solutions of chromic or picric acid or corrosive sublimate. The chromic acid solution should be a 1 per cent. solution; the others concentrated. In these solutions they should remain from one to two hours, though in the corrosive sublimate solution less time is required. The chromic and picric acid preparations must be washed in several waters before staining. It has been found a good plan to leave them overnight in abundant fresh water before the final washing. The sublimate preparations may be transferred to absolute alcohol, in which they should remain several hours.

The specimens are now ready for staining. The best results were obtained with hæmatoxylin and gold chloride. The secret of good hæmatoxylin staining is to use a very dilute solution; three or four drops of the prepared solution in a watchglassful of distilled water, and to allow the specimens to remain in this for at least twenty-four hours.

After taking the specimens from the hæmatoxylin solution, they must be passed successively through 50 per cent., 70 per cent., and absolute alcohol before mounting. Half an hour is usually sufficient for each of the alcohols. For immediate examination they may be mounted in glycerin, but for permanent preparations first in origanum oil, and then transferred to Canada balsam (dissolved in chloroform.)

The gold chloride method is simpler, and is found to answer admirably for specimens fixed in picric or chromic acid; but with those fixed with the corrosive sublimate or alcohol, it has not answered so well. A few drops of 1 per cent. gold chloride in water are placed in a watchglass almost half-filled with distilled water, and the specimens are allowed to remain from one-half to one hour, the solution being kept in the dark. Strasburger recommends a trace of HCl, but with the picric and chromic acid preparations, although thoroughly washed, the author found this unnecessary. The specimens are then thoroughly washed, being at the same time exposed to the light and finally mounted in glycerin. With alcohol material, hæmatoxylin was found to give the best results.

The above notes embody (the author says) nothing specially new, but may be useful as a memorandum of work actually done.

* Bot. Gazette, xii. (1887) p. 40.

Staining Elastic Fibres with Victoria Blue.*—Dr. L. Lustgarten states that Victoria blue stains elastic fibres in the fresh condition if the preparations are hardened for 24 hours in chrom-osmic-acetic acid and then in spirit. 1–2 parts of an alcoholic solution of Victoria blue are mixed with four parts of water. Then alcohol and bergamot oil. The hue is blue-green. Nuclear staining is more successful with a watery solution, followed by alcohol, bergamot oil, and xylol balsam.

Staining Peziza Specimens.†—Mr. C. F. Fairman decolorizes the *Pezizæ* by soaking in a solution of corrosive sublimate (1 to 2000 aq. dist.); then washing from precipitated calomel by agitation in distilled water and macerating in 90 per cent. alcohol for twenty-four hours. For immediate examination, lower for a few seconds in a strong hæmatoxylin solution, wash in distilled water, or if preferred, use the dilute hæmatoxylin fluid. (See *supra*, p. 687.)

Staining relations of Leprosy and Tubercle Bacilli.‡—Dr. F. Wesener, who has recently investigated the receptivity of these bacilli for anilin dyes in order to ascertain if any crucial difference existed between these micro-organisms, finds that a diagnosis between the two must be made from several kinds of proof and not from one alone. With regard to the reaction to the simple anilin solutions (Weigert's method) he found that methyl-violet was more efficient than fuchsin for tubercle bacilli, but that such distinction did not hold good for leprosy bacilli; nor did he find a minimum time test of a satisfactory nature, although leprosy bacilli took up red dyes rather quicker. Nor did the more complicated solutions (Koch's, Ehrlich's, Ziehl's methods) afford any satisfactory test.

The author in view of the fact that a diagnosis must be made from differences of degree, advises the following stains if the Ehrlich method has demonstrated the presence of bacilli, and it is desirable to ascertain if the bacilli be those of leprosy or tubercle.

(1) Methyl-violet (in concentrated watery or dilute alcoholic solution) for twenty-four hours: decolorize in nitric acid. (2) Fuchsin as above. (3) Baumgarten's methods. (4) Four to six minutes in a watery solution of fuchsin: decolorize in alcohol. (5) The same with methyl-violet.

Staining Differences of Leprosy and Tubercle Bacilli.§—Prof. Baumgarten controverts the statement of Dr. Wesener with regard to the respective receptivity of leprosy and tubercle bacilli for anilin stains. By using a dilute solution of fuchsin and immersing the sections for 12–15 minutes, and then decolorizing in nitric acid (1–10) with after-staining in methylen-blue for 2–3 minutes and dehydration in absolute alcohol 3–4 minutes, the leprosy bacilli show red, the tubercle bacilli are unstained. Or the sections may be stained in the Ehrlich fuchsin for 2–3 minutes with subsequent procedure as above. Cover-glass preparations give analogous results, for leprosy bacilli will stain in 6–7 minutes in a cold dilute alcoholic solution of fuchsin, but tubercle bacilli will not. Yet Prof. Baumgarten would not rely alone on colour reaction—the point at issue, by the way—but would also take into consideration the position and arrangement of the microbes and verify the results by inoculation experiments.

Decoloration of Bacteria stained with Anilin dyes.‖—Dr. A. Spina, starting from the observation that cotton fibre treated with tannin as a mor-

* Medicin. Jahrb. K. Gesell. der Aerzte zu Wien, 1886, pp. 285–91 (1 pl.).
† Bot. Gazette, xii. (1887) p. 85.
‡ Centralbl. f. Bacteriol. u. Parasitenk., i (1887) pp. 450–6.
§ Ibid., pp. 573–6. ‖ Allg. Wien. Med. Ztg., 1887, Nos. 15 and 16.

dant gives up anilin stains to acids very slowly, subjected some fission fungi to a corresponding treatment. Dry preparations of rotting meat infusion treated with a strong tannin solution, and then stained for twenty-four hours with anilin or methyl violet, were found to be thoroughly stained after acid, while the preparations not treated with tannin were either only faintly stained or not at all. The difference became more apparent if a saturated solution of tannin were used, and this peculiarity was found to affect all kinds of Bacteria alike. A similar effect, but less marked, was obtained with various albuminates and fats. By preparing a decomposing fluid containing tannin, the author found the same resistance to acids in living Bacteria.

Demonstration of Phloroglucin.*—Herr O. Lindt has discovered that vanillin in very dilute solution (1 : 1000) gives a colour reaction with phloroglucin and orcin, but not with resorcin. Both these bodies are, however, sharply distinguished from each other by the different colour given to these solutions. The phloroglucin is a bright red, assuming a violet-red tone later on. The orcin solution is a bright blue with a trace of red. The reaction is so sensitive that 0·000001 grm. of the dry substance can be easily recognized on the addition of a drop of the vanillin solution made according to the following formula:—Dissolve vanillin 0·005 grm. in spirit 0·5 grm., to this add water 0·5 grm., strong hydrochloric acid 3·0 grm. The reaction takes place so quickly that the disturbing influence of secondary appearances does not interfere with the histo-chemical investigation.

It is, however, necessary that the microscopical sections should be previously dried on the slide, because water impedes the reaction and lessens its intensity. It is further recommended that a control examination should be simultaneously carried on. By means of this solution the author has been able to determine the presence of phloroglucin in tissues which have been hitherto supposed to be devoid of it. On the other hand, phloroglucin was found to exist in considerable quantity in the tissues of certain leaves which later on became crimson, although the leaves of most plants which remain green in autumn contain little or none.

Dr. Lindt suspects that the red colour of certain leaves and plant stems is not less dependent on the presence of phloroglucin than on the existence of a certain quantity of tannin, for it is quite possible that the relations which exist between the latter and the red colouring matter may depend on a similar reaction of certain transformation-products due to the action of tannic acid on phloroglucin—a reaction comparable to the effect of vanillin on phloroglucin.

It may be mentioned that the presence of a mineral acid does not seem to be indispensable to the appearance of the reaction, for if vanillin, phloroglucin, and oxalic acid be dissolved in water and the solution evaporated to dryness, the residue is bright red.

Staining Preparations for Photography.†—Dr. P. Francotte gives the results of experiments in photographing preparations stained with various colours.

For picro-carmine preparations two baths are necessary—(1) The plate is steeped for two minutes in distilled water 200 cc.; ammonia 2 cc. (2) Then for two minutes in distilled water 200 cc.; ammonia 2 cc.; alcohol 10 cc.; solution of cyanin 1 : 500 in absolute alcohol 5 cc.

* Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 495–9.
† Bull. Soc. Belge Micr., xiii. (1887) pp. 151–8.

The plates are placed on blotting-paper and dried rapidly. They only keep for a few days.

For preparations stained with vesuvin, Bismarck brown, methyl-green, or picro-carmine with yellow and red stain, the formula which gives the best results is that of Mulman and Scolik:—1 gr. of quinoline red is dissolved in 500 cc. alcohol, and 50 cc. of an alcoholic solution of cyanin 1:500 is added. The plate is steeped for a minute in water 100 cc.; ammonia 1/2 cc. It is then transferred to a bath composed of the quinoline red solution 1 cc.; water 100 cc.; ammonia 1/2 cc., for one minute. The superfluous water having been removed with blotting-paper, the plate is dried in a stove at about 30°.

For preparations stained with any colour the following formula succeeds well:—Bath for two minutes in a watery solution of erythrosin 1:1000, 25 cc.; ammonia 4 cc.; water 175 cc. If the preparations are stained red, 1 cc. of an alcoholic solution of cyanin 1:500 is added.

Another formula is—Solution of erythrosin 1:1000, 25 cc.; solution of silver nitrate 1:1000, 25 cc.; water 50–100 cc.; and if the preparations are deeply stained with red, the author adds 5–10 cc. of an alcoholic solution of cyanin 1:500.

Dr. Francotte remarks that it is absolutely indispensable to use orthochromatic plates when dealing with coloured preparations, and if the stain be blue or violet, a yellow glass must be interposed between the light and the preparation.

For developing, the author prefers pyrogallic acid and sulphite of soda. Four baths are required:—(1) 10 gr. pyrogallic acid dissolved in 100 cc. of alcohol at 90°. (2) 100 gr. of pure sulphite of soda dissolved in 200 cc. distilled water. (3) 100 gr. of pure carbonate of soda dissolved in 200 cc. distilled water. (4) An aqueous 10 per cent. solution of bromide of potash.

In order to develope, 5 cc. of No. 1, 10 cc. of No. 2, and 5 cc. of No. 3 are poured into a vessel containing 100 cc. of water, and if the time of exposure be in excess, a few drops of No. 4 are added.

The time of development is about five minutes.

Fixing is performed in the usual way. If the plates are still coloured after the operation (and this often happens) they are immersed in a bath of spirit at 90°, to which a few drops of ammonia are added.

BIDERT.—**Ein Verfahren, den Nachweis vereinzelter Tuberkelbacillen zu sichern, nebst Bemerkungen über die Färbbarkeit der Bacillen und Aetiologie der Tuberculose.** (A process of authenticating the presence of single tubercle bacilli, with remarks on the staining capacity of the bacilli and the ætiology of tuberculosis.)

Berl. Klin. Wochenschr., 1886, Nos. 42, 43.

Cf. *Centralbl. f. Bacteriol.*, I. (1887) p. 55.

DEKHUYZEN, M. C.—**Ueber die Tinction.** (On staining.)

Centralbl. f. d. Med. Wiss., 1886, Nos. 51–2.

DOHERTY, A. J.—**The Staining of Animal and Vegetable Tissues.**

["The object of the present paper, which is addressed to professed biologists as well as to *dilettanti*, is twofold; firstly, to record the results of my own extensive researches into the properties of staining reagents; and secondly, to place before the microtomist in a condensed form an account of various processes adopted by other workers with the Microscope."]

Trans. and Ann. Rep. Manchester Micr. Soc., 1886, pp. 1–19.

GRIGERJEW, A.—**[On Ehrlich's Staining of Micro-organisms.]**

Russkaja Med., 1886, No. 42.

HERXHEIMER, C.—**Ein neues Färbungsverfahren für die elastischen Fasern der Haut.** (A new staining process for the elastic fibres of the skin.)

Fortschr. d. Med., IV. (1886) p. 787.

KAMENSKI, D. A.—**Eine neue Methode die Koch'schen Bacillen im Sputum zu färben.** (A new method of staining Koch's bacilli in sputum.)

Wratsch, 1887, pp. 276–7 (in Russian).

LATHAM, V. A.—**The Microscope and how to use it. XI. Injecting, &c.** (*contd.*)
Journ. of Microscopy, VI. (1887) pp. 169-79.

LUSTGARTEN, S.—**Victoriablau, ein neues Tinctionsmittel für elastische Fasern und für Kerne.** (Victoria blue, a new staining medium for elastic fibres and nuclei.)
Wiener Med. Jahrb., 1886, p. 285.

[MANTON, W. P., AND OTHERS.]—**Stains.**
["How often, for instance, we read of a new objective that promises wonders. Such and kindred productions, of great value withal, are examined and discussed, till the next new objective or what-not displaces it. All this is as it should be. But do we show the same enthusiasm and interest over a new stain that allows us, perhaps, to study some object more satisfactorily with a 1/6 than could formerly have been done with a 1/8? We think not. All this is wrong. Is the new apochromatic glass—granting, even, all that is claimed for it—of greater importance to us than the results of the studies in the anilin dyes that individualized the *B. tuberculosis*? There are many who hold that we have about reached the limit of perfection in lenses. Be this as it may, the goal certainly does not seem to be so very far distant. But the province of stains has not as yet been invaded to any very great extent. And especially is this true as regards differential staining."]
The Microscope, VII. (1887) p. 110.

REYNOLDS, R. W.—**Injecting and cutting sections of the Cat.**
The Microscope, VII. (1887) pp. 156-9.

UNNA, P. G.—**Ueber Erzeugung von Vesuvin im Gewebe und über Metaphenylendiamin als Kernfärbemittel.** (On the formation of vesuvin in the tissues and on metaphenylendiamin for nuclear staining.)
Monatschr. f. prakt. Dermatol., 1887, p. 62.

V., R. E.—**Permanganate of Potash as a Staining Medium for Micro Objects.**
[For examining tissues of plants. "It defines edges of cells, markings on cell-walls, &c., more strongly than other dyes."]
Engl. Mech., XLV. (1887) p. 346.

WEIGERT, C.—**Ueber eine neue Methode zur Färbung von Fibrin und von Micro-organismen.** (On a new method of staining fibrin and micro-organisms.)
Fortschr. d. Med., 1887, pp. 228-32.

WELLINGTON, C.—**Staining and Mounting Plant Sections.**
The Microscope, VII. (1887) pp. 133-4.

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

Flask for dehydrating specimens to be mounted in balsam or paraffin.* —Dr. P. Francotte's dehydrator, the idea of which is taken from Schulze's apparatus,† consists of a broad-necked flask to hold about half a litre. This contains alcohol and sulphate of copper. Into this flask is passed a dialysing tube, 5–6 cm. in diameter. It is closed above by a plate of glass, and below by a piece of parchment paper. The flask is plugged with a muslin bag filled with quicklime. The flask contains a float for marking the strength of the spirit from 94°–100°. A similar float is placed in the dialysing tube, and when the spirit in this tube is of 100°, it is emptied into the flask. The specimen is placed in the tube along with alcohol at 94°, and care has to be taken that the level of the liquid in the tube is the same as that in the flask. The apparatus works more quickly in a warm place.

Permanent Preparations on firm media.‡—Dr. J. Soyka when employing firm opaque nutritive material, as bread, potato, rice, uses round glass vessels about 6 cm. in diameter and 3 cm. high. The edge is bent outwards at the top for about 1 cm. and well ground, so that a plate of glass about 8 cm. in diameter can be cemented on. These vessels are then carefully stuffed to the height of 1 cm. with the medium, and the surface of the latter carefully levelled. After having been sterilized and inoculated with the cultivation the sterilized cover is cemented on. Pure cultivations, as bread and potato, will keep for at least two years, and thus are always ready

* Bull. Soc. Belge Micr., xiii. (1887) pp. 146-7.
† See this Journal, 1886, p. 537.
‡ Centralbl. f. Bacteriol. u. Parasitenk., i. (1887) pp. 542-4.

for demonstration purposes. In an analogous manner may be preserved macro- and microscopical preparations. For this purpose small glass vessels like watch-glasses with flat bottoms are used. The floor is about 5 cm. in diameter, and the walls may ascend vertically or obliquely. Upon these a thin glass cover is placed, after the nutrient medium, with the bacteria to be cultivated, has been poured in. The organisms may or may not be developed in an incubator. Low powers are always available for inspecting the results of this method through the cover-glass, and if the gelatin or agar layer be very thin higher powers can be used. Before closing permanently it is advisable to wash the surface of the gelatin, &c., with a sublimate solution 1:1000. Drops of moisture which may condense on the cover and so obscure the colonies may be avoided by placing on the top a piece of warm glass or metal.

Use of Styrax in Histology.*—Dr. P. Francotte recommends styrax instead of balsam when the latter renders the object too transparent, e. g. for bacteria and in the study of karyokinesis styrax gives a greater resolution than balsam, while its slightly yellow tint is eminently favourable for photographic purposes. The author has obtained with ordinary plates excellent figures of the cells in the branchiæ of larvæ of salamander from specimens mounted in styrax, while similar preparations mounted in balsam required isochromatic plates or the use of chrysoidin previous to the eosin.

No excess of balsam necessary.†—Mr. J. E. Whitney emphasizes the fact that there should not be any surplus balsam to remove from around the cover. Experience soon learns to graduate the amount so that it will fill the required space. The balsam slide and cover should be exactly centered, and if the balsam happen to be too thick a very slight amount of heat will make it flow to the edge. It is a good rule to mix a little less balsam than seems necessary, as a little pressure will squeeze the balsam right out to the edge. When a cell is used it is impossible, however, to avoid some excess of balsam, as it needs to exude slightly around the cover to drive out the air from the cell; but even in this case, if carefully graduated to the cell, the excess need not be noticeable, and it can be covered with a ring of cement without being cleaned away at all.

Mounting Opaque Objects.‡—Mr. C. M. Vorce deprecates the use of pasteboard slides for mounting opaque objects; for even when of heavy tarboard they bend so readily as to crack or loosen the covers very easily, and, unless well saturated with some resinous varnish, are liable to mould or to take up moisture and deposit it under the cover. Even covered with paper they do not stand reasonable wear. Wooden slips are vastly better, and can be cheaply made by boring a hole centrally edgewise through a piece of wood 1 in. thick and 3 in. long of any width, and slitting it upon a saw table. But for this class of objects, for which low powers will ordinarily be sufficient, glass is the best material, and admits of examining both sides of the object. For objects that must be viewed uncovered and on both sides, no other mount will equal two of Pierce's capped cells mounted back to back with the object between and fixed in a wooden slip, either temporarily or permanently, or on a metal plate.

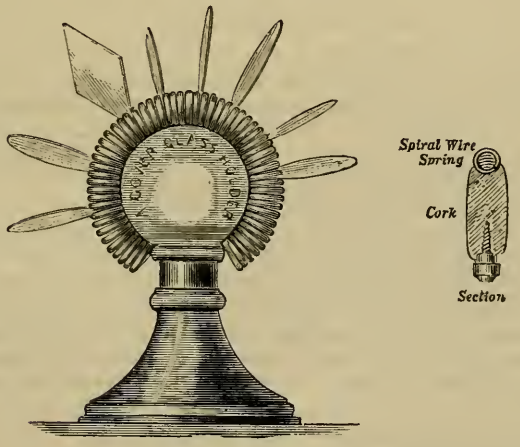
Mounting Opaque Objects on a Micrometer Background.§—Mr. R. Parkes writes:—"Most people on looking at an object under the Microscope

* Bull. Soc. Belg. Micr., xiii. (1887) pp. 144–6.
† The Microscope, vii. (1887) pp. 98–9.
‡ Amer. Mon. Micr. Journ., viii. (1887) pp. 92–3.
§ Trans. and Ann. Rep. Manchester Micr. Soc., 1886, pp. 58–9.

for the first time wish to know the natural size of the object exhibited, and for all opaque objects which could be mounted on a white, black, or coloured background, this information can be best attained by printing on the ground a scale ruled, say, one hundred lines to the inch, and upon which the object can be mounted, when its size will be at once apparent. I have engraved and brought down for presentation to the Society a ruled plate and other requisites, which will enable those members who care to do so, to produce any number of scales required. The plate before being used should be cleaned with turpentine, and the colouring matter rubbed in dry, lampblack, or any other powder colour will do, the excess colour being wiped off by passing a piece of tightly wrapped wash-leather across the plate. A piece of smooth wood or glass should then be taken, and soap or bees'-wax drawn across the face, and the paper about to be printed on should be laid upon it, the soap making it adhere to the face and keeping it straight. The soap or wax should then be passed over the paper, taking care to have a smooth and even film. The paper being thus prepared should be placed on the plate and the back rubbed lightly with the steel burnisher provided, and, on removing it, a clear impression of the scale will be found imprinted on the surface. If ordinary note-paper be used, many objects can be well illuminated by sending light through from the mirror of the Microscope. I have also engraved for the Society a metal micrometer ruled 100, 250, 500, and 1000 lines to the inch, which the members will find useful for measuring opaque objects. It has the advantage of not being so liable to break as the glass micrometers, and can be readily used with all powers up to 1/6 in. objective."

Cover-glass Holder.*—Dr. F. L. James describes the device (fig. 199) for holding cover-glasses after they are cleaned and ready for application to the slip. It consists of a coil of brass spiral spring wire bent round a

Fig. 199.



cork, which has been grooved to receive it. The method of using is illustrated by the cover-glasses in position on it.

* Proc. Amer. Soc. Micr. 9th Ann. Meeting, 1886, p. 145 (2 figs.).

James's Improved Slide Cabinet.*—Dr. F. L. James fastens, by marine glue, to the under side of each tray, pieces of vulcanized indiarubber, 1/2 in. in diameter, and 1/8 in. in thickness. These pieces are so arranged that one of them comes on each end of the slide beneath it in such manner that the slide is prevented from rising up against the bottom of the superincumbent tray. The slips in the upper tray are held in place by similar bits of rubber fastened to the cover of the box.

Griffith's Pocket Slide Cabinet.†—Mr. E. H. Griffith's cabinet (fig. 200) is intended especially for pocket use. It is similar to another already in the

Fig. 200.

market, but in the place of rack-work in that, trays are used in this. A feature in its favour, that will be appreciated by those who carry slides in pockets, is its security from opening.

Baker, S. W.—**Wax Cells.**

[Made by building up layers of artists' wax on the slide, which is placed on the turning-table, and a cut made through the first layer of wax the size of the cover-glass intended to be used, and the centre taken out; a cut is then made with a needle a little inside of the first cut, extending down to the glass; the centre is then removed and another cut made through the wax a little outside of the first cut, leaving a wall of wax to form the cell. This is finished by smoothing with a piece of ivory, shaped like a chisel, thoroughly varnishing, inside and out, with Brown's cement. By using dark-coloured wax for the first sheet next the slide, and leaving it as a bottom to the cell, a background can be made to suit any object.]

Proc. Amer. Soc. Micr. 9th Ann. Meeting, 1886, p. 196.

Brokenshire, F. R.—**Mounting without Pressure.**

Scientif. Enquirer, II. (1887) pp. 135–8.

Caldwell, C. T.—**New Cement.**

["It is simply the article sold at the paint and oil stores under the name of 'hard oil finish.' . . . It runs freely, makes smooth rings, dries readily and quickly, and is extremely adhesive. It is cleanly."]

Amer. Mon. Micr. Journ., VIII. (1887) pp. 98–9.

Eliel, L.—**Gums and Pastes for Labels.** *Engl. Mech.*, XLIV. (1887) pp. 535–6.

Hopkins, G. M.—**A quick method of mounting dry objects.**

[Recommends metal rings with a narrow internal flange at the top for the cover-glass, and a wider external flange at the bottom for attachment to the slide.]

Engl. Mech., XLV. (1887) pp. 310–11 (2 figs.), from *Scientific American.*

James, F. L.—**Device for centering and holding the slide upon the turntable.**

["It consists of the ordinary triangular jaws pivoted exactly opposite to each other, and the acute end of one of the slips resting against a good strong spring. The slip is shoved into place from the open end of the jaws, opposite to the end held by the spring. A slide placed between these jaws is held as firmly as in a vice, and the cell can be turned down or manipulated exactly as though it were in a lathe."]

Proc. Amer. Soc. Micr. 9th Ann. Meeting, 1886, p. 146.

Kellicott, D. S.—**Kaiser's Glycerin Jelly for Plant Sections.**

["Stained leaf sections are best shown in Kaiser's glycerin jelly to which a large per cent. of gelatin has been added."]

The Microscope, VII. (1887) p. 152.

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* Proc. Amer. Soc. Micr. 9th Ann. Meeting, 1886, p. 146. † Ibid., p. 152.

Laboratory Notes.

[Preserving a specimen temporarily by applying a drop of glycerin at the side of the cover-glass in such a manner as to effect a union between the water and the glycerin; value of dried specimens of algæ, &c.]

Amer. Natural., XXI. (1887) pp. 477–9.

Trzebinski, St.—**Einiges über die Einwirkung der Härtungsmethoden auf die Beschaffenheit der Ganglienzellen im Rückenmark der Kaninchen und Hunde.** (On the influence of hardening methods on the condition of the ganglion-cells in the spinal cord of rabbits and dogs.) *Virchow's Arch. f. Path. Anat.*, CVII. (1887) p. 1.

Williams, C. F. W. T.—**Mounting in Castor Oil.**

[Cell to be made with Ward's brown cement and filled with best castor oil. "For plant crystals, such as raphides and the like, there is no preservative so good in my opinion as this oil."

Sci.-Gossip, 1887, p. 138.

(6) Miscellaneous.

New Micro-chemical Reaction for Tannin.*—Experiments were made by Herr J. W. Moll, for the purpose of discovering a good reagent for tannin in the cells of plants, which should give a precipitate sharply separated from the surrounding fluid, and at the same time should show clearly the distinction between the tannins which colour iron green, and those which colour it blue. He obtained the desired results with lithium chlorate, copper acetate, copper nitrate, lead nitrate, and uranium acetate, the iron-salt used being the acetate. Of these copper acetate answered the best.

The living parts of plants to be examined were cut into small pieces and left in a saturated solution (7 per cent.) of copper acetate for from eight to ten days; longer immersion produces no injurious results. The sections were then placed on the slide in a drop of 0·5 per cent. iron acetate solution, but allowed to remain in it only for a few minutes, as longer action colours the cell-walls brown. After washing with water, and then with alcohol to remove the air and chlorophyll, they were examined in glycerin, or glycerin jelly, in which they remain unaltered for a lengthened period, even as much as two years. Or the sections may be removed directly from the copper acetate into alcohol, and examined afterwards with the assistance of iron acetate. The distinction between the tannins which give green and blue colours with iron were very clearly brought out. Thus in branches of *Fagus* the tannin-cells of the bark were coloured green, those of the pith blue.

Micro-chemical Reactions based on the formation of Crystals.†—MM. Klement and Renard have published an important paper on micro-chemical reactions. The methods available for the qualitative analysis of minute quantities of a substance are spectroscopic analysis, blow-pipe analysis, and micro-chemical reactions. The last method depends on the form and appearance of the crystals deposited by the action of reagents. Availing themselves of the researches of Boricky, Behrens, Streng, Lehmann, Haushofer, and others, combined with the results of their own extensive researches, the authors have produced the most complete account of the subject which has yet appeared. They describe the methods of research and the reactions, simple and characteristic, by which compounds of more than fifty elementary bodies may be identified in minute crystals recognizable under the Microscope. They also give a brief description of the processes of isolation and identification applicable to such compounds as the mineral constituents of rocks. The value of the treatise is much enhanced by the accompanying plates, eight in number, comprising nearly 100 figures of the forms of crystals obtained by the various reactions described in the text.

* Maandbl. voor Natuurwet., 1884. See Bot. Centralbl. xxiv. (1885) p. 250.

† Cf. Bull. Soc. Belg. Micr., xii. (1886) pp. 11 and 55–6.

ERMENGHEM, E. VAN.—**Manuel technique de Microbiologie d'après l'ouvrage de Hueppe Bacterien-Forschung.** (Manual of Microbiological Technique, after Hueppe's 'Bacterien-Forschung.') 500 pp., 76 figs. and 2 pls., 8vo, Paris, 1887.

JAMES, F. L.—**Elementary Microscopical Technology.** A Manual for Students of Microscopy. In three parts. Part I. The technical history of a slide from the crude materials to the finished mount.
107 pp. and 15 figs., 8vo, St. Louis, Mo., 1887.

„ „ **Clinical Microscopical Technology.** IV. The examination of Urine. V. Urinary Examinations: Inorganic Sediments.
St. Louis Med. and Surg. Journ., LII. (1887) pp. 289–91, 349–51.

[MANTON, W. P., AND OTHERS.]—**Elementary Department.** Third and Fourth Lesson. "Cleanliness is akin to godliness."
The Microscope, VII. (1887) pp. 146–7, 172–6.

SATTERTHWAITE, T. E.—**Practical Bacteriology.** 85 pp., 16mo, Detroit, 1887.

STÖHR, P.—**Lehrbuch der Histologie und der mikroskopischen Anatomie des Menschen mit Einschluss der mikroskopischen Technik.** (Manual of histology and human microscopical anatomy, including microscopical technique.)
199 figs., 8vo, Jena, 1887.

TAYLOR, T.—**Reply to Professor Weber.**
Proc. Amer. Soc. Micr. 9th Ann. Meeting, 1886, pp. 116–9 (1 pl.).

WEBER, H. A.—**Microscopic examination of Butter and its Adulterations.**
[Concludes that "the microscopic methods as laid down by Dr. Taylor are of no practical value in the examination of butter for adulterations."]
Proc. Amer. Soc. Micr. 9th Ann. Meeting, 1886, pp. 103–15 (1 pl.)

ZUNE, A.—**Etude microscopique et microchimique des Farines et des Fécules ou application du Microscope à la recherche de leurs falsifications et de leurs altérations.** (Microscopical and microchemical study of flour and starch, or application of the Microscope to the investigation of their falsifications and adulterations.)
Mon. du Praticien, II. (1886) pp. 166, 183, 211, and 263.

into ammonia; and even the same organisms, according to the conditions, may either have an oxidising or a reducing function. In the first phase, when the nutritive matter is readily oxidizable and assimilated, the micro-organisms thrive at its expense, the process of nitrification being materially assisted by atmospheric oxygen; in the second phase, on the other hand, the necessary oxygen is derived from the nitrates; thus a change, seemingly of reduction, is induced.

MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Thury's Multiocular Microscope. — Prof. M. Thury has devised a Microscope (figs. 201 and 202) for enabling several observers to view the same object without having to change their seats. The following is a translation of the description which he sends us:—

"It is well known how tedious demonstrations with the ordinary Microscope are in consequence of the professor and his pupils having to continually change places. The Microscopes with two or three tubes, designed by M. Nachet (figs. 203 and 204) [and that of Prof. Harting,† fig. 205] obviate this inconvenience, but at the expense of a deterioration of the image, which is the more objectionable in consequence of its increasing rapidly with the power of the objective. This essential defect arises from the injurious influence of the edge of the prism, always imperfect, which occupies a diametral position relatively to the objective, disturbing a zone in the latter of constant size, which has therefore a greater influence on the image according as the objective has a smaller diameter.

It seemed to me that these inconveniences might be avoided, if in place of dividing the image between different observers it was received entire by a total-reflection prism, and by a movement of the prism passed successively to the different oculars of a Microscope with several tubes.

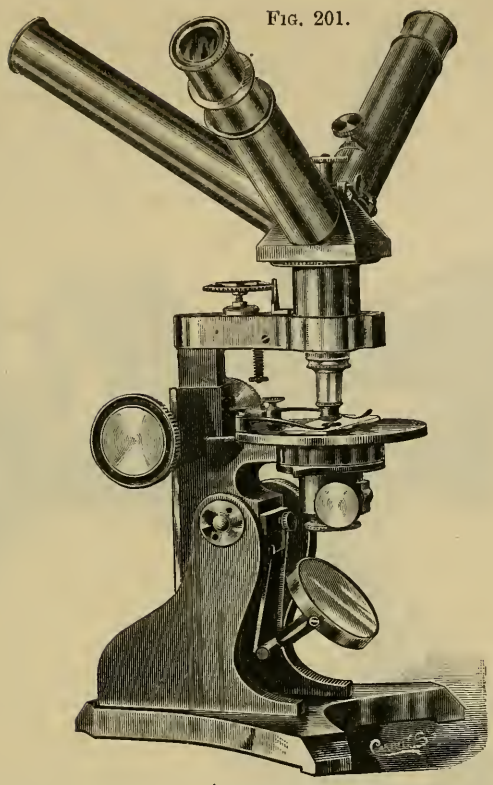
In consequence of the aberrations of colour and form which always take place in the case of prisms, the reflected image cannot be as perfect as the image obtained without it, but the difference is hardly appreciable. For instance, a Hartnack No. 9 objective which shows the beads of *Pleurosigma angulatum* with central light in the ordinary Microscope, shows them also, a little less distinct only, after reflection by the prism. A mirror of silvered glass would remedy this defect but at the expense of diminished permanence of the reflector.

The position of the prism P is shown in fig. 202. It is placed at a little distance behind the objective so as to diminish the effects of aberration, which are at their maximum when the prism is immediately behind the objective, as is necessarily the case when the image is multiplied in the manner hitherto adopted. The stage of the Microscope being horizontal and the optic axis of the objective consequently vertical, the prism is arranged to turn round a vertical axis situated in the prolongation of the

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

† Harting, P., Das Mikroskop, 1859, p. 780 (1 fig.).

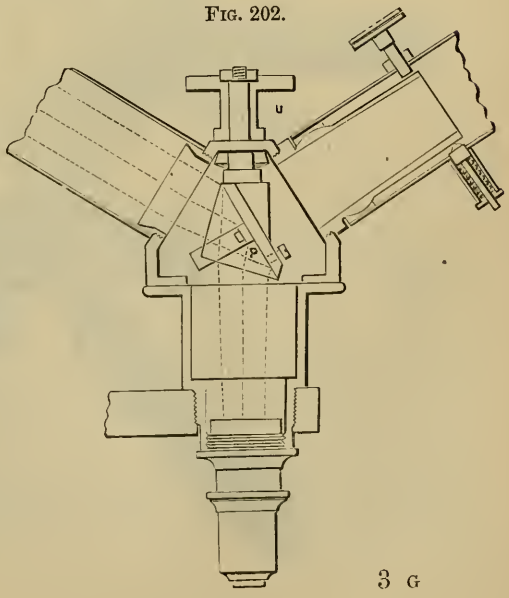
FIG. 201.



axis of the objective. The prism is inclined on its axis of movement so as to reflect the light in a direction making an angle of 30° with the horizon.

There are two tubes each with an eye-piece inclined about 60° to the vertical, and which can be placed opposite each other in the same vertical plane or in two planes at right angles. If the Microscope is intended for three persons there is a middle tube with two lateral ones at right angles with it.

FIG. 202.



All the tubes except one have an arrangement for focusing by the eye-piece, so that each observer may adjust the instrument to his own sight once for all.

The possible defect of centering of the objectives, in consequence of which the image fails to occupy the same situation in the field of the different eye-pieces, is remedied by allowing the inclination of the tubes to be

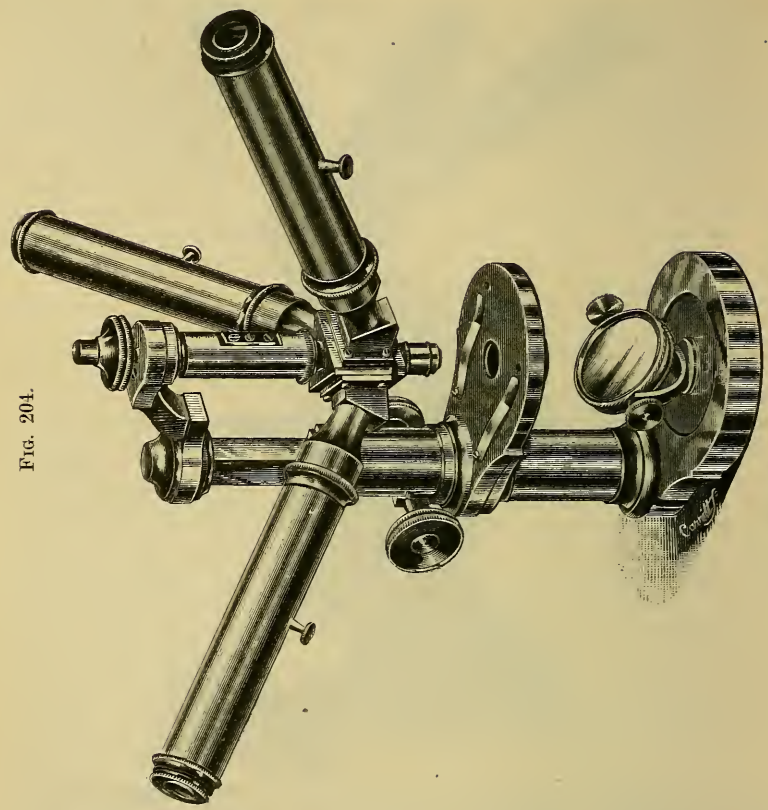


FIG. 204. NACHET'S MICROSCOPE À TROIS CORPS.

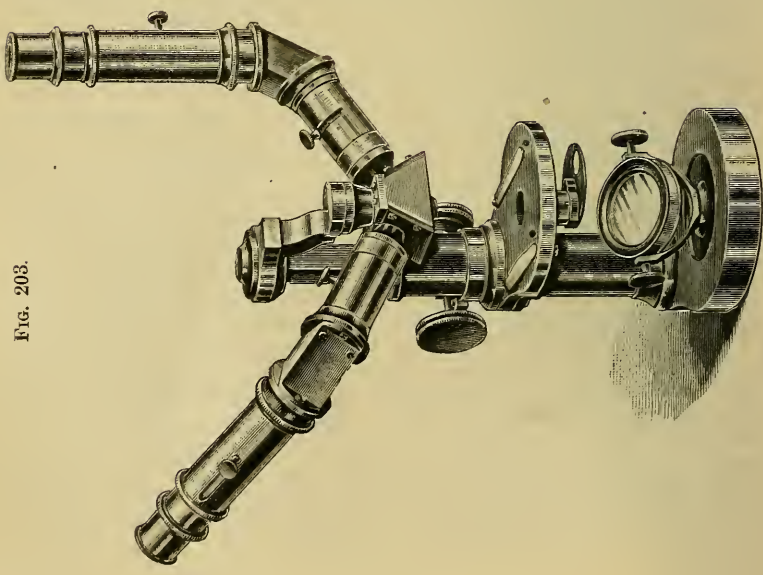


FIG. 203. NACHET'S MICROSCOPE À DEUX CORPS.

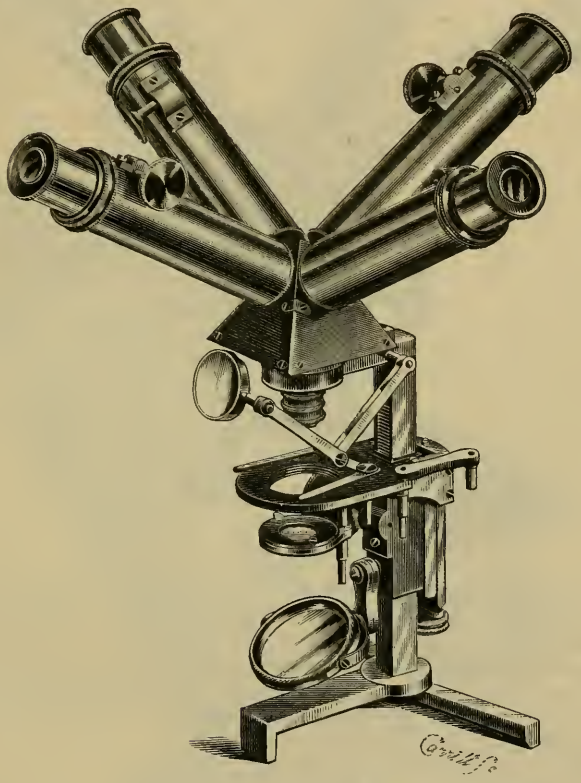
slightly varied, which makes the position of the images identical. There are also stops to limit at pleasure the movement of the prism.

By turning the prism by the milled head at U the image is transferred instantaneously from one tube to the other.

I hope that the new arrangement will render good service to the laboratories where microscopical anatomy is taught."

In some of the earlier forms of Stephenson's Binocular Microscope the upper prism box was made to rotate on the optic axis, carrying with it the

Fig. 205.



HARTING'S QUADRIOCULAR MICROSCOPE.

body-tubes, so that a circle of observers could view the object successively. Prof. Thury's plan, however, avoids the loss of time involved in swinging the tube round, and, what is more important, especially in the case of moving objects, in readjusting the focus for each observer.

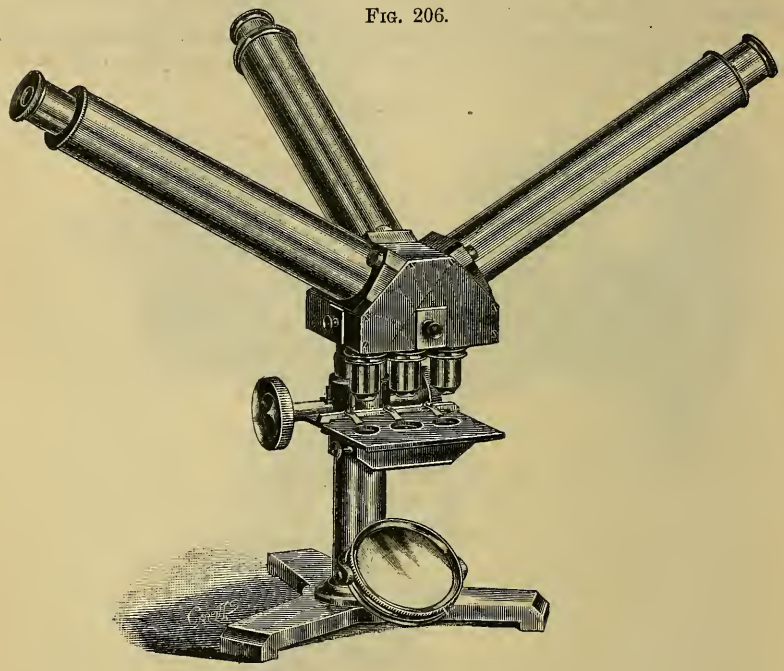
Ahrens's Triocular Microscope.—We cannot be sure that we fully appreciate the rationale of this instrument made by Mr. C. D. Ahrens (fig. 206), but it seems none the less necessary to notice it here if we are to maintain our original intention of recording such designs as have been considered sufficiently practical to be actually manufactured. Moreover, all classes of scientific bodies—zoologists, botanists, horticulturists, medical men, &c.—exhibit and record the abnormalities of their respective branches.

The Microscope consists, as will be seen, of a stand with three bodies

and three objectives, over which are three prisms, which deflect the rays at angles of about 45°.

In order to make use of one mirror only, Mr. Ahrens fits beneath the stage the arrangement of prisms shown in fig. 207, consisting of one equi-

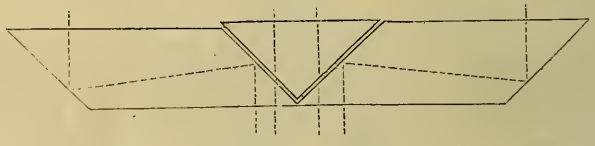
Fig. 206.



lateral and two rhomboidal prisms. These divide the rays from the mirror, sending part into each of the side prisms whence they are reflected into the two lateral objectives.

A Microscope with several bodies and *one* objective so that the *same object* may be viewed by several observers (as in the forms above described) has obvious uses, while a Microscope with two bodies and *two* objectives is

Fig. 207.



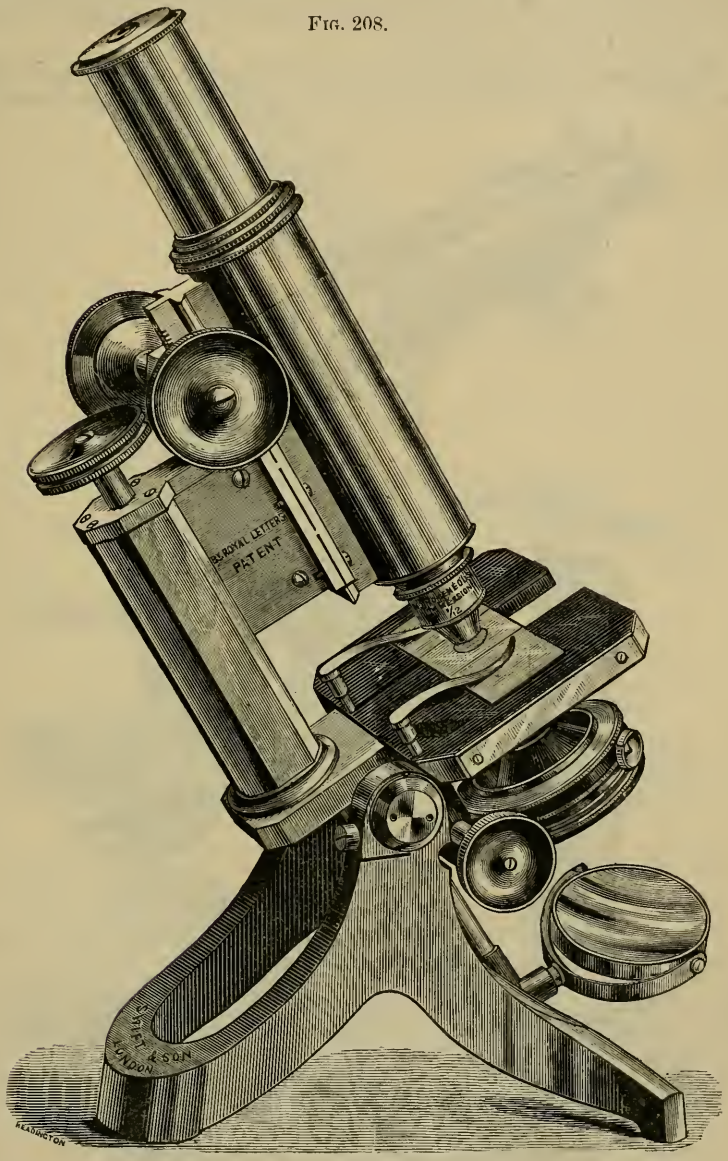
convenient for mounting purposes, as shown by Mr. Deby's Twin Microscope.* Three bodies and three objectives (by which three observers can look at three different objects at once) do not, however, afford the convenience of the former arrangement, while they make a useless addition to the latter.

The three objectives have a common focusing arrangement, no provision being made for focusing separately objectives of different powers.

* See this Journal, 1886, p. 854.

Crookshank's Bacteriological Microscope.—Messrs. Swift and Son have recently brought out this instrument (fig. 208), under the instructions of Dr. E. M. Crookshank, specially for bacteriological work.

Fig. 208.



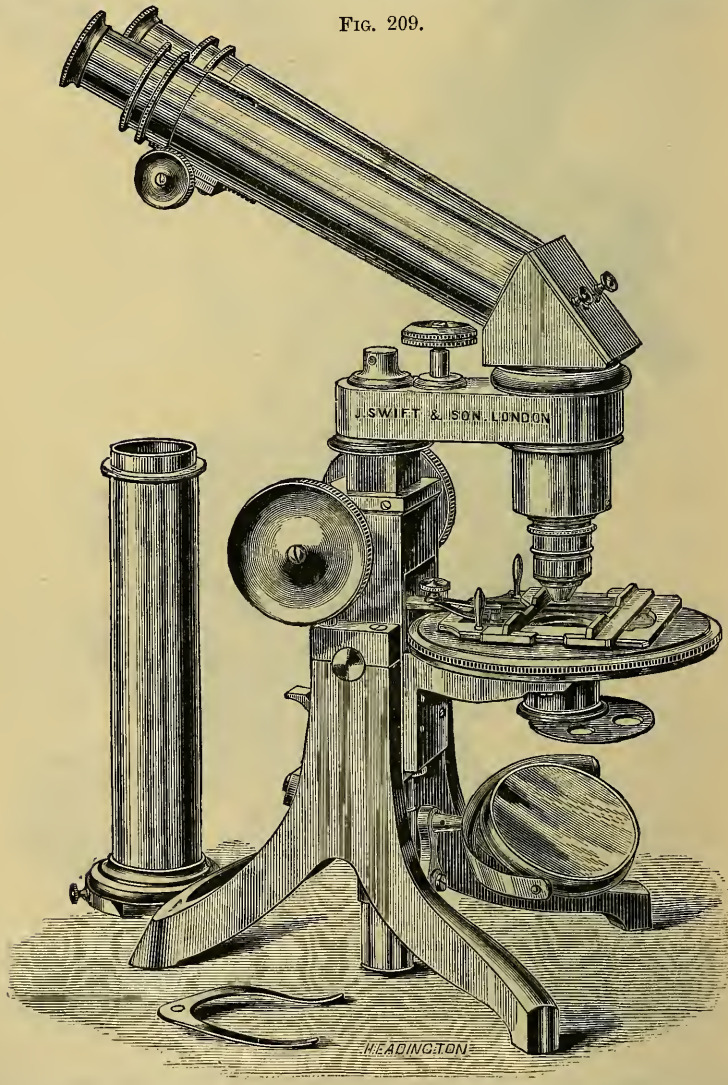
It is provided with an extra large stage with glass surface, which is slotted in the centre to facilitate focusing with high powers, and the removal of the slides. A modified form of the Abbe condenser, with high angle, is applied to the centering substage and fine crossed lines are ruled on the

upper surface of the condenser to mark the centre. The focus of the condenser is adjusted by rack-and-pinion movement.

The principal novelty, however, is in the application of a *lever* to the parallel-spring fine-adjustment of Bausch and Lomb, by which Messrs. Swift have greatly lessened the speed of the movement, at the same time reversing the action of the focusing screw.*

Stephenson's Erecting Binocular Microscope.—Mr. J. W. Stephenson's Erecting Binocular Microscope has approved itself to microscopists, and

Fig. 209.



especially to botanists, as by far the most practical and convenient form hitherto devised where high powers are to be used. Indeed, with the

* See *infra*, p. 808.

higher power objectives it has no rival, as a 1/16 in. or even 1/25 in. objective can be used binocularly with full and equal illumination in both tubes. Messrs. Swift & Son now issue it in three forms, two of which are shown in figs. 209 and 210, the third form being intermediate in size between these two.

Fig. 210.

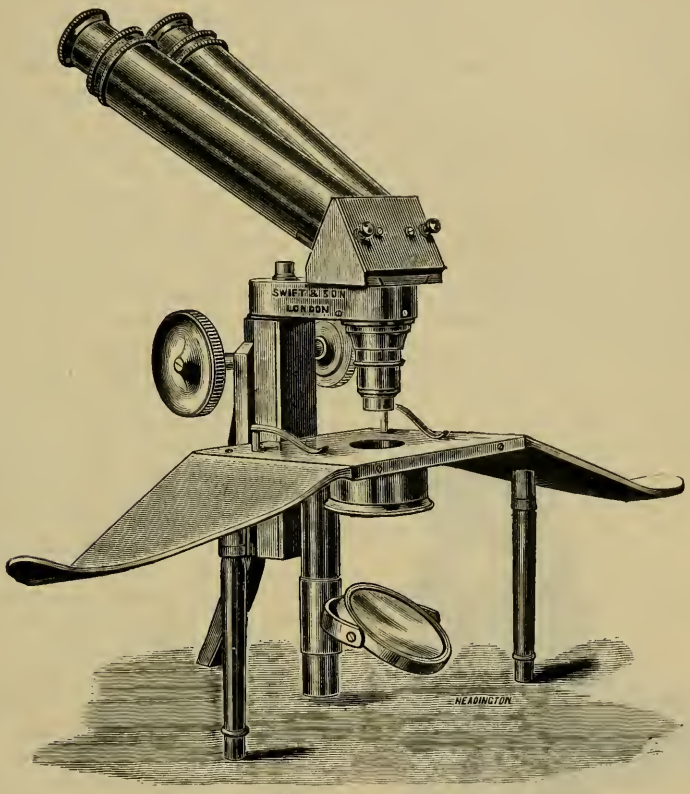


Fig. 210 shows the binocular adapted to a dissecting stand, the erection of the image being especially convenient for making dissections.

The instrument can be readily converted into a monocular when required; the monocular tube is shown in fig. 209.

Gomont's "new" Botanizing Microscope.*—We often have to comment on our German friends for reproducing as novelties microscopical accessories—notably mechanical stages—which have been in existence in this country for many years. We here have a similar case from a French source, the Microscope described as a novelty by M. M. Gomont being a very old friend. We translate the description verbatim:—

"Botanical excursions for collecting algæ and the lower fungi lose, as is well known, a part of their charm and utility in consequence of the difficulty which the botanist experiences in recognizing on the spot the species which he finds. For these small plants a simple lens, whatever may be its amplifying power, is always much too feeble, and it is absolutely

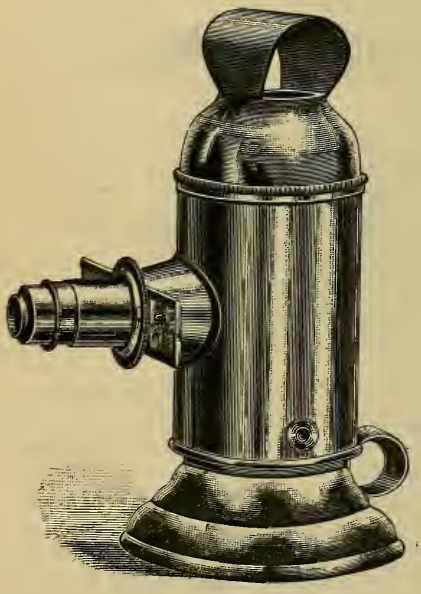
* Bull. Soc. Bot. France, xxxiv. (1887) pp. 216–7.

necessary to have recourse to a compound Microscope. I have endeavoured to modify the form and mode of illumination of this instrument whilst preserving a sufficient power to make it applicable to all cases. The arrangement which I have devised having appeared to some of my colleagues to be very practical I will give here a short description of it.

The instrument consists of an ordinary Microscope tube, sliding smoothly in another tube, which is closed at its lower or objective end by a kind of screw cover which has a small aperture in the centre, which acts as a diaphragm. At the plane of this diaphragm the tube has a slit for the introduction of a slide. A ring sliding on the tube presses on the slide and fulfils the same functions as the clips of a Microscope. The object is illuminated by directing the instrument like an opera-glass to a white cloud or any other brightly illuminated object. The light from these large natural reflectors is sufficient for a power of 250 diameters, a power which it is useless to exceed for the purpose in view, and which it will be very rarely necessary to reach. The preparation of the object to be examined is effected in the field in a very simple manner, the cover-glass adhering sufficiently to the slide to allow of all possible positions being given to the instrument. The diaphragm can be readily removed when it is necessary to alter the tube.

As will be seen, I have been obliged to give to this Microscope as simple an arrangement as possible in consequence of the accidents to which an instrument of this kind is exposed during botanizing. I hope that, notwithstanding its little complication, it will be useful to botanists who are addicted to the investigation of the lower plants, or even in a more general way, to naturalists who have taken as the object of their studies the microscopical organisms."

Fig. 211.



Rochester Magic Lantern and Projection Microscope. — Without committing ourselves to the statement of the designers (the Bausch and Lomb Optical Co.) that this, fig. 211, is "the neatest, cheapest, and best lantern ever introduced," and "without exception far superior to any other both for its size and price," it may be admitted that it is a very handy little lantern (8 in. high). It is made entirely of brass, lacquered, and is so arranged that ordinary 3 × 1 in. slides can be used, and the image projected on a screen.

An additional recommendation (to utilitarian Microscopists at any rate) is that the lamp "being a regular hand-lamp, makes the lantern more valuable, as the same can be used at any time about the house."

Schott's Microscopes.—On pp. 148–150 we directed attention to certain figures of Microscopes from Schott's 'Magia Universalis,' published in 1657, which had long puzzled microscopists by their apparently exceptional and extraordinary size. We submitted an explanation, namely, that

the draughtsman, knowing possibly nothing of the purposes of the instruments, instead of drawing *an eye* directed upon them, drew full-length figures, whence by comparison the Microscopes appear of enormous size. This explanation was suggested to us by certain figures of Microscopes in Traber's 'Nervus opticus,' published in 1690, which we reproduced in support of our view of the matter. We have since met with the first edition of Traber's work, published in 1675, in which the same figures were given. On comparing Traber's descriptions with those given by Schott we are strongly confirmed in our opinion that the former was referring to the same Microscopes as those described by the latter.

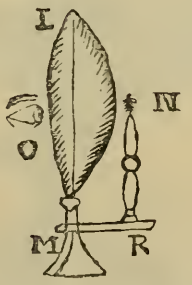
In support of our explanation we remark that our fig. 13 from Schott's 'Magia Universalis' does not correspond with his own *description* of it (loc. cit., p. 535), for he states that the Microscope is "super tripedale fulcrum," though the drawing shows a cylindrical tube-support without any visible means of illuminating the objects, and such as, in our opinion, was never actually constructed. Whereas Traber's figure (our fig. 16) answers fairly to Schott's description, the open tripod support being a practical form that clearly forms a link in the evolution of the mechanical designs of Microscopes.

We omitted to note that Schott assigns the construction of the instrument to Eustachio Divini thus:—"Huius modi microscopia excellentissima facit Romæ Eustachius Divini . . . ." (loc. cit.).

In further confirmation we remark that in another drawing given by Schott (our fig. 212) a candle and a lens are shown, and by comparison with the full-length figure of a man kneeling and viewing the candle through the lens the latter might be supposed 3–4 feet in diameter, quite beyond the possibility of manufacture at that date. Schott states that from Kircher's 'Ars magna lucis et umbræ' (1646) he found the lens was

Fig. 212.

Fig. 213.

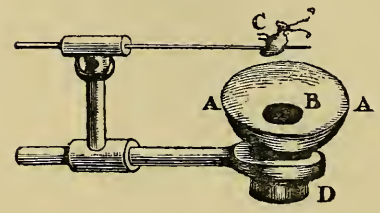


designed by Descartes to have hyperbolic surfaces. On reference to Kircher's text we find Descartes and the hyperbolic surfaces mentioned, thus identifying the instrument, but the figure illustrating the text again shows *an eye* only directed to the lens (vide fig. 213 reproduced from Kircher), whence by comparison the lens appears to be only 4–5 in. in diameter, a size that may have been reached at that date. In reproducing Kircher's woodcut Schott's draughtsman is thus clearly proved to have substituted a full-length figure of a man for the representation of the eye only of the original; the probability of his having done so likewise with other drawings is hence easy to understand and our conjecture is thus shown to have been the true explanation.

Another ludicrous feature may also be noted, viz.:—that in Kircher's figure the eye is viewing an *insect* through the lens, which Schott's draughtsman apparently mistook for a *candle-flame*, and hence substituted the latter!

Lieberkühn's Microscope.—The earliest representation we have met with of this instrument is in P. van Musschenbroek's 'Essai de Physique,'* tome ii. pl. xviii. fig. 6, and as we believe it to be hitherto practically unknown to English microscopists we reproduce it in fig. 214.

Fig. 214.

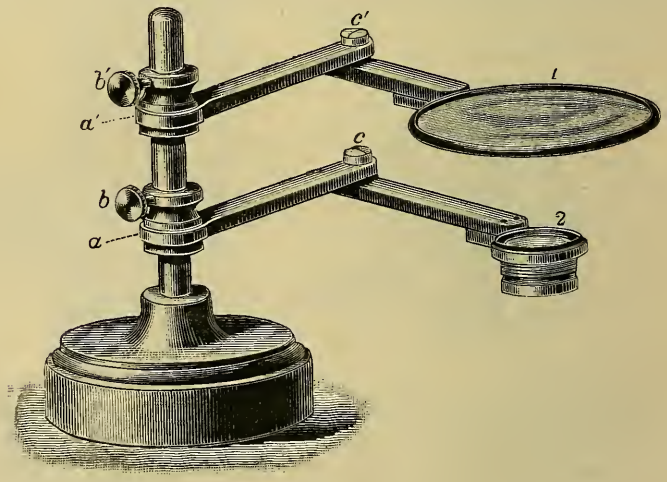


The following is a translation of Musschenbroek's description (loc. cit., p. 595) of the figure:—

"There has also been recently discovered a good way of strongly illuminating large opaque objects, so that they may be examined by every kind of Microscope, even by means of the smallest kinds. A A is a small spherical concave mirror of fine silver, well ground and polished, whence the light is reflected to a focus on the object C, so that it is strongly illuminated at the back. This mirror is pierced in the middle B, and the Microscope [lens or object-glass] is there inserted and adjusted either forward or backward: the eye is placed at D and the object is seen very clearly."

Weinzierl's Simple Microscope for the Examination of Seeds.†—This instrument (fig. 215), the invention of Dr. v. Weinzierl, consists of a solid brass stand leaded at the foot, and carrying two arms jointed at *c'* and *c*, at

Fig. 215.



the extremity of which are lenses 1 and 2. The arms move horizontally round through the bearings at *a* and *a'*, and they are fixed by the screws *b* and *b'* in any desired position.

The weaker lens No. 1 is a simple biconvex lens 9 cm. in diameter, and with a focal distance of 25 cm. It has a magnifying power of $2\frac{1}{3}$ times. No. 2 is more powerful. It consists of two achromatic lenses 29 mm. in

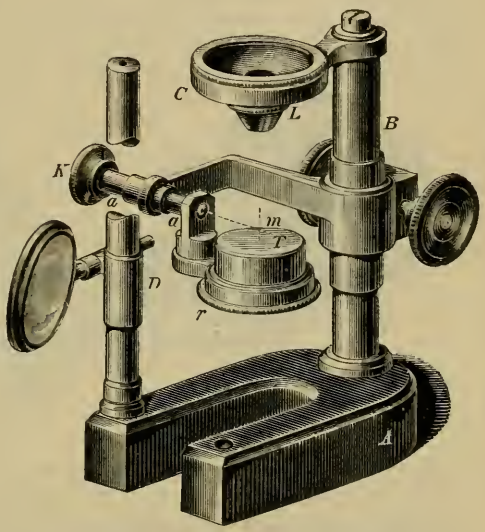
* 2 vols 4to, Leyden, 1739. † Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 42-4 (1 fig.).

diameter, and has a focal distance of 14 cm. It magnifies about 5 times. The advantages claimed for this instrument are that with No. 1 lens both eyes can be used at once, the field of vision is considerable, and both hands are left free for manipulation. If greater magnification be desired, No. 2 lens is easily put in position, or both may be employed at the same time.

Vogel's Lens-stand for Entomological purposes. *— This apparatus (fig. 216), has been for many years used by Prof. H. C. Vogel in the study of small insects.

On a horseshoe foot A is a brass pillar B, which carries a conical piece C to hold the lenses. T is the stage which is raised or lowered on the pillar B by rack and pinion, and so focused to the lens L. The lenses supplied with the apparatus are all set in conical fittings which drop into C. The important feature of the apparatus is the facility for moving the stage into any desired position. It consists of a cork T, set in a brass ring, terminating below in a milled head *r*, by which the stage is rotated in its own plane, while by the milled head K it can be rotated about a horizontal axis *a a*. This axis is also made to slide in its bearings, so that different small objects fixed in a line on T can be successively brought into the centre of the field. Thus, the object *m* when placed at a point on the prolongation of *a a*, is capable of a fourfold movement without having materially to alter the focal adjustment. D is the illuminating lens which slides along a brass pillar fixed in either of two holes upon the ends of the horseshoe foot, so that the object can be illuminated from either side. This lens may also be conveniently used in mounting large objects, for which purpose it is raised to the top of the pillar and swung round to occupy the position of C which is thrown back. For transparent objects the cork is replaced by a glass plate.

Fig. 216.



Westien's improved Universal Clamp for Lens-holders, &c. †— The clamp of Herr H. Westien, the construction of which was described in 1885,‡ has since received improvements which have not only made its production easier but have considerably widened its field of utility. This clamp renders it possible by a single screw motion to clamp securely to an upright an object provided with a bar of any form, whether round, oval, triangular, square, or flat. The upright may also vary in size from 2–9 mm., from

* Zeitschr. f. Instrumentenk., vii. (1887) pp. 173–5 (1 fig.).
† Ibid., pp. 54–5 (1 fig.).
‡ See this Journal, 1885, p. 316.

5–13 mm., or from 7–15 mm., according to the clamp used, and may also be round, oval, triangular, square, or flat in section. The construction is as follows (fig. 217).

On the pin A having a hook-shaped head, is the cup B, the clamp C, and the nut D, which is provided with a washer. D works upon a screw-thread on the pin, and when screwed up presses together the clamp C and the cup B, by which the bar H is clamped in the angle of C, while on the other side the hook draws the cup against the upright J, so that J and H are firmly clamped together by the single screw D.

Fig. 217.

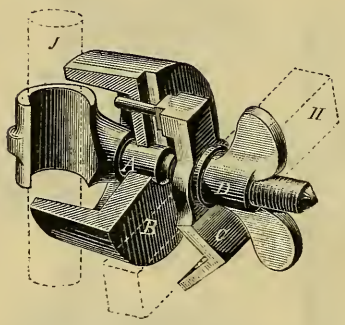
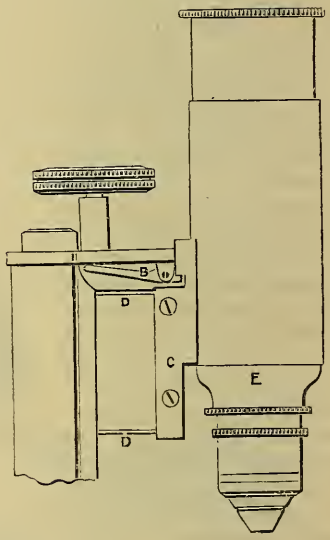


Fig. 218.



Swift's Lever and Parallel-spring Fine-adjustment. — Messrs. Swift and Son, as noted *supra*, p. 218, have applied a lever to the parallel-spring fine-adjustment of Bausch and Lomb by which the speed of the movement is much lessened. The mechanism is shown in fig. 218 (reduced from the drawing to the specification of the patent).

The milled-head screw acts upon the lever B, the short end of which engages in the piece C, which is attached to the body-tube E, and is supported at the back by the parallel springs D D connected with the stem.

The movement of the screw raises or lowers C at a very slow rate against the tension of the springs DD.

Neumann, C.—**Die Brillen, das dioptrische Fernrohr und Mikroskop. Handbuch für praktische Optiker.** (Spectacles, the dioptric Telescope and Microscope. Handbook for practical opticians.) 256 pp. and 60 figs., 8vo, Wien, 1887.

Stein, S. T.—**Die Optische Projektionskunst im Dienste der exakten Wissenschaften.** (The art of optical projection in aid of the exact sciences.)
[Reprint from Part V. of 'Das Licht.' Cf. *ante*, p. 161. Contains a chapter on "the Projection of Microscopic Objects."]
viii. and 155 pp., 183 figs., 8vo, Halle a. S., 1887.

Woodhead's Microscope with large stage for the examination of sections through entire organs. *Brit. Med. Journ.*, 1887, No. 1391, p. 469.

(2) Eye-pieces and Objectives.

Burrill, T. J.—**A new Objective.**

[Report of examination of a Zeiss 2 mm. apochromatic objective and eye-pieces. "The objective has shown itself to be of very high grade among those of modern production, but judging by results obtained it cannot reveal anything not heretofore seen under similar circumstances with the best work of at least six opticians."]

The Microscope, VII. (1887) pp. 233–7.

Schüll, P.—**Ueber das Centriren optischer Linsen.** (On the centering of optical lenses.)

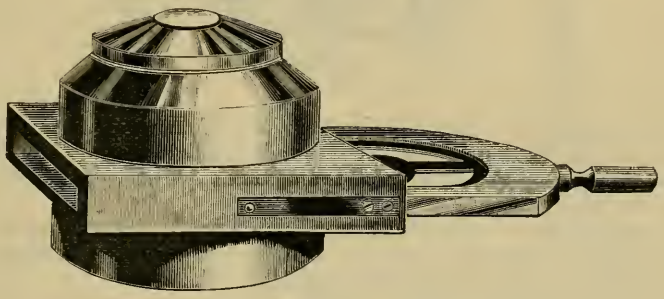
[Practical directions.]

Central-Ztg. f. Opt. u. Mech., VIII. (1887) pp. 181–2, 194–6 (3 figs.).

(3) Illuminating and other Apparatus.

Bausch and Lomb Condenser and Substage.*—This (fig. 219) consists of a condenser and substage, the latter having five stops, diaphragms and blue glass. The lenses of the condenser are of such a size as to utilize almost all the rays of light which may pass through the substage ring. In order that objectives having a large aperture may be used, the condenser

Fig. 219.



has been made with a numerical aperture of about 1·42 (another of 1·20 is also manufactured). Its volume of light is sufficient with the highest amplification, and although it gives an intense light at the focal point it may be distributed over a large space by varying its distance from the object. It will work both dry and immersion. The mounting of this condenser is new and simple, and is so arranged that the instrument can be used where the substage is adjustable or fixed. The diaphragms are separate.

Reichert's improved Mechanical Stage.†—Prof. E. F. v. Marxow describes an improvement of Reichert's mechanical stage which allows it to be fitted to any Microscope without requiring any alteration of the stand. In the original form it will be remembered the stage was fitted to the Microscope by passing the bar projecting from the posterior side of the stage through an aperture cut in the pillar of the Microscope, the bar having rackwork on it by which the stage was moved backwards and forwards. In the new form the pillar is not required to be pierced, but the stage is clamped to the pillar.

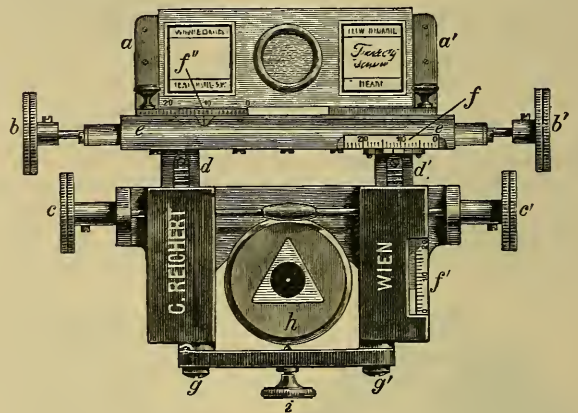
The posterior part of the stage (fig. 220) consists of two parallel bars *d d'* on the upper surface of which is rackwork. These bars are joined together by the pieces *c c'* and *g g'*, the former being hollowed out in order

* The Microscope, vii. (1887) p. 16 (1 fig.).

† Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 25–30 (1 fig.).

to fit against the pillar *h* of the Microscope. The piece *g g'* turns on *g'*, in order that the stage may be slipped on the Microscope, and this done, it is held in position by means of the steel-pointed screw *i*. The piece *c c'* is terminated at each end by a milled head, which, in connection with the

Fig. 220.



rackwork on *d d'*, moves the stage backwards and forwards. These two bars *d d'* are also connected with *a a'*, upon which the slide rests. Lateral movement is obtained through *e e*, which is a slotted cylinder terminated at each end by the milled heads *b b'*.

The scales *f* and *f'* enable any particular point of the preparation to be found again, but if the slide has been removed from the stage it is necessary also to note the reading of the scale *f''*.

Borden's Electrical Constant-temperature Apparatus.* — Dr. W. C. Borden describes an apparatus for maintaining a constant temperature, which will not easily get out of order, and can be depended upon to maintain the temperature desired, intended more especially for the use of those who have no gas at command, but have to use either petroleum or alcohol as a source of heat. It can be left for hours with the certainty that when again examined the heat will not have gone above a certain point or have dropped at any time more than one-half or possibly one degree below it.

The general form of the entire apparatus is shown in fig. 222, and the regulating thermometer in fig. 221. The battery used is the ordinary gravity battery used in telegraphy which gives a current of nearly constant quantity, and requires but little attention.

The regulating thermometer (fig. 221) is made by taking a small glass vial, filling the lower part with mercury and the upper with 95 per cent. alcohol, corking it tightly and passing a small glass tube through the cork at the bottom. The cork must fit very closely and should be made impervious to water by soaking in melted paraffin for several hours. The top of the tube is to be loosely corked and two wires passed down into it through the cork without touching each other—one A well down into the mercury, and the other B free above it. This regulating thermometer is now hung in the water-bath supported by the cork C, and when the temperature of the bath, as shown by a standard thermometer, has reached

* Amer. Mon. Micr. Journ., viii. (1887) pp. 131–3 (2 figs.).

the highest point desired the wire above the mercury is pushed down so as just to touch the surface of the latter. It is obvious that if the bath be filled with water below the temperature desired the mercury will not rise and touch the wire B, thus making connection with the other wire, until

Fig. 221.

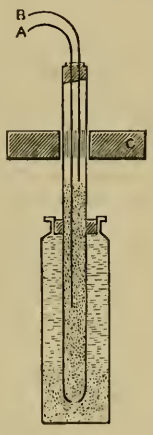
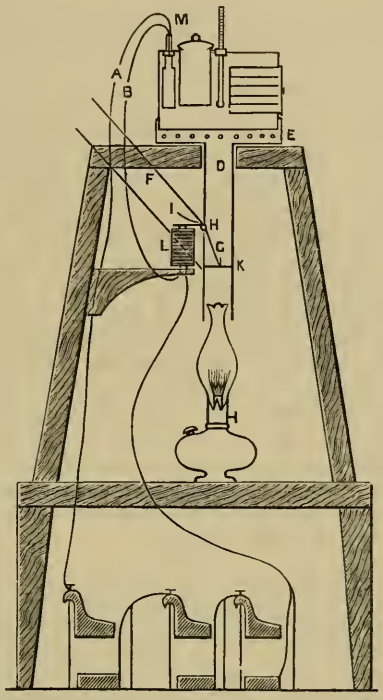


Fig. 222.



the bath reaches that temperature, and that as soon as the temperature falls below this point the mercury will fall with it and away from the wire B; also that by raising or lowering this wire the connection can be made to take place at any desired higher or lower temperature. This regulating thermometer will be found to be sufficiently delicate to keep the temperature to within two degrees. It can be made by simply blowing a bulb on a glass tube and filling the bulb and tube with mercury alone.

Fitting over the top of the lamp-chimney is a chimney D, 11 in. long and $2\frac{3}{4}$ in. square, having at its top a hot-air chamber E, into which the water-bath fits. This chamber has holes round the sides near the bottom for the escape of air. The chimney D has at one side a branch chimney F, 12 in. long, opening into it at an angle of 45°. In the opening between the chimneys is hung a valve G, turning on a hinge H, and moved by a lever I on the outside. This valve should be very light, and must turn easily on the hinge which is made by hanging the valve fastened on a wire through holes on the sides of the chimney; to this wire is attached on the outside the lever which is to be weighted on the end with a small bullet, so as nearly to balance the valve which must just fall of its own weight. At K is a shelf $2\frac{1}{4}$ in. wide extending into the chimney D. This shelf leaves an opening in the chimney 1/2 in. wide which is sufficient for

the passage upwards of the hot-air, and which can be readily closed or opened by the valve without too far swinging. At L is an electro-magnet, which is connected with one pole of the battery and with the regulating thermometer by means of the wire B. The regulating thermometer is connected with the other pole of the battery by means of the wire A.

The action of the apparatus is sufficiently plain. The lamp being lighted, the temperature of the water-bath will rise, and the mercury in the regulating thermometer M with it, until it touches the wire B, thus closing the circuit and magnetizing the electro-magnet, which will attract the lever I, pulling it down, and raising the valve G, so closing the opening in the chimney K, when the heat will escape by the branch chimney F. The temperature of the bath will now fall slightly, and the mercury with it away from B, thus breaking the circuit and demagnetizing the electro-magnet, which will cease to attract the lever, and so allow the valve to fall of its own weight, closing the opening into the branch chimney and allowing the hot air to again ascend through K and reheat the water-bath. This regulating action will continue as long as any oil remains in the lamp, which should therefore have a large reservoir and the flame be turned only high enough to keep the bath slightly above the temperature desired. "With this apparatus many processes such as Weigert's hæmatoxylin staining of the nervous system, which, without a constant temperature of long continued duration are impossible of performing, are made easy; and any one who has had the bother of watching a bath while imbedding in paraffin will appreciate the gain arising from an apparatus which will run all night and have the tissues in good condition for imbedding in the morning, to say nothing of the many other uses, besides staining and imbedding, to which it can be put."

Lighton's Analysing Diaphragm for the Polariscope.* — Mr. W. Lighton describes this apparatus as follows, stating that he has found it to be of great help in the study of crystallography.

"We will suppose that the polariscope as ordinarily used has been placed in position, the polarizing prism below the stage and the analysing prism above the objective. The apparatus consists simply of a cap with movable diaphragm placed over the eye-piece, as illustrated in figs. 223 and 224. Fig. 223 is a sectional view, and fig. 224 a top view of the cap of the eye-piece. The letters in both figs. refer to the same parts. Let AA indicate the axis of the tube; B, the eye-piece; C, the cap of the eye-piece. The apparatus consists merely in a diaphragm plate D, swinging from right to left on the pivot I. This motion is given by placing the finger at the knob L. The amount of motion is controlled by the two small studs G. The diaphragm is pierced by a small hole H, 1/8 in. in diameter. E is a screw in the top of I, holding the diaphragm in place. F is the apex of the cone of light formed by the image of the source of light passing through the eye-piece. Now, if the diaphragm be so adjusted by sliding the cap upon the eye-piece that it will be on a level with this point of light a very interesting series of optical effects will be observed. The small studs G should be so placed that when the diaphragm is swung to the right or left the sides of the hole H will just cut the axis of the eye-lens (apex of cone of light).

I will mention a few of the sights seen by its use as described above. In no case were the prisms of the polariscope revolved. A crystal of chlorate of potash was selected, which, upon simply revolving the stage, passed merely from an orange-purple to a dull grey. On introducing the cap and

* Amer. Mon. Micr. Journ., viii. (1887) pp. 109–10 (2 figs.).

passing the diaphragm from right to left a beautiful series of the most brilliant tints was seen—a fine navy blue changing to purple, orange, and then to lemon-yellow, and lastly pale straw colour. A section of fortification agate was taken which showed a small crystal of pure quartz in one portion. With the diaphragm used as before from right to left, the colour

FIG. 223.

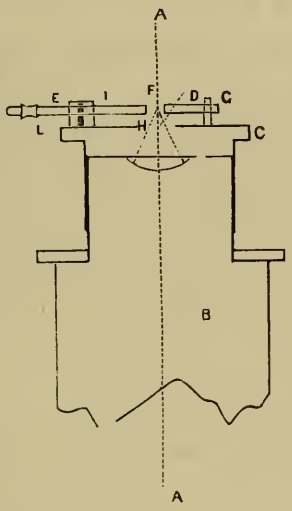
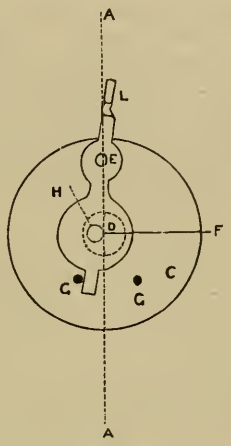


FIG. 224.



of the crystal was merged from bright-green to magenta, and then to a velvety brown-red. With the usual revolution of the stage the colours exhibited were green fading to a dull black.

With this apparatus there is not only a more varied and brilliant series of colours, but also a marked intensification of points of structure. In the two above-mentioned slides delicate lines of crystallization were shown which were invisible under ordinary circumstances.

One of the small, curiously-branched bones of the red-horse, a fish common in this region, was examined, and showed the bone-cells in a remarkably distinct way, they being quite indistinct without the diaphragm."

Auer's Incandescent Gas-burner as a Microscope Lamp.*—Dr. K. Bürkner recommends Auer's gas-lamp for use with the Microscope. He has employed it for some time and finds it very satisfactory both in power and quality. The light emitted is intense, but not blinding, and is relatively white as compared with the ordinary gas-flame or that from paraffin. Another advantage is the small amount of heat given off. The lamp is merely an ordinary Bunsen's burner, the flame of which is surrounded by a chimney or sheath impregnated with the nitrates of cerium, didymium, lanthanum, ittrium. The incandescent chimney is upheld by a platinum wire tied to a bearer which can be raised or lowered by means of a screw, and is further inclosed in a glass chimney. As the incandescent chimney consists of ash, it is necessarily somewhat susceptible of damage.

* Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 35–8 (1 fig.).

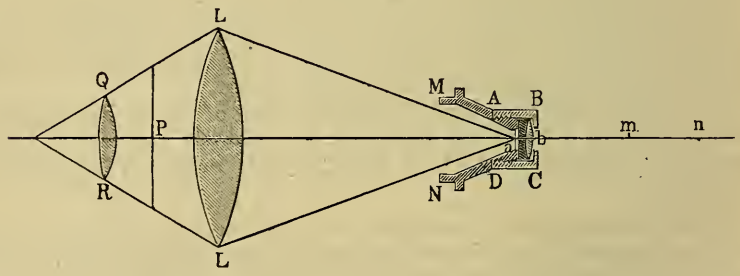
This is apparently the only inconvenience associated with the burner, and is more than compensated by the advantages of the light.

"Old and New Microscopical Instruments."—Apparatus for testing Refractive Index.*—The text of Dr. G. Martinotti's article under the above quoted title is that there is nothing new under the sun, and as here applied, he remarks how frequently the newer apparatus is but an improvement on, or a perfectioning of, some older instrument. As an example, he refers to Prof. H. L. Smith's apparatus for determining the refractive index of liquids.†

Between two plates of crown glass is formed a space, one side of which is flat, the other concave. When the cavity is filled with a liquid with higher refractive index than that of glass, a plano-convex lens is the result. By means of a simple device this artificial lens is fitted behind the weak objective of a compound Microscope, so that the two form an optical system. Then, according to the difference in the refractive index of the interposed lens, the image of the object examined falls at a different distance, and the amount of displacement imparted to the optical arrangement in order to see the object clearly gives the refractive index of the liquid under examination.

The author then remarks that the principle had been previously applied for the same purpose, but in a somewhat different manner. The reference is to Sir D. Brewster's 'Treatise on new Philosophical Instruments for various purposes in the arts and sciences,' Edinburgh, 1813. In this, at p. 240, will be found the 'Description of an instrument for measuring the refractive power of fluids. . . .' There Brewster refers to the fact that Euler had already conceived the notion of determining the refractive indices of liquids by inclosing them between two lenses (menisci). This idea was carried out, though imperfectly, by his son. Brewster's device was as follows (p. 247):—In the extremity M N of a Microscope fitted with its objective is placed a thin plate of glass *a*. The biconvex lens *b* is fixed to the end of a short tube A B C D, screwed on to M N so that the internal

Fig. 225.



surface of the lens could be made to touch the plate *a*, or removed away from it. In A B C D, just behind the lens *b*, are two holes for the introduction of fluids into the cavity between *a* and *b*. Thus is formed a plano-convex lens which can be diminished or increased in size by altering the position of the screw.

The plano-convex lens increases the focal length of *b*, and therefore forms the image of any object *m*, at a greater distance from the point P, situate at the anterior focus of the ocular Q R. But as the lenses Q R and

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 320–30 (1 fig.).
† See this Journal, 1885, p. 1066.

L L are fixed, the object must be removed to a in order to get a distinct image at the point P, and the greater the density of the fluid the longer the distance from b. Hence $b\,m$, $b\,n$ give the relative value of the refractive index of the liquid under examination, and with a little calculation the absolute value also. In his research Brewster kept the distance between the lenses invariable, and the thickness of the plano-convex lens identical, for all cases under examination. The objects used were scratches on the surface of a piece of glass. He adds an important detail which has been passed over by Smith. Across the diaphragm at the anterior focus of the ocular he stretched a very fine thread, which, as well as the mark in front of the objective, he tried to keep distinctly in view, in order to prevent any error depending on the eye of the observer.

The fundamental principle of the two instruments is alike, although, instead of a plano-convex lens of definite thickness, in the older apparatus the thickness was variable. It is more convenient, however, for the artificial lens to have constant dimensions as in Smith's apparatus, and not variable ones as in Brewster's instrument, for when the distance which it is necessary to remove the objective from the object in order to see it distinctly is known, the calculation is readily made.

A plate of glass is placed behind the objective, and the latter removed to such a distance from the object (say a micrometer) that it is seen distinctly. Let this distance be p. The cavity containing the liquid to be examined is then placed behind the objective. In order that the eye behind the ocular Q R may clearly distinguish the micrometer image at P, it becomes necessary to remove the objective to a further point p'. Let P indicate the distance at which, in both cases, the image of the micrometer is formed behind the objective; f the focal length of the biconvex lens b; f' that of the added lens; and F the focal length which results from the combination of the two lenses.

From the law of conjugate foci

$$\frac{1}{p}+\frac{1}{\mathrm{P}}=\frac{1}{f} \quad \text{and} \quad \frac{1}{p'}+\frac{1}{\mathrm{P}}=\frac{1}{\mathrm{F}}.$$

By subtraction—

$$\frac{1}{p}-\frac{1}{p'}+\frac{1}{\mathrm{P}}-\frac{1}{\mathrm{P}}=\frac{1}{f}-\frac{1}{\mathrm{F}};$$

or

$$\frac{1}{p}-\frac{1}{p'}=\frac{1}{f}-\frac{1}{\mathrm{F}}.$$

But

$$\frac{1}{\mathrm{F}}=\frac{1}{f}-\frac{1}{f'};$$

and on substituting this value in the previous equation we have

$$\frac{1}{p}-\frac{1}{p'}=\frac{1}{f}-\frac{1}{f}+\frac{1}{f'}=\frac{1}{f'}.$$

Next let n be the index of refraction of the artificial lens, and r its radius of curvature: then as

$$\frac{1}{f}=\frac{n-1}{r},$$

we have

$$\frac{1}{p}-\frac{1}{p'}=\frac{n-1}{r}.$$

If the value of r be accurately known, it becomes easy to find the value of n:

$$n - 1 = r\left(\frac{1}{p} - \frac{1}{p'}\right)$$

$$n = 1 + r\left(\frac{1}{p} - \frac{1}{p'}\right) \quad . \quad . \quad . \quad \alpha.$$

But as in practice it is difficult to determine the exact value of r, it is better to find, not the absolute refractive index of the liquid, but that relative to a substance the refractive power of which is already known, for example, glass or water.

Let n' be the index of refraction of the comparing substance, and p'' the distance to which in this case the objective is moved from the micrometer; the formula then becomes

$$\frac{1}{p} - \frac{1}{p''} = \frac{n' - 1}{r},$$

from which

$$r = \frac{n' - 1}{\frac{1}{p} - \frac{1}{p''}} = (n' - 1)\left(\frac{1}{\frac{1}{p} - \frac{1}{p''}}\right).$$

By substituting the value of r in the equation α we get

$$n = 1 + (n' - 1)\left(\frac{1}{\frac{1}{p} - \frac{1}{p''}}\right)\left(\frac{1}{p} - \frac{1}{p'}\right),$$

or

$$n = 1 + (n' - 1)\frac{\left(\frac{1}{p} - \frac{1}{p'}\right)}{\left(\frac{1}{p} - \frac{1}{p''}\right)}.$$

But

$$\frac{\frac{1}{p} - \frac{1}{p'}}{\frac{1}{p} - \frac{1}{p''}} = \frac{\frac{p' - p}{pp'}}{\frac{p'' - p}{pp''}} = \frac{p''(p' - p)}{p'(p'' - p)} = \frac{p''}{p'}\frac{p' - p}{p'' - p} = \frac{p''p(p' - p)}{p'p(p'' - p')},$$

and the equation becomes

$$n = 1 + \frac{p''}{p'}\frac{p' - p}{p'' - p}(n' - 1) \quad . \quad . \quad . \quad \beta.$$

Where the value of n', that is the refractive index of the liquid used for comparison, is known, and the other values, that is, the distances between the objective and the object, it becomes sufficiently easy to make the required calculation.

Instead of measuring these distances, it is possible and more convenient to calculate them. In the three cases before us let us suppose these to be $g\ g'\ g''$: then when the optical arrangement remains the same, there is a constant relation between these and the focal length of

$$g\,p = g\,p' = g''\,p'' \quad . \quad . \quad . \quad \gamma.$$

In the equation β the values of $p\ p'\ p''$ may be expressed in functions of $g\ g'\ g''$ taken from equation γ.

Then

$$p'' = \frac{g\,p}{g''}\,p' = \frac{p\,g}{g'},$$

and

$$\frac{p''}{p'} = \frac{\frac{g\,p}{g''}}{\frac{g\,p}{g'}} = \frac{g'}{g''}.$$

Again,

$$p' - p = \frac{g\,p}{g} - p = p\left(\frac{g}{g'} - 1\right),$$

and

$$p'' - p = \frac{g\,p}{g''} - p = p\left(\frac{g}{g''} - 1\right).$$

By substituting in equation β these values,

$$n = 1 + \frac{g'}{g''}\,\frac{p\left(\frac{g}{g'} - 1\right)}{p\left(\frac{g}{g''} - 1\right)}\,(n' - 1),$$

or

$$n = 1 + \frac{g'}{g''}\,\frac{\frac{g}{g'} - 1}{\frac{g}{g''} - 1}\,(n' - 1),$$

from which

$$n = 1 + \frac{g'\left(\frac{g}{g'} - 1\right)}{g''\left(\frac{g}{g''} - 1\right)}\,(n' - 1),$$

and lastly,

$$n = 1 + \frac{g - g'}{g - g''}\,(n' - 1).$$

This calculation is for Brewster's instrument, in which the artificial lens is plano-concave. In Smith's apparatus, in which the lens is plano-convex, the fraction $\frac{1}{f'}$ changes sign, so that $\frac{1}{\mathrm{F}} = \frac{1}{f} + \frac{1}{f'}$.

In the two equations which express the law of conjugate foci,

$$\frac{1}{p'} + \frac{1}{\mathrm{P}} = \frac{1}{\mathrm{F}}, \quad \frac{1}{p} + \frac{1}{\mathrm{P}} = \frac{1}{f}$$

by subtraction

$$\frac{1}{p'} + \frac{1}{\mathrm{P}} - \frac{1}{p} - \frac{1}{\mathrm{P}} = \frac{1}{\mathrm{F}} - \frac{1}{f}$$

$$\frac{1}{p'} - \frac{1}{p} = \frac{1}{\mathrm{F}} - \frac{1}{f}.$$

Substituting for $\frac{1}{f}$ its value we get

$$\frac{1}{p'} - \frac{1}{p} = \frac{1}{f} + \frac{1}{f'} - \frac{1}{f} = \frac{1}{f'}.$$

Now

$$\frac{1}{f'} = \frac{n-1}{r};$$

then

$$\frac{1}{p'} - \frac{1}{p} = \frac{n-1}{r};$$

from which

$$n - 1 = r\left(\frac{1}{p'} - \frac{1}{p}\right)$$

$$n = 1 + r\left(\frac{1}{p'} - \frac{1}{p}\right) \ldots . \alpha.$$

With the liquid used for comparison the equation becomes

$$\frac{1}{p''} - \frac{1}{p} = \frac{n'-1}{r},$$

whence

$$r = n' - 1 \frac{1}{\frac{1}{p''} - \frac{1}{p}}.$$

By substituting the value of r in the equation α we get

$$n = 1 + (n'-1)\left(\frac{1}{\frac{1}{p''} - \frac{1}{p}}\right)\left(\frac{1}{p'} - \frac{1}{p}\right)$$

$$n = 1 + (n'-1)\frac{\frac{1}{p'} - \frac{1}{p}}{\frac{1}{p} - \frac{1}{p}}.$$

But

$$\frac{\frac{1}{p'} - \frac{1}{p}}{\frac{1}{p''} - \frac{1}{p}} = \frac{\frac{p-p'}{p'p}}{\frac{p-p''}{p''p}} = \frac{p''p(p-p')}{pp'(p-p'')} = \frac{p''(p-p')}{p'(p-p'')} = \frac{p''}{p}\frac{p-p'}{p-p''}$$

then

$$n = 1 + (n'-1)\frac{p''}{p'}\frac{p-p'}{p-p''} \ldots \beta'.$$

By substituting for $pp'p''$ their values in functions of $gg'g''$, and remembering that

$$gp = g'p' = g''p'',$$

and that consequently

$$p'' = \frac{pg}{g''}p' = \frac{gp}{g'},$$

we get

$$\frac{p''}{p} = \frac{\frac{gp}{g''}}{\frac{gp}{g'}} = \frac{g'}{g''}.$$

Furthermore,

$$p - p' = p - \frac{g\,p}{g'} = p\left(1 - \frac{g}{g'}\right)$$

$$p - p'' = p - \frac{g\,p}{g''} = p\left(1 - \frac{g}{g''}\right).$$

By substituting these values in the equation β' we get

$$n = 1 + (n' - 1)\frac{g'}{g''}\frac{p\left(1 - \frac{g}{g'}\right)}{p\left(1 - \frac{g}{g''}\right)}$$

$$n = 1 + (n' - 1)\frac{g\left(1 - \frac{g}{g'}\right)}{g''\left(1 - \frac{g}{g''}\right)}$$

$$n = 1 + (n - 1)\frac{g' - g}{g'' - g}.$$

In conclusion, it only remains to be said that these formulæ do not take into account certain values which, if absolute precision were required, ought to come into the calculation (distance of the objective from the artificial lens, radius of curvature of the latter, &c.). Hence these formulæ give only an approximate result, but one which is sufficient for ordinary and practical purposes.

Dr. Martinotti might we think have found many better instances to illustrate his text as to the want of novelty in sub-solar matters, as Prof. Smith's apparatus is certainly a very useful device, and one for which he is entitled to all the credit of independent invention.

DAVIS, T. S.—**New Stage Accessory.**

[Consisting of a slip of glass, from the surface of which a brass pin projects at each end. Over these pins another piece of glass, with corresponding holes drilled in it, slides, and thus objects requiring to be flattened may be conveniently secured for observation.]

16th Ann. Rep. S. Lond. Micr. and Nat. Hist. Club, 1887, p. 12.

Fasoldt's (C.) Eye-piece Micrometer.

["The lines are said to be ground in the glass, not ruled."]

Journ. New York Micr. Soc., III. (1887) p. 40.

Rogers' (W. A.) Stage Micrometer.

[In squares upon speculum metal—parts of an inch and millimetre.]

Journ. New York Micr. Soc., III. (1887) p. 40.

WINKEL, R.—**Apparat zum Markiren mikroskopischer Objekttheile.** (Apparatus for marking parts of microscopic objects.)

[Same as that described, *ante*, p. 468.]

German Patent, Kl. 42, No. 38858, 15th Sept., 1886 (1 fig.).

(4) Photomicrography.

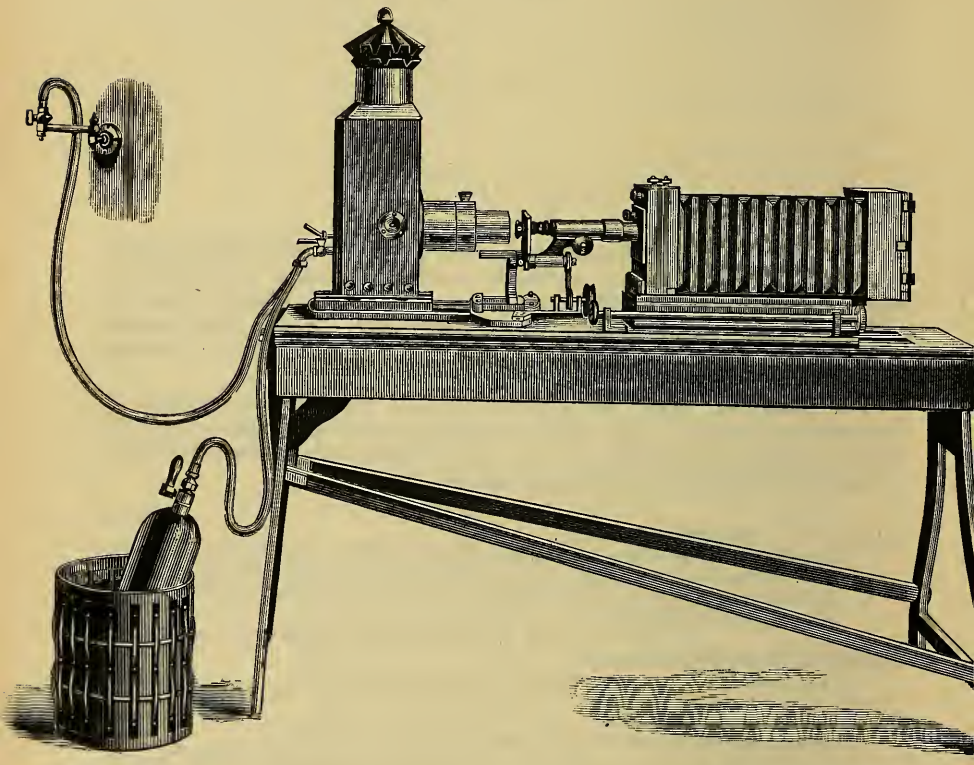
Crookshank's Reversible Photo-micrographic Apparatus.*—Dr. E. M. Crookshank's apparatus (fig. 226) consists of a camera fixed upon a base-board 4 or 5 feet in length, upon which the Microscope is clamped, and

* Journ. and Trans. Photographic Soc. of Great Britain, xi. (1837) pp. 144–52 (1 fig.). See also Crookshank's 'Photography of Bacteria,' 1887, p. 22.

which carries also an oxyhydrogen lantern. In order to photograph micro-organisms in liquids or the colony growths in gelatin which has been partially liquefied, the apparatus can be placed in the vertical position so that the stage is horizontal.

To place the apparatus in the vertical position, two small hinged brackets at the end, distant from the camera, are forced up with a smart blow of the hand. The corresponding ends of the stretcher bars are dislodged from their fittings, and allowed to descend; when horizontal, the opposite extremities of the bars are easily released from their sockets. The leg or support at this end can then be turned up and fixed underneath

Fig. 226.



the apparatus by a button, and the end of the apparatus itself gently lowered to the ground. A hinged end-piece is also to be turned out to increase the base upon which the whole apparatus will stand when raised to the vertical. The two-legged support at the opposite end of the apparatus is next worked down by a quick thread screw, and, on raising the apparatus to the vertical, the two-legged support drops to the ground, and assists in maintaining the stability of the whole. If it be thought necessary, a simple means can be readily devised for clamping the apparatus in either position to the wall of the room, so as to eliminate as much as possible all chances of vibration. A second quick thread screw moves the base-board upon which the camera

and central sliding-board are mounted, so that the camera, Microscope, and lantern can be raised to a convenient height above the ground.

The various parts of the apparatus are described more in detail as follows:—The Microscope utilized was one constructed by Zeiss, but any good stand may be adapted in the same way. The advantage of Zeiss's stand, for bacteriological photography, is that the wide stage forms a steady support for cultivations on small panes of glass coated with nutrient jelly. A mechanical stage greatly facilitates manipulation with the highest powers; but it is not indispensable, for Dr. Crookshank has taken, without the use of one, a large number of photographs, though employing, as a rule, a 1/25 hom. imm. It is most essential that the Microscope should be perfectly steady. To ensure this the horseshoe foot-piece of the Zeiss stand fits under a projecting ledge, and is then clamped by a cross-piece, so that it is firmly fixed.

The Microscope, with the means for clamping it, and the oxyhydrogen lantern are carried upon an independent sliding-board, which admits of movement to or from the camera. The sliding-board also moves upon a centre, which enables the Microscope to be turned out from the median line; in fact, to be turned at a right angle to the position it occupies when ready for the exposure. The object of this contrivance is to enable the operator to sit down by the side of the apparatus, and with comfort to arrange the object in the field of the Microscope. On turning the Microscope back into the median line, it is fixed in the optical axis of the apparatus by means of a stop. The sliding-board was originally provided with a small grooved wheel receiving an endless cord, made of silk or fishing-line, which passed round the grooved, milled head of the fine adjustment. When the sliding-board was returned to the median line of the apparatus, the milled wheel connected with the fine-adjustment impinged upon the wheel of the long focusing rod. The latter was provided with an indiarubber tyre, which gripped the teeth of the milled wheel, and thus the long focusing rod was placed in connection with the fine-adjustment. Dr. Crookshank now dispenses with this arrangement, as he believes it to be a mistake to strain the objective by having the screen at a greater distance from the object than, say, 30 inches, and with that distance of screen one can easily move the fine-adjustment with one hand, while holding the focusing glass in the other.

Of equal importance to the objective is the sub-stage condenser, and this, for the best results, must be provided with arrangements for focusing and accurate centering.

For illumination the author has chiefly employed the oxyhydrogen light, which can be used without the interposition of a mirror in either position of the apparatus. In the horizontal position a paraffin lamp may be employed by simply removing the lantern and substituting the one for the other; but to employ this illumination when the apparatus is vertical would obviously entail another arrangement. It would in this case be necessary to adjust the mirror of the Microscope and to place the lamp in such a position that the light would be reflected in the ordinary way.

If the paraffin lamp be preferred, it should be provided with a large broad wick and a metal chimney. The burner may be made to revolve, so that either the edge or the flat of the flame may be utilized. The metal chimney has an aperture in front, giving exit to the rays of light, which is closed in by a slip of glass. The glass is very liable to crack when exposed to the full force of the flame, and it is as well, therefore, to be provided with a stock of glass slips, which have been annealed by being enveloped in a cloth and boiled for two or three hours.

Dr. Crookshank has, so far, been so satisfied with the oxyhydrogen light, both for taking direct pictures and enlarging, that he has not deemed it worth while to substitute any other. He more frequently employs it than the paraffin lamp, partly on account of the diminished time in exposure, especially when employing very high powers; this is of great importance where there is likely to be vibration from passing traffic. With rapid plates and the highest powers, the exposure has only been two or three seconds, whereas, with the paraffin lamp, it may vary from three to ten minutes, or even longer.

The illuminating apparatus here shown consists of a lantern which not only moves together with the Microscope on the central sliding-board, but can be moved independently to or from the Microscope, and be clamped with screws at the requisite distance for obtaining the best illumination. The lime cylinders should be of the best quality, of hard lime. Oxygen should be supplied preferably in a compressed state in iron bottles. Not only are the bottles much less cumbrous than the bags, but a small quantity of gas can be used, and the residue left for an indefinite time, and is always at hand to be turned on when required. On the other hand, the retention of unused gas in the bags is liable to cause their corrosion, owing to the impurities which are carried over in the manufacture of the oxygen.

A half-plate camera is employed, which is mounted upon a sliding platform. This admits of the camera being pushed up to the Microscope when it is in the long axis of the apparatus, so as to make a light-tight combination. The opening occupied in an ordinary camera by the lens, can be shut off by means of an internal shutter, which is opened and closed by turning a screw at the side of the camera. The dark-back is provided with plate-carriers, so that either half, quarter, or lantern-size plates can be employed. It is found convenient to have two or more dark-backs, so that several plates may be exposed without re-arranging the light for each exposure.

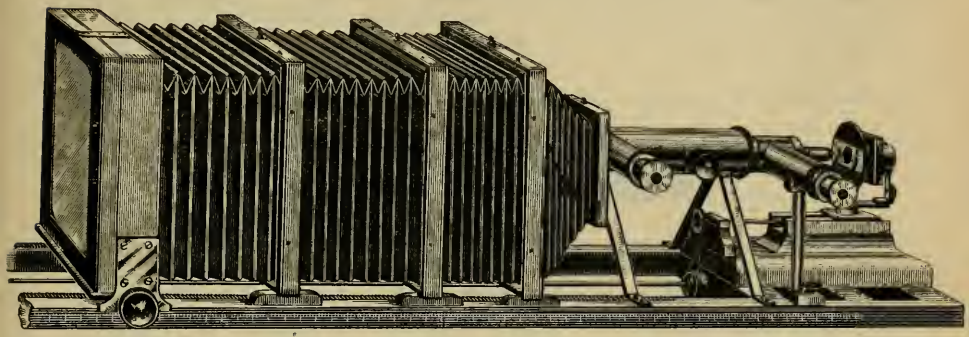
Rafter's "Professional Photo-Micro-Camera."*—Mr. G. W. Rafter criticizes a statement of the Hon. J. D. Cox that he obtained the best results in photomicrography by using a No. 1 eye-piece in the Microscope and no other amplifier. In his view the use of an eye-piece causes not only great loss of light, but also great loss of distinctness in the image. He also condemns the use of the Zeiss projection eye-pieces, on the ground that "any process that necessitates the removal of one piece of apparatus and the substitution of another in its place is for high-power work fundamentally defective," the inevitable disturbance of apparatus in making such changes leading not only to loss of time, but usually to deterioration of the negative. The author considers that the use of the simpler optical combination of the adjustable achromatic amplifier for correcting microscopic objectives when they are required to be used for projection is on the whole preferable, and hence he included in a new camera which he recently devised an arrangement for adjusting the amplifier so that the best correction of the objective can be readily obtained. After a very full exposition of the optical principles involved, the camera is described as follows:—

"In order to get such ready means of adjusting the amplifier and to

* Rafter, G. W., 'On the use of the Amplifier, With observations on the Theory and Practice of Photomicrography, suggested by the design of a new Photo-micro-camera,' sep. repr. from Rochester (N. Y.) Odontographic Journal, viii. (1887) pp. 110–44 (14 figs.).

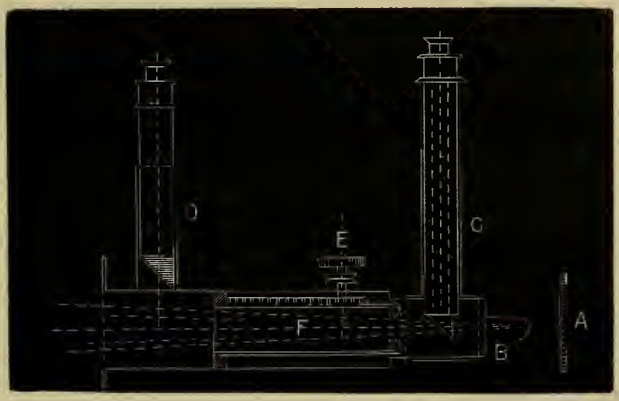
develope a photo-micro-camera which would answer all the demands which might be made upon it I have designed the apparatus shown in fig. 227. This is really a photo-micro-camera complete within itself, and not a Microscope and camera combined. I found early in my experience as a photomicrographer that one instrument could not be made to do the work

Fig. 227.



of two, and that it was only possible to use photography as a real aid to microscopical investigation by having photomicrographic apparatus which in addition to being always ready, also possessed the quality of easy adjustment to any and all kinds of work. The present design possesses not only all these qualities, but it can also be furnished at a price quite

Fig. 228.



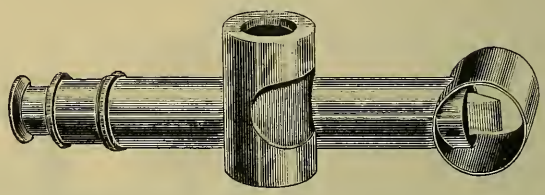
within the reach of any person really desiring such an aid to scientific investigation.

A reference to fig. 228 in conjunction with fig. 227 will show the novel points.

A in fig. 228 is the stage, B is a nose-piece which carries the objective

and also a removable collar carrying the tube C, which is supported by a removable pillar shown in fig. 227. Inside the tube C is a second tube made to work back and forth very easily, and carrying at its lower end a right-angle prism set for total reflection. This tube is of such a length as to give, when in position for receiving the image from the objective through the prism, a length of 10 in. measured along the optical axis. The eye-piece in the outer end has cross-hairs set in the diaphragm, so adjusted in relation to the prism at the other end as to correspond with cross lines on the ground glass of the camera screen. The tube C, therefore, gives

Fig. 229.



the opportunity to examine the object under the conditions of microscopic vision, and with the cross-hairs in the eye-piece farther enables the operator to exactly centre the object on the screen.

F is an adjustable tube carrying within it a second tube, which may be slid back and forth. This interior sliding tube has an adapter at the front end, into which an amplifier may be screwed, and the whole racked back and forth by the pinion E, which also carries between the thumb-screw and the body a pulley over which a band can be passed for working the amplifier from the rear of the camera screen.

This inner tube also has a graduation on the side, in order to facilitate recording the proper position of the amplifier for various extensions of the screen.

In working with high powers where it is desirable to use the amplifier, the objective is set to normal working distance by observing the object through the tube C. The operator then, from the rear of the camera, by use of the band over the pulley at E, racks the amplifier to such a position as to give a sharp and distinct image on the ground glass, the objective in the meantime remaining undisturbed. It is of course understood that after having adjusted the objective to normal working distance the inner tube at C, carrying the prism and eye-piece, has been sufficiently withdrawn to allow the rays of light to pass unobstructed to the camera screen. This gives us almost instantly the conditions which have been shown above to be necessary for production of the highest results, and with this apparatus the most difficult tests are easily photographed.

When working with low powers the amplifier is not essential for the production of sharp images, and the tube C and nose-piece B are removed by simply slipping off the collar from the nose-piece, and unscrewing the nose-piece from the body, an operation which may be performed in a moment. Fig. 229 shows these parts when detached.

After removing B and C, the inner tube F is drawn forward so that the front end of it occupies approximately the position of B when in place, and the objective is screwed into the adapter in the end of said tube F, which in high-power work carries the amplifier.

D is a second tube back of F, with prism and eye-piece with cross-wires, precisely as in C. With this tube the object is examined and centered on the ground glass, as above described, for work with C. After such centering

the focusing is completed either by use of the band passing over the pulley at E, or by use of the long rod and fine-adjustment to be described below. The inner tube at D is shown as drawn back in such position as to allow the rays of light to pass unobstructed to the screen.

The camera itself has both bellows and base made in sections, each two feet in length. The sections of the bellows can be readily removed, or additional sections inserted, when greater extension is required. . . .

The plate and screen-holder is racked back and forth as clearly shown in fig.

On the side of the base is a graduation in feet, tenths and hundredths of a foot, which enables one to record positions of the screen for producing given magnifications easily.

The fine motion is communicated to the stage, and not to the objective, as is shown in fig. 227.

The camera, as shown in the fig., admits of an extension of 8 feet, and sections of base and bellows similar to those above described can be added, extending it almost indefinitely. The extension above given will, however, answer all ordinary demands.

In its present form the camera takes a $6\frac{1}{2} \times 8\frac{1}{2}$ plate, and all sizes less than that down to the smallest.

This apparatus has been specially designed with reference to doing photo-micrographic work of a high character with the greatest possible economy of time. It is for this purpose that the second prism-tube has been added specially for low-power work without the amplifier, and I have no difficulty in making with this camera a half dozen negatives in an evening, when working with lamplight and the amplifier, or from eight to ten in the same time when working with low powers and without the amplifier, in each case doing my own developing. In working by sunlight, where much shorter exposures are required, the same length of time gives an additional amount of work.

In case one has an extra Microscope, the new apparatus for working the amplifier may be adapted to it at moderate expense, and, by construction of the bellows and extension arrangements as above described, the more important advantages of the camera gained.

I desire, however, to put myself on record as opposed to the combination instruments—those which are to be used for microscopy ordinarily, but which can be, when one has something worth photographing, for the time being transformed into a camera. The trouble with all such instruments is, they have in general failed to do satisfactory photomicrographic work.

For rapid work the camera should be placed on a shelf on one side of the room at such a height as to bring the horizontal prism-tubes level with the operator's eye. The position of the camera at one side of the room insures economy of space, and does away with the objection that the camera, even though of considerable size, takes up much room.

When it is intended to work by lamplight only it will not matter which side of the room is used for this purpose, and the operator may locate the camera to suit his surroundings ; care must be taken, however, to have the graduation of the base on the side away from the wall. If one has plenty of room, the best arrangement would of course be to erect a shelf on horses in the middle of the room, so that the camera is accessible on both sides.

When it is intended to work by sunlight the camera must of necessity be at either the east or west side of a room with an exposure to the south, or when economy of space is of no importance, it can be conveniently placed in front of a window facing the south, in which may be fitted up the necessary arrangements for heliostat, mirrors, or condensing lens.

In any case, the surroundings will decide to some extent just what arrangement will be adopted.

The following are, so far as I know, the new features embodied in this camera :—

(1) The application of specific appliances for moving the amplifier back and forth, in order to find by trial, for any given extension of the camera, the best position of the amplifier for projecting the image upon the screen.

(2) The application of two horizontal prism-tubes, one for use with high powers and the amplifier, and the other for use with low powers without the amplifier.

(3) The detachable nose-piece and prism-tube for high powers only (fig. 228).

(4) The cross wires in the diaphragm of the eye-piece of the prism-tube, giving an immediate centering of the object on the camera screen.

(5) The making of the bellows in sections in such manner as to admit of their easy removal or of a ready indefinite extension.

(6) The making of the base in sections in combination with the focusing-rod, connected by an automatic coupling.

(7) The plate-holder, which admits of all sizes of plates, from the maximum of $6\frac{1}{2} \times 8\frac{1}{2}$ to the smallest, without the use of kits.

Another new feature, which, however, is not specifically claimed, is this : If one has a prejudice in favour of photographing with an eye-piece, or if, from motives of economy, one desires to dispense with the amplifier and work with the eye-piece, this may be done by simply inserting an eye-piece in the back end of the amplifier-tube. For so working, an adjustable nose-piece for carrying the objective without the high power prism-tube may be furnished, thus dispensing with one of the prism-tubes, which, however, can be added at any time by change of nose-pieces. The object can be still centered by the posterior prism-tube, which is permanently fixed to the body, and the projection of a sharp image upon the screen completed by moving the eye-piece with the pinion E (fig. 228).

The general claim is made, therefore, that this camera embodies more nearly all the conditions necessary for rapid and successful work than anything heretofore produced. I have no doubt, however, but that a very considerable improvement can still be made, and confidently expect, in view of the great interest now centering in photomicrographic work, that the next few years will develope such improvements."

It should be added that the author is not unmindful of his obligations to the photomicrographic Microscope of Nachet,* as he says, " The novel point of this camera is the use of the prism-tube somewhat as I have arranged it in my camera, and I very willingly acknowledge my indebtedness to M. Nachet for the suggestion. He has, however, used the tube vertical, and as a fixed part of the apparatus."

Hartnack's Cupro-ammonia Cell.†—Dr. E. Hartnack has ingeniously modified the form of this cell, so as to enable a thicker or thinner stratum of the blue fluid to be used at pleasure in photomicrography, thus varying the illumination according to the requirements of the particular object.

The apparatus consists of two ebonite rings, each closed on one side by a parallel plate of glass. The rings slide in one another (hermetically), and when pushed together part of the liquid is forced into a lateral reservoir, from which it is drawn again when the rings are separated.

* See this Journal, 1886, p. 840. † Journ. de Microgr., ix. (1885) p 366.

Cox, C. F.—**Remarks on Photomicrography.**
[Principally as to letting the negatives alone after they are taken.]
Journ. New York. Micr. Soc., 1887, pp. 18–9.

H., G. M.—**A simple Photographic and Photomicrographic Apparatus.**
Engl. Mech., XLV. (1887) p. 503 (12 figs.), from *Scientific American.*

King, Y. M.—**The Photomicrography of Histological Subjects.**
New York Med. Journ., II. (1887) pp. 7–11.

Photo-Microscopy. I., II. *Charterhouse Phot. Art. Journ.*, I. (1887) pp. 2–4.

Roux, E.—**La Photographie appliquée à l'étude des microbes.** (Photography applied to the study of microbes.) *Ann. de l'Institut Pasteur*, 1887, pp. 209–25.

(5) Microscopical Optics and Manipulation.

Limit of Visibility.—In his Presidential Address at the Manchester Meeting of the British Association, Sir H. Roscoe appears to have fallen into a not unimportant mistake with regard to the smallest dimensions which can be distinguished by the Microscope.

In dealing with atoms he said:—

"Next let us ask what light the research of the last fifty years has thrown on the Daltonian atoms: first, as regards their size; secondly, in respect to their indivisibility and mutual relationships; and, thirdly, as regards their motions.

As regards the size and shape of the atoms, Dalton offered no opinion, for he had no experimental grounds on which to form it, believing that they were inconceivably small and altogether beyond the grasp of our senses aided by the most powerful appliances of art. . . .

But modern research has accomplished, as regards the size of the atom, at any rate to a certain extent, what Dalton regarded as impossible. Thus, in 1865, Loschmidt, of Vienna, came to the conclusion that the diameter of an atom of oxygen or nitrogen was 1/10,000,000 part of a centimetre. *With the highest known magnifying power we can distinguish the* 1/40,000 *part of a centimetre;* if now we imagine a cubic box each of whose sides has the above length, such a box when filled with air will contain from 60 to 100 millions of atoms of oxygen and nitrogen. A few years later William Thomson extended the methods of atomic measurement, and came to the conclusion that the distance between the centres of contiguous molecules is less than 1/5,000,000 and greater than 1/1000,000,000 of a centimetre; or, to put it in language more suited to the ordinary mind, Thomson asks us to imagine a drop of water magnified up to the size of the earth, and tells us that the coarseness of the graining of such a mass would be something between a heap of small shot and a heap of cricket-balls. Or, again, to take Clifford's illustration, you know that our best Microscopes magnify from 6000–8000 times; a Microscope which would magnify that result as much again would show the molecular structure of water. Or again, to put it in another form, if we suppose that the minutest orgauism we can now see were provided with equally powerful Microscopes, these beings would be able to see the atoms."*

Microscopists will readily recognize that the 1/40,000 of a centimetre —which is approximately 1/100,000 of an inch—is vastly too low a figure, which should be at least 5 times smaller. Dr. Royston-Pigott claims to have seen the 1/1,000,000 of an inch, but, whether he has or not, it is certain that the 1/500,000 of an inch has been distinctly recognized. Moreover, Sir Henry himself, as will be seen, states that a power of 8000 times is attainable "with our best Microscopes"; multiply 1/100,000 in.

* Cf. Nature, xxxvi. (1887) p. 417.

by 8000, and we get nearly 1/12 in., which it is obviously absurd to put as the limit of visibility in the microscopic image.

The difference does not affect Sir H. Roscoe's argument, for the capacity to see even the 1/1,000,000 of an inch would still leave us far from the point when atoms would be visible, but we call attention to his statement because, coming from so high an authority as a President of the British Association, it may give rise to a serious misapprehension as to the powers of the Microscope of the present day.

Heath's 'Geometrical Optics.'*—Measure of the Aperture of the Microscope.—Dr. R. S. Heath's book is, we believe, the first English treatise on optics in which aperture is dealt with. The following is the author's treatment of the subject:—

It has been shown that the brightness of an image given by a Microscope is determined by the formula

$$I = I_0 \frac{\lambda^2}{p^2} \cdot \frac{u^2 \sin^2 a}{m^2},$$

where λ is the conventional image distance, p the radius of the pupil of the eye, m the magnifying power, and a the divergence of the cone of rays proceeding from the object in a medium whose refractive index is u. Thus for an instrument of given magnifying power,

$$I \propto (u \sin a)^2,$$

and accordingly, $u \sin a$ may be taken to be the numerical measure of the aperture.

This measure of the aperture may be expressed in terms of the focal length of the objective, and diameter of the pencil passing through it. The diameter of the pencil as it passes through the object varies from the first to the last surface. We shall suppose that the diameter is taken at the back surface of the objective as the pencil emerges from it. This will be so close to the second principal focus of the objective in microscopic objectives of the ordinary type of construction, that the difference in the distance may be disregarded. We shall therefore suppose that b is the semi-diameter of the pencil at the second focal plane of the objective, and that f is the focal length of the objective. Let u' be the distance of the image from the second principal focus; then, using the ordinary notation,

$$\frac{\beta'}{\beta} = -\frac{u'}{f}.$$

Also by Helmholtz's theorem, we have

$$u \beta \sin a = u' \beta' \sin a',$$

and therefore

$$u \sin a = u' \frac{\beta'}{\beta} \sin a'$$

$$= -\frac{u'}{f} u' \sin a'.$$

The angle a' is always very small in Microscopes, never exceeding a few degrees, and therefore $u' \sin a'$ will not differ sensibly from $u' \tan a'$. But $b = -u' \tan a'$, and therefore

$$u \sin a = \frac{u' b}{f}.$$

* Heath, R. S., 'A Treatise on Geometrical Optics,' xvii. and 356 pp., figs., 8vo, Cambridge, 1887, pp. 294–6.

The last image is always formed in air, so that $u' = 1$, and therefore finally

$$u \sin a = \frac{b}{f}.$$

This numerical measure of the aperture may be justified by general reasoning. Other things being equal, it is clear that the numerical measure of the aperture ought to vary as the diameter of the pencil. Next suppose we have objectives of the same diameter of opening, but of different focal lengths. Imagine rays traced backwards through the two objectives in succession from the same object. The incident rays are nearly parallel, and since the openings of the objectives are the same, they will admit backwards the same number of rays. But these rays will be concentrated to a smaller area by the lens of shorter focal length than by the other, the linear dimensions of the areas varying as the focal lengths, but their brightness being the same. Reverting to the original arrangement of the instrument, the objective of shorter focal length will admit the same number of rays from the smaller area as the other will admit from the larger area. The real aperture of the former is therefore greater than the other in the inverse ratio of their focal lengths.

The value b/f is independent of the medium in which the object is placed; it is the same for air, water, balsam, or any other immersion system. A numerical aperture *unity* would correspond to an incident cone of rays in air whose vertical angle is 180°, while with homogeneous immersion the same aperture would correspond to a cone of angle 82° 17′; and with modern objectives the apertures reach 1·40, and sometimes more than this.

The magnifying power of an objective may be measured for a definite position of the image by projecting the image of a stage micrometer upon an eye-piece micrometer. And then we can find the numerical aperture of the objective by means of the formula

$$u \sin a = \frac{m b}{u'}.$$

An auxiliary Microscope may be focused to the focal plane, and the linear diameter $2b$ of the emergent pencil measured there; then we have only to measure u', the distance of the focal plane from the image to which m refers, and we have the means of finding the value of $u \sin a$.

Conversely, if we know the numerical aperture, the focal length of the object-glass may easily be measured; for using the formula

$$u \sin a = \frac{b}{f},$$

we have only to measure micrometrically the diameter $2b$ of the pencil as it emerges at the principal focal plane.

Binocular Vision with the Microscope.—It will be remembered that Prof. Abbe a few years back startled microscopists by the statement * that the action of the binocular Microscope was quite different from ordinary vision, a view which produced an energetic protest from the late Dr. Carpenter,† who had not, however, apprehended the point of Prof. Abbe's argument, which was left untouched. In the last volume of the Encyclopedia Britannica ‡ we observe that Prof. J. G. M'Kendrick (under the head of "Stereoscope") very tersely sums up the result of the controversy (if it can be so called) as follows:—

* See this Journal, 1884, p. 20.
† Ibid., p. 486.
‡ Ency. Brit., xxii. (9th ed. 1887) p. 541.

"Prof. Abbe shows, however, that 'oblique vision in the Microscope is entirely different from that in ordinary vision, inasmuch as there is no perspective, so that we have no longer the dissimilarity which is the basis of the ordinary stereoscopic effect, but an essentially different mode of dissimilarity between the two pictures.' In the Microscope there is no perspective foreshortening. There is no difference in the outline of an object viewed under the Microscope by an axial or by an oblique pencil. There is simply a lateral displacement of the image—an entirely different phenomenon to that which occurs in non-microscopic vision. Thus, whilst the mode of formation of dissimilar pictures in the binocular Microscope is different from the production of ordinary stereoscopic pictures, the brain mechanism by which they are so fused as to give rise to sensations of solidity, depth, and perspective, is the same."

HANKS, H.—**Errors likely to occur in Microscopical Observations.**
[(Abstract only). "The hemispherical bosses upon certain diatoms are persistently seen by some as cup-shaped depressions or concavities."]
Report of Proceedings of San Francisco Micr. Soc., July 13th, 1887.

Magnifying-power of Objectives, Measurement of.
[Further letters by F. R. Brokenshire and F. J. George.]
Engl. Mech, XLV. (1887) pp. 540, 561–2.

MARSHALL, W. P.—**On the measurement of the magnifying power of Microscope Objectives**; with exhibition of 1/25 in. water-immersion objective of Powell and Lealand.
[Camera lucida method.] *Midl. Natural.*, X. (1887) pp. 226–8.

POLI, A.—**I recenti progressi nella Teoria del Microscopio.** (Recent progress in the theory of the Microscope.)
25 pp. 8vo, Firenze, 1887. (Sep. repr. from *Rivista Scientifico-Industriale.*)

ROYSTON-PIGOTT, G. W.—**Microscopical Advances. XXII., XXIII.**
[Diffraction ancient and modern—Insects' scales.]
Engl. Mech., XLV. (1887) pp. 547–8; XLVI. (1887) pp. 1–2 (3 figs.).

(6) Miscellaneous.

Royal Microscopical Society of the Sandwich Islands.—In 1878* we referred to the establishment of this Society by King Kalakua, a Society which we gather has now ceased to exist. This would appear to be the case from a report of a recent meeting of the San Francisco Microscopical Society, where Prof. F. L. Clarke, of Honolulu, is stated to have "given an interesting account of microscopical matters in the Hawaiian Islands," and in the course of which he "narrated the career of the Microscopical Society which once existed there." The king is now desirous to perfect arrangements for the systematic exploration and study of the natural history of the islands, and in pursuance of this plan the San Francisco Society is to be plentifully supplied with collections of objects suitable for microscopical investigation, and it has been "selected as an agent for the distribution of such material to societies with similar aims in other parts of the world."

Curiosities of Microscopical Literature.—A recent paper† on "Mounting Media, so far as they relate to diatoms," may certainly be ranked amongst the curiosities of microscopical literature, and we are at a loss to understand how it came to be printed. We quote below in full that part of the paper which is headed "Fluids" and it will be seen that the author begins by the statement that he "cannot too emphatically condemn" certain media, such as biniodide of mercury and iodide of potassium, "simply from "the fact that the diatoms will not remain on the cover-glass, but must "necessarily fall to the bottom of the cell." This, to begin with, was a most astounding statement to make after all that has been said on the subject,

* See this Journal, 1878, p. 152.
† Journ. Quek. Micr. Club, iii. (1887) pp. 108–14.

but it is made even more surprising when we come upon the statement lower down in the paper, "I have never seen a slide of diatoms mounted "in biniodide of mercury and iodide of potassium," so that the cannot-be-too-emphatic condemnation of the medium with which the author began was not founded on any practical experience whatever.

The climax, however, is not yet reached, for in a footnote the author, it will be seen, states that he has now learnt that the diatoms will *not* fall to the bottom of the cell, as he had asserted, but will float and press upwards against the cover-glass!

The following is the paragraph:—

> "*Fluids.*—Although certain of these media, such as biniodide of mercury with iodide of potassium, as well as oil of cassia, can be obtained with fairly high refractive indices, yet I cannot too emphatically condemn them for use with the higher powers of the Microscope, simply from the fact that the diatoms will not remain on the cover-glass, but must necessarily fall to the bottom of the cell, which consequently must be very shallow, otherwise the diatoms will be beyond the focus of the objective. With shallow cells in fluid mounts the diatoms can easily get crushed on cleaning the cover-glasses. If it were not for these fatal objections, I should be disposed to regard oil of cassia very favourably as a mounting medium, as these essential oils give great brilliancy; but whether they can be effectually sealed for a permanency I cannot say. I once mounted a slide in oil of cloves, and it remained perfect for some considerable time, but eventually a bubble made its appearance. I have never seen a slide of diatoms mounted in biniodide of mercury and iodide of potassium, and am inclined to think that this medium is very little used.
>
> [Since writing the above I have learnt, with respect to the solution of biniodide of mercury and iodide of potassium, that the medium is of such high specific gravity—viz. 3·02—that any diatoms which may chance to become detached will float in the fluid and press upwards against the covering-glass, instead of falling to the bottom of the cell."]

The paragraph headed "Canada Balsam" is, however, still more wonderful than the preceding, as the author makes this statement:—"The only "objection, to my mind, against this medium is that its refractive index "is not sufficiently high for the new immersion lenses"! Let us put the refractive index of Canada balsam at its lowest limit and call it 1·52, where are these new immersion lenses which, according to the author, have a higher "refractive index"? The simple explanation no doubt is that the author was quite unaware of the principle on which the use of media of high refractive index depends, but that does not make it any the less lamentable that such matter should have been presented in a scientific paper to a Microscopical Society at the present day.

"A Quekett Club-Man."—**My Microscope and some Objects from my Cabinet.** A simple introduction to the study of the "infinitely little."
78 pp., 5 figs., 8vo, London, 1887.

American Society of Microscopists—Pittsburgh Meeting.
Amer. Mon. Micr. Journ., VIII. (1887) pp. 156–7.
Microscope, VII. (1887) pp. 248–50, 269–74.

Dallinger, W. H.—**The Marvels of Microscopy.**
[Presidential Address to Devonshire Association for the Advancement of Science, Literature, and Art.]
Western Daily Mercury, 17th July, 1887.

Mayall, J., jun.—**Conférences sur le Microscope.** (Lectures on the Microscope.) (*Contd.*)
[*Transl.* of the Cantor Lectures.]
Journ. de Microgr., XI. (1887) pp. 240–6 (1 fig.), 269–75 (2 figs.), 335–41 (9 figs.).

β. Technique.*

(1) Collecting Objects, including Culture Processes.

Solid Medium for the Culture of Micro-organisms.†—Dr. Schenk recommends the outer layers of the white of the eggs of marsh fowl and waders as a suitable medium for breeding micro-organisms, on account of its great transparency when coagulated at temperatures of 65°–70° C. This albumen can be diluted with a fourth of its volume of water before coagulation, and can be mixed with salt, dextrin flour, sugar, glycerin, &c. Of course discontinuous sterilization must be employed as usual.

New kind of solid Blood-serum—Blood-serum Plates.‡—Dr. P. G. Unna states that by the addition of peroxide of hydrogen and carbonate of soda to blood-serum he produces a fluid which coagulates at a high temperature, can be easily sterilized, and preserves its transparency and suitability as a nutritive medium for micro-organisms.

The procedure is as follows:—To a small quantity of calf's blood-serum hydrogen peroxide is added drop by drop, and the mass kept agitated until the brownish-yellow mixture clears up and assumes quite a white colour. The quantity of peroxide of hydrogen added is equal to about half the volume of the serum, and as the commercial fluid is acid, a 2 per cent. solution of sodium carbonate must be added until a slight alkalinity is perceived. It is then filtered until quite clear. The serum is then solidified in Koch's apparatus at a temperature of 90°–120°, according as less or more peroxide and carbonate have been added. The condensation water having been poured off, discontinuous sterilization is continued until sufficient.

For serum plates the author adds 10 per cent. gelatin or 6 per cent. agar-agar to the mixture if the blood-serum have lost its susceptibility to coagulate owing to an excessive addition of alkali.

Preserving cultivations made by Koch's plate method.§—Dr. C. Garré removes a piece of gelatin 2–5 sq. cm. in size, and in which is the colony to be transplanted to a slide, with a thin moistened knife. Should the gelatin layer roll up, it is to be immersed in water, and then the piece is dried under a bell-jar or in a sulphuric acid apparatus until it is reduced to one-half or one-third its original volume. A drop of glycerin-gelatin fluidified at a gentle heat is then added in order to prevent the gelatin tablet from crumpling up. The cover-glass is next imposed.

This manipulation must be carefully carried out, otherwise the colonies, especially if luxuriant, might be damaged. As the drying stops development the organisms may be fixed in any stage of their existence; the colonies do not undergo any change with keeping, and, if desired, by merely removing the cover, they are always available for cover preparations or pure cultivation.

Modification of Koch's plate method for the isolation and quantitative determination of Micro-organisms.‖—Dr. E. Esmarch's modification simply consists in the use of a test-tube, the interior of which is covered with a layer of some nutritive medium, e. g. gelatin. The test-tube, the mouth being covered with a rubber cap, is laid horizontally on a vessel filled with ice-cold water, and turned round with the hands until the gelatin has set.

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

† Allgemein. Wiener Med. Ztg., xxxii. (1887) p. 214.

‡ Monatshefte f. pract. Dermatologie, v. (1886) No. 9.

§ Fortschr. d. Med., iv. (1886) p. 392. ‖ Zeitschr. f. Hygiene, i. (1886) p. 293.

When developed the colonies may be examined with low powers, and even photographed. Individual colonies may also be taken out for further examination. The estimation of the number of germs is made in the ordinary way. The enumeration of the colonies may be made by placing a piece of paper divided into parts of a centimetre and multiplying the number in a given square by the superficies, or a special apparatus devised by the author may be used.

If instead of gelatin agar be desired, it is advisable to add to each 10 cm. of agar 2 or 3 drops of a neutral sterilized solution of gum arabic or isinglass. If anaerobic bacteria are to be studied, the central space must be filled with gelatin while the tube is still in the ice-water.

The advantages of this method over the ordinary plate cultivation are its safety against impurities, the simplicity and rapidity of its execution, the small amount of apparatus, and its facility of transport.

Bacteriological experiments with coloured nutrient media.*—It is well known, says Dr. A. Spina, that indigo-blue turns white when acted on by reducing agents, and recovers its former colour on exposure to the air. It was this property which induced the author to make some experiments in order to ascertain if it could not be made available for cultivation research.

A test-tube was half filled with the following solution:—0·5 phosphate of potash, 0·5 sulphate of magnesia, 1·0 tartrate of ammonia, and 100 distilled water; and this stained with two or three drops of a watery solution of sulphindigotate of soda. The coloured fluid was inoculated with some drops of putrid blood, the test-tube plugged with cotton wool, and incubated at 38°. After three or four days the fluid was decolorized, and the bacteria much augmented in number. The nutrient medium acquired the appearance of thin milk, and only on the surface was a blue layer evident. If the tube was shaken the fluid became blue again, and white when put in the incubator again. Methylen-blue behaves in a manner quite similar.

The objection might be raised that the loss of oxygen was due, not to the bacteria, but to the nutrient medium. That this is not the case the following experiments prove:—(*a*) If a test-tube filled with the coloured medium be inoculated, and after having been decolorized in the incubator, and then sterilized, it rapidly becomes blue, but no further decoloration ensues, although it remains several days in the incubator. (*b*) If a test-tube filled with the coloured medium, and having been sterilized, be kept for a week at a temperature of 38°, no decoloration of the fluid takes place. Experiment also shows that the loss of oxygen was not produced by means of the chemical products of the proliferating bacteria. It was remarked before that shaking or warming restored to the decolorized fluid its original hue. This is explicable only on the assumption that the white methylen-blue or indigo takes up oxygen, and the correctness of this view is shown by the following experiment:—A glass tube filled with the stained and inoculated fluid is melted up at the open end after all air has been expelled, and decolorized in the incubator. In this case shaking will not bring back the blue colour.

From fluid the author passed to solid media, of which he employed two—(1) meat-peptone-gelatin and (2) meat-peptone-agar. A weak solution of the former, stained and inoculated, and kept at a temperature of 22°, became decolorized below the colony in about three days. (The bacteria used were developed on potato, and from the air, but no name is given.) In a few days the decolorized column was quite large, but at the surface the layer in con-

* Centralbl. f. Bacteriol. u. Parasitenk., ii. (1887) pp. 71–5.

tact with air still blue. When the tube was shaken up, the whole of the fluidified gelatin became blue. The return of the blue obviously depended on the inclosed air, for it disappears almost completely if the fluid be kept from contact with air by pouring oil over it. (2) Meat-peptone-agar possesses an advantage over the foregoing in that it does not reduce the methylen-blue. For staining, one-third of a tube full of this medium with two drops of a watery sterilized concentrated solution of methylen-blue were employed. After sterilization and inoculation with the potato-grown bacillus, there appears, after about three days at a temperature of 22°, a decoloration of the superficial layers of the agar, and this in six days amounts to about 1·5 cm., while the colony itself seems slightly blue. The loss of colour proceeds more rapidly than the growth of the vegetation, and the decolorized gelatin is, as is shown by microscopical examination and inoculation, free from bacteria.

Numerous bacteria were found to be incapable of reducing either of the dyes, and the author believes from this that he has hit upon a way of ascertaining certain chemical relations between bacteria and nutrient media.

Heydenreich, L.—**Sterilisation mittels des Dampfkochtopf (Papin'scher Topf) für bacteriologische Zwecke.** (Sterilization by the steam digester (Papin's digester) for bacteriological purposes.)

[The author finds that a nutrient fluid placed close to the source of heat, in the water, quickly acquires the surrounding temperature of the superheated steam, if only the walls of the glass vessels be not too thick, the air as far as possible removed, and the quantity of the nutrient fluid not too great. And also that as no bacteria or fungi can withstand steam at a temperature of 120° for 5–10 minutes, it may therefore be considered that 15–20 cc. of fluid is safely sterilized if the thermometer keeps at 120° for 5–10 minutes, and if the air has been previously carefully removed (the manometer marking two atmospheres.)]

Zeitschr. f. Wiss. Mikr., IV. (1887) pp. 1–24 (4 figs.).

Kellicott, D. S.—**Notice of some Fresh-water Infusoria, with remarks on collecting and preserving these delicate animals.**

Microscope, VII. (1887) pp. 225–33 (4 figs.).

Nasmyth, T. G.—**Methods for cultivation of micro-organisms from water.**

Sanit. Record, 1887–8, pp. 16–9.

Rohrbeck, H.—**Ueber störende Einflüsse auf das Constanthalten der Temperatur bei Vegetationsapparaten und über einen neuen Thermostaten.** (On disturbing influences on the constancy of the temperature in culture-apparatus, and on a new thermostat.)

Centralbl. f. Bacteriol. u. Parasitenk., II. (1887) pp. 262–5, 286–90 (3 figs.).

Vignal, W.—**Sur un moyen d'isolation et de culture des microbes anaérobies.** (On a method of isolation and culture for anaerobic microbes.)

Ann. Instit. Pasteur, 1887, pp. 358–9.

Wilfarth, H.—**Ueber eine Modification der bacteriologischen Plattenculturen.** (On a modification of the bacteriological plate-cultures.)

Deutsche Med. Wochenschr., 1887, pp. 618–9.

Zäslein, T.—**Ueber den praktischen Nutzen der Koch'schen Plattenculturen in der Choleraepidemie des Jahres 1886 in Genua.** (On the practical use of Koch's plate-cultures in the Genoa cholera epidemic of 1886.)

Deutsche Medicinische Ztg., 1887, pp. 389–91.

(2) Preparing Objects.

Methods for killing Invertebrata.*—For the preservation of animals, Prof. F. E. Schultze points out, it is desirable that they should seem as lifelike as is possible, or that no changes should occur to prevent them from being useful for fine microscopical work. Care must be taken to fix the animal in the extended condition, and to prevent the tendency to contrac-

* Tageblatt 59 Versamml. Deutscher Naturf. u. Aerzte, 1886, pp. 411–4. Cf. Biol. Centralbl., vi. (1887) pp. 760–4.

tion. To effect this two methods are in vogue; the one acts with rapidity sufficient to prevent contraction, the other kills slowly by means of some paralysing medium. Absolute alcohol, osmic acid, sublimate solution, chromic acid, and other mineral acids are agents of the rapid process.

Paralysis is produced by slow cooling, or gradual warming, or even by immersion in boiling water; but good service is rendered by alcohol chloroform in watery solution or vapour, sulphuric ether, prussic acid, carbonic acid, atropin, nicotin, strychnin, chloral hydrate, cocain. As suitable reagents for some of the divisions of the Invertebrata, the following are recommended:—

Rhizopoda.—For rapid fixation, osmic acid, and after-treatment with picrocarmin, or absolute alcohol, sublimate, and chromic acid. Chinin in weak solution produces palsy of the protoplasm.

Infusoria.—For paralysing ciliary action, chloroform, soda or seltzer water. For killing quickly, osmic acid, sublimate, absolute alcohol, or chloral hydrate. Keeping animals alive but paralysed, salt solution. Regulated compression under cover-glass for purposes of observation effected by melting away wax supports with heated needles.

Spongia and Cœlenterata.—For sponges no reliable method is known. For Hydromedusa, Scyphomedusa, and Ctenophora, the rapid action of osmic acid. At Naples, polyps are killed rapidly with success by a boiling mixture of equal parts of sublimate and acetic acid. With Siphonophora, paralysing with chloral hydrate is excellent. For Pennatulida with large polyps the gradual addition of fresh water. For histological work, Anthozoa may be paralysed with chloral, but this, like cocain, sometimes gives rise to contraction and deformity. For museum specimens, Anthozoa should be killed suddenly as with glacial acetic acid.

Echinodermata.—Casting of the arms may be avoided by imbedding star-fish in sand. The colour of star-fishes may be retained by immersing them for about 6 hours in Wickersheimer's solution.

Worms.—Some alcohol poured on the surface of the water in which the worms are, or chloroform water, acts as a paralysing agent. Warm solution of corrosive sublimate or picro-sulphuric acid. Nemertines remain extended in chloral hydrate, yet much depends on the degree of concentration of the paralysing fluid. Sudden heating over the flame of a spirit-lamp kills Trematoda. For Polychæta, alcohol. It is very difficult to obtain Rotifera in the extended condition. Carbonic acid water, chloral hydrate, cocain, followed by hardening in osmic acid or cocain solution cooled in ice, all recommended. On Bryozoa the last named medium has the same effect; chloral is not always satisfactory for the marine forms.

Mollusca.—Hot water for fixation. For slugs, tobacco smoke or concentrated sublimate may be used. Chromic acid should be altogether avoided as it renders them too brittle.

Tunicata.—Large animals are killed by passing a glass tube into the two openings and then injecting glacial acetic acid, alcohol, or Kleinenberg's fluid. Small species may be killed by pouring some alcohol or Kleinenberg's fluid and spirit on the top of the water.

Influence of reagents on the Fertilization and Segmentation of the Animal Ovum.*—Drs. O. and R. Hertwig who have previously demonstrated that the ova of the sea-urchin became weakened by immersion in sea water, and therefore became more susceptible to hybridization or polyspermia, i. e. to the penetration of several spermatozoa, now discuss the

* Jenaische Zeitschr. f. Naturwiss., xx. (1887) pp. 120–4 (7 pls.).

effect of various chemical reagents of higher temperature, and of mechanical injury on the ova of *Strongylocentrotus lividus*, and also the effect of external agents on the sperma.

(1) Ova before fertilization. (*a*) Nicotin. A mixture of one drop of concentrated nicotin solution with 100 grms. sea water acting for 3–5 minutes, or with 1000 grms. sea water acting for 10–15 minutes. By stronger solutions or by longer immersion the degree of over-fertilization can be increased. By immersion for one hour in a solution of 1 : 100 the ova were not killed. (*b*) Morphia hydrochlorate solutions of 0·1–0·2 per cent. must act for one hour. Solutions of 0·4–0·6 per cent. produced after 1/2–1/4 hour a few cases of polyspermia. (*c*) Strychnine. Solutions of 0·005 per cent. produced a notable influence in 10 minutes, a remarkable one in 20 minutes. Solutions of 0·1 per cent. in 5 minutes effected strong polyspermia; in solutions of 0·25 the ova died in 25–60 minutes. (*d*) Chloral hydrate. A 0·2 per cent. solution produced polyspermia in 4½ hours, while a 0·5 per cent. solution did so in 5 minutes, but after 4 hours the ova did not seem susceptible of fertilization. (*e*) Chloroform (the eggs placed in watch-glasses filled with sea water were exposed to the vapour of chloroform under bell-jars). The ova died in 15–20 minutes, a shorter time produced polyspermia. Chloroform water (chloroform shaken up with sea-water) prevented fertilization, the membrane immediately separating from the ovum. (*f*) Cocain. Solutions of 0·025 and 0·05 per cent. produced polyspermia in 5 minutes. A longer action weakened the ova too much. (*g*) Chinium sulfuricum. A solution of 0·005 per cent. produced perfect polyspermia in 75 minutes; in a shorter time the action was correspondingly less. A solution of 0·05 per cent. produced in 10 minutes and still more so in 15 minutes, very considerable polyspermia.

(2) Sperma before fertilization. (*a*) Nicotin. In solutions ten times as strong as used for ova the spermatozoa were mobile and quite fertile after two hours. (*b*) Chloral hydrate. In 0·5 per cent. solution motion ceased in 5 minutes, but returned on addition of fresh sea water even after 35 minutes' action of the solution, and were fertile. (*c*) Chinin. A 0·05 per cent. solution produced diminution after 5 minutes, and in 35 minutes cessation of movement. When the water was changed the motion only returned slowly and with imperfect fertilization of ova. (*d*) Strychnine. A 0·05 per cent. solution had a retarding influence after acting for 3 hours. (*e*) Morphia. A 0·5 per cent. solution seemed to have no influence. Fertilization was normal after 3/4 hour.

(3) Influence of chemical agents on the course of fertilization. Chinin and chloral diminished the radiation appearances in the protoplasm considerably, and hence inhibited the progress of the internal fertilization appearances. (*a*) The authors immersed the fertilized eggs for 10 minutes in a 0·5 per cent. chloral solution. (1) 1 minute. (2) 1½ minute. (3) 5 minutes. (4) 15 minutes, after fertilization, and then examined a part of the fresh or fixed material. Specimens from each of these four divisions were taken at intervals from 10 minutes to 5 hours after the action of the chloral. The general results did not quite coincide with the previous observations, one part being more, the rest less strongly affected by the reagents, while the changes in the nucleus and protoplasm were not impeded to a like extent.

(4) Effect of chemical reagents after fertilization. (*a*) Nicotin solution (1–100) after acting for 3/4 hour on fertilized eggs, no appreciable result. (*b*) 0·1 per cent. solution of nicotin acting for 10–60 minutes had only slight influence. (*c*) Morphia. A 0·1 and 0·6 solution had only a retarding action; and a 0·5 solution and a 0·4 acting for 30–60 minutes had a

similar effect. (*d*) Chinium sulfuricum in 0·05 per cent. solution acting for 20–30 minutes caused retrogression of the plasma radiation, and this was restored after immersion for a longer period. In 5 minutes the amphiaster underwent a retrogressive segmentation. Preserved material showed that an action of 20 minutes sufficed to prevent or destroy nuclear fission. (*e*) Chloral; in eggs treated with 0·5 per cent. solution for 15 minutes the radiation disappeared, and in 30–60 minutes small projections appeared on the surface. After 5½ hours the ova lost their susceptibility to impregnation. (*f*) Cocain acted like chloral and chinium sulfuricum.

(5) Results of thermic action on the products of reproduction. (1) Eggs kept in sea water at a temperature of 31° C. (*a*) 10 minutes; penetration of spermatozoa abnormal and incomplete: after 1¼ hours no copulation of nuclei took place. (*b*) 20 minutes; greater part of the ova fertilized by two to three spermatozoa. In 2½ hours segmentation began; somewhat impaired. (*c*) 45 minutes; fertilization, usually by three to four spermatozoa, sometimes by five, rarely by two (15 ova—56 sperms). (*d*) 60 minutes; fertilization by three to five spermatozoa, rarely by seven or eight: no segmentation observed. (*e*) 90 minutes; fertilization by three to four spermatozoa: no reaction of the female plasma. (2) Ova heated to 55° C. for 5 minutes were killed, drops of albumen separating out. (3) Heated to 50°, 47°, 45°, 42°, 41° C. for 5 minutes, no fertilization. (4) Heated to 39°, 37°, 36° C., fertilization took place, no segmentation. (5) Heated to 34°, 32°, 31° C. for 5 minutes, fertilization and segmentation with subsequent "monster" formation.

(6) Effect of mechanical injuries. Ova shaken up in a test-tube half filled with sea water for 20–30 minutes. The gelatinous membrane separated from the yolk-sac. The otherwise undamaged ova were as a rule fertilized by one spermatozoon. Ruptured ova may be impregnated by several spermatozoa.

(7) Preservation. Eggs were killed in picro-acetic acid, carefully washed, and put in 75 per cent. spirit. Staining with lithium carmine or Grenacher's borax carmine (24 hours, extraction with 75 per cent. spirit acidulated with 1/2–1 per cent. hydrochloric acid). Finally absolute alcohol; then mixture of equal parts absolute alcohol and oil of cloves; evaporation of the alcohol (best under a bell-jar and with vessel filled with strong sulphuric acid close by) dammar or glycerin. Gradual transference from one reagent to another brought out the nuclear figures more clearly than when those operations were quickly performed.

Preparing Tendon-cells and Cells of the loose Subcutaneous Tissue.*—Dr. A. Dogiel obtained very good preparations of tendon by placing rat's tail in Grenacher's alum-carmine for two or three hours, or still better, for a week or even a month. The tendon bundles swell up and become transparent, and the cells appear beautifully stained. The elastic fibres stand out very clearly. The same effect may be obtained if tendon be placed in a saturated solution of potash or ammonia alum, and afterwards staining with Grenacher's carmine, alum logwood, hæmatoxylin, eosin, &c. Mounted in glycerin, the preparations keep for a long time, but afterwards a slight decoloration takes place. Permanent preparations of tendon are better placed in spirit, then oil of cloves, wherein they are teased out, then dammar or balsam. For the subcutaneous tissue it is recommended to take a piece free from fat from the inguinal or abdominal region of a mammal, and having spread it out, to stain with a concentrated solution of fuchsin, diluted with an equal volume of water, and then stain under the cover-

* Anat. Anzeig., ii. (1887) pp. 139–42.

glass, where the preparation lies in half per cent. solution. For permanent preparations picrocarmine, glycerin.

Preparing Medullated Nerve-fibres.*—Dr. T. Boveri, when examining medullated nerve-fibres, used the sciatic nerve of the frog, which was treated in the following way.

The nerve, carefully cut out from a frog recently killed, was stretched out according to Ranvier's method, and placed for four hours in a half per cent. solution of hyperosmic acid. It was then washed in distilled water, and hardened in 90 per cent. spirit. Pieces of nerve about 6 mm. long were then stained in a concentrated solution of acid fuchsin for twenty-four hours, and afterwards treated for a similar time with absolute alcohol. For cutting, the object was imbedded in paraffin. The author found that osmic acid gave good results if the 1 or 0·5 per cent. acid had come into actual contact with the nerve-fibres. In practice the central fibres of a bundle were only partially affected by this reagent, so that the action of water preponderated over that of the osmic acid.

For treating nerves with silver the author indicates the following course:—(1) If a nerve be placed in a 1 per cent. solution of silver nitrate, to which an equal volume of 10 per cent. nitric acid be added, the silver reaction takes place, and the fibrillar structure of the axis cylinder is to a certain extent retained, so that a periaxial space does not arise, owing to shrinking of the axis cylinder. (2) Nerves freshly teased out and exposed to osmic acid vapour on a slide in a half dry state are treated with a dilute watery or alcoholic silver solution. In well-hardened fibres the silver reaction occurs almost at once.

It may be remarked here that a mixture of equal volumes of 1 per cent. silver solution and 1 per cent. osmic acid gives the same reaction on fresh tissues as the silver solution shows by itself; hence this mixture is especially suitable for demonstrating the boundary parts of cells, and also for preserving the elements at the same time.

Demonstrating Sharpey's Fibres.†—Dr. A. Kölliker had only poor results when examining Sharpey's fibres in thin sections of decalcified bones of adults in water or dilute spirit. Far superior were 5–10 per cent. salt solution, acetic acid of various strengths, oxalic acid, and strong hydrochloric acid. Of the stains the most satisfactory was indigo-carmine, by which Sharpey's fibres were stained red, the rest of the bone-tissue blue. A section of the bone cartilage, rendered transparent with concentrated acetic acid, is placed for a quarter to one minute in the undiluted stain; then, after having been carefully washed, mounted in glycerin or balsam. Lithia-carmine and, less so, safranin, stain the fibres and the rest of the bone substance differently. New solid green 3 B, tartrazin Victoria blue B, Victoria blue 4 R, auramin, hæmatoxylin, osmic acid, palladium chloride, picric acid, and fuchsin were without effect.

With the polariscope and crossed nicols Sharpey's fibres appear dark transversely and bright longitudinally; for this accurate vertical focusing is necessary. Elastic fibres, rendered evident by acetic acid, are dark longitudinally. They are to be distinguished from Sharpey's fibres by treating sections with acetic acid, oxalic acid, and hydrochloric acid, or by destroying them with strong cold caustic potash or soda, or by staining (the elastic fibres) with fuchsin or safranin.

In preparations obtained by grinding bone Sharpey's *tubules* contain air, and after the addition of turpentine oil and balsam stand out quite clearly

* Abh. K. Bayer. Akad. Wiss., xv. pp. 423–94 (2 pls.).
† Zeitschr. f. Wiss. Zool., xliv. (1886) pp. 644–80 (4 pls.).

(the fluid penetrates the bone-cells and canaliculi). But a short heating of thin plates is better. The author was able to distinguish Sharpey's fibres in the soft and uncalcified condition from those partially calcified.

Physiological Silvering of Elastic Tissue.*—Dr. A. Blaschko states that in the cutis of silver-workers there are frequently found, in places exposed to the light, blue-black spots, which are formed from the penetration of minute fragments of metallic silver into the skin. It is obvious the silver is dissolved in the skin, and separates out from the solution into very fine granules under the influence of light. This reduction of silver takes place in the living tissue, especially in the course of the elastic connective tissue, the fine fibrillations of which are thus rendered manifest.

Preparation of the Retina.†—Dr. P. Schiefferdecker finds the following mixture preferable to Ranvier's alcohol as an isolation medium for the retina:—Aqua destillata, 20 vol.; glycerin, 10 vol.; methyl alcohol, 1 vol.

The eye, cut up, or only the retina is placed in this fluid for several days. A small piece of the retina with some water is placed in a test-tube and shaken up. It is then emptied into a watch-glass and some drops of glycerin and of a cold saturated watery solution of picrocarminate of soda added. It is then stirred up with a needle and placed in a sulphuric acid drying apparatus. The red-stained retina elements are mounted in glycerin. As this method is not always successful, several preparations are necessary. For hardening, the author used Müller's fluid, chromic acid 1–600, and acetum pyrolignosum, one part to three parts distilled water. The latter is especially recommended. Eyes of small animals should be hardened in osmic acid or its vapour, and afterwards treated with Müller's fluid. These small eyes are best hardened before being opened.

Imbedding in celloidin. This must be allowed to soak in for some days, and the cover removed little by little. When the ether and alcohol have so far evaporated that the finger scarcely leaves an impression on the celloidin mass, 50 per cent. spirit is poured in and the mass taken out the next day, when it may be cut. The knife should always be kept wet with spirit. Paraffin imbedding alters the retinal elements, and osmic acid is to be avoided as it gives rise to deceptive appearances owing to precipitation.

Preparing the Mammalian Testis.‡—In investigating the mammalian testis, Herr C. Benda used the following reagents and methods.

For hardening purposes, he imitated Biondi in the almost exclusive use of Flemming's chromic-osmic-acetic mixture (1 per cent. chromic acid 7 vols., 2 per cent. osmic acid 2 vols., glacial acetic 0·3–0·5 gr.). Concentrated picric acid and sublimate also yielded very fair results. The imbedding, cutting, and fixing in albumen-glycerin were accomplished as usual. Staining was effected by a modification of Heidenhain's and Weigert's hæmatoxylin method. The sections remain twenty-four hours at about 40° C. in concentrated solution of neutral acetic acid and oxide of copper, are then carefully washed, darkly stained in aqueous solution of hæmatoxylin, decolorized to a bright yellow in very dilute hydrochloric acid solution (1:300–500). The acid is again neutralized, best in the copper solution; the sections become light bluish-green and are finally dehydrated and mounted. The staining thus laboriously effected is very well defined and graduated, and is also persistent. The portions of testis

* Arch. f. Mikr. Anat., xxvii. (1886) pp. 651–5 (1 pl.).
† Ibid., xxviii. (1886) pp. 305–95 (3 pls.). ‡ Ibid., xxx. (1887) pp. 49–110 (3 pls.).

examined were removed from the living or just-killed animal, and were placed in the preserving fluid in very small pieces.

Preparing Cochlea of Guinea-pig.*—Dr. G. Schwalbe places the fresh cochlea of the guinea-pig for eight to ten hours in Flemming's solution, and after thorough washing, decalcifies in one per cent. hydrochloric acid wherein it requires to remain for twenty-four hours. After the acid is quite washed out, absolute alcohol, xylol, xylol paraffin, saturation with Spee's paraffin at 35°–60° C. If the animal killed with the chloroform is allowed to hang with the head downwards for some hours, a perfectly natural injection of the cochlear vessels is obtained. To isolate these vessels, the following maceration method is recommended:—The cochlea filled with blood is decalcified in three per cent. hydrochloric acid and is then kept at a temperature of 40° in an incubator in the same acid. In one or two days the sheath of the cochlea is so softened that the nervous cochlea and its spiral expansion can be isolated from the basilar membrane, and the ductus cochlearis unwound from the expansion of the nerve. After separating the nerve and the duct the spiral vein can be seen with a low power lying by the ganglion spirale and beneath this the tractus spiralis glomerulorum winding round the nervus cochleæ.

Preparing the Central Nervous System of Acephala.†—For the examination of the central nervous system of mussels, Dr. B. Rawitz recommends (1) absolute alcohol 1 part to 3 parts distilled water. This keeps the parts perfectly and causes a slight isolation of the cells, and yet affords useful pictures after four to five weeks. With Solbrig's one-sixth spirit, the contents of the nerve-fibrils disappeared, and Ranvier's one-third spirit could only be used for one day as decomposition appearances occurred afterwards. (2) Bichromate of potash in solutions of 0·2, 0·05, 0·025 per cent. effected perfect maceration in 8 to 24 hours; after a longer period the tissues became completely softened. For hardening the animal in the shell a 5 per cent. solution was used for 4 to 6 weeks. The animals were then easily separated from the shell. After 8 days in absolute alcohol the ganglia were sectioned. (3) Bichromate of ammonia in 0·1 per cent. solution caused shrinking of the nuclei, and changes in the central nervous system. (4) Chromic acid is said to be as useless as a maceration medium as it is for hardening; even Arnold's chromacetic acid solution produced changes in the tissues. (5) Haller's fluid quite destroyed the nervous elements of the Acephala in half an hour. (6) Osmic acid was of very little use. Solutions of 0·1 and 0·05 per cent. were inferior to spirit or bichromate of potash; with solutions of 1 and 2 per cent. the cells seemed to be scorched. 5 to 10 drops of a cold saturated solution of picric acid to 15 cc. of distilled water effected the isolation of cells in 12 to 24 hours and gave good pictures. The mixture of spirit and iodine used by Fritsch for the brains of fish and followed by bichromate were found to make the nervous system very brittle.

As stains, rubin, safranin and eosin gave the best pictures. Gentian-violet, malachite-green, and Weigert's hæmatoxylin were useless. Ammoniacal carmine and much diluted solutions of "Rosenliqueurs" stain excellently, especially the central nervous network. The objects remain therein 4–10 days; they are then washed in spirit slightly acidulated with acetic acid, then absolute alcohol. Gold chloride in 0·1 to 0·25 per cent. solutions gives good pictures.

* 'Beiträge zur Physiologie. Carl Ludwig zu seinem 70. Geburtstage gewidmet von seinem Schülern,' 1887. Cf. Zeitschr. f. Wiss. Mikr., iv. (1887) p. 90.

† Jenaische Zeitschr. f. Naturwiss., xx. (1887) pp. 384–460 (5 pls.). Cf. *supra*, p. 735.

Preparation of Ova of Ants and Wasps.*—Dr. F. Blochmann examined *Camponotus ligniperda* Latr. and *Formica fusca* L. The ovaries were usually fixed with picric acid or sublimate, and stained on the slide with picrocarmine or borax-carmine. For examining the elements of the yolk, double staining with borax- or picrocarmine and bleu de Lyon are advised. The preparations, not always successful, show in favourable cases a blue staining of the yolk-granules and a rosy colour of the surrounding plasma, sometimes with a tendency to violet. A somewhat similar effect was obtained by the addition of a little picric acid to the turpentine oil used for clarifying. The yolk-sac and the chorion are recognizable from the deep blue they acquire from the bleu de Lyon. Young ova of *Camponotus ligniperda* are noteworthy on account of the rod-like corpuscles containing highly refracting granules, and which after being treated with 1 per cent. acetic acid appear more clearly. The addition of 5 per cent. soda solution to the rodlets causes them to pale in fifteen to thirty minutes, and finally to disappear, while the chromatin masses in the nuclei immediately disappear. Against the bacterial nature of these rodlets is to be said that bacteria from hay-infusion are not altered by immersion for three days in 5 per cent. soda solution. In dilute albumen solution in a moist chamber at 30°, after about twenty-four hours they inflate in places, and finally become quite bladder-like. In trypsin solution they become granular at first, and afterwards are partially dissolved.

Preparing Ova of Mysis Chamæleo.†—Herr J. Nusbaum is of opinion that one method of preservation can never afford satisfactory material for study, as each method gives different results. Thus, in treating fresh ova with Kleinenberg's or Perenyi's fluid we get large and distinct cellular elements, but the yolk is lost very easily; on the other hand, when the ova are treated for a few seconds with hot water and then with bichromate of potash, the yolk remains with the elements, but the latter contract. After the ova had been from twenty-four to forty-eight hours in a weak solution (1 per cent. of chromic acid or bichromate of potash, or for four to five hours in Kleinenberg's or Perenyi's fluid, they were put into 70 per cent. and then into absolute alcohol. The eggs thus hardened were coloured *in toto* by hæmatoxylin, borax-carmine, or red magdala; the first of these was very useful, because, in the early stages of development it gave a different coloration to the not yet modified yolk, and the yolk which was already modified by the influence of immigrated cells. As in all researches on Arthropods, the red magdala gave a perfect staining reagent, as it coloured the eggs and embryos in a relatively short time (a few hours), and very intensely, though sometimes too uniformly.

The hardened and stained egg was put into alcohol, then into a mixture of equal parts of 70 per cent. alcohol and essence of cloves, and then into pure essence of cloves, until it became transparent; it was then plunged for a short time into essence of turpentine, and finally imbedded in paraffin. Sections were made by Schanze's microtome, fixed by collodion and essence of cloves, and put up in Canada balsam.

Preparation of Male Reproductive Organs of Cypridæ.‡—Dr. F. Stahlman teases out the fresh animal in physiological salt solution, and stains with picrocarmine, methyl-green, acetic acid, Schneider's acetic carmine. The best fixation is with hot water from 60–65°, or with hot

* Zeitschr. f. Wiss. Zool., xliii. (1886) pp. 537–720 (5 pls. and 6 figs.).

† Arch. Zool. Expér. et Gén., v. (1887) pp. 124–5.

‡ Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 511–2. From Zool. Inst. zu Freiburg i. B., 1886, 33 pp. (1 pl.).

30 per cent. spirit. The latter makes the tissue somewhat too brittle. The best staining results were obtained from Ranvier's picrocarmine, but borax-carmine, lithium-carmine, hæmatoxylin, and eosin were also used. The lime in the shell is extracted by acting on it for twenty-four to forty-eight hours with a concentrated solution of picric acid in an incubator, and the acid removed by immersion for a similar period in water heated as before. Perforation or slight fracture of the shell hastens the staining, &c. Flemming's solution is not very advantageous, because it penetrates too slowly. Lively movements of the spermatozoa of *Cypris punctata* Jur. and *Cyproïs monacha* Müll. may often be perceived after teasing open a receptaculum seminis in three-fourths salt solution. The spermatic filament of an undetermined Cyprid was uniformly stained with methyl-green, and scarcely altered at all by long immersion in concentrated hydrochloric acid or caustic potash.

Preparation of endothelium of the general cavity of Arenicola and Lumbrica.*—M. H. Viallanes anæsthetizes the animal by immersing it for an hour in sea water to which chloroform is added. It is then spread out on a wooden plate and fixed with two pins. The middle zone is opened by a longitudinal incision and the integument reflected and fixed down with pins. A piece of the alimentary canal and of the muscular sheath from the anterior and posterior ends of the body are removed and then washed with water and with an acid 0·01 per cent. solution of silver oxide. It is again washed, and then placed in 36 per cent. spirit until the silver is reduced. Immersion in spirit is necessary, because if reduction take place in water the muscles contract and further observation is rendered difficult. When the silver oxide is sufficiently reduced the piece is removed, cleared up in clove oil, and mounted in balsam. This procedure brings out the endothelial cells covering the muscles with perfect clearness.

In order to show the endothelium covering the interannular septa the following method is useful. The annelid is first syringed with one-third spirit and then immersed for twenty-four hours in 80 per cent. spirit. The animal is then opened, one of the septa (the third is the most perfect and best for observation) isolated, carefully spread on a slide, and examined after being stained with picrocarmine or eosin and logwood. By the action of 30 per cent. spirit the endothelial cells are set free, and only the tissue forming the framework of the septum remains.

Preparing Eggs of Rotatoria.†—Dr. G. Tessin states that it is very difficult to obtain good preparations from the small eggs of Rotatoria. With those of *Brachionus* he usually proceeds by rapidly killing the egg in chrom-acetic acid; no distortion results. From weak they are transferred to strong spirit. Picrosulphuric acid produces great distortion, and sublimate does not penetrate. Staining is only possible with hæmatoxylin, as carmine is useless. Creosote is the best clarifier. Paraffin only penetrates with difficulty.

Examination of Nectarial Tissue.‡—Dr. S. Stadler finds that osmic acid is a test for tannin, which it stains brown to a black or blue violet. If any fatty oils are present the test cannot be employed. The author, who had previously used three kinds of zinc chlor-iodide solution for the examination of the cell-wall and of the cuticle in nectaries, has, on account

* Ann. Sci. Nat.—Zool., xx. (1886) 10 pp., 1 pl.

† Zeitschr. f. Wiss. Zool., xliv. (1886) pp. 273-302 (2 pls.). See this Journal, *ante*, p. 94.

‡ Stadler, S., 'Beitr. z. Kenntniss der Nectarien u. Biologie der Blüten,' 88 pp., 8 pls., 8vo, Berlin, 1886.

of the trouble and time expended in making these solutions, now adopted the following method.

The preparation is placed on a slide with a drop of zinc chloride solution; to this is added a drop of a weak iodine solution, and the cover-glass is then imposed. The reaction immediately takes place, and if the chloride is in excess, the iodine colour disappears from everywhere except the stained parts of the preparation. It seems indifferent which reagent is first used.

Mounting Mosses.*—Miss V. A. Latham gives the following directions for mounting mosses: —

"We will take the pretty moss, *Dicranum heteromallus*. The chief beauty in this moss lies in the capsule, and I may remark here that mosses for mounting should be in fruit, and, what is more, ripe. The peristome is very pretty, and we must try and preserve the capsule uninjured. In its natural state, when growing and quite ripe, the calyptra and operculum are thrown off, the peristome unfolds itself, and the spores issue from the capsule, and either fall to the ground or are scattered by the wind. All this should be borne in mind whilst mounting mosses, and if you can show the spores leaving the capsule, and also the calyptra and operculum, so much the better. Gently shake, and remove, with the aid of a small sable brush, as much dirt, dust, and grit as you can. Then place the specimens in clean water, and shortly the leaves will expand and look as fresh and green as when growing. Use your brush, and move them carefully and quickly about in the water to further cleanse them. Transfer to a small bottle of water again, and shake carefully. Change the water, and repeat if necessary. During washing the opercula will probably fall from the capsules; therefore keep a look out. Take from bottle, examine your specimens, and remove ragged and imperfect portions, if any; place upon slip, and see if clean with a low power. If so, you will be lucky. Most probably you will find it necessary to use the brush again, holding the moss under water with one brush whilst you clean with another. You can try placing them in a saucer, and letting the water tap drop on them. Now arrange your moss on a slip, unfold and spread out the leaves gracefully and naturally, and with the capsules placed with an eye to artistic effect, as if growing. Put three small beads or portions of broken glass circles for the edges of your cover-glass to rest evenly upon, so as not to rest upon and burst the capsules, and to prevent tilting. Put on the cover-glass and secure with wire clip; drop the glycerin jelly round the edge of the cover, and it will run under. Now gently heat until ebullition takes place. This operation requires a little practice, but when done successfully, it drives out all air-bubbles, liberates a few spores from the capsule, and makes the leaves more transparent for examination Should the spores leave the capsule in excess and cloud the field, transfer to clean slip and repeat the process. Good glycerin jelly will set immediately, when you may possibly find the boiling has interfered a little with the nice (that is, natural) position of some of the leaves and capsules. If so, warm the slide until the jelly is in a fluid state, insert the needle under the cover, and replace all straight; at the same time, and by the same means, push under and place in position the opercula.

Occasionally there may be a desire to preserve intact the beautiful fresh green tint of the leaves. In that case, after you have got your moss clean, soak it in glycerin for several weeks until the glycerin has thoroughly permeated and driven out all air from the capsules and leaves. When ready, place a warm slip on your mounting stage, put your moss in

* Scientif. Enquirer, ii. (1887) pp. 156-7.

the centre, and with the aid of a lens arrange as straight a line as possible, seeing at the same time any air-bubbles are dislodged either with a needle-point or gentle pressure of some kind. Apply the jelly, dip your cover in warm water, put over all, and gently press down. In adopting this method, you are not very sure of keeping the moss as artistically displayed as you could wish, but the judicious use of a needle, quickly handled before the jelly sets, will put right any serious defect. Ring and finish as with other slides. This is Captain P. G. Cunliffe's method, and was used by him in preparing his slides for the Manchester Cryptogamic Society, and which were acknowledged by all to be beautifully mounted specimens."

Cleaning and arranging Diatoms.*—Dr. F. S. Newcomer proceeds as follows:—He uses a test-tube 10 in. long and 1/4 in. in diameter, cuts the *Zostera marina* into inch lengths for convenience of boiling, boils to wash out the chloride of sodium, then boils in bicarbonate of soda to break up the fibres of the plant, then washes out the soda, and having poured into a Berlin dish, evaporates the remaining water. Sulphuric acid is then added until the organic matter is completely charred. The mass is then deflagrated with chlorate or nitrate of potash. After the acid is cooled, about a quart of distilled water is poured in gradually, and stirred the while. The acid having been removed, any flocculent material is got rid of by boiling with soap (not more than 10 grs. to the test-tube). When the soap is washed away, the diatoms will be clean and bright. The diatoms are extracted by pouring the material into a Berlin dish; the diatoms will be found at the top and the sand, if any, at the bottom of the dish. It is not advisable to throw away the sand, as the largest diatoms are frequently found among it. The material is preserved in a mixture of equal parts of spirit and water.

Diatomaceous earths require great patience; the Barbados material, in which there are traces of iron, is best treated at first with a concentrated solution of citric acid.

In arranging geometric forms of diatoms a guide slide with micrometer circles is used. On this is placed the cover-glass by moistening the surface of the guide slide by breathing upon it; then centered with a pocket lens. The best fixative for the purpose is that of Mr. Febiger: glacial acetic acid 12 fluid drachms, gelatin 2 drachms, alcohol 1 fluid drachm. The gelatin is dissolved by adding the acid over a water-bath, and after the alcohol is mixed in the whole is filtered. The fixative is then spread across the face of the cover-glass by means of the finest cambric needle. The slide on which the diatoms are to be arranged is then fixed on a turntable, and a ring the size of the cover-glass run on with any anilin ink or colour; the slide is then turned over, heated, and a drop of balsam placed upon it and the cover-glass on it, the anilin ring on the under side being used as a guide. The slide is finished off by running the flame of a spirit-lamp round the edge of the cover-glass. The flame of the lamp must be turned down until it is blue.

Cleaning Diatomaceous Mud.†—Dr. G. H. Taylor does not agree with Mr. C. H. Kain as to the avoidance of muds in the collection of diatoms. If muds are avoided, some of the finest specimens obtainable are missed. The author is now engaged in working up the muds of the North Carolina coast. This mud is most difficult to clean, that is, to eliminate the sand; as much as 250 gallons of water have been used before obtaining enough material in a cleaned state to cover the bottom of a half-drachm phial.

* Proc. Amer. Soc. Micr. 9th Ann. Meeting, 1886, pp. 128-30.
† Bull. Torrey Bot. Club, xiv. (1887) pp. 141-3.

The great mistake generally made in cleaning marine muds is that not enough care is taken in the first washings with water. The author's method is to remove all sand possible before shaking is commenced, for the violent agitation of a mixture of sand and diatoms is prejudicial to the latter. Only as much raw material should be placed in the bottle or jar as will settle in ten minutes, and this should be repeatedly washed until the water will settle clear in a few minutes. The jar should not be shaken, but rotated, and the sand removed after each settling.

Preservation of recent Pathological Specimens.*—Prof. E. Lund preserves recent pathological specimens by placing them in an air-tight vessel filled with the vapour of sulphuric ether, chloroform, or ether and creosote previously mixed with alcohol. Several thick folds of lint, saturated with one of these solutions, are put at the bottom of the vessel, and the specimens are arranged in trays over it, so that the vapour can have free access to each of the specimens. In this way the specimens are always ready for examination, without being softened or decolorized by immersion in weak spirit and water or other preservative fluids. The cover of the vessel can be made air-tight by a vulcanized indiarubber ring, on which the edge of the lid is firmly pressed, or by allowing it to dip into a groove around the top of the vessel, which can be filled with vaseline, or, better still, with liquid mercury, if the vessel is not to be much moved about from place to place.

COURROUX, E. S.—**On the washing and cleansing of diatomaceous deposits.** *Scientif. Enquirer*, II. (1887) pp. 144–7.

QUIMBY, B. F.—**Insect Preparations. I.**
[Collecting. Fluids. Implements (including a mounting and dissecting box, illuminated by a mirror set at 45°). Preparation.]
Microscope, VII. (1887) pp. 197–202.

STOSS.—**Notizen über Anfertigung mikroskopischer Parasitenpräparate.** (Notes on making microscopical preparations of parasites.)
Deutsche Zeitschr. f. Thiermed., XIII. (1887) pp. 202–5.

(3) Cutting, including Imbedding and Microtomes.

Celloidin-Paraffin Imbedding.†—In order to obviate the difficulties and inconveniences inherent in the methods of imbedding in celloidin and paraffin, Dr. Kultschizky has devised a combination of these two media which are manipulated as follows:—The object, taken from spirit, is placed for some hours in a mixture of equal parts of ether and alcohol. It is then removed to a solution of celloidin of any strength; herein it remains for twenty-four hours. From the celloidin the object is transferred to origanum oil, and then to a mixture of paraffin and origanum oil which has been heated to 40°, and finally to melted paraffin. The time which the object remains in the origanum oil, the paraffin solution, and in the melted paraffin, must be determined by trial, as it depends on the characteristics of the imbedded objects.

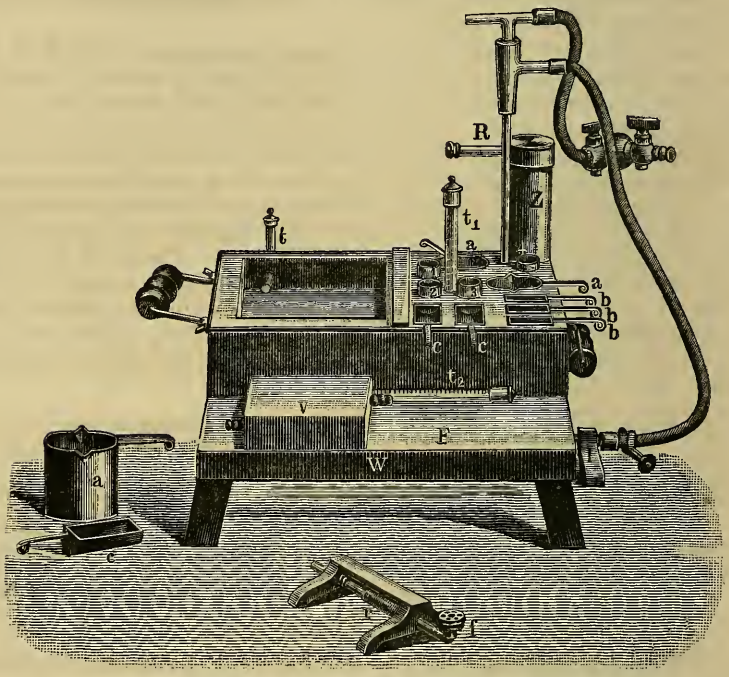
The chief advantages claimed for this method are that very fragile objects can be imbedded; that very thin sections, owing to the celloidin, do not break up, even though the paraffin has given way; that it is not necessary to use an alcoholic drip while cutting; and that sections of the same tenuity as those from paraffin in imbedding can be obtained.

Water-bath for Paraffin Imbedding.‡—Dr. P. Mayer has in conjunction with Dr. W. Giesbrecht and Dr. G. C. J. Vosmaer, devised a convenient

* Scientif. Enquirer, ii. (1887) p. 148.
† Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 48–9.
‡ Internat. Monatschr. f. Anat. u. Physiol., iv. (1887) Heft 2, 1 fig.

form of water-bath for paraffin imbedding. W is the bath; Z the tube by which it is filled with water; 1, 2, 3, 4, are glass tubes; *a* is a pot for melting and clarifying the paraffin; *b* and *c* are half-cylinders with handles for imbedding; *t* is a thermometer bent at a right angle; the horizontal leg ends in the air-bath, which can be closed with a glass plate. The

Fig. 229.



temperature in the air-bath is about 10° less than the water-bath, and it is used for evaporating chloroform, &c.; t_1 is the thermometer for the water-bath; R is a Reichert's thermo-regulator. The variation in temperature is less than 1° C. *r* is the tube in which the gas and air mix, and *f* a mica chimney. There is a small independent and removable water-bath *v* fitted with water by means of rubber tubes attached to lateral openings. It is supplied with a thermometer t_2, is warmed on the platform F, and is intended chiefly for orienting objects under a simple lens or dissecting Microscope.

Modification of Reichert's Object-holder.*—Dr. J. H. List has made two alterations in this object-holder, by which greater mobility of the ball-and-socket joint and greater space for the play of the knife are obtained. The jaws of the clamp holding the object are now made convex, and the ball-and-socket joint works in one of the jaws. No impediment is therefore offered to the knife, even when the clamp is turned to its utmost. By shortening one of the screws moving the jaws still more room is obtained.

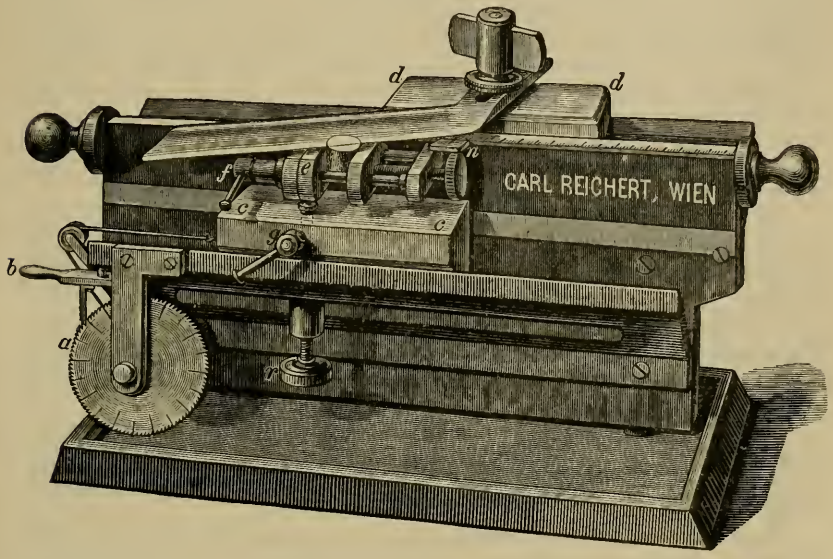
Modification of the Naples Section-smoother.†—In order to increase the size of the Naples section-smoother, which is somewhat too thin,

* Zeitschr. f. Wiss. Mikr., iii. (1886) p. 484.
† Internat. Monatschr. f. Anat. u. Physiol., iv. (1887) Heft 2.

Dr. P. Mayer advises that strips of gelatin plate, such as are used by lithographers, should be stuck on the cylinder with some very soft paraffin.

Reichert's small Rivet's Microtome.—The only peculiarity, so far as we are aware, of Herr C. Reichert's latest form of this Microtome (fig. 231)

Fig. 231.



consists in the arrangement for raising the object-holder, which is effected by a cord which winds round the axis of the toothed wheel *a*.

Letulle.—**Microtome de précision.** *Bull. Soc. Anat. Paris*, XI. (1886) p. 355.

(4) Staining and Injecting.

Carmine solution made with Carbonate of Soda.*—Dr. G. Cuccati's improved carmine stain, especially suited for animal tissues, is made as follows:—Warm water 100 cc.; carbonate of soda crystals 20 grms.; mix and heat; add best powdered carmine 5 grms.; stir and cover. When it boils cease heating, and add absolute alcohol 30 cc. Allow to cool in a partially closed vessel. Next day filter, and add to the filtrate 300 cc. H_2O, acidulated with 8 cc. of a 20 per cent. solution of acetic acid. Next add chloral hydrate 2 grms. Decolorize with 100 cc. spirit and hydrochloric acid 1 cc. This carmine acts intensely on the chromatin of the nucleus, showing up the karyokinetic figures quite brilliantly. It stains *in toto* very well tissues treated with spirit, perchloride of mercury, or Kleinenberg's fluid, in five to twelve hours, according to the size of the piece. Staining of sections or pieces *in toto* must always be performed in closed vessels, and before decoloration these must be washed for a few seconds in distilled water. This carmine also has the power of removing the pigment from the eyes of arthropods which have been treated with spirit, while it stains the nuclei of the retinal cells at the same time.

* Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 50–1.

Mayer's Modification of Grenacher's Carmine.*—Dr. P. Mayer thus modifies Grenacher's carmine:—4 gr. carmine are dissolved by boiling in 15 cc. water and 30 drops of hydrochloric acid; 95 cc. of 85 per cent. alcohol are then added, and the mixture then neutralized with ammonia.

Acid Chloral hydrate Carmine.†—Dr. Kultschizky recommends a carmine stain which is prepared by mixing chloral hydrate 10 grms., hydrochloric acid, 2 per cent., 100 cc., and 1 grm. dry carmine. The mixture is boiled from an hour to an hour and a half in a flask. Too much evaporation is prevented by corking the flask, and passing a glass tube through the cork. The solution is allowed to cool for twenty-four hours, and is then filtered.

Thus prepared, the solution gives a red stain, but if a violet be preferred, the sections are to be immersed in a 2 per cent. alum solution afterwards. The omission of the acid gives a neutral solution, which may be used in conjunction with Grenacher's alum-carmine and also picric acid, and a double stain thereby obtained.

New method for making Picrocarmine.‡—Dr. N. Löwenthal supersedes ammonia with the hydroxide of sodium in preparing picrocarmine. Picrocarminate of soda is a very powerful stain, especially for the central nervous system.

(1) The carmine solution is composed of water 100 cc.; sodium hydroxide 1 g.; carmine 0·4 g. The sodium is dissolved in the water, and the carmine added. The solution is effected in the cold in 24 hours, and in 10–15 minutes with the aid of heat. The solution is then filtered.

(2) To solution No. 1, 100 cc. of water is added, and then 20–25 cc. of a 1 per cent. solution of picric acid poured in. The solution, which is rather cloudy, is allowed to stand for about an hour, and is then filtered twice or thrice.

Employment of Perruthenic Acid in Histological Researches.§—Prof. L. Ranvier has a note on the employment in histological researches of perruthenic acid, and its application to the study of the vacuoles of calyciform cells. He has learnt, from a demonstration of M. Debray, that this acid (RuO^4) is reduced in the presence of organic bodies much more actively than in osmic acid. This reducing action is so rapid and so easy that the retrolingual membrane of the frog, although it contains a number of very different elements, becomes completely black when subjected to the influence of the vapour for a few minutes. If we gradually diminish the time of action, it will be found that the membrane is darkened for a diminishing thickness, but all the elements comprised in one layer are equally blackened. If the time of exposure has been very short, the cilia of the epithelial cells may alone be blackened.

This "brutality" of perruthenic acid seems, at first sight, to deprive it of all value as a histological reagent, but Prof. Ranvier reflected on the mode of action of osmic acid, and coming to the conclusion that the result of exposure to osmic acid is a sort of metallization of the organic elements, he judged that those which were the least blackened were the least metallized. If this were so, the mucigen which remains uncoloured in the retrolingual membrane treated with osmic acid would offer the largest amount of disposable organic substance. After the retrolingual membrane has been exposed to the vapour of osmic acid from ten to twelve hours the calyciform cells appear as clear colourless circles. If now submitted to the action of

* Internat. Monatschr. f. Anat. u. Physiol., iv. (1887) Heft 2.
† Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 46–8.
‡ Anat. Anzeig., ii. (1887) pp. 22–4. § Comptes Rendus, cv. (1887) pp. 145–9.

the vapour of perruthenic acid the membrane blackens, and the calyciform cells are the first to become black, the mucigen alone being coloured, and the vacuoles remaining colourless.

Methylen-blue Staining.*—Dr. C. Arnstein has examined methylen-blue staining on the living frog by injecting into the vena cutanea magna 1 cc. of a saturated solution of this dye. The tongue and palate were stained at once, the nerves were not coloured, the dye being found in the blood-vessels only. One or two hours later the nervelets in the taste papillæ and the thick plexuses of the palate are seen to be blue. The motor-nerve terminations become stained still later. Reichert's pleural muscle may be used to determine the appearance of the stain. "One muscle is removed in two hours, and if insufficiently stained, the second muscle is inspected after another two hours. The eye-muscles are treated in a similar manner, one ball being removed at an early stage, the other at the end of the experiment." Sometimes, however, these muscles do not stain at all, and even if the nerves are well stained they remain so only for a short time, 5–10 minutes about. To retain the colour it is necessary to fix the methylen-blue with iodine, and this reaction turns the blue to brown. A 1 per cent. watery solution of iodide of potassium in iodine dissolved to saturation, is used. The solution is injected through the blood circulation system, and serves also to remove the blood. The frog may be allowed to remain in this solution. The necessary pieces are then cut out and placed in the iodine solution for 6–12 hours, after which the iodine is removed by a thorough washing. Next day the black-brown or grey nerves stand out clearly on a colourless background. Mount in acidulated glycerin. Besides nerves and nerve epithelia, certain other elements are stained during life, such as the cells in the gustatory papillæ of the frog's tongue, certain cells of the palate which lie between the unstained mucous cells, the gland-cells of the membrana nictitans, the cells of the propria in the lingual glands, which as isolation preparations treated with iodine, appears as brown ramified plates. The cells of the cornea, too, are partially stained if the ball be allowed to remain *in situ* for a short time after death. The cornea is then excised and thrown into the iodine solution, but the staining of the corneal cells only occurs when the plexus has been stained during life. Over gold chloride it has the advantage of staining only the cells and their prolongations, and not the lymph channels of the connective tissue cells; those which show the most affinity for methylen-blue are the fat-cells. At one time they stain deeply, even when the nerves are yet uncoloured; later they seem to lose their colour. Sometimes after death they are again very beautifully stained. During life, many red blood-corpuscles show a nuclear stain, but the white corpuscles do not take up any dye.

New Green Dye.†—Dr. W. Krause has been examining a double zinc salt of thiophin-green ($C_{21}H_{24}N_2OS$) as to its utility for microscopical purposes. It is easily soluble in water, alcohol, oil of cloves, chloroform, with a beautiful green colour in which there is a trace of blue. It may be used in conjunction with carmine as a double stain. Fresh tissue hardened in absolute alcohol. Staining with borax-carmine *in toto*, washing, spirit, chloroform-paraffin, paraffin. Sections 0·005 mm. thick fixed to the slide. Collodion, clove oil, paraffin dissolved in benzol, and then removed with absolute alcohol. A drop of a concentrated watery solution of thiophin-green is allowed to act on the moist section for some minutes. It is then

* Anat. Anzeig., ii. (1887) pp. 125–35.
† Internat. Monatschr. f. Anat. u. Physiol., iv. (1887) 2 pp.

washed with absolute alcohol. Benzol. Benzol dammar. (If not washed thoroughly the nuclei are blackish instead of red; if too long, the ground substance is too pale.) The stain was used for the electric organ and embryos of the torpedo. The nuclei of fish-corpuscles are red, the plasma green.

New Formula for Burrill's Stain.*—Prof. T. J. Burrill finds the following formula gives excellent results in staining *Bacillus tuberculosis*:—Fuchsin (anilin-red), 1 part; pure carbolic acid 2·5 parts; glycerin (commercial) 10 parts.

The directions for use are as follows:—Add 3 drops of this stain to a drachm (teaspoonful) of distilled or soft water; float a cover-glass, on which a thin film of sputum hardened by heat has been spread, on the liquid and heat to near boiling; remove from lamp and let stand two or three minutes; decolorize in nitric acid (1 part) and water (5 parts); wash in water, and examine, or dry and mount in balsam. Contrast stain, if desired, after the first decolorizing, with anilin-blue.

This formula is much more satisfactory than the previous one, for there is less liability of precipitation of granules on the cover, and the time is greatly shortened.

In the absence of other apparatus, &c., a cheap tablespoon, with the end of the handle bent down to make a level support, answers excellently well for holding and heating the stand, and nothing can be better for the heating than a common coal-oil lamp, the watch-glass, crucible-cover, spoon, or what not being held above the top of the chimney. This is better, too, for hardening the sputum-film than the flame of a Bunsen burner.

Prof. Burrill is sure this stain will keep, for there is nothing in it to precipitate by keeping, as so generally occurs with anilin-oil mixtures.

Staining Elastic Fibres.†—Dr. G. Martinotti fixes and hardens the material with a 0·2 per cent. solution of chromic acid. The sections, after having been well washed in water, are placed for forty-eight hours in a solution of safranin (safranin 5 parts, dissolved in absolute alcohol 100 parts, to which 200 parts of water are added after a few days). The sections are again washed, dehydrated in spirit, cleared up in oil of cloves, and mounted in balsam. The elastic fibres are stained a deep black, the nuclei are of a bright red colour, and the rest of the specimen is stained diffusely red. The elastic fibres come out quite clear and distinct; those in arterial walls are especially suited for this method.

Nerve Staining.‡—Dr. J. Pal remarks that Golgi's method causes a precipitate of mercury upon the cells, for if the sublimate pieces are treated with a 1/2–1 per cent. solution of soda sulphide, the staining is more intense, owing to the formation of sulphide of mercury. Such preparations, after being stained with a bright red, give excellent pictures. The author, however, succeeded in staining all the cells by Golgi's method. By the silver method such good pictures are not obtained, and there is more precipitate than occurs from the use of sublimate. As the chromic acid silver salt is soluble in many dyes, it is necessary, if a contrast stain be desired, to change the salt into mercury sulphide by means of soda sulphide.

Golgi's cell-staining may be used in conjunction with Weigert's hæmatoxylin stain. The sections which have lost, either in the sublimate or silver solutions or in water, their chromic salt, must be placed in a 1/2 per cent. solution of chromic acid for twenty-four hours. Then, without the copper

* Queen's Micr. Bulletin, iv. (1887) p. 24.
† Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 31–4.
‡ Wien. Med. Jahrb., 1886. Cf. Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 92–6.

treatment, Weigert's logwood may be used in the ordinary manner. For decolorizing these sections, or those prepared by the original method of Weigert, the author proposes a new reagent, with the intent of quite removing the stain from the interstitial tissue, in order that this may be contrast-stained. The blue-black sections are placed in water, to which some alkali (1–2 cc. of lithia solution to 100 cc. water) is added if the preparation does not seem stained a deep blue. From the water the sections are transferred to 1/4 per cent. solution of permanganate of potash for 20–30 seconds. They are next washed with water, and then transferred to the following acid fluid:—Oxalic acid, 1 part; sulphite of potash (K_2SO_3) 1 part; aq. destil. 200 parts. In a few seconds the sections are sufficiently decolorized. They are then stained with Magdala red or eosin (4–5 minutes), or still better, with picrocarmine or with acetic acid carmine. Should any spots remain after the acid solution, the section must be returned to the permanganate solution for a moment, and the process repeated. Should the sections have been treated with copper, the medullary sheath becomes red-brown in the acid solution, and accordingly requires an alkaline bath, or some suitable afterstain, as malachite green. It is advisable that the permanganate solution should be made fresh every time, and should be changed as soon as it shows a trace of brown. So too the acid solution should be promptly replaced by a fresh quantity directly it begins to act slowly. The foregoing method of decolorizing has the disadvantage that each section or preparation requires the greatest attention on the part of the operator.

Exner had treated osmic acid preparations of the central nervous system with ammonia, and thereby brought out many very fine nerve-fibres. Instead of ammonia, Pal used the reagents in the foregoing logwood method. But for the cortex he advises weak ammonia (0·1 cc. ammonia to 100 cc. water). The procedure is as follows:—Very small pieces of brain are hardened in 1 per cent. osmic acid for four to six days, the fluid being changed daily. The piece is then washed with distilled water, laid in absolute alcohol for one or two minutes, imbedded in celloidin and then in wax or paraffin, and then sectioned. The sections are removed from the knife to pure glycerin, or diluted with 1/4 water. Therein they may be allowed to remain for a length of time, but when required for use the glycerin must be thoroughly removed. The sections are then removed with 1/4 per cent. of permanganate solution for ten to fifteen seconds, after which they are transferred to the acid solution. The sections having been carefully washed, are then stained again with some red dye (Magdala red, neutral picrocarmine, acetic acid carmine). Mounting may be done in glycerin, or after dehydration and clearing up, in xylol or creosote in dammar.

Staining Tubercle Bacilli.*—The contribution of Dr. P. Ehrlich on staining tubercle bacilli is chiefly occupied by problematical doctrines about the capacity of the bacterial envelope for taking up dyes. These doctrines simply amount to the well-known facts that alkalis, anilin, and phenol render the envelope more penetrable to stains, that mineral acids penetrate relatively slowly, and that the membrane, when under the influence of acids, is quite impenetrable to the compound molecules of the ordinary dyes.

The author's hints on practice are more valuable than his theories. Thus he remarks that contrast stains, such as Bismarck brown for methyl-violet, and methylen-blue for fuchsin, should be slightly acidulated with acetic acid.

* Charité-Annalen, 1886. Cf. Zeitsch. f. Wiss. Mikr., iii. (1886) pp. 525–30.

For cover preparations the glasses used by him are from 0·01–0·012 in. thick. The sputum is pressed into a thin and even layer, and before separating the two covers they are laid on a hot plate at a temperature of nearly 100° C. until coagulation, shown by opacity, occurs.

For staining, the author usually employs anilin-fuchsin, and for decoloration nitric acid diluted with 2 parts of saturated sulphanilic acid. Decoloration is not continuous, but is performed at intervals of a few seconds, and each time the acid is thoroughly washed away.

For demonstrating tubercle bacilli in fragments of tissue where thin sections are only obtainable with difficulty, the author adopts the following method :—

(1) Stain cover preparations in watery solution of fuchsin for twenty-four hours. (2) Anilin-fuchsin for twenty-four hours. (3) Wash in spirit, or for a short while in sulphanilin nitric acid, afterwards washing with water carefully. (4) Immerse in concentrated solution of sodium sulphide for twenty-four hours, and then transfer to a vessel filled with recently boiled water. (5) Dry the preparation and examine, without contrast staining, in balsam.

Chemistry of Staining.* — Herr P. G. Unna has made a further contribution to the chemical theory of staining. He has previously shown that two reagents, metaphenylenediamine and nitric acid, which outside the tissue at once unite into the brown triamidoazobenzol (vesuvin), when separately introduced into the tissue lose this affinity. He has utilized sections of leprous skin hardened in alcohol for the corroboration of his theory of the occurrence of a chemical process in staining. This tissue was peculiarly suitable as containing within a minimum space the most diverse vegetable and animal substances.

By mixing equal parts of an aqueous solution of metatoluylenediamine and hydrochloric acid with nitrosodimethyl anilin, there results the beautiful deep-blue solution of toluylene-blue. When sections of the above skin are treated with 1 per cent. of this blue in aqueous-alcoholic solution they stain blue. The vegetable parasites become dark-blue, and by solution in certain acids the general blue colour of the rest of the section is replaced by red in certain regions. But if the two components be introduced separately into the tissue the result is quite different. The difference is carefully analysed, and a chemical explanation offered. It is impossible to summarize the chemical details by which the author seeks to corroborate his point. By union with the tissue a colouring substance may lose its reducibility or another its power of being oxidized. In some cases the section appears to act as an alkali. The paper is an interesting attempt to rationalize our highly elaborated technique.

FERRÉ, J.—**Acide osmique et procédé d'Ehrlich dans la préparation du bacille de la lèpre.** (Osmic acid and Ehrlich's process in the preparation of the bacillus of leprosy.) *Journ. de Med. Bordeaux*, 1887, p. 622.

GEDOELST, L.—**Un nouveau procédé pour préparer le picro-carmine.** (New process for preparing picro-carmine.) *Moniteur du Pract.*, III. (1887) p. 91.

GÜNTHER, C.—**Ueber die mikroskopische Färbung der wichtigsten pathogenen Bacterien mit Anilinfarbstoffen.** (On the microscopic staining of the most important pathogenic bacteria with anilin colouring matters.) *Deutsche Med. Wochenschr.*, 1887, pp. 471–5.

Imada, Y.—**An improved Fluid for Injection.** [*Transl.* from the 'Chū-gwai lji-schimpō.] *Sei-i-Kwai Med. Journ. Tokio*, VI. (1887) p. 7.

* Arch. f. Mikr. Anat., xxx. (1887) pp. 38–48.

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

Treatment of Sections which have been imbedded in Paraffin.*—Dr. H. Strasser removes the paraffin with benzin or with warmed turpentine, after which the sections are placed in chloroform for a short time and then in 60 per cent. spirit. From the spirit they are transferred to solutions, either watery, or mixed with a little spirit.

When treating serial sections the author has somewhat modified his former method for producing paper plates covered with gum and collodion. Sheets of stout smooth writing paper are pinned down to any flat surface and brushed over with a solution of gum arabic. With the mucilage of gum arabic of the pharmacopœia is mixed 1/5 vol. of glycerin. This addition renders pressing the sheets superfluous. When the gum layer is dry, it is coated over with collodion thinned down with ether to the consistency of glycerin, and 1/100 vol. of castor oil added to impart elasticity. The collodion mixture should be smeared on with a large soft brush, and with practice several layers can be put on in a few minutes. Thus prepared they are folded in the middle, the paper side outwards, and laid aside till wanted. The sections are stuck on with the following mixture:—Collodion 2 vols, ether 2 vols, castor oil 3 vols. Care must be taken that no air remain under the section, and when it is fairly fixed, the surface is brushed over with the same solution. The plates thus prepared are then immersed in benzin or turpentine for a half to several hours. Turpentine is to be preferred for most reasons, while the chief advantage of benzin is that the plates require less careful manipulation. The plates are then placed in chloroform, from which in fifteen minutes or longer they are transferred to 80–85 per cent. spirit, wherein the collodion is gradually hardened.

Fixing Sections.†—Clouding of the shellac used for sticking on sections can be avoided by dissolving the shellac in carbolic acid. But as the acid attacks many tissues—for example, the skin of vertebrates—the author recommends the warm slide to be smeared with an alcoholic solution of shellac, and then allowed to cool. The sections are then placed on dry, and having been carefully smoothed out, are exposed to the vapour of ether. This is most easily and simply done by putting the slide in a vessel, at the bottom of which is some ether. The vessel is then closed, and in about half a minute the sections are saturated with ether, which is afterwards removed in a water-bath. The further treatment is as usual. Softening the shellac with ether vapour is not so safe for brittle sections as the carbolic shellac. As chloroform also softens shellac, the use of chloroform balsam is rather dangerous; it is safer to use turpentine or benzol (not benzin) balsam.

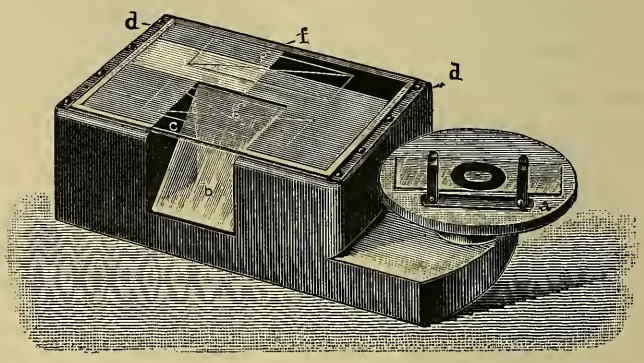
The formula given for the author's albumen adhesive is:—Albumen 50 cc.; glycerin 50 cc.; salicylate of soda 1 gr.; the mixture is to be well shaken, and then filtered into a clean bottle. Is said to keep for at least three years.

Eternod's Turntable "to serve several purposes."‡—Prof. A. Eternod has utilized the body of the turntable (fig. 232), so that it is now available for different purposes, and this is effected without increase of space, a desideratum to many workers. The turntable is at *a*, the upper surface

* Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 44–6.
† Internat. Monatschr. f. Anat. u. Physiol., iv. (1887) Heft 2.
‡ Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 41–2 (1 fig.).

of the body of the stand is filled with a plate of glass *c*, the bevelled edges of which are fixed by a strip of metal *d*. Part of one side is excavated so that a mirror *b* can be fitted in. Beneath one half of the glass plate is a strip of cardboard *f*, stained in different colours, blue, green, red, black, or white; at *g g* are two devices drawn with a diamond for exactly centering

Fig. 232.



objects on the slide. The use of the mirror is for finding specimens immersed in dark staining fluids. Above the coloured paper, objects can be teased out on grounds suitable to their colour.

Wax as a Cell Material.*—Mr. J. E. Whitney recommends the sheet wax used for making artificial flowers as a material for cells. The objection usually raised against wax as a dry mount, is that it sweats, and consequently the mounted objects become obscured by condensed vapours. The author has met this difficulty by the simple plan of coating the inside of the cell with cement, and his experience of this medium after some years and of some two thousand dry mounts, is that no sweating occurs when this material is properly manipulated. Ordinary sheet wax, the fresher the better, as when old it is brittle, and requires to be warmed, is placed in layers one above the other according to the desired thickness; and from these layers which are made to adhere by the heat of the hand, rings are punched out. Suitable punches devised by Mr. Whitney were described in the 'Proceedings' of the American Society of Microscopists for 1884.

The rings having been punched out are placed on a slide previously warmed and cleaned; pressure with the finger causing them to adhere to the glass firmly. The turntable upon which the slide had been placed for the previous operation is now revolved, and the inner and outer edges of the ring smoothed down with a penknife. When this is finished, a coating of some transparent cement is laid over the outer and inner surfaces of the ring. The varnish dries in a few hours, but it is better to leave them for a few days well covered up from dust. When the object is placed in the cell and secured by a minute drop of cement, a thin coat of cement is given to the top rim of the cell so that the cover will adhere firmly. The author then usually finishes off his mounts at once by putting on a coat of cement after the cover-glass has been fixed; for that purpose shellac varnish is

* Proc. Amer. Soc. Micr. 9th Ann. Meeting, 1886, pp. 153–6.

perfectly safe. If, however, the cement should tend to run in when the cover is applied, the finishing coat must be delayed for a few hours.

Mounting in Fluids.*—Mr. E. Ward writes on this subject as follows:—"There are some microscopic objects that we cannot mount, either dry or in balsam, nor yet in glycerin jelly, because the heat necessary to liquefy the jelly destroys the structure of the object. In such cases we must use fluid, but to seal up the fluid permanently is one of the difficulties of micro-mounting. I have been most successful in the way I purpose to show to-night. I first make a cell of brown cement, and allow it to harden thoroughly. I then spin a second ring of cement when just upon the point of mounting any suitable object; then fill the cell with water or other fluid, and arrange in it the object: place the cover-glass gently down, and fix with a clip just strong enough to hold it in position without causing any convexity, and absorb the exuded moisture by means of blotting-paper. After the clip has remained for an hour or so it may be removed, and another ring of brown cement spun over the junction of cell, slip, and cover-glass. This will make all secure. Brown cement is not suitable if used by itself for any fluids containing alcohol, because the spirit has some action upon this medium. In this case the cell, after being made in brown cement, should be covered entirely with balsam and benzole, and when dry this is again made tacky by a thin line of balsam, which fastens down the cover-glass. A ring of brown cement may be spun over all, and completely seal the mount, which may be afterwards finished in any way desired."

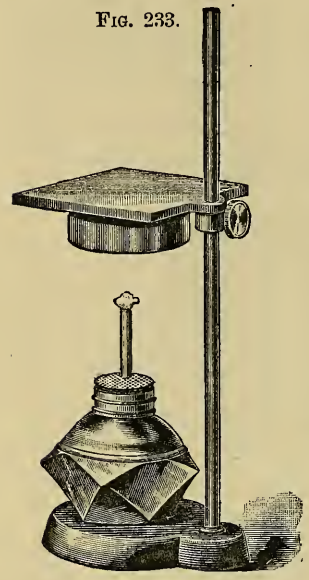
Media for mounting very perishable Artificial Crystal Sections.†—By very perishable crystals Prof. C. Johnston means such as lose their polish or become opaque in Canada balsam as well as in air. Examples of these are potassium and sodium tartrate, potassium nitrate, ammonia-sodium tartrate, and potassium and ammonia-sodium tartrate. Plumbic acetate is especially prone to undergo decomposition. A mounting medium should be transparent, and if possible colourless, enduring as such; of an index of refraction having reference to the substance treated; free from moisture, and not a solvent of the matters it is employed to defend. The author mentions the following as especially worthy of attention.

(1) Finest gum copal dissolved in chemically pure amylic alcohol. (2) Finest gum copal dissolved in chemically pure absolute alcohol. (3) Dammar resin dissolved in rectified spirits of turpentine. In making these solutions no heat is to be used. The gum copal should be broken up to the size of buckshot, set in a warm dry place for a while, and then having been placed in a well dried bottle to the extent of two-thirds its capacity, alcohol is poured in until the bottle seems half full. The bottle is then corked and the solution is left to time. The resultant fluids should be very thick. The absolute alcohol solution is highly transparent, the amylic slightly opalescent. The dammar solution is made in an analogous manner. (4) Dammar resin dissolved in well boiled copaiba balsam. To this latter, number 3 dammar solution is added, and melted by heat until the solution becomes very thick. On cooling it thins and is ready for use. It is of a dark sherry colour but quite transparent, and a preservative of crystalline films as ethel ether of gallic acid. (5) Boiled Chian turpentine dissolved in boiled balsam of copaiba. The turpentine is boiled until, when cold, it becomes nearly hard. The boiled copaiba and the turpentine are then melted together, until the mass, when cold, is too thick to flow.

* Trans. and Ann. Rep. Manchester Micr. Soc., 1886, p. 69.
† Johns-Hopkins Univ. Circ., vi. (1887) pp. 79-80.

The colour is a dark sherry, but the medium is transparent and brilliant, and is excellent for sections of potassium nitrate made parallel to the axis.

Fig. 233.



Solution number 1 is suitable to perishable crystals, as plumbic acetate, Rochelle salt. Number 2 is best fitted for attaching crystals or sections of any kind, or for holding sections to be ground very thin. Number 3 is preferable to Canada balsam on account of its white colour. It serves well to mount separately halves of the same crystal section, and is a capital cement for these two mounts when crossed. Numbers 4 and 5 are preferred by the author as they are perfectly free from humidity, and though darker than fresh Canada balsam, their tint does not deepen by time. A sixth medium, of which Prof. Johnston has had less experience, but of which he speaks favourably, especially for potassium nitrate, is made by boiling the whitest dammar until the scum is nearly dissipated; the rest of the scum is then spooned off. Rectified spirits of turpentine are then added till the proper tenuity is attained. It is then passed while still warm into a bottle, or the dammar having been boiled may be allowed to cool and then broken up into small pieces; these pieces are then put into a bottle and covered with rectified spirits of turpentine, the solution being left to time to accomplish.

Fig. 234.

Bausch & Lomb Optical Co.'s Spirit-lamp.—The peculiarity of these glass lamps is that they have nine facets, so that they can either be used upright on a mounting stand, as in fig. 233, or inclined as in fig. 234. The size of the flame may be regulated by a sliding tube. In use the lamp is filled only one-third full.

Briant, T. J.—**New Form of Microscopic Cell** for mounting objects requiring to be examined on both sides.

[A piece of cardboard, the size of the usual glass slip, and having a circular aperture punched in its centre, is pasted between two similar cards with apertures slightly larger. A ring of Miller's cement is then run round the edge of the inner card, on one side of which a cover-glass is fastened, thus forming a fluid-tight cell. In this the object is placed, and is secured by another cover-glass, also fitting the aperture of the outer card. Objects mounted in this way may readily be examined with high powers, both on their upper and under surfaces.]

16*th Ann. Rep. S. Lond. Micr. and Nat. Hist. Club*, 1887, p. 12.

Neville, J.—**New Form of Dry Cell.**

["Made of vulcanite, which he had named the window-slide. This cell allows the cover-glass to be slipped on and off at pleasure, so that objects may be at once put up for examination, and dust or damp on the glass at any time removed."]

16*th Ann. Rep. S. Lond. Micr. and Nat. Hist. Club*, 1887, p. 12.

Pinckney, E.—**Slide-Index.**

[Considers that the catalogues prepared by Ward and others may serve their purpose as a *record*, but not as an *index*. Every worker needs a reliable slide-index, to which he may turn for instant reference, and he therefore suggests the following:—Take a six-quire blank book, commonly known as "record" form, plain blue lines for writing and one vertical red line about one inch from left-

hand side of page. With a ruling-pen, draw a second similar red line, about half an inch to right of first one. This gives three spaces on each page. Now index the edges, giving each letter its due proportion. In the first space write the generic name, as *Amphipleura*, while in the third space you write the specific name, as *pellucida*, together with the number of the slide. The second space is for a key, or catch-word, and for this purpose a set of abbreviations is used.]

Microscope, VII. (1887) pp. 239–40.

(6) Miscellaneous.

BASTIN, E. S.—**Elements of Botany, including Organography, Vegetable Histology, Vegetable Physiology, and Vegetable Taxonomy.**

[Appendix treating of the Microscope, accessories, staining and mounting, fluids, and micro-reagents.]

300 pp., nearly 500 figs., 8vo, Chicago, 1887.

Bizzozero, G.—**Handbuch der Klinischen Mikroskopie, mit Berücksichtigung der Verwendung des Mikroskops in der gerichtlichen Medizin.** (Handbook of Clinical Microscopy, with reference to the use of the Microscope in Medical Jurisprudence.) *Translated* by *Dr. S. Bernheimer*, with a preface by *Dr. H. Nothnagel.*

2nd ed., x. and 352 pp., 45 figs. and 8 pls., 8vo, Erlangen, 1887.

COLE, A. C.—**Studies in Microscopical Science.** Vol. IV. Secs. I.–IV. Nos. 10, 11, and 12.

Sec. I. Botanical Histology, pp. 37–47. No. 10, X. Studies in Vegetable Physiology: Waste products. Glandular structures. (Plate 10. Resin glands from leaf of *Psoralea hirta*.) No. 11, XI. Glandular structures and crystals. (Plate 11. Petiole of Ivy.) No. 12, XII. Growth. (Plate 12. Young twig of *Aristolochia sipho* T. S.)

Sec. II. Animal Histology, pp. 37–50. No. 10. Reproduction in Snails. (Plate 10. Ovotestis of Roman Snail—*Helix pomatia*, Tr. S. × 230.) No. 11. Reproduction and Development of the Liver Fluke. (Plate 11. Liver Fluke—*Fasciola hepaticum* × 4.) No. 12. Reproduction in Tape-worms. (Plate 12. Tape-worm —*Tænia mediocanellata*, L.V.S. × 12.)

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JAMES, F. L.—**Clinical Microscopical Technology.** VI.

[Urinary Examinations. Micro-clinical Reactions. Parasites and Fungi.]

St. Louis Med. and Surg. Journ., LIII. (1887) pp. 31–3, 100–2, 167–8.

JENNINGS, C. G.—**The Microscopical Examination of Urinary Deposits.** II.

Microscope, VII. (1887) pp. 202–4 (2 figs.)

[MANTON, W. P., and others.]—**Elementary Department.** Fifth and Sixth Lessons. "Cleanliness is akin to godliness."

[Section cutting and staining. Microtomes. Stains.]

Microscope, VII. (1887) pp. 211–4 and pp. 244–8.

(Cf. *St. Louis Med. and Surg. Journ.*, LIII., 1887, p. 99; comment on motto, which "wants reversing.")

M'CASSEY, G. H.—**Microscopy and Histology for Office Students.**

Arch. of Dentistry, 1887, May.

RAFTER, G. W.—**How to study the biology of a water supply**

19 pp., 8vo, Rochester, N.Y., 1887.

TAYLOR, T.—**Crystalline formations of Butter and other Fats.**

Microscope, VII. (1887) p. 239 (1 pl.).

WEINZIE'RL, T. RITTER v.—**Die qualitative und quantitative mechanisch-mikroskopische Analyse; eine neue Untersuchungsmethode der Mahlproducte auf deren Futterwerth und eventuelle Verfälschungen.** (Qualitative and quantitative mechanico-microscopical analysis; a new method of investigation of food-products, with reference to their value as food and their possible adulterations.)

Zeitschr. f. Nahrungsmitteluntersuchung und Hygiene, 1887, July, 14 pp. and 1 pl.

examined without the prism the phosphorescent colonies seem greenish, or even greenish blue.

Transmitted light is absorbed by the colonies, although absorption-bands are to be perceived. Examined with Zeiss objective A, microspectrophotometer, comparing prism, two Engelmann incandescent lamps, three large Groves, both spectra with a slit of $s = s_1 = 20$ (wherefore $1 = 0{\cdot}01$) were approximately equal, and gradations of light were found which on interposing the colony required for given wave-lengths the following decrease in the slit of the comparing prism:—

$$\lambda = 0{\cdot}66, 0{\cdot}63, 0{\cdot}60, 0{\cdot}57, 0{\cdot}54, 0{\cdot}51, 0{\cdot}48, 0{\cdot}45.$$
$$s_1 = 12{\cdot}1, 12{\cdot}4, 12{\cdot}0, 10{\cdot}8, 9{\cdot}9, 9{\cdot}4, 7{\cdot}7, 6{\cdot}3.$$

By multiplying the numbers found for s_1 by 5, the per cent. equivalent of the absorption is obtained.

These micro-organisms moreover show a vital phenomenon in which they differ from other phosphorescent bacteria. Pure cultivations in salinated gelatin, bouillon, potato, &c., emit light equally well at temperatures from 0°–20° C., but cease to give off light at from 32°. So far these properties agree approximately with the results of Pflüger, but if these bacilli be kept at 35°–37° C. for some hours, their vitality is so impaired that inoculation from colonies thus treated can no longer be reproduced in a nutritive medium previously found quite suitable. Yet they will grow almost equally well in a refrigerator, and even if the test-tube be surrounded by finely-powdered ice and then placed in the refrigerator, that is to say, at a temperature of 0° C.

MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

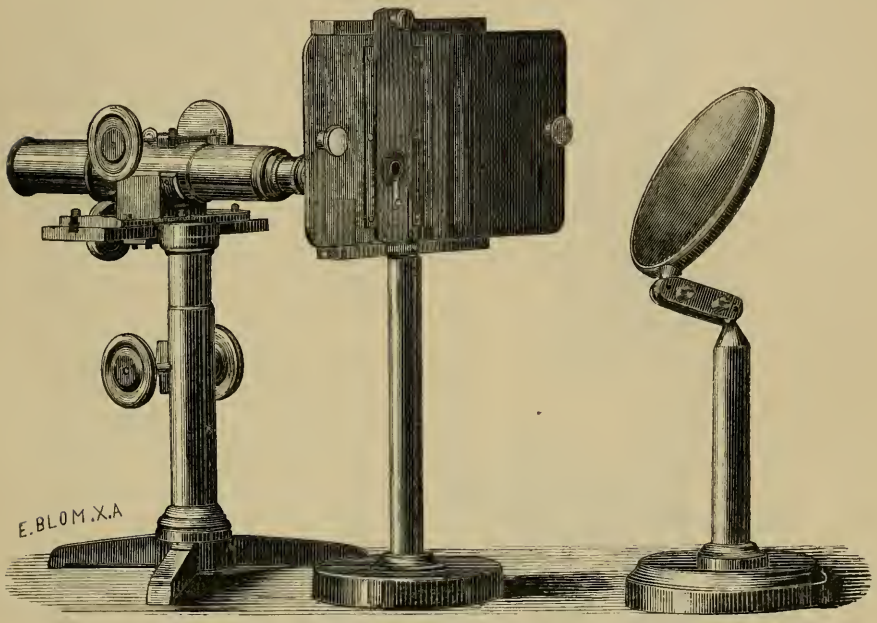
Schulze's Aquarium Microscope.—Prof. E. Schulze has designed and Messrs. Klönne and Müller have made the Microscope shown in fig. 235, for the observation of small aquatic organisms in an aquarium specially constructed for the purpose. There are three parts,—(1) the stand, the greater part of which is nickel-plated; (2) the aquarium; (3) the illuminating mirror.

The stand consists essentially of a Microscope-tube which is supported in a horizontal position upon a tripod in such a way that it can be moved in three different directions by rack-and-pinion. The column of the tripod carries a rack-and-pinion by which the tube is moved vertically. On the tube which carries the rack is a sliding-piece with a second rack for the horizontal movement from right to left; upon this slide the Microscope is fixed in a horizontal position and can be moved backwards and forwards in a tube provided with rack-and-pinion. There are therefore three movements, vertical, horizontal-lateral, and horizontal-sagittal, so that the organism observed can be followed by the tube as it moves upon the glass wall of the aquarium.

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

The aquarium consists of a stand with a frame which carries the aquarium proper, 10 cm. in breadth and height, and 10 mm. in thickness; this may be replaced by others. The frame is made of brass lacquered black. The aquarium itself consists of a horseshoe-shaped piece of glass, both sides of which are closed by plates of cover-glass leaving the upper end open. It is thus possible to observe an organism upon either of the

Fig. 235.



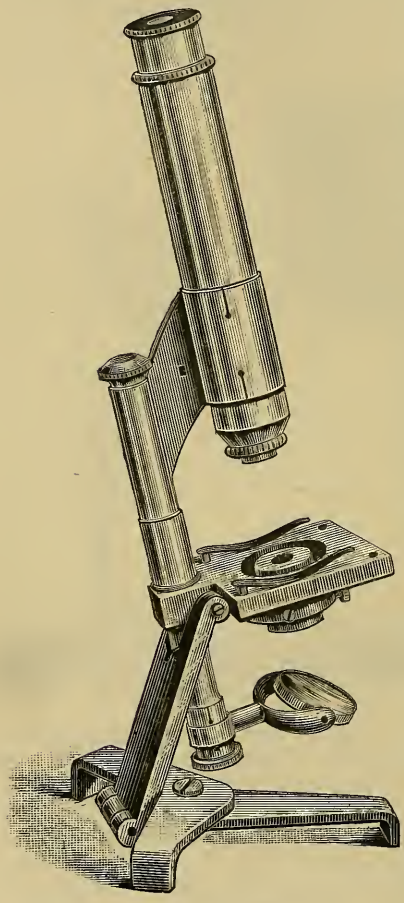
two thin sides with an objective giving a linear amplification of 200–300. To screen off the superfluous light and the numerous reflections in the aquarium, the frame carries a diaphragm arrangement which can be applied on either side at pleasure. This consists of a sliding-plate which moves in two horizontal guides; it is divided into three parts, and has an oblong opening in one of the divisions. In this opening a thin plate slides and can be clamped at any point. In this plate again is a circular aperture, which can be closed to a greater or less extent by various diaphragms kept in position by a small spring.

If an animal is on the upper left-hand corner of the side turned towards the Microscope, the sliding-plate is first moved so that the vertical longitudinal opening lies in the left-hand third, the small plate is then set so that its opening lies in the upper third. If, on the other hand, the animal is on the right-hand side, the larger sliding-plate is moved so that the longitudinal opening lies on the right, and if the animal is towards the bottom, the small slide with its opening is moved downwards. The two sliding-plates are now so directed that light may be thrown by the mirror through the aquarium and upon the animal on the front side. The aperture can be further reduced by diaphragms.

The mirror is concave, 10 cm. in diameter, and fixed upon its stand with a ball-and-socket joint so that it can be adjusted in any position.

Giles's Army Medical Microscope. — Mr. G. M. Giles, Surgeon-Naturalist, Indian Marine Survey, writes, that "to the military surgeon, or explorer, who has to carry a Microscope with him, bulk and weight are considerations of the first importance. Even in peace time the former is so often on the move, that he early learns to dispense, as far as possible, with bulky and heavy articles." Hence he was "anxious to devise an instrument which while it should pack into a moderate-sized box, should not be open to the objections of some of the existing forms, and in fact should be applicable to all the work of the military surgeon in station as well as in camp life." This is shown in fig. 236.

Fig. 236.



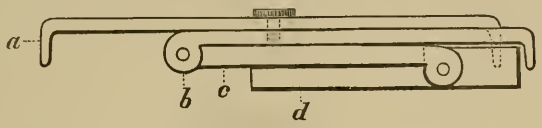
"The great obstacle in the way of making a sufficiently portable stand is that, in all previous patterns, the stage is permanently fixed to the body, and so has to be limited in size in order not to unduly increase the cross measurement of the box. This difficulty has been met by making the stage and foot in one piece, arranged so as to fold up flat, for packing (fig. 237), the body and pillar being keyed on to the stage and fixed in position by the arm carrying the mirror being used as a nut.

When set up, the instrument is about 9 in. high, and the stage measures 2·5 in. by 2·2 in., and is quite adequate to all ordinary pathological work. When folded up, it packs, including the centering substage described below, into a strong box 5·8 in. by 3·2 in. by 2·75 in. outside measurement. By making the box a little longer (7 inches) an extra objective, double nose-piece, and polariscope can be carried in addition, the last-mentioned piece of apparatus being a special desideratum to the geological explorer.

Every microscopist knows how much definition is improved by the use of the German form of diaphragm, the aperture of which is level with the stage, and does not markedly exceed the field of the objective. In a portable instrument, these can hardly be used except in a centering substage, of which I have devised a very simple and inexpensive form for the purposes of this instrument. It consists of a short, stout brass tube, screwing into the opening in the stage. The tube carrying the diaphragms, polarizer, condenser, &c., is provided with a double collar, and is supported within the larger tube by means of three screws. One of these has a thread only at its point where it screws into the inner tube, its shaft working freely in a hole in the outer. Between the two tubes it pierces a small piece of solid

rubber which acts as a spring. The other two screws are provided with milled heads, and work in holes tapped in the outer tube, their points alone being free from thread, and made to fit exactly into the slot of the double

Fig. 237.

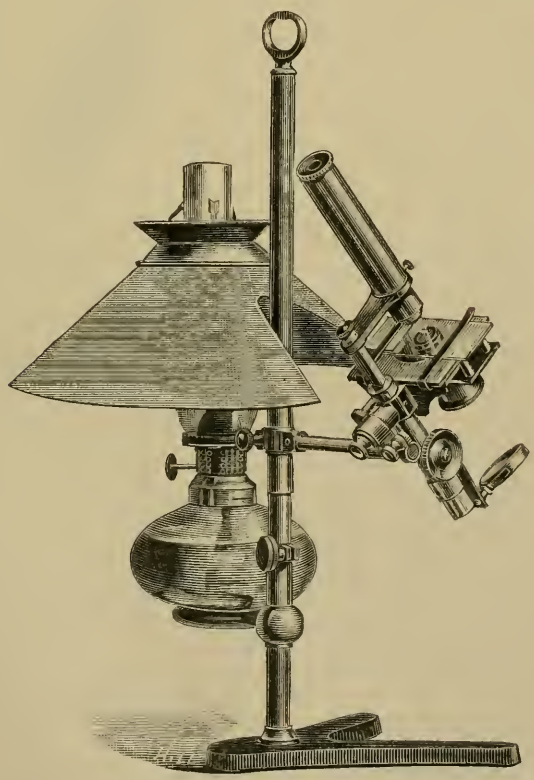


Elevation of stage and foot when folded. *a*, transverse limb of foot; *b*, antero-posterior ditto; *c*, pillar; *d*, stage.

collar, which they press against the resistance of the rubber spring. The second objective is carried within the tube of the Microscope, screwing for packing on to the upper side of an adapter. This also serves to carry the analyser when the polariscope is in use."

Nelson's Portable Microscope.—Mr. E. M. Nelson exhibited at the November meeting of the Society a new portable Microscope (figs. 238 and 239), made by Messrs. Powell & Lealand from his drawings.

Fig. 238.

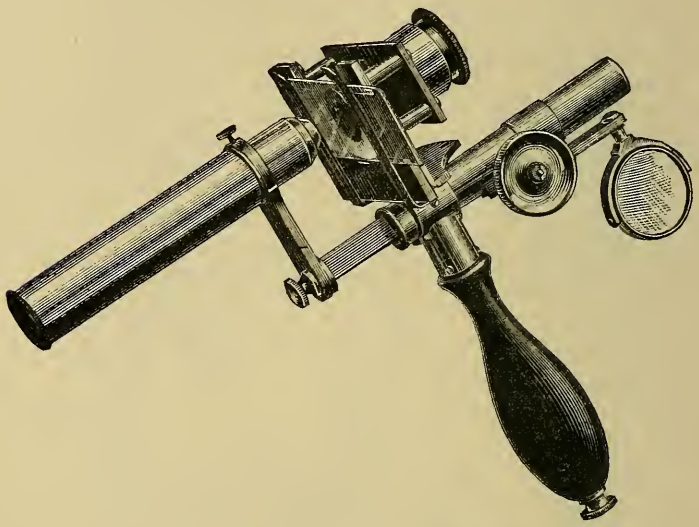


The instrument is adapted for three different modes of use, viz.:—(1) As a small table Microscope for home use (a very useful adjunct to a large instrument); (2) as a portable Microscope for the exhibition of objects at

Societies, &c. (fig. 238); (3) as a field Microscope and class demonstration instrument (fig. 239).

The instrument has two objectives, a 4/10 in. and a 1 in., which, with two eye-pieces, give the following powers:—35, 70, 100, 200. The 4/10 is of 0·65 N.A. The highest power, therefore, is equivalent to a 1/2 in. of

Fig. 239.



80° with a C eye-piece, or a 1/4 of 80° with an A eye-piece, on an ordinary full-sized English Microscope. The lowest eye-piece is on the Abbe compensating principle.

In the mechanical portion of the instrument are several new features. The design of the Microscope is that which is generally known as the bar movement. It has a rack-and-pinion coarse-adjustment, and no fine-adjustment, thereby following the dictum of the great master (the late Hugh Powell), who said, "In an elementary Microscope a good coarse-adjustment without any fine is better than one with a second-rate fine and no coarse-adjustment." The truth of this statement is daily verified in the shaky condition of the fine-adjustments of students' Microscopes which are fitted with a direct-acting screw fine-adjustment and a sliding-tube coarse-adjustment. The body of the Microscope is 3 inches long. The stage is of Mr. Nelson's horseshoe pattern, and the spring clips are those of Hugh Powell. Although strongly opposed to all kinds of clips, Mr. Nelson found they were necessary in this instance to permit of the complete inversion of the instrument. The great difference between these clips and those of the usual form is that these being fixed underneath the stage, allow a smoothness of action to the slip which is totally foreign to the others.

To the underneath side of the stage is fixed the substage which carries an achromatic condenser, focusing by means of a sliding-tube.

The stage and substage rotate on an axis, so that they may be turned into the plane of the trunk for packing.

There is a plane mirror mounted on a crank arm. The foot is circular, rests on three points, and has an upright rod capable of extension like a

bull's-eye stand. On the top of the upright there is a short horizontal arm, to which the Microscope is attached.

For portable and exhibition purposes the instrument fits on to the Microscope lamp-stand, the same apparatus being used to attach it as in the first case (fig. 238).

When the Microscope is required for field or class purposes this attaching piece is taken off, and is replaced by a handle (fig. 239). The handle and the attaching piece are so arranged that the Microscope cannot shake loose or twist off, or get off the square.

When the instrument is used in the field, the mirror is swung to one side, and the condenser is pointed to the sky.

Woodhead's Microscope with large Stage.—This Microscope, devised by Dr. Woodhead and made by Mr. H. Crouch, has a stage of unusually large size, 11¾ by 9¾ in., for the examination of sections through entire organs.

Selenka's Electric Projection-Lamp for Microscopic Purposes.*—Prof. E. Selenka describes a Projection-Microscope constructed for him by Herren Reiniger, Gebbert, and Schall, of Erlangen, "which, by its practical and convenient construction, fulfils its purpose in a remarkable manner." He describes the apparatus fully "in the expectation that it will soon be more largely used; for thousands of microscopic objects can in this way be used without difficulty for demonstration, and although there is no question that the ordinary diagrams and lithographs have done, and will do good service, yet the impression made by the exhibition of the object itself is much more vivid and permanent than that produced by a representation."

To show what objects are of value for demonstration in zoological lectures, for a large circle of students, the author states that at a distance of 5 metres from the screen the contractile vacuoles and the so-called streaming of granules in living *Amœbæ* are clearly visible, as are also the ciliary movements and ingestion of food by Infusoria. "In stained calcareous sponges the flagellated chambers and spicules may be shown, as may also the cellular structure of the arms of hydroid polyps, and the entire sexual apparatus in the proglottides of tape-worms. *Trichinæ*, *Echinorhynchi*, Trematodes, worm-larvæ, small Annelids mounted in balsam, Rotatoria, and Copepoda in the living condition give incomparable images, as also the larvæ of Echinoderms and Molluscs. Sections of the embryos of vertebrates stained with carmine or hæmatoxylin make excellent objects to show the development of the vertebræ, heart, nerve-fibres, sense-organs, amnion, allantois, and urogenital system. I can show without any difficulty the cleavage of the egg, gastrulation, rudiments of the cœlom, and even the formation of yolk-rays in the segmenting ovum, and the filamentar loops in the dividing nucleus. Charming images are given by the membrane between the digits of the foot of the living frog or the gills of the *Salamander* larva, the tracheæ of the flea or the louse, &c. And how quickly and simply is the demonstration effected! In those lectures in which I intend to project microscopic objects, the discourse proceeds without interruption, and the last five to ten minutes are used for the demonstration. At a given signal the projection-lamp is put into action, and then all that is required is the complete darkening of the auditorium. This is rapidly and easily effected by lowering canvas blinds covered on both sides with a thick coating of oil-paint of any desired colour. The blinds are raised and lowered by means of a winch; the demonstration is made without any assistance.

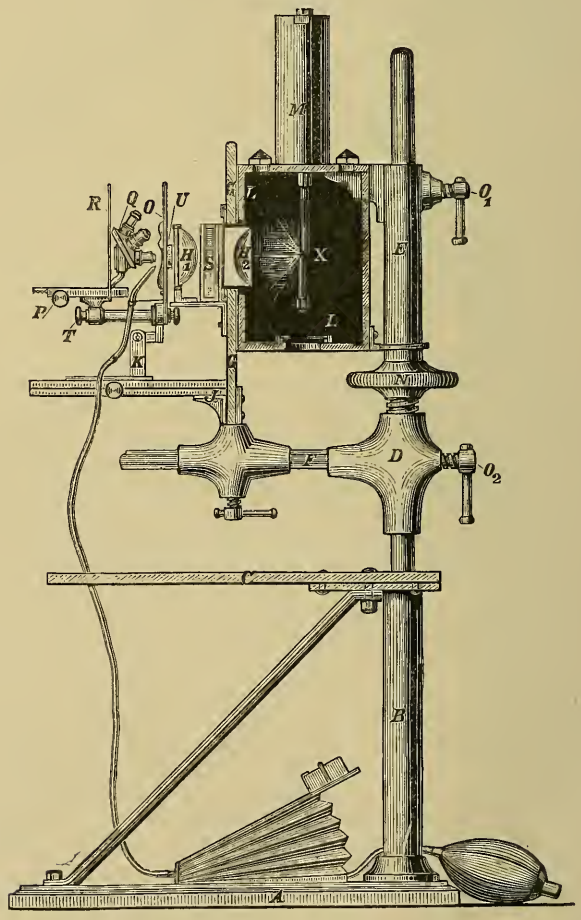
The light is obtained from a dynamo machine driven by an engine of

* SB. Physikal.-Med. Soc. Erlangen, 1887, Heft 19, 8 pp. (1 fig.).

two horse-power, and supplying an arc light of about 1200 candle-power. This is sufficient for a linear amplification of 1000 ; but for oil-immersion or for high-power dry systems an illuminator is required. An achromatic condenser has accordingly been designed by Prof. Abbe, as the ordinary chromatic Abbe condenser cannot be used for the purpose. The brightness of the image is increased to an extraordinary extent by the achromatic Abbe condenser, and, so far as I can estimate, is nearly equal to that which, without this system of lenses, would only be attained by an arc light of 2500 candle-power. Since the condenser is only used with the higher powers, it requires a simple adjustment by which it can be removed. The brightness of the image can, of course, be considerably increased by using a more powerful source of light.

The construction of the lamp (fig. 240) has been left entirely to the

Fig. 240.



mechanician. A is a rectangular plate of cast iron into which the cylindrical iron rod B is set, and fixed by two iron stays. At the height of the table is a shelf C for the objects not in use. Above the shelf are the two iron

tube-pieces which slide upon the rod B and are clamped by the screws O_1 and O_2; the lower and shorter of these tubes D carries on the horizontal ribbed arm F, the plate G with the condensers H_1 and H_2, and also the plate J with the Microscope K. To the upper and longer tube E is fixed the light-chamber L with the arc-lamp M screwed to its upper side.

The light used is that known as the Piette-Krizik lamp which, on account of its accuracy of regulation, has been very largely used, and for this very reason has been better tested than many other systems, and which, in spite of its excellent construction, is moderate in price. Since, however, with the best regulated lamps the point of light after long use is invariably shifted slightly upwards or downwards, the piece which carries the lamp and the light-chamber is made to slide up and down the fixed part which supports the condensers and the Microscope, so as to bring the point of light back into the axis of the condensers. This movement is effected by means of a nut N which works between the parts D and E upon the screw-thread of D, so as to raise or lower the light-chamber L and the lamp M, and bring the point of light X to any desired height. A rotation of E with the light-chamber is rendered impossible by bringing the plate G close against the front side of L and making it fit in grooves upon the front of the light-chamber, so that the two parts can only move upon one another in a vertical direction and keep the source of light completely inclosed.

The light-chamber is made of strong oak, and to the top is screwed the lamp from which the two iron rods which carry the carbons project into the chamber. In the top are also, besides the aperture for the carbon-holders, several ventilating holes to carry off the hot air; these holes are covered with tin caps to screen the light. The left side of the chamber is entirely closed, while the right side is provided with a door to allow the insertion of new carbons, &c. In the centre of the door is a circular hole closed with dark glass through which to observe the glowing carbon points. At the bottom of the chamber is a circular opening through which the shelf for the objects is illuminated, and which serves for ventilation; above the opening is a dark glass to moderate the light and to catch the ash which falls from the carbons.

The front side of the chamber has an aperture into which the condenser-holder projects. This aperture is made large enough to allow free play for the chamber; the source of light being brought into the axis of the condensers, as was said above, by a motion of the chamber. In the axis of the lenses H_1 and H_2, is the Microscope K, supported on the plate J which is attached to G.

For the lenses I use the ordinary horseshoe stand with the following alterations: (1) the upper piece for rotating the Microscope is unscrewed from the foot, turned through 180°, and fixed again to the foot so that the stage is not over the horseshoe, but projects behind it; the horizontal Microscope can then be brought as near as is required to the large condensing lens H_1, which with low powers is necessary to secure a colourless image. (2) Instead of the small thick stage, a large plate O with diaphragm U and two clips is used; (3) in place of the tube moved with rack and pinion, there is an arm P, moved in the same way and carrying the nose-piece Q, which allows a rapid change of objectives. A metallic screen R, of 15 cm. diameter, serves to arrest the rays which pass beside the objective; this is placed immediately behind the nose-piece.

With high powers the object must be brought near to the focus of the condensers, while with low powers it must be moved beyond the focus and

brought nearer to the condenser. This movement is effected by a sliding motion of the stand K between two wooden guides, by means of rackwork.

Between the two condensing lenses it is necessary to insert a glass trough S, with plane sides filled with concentrated alum solution, to prevent the over-heating of the object. Thick or dark-coloured objects are very easily over-heated; an energetic and invariably sufficient means of cooling is obtained by a current of air directed upon the surface of the object or upon the cover-glass. Compressed air is obtained from a loaded india-rubber bag (above A). The delivery tube is of brass, with an aperture of 1/2–1 mm., and is fixed to the stand at an angle of 45° on the under side of the objective; the distance of the aperture from the cover-glass being about 1 to 1½ cm.

The coarse-adjustment is effected by the rackwork on P, the fine-adjustment by the micrometer-screw T. The objects are held by one or two of the usual clips against the vertical stage.

The nearer the lamp is to the white paper screen, the brighter will be the images, but the less the amplification. After several trials a distance of 5 metres between the object and the screen has proved the most convenient. By using a stronger source of light, this distance may easily be increased to 6–10 metres.

To bring the projected image as near as possible to my audience, I place the electric lamp in the middle of the amphitheatre, and the screen in front of the first row of seats, an open passage being left between the lamp and screen. There is no objection to the image being seen obliquely foreshortened by those of the audience who are at the sides; it scarcely loses in clearness thereby.

White paper does not give nearly such bright and clear images as a plaster surface. This is made by bending an iron band into a circular or rectangular form, making a network of wire across it, and placing the whole upon a glass plate which has been rubbed over with powdered talc. Alabaster plaster is poured upon the network, and when it is cool the whole mass is lifted off. The projection plate should have a diameter of 1·2 to 2 metres. Trials with transparent screens, such as oil paper, tracing paper, or ground glass plates gave unsatisfactory results.

After numerous experiments it has been found that the finest images are given by those objectives which have been made for a long tube, especially the so-called photographic objectives. It is not advisable to make use of an eye-piece for projection purposes.

To cut off all extraneous light, it is a good plan to place over the condensing lens H_1 and the alum trough S, a light cardboard case which is prolonged into a cardboard tube towards the stage of the Microscope in the direction of the beam of light.

Finally it may be mentioned that it is possible to use a horizontal stage. The beam of light is then reflected upwards by the ordinary plane mirror, and again deflected into a horizontal direction by a prism of flint glass, which rests against the upper nose-piece aperture.

Of the objectives which I have employed, the following give the best defined images:—Hartnack, objectives 1 and 2; Seibert, 1 in., 1/2 in., and 1/4 in. photographic objectives; Winkel, objective 7; as well as water- and oil-immersion objectives of various makers.

Absolutely colourless images of extraordinary clearness are given by the combination of the new Zeiss apochromatic objectives with the corresponding 'projection-eye-pieces.' Though this combination is unrivalled for photographic purposes, it is not convenient for demonstration, since the image is too faint and of too limited dimensions."

The whole apparatus is supplied in this country by Mr. K. Schall, of

55, Wigmore Street, W. It was exhibited at the meeting of the Medical Congress at Dublin in August, where it was reported * to have "proved itself infinitely superior to the oxyhydrogen limelight as a means of class demonstration."

At the Hygienic Congress in Vienna, Prof. S. Stricker also gave demonstrations with the electric Microscope, which, it is claimed,† conclusively prove the value of this new method of medical teaching. Among other things, Prof. Stricker exhibited photographs by transmitted light, with 1400 linear amplification, and a section through the spinal marrow of an adult man, in which the ramifications and crossings of the nerves could be most clearly seen. A demonstration was also made with incident light and an amplification of 72,000 times, the object being the exposed pulsating heart of a turtle. "The whole action of the heart could be followed in the most surprising manner, the flow of blood to the great aorta could be observed, and an insight obtained into the inner life to an extent which is seldom realized by experienced students of hygiene."

Leach's Lantern Microscope.‡—At the Soirée of the Manchester Microscopical Society, on the 29th January, 1887, Mr. W. Leach exhibited a Lantern Microscope, attached to a photographic camera, the bellows body of which opened out to thirty-six inches. With a 4/10 in. objective, images were shown upon the screen magnified eighty diameters, and "were seen well defined, brilliantly and equally lighted, without covering being placed over the camera, notwithstanding the gaslights overhead and all around the room. The field was noted for being as even as a sheet of writing-paper. When the lantern door was opened much astonishment was expressed, when it was seen that all this illumination was obtained from a small paraffin lamp burning with a single half-inch wick."

The author in his paper describes his experiments and results as follows :—

"It is some eight or ten years since I felt dissatisfied with the results which I was then able to obtain with the ordinary lantern arrangements for projecting microscopic objects upon the screen, and began to make experiments with the aim of getting more successful illumination. The amount of light transmitted through the bi-lens lantern condenser being in the inverse ratio of the square of the distance between it and the luminant, I tried to shorten the space by the well-known device, first introduced by the Rev. W. T. Kingsley about 1855, of adding a third lens to the other two, and thus shortening the compound focus. But this I soon found was, without further addition, of no use whatever, as the cone of rays at its apex was so large, or the light passed through it at so great an angle, that it was impossible to transmit it through both the object and the objective. Thus the beam of light, however strong it might be at the focus of the condenser, did not reach the screen, and therefore served no purpose except that of boiling the object in the balsam used in mounting it.

I next placed another lens in the cone of rays a little beyond the focus, and hoped by this means to so lessen its diameter as to make it capable of transmission. This was a sort of substage arrangement, and was found to be a great improvement when the lens was of the right focus for the objective, and was situated at the right distance from both it and the object. To be able to thus place it at the right distance from both, meant having a substage lens for all objectives differing widely in power, the focus of each being such as the power and construction of the others might require.

* Brit. Med. Journ., 1887, Aug. 27, p. 470.
† Central-Ztg. f. Opt. u. Mech., viii. (1887) p. 250.
‡ Brit. Journ. of Phot., xxxiv. (1887) pp. 153-4.

Rack-and-pinion movement was also found to be necessary, so that the rays might be properly focused on either side of the object. The lenses used should be large enough to take in the whole cone of the principal condenser, and for the higher powers it is requisite to combine two or three of them together. The highest as well as the lowest powers may thus be made useful for lantern projections. Mr. Kingsley stated in his paper upon this subject at the time I have just named that he could transmit as much light through the higher as through any of the lower powers, and gave diagrams of the arrangement which he made use of.

So much for the past; now we come to the present. The objectives which I shall use this evening are 2 in., 1 in., and 4/10 in. The 2 in. requires the substage lens to be a little over 2 in. focus, $1\frac{3}{8}$ in. diameter, plano-convex. A similar kind of lens, $1\frac{3}{4}$ in. focus, proves in my hands to be a good all-round condenser for all powers from $1\frac{1}{2}$ in. up to 4/10 in. objectives. By liberal use of the rack-and-pinion and of the concave lens to be presently described, this substage lens gives the most brilliant results throughout this wide range of powers. The 1/4 in. objective, when it is desirable to use it for photographic purposes, requires two lenses; the back one to be $2\frac{1}{2}$ in. focus and $1\frac{3}{8}$ in. diameter, and the front one $1\frac{1}{4}$ in. focus and 1 in. diameter, both plano-convex. This also makes a good condenser for the 4/10 in. objective. All the lenses must have the curved surfaces turned towards the lantern. The luminant goes to within $1\frac{3}{4}$ in. of the back lens of the principal condenser with the 2 in., and to within 2 in. with the other two objectives. I have tried it closer than this, by using a back lens of shorter focus, without advantage—in fact, considerably otherwise. If a flint concave lens is placed in the cone of rays about one or two inches before the really active ones begin to cross, the light is much improved. The concave which I use is about 6 in. focus and $1\frac{3}{4}$ in. diameter. It is so placed in the tube which carries the other substage lenses that its distance from the principal condenser can be altered so as to modify the length of the cone of rays to adapt the focus of the other lenses to the objective when they do not exactly meet its requirements. The concave lens was, I believe, first introduced into the lantern cone of rays by J. T. Taylor in 1866, for the purpose of parallelizing them, but I do not use it for any such purpose in this lantern Microscope. In my lantern polariscope I imitate Taylor in the use of the concave, but here the purpose served is quite a different one. My lantern condenser is $3\frac{3}{4}$ in. diameter, with a plano-convex $3\frac{1}{2}$ in. diameter and 7 in. focus, mounted upon the back of the tube which carries the other lenses.

In lantern Microscope projection three things are essential. The first is brilliant illumination, the second large amplification, and the third clear display of detail. But brilliant illumination does not mean a dazzling display of light upon a large white screen, showing a dark, patchy outline of an object, without detail. Objects shown in this way are far inferior to an enlarged woodcut. The light must be made to enter the object so as to bring its structure out to the eye of the onlooker. But no amount of light will do this if its dimensions are too small for the crystalline lens to form an image of it upon the retina. With high-power objectives the light must, in the nature of things, be greatly subdued. Still, a large image, moderately but properly lighted, can be far better seen than a small one many times as bright. An object may in fact be too bright to be seen. If rays of great angle are too powerfully converged upon it the image becomes as bright as that part of the screen which represents nothing but bare glass. It is in this case just like an over-exposed photograph, flat and without contrast. The image may, therefore, be too bright for the screen, just as it

may be too black for it, and what we have to aim at is that mean which will show the detail in one without making the other too glaring.

Having made our arrangements according to what is here advanced, we ought to be able to show the various minute organs of insects and the details of vegetable and animal tissue. I have shown very finely the blowfly's tongue over sixteen feet long, and the male flea with its outstretched legs twelve feet long. Sections of spine of *Echinus* may be magnified to seven or twelve feet diameter, and sections of a rat's tail eight feet diameter. Mites in cheese with such powers become large as guinea-pigs, and *Volvox globator* gracefully rolling over a sixteen-feet screen are larger than tennis-balls. The cornea of the *Dytiscus* is a most wonderful object when shown eight to ten feet in diameter.

When I say that such things can be shown in such enormous sizes, you must not suppose that the display will be like an outline map, black and skeleton-like in appearance upon a white ground. Instead of that the small capillary blood-vessels in anatomical sections, the various appendages of the feet of insects, the hairs of plants, the rings of insect tracheæ, the eyes of insects with the light gleaming through each facet of the cornea, with other equally minute details, can be displayed to an audience with very great satisfaction. That, you must admit, far surpasses anything ever achieved by the old lantern Microscope, and we boldly challenge any admirer of the old method to show that he is not now left as far behind by the new one as the old stage-coach is left behind by the railway train.

I think I ought to say that my lantern Microscope has been made by myself. All its details have been worked out by myself. I have, of course, utilized any old photographic lens mount, or old Microscope fittings which I could get to work up into my arrangement, so as to save mechanical labour. It fits, as you will see, into the ordinary lantern front. The alum trough goes into the place which holds the slider when the lantern is used for ordinary pictures. The stage is one of Dancer's old lantern Microscope stages, but is modified so as to hold and enable me to change the substage condensers, which can be done more easily and with less loss of time through mine than it can be done through any other arrangement. The compactness of the instrument is also something worth considering.

Since the foregoing pages were written I have fitted up a 1-inch objective which is very satisfactory. It transmits a large beam of light, and gives a flat field of great size, the central and marginal definition being fairly good at the same time. As a rule the best ordinary objectives give no definition beyond a small circle in the middle of the field."

Newton's Electric Polarizing Projection-Microscope.—This instrument, constructed for the Science and Art Department, South Kensington, by Messrs. Newton and Co., and exhibited at the Conversazione in November, is of similar construction (with only necessary modifications) to the oxyhydrogen projection Microscope which was described by Mr. L. Wright in this Journal, 1885, p. 196. It will give good results with immersion lenses up to 6000 diameters and upwards; the magnification possible depending chiefly upon the *opacity* of detail necessary for a large screen image.

In addition to the usual polarizing effects it is fitted with lenses for exhibiting the brushes and coloured fringes in crystals, and also for use with the oxyhydrogen jet.

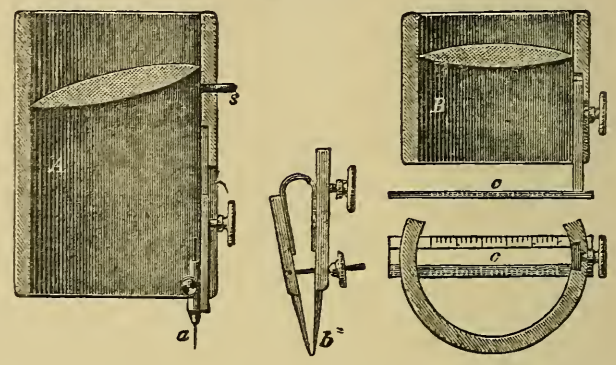
Lehrke's Lens-holder.*—Herr J. Lehrke's arrangement (fig. 241) consists of a cylindrical metal- or horn-mounted lens, 2–4 cm. long, and

* Zeitschr. f. Instrumentenk., vii. (1887) pp. 218–9 (4 figs.).

2–3 cm. in diameter, and magnifying from 1–2 times, whose side is provided with a contrivance for holding a copying needle, a protractor, &c.

While hitherto the architect, in using millimetre paper, must hold separately in his hands a magnifying glass and needle, while the engraver holds the engraving tool inclined in one hand and the magnifying glass in the other, or must work under a large lens standing on three feet, it is now possible, by a firm connection between the lens and needle or other

Fig. 241.



instrument, to draw directly with one hand, and under the lens. One of these lenses is shown in section at A, the glass is set obliquely, the needle *a* being in the focus. The stud *s*, projecting a little near the glass, is for the purpose of preventing the instrument from leaving the position coinciding with the plane of the drawing. For architects and engineers is provided a small compass *b* (about 2 cm.), for laying off parallel divisions, for making smaller scales, and the like. In these cases it is substituted for the needle. In like manner, for reading parallel divisions, for estimating areas, or revising maps, a finely divided, prismatic, ivory rule *c* can be placed under the glass B. In this case the plane of the lens must be perpendicular to the axis of the tube. For draughtsmen a parallel drawing-pen, something like *b*, is used, which gives several lines at once, perfectly parallel and close together; or a drawing-pen with which the smallest names, such as boundary stones and figures, can be made neatly and exactly. Thus a whole series of instruments can be used with the lens. For instance, a naturalist can use with it a knife or other instrument.

Henneguy.—**Sur un nouveau Microscope de voyage construit par Dumaige..** (On a new travelling Microscope made by Dumaige.) *CR. Soc. Biol.*, IV. (1887) No. 7.

Linnæus's Microscope.

[At the Pittsburg meeting of the American Society of Microscopists, "a very curious Microscope, once the property of Linnæus, was described by C. C. Mellor," President of the Iron City Microscopical Society.]

Microscope, VII. (1887) p. 271.

(2) Eye-pieces and Objectives.

Thickness of cover-glass for which unadjustable objectives are corrected.*—Prof. S. H. Gage communicated to the Pittsburg Meeting of the American Society of Microscopists the following paper:—"As the thick-

* Microscope, vii. (1887) pp. 292–3.

ness of the cover-glass as well as the tube-length has an important influence on the perfection of the microscopic image, and as almost all objects for microscopic examination are covered, the objective must be adjustable to compensate for the various thicknesses of cover-glasses used, or some uniform thickness of cover-glass must be selected, for which the optician corrects or adjusts the objective once for all. The thickness for which such unadjustable objectives are adjusted varies with the different opticians, as shown in the table below. The information in the table was obtained by direct inquiry as for the information concerning 'tube-length' hereinafter mentioned.' *

TABLE *showing the Thickness of Cover-glass for which unadjustable objectives are corrected by various Opticians.*

0·25	mm.	J. Green, Brooklyn. J. Grunow, New York. Powell & Lealand, London. H. R. Spencer & Co., Geneva, New York. W. Wales, New York.
0·18	mm.	Klönne & Müller, Berlin.
0·17	,,	E. Leitz, Wetzlar (when tube 160–170 mm.)
0·16–25	,,	Ross & Co., London.
0·16	,,	Bausch & Lomb Optical Co., Rochester.
0·15–20	,,	(16 mm. apochromatic oil-immersions), C. Zeiss, Jena.
0·15–18	,,	C. Reichert, Vienna.
0·15	,,	Gundlach Optical Co., Rochester. W. & H. Seibert, Wetzlar. R. & J. Beck, London.
0·12–17	,,	J. Zentmayer, Philadelphia.
0·10-125	,,	Nachet et Fils, Paris. Bezu, Hausser et Cie, Paris.
0·1	,,	Swift & Son, London.

A uniform thickness of cover-glass for unadjustable objectives seems also desirable; then by the use of some cover-glass measure, like the one made by Zeiss, the microscopist could select covers of the proper thickness to be used for the specimens to be studied with unadjustable objectives."

Objectives.

["An optical firm offers for sale 'homogenerous' immersion objectives."]

Queen's Micr. Bull., IV. (1887) p. 39.

PELLETAN, J.—**Les Objectifs.** (Objectives.)

Journ. de Microgr., XI. (1887) pp. 446–8, 476–81 (in part).

ROSS, W. A.—**New Optical Substance for Objectives of Microscopes, &c.**

["A transparent substance (it is not glass, for no alkali is employed in its manufacture)" having "a hardness and specific gravity equal to that of emerald, whilst its refractive index is obviously very high." And reply by F. H. Wenham that he has "seceded from the ranks of the 'Diatomaniacs,' and ceased to take any interest in dots and striæ, and it is not probable that I shall ever again work at the Microscope or its appliances."]

Engl. Mech., XLVI. (1887) pp. 278 and 301.

SCHULZE, A.—**On Abbe's Apochromatic Micro-objectives and Compensating Eye-pieces, made of the new optical glasses in the works of Dr. Carl Zeiss in Jena, with some general remarks on object-glasses.**

Proc. Phil. Soc. Glasgow, XVIII. (1887) pp. 28–40.

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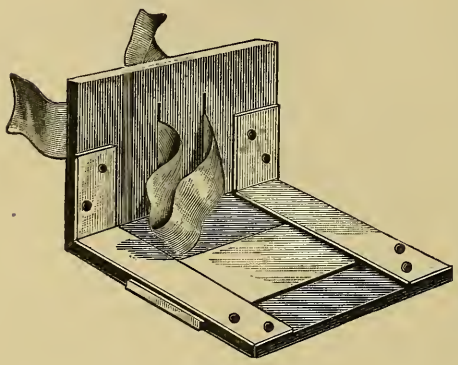
* Cf. *infra*, p. 1029.

(3) Illuminating and other Apparatus.

Borden's Electrical Constant-temperature Apparatus.*—Referring to this apparatus described *ante*, p. 810, Dr. W. C. Borden writes that, owing to some mistake, the latter part of the description of the regulating thermometer was not clear. After describing the regulating thermometer made from a glass tube and small vial, and filled with 95 per cent. alcohol and mercury, which will keep the temperature within one-half a degree, it was intended to say that a simpler one, which will keep the temperature within two degrees, can be made by simply blowing a bulb on a glass tube and filling the bulb and a portion of the tube with mercury alone.

Fig. 242.



Frog-holder.† — Mr. W. Fearnley describes the frog-holder, fig. 242, which he recommends, as enabling the frog to be placed "in a comfortable position."

It consists of a piece of cardboard 13 × 8 cm., bent at right angles across its larger axis, the angle being maintained by two copper rectangular straps riveted to the cardboard. A rectangular piece is cut out of the middle of the horizontal half and a glass slip put in between the cardboard and the copper straps. Two slits in the upright half, 1 cm. apart, admit a length (12 cm.) of broad tape. "The frog sits quietly for half an hour at a time upon this contrivance with or without whiffs of chloroform."

Macer's Insect-holder.—This (fig. 243) has been designed by Mr. R. Macer for showing the head, eyes, proboscis, &c., of insects in their living state, with their mode of taking food.

The cones are made of pieces of writing-paper gummed together, and left to dry. Some small discs about 5/16 in. in diameter are cut, and a hole made in the centre with a No. 3 or 4 saddler's punch. These are blacked and gummed on the cone near to the apex, and, when dry, the apex is cut off level with the disc. With a small stiletto the hole should be made round and smooth. It is necessary to make the holes of different sizes, viz. Nos. 11, 12, 13, 14, 15, and 16 B.W. gauge, to suit the various-sized insects. The disc on the top of the cone is to lay a piece of honey on, to tempt the insect to extend its proboscis in order to show the act of sucking.

Fig. 243.

For catching the fly, glass tubes, 2½ in. long by 1/2 in. in diameter, with corks to fit, are useful, having a V groove cut in the cork in order to let air into the tube. At the other end of the tube is placed a small plug of cotton-wool. To pass the fly into the cone, hold the tube upright, shake the fly to the bottom (the wool being at the bottom), draw the cork, and place the base of the cone on the tube; then hold the apex of the cone to a bright light, and gently push the plug of wool up

* Amer. Mon. Micr. Journ., viii. (1887) p. 175.

† 'A Course of Elementary Practical Histology,' 1887, pp. 194-5 (1 fig.).

the tube with a pencil, and the fly will soon show its head through the hole in the disc. The tube is then taken away, and the wool plugged up in the cone to keep the fly in its place. A pair of stage forceps, with the ends made hollow like a pair of gasfitter's pliers, can be used to hold the cone.

Mr. Macer showed a living house-fly with this apparatus, at the November Conversazione, in a very effective manner.

(4) Photomicrography.

Nelson and Curties's Photomicrographic Camera.—At the November meeting of the Society Mr. E. M. Nelson read the following description of his photomicrographic camera (fig. 244) *:—"Mr. C. L. Curties and myself have designed this camera in the hope of combining efficiency with simplicity. The points in its construction are as follows:—A board on indiarubber feet of sufficient length to take lamp, Microscope, and camera when fully extended. The usual chocks to hold the Microscope feet, and the fine-adjustment focusing-rod on the right-hand side of the board. The camera made of two square † tubes of cardboard sliding one inside the other. Upright wooden ends to hold the cardboard tubes; these slide in grooves in the base board, and are fixed by clamping-screws. The front board has a brass nozzle to fit into the light-excluding cap on the Microscope. The back board is grooved to receive the focusing-glass and the double back. The light-excluding cap is made of cardboard covered with leather, which is as efficient, and not so heavy, as the ordinary brass ones. The double backs are of iron; they are about one-sixth of the cost, and far smoother in their action, than mahogany ones. There is a fitting to hold diaphragms in the back.

The method of working is as follows:—The Microscope, inclined to a horizontal position, is placed in the chocks, the camera closed up, and slid back as far as it will go to the other end of the board. There will now be plenty of room between the camera and the Microscope for the eye to be conveniently placed to the eye-piece. The lamp, condenser, &c., are now centered in the usual manner, and a critical image of the object received by an ordinary eye-piece. When all the necessary adjustments are completed, the ordinary eye-piece is removed, and a projection eye-piece substituted for it. The camera, still closed, is now slid up to the Microscope, leaving sufficient distance between them to allow the hand to focus the eye-lens of the eye-piece. Next let a piece of paper be held up in the position the back will occupy when the photograph is being taken, and the diaphragm of the eye-piece focused, by means of the eye-lens, sharply upon it. The camera is now slid up to the Microscope, and the nozzle inserted in the light-excluding cap. The camera is now extended to the required distance, and the object focused on the plate in the usual manner.

The following are a few hints in the use of the above camera:—It is not advisable to push magnifying power more than ten times the initial power of the objective. To this end the camera has been designed for use with Prof. Abbe's lower-power projection eye-pieces, as he recommends the lower-power eye-pieces in preference to the higher when sufficient camera length can be obtained.

A plain glass screen is recommended in place of the usual ground glass.

The best focusing-lens is an aplanatic lens of six power by Zeiss (Catalogue No. 127).

* Described *ante*, p. 661.

† As shown in the fig. these are round; they were subsequently made square on the suggestion of Mr. J. Mayall, junr., as being more serviceable in that form.

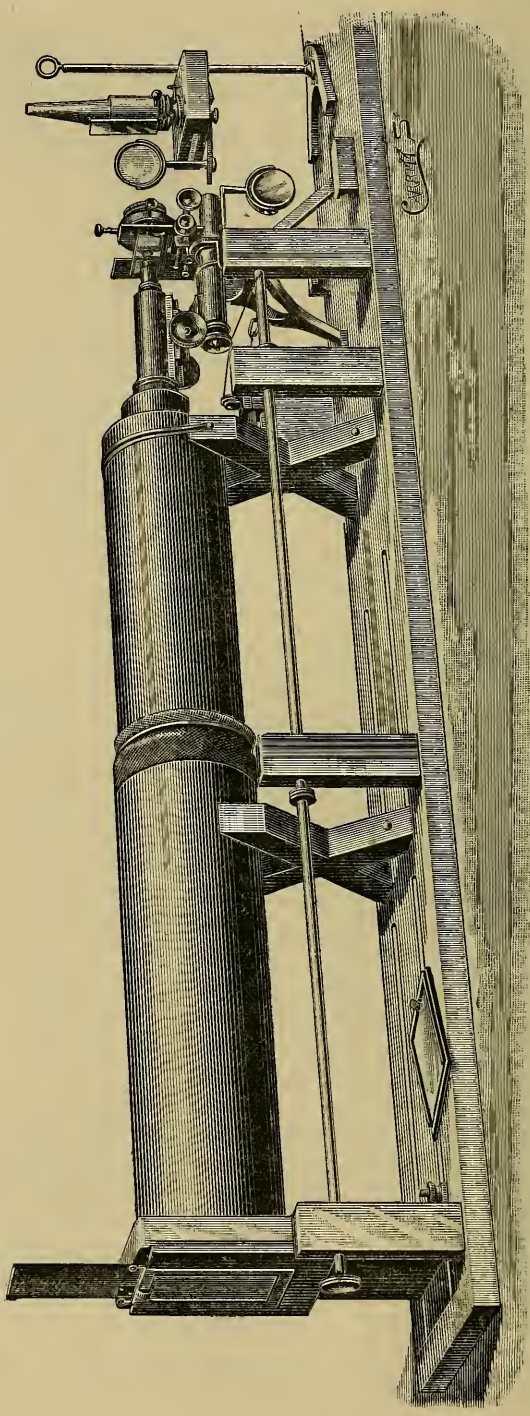


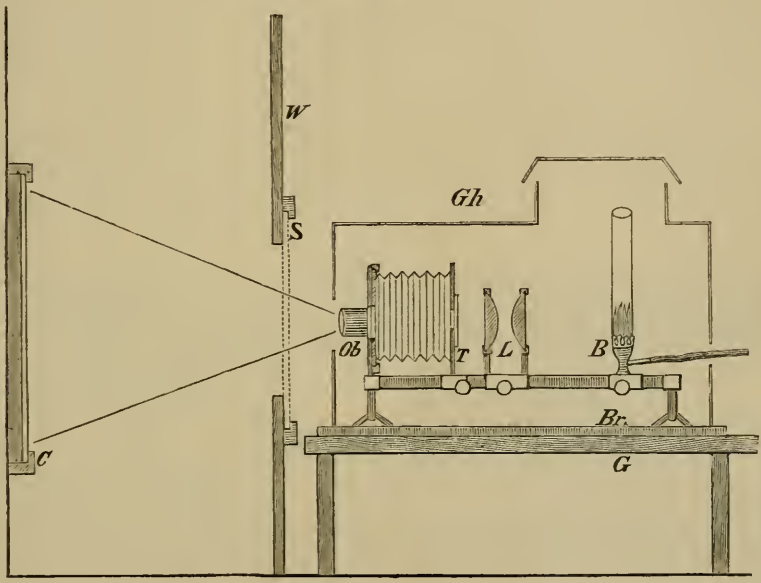
FIG. 244.

NELSON AND CURTIES'S PHOTOMICROGRAPHIC CAMERA.

To find out the length of exposure, use a Warnerke's sensitometer, in conjunction with the table and directions in Mr. Bousfield's 'Guide to Photomicrography.'"

Photographing Series of Sections.*—Dr. W. His photographs serial sections with a magnification of 10–20 diameters with the following apparatus:—A toothed bar carries at its front end a plate with the photographic objective Ob: a second plate, moved by a rack and provided with a central aperture, serves as object-carrier T: the two plates are united by bellows. The source of light is an Argand burner B, movable along the toothed stage. The light is concentrated by two plano-convex lenses L, with a

Fig 245.



diameter of 11·5 cm. and a focal distance of 8 cm. Diffuse light is avoided by the tin case Gh, in one side of which a broad valve or door is situated, in order to obtain access to the inclosed parts. The objectives used were a Steinheil's *antiplanatic* of 12 cm. focal distance or an *aplanatic* of 14 cm. The latter, though not so powerful as the former, gives a correcter and more definite image. Instead of a camera, the wall of the dark chamber W is used as a reception surface; the latter is divided into two halves and fitted with a door and shutter S. By means of S the light is thrown on or turned off the sensitized paper. The apparatus rests on a board Br which can be moved along the surface of the wooden stand G. This suffices for rough focusing. Finer focusing is obtained by moving the object-carrier T with a screw. Exact focusing is made by turning the objective, which works in a tube provided with a fine screw-thread. The sensitized paper is, if small, fixed down by small pegs; if large it must be fitted into a frame C, fastened to the wall. The image is first focused on a piece of white paper placed behind the glass plate of the frame, and, this done, the sensitized paper is introduced while the shutter S is closed. The paper employed is Eastman's silver bromide paper, which is sensitive enough to artificial light,

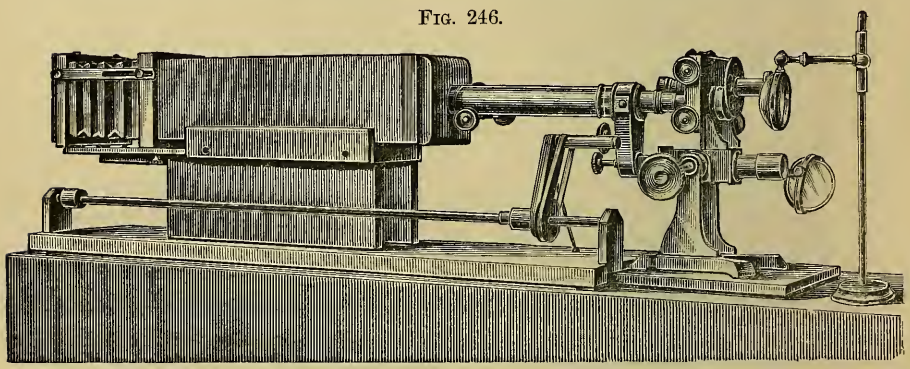
* Arch. f. Anat. u. Physiol.—Anat. Abtheil., 1887, pp. 174–8 1 fig.).

and requires but simple manipulation. The length of exposure varies with magnification and the diaphragm; with Steinheil's aplanatic of 14 cm. focal distance, with diaphragm 4 for a magnification of 10 times, 6–8 minutes are required. Thin sections require longer than thick or deeply stained specimens. All the necessary details of manipulation are given with each packet of the Eastman's paper, but it may be mentioned that after exposure the paper is moistened with water and the image developed with acetate of potash and sulphate of iron. It is then washed in acidulated water, and having been fixed with hyposulphite of soda, is frequently washed, and the sheet is then dried. The time occupied in taking four slides with twenty-five sections each, magnified 10 times, is from an hour to an hour and a quarter.

In addition to giving an accurate copy of the sections, the method is most useful for reconstruction of the image, and if before cutting Kastschenko's definition planes * are applied, the fine lines appear on every negative, and this renders the copies still more suitable and convenient for reconstruction purposes.

Ellis's Focusing Arrangement for Photomicrography.—Mr. John Ellis writes us:—"All the focusing arrangements for photomicrography have appeared so defective to me, that I venture to send a description and drawing of the one I use. The rod running the length of the camera carries

Fig. 246.



a loose arm, at the end of which is a roller, covered with indiarubber, which is made to revolve by an endless strap passing round a wheel upon the rod. The roller is kept in contact with the fine-adjustment screw of the Microscope by an indiarubber band attached to the base-board and the arm."

Nelson's Photomicrographic Focusing-screen.—This (the design of Mr. E. M. Nelson) is made by engraving the English and metrical scales, as well as a crossed diagonal, on the plane-glass plate which is used by nearly all photomicrographers. The engraving, which forms a convenient object to focus on, is a scale for measuring the magnifying power. The English scale is divided into inches, tenths, and half-tenths, and the metrical into cm. and mm. The scales are ruled horizontally, one inch apart, across the plate, one on either side of the cross made by the diagonals. The diagonals are not ruled at the points where they pass through the scales, in order that they may not interfere with the divisions.

Denaeyer, A.—Résumé de la conférence publique sur les procédés de reproduction aux encres grasses des clichés photomicrographiques et des images d'objets scientifiques. Exposé d'un procédé nouveau de photolithographie, avec démonstrations.

* See this Journal, *ante*, p. 511.

pratiques. (Résumé of the public lecture on the processes of reproducing with printing inks photomicrographic clichés and images of scientific objects. Description of a new method of photolithography, with practical demonstrations.)
Bull. Soc. Belg. Micr., XIII. (1887) pp. 182–5 (1 pl.).

HENSEN, V.—**Ein photographisches Zimmer für Mikroskopiker.** (A photographic room for microscopists.) *Kölliker's Gratulationschrift*, 1887, pp. 61–71 (1 pl.).

KING, Y. M.—**The Photomicrography of Histological Subjects.**
Journ. of Micr., VI. (1887) pp. 205–16, from *New York Med. Journ.*

MARKTANNER, G.—**Bemerkungen über Mikrophotographie.** (Remarks on photomicrography.) *Phot. Corresp.*, 1887, p. 237.

(5) Microscopical Optics and Manipulation.

Microscopical Tube-length, its length in millimetres, and the parts included in it by the various opticians of the world.*—Prof. S. H. Gage read a paper with the above title to the Pittsburg Meeting of the American Society of Microscopists.

"In the construction of microscopic objectives, the corrections must be made for the formation of the image at a definite distance, or, in other words, the tube of the stand of the Microscope on which the objective is to be used, must have a definite length. Consequently, the microscopist must know and use this distance or 'microscopical tube-length' to obtain the best results in using the objective in practical work.

In order to obtain the exact distance in millimetres for which objectives are corrected, and the parts of the Microscope included in this distance or 'tube-length,' the following questions were submitted to all the opticians of the world whose addresses could be obtained:—1. For what 'tube-length' do you correct your microscopic objectives? Please give the length in millimetres or inches. 2. Please indicate on the diagram on the opposite page (fig. 247) exactly what parts of the Microscope you include in 'tube-length.' From nearly all precise and satisfactory answers were received, and I wish to express here my appreciation of their courtesy. The answers received are given below, and indicated on the accompanying diagram.

TABLE *giving Length in Millimetres and showing parts included in 'Tube-Length' by various Opticians.*

Parts included in 'Tube-length.' See Diagram.		'Tube-length' in millimetres.
a–d	Grunow, New York	203.
	Nachet et Fils, Paris	146 or 200.
	Powell and Lealand, London	254.
a–d	C. Reichert, Vienna	160–180.
	W. Wales, New York	254.
b–d	Bausch & Lomb Optical Co., Rochester	216.
	Bézu, Hausser et Cie., Paris	220.
	Klönne und Müller, Berlin	160–180 or 254.
	W. & H. Seibert, Wetzlar	190.
	Swift & Son, London	165 to 228½.
	C. Zeiss, Jena	160 or 250.
a–g	Gundlach Optical Co., Rochester ..	254.
c–d	Ross & Co., London	254.
c–e	R. & J. Beck, London	254.
c–g	H. R. Spencer & Co., Geneva, N.Y. ..	254.
c–f	J. Green, Brooklyn	254.
c'–e	E. Leitz, Wetzlar	125–180.
	For Oil-immersions	160.

* Microscope, vii. (1887) pp. 289–92 (1 fig.).

A glance at the table and diagram is sufficient to show that there is about as great diversity as possible in the parts included in 'tube-length,' and that the length in millimetres, including these parts, is likewise very diverse. This has, doubtless, come about simply because there was no general standard, and each optician selected for himself a standard. For the sake of those who *use* the Microscope, it is hoped that a uniform standard may be chosen, or that, at most, but two standards should be decided on by all opticians. These two lengths in millimetres would probably best be 254 mm. for a long or English 'tube-length,' and 160 mm. for the short or Continental 'tube-length.' Furthermore, the same parts of the Microscope should be included in the 'tube-length,' and the parts included should be readily determinable by the youngest student. The parts included by six of the opticians named above, viz.: from the top of the tube (*b*) where the ocular is inserted, to the lower end (*d*) where the objective is screwed in, answer this requirement of simplicity. Without urging this as the best possible selection, it will readily be seen that this 'tube-length' may be easily measured where the ocular and objective are not in position, and that makers of stands who do not also make objectives could easily make the tubes of their Microscopes of exactly the right length for the objectives of all objective-makers. While it is true that the objectives of various makers are in mountings of different lengths, and therefore, other things being equal, tend to increase or diminish the actual or optical 'tube-length,' and thus to vary the magnification of the Microscope, if each maker would choose the length designated above (*b*–*d*) for which to correct his objectives in their mountings, then no matter how long or short that mounting might be, the microscopist would be able to measure off the right length on the tube of his Microscope, for which the objective was corrected, and having this length once determined, it would not need to be changed when an objective of different length of setting was used.

Fig. 247.

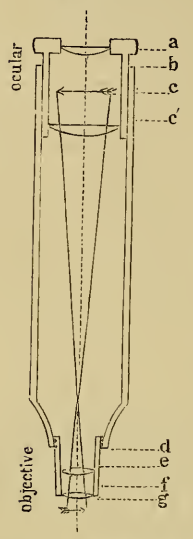


Diagram showing the parts of the Microscope included in 'Tube-length' by various opticians of the world. (See table above.)

Furthermore, the convenience of the microscopist and uniformity in 'tube-length' would be both subserved if the eye-pieces or oculars were made '*parfocal*,'* that is, the settings be so adjusted that the lower focal points of all the eye-pieces shall be at the same level when in position in the tube of the Microscope, then no refocusing of the Microscope would be necessary upon changing oculars. If also the level of the 'lower focal points' of the different oculars were made to fall at the level of the top of the body-tube of the Microscope, one end of the so-called 'optical tube-length' would be always determinable, and correspond with one end, that is the upper end, of the tube of the Microscope.

So long as no common standard is employed, it seems to the writer that every objective should be accompanied by a statement and a diagram indicating the tube-length in millimetres for which it was corrected, and showing also the parts of the Microscope included in this measurement.

* See this Journal, 1886, p. 1050.

If the objective is unadjustable, a statement should also accompany it, giving the thickness of cover-glass for which it was adjusted."

On this paper the editor of 'The Microscope' * writes as follows:—

"Every microscopist will thank Prof. S. H. Gage for publicly calling attention, in his article, read at the recent meeting of the American Society of Microscopists, to the remarkable lack of uniformity which exists among opticians in their standards of tube-length and in the parts which they include in their computation of it.

All who seek and desire accuracy in their objectives, understand that they are corrected for a definite tube-length, and that perfect performance is possible only when that tube-length is used. The lack of knowledge, even among expert microscopists, of the exact length for which given objectives are corrected, and the difficulty of measuring it from the hidden points adopted by many makers, have led them frequently to disregard the perfect accuracy which they should observe in adjusting their Microscopes, and to be satisfied with an approximation to the proper tube-length. Text-books and makers' catalogues, also, are almost silent in the matter, and microscopists who use the Microscope in their every-day business, but who give but little attention to the optical principles of its construction and working, have remained in ignorance of any necessity for such an adjustment. Prof. Gage's article, with its complete tables, brings the subject forcibly to the mind of every microscopist, and makes clear the necessity of the adoption by makers of a uniform tube-length, and of uniform and easily accessible points between which to compute it.

Prof. Gage, in his remarks, rather hesitated to ask opticians to change their various standards to a common one. From conversations with several opticians we have learned that there are no serious objections to such a change, and we urge upon manufacturers that it be made. The committee appointed by the American Society of Microscopists to investigate the subject and report at the next meeting, may, if their judgment agree with ours, accomplish much to this end.

A tube-length of 254 mm. is generally spoken of as the standard, and is adopted by the majority of opticians, and this, we believe, should be the only one chosen.

In determining the parts to be included in the measurement of tube-length there is more opportunity for diverse views. The most scientific measurement probably, would be between the optical centre of the objective and the optical centre of the ocular. These points are, however, the most difficult to determine, and they vary with each objective and each eye-piece. The same objections hold good with any measurement which has for its lower extremity any part of the objective. Uniformity in the length of the setting, and the position of the lenses of objectives, is practically impossible. The lower extremity of the tube (*d* in Prof. Gage's figure) is the only lower fixed point, and is the point selected by all but a very few opticians.

For the upper point *c* and *c'* can be excluded, *a* and *b* being the only points that are fixed and accessible, and the majority of opticians include the parts between one of these points and *d* in their measurement of tube-length. These points can be determined by the youngest student, and variations in objectives will not affect the length. Prof. Gage prefers the measurement *b* to *d*. This is, perhaps, the simplest, but is open to the objection that different opticians use eye-pieces of different construction. European makers use the Continental pattern, in which the eye-lens is but 1 or 2 mm. above the body, while Americans prefer the eye-piece with

* Microscope, vii. (1887) pp. 305–6.

neck, which brings the eye-lens 12 to 15 mm. above the body. This, of course, increases the optical tube-length just so much, and it would be necessary for opticians to indicate on the objective whether it was corrected for the Continental or the American ocular. With the measurement *a* to *d* each microscopist could easily adapt his tube-length to suit either style of ocular.

We can join Prof. Gage also in his plea for 'par-focal' oculars. Their adoption would be another step in the development of a uniformity in apparatus, which is of so great convenience to busy workers, and which tends so much to harmonize the work of various manufacturers.

We believe that these subjects, so tersely brought foward by Prof. Gage, should be agitated until manufacturers adopt them; and to further this end we shall be glad to publish correspondence from all interested opticians and microscopists."

Measurement of Power.*—Mr. E. M. Nelson says that it is sometimes useful to know the "initial" magnifying power of an objective, by "initial" power meaning the size to which an image will be magnified by an objective alone when projected on a screen at a distance of 10 in.

In practically measuring this power, it will be found a more accurate plan to increase the distance to, say, 60 in., and divide the result by 6. These measurements are very easily performed when one has a camera, but it is not so easy to do them without. Therefore, another and somewhat loose way of getting at the initial power is adopted, viz. as follows:— Measure the combined magnifying power of the objective, and say 2 in., or A, eye-piece, and divide the result by 5. This method would do very well if the exact multiplying power of the eye-piece was 5, and if the length of the body remained constant. As it is not an easy matter to find out the exact multiplying power of an eye-piece, Mr. Nelson recommends any one desirous of knowing this to measure or get measured the initial power of one of his objectives; then measure the combined power of this lens and his eye-piece, paying great attention to his tube-length during the operation. This will give him once for all the multiplying power of his eye-piece with that tube-length. He will then be in a position to ascertain the initial power of any other lens with that eye-piece and the same tube-length. But as the optical tube-length may differ from the actual tube-length, and does differ to a certain extent, with objectives of ordinary construction, this process is not so simple as it appears. In order to get fairly accurate results with the higher powers, a certain percentage must be deducted. To give some examples:

Thus, 1 in. at 60 in. increases the image of ·01 in. to ·66 in., its power, therefore, is 66, which at 10 in. = 11 = initial power. The combined power of this lens with an A eye-piece is 55, which gives 5 as the multiplying power of the eye-piece. Now, if the combined power of this eye-piece with a 2/3 = 75 we may assume the initial power of the 2/3 is 15.

If, however, we treat higher powers in the same way, we shall get too high values. Thus the combined power of a 1/4 and the eye-piece is 203; dividing by 5 we get 40·6 as the initial power, whereas 39·3 is the real power.

Again, the combined power of a certain 1/12 and the eye-piece is 600, which, divided by 5, gives 120 as its initial power, whereas it is in reality 113·2. The empirical rule Mr. Nelson employs is to deduct 2 per cent. for 1/2, 3 per cent. for 1/4, 4 per cent. for 1/6, 6 per cent. for 1/8, 1/12,

* Eng. Mech., xlvi. (1887) pp. 188–9.

&c. Thus taking the 1/4 above and deducting 3 per cent. from the 203, we get 197, which, divided by 5, gives 39·4, a result very near the truth.

A certain 1/8 gives a combined power of 450, deduct 6 per cent. = 423, divide by 5 = 84·6, the actual being 85. For short bodies of 6¾ in., or Continental size, a different percentage must be employed. The following gives fair results:—2 per cent. for 1/2, 4 per cent. for 1/4, 6 per cent. for 1/6, 8 per cent. for 1/8, and 10 per cent for 1/12.

Method of Intensifying the Resolving Power of Microscope Objectives.*—Mr. G. D. Hirst describes a simple way of vastly improving the definition of objectives on close-lined test objects, which has lately come under his notice. The credit of the discovery is due to Mr. Francis, of Sydney.

Take a valve of, say, *Amphipleura pellucida*, and, having got the best results obtainable with mirror and condenser, let the analysing prism belonging to the polarizing apparatus be placed over the eye-piece, and rotated until it darkens the field, which it will do, though not to the same extent as when used with the polarizing prism. On carefully focusing the diatom, the lines will show themselves with an extraordinary increase of definition. Valves that without the aid of the prism only show a washy sort of resolution, will now show the lines as black as the bars of a gridiron.

On *P. angulatum* by central light the result is also splendid. The same effect can also be obtained, though perhaps to a slightly inferior degree, with the objective, or, as it is placed in some stands, in a sliding box in the body of the Microscope; in the latter case, as it cannot be rotated, the valve of *A. pellucida* should lie horizontally. For general purposes, it is better for the prism to fit over the eye-piece, as besides giving better definition in that position, with a diatom like *P. angulatum* and prism over the objective, the diffraction spectra would be cut out of the top and bottom of the back lens and the effect spoiled. Of course, in the case of *A. pellucida*, with the valve lying horizontally, it does not matter, as the dioptric ray and single spectrum are not cut off in any way by the prism or the box in which it is set. The prism has the effect of greatly diminishing the light of the dioptric beam; at the same time it scarcely touches that transmitted by the diffraction spectra.

The application of the prism will not of course make an objective resolve a test beyond the reach of its aperture; but it often happens that in the case of close-lined objects we can see the spectrum at the back of the objective when the lines cannot be seen in the object itself. It is then that the prism shows its power, as its use will at once bring out the lines with the greatest ease and sharpness.

Mr. E. M. Nelson† found, while investigating the matter, that the diffraction spectrum of *A. pellucida* (illuminated by oblique beam from oil-imm. achromatic condenser, and with a water-imm. 1/12) showed all the green, but no red. On examining the spectrum through the analysing prism without an eye-piece he found that when the prism was in a line with the dioptric beam and the diffraction spectrum, the brightness of the green was intensified. On replacing the eye-piece, and viewing the image through the prism used above the eye-piece, as directed by Mr. Hirst, there could be no doubt that the transverse striæ were much sharper and blacker than when viewed without the prism. The prism must, of course, be kept in a line with the dioptric beam and the diffraction spectra. Should the prism be turned across, even if it does not cut off aperture, the definition will be impaired.

* Eng. Mech., xlvi. (1887) p. 232. † Ibid., p. 254.

He next changed the water-imm. 1/12 for a water-imm. 1/16 of less angle, which would barely resolve the *A. pellucida*—that is to say, would only resolve it in patches, and not from end to end. On examining this with the prism, he found that the parts which were unresolved were still unresolved; but those parts which were resolved were intensified.

"The image of *A. pellucida* with an apochromatic 1/8 (1·4 N.A.), my new eye-piece, and the prism is something very fine, such as I have never seen before."

He also tried the prism with several very subtle direct light tests, but cannot say that he found any improvement in the image. On the whole, he should think this class of objects would be seen better without the prism. Probably the efficacy of the prism, when used with a lined test, lies in the fact that it intensifies the diffraction spectra when it is placed in a certain direction to it.

BROKENSHIRE, F. R.—**Measurement of Magnifying Power of Micro-objectives.** [Complaint that the subject has not received the elucidation he anticipated.] *Engl. Mech.*, XLVI. (1887) p. 300.

DIDELOT, L.—**Du pouvoir amplifiant du Microscope, détermination théorique et expérimentale: suivi d'une table à quatre décimales, des inverses de 1000 premiers nombres de 0·01 à 10·00.** (The magnifying power of the Microscope. Theoretical and experimental determination: followed by a table to four places of decimals of the reciprocals of 1000 prime numbers from 0·01 to 10·00.) 2nd ed., 90 pp., 2 pls., 8vo, Paris, 1887.

GARIEL.—**Quelques généralités sur les instruments d'optique.** (Some general considerations on optical instruments.) *Arch. Sci. Phys. et Nat.*, XVIII. (1887) pp. 339–41.

HODGKINSON, A.—**On the Diffraction of Microscopic Objects in Relation to the Resolving Power of Objectives.** *Proc. Manch. Lit. and Phil. Soc.*, XXV. (1886) p. 263.

(6) Miscellaneous.

"The Microscope as a factor in the establishment of a constant of nature."—The following is the first part of the Presidential Address delivered by Prof. W. A. Rogers before the American Society of Microscopists at the Pittsburg Annual Meeting:*—

"Microscopy is a cosmopolitan science. We may go farther than this, and say that microscopy is more nearly cosmopolitan in its character than any other science. If I did not believe this to be true I should not have consented to occupy the honourable position which I now hold by your suffrages, for there are many members of this Society to whom the honour more justly belongs by virtue of greater familiarity with the technics of our science. I suppose that I am indebted to this expression of your confidence on account of the use which I have made of the Microscope as an essential factor in a single line of research.

It is the glory of our science that the Microscope supplements the natural vision to such an extent that we can submit nearly every theory, nearly every deduction from experiment, nearly every fact of observation, to the supreme and only test by which a real truth in nature can be established, viz. through the medium of one of the senses with which we have been endowed by the Creator. It has been said that microscopy has no claim to be regarded as a science, and that the Microscope is simply an instrumental agent occupying with respect to other sciences a position similar to that which the telescope sustains in its relation to astronomy. A convincing answer to this criticism is found in the fact that the telescope is limited in its application to a comparatively narrow field of research. Where the telescope answers a single question the Microscope answers a

* Microscope, vii. (1887) pp. 257–61. Corrected by Prof. Rogers.

thousand. Spectroscopy has become a recognized science, not so much because of its revelations in regard to the nature of light, as on account of the application of the spectroscope as an instrument to the study of the physical properties of matter and of motion not only on the earth, but in worlds other than our own.

In discussing the question whether microscopy can be regarded as a science, we must always bear in mind the fact that a science is only a convenient name *for a group of similar laws of nature*, and that the term is properly applicable not only to the development of these laws, but to their application to the useful economies of life. Thus we have the science of engineering, in which mathematical analysis is as much an essential part as skill in mechanical construction. But this analysis would serve no useful purpose if did not rest ultimately on facts of observation.

The limitations which necessarily belong to a definition of physical science are clearly expressed by Tate in his most admirable treatise on Heat. He says: 'Nothing can be learned as to the physical world save by observation and experiment, *or by mathematical deductions from data so obtained.*' Now the Microscope as an instrument of research stands unrivalled, not only in respect to the precision of the observations made with its aid, but also in the universality of its application in furnishing what Tate calls 'the data so obtained.'

Each succeeding year witnesses an extension of the range of its applications. Within a few years, while retaining its claim as an essential factor in scientific research, it has also become a very material aid in many mechanical industries. It is a common impression that the Microscope is too delicate an instrument to be used in the ordinary operations of mechanical construction, and that the apparent necessity of using transmitted light for the purpose of illumination is an absolute barrier to any extended employment of the instrument. The latter difficulty is entirely obviated by the use of the opaque illuminator invented by Tolles, by which a bright metal surface can be examined with the utmost ease, while actual experience has shown that it is by no means necessary that the instrument should be mounted upon massive piers insulated from surrounding objects.

I cannot more forcibly combat this impression than by referring to two cases within my own experience. The 'Proceedings' of the Society of Mechanical Engineers for 1884 contains a description of a method of cutting a screw in which each thread is made to correspond in pitch with equal subdivisions of a standard yard traced upon a metal bar. The screw for the engine constructed for Cornell University was made in this manner. Prof. Anthony has shown that the maximum accumulated error of the screw does not reach 2 mikrons for a limit of 20 inches, while the actual error at any selected point will not reach 1 mikron. This screw was cut in the manner indicated, in the third storey of a building occupied by machinery, which produced a decided tremor in every room. It was only found necessary to make the attachment of the Microscope to the compound rest of the lathe very firm, and to brace the bed of the lathe very securely from the floor.

The writer was recently called upon to 'level up' the bed of a very heavy planer, having ways 18 ft. in length. Several days had already been spent in securing as good an adjustment as could be obtained with the aid of a spirit-level of special construction. A plank 22 ft. in length, 8 in. in width, and 2 in. in thickness was set up edgewise beside the platen of the planer, but insulated from it. A groove 1/2 in. wide and 1/2 in. deep was ploughed in the upper face of the plank, and after having stopped both ends, the groove was filled with mercury. The surface of the mercury then

formed an invariable plane of reference. The Microscope was securely attached to the platen and adjusted for sharp focus upon the surface of the mercury at one end. The platen was then moved along until the Microscope occupied a position near the other end of the groove. This end was then adjusted by elevation or depression as required, until the surface of the mercury was sharply in focus. After two trials it was found that the surface of the mercury was at the same constant focal distance from the Microscope as indicated by the sharpness of definition. Notwithstanding the fact that extreme care had been taken in the original adjustment by the aid of the spirit-level, it was found that as the platen moved towards the central part of the bed the focus became more and more indistinct, indicating that the central part was too low. The proper elevation was then made at these points by means of heavy set-screws, when it was found that the mercury was sharply in focus under the objective throughout the entire range of motion. As a check upon the accuracy of the adjustment a surface-plate 8 ft. in length was now planed, when it was found that the deviation from a true surface did not at any point exceed the third part of the thickness of tissue paper. Two facts of considerable importance are to be noticed in connection with this experiment. First, that the time occupied for the complete adjustment was only twenty-five minutes; and, second, that during the entire operation the machinery of the shop was running at half-speed.

These and similar observations have led the writer to advocate a more extended use of the Microscope in the every-day work of the machine shop. By attaching the Microscope firmly to the slide-rest of the lathe, the ordinary operations of turning shoulders to a given length, and of cylinders to a given diameter, can be more expeditiously, more exactly, more economically performed than by the usual method.

It is freely admitted by mechanicians that a decided advance in mechanical construction would be made by the employment of uniform measures of length. This can be easily and profitably accomplished in any well regulated shop, employing as many as fifty hands, by delivering from a standards room any desired unit of length, in the same way that tools are delivered from a tool-room. The expense of a comparator, from which any measure of length could be obtained within a limit of time which would not ordinarily exceed one minute, would not be great. If this comparator were placed in charge of a person familiar with its use, and in a convenient location, any workman could have a calliper set for him in half the time that would be required in setting it to a scale by the usual method; the precision would be incomparably greater, and absolute uniformity would be secured in every dimension of length employed. The various points to which I have briefly called attention are to be considered simply as illustrations of the many ways in which the useful service of the Microscope may be extended.

In the address which I am called upon to make this evening, as President of the American Society of Microscopists, I have selected a single application of the Microscope in scientific research. *I beg to call your attention to the Microscope as a factor in the establishment of a constant of nature.*

If a bar of metal, which has the faces of each end parallel and at right angles to its axis, is submerged in melting ice, the perpendicular distance between the two faces may be said to represent a definite unit of length at the temperature of 32° F. or of 0° C. If this distance is identical in length under similar conditions with a certain bar of platinum now deposited at the International Bureau of Weights and Measures at Breteuil

near Paris, and designated the '*Mètre des Archives*,' the length of the bar is said to be one metre. If now the bar is submerged in a liquid which has throughout its entire mass a temperature one degree higher than that of melting ice, its length, after it has reached the same temperature as the liquid, will be increased by a certain fraction of its entire length. If this length is subdivided into one million equal parts, and if the increase is, for example, ten parts in one million, the coefficient of expansion of the metal is said to be ten mikrons. If the increase in length proceeds uniformly for each and for every increment of temperature, we can say, for example, that the length of the bar at 100° C. will be 1000 mikrons, or one millimetre greater than it was at 0° C. We can also say that if the temperature of the entire mass of metal is again reduced to 0° the length of the bar will be exactly the same as it was before the increase of temperature took place.

There is some evidence that when certain metals are exposed to very violent changes in temperature, as when zinc is removed from a temperature of 100° C. and is submerged in melting ice, the molecular arrangement of the metal is disturbed to such an extent that the return to its original condition may be delayed for several days, and even for several weeks; but it cannot, at the present time, be positively asserted that the return will not ultimately take place.

It will be noticed that the definition of the coefficient of expansion which has been given, viz. the increase in length due to an increase of temperature from 0° to 1°, contains the important limitation that the entire mass of the metal shall have reached the temperature of 0°."

We have no report of the remaining part of the address, except the following abstract of the 'Pittsburg Dispatch,' which gave an account of the proceedings of the meeting:—

"Prof. Rogers chose as his subject, 'A demonstration of the fact that metals may be safely employed to measure temperature by means of their expansion under an increase of temperature.' He began with a defence of microscopy as a science, and gave a brief review of the various ways in which the usefulness of the Microscope may be extended, especially in the direction of mechanical constructions. He then proceeded to discuss the Microscope as a factor in the determination of a constant of nature, which was practically the real subject of his address. In general the problem to be considered is, 'Do metals expand uniformly under every variation of temperature?' After limiting the definition of the term 'constant of nature,' to the three bars of metal investigated, viz. a bar of Baily's metal, composed of 16 parts copper, $2\frac{1}{2}$ parts tin, and 1 part zinc; a bar of Jessup's steel and a bar of glass made by Chance & Sons in 1870 for the British Board of Trade, he gave an account of the various kinds of errors to which observations of this class are liable. Incidentally he referred to the different kinds of thermometers in use, and the manner in which they are constructed, relating many interesting experiments showing the real value of their indications, and how they sometimes fail to register correctly on account of atmospheric changes and conditions. After describing the methods employed to detect the errors of the thermometers employed to measure the temperature at which these three standards of length were compared, he gave an account of the investigation by which he determined that the relative coefficients of expansion of these metals are constant for all temperatures between − 5° and 95° temperature. He made 293 sets of observations, nearly all of them about half an hour after sunrise on clear days, and a little later on cloudy days. The time at which the comparisons between the lengths of these standards were made, was defined by

the speaker to be the critical point of no variation of temperature when there was an equilibrium between the temperature of the bars of metal, of the surrounding air, and of the thermometer employed. As a result of observations extending from December, 1886, to July, 1887, the conclusion was reached, first: 'That the relative coefficients of expansion of these metals are really constant for ordinary temperatures; and second, that the values of the absolute coefficients have not changed since 1881.'" *

Fasoldt's Rulings.†—Mr. C. Fasoldt writes as follows:—"A gentleman interested in microscopy lately called my attention to an item in the report of the Microscopical Society of Washington, D.C., in the April number of the 'American Monthly Microscopical Journal,' p. 77: 'Dr. Schaeffer asked if any of the Society had seen Fasoldt's ruling on glass. Prof. Seaman said Fasoldt had done some fine work, but the finest was that done by Prof. Rogers,' &c.

I was not aware that I was recognized as an amateur in mechanics, and that I imposed on the world with inferior products; neither has a commission of any exhibition ever rendered such a verdict. Contrary to that, in World, International, and State Exhibitions I was always recognized as master of the masters, which is shown by the following first-class awards:—

Prize Medal of Honour and Diploma of Merit awarded at the Centennial Exposition of 1876. Also First Prize Medal and Diploma, International Industrial Exhibition, Buffalo, N.Y. Three First Prize Medals, Utica Mechanics' Association. First Premium Medal, Syracuse Mechanics' Association. Silver Medal and Certificate of Highest Merit of New York State.

Regarding the sentence that I do not publish my method of ruling, I do not want to dictate to other persons what methods to use to accomplish a certain work—in somewhat by showing and illustrating my machine—neither do I want to contradict those who attempt to illustrate how work is and should be done. I claim that everybody has the privilege to construct and make their own Microscope, measuring and illuminating apparatus, ruling machine, and machinery to make those and all other devices that anybody wished to make for private or general public use, as I have done.

As it is proper for a man to uphold and prove what he has said, or either retract such quotation, I would ask Prof. Seaman to send the following rulings made by Prof. Rogers. All test-plates should be ruled in bands, beginning with and running up every 10,000 to the denomination as given below.

1 plate ruled up to 200,000, or 250,000 lines per inch
1 „ „ „ 120,000 „
1 „ „ „ 6,000 „
3 stage mic. ruled 1, 10, 100, 1000 per inch.
3 stage mic. ruled 100, 1000, 5000, 10,000 lines per inch.

When I will appoint a committee of four to measure and resolve them. And the Professor can appoint his committee and do likewise with my rulings.

We have numerous times resolved 200,000 and over. I have the facilities to do it with, and measuring likewise."

* Cf. Amer. Mon. Micr. Journ., viii. (1887) pp. 196–7, for a criticism on this address, so far as it defends the claim of microscopy to the title of a science. "We see no advantage to be gained by naming a science which does not exist. In a truly scientific sense there is no such thing as a science of microscopy as defined by Prof. Rogers."

† Amer. Mon. Micr. Journ., viii. (1887) pp. 175–6.

It would be very interesting if Mr. Fasoldt would tell us how he resolves the "numerous lines, 200,000 and over." Until he does this his claim to be recognized as a "master of the masters" cannot be admitted.

Nägeli and Schwendener's 'The Microscope in Theory and Practice.'* —This translation of Prof. Nägeli and Schwendener's well-known treatise on the Microscope is at last published, after suffering almost unprecedented vicissitudes. In addition to disasters to the manuscript, the whole book, after being printed off, was burnt in 1884, in a great fire in the City in which the printer's works were involved. Those responsible for the publication were so far discouraged that they practically abandoned the matter, and it is due to the enterprise of the publishers that the translation is after all given to the English-speaking public. Although advances have been made since the book was written in several directions, notably by Professor Abbe, Nägeli and Schwendener's work will always be a classical landmark in the history of the Microscope, and will be more especially valuable to English microscopists as the first book in their language to deal with the Microscope on a scientific basis unadulterated on one side by descriptions of the various forms of Microscopes and microscopical apparatus, or on the other by a review of the microscopical subjects of the Animal, Vegetable, and Mineral Kingdoms. As such we may commend the book to a place in every microscopical library.

The following is extracted from the preface:—

"This translation of Nägeli and Schwendener's well-known treatise 'Das Mikroskop' was commenced by Mr. Frank Crisp, Secretary of the Royal Microscopical Society, immediately after the publication of the last (German) edition (1877), with the intention—as indicated by him in a communication to the Quekett Microscopical Club—of filling up a blank in English miroscopical literature in regard to the scientific technical treatment of the theory of the Microscope, in which English text-books were so deficient.

The student refers in vain, even at the present date, to English works on the Microscope for explanations of the theory of the construction of objectives, eye-pieces, &c., or for the discussion of the phenomena of diffraction and polarization in their connection with the Microscope, or for any scientific treatment of the question of interpreting microscopical images or the theory of microscopic observation. These subjects are dealt with systematically in German works only, and notably in that of Nägeli and Schwendener.

The translation was thus undertaken with a view to placing before English readers the then best known collective exposition or technical treatment of these points by German writers.

When the rough draft of the translation was completed, the first five sheets (80 pp.), were revised and put in type, but in consequence of prior claims upon his time in connection with the Royal Microscopical Society, Mr. Crisp was compelled to relinquish the task of further revision, and of passing the volume through the press, a labour which was undertaken by Mr. John Mayall, jun., one of the editors of the Society's Journal.

Just as the printing was completed, a fire destroyed the premises of the printers, and the whole of the printed sheets of the volume were burnt, except one set as far as p. 374, which the publishers had retained in their possession, together with a few of the woodcuts.

* Nägeli, C., and Schwendener, S., 'The Microscope in Theory and Practice' (translated from the German), xi. and 382 pp. and 210 figs. (8vo, Swan Sonnenschein, Lowrey & Co., London, 1887).

Under these circumstances the publishers had to consider the alternatives (1) of abandoning the issue of the volume; or (2) of incurring the additional expense of re-translating the portion of the work totally lost by the fire, replacing the missing woodcuts, and reprinting the whole; or (3) of reprinting as far as p. 374 only, omitting therefore Part VIII. (Microphysics), Part IX. (Microchemistry), and Part X. (Morphology). It was finally decided to adopt the last course, hence the present issue.

Whilst it is much to be regretted that this translation should only now be issued, microscopists will no doubt appreciate the advantage of having a version in English of a work which has received high commendation from both English and foreign critics; and it is hoped that this volume may be supplemented before long by an English version of the further researches in microscopical optics by Professor E. Abbe, of Jena, which have extended so much our knowledge of the matters dealt with in Nägeli and Schwendener's work."

Death of Mr. T. Bolton.—We much regret to have to chronicle the death of Mr. T. Bolton, a Fellow of the Society. Mr. Bolton's intense devotion to microscopical matters is well known to all microscopists, and the perseverance with which he carried on his supply of microscopical organisms was beyond all praise. His services in this connection had materially added to our knowledge of the fresh-water and other fauna of this country, and he was the discoverer of forms not only new to England but new to science. He was ever ready to assist microscopists and naturalists to the utmost of the means at his command, without, as we have often found, making any sufficiently adequate pecuniary demand in return. His death is a serious loss to microscopy.

In 1884 the Council of the Royal Society placed 50*l.* in the hands of Prof. Ray Lankester for the purpose of employing Mr. Bolton to collect material for an investigation of the fresh-water fauna of the midland counties; and at the Fisheries Exhibition a gold medal was awarded to him for an exhibition of minute life relating to the food of fishes. It will be remembered that last year, in response to a memorial signed by many eminent men of science, a Civil List pension of 50*l.* per annum was granted to him.

"A Quekett Clubman."—**The Student's Handbook to the Microscope**: A Practical Guide to its Selection and Management. 72 pp. and figs., 8vo, London, 1887.

Alessandri, P. E.—**Il Microscopio e sua applicazione alla Merceologia e Bromatologia.** 173 pp. and 230 figs., 8vo, Milano, 1886.

American Society of Microscopists.—Pittsburg Meeting.
St. Louis Med. and Surg. Journ., LIII. (1887) pp. 229–34.

Brezina, A.—**Das neue Goniometer der K.K. Geologischen Reichsanstalt.** (The new goniometer of the I.R. Geological Reichsanstalt.)

[The optical part is thus described:—"The observing telescope is provided with a Huyghenian eye-piece, which can be moved to or from the objective, so that by inserting a lens in front of the objective the observer is able to use the whole system of lenses as a Microscope, and by approaching the eye-piece towards the objective to convert it into a telescope. In this way the connection between the image of the signal and that of the face may be tested in crystals with numerous faces. Since, however, the telescope may be raised or lowered, by which movements its distance from the axis of the circle is changed, the lens must also be capable of movement towards or from the axis. For this purpose the lens-holder is made to slide upon the telescope tube."]

Jahrb. Geol. Reichsanst., XXXIV. (1884) pp. 321–34,
Abstr. in *Neues Jahrb. f. Mineral.*, II. (1887) pp. 239–40.

[Cope, E. D., and Kingsley, J. S.]—**Wanted a Definition of a "Philosophical Instrument."**

[Complaint that with the U.S. Custom officials a hydrometer is a "philosophical instrument," while a thermometer is a "manufacture of glass," paying a higher

duty, while "Microscopes and microtomes are 'manufactures of metal,' as ruled by the Washington wiseacres in opposition to the opinions of the best scientific men of the country. . . . A more reasonable interpretation of existing laws, or better, a revision and a reduction of the present duties, would tend generally towards the advancement of American science and the promotion of American honesty."]

Amer. Natural., XXI. (1887) p. 922.

CUTTER, E.—**[The Microscope and Old Age.]**

["I hope that the Microscope may not be relegated to the younger members of our profession alone. It is an instrument for old age. Ehrenberg worked with his Microscope up to within a few days of his death. The focusing accommodates the defects of vision. Moreover, it is a comfort and solace to an aged physician to quietly explore the mysteries of the unseen world he has been dealing with microscopically during a long and laborious life. May it be a good preparation for that endless life where we shall no longer see through a glass darkly."]

Microscope, VII. (1887) p. 284.

GORECKI.—**Du Microscope appliqué à l'étude de la Minéralogie et de la Pétrographie. Minéralogie micrographique.** (The Microscope applied to the study of mineralogy and petrography. Microscopical mineralogy.) 8vo, Paris, 1887.

Microscopical Studies, Pursuit of, by Amateurs.

[Discussion of the question "How can a man who uses the Microscope, and studies pursued by its aid as a means of recreation, retain his interest in the subject?"]

Amer. Mon. Micr. Journ., VIII. (1887) pp. 197–8.

Microscopy in Calcutta. *Sci.-Gossip*, 1887, pp. 229–30.

NEUMANN, C.—**Die Brillen, das dioptrische Fernrohr und Mikroskop.** Ein Handbuch für praktische Optiker. (Spectacles, the dioptric telescope and Microscope. A handbook for practical opticians.)

xxxii. and 232 pp., 95 figs., 8vo, Wien, Pest, Leipzig, 1887.

[OSBORN, H. L.]—**Microscope in Medicine.**

Amer. Mon. Micr. Journ., VIII. (1887) pp. 155–6.

ROYSTON-PIGOTT, G. W.—**Microscopical Advances. XXV., XXVI., XXVII., XXVIII.**

[Butterfly dust; villi and beads; its isolated beading and reticulations; reticulations and crossbars; ultimate beading and woof.]

Engl. Mech., XLVI. (1887) pp. 101–2, 173–4, 245–6, 291–2 (4, 10, 5, and 8 figs.).

VERLOT, B.—**Le Guide du Botaniste herborisant.** (Guide for the collecting botanist.)

[Contains descriptions of Microscopes, &c.]

3rd ed. with introduction by Naudin, xvi. and 776 pp. and 34 figs., 12mo, Paris, 1886.

β. Technique.*

(1) Collecting Objects, including Culture Processes.

Cultivation of Chætomium.†—For the cultivation of *Chætomium Kunzeanum*, says Dr. F. Oltmanns, plum decoction is more suitable than that of dung, as bacteria develope in it less easily. In order to determine whether the formation of a pollinodium ceases in the ascogonium, the examination of a dead cultivation does not suffice; recourse must be had to cultivations which allow continual observation of a particular carpogonium. Cultivations in moist chambers in hanging drops as they are usually carried out are impracticable, for the fungus stands in need of much oxygen. The mycelia are rarely brought to the fructification, for before this occurs a cessation of their general growth takes place, and even if the perithecia are actually formed it is not of much use, as these prefer to arise from mycelia projecting into the air, or are as near the culture-drops and air as possible —positions unattainable with high powers. To observe an ascogonium for a long time, nothing remains but to keep the ordinary slide-cultivations in the usual way under moist bell-jars until spores are formed. A suitable

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

† Bot. Ztg., xlv. (1887) Nos. 13–7 (1 pl.). Cf. this Journal, *ante*, p. 791.

ascogonium is then sought for under the Microscope, and the position of the slide upon the stage noted by means of a piece of paper stuck thereon. This device enables us to remove the slide and replace it under the bell-jar for further growth, and thus the stages of development may be examined without difficulty. Medium powers (Zeiss D, Oc. 4) are only available, and these do not meet the requirements of all cases. If the pollinodium be evident, it may perhaps be followed up with this objective. The younger parts can be observed until the brown hairs appear, after which their growth stops. In selecting ascogonia for observation, such as are quite immersed beneath the culture-fluid must be chosen. But as the fungi stand in need of much oxygen, they usually die if, when removed from the culture-drops, they do not receive sufficient air. From the moment when the perithecium is quite closed it becomes more difficult to follow the fate of the ascogonium.

From very small perithecia some knowledge may be derived from cleared up sections. It may then be noticed in young fruit-organs in which the hyphæ almost completely close up that the ascogonium is quite unchanged. For further examination the assistance of the knife is required. Axial longitudinal sections may be made in the following manner:—Pieces of elder pith cut smooth on one side are soaked in plum decoction until quite saturated therewith. The process, which is slow, may be hastened by frequent and prolonged boiling. Upon the smooth side of the pieces thus prepared spores are sown; these develope so that the perithecia stand vertical to the pith-surface. The fungi, having sufficiently grown, the piece of pith is laid in osmic acid; after hardening they are washed and then imbedded in glycerin jelly. It is also advisable to shave off a thin layer which carries the perithecia and imbed it in glycerin jelly. In both cases the gelatin is hardened in spirit, and then longitudinal sections of the perithecia are made. Imbedding may also be made in ordinary gelatin and in celloidin, but the latter is only suitable for young perithecia. Orienting perithecia under a dissecting Microscope and fixation on elder pith is only possible in the adult stages where the ascogonium formation has already begun, as in this case there is a safe criterion between apex and base. The author finds, too, apart from the fact that the ascogonium does not always lie centrally, and that every axial section does not afford correct information as to the relation of the carpogonium, that it is difficult to decide whether a section is accurately axial or not.

Osmic acid facilitates the examination, as it stains the hyphæ of the carpogonium brown or brownish yellow. The same colouring also appears in the old cells which proceed from the ascogonium.

Some Novelties in Bacteriological Apparatus.*—(1) *New form of Incubator.*—Dr. M. Schottelius has devised an incubator which, though unprovided with a gas-pressure or thermo-regulator, does not vary summer or winter more than 0·15°. The incubator contains two approximately cubical compartments (50 cm.), and consists of a double-walled box of zinc plate 1·37 m. long, 0·80 m. deep, and 0·80 m. high. Between the double walls circulates a layer of water 10 cm. thick, except at the top, where the layer is 20 cm. thick. The box is subdivided by a median partition, also double-walled and filled with water. The capacity of each chamber is therefore about 1/8 cubic metre. Access to the chamber is obtained by two double-walled zinc doors filled with a layer of ashes 10 cm. thick. The doors are placed at opposite ends of the long sides of the incubator. At the lower part of one of the shorter sides is a tap for letting off the water. Between the inner wall of the door and the incubator space is a

* Centralbl. f. Bacteriol. u. Parasitenk., ii. (1887) pp. 97–102.

plate of glass fitted in a frame of wood and covered with felt. The incubator is encased in wood, and stands 55 cm. high. Three thermometers, each 72 cm. long, are employed to indicate the temperature of the water and of the two compartments. The scale is marked from 30°–50°, and subdivided into tenths of a degree in such a way that each division is 1 mm. distant from the next.

A constant temperature is obtained by means of two simple Bunsen burners fed direct from the meter usually kept at half power. By raising the burner 1 cm. the temperature rises a tenth of a degree, so that to obtain the desired temperature (37°), twenty slips of wood, each 1 cm. thick, will be required. If higher temperatures are desired, the burner must be altered. The heating action of the apparatus must of course be ascertained first of all empirically, but this is only required to be done once. It may be mentioned that the course of the circulation is from the floor upwards through the central partition, then right and left along the top, and then downwards to the floor again by the short sides. The thermometers are all encased in a copper sheath, and the floor of the incubator is also made of copper.

(2) *A perfectly clear Agar Medium*, which will withstand a temperature of 40° without melting, is produced in the following manner:—Obtain the raw material, the dried *Fucus spinosus* (the ordinary agar powder is of no use), and pick out therefrom the clear yellowish transparent pieces. Then weigh the pure agar thus obtained, and wash with a 2 per cent. hydrochloric acid for five minutes, then with ordinary water frequently changed and perfectly free from dirt. By frequent weighing the quantity of water is ascertained, and by addition of concentrated bouillon the desired consistence is attained. It must be noted that for this quality of agar 5–10 per cent. is required to produce a firm medium. The agar bouillon is then left to macerate all night at the ordinary temperature. The next day it is boiled in a water-bath and strained through a linen filter. The usual quantity of pepton and common salt is then added, and after being neutralized with carbonate of potash or soda, is heated once again in the water-bath for about half an hour. The agar solution is then filtered through filter-paper. It flows through clear but slowly. On account of its rapid coagulation it is well to filter direct into sterilized test-tubes or Koch's flasks. Produced in this way the agar medium is perfectly crystal clear, remains quite firm at 40°, but is, however, somewhat softer than the ordinary solution.

(3) *Glass vessels for observing potato cultivations, &c., in various gases* may be made by expanding as much as possible the lower part of the neck of Koch's flask of about 200 grm. capacity, and then cutting them off at the middle of the neck. To the upper somewhat conical end an air-tight glass cap is fitted on, and to the side of the bulb a thin glass tube about 10 cm. long is melted in. The latter tube is intended to communicate with the air-pump. The raw potato discs are pushed through the neck opening by removing the glass cap, and after the side tube is plugged with cotton-wool the flask is sterilized. The medium having been inoculated while the flask is held in the oblique position, the air-pump is connected with the side tube; the air is withdrawn and replaced with the desired gas. When full the side tube is melted up with a Bunsen burner. In case the access of impurities should be feared during inoculation, a narrow glass tube terminated by a small cap can be fitted to the larger cap, and then inoculation may be performed in a current of the gas selected by quickly removing the smaller cover. Absolute safety is attained by closing the rims with vaselin. The tap connecting with the air-valve must be triply perforated, so that the

closure of the air-pump is simultaneous with the opening of the gasometer. It is of course obvious that experiments with this apparatus can only be made up to one atmospheric pressure.

Cultivation of Bacteria on Coloured Nutrient Media.—Prof. A. v. Rozsahegyi has experimented with the following Bacteria in order to ascertain the effect of cultivation in coloured nutrient media, and the influence of the dye on their growth, and to acquire, if possible, a new criterion for the differential diagnosis of the various species:—(1) bacilli of blue milk and green pus; (2) bacilli of rabbit septicæmia and fowl cholera; (3) bacilli of mouse septicæmia and swine plague; (4) the Koch and Finkler-Prior comma bacilli.

The gelatin was stained with various anilin dyes, prepared in the manner used for staining cover-glass preparations, and with "Tinctura Kermesina" (cochineal). A few drops of the stain were added to a small flask of liquefied 5 per cent. gelatin, some of which was filtered into test-tubes and sterilized by steam. When set, the gelatin was deeply stained, but quite clear and transparent. The cultivations were made at a temperature of about 20° C., the ordinary temperature of a room.

In the result, it was found that in certain cases it was evident to the naked eye that the dye was taken up very freely (e. g. Finkler-Prior comma bacillus in methyl-violet), and the bacilli seemed very deeply stained; yet on microscopical examination they appeared so pale that no advantage accrued from the method of staining. The influence of the dye on the growth of the bacteria was very various, although the alkaline reaction of the gelatin was unchanged by the addition of the reagent. Vesuvin was the most active preventive of growth, and less so gentian, methyl-violet, and Tinctura Kermesina. The impairment of growth was most noticeable in the liquefying varieties, and the form of the liquefaction area was also altered; thus the Finkler-Prior comma bacillus, instead of growing quickly down along the inoculation track, spread downwards in a broad channel, presenting the appearance of a cultivation of Koch's comma bacillus. In the latter the characteristic air-bubble was usually scarcely visible. In the non-liquefying varieties, the surface growth only was as a rule impaired.

In most cases the colouring matter was unaffected by non-liquefying bacteria, and where a change was observed, this began at the bottom of the cultivation; the matter causing this decoloration must therefore be produced in the absence of air. Of the liquefying comma bacilli, Finkler's had no effect on methyl-violet, while both this and Koch's comma bacillus decolorized fuchsin in the fluid part, and methylen-blue in the solid. With methylen-blue the colour could be restored on shaking, the effect lasting in a cultivation of Koch's bacillus for days, but in one of Finkler's a few hours only.

With regard to distinguishing between very similar kinds of bacteria, the author found that rabbit septicæmia did not grow in gentian, but very strongly in vesuvin. Fowl cholera grew well in gentian, but not in vesuvin. Mouse septicæmia grew strongly in methylen-blue; swine plague very poorly. Cultivations of the Finkler-Prior and Koch's comma bacilli in fuchsin appeared pretty different; in methylen-blue the former lost colour more rapidly, and while it grew well, though slowly in methyl-violet, Koch's bacillus would not grow at all.

* Centralbl. f. Bacteriol. u. Parasitenk., ii. (1887) pp. 418–24.

(2) Preparing Objects.

Preparing Supra-œsophageal Ganglia of Orthoptera.*—Signor G. Cuccato snips off the head of the insect with a pair of scissors, and pins it on cork. Thus fixed, the head is immersed in 0·75 per cent. NaCl solution. Then with the aid of scissors and forceps, the chitinous sheath, and the eyes, are removed from the supra-œsophageal ganglion, and the specimen removed to a watch-glass full of salt solution, wherein the tracheæ and muscles are removed. After a short time the object is placed for forty-eight hours in Flemming's mixture, and then having been well washed, the rest of the muscles and the fat are removed from the ganglion. It is next put in 36 per cent. spirit, and gradually hardened. After dehydration it is imbedded in paraffin. The sections were fixed down by Mayer's method, and stained with a saturated watery solution of acid fuchsin. The fixative used was Rabl's solution (chromo-formic acid and platinum chloride).

Treatment of Acari.†—Dr. C. Nörner remarks that Acaridæ should be treated according to their species and habitat. Such as live within a tissue, e. g. the *Acarus scabiei*, are best obtained by softening the scabs in a 10 per cent. potash solution for an hour, or perhaps better by allowing a weaker solution to act for a longer time. Very good results are produced by soaking the scabs for a day in a dilute mixture of potash, glycerin, water, and spirit. The mites are thereby rendered not too transparent and preserve their form well. A very good preserving fluid consists of equal parts of 90 per cent. spirit, glycerin, and water. When the scabs are sufficiently softened, they are teased out in dilute glycerin under a dissecting Microscope and all extraneous matter removed. Glycerin preparations may be ringed round with turpentine, with red sealing-wax dissolved in absolute alcohol or with gold size, &c. A good preparation should contain mites in all stages of development, that is to say, eggs, larva, nympha, male and female, and if possible the stage of exuviation. For such slides glycerin jelly is a better mount than glycerin. The free-living mites and ticks which infest the surface of their host are more easily obtained than the pit-digging itch insect. The feather ticks of birds are almost as numerous as the species of birds. These are obtained by laying feathers under a dissecting Microscope and removing the animals with the needles; the breast feathers of small birds require to be placed in a dilute potash solution from which they are picked out under the Microscope. The histological structure of the Acaridæ is best studied in the living animal immersed in a drop of oil, glycerin, or water. The author has also used a mixture of glycerin, spirit, acetic acid and eosin, where these reagents were extremely dilute. To prevent the animals from being crushed during the microscopical examination it is only necessary to support the cover-glass on two others.

Very pretty pictures may be obtained by staining: for his purposes Ranvier's picrocarmine is the most generally useful. Other staining fluids recommended are (1) a mixture of equal parts of picrocarmine and indigo-carmine, (2) eosin either in alcoholic solution or watery, to which 1/3 glycerin is added; (3) methyl-green; (4) ammonia-carmine; (5) Magdala red. Rosanilin and fuchsin are the most suitable for the cast-off skin. With regard to their receptivity for dyes it should be borne in mind that mites are very uncertain, some taking up none or with great difficulty, while

* Cuccato, G., 'Sulla struttura del ganglio sopra-esofageo di alcuni ortotteri,' Bologna, 1887.

† Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 159-67.

others take up too much. Haller recommends boiling the mites, &c., in a mixture of aq. dest. and potash (2:1) and then mounting the chitinous framework of the head in glycerin slightly dilute, while Ehlers treated them with ammonia and oil of cloves, but the author had no success with either of these methods.

The structure of the tracheæ is best shown by slight staining with picrocarmine, illuminated by Abbe's condenser with central stop.

Sections of stained mites and ticks are prepared by immersing them in gelatin and hardening in alcohol. They are then imbedded in elder pith and so sectioned. Ova should be examined in dilute salt solution (glycerin swells their capsule too much) and without a cover-glass. Picrocarmine stains ova very well and clearly brings out the segmentation, which if unstained and in glycerin does not appear.

Preparation of Microscopical Parasites.*—Dr. Stoss obtains his preparations of Acaridæ by scraping off the scabs from the diseased animal and softening them in a 10 per cent. potash solution for half an hour. A little piece of the softened scab is then mixed with a drop of water and examined carefully under a low power (× 90). A suitable *Acarus* having been discovered, it is removed from the action of the potash solution by pushing the slide to the right and the cover-glass to the left with a needle. The *Acarus* is then freed from all extraneous objects and left on the slide for mounting, or is transferred to a watchglass containing glycerin by means of a needle. The fluid, which is suitable for extracting the potash lye, for preventing the *Acarus* from drying, or for preserving the animal, consists of a mixture of equal parts of 90 per cent. spirit, glycerin, and water. The *Acarus*, immersed in a drop of this fluid, is sealed up with a rim of wax, paraffin, or asphalt run round the cover-glass, but dammar or Canada balsam dissolved in chloroform or xylol are probably better and more durable.

When the *Acari* exist in quantity among the scabs and scales, and there is no difficulty in obtaining a good specimen, as, for example, is usually the case in cat's mange, the following procedure is recommended:—The scales are put for some time in the potash solution, and are then washed in distilled water several times. The *Acari* and scales are allowed to settle at the bottom of the vessel, and the supernatant fluid decanted off. The glycerin-spirit mixture is then poured over them, and in this they may be kept for an indefinite period without undergoing any change.

Psorosperms are well preserved in the glycerin-spirit mixture, but the proportions are different (1—1—2 water). And it is noticeable that different objects require slight alterations in the quantities of the constituents in order to produce an equilibrium between the contracting action of the spirit and the swelling action of the glycerin. Thus *Oxyuris mastigodes* remains quite intact in a fluid of 1—1—2, while *Filaria* shows fine surface-creasings, which do not appear with a little more water.

Although these parasites keep very well by the foregoing methods, they are extremely susceptible of mechanical injury. Damage from this cause is avoided by mounting in glycerin jelly. This medium is produced by softening gelatin by leaving it all night in water. It is then cut up and fluidified in a water-bath without the addition of water, and mixed with 10 per cent. glycerin and 1 per cent. carbolic acid. When cold the mass is cut up and kept in stoppered bottles. A mite or tick is mounted by placing small bits round it on a slide and then warming gently over a

* Deutsche Zeitschr. f. Thiermed. u. Vergl. Pathol., xii. (1887) pp. 202–5.

spirit-lamp. When the jelly is melted a warm cover-glass is imposed. If the mass should swell up over the cover-glass, it is easily removed when cold.

Investigation of Histology of Eunice.*—Prof. E. Jourdan reports that the use of alcohol at 90 per cent. has always given him the worst results with Annelids, and that the same has been the case with picric acid; when either of these reagents has been used the elements of the tissues are quite beyond recognition. The use of 2 per cent, solution of bichromate of ammonia, of bichloride of mercury, either saturated, as Lang's solution, or in a 5 per cent. solution, was more successful. Osmic acid (1 in 200 parts) was the best reagent for the study of the antennæ and the delicate organs in general, and was always regarded as a good means of control for observations made after the use of other reagents. After the use of these fixing solutions, the specimens were washed and then placed in alcohol of increasing degrees of strength up to 90 per cent. The alum-carmine solution of Grenacher was most used in staining. Celloidin was used at the commencement of the research, but was not found to present any advantage over paraffin; the mixture of Schällibaum was found excellent in fixing the pieces after placing in paraffin, and they were thus completely coloured. The plates carrying the series of sections were treated with various strengths of alcohol, dehydrated by absolute alcohol, and mounted in Canada balsam.

Prof. Jourdan found greater difficulty in his teasings; the most successful method was one which has been used to isolate the nerve-tubes of Vertebrates. Fresh pieces were treated with one-hundredth solution of osmic acid, and were then allowed to macerate in weak alcohol or even distilled water. Specimens preserved for a year in bichromate of ammonia were also successfully teased in a drop of hæmatoxylic glycerin, to which a drop of glycerin was added for examination and preservation.

Preparing Epithelia of Actiniæ.†—Dr. J. H. List used the tentacles of *Anthea cereus* and *Sagartia parasitica* in his examination of the epithelia of Actiniæ. The tentacles were snipped off in the vessels in which the animals were kept alive, and when the contraction due to the irritation had passed off, the greater part of the sea-water was removed with a pipette, only so much being left as would serve to keep the specimen moist. The tissue of the tentacles was then fixed with chrom-osmium acetic acid. This was allowed to act for ten minutes; the specimen was then washed, and after-hardened in spirit.

Isolation of the elements was effected by placing the tentacles in a vessel containing 100 ccm. sea-water and 30 ccm. Flemming's fluid (chrom-osmium acetic acid mixture). After allowing this to act for ten minutes, the tentacles were transferred to a large quantity of 0·2 per cent. acetic acid, wherein they remained for two to three hours. The specimens thus treated were afterwards placed in glycerin and water (equal volumes), and there teased out. Excellent isolation-preparations of the cells of the ectoderm were thus obtained; these kept extremely well, and further differentiation was obtained by staining with picrocarmine.

Breaking up Diatomaceous Rocks.‡—M. Guinard breaks up diatomaceous rocks by putting small fragments in a test-tube and covering them for about 2 cm. with crystals of commercial acetate of soda and then adding one or two drops of water. (On a larger scale the proportion of water is

* Ann. Sci. Nat.—Zool., ii. (1887) pp. 239–42.
† Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 210–1.
‡ Bull. Soc. Belg. Micr.. xiii. (1887) pp. 180–2.

5 ccm. to 100 of the salt.) The test-tube is then placed in a water-bath, and the contents dissolved at boiling-point. It is left for ten minutes in the hot water and then removed and allowed to cool gradually, or it may be cooled rapidly by plunging it in cold water. A small crystal of soda acetate is then dropped in, when, owing to its supersaturation, it at once crystallizes. By repeating this two or three times the rock is quite reduced to powder. However, very refractory rocks, such as those from Jutland, require five or six repetitions. The next step merely consists in adding water to excess to dissolve out the salt. Another substance, the hyposulphite of soda, may be used for the same purpose. The hyposulphite of soda and some bits of rocks are mixed up in a test-tube and heated in a water-bath to 48°. The salt deliquesces, and then having been allowed to cool, a small crystal is dropped in. Water is then added in excess to dissolve out the salt. Of course the operation must be repeated until the rock is properly pulverized.

The foregoing methods, the first of which is preferred by the author, are simpler than the sulphate of soda method of Brun.

Hueppe, F.—**Cover-glass Preparations in Bacteriological Investigations.**
Amer. Mon. Micr. Journ., VIII. (1887) pp. 190–4, from Hueppe's 'Methods of Bacteriological Investigation,' *transl.* by Dr. H. M. Biggs (New York).

James, F. L.—**Preparing Crystals of Salicine.**—Referring to the note at p. 507, Dr. F. L. James further writes:—

> "When, some months ago, I made note of the fact that I had hit upon the method of reduplicating the astonishingly beautiful slides of salicine accidentally made some years ago, I had little idea of the possibilities of that alkaloid in the way of strange and gorgeous groupings. Some of my later experiments in this direction have resulted in slides utterly throwing into the shade all former successes. The human eye never before dwelt on so wonderful and gorgeous phenomena as are presented in some of these latest slides. All laws and rules of crystallization seem to be set aside, and the material runs riot in its bewildering forms and combinations. The most beautiful auroras and most brilliant pyrotechnics fade into insignificance alongside some of the latest results."

St. Louis Med. and Surg. Journ., LIII. (1887) pp. 166–7.

Quimby, B. F.—**Insect Preparation. II.**
[Mounting—mounting insects as opaque objects.]
Microscope, VII. (1887) pp. 266–9.

(3) Cutting, including Imbedding.

Myrtle Wax Imbedding Process.*—Myrtle wax, or bayberry tallow, writes Mr. J. W. Blackburn, is a substance derived from *Myrica cerifera*. The wax is found covering the fruit as a whitish coat, and is separated by boiling the berries in water and removing the wax on cooling. It is of a pale greyish-green colour, somewhat diaphanous, brittle, slightly unctuous to the touch, is feebly aromatic, and a little bitter to the taste. Its specific gravity is about that of water, and its melting-point 46°·6 C.–48°·8 C. (116°–120° F.). It is insoluble in water, scarcely soluble in cold alcohol, soluble except about 13 per cent. in 20 parts boiling alcohol, which deposits the greater part of it on cooling. It is also soluble in boiling ether, and slightly so in oil of turpentine. It is very soluble in chloroform benzol and xylol. The foregoing account is descriptive of the true product of *Myrica cerifera*, but for the purposes of the microtomist it will not answer. A variety must be obtained which is yellowish-white in colour, tougher and softer. This variety is probably the product of *Rhus succedanea* Ln., and should be called "Japan wax."

Dr. M. N. Miller, who first described this method,† states that "bayberry tallow is firm and solid at ordinary temperature, and is solid in warm alcohol." He states that specimens may be removed from the alcohol in

* Amer. Mon. Micr. Journ., viii. (1887) pp. 164–5.
† N. York. Med. Record, xxvii. (1885) p. 429.

which they have been preserved, and placed at once in a bath of melted wax; but the author thinks it is better to first dehydrate in absolute alcohol, and then place in a preliminary bath of wax dissolved in chloroform. Benzol and xylol will dissolve large quantities of the wax, but it is deposited in a granular form on their evaporation; but after solution in chloroform the wax is left in a soli l form. Hence chloroform is preferred as a solvent for the preparatory bath, but for all other purposes the less expensive reagents may be used. The chloroform may be used over and over again, and if occasionally a little fresh be added to it, the bath may be kept always ready.

The method of using myrtle wax is as follows:—The specimens are dehydrated in absolute alcohol and then placed in a solution of wax in chloroform as a preliminary bath, or transferred directly to the melted wax. The pieces will be infiltrated in about the same time required by the paraffin method. The pieces may be fastened on cork, by using the melted wax, or imbedded in blocks of wax or paraffin to support the specimen in the clamp of the microtome. The sections are cut dry into benzol, washed in alcohol, stained and mounted as usual. To completely remove the wax, it is best to take the sections through a second bath of benzol, as any remaining wax will be precipitated by the alcohol used in the washing. Warm absolute alcohol may be used to free the sections from wax, but the benzol is better and cheaper. Ordinary alcohol warmed will not dissolve the wax perfectly. Warmed absolute alcohol will dissolve most of it, but will deposit it on cooling. The author therefore thinks that the above method is preferable to the immediate transferring from the preserving alcohol to the wax-bath, as advised by Dr. Miller. The method is more rapid than the paraffin or celloidin process; there is very little if any shrinkage; it does not injure the most delicate tissues; and it is inexpensive. If hardened in large masses there is slight shrinkage and a tendency to crack; this may be prevented by the addition of a small amount of paraffin, with which it is miscible in all proportions. The author states that he has never seen a section injured by cracking.

De Groot's Automatic Microtome.*—Herr J. G. de Groot's instrument (fig. 248) consists of a rectangular frame, supported on four feet. To the long sides of this frame are fitted two cylindrical bars, upon which the object-carrier slides. The latter is a metal plate *b* faced with ebonite, and supported on the slide rails by four feet: on its under side are two vertical bars, joined at their ends by a cross-piece, from the centre of which uprises a thick screw, and this latter passes through a threaded ring *r*. This screw-ring supports two vertical bars, the upper ends of which pass through openings in the metal plate and are then again united by a second ring. To this last is fixed a third ring *c*, which supports a cup-shaped tube *d* filled with paraffin for the reception of the object to be cut. At the lower end of the main screw is a horizontal cog-wheel *e* by the movement of which the ring *r* and with it the object-holder *d* are raised or lowered. The to-and-fro movement of the object-carrier is effected by means of a rod which connects with the large wheel *f*. The extent to which the screw is turned in the to-and-fro movement is regulated by the escapement *a*. This is a rod with rack which works up and down in a box and is fixed by a screw. When the object-carrier moves backwards, the teeth of the rack grip those of the toothed wheel *c*, so that the more they are engaged the deeper the rod is pushed in. This depth is easily determined from the figures on the rod, but it must be noticed that the hinder side of the box coincides with the

* Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 145–8 (1 fig.).

streaks upon which the numbers stand. When the slide is pushed forwards the toothed rod is disengaged from the wheel, and is replaced by another

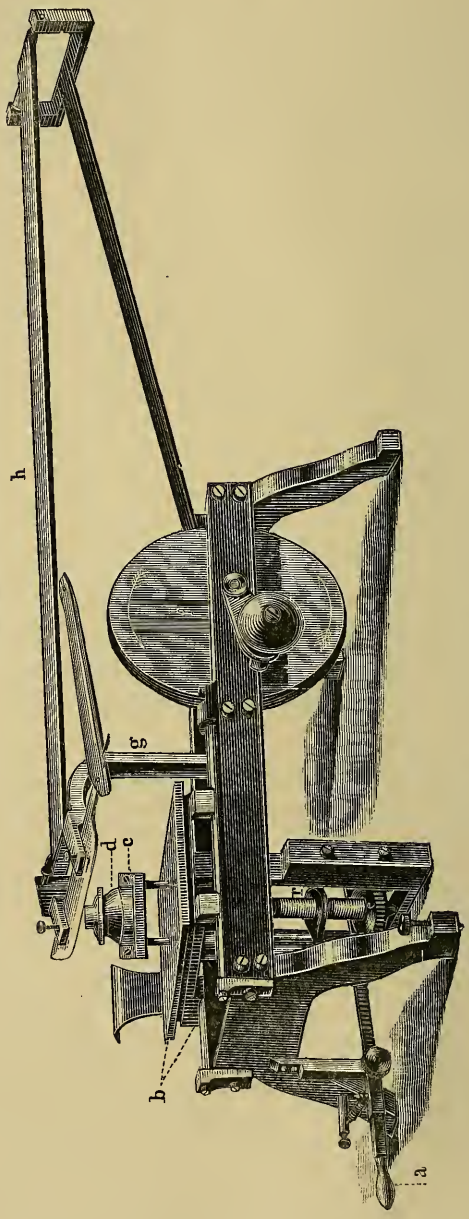


Fig 248. De Groot's Automatic Microtome.

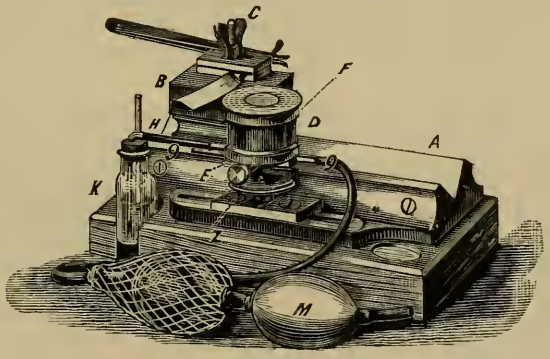
simple arrangement not shown in the illustration. The cog-wheel *e* has 150 teeth, and as one complete turn raises the object 3/4 mm., one tooth represents an ascent of 1/200 mm.

The knife-carrier *g* terminates in front in two openings, through which the knife is passed, and is there fastened by means of two screws. The cup-shaped object-holder *d* fits accurately in the ring *c*. One-half of the latter is movable and fixed by two screws, so that the preparation may be placed in any desired position. The object is imbedded in the usual manner in pure paraffin, and is then melted in the cup filled with hard paraffin. The cup is then fixed in the ring in such a manner that one surface of the paraffin mass is parallel to the knife. When cutting, each section is pushed off the knife by its predecessor, and adheres to it so that a ribbon-like strip is produced, and this is taken upon a brush and placed on the band *h*. This band moves over two rollers, one of which is attached to the front side of the microtome, the other to the knife-carrier *g*. The first section is stuck firmly to the band, the lower side of which is pulled by the left hand, so that the whole series of sections eventually lie on the upper side.

Excellent sections of the frog's embryo, and series of sections of the embryos of *Erinaceus* and *Gallus domesticus*, which are 15 mm. long, have been prepared by this instrument, which is also said to work very quickly, so that 1000 sections can be prepared in ten minutes. The fig. represents the microtome about 1/5 its natural size.

Hayes's Ether Freezing Microtome.—This instrument (fig. 249*) was designed by Dr. R. A. Hayes with the object of affording to those who have occasional need to cut sections of tissues for pathological investigations, &c., with the means of doing so quickly, conveniently, and accurately. It is

Fig. 249.



very compact, solidly constructed, and simple in plan. It freezes rapidly, and permits sections of large surface to be made with precision, sections 1 in. × 5/8 in. having been cut by it without difficulty.

It consists of a solid cast-iron base A, 10 in. × 4½ in., which rests upon a mahogany block. Extending the whole length of the upper surface of the base is a V-shaped gutter, on the planed sides of which slides a heavy metal block B, on the flat top of which the razor is secured (any ordinary razor can be used), the tang being grasped between two flat pieces of iron, which are pressed together by a winged nut C. The razor by this arrangement can be secured at any desired angle to the direction of its motion to and fro.

The freezing chamber is formed by a short vulcanite cylinder D, its

* The block is supplied by the author, but hardly does justice to the apparatus.

lower end being screwed into a brass base E. To its upper end is fastened by two bayonet-catches a brass plate F, on which the tissue to be cut is placed. Inside the cylinder D, and rising from the base E, is an ordinary spray, the air and ether being supplied through tubes G and H, passing outside, through the base. There is also an opening in the floor of the chamber communicating with the tube I, to allow the overflow of ether in case of any accumulation inside the cylinder; any such overflow may be returned by the tube to the ether supply bottle K. The freezing chamber is secured to the top of the micrometer-screw arrangement Z, which is of the simplest form, but has a perfectly smooth and regular motion. The nut is divided to indicate a section 0·01 mm. in thickness, but half this thickness can be cut without difficulty.

The method of using the microtome is very simple. The slide and block D having been carefully rubbed clean and well oiled, the razor is clamped at any desired angle, the bottle K is filled with ether (good dry methylated ether answers perfectly), and the piece of tissue to be cut having been previously saturated with thick gum solution, is placed upon the plate F, and the spray which plays upon the under surface of the plate F set working by the hand-pump M; in a short time the tissue will be frozen quite through, and if a number of sections are required, an occasional stroke or two of the pump will keep the gum in proper condition for cutting. The sections are easily cut, as in other microtomes of this class, by alternate movements of the screw Z and stroke of the razor.

The instrument may also be used for cutting tissue imbedded in paraffin or other mass, the object to be cut being secured in position, either by being gently heated at its under surface and pressed on the plate F, to which it firmly adheres on cooling, or by a simple clamping arrangement, which can be substituted for the freezing-chamber. When used in this way large numbers of sections may be cut in series by attaching to the razor a light support to receive the sections as they are cut.

Paoletti's Automatic Microtome.*—Sig. E. Paoletti has invented an automatic microtome, which is said to answer perfectly. To a rectangular vertical upright are adapted two guides, between which the object-carrier moves vertically. The carrier is fitted with a clamp, movable in all directions. A micrometer screw, to which is fixed a toothed wheel, moves the carrier vertically upwards. Another wheel fixed to the upper end of a vertical plate is moved with this in a horizontal plane by a movement of rotation, which is transmitted to it by a lever. From the periphery of the wheel projects a vertical tooth, which, acting excentrically, displaces with a to-and-fro horizontal movement a knife-carrier, the level of which is a little higher than that of the clamp containing the preparation. At the lowest part of the plate is another tooth, which, as the instrument works, meets at intervals of about half the circumference the teeth of the cogwheel, and by locking with these imparts to the screw a displacement which serves to raise the object-carrier. Now in one complete turn of the plate the movement of the knife takes place in one half, the raising of the specimen in the other half. The tooth which causes the cogwheel to revolve can be approximated to or removed from the latter by a milled head, and thus displace it by a greater or less segment, according to the thickness desired to be given to the sections. According to the distance of the tooth from the cogwheel, the latter can be displaced by a fifth to a twenty-seventh of the circumference, and thus a thickness varying from 0·1 to 0·02 mm. can be given to the sections.

* Atti Soc. Tosc. Sci. Nat.—Proc. Verb., v. (1887) pp. 250–1.

BLACKBURN, J. W.—**On Methods of preparing Tissues for Microscopical Study, and Brains for Anatomical Demonstration.**

[Freezing method. Hardening agents. Interstitial imbedding. Myrtle-wax imbedding process, *supra*, p. 1048. Wax method applied to the preparation of brains for anatomical demonstration.]

Amer. Mon. Micr. Journ., VIII. (1887) pp. 161–5.

GAY, G.—**[Home-made Microtome.]**

["The materials needed are a block of hard wood 5 in. by $3\frac{3}{8}$ in. by 2 in., a fine thumbscrew with a nut on it, a piece of glass tubing, and a glass slide cut lengthwise through the middle. Plane the top of the block perfectly true, then bore a hole, the centre of which should be $1\frac{1}{2}$ in. from the end, which the glass tube will exactly fit. Saw a strip from the bottom of the block, and fit the nut in the hole. Cement the glass tube in the hole in the large block with marine glue, allowing it to project through nearly the thickness of the glass side. Cement the glass slips on the top touching each side of the tube. Fit a block of wood $1\frac{1}{4}$ in. long, with a rivet in the bottom, so that the thumbscrew will work smoothly on it, to the glass tube. Screw the 3/8 in. strip with the notch in it to the block, and cut a notch $1\frac{1}{4}$ in. by $2\frac{1}{2}$ in. in the block to fasten it to a table, and the microtome is complete. Sections may be cut with a flat or common razor."]

Microscope, VII. (1887) p. 287.

KRYSINSKI, S.—**Beiträge zur histologischen Technik. 1. Photoxylin als Einbettungsmittel.** 2. and 3. see Staining. (Contributions to histological technique. 1. Photoxylin as an imbedding medium.)

Virchhow's Arch. f. path. Anat. u. Hist., CVIII. (1887) pp. 217–9.

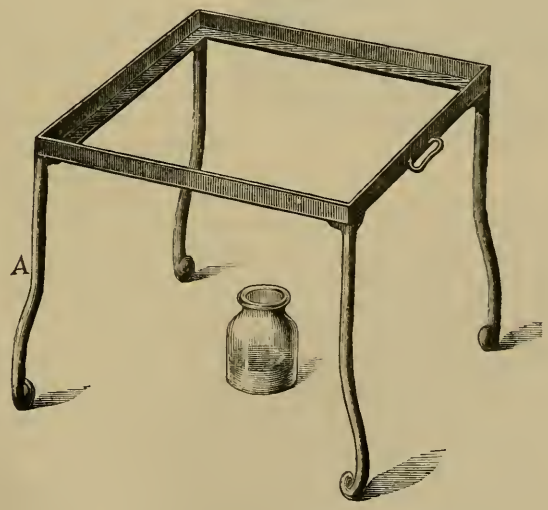
LATHAM, V. A.—**The Microscope and How to Use It. XII. Section-cutting.**

Journ. of Micr., VI. (1887) pp. 238–48.

(4) Staining and Injecting.

Perényi's Mikrolektron, for hardening, staining, and imbedding.*—Prof. J. v. Perényi has devised an apparatus, which he calls a "Mikrolektron," for facilitating the processes of hardening, staining, and imbedding without incurring the risk of damaging the preparation. Figs. 250–252

FIG. 250.

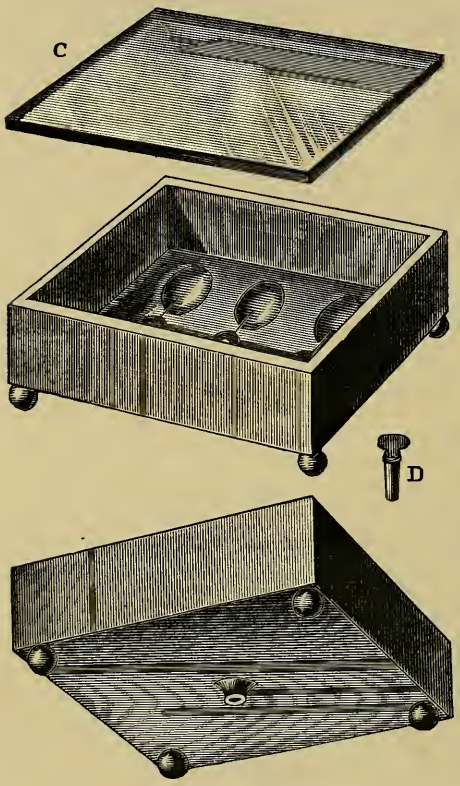


give a complete idea of the apparatus, which is nothing more than a rectangular vessel made of glazed majolica, and placed for convenience on a metal stand A (fig. 250). A dish of the size recommended, measures 16 cm.

* Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 148–52 (3 figs.).

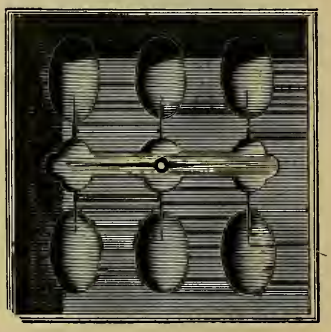
long, 16 cm. broad, and 6 cm. high, and holds 500 ccm. of fluid. On the bottom (figs. 251 and 252) are seen six oval pits, each holding 50 ccm. of fluid. These pits communicate by narrow channels with a deepish central hollow, in the middle of which is a hole, closed when the vessel is in use by a plug D (fig. 251). The dish or tray is covered with a glass top C.

Fig. 251.



The way to use this apparatus is of course obvious; the various fluids are simply poured in through a funnel, and after the necessary time are withdrawn by removing the plug D. Imbedding with paraffin is executed by putting some soft paraffin in the mid-channel, and then transferring to an incubator. When melted the paraffin finds its way into the egg-shaped pits, and thus saturates the preparation. The excess of soft paraffin having been withdrawn by removing the plug, the process is repeated with hard paraffin. It is not necessary to use an incubator, a naked flame answers the purpose. Celloidin or any other imbedding medium can be manipulated in the Mikrolektron. After using the apparatus, it is advisable to clean out the cavities and channels by the aid of heat and absolute alcohol.

Fig. 252.



Method of Staining and Fixing the Elements of Blood.*—Recent discoveries of morphological elements in the blood hitherto unknown, as well as the newly-published facts concerning its coagulation, have aroused an interest in the subject which calls for an acquaintance with the methods with which it is possible to follow those results. Accordingly, Miss Alice L. Gaule describes the method employed in the Physiological Laboratory, Zurich; for, although it has been mentioned by Prof. Gaule in his lectures for several years, it has not as yet been published.

The methods formerly used were that of examining fresh blood, and that, perfected by Ehrlich, which consisted in staining dried blood.

* Amer. Natural., xxi. (1887) pp. 677–83.

The new method consists in a series of manipulations requiring only thirty-five minutes for their completion. The following is a list of the reagents, together with the length of time and the order in which each is to be used:—

	Mins.
1. Corrosive sublimate (concentrated solution)	6
2. Distilled water	1
3. Absolute alcohol	5
4. Distilled water	1
5. Hæmatoxylin (1/2 per cent. alum solution, to which, for every 100 ccm. employed, 20 drops 5 per cent. alcoholic solution have been added)	6
6. Distilled water	1
7. Nigrosin (1/2 per cent. water solution)	1
8. Distilled water	½
9. Eosin (1 gr. eosin dissolved in 60 ccm. alcohol; 140 ccm. distilled water)	2
10. Alcohol	5
11. Oil of cloves	1–2
12. Xylol.	
13. Canada balsam (diluted with xylol until it readily flows).	

As receptacles for these fluids, each person has upon his table three shallow glass dishes with flat bottoms, so large that a slide may be easily put in and taken out of them. Into the first of these is poured corrosive sublimate, into the second distilled water, and into the third absolute alcohol. It is necessary either to label the dishes or to place the two not at the moment in use at one side. For the colouring fluids bottles are used whose stoppers serve at the same time as droppers or pipettes. The most convenient form is the glass stopper, which broadens into a funnel, closed by a rubber membrane. For oil of cloves, xylol, and Canada balsam wide-mouthed bottles are used. In the first two bottles are brushes; in the last, the ordinary glass rod. Other necessary utensils are a glass rod, sharp-pointed scissors, clean slides and cover-slips, filter-paper, twine or coarse thread, a small bottle of absolute alcohol, a sharp, clean needle, a fine clean rag, and a hand-towel.

Aside from these, a board, 5 by 15 in., with two pairs of holes, large enough for a piece of tape to pass through double, is an essential help. The first pair of holes should be 4 in. distant from the second, and the two holes of each pair 1½ in. apart. The tape should be so passed through the holes that there will remain upon one side of the board loops, on the other long ends, by which, upon passing the extremities of the frog through the loops, one may easily and firmly tie the frog upon the board. Such preparation is necessary, otherwise the manipulations cannot follow one another quickly enough. After these preliminaries have been completed, the labelled bottles being placed within reaching distance, the distilled water and alcohol in front of these, and the corrosive sublimate nearest of all, we are ready to bind our frog upon the above-mentioned board and begin our preparation. We make use of the frog for this purpose at first, since its blood coagulates less quickly than that of mammals. The vena femoralis, which may be seen as a dark blue line below the knee-joint on the inner side of the leg, having been snipped, we quickly bring with a glass rod a drop of the blood which comes from the wound upon a slide previously moistened by the breath, and throw the whole into the dish of sublimate for six minutes. If a little care is taken to spread out the drop of blood in putting it on the slide, the result is more satisfactory. Brought from the sublimate into the dish of water, we find that the greater part of the blood adheres to the slide. The superfluous sublimate being washed from the preparation during the moment that it remains in the water, we next

partially dry the slide by resting it upon filter-paper before dropping it into the alcohol-bath. The slide, which has remained in alcohol six minutes, is brought again into distilled water for half a minute, since our colouring fluids are water solutions. The hæmatoxylin is then dropped upon the slide, and removed again at the end of six minutes by resting the edge of the slide upon filter-paper, and afterwards washing with distilled water for one minute. The same process follows with the nigrosin and eosin, the first remaining upon the slide for one minute, the second two minutes. From the eosin we bring the preparation directly into alcohol, since the eosin is partially an alcohol solution. At the end of five minutes the slide is taken out of the alcohol, and, in order to be quite sure that there is no water still clinging to the preparation, we incline the slide at a slight angle to the rag with which we are holding it, and pour a few drops of alcohol from the small bottle over it. If upon dropping oil of cloves on the preparation it should be dark upon a dark sleeve or other dark background, we may remove the oil of cloves with a few drops of xylol. Having quickly cleaned the slide close up to the preparation, we place a drop of Canada balsam upon it, which must be allowed to spread out before the cover-slip is lowered upon it.

Human blood is prepared in the same way, except that here the finger-tip undergoes the surgical operation.

Mitosis Staining.*—Dr. H. Zwaardemaker states that mitoses are most successfully stained by the aid of a mordant. For hardening he usually employs Flemming's chromo-osmium-acetic acid mixture, and then stains the sections with an anilin-safranin solution. This is made by pouring an alcoholic solution of safranin into about an equal volume of anilin water. In this stain the sections remain from two minutes to an hour, the exact length of time depending on the softness or the compactness of the tissue. Decoloration is performed with slightly acidulated spirit.

Colouring the Nuclei of Living Cells.†—The most interesting fact brought out in Mr. D. H. Campbell's work at Tübingen is the fact that several anilin colours have the property of colouring the nucleus of many plant cells without killing them. That the living nucleus can be stained has been demonstrated by several observers in the case of animal cells, but as far as he knows, it has not hitherto been observed in plant cells. Though the work is not yet completed, he thinks it will be interesting to give briefly some of the processes by which the results were obtained, and some of the objects employed.

The first colour used was dahlia, a violet-purple pigment, by whose aid Lavalette had succeeded in colouring living spermatozoa and the nuclei of sperm-cells. The most favourable object so far found by the author is the nucleus of the cells of stamen hairs of *Tradescantia*. *T. Virginica* was principally used, but other species gave equally good results. Hairs should be chosen from young buds, as these are perfectly colourless, not having developed the coloured cell-sap of the older hairs. The sepals and petals are removed, and the stamens thus exposed are plunged into an aqueous solution of the dahlia. After an immersion of from half an hour to three or four hours, or even much longer, depending on the strength of the solution, it will be found that in many cases the nuclei are more or less deeply coloured, and that the cell is not killed is evinced by the continuance of the protoplasmic streaming. It is quite surprising to see how deep the nucleus is often stained without killing the cell. A nucleus so coloured appears

* Zeitschr. f. Wiss. Mikr., iv. (1887) p. 212. † Bot. Gazette, xii. (1887) pp. 192–3.

perfectly normal, there being no distortion or change beyond the change in colour. As yet he has not studied especially what parts of the nucleus are coloured, but it appears to be the nucleolus and microsomes only, as in the case of cells that have first been killed and then stained according to the ordinary methods.

Among other objects that have given more or less satisfactory results were the hairs from the base of the perianth of *Lilium bulbiferum*, stamen hairs of *Aphodelus albus*, leaves of *Elodea Canadensis* and *Vallisneria spiralis*, root-hairs of *Trianea Bogatensis*, *Cucurbita Pepo*, *Tradescantia zebrina*, spermatozoids of *Chara* and a fern (probably *Blechnum*). In all cases cells were chosen in which there was evident protoplasmic movement, in order that there might be a certain means of determining whether or not the cell was still living.

Similar and usually quite as good results were also obtained with mauvein and methyl-violet, both colours closely resembling dahlia. Usually a 1 per cent. solution was made, and this diluted with from 50 to 1000 parts of water, according to circumstances. Some doubtful results were obtained with other colours, but too uncertain to warrant recording.

Absorption of Anilin Colours by Living Cells.*—Referring to Pfeffer's experiments showing that, contrary to the ordinarily accepted idea, various anilin colours can be absorbed in large quantities by living cells, Mr. D. H. Campbell calls attention to some easily made but instructive experiments bearing on the subject.

Pfeffer's experiments were mostly made with methylen-blue and methyl-violet, though numerous other colours were also tried. Among colours not employed by him, the author found that dahlia and mauvein, both very similar to methyl-violet, were quite as good, and acted much in the same way. The yellow colour chrysoidin also gave good results. No very satisfactory results were obtained with red pigments, though in some cases safranin, tropæolin, and fuchsin gave tolerably good colouring, but either it was too diffuse or the cell-wall was more deeply coloured than the contents.

With methylen-blue either the cell-sap is coloured, often very intensely, e. g. root-hairs of *Trianea Bogatensis*, or a precipitate is formed in the cell-sap, e. g. *Spirogyra*. If vesicles of tannic acid are present, as is the case in *Zygnema*, these are coloured dark blue. Methyl-violet, dahlia, and mauvein colour the protoplasm and nucleus, and are specially valuable in the study of the latter. In some cases they are also precipitated in the cell-sap. Chrysoidin appears to colour only the protoplasm. The following are some of the objects that were used :—Root-hairs of *Trianea Bogatensis*, *Cucurbita*, *Tradescantia zebrina;* stamen-hairs of various species of *Tradescantia;* *Spirogyra* spp., *Zygnema* spp.; roots of *Lemna minor;* leaves of *Elodea* (*Anacharis*) *Canadensis*, *Vallisneria spiralis;* pollen-tubes of *Hemerocallis* spp., *Tradescantia Virginica*, *Scilla* spp.; spermatozoids of *Chara*.

The objects are placed in a solution of 0·002–0·001 per cent., varying with the nature of the cell-wall and the time of immersion. Root-hairs are usually especially delicate, and the solution should be very dilute or the immersion very brief.

In most cases objects were selected where there was marked protoplasmic streaming, as this is the best means of determining whether the cell is alive or not. It is surprising how deeply the protoplasm or nucleus may be stained without materially affecting the streaming. For a demonstration of the staining of the protoplasm the root-hairs of *Trianea* were found to be

* Bot. Gazette, xii. (1887) pp. 193–4.

specially favourable, on account of their large size and the rapid streaming, as well as the readiness with which the colour is absorbed.

Staining Pathogenic Bacteria with Anilin Dyes.*—Dr. C. Günther, when dealing with pathogenic bacteria, usually employs Ehrlich's anilin-gentian solution, Löffler's potassium methylen-blue and Ziehl's carbolic-acid fuchsin solution. Dry preparations stain better if before staining they are washed with 1–5 per cent. acetic acid, and, if they have been kept unstained for a long time, with a 2–3 per cent. watery pepsin solution.

The author discusses Koch's method for staining tubercle bacilli with the improvements of Ehrlich and Rindefleisch, and recommends the Ehrlich procedure as the best and safest in practice. Gram's method is advised for the pneumonia cocci of Friedländer and Fränkel, for the cocci of pyæmia and erysipelas, for the bacilli of anthrax, lepra, and tubercle, and for actinomyces. On the other hand, Gram's treatment is quite unsuited for gonococci, bacillus of typhus, of glanders and of cholera, and also for the spirochæte of recurrent fever. For preparations which have been a long time in bad spirit and which resist decoloration by Gram's method, the following modification is recommended:—Stain the sections for 1 minute, dry with blotting-paper; decolorize for 2 minutes in the iodide-iodine solution, then 1/2 minute in spirit, then 10 sec. in 3 per cent. hydrochloric acid alcohol, after this the sections are transferred to spirit. An inconvenience appertaining to Gram's method, in the deep-staining of minute fat-globules, is best avoided by treating the specimen before it is stained with chloroform, and then washing with absolute alcohol. In order that the sections may be well stained it is advisable that not more than two or three should be manipulated at a time, as decoloration is often difficult. For double staining, the author recommends the ordinary nuclear stains for contrasting with the stain of the micro-organisms. For erysipelas sections stained by Gram's method, a double stain is best effected by previously using ammonia-carmine or picrocarmine, a procedure which will be found more suitable than after-staining. The preparations are best mounted in xylol balsam; and decoloration of tubercle and lepra bacilli, both in sections and in cover-glasses, is most perfectly avoided by the dry method as recommended by Unna.

Staining the Bacillus of Glanders.†—Dr. G. M. Sternberg says that these bacilli are best stained with a concentrated alkaline solution of methylen-blue. For staining the bacilli in sections of tissue containing them, Löffler recommends that they be immersed in the above-mentioned solution for 12 to 24 hours, and then very carefully treated with very dilute acetic acid until the sections have been decolorized sufficiently to bring the bacilli into view. After this treatment they should be washed in alcohol, and immersed in oil of cedar, which does not dissolve the anilin colours, and is therefore to be preferred to oil of cloves in all preparations in which these colours are used for staining bacteria.

Anilin Stains.‡—Dr. S. Griesbach's experiments on the anilin dyes lead him to the conclusion that between the constituents of the dyes and those of the tissues direct chemical combinations according to the laws of affinity are effected, and therefore all those forces which have a promoting, retarding, or destructive influence on affinity play a part in the staining process, while above all influences is the capacity for a saturation of the tissues with free gases, or, as Ehrlich expresses it, the gas saturation. The intro-

* Deutsche Med. Wochenschr., 1887, No. 22.
† Microscope, vii. (1887) p. 309, from Med. News.
‡ Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 358–85.

ductory remarks close with a reference to the so-called mordants, the effect and use of which is well known. The author believes that for microscopical research such aids are of little or no value for staining purposes, as much of what is afterwards seen and described in the preparation must be ascribed to structural alterations due to the action of the mordants.

After enumerating the various anilin dyes, the classification of which is adopted from Hummel,* the author proceeds to discuss the characters and staining properties of Congo red and benzo-purpurin. Congo red is soluble in water, the solution being bromide-red. The specific gravity of the commercial article is 2·2149. The reaction of the chemically pure preparation is neutral, that of the trade preparation alkaline. To obtain this pure article the dye is dissolved in about 20 parts water, and is then precipitated by the aid of heat with an equal volume of saturated salt solution. After cooling, the dye is washed off the filter with the salt solution. The least quantity of a free acid turns the Congo solution blue, hence Congo is a delicate test for a free acid. This double action has been turned to account for demonstrating the presence of free acids in certain animals, and the alkaline reaction of the living tissue in others. According to the author, the watery solution of Congo is alone suitable for microscopical purposes, for, although miscible with glycerin and turpentine oil, the results therefrom are not satisfactory. For tissue staining, a concentrated watery solution stains both fresh and preserved material. Blood-corpuscles must be dried at 80° for twelve hours before using the watery solution, otherwise the action of the dye quite destroys the tissue. With regard to the staining of animal tissue generally, it appears that the plasma takes up the stain more freely than the nuclei, which are frequently devoid of colour. The hue varies from yellow to red, and preserved material stains better than fresh. One interesting example of its action is that of a section of a fibroneuroma, in which the connective tissue became of a dark orange, and the nervous tissue received a bright-orange stain. Transverse sections of nerves only stained in the sheaths, the axis-cylinder being unaffected.

Benzo-purpurin is obtainable in two shades, 1 B and 4 B. It is soluble in water, and has approximately the same hue as Congo, but is not affected by acids in the same way as Congo. Its reaction is neutral. Cover-glass preparations dried for ten hours at 200° are said to be successful. In general the stain is somewhat similar to that of Congo, but as a rule the hue is redder.

Rosanilin and Pararosanilin.†—Dr. P. G. Unna has tried to solve the question whether the appearance of lepra bacillus as threads containing cocci is dependent on the Lutz procedure, a combination of Gram's method with decoloration in nitric acid; whether this special appearance is due to a reaction between the gentian-violet and iodine, and how this peculiarity can be explained.

After numerous experiments with various chemically pure dyes the author discovered that only the pararosanilins, to which gentian-violet belongs, possess the property (when used as stated) of showing lepra bacilli as "coccothrix," while rosanilin, under similar circumstances, presented the same micro-organisms as bacilli. This difference is so constant that by their aid it is always possible under the Microscope to distinguish the two dyes, and this is all the more striking, as between rosanilin and pararosanilin there is only a slight chemical difference, CH_3 replacing H.

The author, furthermore, showed the relation of the iodine preparation

* 'The Dyeing of Textile Fabrics,' London, 1885.
† Dermatol. Studien, 1887, Heft iv., 73 pp.

to these dyes, finding that only between the combinations of simple iodine with rosanilin on the one part, and with the pararosanilin on the other part, do the characteristic differences in the staining of the lepra bacillus exist.

He suspects, therefore, that the iodine in pararosanilin staining completely extracts the dye where it is more loosely associated with the tissue, and where the combination is stronger it unites with it in the tissue. A new dye is therefore formed, which, on account of its slow and difficult extraction, is more suitable to show further differences of the tissues than the simple dye. The methods of Gram, Lutz, and Unna are accordingly to be considered as variations of a general iodine-pararosanilin method.

Extract of Logwood as a substitute for pure Hæmatoxylin.*—Dr. J. Paneth finds that the commercial extract of logwood is a satisfactory substitute for pure hæmatoxylin in staining the central nervous system after Weigert's method. From this extract is made a solution which contains 90 parts water, 10 parts spirit, 1 part dye. Before use it is filtered. To 100 ccm. of this solution 8 drops of a concentrated solution of lithium carbonate are added. The celloidin-imbedded sections are placed for twenty-four hours in Weigert's copper acetate solution, then in 80 per cent. spirit; then are stained in the above solution for 18–24 hours at the ordinary temperature. They are next decolorized with the borax and ferro-cyanide solution.

This method, which is practically that of Weigert, gives similar results, but at a much less cost.

Reduction of Chromic Solutions in Animal Tissues corrected by Reoxidation with H_2O_2.†—It is well known that the brownish-green colour assumed by animal tissues under exposure to chromic solutions is due to a combination of the oxide of chromium (Cr_2O_3) with CrO_3. There is a partial reduction of the chromic acid in the tissues, resulting in the formation of Cr_2O_3, which then unites with the remaining CrO_3 to form the compound known as chromic chromate. Dr. P. G. Unna has shown that the greenish colour can be removed by treating the tissues with hydrogen dioxide.

The chemical processes involved are explained in the following manner:—If a solution of chromic acid or bichromate of potassium be mixed with a solution of H_2O_2, a deep green precipitate of chromoxide (Cr_2O_3) is immediately formed, which combines with the remaining chromic acid to form the intermediate salt (chromic chromate) with a brownish-green colour. If the mixture is left to itself, the process of reduction, after reaching a definite point, changes to one of oxidation, and the chromic chromate is soon reoxidized, leaving the solution yellow as at first. The same phenomenon is seen when (1) sections coloured by chromic acid or bichromate of potassium are placed in H_2O_2, or when (2) sections treated with H_2O_2 are immersed in the chromic solutions. The sections at once become dark green, then brownish-green, and finally, in the first case yellow, in the second colourless. If the sections, at the moment when the brownish-green colour appears, are removed from the solution and thoroughly washed, the colour of the chromic chromate, which is not unimportant for many histological details, remains fixed.

BABES.—**Nouvelle coloration des tissus normaux et pathologiques.** (New stain for normal and pathological tissues.) *Bull. Soc. Anat. Paris*, XI. (1886) p. 73.

HAUSER, G.—**Zur Sporenfärbung.** (On spore-staining.) *Münch. Med. Wochenschr.*, 1887, p. 654.

JOSEPH, M., and C. WURSTER.—**Über der Metaphenyldiamin als Kernfärbemittel.** (On metaphenyldiamin as a staining agent for the nucleus.) *Monatschr. f. prakt. Dermatol.*, 1887, Nr. 6.

* Zeitschr. f. Wiss. Mikr., iv. (1887) p. 213.

† Arch. f. Mikr. Anat., xxx. (1887) p. 47. Cf. Amer. Natural., xxii. (1887) p. 868.

KRYSINSKI, S.—**Beiträge zur histologischen Technik. 1. See Imbedding. 2. Indigo-carmin als Tinctionsmittel. 3. Alauncarmin.** (Contributions to histological technique. 2. Indigo carmine as a staining agent. 3. Alum carmine.)
Virchow's Arch. f. path. Anat. u. Hist., CVIII. (1887) pp. 217–9.

WEIGERT, C.—**Über eine neue Methode zur Färbung von Fibrin und von Micro-organismen.** (On a new method of staining fibrin and micro-organisms.)
5 pp., 8vo, Berlin, 1887.

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

Mounting Sections without Cover-glasses.*—Dr. C. Weigert recently showed that celloidin sections could be cleared up with carbol xylol, and as many of these sections were intended to be mounted under the same cover-glass it was found in practice to be somewhat expensive to provide cover-glasses of sufficient size. He resolved to follow in Golgi's footsteps, and do without the cover-glass, but as the Italian method has several inconveniences attached to it he adopted the photographic negative varnish as the substitute for dammar.

After the sections have been cleared up with carbol xylol, the excess of fluid is removed in the usual way with blotting-paper, and a thin layer of the negative varnish is poured on. This dries very quickly. The drying may be accelerated by gently warming the slide, and this must always be done if the layer appears cloudy. When the first layer is dry, another coat is laid on, and so on until the surface remains quite smooth. Three coats are usually sufficient. When finished, the surface may, if necessary, be wiped or washed with water; high powers and even oil-immersion lenses may be used in the examination. In the latter case, a small drop of water must be placed on the surface, and upon this a cover-glass. This method cannot be used for sections stained with the anilin dyes as the carbol xylol destroys them.

Gum Dammar.†—Dr. F. L. James, referring to a paper by Mr. H. Morland‡ (in which he discredits gum dammar on the ground that it is as friable as chalk) says that he has used dammar for several years as a medium for mounting diatoms, crystals, &c.; in fact, to the entire exclusion of Canada balsam, styrax, and all other resinous media, and with perfect satisfaction. It may be used without decolorization by proceeding as follows: Dissolve the dammar in sufficient benzol to give a fluid which will pass through the best Swedish filtering paper. When filtered, evaporate the surplus benzol, and bring the solution to the consistency of treacle. Now add to each ounce of the resultant solution ten minims of the best nut or poppy oil, and shake well. The result will be a "balsam" that will never become brittle, turn red, or become opaque.

Decolorized dammar may be made as follows: Dissolve dammar in benzol, and to the solution (which should be filtered through absorbent cotton or mineral wool) add alcohol of 95% until it no longer throws down a white precipitate. Stir thoroughly, decant the supernatant liquid, and wash the precipitate gum in absolute alcohol. Wash well, mulling the gum while washing, and afterwards rinse with water. Throw the washed gum on a filter and let dry (which it will do in twenty-four hours), after which it should be dissolved in pure benzol (*benzol purissima*, or the crystallizable benzol of Merck), and either allowed to stand a while or filtered. The solution will be as limpid and clear as crystal; but the gum contained in it is excessively friable. This defect is corrected, as in the former instance,

* Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 209–10.
† Engl. Mech., xlvi. (1887) pp. 184–5.
‡ Journ. Quek. Micr. Club, iii. (1887) pp. 108–14.

by the addition of nut or poppy oil. The refractive index of this gum the author has not accurately determined; but it is so nearly identical with that of crown glass that a bit of the latter substance dropped therein is visible only with the closest scrutiny.

Xylol-Dammar.*—In an article on resinous substances and the preservation of microscopical preparations, Dr. G. Martinotti advocates the use of dammar as the fittest medium for mounting microscopical preparations when the general structure is desired to be brought out. In this respect it is superior to Canada balsam which is most suited for throwing into relief certain parts of a specimen which are deeply stained, such as nuclei, micro-organisms, &c. A suitable solvent for dammar has long been a desideratum, for though Flemming and Pfitzner have produced dammar solutions with turpentine and benzin, the resulting fluids have the fatal fault of losing their transparency in a comparatively short space of time. After numerous experiments, the author finally selected xylol as the solvent, and he found it to possess the necessary qualifications. The medium he produced, xylol-turpentine-dammar, is a white or slightly yellowish fluid which does not affect the anilin stains nor dissolve celloidin, retains its transparency (for nine months at least), and gives a perfect definition of the histological elements. Finely powdered dammar resin and xylol are placed together in a closed vessel, and after some days the clear supernatant fluid decanted off, or the mixture filtered. The clear white fluid is then evaporated in a water-bath to a semi-fluid mass, which is yellowish and resembles Canada balsam. If desired, the mass may be further concentrated, and in this denser condition it does not lose its transparency or viscidity. In practice, however, it is not necessary to proceed further than the semi-fluid condition. To produce a medium suitable for microscopical purposes, oil of turpentine is added. By this addition the microscopical images are rendered more effective than with the simple xylol solution; the medium is less brittle when dry, and also loses most of its yellow colour. The author regrets this slight defect, and thinks it might be obviated if the concentration were carried out in vacuo and not by the aid of heat. In a note the author appends the exact quantities for making the solution. 40 gr. of powdered dammar resin, and 40 gr. of xylol are left for three to four days at the ordinary temperature in a closed vessel and then filtered. The filtrate is evaporated in a water-bath down to about 45 gr., and to this 25 gr. (or even more) of essence of turpentine are added.

The author next refers to some solvents of Canada balsam, chloroform, turpentine, benzin, oil of cedar, and xylol. Chloroform is objected to on account of the yellowness which increases with time. Turpentine decolorizes certain dyes, e. g. hæmatoxylin, and after a certain period bubbles of gas are developed within the preparation. Benzoin is fairly good, but the fluid is rather viscid. Of cedar oil as a solvent the author has no personal acquaintance. Xylol gives fair results, but the colour of balsam dissolved therein is markedly yellow. Safranin and other dyes seem to be injuriously affected by this reagent, which moreover is destructive of certain delicate structures, such as karyokinetic figures.

Oil of lavender produces with Canada balsam an almost colourless fluid; preparations mounted therein are said to be quite elegant, especially those stained with logwood. Some anilin stains, e. g. safranin, are however dissolved by the action of lavender oil, but others retain their brilliancy. The author, however, admits that his experience of this solvent is too short

* Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 153–9.

to give a definite opinion of its value, but he thinks that it will be found to be extremely useful.

Directions for using Prof. H. L. Smith's High Refractive Mounting Media.*—Prof. H. L. Smith gives the following directions:—Use barely enough of the medium to fill in under the cover when the slide is warmed; it does not materially diminish by any subsequent heating.

Boil thoroughly under the cover and until all bubbles disappear on allowing the slide to cool; if any should still remain they may be readily coaxed out by proper application of a small flame.

When the slide is cold the cover should remain firmly fixed; any excess of the medium must be removed by means of a moist cloth or a roll of moistened tissue paper. The cleansing must be thorough; all excess must be removed around the edge of the cover, as otherwise it is liable to act upon the cement or finishing ring. If, after the cleaning, the cover shows metallic stains, do not attempt to clean them off until after the finishing ring is hard. When the excess has been removed around the edge of the cover, gently warm the slide to drive off the small amount of moisture that may have been absorbed during the cleaning. When again cooled apply a protecting ring of asphalt-black, or white zinc, or, perhaps better, if one will take the trouble to make them, a wax ring, punched from the sheet-wax used for artificial flowers. The wax ring is a sure protection, especially for the highest medium, yet the white zinc or the asphalt answers well. In using the wax ring, the heat must be very cautiously applied, so as barely to melt it, following gently around with a very small flame. If bubbles of air are entangled under the ring, touch them with a heated needle-point just before the wax cools.

When the asphalt, white zinc, or wax ring is solid, apply a good coat of shellac dissolved in alcohol. Slides thus protected keep perfectly well. After the ring is firmly set, any metallic stains remaining on the cover may be removed by a piece of tissue paper and moistened with hydrochloric acid.

Section-lifters.†—Dr. W. Y. Cowl advocates the use of section-lifters made of horn. They are in one flat piece, weigh 10 grains, are 3 in. long, and 5/8 in. wide at the blade, which is square, of about 1/200 in. thick, and merging into a handle 1/20 in. thick and 3/8 in. wide. The blade is smooth, flexible as paper, and pierced with fine holes. It can thus be insinuated beneath a section lying flat on the bottom of a dish and upon removal from the surrounding fluid will allow it to drain away from between the section and lifter. This brings the two into uniform apposition, which is a great desideratum. The perforations also favour the floating of the section from the lifter to the mounting or preparatory fluid on the slide. As horn normally contains grease as well as moisture, it will take oily or gummy media, but must then be confined to use with them. Lifters for water or glycerin must be made of burnt horn, i.e. mostly deprived of fat. In preparing specimens, the lifter is preferably inverted over the slide when loaded with a section, whilst a drop of fluid let fall on the holes in the middle of the blade, loosens the tissue, from which the instrument may then easily be withdrawn. As the horn is transparent, every detail of the section on its under side can be seen.

The use of such a section-lifter naturally suggests a stout bristle instead of a needle. It may be held in a clamping needle-holder, and when so mounted, or even simply tied to a stick, will so far surpass the needle as a means of manipulation that no one who has ever tried it will cease its use.

* Microscope, vii. (1887) pp. 308-9.

† Ibid., pp. 164-6.

"Berry's Hard Finish" as a Cement and Mounting Medium.*—Prof. W. H. Seaman writes that early last winter Dr. Taylor suggested that a varnish known as Berry's hard finish (substantially Zanzibar copal dissolved in turpentine) might serve as a cement. This varnish is in very extensive use for coating wood in its natural colours, in the method now so common, and hence easily got everywhere. Dr. C. T. Caldwell took up the subject, and in the course of mounting a few slides, found he had a material which was not only useful as a cement, but also as an imbedding or mounting substance proper. Since his trials a number have used it, all with the most favourable results. Prof. Seaman has slides showing insects imbedded in it that have cleared up well without any previous preparation. Numerous other mounts have been made by other persons of different kinds, and he "has no hesitation in recommending it for trial as the most promising thing in this line he knows." It is so common it may be obtained at any paint store, and may be thinned with turpentine if too thick. One of its advantages is that it does not precipitate when brought in contact with aqueous solutions to anything like the extent that balsam does.

King's Cement.†—Under the heading "a thoroughly reliable cement," Miss M. A. Booth says that after an extended and critical experience she thinks that the cement prepared by the Rev. J. D. King possesses all the desirable qualities of a universally useful cement. To lovers of the beautiful, King's scarlet or blue cement is pleasing to the eye, while that large class of microscopists to whom such beauty is a blemish will find in his amber cement reliability shorn of any objectionable features. In every instance in which she has known where King's cements have not proved fully satisfactory the fault has been with the user.

In using Mr. King's cements, four points are to be observed:—

(1) Keep your cement of the right consistency; if too thick, thin it with alcohol.

(2) Use a Winsor and Newton Rigger brush No. 2; have its handle put through rubber cork, and keep the brush when not in use in a corked vial of alcohol.

(3) While using the brush wash it frequently in alcohol.

(4) Use no cement cells until they are *thoroughly dry*.

"Observing these precautions, we have an infallible cement."

HOLDEN, A. L.—**A New Material Cabinet.**

["A very artistic and inexpensive material cabinet can easily be constructed in the following manner:—It consists of three tin or wooden boxes, of equal height, with flat covers, varying in diameter from $1\frac{1}{2}$ to $3\frac{3}{4}$ in. Take the largest, and fasten to the bottom a circle of wood or metal, $4\frac{1}{2}$ in. in diameter and 1/2 in. in thickness. The projection will form a rest for the vials, which are held in position by a rubber band placed around each box. The next smaller box, $2\frac{3}{4}$ in. in diameter, should be fastened to the cover of the largest, and so on. The interiors of the boxes form a receptacle for packets of dry material. If painted a light colour, the objects in the vials will be easily seen, and when finished, it makes a useful ornament for the microscopist's table."]

Microscope, VII. (1887) p. 293 (1 fig.).

[MANTON, W. P., and others.]—**Elementary Department. Seventh, Eighth, and Ninth Lessons.** [Mounting media.—Sealing and cements.—Cells.—Cell-building.]

Microscope, VII. (1887) pp. 277–80, 302–4, 337–9.

(6) Miscellaneous.

Crystallization by Cold.‡—Dr. F. L. James makes geometrically perfect crystals in the following manner:—Provide two watch-glasses of nearly equal size and shape, so that they fit snugly into each other. Into one of

* Queen's Micr. Bulletin, iv. (1887) p. 33.

† Microscope, vii. (1887) pp. 297–8.

‡ Ibid., pp. 166–8.

these pour the liquid to be crystallized, and having warmed the other by passing it through the flame of the lamp or dipping it in hot water, place it immediately on the top of the globule of fluid, letting it settle to place of its own weight. The fluid is thus spread out into a tenuous film between the two watch-glasses. Now place the watch-glasses upon a piece of felt, two or three thicknesses of blotting-paper, or some other non-conducting material, and with a pipette pour on to the cavity of the upper glass a half fluid drachm of rhigoline, benzol, or ether, and blow on it with the lips. As the temperature falls the film of liquid begins to deposit crystals; sometimes this occurs instantaneously, usually it requires about fifteen seconds to a minute to thoroughly cool the glasses. If necessary, the process must be repeated.

As soon as the deposition of crystals ceases take a bit of blotting-paper and pass the edge of it between the glasses to absorb the remaining mother liquor, leaving the crystals nearly dry. The upper glass is then removed and the crystals in the lower glass may be examined at once under the Microscope or collected and washed.

It is presumed that the liquid to be crystallized is in a concentrated state: if not, the small quantity required for this process is easily thickened by placing the glass on a hot slide for a few moments. Where the operation must be repeated, it is best to use a clean glass for each portion, or to carefully remove the crystals resulting from previous refrigerations, since the second crop has a tendency to form around and on the first, thus making masses too large for convenient examination with high powers. The use of the pipette for placing the volatile fluid in the upper watch-glass is recommended, because of the difficulty of pouring small quantities of readily flowing fluids with any exactness, and the consequent danger of overflowing and mixing with the fluid to be crystallized.

Method of obtaining Methæmoglobin Crystals.*—Prof. W. D. Halliburton recommends the following easy method for obtaining methæmoglobin crystals. A few cubic centimetres of the defibrinated blood of a rat, guinea-pig, or squirrel, have added to them an equal number of drops of nitrite of amyl, and the whole is shaken vigorously in a test-tube for a minute or so. As soon as the liquid becomes chocolate-coloured a drop is placed on a slide and covered. In a few minutes crystals of methæmoglobin are formed, and if the edges of the cover-glass be sealed they may be kept unchanged for several months. From guinea-pigs' blood the crystals thus obtained are tetrahedra; from squirrels' blood they are perfectly regular hexagonal plates, as are also those from rats' blood; but in the case of the last there were a few other plates which, in the opinion of Mr. L. Fletcher, are merely variations of the hexagons.

Fearnley's 'Elementary Practical Histology.'†—This book has a feature which is extremely novel in a histological work, viz. it contains an account of the Diffraction Theory (under the head of "Immersion Lenses"), with diagrams illustrating Prof. Abbe's leading experiments. The author has been recommended ‡ to omit this portion in future editions, a recommendation which we hope he will not adopt. His reviewer, like so many histologists, has evidently not appreciated the practical importance of the discussion; but one good effect of the book will, we have no doubt, be to make many practical workers with the Microscope acquainted with one of

* Quart. Journ. Micr. Sci., xxviii. (1887) pp. 201–4.

† Fearnley, W., 'A Course of Elementary Practical Histology,' xi. and 363 pp., 46 figs. (8vo, London, 1887). ‡ Nature, xxxvi. (1887) pp. 481–2.

the most important points in connection with microscopical observation, without a knowledge of which they are continually liable to misinterpret histological structures.

ARLOING.—**Un analyseur bactériologique pour l'étude des germes de l'eau.** (A bacteriological analyser for the study of germs in water.)
CR. Soc. Biol., 1887, pp. 539–40; *Arch. de Physiol.*, 1887, pp. 273–85.

BISCHOF, G.—**Dr. R. Koch's Bacteriological Water Test. III.**
Lancet, 1887, II. pp. 516–8.

CARNELLY and T. WILSON.—**A New Method for determining Micro-organisms in Air.**
[Consists essentially in the substitution of a flat-bottomed conical flask for a Hesse's tube.]
Nature, XXXVI. (1887) p. 570; *Chem. News*, 1887, p. 145.

EVANS, J.—**Address to Middlesex Natural History and Science Society.**
["The water supplied by the companies no longer, I am glad to say, affords so varied a field for microscopical observation as it did some fifty years ago; but for microscopic studies it is doubtful whether there is not fully as much scope for students living in towns as for those who reside in the country."]
Trans. Middlesex Nat. Hist. and Sci. Soc., 1886–7, p. 7.

FABRE-DOMERGUE.—**Les Invisibles. Phénomènes les plus intéressants de la vie des êtres microscopiques.** (The Invisibles. The most interesting phenomena in the life of microscopic beings.) 120 figs., 16mo, Paris, 1887.

HITCHCOCK, R.—**The Biological Examination of Water. II.**
Amer. Mon. Micr. Journ., VIII. (1887) pp. 169–71.

JAMES, F. L.—**Clinical Microscopical Technology. IX.** The examination of Semen.
St. Louis Med. and Surg. Journ., LIII. (1887) pp. 292–4.

PETRI, R. J.—**Ueber die Methoden der modernen Bakterienforschung.** (On the methods of modern bacteria research.)
Samml. Gemeinverständl. Wiss. Vorträge (Virchow and Holtzendorff), 8vo, Hamburg, 1887, 62 pp.

„ „ **Eine neue Methode, Bakterien und Pilzsporen in der Luft nachzuweisen und zu zählen.** (A new method for demonstrating and counting bacteria and fungus-spores in the air.) *Zeitschr. f. Hygiene*, III. (1887) pp. 1–145.

PEYER, A.—**Atlas der Mikroskopie am Krankenbette.** (Atlas of the microscopy of the sick-bed.) 2nd ed., xii. and 232 pp., 100 pls., 8vo, Stuttgart, 1887.

SLACK, H. J.—**Pleasant Hours with the Microscope.**
[*Actinophrys*, *Actinomonas*, &c.] *Knowledge*, XI. (1887) pp. 267–8 (4 figs.).

TAYLOR, T.—**The Crystallography of Butter and other Fats. I., II., III.**
Amer. Mon. Micr. Journ., VIII. (1887) pp. 152–3 (1 pl.), 172 (1 pl.), 190 (1 pl.).

WHITE, T. C.—**A Manual of Elementary Microscopical Manipulation for the use of Amateurs.** iii. and 104 pp., 1 pl. and 6 figs., 8vo, London, 1887.