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

A. W. BENNETT, M.A., B.Sc., *Lecturer on Botany at St. Thomas's Hospital,* | F. JEFFREY BELL, M.A., *Professor of Comparative Anatomy in King's College,*

S. O. RIDLEY, M.A., *of the British Museum,* AND JOHN MAYALL, JUN.,

FELLOWS OF THE SOCIETY.

Ser. II.—VOL. II. PART 1.

PUBLISHED FOR THE SOCIETY BY

WILLIAMS & NORGATE,

LONDON AND EDINBURGH.

1882.

MICROSCOPY.

a. Instruments, Accessories, &c.*

Goltzsch's Binocular Microscope.†—We give the description of this Microscope, translated from the author's German original, with slight modifications only.

"This Microscope (Fig. 3), which is simple to the highest imaginable degree, is calculated to obviate a number of theoretical and practical objections which may be raised against instruments of the same kind hitherto described. In particular we get rid of—

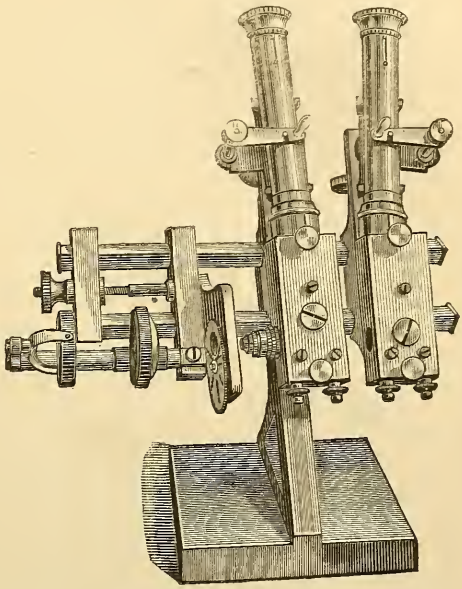
(1) All difficulty in combining the images and all strain to the eyes.

(2) All variation in magnitude and distinctness, as also in the adjustment of the images.

(3) All difficulty in accommodating the instrument for different widths between the eyes.

(4) The influence which the thickness of the glass prisms, analogous to the known influence of the thickness of the covering glass, might exert on the course of the rays.

Fig. 3.



And lastly, instead of the double reflection, which is not avoided in any of the instruments known, there is only a single reflection for each half of the rays.‡

All these advantages are obtained by a slight modification in the manner in which the images are produced. Whilst in the case of the compound Microscope the object must always be a little beyond the focal point, and in the simple Microscope is generally nearer, in the new arrangement it is brought to the focus itself, so that the pencils of rays proceeding from the different points of the object,

* In this section are also included optical notes, notices of books relating to the Microscope, and miscellaneous microscopical notes.

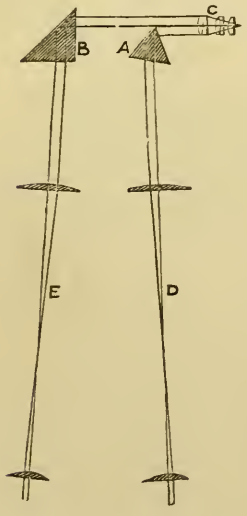
† Carl's Repert. f. Exper.-Physik, 1879, pp. 653–6 (1 fig.). Zeitschr. f. Mikr., ii. (1879) p. 166–9.

‡ The author appears not to have seen the Stephenson binocular.

although their inclination to the axis is different, leave the objective as pencils of parallel rays, and therefore of themselves produce no image, or rather one at an infinite distance. The convergence of the pencils of rays requisite to produce a real image is effected afterwards by means of the eye-pieces, which consequently it would be more correct to regard as telescopes, though they consist, like ordinary microscopical eye-pieces, only of two plano-convex lenses of crown glass, the ratio between their focal lengths being about 1 : 3. It will be seen at once that, by employing this telescopic eye-piece to receive the pencils of rays emerging parallel from the objective and coming as it were from an infinite distance, it is not necessary that Microscopes thus constructed should be of a fixed length. The length may be altered at will without producing any change in the amplification and distinctness of the image after it has been once obtained, provided the telescopic eye-piece is so adjusted, by means of a draw-tube arrangement, that distant objects can be clearly seen by it. It is equally obvious how, by this process, the exact parallelism of the pencils of rays emerging from the objective, and consequently the position of the object in the focus, is regulated and known. This furnishes us with a basis which renders it possible to obtain such a direction for each half of the pencil of rays by a single reflection that each eye can take in one of the halves.

In the original axis of the Microscope there are placed two glass prisms, a smaller, A, Fig. 4, and a larger one B, which are fixed in such a manner that the smaller prism causes one half of the rays and the larger prism the other half to be diverted from the axis under different angles by total reflection. The two pencils D E of parallel rays, are directed into the eye-pieces through two tubes which converge slightly towards the lower extremity. The original axis of the Microscope lies horizontally, and on the right of the observer is the objective C, the stage, and the illuminating apparatus; the observer looks down from above (in a direction inclined as may be desired) through the two converging tubes, directly upon the horizontal axis and with each eye over one of the two reflecting prisms. The first of these of course projects only as far as the axis, so as to leave half the opening free for the second. They are so arranged on the axis that they, with the eye-pieces to which they are attached, can be moved by rack and pinion so that their distance apart corresponds with the distance between the eyes of the observer, without the image being affected by the difference or alteration in the course traversed by the pencils

Fig. 4.



up to the first lens of the eye-piece, their rays being parallel. To this parallelism it is due likewise that every disturbing effect (like that which the thickness of the cover-glass exerts) by the prisms on the transmitted pencil is excluded, for such effects can only be produced by converging or diverging pencils.

The mode of using an instrument so constructed does not differ from that of an ordinary Microscope, except that first the two eye-pieces must be removed and adjusted for infinite distance, and then replaced. By means of the adjusting movement the left eye-piece tube is then put in such a position that with proper illumination the two diaphragm apertures of equal size, which are inside the eye-pieces, are seen without effort as one; an object being now introduced and brought into focus, the plastic image infallibly appears, and cannot be seen double. To produce this effect in perfection, however, the position of the prisms must be so adjusted that the images together with the diaphragm apertures become merged into one complete whole, and the impression is produced of looking through a round opening at the object which is behind. After this position of the prisms has been once fixed no focussing that may be necessary alters the effect. The figure shows that the half of the rays which pass to the second prism is that furthest from the observer; in the opposite case the effect would be pseudoscopic.

Plane mirrors of glass may be used instead of the prisms, but the surfaces of both the prisms and the mirrors must of course be perfect. The prism which is inserted half-way, A, is best made equilateral, because with a rectangular one the total reflection might be questionable, and the edge is better; the other may be rectangular, and should be of such a size that when the first is removed it can take in and reflect the full pencil of rays; we then have a monocular Microscope. It is obvious that instead of the eye-pieces described, actual achromatic telescopes could be used."

Fig. 5.

Hartnack's Demonstration Microscope.* — This (Fig. 5) consists of a tube, carrying eye-piece and objective, fixed to a frame by which it can be held in the hand. A micrometer screw *a* serves for focussing the object which is fixed to the circular stage by clamps. The continuation of the stage forms a metallic drum, at the lower end of which is a convex lens L to concentrate light on the object. A diaphragm-disk is inserted in the drum with a portion of its margin projecting on one side so as to be revolved by the finger.

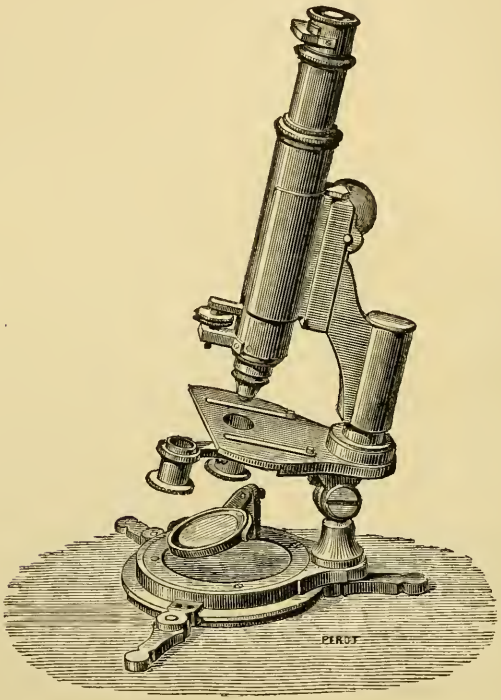
Lacaze-Duthiers' Microscope with Rotating Foot.—M. Nachet has supplied us with a drawing (Fig. 6) of a Microscope similar to that which we described at p. 873 of Vol. III. It is the device of Professor H. de Lacaze-Duthiers.

The speciality of the instrument is that the bottom of the pillar

* Thanhoffer's 'Das Mikroskop und seine Anwendung,' 1880, p. 55 (1 fig.).

is attached to a movable ring so that the rotation is on the base and not on the stage (as in the larger Nachet models), the mirror remaining fixed.

Fig. 6.



The special object of the design is stated to have been to reduce the height of the instrument as much as possible, the method adopted for the rotation "allowing the stage to be less elevated above the table and thinner."

Nachet's Portable Microscope. — This Microscope is shown in Figs. 7 and 8 set up for use as a table Microscope. Fig. 8 is intended to show its application to the observation and dissection of large surfaces or objects contained in small troughs or tubs. By loosening the milled ring just above the stage (A, Fig. 8, C, Fig. 9) the compound body can be removed, and an arm L carrying a lens or doublet substituted. To put the instrument in its box (Fig. 11), the stage P (Fig. 10) is turned completely over on the pivot O, and the base is then only 4·5 cm. in height. The box is 19 cm. × 11 cm. × 6 cm.

The instrument seems to be an excellent solution of the problem of constructing a Microscope which shall be really "portable" and at the same time quite steady for ordinary use.

FIG. 7.

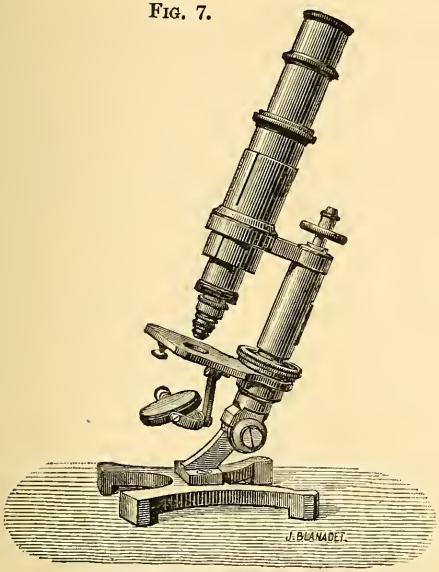


FIG. 8.

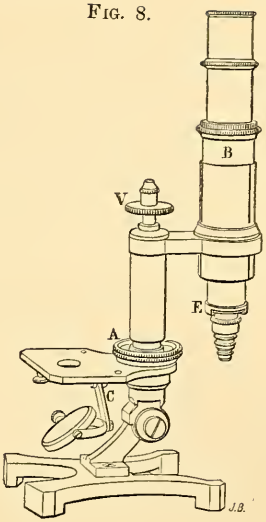


FIG. 9.

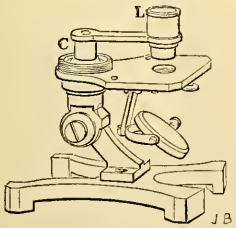


FIG. 10.

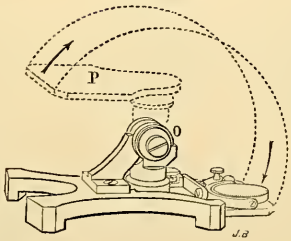
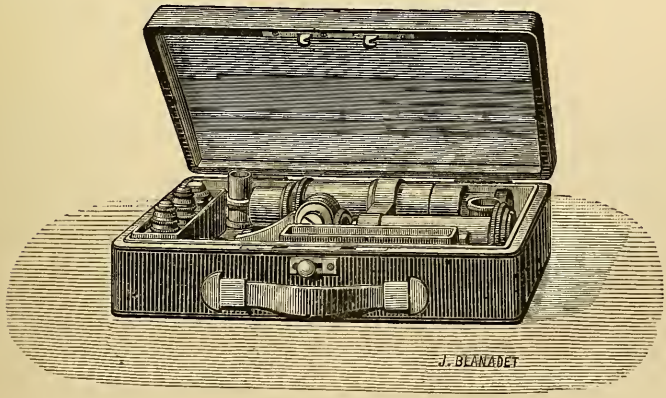


FIG. 11.



Parkes's "Drawing-room" Microscope.—The peculiarity of this Microscope (apart from its title and golden colour) consists in the revival of the "magnetic bar adjustment" to the stage, a device originated by Mr. G. Busk.

Piffard's Skin Microscope.—Dr. Stowell recalls * the Microscope for the examination of the skin, devised by Dr. H. G. Piffard,† to obviate the inconveniences attendant upon a simple lens of high power, which "often involves a constrained position of the head and neck, and in some cases an unpleasant proximity to the subject under investigation."

Dr. Piffard's description is as follows:—"A (Fig. 12) represents the body of a binocular Microscope made by Nachet, from which the

Fig. 12.

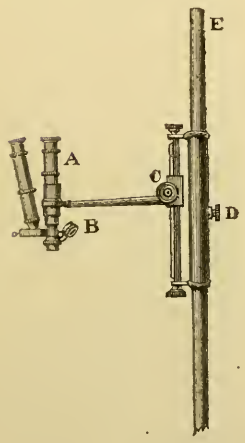
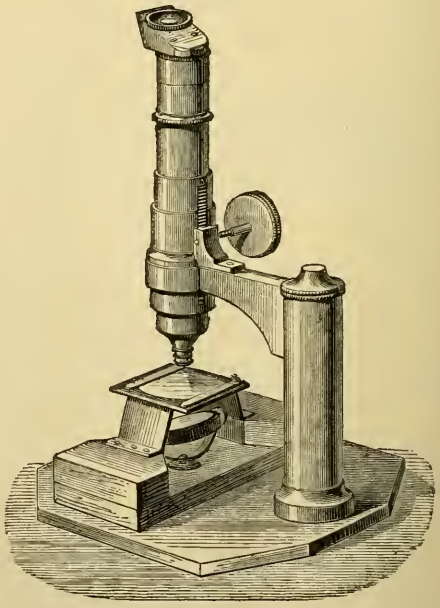


Fig. 13.



reflecting prism situated above the objective was removed, and another of the same focus but double the size substituted. B is a double nose-piece carrying two objectives of different powers. C is the pinion for fine adjustment (raising and lowering the horizontal arm); and D the clamping screw for coarse adjustment, the whole apparatus sliding up and down the rod. E is a rod, five feet in length, which supports the other apparatus, and is itself supported by a cast-iron foot not shown in

* 'The Microscope,' i. (1881) pp. 33–8. (1 fig.).

† 'An Elementary Treatise on Diseases of the Skin, for the use of Students and Practitioners.' (8vo, London and New York, 1876.) See pp. 32–41. (1 fig.)

the drawing. Other adjustments permit the body of the Microscope to be placed in a horizontal or any other desired position. . . . With the instrument described, any portion of the integument, from the scalp to the sole of the feet, can be conveniently examined, and a prolonged examination can be made without fatigue to the observer. It is an instrument which I cannot too highly recommend to those desiring a thorough knowledge of the surface aspect of the skin and its lesions."

Robin's Dissecting Microscope.—This (made by MM. Nachet) is shown in Fig. 13, with their erecting eye-piece. The stage is arranged so as to provide rests for the hands on either side of the dissecting plate.

Brücke Lens.—A description of this lens (Fig. 14), much in use on the Continent, does not appear in any of the English books on the Microscope. We take the following from M. Robin's treatise.*

"To remedy the inconvenience of the lens being too close to the object in all but low powers, Charles Chevalier in his 'Manuel du

Fig. 14.

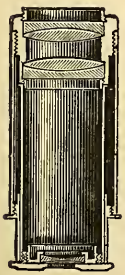
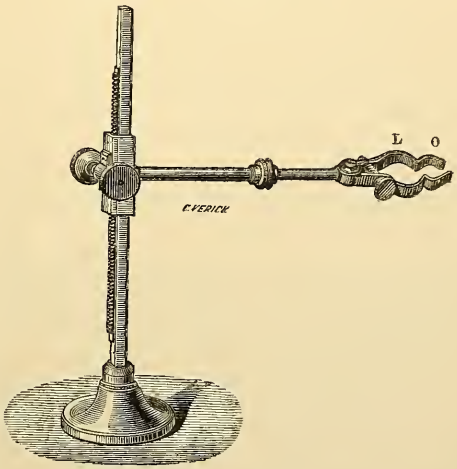


Fig. 15.



Micrographe' (1839) proposed 'to place above a doublet a concave achromatic lens, the distance of which could be varied at pleasure. The effect of this combination is to increase the magnifying power and lengthen the focus. Thus arranged, this instrument will be the most powerful of all simple Microscopes, and the space available for scalpels, needles, &c., will be much greater than with a doublet alone. The further the concave lens is removed from the latter, the greater will be the amplification.' This combination, applied to lenses for examining the eye and skin, allows the use of doublets which leave

* Robin, C., 'Traité du Microscope et des Injections,' 2nd ed. (8vo, Paris, 1877), pp. 33-4 (1 fig.).

a considerable distance above the object, and it is this idea which has governed the construction of the Brücke lens.

"The lens has a very long focus, and the construction is that of the Galileo telescope as applied to opera-glasses, but the amplification of the objective is much greater than that usually obtained in opera-glasses. The focus is about 6 cm., and the power three to eight times. The latter power is obtained by lengthening the tube, by which means the distance between the two lenses is much enlarged and the amplification increased without inconveniently modifying the focus.

"This lens may be used in place of the body of a compound Microscope when it is desired to dissect or to find small objects, or it can be adapted to a simple Microscope or lens-holder with from 3 to 8 cm. between the object and objective."

Künckel d'Herculais devised a holder for the lens shown in Fig. 15. By tightening the screw on the horizontal arm the "jaws" are separated or closed. The arm can be lengthened if desired and also raised or lowered by the rack and pinion. L is the place for the lens and O for doublets.

The Model Stand.*—Mr. J. D. Cox discusses the changes that have taken place in microscope-stands with a view of determining which will be of permanent value and should form part of the features of a complete stand, and thus summarizes the essential requisites which ought to be embodied in every instrument intended for real scientific use.

1. A firm and rigid *arm* having the general character of the Jackson model, carrying the body of the instrument, with coarse and fine adjustments conveniently placed below the body, with perfectly even and reliable motion.

2. A firm ring as the basis of the *stage*, to which any form of stage-plate, plain with clips, glass, or mechanical, may be adapted and interchanged. Nearly every microscopist has work to do for which a mechanical stage is almost indispensable, such as micrometric measurements, and the systematic sweeping of a slide to make sure that every part has been examined. There should be no rack and pinion movement for revolving the stage as it can be better done with the fingers, nor a centering adjustment unless the instrument is intended for goniometry. The stage thin enough to allow the use of light of at least 70° obliquity from the axis of the instrument.

In regard to the requisite of reversibility for the stage, Mr. Cox points out that in nearly every department of natural science (and not for diatoms only) there is need of the occasional use of light of extreme obliquity upon dry mounts and from the mirror alone, so that an easily reversible stage is desirable. If, however, immersion illuminators came to be used for dry mounts as well as those in balsam† a reversible stage would not be necessary, as a ray incident at 41° only would emerge at the maximum obliquity of 90°.

3. A grooved bar—immovable and not swinging—for the support

* Amer. Jour. Micr., vi. (1881) pp. 89–95 (4 figs.).

† This should read "for dry *objectives* as well as immersion." Balsam mounts are on the same footing as dry mounts *when a dry objective is used.*

of the *substage* with centering screws and which may or may not be fitted with rack and pinion movement. No illuminating apparatus to be attached to the bottom of the stage proper. The diaphragm with tapering nose so that it can be racked up close to the bottom of the slide.

4. The *mirror-bar* to swing on the optical centre of the instrument above as well as below the stage, and to have a sliding extension so as to increase the distance between the mirror and the stage without changing the angle of the incident light.

5. Such form of *base* as will permit the mirror to be swung laterally when the instrument is in upright position.

Mr. Cox objects to the substage and mirror-bar swinging together, on the ground that it is then necessary to attach "the immersion illuminators to the bottom of the stage by some special means, such as bayonet catch, screw in the stage-well, &c.," and he advises that all such apparatus should be used in the substage for which it was in fact devised. He suggests and figures an attachment to carry an immersion illuminator, consisting of a movable elbow-piece on a slotted arm sliding on a pin that screws on the outer end of a short right-angled dove-tail slide fitting into a corresponding bar cast on the substage carrier that racks or slides on the fixed tail-piece. This appears to us, however, a complicated way of applying a simple immersion illuminator such as the hemispherical lens, and we cannot see any objection to mounting the lens in a disk to fit into the stage-well or the under surface of the rotating stage plate.

For use with the Continental stands that are not provided with mechanical stages, Mr. Zeiss mounts the lens in a disk of brass which drops into the bevelled central stage opening, the plane face is then flush with the surface of the stage.

Denomination of Eye-pieces and Standard Gauges for same.—The Committee appointed by the Council in October last to consider the question of standard gauges for eye-pieces (and substages) duly presented their report, which was thereupon ordered to be printed and circulated amongst the members of the Council, and is now under consideration.

Subsequently to the report being made, the following circular was received by some of the English opticians from a committee of the American Society of Microscopists, unfortunately too late to be laid before the Committee.

"1*st Question.*—Please give list of various eye-pieces or oculars for the Microscope made by you, with construction (Huyghenian, orthoscopic, periscopic, &c., &c.), with the equivalent amplifying power of each, at a standard distance of 10 English inches or 254 mm.

2. Please state how you determine the amplifying power of your eye-pieces.

3. Do you consider it desirable that a uniform nomenclature (with reference to amplifying power) of eye-pieces should be adopted by makers of Microscopes?

4. Will you adopt such a nomenclature if decided upon by this Society?

5. Please suggest such a nomenclature which seems to you most generally applicable and desirable.

6. Do you consider it desirable that eye-pieces should be so constructed—by means of a shoulder or other device on the longer ones—that all should pass the same distance into the tube of the Microscope, thereby preserving the blackening of the inside of the microscope-tube?

7. Please give inside diameter of microscope-tube, or draw-tube where there is one, or outside diameter of that portion of eye-piece fitting into the microscope-tube for each size of stand made by you.

8. Do you consider it desirable that two, or three, or more *standard diameters* of tube for Microscopes be generally adopted with a view to interchangeability of eye-pieces?

9. Please suggest the number of sizes and the inside diameter of tube in each case, which you would recommend for adoption.

10. Will you adopt a standard set of sizes if agreed upon and recommended by this Society?

11. Please give this committee the benefit of any suggestions not included in the above answers."

The inquiry of the American committee embraces a wider field than that of the Society's committee, which was limited to the question of standard gauges for eye-pieces and substages, and does not include a consideration of the proper denomination for eye-pieces, though the present system of nomenclature is an even greater evil than that of the numerous different sizes.

Every one feels the inconvenience of the Continental method of numbering or lettering *objectives*, a special table being necessary to enable the relative powers of Monsieur A's No. 2, and Herr B's No. 3 to be compared; the English plan of denoting the objective by inches and fractions of an inch is obviously preferable.

Having adopted this improvement, however, and even being accustomed to wonder how our Continental brethren can still tolerate so barbarous a system of marking objectives, it is remarkable that the designation of eye-pieces should have been allowed to remain on the principle abandoned for objectives, and that the letters A, B, C, D, &c., by which they are known, should still express absolutely nothing as to their magnifying power, beyond the fact that D is to some undefined extent more powerful than C, C than B, and B than A; so that not only is it impossible to compare the eye-pieces of different makers, but it is not possible to do so in the case of the same maker, unless the powers are actually known.

If eye-pieces were, however, denoted on the same principle as objectives, nothing whatever would be lost, and much would be gained.

For instance, if the magnifying power of a $\frac{1}{5}$-inch objective with a C eye-piece is required, it will be 500 or 750, according as the eye-piece is that of one or the other maker. If, however, instead of being labelled C (or No. 3), the eye-pieces were called $\frac{2}{3}$-inch or 1-inch, the necessary calculation ($50 \times 15 = 750$ or $50 \times 10 = 500$) is instantly made.

TABLE OF MAGNIFYING POWERS.

OBJECTIVES. Focal Length.	Magnifying Power.	EYE-PIECES. Beck's 1, Powell's 1 Ross's A.	Beck's 2, Powell's 2 and Ross's B, nearly.*	Powell's 3	Ross's C.	Beck's 3.	Beck's 4, Powell's 4. Ross's D.	Beck's 5. Ross's E.	Powell's 5.	Ross's F.
		Focal Length. 2 in.	$1\frac{1}{3}$ in.	1 in.	$\frac{4}{5}$ in.	$\frac{2}{3}$ in.	$\frac{1}{2}$ in.	$\frac{4}{10}$ in.	$\frac{1}{3}$ in.	$\frac{1}{4}$ in.
		Magnifying Power. 5	$7\frac{1}{2}$	10	$12\frac{1}{2}$	15	20	25	30	40
		COMBINED AMPLIFICATION OF OBJECTIVES AND EYE-PIECES.								
in.										
5	2	10	15	20	25	30	40	50	60	80
4	$2\frac{1}{2}$	$12\frac{1}{2}$	$18\frac{3}{4}$	25	$31\frac{1}{4}$	$37\frac{1}{2}$	50	$62\frac{1}{2}$	75	100
3	$3\frac{1}{3}$	$16\frac{2}{3}$	25	$33\frac{1}{3}$	$41\frac{2}{3}$	50	$66\frac{2}{3}$	$83\frac{1}{3}$	100	$133\frac{1}{3}$
2	5	25	$37\frac{1}{2}$	50	$62\frac{1}{2}$	75	100	125	150	200
$1\frac{1}{2}$	$6\frac{2}{3}$	$33\frac{1}{3}$	50	$66\frac{2}{3}$	$83\frac{1}{3}$	100	$133\frac{1}{3}$	$166\frac{2}{3}$	200	$266\frac{2}{3}$
1	10	50	75	100	125	150	200	250	300	400
$\frac{8}{10}$	$12\frac{1}{2}$	$62\frac{1}{2}$	$93\frac{3}{4}$	125	$156\frac{1}{4}$	$187\frac{1}{2}$	250	$312\frac{1}{2}$	375	500
$\frac{3}{4}$	$13\frac{1}{3}$	$66\frac{2}{3}$	100	$133\frac{1}{3}$	$166\frac{2}{3}$	200	$266\frac{2}{3}$	$333\frac{1}{3}$	400	$533\frac{1}{3}$
$\frac{6}{8}$	15	75	$112\frac{1}{2}$	150	$187\frac{1}{2}$	225	300	375	450	600
$\frac{1}{2}$	20	100	150	200	250	300	400	500	600	800
$\frac{4}{10}$	25	125	$187\frac{1}{2}$	250	$312\frac{1}{2}$	375	500	625	750	1000
$\frac{1}{3}$	30	150	225	300	375	450	600	750	900	1200
$\frac{3}{10}$	$33\frac{1}{3}$	$166\frac{2}{3}$	250	$333\frac{1}{3}$	$416\frac{2}{3}$	500	$666\frac{2}{3}$	$833\frac{1}{3}$	1000	$1333\frac{1}{3}$
$\frac{1}{4}$	40	200	300	400	500	600	800	1000	1200	1600
$\frac{1}{5}$	50	250	375	500	625	750	1000	1250	1500	2000
$\frac{1}{6}$	60	300	450	600	750	900	1200	1500	1800	2400
$\frac{1}{7}$	70	350	525	700	875	1050	1400	1750	2100	2800
$\frac{1}{8}$	80	400	600	800	1000	1200	1600	2000	2400	3200
$\frac{1}{9}$	90	450	675	900	1125	1350	1800	2250	2700	3600
$\frac{1}{10}$	100	500	750	1000	1250	1500	2000	2500	3000	4000
$\frac{1}{11}$	110	550	825	1100	1375	1650	2200	2750	3300	4400
$\frac{1}{12}$	120	600	900	1200	1500	1800	2400	3000	3600	4800
$\frac{1}{13}$	130	650	975	1300	1625	1950	2600	3250	3900	5200
$\frac{1}{14}$	140	700	1050	1400	1750	2100	2800	3500	4200	5600
$\frac{1}{15}$	150	750	1125	1500	1875	2250	3000	3750	4500	6000
$\frac{1}{16}$	160	800	1200	1600	2000	2400	3200	4000	4800	6400
$\frac{1}{17}$	170	850	1275	1700	2125	2550	3400	4250	5100	6800
$\frac{1}{18}$	180	900	1350	1800	2250	2700	3600	4500	5400	7200
$\frac{1}{19}$	190	950	1425	1900	2375	2850	3800	4750	5700	7600
$\frac{1}{20}$	200	1000	1500	2000	2500	3000	4000	5000	6000	8000
$\frac{1}{25}$	250	1250	1875	2500	3125	3750	5000	6250	7500	10000
$\frac{1}{30}$	300	1500	2250	3000	3750	4500	6000	7500	9000	12000
$\frac{1}{40}$	400	2000	3000	4000	5000	6000	8000	10000	12000	16000
$\frac{1}{50}$	500	2500	3750	5000	6250	7500	10000	12500	15000	20000
$\frac{1}{60}$	600	3000	4500	6000	7500	9000	12000	15000	18000	24000
$\frac{1}{80}$	800	4000	6000	8000	10000	12000	16000	20000	24000	32000

* Powell and Lealand's No. 2 = 7·4, and Beck's No. 2 and Ross's B = 8 magnifying power or respectively $\frac{1}{75}$ less and $\frac{1}{75}$ more than the figures given in this column.

Judging from past experience, it will probably be too much to expect that the desired change should take place all at once, and that the A, B, C, &c., or Nos. 1, 2, 3, &c., should forthwith be swept away, but we would venture to suggest that the power of the eye-piece should be indicated in the catalogues and elsewhere, as well as the old title, and if this were done we are sure that the latter would soon be wholly disused.

The tables of magnifying powers issued by opticians are at present, in many cases, of a very misleading character, not so much from the fact that the objectives are underrated—a true $\frac{1}{10}$-inch being called a $\frac{1}{8}$-inch—but that, according to the tables, one and the same eye-piece magnifies differently when it is used with different objectives!

We have accordingly compiled the annexed table of magnifying powers for ready reference. It includes all the more usual objectives, and the full series of eye-pieces of Messrs. Beck, Powell, and Ross. It will be noticed that the magnifying powers of the No. 1 or A agree in all three cases, those of the No. 2 or B slightly varying, being 8, 7·4, and 8. It would be an improvement if they could all be made $7\frac{1}{2}$, which would preserve the uniformity of the series. The No. 3 or C vary greatly, being 15, 10, and $12\frac{1}{2}$. The No. 4 or D agree, whilst No. 5 or E are 25, 30, and 25.

We think that an ideal series should run thus:—No. 1 = 5, No. 2 = $7\frac{1}{2}$, No. 3 = $12\frac{1}{2}$, No. 4 = 20, No. 5 = 30.

With the exception of the $\frac{1}{13}$, $\frac{1}{17}$, and $\frac{1}{19}$, all the objectives included in the table are actually constructed by English or foreign opticians. As objectives are, however, not uncommonly found to vary somewhat from the designated focal lengths, the figures for the $\frac{1}{13}$, $\frac{1}{17}$, and $\frac{1}{19}$ have been retained.

The length of tube is assumed as usual to be 10 inches.

Braham's Microgoniometer.*—At a recent meeting of the Bath Microscopical Society, Mr. Braham described a microgoniometer for measuring the angles of crystals. "The body of the microscope-tube is formed at right angles. A rectangular prism is so adjusted that the plane of the hypothenuse is at an angle of 45 degrees to the axis of rotation. On bringing any crystal into the centre of the field, a fibre in the focus of the eye-piece is made to coincide with either of its edges so that the degrees passed through can easily be read. Thus, as the instrument measures a magnified image of the crystal, and the object itself is stationary, it will readily be seen that the angles of any crystal visible under the highest powers of the Microscope can easily be measured."

Watson's Sliding-box Nose-piece.—Messrs. Watson have recently contrived a sliding-box nose-piece to carry (1) the vertical illuminator (Fig. 16), or (2) the analyzing prism (Fig. 17) of the polarizing apparatus, or (3) the binocular prism. The application of an extra nose-piece in this form appears to be convenient. Experience must,

* Engl. Mech., xxxiv. (1881) p. 277.

however, decide how far it is advisable to add to Microscopes focussing at the nose-piece, extra appliances tending to affect the delicate fitting of the fine adjustment.

Fig. 16.

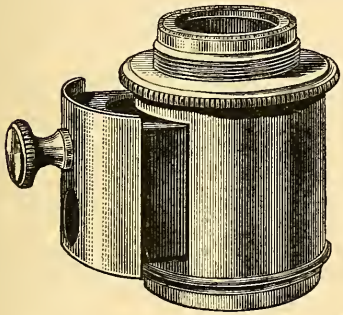
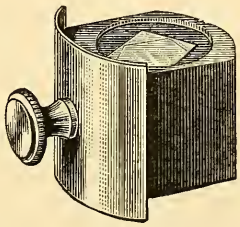
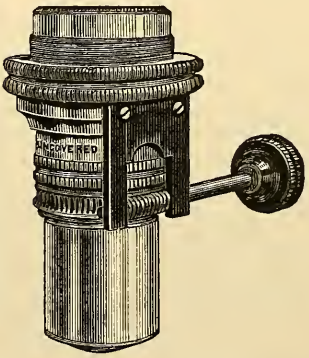


Fig. 17.



Deby's Screw-Collar Adjustment.—Mr. J. Deby suggests that the application of a worm-wheel and tangent screw to the screw-collar adjustment of objectives (Fig. 18) would be found more convenient than the usual system for adjusting the corrections with accuracy. The device, as figured, would not permit the objective to be enclosed in the ordinary brass box; but, as suggested by Mr. Beck, the tangent pinion might be cut off short and provided with a slightly tapering square head upon which the milled head would fit when required.

Fig. 18.



Number of Lenses required in Achromatic Objectives. * —Mr. W. Harkness discusses the number of lenses required in an achromatic objective consisting of infinitely thin lenses in contact, in order that with any given law of dispersion whatever, the greatest possible number of light-rays of different degrees of refrangibility may be brought to a common focus.

For any system of thin lenses in contact we have

$$\frac{1}{f} = (\mu_1 - 1)\,A_1 + (\mu_2 - 1)\,A_2 + (\mu_3 - 1)\,A_3 + \text{etc.}, \qquad (1)$$

the number of terms being unlimited. For a dispersion formula we write

$$\mu = \phi(\lambda) \qquad (2)$$

The form of $\phi(\lambda)$ is unknown, but there will be no loss of gene-

* Bull. Phil. Soc. Washington, iii. (1878–80) pp. 65–7. Smithsonian Misc. Collections, xx. (1881).

rality if it is developed in a series arranged according to the powers of λ. We, therefore, have

$$\mu = a + b\lambda^m + c\lambda^n + e\lambda^p + \text{etc.}, \tag{3}$$

in which a, b, c, etc., are constants, and the number of terms may be taken as great as is desired.

Let us also put

$$\begin{aligned} C &= A_1(a_1 - 1) + A_2(a_2 - 1) + A_3(a_3 - 1) + \text{etc.} \\ D &= A_1 b_1 + A_2 b_2 + A_3 b_3 + \text{etc.} \\ E &= A_1 c_1 + A_2 c_2 + A_3 c_3 + \text{etc.} \\ F &= A_1 e_1 + A_2 e_2 + A_3 e_3 + \text{etc.} \\ &\text{etc.} \qquad \text{etc.} \qquad \text{etc.} \end{aligned} \tag{4}$$

the number of these equations, and the number of terms in the right-hand member of each of them, being the same as the number of terms in the right-hand member of (3). Now substituting for the μ's in (1) their values in terms of the auxiliaries C, D, E, etc., of the equations (4), we find

$$\frac{1}{f} = C + D\lambda^m + E\lambda^n + F\lambda^p + \text{etc.} \tag{5}$$

Considering λ as the abscissa, and f as the ordinate, this is the equation of the focal curve. Its first derivative, with respect to f and λ, is

$$\frac{df}{d\lambda} = -f^2(mD\lambda^{m-1} + nE\lambda^{n-1} + \text{etc.}), \tag{6}$$

which, as is well known, expresses for every point of the curve the tangent of the angle made by the tangent line with the axis of abscissas. The number of rays of different degrees of refrangibility which can be brought to a common focus will evidently be the same as the number of times that the focal curve intersects the focal plane. But the focal plane is necessarily parallel to the axis of abscissas; and therefore the greatest possible number of intersections of the curve with the plane can only exceed by one the number of tangents which can be drawn parallel to the axis of abscissas. To find these tangents we equate (6) to zero, and obtain

$$0 = mD\lambda^{m-1} + nE\lambda^{n-1} + \text{etc.} \tag{7}$$

As λ can never be either zero, negative, or imaginary, we have to consider only the real positive roots of this equation; each of which corresponds to a tangent. To make the number of tangents as great as possible, the quantities D, E, F, etc., must be independent of each other; which will be the case when the right-hand members of the equations (4) contain as many A's as there are powers of λ in the dispersion formula (4). All the terms of (7) contain the common factor λ^{m-1}. Taking it out we have

$$-mD = nE\lambda^{n-m} + pF\lambda^{p-m} + \text{etc.}, \tag{8}$$

from which it is evident that the number of real positive roots in (7) will always be one less than the number of powers of λ in (3). Hence we conclude that:—

In any system of infinitely thin lenses in contact, the number of lenses required to bring the greatest possible number of light-rays of different degrees of refrangibility to a common focus is the same as the number of different powers of λ contained in the dispersion formula employed.

The method made use of in arriving at this result has been adopted, because it brings out clearly the geometrical relations of the problem. The result itself is evident from a mere inspection of equation (5), which cannot possess more real positive roots than it has independent auxiliaries, D, E, F, etc.

Colour Corrections of Achromatic Objectives.*—The following abstract is published of a paper by W. Harkness:—

1. From any three pieces of glass suitable for making a corrected objective, but not fulfilling the conditions necessary for the complete destruction of the secondary spectrum, it will always be possible to select two pieces from which a double objective can be made that will be superior to any triple objective made from all three of the pieces.

2. The colour correction of any objective is completely defined by stating the wave-length of the light for which it gives the minimum focal distance.

3. An objective is properly corrected for any given purpose when its minimum focal distance corresponds to rays of the wave-length which is most efficient for that purpose. For example: in an objective corrected for visual purposes, the rays which seem brightest to the human eye should have the minimum focal-distance; while in an objective intended for photographic work the rays which produce the greatest effect upon silver bromo-iodide should have the minimum focal-distance.

4. In the case of a double achromatic, the secondary spectrum (or in other words, the diameter, at its intersection with the focal plane, of the cone of rays having the maximum focal length) is absolutely independent both of the focal length of the combination, and of the curves of its lenses; and depends solely upon the aperture of the combination, and the physical properties of the materials composing it.

5. When the focal curve of an objective is known, and the relative intensity, for the purpose for which the objective is corrected, of light of every wave-length is also known; then the exact position which the focal plane should occupy can be readily calculated.

Incidentally, it may be remarked that in an objective corrected for photographic purposes the interval between the maximum and minimum focal distance is less than in one corrected for visual purposes. Hence a photographic objective has less secondary spectrum, and is better adapted for spectroscopic work, than a visual objective.

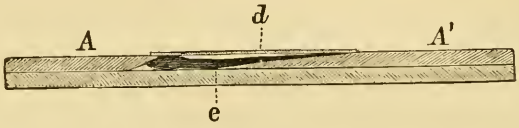
Verification of Objectives.—The editor of the 'Northern Microscopist' undertakes, for a nominal fee of 1*s.* 6*d.*, to verify

* Bull. Phil. Soc. Washington, iii. (1878–80) pp. 39–40. Smithsonian Misc. Coll., xx. (1881).

objectives sent to him in regard to their amplifying power, working distance, absolute size of field, and real aperture.*

Schultze's Tadpole-Slide.† — This slide (or "microscopic aquarium") (Fig. 19) was devised for showing the circulation of the blood or the development of the blood-vessels in the larvæ of the frog and triton. To one side of a thick slide is fastened by means of

Fig. 19.

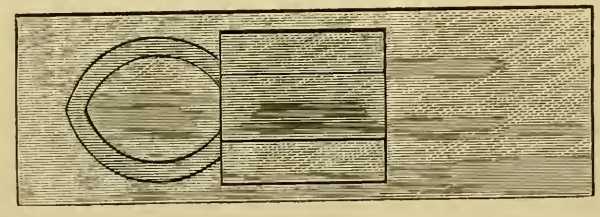


Canada balsam a piece of another slide, cut as represented at A, and to the other side a second piece, of the shape seen at A', so that there is a small cell in the centre of the slide, of the form shown in section in the figure. A cover-glass *d* closes the cell.

To place the larva *e* in the cell, the cover-glass is taken off and the larva fished out of the water in a small watch-glass, and poured with the water into the cell. By manipulating with a brush, its head is brought into the hollow of the glass at A, and the tail placed on the sloping surface at A'. The cover is then quickly replaced, care being taken that the cell is full of water. The animal is excluded from air by the water, which, when it evaporates, can be replaced with the brush. In this way the circulation of the blood in the tail may be observed for hours at a time.

Stokes' Tadpole-Slide.‡—Mr. A. W. Stokes fastens two pieces of a vulcanite ring (Fig. 20) to an ordinary slide so as to form an oval cell just large enough for the body of the tadpole, the tail projecting through an opening in the cell. Close to the latter a square of thin

Fig. 20.



cover-glass is cemented by Canada balsam so as to raise the tail to a level with the body. On each side of this are cemented two small oblong pieces of thin glass forming a cell for the tail to lie in. A square of cover-glass over the body, and another over the tail, will keep the tadpole in place.

* North. Microscopist, i. (1881) pp. 253–7.
† Thanhoffer's 'Das Mikroskop und seine Anwendung,' 1880, pp. 148–9 (1 fig.).
‡ Ann. Rep. Postal Micr. Soc., 1881, p. 13 (1 fig.).

"**Swinging Substage,**" or "**Swinging Tail-piece.**"—At the time this contrivance was first introduced it was known as a "Swinging Tail-piece," but since that time the term "substage" has been almost universally substituted. The earlier name is obviously, however, the more appropriate, as it is not simply the substage which swings, but the mirror also, and we intend to adopt in future the expression "swinging tail-piece."

Value of Swinging Tail-pieces.—In addition to the opinions cited at p. 666 of Vol. I. (1881), the following has been published during the past year :—

Mr. J. D. Cox, in the paper above referred to (see p. 102), considers that the swinging of the mirror-bar on the optical centre of the instrument is a positive improvement, but that the swinging of the substage is of very doubtful value. "In the former case several real advantages are gained. First, the mirror is kept at its proper focal distance from the object. Second, it may be swung above the stage for illumination of opaque objects. Third, it allows the instrument to be used for measuring aperture of object-glasses, by converting it into Smith's 'Universal Apertometer.'* But when we ask for the advantages of swinging the substage with illuminating apparatus, it is difficult to find them. It is plain that we don't want to swing the polariscope, the parabola, the dark wells, the Webster condenser, the wide-angled achromatic condenser, or the immersion illuminators, and could not if we would, for the form and mounting of these accessories is inconsistent with doing so. The question must practically be narrowed to the desirability of swinging the diaphragm and the low-angled achromatic condenser. Of course none of the flat diaphragms can be swung in this manner, and no advantage seems to be found in the use of the sharp-nosed diaphragms with oblique light. The fact is that there are advantages in taking oblique light directly from the mirror; for the chromatic fringes at the margin of the illumination often enable the microscopist to modify the light in a way to get increased resolution by turning the mirror so as to take the most lateral rays and those nearest the blue end of the spectrum. More range in quality of illumination can be got by the practised hand in this way than by the oblique use of the diaphragm.

"In the use of an achromatic condenser, it must be a very low angle indeed which will work far enough from the bottom of the stage to allow much swinging to right or left, especially when we take into account the fact that the centering of the substage becomes more important when it is swung away from the axis of the instrument.

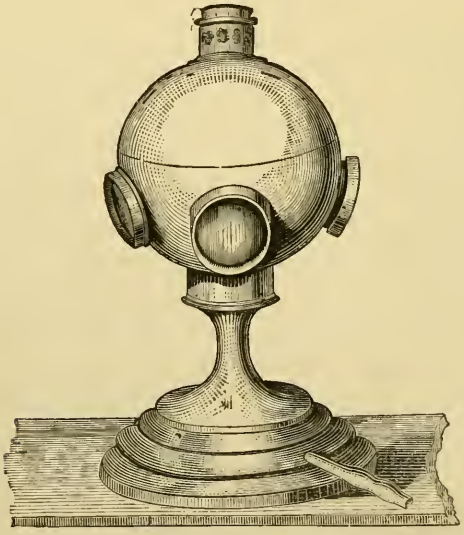
"The centering arrangement of the substage will occupy so much lateral room that it can be swung but a little way before striking the stage. Again, any achromatic condenser of even moderate angle can be swung very little to right or left before its marginal rays will become parallel to the bottom of the slide containing the object under examination, and they then, of course, cease

* See this Journal, ii. (1879) p. 775.

to penetrate to the object or be of use for illumination. Still, again, experience seems to prove very conclusively that the most effective as well as the simplest arrangement for securing oblique light (otherwise than from the mirror alone) is by the prism, the traverse lens, the Wenham 'half button,' or other immersion substage illuminators. These considerations lead strongly to the conclusion that the swinging of the substage is useless."

Ranvier's Microscope-Lamp.*—This (Fig. 21) is described as consisting essentially of a metal globe, which covers the cobalt glass lamp chimney "and prevents the radiation of heat." Four openings with plano-convex lenses conduct the light to four Microscopes. "The light can be so subdued that it is possible to work a long time

Fig. 21.



in the evening without straining the eyes, for which reason the lamp is preferable to all other kinds of illuminating apparatus. The cobalt glass is an essential feature, because the yellow-colour of the lamp-light is thereby obviated, and the sensation of white is produced. Certain shades of yellow and blue, as is well known, stand in relationship to each other as complementary colours, that is they produce white."

Hollow Glass Sphere as a Condenser.†—Mr. F. Kitton describes the effects of using a glass globe filled with water for the purpose of condensing light upon the object. This was used by some of the early microscopists,‡ though it appears soon to have fallen into disuse, as it

* Thanhoffer's 'Das Mikroskop und seine Anwendung,' 1880, pp. 73–4 (1 fig.).

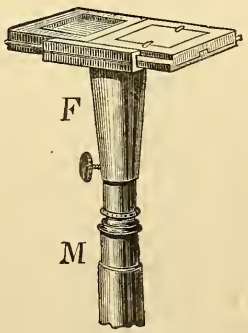
† Sci.-Gossip, 1881, pp. 274–5 (1 fig.).

‡ Hooke, 'Micrographia,' 1665; Ledermüller, 'Mikroskopische Gemüths- und Augen-Ergözung,' 1762.

is not mentioned by Adams in his 'Micrographia Illustrata,' 1771, or in his 'Essays on the Microscope,' 1787. Mr. Kitton tried it first with a $\frac{1}{4}$-inch objective upon *Pleurosigma angulatum*, using oblique light from the mirror; the striæ came out very distinctly. On removing the globe, the striæ vanished and required a more oblique ray to render them again visible. Tried on *Synedra robusta*, it resolved the striæ into beads. With a $\frac{2}{3}$ inch, and not altering the previous position of the mirror, a "black field" was obtained. The object *Haliomma Humboldtii* was seen with beautiful effect, appearing as though illuminated by intense moonlight with a slight green tinge and delightfully cool to the eye. It is also to be recommended with polarized light for softness of tint and impenetrable blackness of field when the prisms are crossed. A globe (6 inches in diameter) should be used, filled with a dilute solution of sulphate of copper (about $\frac{1}{2}$ ounce of saturated solution to 1 pint of water). The mixture must be filtered if ordinary water is used, though the intensity of colour is somewhat a matter of taste. The distance of the globe from the lamp should be about two or three inches; from the globe to the mirror about eight to twelve inches.

Stein's small Microphotographic Apparatus.*—Fig. 22 shows Stein's microphotographic apparatus which, though small and simple, is said to answer its purpose completely. It is on the plan of Harting's apparatus and consists of a cone F which is inserted into the tube M of the Microscope instead of an eye-piece, a plate of ground-glass is fixed to the top, and on this the image can be focussed, the observer's head being covered with a black cloth. The ground-glass plate is replaced by the prepared sensitive plate and the image can then be readily photographed.

Fig. 22.



Ranvier's Myo-Spectroscope.†—In this simple and ingenious instrument (available for rapid superficial demonstrations) a prism is replaced by the muscular tissue, the transverse striæ of the muscular bundles acting on white light like a grating and producing spectra.

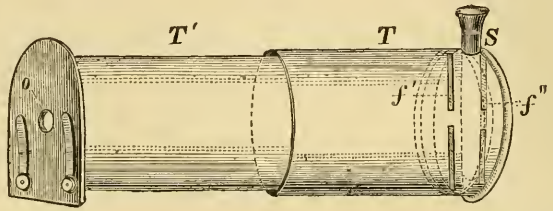
The muscles of the frog are the most suitable for observation, and especially the sartorius muscle, the bundles of which are parallel. The muscle having been taken with care from a living frog, it is dried for some hours in a stove at 40° C., after having been stretched with pins on a piece of cork. The muscle is then planed on both sides with a sharp scalpel, soaked in turpentine, and mounted in Canada balsam.

* Thanhoffer's 'Das Mikroskop und seine Anwendung,' 1880, p. 48 (1 fig.).

† Ranvier's 'Traité technique d'Histologie,' Paris, 1878–80, pp. 316–19 (1 fig.).

The myo-spectroscope is shown in Fig. 23. T′ is a tube 12 cm. long and 4 cm. in diameter, blackened internally, and closed at one end by

FIG. 23.



a diaphragm with a vertical slit f' half a millimetre in breadth. At the other end is a stage plate with a central hole o (5 cm.). The preparation of muscle is placed in the clips in front of the latter hole and so that the axes of the muscular bundles are at right angles to the slit f'. On looking through the hole, whilst the instrument is directed to a light, spectra will be seen on the right or left of the slit.

To observe the absorption-bands of hæmoglobin, a second tube T is added to the instrument, sliding over T′ and having a diaphragm with a large vertical slit f'' in which is placed a tube S containing a solution of blood. Having first seen that the muscle gives a clear spectrum, T with S is replaced and the two absorption-bands of hæmoglobin will be seen in the spectrum.

As the spectrum produced by a grating is more extended according as the lines of the grating are closer together, we are led to investigate whether a muscle at the moment of contraction gives a wider spectrum than when at rest. The lower tendon of the sartorius muscle of a frog is separated from the tibia and the muscle stretched before a slit and it will be seen that on slightly stretching the muscle, the spectrum will be narrow and close to the slit. When the muscle is contracted the converse phenomena are produced, and when it is excited by a current and attains its maximum of contraction the width of the spectra and their distance from the slit are much angmented.

The muscles of different animals thus examined do not give identical spectra. For example, those of the muscles of the frog are broader than those of the white muscles of the rabbit in the ratio of 9 : 7. The transverse striation is therefore finer in the former case than in the latter.

Standard for Micrometry.*—The Philosophical Society of Washington publishes the reply given by Dr. J. J. Woodward to the committee of the Microscopical section of the Troy Scientific Association who asked answers to the following questions:†—

"1. Is it expedient at present to adopt a standard for micrometry?

2. If so, should the English or the metric system be employed?

* Bull. Phil. Soc. Washington, iii. (1878–80) pp. 22–4; Smithsonian Misc. Coll., xx. (1881).

† See this Journal, ii. (1879) pp. 154–5.

3. What unit, within the system selected, is most eligible?

4. What steps should be taken to obtain a suitable standard measure of this unit?

5. How can this standard micrometer be best preserved and made useful to all parties concerned?"

The reply was as follows:—

"1. I am in favour of the adoption of a suitable standard for micrometry by the American Society of Microscopists at their next meeting.

2. For this particular purpose I think the metric system offers so many conveniences that I favour its employment.

3. The selection of an eligible unit within the system involves, it appears to me, two distinct questions: A. How shall the stage-micrometer be ruled? B. How shall the measurements made, be expressed in speech or writing?

A. The object of the stage-micrometer is chiefly to give values to the divisions of the eye-piece micrometer with the power used in any given case. It should be long enough to be used for this purpose with the lowest powers of the compound Microscope, and have a part of its length ruled sufficiently close to answer the same end with the highest powers. I favour the adoption of a standard scale a centimetre long ruled in millimetres, and one of these ruled in hundredths. I have used stage-micrometers ruled in thousandths of a millimetre, but regard such divisions as inconveniently close for this purpose. To measure in thousandths of a millimetre as the unit, which is very convenient in a large number of cases, the simplest way is to use a magnifying power that will make ten divisions of the eye-piece micrometer exactly coincide with one-hundredth of a millimetre on the stage-micrometer. The glass eye-piece micrometer should have a scale a centimetre long ruled in one hundred parts. By increasing the power so that a larger number than ten of these divisions shall correspond to one-hundredth of a millimetre on the stage-micrometer, a unit of any degree of minuteness that may be required for any special work can be obtained up to the limits of distinct vision with the Microscope.

B. But although I regard the hundredth of a millimetre as a very eligible dimension for the closest divisions of the stage-micrometer, when it comes to expressing the results of our measurement in speech or writing, I do not think it is convenient to use the hundredth of a millimetre as the unit of expression. It is too large, and the results of too many measurements would still have to be expressed in decimal fractions. The thousandth of a millimetre is much more convenient as a unit of expression, and I would advise that microscopists should agree to call this dimension a *micron*, and represent it in writing by the Greek letter μ. This dimension has already been adopted as the unit of expression by a number of European microscopists, who represent it by the same Greek letter, but call it a micro-millimetre. The term *micron* should, I think, be preferred because well known to scientific men other than microscopists, having for some time been used in expressing minute differences by those officially engaged in

preparing standard measures of length, and having been adopted by the International Metric Commission. I think it running an unnecessary risk of confusion to select any other than this well-recognized term for the dimension in question.

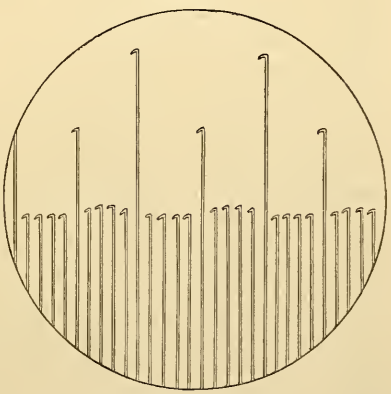
4 & 5. To obtain a suitable standard stage-micrometer, I would advise each microscopical society to select one ruled, as above described, by any person in whom they have confidence, and to satisfy themselves by comparison of the several parts with each other, by means of the same part of the eye-piece micrometer, that the divisions agree among themselves. This is comparatively easily done; the real difficulty will be to determine whether the whole scale is really a centimetre long. To ascertain this, I would advise each microscopical society to send its standard micrometer to the Superintendent of the Coast Survey at Washington, with the request that he will have it compared with a recognized standard in the Bureau of Weights and Measures, and return it with a report of the error, if any. I have reason to believe that such requests would be promptly and courteously responded to. Each society should then preserve the standard thus obtained for the sole purpose of enabling its members to compare their stage-micrometers with it. I think this plan much wiser than to relegate the question to any one of the ingenious men who are endeavouring in this country, with considerable success, to make accurate rulings on glass, and I should anticipate better results from it than from the appointment of a special committee of the American Society of Microscopists to prepare a standard scale.

In conclusion, I readily admit that so long as the English microscopists continue to express the results of their measurements in decimals of an English inch, there will be American microscopists who will do the same, either for all purposes or for particular work, and of course it is very desirable that these measurements also should be accurate. The stage-micrometers on this system in the market are usually ruled in hundredths and thousandths of an inch. The latter divisions are too wide to give values to the eye-piece micrometer with the higher powers, while the five-thousandths, ten-thousandths, or even finer divisions, ruled also on some of these micrometers, are inconveniently close. I would advise the makers to rule such micrometers four-tenths of an inch long, divided into hundredths of an inch, one of the hundredths being subdivided into ten, another into twenty-five spaces. These latter spaces, each representing one twenty-five-hundredth of an inch, sufficiently approximate the hundredth of a millimetre to be used with equal convenience with the higher powers. The scale on the glass eye-piece micrometer, used with these stage-micrometers, should be, if specially made for the purpose, four-tenths of an inch long, divided into one hundred parts, each one two-hundred-and-fiftieth of an inch; but these divisions would so closly approximate those of the metric eye-piece micrometer proposed, that it might be used without inconvenience instead. Where it is thought worth while by a microscopical society to procure a standard scale of this kind, it should be sent to the Coast Survey Office for measurement, as in the case of the metric scales."

Rogers' Micrometers.—Prof. W. A. Rogers, of Cambridge, U.S.A., recently offered, as we announced,* to present a ruled stage micrometer to any one who would undertake to examine its divisions and publish the results. Mr. T. S. Bazley having accepted the proposal, now details the result of the investigation.† "Placed on the stage, and viewed with a two-thirds objective, and a dark field, the ruled lines, which are not filled in with a dark pigment as is common, sparkle like streaks of diamonds; and under this illumination a singular appearance is noticed. In some of the lines a slight internal splintering of the glass has apparently followed the course of the ruling-point, giving an effect of deeper cuts in certain places. But, as this effect is invisible with a bright field, and as there is certainly no variation in the width of the several lines, it probably arises solely from the nature of the glass; and the more so, as these apparently deeper cuts do not often extend for the entire length of a line, and sometimes occur side by side for a few lines.

"The micrometer is of the ordinary 3 by 1 size. The ruled portion is a centimetre in length, and contains 1000 spaces, subdivided at every fifth and tenth, the lines being thus 0·01 mm. apart. The width of the band, neglecting those lines that project, is 1·375 mm. Every tenth line is 1·6 mm. long, and the principal spaces of 6·1 mm. are subdivided by a shorter prolongation of the fifth lines, which measure 1·55 mm. These measurements are the average only, for the lengths of the individual lines vary a few thousandths of a millimetre, and the lower edge of the band is not consequently strictly in one straight line. The terminations of the lines at the upper edge, independently of those projecting at every fifth and tenth, are not in the same straight line either. These deviate in a symmetrical manner; four lines between two long ones having their ends equal and straight, while the ends of the next four form a gentle convex curve. All the lines at this, which may be considered the reading edge of the band, are terminated by singular hooks, suggestive of the curved handle of a walking-stick (see Fig. 24); they differ somewhat in size and character, but have all the same direction, and are probably due to the stopping, lifting, and reversal, of the cutting diamond.

Fig. 24.



"The objectives used were a series by several makers (dry, as well as immersion adapted to various media) up to Zeiss's L, equivalent to

* See this Journal, i. (1881) p. 678.

† Engl. Mech., xxxiv. (1881) pp. 341-2 (1 fig.).

$\frac{1}{24}$; the lines of the band being well defined under all of them; and the eye-piece micrometer, Jackson's form, and a small spider-line micrometer. The former depends a good deal for its result upon an estimation to tenths of its graduations, and can hardly be susceptible of the accuracy which should be attained with a well-made 'wire micrometer.' The latter was therefore adopted and provided with additional draw-tubes, for use, either as an eye-piece in the usual manner, or in the substage, giving an aerial image of the spider-lines as proposed by Dr. Pigott.* This latter method, however, so far as my own experience goes, is more ingenious than effective; principally because all vibration of the micrometer in that position is magnified by the whole power of the Microscope. There is one advantage possessed by Jackson's in the spring action, which moves the whole scale, and consequently its zero point, with extreme nicety. In the spider-line micrometer, one wire is generally fixed, and the only way to bring a given point of an object under the Microscope to coincide with that wire is by the screw action of the stage, which, with a high power, is far too sensitive and rapid. To obviate this difficulty, a traversing movement to the extent of a fifth of an inch, controlled by a screw of fine pitch, was added to the small micrometer between its screw-plate and draw-tube. By this means any given line on the ruled band, after being brought approximately into position with the stage movement, could be accurately bisected by the fixed wire of the micrometer. The objectives finally selected were a $\frac{1}{4}$ for the measurement of the principal subdivisions of 0·05 mm. each, and a $\frac{1}{10}$ imm. for the close spaces. These objectives gave the most convenient decimal values; the former by suitable adjustment of the draw-tube giving ·00025 mm. as the equivalent of one division of the micrometer divided head (50 divisions to one turn); and the latter ·0001 mm. Both glasses were by Beck, and their magnifying powers, with the positive eye-piece employed, were 950 and 2500 respectively. Of course the eye-piece could be changed at pleasure, without altering the ratio of scale to image. The fine movement of the Microscope employed is on its main tube; its action propels or withdraws the nose-piece, thus possibly interfering with the value, as adjusted by the lengthening draw-tube, of the micrometer scale in terms of a given unit. It proved, however, by actual experiment, using a power of 1000 diameters, that an alteration of the fiftieth of an inch in the distance from eye-piece to stage, made no perceptible change in the ratio between the micrometer in the eye-piece and that on the stage, so any supposed error in measurement from this cause may be dismissed as visionary. All kinds of illumination were tried, the preference being given to that described [in this Journal, I. (1881) p. 666], using the concave mirror without condenser, at an obliquity of about 40°, and a thin metal plate attached below the stage, at such an angle that no rays from the lamp can reach the object, except by reflection from the inclined mirror. With the light so directed, each line of the band was evenly divided, longitudinally, into a dark half and a light half, giving much facility for the exact superposition of a

* Mon. Micr. Journ., ix. p. 3.

micrometer-wire upon the centre of the image of any line. In examining the spaces seriatim, there was some risk of losing count, and as a means of reference, a scale of figures, photographed by Mr. J. Mayall, jun., to the exact length of a centimetre, was pasted at the upper edge of the band, so that the principal graduations of the latter could be identified with a low power.

"Coming, at last, to the examination of the plate ruled by Prof. Rogers, perhaps its most distinguishing feature is the perfect straightness and similarity of the individual lines. The stage micrometers commonly met with are so deficient in this respect, that it is impossible to obtain equal distances from different parts of the same two lines of the scale. But with the rulings of Prof. Rogers no such inequality exists. The spider-lines at the eye-piece may be set to any interval of lines on his micrometer, and the scale will rigidly indicate the same distance at any other part of the band, whether above, below, or on either side the position first selected. As to the actual width of the lines themselves, I make it to be ·001 mm. almost exactly. After all these precautions for the study of this micrometer, perhaps a list of small, though definite, errata may be looked for; but I have carefully verified the principal intervals of the band, and a large number, taken at hazard, of the 1000 close spaces, and have detected no discrepancies whatever. The only possible criticism that occurs to me is that the projecting lines at the reading edge are perhaps needlessly long, and that if the 'walking-stick hooks' could be transferred to the other side of the band, it would be an improvement. I believe the ruling to be as accurate as mechanical means can produce; and though there is no means of deciding whether the spaces are true subdivisions of the French metre, the perfection of the subdivisions themselves is a tolerably sure guarantee that the Professor took every care to verify his unit to begin with."

Section of "Histology and Microscopy" at the American Association.—At the last meeting of the American Association for the Advancement of Science, a section of "Histology and Microscopy," in place of the previously existing sub-section of Microscopy, was established, to rank on the same footing as the other sections of the Association, and to be represented on the Standing Committee, its Chairman being *ex officio* a Vice-President.

Structure of Cotton Fibre.*—Dr. F. H. Bowman has published an elaborate investigation into the structure of cotton fibre, in which he gives a general account of the plant botanically, and deals with the typical structure of a cotton fibre, both in regard to the mechanical arrangement of its ultimate parts, and chemically. A full consideration is given to the variations from the type structure which are found to exist and the extent to which any variation in the ultimate fibre may affect its use in the manufacturing process.

The book is illustrated with plates of typical and other cotton

* Bowman, F. H., 'The Structure of the Cotton Fibre in its relation to technical applications,' xvi. and 211 pp., 5 figs. and 12 pls. 8vo, Manchester, 1881.

fibres and with coloured plates, showing their appearance when dyed with turmeric yellow, indigo blue, &c.

The value of the Microscope with ordinary and polarized light, and with dyed and undyed fibres, is throughout made a special feature, and the book is to be welcomed as a noteworthy addition to the, at present, very scanty literature relating to the practical applications of the Microscope to manufactures. We should imagine that both silk and woollen manufacturers would be benefited by similar treatises on silk and wool.

The limit of microscopical *vision* is, on pp. 156–7, treated as synonymous with the limit of microscopical *resolution*, and in any future references to the subject care should be taken to show that the latter refers exclusively to the power of distinguishing as separate two lines or other objects close together, the limit of which is half the wave-length in the medium employed $\times$ sin. u, whilst the vision of isolated minute objects is only limited by the sensitiveness of the particular observer's retina, the distribution of light, &c. Limit of "visibility" is distinct from the limit of "visible separation."

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

Durable Preparations of Microscopical Organisms.*—Professor G. Entz describes the method used by him for mounting microscopical organisms, Protozoa, Rotifera, &c., preceded by an historical review of the processes hitherto adopted.

Ehrenberg† used a dry process which answered well only for certain objects. Its use may be somewhat extended by soaking the dried preparation in 1 part distilled water, 1 part glycerine, and (in a large quantity) 1–2 drops of picric acid. The shrivelled parts swell out and look very life-like. Amongst the organisms capable of being so treated are the Volvocineæ, Chlamydomonads, the loricated *Euglenæ* (*E. acus* and *E. Spirogyra*) Peridineæ, the tests of Rhizopods, tubes of *Melicerta*, Ciliata with resisting cuticles (as *Stentor igneus*, *Epistylis plicatilis*, and fine chitinous elements, such as the masticatory apparatus of Rotifera and small Nematodes. The protoplasmic parts of organisms are of course entirely lost by this method.

Later still, Du Plessis‡ suggested glycerine coloured with chromate of potash, and Duncker§ in 1877 exhibited Rotifers, Protozoa, and Algæ, which were highly commended by such authorities as Cohn, Stein, and Leuckhart, and which showed the fine parts in a most wonderful manner. Unhappily they were not permanent. In a few weeks brown oily drops began to make their appearance in the fluid, and ultimately the protoplasm also browned, so that they are now useless. Duncker never published his method, but the author considers it probable that the basis of the fluid he used was rectified

* Zool. Anzeig., iv. (1881) pp. 575–80.
† Abh. K. Akad. Wiss. Berlin, 1835, p. 141; 1862, p. 39.
‡ Arch. f. Naturg., 1864, ii. Band, p. 162.
§ See this Journal, i. (1878) p. 221.

pyroligneous acid, which, allowed to run in under the cover-glass in small quantities, killed and fixed the organisms in their natural form.

After referring to the methods suggested by Certes,* Bütschli,† and Thanhoffer and Davida,‡ the author describes that which he has adopted in the hope of obtaining the same beautiful results as Duncker, but at the same time more durable.

"According to my experience, various means, long known, are adapted for fixing the smallest and most delicate organisms; for instance, rectified pyroligneous acid, the 'liqueur salin hydrargyrique' of Blanchard, in the mixture which Arnold Lang recommends for preserving marine Planarians, § and which has been also used by Paradi for fixing fresh-water Turbellarians with the best results; also picric acid; and lastly, what Paul Mayer has so strongly recommended || for the lower animals, viz. picro-sulphuric acid, which certainly should have the preference over the others. All these media (the list of which is by no means exhausted), kill microscopical organisms instantaneously, without destroying their organization. Flagella and cilia, the suctorial disks of the *Acinetæ*, and even the fine pseudopodia of the Heliozoa can be fixed as well as the pedicel of the rapidly-jerking *Vorticellæ*. Also the muscle of the pedicel, the contractile vacuoles, and the œsophagus and digestive vacuoles. *Euglenæ* and *Amœbæ* may be fixed in their various changing shapes. Rotifera die mostly with their peristomes moderately withdrawn, and *Vorticellæ* the same; but examples may be obtained from *Carchesium*- and *Epistylis*-stems, which are fixed in the act of lively rotation. Infusoria are fixed in the same life-like state, in the act of fission or conjugation, and *Vorticellæ* in the bud form of conjugation. The nucleated elements also come out very prominently, even the nucleolar capsules can be splendidly preserved for further study, and their striation retained. *Spongillæ*, *Hydræ*, small Nematodes, Tardigrades, delicate insect larvæ, and ciliated cells (e. g. of the gills of mussels) can be excellently fixed and preserved. To obtain durable preparations, however, it is absolutely necessary to remove the fluid which has completed its work in the process of fixing, as it might injure the fine organisms by longer action, afterwards placing the preparation in a fluid which is suited to it.

"My procedure is essentially the same as that which Paul Mayer used for treating the lower marine animals with picro-sulphuric acid.

"I place the Protozoa and other microscopical organisms with the Algæ, sediment, or other objects to which they are affixed or between which they move, with some water in a watch-glass, then drop in a few drops of the fixing fluid, which I allow to act only 1–2 minutes. I then pour off the fluid carefully, or simply lift the

* Comptes Rendus, lxxxviii. (1879) p. 433. See this Journal, ii. (1879) pp. 331 and 763.

† Zool. Jahresber., 1879, p. 173.

‡ Thanhoffer, L. v., 'Das Mikroskop und seine Anwendung,' 1880, p. 110.

§ Zool. Anzeig., i. (1878) p. 14. See this Journal, i. (1878) p. 256.

|| MT. Zool. Stat. Neap., ii. (1880) pp. 1–27.

preparation out with a pencil or scalpel, in order to transfer it at once into a larger quantity of alcohol, which must not be too strong. Half an hour is usually enough to withdraw the fixing fluid and replace it by alcohol, in which it may remain a longer time without damage. For removing the chlorophyll colouring-matter of many Infusoria, and also the Algæ in the preparation, a longer stay in alcohol is of course necessary, replacing it by clear alcohol when it has become coloured.

"Microscopical organisms thus treated are ready to be at once mounted in dilute glycerine (1 part of distilled water to 1 of glycerine). But colouring must not be neglected. Among the colouring materials commonly used (carmine, hæmatoxylin, and various aniline dyes), carmine certainly is to be preferred, because it is not bleached in glycerine, and moreover does not colour everything with one tint like the aniline dyes, but principally the nuclear elements. Preparations transferred from alcohol to carmine are mostly coloured sufficiently in 10–20 minutes, only loricated forms as *Euglena*, *Spirogyra* and species of *Phacus*, the Peridineæ, &c., require several hours to make their nuclei sufficiently prominent. Before being transferred into dilute glycerine, the preparations must of course be put into distilled water, and remain until the yellow picric acid is drawn out, and the preparation shows a nice rose colour.

"By the above process beautiful and instructive preparations are obtained, which when carefully mounted show no further change. I have a fairly considerable collection of different Protozoa which have not altered in the least for 6–7 months, and are adapted both for demonstration and for detailed study."

Preparing Anthers.*—J. Rataboul proposes an improved method for preparing anthers, to show the fibrous cells of their walls.

The ordinary method of preparation is to leave the anthers in water until the walls swell, and by triturating with a quill to loosen some shreds of tissue. If any cells are found the tissue must be washed with care to remove pollen-grains and air-bubbles. These manipulations are long, delicate, and difficult, and are not always successful; and the author's method is to place the anthers in 90° or 100° alcohol for 4–5 minutes, triturating *grosso modo*, and immediately putting it in distilled water. The cells open as if by enchantment, the pollen-grains are readily detached, the alcohol dissipates the air-bubbles, and by this process a much larger portion of the anthers can be obtained for examination.

Herpell's Method of Preparing Fungi for the Herbarium.†—G. Herpell announces some improvements on his method previously published, and which we have already described.‡

In the method proposed for the preservation of the fleshy parts he has no improvement to suggest; but in the preparation of the spores various slight emendations have presented themselves.

* Bull. Soc. Belg. Micr., vii. (1881) pp. cxliv–v.
† SB. Bot. Ver. Prov. Brandenburg, June 24, 1881.
‡ See this Journal, i. (1881) p. 136.

The fixing of the coloured spores with lac on white paper answers completely; but, in the case of the Leucospori, only those of species of *Russula* and *Lactarius* unite firmly with the resin of the lac. On the other hand, the mode of fixing the white spores on blue cardboard simply with gelatine appears to answer in all cases; but the solution should be somewhat more dilute than previously stated. The best fluid is a warm solution of 1 part gelatine in a mixture of 150 parts water and 150 parts alcohol. This answers with species of *Russula* and *Lactarius*, while with *Agaricus* (*Collybia*) *radicatus* so concentrated a solution as 1 part gelatine in 30 parts water is necessary. The writer gives a list of a number of species, with the strength of solution required in each case. Some spores can be fixed on blue cardboard by the use of pure water only. In some cases, again, it is necessary to heat the solution strongly. *Agaricus* (*Collybia*) *maculatus*, *A.* (*C.*) *velutipes*, and *Marasimus peronatus* require a different treatment, which is described.

The author found the same results with the fluid recommended by Patouillard (2 parts mastic in 15 parts ether) as with the lac; the resin does not in all cases combine well with the white spores. The ether has some advantages in penetrating the paper more rapidly and completely, but, on the whole, Herpell prefers the use of alcohol.

Dissociation of Gland-Elements.*—Cauderau finds boiling the mucous membrane of the stomach in a solution of nitrate of soda a very good process for isolating the glands and gland-elements, but the constituent parts of the tissues become too brittle. This defect can be obviated by a previous immersion of some minutes in osmic acid. The cells will then remain admirably preserved after boiling for three hours, but can scarcely be stained at all. The following combination is therefore recommended:—One part of Müller's fluid is diluted with two parts of water and about 30 to 40 grammes of the sodic nitrate is dissolved in a litre of the mixture. Boiling for three hours in this compound is sufficient to break up the mucous membrane of the stomach. The maceration, besides acting on the glands, extends to the muscular coat.

Method of Preparing and Mounting Soft Tissues.†—The conclusions arrived at with regard to the structure of the nervous centres by means of the successive action of bichromate of potash and nitrate of silver will certainly receive confirmation from this method, which we owe to Professor C. Golgi. It has the double advantage of enabling us to stain the nerve-cells black within a given time, and of turning out preparations which may be kept for a long period in the ordinary mounting media.

The pieces of tissue are hardened to the necessary degree in Müller's fluid, or in solutions of bichromate of potash, whose strength

* Gaz. méd. de Paris, No. 45, pp. 577–8. Cf. Jahresber. Anat. u. Physiol., viii. pp. 13–14.

† Rendiconti R. Istit. Lombard., xii. pp. 206–10. Cf. Jahresber. Anat. u. Physiol., viii. pp. 12–13.

is gradually increased from 1 to 2½ per cent. The pieces must not be more than 1 to 2 cm. thick, a large proportion of fluid must be used, and it must be frequently changed. In from 15 to 20 days the pieces are put into corrosive sublimate solution ¼ to ½ per cent. in strength. The reaction requires at least 8 to 10 days, and during this time the liquid must be daily renewed. The pieces gradually change colour and acquire the appearance of fresh brain-substance. They may be allowed to remain even for a longer time in the solution, which serves at the same time to harden them. Sections which are to be kept must be repeatedly washed, else crystals and other deposits appear upon them and alter the appearance under the Microscope. They keep admirably well in glycerine, which is perhaps better for the purpose than Canada balsam and dammar. By this method the ganglion-cells with their processes are acted upon; their nuclei are often left visible; the elementary constituents of the walls of the vessels, and especially the smooth muscular fibres (muscle fibre-cells), are also brought out. Golgi reports having had good results from the application of this treatment to the cortex of the cerebrum, negative results in the case of the spinal cord, and but slight success with the cerebellum. The author calls the reaction an *apparently black* one, inasmuch as the elements on which it has taken effect appear white under surface illumination, and black only by transmitted light.

Preservation of Anatomical Specimens.*— L. Gerlach recommends the glycerine process of Van Vetter, which has been somewhat modified, firstly by Stieda and then by Gerlach himself. Stieda's recipe is as follows:—Make a mixture of 6 parts of glycerine, 1 of brown sugar, and ½ part of saltpetre; Gerlach uses 12 instead of 6 parts of glycerine. The preparations are cleaned and laid in this liquid, in which they remain from three to six weeks, according to their size. When taken out they have a dark-brown colour and are quite firm; they are then hung up in a chamber of the temperature of 12°–14° R. (59° to 63½° Fahr.). In the course of eight to ten days they become soft and flexible, but must be allowed to hang from two to six months longer, to be available for demonstrations. The more glycerine used, the lighter in colour the preparations remain. The method is best applied to preparations of articulations, to sense organs (eye, ear), larynx, &c. The formation of a crystalline precipitate, which sometimes appears in the drying, is met by the increase in the proportion of glycerine and a diminution of the saltpetre and sugar. If large objects are to be set up, such as whole extremities with their muscles, or the thorax with the ligaments dissected, pure glycerine is preferable to the cheap crude article, for specimens turn out whiter and less hard in it. Gerlach has used it for temporal bone with tympanum and auditory ossicles, and obtained valuable preparations which may be employed with great success to demonstrate the transmission of waves of sound from the tympanum to the labyrinth.

Barff's Preservative for Organic Substances.—A new preservative applicable to all animal and vegetable substances has been

* SB. phys.-med. Soc. Erlangen, July 28, 1879. Cf. Jahresber. Anat. u. Physiol., viii. pp. 112–13, and Jahresber. (Virchow and Hirsch) for 1879, p. 2.

patented by Professor F. S. Barff. It is a compound prepared by mixing boracic acid with glycerine. The former is dissolved in the latter by the aid of heat, the solution taking about four or five hours, care being taken, however, that the temperature employed shall not be so excessive as to decompose the glycerine. To such solution or compound a further quantity of boracic acid is added from time to time until the boracic acid ceases to be dissolved. The compound resulting when allowed to cool, is solid, and is called by the patentee boroglyceride.

In order to employ the compound, a solution is prepared in water, alcohol, or other suitable solvent, and the organic substances to be operated upon, either immersed in or impregnated with such solutions. Solutions may be prepared of various degrees of strength; but Professor Barff finds that a solution consisting of about one part by weight of the compound and forty parts by weight of water will give good results; other proportions may, however, be adopted for special purposes. Solutions of the compound may be applied to the preservation of all organic substances either animal or vegetable.

Injection-mass.*—L. Teichmann injects blood-vessels and lymphatic vessels with a mass which is fluid when cold; it is made with finely powdered materials and linseed-oil varnish up to the consistency of putty, and altered to that of honey or syrup as required, by volatile liquids (such as ether and carbon disulphide). Prepared chalk, zinc white, &c., may be used, coloured with cinnabar, ultramarine, chrome yellow, &c. Ordinary hand-pressure is not powerful enough, so Teichmann makes use of syringes, such as those for injecting gutta-percha, in which the piston is impelled by a screw arrangement.

In this way, even the finest and most elaborate ramifications of the vessels may be readily and with certainty filled. The mass soon stiffens, partly owing to transudation, partly to evaporation of the ether, so that it does not ooze from vessels which may be cut through; it remains soft for a certain time and is as hard as stone when the preparation is finished. The advantages of this method are obvious.

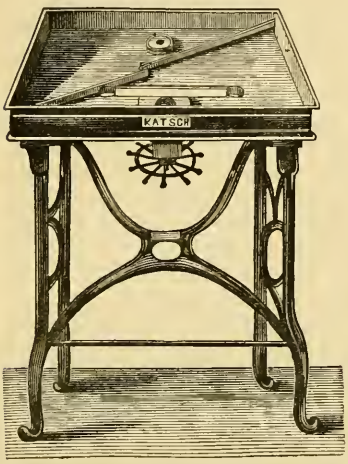
Imbedding Delicate Organs.†—L. Frédéricq describes a method by which pieces of tissue or organs, such as brains of small animals, livers, kidneys, &c., are so thoroughly impregnated with paraffin that they retain a firm consistence, do not shrink up, and keep as well as the best casts of the organs. The tissue or organ is hardened by placing in alcohol, first dilute, then absolute, for several days, is then laid for several days in oil of turpentine, until transparent, when it is transferred to paraffin melted in a water bath, and kept there at a temperature of about 55° C. (it must not exceed 60°), for from two to eight hours, according to the size of the object. It is removed and dried while hot in a current of steam, by blotting-paper or otherwise, and finally allowed to cool.

* SB. Math. Kl. Krakau. Akad., vii. pp. 108–58. Cf. Jahresber. (Virchow and Hirsch) for 1879, p. 2.

† Gaz. méd. de Paris, 1879, No. 4, pp. 45–6. Cf. Jahresber. Anat. u. Physiol., viii. p. 12.

Katsch's Large Microtome.*—In this instrument (Fig. 25), a stand, similar to that of a sewing-machine, supports a tray, across which, in a diagonal direction, a small ledge is fixed. This is inclined rather outwards, and on one end of it the cutting knife rests, so as to move steadily against the microtome plate which rises a little above the tray, and surrounds the preparation. The plate itself is at the end of a hollow cylinder fixed to the tray, in which a massive metal cylinder can be raised and lowered by a screw underneath. There are three knobs on the upper part of this cylinder to fix the substance in which the preparation is imbedded.

Fig. 25.



When the latter is cooled (which is done by pouring water into the tray) the section can be made.

A special advantage of this form of instrument is that sections can be cut under water, and that the screw may be fixed by means of a small click to the $\frac{1}{5000}$ mm. In turning the screw the click is caught at every $\frac{1}{5000}$ mm., and gives an audible signal.

Cox's "Simple Section-cutter for Beginners."†—In this, economy and simplicity have been carried to at least their furthest practicable limits, as the basis of the instrument is a sewing-machine cotton-reel, and a Perry's music binder. The cost does not exceed 2 or 3 pence.

Cutting Sections of very small Objects.‡—H. Strasser adds from 3 to 4 parts of tallow to the imbedding mixture recommended by Kleinenberg (spermaceti 4 parts, castor-oil 1 part), and in order to be able conveniently to arrange very small objects for cutting sections in any required position, he places them in the mass while this is still warm, between plates of mica; the temperature must never exceed 45° C. After cooling the mica plates may be readily separated from the mass, which has the form of a thin sheet, and contains the object; it may be then fixed with heated pins in the desired position upon a block of a substance not easily melted.

Mounting in Balsam.§—Dr. C. Seiler, in a paper contrasting glycerine and balsam as mounting materials, gives the following as a desirable modification of the old process of mounting in various

* Thanhoffer's 'Das Mikroskop und seine Anwendung,' 1880, pp. 96–7 (1 fig.).

† Ann. Rep. Postal Micr. Soc., 1881, pp. 12–13 (1 fig.)

‡ Morphol. Jahrbuch, v. (1879) p. 243. Cf. Zool. Jahresber. Naples, i. (for 1879) p. 35.

§ Proc. Amer. Soc. Micr., 1881, pp. 60–2.

media, whereby the disadvantages attendant upon the use of balsam are removed, so that it becomes the preferable method.

Take a clear sample of Canada balsam and evaporate it in a water or sand bath to dryness; i. e. until it becomes brittle and resinous when cold. Dissolve this while warm in warm *absolute* alcohol (Squibbs'), and filter through absorbent cotton. Place the section, after it has been stained, in weak alcohol (about ·60), and allow it to remain in a few minutes, then transfer it to ·80, ·95, and finally to absolute alcohol, in which it should remain a few minutes also. Then transfer it to the slide (which has been slightly warmed above a spirit-lamp so as to remove all moisture), drain off all superfluous alcohol, and place a drop of the alcoholic balsam solution on the specimen. In a few seconds the latter will become transparent, when it may be covered, and set aside to dry. In damp weather, or when breathed upon, a milky edge will be noticed on the drop of balsam, which is caused by minute globules of water, which, however, may readily be dispelled by the application of a little heat to the under side of the slide. It will be seen that by the *gradual* dehydration of the specimen, the danger of distortion of the histological elements is materially diminished; that by the omission of any clearing agent the shrivelling is avoided as well as the solution of fat in the cells prevented, for cold alcohol alone will not dissolve fat; and finally by evaporating the balsam to dryness all other constituents except the pure balsam are driven off, so that the danger of crystallization is avoided.

Mounting in Glycerine.*—Dr. S. R. Holdsworth finds the following plan to be efficacious in avoiding the difficulty found in getting rid of the surplus glycerine when it has passed beyond the cover-glass. He puts a very small drop of glycerine upon the object, just sufficient that when the cover-glass is applied it will not extend to the margin. A solution of Canada balsam in chloroform or benzoline is then run in to fix the cover-glass, and not being miscible with the glycerine, an air-space is formed between the two fluids which has not been found to be detrimental. The slide can be finished with a ring of balsam or other cement.

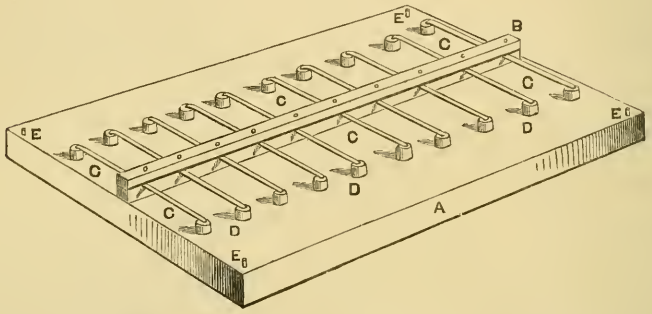
Smith's Slides.†—The Editor of the 'American Monthly Microscopical Journal' writes:—"Mr. J. Lees Smith, of this city, has prepared some very attractive slides in this manner: the glass slips are first coated with photographer's 'granite varnish' by flowing, just as a plate is coated with collodion in photography. This coating of varnish gives the slide the appearance of finely ground glass. It is then placed on the turntable, and, by means of a knife-blade, the varnish is entirely removed from a circular spot in the centre, just large enough for the cell in which the mount is to be preserved. The preparations we saw were mounted in glycerine, and the clear and transparent cells were made of Brown's rubber cement, which Mr. Smith regards as a most excellent cement, especially for glycerine

* Ann. Rep. Postal Micr. Soc., 1881, p. 11.
† Amer. Mon. Micr. Journ., ii. (1881) p. 179.

mounts. Imagine a slip of ground glass with a transparent spot in the centre, upon which objects can be mounted, and one can thus form an idea of the appearance of these slides."

Spring Clip Board.*—Mr. W. Stringfield gives the accompanying sketch (Fig. 26) of the spring clip boards he has had in use for some time, and which, for reducing the breakage of thin glass covers to a minimum, economy of construction, and convenience of moving, far

Fig. 26.



surpass, he considers, any arrangement that has come under his notice. They are made of mahogany, but of course pine or other wood can be used. All, however, should be baked previously to finally planing up. A is a piece of mahogany 12 × $7\frac{3}{4}$ × $\frac{3}{4}$ inches; B two strips, each securely fastened down the centre of the base board A by eleven screws; C C pieces of watch or crinoline steel, $3\frac{3}{4}$ inches long, $\frac{3}{8}$ inch wide, with a hole punched in either end to allow of a small brass pin passing through for securing the pressers; D D small pieces of phial corks; E E E E four screws fitting in corresponding holes drilled in the bottom of each board, thus allowing a number to be placed one on the other without injury to the slides, and admitting a free current of air.

Examination of Living Cartilage.†—J. M. Prudden found the episternum of the frog, especially of *Rana temporaria*, an extremely good object in which to examine cartilage in the living animal. A moderately curarized frog should be taken, and an incision made in the skin from the lower jaw to the middle of the sternum, and then two cross cuts; the operator must turn back the edges of the skin, and divide the submaxillary muscle, thus exposed, near the middle, avoiding the large veins which pass inwards over the apex of the episternum. The latter lies at the bottom of the incision, being covered only by a somewhat loose connective tissue. If the delicate laminæ of connective tissue between the episternum and hyoid bone are now cut through, and the head turned back at right angles to the body, the episternum is extruded from the wound, projects forwards,

* Sci.-Gossip, 1881, p. 232 (1 fig.)

† Virchow's Archiv, lxxv. pp. 185-98. Cf. Jahresber. Anat. u. Physiol., viii. pp. 11-12.

and may be rendered accessible even to strong magnifying powers if placed on a glass block of suitable size. For prolonged observations the whole object may be attached to Thomas's object-holder, with arrangement for irrigation, and may be kept in the natural fresh condition of life by irrigating with amniotic fluid or ½ per cent. salt solution.

By this method Prudden was able, by irrigating with the latter fluid, to observe the cartilage cells in the episternum of the frog for many hours, in the living and fresh condition. Under these circumstances the intercellular substance appears homogeneous, the outline of the cell is very clear, and the cell-protoplasm has a finely granular appearance, with bright globules near the nucleus; the latter has a double contour, is penetrated internally by a number of fine lines, which meet at broader internodes. In this form of nucleus he could observe phenomena of movement, but could not determine that any effect was produced upon these movements by weak chemical reagents, by heat, or by electric currents. Under the action of 1 to 3 per cent. salt solution the cells shrink back from their walls, and are seen to be provided with numerous processes, which radiate to the walls of the cavities; vacuoles are also formed in the interior of the cells under these circumstances. When water is added to the solution, the cells resume their original appearance. Similar production of vacuoles under pathological conditions in cells, which have in like manner the power of reverting to the normal condition (Swetsky), the author believes to be explicable by an increase in the density of the liquid which the tissues contain. If the living episternum is irrigated with indifferent liquids and then replaced, the cells appear quite unaltered at the end of nine weeks.

In an episternum which had been excised and placed in the lymph sac of a frog, the cells were found to be filled with yellow drops, soluble in ether, after five days, and the cell-nuclei stained with carmine. An identical degeneration of the cells, accompanied by susceptibility to staining with carmine, took place when the episternum was exposed and replaced after its cells had been killed by chemical reagents or electric shocks. Carmine did not stain the nuclei at all in the living cartilage, neither after irrigation with 2 per cent. salt solution, nor after subsequent dilution of this liquid with water, nor when the episternum had been restored to the body for some weeks; consequently the cells had not died. The author found that even very weak solutions of iodine, and also carbolic acid solutions of a greater strength than ¼ per cent.—that is, solutions which are actually employed in the treatment of affections of the joints—caused the immediate death of the cells, so that when the tissue was subsequently replaced the degenerative processes just mentioned set in. The author found that the cells of living cartilage collapsed under a temperature of 53° C., in detached pieces at that of 50° C., a lower temperature than that which Rollet found necessary.

Statoblasts of Lophopus crystallinus as a Test for High-power Objectives.—Areolations of Isthmia nervosa.—Dr. John Anthony writes:—"I forward an object which I think will be found of value

as a test for high-power objectives, and which, not being a diatom or very diaphanous, needs rather the quality of 'resolution' than that of 'definition' to deal with it satisfactorily. I take it that a 'test' to be of use should be fairly easily obtainable; that the specimens should, from the nature of the structure, be uniform; and that to merit the name of a 'test' it should not be *too* easily made out, even by the best modern glasses.

"I am sanguine enough to think that the statoblast of *Lophopus crystallinus*, which is easily procurable in any numbers, will be found to meet these conditions. The difficult part is the structure of the membrane, which seems to be stretched over the coarse hexagonal framework of the statoblast. I have seen it well, but it tried my fine $\frac{1}{25}$ of Tolles, and was most bright and clear with an excellent $\frac{1}{10}$ homogeneous-immersion objective, which Mr. Tolles has just sent to me. I found the more axial the illumination the better—obliquity was fatal. I used a cap on my condenser of $\frac{3}{16}$, the diameter of condenser being $\frac{1}{4}$, and it evidently aided the definition.

"While on high-power testing, let me say that the hexagonal areolations seen in the apparent openings in *Isthmia nervosa* are valuable for trying the qualities of $\frac{1}{8}$, $\frac{1}{10}$, and $\frac{1}{16}$ or more. The areolations are not small, but so delicate as not to be seen at all by a poor object-glass, while the better the quality of objective the more clearly can they be made out, till they look like delicate network. I mention this because I find the existence of this delicate structure is not generally known; though I have used it for some years to try the quality of objectives."

Microscopical Structure of Malleable Metals.*—The following observations have been made by Mr. J. V. Elsden on the minute structure of metals which have been hammered into thin leaves. Notwithstanding the great opacity of metals, it is quite possible to procure, by chemical means, metallic leaves sufficiently thin to examine beneath the Microscope, by transmitted light. Silver leaf, for instance, when mounted upon a glass slip and immersed for a short time in a solution of potassium cyanide, perchloride of iron, or iron-alum, becomes reduced in thickness to any required extent. The structure of silver leaf may also be conveniently examined by converting it into a transparent salt by the action upon it of chlorine, iodine, or bromine. Similar suitable means may also be found for rendering more or less transparent most of the other metals which can be obtained in leaf.

An examination of such metallic sections will show two principal types of structure, one being essentially granular, and the other fibrous.

The granular metals, of which tin may be taken as an example, present the appearance of exceedingly minute grains, each one being perfectly isolated from its neighbours by still smaller interspaces. The cohesion of such leaves is very small.

The fibrous metals, on the other hand, such as silver and gold, have a very marked structure. Silver, especially, has the appearance

* 'Nature,' xxiii. (1881) p. 391.

of a mass of fine, elongated fibres, which are matted and interlaced in a manner which very much resembles hair. In gold, this fibrous structure, although present, is far less marked. The influence of extreme pressure upon gold and silver seems to be, therefore, to develope a definite internal structure. Gold and silver, in fact, appear to behave in some respects like plastic bodies. When forced to spread out in the direction of least resistance their molecules do not move uniformly, but neighbouring molecules, having different velocities, glide over one another, causing a pronounced arrangement of particles in straight lines.

This development of a fibrous structure, by means of pressure, in a homogeneous substance like silver, is an interesting lesson in experimental geology, which may serve to illustrate the probable origin of the fibrous structure of the comparatively homogeneous limestones of the Pyrenees, Scotland, and the Tyrol.

Sections of Fossil Coniferous Woods.—Voigt and Hochgesang of Göttingen have issued (price 65 marks) a collection of seventy microscopic slides of coniferous woods, fossil and recent, prepared by Professor Göppert. The present collection is a first instalment only, and is devoted to the Araucarieæ. Where possible, each species is represented by three sections, one transverse, the second central or radial, and the third cortical or tangential. Sections of recent woods are placed side by side with those of the most nearly allied fossil woods; as sections of an *Araucaria* (*A. Cunninghami*) and of a *Dammara* (*D. australis*) by the side of the fossil *Araucarites*. The preparations are arranged in a polished mahogany box with ledges, and have been made on slides of white glass 50 × 33 mm., and 1·5 mm. thick, with polished edges, under square cover-glasses of 18 mm. length and breadth, in Canada balsam. Only those of the recent Araucarieæ are under round cover-glasses of 20 mm. diam. in glycerine. The sections have been made with the greatest care and skill. Instead of the ordinary length of about 4 mm., these are of double or treble that length, so as to render possible a more complete examination. Special care has been taken to furnish sections which illustrate the nature of the process of petrifaction.

Aeration of Laboratory Marine Aquaria.*—The plan shown in Fig. 27 is recommended by M. Kunckel d'Herculais for aerating a salt-water aquarium by means of a fall of fresh water.

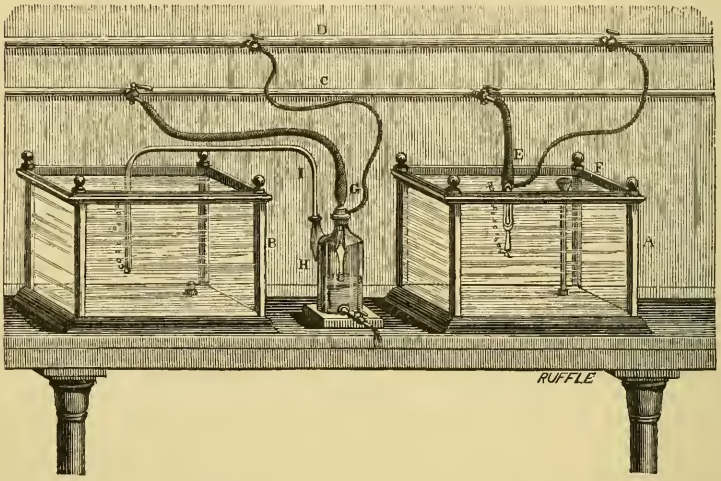
The figure shows two aquaria, A being fresh-water and B salt-water. In the first case the process is of course very simple, the water from the pipe C passing down the tube E, air being obtained through the tube F and pipe D which communicates with the open air so as to prevent air being abstracted from the confined laboratory.

In the case of the salt-water aquarium B, the fresh-water passes from the pipe C down the tube G into the bottle H, with three openings, which holds about two litres, air being obtained as before from the open air through D and the tube shown on the right. A

* See 'Manuel de Zootomie,' par A. Mojsisovics, traduit par J. L. de Lanessan (8vo, Paris, 1881), pp. 61–6 (1 fig.).

third tube I conducts the air from the bottle to the aquarium, while the water escapes from the bottle through the tap at the bottom. All that is necessary is to regulate the flow into and out of the bottle in such a way that the water shall be at a constant level. When this has once been experimentally ascertained the aquarium may be left

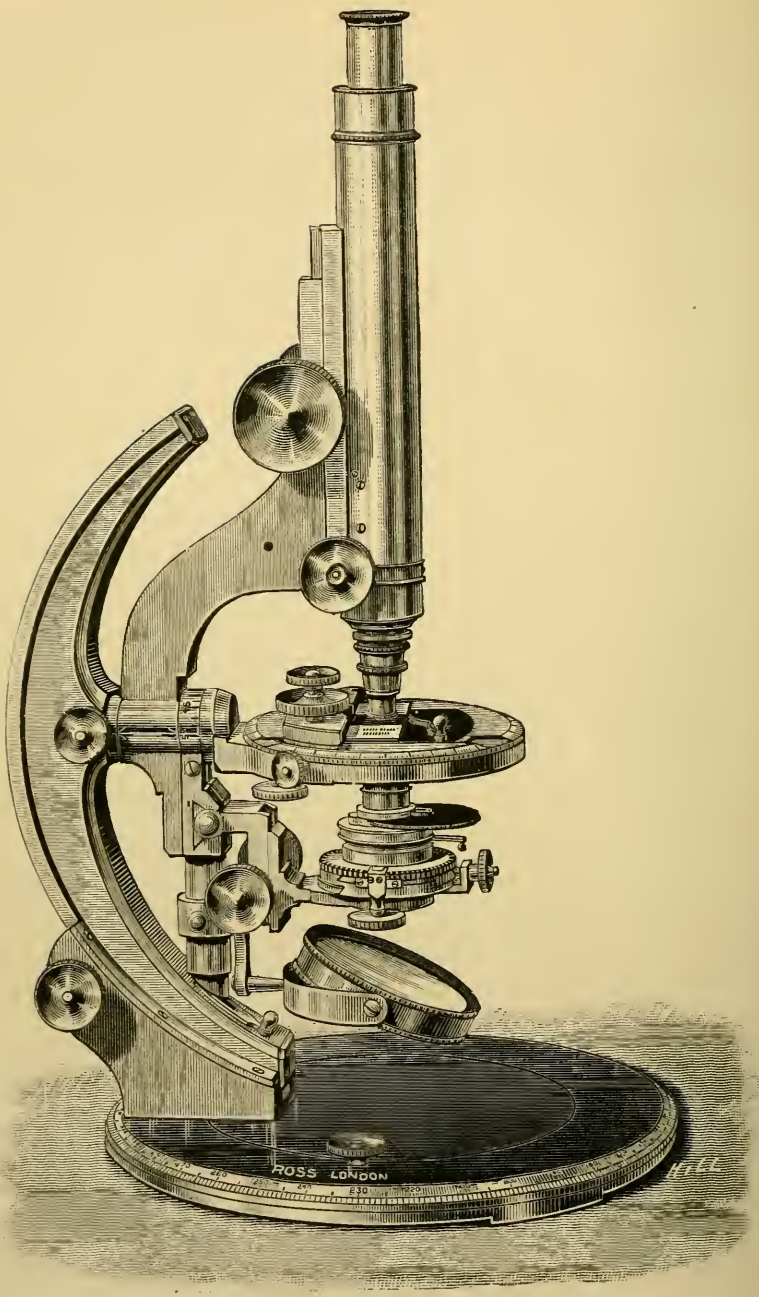
Fig. 27.



without fear day and night. If the bottle were allowed to get empty the aeration would of course stop, while if it were filled the fresh water would pass into the aquarium. In order to supply the loss from evaporation a little fresh water should be added from time to time, which will prevent the necessity for renewing with salt water.

The apparatus will pass 22½ litres of air per hour through an aquarium of 90 litres at an expenditure of water of 36 litres. In this case the exit tube for the air, 5 mm. in diameter, is plunged 11 cm. into the aquarium. If the tube is plunged lower, say 36 cm., the pressure of the water which obstructs the exit of the air is greater, and 45 litres of water would be expended in passing 16 litres of air, i. e. 9 litres of water more, and 6½ litres of air less. In the author's opinion, apart from the increase in the expenditure of water, it is undesirable that the air tube should go to the bottom of the aquarium, as the disturbance to the water which is thus caused is unfavourable to the development of delicate animals.

To ensure that the air-bubbles shall be small, the air tube is terminated by a small sphere with half-a-dozen very small orifices at its equator, and enveloped with two or three thicknesses of muslin.



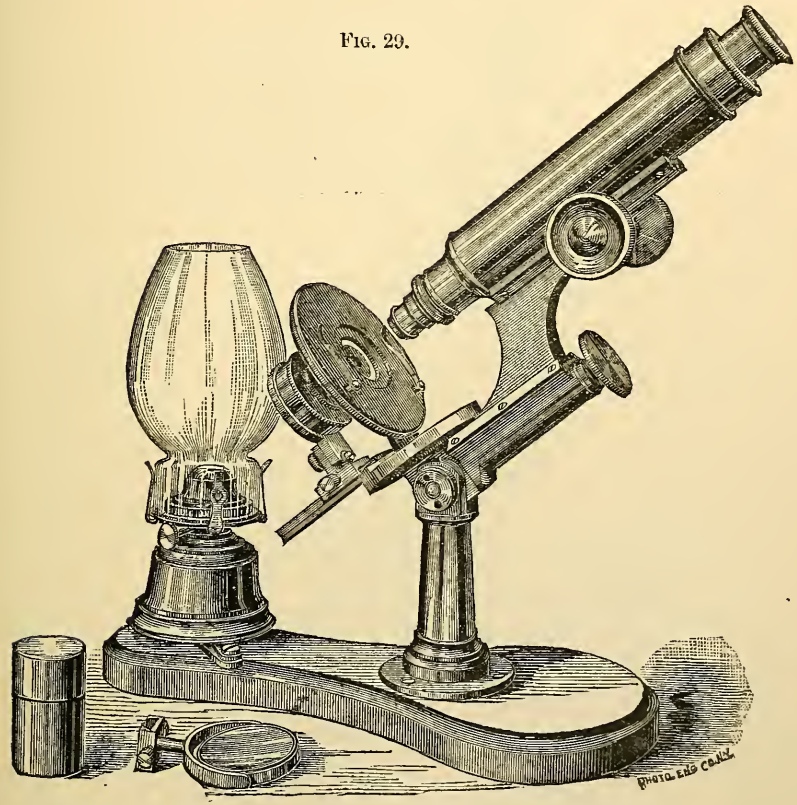
Wenham's Universal Inclining and Rotating Microscope.

MICROSCOPY.

a. Instruments, Accessories, &c.

"Acme" Class Microscope.—The "Acme" Microscope of Messrs. Sidle and Co. (described in Vol. III. (1880) p. 523) is now adapted for being readily converted into a Class Microscope (Fig. 29). This

Fig. 29.

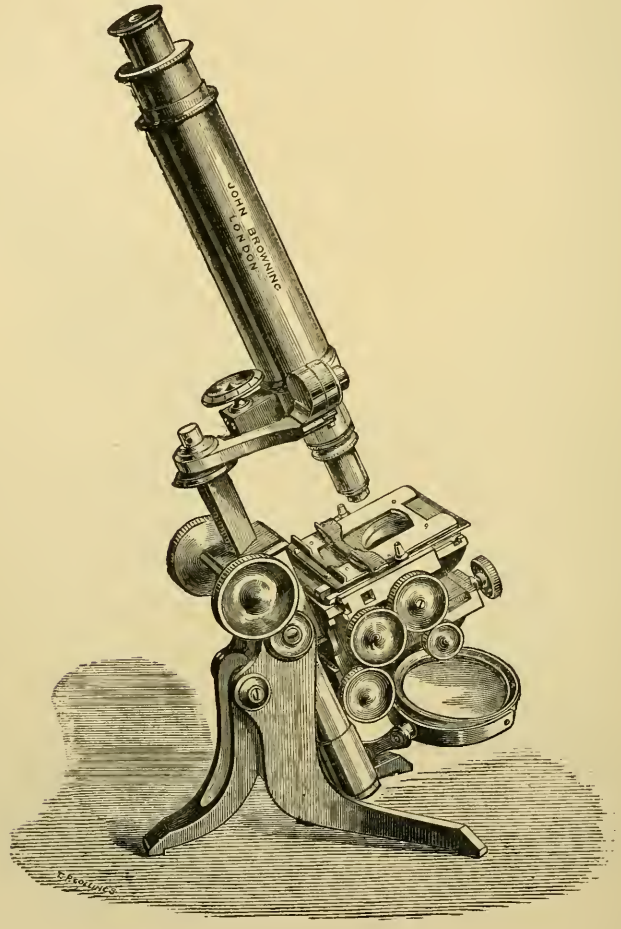


is accomplished by removing the metal tripod foot, and substituting for it a wooden base of suitable form, carrying upon a jointed arm a small lamp. It can then be handed round the class or lecture-room.

We think the ready conversion of ordinary students' stands into class Microscopes, is a point deserving the attention of opticians.

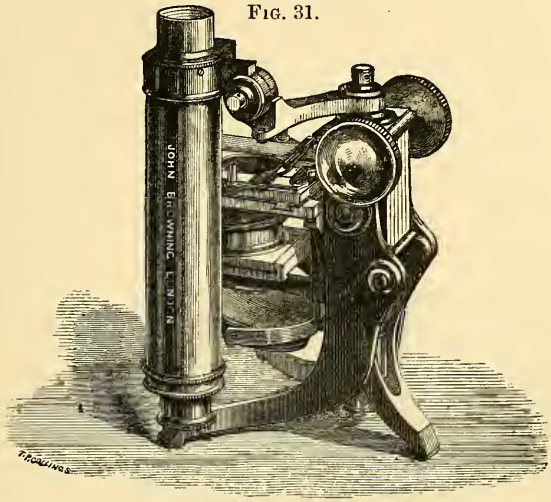
Browning's Portable Microscope.—This Microscope as set up for use is shown in Fig. 30. The stage has the usual rectangular motions, and there is also a substage. The speciality of the instru-

Fig. 30.



ment is that the body-tube turns on a joint as shown in Fig. 31, and that the posterior foot *b* of the tripod can be closed up between the anterior ones. The whole instrument will then pack into a case 6 × 6 × 9 inches.

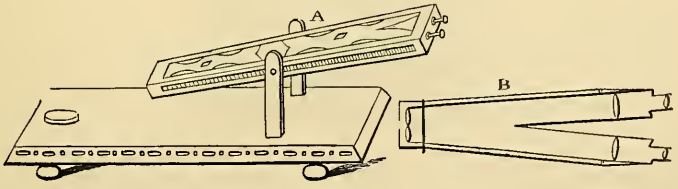
Fig. 31.



Harting's Binocular Microscope. — Professor P. Harting has suggested * a mode of making a binocular Microscope which has not hitherto been described.

The earliest binocular Microscope was that of Cherubin, 1678,† who simply combined two complete Microscopes in one frame (Fig. 32 ‡). Such a device could obviously only be made available with the lower

Fig. 32.



powers; with high powers the necessary proximity of the object would prevent the possibility of any joint convergence of the two objectives.

To obviate this difficulty Professor Harting placed two identical lenses side by side (A and B, Fig. 33) with their axes at an angle *m o n* with one another. If the object *a b* is at a distance equal to twice their focal length, two images of it will then be formed *a' b'*

* Das Mikroskop, 1859, p. 180.

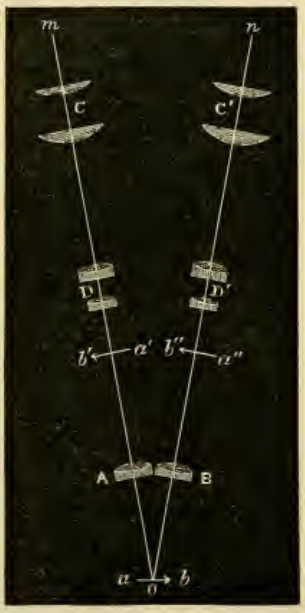
† 'De visione perfecta, sive de amborum visionis axium concursu in eodem objecti puncto.' Paris, 1678, pp. 77–100.

‡ This figure has been correctly copied by the engraver, but the eye-pieces in A would appear to be too narrow.

and $a'' b''$, each of which will be of the same size as the object. Two compound Microscopes with eye-pieces C and C′, and objectives D and D′, are then used to examine the two images.

Professor Harting writing in 1858 said "were the images $a' b'$ and $a'' b''$ so clear and sharp that they might be assumed to represent the object itself, objectives of short focal length might be used. But we are yet far from having the objects so represented by our present lenses. Even if the images are formed by objectives of fairly low power—1 to 2 cm.—the difference between the images and the

FIG. 33.



object is still too great, as was found as the result of some experiments made for the purpose. This contrivance cannot therefore be applied successfully to the construction of binocular Microscopes, which is the more to be regretted as this arrangement seems to satisfy better than any other the requirements of true stereoscopic vision. Perhaps future improvements in the construction of objectives will more readily allow of the accomplishment of the desired aim."

As this was written nearly thirty years ago, it is very probable that the defects in the objectives which were then found to mar the action of the suggested instrument would not now be met with, but we doubt nevertheless if it would be found at all worth while to construct such an instrument. Any improvement in the stereoscopic effect over

that furnished by some of the modern binoculars would be likely to be more than balanced by the additional complication of the instrument.

Nachet's Double-bodied Microscope-tube.*—An ordinary Microscope can be readily converted into one for two observers by the plan shown in Figs. 34 and 35. A nose-piece screws into the end of the

Fig. 34.

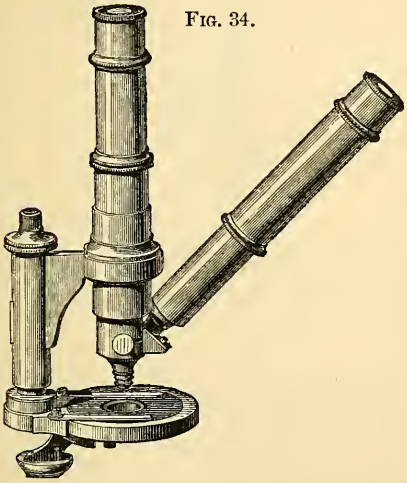


Fig. 35.

body-tube, carrying just above the objective a truncated prism, which bisects the pencil from the objective, allowing half to pass direct to the eye-piece, while the other is diverted by the prism into a second tube screwing into the nose-piece and set obliquely. Powers of 200 to 300 times can be used.

Wenham's Universal Inclining and Rotating Microscope.—This new Microscope (Plate IV.) has been devised by Mr. Wenham for the special purpose of obtaining a large range of effects of oblique light both in altitude and azimuth.

The principal movements are as follows: (1) an inclination of the limb together with the body-tube, stage, substage, and mirror, in a sector sliding within jaws attached to the rotating base-plate. The centre of this inclining motion is (very approximately) the point where the plane of the object cuts the optic axis, i. e. a point situated about the thickness of an ordinary object-slide above the centre of the surface of the stage; (2) a lateral inclination of the limb to either side upon an axis attached to the centre of the sector. The centre line of this axis prolonged forwards also intersects the optic axis in the plane of the object on the stage; (3) a rotation of

* See Robin, C., 'Traité du Microscope,' &c., 1877, pp. 72–3 (2 figs.).

the instrument upon its circular base, the optic axis being the centre of motion.

The leading principle followed in the construction of the stand is

Fig. 36.

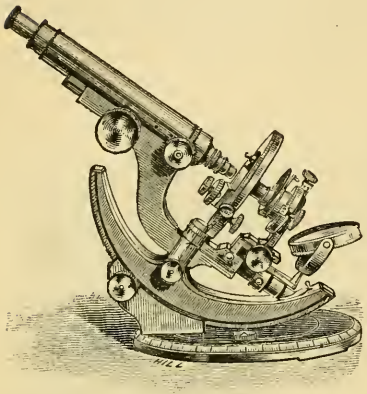
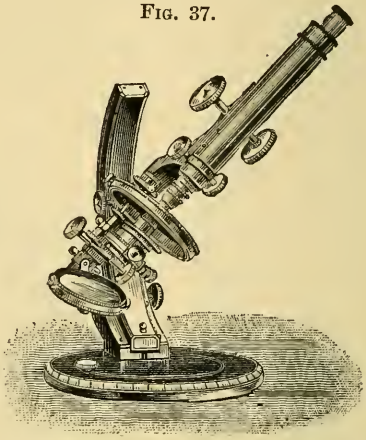


Fig. 37.



that when it is inclined backwards (as in Fig. 36), or turned laterally (as in Figs. 37, 38, and 39), or rotated on the base-plate, a pencil of

Fig. 38.

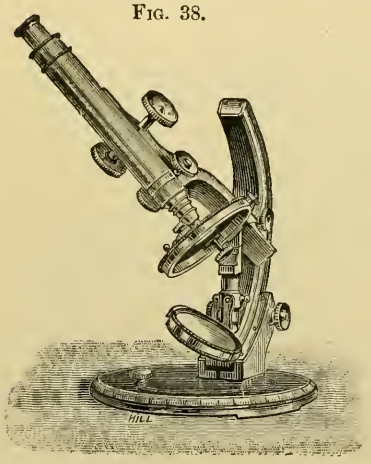
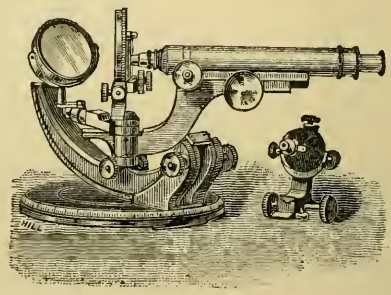


Fig. 39.



light from a fixed source will always reach the object, all the movements, whether separate or combined, radiating from the object (or the prolongation of its axes) as a centre.

The stage rotates completely and is a modification of Mr. Tolles's, in which the rectangular motions are effected by milled

heads acting on the surface and entirely within the circumference.* It is mounted on the Zentmayer system, and graduated near the edge, "finders" being engraved in convenient positions; two centering screws are provided by which exact rotation round the optic axis can be secured; and it can be easily removed, or may be replaced by a glass or metal friction-stage, &c. A simple and effective plan has been adopted of applying the iris-diaphragm, hemispherical immersion illuminator, or Wenham's "half-disk" illuminator, beneath the stage, where they are held by a small projecting peg and a spring latchet.

The substage can be removed entirely from the lower part of the limb by means of a metal dove-tail slide The usual rectangular (centering) and rotating motions are provided.

The substage condenser is furnished with a centering cap and a rotating plate of the usual series of slots, central stops, &c., an iris-diaphragm immediately beneath modifies the diameter of the circular opening utilized.

The coarse adjustment is of the usual "Jackson" form by means of a spiral pinion and diagonal rack-work.

The fine adjustment acts directly upon a vertical slide carrying the objective only, and is controlled by vertical milled heads on both sides of the nose-piece.

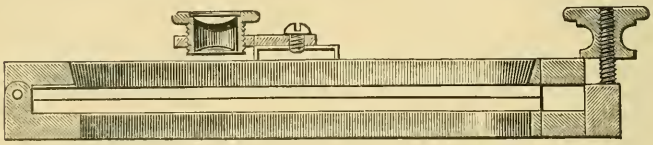
In illustration of the variety of motions obtained with this Microscope, Fig. 36 shows the sector inclined at about the usual position for working with central illumination; Fig. 37 shows the lateral inclination of the limb, &c., the sector being at its highest position; Fig. 38 shows the Zentmayer swinging tail-piece clamped to the sector (as suggested by Mr. J. Mayall, jun.), the limb being inclined laterally, and the substage removed. This lateral inclination of the limb causes the stage to revolve upon a central horizontal axis, so as to present the object to the illuminating pencil at all obliquities; Fig. 39 shows the sector at the lowest point so that the microscope-body is horizontal, the tail-piece being clamped to the sector, the limb swung laterally about 45° (to the right), and the substage removed. This position of the sector would be that required for measuring angles of aperture by means of the graduations on the circular base. The axis of the lateral inclining motion is also graduated, so that either the degree of inclination of the limb or that of the swinging tail-piece can be registered. In all these positions, and indeed in every position in which the various movements enable it to be placed, the Microscope is very steady.

The construction of the stand has been carried out by Messrs. Ross under Mr. Wenham's instructions, and we understand that they purpose making such modifications as will permit a lamp to be carried by the swinging tail-piece, or placed at the lower end of the sector; and the mirror to be attached at pleasure to a rotating slide in the centre of the base: these additions will add still more to the facilities for obtaining obliquely incident light.

* See the descriptions of similar stages, this Journal, i. (1881) pp. 116–117 (Figs. 9 and 10), p. 300 (Fig. 46), and pp. 944–6 (Figs. 221–3).

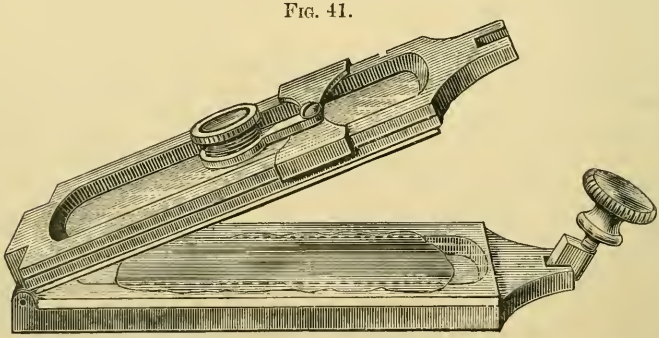
Bausch and Lomb Optical Co.'s Trichinoscope.*—Figs. 40 and 41 show the Trichinoscope recently issued by the Bausch and Lomb Optical Co. It consists of two metal plates, each pierced with a central hole and hinged together at one end, and so arranged that they can be forced together by the screw at the opposite end. Two glass plates

Fig. 40.



are inserted between them. A simple Microscope can be moved in different directions across the apertures in the plates so as to command a view of every part. It is focussed by being screwed up and down in the socket at the end of the arm which carries it.

Fig. 41.



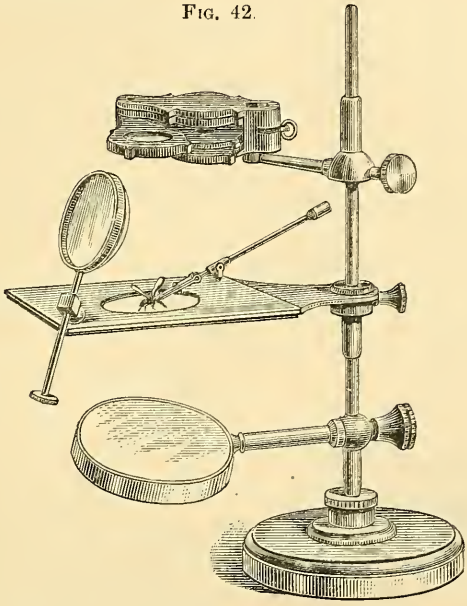
A thin slice of flesh having been moistened with a mixture of equal parts of acetic acid and glycerine, is put on the lower glass plate and spread out by needles or a brush, the second plate is brought down upon the lower one and the screw is placed in the slot into which it fits. By turning the screw any degree of pressure may be brought to bear on the flesh, which may thus be rendered so thin and transparent that any trichinæ present will be readily visible when the Trichinoscope is held up between the eye and light.

"Hampden" Portable Simple Microscope.—This instrument (Figs. 42 and 43) is made by Messrs. Beck and is the device of the wife of a distinguished English statesman now ruling in India. It combines, with great portability, very convenient arrangements for the

* Amer. Jour. Micr., vi. (1881) pp. 183–5 (3 figs.).

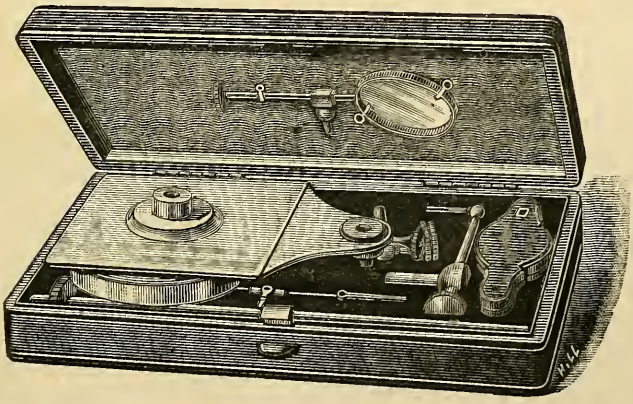
most effective use of a dissecting lens or simple Microscope in the field or when travelling.

Fig. 42.



The lens, stage, and mirror are each carried by a bar sliding on the upright stem which screws into the circular foot. The bars can be

Fig. 43.



adjusted to any height and secured by the screws, of which the milled heads are shown on the right of Fig. 42. When detached the instru-

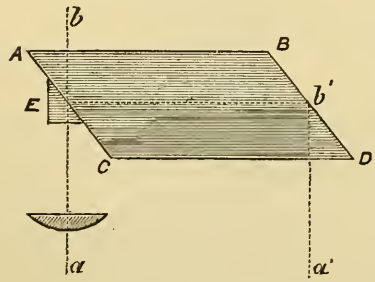
ment packs very conveniently into a small case 5½ in. × 2¾ in. × 1¼ in. in the manner shown in Fig. 43, and is then readily carried in the pocket.

Sir John Lubbock, who has on several botanical excursions taken the instrument with him, speaks highly of its usefulness.

Excluding Extraneous Light from the Microscope.*—In order to exclude light of an injurious character, whether falling laterally on the eye of the observer or on the stage from above, T. W. Engelmann places the Microscope in a dark box, made portable, and admitting the light through a funnel-shaped opening in the broad front side. The body of the observer as well as the Microscope and its belongings are intended to be included in the box, which is 75 cm. high, 80 cm. broad, and 40 cm. deep, and is arranged so as to carry accessory apparatus, reagents, coloured glass plates, &c.

Nachet's Improved Camera Lucida.—In its original form this camera lucida consisted of a rhomboidal prism A B C D, placed over the eye-piece of the Microscope, as shown in Fig. 44, and having cemented to the face A C a segment of a small glass cylinder E, the ray *a b* from the eye-piece and that (*a' b'*) from the pencil meeting the eye at *b*.

Fig. 44.



The disadvantage of this form was that the eye must be held very steadily just over the glass cylinder E (the function of which was to allow the rays from the object to pass to the eye-piece without refraction), to obviate which M. Nachet has made use of a suggestion of Professor G. Govi, and deposits a thin film of gold on the face A C of the prism (Fig. 45). The gold reflects the ray *a' b'* to *b* as

Fig. 45.

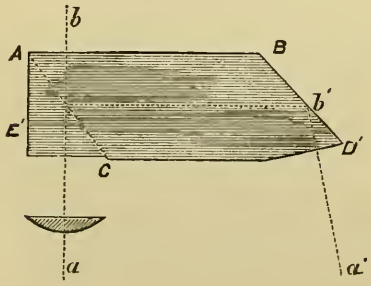
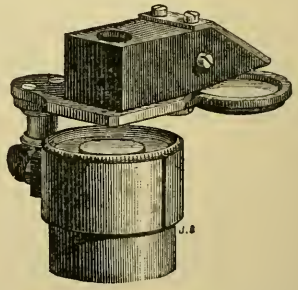


Fig. 46.



before; whilst, at the same time, on account of its translucency, it allows the ray *a* to pass through it from the eye-piece. The small

* Pflüger's Archiv ges. Physiol., xxiii. (1880) p. 571.

prism E is replaced by a larger one, E′, cemented upon the gold film (protecting it also from being rubbed off), and a slight inclination is given to the under surface at D′, in order to avoid too great an approximation of the pencil to the foot of the Microscope.

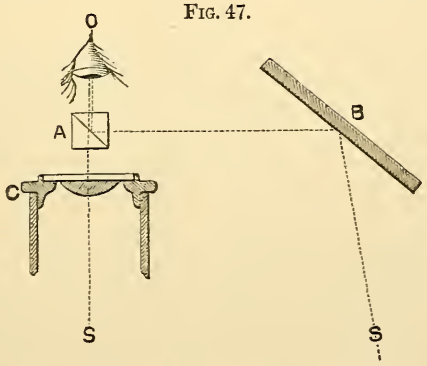
The image of the paper is tinted yellow by the rays reflected from the surface of the gold, while that of the object is of an emerald green tint, that being the colour given to the rays in passing through gold.

Fig. 46 shows the camera lucida in place over the eye-piece.

Abbe's Camera Lucida.*—Dr. L. Dippel commends the following as an extremely simple and complete apparatus for drawing on a horizontal surface.

A small glass cube A (Fig. 47) composed of two right-angled prisms cemented together is placed over the eye-piece C, one of the prisms having an hypothenuse surface silvered, leaving, however, a

Fig. 47.



circular hole. The cube is so adjusted that the hole exactly coincides with the "eye-point" of a Zeiss No. 2 ocular (C). The mirror B is connected with the fastening of A by an arm about 70 mm. from the axis of the Microscope.

In use, the instrument is fastened to the eye-piece cover by two centering screws, and the mirror so turned that the surface of the table close beside the foot of the Microscope appears to be projected on the circular field of the eye-piece. The whole field of view is now readily seen, and with uniform sharpness, and this is the case also when the higher powers are used, no perceptible loss of light taking place in the vision of the microscopical image. One of the most essential qualities of a good camera lucida is therefore obtained.

That the camera is attached to a particular eye-piece, and is not, as usual, made adjustable for those of different power, arises from the fact that in the higher Huyghenian eye-pieces the eye-point lies too near the eye-lens.

* Bot. Centralbl., ix. (1882) pp. 242–3 (1 fig.).

Dr. Dippel says that he has thoroughly tested the camera with very delicate drawings, and has found it of excellent service, and he considers it is to be preferred over all those forms for drawing on a horizontal surface in which the microscopical image is seen after several reflections, and the pencil direct.

Curtis's Camera Lucida Drawing Arrangement.*—Mr. Bulloch's new "Congress" stand has an arrangement for drawing, suggested by Dr. L. Curtis, "which is designed to do away with some of the difficulties attending the use of the ordinary camera lucida. A little table is fastened to the limb by milled-head screws; paper is placed upon this for drawing. One of Hartnack's right-angled camera lucidas is used. Drawing can be done in any position of the Microscope. There is hardly more preparation required for this than would be required to change an eye-piece. The comfort of this arrangement, when one is doing work which requires much drawing while observation is going on, needs to be experienced to be appreciated."

Drawing on Gelatine with the Camera Lucida.†—M. Créteur uses a metallic point for drawing objects with a camera lucida, the drawing being made not on paper, but on a sheet of gelatine laid on a dark ground. The shining point is always visible, and is claimed to provide a remedy for the indistinctness of the point of the pencil, which is the chief difficulty experienced in drawing with the camera by the ordinary method. The drawing can also be readily transferred to stone.

It is questionable whether the advantage gained through the greater distinctness of the drawing-point is not more than counterbalanced by the disadvantage of not being able to draw on paper. As the particular benefit claimed appears to rest upon the shining point, that could be obtained without great difficulty with an ordinary pencil.

Iris-Diaphragm for varying the Aperture of Objectives.—In 1869, Dr. Royston-Pigott applied an Iris-diaphragm behind the objective for reducing the aperture of objectives, in support of the view which he was then advocating that wide-aperture objectives produced confused images.

The editor of the 'Northern Microscopist' has recently suggested the use of such a diaphragm to enable penetration to be obtained with wide-angled objectives of different apertures. Fig. 48 is a side view of the apparatus, as made by Mr. C. Collins, and Fig. 49 a front view. The upper end in the former figure screws into the microscope-tube, while the lower receives the objective. The diaphragm is opened or shut by sliding the lever projecting at the side. The partial closing of the diaphragm does not, of course, contract the *field*, but diminishes its brightness by obstructing the passage of a greater or less part of the cone of rays.

* Amer. Mon. Micr. Journ., iii. (1882) p. 13.
† Bull. Acad. R. Méd. Belg., 1880, p. 617.

In some remarks on the use of the apparatus it is pointed out * that it shows the value of wide apertures for good definition, for if a preparation of the proboscis of the blow-fly be observed with an inch objective having an air angle of 30°, the view is superb, the pseudo-tracheal markings come out well-defined and sharp; but close the shutter until an angle of 14° or less is obtained, and examine again,

Fig. 48.

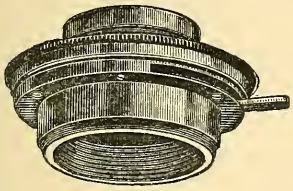
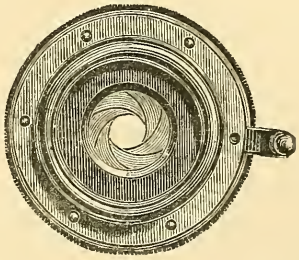


Fig. 49.



when it will be found that the definition is not nearly so good, while there is more penetration, the whole of the pseudo-tracheal tube being observed under one focussing. While in this condition, the eye being still applied to the tube, open the shutter to its full extent, and the effect of wide aperture will demonstrate itself.

"Perhaps the best object to show the amount of penetration possessed by objectives of low angle, may be found in the micro-fungus, *Myxotrichum deflexum*, or *M. chartarum*, observed under the 1-inch objective. The former object consists of little patches of grey downy balls, from which arise a number of radiating threads, furnished with a few opposite and deflexed branches. Under an inch objective of 30° air angle, but few of these branches can be seen under one focussing, the remainder being enveloped in a haze of light; but if a central layer be focussed, the simple closing of the shutter will suffice to bring the superior and inferior layers into view, though, of course, the image is not so bright and well defined as before."

Gundlach ½-inch Objective †—Dr. L. Curtis recently exhibited to the State Microscopical Society of Illinois a new ½-inch objective made by Gundlach, and claimed by the maker to have an angle of 100°. The back lens is large, and extends beyond the border of the opening in the screw. This opening, therefore, acts as a diaphragm. In order to secure the benefit of the full aperture, the portion of the objective can be removed, and an adapter furnished with the Butterfield broad gauge screw can be substituted. It has also another screw of about the same diameter as the Butterfield screw, but provided with a finer thread. The name and description of this screw were not known. The front of the objective is ground down to a conical

* North. Microscopist, ii. (1882) pp. 13–14 (2 figs.).
† Science, iii. (1882) pp. 19–20.

shape. For ordinary use this front is covered with a brass cap, having an aperture in the centre to allow the conical end of the objective to pass through. The cap can be removed when it is desired to use the objective for the examination of opaque objects. On removal of the cap the conical sides of the lens are seen to be covered with some sort of black varnish to prevent the passage of outside light. A Lieberkuhn is furnished, which can be screwed on in place of the cap while examining opaque objects.

Scratching the Front Lenses of Homogeneous-immersion Objectives.—It was recently objected to homogeneous-immersion objectives that the necessity of wiping the oil from the front lens after each observation was fatal to their utility as in time the front surface would thus become so scratched as to render the objective unfit for use.

This objection, however, overlooks the fact that even assuming it was really impossible to properly clear off the immersion fluid without "scratching" the lens, such scratches would not interfere with the use of the objectives. As the fluid used for immersion is *homogeneous*, that is, may practically be considered fluid crown glass, the scratches are optically obliterated as soon as they are in contact with the oil or other medium; in fact, it will be seen on reference to the original paper of Mr. Stephenson on homogeneous-immersion objectives,* that one advantage of the system was pointed out to be that in petrographical work the very imperfect polishing of thin sections of minerals, which had previously been a source of difficulty, was overcome by the approximately optical identity of the object and immersion fluid.

Fluids for Homogeneous Immersion.†—Dr. H. van Heurck, Director of the Antwerp Botanical Gardens, has undertaken an extended investigation of fluids suitable for homogeneous immersion, which (1) should have an index of 1·510–1·520 (line F), and (2) a dispersive power of 0·006 (between D and F), (3) should not be too fluid, and (4) should not attack the varnish of the slides.

Amongst the chemical solutions hitherto suggested, Dr. van Heurck mentions Bassett's fluid (which attacks varnish), chloride of cadmium in glycerine, iodide of zinc in glycerine, sulpho-carbolate of zinc in glycerine, and distilled chloride of zinc (difficult to use and not capable of being well preserved). Of the vegetable substances, cedar oil and oil of copaiba are referred to. The first is a product not of the cedar, but of *Juniperus virginiana*, and is much too fluid, and attacks the varnish of the cells. The second (distilled from different species of *Dipterocarpus*) is a little less fluid and therefore better.

To remedy the inconvenience of the extreme fluidity of cedar-oil, dammar has been dissolved in it, by which also its index may be raised to 1·54. Professor Abbe has recently suggested to the author that an excellent fluid may be obtained by dissolving dammar until the index is 1·520, and then reducing it to 1·509 by the addition of castor-oil.

* See this Journal, i. (1878) p. 52.

† Bull. Soc. Belg. Micr., vii. (1881) pp. xxii.–xxxi.

In his examination of new fluids, Dr. van Heurck met with no sufficient success amongst chemical products, but of vegetable substances three were discovered which appear to be in every way suitable.

The first is a solution of the resinous gum known as *olĭban* (from several species of *Boswellia* of East Africa) partially dissolved in cedar-oil. It gives a fairly thick lemon-yellow liquid of refractive index 1·510, and dispersive power 0·0077. To prepare the liquid, pieces of very pure oliban are powdered finely, and the powder, mixed with its own volume of cedar-oil, is heated in the water-bath in a glass beaker for 2–3 hours. It is then left till the next day, when the supernatant liquid is drawn off.

The resin (*élemi*) of Brazil, and the white oily *tacamaque* of Guibourt give equally good solutions with oil of cedar. By dissolving the tacamaque in the oil a liquid is obtained with a refractive index of 1·519, and dispersive power of ·0074. By adding castor-oil to the solution in suitable quantity the index is lowered to 1·508, and the dispersive power to 0·0072. To prepare the solution, 20 parts by weight of the tacamaque are dissolved in the water-bath in 22 parts of cedar-oil and 14 parts of castor-oil added.

According to Professor Abbe, the latter solution and that of dammar in cedar-oil constitute the two best fluids for homogeneous-immersion objectives.

The third is copaiba of Maracaibo, derived from *Copaifera officinalis*. That found in commerce at Antwerp, and apparently authentic, had an index of 1·519, whilst a specimen from Guibourt of copaiba of Para was only 1·506. It dissolves readily in cedar-oil. Another liquid of 1·510 index and ·0076 dispersive power is obtained by dissolving 7 parts of light vaseline in 30 parts of copaiba. A very thick liquid results, not attacking varnish even after a contact of 24 hours. If it is found to be too thick it can be diluted by mixing with it a solution of copaiba in cedar-oil.

Other liquids from conifers were tried, but in all the dispersive power was found to be too high.

Dr. van Heurck fears that it will be very difficult to discover any substances which will satisfy microscopists who prefer *aqueous* liquids.

Advantage of Homogeneous Immersion.*—Dr. van Heurck also says that "the suggestion of Mr. Stephenson . . . . constitutes certainly the greatest advance which has been made in microscopy during late years. Personally we have been able to appreciate, better perhaps than any one, the importance of such objectives, for it is owing to them that the thousands of drawings in the 'Synopsis des Diatomées de Belgique' could be furnished in a relatively short time. When we think of the trouble that monochromatic illumination has caused us, and the frequent interruptions necessitated by the absence of the sun, we cannot sufficiently congratulate ourselves upon this fortunate discovery, which has enabled us to advance, by a good many

* Loc. cit., pp. xxii.–iii.

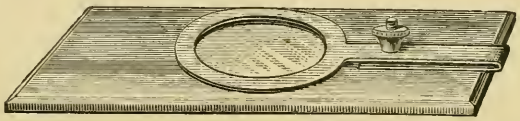
years perhaps, the publication of our work, all the drawings of which have been made or perfected by homogeneous-immersion objectives."

Vertical Illuminator for examining Histological Elements.*—Dr. E. van Ermengem commends the vertical illuminator for the illumination of such of the histological elements as can be mounted on the cover-glass dry. "Blood-corpuscles present an extraordinary appearance, their colour a lively red, their relief very appreciable, and the slightest inequalities on their surface clearly visible." Good results had also been obtained in the examination of semen, mucus, pus, and liquids containing bacteria, &c.; also of the minute structure of muscles and nerve-fibres.

Griffith's Parabolic Reflector.†—Mr. W. H. Tivy describes a method suggested to him by Mr. E. H. Griffith for utilizing a spoon for a "parabolic" reflector. Wind a clean copper wire of $\frac{1}{24}$ inch diameter closely round the base of an objective three times, twisting and bending the ends for a length sufficient to reach a little beyond the end of the objective. Cut a section of about half an inch from the bowl of a new plated teaspoon, and solder the convex side to the ends of the wire, also making the loop solid with solder, and filing it up to a good fit and figure, so that it will slip easily on and off the objective. The reflector is adjusted by bending the wire. "Thus I have a handy and useful piece of apparatus, at the cost of the spoon, 30 cents."

Forrest's Compressorium.—This compressorium (Fig. 50), designed by Mr. H. E. Forrest, is specially constructed with a view to cheapness. It consists of a strong glass (or if desired brass) plate,

Fig. 50.



3 inches by $1\frac{1}{4}$ inches, with ground edges. A small brass screw passes through the plate, the point projecting upwards through it about $\frac{3}{4}$ inch. A brass arm, bent so as to form a spring, rotates upon the screw as on a pivot, and carries at one end a brass ring holding a thin cover-glass, 1 inch in diameter, which covers the centre of the plate when in use. A milled nut works upon the screw above the arm, and when screwed down brings the cover-glass in contact with the glass plate. The spring acts upon and raises the cover, if the nut is unscrewed, so that the two glasses can be fixed at any degree of proximity required.

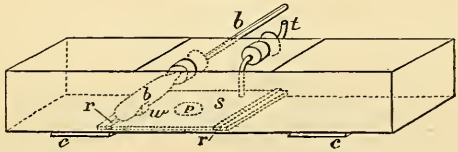
Julien's Stage Heating Apparatus.‡—In a paper on the examination of carbon dioxide in the fluid cavities of topaz, Mr. A. A. Julien thus describes the method employed in his investigations.

* Bull. Soc. Belg. Micr., vii. (1881) pp. xxxvii.-xl.
† Amer. Mon. Micr. Journ., ii. (1881) p. 238.
‡ Journ. Amer. Chem. Soc., iii. (1881) 12 pp. and 4 figs.

"The qualitative identification of carbon dioxide in the cavities of a mounted thin section of a mineral may be determined, at least with probability, after some experience, through various optical appearances and physical characteristics which have been often described. It is usually effected with certainty and ease, through the rapid and enormous expansion and ultimate disappearance, either of the liquid or of the gaseous bubble on the application of a gentle heat for a few seconds, such as that of a cigar, the heated end of a rod, or jet of hot air, or even a jet of the warm breath conveyed through a flexible rubber tube. When the slide and the section are thin, even the heat (37° C.) of the tip of one's finger applied for a few seconds to the bottom of the slide, without removal from the stage of the Microscope, may be sufficient to produce the characteristic phenomena, e. g. the contraction and disappearance of a bubble whose size is relatively small to that of the liquid in which it floats.

For the determination of the temperature of disappearance of the bubble, which may vary from 20° to 32° C., several forms of stage heating apparatus may be employed (those of Nachet, Beale, Fuess, Schultze, Chevalier, Dujardin, Ransom, Polaillon, Ranvier, and Vogelsang). In place of all these, a simple and inexpensive apparatus may be substituted, consisting of a miniature water-bath, in which are immersed the entire section and slide, the bulb of the thermometer, and the nose of the objective. It consists of a box of tinned copper (Fig. 51) (tinned iron is liable to rust), of length sufficient to project

Fig. 51.



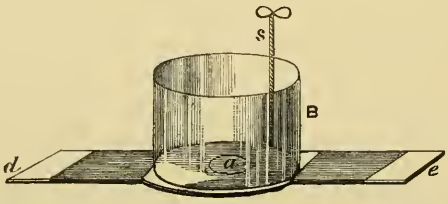
a few centimetres on either side of the stage of the Microscope employed; the one I use being 23 cm. in length, 4 cm. in width, and 3 cm. in depth. This is laid across the stage, separated from the metal by thin plates of cork *c c*, and is heated by a short wax taper (night-light) underneath either extremity. The slide *s* may rest upon the bottom, guarded from the metal by little rubber bands *r r* beneath its ends, and wedged firmly by a little wooden wedge *w* beneath the horizontal thermometer bulb *b*; or a thermometer with a ring-shaped bulb may be inserted, upon which the slide may rest directly, firmly attached by one or two slender rubber bands. The thermometer should be of guaranteed accuracy, with wide degrees, subdivided if possible, with a range which need not much exceed 20° to 32° C. The preparation is then covered by any pure and clear water, preferably filtered (distilled is unnecessary), to a depth of about 2 cm. A circular aperture in the bottom of the box, 18 mm. in diameter, is covered with glass attached by cement, and through this the light is thrown up from the mirror. The cavity to be examined is then care-

fully adjusted and focussed, a taper is lit, and the eye remains at the eye-piece until the critical point is reached. The glass tube *t*, with its point terminating just below the edge of the slide, is connected with the mouth during the experiment by a small rubber tube. As the temperature slowly rises, a constant current of small bubbles of the warm breath (whose temperature, 32°, only assists the operation) may be blown with little fatigue through the tube, to effect a thorough intermixture of unequally heated layers in the water stratum. The determination of the temperature of disappearance of the bubble is easily obtained within five minutes, and that of its reappearance in about the same time. A low-power objective may be carefully wiped if its anterior lens is dimmed by flying drops or rising vapour, when a high temperature is being attained; but it is best to insert the whole objective in a small, narrow glass beaker floating upon the surface of the bath over the preparation.

The apparatus, as thus constructed, may, the author thinks, be found the most convenient warm stage when high temperatures are required; but another still more simple, lately devised, will best serve for the determination of carbon dioxide, and consists of the following parts:—

First, a shallow glass tank (Fig. 52), with thin and well-annealed sides, of size sufficient to enclose the slide, upon which the thin

Fig. 52.



section is mounted. For this purpose I use a small chemical beaker B, with the thinnest bottom, and with its upper portion cut off, forming a thin round glass tank, about 6 cm. in diameter, and 3 cm. deep.

Secondly, a plate of copper or brass, like that used in Schultze's apparatus, or more simply one of the form represented in the figure *d e*. Its dimensions, proportioned to those of the beaker-tank and of the stage of a large Microscope, are as follows:—Length, 23 cm.; diameter at centre, 6·5 cm.; width of arms, 3·5 cm.; central aperture, 2·5 cm.; height of wire support, 13 cm.; thickness of plate, 1 mm. Each arm is wrapped in pasteboard, to prevent radiation, to the extent indicated by the shaded portion.

Thirdly, a delicate thermometer, with a small, short bulb bent at right angles to the stem, and a very fine column, to obtain sufficient sensitiveness to minute variations of temperature, and complete immersion of the bulb in the small volume of liquid employed in the bath. The scale need not exceed in range from about 20° to 32° C., the thermometer being of such length that when in position the scale from 27° to 30° C. may be on the level of the eye-piece of the Micro-

scope, and readily visible without motion of the head. Each degree of the column should be about a cm. in length, and subdivided to tenths.

Lastly, a pointed glass tube, with flexible rubber connection for blowing, and a wire support *s*, to receive both this and the thermometer, attached to the metal plate.

The latter is laid upon the stage of the Microscope, separated by thin plates of cork or a perforated piece of pasteboard; the tank, supplied with about 40 cc. of water, is placed over the central aperture *a*, and a taper beneath an extremity of one arm of the plate, and the apparatus is then ready for use in the way already described, the water of the tank being heated by conduction through the metal plate. The section of the mineral is best mounted upon a very thin slide, 45 mm. by 26 mm., and this is guarded as before with rubber bands, and held down by one or two little brass weights. Only a single taper is necessary for the low temperature required in the examination of carbon dioxide cavities, and even with this a temperature of 43° C. may be obtained in the bath within a few minutes. The disappearance of the bubble may be completed in less than five minutes, the taper being removed as soon as the rising column approaches within 2 or 3 degrees of the critical point, roughly determined by a previous trial. If two tapers are used, the temperature of the water may be raised to 55° in about 20 minutes, or even much higher, by the use of Bunsen gas burners. In summer the temperature of the atmosphere alone may be sufficient, especially if assisted merely by the current of warm breath, to obliterate the gas bubble. Its return may be readily caused, in a warm atmosphere, by adding from time to time a few drops of cool water to the bath, while the eye remains at the eye-piece, and a steady current of air is blown through the glass tube. Mounted slides used for such experiments must be labelled by writing with a diamond, or the paper label may be rendered waterproof by being coated successively with weak size and any transparent varnish, such as copal or shellac.

From these experiments it may be inferred that with this apparatus, which may be called the immersion warm bath, it matters little for most purposes what liquid, stand, or objective is employed; that water is preferable to glycerine, from its greater mobility, convenience, and lack of cost; that its bulk is immaterial, so long as the bulb of the thermometer is covered; that it is decidedly advantageous to immerse the anterior lens of every objective in the bath, to avoid the annoying interference with observation produced by the vibration of the surface, and by the necessity for repeated refocussing, when the objective is above the surface of the liquid; that careful determination on minute cavities, with high powers, carried on slowly to enable the preparation, objective, and thermometer to assume the same temperature, may be as accurate as any others; and that there is no difficulty in obtaining satisfactorily the two determinations within ten minutes to an approximation of about one-twentieth of a degree.

The descriptions of this method, and of these forms of apparatus, have been given in the more detail, inasmuch as they may be of

service in many other branches of thermal microscopy where the exact determination of the temperature applied is desirable, e. g. as suggested by Mr. A. H. Elliott, in the determination of the melting point of rare chemical substances, &c. For this purpose, the apparatus in Fig. 51 might be supplied with another tube, on the opposite side to those represented, through which might be inserted, beneath the objective, a small glass tube containing the substance to be examined, and thus immersed, by the side of the thermometer bulb, in the water, oil, paraffin, or other liquid which the circumstances may require for the bath."

Beck's Achromatic Condenser for Dry and Immersion Objectives.—In an earlier form of (dry) condenser (Fig. 53), Mr. Beck made use of a revolving front rotating a series of lenses mounted on a plane

Fig. 53.

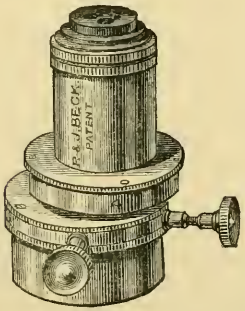
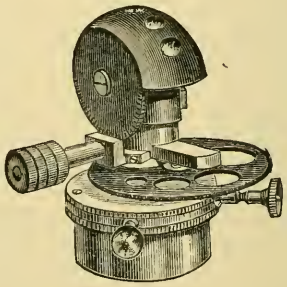


Fig. 54.



surface over the back combination. This plan was, however, only available for a dry condenser; if used for immersion, the connecting fluid would be drawn away by capillary attraction.

To avoid this inconvenience, the new form shown in Fig. 54 has been devised, the movable series of front lenses being mounted in a segment of a sphere and rotated by a milled head acting on a pinion and toothed disk. The first lens, when brought over the back combination, has a low angle, and is intended for use without fluid for histological objects. By revolving the diaphragm, the angle can be varied from 35° to 7°. The next is a full aperture lens with which, by revolving the diaphragm, the angle can be varied from 180° downwards. The third lens, with full aperture of diaphragm, has an angle of 110° in glass = 1·25 N.A., and is truncated, cutting out the central rays. The fourth lens has also an aperture of 1·25, and is truncated, so as to stop out all rays up to 180° in air. The fifth is similar to No. 3, but the periphery is painted over, so as to allow pencils only at right angles to pass.

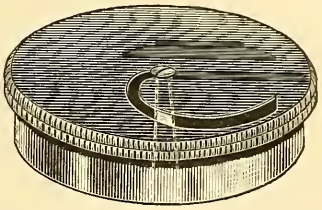
Pennock's Oblique Diaphragm.*—Mr. E. Pennock suggests an adaptation of Mr. Mayall's spiral diaphragm,† to be attached to the

* Amer. Journ. Micr., vii. (1881) p. 161 (3 figs.).
† See this Journal, i. (1881) p. 126.

under side of the stage, for shutting off all light except a small pencil from the mirror. It may be mounted in either of two forms: the one to fit into the usual tube, which, in the cheaper Microscopes, is attached to the under side of the stage, the other to screw directly into the stage aperture.

The device is shown in Fig. 55. The milled edge serves to rotate the plate with the spiral slot over the radial slot (shown by dotted lines), thus giving varying degrees of obliquity.

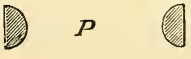
Fig. 55.



Stereoscopic Vision with Non-stereoscopic Binocular Arrangements.—It will be remembered that in his paper "On the Conditions of Orthoscopic and Pseudoscopic Effects in the Binocular Microscope," * Professor Abbe pointed out that an orthoscopic (stereoscopic) effect was produced if the *inner* halves of the "Ramsden circles" just above the eye-pieces were shut off by diaphragms (that is like O, Fig. 56), and a pseudoscopic effect when the *outer* halves were so dealt with (that is like P, Fig. 57).

Fig. 56.

Fig. 57.



Dr. A. C. Mercer, of Syracuse, U.S.A., points out that this explanation solves a difficulty which has perplexed many microscopists, and has hitherto remained unexplained. Powell and Lealand's high-power binocular is essentially non-stereoscopic, and theoretically ought not to give any appearance of relief to the objects. It has nevertheless been frequently observed that a distinctly stereoscopic effect was obtained, and this was attributed entirely to the imagination of the observer. Dr. Mercer, however, shows that it is a true and not an illusory effect, and that it depends upon the extent to which the eye-pieces are separated.

Fig. 58.

When the eye-pieces are at such a distance apart that the Ramsden circles correspond exactly with the pupils of the eyes, centre to centre (Fig. 58), the object appears flat. If, however, they are racked down so as to be somewhat nearer together, the centres of the pupils fall upon the *outer* halves of the Ramsden circles, and we have the conditions for orthoscopic effect; while if they are racked up so as to be more separated the centres of the pupils fall on the *inner* halves and we have pseudoscopic effect.

This is quite in accordance with what takes place in the use of

* See this Journal, i. (1881) pp. 203–11 (3 figs.).

eye-pieces, the halves of which are actually covered with diaphragms, for when the inner halves are cut off the tubes naturally require to be racked down to diminish the separation of the eye-pieces, and in the converse case to be racked up; Dr. Mercer also satisfied himself by experiment as to the validity of his deductions by observing sugar pills pushed half-way through holes in black cards, the pills being marked with cross marks in pencil to increase the effect. They could be made to appear convex, concave, or flat, according to the position of separation of the draw-tubes.

We have, for simplicity, referred to the covering up of *both* halves of the eye-pieces, but it is not of course necessary to cover up more than *one*.*

In order to obtain the *best* stereoscopic effect the halves (or one of the halves) of the eye-pieces of the Powell and Lealand or other similar binocular arrangements should be actually shaded by diaphragms so as to aid in properly centering the pupils, but Dr. Mercer's object is to show that the effects observed with ordinary eye-pieces are explicable upon proper theoretical principles, and so to relieve those observers who have insisted upon the existence of true orthoscopic effects in such cases, from the reproach which has unjustifiably attached to them on account of their supposed abnormal and unscientific development of a power of drawing upon their imagination.

[The Bibliography for the period intervening between that contained in the Journal of October 1880 and the end of 1881, will be found in the Appendix to the next volume.]

Abbe's Experiments on the Diffraction Theory of Microscopical Vision.
[General Remarks.]
Journ. of Sci., IV. (1882) pp. 118–9.

Acme Microscopes. *Amer. Natural.*, XVI. (1882) p. 261.

American Society of Microscopists.
[Review of Proceedings for 1881, and remarks on the meeting at Elmira for 1882.]
The Microscope, I. (1882) pp. 175–7.

Angular Aperture.
[Letter by 'Akakia,' describing Dr. Robinson's method of measurement.]
Engl. Mech., XXXIV. (1882) pp. 454–5.

Brownell, J. T.—A much-needed stop.
[Suggestion for a "thumb-screw" to prevent Microscopes at Soirées being focussed too low to the injury of the slides.]
Amer. Mon. Micr. Journ., III. (1882) p. 39.

Bulloch's New "Congress" Stand.
Amer. Mon. Micr. Journ., III. (1882) pp. 9–13 (2 figs.).

Carlisle Microscopical Society—Inaugural Address by the President, Canon Carr. *North. Microscopist*, II. (1882) pp. 17–19.

Carr, E.—*See* Carlisle.

Cheap Microscopes.
[Letter by C., advocating the encouragement of their purchase and display, and further discussion by Welborn, G., Ollard, J. A., Cooper, C. C., F., J., E. Holmes, A., E. C., and Medehanstade.]
Engl. Mech., XXXIV. (1882) pp. 470, 495–6, 520–1, 545.

Cox, J. D.—Prof. Rogers' Micrometers.
Amer. Mon. Micr. Journ., III. (1882) pp. 23–5.

---

* See this Journal, i. (1881) p. 211, Fig. 38.

Crisp, F.—Notes sur l'Ouverture, la vision microscopique et la valeur des objectifs à immersion à grand angle. (Notes on Aperture, Microscopical Vision, and the value of wide-angled Immersion Objectives)—*contd.*

[Transl. of paper I. (1881) pp. 303–60.]

Journ. de Microgr., VI. (1882) pp. 44–8, 91–5 (13 figs.).

Curtis, L.—New ½-in. Gundlach Objective of 100°.

Amer. Mon. Micr. Journ., III. (1882) pp. 19–20.

The Microscope, I. (1882) pp. 194–5. *Science*, III. (1882) pp. 19–20.

Davis, G. E.—The limiting Diaphragm or Aperture Shutter.

North. Microscopist, II. (1882) pp. 13–14 (2 figs.) p. 75.

Amer. Mon. Micr. Journ., III. (1882) pp. 49–50.

Engl. Mech., XXXV. (1882) p. 25 (2 figs.).

" " A Visit to an Objective Factory.

[W. Wray's, Highgate.]

North. Microscopist, II. (1882) pp. 21–4.

Dippel, L.—Abbe's Camera Lucida.

Bot. Centralbl., IX. (1882) pp. 242–3 (1 fig.).

Forrest's (H. E.) Compressorium. *North. Microscopist*, II. (1882) p. 51.

Griffith, E. H.—The Griffith Cell. *Amer. Mon. Micr. Journ.*, III. (1882) p. 9.

Guillemin, A.—Le Monde Physique. Tome II. La Lumière. (The Physical World, Vol. II., Light.)

[Contains a Chapter on the Microscope (20 pp., 20 figs., and 3 coloured Plates), a section on Microscopical Photography (7 pp. and 5 figs.), and one on the Applications of Photography to the Arts and Physical and Natural Sciences, 4 pp. and 3 figs.]

8vo, Paris, 1882. 668 pp., 353 figs., and 26 plates.

Hitchcock, R.—Large and Small Microscopes.

[Rejoinder to C. Stodder.]

Amer. Mon. Micr. Journ., III. (1882) pp. 16–7.

" " The Microscopist.

[Further reply as to Stowell's 'The Microscope.']

Amer. Mon. Micr. Journ., III. (1882) pp. 18–9.

Holmes, E.—Drawing, &c., from the Microscope.

[Recommends Mr. Dallinger's plan of drawing on finely smoothed glass.]

Sci.-Gossip, 1882, p. 39.

Journal of the Royal Microscopical Society for 1881.

[Note on the small number of original contributions to the 'Transactions' and the reason for it.]

Journ. of Sci., IV. (1882) p. 56.

Microscopical Societies.

[Note as to an intended alteration in the printing of their Reports.]

Amer. Mon. Micr. Journ., III. (1882) pp. 14–5.

Miles, J. L. W.—Dark-field Illumination by the Bull's-eye Condenser.

[Placed beneath the stage, plane side uppermost, with a spot of black paper in the centre.]

North. Microscopist, II. (1882) p. 39.

" " Substitute for a Revolving Table.

[A piece of table oil-cloth, 15 in. sq., the cloth side turned to polished and the oil side to painted tables.]

North. Microscopist, II. (1882) pp. 39–40.

Nachet, C. S., Death of. *Journ. de Microgr.*, VI. (1882) pp. 3–4.

Objectives, Verification Department for.

[Tabular results of measurements of objectives.]

North. Microscopist, II. (1882) pp. 7, 24, 59.

Ollard, J. A.—Mr. Kitton's Illumination.

[Commending same, and recommending the use of distilled filtered water, filling the globe full to prevent a shaky light, and not using too much sulphur chlorate (first filtered).]

Sci.-Gossip, 1882, p. 47.

Pocklington, H.—The Microscope at Home.

Engl. Mech., XXXIV. (1882) pp. 538–9, 560–1.

Pringsheim's Photochemical Microscope.
Quart. Journ. Micr. Sci., XXII. (1882) p. 86.

S., H. C.—An "English Mechanic" Microscopic Club.
Engl. Mech., XXXIV. (1882) p. 615.

Salt's and Swift-Brown Microscopes.
Engl. Mech., XXXIV. (1882) p. 463 (3 figs.).

Schröder, H.—Ueber Projektions-Mikroskope. (On Projection Microscopes.)
Centr. Ztg. f. Optik u. Mech., III. (1882) pp. 2–4, 15–17 (1 fig.).

Shipperbottom, W.—Improvements in Photo-micrography.
North. Microscopist, II. (1882) pp. 48–9 (2 figs.) p. 75.

„ „ Use of the 'Aperture-shutter' in Photo-micrography.
North. Microscopist, II. (1882) p. 75.

Slow motion for Micro. Stand.
[Letter by 'Sunlight,' describing the ordinary form used with the 'Jackson Model.']
Engl. Mech., XXXIV. (1882) p. 457 (1 fig.).

Stallybrass, H. M.—Microscopic Illumination.
[Approval of F. Kitton's Hollow Glass Sphere Method, I. (1881) pp. 112-3—by adding a few drops of pure sulphuric acid, cloudiness of the liquid is prevented.]
Sci.-Gossip, 1882, p. 64.

Stodder, C.—Large vs. Small Stands.
[Reply to R. Hitchcock's Criticism.]
Amer. Mon. Micr. Journ., III. (1882) pp. 13–4.

Suffolk, W. T.—On Microscopical Drawing. *Sci.-Gossip*, 1882, pp. 49–50.

Tissandier.—Microscopic Photography in Paris.
[Abstr. of article from 'La Nature.']
Engl. Mech., XXXIV. (1882) p. 561.

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

Injection of Invertebrate Animals.*—G. Joseph uses filtered white of egg, diluted with 1 to 5 per cent. of carmine solution, for cold injections. This mass remains liquid when cold; it coagulates when immersed in dilute nitric, chromic or osmic acids, remains transparent, and is sufficiently indifferent to reagents. A mass of similar properties is made of glue liquid when cold, coloured with the violet extract of logwood reduced with alum. Injection is effected in the case of worms (leech and earthworm), by way of the ventral or dorsal vessel, with large Crustacea by the heart or the ventral vessel which lies in the sternal canal.

In many cases, especially when lacunar spaces have to be filled, useful preparations are obtained by natural injection (*auto-injection*, or *autoplerosia*). Natural injection of Medusæ is effected without injuring the vessels; in the case of Crustacea, Insects, and Mollusca, through a slit with an opening at the side remote from it. Medusæ are laid in a glass vessel, with the bell downwards, and a bell-jar ending in a narrow tube above is placed over it and made air-tight; after the Medusa is covered with the injection-mass, the air in the glass is exhausted, and the sea-water running out by slits in the lower side of the annular canal the coloured fluid runs in.

* Ber. naturw. sect. Schles. Ges., 1879, pp. 36–40. Cf. Zool. Jahresber. Neapel for 1880, i. pp. 45–6.

In the case of leeches and large species of earthworms, the natural injection is made from the ventral sinus. In all cases a glass tube is used, with a finely drawn-out point. The injection is complete when the injection issues from the counter-opening.

Animals to be injected alive are kept quiet by cold (laying upon ice). Besides the animals mentioned, large caterpillars, beetles, Libellulid larvæ, locusts, &c., have served as objects for injection; the glass cannula is introduced into the posterior end of the dorsal vessel, and the counter-opening is made in the ventral vessel, and *vice versâ*.

Cold Injection Mass.*—A. Wikszemski describes a modification of Pansch's method:—Thirty parts by weight of flour and one of vermilion are mixed while dry, and then added to 15 parts by weight of glycerine and subjected to a continuous stirring until of a homogeneous viscous consistency; then 2 parts of carbolic acid (dissolved in a little spirit) are added to it, and finally 30 to 40 parts of water. This injection mass is specially adapted for subjects already injected with carbolic acid (in the proportion of $1\frac{1}{2}$ part by weight each of carbolic acid, spirit, and glycerine to 20 of water); 24 hours are allowed to elapse between the two injections. It is a good thing to introduce a little dilute injection first.

Staining with Saffranin.†—According to W. Pfitzner, staining with saffranin is most successful with chromic acid preparations which have been entirely freed from the acid, less so with substances hardened in picric acid; the only tissues suited to it are those which very readily take up colour, and these must be cut extremely thin. The sections are transferred to the staining fluid (1 part saffranin, 100 absolute alcohol, 200 distilled water) from distilled water, are again placed in distilled water after a few seconds, and then into absolute alcohol, from which they are removed at the right moment (i. e. when the nuclei are properly stained) to dammar varnish. The advantage of staining with saffranin is that it affects the nuclei exclusively. Dr. M. Flesch‡ remarks that the advantage claimed by Pfitzner for saffranin has been shown by Hermann to be shared with it by other aniline dyes when applied in the same manner.

Staining with Silver Nitrate.—Staining with nitrate of silver is very difficult to effect in the case of marine organisms, owing to the abundance in which chlorides occur in them. R. Hertwig § meets this difficulty by washing the animals (after hardening in osmic acid) with distilled water until the water used for washing gives but a very slight precipitate with solution of silver nitrate, and then allowing a 1 per cent. solution of the nitrate to act for 6 minutes.

* Arch. f. Anat. u. Entwick., 1880, pp. 232–4.

† Morph. Jahrbuch, vi. (1880) p. 469. Cf. Zool. Jahresber. Neapel for 1880, i. p. 43.

‡ Ibid., pp. 43–4.

§ Jen. Zeitschr., xiv. (1880) p. 324.

C. Golgi,* in studying the peripheral and central nervous fibres of the spinal cord, exposes the nerves to the action of osmic acid, chromic salts, and silver nitrate, according to certain methods of combination. For example, a nerve is removed with care from a freshly killed animal (rabbit), and placed in a mixture of 10 parts of a 2 per cent. solution of potassium bichromate with 2 parts of 1 per cent. osmic acid solution. After about an hour the nerve is divided into smaller pieces of ½ to 1 cm. in length, and again placed in the solution, where it is left some hours longer (it must be examined every 3 hours), and finally is placed for not less than 8 hours in 0·5 per cent. solution of nitrate of silver, and then mounted in dammar varnish in the ordinary way. Better preparations are produced by placing nerves which have been exposed—in the case of peripheral nerves 8 hours, of central nerves 10 to 15 days—to the action of bichromate of potash, then from 12 to 24 hours to silver nitrate, and mounted in dammar varnish without previous exposure to the light.

Staining Tissues treated with Osmic Acid.—Damaschino, in a communication † to the Société de Biologie, advocates osmic acid in the form of a solution of 1 per cent. for human spinal cord divided into lengths of 1 cm., and for the spinal cord of smaller animals treated entire; he afterwards hardens in absolute alcohol. If it is then not sufficiently hard, the preparation is saturated with gum before being placed in the alcohol; the sections, which are penetrated with gum, are transferred unstained to Canada balsam without being previously freed of gum by means of water.

Referring to this communication (which contains no really new point), L. Malassez ‡ remarks on the difficulty of staining substances which have been treated with osmic acid, and for this reason he first stains the sections with other staining matters, and then exposes them to the action of osmic acid, and this in such a way as to allow only the vapour of the solution of acid to act. He claims to have obtained admirable results by this method, since in this way all the properties of the osmic acid come into play without affecting the other staining substances.

R. Hertwig § placed the animals (Ctenophora) examined by him in a 0·05 per cent. solution of osmic acid, to which in some cases he added acetic acid solution of 0·2 per cent. for from 5 to 15 minutes, according as he wished to investigate the epithelium or the elements of the gelatinous tissue; he then stained with carmine and finally preserved in dilute glycerine.

Mounting the "Saw" of the Tenthredinidæ.||—Mr. P. Cameron describes his method of mounting and preserving the "saw" of the Tenthredinidæ for microscopical examination, a method which can be applied to microscopical mounting generally.

* Arch. per le Sci. Med., iv. (1880) pp. 221–46 (1 pl.). Cf. Zool. Jahresber. Neapel for 1880, i. p. 44.

† Gazette medic. Ann., li. (1880) p. 636. ‡ Ibid., p. 637.

§ Jenaisch. Zeitschr., xiv. (1880) p. 315. Cf. Zool. Jahresber. Neapel for 1880, i. p. 41.

|| Trans. Entomol. Soc. Lond. 1881, pp. 576–7.

With fresh specimens the saws can be extracted by pressing the abdomen, when they will be protruded and readily extracted. With old specimens it can be done equally well by placing the insect in a relaxing-dish, or, more promptly, by steeping it in water for a day, when they can be taken out in the same way as with fresh insects, the only difficulty being experienced with insects full of eggs. For their better examination the four pieces composing the ovipositor proper should be separated; after which they must be steeped in turpentine for a day or two so as to get rid of air. This is best done by enclosing them in a small folded piece of paper; and, if they be properly labelled, many different preparations can be placed in the turpentine-bottle together.

Next take a sheet of fine Bristol board, and cut it up into pieces, say 12 lines × 9 lines, and punch at one end a round or square hole, four or five lines across. On the lower side of this fasten, by means of Canada balsam dissolved in benzine, a cover-glass. When this has dried fill up half the cell thus formed with the same composition, spreading it as evenly as possible, and in it arrange your preparation. Put it aside for some hours in a place where no dust will fall on it, then fill the cell with enough balsam to run over the edge of the cell, place a cover-glass over it, and press it down. All that now requires to be done is to allow the preparation to dry, taking special care to keep it flat, to label it, and stick a pin through the card, by means of which it is fixed in the cabinet alongside the insect from which the part was taken. To examine it under the Microscope, all that is necessary to do is to place an ordinary glass slide across the stage, and put the card on it, in doing which it is not necessary to take the pin out of it if a short pin be used.

The great advantage of this plan for entomological purposes is that it does not necessitate the formation of two distinct collections, which must be the case if dissections are mounted on glass slides, which cannot of course be placed alongside the insects. Besides that, it is cheaper, more expeditious, and safer; for the cards are so light that no injury comes to them from falling, or getting loose in the box. If desired, a coloured ring can be put round the top object-glass by the turntable in the ordinary way, but except for ornament, is not necessary. The author usually prepares two or three dozen of the cards with one cover-glass on at a time, so as to have them ready for use. The object of letting the dissections harden in the cell, half filled with balsam, is that three or four separate parts may be arranged in the most suitable way in the same cell without fear of their being disarranged or injured when the top cover-glass is put on, while both might happen if the whole operation was performed at once.

For the examination of the saws, a quarter-inch objective is the best, the teeth, in some cases, are so fine that they are apt to be overlooked if lower powers are used.

Mounting Butterfly-scales.*—Dr. D. H. Briggs recommends the following process. Dissolve 1 part of Anthony's "French Diamond

* Amer. Mon. Micr. Journ., ii. (1881) p. 227.

varnish" in 2 parts of pure benzole. Apply a drop or two of the solution to a slide, and in a few seconds, or as soon as the varnish has set, press the wing of the butterfly gently upon the slide, and then carefully lift it away. The scales will be found transferred to the slide in their beautiful natural arrangement * on the wing. Make a shallow cell around the mounting and apply the cover-glass. Canada balsam must not be used, as it disarranges the object.

Imbedding Ctenophora.†—For imbedding Ctenophora (for the most part after hardening in osmic acid), R. Hertwig employs gum-glycerine very largely diluted with water; it is allowed to remain in contact with the air, with the substance to be cut immersed in it, until it has acquired the consistency of a stiff syrup. Shrinkage of the gelatinous tissue is to some extent obviated by this plan, owing to the slowness with which it absorbs the constantly thickening gum-glycerine.

Staining Living Protoplasm with Bismarck Brown.‡—L. F. Henneguy having treated *Paramœcium aurelia* with an aqueous solution of aniline brown (known in commerce as "Bismarck brown"), was surprised to see them assume a rather intense yellow brown colour, and move rapidly about in the fluid. The colour first appeared in the vacuoles of the protoplasm, and then it invaded the protoplasm itself. The nucleus generally remains colourless, and thus becomes more visible than in the normal state. Infusoria thus coloured were kept for nearly fifteen days. If a yellow-tinted *Paramœcium* is wounded or compressed so as to cause a small quantity of the protoplasm to exude, it is seen that it is really the protoplasmic substance which is coloured. All Infusoria may be equally stained with Bismarck brown, but no other aniline colours employed by the author exhibited the same property, they only stained the Infusoria after death, and some of them are in fact poisonous.

As it is generally admitted that living protoplasm does not absorb colouring matters, and that Infusoria are essentially composed of protoplasm, M. Henneguy endeavoured to ascertain whether protoplasm in general, of animal or vegetable origin, behaved in the same way in the presence of aniline brown.

A tolerably strong dose of Bismarck brown was injected under the skin of the back of several frogs. After some hours, the tissues were uniformly tinted a deep yellow, the muscular substance especially had a very marked yellow tint. The frogs did not appear in the least incommoded.

Small fry of trout placed in a solution stained rapidly and continued to swim about.

Finally, a guinea pig, under whose skin some powder of Bismarck brown had been introduced, soon presented a yellow staining of the buccal and anal mucous membranes and of the skin.

Seeds of cress sown on cotton soaked with a concentrated solution

* It should be observed that the scales will have their under sides uppermost, which is not the "natural arrangement."—Ed.

† Jen. Zeitschr., xiv. (1880) pp. 313–14.

‡ Rev. Internat. Sci. Biol., viii. (1881) pp. 71–2.

of the Bismarck brown sprouted, and the young plants were strongly stained brown; but on crushing the tissues and examining them under the Microscope it was ascertained that the protoplasm of the cells was very feebly coloured; the vessels on the contrary showed a very deep brown staining up to their termination in the leaves.

The mycelium of a mould which had been developed in a solution of Bismarck brown, was clearly stained after having been washed in water, whilst it is known that the mycelium which frequently forms in coloured solutions, picrocarmine, hæmatoxylin, &c., remains perfectly colourless.

Other aniline colours injected under the skin of frogs stained the fundamental substance of the connective tissue as deeply as did the Bismarck brown; but the cells of the muscular substance remained perfectly colourless.

The author concludes therefore that Bismarck brown possesses the property of colouring living protoplasm both in plants and animals.

Preservation of Infusoria and other Microscopical Organisms.* —A. Certes, in a note supplementary to his previous communications,† says that five years' experience has only confirmed his view of the efficacy of osmic acid and iodized serum for preparing Infusoria; but sometimes, notwithstanding precautions, the animalcules become black and opaque from a too prolonged action of the osmic acid; or, especially when iodized serum or lemon juice has been employed as a fixing reagent, mouldiness attacks the preparations either because the bottles have been badly corked or precautions for excluding germs from the preparations have been neglected.

It will be found however that ammonia ($\frac{1}{3}$) will clear preparations blackened by osmic acid, and thus the always dangerous use of cyanide of potassium will be avoided; but it is necessary to watch the operation with care, the time of immersion in ammonia being essentially variable according to the thickness of the animalcules and the quantity of osmic acid in excess.

With regard to mouldiness, it is possible, with certain precautions, to filter the liquid which holds the altered gatherings in suspension, upon pure glycerine. To increase the hardening of the animalcules, the liquid in excess is first removed and replaced by strong alcohol, by picrocarmine, or by green picrate of methyl, it is then poured gently on the glycerine, which, owing to its density, remains at the bottom of the vessel, but previously the liquid to be filtered must be briskly agitated so as to disengage the animalcules caught by their cilia in the matted fibres of the moulds.

The Infusoria thus detached fall first to the bottom. The patches of mycelium which offer more surface and consequently more resistance do not sink, or sink much more slowly. Advantage is taken of this circumstance to decant the liquid with a pipette, and to collect from the bottom of the vessel the Infusoria which, being isolated, are best adapted for observation.

* Bull. Soc. Zool. France, vi. (1881) pp. 36–37.

† See this Journal, ii. (1879) p. 331; iii. (1880) p. 847.

In default of osmic acid, filtered lemon juice may be employed; but it is necessary to follow the operation closely in order to check at the right moment the action of the reagent, which should be employed in a strong dose, and which consequently would in the long run injure the extremely delicate tissues of the Infusoria.

Impregnation by chloride of gold is generally successful after the action of lemon juice. Often, however, the pulverulent deposit gets entangled in the cilia of the Infusoria and obscures observation. Filtration upon glycerine reduces this inconvenience.

In conclusion, M. Certes indicates the process which he considers best for preserving the intestines of Batrachians with the object of examining the parasites they enclose. Having tied the intestine at the two extremities, it is washed in distilled water and placed in a solution of osmic acid (1–1000). After twenty-four hours' immersion, this solution is replaced by strong alcohol or by glycerinated water. Under these conditions, Opalinæ and other inhabitants of the rectum of Batrachians may be kept undistorted till they can be examined.

In a subsequent paper,* the author mentions that he has met with difficulties in the latter process. When the walls of the intestine are too thick or are too much filled by food, there is so great an absorption of the reagent that the Opalinæ and other parasitic Infusoria are dissolved under the action of the liquids of the organism or by the preservative liquids. He thinks it will be found sufficient to increase the strength of the osmic acid solution, and to slit the intestine longitudinally.

Staining the Nucleus of Infusoria.†—A. Certes has already shown‡ the property possessed by cyanin or chinolin blue (and Bismarck brown) of staining living tissues, the nucleus of Infusoria not, however, appearing to be coloured either during life or even several hours after death. Dr. Henneguy having pointed out to him the analogous properties of a methyl violet, known as dahlia, M. Certes has repeated his experiments with several violets, and has found that, notwithstanding their very similar chemical composition, their action varies considerably. Some are always toxic, and for all species of Infusoria. Others only stain certain species out of those living in the same liquid. Others—and this is the special object of his further communication—stain the nucleus of living Infusoria, and more strongly than the rest of the protoplasm. In general with the violets in question, the cilia are always stained, and the liquid of the contractile vacuole often participates (so far as could be judged) in the general colouring.

The phenomena of selection of the colouring matter in regard to the nucleus was clearly established, at first with B B B B B violet on *Balantidium* from the intestine of *Bombinetor igneus*, and then on *Paramecium*, *Vorticella*, &c., with the same and dahlia violet. Gentian

* Bull. Soc. Zool. France, vi. (1881) p. 228.
† Ibid., pp. 226–7.
‡ See this Journal, i. (1881) pp. 527, 694.

and 50 N violet on the contrary, notwithstanding their great colouring power, did not exhibit any selective action with the nuclei.

As to the greater or less resistance which very closely allied species oppose to the action of the same reagent, the author mentions that he has found small species of *Paramecium* continue to live indefinitely without staining, whilst all the others of equal or greater size had entirely disappeared from the same liquid.

The staining of the nucleus of the Infusoria is, the author (erroneously) says, "a new fact, and it is so much the more interesting to note that the most recent researches demonstrate the preponderating part which the nucleus plays in the phenomena of nutrition and reproduction, and, if one may so say, in the government of the life of unicellular organisms."

Aniline Dyes and Vegetable Tissues.*—Mr. J. M. Macfarlane, in a paper on the action of some aniline dyes on vegetable tissues, records some of the more important methods arrived at.

"*Staining of Laticiferous Vessels.*—Every botanist must have experienced the difficulty of obtaining thoroughly good preparations of laticiferous vessels. Sachs recommends boiling in dilute potash; but, while tolerably good sections may be obtained in this way, several difficulties are encountered. The points to be aimed at in preparing this tissue are (*a*) the coagulation of the latex, so that it may continue to fill the vessels; (*b*) the staining of the cut sections, so that the vessels may be distinctly differentiated from the surrounding cellular substance; (*c*) the successful mounting of these, so that the tint may be permanently retained. The first part of the process is best accomplished by obtaining, for example, a large and entire root of *Scorzonera*, so that extensive bleeding may be prevented. A suitable sized bottle being filled with alcohol, pieces of the root from one to two inches in length are cut and immediately placed in it. Coagulation of the latex is quickly effected. After lying thus for a week or longer, sections are cut with the hand, or by aid of a microtome. The second point is most important, and on its success the beauty of the object will depend. The sections are placed in alcoholic solution of saffranine, obtained by dissolving 1 part of this dye in 800 parts spirit. After 18 to 24 hours, they are removed from the stain and decolorized by washing repeatedly in spirit. It will be found that the stain leaves the cellular tissues rapidly, while it is retained by the latex in the vessels. We will notice, lastly, the best method for mounting these. While such media as balsam or dammar would cause unnatural contraction, fluids, on the other hand—especially acetic acid solution—are apt to act slightly on the dye. I have found nothing to equal glycerine jelly, as it preserves the tint and is easily worked.

Double Staining of Stems, &c.—The dyes usually recommended for this purpose are rosaniline and iodine green; but saffranine and emeraldine are preferable, as the former is, for vegetable tissues, a

* Trans. Bot. Soc. Edin., xiv. (1881) pp. 190–1.

most permanent dye, while the latter imparts a brighter colour than iodine green.

Staining of Cell Contents.—While some aniline dyes act specially on the thickened walls of cells, others are extremely useful for demonstrating the structure of protoplasm. Heliocin and naphthaline in this respect are valuable; and eosin, though not an aniline dye, is equally so. For epidermis cells and ordinary parenchyma the latter is preferable. It is best prepared by dissolving 1 part in 1200 of alcohol. The specimens are allowed to lie for 5 minutes in the stain, and are then washed in water and mounted in a cell with acetic acid, or Goadby's solution. The cells of *Spirogyra*, however, have their minute structure beautifully revealed by treatment with heliocin. The following is the best method to adopt:—Decolorize the filaments by placing them in a 1 per cent. solution of chromic acid for two days; add then to the solution 1 part in 2000 of the dye, and shake slightly, so that it may dissolve equally. In an hour the filaments will be ready for examination or permanent preparation."

Indol as a reagent for Lignified Cell-membrane.*—Max Niggl gives a *résumé* of the observations of previous observers on the use of indol as a reagent for testing the lignified condition of the cell-wall, supplemented with additional observations of his own.

If a section of a branch is treated with dilute hydrochloric acid, and an alcoholic solution of indol added, the lignified cells acquire a beautiful cherry-red colour, while the non-lignified cells of the cambium, cortex, and epidermis remain uncoloured. The use of hydrochloric acid is, however, for several reasons inconvenient, and the author prefers the use of dilute sulphuric acid of sp. gr. 1·2 (1 vol. English sulphuric acid with 4 vols. water). The best mode of procedure is as follows:—Pure indol is dissolved in warm water. The section is moistened with a drop of this solution, and covered with a cover-glass. The indol is then removed by blotting-paper, and a drop or two of the dilute sulphuric acid run in. Wherever this comes into contact with the indol which permeates the section, the lignified cell-walls take a beautiful cherry-red, the sclerenchymatous cells even a purple colour, which is retained by the preparation for a considerable time. If the acid used is too concentrated, or the excess not removed, the colour passes, after some weeks, to brownish red.

Among Thallophytes, Niggl found, by the use of this reagent, no trace of lignification in algæ, or in the majority of fungi; it was only present in the cortical and medullary layers of a few lichens.

In vascular plants the cuticle is as a rule uncoloured by indol. In many plants (contrary to the statement of other observers), the walls of the guard-cells of stomata appear to be strongly coloured. This is also the case with cork, except that in older cork-cells the middle lamella gives indications of lignification. With very few exceptions collenchyma also shows no colouring with indol. The author enters into considerable detail with regard to the colouring of the various elements of parenchyma, and of sclerenchyma. A charac-

* Flora, lxiv. (1881) pp. 545–59, 561–8.

teristic property of tracheids is the very early and strong development of lignification in their cell-walls. In the walls and disks of sieve-plates, on the contrary, indol produces not the least reaction.

Protoplasm acquires a slight rose-colour with indol and sulphuric acid, but no differentiation of the nucleus is observable; the contents of the stinging hairs of the nettle assume throughout a red colour. No effect is produced on the contents of resin-passages.

The author concludes that the red colour imparted by indol and sulphuric acid is an unfailing test for the lignification of the cell-wall.

English's Method of Preserving Hymenomycetes and Wild Flowers.*—When we mention that the price of this book is 7*s.* 6*d.*, and that each of the two sections only contains as much matter as two columns of the *Times*, it will be obvious that it cannot be abstracted without seriously interfering with its proprietor's expected profits. We therefore confine ourselves to generalities.

For Fungi, a double preservative compound is used, formed of British farina, methylated spirit and corrosive sublimate, oxalic acid and sulphur. There is also an "adjunct to the process," formed of plaster of Paris and sulphur, for imbedding the specimens after the preservative has been applied. The final process consists of varnishing. Waxing and colouring can also be adopted if desired, for which directions are given.

The process for flowers (which has only been tried for two years) is to imbed them in plaster and lime as an absorbent, and gradually heat them up to 100° F. After dusting, they are varnished with similar varnish to that used for Fungi.

Mounting Salicine Crystals.†—Dr. D. H. Briggs recommends the following process:—

Clean the slide perfectly with ammonia, then rinse with hot water and cleanse with ammonia again.

Add to the salicine from one-tenth to one-twentieth its weight of pulverized gum arabic. Make a nearly saturated solution of the salicine and gum in distilled water, or in ice-water heated to the boiling point, and carefully filter the solution. Heat the solution to 100° C. in the beaker, and pour the hot solution upon a still hotter (*sic*) slide, and drain off. Only a hot solution will give bright colours.

Hold the slide, and watch for disks of crystals. As soon as these appear, place the slide on a cold iron block.

A rim is put on the crystals by another heating over the lamp and another cooling on the iron. Without delay heat a drop of Canada balsam on a circular cover-glass, and apply the cover to the crystals, and fasten with white zinc cement on a turntable.

The process described, if followed with care, will yield most

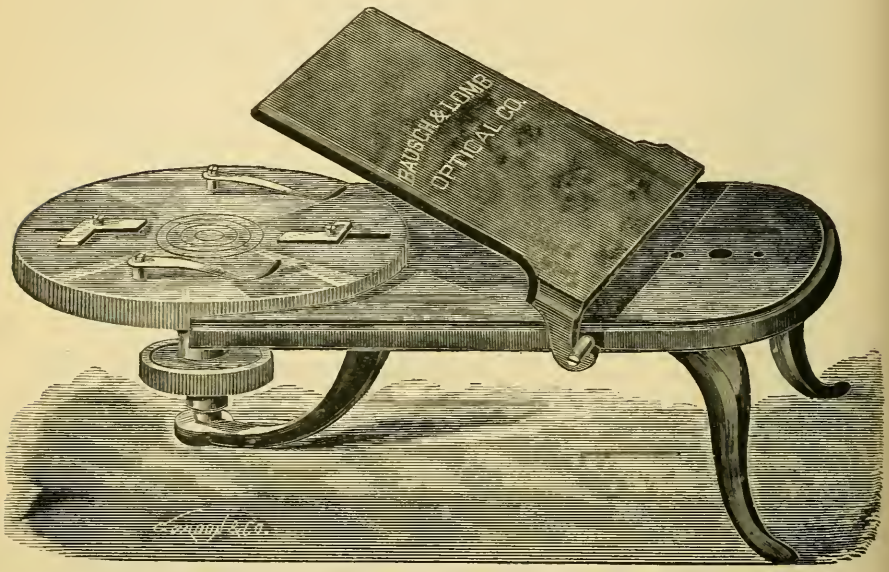
* English, J. L., 'A Manual for the Preservation of the Larger Fungi (Hymenomycetes) in their natural condition, by a new and approved Method; also a new Process for the Preservation of Wild Flowers.' viii. and 41 pp. 8vo. Epping, 1882.

† Amer. Mon. Micr. Journ., ii. (1881) pp. 227–8.

excellent results; perfect rosettes of crystals can be readily obtained, giving brilliant effects with polarized light.

Bausch and Lomb Turntable.—We have no description of this turntable, but so far as we can gather from the drawing (Fig. 59), it

Fig. 59.



differs from other turntables in being provided with a hand rest, which can be adjusted to any convenient height.

Griffith Cell.*—Mr. E. H. Griffith places the slide on a turntable, and with white-zinc cement turns a circle on the centre if for a transparent mount, or a disk if for an opaque one, then centres to the circle or to the disk a common curtain ring, and immediately paints the ring with the cement, taking care not to push it from its position. When dry, the cement will hold the ring very firmly, so that there need be no fear that it will break off.

If a shallow cell is desired the rings may be flattened easily; or if a deep one is required, several rings may be securely fastened one above the other by painting each one in succession. If the cement does not flow readily add benzole; and in case the cell becomes rough, dip the brush in clear benzole and smooth it. Use a brush well filled with the cement to secure a smooth background. With a little practice a person may easily make fifty beautiful and practical white cells in one evening, and in a few hours they will be hard and ready for use. When the cover-glass is to be fastened, a little of the

* Amer. Mon. Micr. Journ., iii. (1882) p. 9.

cement is easily applied. When dry, the slide may be finished with colours prepared from tube paints mixed with benzole balsam, or with dammar and benzole. Before mounting, if a dark background is desired, a disk of asphalt of any desired size turned in the centre of the ring will be found convenient. Over the asphalt a small-sized cover-glass may be used for the object to be placed upon, or the asphalt may be covered with shellac when dry. The object may be fastened with gelatine or gum arabic, or made to adhere to the coat of shellac before it becomes dry.

Bausch and Lomb Circle Cutter.*—This instrument for cutting circles of thin glass (Fig. 60) is intended to be attached to the turntable, by means of the screw shown at the right of the figure, so

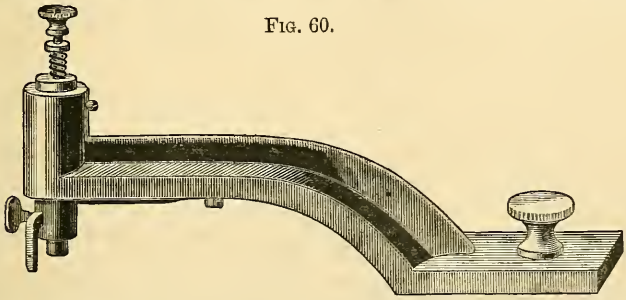


Fig. 60.

that the cutting point stands over the turning plate. The thin glass is placed upon the turntable and held by the central pin which then revolves with the glass. A gentle pressure causes the cutting point to touch the glass, and perfect circles can thus be readily obtained.

Wax and Guttapercha in Dry Mounting.†—Prof. W. A. Rogers, of Harvard College Observatory, writes:—"Notwithstanding the general condemnation of wax as a cement for covers in dry mountings, it is doubtful whether the objections urged against its use are altogether valid. I have had rather more than my share of experience in unsuccessful mountings of this class. During the past five or six years, I have been engaged upon the problem of the exact subdivision of any given unit into equal parts. Whatever success I may have gained in this direction has, I suspect, been somewhat more than counterbalanced by the deterioration of the ruled plates through the condensations which have formed under the covers.

"I have lately collected quite a large number of these plates for the purpose of studying the characteristic defects of different kinds of mountings. As the result of this study, I have reached the conclusion that, for the most part, the primary cause of the condensations which form under the covers, is the moisture remaining upon the glass after the operation of mounting. No matter how thoroughly a glass slide

* Amer. Mon. Micr. Journ., ii. (1881) pp. 225–6 (1 fig.).
† Ibid., p. 190.

may be rubbed, if it is immediately held over a flame, a certain amount of moisture will appear.*

"The evaporation from certain kinds of cement, without doubt aggravates the difficulty, and probably this is, in some cases, the independent cause of 'sweating.'

"Nearly all of the slides examined were prepared in the following way: First, the cover-glass being held in position upon the slide by a clip, the moisture was expelled by heating. After the glass had become sufficiently cooled, small bits of white wax were placed around the edge of the cover-glass. The blunt point of a heated piece of metal was then passed slowly around the cover, and the melted wax flowed under it, far enough to hold it in position. The larger number of the slides prepared in this way were found to be well preserved. When, however, rings of cement were turned upon the slides, the protection was in almost every case less perfect. In every case in which shellac with anilin colouring was used, condensations on the under side of the cover-glass were found. The covers of several slides were removed, and in no case was there any sweating found upon the surface of the slide.

"About eighteen months ago, my attention was called to the use of sheet guttapercha rings for dry mounting. My first experience with these rings was not altogether satisfactory. It is now evident that I did not, at first, apply sufficient heat to expel all of the moisture between the cover and the slide.

"After an experience of several months, I am convinced that slides prepared in the following way, will remain in a perfect state of preservation for any length of time. Use guttapercha rings having a thickness of about one five-hundredth of an inch, and a diameter about one-twentieth of an inch less than that of the cover-glass. Hold the cover in position upon the ring with a light clip, while the guttapercha is being melted by a gentle heat. If too much heat is applied at first, the ring will lose its normal shape. After the guttapercha is thoroughly melted, the slide should be heated sufficiently to expel every particle of moisture from under the cover. While the slide is hot apply white wax to the surface, the melted wax will run under the cover and will be stopped by the ring. After covering, the wax can be removed from the surface of the glass with turpentine.

"I shall esteem it a favour to be informed of any case in which a ruled plate, mounted in this way, has failed to remain in good condition."

Aeration of Aquaria.—Mr. J. W. Stephenson points out that it is impracticable to effectually aerate an aquarium in the way suggested by M. Künckel d'Herculais, *ante*, p. 131. The only really effectual method is to direct a very fine stream of water at a high velocity obliquely upon the surface of the aquarium at about the distance of an inch. By this means air in the finest possible state of subdivision is carried some distance below the surface with the result of ensuring a thorough aeration of the whole contents.

* But will not moisture always appear on glass placed over a candle or other flame, through water being formed by the union of hydrogen with the oxygen of the air?—Ed.

It was by this method that Mr. Stephenson was able to keep the water in his marine aquarium so pure that (in 1867) he hatched the spotted dog-fish and (in 1870) herring from the egg, which had not previously been accomplished. The former was hatched at the expiration of five months and nine days, and the latter of ten days, after the eggs were placed in the aquarium.

The object of M. Künckel d'Herculais was apparently to devise a means of aerating a *marine* aquarium by means of a fall of *fresh water*, but the extra quantity of sea-water required to aerate an aquarium in the way proposed by Mr. Stephenson is not likely to present any difficulty, as it is easy to devise a plan by which a constant circulation can be maintained between the reservoir and the aquarium, without loss of water taking place.

Reference may also be usefully made to an article by Mr. C. J. Watson on "a simple mode of aerating small marine aquaria," * in which he also describes a method of injecting air by the fall of a small quantity of fresh water.

Boyd, J.—How to Make Wax-cells.
[F. Barnard's method, III. (1880) p. 860–1.]
Sci.-Gossip, 1882, pp. 59–60.

Brittain, T.—Micro-fungi: when and where to find them.
North. Microscopist, II. (1882) pp. 15–16.

Bryan, G. H.—How to label Microscopic Slides.
[Instead of one thin paper label at one end, use two made of slips of thick card 1 in. by ½ to ¾ in.—they can then be placed one against the other without the glass of one slide touching the cover of the next, and hence there is no need of a cabinet, as any box of a suitable size will do.]
Sci.-Gossip, 1882, p. 64.

Crumbaugh, J. W.—Our Histological and Pathological Laboratories. II.
[Views as to what should constitute a good working laboratory.]
Amer. Mon. Micr. Journ., III. (1882) pp. 37–9.

Cunningham, K. M.—Cleaning Diatoms.
Amer. Mon. Micr. Journ., III. (1882) p. 14.

D., A. J.—Improvements in Turntables.
[Improvement by W. D. Smith in Kinné's self-centering turntable—explanation unintelligible.]
North. Microscopist, II. (1882) pp. 74–5.

Eger, L.—Der Naturalien-Sammler. Praktische Anleitung zum Sammeln, Präpariren, Conserviren organischer und unorganischer Naturkörper. (The Collecting Naturalist. Practical Guide to the Collection, Preparation, and Preservation of organic and inorganic Natural Objects.) 5th Ed. 8vo. Vienna, 1882, pp. iii. and 221. 37 figs.

English, J. L.—A Manual for the Preservation of the Larger Fungi (Hymenomycetes) in their natural condition, by a new and approved Method; also a new Process for the Preservation of Wild Flowers. viii. and 41 pp. 8vo. Epping, 1882.

Heurck, H. van.—Immersion Fluids.
[Transl. of paper in 'Bull. Soc. Belge Micr.' See Appendix.]
Amer. Mon. Micr. Journ., III. (1882) pp. 26–8.

Hey, W. C.—Pond-collecting in Mid-winter.
[Reports result of fishing some ponds near York on 2nd January.]
Sci.-Gossip, 1882, p. 31.

Laspeyres, H.—Ueber Stauroskope und Stauroskopische Methoden. (On Stauroscopes and Stauroscopic Methods.)
Zeitschr. f. Instrumentenk., II. (1882) pp. 14–24 (3 figs.).

* Midl. Natural., iii. (1880) p. 270.

Malbranche, A.—Réactifs pour l'étude des Lichens. (Reagents for the study of Lichens.) *Rev. Mycol.*, IV. (1882) pp. 9–10.

Microscopic Curiosity.

[Working steam-engine so small that a thimble will cover it.]

Amer. Mon. Micr. Journ., III. (1882) p. 19.

Mounting Class of Manchester Microscopical Society.

[Report of meeting.]

North. Microscopist, II. (1882) p. 40.

Niggl, M.—Das Indol ein Reagens auf verholzte Membranen. (Indol, a Reagent for Lignified Membranes.)

[Abstr. of original article in 'Flora,' LXIV. (1881) pp. 545–59, 61–6.]

Bot. Centralbl., IX. (1882) pp. 284–5.

Reinsch, H.—Detection of Boric Acid, Silica, and certain Metals by means of the Microscope. *Journ. Chem. Soc.*, XLII., Abstracts, (1882) p. 245, from *Ber. Deutsch. Chem. Soc.*, XIV. 2325–31.

S., W. J.—Mounting for Hot Countries.

[Inquiry for hints as to mounting in Canada Balsam and Dammar Varnish in India, and statement of difficulties experienced.]

Sci.-Gossip, 1882, pp. 39–40.

Semper, C.—Bemerkungen zu Herrn Dr. Riehm's Notiz "Eine neue Methode der Trockenpräparation." (Remarks on Dr. Riehm's note on "a new method of dry preparation.") *Zool. Anzeig.*, V. (1882) pp. 144–6.

Stocker, G.—Preserving Flowers. *Sci.-Gossip*, 1882, pp. 65–6.

Stowell, C. H.—Laboratory Notes (*contd.*).

[Examination of sputa in suspected cases of phthisis, &c.]

The Microscope, I. (1882) pp. 172–4 (1 fig.).

Vorce, C. M.—The Detection of Adulteration in Food. V. Red-pepper and Turmeric. VI. Butter.

Amer. Mon. Micr. Journ., III. (1882) pp. 1–6 (1 pl.) pp. 21–3 (5 figs.).

Walmsley, W. H.—Some Hints on the Preparation and Mounting of Microscopic Objects. 2nd paper.

[Mounting in balsam in cells.]

The Microscope, I. (1882) pp. 161–72 (7 figs.).

Ward, E.—Micro-crystallization.

[Describes the mode of preparation of Micro-crystals.]

North. Microscopist, II. (1882) pp. 25–33.

White, M. C.—Examination of Blood-stains by Reflected Light.

[With Beck's (vertical?) illuminator and $\frac{1}{8}$ in. objective.]

Amer. Mon. Micr. Journ., III. (1882) p. 6.

Wightman, G. J.—Crystallized Fruit Salt.

[Recommended as an object for the Polariscope.]

Sci.-Gossip, 1882, p. 64.

Woronin, —.—Les meilleurs Liquides Conservateurs pour les Préparations Microscopiques. (The best preservative liquids for microscopical preparations.)

Rev. Mycol., IV. (1882) p. 71.

Zimmermann's (O. E. R.) Mykologische (mikroskopische) Präparate. (Mycological—microscopical—preparations.)

[General description by G. W.]

Hedwigia, XXI. (1882) p. 5.

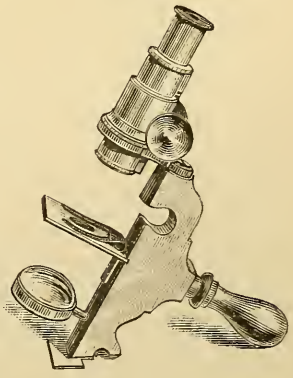
records some of the results of his observations. Many of the phenomena connected with the motion of diatoms, indicate that the frustules are enveloped in a membrane which, if adhesive, would cause many of the appearances noted, provided the motion be accounted for. Where extraneous matter is seen trailing after a diatom it is, however, as likely that the adhesive property resides in it as in the diatom. The remarkable alternation of motion seems a very strong objection to the ciliary theory and equally so to that of prehensile filaments. No other ciliated or flagellate organism exhibits such alternations. Not even in the case of large diatoms when moving with great force can any trace of cilia or filaments be seen. If ciliary action or currents produced by osmose were the true explanation, we should expect them to move adjacent particles when the diatom is held fast, but yet free particles are not moved nor is there any evidence of current in the water, except where it is in contact with the diatom. In fact, none of the suggested causes of motion explain satisfactorily all the phenomena observed, and the problem still lies open to some persevering observer.

MICROSCOPY.

a. Instruments, Accessories, &c.

Griffith's Portable Microscope.*—Mr. E. H. Griffith has further modified this instrument, which now "has the usual coarse adjustment by rack and pinion, which is very accurately made, and by an ingenious addition, serves also as a fine adjustment. A ring is mounted on the axle of the hand-wheel; a set-screw clamps the hand-wheel when the coarse adjustment is effected, so that it cannot be moved, and all danger of breaking the slide is avoided. Then a lever working in the ring moves the tubes by means of the same rack and pinion. As the lever is itself moved by a worm-screw, it forms a very exact and delicate focussing arrangement."

Fig. 61.



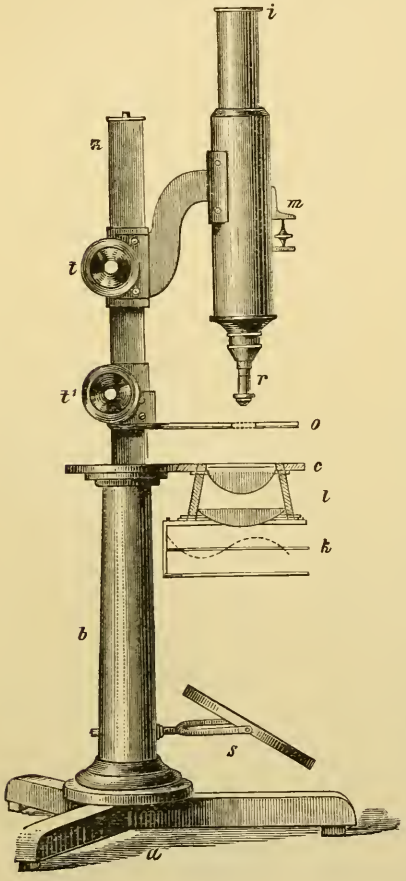
Parkes' Class Microscope.—Messrs. Parkes have adapted the Microscope described *ante*, vol. i. (1881) p. 655, for use as a Class or Demonstrating Microscope. It is shown in Fig. 61. The handle, in conjunction with the base of the stand, enables it to be placed on a table in the ordinary way when so desired. The condensing lens more usually employed when the instrument is being handed round a class can be replaced by a mirror.

Pringsheim's Photo-chemical Microscope.—Professor Pringsheim's researches on the functions of chlorophyll in the life of the

* Proc. Amer. Soc. Micr., 1881, p. 85.

plant, and the connection of its production and destruction with the intensity of the light, have been already fully described,* and we now add Dr. A. Tschirch's description † of the special Microscope which Professor Pringsheim constructed for observing the effect of a high intensity of light on objects directly on the stage, and to carry out his method of "microscopical photo-chemistry"— a method which he considered would also be valuable in investigating the action of light on protoplasm and the formed constituents of the cell-body, for investigations on the sensations of heat in the lowest animals, and in certain cases for ascertaining the truth respecting the presence and seat of the perception of light.

Fig. 62.



The instrument is three times larger than the ordinary [German] Microscopes, and its form resembles that of the older Schieck stand. Upon a firm tripod *a* rests the conical column *b*, to which is fixed the large round mirror *s*. The latter is 160 mm. in diameter, and is as strictly plane as possible. It receives the sunlight from a heliostat, whose mirror must be considerably larger than that generally used, so that the mirror of the Microscope may be fully illuminated at any altitude of the sun; 235 mm. by 165 mm. is a sufficient size. At a distance of 165 mm. above the mirror, the column supports a large stage *c*, about 110 mm. square, beneath which the lens-system is screwed for the production of the sun's image. In the instruments hitherto employed, a doublet of two plano-convex lenses is made use of, placed in the same frame *l*, 28 mm. from each other. The lower has an aperture of 66 mm. and a focus of 93 mm., the aperture of the upper being 48·4 mm. and the focus 35 mm. In this position they form a round image of the sun 0·35 mm.

* See this Journal, iii. (1880) pp. 117–19, 323–4.

† Zeitschr. f. Instrumentenk., i. (1881) pp. 330–3 (4 figs.).

in diameter, and although the lenses are not perfectly achromatic, yet it is not too strongly coloured at the margin by chromatic aberration.

Below the doublet another piece of apparatus can be screwed with either two springs, or better a double fork *k*, for holding the coloured solutions or glasses for producing monochromatic images, also the media for the absorption of the dark heat-rays. If it be required to have additional vessels for the absorption of heat or to employ different absorption media at the same time, others can easily be fastened under the forks by indiarubber rings, the height of the stage *c* above the mirror giving sufficient space for four or five. It is not advisable to fix them above the lenses upon the stage *c*, because while the warmth beneath the lenses extends uniformly through the whole of the fluid, there is above them a very hot cone of rays, which strongly heats a small portion of the absorption liquid, and with liquids such as iodine in bisulphide of carbon explosions may easily take place. Indeed, it is in this case necessary, instead of the Desaga bottles (at first exclusively employed by Professor Pringsheim), to use glass boxes for holding the absorption fluids, of greater width than the aperture of the doublet. For this purpose round, well-polished glass rings can be employed, 10 mm. deep, closed on either side by flat glass plates, held together by strong indiarubber rings. If these are carefully closed, all aqueous solutions can be kept in them for months without evaporating to any considerable extent, particularly as a stratum of small crystals speedily forms at the edge, and thus makes them still more air-tight. Solutions of bisulphide of carbon must often be renewed, because they evaporate, even when most tightly closed.

After many experiments, the following have been proved to be the best absorption fluids:—For the absorption of red-yellow, a solution of ammonio-oxide of copper; for the blue and red ends of the spectrum, solutions of chloride of copper, obtained by the evaporation of a saturated solution of the salt, according to the intensity of the colour and the extent of the absorption; for the green-violet, a solution of bichromate of potassium ($K_2Cr_2O_7$); and for the orange-violet a solution of iodine in bisulphide of carbon or iodine in iodide of potassium. As far as can be at present ascertained, solutions of organic pigments or of aniline colours are unsuitable, at least they possess no superiority over the above solutions. Coloured glass plates may be used, if perfectly uniform. Of course, the value of all media for absorption must first be tested in the spectroscope. Water or a concentrated solution of alum can be used for the absorption of the dark heat-rays.

Above the fixed lower stage is the movable stage *o*, moved by the screw t^1. It is pierced in the centre, and serves to carry the slide, the gas chambers, &c. By means of the screw, the object can be brought into the plane of the sun image formed by the lenses, or immersed in it if necessary. The screw t^1, as well as *t*, which moves the microscope-tube, works on a triangular bar *z*. The screw *t* gives the coarse focussing, after the object on the stage has been adjusted by means of t^1, whilst the micrometer-screw *m* gives the necessary fine focussing

movement. The objective is shown at *r*. (The author says that it is better to produce the fine adjustment by means of a screw on the end of the tube, similar to the correction adjustment of objectives.)

To be able to produce a clear image of the sun, the whole of it must be seen, and therefore only low powers can be used. The field must be about 1 mm. in diameter. To protect the eye against the intensity of the light, a number of smoked glasses can be placed on the eye-piece *i*.

Two methods were employed by Professor Pringsheim for the temperature determinations*: (*a*) the insertion of a thermo-electric couple of iron and nickel into the drop, the results being read off by a galvanometer; and (*b*) the introduction of small crystals of substances of known melting-point. For the latter purpose two substances, azoxybenzol, which melts at 45° C., and mint-camphor, with its melting-point 35° C., were found most convenient.

Waechter's (or Engell's) Class or Demonstrating Microscope.—This instrument might readily be mistaken for an ordinary brass candlestick. Its original form is figured by Harting†; Figs. 63 and 64 show it as improved by Waechter, the lower part being seen in Fig. 63 *in section*.

Fig. 63.

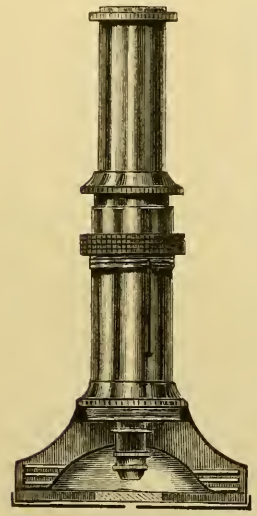
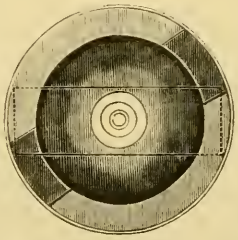


Fig. 64.



The body-tube, carrying eye-piece and objective, slides in an outer "sprung" tube which is attached at its lower end to a conical base, which forms a wide support for the instrument to stand upon when not in actual use. The inside of the base is polished so as to reflect light upon opaque objects. The ends of the slides are held beneath a metal ring at the lower end of the base, as shown in Fig. 64, and they can be removed by turning them round till they coincide with the two openings in the ring. The instrument is held up to the light and focussed by sliding the inner tube in the usual way. It can be secured at any given focus if desired by the milled clamp ring near the top of the sprung tube. A cover fits over the base (shown in Fig. 63) and is pierced with a small hole to act as a diaphragm with high powers.

The instrument is intended for class demonstration.

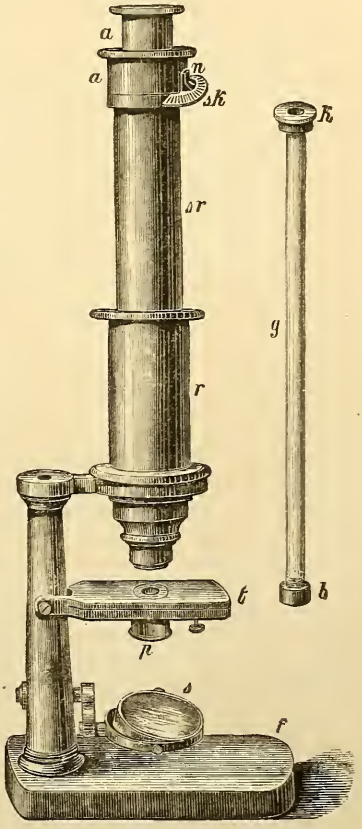
* See translation of Prof. Pringsheim's Researches by Prof. Bayley Balfour, Quart. Journ. Micr. Sci., xxii. (1882) pp. 76–112 (2 pls.).

† Harting, P., 'Das Mikroskop,' iii. (1866) pp. 196–7 (2 figs.).

Wasserlein's Saccharometer Microscope.*—This instrument is shown in Fig. 65, and its special feature (though one of very doubtful advantage) is that it enables one and the same instrument to be used as an ordinary Microscope and as a saccharometer.

The following is the method of using it:—The diaphragm having been removed from the stage *t*, and the polarizer *p* substituted, the body-tube (with eye-piece and objective) is taken out of the tube *r*, and the saccharometer-tube *sr* inserted so that its lower end is close over the polarizer. The latter tube has at its upper end, and on one side, a semicircle *sk* fixed at right angles, on which is a scale graduated up to 25° from the centre on either side. The analyzer *aa* is inserted, and the mirror *s* arranged in the usual way for microscopical observation. The nonius *n*, attached to the analyzer, is then adjusted by turning the latter so that the centre division of the nonius exactly agrees with the 0° of the scale, and the polarizer is revolved on its axis to the right or left until the so-called neutral point is reached, at which both halves of the field of view appear of equal intensity and colour. Removing the analyzer, the glass cylinder *g* (20 cm. long) is inserted into the saccharometer-tube (being first completely filled with clear solution of sugar or urine), and the analyzer replaced in its original position. On revolving it to the right or left until the neutral point is again reached, the nonius will now have another position on the scale, and its central division marks the degree, from which the percentage of sugar in the solution can be determined. A petroleum lamp is the best for the observation. The glass cylinder *g* must be completely filled, so that after being closed by the cap *k* there are no air-bubbles.

Fig. 65.



The scale (not divided into 360° but into 180°) shows the quantity of glucose or grape-sugar direct.

* Cf. Hager, H., 'Das Mikroskop' (8vo, Berlin, 1879), pp. 45–7, 1 fig.

Wenham's Universal Inclining and Rotating Microscope.—"Another F.R.M.S." suggests* that there was one point in connection with this Microscope which has been omitted, and claims that the merit of the principle of construction is due to Dr. Edmunds, on the following grounds:—

"On November 10, 1880, at the Royal Microscopical Society, Dr. W. B. Carpenter exhibited and fully described a small rough stand made for students' purposes by Mr. George Wale, and the record of the proceedings of that meeting will be found in the Journal of the Society for 1880, p. 1087. From that published record I extract the following paragraph:—

'Dr. Edmunds pointed out that this most useful microscope-stand would be vastly improved if only the arc upon which the body turns were so constructed that the centre of the circle of which the arc forms part were made to coincide in position with the centre of the stage. The object would then undergo no movement of translation, either in rotating the stage or in turning the optical tube from the vertical to the horizontal In rotating the stage, the object would turn upon the optic axis; in moving the tube into various degrees of obliquity from 0° to 90°, the object would rotate upon its horizontal axis. The result would be that, with a thin stage and a hemispherical lens in immersion contact with the under surface of the slide, all the complicated swinging substages and other contrivances now upon the table might be swept away, and every angle of illumination could be got by merely inclining the body of the Microscope upon its sustaining arc. There would only be needed a lamp on a level with the object, with a condenser at its focal distance standing upon the table in line between the lamp and the object.'"

The writer, in some criticisms of the design, insists that with the object centered upon a revolving stage and *one* movement in altitude, all possible illuminations are at command.

Mr. Wenham subsequently writes† denying that he had previously read Dr. Edmunds' remarks above quoted, and stating that his own Microscope was designed before their date.

A similar disclaimer is made‡ by Mr. J. M. Moss, the designer of the Microscope described in this Journal, i. (1881) p. 516.

Brücke Lens.—Mr. A. Smith points out, with reference to our description of this lens, *ante*, p. 101, that it is also described in Rutherford's 'Outlines of Practical Histology,' 1876, p. 36, and figured, with a holder, on p. 38.§ Our sectional woodcut, Fig. 14, was unfortunately reversed by the printer.

Bausch and Lomb Handy Dissecting Microscope.—This instrument (Fig. 66) made by the Bausch and Lomb Optical Company, for use in mounting Foraminifera or other objects which have to be

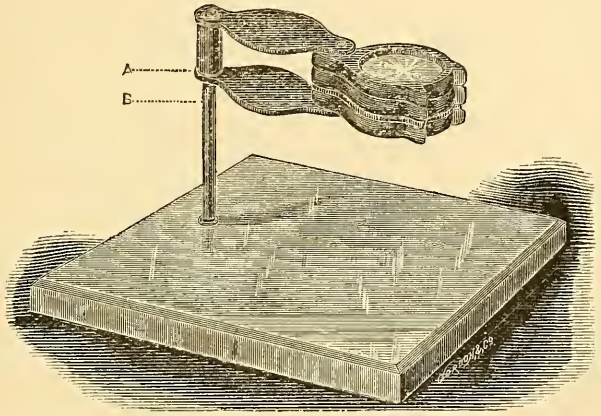
* Engl. Mech., xxxv. (1882) p. 217.

† Ibid., pp. 237 and 282. ‡ Ibid.

§ It is also referred to by Dr. Carpenter, 'The Microscope and its Revelations,' 1881, pp. 58–9.

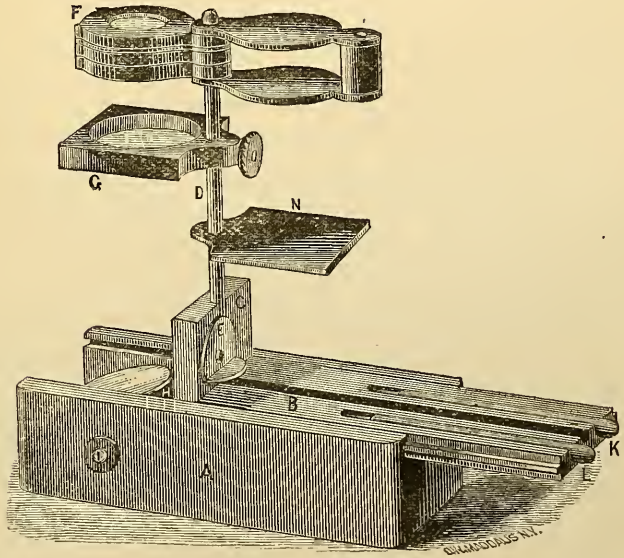
selected from sand and other débris, differs from other similar forms in that the base (into which the steel stem supporting the lens is screwed) is made of a thick plate of glass, so that by placing a sheet

Fig. 66.



of white paper beneath it, and using a bull's-eye condenser, opaque objects can be easily selected for mounting.

Fig. 67.



Excelsior Pocket and Dissecting Microscope.—This instrument patented by J. J. Bausch (Fig. 67) comes from the United States,

where it has been several times described. It consists primarily of a small wooden case A, about one-third larger than shown in the figure. To one end of the lid B is attached one of the ends C of the case, and when the lid is reversed it may be slid into the groove of the case, and then forms a stand for the lenses and stage. These are supported by a steel rod D, the lower end of which is hinged to the lid so that it may be turned down and lie in the groove provided for it. When raised into the position shown in the figure, it is held securely in place by means of the button E, which also serves to retain it in the groove when it is turned down. The glass stage G is fitted into a frame of hard rubber, and slides easily on the stem D, so as to be readily adjustable for focus, while at the same time it may be firmly fixed by means of a set-screw, at any desired height, and will then serve as a stage for dissecting purposes. The frame which holds the lenses F (magnifying 5–30 diameters) fits on the top of the stem. A mirror H is fitted into the case, and is readily adjustable by means of the button I shown on the outside, so that light may be reflected up through the stage when the objects to be examined are transparent. When they are to be viewed by reflected light there is a dark plate of hard rubber N, which is also carried by the stem D, and may be turned under the stage so as to cut off all transmitted light. Dissecting needles (K and I), with handles, fit into appropriate grooves.

The glass plate is fitted into the stage so as to form a cell capable of holding water, so that dissection may be carried on under that liquid, or aquatic animals may be kept alive and examined at leisure. The stage may also be turned so that the flat side will be uppermost if desired. When the lenses and stage are removed they are readily packed in the case, and the entire instrument goes into a compass "which readily admits of it being carried in the vest pocket."

Dr. Phin recommends * that in order to increase the steadiness of the instrument the case should be attached to a board 6 in. × 4 in. × ¾ in. A single small screw is sufficient, and the board can be easily detached when it is desired to carry the Microscope in the pocket.

Hartnack's Drawing Apparatus (His's Embryograph).†—Dr. E. Hartnack describes his new drawing apparatus, which is a modification of the embryograph of Professor His. He writes:—"It is desirable for many purposes of natural history to trace exact outline drawings with low magnifying-powers, and to be able to regulate the power so that it may be easy to pass from one scale to another. The drawing apparatus hitherto employed in microscopy (even with the use of low objectives) have hardly allowed the use of a power less than 20; moreover, although through the movement of the tube it was not impossible to obtain any scale desired, yet, at any rate, it was not convenient.

"A short time ago Professor W. His published ‡ the design of a drawing-apparatus which allowed the power to be varied at will from 4 to 40. He combined the Oberhäuser camera with a small photo-

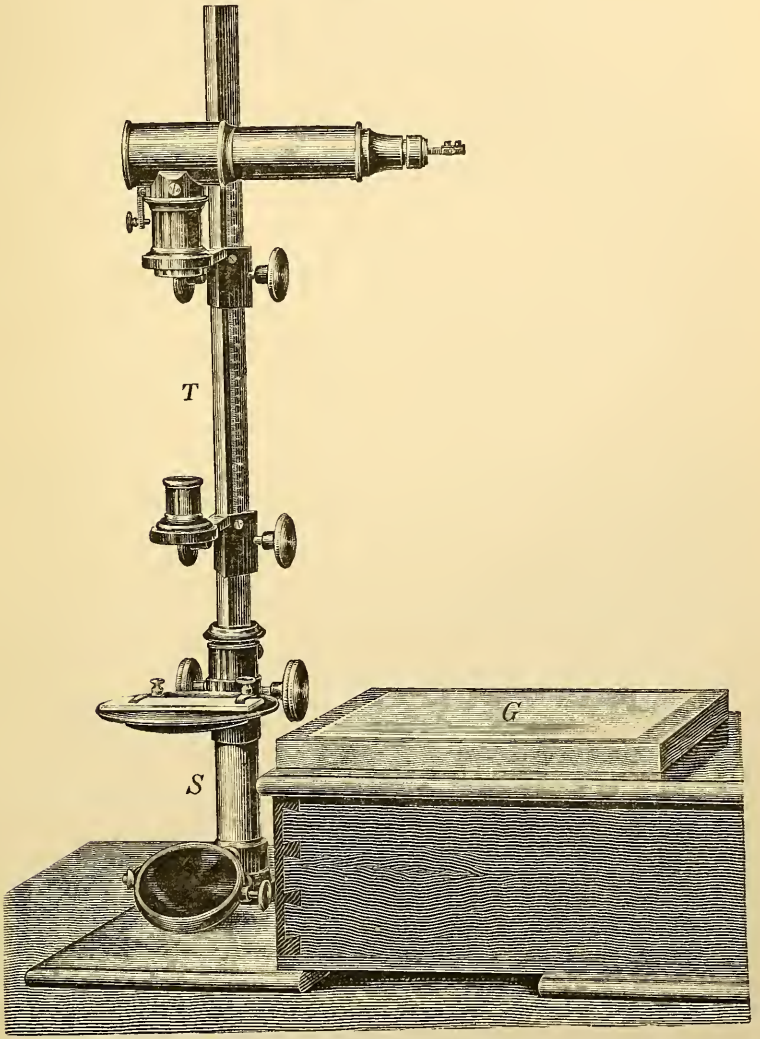
* 'How to use the Microscope,' 4th ed., 1881.

† Zeitschr. f. Instrumentenk., i. (1881) pp. 284–7 (1 fig.).

‡ 'Anatomie menschlicher Embryonen,' fol., Leipzig, 1880.

graphic objective in such a manner, that both could slide backwards and forwards in movable sockets, on a bar 60 centimetres long, provided with a scale. The bottom of the bar bears the movable

Fig. 68.



object-stage, and under this is a microscope mirror. A glass plate placed at the side of the apparatus acts as the drawing surface.

"This apparatus has been employed for years by Professor His, but I have endeavoured to give it a more compendious form, and at

the same time to extend its magnifying power still more. In this I have succeeded by employing different objectives for the lower and higher powers, so that it was possible to reduce the height of the apparatus by a third."

The accompanying figure shows the apparatus (Fig. 68), S being a circular column, and T an angular bar, the latter divided into millimetres. G is the drawing plate placed on the box (38 × 22·5 × 9·5 cm.) in which the apparatus packs by separating the pedestal, column and bar, the stage, &c.

Professor His writes to Dr. Hartnack as follows as to the use of the apparatus:—"Your form is thoroughly serviceable, and allows of correct and convenient working with powers of 4 to 70. According to your request I append some information as to its management. The regulating of the magnifying power is the first thing to be attended to by means of a scale divided into half-millimetres as an object. The stage must be placed in its highest position, and the objective and the prism moved until the image projected upon the glass plate shows the desired magnifying power. . . .

"For a power of 4, the stage must be pushed downwards 20 mm., and in order to take in the whole of the field of view with powers of 4 or 5 it must be unscrewed from its ring and the latter used as the stage.

"The aperture of the stage is only 20 mm.; short or long-sighted people should always use the same spectacles. When the desired power has been determined the object to be drawn is placed on the stage, and focussed *only* by moving the latter. In order to obtain a distinct image, the object must be in the same plane as the numbers and strokes of the scale were previously, and if this is obtained by unaltered position of the objective and prism, the magnifying power of the whole apparatus must remain the same as before, the distance of the drawing-surface from the objective remaining unchanged."

[Some general remarks follow as to testing the objectives, the regulation of the light, &c.]

"Opaque objects are best drawn in liquids. My chief object being to draw embryos, I have had unpolished hollow vessels of black glass or marble made, 5–20 mm. in depth; the embryos were covered with alcohol and a thin glass plate placed over them in such a manner as to exclude air bubbles. If it is necessary to keep the embryo in a given more or less depressed position, this can be done by using small strips of glass suitably bent.

"The above directions will perhaps suffice to assist the inexperienced in the use of the apparatus, and I only hope that others may find it, in the elegant and convenient form which you have given it, as useful as I have done."

Drawing from the Microscope.*—Mr. W. T. Suffolk dispenses entirely with the camera lucida, and substitutes a grating ruled in squares and placed over the diaphragm of the eye-piece. It is better

* Sci.-Gossip, 1882, pp. 49–50.

to have the lines ruled on a double-convex lens of shallow curvature, as the interference with the definition is considerably less than when a glass with plane surfaces is used: with this arrangement Podura-markings can be well shown with a $\frac{1}{8}$ objective. When the binocular is required, a lens without ruling, but of similar curves, should be placed in the other eye-piece to equalize the magnifying power in each field. A convenient distance for the lines is $\frac{1}{20}$ inch, this gives a field not too much crowded with squares, and on the other hand the divisions are not too large to render the setting out of the outline inexact. The drawing is made on ruled paper, the squares being of a size suitable to the intended size of the design, just as in the well-known draughtsman's process of enlarging and reducing by squares. A drawing of any size, from a small sheet to a large lecture diagram, can thus be made directly from the Microscope.

The process also possesses the additional advantage of requiring no change in the position of the Microscope, as is the case with the camera-lucida, and can be used for a long time without any of the strain upon the eye inseparable from the use of instruments, where the image and pencil point are viewed through the divided pupil of the eye.

With regard to materials, Mr. Suffolk takes exception to the use of *flake white* for compounding body colours, as in water all pigments made of carbonate of lead rapidly become blackened. Chinese white, a preparation of oxide of zinc, should alone be used for this purpose. He also gives the following list of colours which he considers will be found sufficient for nearly every purpose:—aureolin,* yellow ochre, lemon yellow, cadmium yellow, vermilion, purple madder, raw sienna, burnt sienna, rose madder, light red, brown madder, cobalt, French blue, indigo,† vandyke brown, blue black, sepia, viridian.‡ In addition to the colours in cakes, a few that are likely to be used in large quantities should be obtained in tubes; where thick painting is required, this form of colour is particularly useful. The Chinese white should be kept in a bottle with a greased stopper; in tubes it soon hardens and becomes unfit for use; it should be worked with the palette-knife and a little water to the consistency required.

The use of crimson and purple lakes, carmine and all other cochineal colours should be avoided; the madders are the only safe substitutes. Iodine, scarlet, the chrome yellows, and all aniline colours, should find no place in the colour box.

Very good effects are obtainable by the use of blacklead, and

* Aureolin, a transparent pure yellow, quite permanent, and an excellent substitute for gamboge, as, being without gloss, it can be employed in skies and distances.

† Indigo is only very slowly acted upon by light, and may be considered permanent in the diffused light of an ordinary room; avoid mixing with Indian red, which speedily destroys it.

‡ A transparent oxide of chromium, perfectly permanent, of great use both by itself and in compounding other greens; the opaque oxide of chromium may also be found useful; both are extremely permanent colours.

for rapid work it offers many facilities. In addition to pencils of the usual kind, some with broad leads will be found useful for covering larger surfaces. Very delicate tints can be made with blacklead powder rubbed on the paper with a suitable leather stump. Tints of any depth can also be obtained from blacklead used as a water-colour, which can be procured in cakes.

Blacklead, charcoal, and chalk drawings can be permanently fixed, by saturating the paper from behind with a varnish composed of bleached shellac and alcohol. This should be very freely applied and dried in a warm room or with caution before a fire. The strength should be such that it will just dry without leaving a gloss on the paper. Winsor and Newton's white lac varnish, mixed with an equal bulk of methylated spirit, will be the right strength. After this treatment a pencil drawing may be placed in the portfolio, and even exposed to some amount of rubbing, without injury. The varnish does no harm to any water-colour tints that may be used in combination with pencil.

Ulmer's Silk Thread Movement.*—J. Ulmer suggests the use of a silk thread for microscope-tubes and the eye-pieces of telescopes.

The tube T (Figs. 69–72) has above and below in the socket two guides *c c*, against which it is gently pressed by the small pulley *d* and spring *e*, by which means easy sliding is secured. The movement of

Fig. 69.

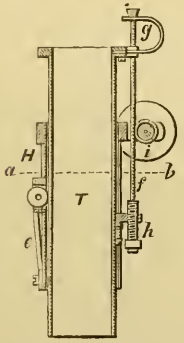


Fig. 70.

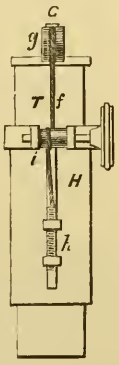


Fig. 71.

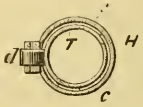
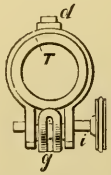


Fig. 72.



the tube is effected by the silk thread *f* which is attached to a spring *g* and screw *h*, both of which are fixed to the tube. The spring is slit as shown in the figures, and the screw is hollow and serves for stretching the thread and the spring, after the former has been laid in the slit, and turned round the pinion *i*, which is fluted to avoid slipping. The rotation of the tube is prevented by making the support by which the female screw at *h* is attached to the tube slide in a slit in H.

The apparatus works, it is said, without any "loss of time," and secures an easy motion, at the same time being very simple.

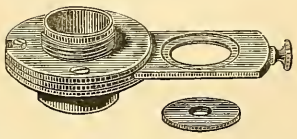
* Centralztg. f. Optik u. Med., ii. (1881) p. 148 (4 figs.).

Diaphragms for Limiting the Apertures of Objectives.—Mr. J. B. Dancer proposes * other forms of diaphragms for this purpose, the iris-diaphragm being unsuitable on account of the "ragged" outline which it gives. The first form is an oblong plate of diaphragms, which *slides* in an adapter screwed to the nose-piece, the second is a circular *rotating* plate.

The third method utilizes the ordinary double nose-piece. A shallow recess is made in the top edge of one of the female screw parts of the nose-piece to receive thin metallic (numbered) disks, having holes of suitable diameters. A disk with the required aperture can be dropped into the recess by merely moving the arm, which carries the objective, on one side. A wire hook is useful for lifting them out again.

A still later device is shown in Fig. 73, and is a combination of the first and third plans. An oblong plate slides in an adapter, but instead of being pierced with several apertures of different sizes, it has two apertures of equal size, into which can be dropped the various diaphragm disks used with the third plan. This gives great facility for removing and changing the diaphragms quickly, and might, we think, be usefully adapted for taking the diaphragms required for the diffraction experiments.

Fig. 73.



It must be observed, however, that the object for which the use of these diaphragms was suggested is not practically attainable. The suggestion was founded on the fact that a low-angled objective has greater penetrating power than a high-angled one, and it was considered that by using a diaphragm at the back of the objective, thus cutting down the aperture, an objective of wide aperture could be made to do duty as a narrow-angled one also, so that two classes of objectives were unnecessary. As Professor Abbe points out at p. 308, the plan adopted in the construction of wide-angled objectives will not allow of such a double use; and it is still necessary to employ two classes of objectives, using those of small aperture when penetration is required.

Correction-adjustment for Homogeneous-immersion Objectives.†—Dr. G. E. Blackham discusses the reasons suggested for dispensing with an adjustment to these objectives, viz. no risk of decentering, the existence of a *one best* position in all objectives, the cost of the adjustment, and the trouble of correcting.

To these objections the following he considers to be conclusive replies.

First, if the brass-work is done with a degree of skill at all commensurate with that necessarily expended on the glass-work of a really first-class homogeneous-immersion objective, there need be no fear of injurious decentering by the movements of the adjustment-collar.

Second, while it is true that the adjustment by means of varying

* North. Microscopist, ii. (1882) pp. 89–90, 92.

† Proc. Amer. Soc. Micr., 1881, pp. 61–4.

position of the systems is only an expedient, yet if it can be shown that it reaches the desired end more certainly, speedily, and accurately than any other, the objection to it must fall to the ground.

Third, that while it is conceded that really first-class metal-work is expensive, if it can be shown that it is *necessary*, the objections to it must also fall.

The term homogeneous-immersion, though honestly applied and correct as to the *idea*, is only approximately true at present, as no truly homogeneous-immersion fluid has as yet been discovered, so far as the author can learn. That is, no fluid whose optical properties are *absolutely identical* with those of the front lens of any objective. The *refractive* power of crown glass has been closely approximated, but minute differences of *dispersive* power remain; and even if this difficulty could be overcome, the varying refractive and dispersive powers of various samples of crown-glass must always remain an unknown quantity in our problem, to be provided for by some kind of adjustment.

This fact has been recognized by at least one maker, who advises to correct for extremely thick or thin covers, by means of the draw-tube, and furnishes *two* fluids, one for use with direct central light, and the other with very oblique light. Of course it follows that for perfect accuracy of correction by means of the immersion fluid, a different fluid would be needed for each degree of obliquity of illumination. That this would involve serious inconvenience hardly needs demonstration; more especially when we consider that it is often desirable to examine an object under *gradually* varying obliquity of illumination, from direct central to the most oblique the lens can utilize.

Another point is the variation in the human eye; which must be compensated for in some way.

"It appears then, that the homogeneous-immersion system does not entirely obviate the necessity for adjustments of some kind, though it greatly lessens their *extent*. That these small residual adjustments can be made with more ease, rapidity, and accuracy by means of the screw-collar moving the back system of the objective, than by means of varying the distance between the objective and eye-piece by means of the draw-tube, or by varying the refractive and dispersive powers of the immersion medium by means of mixtures of various oils, &c., in varying proportions will, I think, on consideration be generally admitted.

But this greater ease, rapidity, and accuracy of adjustment with homogeneous-immersion (so called), is not the only argument in favour of the retention of the adjustable mounting for objectives. Most immersion fluids are apt to vary in their optical properties with their age or the state of the weather. One of the best of them, the solution of the sulpho-carbolate of zinc in glycerine, has its refractive power increased in very dry and decreased in very wet weather. In this case it is more convenient to turn the adjustment-collar slightly, than to make a new solution for immersion.

Again, it is often desirable to use an objective with a much longer

or shorter tube than it was specially constructed for, or to use some other immersion medium than its own, water or glycerine for instance, for some special purpose. Here, again, the advantage, nay, the necessity, of the adjustable mounting, becomes evident. I believe then that I have shown:—

First, that homogeneous immersion has not been and is not likely to be more than approximately attained.

Second, that even if it should be fully attained, so far as the front lens of the objective is concerned, the varying refractive and dispersive powers of different eyes, and different samples of cover-glass would always remain to be accounted for.

Third, hence adjustment of some kind will always be necessary.

Fourth, that a well-made adjustable mounting for the objective is the most convenient, satisfactory, and perfect arrangement for this purpose yet devised.

Fifth, that by means of such an adjustable mounting the range of usefulness of an objective, as well as the convenience of using it are greatly increased, and therefore,—

Sixth, homogeneous-immersion objectives (so called or real), as well as all other objectives of wide angle, should be made adjustable."

Hitchcock's Modified Form of Vertical Illuminator.*—Professor R. Hitchcock suggests another form for a vertical illuminator, which, he thinks, will be better than the ordinary one, and more convenient for use.

"Instead of the reflector now used, a small glass reflecting prism is placed in the nose-piece in the same way and in the same position as the Wenham binocular prism, and in the case of binocular Microscopes should replace the latter. The back surface of the prism, which receives the light, may be either plane or curved; it might be found advisable to make this surface act as a lens to throw the light upon the back of the objective in the most advantageous manner for illumination. All parts of the prism not used should be blackened, so that no light except what passes down to the objective can enter the tube. A rotating diaphragm can be added, working in front of the exposed surface of the prism; but this would probably be an unnecessary expense."†

Flesch's Finder.‡—Dr. Max Flesch describes the arrangement shown in Fig. 74, as a simple contrivance for finding objects on a slide where a more complicated apparatus is not suitable.

A clip of horse-shoe shape attached by two pins, holds the slide upon the stage. The outer sides of both arms are bevelled off and all four sides graduated. When a particular object or part of an object is in the field a line is drawn with a pencil along both sides of each arm crossing the slide. The numbers of the divisions are also marked on the slide with short cross lines, as shown in Fig. 75. If the slide is again brought into its original position, as determined by the

* Amer. Mon. Micr. Journ., iii. (1882) p. 54.

† Mr. J. W. Stephenson informs us that he had a vertical illuminator on this plan constructed in 1879.

‡ Arch. f. Mikr. Anat., xx. (1882) pp. 502–3 (2 figs.).

coincidence of the arms and divisions of the clip with the lines on the slide, the object will necessarily be in the field of view. The

Fig. 74.

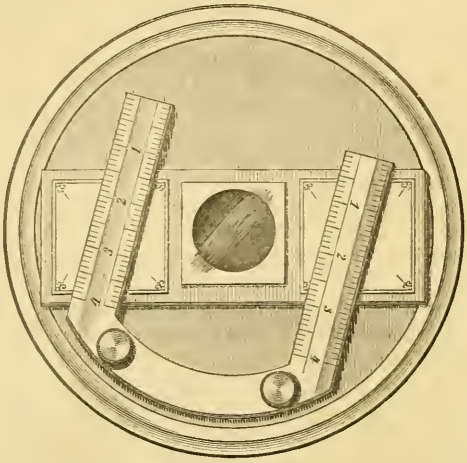


Fig. 75.

arrangement has been found sufficient for an *Hipparchia* scale, with a power of 150.

Burnett's Rotating Live-Box.—This is thus described by Mr. R. T. Burnett, its designer:—"The arrangement of this live-box is very simple. Hitherto live-boxes have had the outer cases, which hold the strong or bottom glass, screwed into, or fixed firmly to, the plate that goes upon the stage. This one is constructed so that the outer case fits into a flange or cylinder its own depth. The cylinder is made fast to the plate, leaving the outer case, together with the inner case, free to be rotated at the will of the manipulator, forming, in point of fact, an ordinary live-box resting within a deeply flanged plate.

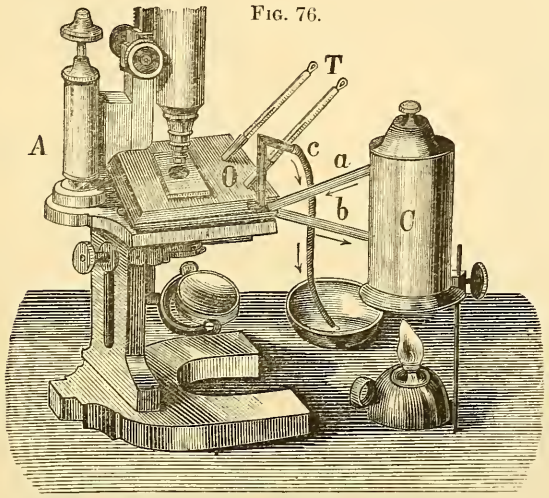
In using the ordinary live-box, it has hitherto been necessary to take it off the stage whenever the observer has been desirous of turning the object round, or when, in the absence of an 'erector,' it has been necessary to have an object which has been placed head downwards changed to an upright position. This is avoided by the rotating live-box.

Further, in using the ordinary live-box with high objectives, the latter will project within the rim of the live-box; consequently no such

change could be made without altering the focus of the Microscope, and causing a loss of time in readjusting the focus and in finding the particular part of the object. By the rotating live-box no alteration of the focus is necessary."

Schklarewski's Hot-water Stage.*—This is represented in Fig. 76. The water, heated by gas or a spirit lamp, passes from the vessel C, through the tube *a*, into the hollow stage O placed on the microscope-stand A. A thermometer T shows the temperature. The

Fig. 76.



water, after passing through the stage and becoming cool, flows back again through *b* into the vessel C, whilst that which is more heated flows through *c*, and the indiarubber tube attached to it, into another receptacle. The stage does not appear to differ essentially from other well-known forms.

Abbe's Condenser.—This apparatus as originally devised † was not easily applicable to any stand but that of Zeiss for which it was specially made. It has now been so modified (Figs. 77 and 78) that it can be applied to the usual substage fitting.

The upper lens A is a thick plano-convex, somewhat larger than a hemisphere. Just below it is a large bi-convex lens serving as a collecting lens to A. The upper focus of the combination is about 2 mm. (in glass) above the plane face of A, that is, about the distance of an object on an ordinary slide. A small metal cap with a central pin-hole can be placed over A for convenience of centering. B is a box-fitting for diaphragms, &c., forming part of the carrier-plate C,

* Thanhoffer's 'Das Mikroskop und seine Anwendung,' 1880, pp. 88–9 (1 fig.).

† Mon. Micr. Journ., xiii. (1875) pp. 77–82 (1 fig.).

made to rotate immediately below and in the axis of the optical combination. The carrier-plate moves laterally by rackwork acted upon by the toothed pinion D. To facilitate changing the diaphragms C can be swung out of the axis on the swivel-joint E, as shown in

Fig. 77.

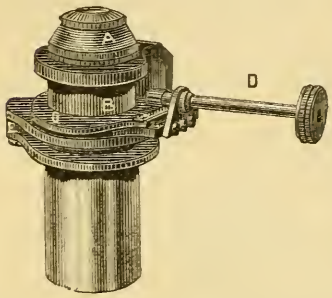


Fig. 78.

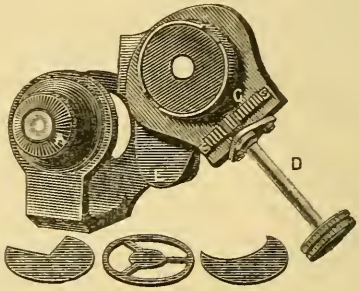


Fig. 78. Circular, lune-shaped, and other diaphragms are supplied, which give a large variety of effects of obliquity both in altitude and in azimuth when used with the lateral and rotating movements of C. For black-ground illumination a central stop is placed in B, and Zeiss supplies special diaphragms to be applied at the back of several of his objectives of large aperture which ensure the dark-ground when used in conjunction with this condenser. With objectives of greater aperture than 1·0 N.A. the condenser must of course be in immersion contact with the base of the slide. The condenser has a numerical aperture of 1·4 nearly.

Bausch and Lomb's Immersion Illuminator.—This illuminator (of which we have no drawing) is intended "to utilize the full capacity of medium and wide angle objectives," up to 152° in crown glass or 1·47 N.A. Its mounting is arranged with an internal diaphragm, which is placed directly under the posterior system of lenses, and entirely contained in the tube comprising the mounting, so as to avoid the projection existing with other condensers, and allows the light to enter only from below. By revolving the milled ring of the mounting, the diaphragm is made to pass laterally from the centre to the extreme edge of the illuminator, thereby projecting a bundle of rays of any obliquity, between 0° (central illumination) and the extreme possible limit 1·47 N.A. When the diaphragm is at its extreme, a second slit, at right angles to it, giving the same volume of light, is opened by the further movement of the milled ring. The makers add that "the fact that it is used with only central illumination of the mirror, will prove especially valuable to those who do not possess instruments with the modern swinging substage and mirror bar."

Bausch's Paraboloid.*—Mr. E. Bausch describes a new form of paraboloid in which the hemispherical hollow in the top is left clear,

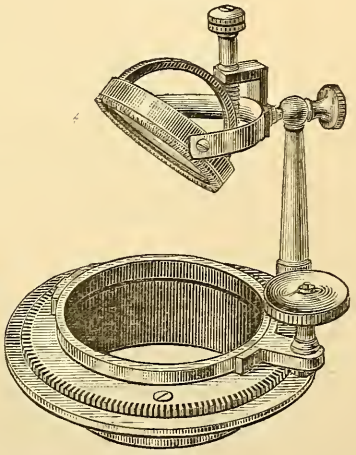
* Proc. Amer. Soc. Micr. 1881, p. 88.

there being a blackened brass cup to fit into it when desired. A hemispherical glass lens fits in the same hollow, "optical contact" being made between the paraboloid and the lens by glycerine and a homogeneous medium. There is also an opening in the side for the admission of light, all other light being stopped out.

The apparatus can thus be used as a Wenham reflex illuminator or an ordinary paraboloid, at the same time providing a hemispherical lens if required.

Browning's Simple Heliostat.—Fig. 79 shows a simple form of heliostat for the Microscope. It is provided with three movements:—(1) The rotation in the vertical plane of the inner cylindrical fitting, carrying the mirror arm, on the fixed toothed disk, by the large milled head; (2) The inclination of the mirror in the double gimbal fitting by means of the endless screw (milled head to the right) acting upon a countersunk worm on the posterior sector forming the inner arc of the gimbal; (3) The rotation of the entire gimbal-mounting of the mirror by the milled head beneath (this movement serving principally for the first adjustment of the mirror to the direction in the horizontal plane in which the reflected beam is to be utilized).

Fig. 79.



The particular heliostat figured was adapted for mounting in the substage of a Microscope which in that case would have to be inclined so that the optic axis is parallel with the pole of the earth. The mirror being then adjusted to the direction required, the beam of reflected light would be maintained on the same spot by the simple rotation of the mirror arm on the toothed disk, acting as the hour circle of an equatorially mounted telescope, the inner gimbal arc acting as the declination circle.

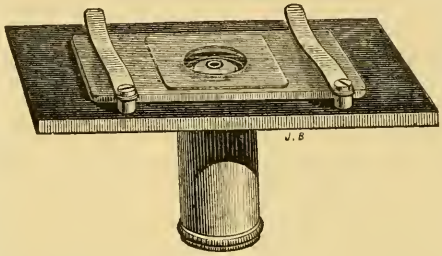
It can also (and probably better), be mounted vertically upon a separate stand apart from the Microscope, or in a shutter exposed to a southern aspect.

Hayem and Nachet's Modified Hæmatometer.—This is now arranged as shown in Figs. 80–82, and is thus described by M. Nachet:—

"The hæmatometer, formed of a cell with a flat base, devised by Dr. G. Hayem and myself some years ago, has been adopted by the different authors who have experimented on the number of the blood-corpuscles. Some modifications have been made in the apparatus, without changing it essentially, amongst which may be noted the

attempt to do away with the eye-piece micrometer ruled in squares. Drs. Thomas and Gowers suggested engraving the lines on the base of the cell itself, an eye-piece micrometer being replaced by an objective micrometer. It is, however, in the first place, nearly impossible to

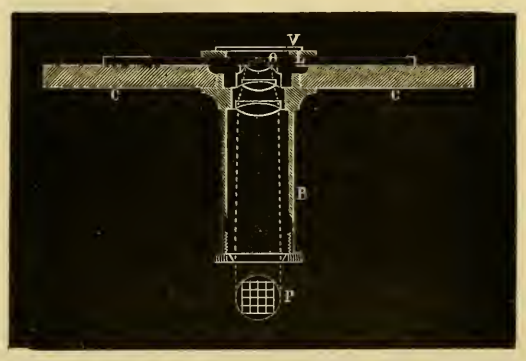
Fig. 80.



engrave lines as fine as are required on such smooth and polished glass as that of which the cell is made, so as to be clearly visible; there is also the risk of breakage, &c., and the inconvenience that when the cell is filled with the liquid, the lines are still fainter and unsuitable for being easily seen.

The new arrangement consists of a metal plate C C, to which a

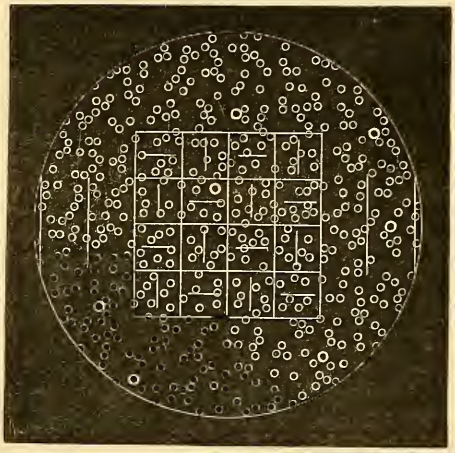
Fig. 81.



tube B, about 20 mm. long, is screwed, containing on its upper part a system of lenses, intended to form a very small image of a set of divisions P in squares, engraved or photographed on glass, and placed at the lower end of the tube. The tube is introduced into the opening of the stage, and on the plate C C is placed the cell of the hæmatometer, containing the liquid with the globules in suspension. These soon fall to the bottom plate of the cell, and the focus of the lenses being exactly upon this plate at O, the image of the squares P is formed there and is visible through the Microscope, at the same time as that of the globules (see Fig. 82).

By this means all the inconveniences attendant upon engraving the divisions at the bottom of the cell are avoided. The divisions may be as exact and as strongly marked as possible, the image

Fig. 82.



depending entirely upon the intensity of the photograph and its size on the reciprocal distance of P and O."

Fasoldt's Test-plate.*—Professor R. Hitchcock does not consider that the diffraction spectra alleged to have been seen by Mr. Fasoldt are any proof of the presence of the separate lines claimed, and "would like Mr. Fasoldt to inform us how fine the individual lines of his wonderful plate are? If the plate has 1,000,000 lines to the inch, the individual lines cannot be broader than half a millionth of an inch. Can such fine lines be ruled? Then it is a question in mechanics, whether a tool can be made so steady that it can draw a line without a tremor of half a millionth of an inch—for if not, then the lines of the plate must run together.

"In regard to the first question, there is already some evidence that Mr. Fasoldt's assumption is not justified. Professor W. A. Rogers ruled a plate with his machine set for 500,000 lines to the inch, making every fifth and tenth line longer than the rest. He then measured the long lines, where they projected from the band, and found that they were so broad, that they overlapped each other, leaving no spaces between them. Evidently, therefore, the band of 500,000 lines did not consist of distinct lines. The spectra were, nevertheless, clear and bright. Hence, we are forced to conclude that the spectra do not prove that Mr. Fasoldt's plate contains 1,000,000 lines to the inch."

We have not seen Mr. Fasoldt's claim as to the diffraction spectra

* Amer. Mon. Micr. Journ., iii. (1882) pp. 52–3.

and do not know how it is worded, but however worded any such claim must originate in a very strange misconception.

The number of lines to an inch capable of being resolved are defined by the equation

$$\delta = \tfrac{1}{2} \frac{\lambda}{n \sin u}.$$

Taking λ for simplicity at $\frac{1}{50000}$ inch (instead of ·5269 μ), and u to be 180° (sin u being = 1), it will be seen that for δ to give 1,000,000 lines to an inch, n—the refractive index of the immersion medium (and with it the objective and the test-plate)—must be made of a substance whose refractive index is 10. What is this wonderful substance—the philosopher's stone of the microscopist?

Or to put the same point in another way:—

The diffraction spectra of lines 145,000 to the inch, can only just be got into the back lens of a homogeneous-immersion objective of 1·50 N.A. To get in the diffraction spectra of 1,000,000 to the inch, the aperture must have been not less than 10 N.A.! How has this aperture been obtained at a time too when we are congratulating ourselves on having reached 1·47 N.A.?

The visibility of the diffraction spectra, so far from proving the existence of lines at the rate of 1,000,000 to an inch, is conclusive proof that they do *not* exist, and that nothing beyond 150,000 at any rate could have been observed.

High Resolving-power.—We have been referred to what is termed a claim of Dr. T. S. Up de Graff to have resolved lines as fine as 152,400 to the inch. Dr. De Graff's statement is, however, simply that he has resolved the last band of Fasoldt's 19-band plate, and he is careful to add "152,400 to an inch, the number of lines *claimed* by the maker to be ruled in this band" (italics in original). While, therefore, fully accepting the observer's statement that the lines which he did resolve were true and not spurious lines, we have, of course, to wait for the demonstration that the maker's claim is correct before commencing again, with clean boards, to endeavour to establish a theory of resolution! The theoretical resolving power of the largest apertured lens yet made (Powell and Lealand's 1·47 N.A.) is about 141,500 lines to an inch.

Binocular Microscopes.*—Professor R. Hitchcock, in discussing the question whether there is any real advantage in binocular over monocular instruments, thinks that the problem is a very difficult one if we attempt to decide on theoretical grounds what effect any particular binocular arrangement will have when applied to the examination of a specified object; to explain how much of the appearance of relief is real, and how much is merely a mental impression produced by the two images in the two eyes.

He, therefore, prefers to confine the discussion to the practical side of the subject. "If the question is whether there is any advantage in a binocular Microscope in studying the form of objects—

* Amer. Mon. Micr. Journ., iii. (1882) pp. 45-8 (8 figs.).

whether the appearance of relief that it gives is necessary to enable us to form a correct idea of the true shape of objects in which the appearance of relief is most striking—the answer must be a decided negative. It is true that the binocular does reveal more of the form of an object at the first glance than the monocular; but it is a matter of experience that those who use only one eye in microscopical work, never make the mistake of supposing that an object is flat merely because it seems to be so. A very short experience enables one to form a perfectly correct idea of the shape of any object by a few turns of the focussing screw. Hence, persons whose means are limited, and who desire to invest a small sum of money in a Microscope to be used for purposes of study, would do well to forego any thought of purchasing binocular stands.

"On the other hand, there are certain qualities of binoculars which commend them to all workers who can afford the additional cost. Apart from any stereoscopic effects it is doubtless true that the use of two eyes whenever possible renders continued observation less tiresome than when only one can be applied to the tube. Some writers have stated that with a monocular one eye is overstrained while the other is not used at all, contending that by using the binocular that trouble is overcome. The two eyes should be used alternately with the monocular, hence they ought to become trained for sharpness of vision, but we doubt if the binocular aids in the way assumed, for we are inclined to believe that although both eyes are simultaneously employed with the binocular, the right eye does most of the real work, the left eye only supplementing its fellow and giving the binocular effect. However this may be, there is a certain ease in working with binoculars which doubtless makes the strain upon the eyes less than with monoculars.

"The stereoscopic effects, while not of great practical importance as already stated, certainly render many objects more attractive to look at. For this reason a Microscope for the entertainment and instruction of friends should certainly be a binocular."

Mr. G. E. Fell also discusses the binocular Microscope and stereoscopic vision,* and the objections that have been made to such instruments, at the same time describing the Powell and Lealand, Nachet, Wenham, Tolles, H. L. Smith, Abbe, and Barnard forms. He is inclined to believe that a trifling temporary defect in the faculty of consentaneous focalization may be produced by the continued use of one eye with the monocular, so that the microscopist may be really incapacitated for realizing the advantage or effect of stereoscopic vision with the binocular, but he does not agree that the convergence of the tubes produces an unnatural straining of the lateral recti muscles, as the angle of that convergence is about equal to that of the eyes in ordinary observation at 10 to 12 inches.

Professor Hamilton L. Smith† prefers the Nachet binocular, though he considers that the Wenham binocular "is beautifully simple in theory and, except for one thing, perfect in practice. The one great

* Proc. Amer. Soc. Micr., 1881, pp. 69–83 (8 figs.).
† Ibid., pp. 89–91.

fault is it necessitates a very quick convergence of the optical axis. . . . With young eyes and nominally sound this difficulty is not distressing, but for older eyes it becomes annoying. Always upon looking up after using Wenham's binocular, for a while he had found an unpleasant feeling of readjustment of the eyes to the normal condition." He also thinks that "a trained eye would make out about as well and with less trouble the actual structure of any object under examination with the monocular as with the binocular—at least such was his own experience offered with much diffidence. For his own special work with high power and wide angles they are not really suited, but others engaged in another line of investigation requiring only medium power and low angles may find them serviceable."

Electric Light in Microscopy.*—Dr. H. Van Heurck describes his experiments with the electric light, commencing by pointing out that, notwithstanding the perfection of homogeneous-immersion objectives, which show readily delicate details, it frequently happens that the study of diatoms (particularly the small forms) gives considerable trouble, as well by the difficulty of resolving the striæ as by the impossibility of counting them with a low power. It is necessary, therefore, to have recourse to a high power, or even to monochromatic light, which is not always possible, as the sun is frequently hidden, particularly in winter. He has, therefore, for some time thought of the electric light for illumination with the Microscope, and his experiments have demonstrated that the incandescent electric light supplies the illumination *par excellence* which the microscopist requires.

The author then proceeds to treat of the *production* of the electricity, referring to the fact that in a probably near future the inhabitants of large towns will have electricity distributed at their doors, so that the necessities to be met will be principally those of microscopists who live in the country or in small centres. Two modes are at present open for the production of electricity, dynamo-electric machines and batteries. The former are, however, out of the question for the purpose under consideration, a small battery being capable of supplying all that is required at a small expense and little trouble.

As to the different forms of batteries the Bunsen is the most powerful, but the vapours which it gives off, and other points, render it unsuitable for microscopical purposes. In his original paper the author recommended the Tommasi battery, a modification of the former, as in every way preferable and cheaper, giving at the same time a full and detailed description of it, with woodcuts. He has since written us, however, that the battery of E. Regnier is still better and the Tommasi has been discarded. The former is thus described in a supplementary note:—

The Regnier battery has modified Daniell elements with very large surface. They consist of a narrow rectangular cell in copper ($45 \times 23 \times 5\frac{1}{2}$ cm.) within which is a zinc plate, closely enveloped

* Bull. Soc. Belg. Micr., vii. (1882) pp. lxii.-lxxiii. (3 figs.).

in a diaphragm of vegetable parchment, and then sewn up in a linen cloth. The cell is filled with pure water, and 400 grammes of sulphate of copper placed in the upper part. Thus charged, the battery will act during 24 hours, and these may be taken either all together or at different times, the battery losing nothing of its charge when it is not employed. When the battery is discharged (which may be known by the liquid becoming colourless) a third of the liquid is removed by an indiarubber tube and replaced by pure water and a new charge of sulphate of copper as before.

The author then treats of the *storage* of the electricity, and gives a woodcut of an "accumulator" made by E. Regnier on the Planté-Faure system. It consists essentially of two plates of lead, coated with a thick layer of minium, separated, wrapped in flannel, rolled upon themselves, and placed in a glass cylinder, well closed, and containing water acidulated with 10 per cent. of sulphuric acid. On leaving off work in the evening a series of these accumulators can be connected with the battery and left until the following evening, and a sufficient amount of electricity will have been stored up for further use.

The third point dealt with is *lamps*. The arc light is inadmissible, and only the incandescent lamps can properly be used. Those not in a vacuum are very good for photo-micrography, but are too brilliant for ordinary work. Of incandescent lamps in a vacuum or rarefied medium (Swan, Edison, and Maxim) the author prefers those of Swan, which can be worked with a force much less than the Maxim lamps. He obtained from Newcastle some special lamps, eminently suitable for microscopical researches, and now employs those exclusively. They are nearly spherical, and are about 3 cm. in diameter, giving a brilliant light with very little expenditure of force. For obtaining a beautiful white light 5–7 Tommasi elements or 3 or 4 accumulators are sufficient. The 4 accumulators will feed the little lamp for more than 12 hours, and a permanent light could therefore be obtained by putting the battery in operation once or twice a week.

The above details refer, as will be seen, to the Tommasi battery. In the note as to the new battery the author only says "for the little microscope Swan lamps, 5 Regnier elements and an accumulator must be employed."

The *advantages* to be obtained from the employment of the electric light by the microscopist are of two kinds, which the author classifies under the head of "Illumination of the Microscope" and "Photo-micrography." As to the first, he says that "The incandescent electric light surpasses all other illumination. It has the softness of a good petroleum lamp, and shows delicate details nearly as well as monochromatic light. The delicate striæ of *Amphipleura* and the 19th band of Nobert's test are seen with perfect sharpness. Professor Abbe, to whom we communicated the result of our researches, attributes it to two causes, 1st, the much greater whiteness of the light; consequently it contains more blue and violet rays. But, as it has been demonstrated by the measurements made by the Professor with different monochromatic lights, that the resolving-power of an

objective of given aperture increases in the same ratio as the wave-length of the light employed diminishes, it follows that the electric light ought to show delicate details more easily than the yellow light of gas or lamps. 2nd. The specific intensity of the electric light being much more considerable than that of other artificial lights, sufficient illumination is obtained with a pencil much narrower than that which must be employed to obtain the same luminous intensity with gas or diffused daylight. Rays much more oblique can therefore be used."

The lamp should be placed in a small box, the cover of which is pierced with an opening. The Microscope is placed on the box, the mirror being turned away from the axis or entirely removed. The light of the lamp is then concentrated by a plano-convex lens and directed into the condenser.

The use of the electric light also allows the microscopist at any moment to photograph an object in the field, and directions are given for proceeding on the dry plate method.

Definition of Natural and Artificial Objects.*—In some "Recollections of my Life," T. Baumann says that the difference between a natural and an artificial object cannot be more briefly or more precisely defined than by saying that under the Microscope the natural object is always more beautiful and the artificial one always more imperfect the more the magnifying power is increased.

Cole's "Studies in Microscopical Science."—Mr. A. C. Cole has projected a weekly periodical under this title "for the use of students, professors and teachers, the medical profession, and others interested in the progress of the natural sciences or engaged in higher education . . . to meet a want, which, even in these days of practical teaching, is felt by every student commencing the study of the natural sciences equally with those who are desirous of devoting their leisure to scientific pursuits.

"It is proposed by means of a carefully prepared and typical object for the Microscope, together with a drawing and descriptive essay, to supply students, microscopists, and members of the medical profession, with a ready means for studying, 1. Microscopical biology in all its branches, 2. The physiological and pathological histology of the body. 3. The essentially modern sciences of microscopical palæontology, mineralogy, and petrology.

"Subscribers will be entitled to receive every week: 1. A microscopical preparation of the highest class and most perfect finish. 2. A printed description of the preparation, in which will be noted: *a*. The literature concerning it. *b*. The habitat, &c. *c*. The methods employed in its preparation as a means of study. *d*. Its principal features, and any necessary additional remarks. 3. A lithographed or engraved drawing, or diagram, of the preparation, in the execution of which the following details will be most carefully considered and adhered to. *a*. Accuracy. *b*. Finish. *c*. Indication of Natural Size, &c.

"The preparations during the first year will consist of a series

* Zeitschr. f. Instrumentenk., ii. (1882) pp. 46-51.

of 26 histological, 18 botanical, and 8 petrological sections issued alternately, and from time to time special subjects will be illustrated by a complete series of preparations with their accompanying drawings and descriptions.

"Announcements will be made for the benefit of special students and practical instruction by this means afforded to those desirous of studying such works as—

Elementary Biology ..	*Huxley and Martin, Parker, &c.*
Practical Histology ..	*Klein, Ranvier, Rutherford, Schäfer, &c.*
Practical Botany ..	*De Bary, Prantl, Sachs, Thomé, Vines, &c.*
Practical Zoology ..	*Claus, Gegenbaur, Huxley, Parker, &c.*
Practical Geology ..	*Geikie, Rosenbusch, Rutley, Zirkel, &c.*

"It is intended that each series when complete shall form a most thoroughly practical work upon the subjects illustrated.

"The letterpress accompanying each series of preparations will afford demonstrations in the special department illustrated, and will thus assist students very materially in their work for university honours, degrees, &c. The drawings and letterpress will be uniform in size, a preface and index will be added, and a suitable case supplied at the end of each year in which the separate numbers can be bound. Small cabinets to contain the preparations, numbered and arranged in such a manner that any object may be readily found on referring to the letterpress (and *vice versâ*) will also be supplied."

The first number, which is before us, deals with yellow fibro-cartilage. After a full description of the specimen, which is a longitudinal vertical section of the pinna of the ear of the cow stained with logwood and eosin, the action of reagents is described. The various methods of preparation which can be adopted for staining and mounting are detailed very fully and completely, and will be found of great practical value. A Bibliography is added in which 37 books and articles are noted. An excellent coloured plate shows the appearance of a section × 333. The second part deals in a similar way with a section of copper beech, stained carmine and iodine green. The plate shows the section × 25.

Mr. Cole's idea appears to us to be an excellent one in every respect, and there is no doubt as to his capability of carrying it out as announced, especially as regards the practical branches of the subject, in which he has acquired a very wide reputation. It only remains for those (and they ought not to be few) who are interested in the success of the scheme to support it.

Journal of the Postal Microscopical Society.—The first number of this quarterly journal has just been issued (56 pp. 9 figs. and 5 plates), containing a considerable amount of useful matter, as will be seen from the following list of contents:—History of the Society; Numerical Aperture; Microscopical examination of Chlorophyll, Inulin, and Protein-crystals; *Tubifex rivulorum;* Diatoms; How to prepare Foraminifera; Lichens. There are notes by Mr. Tuffen West on the slides that have passed through his hands whilst President, and a selection of notes from the Society's note-books, with short notes on preparation and mounting, reviews, apparatus, reports of the Bath Microscopical Society, and Correspondence. If the future

numbers of the journal are equal to the first it will be a very useful one, and should be supported by all the members of the Society.

Aperture Diaphragm. [*Ante*, p. 262.]
Journ. Post. Micr. Soc., I. (1882) p. 51 (2 figs.).

Aylward's (H. P.) Working Microscope.
North. Microscopist, II. (1882) pp. 90–1.

Baumann, T.—Erinnerungen aus meinem Leben, ein Beitrag zur Geschichte der Präcisionsmechanik. (Recollections from My Life, a Contribution to the History of Precision-mechanics.)
[Includes definition of natural and artificial objects, *supra*, p. 420.]
Zeitschr. f. Instrumentenk., II. (1882) pp. 46–51.

Bausch & Lomb Co.'s New Trichinoscope. [*Ante*, p. 258.]
Amer. Natural., XVI. (1882) pp. 429–31 (2 figs.).

Bausch's Homogeneous-Immersion Objectives.
[$\frac{1}{4}$ to $\frac{1}{25}$—140° crown-glass angle—adjustable for water or glycerine immersion.]
Amer. Natural., XVI. (1882) pp. 347.

Blackham, G. E.—Remarks on New Immersion Objectives.
["Do not be troubled or deterred from efforts by 'theoretical limits,' no matter how high the authority that sets them. Newton's dictum as to the impossibility of constructing an achromatic telescope was a stumbling-block in the progress of optical construction and astronomical observation for years, and Mr. Wenham's count of 82° balsam (1·00 N.A.), had it not been disregarded, would have proved an equal barrier in the path of microscopical progress."]
Bausch & Lomb Optical Co.'s Supplement to Catalogue, Feb. 1882, p. 7.

Bolton, T.—Parkes' Class Microscope. [*Supra*, p. 395.]
Journ. Post. Micr. Soc., I. (1882) pp. 52, 55 (2 figs.).

C., F.—Microscopical Club.
[Reply to H. C. S. as to the formation of such a club.]
Engl. Mech., XXXV. (1882) p. 80.

Cox, J. D.—Telescopic Field and Microscopic Aperture.
Amer. Mon. Micr. Journ., III. (1882) pp. 61–9 (3 figs.) p. 76.

Crisp, F.—Notes sur l'ouverture, la vision microscopique et la valeur des objectifs à immersion à grand angle (Notes on Aperture, Microscopical Vision, and the value of wide-angled Immersion Objectives)—*contd.*
[Transl. of paper I. (1881) pp. 303–60.]
Journ. de Microgr., VI. (1882) pp. 143–5, 190–3.

Croullebois, M.—Théorie élémentaire des Lentilles épaisses. (Elementary Theory of Thick Lenses.)
[Geometrical explanation of Gauss's theory—Compound Microscope, pp. 82–3.] x. & 117 pp. (50 figs.). 8vo, Paris, 1882.

D., E. T.—On Drawing and Painting from the Microscope.
[Neutral tint reflector has often been a snare and delusion to young draughtsmen on account of the reversal of the image, which renders it difficult to fill in the drawing from the Microscope afterwards—prefers the Wollaston.]
Sci.-Gossip, 1882, p. 74.

" " The Microscope and Fine Art.
[General remarks on Microscopical drawing and painting.]
Sci.-Gossip, 1882, pp. 97–8.

Dancer, J. B.—On a Method of Mounting the Limiting Apertures for Increasing the Penetrating Power of Objectives. [*Supra*, p. 407.]
North. Microscopist, II. (1882) p. 92.

Davis, G. E.—The Aperture Shutter.
[Further remarks as to the origin of the suggestion.]
North. Microscopist, II. (1882) pp. 88–90 (2 figs.) p. 128.

" " Electric Light for Microscopy.
[Notes as to a trial of the Swan lamp in 1881.]
North. Microscopist, II. (1882) p. 129.

Deby, J.—Apparatus for obtaining monochromatic light.
[The beam of light from the lamp is condensed by a large bull's-eye, passed through a slit, and refracted by a bisulphide of carbon prism.]

Dittmar, W.—Mikroskopische Ablesevorrichtung für feine Waagen. (Microscopical reading apparatus for fine balances.)

[Recommends a Microscope for reading off the scale.]

Zeitschr. f. Instrumentenk., II. (1882) pp. 63–4.

"English Mechanic" Microscopical Society.

[Suggestions for working the proposed Society.]

Engl. Mech., XXXV. (1882) p. 195.

Ermengem, E. van.—The Vertical Illuminator.

[Transl. of paper in 'Bull. Soc. Belg. Micr.,' *ante*, p. 266.]

Amer. Mon. Micr. Journ., III. (1882) pp. 48–9.

Flesch, M.—Einfache Vorrichtung zum Wiederauffinden wichtiger Stellen in Mikroskopischen Präparaten. (Simple contrivance for finding again important points in microscopical preparations.) [*Supra*, p. 409.]

Arch. f. Mikr. Anat., XX. (1882) pp. 502–3 (1 fig.).

„ „ Ueber einige Verbesserungen an Seibert und Krafft's Mikroskop-Stativ. (On some improvements in Seibert and Krafft's microscope-stand.)

[The tube, instead of sliding in a socket, moves by a pinion on a brass plate, the edges of which slide in grooves attached to the tube (similar in short to the usual English plan). This allows the tube to be more securely fixed and to be raised higher from the stage when low powers are required. The analyzer and polarizer can also be more readily placed in any given relative position. The tube is blackened inside.]

Arch. f. Mikr. Anat., XX. (1882) pp. 504–5.

Hardy, J. D.—On an improved Compressorium.

Journ. Quek. Micr. Club, I. (1882) pp. 35–6, 51–2 (2 figs.).

Heurck, H. van.—La lumière électrique appliquée aux recherches de la micrographie. (The electric light applied to microscopical researches.) [*Supra*, p. 418.]

Bull. Soc. Belg. Micr., VII. (1882) pp. lxii.–lxxiii. (3 figs.).

Sep. repr. also with additional note on the new Regnier Battery.

Hitchcock, R.—Binocular Microscopes. [*Supra*, p. 416.]

Amer. Mon. Micr. Journ., III. (1882) pp. 45–8 (8 figs.).

„ „ About Stands.

[Reply to query of the Editors of the 'Botanical Gazette,' (". . . Is it a fact that the extra appliances, &c., are more things of 'fuss and feather' than fruitful additions to biological laboratories?") That some accessories are certainly important, but there is a long list of them which embraces many that are quite useless, and very many others that are mere conveniences. Some few are almost indispensable, and Microscopes should be purchased with substages in every case.]

Amer. Mon. Micr. Journ., III. (1882) p. 54.

„ „ A New Form of Vertical Illuminator. [*Supra*, p. 409.]

Amer. Mon. Micr. Journ., III. (1882) pp. 54, 78.

„ „ "The Microscope."

[Further remarks as to Prof. Stowell's Journal.]

Amer. Mon. Micr. Journ., III. (1882) p. 58.

„ „ The Microscope in Medicine.

[Complaint of the want of interest in practical Microscopy among Physicians.]

Amer. Mon. Micr. Journ., III. (1882) pp. 75–6.

„ „ Ruled Lines as Tests.

["Resolving power alone is not a test to be depended on."]

Amer. Mon. Micr. Journ., III. (1882) pp. 77–8.

Holmes, E.—What is the meaning of × ?

[Reply to T. R. J. *infra* who "is confusing himself needlessly." "If a drawing of a man 5 feet high be made 20 feet he is × 4 whether the grain of his skin becomes visible or not."]

Sci.-Gossip, 1882, p. 114.

J., T. R.—What is the meaning of the sign × ?

[Points out the error in describing a drawing as × 500 when it is drawn from an object × 50, and the drawing enlarged 10 times—"unless there be detail corresponding with the amplitude the object is not × so many diameters."]

Sci.-Gossip, 1882, p. 89.

KAIN, —.—Drawing Microscopic Objects.

["Mr. Kain showed (at a meeting of the Camden Society) a method of throwing the image downward by means of a convex mirror, and receiving the magnified image upon a sheet of white paper placed upon the table. It could then be traced without difficulty."]

Amer. Mon. Micr. Journ., III. (1882) p. 59.

KAIN, C. H.—Photo-micrography.

Amer. Mon. Micr. Journ., III. (1882) pp. 71–2, 75.

LOSSNER, O. W.—Telemikroskop (Telemicroscope).

[Abstract of German patent for a combination of a Microscope and a Telescope, D. R. P. 16672, 5th Apr. 1881.]

Zeitschr. f. Instrumentenk., II. (1882) p. 156.

MARTENS, A.—Instrumentenstativ mit Kugelgelenken und Klemmringen. (Microscope-stand with ball joints and fastening rings.)

Zeitschr. f. Instrumentenk., II. (1882) p. 112 (1 fig.).

MATTHIESSEN, L.—Die mittleren Brechungsindices fester und flüssiger Körper im Vergleich mit ihrer Totaldispersion. (The mean refractive indices of solid and fluid substances in comparison with their total dispersions.)

Centr.-Ztg. f. Opt. u. Mcd., III. (1882) pp. 73–4.

Microscope and Magic-lantern.

[Remarks as to the best objectives by "Sunlight."]

Engl. Mech., XXXV. (1882) p. 202.

MORRISON, —.—Drawing Microscopic Objects.

["Mr. Morrison showed (at a meeting of the Camden Society) an arrangement on the plan of a camera-obscura by which the image was thrown upwards upon a piece of transparent paper placed upon a plate of plain glass."] *Amer. Mon. Micr. Journ.*, III. (1882) p. 59.

Mounting Micro. Lenses.

[Directions by "Prismatique," W. J. Lancaster, and "Micro."]

Engl. Mech., XXXV. (1882) pp. 180, 199, 227.

Objectives and Eye-pieces, best method of determining focal length of.

[Suggestion that Prof. Abbe should give a "short exposition of the subject," with diagrams by Akakia.] *Engl. Mech.*, XXXV. (1882) p. 227.

Objectives, Verification Department for.

[Tabular results of measurements of objectives (*contd.*).]

North. Microscopist, II. (1882) pp. 87, 107, 128–9.

OLLARD, J. A.—Microscopical Drawings.

[Recommends as a simple camera lucida "Forrest's Reflector,"—a thin glass cover adjusted to the eye-piece.] *Sci.-Gossip*, 1882, p. 90.

PINKERNELLE, W.—Apparat zur Erleichterung der mikroskop. Untersuchung von Flüssigkeiten. (Apparatus for facilitating the microscopical investigation of fluids.) *German Patent, No.* 18071, *31st May*, 1881.

Postal Microscopical Society, History of.

Journ. Post. Micr. Soc., I. (1882) pp. 4–7.

President's Address (*contd.*). *Engl. Mech.*, XXXV. (1882) pp. 213–5.

SCHRÖDER, H.—Ueber Projections-Mikroskope. (On projection Microscopes.)

[Abstr. of original article, *ante*, p. 274.]

Zeitschr. f. Instrumentenk., II. (1882) p. 71 (1 fig.).

VEREKER, J. G. P.—Numerical Aperture.

Journ. Post. Micr. Soc., I. (1882) pp. 7–12 (5 figs.).

WENHAM'S Universal Inclining and Rotating Microscope.

This Journal, II. (1882) pp. 255–7 (4 figs. and 1 pl.).
Engl. Mech., XXXV. (1882) pp. 143–5 (5 figs.).
North. Microscopist, II. (1882) pp. 108–10 (1 pl.).

[Remarks by F.R.M.S., supplementing the previous description, and dealing with (1) general design, (2) fine adjustment, (3) stage, (4) diaphragms and substage centering motions.]

Engl. Mech., XXXV. (1882) p. 195.

[Claim by "Another F.R.M.S." that it is the invention of Dr. Edmunds, and replies by F. H. Wenham, Ross and Co., and J. M. Moss; and further remarks by "Another F.R.M.S.," "Yet Another F.R.M.S.," and "Akakia." *Supra*, p. 400.]

Engl. Mech., XXXV. (1882) pp. 217, 237, 260. and 261.

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

Colouring Living Microscopical Organisms.*—A. Certes points out that distilled and ordinary fresh water are toxic to marine Infusoria, and a great number of species which live in water of very different density and chemical composition.

In these special cases the colouring of *living* Infusoria will not succeed, or only very imperfectly, unless care is taken to use a solution of the colouring material prepared with the water which it is desired to examine.

The difficulties attendant upon the above procedure may be avoided by the following process, which has also the advantage that no foreign organisms are introduced. Place on the slide a drop of the *alcoholic solution* (1 : 1000) of the reagent, cyanine, B B B B B violet, gentian violet, dahlia, Bismarck brown, &c. Spread out the liquid with a glass rod and let it evaporate. When the evaporation is complete, or nearly complete, add a drop of the water (fresh or salt) intended to be studied and put on the cover-glass. Almost immediately, if the dose has been well calculated, the phenomena of paralysis and of colouring of the Infusoria may be observed.

In this way the author has coloured several species of *Vorticellæ*, *Paramecia*, *Amœbæ*, *Polytoma uvella* (flagellate) and Bacteria.

Mounting Histological Preparations with Carbolic Acid and Balsam.†—Mr. G. E. Fell transfers the prepared sections from the alcoholic preservative fluid to a clean slip and pours strong carbolic acid over the object immediately, allowing it to run off at one corner of the slide into a suitable receptacle. A thin cover-glass previously prepared with Canada balsam is then quickly applied, the balsam replacing the carbolic acid which, owing to its short contact with the tissue of the preparation, does not produce in it any appreciable shrinkage while still acting as a clearing agent. Pouring the alcohol over the preparation on the slide (followed by the carbolic acid) and allowing it to run off again, removes the extraneous filaments, bits of dust, &c., from about the specimen.

Dr. R. G. Mohr‡ considers, however, that it is scarcely worth while to experiment with carbolic acid for histological mounts, as Seiler's method of mounting in alcohol balsam is so simple and perfect as to leave nothing more to be desired.

Differentiating Motor and Sensory Nerves.§—By the method adopted by L. Löwe and entitled "Method for obtaining preparations which demonstrate the structural difference between motor and sensory nerves, and are hence adapted for enabling the course of the fibres of the peripheral system of nerves to be traced," a fœtal rabbit, 3 to 4 centimetres in length, taken from the mother during life,

* Sep. repr. Bull. Soc. Zool. France, vi. (1881). See the author's previous papers, *ante*, pp. 279 and 280.

† Proc. Amer. Soc. Micr., 1881, p 87.

‡ Ibid., p. 88.

§ Zool. Anzeiger, iii. (1880) p. 503.

is placed for three months in not less than one litre of saturated solution of bichromate of potash, and the liquid changed twice; the bichromate is then carefully washed out with water, and the specimen finally stained entire in one litre of a weakly ammoniacal solution of carminate of ammonia, and may then be prepared for cutting sections by imbedding in gum-glycerine in the usual way. The motor nerves are darkly stained, and the sensory nerves faintly so.

Preparing Nerve-fibrils of the Brain.* —For making preparations to show the nerve-fibrils of the brain, J. Stilling calls renewed attention to Von Recklinghausen's method of macerating well-hardened specimens in wood-vinegar.

Cochineal Carmine-solution.†—J. Czokor grinds to a fine powder 7 grammes of cochineal (the same amount whatever quality is used) with as much burnt alum, and mixes it with 700 grammes distilled water and boils it down to 400 grammes. After cooling, a trace of carbolic acid solution is added and the whole filtered. From time to time a little carbolic acid solution must be added, and the solution filtered again. It stains substances prepared with alcohol or with chromic acid, the latter rather more slowly than the former. A solution made with a better quality of cochineal stains the nuclei the same colour as hæmatoxylin, the other tissues in various shades of red; if it is prepared with "Blut"-cochineal the intermediate tissue is less deeply coloured, the action resembling that of Grenacher's carmine.

Polarized Light as an Addition to Staining.‡—Mr. A. D. Michael, describing a plan of which he and Dr. J. Matthews are joint authors, suggests that polarized light might be of use as an addition to staining for vegetable and some animal substances, as it seemed to differentiate tissues somewhat in the same way. In practice it might be found to have its disadvantages, but it might have its advantages. No special preparation of the tissues was required, and the conditions were more natural than if they had undergone the process of bleaching and staining. It would also be possible, when they had a known selenite, always to repeat the same effect when required, whereas stained tissues frequently fade, and if there were any doubt as to the meaning of what was seen, the effects could be altered, and results secured that would be unattainable with the fixed effects of double staining. There was, of course, no difficulty in getting triple staining, or producing various colours, but the object which he showed was as if stained with a single colour only. [It was a section of *Serjanus* shown with oblique polarized light on a black ground.] He had heard some discussion as to the best means of obtaining polarized light on a black ground, and had heard it suggested that the results depended entirely on the object, that it was to be obtained only now and then

* Arch. Mikr. Anat., xviii. (1880) p. 468.

† Arch. Mikr. Anat., xviii. (1880) pp. 412–14. Cf. Zool. Jahresber. Neapel for 1880, i. p. 42.

‡ Journ. Quek. Micr. Club, i. (1882) pp. 49–51.

in the case of certain objects which had a capacity for it, also that it depended on the size of the polarizing prism and other causes. No doubt these did affect it to some extent, but he was of opinion that the effect was largely a question of what the object was mounted in. He did not find that Canada balsam was the best medium; in fact, the best effects were obtained by mounting in glycerine, when there was very little difficulty in making out the details, and the object looked brighter upon a blacker ground as contrasted with its appearance when mounted in balsam. He thought the idea would be found worth attention, especially where it was desirable to examine objects under various conditions of direct and oblique light.

Mr. T. C. White, in the discussion which followed, said that he had always found a good deal of difficulty in using polarized light on objects mounted in glycerine; while Dr. Matthews, on the point of the superiority of glycerine over balsam for the kind of examination in question, described his experience as rather the reverse of Mr. Michael's. Whether this arose from any difference in the objects he could not say, but he thought the effect was probably due to some difference in their density; the only way of settling the point would be to mount the same objects in both ways. He also thought that with extremely oblique light, they got fringes of colour—probably owing to diffraction. Mr. Michael had been very successful in getting dark-ground illumination, but there appeared to be some curious effect produced by a spot lens, less colour being produced in that way than without, although it might be supposed that the contrary would be the case. As to the differentiation of tissues, precisely the same effects were obtained as by staining, but with the advantage that a harmonious appearance was always produced, whereas with staining the selective power caused differences of colour which were not always harmonious.

Wickersheimer's Preservative Liquid.*—To the wet and dry methods of preserving with this liquid G. Brösike adds a third, the "damp" method. The subject is injected with the liquid, and the separate parts are moistened with it during dissection, and then enclosed in an air-tight vessel. The method is suited to nerves, tendons, fasciæ, vessels, and ligaments; muscles become bleached under its action. It appears to have no real advantages over a proper treatment with spirit, and the fact of the liquid containing poison must be borne in mind.

Brösike takes this occasion to correct an important printer's error in the official patent.† Instead of 10 grammes of arsenious acid it should be 20 grammes.

Preparing Hæmoglobin Crystals.‡—By using pyrogallic acid, C. Wedl has prepared for studying with the Microscope, spectroscope, and polariscope, hæmoglobin crystals from the blood of man, other mammals, and frogs. The best plan is to remove the colouring

* Centralbl. f. med. Wiss., ii. (1880) pp. 17–19. Cf. Jahresber. Anat. Physiol., ix. (1880) p. 82.

† See this Journal, iii. (1880) pp. 325–6.

‡ Virchow's Archiv, lxxx. (1880) p. 172. Cf. Zool. Jahresber. Neapel for 1880, i. p. 57.

matter from the corpuscles by the action of water, and to place some of the solution of hæmoglobin thus obtained, under a cover-glass (which should be raised at one side by a slip of glass laid beneath it) adding some pyrogallic acid. Frog's blood, the colouring matter of which is very difficult to extract, must remain in a moist chamber for several days before the acid is applied; the crystals then appear within the corpuscles. (Kölliker has seen them similarly in the red corpuscles of *Perea fluviatilis*.) It usually requires several hours' treatment to produce the crystals; they will keep for some time in the fluid.

Preserving Flowers.*—For preserving the colours of parts of flowers which it is desired to mount for the Microscope, Mr. G. Stocker finds a saturated solution of the ordinary potash alum crystallized (Al_2 $3SO_4$, K_2 SO_4, 24 H_2O) most excellent. The objects should remain in the liquid for ten minutes or so, and then be dried between bibulous paper, placed in turpentine to render them transparent, and mounted in balsam. A portion of the vexillum of *Ulex Europœus* so mounted is without any of that reddishness which accompanies specimens mounted in the ordinary way; and a stigma of *Crocus sativus* is as full of colour as in its original state.

Cleaning Diatoms.†—Mr. K. M. Cunningham makes the following suggestion for cleaning diatomaceous material when largely contaminated with sand. "A quantity of the material is placed in a teaspoon, and water is then added until the teaspoon is nearly filled; the spoon is gently shaken with a back and forth or a circular motion, for a few seconds or longer, when the water must be quickly drawn off by applying the tip of a finger to the point of the spoon, taking care to draw off the superficial water, without allowing the heavier sediment to pass over the point. Pour from the spoon into a watch-glass, the surplus water is then drained off, and the diatoms removed for mounting. This method produces a magical concentration of the diatoms, large and small, making the remaining sand inconspicuous by the superabundance of the diatoms."

Gaule's Method of Imbedding.‡—The following method of imbedding was worked out by Dr. J. Gaule, by whom it was communicated to Professor E. A. Birge, who, having tried it on all sorts of tissue, can fully recommend it.

"A piece of tissue of convenient size is to be taken, treated with the ordinary reagents, and stained in the mass. If large it may be convenient to remove it from the staining fluid to alcohol for a few hours and then replace it. When thoroughly stained, the specimen is to be put in 70 per cent. alcohol for about twelve hours, then transferred to absolute alcohol until it is completely dehydrated. Then put it in oil of cloves overnight, or leave it there until it is convenient to imbed it. Place it in turpentine half an hour—large

* Sci.-Gossip, 1882, pp. 65–6.
† Amer. Mon. Micr. Journ., iii. (1882) p. 14.
‡ Ibid., pp. 73–5.

specimens for a longer time—then transfer it to a mixture of turpentine and paraffin, kept melted on a water-bath at about 40° C. In this the specimen, if from liver or intestine, &c., should remain for an hour or more; small nerves and blood-vessels of course need not remain so long. Then transfer it to a bath of pure paraffin, melted at a temperature of 60° C., and leave it for the same length of time. Indeed, if care be taken that the temperature does not materially exceed 60°, the specimen may remain as long as convenient. When the tissue is thoroughly saturated with melted paraffin, a small paper box may be filled with melted paraffin and the specimen placed in it to cool. If properly imbedded, a cut surface has a smooth and shining appearance. No line of division must appear between the specimen and surrounding paraffin. The whole mass should cut, as nearly as possible, like one homogeneous mass of paraffin.

The subsequent handling of the sections varies with their nature. Moderately thick sections of firm tissue may be placed in turpentine to remove the paraffin and mounted as usual in chloroform-balsam. Thin specimens, or those which come to pieces when the paraffin is removed, like thin sections of liver, &c., may be laid on the slide on which they are to be mounted, and the paraffin washed out by benzine, carefully applied by a dropping-tube; allow the benzine to evaporate, then lay on the cover-glass and apply thin chloroform-balsam at the edge of the cover. For exceedingly delicate specimens, such as embryos or osmic acid nerves, another method may be used. Lay the section on the slide, wet with absolute alcohol, and let the alcohol completely evaporate, leaving the specimen attached to the slide; carefully heat until the paraffin is softened or slightly melted. When cool, let a few drops of benzine—best applied with a brush—run over the section until most of the paraffin is gone. When dry, apply the cover-glass and put a thin solution of Canada-balsam in xylol to its edge. The xylol may be used instead of benzine, but it is more expensive.

This method is very convenient, especially for histological laboratories. The specimen once imbedded can be kept for years, and new sections cut as wanted. No change takes place in it, nor can it dry up. It is suited to all tissues. I have imbedded all vertebrate soft tissues, chick and trout embryos, hydras, snails, angle worms, clams, star-fishes, &c., with equal success in every case. The ease with which the sections can be made fully compensates for the time required to imbed. The merest tyro, provided with a good section-cutter, a brush to keep the sections from rolling, and such a specimen, must be a bungler indeed if he cannot cut at least thirty even sections from each millimetre of a moderate-sized specimen such as the œsophagus of a rabbit. With a little practice he should be able to cut a millimetre into one hundred sections without losing more than two. The writer has cut a frog's spinal cord so imbedded into 926 sections $\frac{1}{50}$ mm. thick in one day, and mounted them without losing any sections. No one who practises with these specimens will regard this as much of a feat; it is simply a

hard day's work. Specimens as large as the central hemisphere of a rabbit can be stained and imbedded whole.

I append my notes on the spinal cord of a frog, showing the times used in the various processes:—

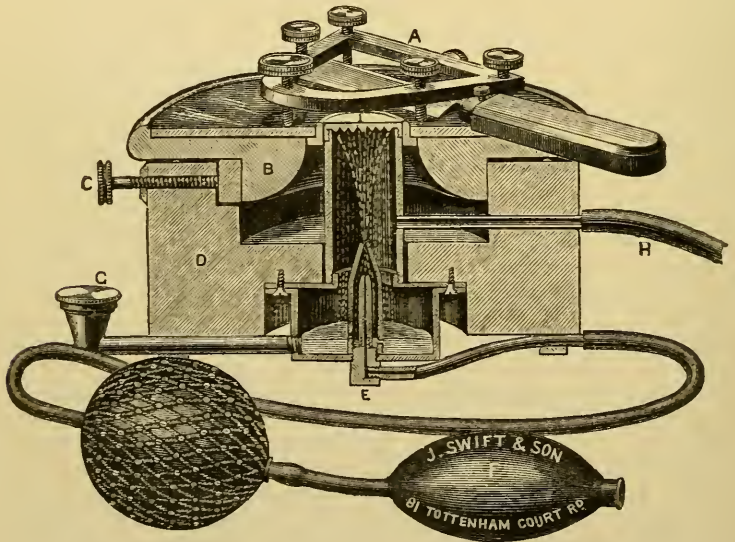
Cord put into 3 per cent. nitric acid, 2 hours.
Seventy per cent. alcohol, 6 hours.
Stained in hæmatoxylin, 4 hours.
Seventy per cent. alcohol, overnight.
Ninety-five per cent. alcohol, 24 hours.
Oil of cloves, 24 hours (did not wish to imbed till next day); then,
Turpentine, stir half-an-hour.
Turpentine and paraffin, 1 hour.
Paraffin, 1 hour.

It should be remembered that these cords imbed easily.

One caution further; select paraffin, if possible, which is bluish-transparent, and which rings slightly when struck. The white opaque sort is by no means as good. Any addition of paraffin-oil, turpentine, &c., to soften the paraffin, renders it granular and brittle, and is decidedly injurious to its cutting qualities."

Williams' Freezing Microtome adapted for Use with Ether.*— The original form of this Microtome was described and figured at pp. 697–9 of vol. i. (1881). It subsequently occurred to Mr. J. W.

Fig. 83.



Groves that it would be an improvement if it were adapted for the use of ether as a freezing agent instead of ice and salt. Mr. J. Swift

* Journ. Quek. Micr. Club, vi. (1881) pp. 293–5 (2 figs.).

accordingly worked out the details of the adaptation which is shown in Fig. 83. D represents the wooden bowl of the original form altered to hold the ether freezing apparatus. A and B are the razor frame and bowl-cover with the glass-plate top upon which the former is moved. The central brass cylinder, instead of being solid, is hollow, so that the ether spray may play up the inside and impinge upon the lower surface of the brass-plate I, upon the upper surface of which the material to be frozen is placed. In the figure, the hollowed cylinder is seen to open below into the ether-containing chamber, into the lower part of which also opens a horizontal tube, which turns up at right angles and ends in a funnel-shaped extremity G, over which screws a cap.

In the centre of the bottom of this chamber is a circular aperture closed by a piece of brass tubing, which passes up vertically to end in a cone with a very small aperture, and having another small hole in it towards the bottom. The lower end of this tube is plugged, and through the plug E passes vertically a very fine tube, which is continuous below with the tube from the apparatus for pumping in air. This consists of an indiarubber pump F, connected by a short piece of tubing with a slightly distensible ball covered with netting, and from the opposite side of which a piece of indiarubber tubing passes on towards E. In the side of the large hollow cylinder of the machine is inserted a small tube connected with a length of pipe H for the escape of the spray after use.

The method of freezing is as follows:—After the material has been partially hardened, and the hardening agent removed, place it on the brass plate I with a little gum mucilage;* then unscrew the cap G, fill the chamber with ether, replace the cap, and commence pumping by pressing the ball F vigorously and rapidly in the palm of the hand. Air will thus be pumped into the net-covered ball, from which it will issue in a continuous jet along the indiarubber tube, up the small tube, through the plug E, and again through the hole at the apex of the conical-ended vertical tube, to pass straight up against the under surface of the plate I. The rush of air thus produced causes pressure on the surface of the ether, and also tends to produce suction at the space between the small central tube and the one which has the conical extremity, so that the ether passes through the hole in the side of the latter tube, rises in the space between the two tubes, and is forced as a jet of spray through the hole in the cone, and so on to the under surface of the plate I. This is roughened in the form of teeth for the purpose of presenting a large area to be acted upon, and also to facilitate drainage. A great deal of the ether drops down into the chamber, and is used again, but a little passes out mingled with the air in such a finely atomized condition that it seems impossible to collect it, and it is therefore conveyed along the tube H to the external air.

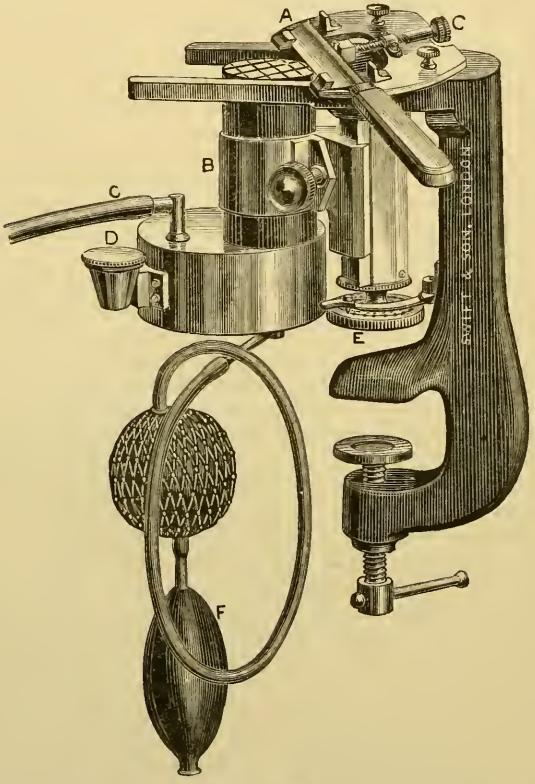
The advantages of the new form are that all mess with ice and salt is avoided, that ether can always be kept at hand, and that inhalation of the vapour is limited to the short period during which

* If the material is quite fresh the mucilage may be dispensed with.

the chamber is being filled. The labour of pumping may be reduced by placing the ball-pump between two pieces of wood hinged like lemon-squeezers. Material has been frozen in a room at 96 F. using ether of · 730 sp. gr.

Swift and Son's Improved Microtome.—In the microtome just described the sections are cut and their thickness regulated by the gradual descent of the knife towards the tissue to be operated upon. In order to reverse this process and provide a machine in which the tissue shall ascend towards the knife—as is the case in the ordinary form of section-cutters—Messrs. Swift and Son have brought out their new microtome, a drawing of which is given in Fig. 84, and which

Fig. 84.



is described as follows by Dr. S. Marsh in the new edition of his useful little work on section-cutting.

"The instrument consists of a massive iron upright, terminating at its lower extremity in a clamping arrangement, by which it may be securely fastened to the table. From the top of the upright two highly polished iron bars, lying parallel to each other, run horizontally for-

wards. These bars correspond to the cutting plate in the usual form of microtome, and upon them, as will be seen at A in the drawing, a flat brass frame carrying a knife is made to glide. The knife is kept firmly in position on this framework by means of the binding screw C, the end of which, terminating in a square clamp, presses against the back of the blade. The face of this clamp is grooved in different directions in such a manner that, according as the back of the blade is received into one or another of these grooves it is pushed from or drawn towards the level of the framework, thus affording a means by which the edge of the knife may be set at varying angles to the tissue to be cut. In front of the iron stand will be seen an angular upright pillar carrying in front of it a short length of sprung brass tube B, into which any of the apparatus presently to be described may be firmly fixed by a clamping screw. By means of a micrometer-screw E fixed at the base of the angular pillar, the sprung tube, and of course whatever it may carry, can be acted upon so as to raise or lower it at pleasure. The amount of movement thus effected is registered by the milled head of the screw, for which purpose three concentric circles have been drawn upon its face, each of which is so graduated that, as the face rotates from mark to mark, the distance traversed by the screw, and which of course determines the thickness of the section, will in the case of the outer circle be 1000th, in that of the middle 500th, and in the inner one 400th of an inch. The index by which these measurements are recorded consists of a spring catch so fitted that, as the milled head rotates, it drops into the divisions of the circles, into either of which it can be shifted at pleasure, or if desired can be thrown out of gear altogether. When it is intended to use the microtome for freezing with ether, the chamber provided for that purpose, and which in the engraving is shown in position, must be employed. This chamber is like the one already described when speaking of the Groves-Williams microtome, and consists of a reservoir for containing the ether and an upright cylinder leading from it, and terminating in a flat plate, upon which the object to be frozen lies. To use the machine, remove the cup D, fill the chamber with ether, then fix the cylinder in the clamp B, when the bellows F being worked the ether will project through the tubes in the interior of the chamber (which were described at p. 431), upon the plate holding the tissue, with the effect of speedily freezing it. When, under the action of the micrometer-screw, the object to be cut has moved upwards between the cutting bars sufficiently high for the purpose, sections are to be obtained by simply pushing the frame carrying the knife obliquely across the bars and through the tissue. For freezing purposes common methylated ether of a density of ·720 answers perfectly well. In winter when ice is plentiful, and where only a very small piece of tissue requires to be frozen, the freezing may be effected without the employment of ether. For this purpose it will be necessary to use Dr. Pritchard's solid freezer, Fig. 85. As will be seen, it consists of a solid metal block, having its upper surface, upon which the tissue to be frozen lies, roughened so as to prevent the specimen from slipping during section. For

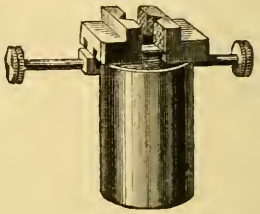
use, the block and tissue are frozen by being immersed in powdered ice and salt, then the block is secured in the clamp B, and sections cut in the manner just described. The microtome, though essentially a freezing one, may however be employed for cutting objects imbedded in paraffin. For carrying out this, the box shown in Fig. 86 has been provided. The tissue is to be imbedded in this box, and when the paraffin has become quite cold, the box must be secured in the clamp B and the tissue sectionized.

"Yet another piece of apparatus belongs to this machine. It is called an adjustable vice, and is shown in Fig. 87. It is the most useful accessory, and there has long been a want felt for something

Fig. 85.

Fig. 86.

Fig. 87.



of its kind. It consists of a cylinder carrying at its upper end the two jaws of a vice. One of the jaws is fixed, whilst the other, being movable, may be made to recede from or approach to its fellow by means of the screw, so that hard substances of different kinds and various sizes may be securely fixed and held between the jaws, when, the cylinder being inserted in the clamp B, sections may be readily obtained. To the really working microscopist, this little appliance will be found of infinite value in a thousand directions. The uses of it are so obvious that no words will be wasted in describing them."

Though in this form, as in the others, the section knife, when in use, is mounted on a frame, no absolute necessity for its adoption exists, for the construction of the microtome permits of the use of an unmounted knife as readily as one mounted on a frame. The frame arranged has some advantages, particularly in retaining the keenness of the blade for a considerable period (coming into contact with nothing but the tissue) and in the confidence which it gives to the inexperienced operator. On the other hand, it renders the disengagement of the sections from the knife both a tedious and unsafe process, and Dr. Marsh is strongly of opinion, as the result of a very considerable amount of practical work, that in the hands of those who by careful practice have taught themselves how to use it, a simple unguarded knife is to be preferred to any mechanical arrangement whatever.

Bausch and Lomb's Standard Self-Centering Turntable.—We were unable to give at p. 284 any description of this turntable, but the following has since been supplied by Mr. E. Bausch.

The self-centering arrangement of the turntable is easily manipulated. The jaws are compressed by springs, and bear gently against the slide, so that, although it is firmly held, there is no danger of mutilating its corners or breaking it. One-sixth of a revolution of the milled ring is sufficient to open the jaws to their full extent, and as this is easily done with one hand, the other is free to place the slides. The hand-rest is detachable from the turntable. It has on its lower surface an adjusting screw for varying the distance from the revolving disk.

For refinishing old slides, or others on which the object has not been well centered, a detachable pair of spring clips are provided. Concentric circles up to one inch diameter are turned on the disk.

Crystallised Fruit Salt.*—Mr. G. J. Wightman says that Eno's fruit salt, when crystallised, makes a magnificent polariscope object. The mode of preparation is as follows: In a small test tube, say $3 \times \frac{5}{8}$ inches, dissolve as much of the salt as would rest on a sixpence, by adding distilled water to the depth of an inch. With the end of a glass rod spread a few drops over an ordinary glass slip, and in a few minutes crystallisation will take place. The slide (with selenite) will be seen to be covered with numerous beautiful formations, each somewhat resembling a Maltese cross made up of brilliantly-coloured needle-like crystals. If it is held over the flame of a lamp as soon as the solution is placed on (so as to hasten crystallisation), the colours will be the more splendid without selenite. Other beautiful effects may be produced by the addition of a few drops of alcohol to the test tube. The slides, as soon as dry, may be mounted in Canada balsam.

Allen, F. J.—Cleaning Gizzards.
[Feed the insects on honey, syrup, or treacle, before killing them.]
Journ. Post. Micr. Soc., I. (1882) pp. 48–9.

Arnold, J. W. S.—Microscopical Laboratories.
[Comments, &c., on the previous articles on the same subject—also as to the superiority of small instruments.]
Amer. Mon. Micr. Journ., III. (1882) pp. 69–70, 75.

Basevi, Col.—Mounting Starches.
[Not in balsam, but dry or in glycerine jelly, and viewed as opaque objects.]
Journ. Post. Micr. Soc., I. (1882) pp. 49–50.

Birge, E. A.—On a Convenient Method of Imbedding.
[*Supra*, p. 428.]
Amer. Mon. Micr. Journ., III. (1882) pp. 73–5.

Blood Stains on Steel.
[Dr. M. C. White recognized and measured by means of the vertical illuminator and $\frac{1}{8}$-inch objective, blood-corpuscles upon a steel instrument that had been exposed during two winters in the woods.]
Amer. Natural., XVI. (1882) p. 347.

Bowman, F. H.—See Cotton *infra*.

Chalon, Listes de préparations histologiques et botaniques de M. (List of histological and botanical preparations of M. Chalon.)
Bull. Soc. Belg. Micr., VII. (1882) pp. liv.–vii.

---

* Sci.-Gossip, 1882, p. 64.

CHEESEMAN, E. L.—Home-made Apparatus for Collecting.

[Bottle-holder to be attached to a stick made of a narrow strip of sheet brass, and an ordinary gimlet-pointed wood-screw with the head flattened.]

Amer. Mon. Micr. Journ., III. (1882) p. 61 (1 fig.).

Coal-sections, Cutting.

[Notes by A. Smith, E. Holmes, and W. D. Smith, on Mr. Kitton's note *infra*—agreeing as to the failure of the carbonate of potash process.]

Sci.-Gossip, 1882, pp. 113–4.

Cotton Fibre, Structure of.

[Review of Dr. F. H. Bowman's book, *ante*, p. 119, with additional remarks.]

Amer. Natural., XVI. (1882) pp. 431–2.

DYCK, F. C. VAN.—Apparent Motions of Objects.

Amer. Mon. Micr. Journ., III. (1882) pp. 72–3.

ELCOCK, C.—How to Prepare Foraminifera.

[For recent Foraminifera *from sand*, such as shore-gatherings, dredgings, &c.—1. Well wash in fresh water to remove the salt. 2. Dry *perfectly*, and allow to get cold. 3. Sift (sieve No. 50 or 60). 4. Float the fine material in cold fresh water. 5. Dry the floatings. Perhaps it may also be found needful to—6. Boil the floatings in *liquor-potassæ*, B. P. 7. *Wash away every trace of potash.* 8. Dry. 9. Re-float in a beaker. 10. Dry again ready for mounting.]

Journ. Post. Micr. Soc., I. (1882) pp. 25–9.

ENOCK, F.—Metal Caps for Glycerine Mounts.

Journ. Quek. Micr. Club, I. (1881) p. 40.

FLEMING, J.—Mounting *Volvox Globator* in Glycerine Jelly.

[After a month's time the *Volvox* mounted in glycerine jelly, boiling, &c. in the usual way, "is perfect in form and colour, and the success of the attempt goes to prove that this Alga can be treated like any other, and may be boiled and pressed without the destruction of its shape."]

North. Microscopist, II. (1882) p. 129.

GOTTSCHAU, —.—Mikrotomklammer für Keil- und plan-parallele Schnitte. (Microtome-clamp for wedge-shaped and plane sections.)

SB. Phys.-Med. Gesell. Würzburg, 1881, pp. 123–5.

GRAFF, T. S. U. DE.—Resolution of Fasoldt's 18-band plate, and last band of 19-band plate.

[*Supra*, p. 416.]

Bausch & Lomb Optical Co.'s Supplement to Catalogue, Feb. 1882, p. 6.

GREEN, J. H.—Cleaning and Mounting Gizzards.

[Kill the insect in spirit and leave for 3 or 4 weeks to harden. On opening the gizzard the loose particles of food or dirt can be washed out by Mr. Nicholson's (*infra*) or other plans.—Mount in slightly acidulated glycerine (not balsam) in a cell of gold-size.]

Journ. Post. Micr. Soc., I. (1882) p. 49.

GROVES, J. W.—Improved Ether Freezing Microtome.

[*Supra*, p. 432.]

Journ. Quek. Micr. Club, I. (1882) pp. 43–4.

Marsh's Microscopical Section-cutting, 2nd ed. 1882, pp. 60–8 (1 fig.).

HATCH, H.—Microscopical Laboratories.

[Remarks on article by Dr. J. W. Crumbaugh, *ante*, p. 287, who, he considers, desires to surround the student with too much and too expensive paraphernalia, discouraging him at the start.]

Amer. Mon. Micr. Journ., III. (1882) pp. 51–2.

HITCHCOCK, R.—Ruled Bands.

[*Supra*, p. 415.]

Amer. Mon. Micr. Journ., III. (1882) pp. 52–3.

" " Illumination and Resolution.

[Directions for resolving *Amphipleura pellucida*—in many cases of failure the fault is entirely in the illumination.]

Amer. Mon. Micr. Journ., III. (1882) pp. 53–4.

Hitchcock, R.—Mounting.

[General remarks as to mounting for "busy professional men who value every moment of their time and who, not having learned any simple process for mounting, are discouraged from attempting it by the multiplicity of processes and cements given in the books."]

Amer. Mon. Micr. Journ., III. (1882) pp. 55–6.

" " Collecting.

[Note on objects to be found in March–May, and suggestions for the novice in collecting.]

Amer. Mon. Micr. Journ., III. (1882) p. 77.

Jijema, J.—On the Origin and Growth of the Eggs and Egg-strings in *Nephelis*, with some observations on the "Spiral Asters."]

[Contains methods of investigation for (1) genital organs in fresh condition, (2) sections of entire leech, (3) hardening ovaries and egg-strings, (4) section-cutting, (5) surface views of the ovary-wall, (6) examination of early changes in mature eggs.]

Quart. Journ. Micr. Sci., XXII. (1882) pp. 189–211 (4 pls.).

Kitton, F.—Cutting Sections of Coal.

[Describes his failures with the process given under "Coal" in the 'Micrographic Dictionary' (maceration in carbonate of potash), and inquiring for the experience of others.]

Sci.-Gossip, 1882, p. 89.

Korschelt, E.—Eine neue Methode zur Conservirung von Infusorien und Amœben. (A New Method for Preserving Infusoria and Amœbæ.)

Zool. Anzeig., V. (1882) pp. 217–9.

Kunz, —.—Cinnamon Oil for the Examination of Rough Minerals.

[By applying a few drops of oil to the surface of a transparent mineral, the interior can be examined for inclusions, flaws, &c., without grinding the surface flat. Sand can thus be examined for inclusions under the Microscope.]

Amer. Mon. Micr. Journ., III. (1882) p. 59.

Lisle, T.—Glycerine-jelly Mounts.

[Remedy for failures caused by imperfect removal of superfluous jelly:—Apply a mixture of whiting or chalk and water about the consistency of cream, to absorb the jelly; dry and break off carefully.]

Journ. Post. Micr. Soc., I. (1882) p. 49.

Marchal, E.—Préparations microscopiques destinées à l'enseignement. (Microscopical Preparations for Teaching)—*contd.*

[B. Compound Organs, Stems, Roots, Leaves, Flowers; C. Cryptogams—Ferns, Mosses, Lichens, Algæ, Fungi.]

Bull. Soc. Belg. Micr., VII. (1882) pp. xlvi.–liv.

Marsh, S.—Microscopical Section-cutting. A practical Guide to the preparation and mounting of sections for the Microscope, special prominence being given to the subject of animal sections. 2nd ed. 8vo, London, 1882, xi. and 156 pp. and 17 figs.

Matthews, J.—*See* Michael, A. D.

Michael, A. D., and Matthews, J.—Polarized Light as an addition to Staining for Vegetable and Animal Substances.

[*Supra*, p. 426.]

Journ. Quek. Micr. Club, I. (1882) pp. 49–51.

Nicholson, A.—Cleaning Gizzards.

[Open and place in water for a day or two, and clean by agitating the water strongly by blowing through a pipette.]

Journ. Post. Micr. Soc., I. (1882) p. 49.

Nobert's Ruling Machine.

[A query as to its construction, &c., by Akakia.]

Engl. Mech., XXXV. (1882) p. 227.

Nordlinger's Wood Sections.

[Transverse sections of the most important and most common trees.]

North. Microscopist, II. (1882) p. 130.

Ollard, J. A.—Micro-Fungi.

[Short note as to mounting.]

Engl. Mech., XXXV. (1882) p. 201.

Pfitzner, W.—Nervenendigungen in Epithel (Nerve-endings in Epithelium).

[Contains description of methods, pp. 731–2.]

Morphol. Jahr., VII. (1882) pp. 726–45 (1 pl.).

Pigeon-post Films.

[Offer of gelatine films used for transmission of news by pigeon post during the siege of Paris.]

Amer. Natural., XVI. (1882) p. 347.

Pocklington, H.—The use of Staining Fluids in Vegetable Microscopy.

[Résumé of various processes.]

Engl. Mech., XXXV. (1882) pp. 210–2.

Schröder's Microtome for Cutting Sections of Diatoms, &c.

[A query as to its practical success, by Akakia.]

Engl. Mech., XXXV. (1882) p. 227.

Snow Crystals.

[Query by T. Pearson as to the best way to examine them, "as they melt even in a room where there is no fire."]

Sci.-Gossip, 1882, p. 114.

Sorby, H. C.—Preparation of Transparent Sections of Rocks and Minerals. (*In part.*)

[Account of the method he originally adopted for rock sections when "everything had to be learnt, and there were then none of the facilities you have now."]

North. Microscopist, II. (1882) pp. 101–6.

Teasdale, W.—G. Chantrill's Method of keeping objects alive for many months.

[A number of zinc shelves kept under a bell-glass, the requisite supply of moisture being provided by a quantity of thick felt kept constantly saturated.]

Journ. Quek. Micr. Club, I. (1882) p. 41.

Underhill, H. M. J.—Cleaning Gizzards.

[Soaking in potash for a day.]

Journ. Post. Micr. Soc., I. (1882) p. 48.

" " —Glycerine-Jelly Mounts.

[Washing superfluous jelly off with a tooth-brush under water is a simpler method than Lisle's (*supra*). Varnish must be applied within half an hour after cleaning or the jelly shrinks from the edge.]

Journ. Post. Micr. Soc., I. (1882) p. 49.

"Volvox."—Microscopy.

[Examining circulation of blood in a tadpole's tail. Take a hollow slide, or make a little trough by cementing four little strips of glass on a 3 × 1 slip so as to make a shallow cell. After placing the tadpole on its side in the cell and covering with water, drop a very small quantity of chloroform over its head. There is then "no pain to the tadpole nor risk of bruising it as when it is put under pressure, and should too much chloroform have been given it could not die in an easier way."]

Engl. Mech., XXXV. (1882) pp. 216–7.

White, T. C.—On the Injection of Specimens for Microscopic Examination.

[Describes the process of making transparent injections of a small Mammal with cold injection fluid (Beale's blue fluid), mounting in weak glycerine and camphor-water, and not in balsam or dammar, which would show nothing beyond the injected vessels, all the substructure which bears an intimate relation to the vascular arrangement being obliterated. Criticism of Dr. Carpenter's recommendation of injections by professional mounters.]

Journ. Quek. Micr. Club, I. (1882) pp. 15–9.

Wilton's (E. W.) Pond Life.

[Intended supply of living objects.]

Sci.-Gossip, 1882, p. 90.

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

A. W. BENNETT, M.A., B.Sc.,
Lecturer on Botany at St. Thomas's Hospital,

F. JEFFREY BELL, M.A.,
Professor of Comparative Anatomy in King's College

S. O. RIDLEY, M.A., *of the British Museum*, AND JOHN MAYALL, JUN.,
FELLOWS OF THE SOCIETY.

Ser. II.—VOL. II. PART 2.

PUBLISHED FOR THE SOCIETY BY

WILLIAMS & NORGATE,

LONDON AND EDINBURGH.

1882.

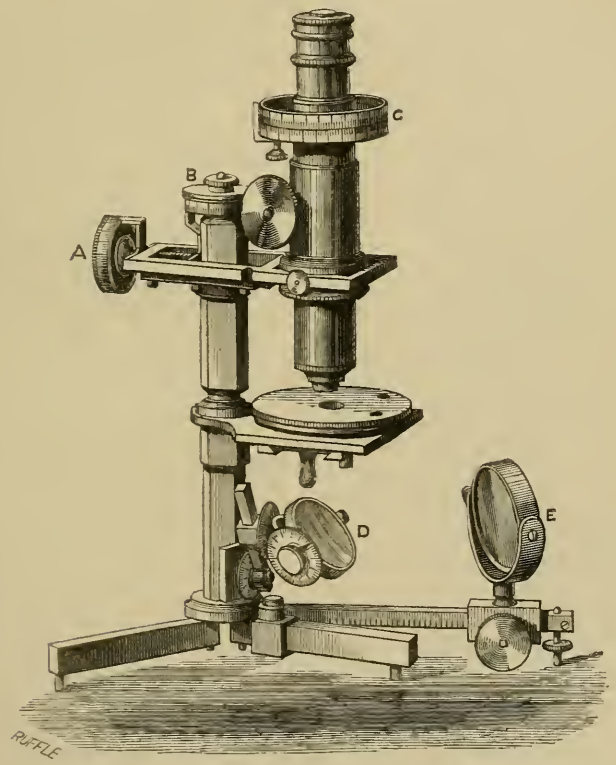
MICROSCOPY.

a. Instruments, Accessories, &c.

Lossner's Tele-microscope.*—O. M. Lossner has patented an instrument under this name. The objective forms a reduced image of a somewhat distant object, and this is enlarged by an ocular of four lenses. The construction of some is in hand, and "if successful this instrument, even if only for small enlargements, will, without doubt, be a welcome tool for the observation of living insects, &c."

Prazmowski's Micrometer Microscope. — This Microscope (Fig. 91) was designed by M. Prazmowski for investigations in

Fig. 91.



which measurements are to be recorded, and when it is also required to note precisely the angle of the illumination, &c., for purposes of repetition. We believe that it was made upon a special order (and not subsequently reclaimed), so that M. Prazmowski must not be

* Centr.-Ztg. f. Opt. u. Mech., iii. (1882) p. 108.

considered as endorsing any practical value in the instrument as a whole.

The principal micrometric movement is controlled by the graduated milled head A working on a fine steel screw against springs, by which the rectangular framework carrying the *optical body* is moved in a direction at right angles to the vertical main limb and parallel with the stage. The optical body, with rack and pinion for coarse adjustment, fits loosely into this carrier; it can be adjusted concentrically with the rotating stage by the action of side screws together with the micrometer-screw at A, and can be clamped in position by a screw-collar beneath. The fine-focussing is effected by the micrometer-head B working on a screw against a spiral spring on the main limb; the whole of the optical portion is thus moved together in focussing, as is usual in Continental Microscopes. The eye-piece has a goniometer circle C attached, and is provided with a movable disk of glass with crossed lines in the usual position of the eye-piece micrometer, by which accurate determinations of angles in azimuth can be made while the object is stationary, &c. The *rotating stage* is of simple construction, similar to that on ordinary "turntables"; it is held in position by an indented key-piece (metal knob shown under stage) that slides into a circular rotating groove beneath, and can be removed at pleasure—the main rectangular stage is then only $\frac{3}{16}$th inch in thickness, and is fitted with a wheel of diaphragms, also removable. The *mirror* D is mounted in a gimbal sliding on a bar with lateral motion; the three axes of motion are each provided with a graduated disk and pointer, so that exact record of the position can be made. The *condenser* E is mounted to slide on one of the feet, and can be adjusted variously to direct the light upon the mirror. The two back feet close up against the front one for convenience of packing.

Simplified Reading Microscope for horizontal and vertical circles.*—Herr Hensoldt, of Wetzlar, claims to have made a great improvement in the application of the compound Microscope to instruments of *medium* size, such as theodolites of from 12 to 20 cm. in diameter of limit. Whilst universally used for the larger, especially astronomical instruments, a Microscope has been found to be inconvenient for others, principally on account of the projecting micrometrical screws and the length of the body hitherto found necessary.

The author says that he "has succeeded in reducing the length of the Microscopes to a most considerable extent by the selection of favourable qualities of glass, and by suitable construction of the lenses. With a power of from 45 to 50 diameters, they only possess a length of 5 cm. and an outer diameter of 16 mm., reading up to 12″, and between the objective and the division there is sufficient room to affix a little illuminator, which throws a more than sufficient amount of light on the division. The latter appears very clear and distinct, and if the limb is provided with a glass cover, the objectives of the Microscopes are constructed accordingly, so as not to lose in definition.

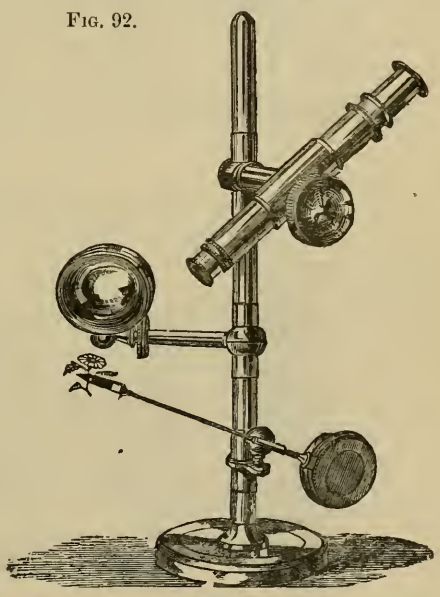
* Zeitschr. f. Vermessungswesen, viii. Transl. in Eng. Mech., xxxiv. (1881) pp. 83-4 (1 fig.).

"The Microscopes are provided with adjustable eye-pieces, to render the division of the micrometer distinct for every eyesight, and at the lower end is a short draw-tube, by means of which a small alteration in the magnification can be effected, whereby the intervals of the micrometer (previously determined by calculation) can be brought to accurately harmonize with the division of the circle.

"As the field of view, though as extensive as possible, cannot be so large as to always include figures of the divided circle, an index with a magnifying lens must be fixed at any desired point, by means of which the reading of the angle up to the nearest division of the circle is obtained, while the determination of the excess is effected by the Microscopes."

The divisions of the circle with which the Microscopes are used are not carried to any great degree of minuteness. The degrees are, for instance, divided into sixths, or 10′, and the micrometer consists of ten equal divisions, representing, therefore, minutes, and the latter can then be mentally subdivided with great facility. An important advantage is, the author considers, obtained by the *small number* of graduations of the micrometer, which permits an easy, rapid, and accurate reading, which does not occupy so much time as in the case of verniers.

Fig. 92.



Swift's Tank Microscope.—This, Fig. 92, consists of the stand of a bull's-eye condenser to which are attached two additional short arms, the upper one carrying the microscope-tube and the lower a revolving cork-holder and forceps for flowers or other objects suitable for low powers. The tube has a rack-and-pinion movement and the arm to which it is attached can be raised or lowered on the standard and clamped in any position. The tube can also be rotated on the arm so as to be either vertical or horizontal, or it can be removed from the arm altogether.

Teasdale's Field Naturalist's Microscope.—This (Figs. 93 and 94) is made by Messrs. Field of Birmingham, and was designed by Mr. W. Teasdale with the view of providing the working microscopist with a really cheap and efficient dissecting Microscope, and it may be readily certified that it fully accomplishes these objects. "It is so simply and substantially made that it

Fig. 93.

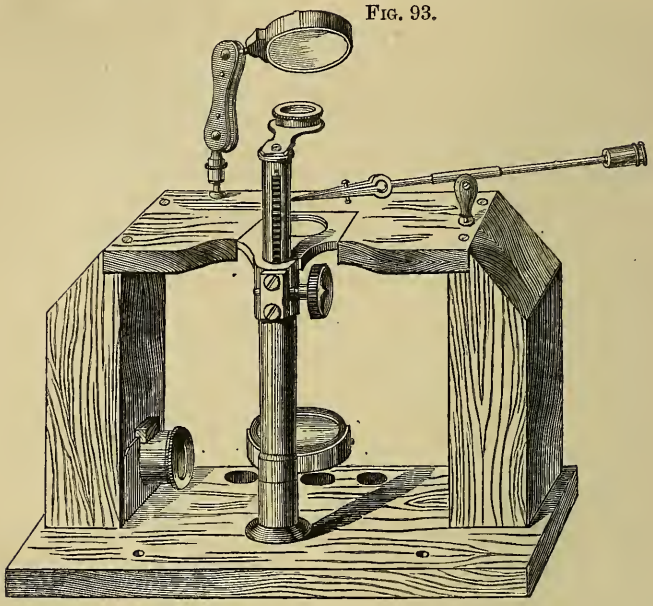
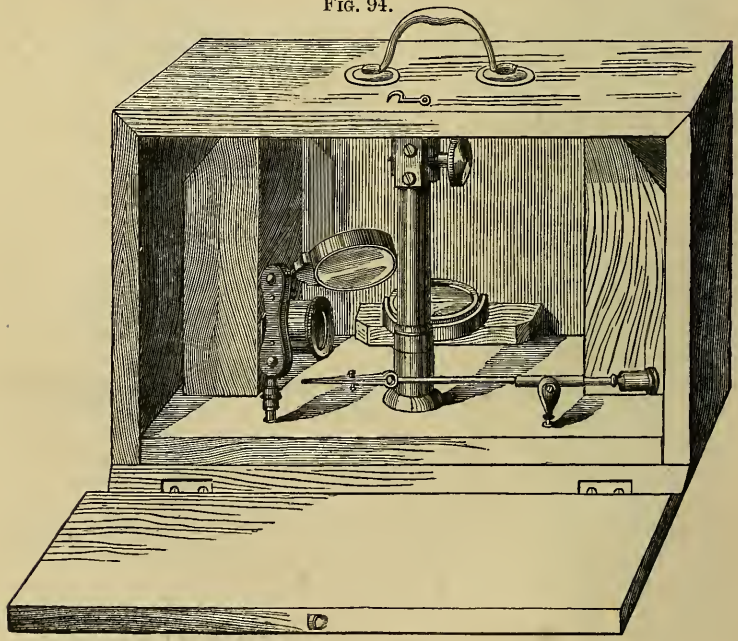


Fig. 94.



may be used by an intelligent child, as well as by the experienced microscopist. It was termed a 'Field Naturalist' rather than a 'Dissecting' Microscope to disarm the suspicion with which some people look upon an instrument with the latter name as a rack or means of torture for frogs, &c."

The woodcuts render any detailed description of the instrument unnecessary, and we need only call attention to the sloping rest for the hands and that there are three lenses, a condensing lens, forceps, and live-box. The lenses drop into the arm which carries them, and also into each other, so that they may be used in combination, producing seven powers in all.

Marshall's turntable can also be used with the instrument, the spindle passing through a hole in front of the stage, and its point revolving in a brass socket below.

Fig. 95.

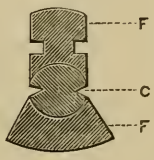


Fig. 96.

Steinheil's Achromatic Eye-pieces.—These eye-pieces ($\frac{3}{4}$ in. and $\frac{1}{3}$ in.), exhibited and described by Mr. Ingpen at the June meeting of the Society, are shown in Figs. 95 and 96 in section. They are especially adapted for micrometry. They consist of a double convex lens of crown between two meniscus lenses of flint, all cemented together. Grooves cut in the edge and blackened, form diaphragms as in the Coddington lens.

New Combination for Objectives.*—The following is the whole of the note by C. V. Zenger under this heading published in the 'Comptes Rendus':—

"The author proposes to obtain an amplification equal to 2000 with a large focal distance. It would then be possible for anatomists and physiologists to carry on their dissections and preparations with a very considerable amplification, at a distance from the objective equal to 4 mm. or 6 mm."

Fluid for Homogeneous Immersion.†—Professor Abbe finds that pure cedar-oil may be prepared so as to render it much less fluid than in its ordinary condition. By spreading it out in thin layers and exposing it for a long time to the influence of air and light, it becomes of the consistency of castor-oil, and without any increase in dispersive power, its refractive index is raised to 1·518–1·520. If desired, the index can of course be reduced to 1·510 by the addition of olive or castor oil.

Dr. L. Dippel considers that this fluid unites in itself *all* the properties required for such a fluid, and that it makes all others superfluous.

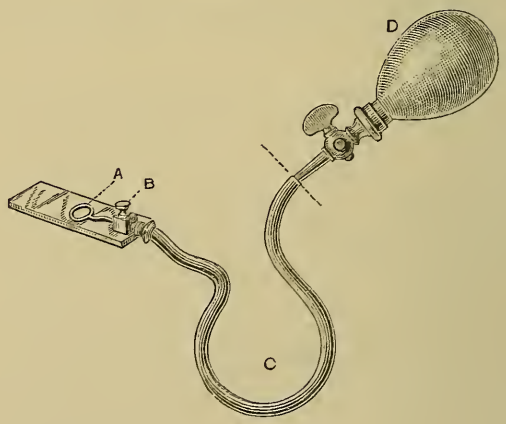
Shurley's Improved Slide for the Examination of Gaseous Matter.‡—Dr. E. L. Shurley describes an apparatus for the examina-

* Comptes Rendus, xciv. (1882) p. 1542.
† Bot. Centralbl., x. (1882) pp. 224–5.
‡ Proc. Amer. Soc. Micr., 4th Ann. Meeting, 1881, pp. 65–8 (1 fig.).

tion of aerial or gaseous material, with the higher power of objectives, without subjecting it to any previous manipulations, thus enabling one to collect and immediately examine with any objective, "even a $\frac{1}{25}$ or perhaps a $\frac{1}{50}$ inch." The apparatus consists of a rubber bag (Fig. 97) with a tapering, hard rubber nozzle, into which is inserted a perfectly tight fitting stopcock. A piece of soft rubber tubing $\frac{1}{8}$ inch in diameter and about 2 feet long is furnished at one end with a metal collar, to be inserted into the outer end of the brass canule of the slide; while the other is to be slipped over the nozzle of the bag. The larger extremity of a small canule about $1\frac{1}{2}$ inch long, is fixed by a binding screw into the upright B on the glass slide, while its small end is inserted into the minute hole at the side of the cell. The larger extremity is smoothly ground, to receive the metal-finished end of the conducting tube. The slide has an ordinary cell A (of rubber).

The cell has its middle portion built up from the bottom by a piece of glass, so as to bring it within the working distance of the objective, allowing depth enough at the sides, which may be compared to two ditches, for the introduction of a canule of reasonable

Fig. 97.



calibre. This, the author says, is an important point, inasmuch as a cell shallow enough for the adjustment of its bottom to the focus of a first-class $\frac{1}{8}$-inch objective, could have a depth of only about a fortieth of an inch, and of course for higher powers less, altogether too shallow to allow of the introduction of a canule of practicable size. But, upon this plan, the cell may be built up ever so much, even for adjustment of a $\frac{1}{50}$-inch objective, while yet at its sides will remain the same depth of ditches, or *sulci*, for the ingress of the gas.

The cover-glass may be cemented on, or laid on loosely. In the former case the opposite side of the cell must be perforated to allow

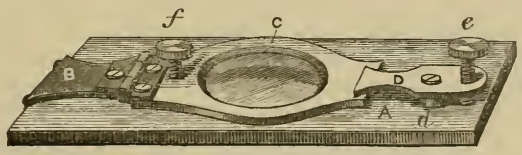
the gas to escape, while in the latter case it escapes by itself lifting up from time to time the cover-glass.

As all objects or particles contained in the air or gas must be at rest when examined with the higher power objectives, it will be necessary to coat either the bottom of the cell, the cover-glass, or both, with something to which the material will adhere as the gas passes through. One of the best methods is to coat both the bottom of the cell and under side of the cover-glass with a thin layer of glycerine—somewhat after Beale's method of collecting aerial germs. This coating is easily accomplished by previously moistening the glass with alcohol. The rubber bag and connecting-tube may be cleansed by drawing alcohol into them, and after expelling this they may be easily dried, if desired, by drawing and expelling air for awhile.

All the parts being in proper connection, by opening the stop-cock of the receiver, and gently pressing upon it, the cell may be supplied at will. As before stated, any gaseous material can be collected and kept any length of time from the access of air, and when desired, *directly* examined under the Microscope without any intermediate manipulation; "a great desideratum and one which cannot be attained so far as I have been able to learn, by any other slide or apparatus hitherto in use. Those most used are the 'Stricker' and 'Hunt' gas slides, the Holman 'life slide,' and the animalcule cell or cage, none of which is applicable in examinations with the higher power objectives; and none of which, excepting one, is arranged so as to allow of the direct introduction in small quantity of gaseous material. The advisability, nay, the necessity, of more perfect means for the examination of aerial or gaseous matter, must have been felt by every one who has ever attempted any work in this direction: and it is obviously only by patient investigation with high-power objectives that we can hope to discover the nature and habitat of those infinitesimal organic poisons which are supposed to originate in some unknown way the so-called zymotic diseases."

Hardy's Compressorium.*—Mr. J. D. Hardy's object in constructing the compressorium shown in Fig. 98, is to remedy, to some extent, the defects of existing compressors as regards the difficulty

Fig. 98.



of regulating the pressure with exactness, the imperfect parallelism, and a deficiency of freedom of action, which causes great risk of losing or damaging the object under observation.

* Journ. Quek. Micr. Club, i. (1882) pp. 35-6 (2 figs.).

A is a brass plate, 3 inches by 1½ inch, in the centre of which is a round hole. At one end is a bent spring B, of thin brass, to which is hinged a second brass plate C, also with a central round hole, and bevelled on the upper surface for high powers. This second plate will, when turned down, overlie the plate A, and the two apertures will correspond. At the other end of the plate A, a button D is mounted so as to turn freely, and to rock on a short stud pin *d*. The outer extremity of this button is bored and tapped to receive a small thumb screw *e*. A similar thumb screw *f* is also fitted to the plate C, near its hinge joint.

A thin cover-glass is cemented to the upper side of the plate A, so as to cover the central hole, and the under side of the plate C is similarly provided.

The mode of using this compressor is as follows:—The plate C is first turned down into place, and the distance that it is desired the glasses should be apart roughly adjusted by means of the screw *f*. The plate C may then be turned back, and the object placed on the lower glass; the covering-plate is then again turned down and secured by turning the button D over it. By means of the two screws *d* and *f*, the pressure can now be regulated with the greatest nicety without any risk of damaging or losing the object under examination. The arrangement admits of the glasses being easily cleaned and readily replaced by new ones when broken.

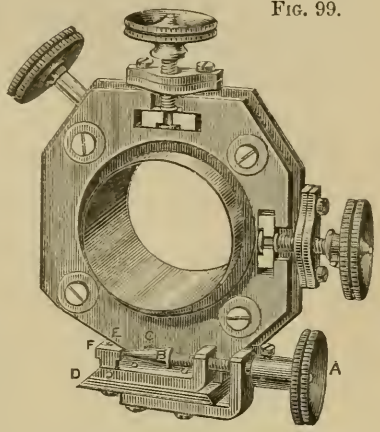
Bulloch's Diatom Stage.*—Mr. W. H. Bulloch has made a supplementary stage for use in arranging diatoms. It fits into the substage ring, and a stem projects up through the hole in the main stage. Upon the stem there is an arrangement like a double nose-piece, which carries two glass slips. One of the slips is intended for the material from which the diatoms are to be selected; the other for the prepared slide upon which they are to be mounted. The two slips can be moved about independently upon their supports. The hair or bristle is mounted on the mechanical stage. The slide carrying the material is first focussed, the diatom picked up, and the supplementary stage turned until the clean slide is in focus, when the diatom is placed in position.

Substage Fine-adjustment.—At the suggestion of Mr. E. M. Nelson, Messrs. Powell and Lealand have recently applied a fine-adjustment to their substage specially for use with their achromatic condenser. Fig. 99 shows (half-size) the under side of the substage with the new fine-adjustment in which A is a milled head controlling a screw-spindle terminating in a steel cone B. On rotating A, B turns and with a very slow motion forces up (or releases, as the case may be) a pin C inserted in the base-plate E of the substage. This motion of C carries with it the condenser. At right angles to, and forming part of E, at the back, an inner sliding plate works against a spring at the upper end between bearings F at each side, which are fixed upon the usual racked slide D of the substage; this inner

* Amer. Mon. Micr. Journ., iii. (1882) p. 97.

sliding plate is the essential addition to the usual racked slide in the application of the new fine-adjustment to the substage. The range of motion is about $\frac{1}{8}$ inch — the difference in radius between the smaller and larger ends of the steel cone.

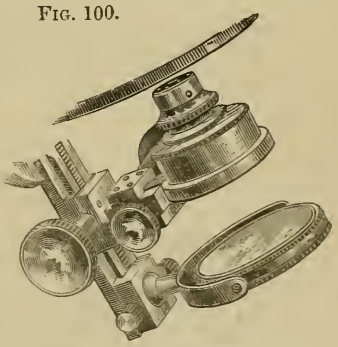
Fig. 99.



Mr. Nelson states that he has found the fine-adjustment on the substage of service in difficult investigations with the condenser in the axis. By this means he can readily exhibit the transverse lines of *A. pellucida* without any diaphragm.

Sidle's Centering Substage.—We gave a figure of Messrs. Sidle's "Iris" diaphragm in Vol. III. (1880) p. 1053, and briefly alluded to the centering arrangement of the substage as "a short bar working with a loosely fitting slot, that can be clamped beneath," which is characterized as a somewhat primitive contrivance. Messrs. Sidle now adopt in their "Acme No. 2 Binocular," the method of centering shown in Fig. 100, the special feature of which is that the substage motions are controlled by two milled heads (right and left) on the arm or bar-attachment at the back of the substage carrier, racking on the swinging tail-piece. By this system the usual *outer* substage-ring, with its projecting centering screws (so generally adopted in America), is done away with. The forward motion is given by the left-hand milled head acting on rackwork; the lateral motion by the right-hand milled head acting on a pointed screw against a U-shaped spring that presses the slide towards that side, the fixed end of the spring being attached to the main base- or angle-plate racking on the tail-piece.

Fig. 100.



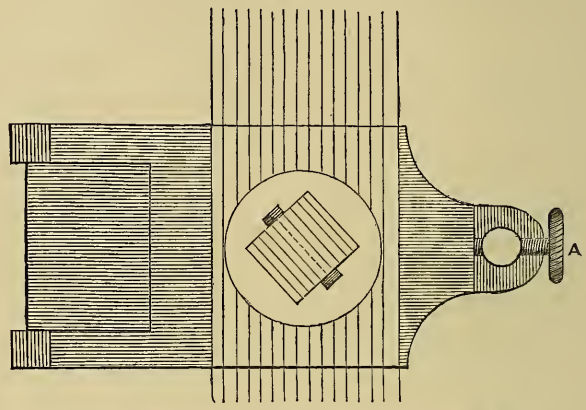
We have not yet seen this mechanism, but with good workmanship we should anticipate the plan to be practical—certainly much better than the former system of centering by the rough process of pushing, pulling, and clamping by hand, which did not suggest the possibility of accurate centering.

Mounting for the "Woodward" Prism.*—Dr. J. Edwards Smith recommends the form of mounting the "Woodward" prism shown in

* 'How to Work with the Microscope' (8vo, Chicago, 1880) p. 171 *et seq.*

Figs. 101 and 102 (where in Fig. 101 A is a vertical view, and in Fig. 102 B a sectional view, and C the prism three-fourths full size). He states that this accessory is easily placed in position in the well-hole of the "Acme" stand, and that doubtless with slight modifications this system of mounting the prism may be applicable to other Microscopes. Provision is made for centering in a lateral direction

Fig. 101.



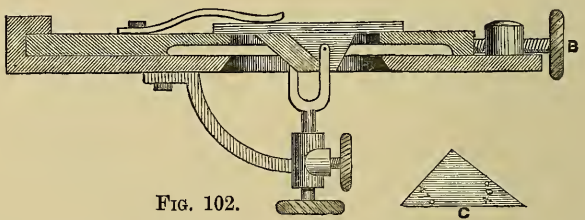


Fig. 102.

by means of the milled head at A. The prism can also be revolved by the milled head shown below so as to use either face, the faces being cut at different angles. Regarding the angles of the prism-faces, he thinks 98°, 41°, and 41°, as suggested by Dr. Woodward, are good; but that 93°, 47°, and 40°, which he has himself adopted, are especially adapted for the general run of modern wide-apertured objectives. He gives detailed instructions for the use of the apparatus and thinks that it "bids fair to come into general use."

Prisms versus the Hemispherical Lens as Illuminators.—In various catalogues issued by American opticians, references are also made to sundry forms of mounting for the "Woodward" prism. It appears to us that much ingenuity is being wasted in such efforts, for whatever may be the angles of the prism-faces, the hemispherical lens must necessarily entirely supersede it, having in fact an infinite number of facets through which normal light may reach the common centre. There may of course be cases where a small beam of parallel rays

directly transmitted by the plane prism-face may be thought to produce the purest effect of oblique illumination; but in our experience wherever oblique light is required for the resolution of striæ, &c., the slight condensation of rays produced by the curved surface of the hemispherical lens is no detriment, but rather the contrary, whilst for facility of manipulation the lens is greatly to be preferred.

Mounting the hemispherical lens on a plate to be put immediately beneath the slide is not to be commended, for every movement of the slide then carries the illuminator with it, and the direction of the light requires continual readjustment. No better plan of applying the lens has been suggested than that adopted by Tolles and Ross, in which it is mounted to slide or screw into the stage-aperture from beneath. This plan is applicable to nearly all the modern Microscopes having mechanical stages.

For the Microscopes generally used on the Continent, without mechanical stage-movements, the hemispherical lens may be mounted, as suggested by Professor Abbe, in a disk of metal made to drop into the stage-opening from above so that the plane face is flush with the level of the stage.

Radial Tail-pieces.—Since the introduction of the Zentmayer swinging tail-piece or swinging substage in 1876, several opticians have carried out the same principle, but instead of the pivot motion of Zentmayer a disk is applied at right angles behind the stage in which a movable zone is fitted to carry the tail-piece. In all the Microscopes we have inspected in which this plan is adopted, we remark that the attachment of the tail-piece is so slight as seriously to interfere with the firmness of the substage. This is a great inconvenience in all manipulations of the substage; the rackwork, centering-screws, diaphragms, mirror, or whatever may be attached to the tail-piece, cannot be touched whilst the eye is directed through the Microscope, without the flexure of the tail-piece causing the illumination to move from the field of view. Of course this applies only to the use of high powers, but all such Microscopes are supposed to be made specially for high-power work.

Electric Light in Microscopy.—Referring to his previous paper on this subject,* Dr. Van Heurck sends us the accompanying Fig. 103, showing the Regnier battery which he has adopted in place of the Tommasi; the sulphate of copper being placed in the small basket at the left-hand side of the cells.

The Regnier accumulator is also shown in Fig. 104.

Dr. Van Heurck adds that the Regnier battery can be placed in the laboratory of the microscopist, as it does not give off any vapours. It will remain charged for at least a month if sulphate of copper is added as required. Sixty-four Regnier elements (each = 1·07 volts), charging sixteen accumulators, lighted a great part of his house for six weeks. They can be used with only one accumulator, to act as a

* See this Journal, *ante*, pp. 418–20.

Fig. 103.

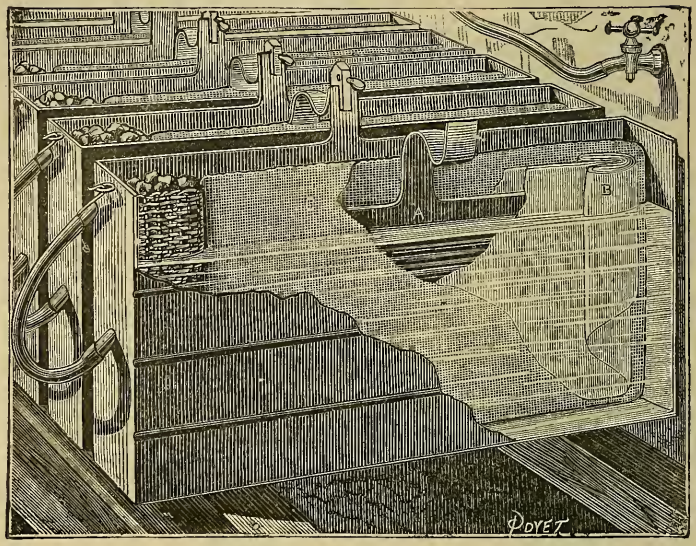
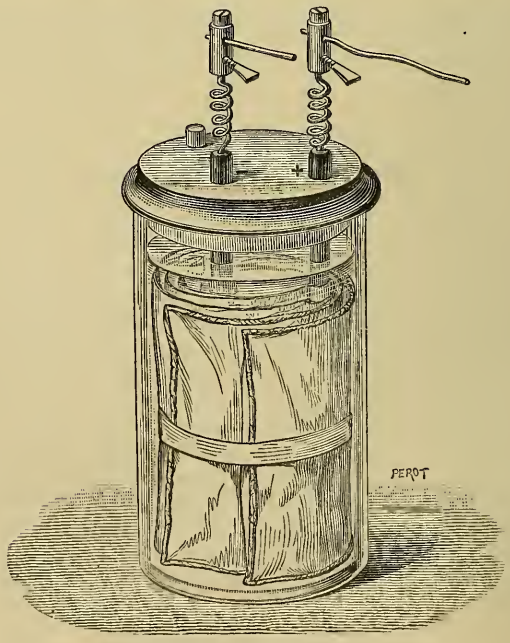


Fig. 104.



regulator of the current. If expense is not an object four accumulators may be used (requiring sixteen elements), the accumulators thus serving both as regulators and reservoirs, and allowing several lamps to be used at a time. The particular Swan lamps he uses are the "$2\frac{1}{2}$-candle" lamps.

Still later Dr. Van Heurck says that he is experimenting with some new accumulators of M. de Kabath, which seem likely to give good results.

Black Backgrounds.*—Mr. Tuffen West on principle very much dislikes to see objects mounted with an irremovable black background. When it is desirable to view objects as opaque, there are so many other ways of doing this; e. g. the diaphragm, the dark-well, a piece of dead-black paper, cloth, or velvet placed behind the slide. The object can then still be viewed as a transparent object also. Otherwise it is the mounter saying to the observer, "You shall see my slide as *I* will, and in no other way."

Micrometrical Measurement by means of Optical Images.†—A paper on this subject was published some time since by Professor Abbe in German, and we at once had it translated with a view to its insertion in this Journal. We must frankly confess, however, our inability to put the paper in proper form for publication here, and as Professor Abbe is much taxed in various ways we have not thought it right to ask him to undertake the matter.

We therefore content ourselves with a translation of a German abstract of the article. ‡

"E. Abbe has turned his attention to the study of the Microscope as used with a micrometer, and finds that the sources of error belonging to the present methods of measurement can be obviated by using 'telescopic' systems of lenses instead of the ordinary objective with a finite focal distance. Such a glass is made up of two separate lenses or systems, whose focal planes are turned towards each other and coincide. It has an unlimited focal length, and the focal points lie at an infinite distance; all objects are reproduced with an enlargement which may be determined at will, but is constant; so that this magnification remains *independent alike of the distance of the object, that of the image, and of the length of the tube.*"

Malassez's Improved Compte-globules.—Professor L. Malassez in 1880 published § a detailed paper on corpuscle-counters in which the various devices of himself, Hayem and Nachet, Gowers and Zeiss were fully referred to with a statement of their respective advantages and disadvantages, and in which he described an improved apparatus suggested by himself. An epitome of the paper by Mrs. Ernest Hart with critical observations has also appeared in English,‖ so that it is unnecessary to refer to it otherwise than briefly here.

* Journ. Post. Micr. Soc., i. (1882) p. 94.
† SB. Jenaisch. Gesell. f. Med. u. Naturw., 1879, p. xi.
‡ Jahresber. (Virchow and Hirsch) for 1879, p. 27.
§ Arch. de Physiologie, 1880, p. 377.
‖ Quart. Journ. Micr. Sci., xxi. (1881) pp. 132–45 (3 figs.).

The improved apparatus is shown in Fig. 105. It is made by M. Vérick, and consists of a thick brass slide, having in the centre an

Fig. 105.

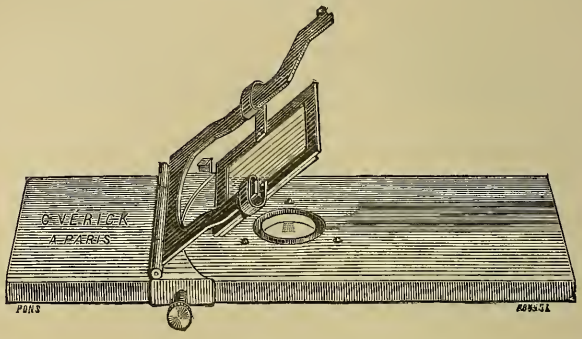
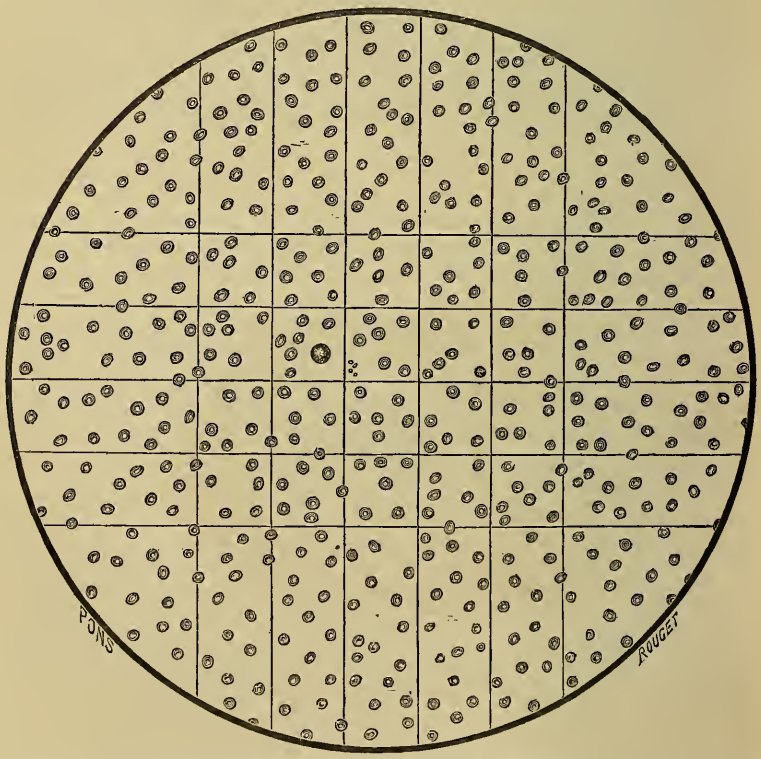


Fig. 106.

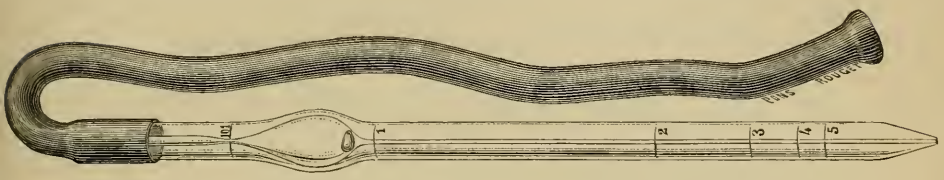


aperture, into which is fixed a circular glass block about a centimetre in diameter, with its upper surface level with the top of the slide, and

surrounded by a groove about half the thickness of the slide in depth. Outside this groove are three pointed metal screws equidistant from each other, the elevation of which above the surface of the slide is exactly $\frac{1}{5}$ mm. In the centre of the glass block the squares are drawn in which the corpuscles are counted. The sides of these are $\frac{1}{20}$ mm., and they are arranged in groups of twenty, as shown in Fig. 106 (× 200).

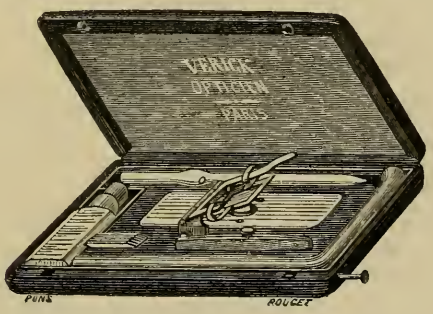
To facilitate lowering the cover-glass so as to be exactly horizontal, M. Malassez devised the frame (Fig. 105) to the underneath part of which the edges of the cover-glass are attached by a little water or saliva. The frame is supported on two arms attached to one flange of

Fig. 107.



a hinge, the other flange being secured to the slide by a clasping screw. The frame with the cover-glass is raised or lowered by the longer of the two arms, and the operation may be quickly performed. A small spring clip keeps the whole down so that there is no danger of the cover being raised or displaced.

Fig. 108.



The mixing of the blood is effected in the "Mélangeur Potain," shown in Fig. 107, and the whole apparatus, with triangular knife for making incisions, cover-glass, and a bottle of diluting liquid, packs into a small pocket-case 13·5 × 8 × 2·5 cm. (Fig. 108).

Surirella linearis W. Sm. vr.; *S. nobilis* W. Sm. c.; *Nitzschia linearis* W. Sm. vr. Family 10, Melosireæ. *Melosira nivalis* W. Sm. = *Coscinodiscus Smithii* vr. Family 15, Coscinodisceæ. *Cyclotella antiqua* W. Sm. c. Also a form that for want of better objectives Mr. Burgess is unable to identify beyond that it is an *Odontidium* or *Navicula*.

MICROSCOPY.

a. Instruments, Accessories, &c.

Bausch and Lomb Optical Co.'s Professional Microscope.—Fig. 113 (sent from America, and one of the best woodcuts of a Microscope which we have seen) shows the "Professional" Microscope of the above Company.

Its specialities are the frictionless fine adjustment (described at p. 683), the glass stage and slide-carrier (described at p. 687), the centering of the substage (of which we have no detailed description), the two draw-tubes which allow of more than the ordinary variations of length, and the mirror and substage bars which are separate and can be moved independently of one another, or simultaneously when the arm on the mirror is placed in a recess in the substage bar.

Bulloch's Newer Congress Stand.*—This (Fig. 114) is made upon the original plan,† with the exception of the stage, the construction of which has been modified.

The stage (Fig. 115, Nos. 1-4) is held by a saddle-piece which is steadied by a strong brace passing down from the limb. It is entirely independent of the swinging of the mirror and substage. This saddle-piece contains a set of screws with perforated heads for centering the ring which supports the stage. These screws are so far back that the ring can be made very thin without reducing the strength or rigidity. The stage rests upon this ring. It rotates, and can be accurately centered by the screws in the saddle-piece.

This stage is a revival of an idea which Mr. Bulloch says was used by Spencer thirty years ago. It consists of the ordinary stage-plate, having in its centre a large square hole. One side of this plate contains a wide dovetailed groove, in which slides a bar with its surface level with the top of the plate. At right angles to this bar is attached another bar. On this second bar slides a third bar, into which it has been dovetailed. The motion of this third bar is at right angles to the motion of the first. A thin plate is attached to the third bar, and lies flat upon the stage-plate. This plate is perforated, and holds the slide by means of a spring. It will be seen that this arrangement permits of motion of the thin plate in two directions at right angles to one another. Two pinions, perpendicular to the stage, control

* Cf. 'National Scientific Journal,' i. (1881) pp. 230–1 (5 figs.).

† See this Journal, iii. (1880) pp. 1076–8.

Fig. 113.

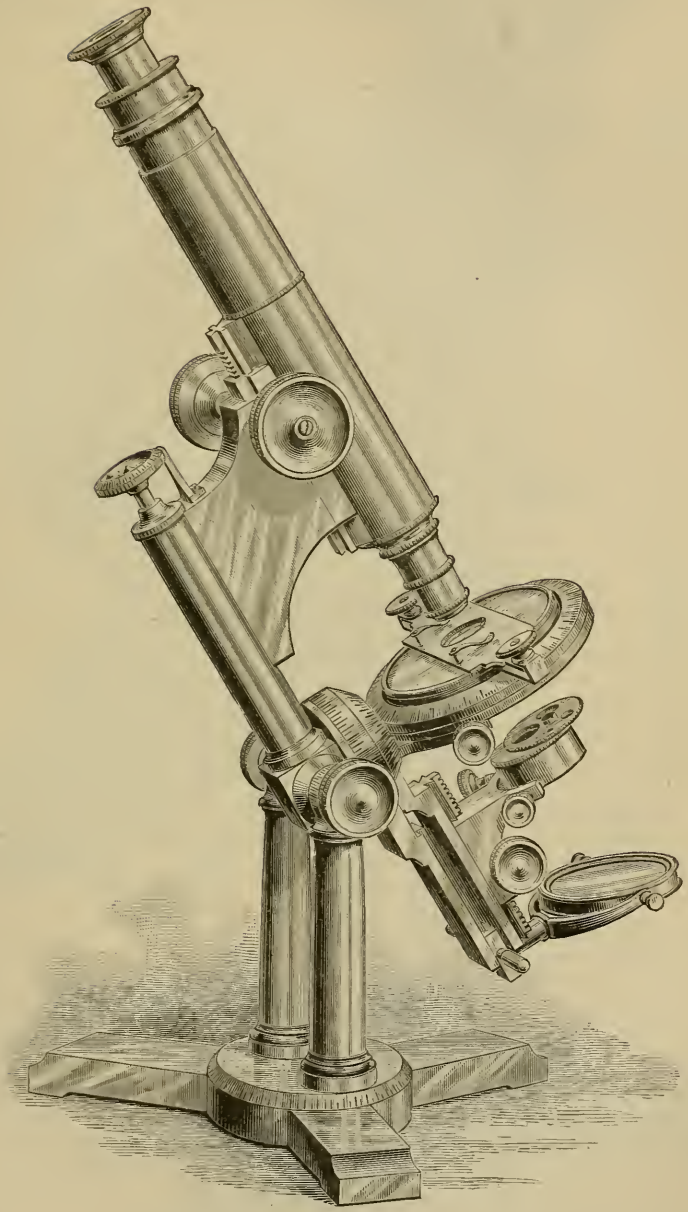
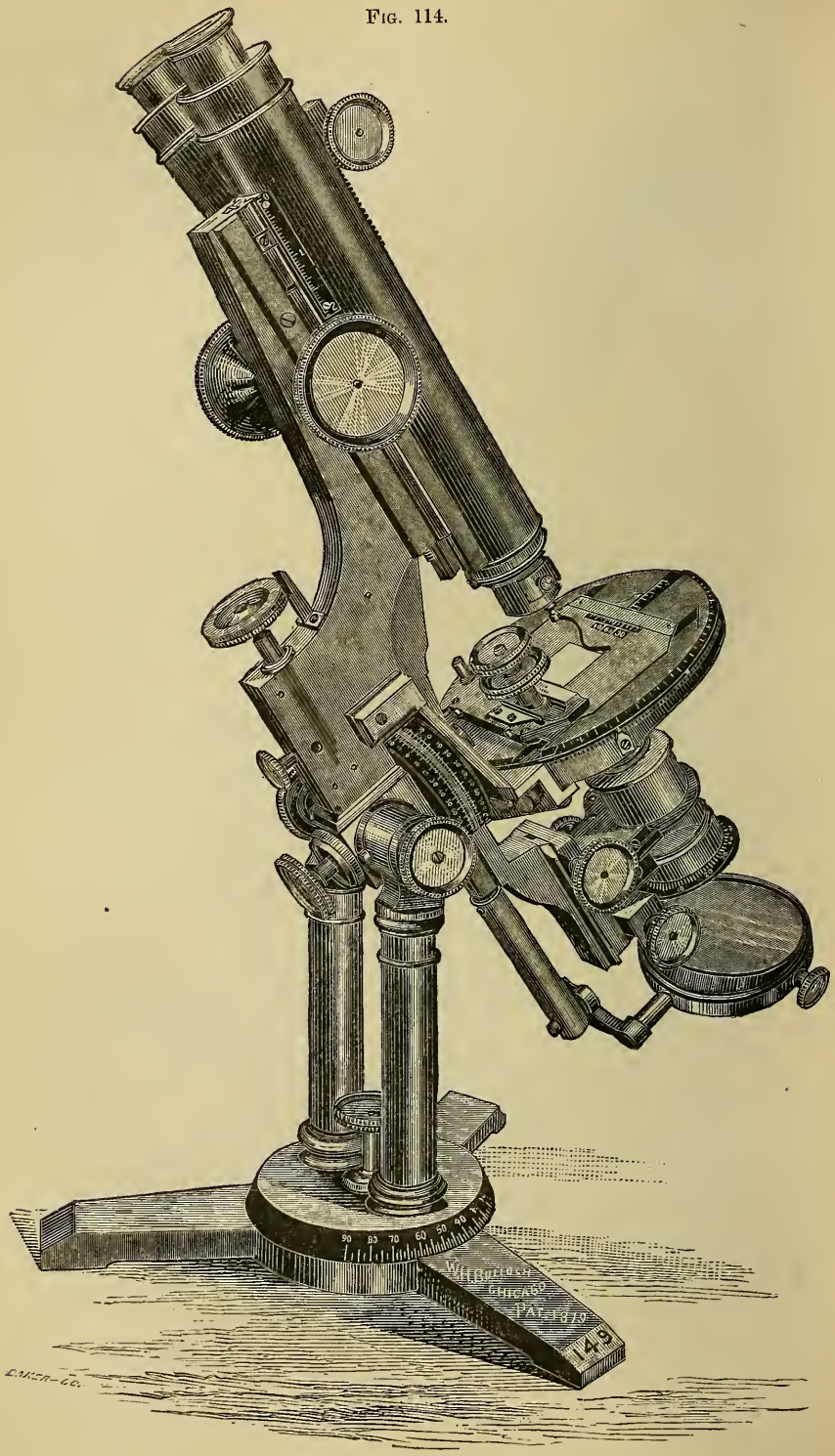
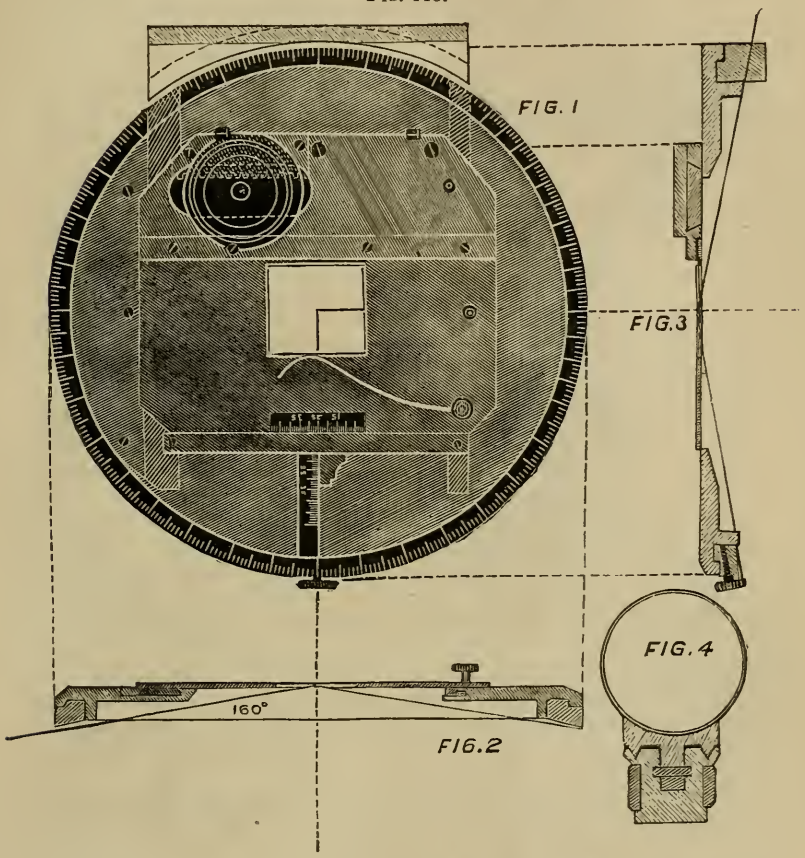


FIG. 114.



this motion; they work one through the other, and act upon racks placed at right angles. Scales placed at right angles serve as finders.

Fig. 115.



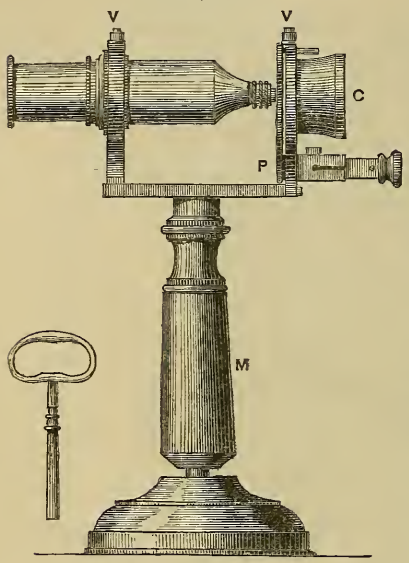
The substage is similar in design to that of Messrs. Sidle, described *ante*, p. 555, and a screw has been added to the base for clamping the base-plate which rotates on the tripod.

Guillemare's School Microscope.*—This (Fig. 116, $\frac{1}{3}$ nat. size) is the design of Professor A. Guillemare, of the Lycée Charlemagne, Paris, and is apparently intended for junior pupils, its speciality being the screws V and V, by which both the tube and the slide are locked, so that they can only be freed by the professor with the aid of the key shown in the woodcut.

* Journ. de Microgr., vi. (1882) pp. 233–5 (1 fig.).

The handle M, by which the instrument is held when passed round a class, is hollow, so that it can be placed on a vertical support, if desired. C is a metal cone polished inside, and we gather that at P is the arrangement for fine focussing after the tube has been adjusted as nearly as possible and locked.

Fig. 116.



Gundlach's College Microscope.—This Microscope, till now called the "Physician's Microscope No. 1," is shown in Fig. 117. Its speciality consists in the *adjustments*, of which there are four, thus described (from the maker's catalogue):—

"(1) A rack-and-pinion movement; (2) a sliding adjustment of the body; (3) a micrometer-screw, and (4) a combination of micrometer-screws giving a slower motion than has ever been brought into use before. The racks and pinions are cut with some new and original tools and with the greatest exactness.

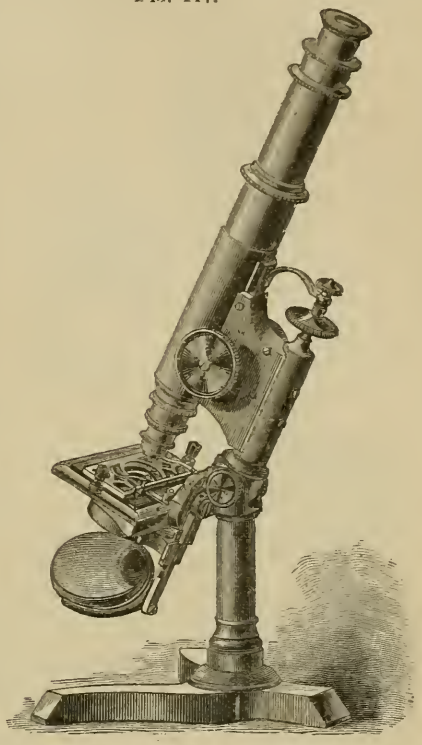
"Gundlach was the first to think of the advantages of the combination of the sliding adjustment with the rack and pinion, and to bring out a series of Microscopes on this plan. The former allows the body to be removed for changing objectives; and, by combining the two, the body may be made to stand so high that first-class low-power objectives may be used on these stands. Lower powers may be used on them than most large stands will allow.

"The ordinary fine adjustment is by micrometer-screw acting on Gundlach's new frictionless roller motion, patented in 1879. This motion is free from the fault of displacement of the optical axis, from so-called loss of motion, and from lateral motion, while it has twice the old extent of motion. . . . .

"In working high powers, microscopists have felt the need in some work of a slower motion than that of the ordinary micrometer-screw, which cannot be made much finer and still be durable enough. This need is now supplied by the combination of two screws which give a resultant motion equal to the difference in the threads employed. One of these screws is a little coarser than the ordinary micrometer-screw, and may be used alone as a fine adjustment, and a change can be made instantly from this to the finer motion. Either motion is given by one milled head next to the top of the pillar, and the change is made by turning a smaller clamping screw having its head over the

fine adjustment screw. By tightening the clamping screw, the adjustment is in order for the work of the combination; by loosening, for that of the coarser screw only. As the thread of this is a very little coarser than the ordinary micrometer-screw, it alone gives a better motion for medium powers than the fine adjustment in common use, a second advantage of the invention. The combination of screws in use on these Microscopes gives a motion equivalent to that of a screw having three hundred and sixty threads to the inch. Any desired combination can be made."

Fig. 117.



The *stage* consists of a strong, polished glass plate, made secure by a brass frame, which is nickel-plated. The glass plate has a hole in the centre, and is ground to permit the greatest obliquity of light. A new object-carrier, consisting of an ornamented brass frame, with a rest for the object-slide, removable clips, and two handles, moves with evenness upon the stage, to which it is pressed by lever springs, with double joint, to permit motion in every direction, and from which it is kept by frictionless pins that do not scratch the stage. The whole carrier can be removed and its place supplied with spring clips.

The *substage* slides along the mirror-bar, thus keeping the diaphragm or other accessory concentrically with the mirror upon the object with central as well as oblique illumination. It can be removed without interfering with the mirror.

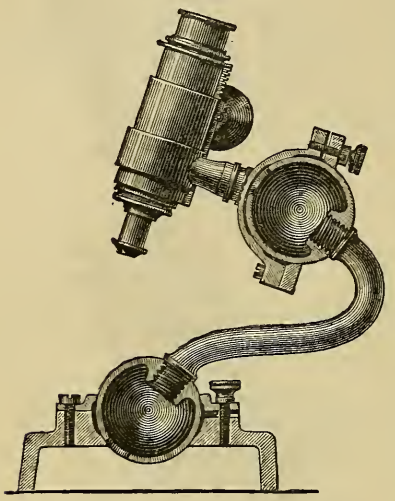
The *diaphragm* is of novel construction, and is fitted to the substage. It is of such form that it can be brought close to the slide, and its openings brought in use without changing its position on the mirror-bar.

The *mirror-bar* swings to an angle of 45° above the plane of the object, allowing the mirror to be used as a condenser on opaque objects. The mirrors have their centre of motion around the point where the optical axis intersects the plane of the object.

Martens' Ball-jointed Microscope.*—This (Fig. 118) is the invention (patented) of A. Martens, of Berlin, and is thus described :—

In the observation of metals in their microscopical relations it is desirable to be able to give the Microscope the greatest possible power of movement, since the objects for the most part do not admit of small fragments being taken from them. A Microscope was originally made for the author by Zeiss, in which movability of the stand was obtained by three hinge-joints, which could be clamped up by a screw so that the tube remained quite firm at every angle ; indeed it was firm enough to admit of a fine adjustment being used. It was, however, too limited in its action, it worked properly only in a line perpendicular to the object, and in order to examine the neighbouring parts either the heavy object or the equally heavy instrument had to be moved.

Fig. 118.



In the new construction the inventor has obtained far greater movability. Instead of the hinges, ball-joints of large diameter are made use of, the balls being hollow and clamped between two annular plates, placed unsymmetrically with regard to the centre of the ball. The plates are forced together by the action of a screw, a strong spring between them separating them again when the pressure of the screw is slackened. Thus a clamp, firm but readily loosened, is obtained. One or more ball-joints can be used for each stand.

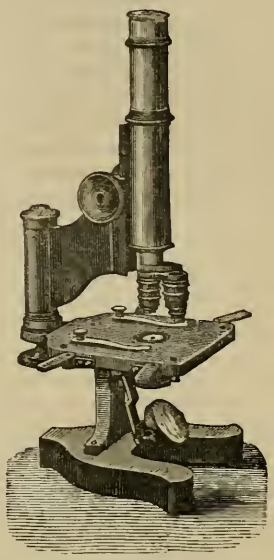
Polarizing Microscopes.†—Prof. J. B. Listing objects to the term "polarizing Microscope," so commonly applied to the Nörremberg (or Hofmann) polarizing apparatus. The use of the name "Microscope" is not only incorrect in itself but it conflicts with that which properly belongs to a Microscope by means of which small objects are examined by polarized light, such as sections of minerals, crystals, hairs, muscle-fibres, &c. The objective of the true polarizing Microscope retains its ordinary dioptrical function, but in the other case no question of amplification comes into consideration (but rather a large angular diminution), the instrument without the lower collecting-lens being in reality an inverted astronomical telescope with the eye-piece turned to the object.

* Zeitschr. f. Instrumentenk., ii. (1882) p. 112 (1 fig.).

† Bericht wiss. Apparate Lond. Internat. Ausstellung im Jahre 1876 (A. W. Hofmann, 1878–81) pp. 367–8.

Schieck's Microscope with Large Stage.*—Prof. G. Fritsch writes that F. W. Schieck deserves special commendation "for constructing stands which, in regard to the size of the stage, very considerably exceed the ordinary dimensions without being either clumsy or unsightly. The ever increasing necessity for examining preparations of large size (such as sections of brain), or series of preparations on large slides, make such stages a pressing necessity." Fig. 119 shows one of these stands with a stage 14 cm. wide. To prevent the slide from falling over the sides when moved to the furthest extent, two arms are attached to each side, the upper surface of which is on a level with the stage. When not required they can be turned back close to the sides of the stage.

Fig. 119.



Projection-Microscopes.†—Dr. Hugo Schröder, in an interesting paper on lantern or projection-Microscopes, points out that the oldest forms originated in the earliest times of microscopical observation, when the whole magnifying apparatus consisted of a simple bi-convex lens with very small aperture. In consequence, the images had great depth, so that relatively thick objects were shown with distinctness. The images, however, by lamplight were exceedingly dim, if the power amounted to 100 or more. This was not, however, the only defect arising from the very small aperture, for the resolving power was also very insignificant, and the image was injuriously affected by the chromatic and spherical aberrations of the objective-lenses. As the result of these and other defects, the instrument was so unsatisfactory with regard to distinctness of detail that the same objective-lens was more efficient when used as a simple magnifying-glass.

It will therefore be naturally asked in what consists the usefulness of the projection-Microscope?

Its utility is to be sought in quite another direction, and under certain circumstances it becomes highly important, if not indispensable. For purposes of demonstration there is nothing better than a good projection-Microscope. Many persons can examine the object at the same time, and a larger field of view can be obtained than would be possible with any other combination. The angle of the image, which in the compound Microscope is at most 10°, can be increased to

* Bericht wiss. Instrumente Berliner Gewerbeausstellung im Jahre 1879 (L. Loewenberg, 1880) p. 293 (1 fig.).

† Central-Ztg. f. Opt. u. Mech., iii. (1882) pp. 2–4, 15–17 (1 fig.).

40° or even to 60°, whereby, under equal circumstances, a 36-times larger surface can be viewed, and by 100 and more spectators. It is also very useful for pointing out to beginners particular parts of the object, in the same way as a drawing would be explained. The observation of the projected image requires no especial practice, as in the compound Microscope; and finally the image can be easily drawn or even photographed.

Notwithstanding all these advantages, however, these instruments —called by Professor Petzval the "*chef-d'œuvre* of optical art"—have hitherto been very hardly treated. Usually the lenses of a compound, Microscope (often most unsuitable) were employed, and illuminating lenses with surfaces exactly convex, thus constituting a very indifferent instrument. The necessity of employing a heliostat, and the difficulty of always obtaining sunlight at the required moment, gave an impulse to the construction of the so-called lantern Microscope used only with artificial light, and in the last century Adams was celebrated for such instruments, which could be used in several ways, as simple, compound or lantern Microscopes. Their performance was best as simple, moderately so as compound, and very inefficiently as lantern Microscopes.

Much later, when achromatic objectives were introduced, Chevalier in Paris and Duboscque constructed much more complete instruments, and in modern times Foucault invented the excellent photo-electric projection-Microscope.

At first sight nothing seems simpler than to construct a good lantern Microscope since we have only to replace sunlight by lamplight. This is, however, not the case, for on further consideration it will be found that the conditions which are so favourable with sunlight cannot be maintained with any artificial light—we can only approximate to them. The intensity of all artificial illumination, even the strongest electric light, is considerably less than that of the sun; besides, all strong lights have far too large an illuminating surface to give distinct images with many fine details. The earlier lantern Microscopes had the worst possible illumination, for good oil-lamps did not then exist. If petroleum or gas lamps be used, it will soon be found that the magnitude of the flame in no way heightens the effect; although the image surface may appear to be more brightly illuminated, the contrast between the light and dark parts will be less—the absolute intensity is greater, but the relative smaller. If we follow the course of the illuminating rays it will be seen that the flame limits light diverging in all directions. Divergent light cannot, however, be employed for the illumination of an object, but we must always have convergent light. The source of light is therefore placed in the first focal point of a convex illuminating lens and the object in the second. The nearer a lens of given diameter is to the source of light, the greater will be the aperture-angle of the illumination; the greater the quantity of light utilized the further off will be the second focal point and the less the convergence of the rays upon the object. The convergence of these rays must, however, correspond with the final convergence of those which limit the field of view, and therefore, for all the rays falling on

the first illuminating lens to be utilized, a second condition must be fulfilled, viz. that the image of the source of light which falls on the object must not be larger than the object itself. Since the source of light and its image are as the two focal lengths it is obvious that these conditions can only be strictly fulfilled with very low powers and under very favourable conditions. With higher powers the greater part of the light is lost for this reason, that the intensity of the light with the higher powers diminishes not with the second, but approximately with the third power of the amplification.

The greater part of the light from the lamp does not fall on the first illuminating lens. In order to utilize as much of this portion as is possible the attempt has been made to concentrate by means of large concave mirrors the light which is lost on the side opposite to the condensing lenses. The mirror—which should be concave—must have the flame in its centre of curvature, the image of the flame, therefore, coinciding with the flame itself. As this is transparent, only a small portion is lost by absorption, and the part that is utilized follows the same direction as the other rays. This condition is absolutely necessary, in order to avoid light-nodes in the illuminating cone produced by two different converging rays, whereby the clearness of the image is materially affected. It is thus evident that with all ordinary flames only the segment of a small circular surface is utilized. The flat flames, the narrow edge of which is used (as for example in the Sciopticon), give the best results. On account of the too great extent of the illuminating surface, lighthouse lamps, which consist of a number of concentric wicks, only yield a very moderate result, notwithstanding the quantity and intensity of their light. Fresnel's ring-lenses are also unsuitable. Illuminating lenses of the smallest dimensions and the largest aperture angle (as near as the temperature of the flame will allow) give the best results. It is also advisable to insert a movable lens between the object and the illuminating system, in order to regulate the convergence of the light according to the requirements of the objective employed. To obtain a perfectly uniform illumination of the image-surface it is further necessary that it should not be the image of the source of light produced by the illuminating lens that falls on the object, but a neighbouring aberration-circle, in which the light is uniformly distributed. (Petzval has already drawn attention to this.)

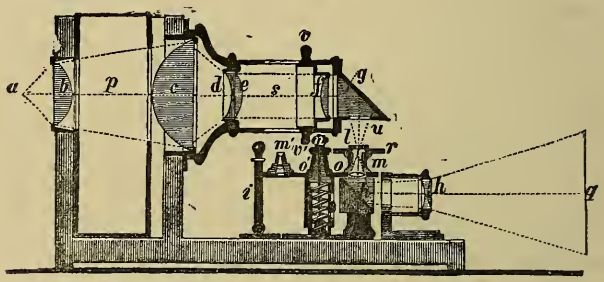
Besides lamplight the Drummond lime-light has been employed very satisfactorily, and after many experiments Dr. Schröder considers it the best on account of the small and intensely illuminating surface of the lime and its pleasant light. In spite of its intensity, the magnesium-light gives no satisfactory result, because it does not burn steadily, and even when a ventilator is employed, the lenses are covered with the burnt magnesium. The electric light is excellent on account of its large intensity in a small space, but its unsteadiness is objectionable. The Jablochkow candle is most suitable, notwithstanding its small intensity, if a uniform height can be maintained. The incandescent light is too small in intensity, and too oblong.

If in course of time the electric light is more perfected a new epoch will commence for the lantern Microscope, and this highly interesting instrument, in a compendious form, will certainly not be wanting in any wealthy (*gebildeten*) family.

The objectives must of course be as free as possible from spherical and chromatic aberration, and must form a perfect image of the object, not only in and near to the axis (as in the ordinary compound Microscope), but over the whole extent of the image-surface, a by no means easy matter with large apertures.

Dr. Schröder has constructed a projection-Microscope for the Microscopical Aquarium at Berlin, and a considerably more improved one for North America, the first of which is shown in Fig. 120.

Fig. 120.



The source of light is at *a*; *b* and *c* are plano-convex lenses of crown glass, between which at *p* an alum cell is interposed to intercept the heat rays. The rays emerge from *c* strongly convergent, but are made parallel and corrected for spherical and chromatic aberration by the combination *d e*. The parallel beam *s* is made convergent by the movable lens *f* according to the requirements of the field of view. For polarized light a large Nicol prism can be placed at *s*, and selenite plates at *u*. The analyser is attached to the objective.

By means of a silver prism *g* the illuminating beam is thrown upon the object *l* vertically "in order to admit of using receptacles for holding living animals in fluid, &c."

The objectives *m*, *m'* are attached to a revolving holder *o*, *o'*. Powers from 100 to 2000 can be used. They are focussed by the screw *n*, the upright piece *t* serving for revolving the holder when a different power is required.

The rays after having passed through the objective are reflected by a silvered prism *h* horizontally through the negative achromatic lens *h'*, and form an image at *q*.

The American instrument has immersion lenses giving a power of 4000 times, and can be used for opaque objects by means of a large Lieberkuhn.

"Notwithstanding the many reflecting surfaces," Dr. Schröder says that "with only an *ordinary petroleum lamp* the larger diatoms such as *Triceratium favus* can be very distinctly seen. With the oxy-

hydrogen light living diatoms and sections of plants are extraordinarily beautiful, all natural colours appearing very bright. With a power of 2000 the cornea of a fly occupies the entire field of view, and the fine vitreous membrane in each cell is seen magnificently."

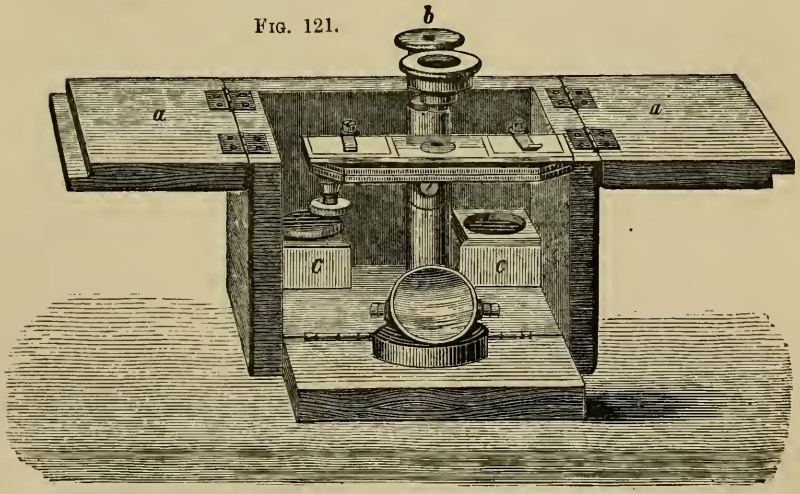
Rock-sections can also be well shown in polarized light.

Apparatus for Projecting an Image to any required Distance with Variable Amplification.*—For lectures it is often desired to throw on the screen an image of an object with a given amplification, and in order to vary the amplification, several auxiliary appliances have hitherto been brought into requisition. A. Crova has devised a means by which, with the same distance of the object from the screen, the amplification may be changed with the aid of only one additional piece of apparatus.

He places between the object and the screen two lenses of equal focus, one plano-convex and the other plano-concave, their distance apart being capable of being altered as required. The plano-convex lens is fixed in a frame which is fastened to a horizontal brass rod resting on the stand, and along this rod the other lens (similarly fixed in a frame) is made to move by rack and pinion. The lenses have a focus of 0·15. By means of divisions marked on the rod the lenses can be set at the distance required; when the plano-concave lens is at zero the two lenses are completely in contact, and their optical centres coincide; according to the distance between the lenses the converging or diverging effect of the system predominates.

Waechter's Travelling Dissecting Microscope.†—This, Fig. 121,

Fig. 121.



* Journ. de Physique, 1881, p. 159 (1 fig.)

† Bericht wiss. Instrumente Berliner Gewerbeausstellung im Jahre 1879 (L. Loewenberg, 1880) p. 302 (1 fig.).

by P. Waechter, of Berlin, is specially adapted for travelling, as when closed, it forms a box of only 10 cm. in length by 10 cm. in breadth and 7 cm. in height. The two halves of the cover *a*, opening right and left, serve as supports for the hand. Inside the box is the stand *b* with the stage and mirror, as well as the receptacles *c* for keeping the three achromatic objectives of 15, 25, and 40 power. The remaining space can be utilized for other apparatus.

Measurement of the Power of Eye-pieces.*—Dr. Royston-Pigott originally suggested the placing of the eye-piece in the substage and throwing an image of a rule, supported at a distance of 10 inches from the diaphragm of the eye-piece, upon a stage micrometer. Mr. W. H. Bulloch having found considerable difficulty in getting the lines of the rule sharply defined, has devised an apparatus consisting of an ordinary Microscope with an objective of 2 inches focus, used to examine an image of a diaphragm, formed by the eye-piece to be measured. The exact size of the diaphragm and its distance from the eye-piece being known, the size of the miniature image formed by the eye-piece can be readily measured, and a simple calculation then gives the magnifying power.

Hall's Eye-protector for use with the Monocular Microscope.† —Dr. L. B. Hall describes an appliance to be used with the monocular instrument, for the purpose of protecting the unemployed eye, pointing out that the employment of one and the same eye at the tube of an optical instrument is the same practice that cost the squinting eye of childhood its power of vision. So many of us are contented at having trained one eye to do acceptable work, that we think we cannot spare the time to discipline the other. If this process ended when the head is withdrawn from the instrument, the practice would be less dangerous, but the trained eye finding an unequal companion, performs reading and all other near work with greater ease than its fellow; sees so much more distinctly that the other is left without exercise, except for large objects, and becomes of less and less value as the process goes on. Dr. Hall could point, he says, to those who have practically lost one eye by this process, and estimates that one-half of all those who have used the monocular Microscope to any considerable extent during five years are monocular men for all fine work, meaning by this that every such person who can "resolve" one of the more difficult tests with one eye will find himself unable to do so with the other.

How often have we heard persons exclaim, upon looking into a binocular Microscope for the first time, how much easier it is to see with the instrument, and this with one field quite dark; such expressions are not to be ascribed wholly to dissimulation or flattery, and for the following reasons, viz.:—When both eyes are left open and one is applied to an instrument, the two images, being unlike,

* Amer. Mon. Micr. Journ., iii. (1882) pp. 103–4 (1 fig.). 'The Microscope,' ii. (1882) pp. 83–4.

† 'The Microscope,' ii. (1882) pp. 88–90 (from the 'Medical and Surgical Reporter').

confuse each other in the natural endeavour to blend them. This requires a mental effort to exclude the impression upon the retina of one eye and regard that upon the other only. Again, when we close one eye by contraction of the orbicular muscle, or by pressure, as by the hand, we cause contraction of the accommodating muscle also, and of the other eye as well.

To facilitate the training of both eyes the following eye-protector is proposed. It consists of a small, opaque disk near the eye, supported by a wire extending from its outer edge downward, to a point on the tube low enough to be out of the way of the nose, then bent upward, parallel to the tube, but not touching it, and attached to a ring near the top. Dr. Hall's is made of a piece of brass wire, No. 18, about 45 cm. long; a loop at one end, 4 cm. in diameter, covered with a piece of black paper folded over and gummed down, forms the disk. At the other end is a ring to fit the draw-tube, and then the intermediate wire bent. It is attached below the flange, on the draw-tube, where there is no lacquer to be scratched, but if it should be thought desirable to attach it above the flange, then the ring ought to be covered with chamois, so as not to wear the polish.

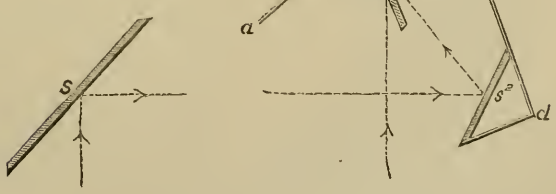
The advantages of this form are, the small size of the disk and its support, interfering with the working of the instrument and view of the stage as little as possible. The support is not in the way of the nose; it is elastic, not uncomfortable when touched by the nose, and striking it does not displace the stand; it can be rotated about the tube and used with either eye alternately; it can be easily adjusted to the eye-distance of any worker; and, lastly, it is of so simple a construction that any one can make it for himself at a very small cost.

Cramer's Camera Lucida* (also Hofmann's and Oberhäuser's).—Dr. C. Cramer can only concur to a small extent in the warm praise which Dr. H. von Heurck has bestowed upon Hofmann's camera lucida.† Besides the advantage of having the paper lie

* Bot. Centralbl., vii. (1881) pp. 385–91 (2 figs.).

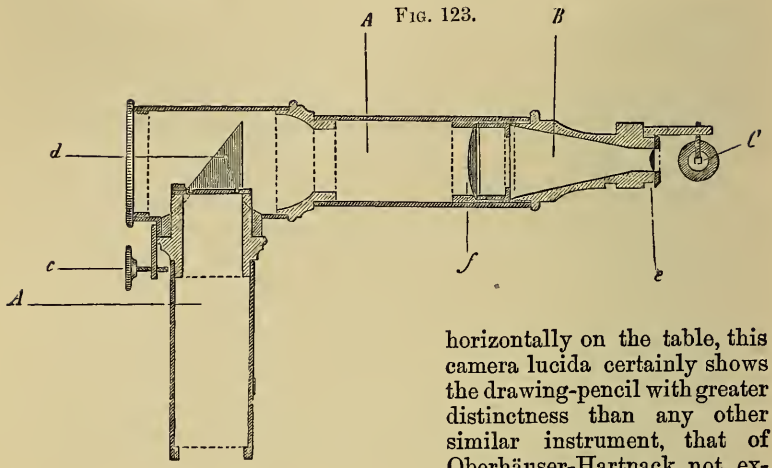
† Hofmann's camera lucida was described and figured in this Journal, ii.

Fig. 122.



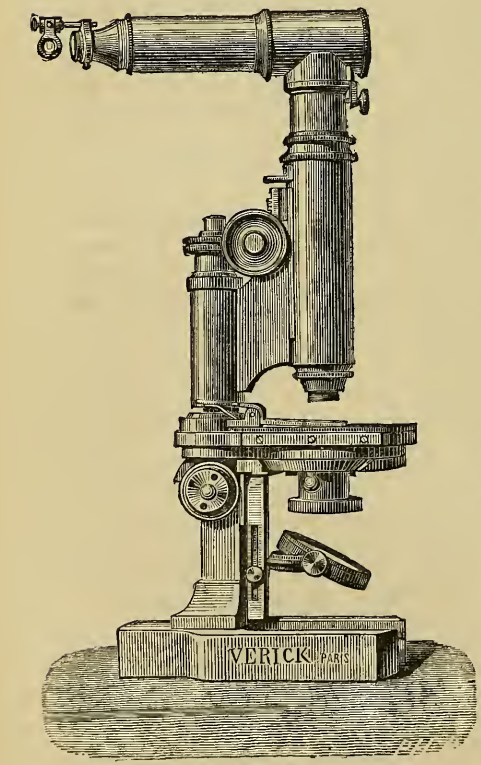
(1879) p. 21. We, however, add here a diagram of it (Fig. 122), S being the silvered mirror over the microscope-tube, s^2 the smaller silvered mirror which

Fig. 123.



horizontally on the table, this camera lucida certainly shows the drawing-pencil with greater distinctness than any other similar instrument, that of Oberhäuser-Hartnack not excepted. For very long-sighted persons the two convex glasses placed below the two smaller mirrors may be of use, but for normal and short-sighted persons they are useless, and it is, moreover, better left to each individual to assist his sight by spectacles as required. The cap (with an aperture) over the two mirrors is also well adapted to serve as a guide to direct the eye of the observer, and thus facilitates its use by beginners, who often have a difficulty in finding the image. These advantages are, how-

Fig. 124.



---

receives the rays from S and reflects them upon a plate of glass s^1 and thence to the eye, the pencil being seen through the latter (*a b c d* is the fitting which holds s^1 and s^2). There is a subsidiary apparatus formed of two plano-convex lenses for reducing the amplification.

Oberhäuser's (or Hartnack's) camera is shown in Figs. 123 and 124. It consists of two tubes A A at right angles, a rectangular prism *d* being inserted at the point of junction, by which the rays coming from the object are reflected through an eye-piece B *f e* to a smaller prism C, and thence upwards to the eye.

ever, counterbalanced by considerable defects. The sharpness of the image is impaired by the threefold reflection, which is effected partly by mirrors silvered at the back, and partly by the transparent mirror, the two surfaces of which produce images which of course do not coincide. By using still thinner mirrors this defect might be lessened but not removed entirely. The right and left sides of the object are inverted (though the image is otherwise erect), and this renders it difficult to a most tiresome degree for the microscopist, who is accustomed to the inverted motion of the object, to adjust it, and still more to afterwards correct complicated drawings by the ordinary microscopical image. Employing an orthoscopic eye-piece or inverting the drawing arrangements is of no use, as the microscopical image, compared with the drawing projected by the camera, appears in both cases with right and left hand parts interchanged.

The camera, moreover, will not bear the application of the blue glass disks supplied with the Oberhäuser instrument for modifying the light, as the image becomes almost invisible. As its characteristic, however, is the relatively great brightness of the surface of the paper, a smoked glass mirror, in place of the plain one s^1, would be the more serviceable arrangement, but the instrument is not constructed so as to allow such a change to be readily made.

The combination of lenses for the purpose of reducing the image is, the author thinks, a valuable addition. The insertion of the camera lucida is of course equivalent to lengthening the tube of the Microscope, and the image is strongly magnified, often too much so. It is only to be regretted that when both plano-convex lenses are employed simultaneously, the image, already obscure, becomes still less clear, and in some cases almost invisible. Dr. Cramer also draws attention to the fact, not thought of by Hofmann himself, that his camera lucida combined with the reducing apparatus, when inserted in the tube of the Microscope instead of the eye-piece, will give an image without the objective. The amplification with the two lenses is about four times. He considers that "if Hartnack could prevail upon himself to construct his camera lucida in such a way that in the short arm, or in place of it, a combination of lenses analogous to Hofmann's were introduced so that an image magnified only four to eight times could be obtained, the value of this instrument, already so desirable for the microscopist, would be materially increased."

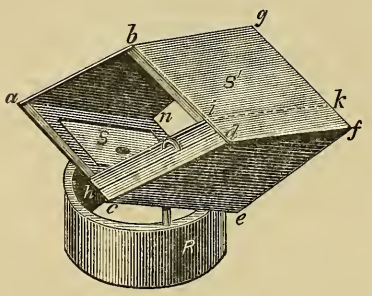
Dr. Cramer then describes an instrument suggested by himself:—

"Those who use the Microscope, especially beginners, are not always in a position to buy a camera lucida. I think, therefore, that I shall be doing many a service by showing how any one who possesses a little mechanical dexterity may make for himself the very serviceable camera lucida shown in Fig. 125.

"It consists essentially of two somewhat diverging mirrors, one of which, S, allows the image of the object to be viewed direct through a circular hole made by removing the quicksilver from the under side of the mirror. By the second mirror, S′, the rays from the pencil and

paper, which lies horizontally on the table to the right, are reflected to S, and thence upwards to the observer's eye. If the field of view is too bright, the light may be moderated by blue glasses placed in front of the illuminating mirror. The apparatus is attached by a wire pin to a ring R, made out of strips of paper, and can be readily detached when required.

Fig. 125.



"The ring should be made first, as it has to move with some friction on the upper end of the tube of the Microscope, and must exceed in diameter the upper rim of the eye-piece about 2‴. The eye-piece should be removed, and the upper end of the tube used as a mould for making the ring. The outer layers of the ring must be made higher than the inner ones by about the thickness of the upper rim of the eye-piece. This rim will thus fit into a corresponding depression in the ring. The aperture for receiving the wire pin is best made last of all, by the repeated insertion of a red-hot needle. This should be done with the eye-piece in place in the ring. After this, two rectangular plates should be cut out of an old mirror, the glass of which must not be too thick, and the coating of quicksilver should be scratched off from a central hole. Then attach by gum two pieces of card of the same shape and size to slightly larger pieces of note paper, and place the mirrors (after making a hole in one of the cards to correspond with that in S) with their backs downwards on the cards. Gum the projecting edges of note paper, turn them up, and press them down over the edges. Then make the trapezoid sides of the apparatus (also out of cardboard), and attach them to larger pieces of note paper so as afterwards to be able to glue them firmly to the backs of the mirrors. Cut two pieces the exact shape of one of the sides out of a cigar box for the purpose of strengthening the side turned towards the observer, which receives the wire pin. A pin of about 1 mm. thickness is quite sufficient. It should be bent twice at right angles, so that its two legs of unequal length are about the thickness of one of the two wooden boards apart. The longest leg passes between the card and one of the boards, and the other shorter one between the two boards which are to be glued together. Grooves must first be made in the boards corresponding to the thickness of the wire. The direction of these is easily settled by remembering that the pin must be placed exactly in the middle of the half of the ring turned towards the observer. The sides *a b c d* must be in a horizontal plane, and the lower edge *e n* of the mirror S (parallel to *a c*) must be exactly on the boundary between the lower and upper halves of the card ring.

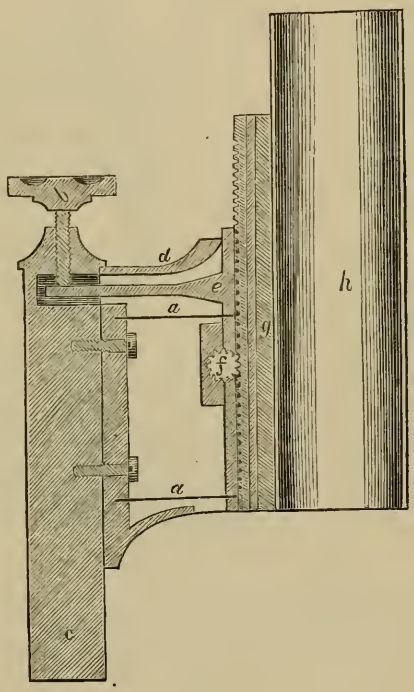
"When all has been put together, it is well to increase the firmness

of the apparatus by pasting on an additional piece of card of the shape *b d f g*, and all the surfaces except the mirror should be blackened with indian ink.

"Dimensions:—*a b* and *c d*, also *a h*, *b i*, *g k* = 30 mm.; *b g*, *d f*, and the corresponding sides of S = 37 mm.; the mirror less by the thickness of the card—*h c*, *i d*, and *k f* (in my apparatus made for Oberhäuser's eye-piece = 10 mm.) will vary according to the size of the eye-piece. Diameter of the hole in the mirror S = 3 mm. Distance of its upper edge from the left side of the mirror = 19 mm., angle *f d c* = 157°, *d c e* = 36°, *c e f* = 130°, *e f d* = 37°."

Bausch and Lomb Optical Co.'s Fine Adjustment.* — Fig. 126 represents the original of the fine-adjustment referred to at Vol. I. (1881) p. 110. Two strong parallel blades of finely tempered steel, *a a*, are securely fastened on one end to the back of case *d*, on the other to the arm *e*, which carries the rack and pinion. *b* shows the micrometer screw, which is fitted to the upright arm *c*, *f* is the pinion, *g* the rack and slide, *h* the tube. Two screws fasten the adjustment case *d* to the pillar *c*. An arm projects from the part *e* and passes into a recess in the pillar *c*. The springs support the entire body, and as their tension is upward, the projecting arm bears continually against the micrometer screw *b*, and it is evident that the distance traversed by the screw involves the same movement of the arm *e*, and consequently the body. The only points of contact are at the ends of the springs *a*, *a*, where they are fastened respectively at *d* and *e*, and on the micrometer screw, and as in the former there is absolutely no friction, there is no wear; while that which may eventually take place in the latter is taken up by the force of the springs.

Fig. 126.



The points of excellence claimed by the makers for this adjustment over all others, are the following:—

* From the Company's Price List, 7th ed., 1882, pp. 4–5 (1 fig.).

"1. It moves the entire body. 2. It is extremely sensitive and direct. 3. It has no lateral motion or displacement of the image, while adjusting. 4. It has absolutely no lost motion. 5. It can in no manner deteriorate." The "Professional" Microscope (shown at

Fig. 127.

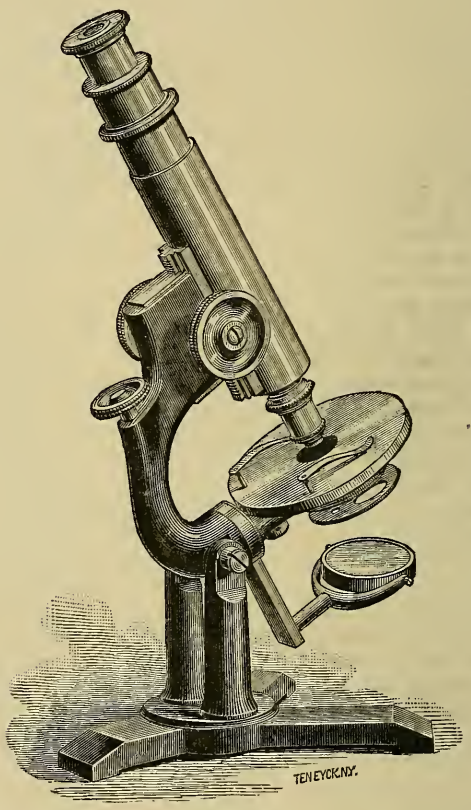


Fig. 113, p. 667) has the fine adjustment in the form above described, while in the "Model" Microscope of the same makers (Fig. 127) a slight variation is made by the bar *e* being placed below instead of above.

Nose-piece for Binocular Prisms.—When the broad gauge ($1\frac{1}{4}$ in.) screw is used (for low powers of wide angle), it is necessary to provide some means, not merely for the withdrawal of the prisms of the binocular, but for the removal of its fittings so that the end of the tube may be left quite free for the full diameter of the objective.

This is perhaps best accomplished by the prism and its fittings being in a separate nose-piece, attached to the tube by a well-made

bayonet catch, when it can be detached as required. By screwing into the broad-gauge thread, after the binocular fitting is removed, an adapter with Society screw, objectives of wide angle, but not requiring the broad screw, can also be used without their being handicapped by the fitting.

This plan, by which there are in fact three distinct arrangements —1st, the broad-gauge screw; 2nd, the Society screw without the binocular; and 3rd, the Society screw with the binocular—is the one adopted by Messrs. Sidle in the "Acme No. 2" Microscope.*

Homogeneous and Water-immersion Objectives.†—"Akakia," replying to an inquiry whether homogeneous-immersion objectives are to be regarded as useful only where apertures greater than the limit for water (1·33 N.A.) are required, says that "experience has demonstrated that all incident pencils from one refracting medium to another of much greater refracting power, beyond the cone 140° in the rarer medium, make unfavourable angles—angles that cannot be effectually dealt with, and this applies the more the greater the difference between the media. For instance, in a strictly dry lens the aperture between the cone 140° in air (·94 N.A.) and 180° (1·0 N.A.) is practically of little use; in a water-immersion lens the cone between 140° in water (1·25 N.A.) and 180° (1·33 N.A.) is likewise of but little service; and equally in a homogeneous-immersion lens the cone between 140° in the immersion fluid (1·43 N.A.) and 180° (1·52 N.A.) is practically useless. Professor Abbe has arrived at the conclusion that the limit of useful aperture is a much lower figure than 1·43 N.A. [Not so. He considers 1·45 the practical limit, *ante*, p. 472—Ed.] With our present means of construction, however, the lenses which exhibit the finest definition with direct oblique illumination that would utilize 1·25 N.A. are not those lenses of precisely 1·25 N.A., but of higher aperture. It would thus appear that in order to get a well-corrected outer zone of 1·25 N.A., the lens must really have a larger aperture to cope successfully with the difficulties of the marginal aberrations. It should be observed that by the homogeneous-immersion formula the higher apertures (say those beyond ·94 N.A.) are more successfully corrected, because the path of the rays is more regular, and can thus be more definitely calculated. This is clearly evidenced by the superiority of definition seen with homogeneous-immersion lenses, when, by the conditions of the object and the illumination, the effective aperture is reduced well within the limits that have already been attained by the water-immersion formula: it is then seen that for all apertures greater than 1·0 N.A. the homogeneous-immersion formula is to be preferred. I believe it is now generally accepted among expert manipulators that the water-immersion formula has seen its best days, and the time is not far distant when it will be entirely superseded."

Collar Correction of Objectives.‡—Prof. A. Y. Moore considers that collar correction has not received the attention which it deserves,

* See also Bulloch's Congress Microscope, this Journal, iii. (1880) p. 1076.
† Engl. Mech., xxxv. (1882) p. 551.
‡ 'The Microscope,' ii. (1882) pp. 8-11.

being overlooked entirely among the younger microscopists. As so little has been written on the subject, he gives "a few simple directions.

Every objective has a certain colour with which it shows best, and there is probably no object better adapted to the purpose of determining this colour than a well-marked *Podura*-scale. . . . . When a good scale is once obtained, great care should be taken to keep it dry, for when wet it is of no use.

Now, by examining this scale with a first-class $\frac{1}{4}$ or higher power of medium or wide aperture, it will be seen that the 'exclamation marks' are more or less coloured. Pay no attention to this at first, but carefully turn the collar back and forth until the marks appear sharpest and smallest. That will be the point of best correction, and now the colour of the markings should be noticed. Having carefully determined the exact tint of best correction, throw the objective a little out of proper adjustment by turning the collar towards open point or zero. This over-corrects it, and at the same time notice the change in colour. The markings seem to expand, becoming hazy and not at all sharp. Now turn the collar towards closed until the point of best correction is passed: here the same thing is seen in regard to expansion and haziness, but a different tint seems to make its appearance. By attending very closely to this colour (which is the secondary spectrum), the proper correction can easily be made. I can best illustrate this by the following trial:—

I have before me a $\frac{1}{15}$ objective. By trial over a *Podura*-scale I find that when best adjusted the marks appear of a brilliant ruby red (and most of the finest objectives which I have seen show best with this colour); by turning the collar below zero they turn greenish, while, if turned towards closed, they become pink. Hence at the first trial of any such object, should it appear green, the collar should be turned towards closed until the ruby tint appears, and if too pale a red, or pink, the collar should be turned towards zero. By a little practice the microscopist can tell at a glance which way to turn the collar.

There are some objects on which a correction cannot be thus made; in such cases the coma must serve as a guide. The edge of a red blood-corpuscle will serve as a good test for practice in this way. By carefully moving the collar back and forth until the edge is sharp and clear, it will be seen that a brisk movement of the fine adjustment causes the edge of the corpuscle to expand, both as it goes beyond the focal point and also within the focal point. If the correction has been made exact, this expansion (coma) is equal both ways, but should the greater expansion be when the object is beyond the focal point, the objective is under-corrected, and the collar should be turned towards zero; but should it be the reverse, that is, the greater expansion within the focal point, the objective is over-corrected, and the collar should be moved towards closed."

The author then refers to the deceptive appearances produced by a want of proper correction, such as lines or network instead of dots and points; and that with homogeneous-immersion objectives without

correction-collar the draw-tube should be pushed in if the object appears too green, or if too pink drawn out until the ruby tint is obtained, assuming, that is, that the objective corrects in that colour.

In the above note we remark that Professor Moore does not specify whether the $\frac{1}{15}$ objective was dry or immersion. It should also be observed that in testing the colour-corrections of a large-apertured immersion objective on a dry Podura adhering to the cover-glass, it may happen that there is an appreciable film of air between the scale and the surface to which it adheres, in which case the "ruby" tint may be replaced by a deep red colour which cannot be corrected by the adjustment-collar. The objective will then be acting as a badly corrected dry lens. In such a case a scale must be sought that is more closely adherent to the cover-glass.

It is a fact well known to opticians that objectives of large aperture which are very perfectly achromatized do not yield such sharp definition of a dry *Podura*-scale as those in which the outstanding colour-aberration is of a moderate ruby tint. The more closely adherent the scale is to the cover-glass, the less red should be the tint; and if by means of the vertical illuminator or equivalent means a scale is chosen which adheres closely, the ruby tint will be less pronounced, and the definition generally more perfect.

Measuring Thickness of Cover-glass by Correction Collar.*—Professor C. K. Wead points out that the thickness of a cover-glass "may be found quite closely by means of an objective with correction. Taking the covers used above [·0058 inch and ·0123 inch], and having focussed on dust or finger marks on the under side, turn the collar till dust on the upper side is in focus; with the thinner glass several trials gave as the reading of the collar 3°·6, 3°·75, &c.; working backwards focussing on the top with the collar at 9°·6 and then on the lower side by the collar the reading was 6°·1 twice, a change of 3·5; mean of seven trials gave 3°·56; similarly with the thicker cover, mean of five trials gave 7°·58. If we assume the change of the collar to be just proportional to the thickness of the glass, since the thin glass is ·0058 inch we should have 3·56 : 7·58 :: ·0058 : thickness of thick cover: solving we find it to be ·01235 inch—a difference of less than $\frac{1}{1000}$ inch from that found by a Brown and Sharpe's gauge—a quantity scarcely measurable with this gauge. If one has, then, a single cover-glass whose thickness is known, by a simple proportion the thickness of any other one can be found in a moment. For this particular lens the reading of a collar multiplied by 1·6 will give very closely the thickness in thousandths of an inch. Makers might easily furnish for their lenses the constant multiplier to be used as this 1·6 is; or divide the scale so as to indicate directly the thickness in thousandths of an inch."

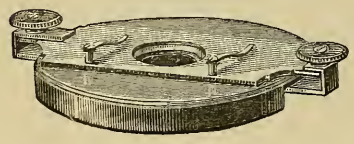
Bausch and Lomb Optical Co.'s Glass Stage and Slide-carrier.†—This (Fig. 128, see also Fig. 113) is intended as a substitute for the mechanical stage to a certain extent. It consists of a

* 'The Microscope,' ii. (1882) p. 72.

† From the Company's Price List, 7th ed., 1882, p. 5 (1 fig.).

polished plate of glass, incased in a brass ring, which clamps on the circular stage. The slide-carrier, which moves on it, consists of a light metallic plate, and has protruding from its lower surface four small points; at its two ends are prolongations, which are bent downward and inward, and, acting as springs, press against the lower surface of the glass. As the contact between glass stage and slide-carrier is only in these six points, friction is reduced to a minimum, and the action of the latter, although firm, is smooth and steady. It is claimed that it enables work to be done with far more facility than in the ordinary brass stage, where the entire surface of the slide bears on it, and that it is altogether more agreeable. The slide-carrier is provided at each end with small milled heads for manipulation, and has spring clips and a stop for Maltwood finder.

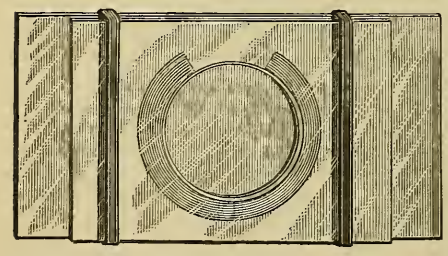
Fig. 128.



Thomas' Vivarium.—Mr. C. Thomas has devised a life-slide which is in effect a modification of the Hardy vivarium, enabling it to be readily applied to observations with high powers. With the earlier form, the upper plate is necessarily so thick that it is impossible to use it for the examination of such organisms as the Cilio-flagellata which require the highest powers.

The new vivarium is shown in Fig. 129, with the two principal plates held together by two indiarubber bands, and a segment of another band forming the sides of the cell as in the Hardy vivarium. The speciality of Mr. Thomas' device is the addition of a third plate of *thin glass*, contiguous to the upper plate and of about the same size, the latter being pierced with a central aperture. We thus have a cell the upper side of which is thin enough to allow high powers to work through it. The thin glass is so supported by the upper plate, with which it is in contact over the greater part of its surface, that we have found from experience that there is practically no risk of breaking it in putting the cell together. A piece of very thin glass can be placed inside the cell and kept close up to the front by wedging it with a small piece of rolled or twisted paper.

Fig. 129.



The upper plate is made shorter than the lower so that there may be no danger of the plates being pressed together unequally and the thin plate crushed when the apparatus is taken up by one end.

Bausch and Lomb Optical Co.'s Immersion Illuminator.*—This (Fig. 130) is designed to utilize the full capacity of medium

* The Company's Price List, 7th ed., 1882, p. 32 (2 figs.).

and wide-angled objectives. In general appearance it is like an ordinary objective. It has an internal diaphragm, which is placed directly under the posterior system of lenses, and is entirely contained in the tube comprising the mounting, therefore avoiding any projection, and allowing the light to enter only from below. By revolving the milled ring of the mounting, the diaphragm is made to pass laterally from the centre to the extreme edge of the illuminator, thereby throwing rays of any desired obliquity, between 0 (central illumination) and the extreme possible limit, 1·52 in crown glass. When the diaphragm is at its extreme limit a second slit, at right angles to it, giving the same volume of light, is opened by the further movement of the milled ring, thus utilizing two pencils at right angles. The illumination is said to be amply sufficient with the highest powers, and the fact that it is used with only central illumination of the mirror, will, it is considered, "prove especially valuable to those who do not possess instruments with the modern swinging substage and mirror-bar."

Fig. 130.

Fig. 131.

The illuminator is also said to give excellent results when used as non-immersion. A cap with minute aperture (Fig. 131) to facilitate centering, and an adapter (to receive the optical part without the diaphragms and so to give full aperture) accompany it.

Gundlach's Immersion Condenser.*—E. Gundlach discusses this subject, and expresses the opinion that of all the apparatus for providing oblique illumination for large apertures, the Abbe condenser has apparently been the most efficient, and has been generally adopted as the most suitable illuminator for the widest angled objectives, hence it is advisable to inquire whether this form of condenser is capable of doing all that is demanded of it now, or that will be demanded in the near future; and to this inquiry he has given much special study. As the full advantage of a very wide-angled objective cannot be had unless light can be made to pass through any part of its aperture at will, the Abbe condenser would be the best, if it were possible, practically, to increase its angle to correspond with that of the objective; but it can be shown, Mr. Gundlach considers, that it cannot be so increased, and that it cannot approach within 20° or more of 1·52 N.A., as is now, or soon will be, desirable.

"If the point where the optical axis of the objective cuts the plane of the object be considered the vertex of an angle which has the extended optical axis of the objective for one side, then the other side of the angle extended downward will cut the under side of the slide on which the object is mounted, at a certain distance from the axis, and this distance is proportional to the thickness of the slide. Besides, if the said angle is equal to half the angle of aperture of the objective,

* Amer. Mon. Micr. Journ., iii. (1882) pp. 85–7 (1 fig.).

then this distance is the radius of a circle which the available front of the condenser, or other apparatus, must cover, so that light may enter the objective at the most extreme angle of obliquity. If this distance, which we will call d, be $\frac{3}{16}$ inch, then the available surface of the condenser must be a circle of at least $\frac{3}{8}$ inch in diameter.

"Now, assuming the thickness of the usual object slide to be $\frac{1}{12}$ inch, though this is hardly enough, if the angle of aperture of the objective is given, we may find the distance d, for with the thickness of the slide, $\frac{1}{12}$ inch, as the cosine, the distance d will be the sine of half the angle of aperture of the objective. If the angle of the aperture of the objective be 120°, or 1·31 N.A. in crown glass of 1·52 refractive index, then the distance d would be 0·144 inch, which, however, will not introduce any special difficulty in the construction of an Abbe condenser, as the connecting, or front, surface of the condenser need not be larger in diameter than 0·288, or a little over $\frac{1}{4}$ inch. But when we come up to 140° crown-glass angle, or 1·42 N.A., the distance d increases at once to 0·228 inch, and the connecting surface of the condenser must be at least 0·456, or nearly $\frac{1}{2}$ inch in diameter. With so large a front surface, or as it is better expressed, front aperture, the condenser to be fully up to 140° crown glass, will have to be of an equivalent focus of at least $\frac{1}{2}$ inch, which with 140° in crown glass, will make the back-aperture 1·42 inch, or near $1\frac{7}{16}$ inch, and in mounting it will be pretty close work to get this inside the substage tube. But let us go a step further and suppose an objective of a crown-glass angle of 160° or 1·49 N.A., which may be expected before long. This angle will increase the distance d to 0·47 inch, and the diameter of the front aperture of the Abbe condenser must be at least 0·94 or $\frac{15}{16}$ inch. Now, as the increase of the angle of aperture of the condenser from 140° to 160° will considerably lessen its working distance, it will have to be constructed of so much longer equivalent focal distance as to keep the working distance of the slide thickness, of at least $1\frac{1}{3}$ inch focus (*sic*), and even with this it will be hard to get the required working distance. But a condenser of $1\frac{1}{3}$ inch equivalent focus and 160° crown-glass angle will require a back-aperture of 3·98 inches.

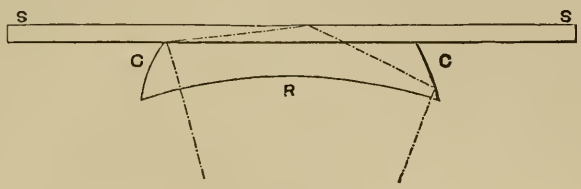
"Attaching this mammoth condenser to a Microscope having a stage, and consequently all the base parts that support it, on the same scale, we should have an instrument of such proportions as would give the appearance of a derrick, rather than that of a Microscope.

"These examples satisfy us that the Abbe condenser, useful as it is, by no means fully meets all the requirements of oblique illumination, and that practically this illumination cannot very well be made of greater angle than it already has. Hence we have either to find some other suitable means of obtaining still more oblique illumination, or to give up, as useless, the increase of the angle of the object for an increase in performance.

"So it is wise to consider the solution of this problem of illumination before the further improvement of the objective by the increase of angle. In this direction, I desire to submit for consideration the idea of an oblique light reflector represented in Fig. 132. S represents the

object-slide; R the proposed reflector. It is a section of a sphere. The upper plane surface is to be brought in contact with the slide by means of a suitable fluid in the usual way. The under surface is concave. The dotted lines show the direction of the light, which

Fig. 132.



undergoes an inner total reflection at the surface C. Perhaps this reflector will answer for the next limited period; and when even this shall prove to be insufficient, I propose to mount the object on the plane surface of this reflector. In this way the theoretical limit would be reached, and opticians can go on constructing objectives that will take and utilize the oblique light of this reflector."

[It is unnecessary to provide for any apertures in excess of 1·45; and the assumption of $\frac{1}{12}$ inch for the thickness of the object-slide is unnecessarily large, $\frac{1}{16}$ inch being the average. With these alterations the maximum figures given by Mr. Gundlach ($\frac{15}{16}$ inch for the front lens and 3·98 inch for the back lens) would be reduced.—Ed.]

Symmetrical Illumination.*—Mr. Gundlach also desires "to call attention to another idea, which, if carried out properly, may be of advantage. I thought that a good result would be obtained if the object should be obliquely illuminated symmetrically, i. e. from diametrically opposite sides at the same time, with equal obliquity, intensity, and quantity, rather than from one side only; for the secondary spectrum, with the unavoidable slight chromatic over-correction of the outer part of the objective, produces a more or less visible and disturbing spectrum, which will be neutralized in the proposed way. I have tried this, and after some difficulty I think I succeeded in obtaining a result in resolving which I could not get in the usual way. From my limited experience in this matter I can say, however, that this symmetrical illumination requires a very delicate fine adjustment; the one I used gives a motion of only $\frac{1}{360}$ of an inch at a full turn of the screw; for apparently the two images, projected separately by the illumination from each side, do not move in the direction of the optical axis when the screw is turned, but they move each toward the side from which they are projected, and it requires great precision to get them to coincide perfectly. Further desirable experimenting in this, for which I do not deem myself competent, I feel obliged to leave to experienced and skilful microscopists, and I

* Amer. Mon. Micr. Journ., iii. (1882) p. 88.

shall be grateful if informed of the results of any experiments tried by them."

Gundlach's Substage Refractor.*—This apparatus, intended for measuring the aperture angle of wide-angled objectives, consists of a small crown-glass cube, with sides about $\frac{3}{16}$ inch. One face is opaque, the one opposite and the two others opposite each other, polished. The cube is made to adhere, by means of a suitable homogeneous medium, to the front surface of the objective by the polished surface opposite the opaque side. Then a ray of light must enter each of the polished side surfaces in the plane described by the optical axis of the objective and a line perpendicular to those polished surfaces, and at such angular inclination to the optical axis that it will pass through the objective close at the edge of its aperture, and emerge from it in the direction of the optical axis.

The angle described by the refracted rays inside the crown-glass cube, is equal to the crown-glass aperture angle of the objective, and is:—

$$\cos n = \cos \frac{a}{r},$$

a being half the angle described by the two rays before entering the cube, r the refractive index of the crown glass, and n the crown-glass angle of the objective.

Silvered Convex Lenses v. Concave Mirrors.†—Mr. C. V. Boys points out that convex lenses silvered at the back make excellent and easily-constructed concave mirrors. Since both surfaces conduce to bring the light to a focus flatter curves may be used than are necessary for a plain concave reflector of the same focal length; also since the two surfaces are not parallel false images are not produced, so that the advantage of glass silvered at the back remains without the usual disadvantage.

Binocular Vision in the Microscope.‡—Professor C. Cramer, in connection with a description of Prazmowski's binocular eye-piece, discusses the conditions of stereoscopic binocular vision in the Microscope. In particular he points out the error of the views of Nägeli and Schwendener that the depth of the field of view is of only secondary importance to the stereoscopic effect, a view which they attempt to support by the fact that in the ordinary stereoscope the two pictures are perfectly plane, but yet produce the impression of solidity. These pictures require, however, to be taken from different points of view, or no stereoscopic effect whatever will be produced. Microphotographs of statuary, &c., do not appear to be more solid when observed with a stereoscopic Binocular than with a single eye. The author further describes the appearances, by the left- and right-hand halves of an objective respectively, of oil-globules and air-bubbles in water by transmitted light and a small cylindrical opaque object, as establishing to what in fact the stereoscopic effect is due. He also

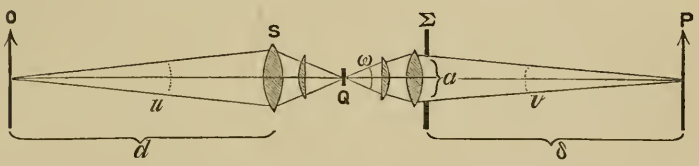
* Amer. Mon. Micr. Journ., iii. (1882) pp. 142-3 (1 fig.).
† Phil. Mag., 1882.
‡ Vierteljahrsschr. Naturf. Gesell. Zürich, xxiv. (1879) pp. 95-106.

discusses the effect of observing the two different images with a single eye (when each point of the object is seen in one direction only), and the difficulties attending the recognition of the respective distances of parts of an object with one eye. With *true* solid vision with two eyes they must constantly be accommodated according as we desire to see the nearer, central, or more remote parts of the object. With *apparent* stereoscopic vision this is not, however, necessary.

Finally, the author expresses his opinion as to the value of binoculars as follows:—"For the solution of natural problems the author cannot expect much of the stereoscopic Microscope since the sharpness of the image leaves much to be desired.* Its use for instruction is, moreover, rendered very difficult in that each observer must regulate not only the focus but also the lateral distance of the eye-pieces. Nevertheless, for microscopical objects of complicated form the instrument may here and there prove useful."

Miniatured Images.—In the President's Address (*ante*, p. 158) a brief reference is made to the unsatisfactory character of experiments made on miniatured images—spider-lines, for instance, "miniatured to the fourteenth part of the hundred-thousandth of an inch." The illusory character of all conclusions on the subject of microscopical vision, which are based on the observation of miniatured images, is demonstrated by the following discussion, which we extract from some notes on the subject by Professor Abbe.

Fig. 133.



Let O (Fig. 133) be an object—a grating or wire gauze, or spider-line, Q its miniature image, projected by means of an objective S, Σ the objective of the Microscope by which this miniature image is observed, and P the re-enlarged image which is finally seen through the eye-piece. The linear aperture of the objective Σ may be denoted by a; the corresponding aperture-angle by ω; the angle of convergence of the delineating pencils at the image P by v; the angle of divergence of the pencils admitted from O by u; the distance of O from S by d, and the distance of the final image from Σ by δ (these distances being measured from the posterior principal foci of the two objectives which will practically be very near to the back lenses), and f and ϕ the equivalent focal lengths of S and Σ respectively. All the conditions of the observation are now strictly defined.

* In the particular case, on account of the interposition of the prism and additional eye-piece combination.

Now what is claimed is, that if the spider-line at O is $\frac{1}{10000}$ inch in breadth, and the objective S diminishes by 100 diameters, we should have at Q a miniature image of $\frac{1}{1000000}$ inch, and that this is depicted by the objective Σ.

This is, however, pure hypothesis, without a shadow of proof that the observation of miniatured images is the same thing as that of real minute objects.* The only *fact* is, that the observer sees the object O as it is delineated by the *composite objective* S + Σ at P.

For demonstrating the fallacy involved in the assumptions in question it is not necessary to concern ourselves with any theory of microscopical vision—it is sufficient to rely on the ordinary principles of geometrical optics.†

In the first place it is readily shown that the appearance of the supposed miniature—as it is actually seen through the Microscope—has no essential connection with that miniature, the image at P, which is actually and only seen, not even requiring the existence of any miniature, so that the conditions of visibility of things are discussed which need not even exist at all.

Suppose the objective S under-corrected and Σ over-corrected in a corresponding degree—the aberrations of both systems just balancing one another—the object at O will be visible at P with the same distinctness as if S and Σ were strictly corrected; for the total system (S + Σ) is so corrected. Now it is obvious that under the above assumption (antagonistic correction-defects in the two systems) no image of very minute dimensions can be depicted at Q at all, where we should only have large circles of confusion.

It need hardly be said that it is an obvious fallacy to infer anything concerning the existence or operation of a given phenomenon from observations which would not be altered in the least degree if that phenomenon did not exist at all.

The true signification of the observations in question is obtained by determining the optical character of the composite system (S + Σ). This can be done by the following formulæ, which give respectively (*a*) the focal length, (*b*) the amplification, and (*c*) the aperture angle, by which three things the action of every optical system is perfectly determined. If two systems are identical in all these respects (and

* Whether a real (isolated) object, such as a fine line (bright or dark) of $\frac{1}{1000000}$ inch is visible or not visible through a given objective is only a question of light, of sensitiveness of the observer's retina, and of good correction of the objective, just as in telescopic vision a single star is always visible, however small its visual angle, provided it is sufficiently bright, but a double star requires a certain minimum aperture of the telescope depending on the angular distance apart of the stars.

† On the principles of the Abbe theory of microscopical vision the matter would stand thus:—If there were at O a coarse object of say $\frac{1}{10}$ inch in diameter, the miniature image would in fact be approximately the $\frac{1}{100}$ part in diameter, i. e. $\frac{1}{1000}$ inch. But this is not the case with objects and images of such minute dimensions as above referred to, the miniature of the spider-line, if it could for instance be photographed (the system S being absolutely free from aberrations) would be found to be a rather broad band not less in diameter than half the wave-length of light.

equally well corrected) they must always give the same image of the same object. With the notation indicated above, the equivalent focal length F of the total system (S + Σ) is

$$\frac{1}{F} = \frac{f}{\phi} \cdot \frac{1}{d} + \frac{\phi}{f} \cdot \frac{1}{\delta},$$

the linear amplification N (of the ultimate image at P),

$$N = \frac{\delta}{d} \cdot \left(\frac{f}{\phi}\right),$$

and the aperture angle u of the total system (resulting from the linear aperture a of the objective Σ),

$$u = \frac{\delta}{d} \cdot \frac{f}{\phi} \cdot v \text{ (where } v = \frac{a}{\delta}\text{)};$$

therefore

$$u = \frac{a}{d} \cdot \frac{f}{\phi}.$$

To take an example: let S be an $\frac{1}{8}$ inch and Σ a $\frac{1}{12}$ objective, d = 400 mm., δ = 200 mm., a = 3 mm., f = 3 mm., ϕ = 2 mm.—then we have

$$\frac{1}{F} = \frac{300}{200} \cdot \frac{1}{400} + \frac{200}{300} \cdot \frac{1}{200} = \frac{3}{800} + \frac{1}{300} = \frac{17}{2400}$$

$$F = \frac{2400}{17} = 141 \text{ mm. } (= 5\tfrac{1}{2} \text{ inches approximately})$$

$$N = \frac{200}{400} \cdot \frac{300}{200} = \frac{3}{4}.$$

The ultimate image at P is therefore a slightly (3:4) diminished image of O.

$$u = \frac{3}{400} \cdot \frac{300}{200} = \frac{9}{880}$$

which is an aperture angle of about $\frac{2}{3}°$.

Thus the simple *matter of fact* is that if the miniature of O is observed at P we observe the *real object* O by means of a very *low-power* objective ($5\frac{1}{2}$ inches) of *very low* aperture ($\frac{2}{3}°$) under a very low linear amplification, and nothing more is shown therefore by the observation but this, that spider-lines and similar things can be seen through very low-power objectives, which nobody will doubt.

The formulæ for F, N, and u show that the focal length of the actually effective system, the ultimate amplification, and the aperture angle do not depend on any other elements except (1) the distances d and δ of the object and the ultimate image, (2) the ratio of the focal lengths of the objectives S and Σ, and the latter in addition (3) on the linear aperture of the objective. Now F, N, and u, as has been said, comprise *all* elements of the effective system (S + Σ) which can possibly have any influence on its performance (spherical correction of

the total system being supposed), and the same values of F, N, and u will therefore indicate the same effect always. Consequently we shall obtain exactly the same results whether we apply an $\frac{1}{8}$-inch and $\frac{1}{12}$-inch, or instead of these any two *low*-power objectives with the same *ratio* of the powers (2 : 3), for instance a 2-inch and a 3-inch or (the simplest case) a single lens of $5\frac{1}{2}$ inches, always preserving the distances $d = 400$, $\delta = 200$ and the narrow diaphragm corresponding to the linear aperture of the $\frac{1}{12}$ (3 mm.).

These considerations show the illusory character of the experiments in question as all the observations would have had the same result even if objectives had been applied not of the high powers actually used but of low power or even consisting of a single lens, that is under circumstances in which either no miniature at all is formed, or none of the minute dimensions claimed. Nothing can be inferred from such experiments in regard to *high-power* vision, at any rate. They are in fact, experiments on *low-power* vision, and under artificially and unnecessarily *complicated* conditions, a complicated system, $E + \Sigma$, composed of a number of lenses being employed for obtaining no other effects than can be produced by a single lens of small aperture.

Black Annuli and Lines of Spherules and Threads.—In the same Address * is a reference to the attempts made to demonstrate the defective vision of objects under objectives with wide apertures, by means of glass spherules and threads, the characteristic black lines seen when low apertures are used nearly disappearing when the aperture is increased.

It is true that transparent spherules and threads of 0·1 inch in diameter, or many times greater than a wave-length, behave according to the laws of refraction, and show annuli, &c., which are very strong and black with low apertures, but are much less marked with wide ones, but very minute spherules or filaments of the same shape, which are only a wave-length or less in diameter, do not show the black annuli and lines *even with the narrowest apertures*. They appear either uniformly illuminated or with a gradation of light which has not the least similarity to the annuli, &c., of the coarser refracting spheres or cylinders, and this for the reason that such minute objects do not act as *refracting* bodies but only by the retardation of the transmitted waves.

This shows the essential fallacy involved in the experiments in question. That the black annuli of the coarse objects become indistinct with wide apertures proves only that wide apertures are not the proper means for examining such coarse objects. This, however, requires no proof nowadays, when it is well recognized that wide apertures should not be applied for objects which are completely depicted by low ones.

The notion that minute objects which require high powers in order to be seen are better seen with low apertures, is a conclusion derived not from direct observation, but simply *inferred* from the *supposed*

* pp. 158–9.

analogy of the phenomena presented by large objects, and with the assumption that the same phenomena must hold good in the other case also.*

Curiosities of Microscopical Literature.—One would hardly have expected to find such a paragraph as the following in a book published in London in 1881, even although written "without assuming the possession on the part of the reader of other attainments than those possessed by the average schoolboy or schoolgirl":—"In the "same year (1824) Tulley, of London, succeeded in constructing for "the first time in England an object-glass of 3 lenses. Sir John "Herschel, Professor Airy, and Professor Barlow [no mention of "Lister!] furnished valuable contributions to the theory of the "achromatic object-glass. More recently a suggestion of Sir David "Brewster's has been carried out, by the construction of lenses of "diamond. By these and other modern improvements, especially in "the mode of illuminating the objects, investigations are now carried "into structures so minute that magnifying powers of 2000 or 3000 "diameters have to be used"! †

The suggestion of diamond lenses was *abandoned* more than fifty years ago,‡ and none of the present generation of Microscopists have ever had an opportunity of testing the "improvement" which it is suggested the diamond has been to microscopical investigation.

When will popular writers get to understand that neither the size nor the magnifying power of a Microscope forms the standard of its efficiency, and that amplifications of 2000 or 3000 diameters could be obtained without any difficulty half a century ago, when, notwithstanding, much less was visible than can now be seen with a tenth of the power.

In a subsequent paragraph it is stated that the "binocular form of construction, though attempted very long ago, was not successfully carried out till 1851."

* It must also be borne in mind that it is impossible to make reliable observations as to the relative performance of objectives with different apertures, unless the fact of their perfect correction is ascertained *independently of the observations in question*, that is on objects the correct appearance of which is not dubious or hypothetical, as for instance, the outlines of thin silver films.

Again, it is out of the question in *such* observations to make arbitrary changes in the conditions under which the objective acts, as shortening and lengthening the tube, interposing other lenses between the objective and the eyepiece, using the objective with immersion fluids for which it was not constructed, &c.

As wide apertures allow of much greater aberration than low ones, it may happen that the former, if the correction is not very carefully made, will show less than a low aperture, even if this is also badly corrected, because the relative deterioration of the image is not so great.

† 'A Popular History of Science,' by R. Routledge (8vo, London, 1881) p. 515.

‡ Dr. Goring suggested diamond lenses to A. Pritchard in 1824, and he made one in the same year (see Sir D. Brewster's 'Treatise on the Microscope,' 1837, pp. 13–21). Sir D. Brewster's reference to diamond lenses will be found in 'Treatise on New Philosophical Instruments,' 1813, pp. 402–10; and 'Treatise on Optical Instruments,' 1832, p. 39.

Abbe's Fluid for Homogeneous-Immersion Objectives. [*Ante*, p. 551.]
Bull. Soc. Belg. Micr., VII. (1882) pp. clvi.–vii.

"Akakia."—Abbe's Apertometer.
[Describes his mode of use. Also replies to question of "Antares" as to whether homogeneous-immersion objectives are useful only where apertures greater than 1·33 are required. *Supra*, p. 685.]
Engl. Mech., XXXV. (1882) p. 551.

American Society of Microscopists.
[Note as to the prospects of the Elmira Meeting.]
Amer. Mon. Micr. Journ., III. (1882) pp. 135–6.

Bizzozero, G.—Manuale di Microscopia clinica. (Manual of Clinical Microscopy.) 2nd ed.
8vo, Milano, 1882, xii. and 246 pp. (44 figs. and 7 pls.).

Blackham, G. E.—Presidential Report and Address (The Evolution of the Modern Microscope) to the Elmira Meeting of the American Society of Microscopists.
[Brief abstracts with omissions. The Report contains recommendations to re-appoint the Committee on eye-pieces, and that (*à propos* of the Griffith and Stowell prizes) the whole subject of giving prizes be taken up, and the fixed policy of the Society in regard thereto be decided upon and announced. "It will require careful consideration, as there is much to be said both for and against the practice." The Address traces the history of the Microscope from the end of the sixteenth century to the present time.]
Amer. Mon. Micr. Journ., III. (1882) pp. 170–3.

Bradbury, W.—The Achromatic Object-glass, VII.–X.
Engl. Mech., XXXV. (1882) pp. 489–90, 537–8;
XXXVI. (1882) pp. 26–8, 78–80.

Brébisson, A. de.—See Chevalier, A.

Brewer, W. H.—Apparent Size of Magnified Objects.
[Abstract of paper presented in the Sections of Histology and Microscopy at the Montreal Meeting of the American Association for the Advancement of Science. *Post.*]
Amer. Mon. Micr. Journ., III. (1882) p. 161.

Brittain, T.—The Beginnings of Microscopic Study.
[Several corrections necessary. (1) Baker (and not Trembley) is credited with the first demonstration of the vitality of *Hydra* when cut to pieces, while (2) the discovery of achromatism and the manufacture of achromatic lenses and the revolution which they caused in Microscopy has been lost sight of, the position of the Microscope in 1830 being thus dealt with:—"About 1830 the mechanism and general arrangements of the materials employed began to show a great advance upon the older instruments, but it was in the lenses that the chief improvements were manifest, and principally in the higher powers. The lower powers, composed of a single lens, remained much as before, while the improvements in the higher powers were carried on to a wonderful state of perfection. The provoking refraction which interfered with the definition of an object when seen with a high power is now got rid of, and what was obscure and doubtful before is no longer so, but becomes a matter of demonstration."]
Field Naturalist, I. (1882) pp. 80–1.

Carpenter, W. B.—Address on the Practical and Theoretical Results in the History of the Microscope.
[Abstract of Address to the Section of Microscopy at the Montreal Meeting of the A.A.A.S. Relates mainly to the relative value of objectives of small and large aperture.]
Amer. Mon. Micr. Journ., III. (1882) pp. 161–3.

Chevalier. A.—L'Étudiant micrographe, traité théorique et pratique du Microscope et des préparations. 3e édition, augmentée des applications à l'étude de l'anatomie, de la botanique et de l'histologie, par MM. Alph. de Brébisson, H. Van

Heurck, G. Pouchet. (The Micrographical Student, theoretical and practical treatise on the Microscope and preparations. 3rd ed., with additions on its applications to the study of anatomy, botany, and histology.) xvi. and 591 pp. Portrait, 179 figs., and 7 pls. 8vo, Paris, 1882.

Crisp, F.—Notes sur l'Ouverture, la vision microscopique et la valeur des objectifs à immersion à grand angle. (Notes on Aperture, Microscopical Vision, and the value of wide-angled Immersion Objectives)—*contd.*

[Transl. of paper, *ante*, I. (1881) pp. 303–60.]

Journ. de Microgr., VI. (1882) pp. 362–5 (3 figs.), 417–8 (3 figs.).

Davis, G. E.—Prof. Abbe's Paper on the Relation of Aperture and Power in the Microscope. *North. Microscopist*, II. (1882) pp. 211–2.

„ „ A Plea for Wide Apertures.

["A reply to Prof. Abbe's paper 'On the Relation of Aperture and Power in the Microscope.'"]

North. Microscopist, II. (1882) pp. 229–38 (1 pl. of 4 photos.).

„ „ How to Found a Local Microscopical Society.

North. Microscopist, II. (1882) pp. 212–6.

Dippel, L.—Das Mikroskop und seine Anwendung, 1er Theil. Handbuch der Allgemeinen Mikroskopie, 1e Abtheilung.

2nd ed., 8vo, Braunschweig, 1882, viii. and 336 pp., 189 figs.

„ „ Die Correctionsfassung bei Objectiv-Systemen für homogene Immersion. *Zeitschr. f. Instrumentenk.*, II. (1882) pp. 269–74.

Dyck, F. C. Van.—Significant Angle.

[Objections to the paper of the Hon. J. D. Cox, *ante*, p. 422.]

Amer. Mon. Micr. Journ., III. (1882) pp. 154–5.

Engelmann, T. W.—Ueber Sauerstoffausscheidung von Pflanzenzellen im Mikrospectrum. (On the disengagement of oxygen by vegetable cells in the Microspectrum.)

[Contains a description of the Microspectroscopic Apparatus, *ante* p. 564, and *supra* p. 661.]

Bot. Ztg., XL. (1882) pp. 419–26 (1 fig.).

Flesch, M.—Beleuchtungsvorrichtung zum Mikroskopiren bei künstlichen Licht. (Illuminating Apparatus for Microscopical Observations by Artificial Light.)

[The numerous lamps of often complicated structure are superfluous for histologists or for other purposes than resolving test objects. Light modifiers of tinted glass are, however, useful, and can be arranged to be conveniently placed in the carrier-plate of the Abbe coudenser.

Sep. repr. *SB. Phys.-Med. Gesell. Würzburg*, 1882, 2 pp.

Grunow's (J.) New Microscope.

[No speciality in form.]

Amer. Mon. Micr. Journ., III. (1882) pp. 146–7 (1 fig.).

Gundlach's (E.) Substage Refractor.

[For measuring the apertures of wide-angled objectives. *Supra*, p. 692.]

Amer. Mon. Micr. Journ., III. (1882) pp. 142–3 (1 fig.).

Gundlach, E.—A Simple Method of determining the Angle of Aperture of Immersion Objectives.

[Apparently the same as the preceding.]

Amer. Mon. Micr. Journ., III. (1882) p. 176.

Gundlach's $\frac{1}{100}$-in. objective.

[Notices its intended manufacture. "We hope to live long enough to see it."]

Amer. Mon. Micr. Journ., III. (1882) p. 158.

Heurck, H. Van.—See Chevalier, A.

Hitchcock, R.—Physicians and Microscopists.

[Rejoinder to the 'Medical Register' as to their comments on the original note, *ante*, p. 423.]

Amer. Mon. Micr. Journ., III. (1882) p. 136.

Hitchcock, R.—Uniformity in Oculars.

["The only way to secure uniformity is to convince purchasers of its importance."]

Amer. Mon. Micr. Journ., III. (1882) pp. 155–6.

" " Table of Numerical Apertures.

[Brief additional remarks.]

Amer. Mon. Micr. Journ., III. (1882) p. 156.

M., W. H.—Schrauer's Microscope.

[Travelling instrument with removable base, not requiring a box, but to be "laid between other goods in one trunk."]

Amer. Mon. Micr. Journ., III. (1882) pp. 158–9.

Mackenzie, J.—Two forms of gas lamp specially for use with the Microscope. (Exhibited.)

[No description.]

Journ. Quek. Micr. Club, I. (1882) p. 105.

Martens, A.—Ueber die hygienische Ausstellung in Berlin. (On the Hygienic Exhibition in Berlin.)

[Records the fact of the exhibition of various Microscopes, apparatus, and preparations.]

Central-Ztg. f. Optik u. Mech., III. (1882) pp. 145–6.

'Northern Microscopist' Verification Department (*contd.*).

North. Microscopist, II. (1882) pp. 239–40.

Numerical Aperture and Micrometric Tables.

[From pp. 7 and 8 of the Wrapper of this Journal.]

Amer. Mon. Micr. Journ., III. (1882) p. 134.

Pelletan, J.—Microscope "Continental" ("Continental" Microscope).

[p. 356: Announcement that it will be ready for delivery on 1st September. — "It represents a 'Centennial' of Zentmayer or a 'Congress' of Bulloch constructed à l'Européenne." pp. 406–7: Description of the instrument.]

Journ. de Microgr., VI. (1882) pp. 356, 406–7 (1 phot.).

Pinkernelle, W.—Apparat zur Erleichterung der Mikroskopischen Untersuchung von Flüssigkeiten. (Apparatus for facilitating the microscopical observation of fluids.)

[Abstract of German Patent, No. 18,071, 31st May, 1881. Simply a slide made of two glass plates cemented together with a channel between them. A tube connected with one end dips into an open vessel with the fluid to be examined, and one connected with the other passes through the cork of a closed receiver, which is also pierced by a second tube ending in an indiarubber ball. A stop-cock at each end of the slide regulates the flow.—Also suggestions for simplifying it by substituting a long tube for the receiver so as to act as a siphon.]

Central-Ztg. f. Optik u. Mech., III. (1882) p. 155 (1 fig.).

Pouchet, G.—See Chevalier, A.

President's Address [Abstract of, *concld.*].

Amer. Mon. Micr. Journ., III. (1882) pp. 128–32.

"Prismatique."—Object-glass working, I.

[Practical directions.]

Engl. Mech., XXXVI. (1882) p. 54.

Royston-Pigott, G. W.—Microscopes and Microscopy.

[Lecture to the 'Eastbourne Young Men's Christian Association.']

Engl. Mech., XXXV. (1882) pp. 231–2.

Standard Gauges for Eye-pieces and Substages.

[Note on the Committee's report, *ante*, p. 595—"it is to be hoped that for the future eye-pieces will only be made of the specified sizes; the inconvenience attending the parts of various instruments not being interchangeable is very great, and might in the course of a few years disappear if all new instruments were made to the standard sizes."]

Journ. of Sci., IV. (1882) pp. 502–3.

Steinheil's Achromatic Eye-pieces.

This Journal, II. (1882) p. 551 (2 figs.).

Engl. Mech., XXXV. (1882) p. 570 (2 figs.).

Stroebelt, O.—Eine verbesserte Vorrichtung mikroskopische Beobachtungen unter dem Einfluss elektrischer Schläge anzustellen. (An improved arrangement for microscopical observations under the influence of el ctrical shocks.) [*Post.*]
Zeitsch. f. Instrumentenk., II. (1882) pp. 274-5 (1 fig.).

Treskow, H.—Führung am Objectivtische des Mikroskops nebst Compressorium. (Carrier to the Stage of the Microscope with Compressorium.)
German Patent, No. 13,399, 9th September, 1880, 2 figs. (1 pl.).

Vorce, C. M.—[Note as to easy and quick resolution of *Amphipleura pellucida* in balsam by Bausch and Lomb $\frac{1}{6}$-inch and $\frac{1}{8}$-inch objectives, with mirror central, sunlight, and no condenser.]
Amer. Mon. Micr. Journ., III. (1882) p. 137.

Ward, R. H.—The August Meetings.
[Elmira Meeting of the American Society of Microscopists, and Montreal Meeting of the Amer. Assoc. Adv. Sci.—at the latter the new section of histology and microscopy will meet for the first time.]
Amer. Natural., XVI. (1882) p. 691.

" " Eye Protectors.
[Description and figure of Pennock's, I. (1881) p. 518, and description of Hall's, *supra*, p. 678.]
Amer. Natural., XVI. (1882) pp. 691-2 (1 fig.).

Wright, L.—Light, a course of experimental Optics chiefly with the Lantern.
[Contains an Appendix to Chap. IX. on "Diffraction in the Microscope," pp. 200-7, 17 figs.]
8vo, London, 1882, xxiv. and 367 pp. (190 figs. and 8 pls.).

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

Preservative Fluids for Animal and Vegetable Tissues, and Methods of Preservation.*—Many years ago, Professor F. Pacini commenced to make microscopical preparations with a view of preserving types of different elements of tissues, both normal and pathological, and experimented largely with aqueous solutions of different substances in variable proportions; then, having put up a large number of preparations in these solutions, he allowed some years to elapse in order to see which had best resisted the effects of time. Many, of course, perished; but those which are preserved serve to indicate the best methods to employ.

Professor Pacini does not deal with the well-known methods of preserving, by means of Canada balsam or glycerine, microscopical preparations of hard, dry, or indurated parts, merely observing that tissues, when they have been dried or indurated to obtain sections, have lost their water of organisation, and are not suited to give an exact idea of their minute structure; it is necessary that they should be preserved in an aqueous medium of low density, in order that they may present as natural an aspect as possible. Very thin sections of tissues, when preserved in so dense a medium as Canada balsam or glycerine, become transparent; it is then necessary to stain them in order to render them visible, and whilst they are then certainly more pretty to look at, they are not natural.

* Journ. de Microgr., iv. (1880) pp. 136, 191, and 235.

The fluids themselves, whose use the author describes, are already known; the new matter in his present communication is the account of the modes in which he finds they can be most advantageously used.

Bichloride of mercury, or corrosive sublimate, is the principal basis of the solutions. Combining with the histological elements, both animal and vegetable, it renders them insoluble, so that they can be preserved indefinitely in an aqueous medium. But, as the bichloride of mercury coagulates and precipitates the albuminous matter that exists in the interstitial fluids of the tissues, to prevent this coagulation salt is associated with it for certain preparations, and acetic acid for others, and in more or less considerable quantities, according to the effects to be obtained.

		Parts.
I.	Bichloride of mercury	1
	Distilled water	200
II.	Bichloride of mercury	1
	Common salt	2
	Distilled water	200
III.	Bichloride of mercury	1
	Common salt	4
	Distilled water	200
IV.	Bichloride of mercury	1
	Acetic acid	2
	Distilled water	300

No. I. is of limited use, but will preserve indefinitely all histological substances, both animal and vegetable, which are solid and non-albuminous, for hollow substances either swell or become too opaque by the coagulation of the albumen. It can, however, generally be substituted for the other solutions when it is desirable to entirely remove the salt or acetic acid from the solution in which any given preparation has been placed.

No. II. may be generally employed for all tissues both cellular and fibrous, animal or vegetable, provided they are sufficiently dissociated in sections of extreme thinness, because they become somewhat opaque, regaining, however, in time a certain transparency. It is especially useful for the blood-corpuscles of cold-blooded animals having a less density than III.

No. III. serves specially for the blood-corpuscles of warm-blooded animals.

No. IV. serves best for the nuclei of animal tissues, but it swells up the fibres and distorts the forms of the cells. Still, in certain cases it is very useful, and it preserves the white blood-corpuscles admirably.

All the solutions should be employed in sufficiently large quantities, and the specimen kept in it for 4–5 days or longer, in order that it may have time to take up a sufficient quantity of the bichloride of mercury before being finally closed up.

The use of metallic instruments is to be avoided, because, being attacked by the bichloride of mercury, they give rise to cloudy precipitates, which render the prepared objects thick. Sections should be cut before plunging them in the solution, and when it is necessary to tease out the elements of a tissue it should be done with porcupine quills or pointed goose-quills.

If it is wished to preserve red blood-corpuscles, the blood must be diluted with at least 50 to 100 times its volume of solution II. (or No. III., see above); this is decanted after the lapse of 24 hours, and changed in the same way three or four times. White blood-corpuscles may be isolated by destroying the red ones; this end is attained by the use of solution IV., by means of the acetic acid contained in it. It must be applied for 48 hours in the proportion of from 50 to 100 times the volume of the blood, and must, as in the former case, be changed three or four times. If transferred to solution II., the leucocytes gradually regain their original form. Spermatic fluid is preserved in solution II. The liquid must first be stirred round with a glass rod to prevent the elements adhering.

Epithelia are examined in the same solution after the parts which support them have remained some days in the solution, spread out, if necessary, on sheets of guttapercha with cactus thorns.

Blood-vessels may be beautifully injected naturally by putting the tissues which contain them into solution II. or III. for a considerable time (fœtus eyes intended to show the vessels of the pupillar membrane should be treated thus for 20 days). Nerve-fibres may be studied advantageously in the cranial and intra-ocular nerves with their comparatively thin medullary sheaths. Muscular fibres are best examined in the muscles of *Petromyzon* after a treatment of several days with solution II.

If it is desired to collect Infusoria or other very small organisms, animal or vegetable, particularly when they are in movement and scattered through a large quantity of water, a tolerably large glass vessel (in order to collect a sufficient quantity) should be filled with the water, and a little of the solution No. II. added. All the Infusoria being killed by the bichloride of mercury, they fall slowly (in three or four days) to the bottom of the vessel, the more slowly as they are smaller. The greater part of the liquid is then to be decanted by a siphon and replaced by some of the solution, which should be changed three or four times. The Infusoria can then be preserved in a bottle or mounted.

Preparing Sections of Axis-cylinder. — For extensive lengths of axis-cylinder G. Bufelius* proceeds as follows:—Fragments of nerves of the dog or rabbit are laid for 24 hours in Müller's fluid. They are then transferred to an aqueous solution of corrosive sublimate (·5 per cent.) in which they remain several days, the liquid being constantly changed, until the solution undergoes no further alteration. The tissue is then teased and treated with dilute picro-

* 'Lo Sperimentale,' 1880, Nov. Cf. Jahresber. Virchow and Hirsch for 1880, p. 22.

carmine. Finally 33 per cent. alcohol, and then absolute alcohol, are applied, and the specimens mounted in dammar.

Mounting Gizzards of Insects.*—Dr. T. J. Sturt was formerly content to pull off the head of a cricket, drag with it the stomach, and attached to it the gizzard or organ containing the pyloric teeth, skin off the muscular coat with the thumbnail, cut off any portion of intestine, and then mount.

This plan, however, missed many interesting points in the stomach and gullet, and he now prefers to kill with a drop of benzine, cut off the extreme tail, pull off the head, cut off the whole intestine, and put it in a 1 oz. phial with 5 or 10 drops of liquid potash. After it has stood about half-an-hour, partly fill with water and shake it well to detach the muscular coat and tracheæ; then slit it up, wash and adjust on a slide. Drain away any moisture, apply a drop of carbolic acid, and place on the thin glass. After a few minutes this will absorb all moisture, and render it quite transparent. If it does not, put a drop of acid at the edge and tilt the slide to drive off the first acid; then put a little balsam on the edge, tilt the slide, warming it to render the balsam more limpid, and it will gradually take the place of the acid, the lines of demarcation between the two being distinctly visible.

Preparing Tape-worms.†—Dr. G. Riehm recommends the following treatment of specimens.

To prevent contraction at death, he cleans the living cestode with a brush, and holds it in the hand until it has extended itself under the action of the warmth, and then rolls it upon a glass tube and plunges the whole into spirit; undue adhesion to the glass is remedied by soaking in water. Such specimens are well adapted for mounting under pressure; they may be stained with alum-carmine or with hæmatoxylin; if with the latter, the specimen should be treated with acetic acid for a minute after staining and then washed in ammonia to remove excess of colour.

For minute investigation, sections made parallel to the flat surfaces are preferable. To prevent the last sections breaking out of the imbedding mass, this should be made of equal parts of paraffin and white wax with the addition of one or two drops of Canada balsam dissolved in turpentine for each gramme of the mixture. The razor should be wetted with benzine, care being taken not to moisten the object itself too much with the benzine. To secure having the sections cut in the right place, the specimen is soaked in turpentine, placed in a watch-glass of imbedding mass kept liquid by heat, and left there until seen by its transparency to be thoroughly penetrated; some of the mass is then removed with a hot instrument and placed on a slide and pressed out, the specimen is placed on the stage of the microtome and the slide with its paraffin is placed on it; when cool the slide may be removed, leaving the specimen imbedded in a strictly horizontal position. The excretory vessels are injected with

* Engl. Mech., xxxv. (1882) p. 282.

† Zeitschr. Ges. Naturwiss., vi. (1881) pp. 547–51.

Berlin blue by simple insertion of the syringe; if the animal is moving actively the injection runs forward with difficulty and in any case the neck and head require manipulating with the finger or a wet brush, in order to drive the injection through the narrow portions of the vessels which occur at the joints.

Staining and Preserving Tube-casts.*—To stain and preserve tube-casts, A. T. Parker finds a logwood solution better than any other, made by adding five grammes of the extract of logwood, and the same quantity of alum, to 100 ccm. of water. The extract and alum should be thoroughly triturated before the water is added, and the whole then left until the extract is completely taken up by the water, which requires several hours, and then filtered. The best course to pursue in staining is to shake the bottle containing the urine, then pour it into a conical flask; after several hours, when the deposit is complete, either draw or pour off the supernatant fluid, and add to the deposit about an equal quantity of the staining fluid. At the end of one or two days, the casts will be stained a beautiful reddish-purple.

Casts prepared in this manner over nine months since, though left in the tube in which they were stained, are as perfect as at the time they were prepared. After staining, the casts can be mounted in balsam or dammar without undergoing any change.

Method for Dry Preparations.†—Dr. G. Riehm, after stating that the method of making the dry preparations recently shown has not been published by its original inventor, describes what he terms a simple and inexpensive process for attaining the same end.

After being arranged so as to show the required anatomical points, the specimen is hardened, preferably by chromic acid (Mollusca), Müller's fluid, picrosulphuric acid or (when the tendency to shrinking is not great) in alcohol. All water must then be extracted with absolute alcohol; if this is not thoroughly done, shrinkage occurs later. It is then placed in oil of lavender or oil of turpentine (the latter is, however, sensitive to traces of water), and, when quite saturated, extended with pins or otherwise on filter paper and left there for forty-eight hours. The specimen has then a brilliant white colour and maintains its colour and condition if protected from dust. The principle of the method consists in the prevention of decomposition by removal of the water and the protection of every particle from the action of the aqueous vapour and oxygen of the air by an investing film of resinous matter, the result of oxidation of the turpentine or oil of lavender. The cost of preparing such an object as the frog's intestine is about 30 pfennings (3½ pence, English value), and may be reduced by distilling the oil and using it again, and by employing the old absolute alcohol for approximate dehydration of other specimens, an important recommendation in the case of museums and other institutions. A dealer in Halle, named Schlüter, undertakes to supply specimens of the more

* Amer. Mon. Micr. Journ., iii. (1882) pp. 153–4.
† Zool. Anzeig., ix. (1881) pp. 672–3.

ordinary objects, prepared in this way. By comparing this process with that described at p. 706 of vol. i. (1881) of this Journal, it be seen that Dr. Riehm's is essentially the same as that of Prof. C. Semper. This gentleman asserts * his claim to the credit of having first made it public, and mentions three other scientific men who have published similar accounts. He disputes Dr. Riehm's explanation of the action of the turpentine, stating that the preparations are readily softened by water. The expense, also, in time and material is not small. Although the white colour seems to be an advantage, it may sometimes be necessary to restore as nearly as possible the colours of life, and this may be done by immersion in a mixture of glycerine and solution of sugar, and then drying; or the white objects may be painted either with honey or oil colours.

Preserving Infusoria. †—E. Maupas, referring to M. Certes' view that the exposure of the Infusoria to the action of the vapour of osmic acid should last from 10 to 30 minutes, says that this time appears to him much too long. He obtains a result much more rapid in the following way. Deposit the drop of water containing the Infusoria so that it shall spread as little as possible on the slide, and then invert it over the neck of the bottle containing the osmic acid (1 per cent.) having an opening sufficiently large so that the drop shall not touch the sides. By this plan the Infusoria never resist more than half a minute.

Mounting Mosses and Hepaticæ. ‡ — M. Delogne recommends glycerine-gelatine which is specially valuable for the study of the stipules of the Hepaticæ, organs which are ordinarily very difficult to see. A special advantage is that it renders a cell unnecessary.

Preparing Bacteria of Tuberculosis. §—Dr. E. Van Ermengem, referring to Ehrlich's improvement of Koch's method,|| describes some modifications of his own which makes it absolutely sure in its results.

Instead of making a solution of the aniline in water, which only takes up 1 part in 30, an alcoholic solution is made, 4 grammes of liquid aniline in 20 grammes of alcohol at 40°, adding an equal quantity of distilled water, and filtering before use. The most stable coloring agents the author finds to be sulphate of rosaniline and methyl-violet B B B B B. The preparations, after having been decolorized by dilute nitric acid, are well washed in distilled water.

Baumgarten also recommends ¶ the following as more simple and expeditious than any others. After having spread the tuberculous matter on the cover-glass, it is placed in a watch-glass and covered with distilled water, to which is added some drops of a 33 per cent.

* Zool. Anzeig., v. (1882) pp. 144–6.

† Arch. de Zool. Expér. et Gén., ix. (1881) p. 360. See this Journal, ii. (1879) p. 331.

‡ Bull. Soc. Belg. Micr., vii. (1882) p. cl.

§ Ibid., vii. (1882) pp. cli.–iii.

|| See this Journal, *ante*, p. 572.

¶ Centralbl. f. d. Med. Wiss., 24th June, 1882.

solution of caustic potash. Without any further preparation the bacteria may then be recognized under a power of 400–500, particularly if a light pressure is applied to the cover-glass so as to disengage the bacteria more completely from the detritus which surrounds them. To distinguish them more clearly from the other bacteria, the cover-glass may be dried by passing it rapidly two or three times through a flame and then staining by a concentrated aqueous solution of aniline violet or other colour. The bacteria of tuberculosis are *absolutely colourless*, while the other bacteria, micrococci, &c., are plainly coloured. The whole process only takes ten minutes.

Preparing Diatoms.*—Dr. R. S. Warren gives detailed directions for the preparation of diatoms, especially for separating them from sand and broken species, the directions for which hitherto published he thinks are insufficient. Coarse sand may be got rid of by repeated settlings and decantations, but it is different with the fine sand. Graduated settlings and decantations have been advised, but these are insufficient, as despite all care, more or less of light silt will float with the light forms of diatoms, and the heavy forms will fall to the bottom with the heavy sand. Whirling in an evaporating dish has been advised, but this is insufficient, and Dr. Warren has found no method better than the one he has used for several years, and which he has never seen described or hinted at except in regard to whirling.†

"If the material contains the lighter forms only, I first use whirling force as follows:—I take an evaporating dish of a size according to the quantity of material, and fasten it on the wheel of my turntable by means of a narrow rubber band passed over it and under the wheel. The material is diffused in five or six times its bulk of water. An empty wide-mouth bottle is near the turntable, and should have the capacity of two or three times the quantity of diffused material. Shaking the material well, I fill the evaporating dish about two-thirds, and then whirl it with considerable rapidity till I think the sand has mostly settled at the bottom of the dish, for the whirling motion causes it to fall. I then pour off the unsettled portion into the empty bottle, and add more of the material to the sand and diatoms remaining in the dish, and stir with a narrow strip of glass; the whirling is repeated; and so on with all the material. When this has been done, water is added to the portion in the dish, and the process continued till no diatoms remain in the sand. To ascertain this, the dipping-tube again comes into use. The material is treated in this way several times, till no sand can be obtained by it. If the material contains heavy diatoms like the large *Pinnulariæ*, *Triceratium favus*, and heavy disk-forms, the whirling process cannot well be used, for these heavy forms fall to the bottom of the dish with the sand.

"After the above process is ended, I proceed as follows, and this is,

* Amer. Mon. Micr. Journ., iii. (1882) pp. 111–5.

† Mr. F. Kitton subsequently (op. cit. p. 153) refers to his own papers in 'Science-Gossip,' 1877, pp. 145 and 217, as containing all or nearly all Dr. Warren's methods.

in most cases, the only method used after the boiling and washings. I have a slide of polished glass 3½ inches by 4½ inches; a smooth block of wood 4 inches by 5 or 6 inches, and 3 inches thick; two wide-mouth bottles of 4 to 6 ounces capacity, with thin, projecting lips, one empty, the other filled with the material thinly diffused in water; several pieces of considerable size of old worn cotton-cloth, and, for I like it best, a clean linen pocket-handkerchief, and a small table. The table I place beside my wash-bowl, which is supplied with water—not filtered in this instance—through a pipe and faucet, and on it are arranged my bottles, block, and cloths. I place the glass slide on the block, taking care that the latter is level, and, well shaking the material, pour a little of it on the slide, and then quickly pour it off, tipping the slide so that the material will flow off from a corner of it into the empty bottle. The diatoms float off into the bottle, and the sand adheres to the slide. The slide is then washed by letting water upon it from the faucet, then wiped as well as may be with one of the large pieces of cloth, and then the surface to be used is wiped with the linen handkerchief. This last wiping dries the surface thoroughly, and removes any little shreds of cotton which may have adhered to it from the cloth. Care is taken that none adhere. In this way the material is all worked over, and this treatment has to be repeated perhaps many times before the material is sufficiently rid of the sand. It may be that before this is accomplished, the sand and diatoms will cling together on the slide, causing considerable loss of the latter. This is owing to little particles of matter getting into the material from the cloths, or from the air, and cannot be prevented. As soon as this clinging is detected, which is easily done by occasionally examining the slide under the Microscope, first drying it after pouring off the material, the latter should be boiled for a minute in sulphuric acid, to which is added a little chlorate of potash while boiling. Of course the diffused material is poured into a beaker, allowed to settle, and the water drained off. It is then washed and the treatment continued. When the material is at last freed of sand, it is boiled a last time in sulphuric acid, chlorate of potash being used as before. It is then thoroughly washed and properly diffused in dilute alcohol for mounting. The alcohol should be filtered as well as the water.

"In this last process some of the diatoms will adhere to the slide, but this is of little consequence if there be plenty of material. As the cloths get pretty wet, as they will, they should be exchanged for dry ones."

Modification of Paraffin-imbedding.*—The ordinary method of imbedding delicate objects in paraffin is attended with so many objections, such as the disagreeable shrinking, brittleness, and fragility which the object shows by lying long in oil of turpentine or in a warm solution of paraffin in oil of turpentine, that O. Bütschli endeavoured for some time to find a substitute for the latter. After several experiments he found chloroform to be a very excellent sub-

* Biol. Centralbl., i. (1881) pp. 591–2.

stitute, and has used it for some time with most satisfactory results. The following is the method employed in the preparation of very delicate objects.

After having removed the water from the object in the usual manner by alcohol, it must be laid for a short time in pure chloroform, until it is completely saturated. The object is then placed in a solution of paraffin in chloroform which is so made that it is fluid at a temperature of 30–49° C., but firm at a moderate temperature. To retain it in a fluid state while the object is in it, it is sufficient to place it in lukewarm water. The author prefers a solution of paraffin in chloroform saturated at 35° C. In this the object is placed until it is thoroughly impregnated with the solution, for which ½–1 hour is sufficient. The object is now placed in a watch-glass with a little of the solution, and the chloroform is completely evaporated at a very moderate temperature (40–50° C.), which is sometimes a long process as the chloroform escapes very slowly when mixed with paraffin. Larger objects can be transferred direct from the solution into melted paraffin in the same way as in using the mixture of paraffin and oil of turpentine. For delicate objects which must be completely and uniformly saturated with paraffin, the first method is in any case more to be recommended. Complete evaporation of the chloroform is also a necessity, for the presence of even a small quantity is apt to make the paraffin very soft. To make the sections the object can either be poured with the melted paraffin upon a small piece of paraffin, or after it has been placed in a larger mass of melted paraffin, it can be poured into a paper box in the usual manner.

This mode of imbedding is the most harmless and effective which the author has hitherto employed. Both object and paraffin form a thoroughly compact mass, which can be cut exceedingly uniformly. The paraffin which remains after the evaporation of the chloroform is of a very uniform structure without any tendency to crystallization, which very much favours the making of thin sections. With careful manipulation a thorough filling of the smallest interstices of the object can be effected, and there need be no apprehension of shrinking or brittleness.

The author (who acknowledges the assistance of Dr. F. Blochmann) mentions some of the cases for which they have found the process very successful, viz. *Amphioxus*, *Cerianthus*, tape-worms, ambulacra of Echini, decalcified ambulacra of Holothurians, gelatinous parts of Ctenophora, Hydroid polyps, &c. Of large objects, such as cross-sections of *Amphioxus* and *Cerianthus*, sections can be made without difficulty of $\frac{1}{100}$ mm. in thickness. Of small objects, as the tentacles of *Cerianthus*, or entire Hydroid polypi, sections can be made of $\frac{1}{250}$ mm.; if Thoma's microtome is used, indeed under some circumstances even to $\frac{1}{500}$ mm. if the knife be placed rather obliquely to the object.

Perenyi's Hardening Fluid.*—Dr. J. Perenyi describes a new hardening fluid for embryological purposes which has given surprising

* Zool. Anzeig., v. (1882) pp. 459–60.

results. Its advantage consists in the fact that the ova do not become porous, and that the segmentation spheres, as well as the nuclei, remain fixed in their respective divisions. The ova may be cut like cartilage.

The composition of the fluid is :—

Nitric acid (10 per cent.)	4 parts.
Alcohol	3 „
Chromic acid (0·5 per cent.)	3 „

which after a short time forms a violet fluid.

In this the ova are placed for 4–5 hours, then for 24 hours in 70 per cent. alcohol, for a few days in strong alcohol, and for 4–5 days more in absolute alcohol.

For staining, either (1) the fluid itself, or (2) the oil of cloves, can be coloured.

The first method is more convenient because quicker, since the ova are hardened and coloured at the same time. The outer albuminous coat should, however, be removed, so that the staining fluid may penetrate better. Some colouring agents, such as eosin, purpurin, and aniline-violet, must be dissolved in three parts of alcohol before they are added to the hardening fluid, whilst others, such as fuchsin and aniline-red can be dissolved direct. Very beautiful preparations are made by colouring the fluid with picrocarmine or borax-carmine.

To get rid of the sediment produced by these agents the fluid must be filtered before the ova are laid in it. For washing, 5 per cent. alcohol is first used (5 hours), then ordinary alcohol (10 hours), and then absolute alcohol; for clearing, oil of cloves; and for mounting, Canada balsam.

By the second method the ova are hardened and cut, and the section placed on the slide wetted with one or two drops of coloured oil of cloves. In 5–10 minutes the latter is sucked away with filtering paper. The oil can be coloured with eosin dissolved in alcohol or with safranin.

If *entire ova* or embryos are freed from their outer albuminous coat and hardened, then taken out of the alcohol, left free until the alcohol is evaporated, and then wetted with a few drops of oil of cloves or turpentine, very excellent and *stable* preparations are obtained for the study of the outer segmentation.

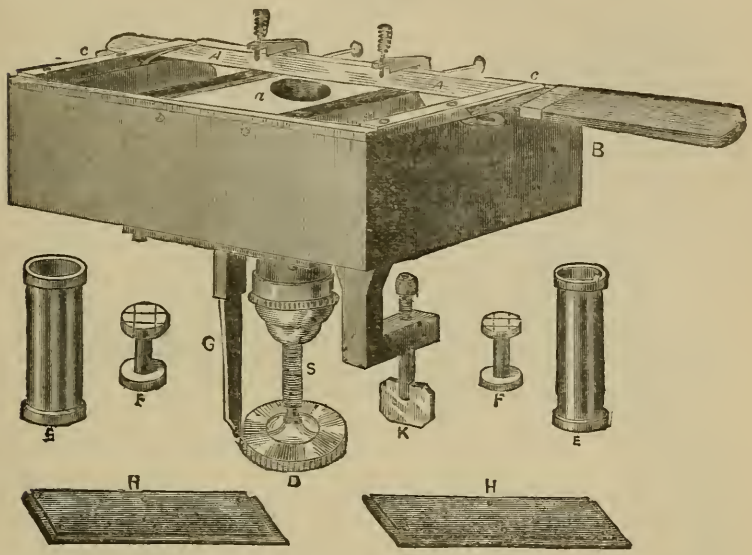
Satterthwaite and Hunt's Freezing Section-cutter.*—Dr. T. E. Satterthwaite, in conjunction with Dr. J. H. Hunt, has devised a modification of the ordinary freezing microtome, shown in Fig. 134.

It consists of the brass cylinder S, made of rather large size and placed in the centre of a metallic box B. The length of the cylinder, with milled head D, is about 5 inches. The diameter of the well *a* is $1\frac{3}{8}$ inch. Fitted round the cylinder is a plate glass for the knife to sweep over.

* Satterthwaite, T. E., 'A Manual of Histology.' 478 pp. and 198 figs., 8vo, London, 1881.

The knife A A is large, measuring 13 inches in length, including handle and $1\frac{3}{8}$ inches in breadth. It is slightly concave on both sides, and is fitted into a brass frame *c*, *c*, $7\frac{1}{4}$ inches by $3\frac{1}{8}$ inches. Two

FIG. 134.



strong brass springs and two sliding clamps hold it in place. The knife and frame are modifications of Dr. Curtis's plan.

The well is so large that it will hold an ordinary kidney after hardening, or, at least, so much of it that a section may be made of the whole organ at one sweep of the knife.

Each revolution of the milled head raises the preparation $\frac{1}{31}$ inch, and as it is divided into 30 divisions, each division represents $\frac{1}{930}$ inch. G is an indicator for marking the thickness of the sections, E E are tubes to fit in well, F F plugs, H H covers to the box, and K a binding screw to attach the latter to a table.

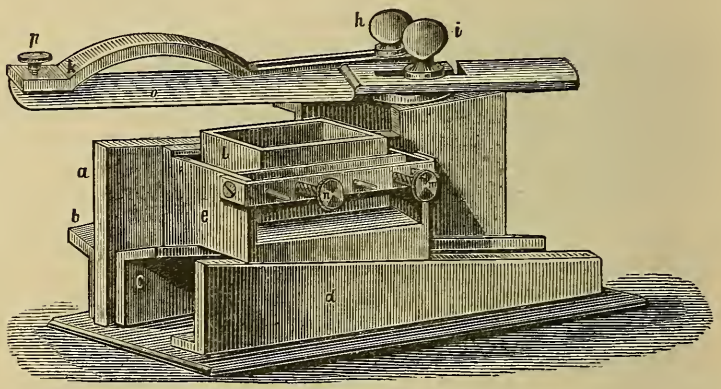
Windler's Microtome.* — This (Fig. 135) is a modification of Rivet's microtome, but retains little more than the principle of the original, i. e. the inclined (*c d*) and horizontal (*b*) slides attached to the vertical plate (*a*), these parts being all of metal. Instead of the ordinary clamp, which is very unsuitable for delicate objects, the inclined slide on the left supports a brass slide *e*, the under surface of which is lined with lead. Metal cases of different sizes *l* for the object to be cut, can be placed within it, and fixed by the screws *n*.

* Bericht wiss. Instrumente Berliner Gewerbeausstellung im Jahre 1879 (L. Loewenberg, 1880) pp. 309–12 (2 figs.).

The elevation of the slide as it is pushed forward can be read off on a scale on the vertical plate and a nonius.

The knife *o* is attached to a slide *f* (Fig. 136), which has an eccentric disk *g* on its upper surface. By turning this disk the knife,

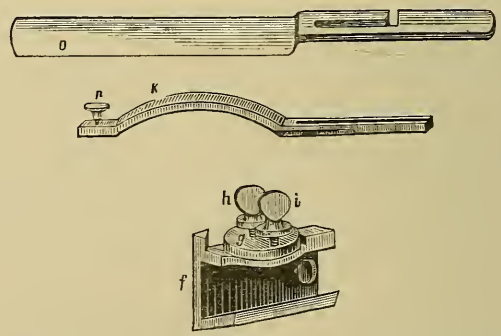
Fig. 135.



which is fixed by the clamp-screw *i*, can be brought into any desired position.

There is one defect in all sliding microtomes, which consists in the tendency of the knife, when fastened only at the handle, to give

Fig. 136.



way at the free end of the blade on any resistance in the object. This defect is remedied by the metal bow *k*, the slit end of which passes through the axial screw *h*, while the front portion is attached to the knife by the screw *p*, by which means any displacement of the end of the blade is prevented.

Marsh's Section Knife.* — It is frequently suggested that the surface of the knife which has to glide along the cutting-plate of the

* 'Microscopical Section-cutting,' 2nd edition, 1882, pp. 32–3 (2 figs.).

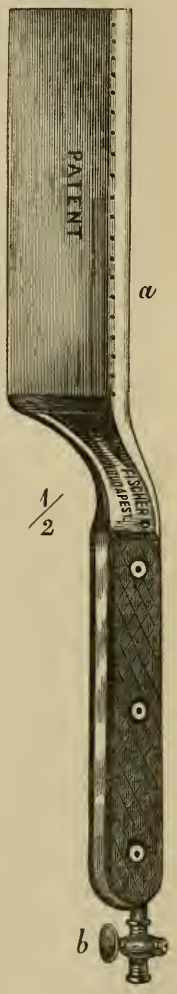
microtome should be ground *flat*. This Dr. S. Marsh considers to be a most unsuitable arrangement, as a very little actual experience of section-cutting will speedily demonstrate. After many unsuccessful attempts to obtain a really good and reliable section-knife, he had one made, which has proved everything that could be desired.

Fig. 137.

Fig. 138.

The knife is shown in Figs. 137 and 138, the latter being a transverse section of the blade. It is furnished with a blade 4 inches long and $\frac{7}{8}$ inch broad, set in a square handle of boxwood, also 4 inches in length. The thickness of the blade at the back is not quite a $\frac{1}{4}$ inch, while *both* of the surfaces are ground slightly hollow. It is essentially necessary that the back and edge of the blade be strictly parallel to each other; that is to say, the edge must form a straight line, and both the edge and under side of the back must lie in the same plane, otherwise the knife, when in use, will have such a tendency to tilt over as to render its management extremely difficult. It is very easy to discover if this condition be fulfilled, for if, on carefully laying the flat of the blade upon a piece of level glass, every portion of both back and edge are found to be in close contact with it, the knife may in this respect be considered perfect.

Fig. 139.



Thanhoffer's Irrigation Knife.* — This (Fig. 139) devised by Professor L. v. Thanhoffer, and adapted either for free-hand cutting or with a hand microtome, consists of a blade (wedge-shaped in section) 11 cm. long and $2\frac{1}{2}$ cm. broad, a handle $12\frac{1}{2}$ cm. long and $1\frac{1}{2}$ cm. broad, and a tube (*a b*) for supplying water to the blade. This tube is attached to the back of the blade, and is there pierced with a row of fine holes; it also traverses the handle and terminates at its butt-end in a tap, to which an indiarubber tube may be attached. The fixed tube is supplied by the indiarubber feeding-tube with water from a vessel placed on a higher level or from a water-main. The water comes out of the small holes in drops

* Arch. Mikr. Anat., xix. (1881) pp. 315-7 (1 fig.).

and flowing together covers the blade with a layer of water along its whole length, even when it is lightly smeared with oil or has become greasy from the imbedding mass. It should, however, be kept in a horizontal position, or better somewhat inclined to ensure the water flowing over it. A vessel is placed under the hand to catch the water and also the sections which can be floated off by its aid, an important advantage of the instrument. If very large sections are required, the tube should not be directly attached to the blade, but a few millimetres above it. The section can then be floated off between the tube and the blade.

Differential Staining of Nucleated Blood-corpuscles.*—It has been urged against the differential staining of histological structures, that the process may induce an alteration which may be mistaken for the normal condition. That this is, in many cases, true, is beyond question, but Dr. A. Y. Moore considers that the exceptions are far too numerous to justify it as a rule. For some years past he has used a process for the double staining of nucleated blood-corpuscles, which causes no alteration, except of course in colour, and as the structure can be seen much better in a semi-transparent than in a more perfectly transparent body, the corpuscles thus stained offer advantages for study which are not found in those left unstained.

The fluids used for this purpose are two, viz.:—A. Eosin, 5 grains; distilled water, 4 drachms; alcohol, 4 drachms. Dissolve the eosin in the water and add the alcohol. B. Methyl-anilin green, 5 grains; distilled water, 1 ounce.

The blood should be spread upon the slide, by placing a drop upon one end and quickly drawing the smooth edge of another slide over it. This, if well done, will leave a single layer of corpuscles evenly spread over the central part of the slide. When the corpuscles on the slide are thoroughly dry, which will only require a few minutes, the slide should be "flooded" with stain A. This should be allowed to remain on for about three minutes, at the end of which time, it may be washed by gently waving back and forth in a glass of clean water. Before it is allowed to dry, the corpuscles should be again flooded, this time with stain B. After two minutes' exposure to this fluid, the slide should be washed, as before, and set away to dry. When dry, a drop of Canada balsam may be put upon the blood, a cover-glass applied and the whole gently warmed until the balsam spreads out properly. When hard it may be finished the same as is usual with balsam mounts.

If now examined with the Microscope, the corpuscles will be found to be well stained with red, while the nuclei and "leucocytes" will be a bluish-green. The granular appearance which is ordinarily seen in the nuclei, now shows with a vigour and sharpness which is difficult of description, while the whole corpuscle is as brilliant as a newly-cut ruby.

The Editors of 'The Microscope' (which since its commencement has contained much valuable matter), call special attention to the

* 'The Microscope,' ii. (1882) pp. 73–6 (1 col. pl.).

above method, working microscopists having long sought after a double-staining process for blood-corpuscles in which Dr. Moore is the first to succeed.

Flemming's Modified Method for Staining Nuclei.*—A method was published in 1875 by G. E. Hermann,† consisting essentially in overstaining with anilin or azotized staining matters, and subsequently extracting the colour, except from the nuclei, by means of absolute alcohol.

On this W. Flemming suggests some improvements. He finds the nitrogenized colouring-matters better than anilin colours for the purpose. Chromic acid is also preferable to alcohol for hardening, as it preserves the characters of the nuclei with more certainty. The preparations are fixed in chromic acid of ·1 to ·5 per cent. according to their nature. Only sections or thin, flat, and readily penetrable pieces should be used, and they must be thoroughly washed in distilled water. They are then placed for 12 to 24 hours in closed vessels in about 1 ccm. of a solution of safranin (or one of the other colouring matters mentioned below) absolute alcohol being used diluted by about the same amount of distilled water.‡ The object is now transferred to alcohol which frees it from part of the colour by shaking for a short time, and then into absolute alcohol and moved about for half a minute or more until no more colour is given off, and the object appears transparent and of the desired tint. If the object is to be permanently mounted it is placed in oil of cloves, but only so long as will admit of the tissue becoming penetrated, as it draws out the colour, and then mounted in cold dammar solution or balsam.

Out of a series of colours which were tested, *mauvein* and *fluorescent red*, while staining the nuclei well, are yet somewhat unequal in their action in that some nuclei will retain more colour than the rest. *Solid green* has the property of being very readily extracted from the intermediate substance of the nucleus, leaving the fibrillar network of the latter well stained. If this is decolorized, the nucleoli long retain the colour. *Fuchsin* gives excellent colours but somewhat paler than safranin, magdala, dahlia, and mauvein. *Bismarck brown* is unsuitable for the above process with chromic acid. *Safranin*, *magdala-red* (or naphthalin-rose), and *dahlia* (monophenylrosanilin) are the most constant and satisfactory in their action.

It must be noted, however, that practically the only application of the method is for nuclei-staining in chromic acid preparations. Where, however, it is desired to preserve and readily investigate the true natural structure in cell-nuclei and divisions of nuclei (which

* Arch. f. Mikr. Anat., xix. (1881) p. 317–30.

† Flemming subsequently stated (tom. cit., pp. 742–3) that the credit of priority so far as regards nuclei-staining with anilin colours, and decolorizing with alcohol, is due to Professor Böttcher, whose method is not, however, to be recommended for the same purposes as Hermann's, as he uses Müller's fluid and alcohol, stains the sections with a solution of rosanilin-nitrate in dilute glycerine, and after extracting the water with alcohol, clarifies with creosote.

‡ Dahlia is best used in aqueous or acetic acid solutions.

succeeds best with chromic acid), the above process is to be preferred to all others. The only alternative method is hæmatoxylin, and that is much more uncertain in its action.

Iodine-green for Human and Animal Tissues.*—Dr. H. Griesbach recommends as the most useful of all anilin staining materials for this purpose, a new green material, tetramethylrosanilinmethyliodide, or "iodine green," or "Hofmann's green." The composition of the solution for staining is preferably 0·1 gr. crystallized iodine green, and 35 gr. distilled water, though it may be varied according to the tint required. The hardened tissue is placed for a few seconds in distilled water and then in the staining fluid, the action being almost momentary. After washing in distilled water it is transferred to glycerine or absolute alcohol, cleared in oil of cloves or aniseed, and mounted in Canada balsam or dammar.

The objection to other anilin colours, that alcohol often draws the colour completely out in a few minutes, scarcely applies to iodine green, which is much more resistant. Its chief advantages, however, are its rapid action, which adapts it excellently for demonstrations, and the fact that it also often gives different tints of the same colour to different parts of the tissues. For instance in a section of the uterus of a deer, the epithelium is blue, the tubular glands dark green, the cylindrical ciliated cells of the single tubes show a splendid colouring of their nuclei, the longitudinal musculature is malachite green, and the connective tissue remains uncoloured. Hardened objects colour better than fresh. Connective tissues and bones are not coloured at all or only very slightly. Glandular organs, hardened in alcohol, are excellent objects. The gland-cells are distinguished from the membrana propria by an intense and uniform colour. Striated muscle (in alcohol preparations) is coloured a cantharides green, the sarcolemma remaining uncoloured. Iodine green is also very useful for blood-corpuscles of vertebrates and invertebrates, for human white blood-corpuscles, and all kinds of isolated cells, spermatozoids, bacteria, &c. Also for ganglion-cells and axis-cylinder. In a section through human spinal cord in a chromic acid preparation (after a brief treatment with absolute alcohol and rinsing in distilled water) the horns of the grey substance were immediately coloured a uniform green, the *substantia gelatinosa* the same but brighter, the *substantia alba* being uncoloured. This is an additional advantage of iodine green as it is well known with what difficulty chromic acid preparations take certain colours.

Professor Kollmann's statement of his satisfactory experiences with iodine green is added.

Teichmann's Injection-mass.†—The exact proportions of the materials used by L. Teichmann for his injection-mass‡ are as follows:—

Red mass:—Prepared chalk 5 gr., vermilion 1 gr., linseed oil

* Zool. Anzeig., v. (1882) pp. 406–10.

† Abh. and SB. Naturw. Kl. Akad. Krakau, vii. (1880) pp. 108. Cf. Jahresber. Anat. u. Physiol., ix. (1881) pp. 11–12.

‡ Described generally in this Journal, *ante*, p. 125.

·9 to 1 cub. cm., carbon disulphide ·75 cub. cm. For the injection of entire subjects by the aorta Teichmann uses first of all a thinner mass consisting of chalk, 500 gr., vermilion 100 gr., linseed oil 120 cub. cm., carbon disulphide 150 cub. cm.; he then employs a stiffer preparation of chalk 1000 gr., vermilion 200 gr., linseed oil 200 cub. cm., carbon disulphide 100 cub. cm. *White masses*, especially adapted for injection of lymphatics, have the following composition:—Zinc white 20 gr., linseed oil 3 cub. cm., ether 2 cub. cm. By addition of colouring matters this mixture forms other combinations. The following proportions are in general suitable for a *blue mass:* Zinc white 15 gr., ultramarine 1 gr., linseed oil 2 to 2½ cub. cm., carbon disulphide 1 cub. cm. The injection is made slowly by a syringe, the piston of which is provided with a screw-thread and is pushed gradually forwards by a twisting movement. The linseed oil is first boiled for eight to ten hours, and no lead compounds are added to it.

Wywodzen's Injecting Material.*—D. Wywodzen has, he says, obtained admirable results by using thymol. The proportions are:—thymol 5 parts, alcohol 45, glycerine 2160, and distilled water 1080.

Mounting in Pure Balsam.†—Dr. S. Marsh, although he cannot too strongly insist upon the use of benzol-balsam wherever practicable, yet points out that it sometimes happens in the mounting of substances of considerable thickness that, after all the benzol has evaporated, an insufficient amount of balsam is left behind to fill up the cavity between slide and cover. In such cases, therefore, it is advisable to use pure balsam, which may be done in the following manner:—The object having been previously thoroughly dehydrated by immersion in absolute alcohol, it is to be thence transferred to a little *good* turpentine or benzol, where it should remain until perfectly transparent. It is now to be placed in the centre of a slide which has been gently warmed, and a drop or two of fresh fluid balsam added, the greatest care being taken to prevent the formation of air-bubbles. Should such arise they must be touched with the point of a heated needle, which will cause them to burst and disappear. The chief difficulty of the process has yet to be encountered in the application of the cover, for it is during this procedure that the development of air-bubbles is most likely to take place. This annoyance may, however, be entirely avoided by taking the simple precaution of dipping the cover into turpentine before it is applied, when it will be found that "you can't get air-bubbles even if you try." The author adds that it is to the courtesy of Mr. J. A. Kay, late of Chatham, that he is able to give his readers the benefit of this practical "wrinkle."

Centering Objects on the Slide.‡—Dr. Marsh considers that the appearance of a slide is vastly improved if the preparation be placed

* St. Petersb. Med. Wochenschrift, No. 51. Cf. Jahresber. Virchow and Hirsch for 1880, p. 2.

† 'Microscopical Section-cutting,' 2nd ed., 1882, p. 109.

‡ Ibid., p. 101.

exactly in its centre. This may readily be done in the following manner:—Take some very finely-powdered Prussian blue and rub it up in a mortar with a little weak mucilage, so as to form a thin blue pigment. A quantity of this should be made so as always to be at hand. A slide having been cleaned, the *best surface* is to be selected, and on the reverse side, by means of a self-centering turntable, a small circle is to be drawn with a camel's-hair pencil charged with the pigment. In the centre of this ring, but on the opposite side of the slide, the section is to be placed, when it, of course, will occupy a position exactly central. When the slide comes to be finished, the blue ring may easily be removed with a wet cloth.

Chalk Cells.*—For dry mounting of diatoms, and objects not much exceeding $\frac{1}{50}$ of an inch in thickness, Mr. F. Kitton has been using cells prepared in the following manner:—Wash some whitening in water to get rid of the coarser parts (foraminifera, sponge-spicules, &c.), or levigated chalk as sold by druggists can be used, and make a mixture about the consistency of cream with weak gum water; three or more applications will make cells of a sufficient depth. When dry go over them two or three times with a solution of Canada balsam dissolved in benzine. The cells should not be used until the balsam is quite hard; then place the cover (upon which the diatoms ought to be mounted) in position, and with a heated slide press it upon the cell; when properly attached the cement ring can be made in the usual manner.

Line and Pattern Mounting.†—Mr. H. Sharp gives the following directions for this kind of mounting, his slides thus prepared being said by Mr. W. H. Wooster to be "exquisite examples of manipulative skill."

"*Requisites*:—(1) One or two cat's or mouse's whiskers fastened on match-like sticks or fine rushes, with shellac rather than gum, with about $\frac{1}{4}$ inch free. I prefer to have one with the natural point, and another with the point cut back to where it is somewhat stiffer. (2) A good simple Microscope of some kind, either attached to a roomy stage-plate, with a mirror below and revolving plate above, or detached on some stand, but capable of being brought over a mounting table with mirror and rotating plate as above. My own is home-made, extremely simple, costing nothing but the trouble, and such as any one with a little ingenuity could make for himself. It consists of a piece of pine 9 inches long, 5 inches wide, and 1 inch thick, on three legs, with a hole in the centre, into which a wooden matchbox (with the bottom cut out) fits tightly, projecting a little above; over this fits a piece of slate just tight enough to rotate easily; beneath, a peg receives the mirror of the Microscope. This forms the detached mounting table. For the simple Microscope, I take the foot and tube pillar of the condenser, fit a piece of cane in this tube, drive a pickle-bottle cork stiffly on it, and fasten on this a horizontal wooden bar with a hole in the middle to fit on the cane, and another at each end

* Amer. Mon. Micr. Journ., iii. (1882) pp. 151–2.
† Journ. Micr. Soc. Victoria, i. (1882) pp. 94–6.

in which to fit the lenses, which are just the 1½-inch and ½-inch objectives, which give far better definition than common pocket lenses. (3) A steady hand. (4) Patience and perseverance.

Dry Mounts.—All diatoms and scales should be mounted on the cover, not the slide. Lay a clean cover on a slide and keep it in place by a drop of water between. As scales are larger than diatoms, it is well to begin with them. Put several on a slide in the ordinary way, pick out the ones wanted with a bristle under the simple Microscope, one at a time; keep the cover flooded with moisture from the breath, and deposit the scales picked up wherever wanted in lines or patterns. They will readily leave the bristle for the wet glass, and can be pushed about quite easily. When the moisture dries off no stain is left, and the objects will adhere with sufficient firmness to resist anything short of a sharp jar. When the line or pattern is finished, mount in a shallow cement cell.

Balsam Mounts.—The cover must have a film of a gelatinous nature which is insoluble in balsam and its solvents. A thin aqueous solution of isinglass carefully filtered serves well. A single drop is placed on a clean cover, and spread out as thin as possible with a clean needle. It dries almost instantly in warm weather, and in a few seconds in winter. A diatom placed on this film and *gently breathed on* is securely sealed, and cannot be dislodged without moisture. Care must be taken to place the diatom in position while the film is quite dry; then breathe on it; allow the film to dry again; then place another diatom, and so on till the line or pattern is finished. If any of the diatoms are thick or likely to be crushed, stick three bits of cover-glass under the edge of the cover with gum, and place a dot of gum on each before placing the cover in position on the slide. This, when dry, will keep the cover in its place while introducing the balsam, before doing which allow a little benzine to run under by capillary attraction, which soon displaces the air from the diatoms. Then apply a little balsam to the edge of the cover and a bit of blotting-paper to the opposite edge. This draws away the benzine, and the balsam follows and takes its place. Another plan is to gum a piece of good cream-laid paper on the slide, centre on the turn-table, and make two cuts through the paper, removing the middle and outer portions and leaving a ring of paper to form a cell as large as the cover; then cut two small openings in opposite sides of the ring, gum the top of the cell and insert the prepared cover on the gummed surface. When dry apply benzine to one of the small 'sluice gates,' and then balsam as before. Put the slide in a warm place for several days, and finish off with white, black, or coloured varnish to fancy. Winter is the best time for dry mounts, as the breath dries off too soon in hot weather; and summer is the best time for the balsam mounts, as it is difficult in the winter to keep the breath from moistening the isinglass at the wrong time. The cement cells should be quite dry and hard before mounting, or a dewiness will appear and ruin the object. Soften the cement over the lamp, press the cover down till it sticks all round, let stand a day or two, and finish off. No doubt the diatoms would be more secure if burnt

on the cover in the dry mounts, and possibly that process would be sufficient for the balsam mounts without the film of isinglass, as stated on p. 68 of Davies' 'Manual of Mounting.'"

Mr. Sharp has tried several kinds of mechanical finger, but declares he "can do the work quite as well and in less than half the time" by the method described above.

Mr. W. M. Bale also discusses * the subject of mounting diatoms in symmetrical groups in continuation of a previous paper † in which he described the process for valves which are very small and flat, and are to be mounted dry. Large or uneven diatoms are, however, liable to leave the slide at the least jar, and must therefore be attached with some cement; while *any* diatoms which are to be mounted in balsam must be fixed to the slide or cover with a cement not soluble in the turpentine contained therein. In these cases, a minute drop of clear gum may be deposited near the centre of a clean slide, and thinned with a drop or two of water, the whole being spread backwards and forwards over the slide with the blade of a knife till none appears to be left in the centre where the objects are to be placed. The diatoms are then arranged on the slide in the usual manner after breathing on it, and when dry they will adhere to its surface, after which they may be covered in the ordinary way. With dry mounts especial care must be taken that the merest invisible film of gum remains on the slide, the appearance of the diatoms being spoiled if they are saturated with gum or any similar material.

For transferring valves from one slide to another mounted bristles are best, one rather stout for large diatoms, and another not thicker than a human hair, and somewhat curved for lifting small valves and remaining particles of dust. Bristles are, however, too elastic for moving the diatoms into the exact position, for which a fine needle is almost indispensable.

When the objects are to be mounted in balsam, the slide should be allowed to dry, and a small drop of carbolic acid placed on the diatoms, which are then to be examined with the Microscope, as it frequently happens that the gum, if not thin enough, seals up the minute cells in the valve, or even the whole cavity beneath it, preventing the entrance of the acid. In this case a drop of spirits of wine placed on the diatoms will usually find speedy entrance and dispel all bubbles, and while the diatoms are still wet with the spirit the carbolic acid may be placed upon them. Gentle warmth will then evaporate the spirit, leaving the acid, and it only remains to apply a small drop of balsam and a cover, taking care, if any of the valves are very convex, to provide rests to prevent the cover from crushing them. It is better to let the balsam fall on the diatoms than to apply the cover first, and let it run in, as it very often carries in with it particles of dust, cotton fibres, &c., which may be on the slide or the edge of the cover, and which are apt to come in contact with the diatoms and remain there. The running-in process is only necessary when the valves are not cemented to the slide, and when,

* Journ. Micr. Soc. Victoria, i. (1882) pp. 97–9.
† Ibid., i. (1881).

consequently, balsam let fall on them would be almost certain to disperse them.

In most cases it is advantageous to mount the diatoms on the cover, which is easily done by first fastening it to a slide with a drop of glycerine, which will not evaporate during the process of mounting, and is easily removed afterwards. Large diatoms, such as *Arachnoidiscus*, when mounted on the slide and examined by reflected light, are apt to show a slight haze surrounding the group, instead of the intense black ground which should be presented when all light is shut off from below the stage. This is caused by reflection from the under surface of the slide, and can be avoided by mounting on the cover and placing some dead-black material at the bottom of the cell.

If Polycistina or Foraminifera are to be mounted, a thicker layer of gum should be placed on the slide than for diatoms, as these objects, from their peculiar forms, have usually a very small part of their surface in contact with the slide.

The author considers "this branch of microscopic art as quite legitimate" where selected species have to be mounted and provided scientific value is not sacrificed to mere prettiness. He also says that he has recently used the gum process with all balsam-mounted diatoms even when they are not arranged symmetrically for the sake of the security it affords against the valves being displaced by slight pressure on the cover-glass, or by the slide being kept in other than a horizontal position, also for the advantage of being able to mount the valves in different positions so often necessary in order to get an exact idea of their true form.

Kain's and Sidle's Mechanical Fingers.*—Mr. C. H. Kain describes a simple mechanical finger for use with any Microscope that has the fine adjustment on the nose-piece. It is designed to obviate the inconvenience of the one described by Professor H. L. Smith,† which requires the loosening and tightening of the objective for the purpose of focussing.

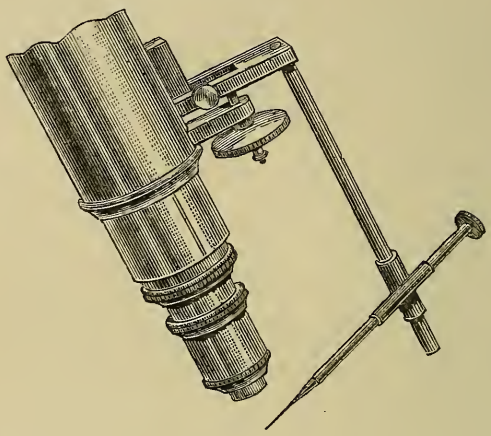
It consists essentially of a slotted bar (Fig. 140), which may be firmly clamped to the upper (immovable) bar of the fine adjustment by means of a milled-headed screw. Through the end of this is fastened a round rod, at such a distance from the objective that, when lowered, the end will not strike the stage. Over this rod slips a split tube, to which is soldered, at an angle, a smaller tube. Through the small tube passes a rod carrying a glass thread at its extremity. This rod is easily rotated by means of a milled head. The capillary glass thread is attached to the extremity by means of beeswax. There is no revolving collar, as it is quite unnecessary, especially when the Microscope is provided with a revolving stage. By dispensing with the revolving collar and making all movements depend entirely upon the adjustments of the Microscope, greater stability and accuracy in working are secured.

* Amer. Journ. Micr., vi. (1881) pp. 149–51 (1 fig.).
† See this Journal, ii. (1879) p. 952.

The author says:—

"To use the finger, the point of the glass thread is first brought into the focus of the objective, or nearly so, by sliding the tube on the vertical rod, and pushing or pulling the rod carrying the thread until the desired position is attained. It is not difficult to do this,

Fig. 140.



and having once been done by hand, it does not have to be repeated, as all further movements are made by the adjustments of the Microscope. Supposing now the point of the glass thread to be in focus; by means of the fine adjustment throw the focus *ahead* of the point, then, by means of the coarse adjustment, rack down and search for the object you wish to pick up. Having found the object desired, again bring the point of the thread into focus by means of the fine adjustment; then rack down with the coarse adjustment and pick it up. Now rack back with the coarse adjustment, remove the slip on which the material is spread, and place your prepared slip or cover upon the stage. Again, by means of the fine adjustment, throw the focus ahead of the object, rack down with the coarse adjustment, and search for the spot where you wish to deposit the object, and having found it, again focus the object, then rack down with the coarse adjustment, and when the object touches the slide and has been placed in proper position, fix it by means of a very gentle breath. I prefer this mode of fixing instead of the arrangement of tubes proposed by Professor Smith.

I coat the surface of the cover or slide upon which the diatoms are to be fixed with an exceedingly thin film of gelatine, prepared thus:—Dissolve 2 drachms of Cox's gelatine in 10 drachms of acetic acid by the aid of a gentle heat. When the gelatine is thoroughly dissolved, add 1 drachm of alcohol and 1 oz. of distilled water; stir well until thoroughly mixed, let stand some hours, and filter through the finest filtering paper. Keep in a glass-stoppered bottle. To coat

the cover or slip I dip a small needle in the solution and wipe it once flatwise across the glass.

There are many little wrinkles which the worker will acquire from time to time. One of the most important of these is the art of using the finger as a lever for moving diatoms or other objects into position when very slight movements are necessary. To do this, move the slide by hand until the point of the finger is just behind the object to be moved; then, by racking down with the coarse adjustment, the glass point pushes the object ahead of it. By a succession of pushes the object may be moved into any desired position. The coarse adjustment may be used in a similar manner for turning diatoms on edge or upside down, by pushing them against some fixed object and forcing the glass point under them. By using a point rather firmer than usual, the valves of a diatom may be separated. To do this I usually fasten the diatom on a slide which has been coated with gelatine, and when it is firmly fixed, the upper valve may be punched off without much difficulty.

Another wrinkle, and quite a valuable one too, is what might be called a scientific use of the imagination. Many cannot work a mechanical finger well without an erecting eye-piece, on account of all movements appearing to be reversed. This difficulty will disappear if the worker will just imagine, as he holds the stage and moves it, that he is holding the finger and moving it; all motions will then appear to be perfectly natural. I might state here that a mechanical stage is not the best for this kind of work.

There is a popular misconception in regard to the mechanical finger which it may not be amiss to mention. Many regard it as a kind of scientific plaything—an instrument used merely for arranging diatoms so as to form pretty slides. I have no doubt but that it will come eventually to be regarded as one of the microscopist's most valuable accessories, and one which every worker will require. It may be used not only in handling and studying diatoms, but also other objects which are too small to be handled in the ordinary way. In studying the Infusoria, for instance, a drop of water containing them may be placed in a concave slide, then, when the water has been almost evaporated, or has been removed by means of bibulous paper, the Infusoria may be picked out with the mechanical finger and studied, or deposited on a slip for mounting. A firm thread of dark-coloured glass is best for this.

In studying diatoms, a mechanical finger is almost indispensable, for it may safely be said that one is not thoroughly acquainted with a diatom until he has turned it over and viewed it in all its aspects. In mounting diatoms for study it is well to mount a number of the same kind in various positions, so as to display the various spines, undulations, or other peculiarities. How often it happens, too, that in a mixed gathering of diatoms—and it is not easy to obtain pure gatherings—we find a rare frustule which we should like to preserve. By means of a mechanical finger the frustule may at once be selected and mounted.

When one wishes to arrange diatoms so as to form symmetrical

figures, an eye-piece micrometer will be found very useful, not only in selecting diatoms of uniform size, but also in determining their position. A circle ruled in squares and used in the same way as the eye-piece micrometer will be found still more desirable. It is a good idea to keep a number of glass points, of different degrees of fineness, ready prepared; that is, attached to little rolls of beeswax, so that if a point is unsuited for a particular work another can be substituted in a moment."

Messrs. Sidle have also modified the mechanical finger described *ante*, Vol. II. (1879) p. 952, by adding a micrometer-screw with a milled-head nut for moving the point of the glass thread in and out of focus, thus avoiding unscrewing the front of the objective. The sliding rod has been retained for getting it approximately into position. By a later improvement the glass "hair" or bristle is carried on a second rod through a sleeve attached to the first or vertical one, nearly at right angles. Thus, by the rotation of the second rod, and of the entire apparatus around the axis of the Microscope, the diatom may be brought into any desired position.

Venice Turpentine as a Cement.*—Professor C. B. Parker says that his attention was called to a substance known in the Pathological Laboratory, at Vienna, as *Venedischer Damarlack* (Venetian dammar varnish), which was exclusively used for sealing and finishing glycerine mounts. No such substance is known to the American trade, but he found after experimenting that Venice turpentine, prepared as presently to be described, if not identical, at least answers every purpose equally as well. The following are the directions for preparing the turpentine. Dissolve true Venice turpentine in enough alcohol, so that after solution it will pass readily through a filter, and, after filtering, place in an evaporating dish, and by means of a sand bath evaporate down to about three-quarters of the quantity originally used. The best way to tell when the evaporation has gone far enough, is to drop some of the melted turpentine, after it is evaporated down to about three-quarters its original volume, into cold water, and on being taken out of the water if it is hard, and breaks with a vitreous fracture on being struck with the point of a knife, cease evaporation and allow to cool.

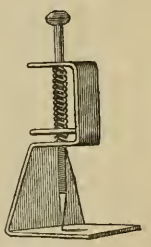
Square covers should be used, and the cover-glass being adjusted with the usual precautions observed in glycerine mounting, the surplus glycerine, if any, should be wiped away, and the slide so placed that the edges of the cover-glass are plainly seen. A piece of wire, No. 10–12 (copper is the best, as it gives to the turpentine a greenish tinge), is bent at right angles, the short arm being just the length of the cover-glass. The wire is heated in the flame of an alcohol lamp, and plunged into the prepared turpentine, some of which adheres to it. The wire is then brought down flat upon the slide at the margin of the cover, and the turpentine will distribute itself evenly along the entire side of the cover. The same process is to be carried out on each of the other three sides. Any little unevenness may be removed by passing the heated wire over it.

* Amer. Mon. Micr. Journ., ii. (1881) pp. 229-30.

The advantages claimed for this substance, over all others used for a similar purpose, are that it is secure. Such thick objects as the female organs of *Vermicularis* and *Tricocephalus dispar* in glycerine, are now as tight and firm as when first mounted in 1878. It hardens immediately. The moment the heated wire is removed, the specimen may be cleaned and handled without fear, a great advantage over such slow-drying fluids as dammar and balsam. It never runs in, as white zinc and other cements are apt to do.

Metal Caps for Glycerine Mounts.* — Mr. F. Enock protects objects mounted in fluid from damage by external pressure by a small metallic ring of angular section fitting closely round the outside of the cell and at the same time slightly overlapping the cover-glass, entirely closing in the rim. He writes: — "I have had much bitter experience with preparations mounted in glycerine, which suffer injury from clumsiness in handling, more than the fault of expansion; for after a preparation has been mounted two or three years, the cement becomes very hard, and if injured by a fall, or knock against the Microscope, starts a leak. The number of preparations ruined by my customers in this and other ways, prompted me to find a remedy, or to lessen the chance of injury. I have now devised the metal caps, which so far have stood the heavy thumps of the Post-office men, and all the clumsy treatment which many give them. The caps are made to fit Pumphrey's vulcanite cells, as they are the only cell to be depended upon for size and shape. I never use any other. My plan of using these caps is as follows:—After having fixed the cover properly and without leakage, I wash the preparation under the tap until all traces of glycerine are removed, then run a good thick ring of any kind of cement round the edge of the cover and cell, finally dropping on the cap, when the mount should be placed aside for a week, so that the cement or varnish may properly set. I use these caps for all deep cells, as they prevent the cover from being pushed off, and am having some made half the depth of those sent, for shallow cells."

Fig. 141.



Nassau Adjustable Spiral Spring Clip.—This clip, the construction of which is sufficiently explained by Fig. 141, can be instantly adjusted by a screw movement to any degree of pressure required upon the cover-glass in mounting.

Green Light for Microscopical Observations.—We briefly alluded to this subject in the previous volume,† but it may be well to record somewhat more specifically that Professor T. W. Engelmann strongly recommends the use of green light for delicate observations; it not only spares the eyes, but also gives images which are markedly sharper than

* North. Microscopist, i. (1881) pp. 297–8. Journ. Quek. Micr. Club, i. (1882) p. 40.

† This Journal, i. (1881) p. 224.

those given by white light. Blue light is less to be recommended, and red is altogether to be rejected.

M. Flesch* points out the disadvantage of green glass for light modifiers, as it absorbs the red rays almost completely, so that the colouring in carmine preparations is not visible, and that of other parts of the objects becomes indistinct.

Photo-Micrography.†—Professor C. H. Kain doubts "whether microscopists in general are fully aware of the extent to which late improvements in dry-plate photography have simplified the work. To the investigating microscopist it is almost absolutely essential to be able to permanently preserve the results of his observations. This is usually done by the aid of the camera lucida, and the zealous worker will often sit for hours with his eye fixed at the instrument laboriously striving to represent an object, and if he is not well skilled in the use of the pencil his labour is frequently almost useless, so inaccurate is the result. By far the greater part of this labour may be saved, at an expense so trifling, and with results so satisfactory, that he thinks the time is at hand when every working microscopist will regard a dry-plate photographic outfit as a necessary part of his equipment.

"The wet-plate process is cumbersome, and not well adapted to the wants of the microscopist, but the dry plates now in the market are admirable, not only for their great sensitiveness and beautiful results, but also for the ease with which they can be manipulated. They can be purchased so cheaply, that it can scarcely pay the microscopist to prepare them himself. Some of the great advantages which they possess are the following:—

"1. They can be kept for any length of time and used as occasion requires.

"2. If not convenient to develope the plate at the time the exposure is made, it can be put away and developed at leisure even after an interval of weeks.

"3. No dangerously poisonous chemicals are necessary in the developing process.

"4. They are so sensitive that the light of an ordinary kerosene lamp (preferably a student lamp) is amply sufficient to photograph objects with all powers not higher than $\frac{1}{2}$-inch objectives." Probably a $\frac{1}{4}$-inch objective could be used by properly arranging a system of condensers.

The author adds: "As some who desire to experiment in this line may require a starting-point as regards the matter of exposure, I would say that with the light of a student lamp, and using a single condenser, I have found that from $1\frac{1}{2}$ to $2\frac{1}{2}$ minutes with a 2-inch, $2\frac{1}{2}$ to 5 with a 1-inch, and 4 to 7 minutes with a $\frac{1}{2}$-inch objective are about the proper times when the A eye-piece is in and using what are known as Carbutt's rapid (B) plates, No. 468. When the eye-

* SB. Phys.-Med. Gesell. Würzburg, 1882 (sep. repr.).
† Amer. Mon. Micr. Journ., iii. (1882) pp. 71–2.

piece is not used about one-half of that time is required. Of course the time of exposure will vary somewhat according to the density or transparency of the object, and if stained, according to the character of the colouring matter."

At a meeting of the Camden (U.S.A.) Microscopical Society,* Mr. J. Carbutt took a negative from a spider's foot with a 2-inch objective and an exposure of 2 minutes, and from a sheep's tick with an exposure of $1\frac{1}{4}$ minute, the shorter exposure being due to the object being much less dense and yellow. "B" dry plates were used in both cases.

Woodward's Photographs of Amphipleura and Pleurosigma.—It will be remembered that Dr. J. J. Woodward forwarded to the Society, in illustration of papers by him,† fourteen photographs of *Amphipleura pellucida*, and three of *Pleurosigma angulatum*.

As these photographs are not generally accessible, it may be useful to note that they were reproduced by a heliographic process (on a scale of $\frac{1}{3}$) in the 'Arch. f. Mikr. Anat.'‡ which is to be found in many libraries in this country. The plates are accompanied by an abstract of Dr. Woodward's papers by C. Janisch.

Microscopical Examination of Handwriting.—Dr. J. H. Wythe, of San Francisco, maintains, as we have already recorded,§ that every man's handwriting is infallibly distinguished by three characteristics, that may be detected by the Microscope while they escape the eye, viz.:—rhythm of *form*, dependent on habit or organization; rhythm of *progress*, or the involuntary rhythm, seen as a wavy line or irregular margin of the letters; and rhythm of *pressure*, or alternation of light and dark strokes. The proper microscopical examination of these three rhythms, under a sufficient illumination of the letters, cannot fail, he believes, to demonstrate the difference between a genuine and an imitated signature.

Professor D. T. Ames,‖ while believing Dr. Wythe's views to be sound, "prefers to more simply define the three characteristics as *habit of form, movement, and shade;* these, in connection with other attendant peculiarities of handwriting, furnish a basis sufficient to enable a skilful examiner of writing to demonstrate the identity of any handwriting with a great degree of certainty.

"In extreme cases, and especially skilfully forged signatures, the aid of the Microscope will be necessary for a proper examination, but for the greater proportion of cases of questioned handwriting a common glass, magnifying from ten to twenty diameters, will serve much the better purpose, as it is amply sufficient to reveal the characteristics of the writing, while its greater convenience of use and broader field of view are greatly in its favour.

"In the writing of every adult are habits of form, movement, and

* See 'The Microscope,' ii. (1882) pp. 43–4.
† See this Journal, ii. (1879) pp. 663–74, 675–6.
‡ Arch. f. Mikr. Anat., xviii. (1880) pp. 260–70.
§ See this Journal, i. (1881) p. 856.
‖ 'Penman's Art Journal.' See Amer. Journ. Micr., vi. (1881) p. 214.

shade, so multitudinous as in the main to be unnoted by the writer, and impossible of perception by any imitator. Hence, in cases of forged or imitated writing, the forger labours under two insuperable difficulties, viz. the incorporation of all the habitual characteristics of the writing he would simulate, and the avoidance of all his own unconscious writing habit, to do which in any extended writing we believe to be utterly impossible.

"How far this inevitable failure may be discovered and demonstrated depends upon the skill of the forger, and the acuteness of the expert."

Examination of Sputa.*—In suspected cases of phthisis where it is very desirable to know the progress made by the disease, great aid may be procured by an examination of the sputa of the patient. It is now a recognized fact that phthisis has been diagnosed, and is diagnosed in this way, weeks and months before other signs are manifested.

As expectorated ingredients in the sputa, one finds remains of food, starch-granules, epithelium, air-bubbles, mucus-cells, pus-cells, blood-corpuscles, large granular cells, and, perhaps, pigment-cells. If now besides these are found fragments of lung tissue, as yellow elastic fibres, it shows that there must be a disintegration of the pulmonary tissue, a condition which must denote serious trouble. If these fibres are not found it does not by any means prove that serious trouble may not exist, but their presence is very significant.

If the patient is in the habit of using tobacco, it should be denied during the collection of the sputa, as the fibres of the leaf might mislead and cause a wrong diagnosis. If the amount of sputa is small, then all raised during the twenty-four hours should be saved. If large, that first raised in the morning should be preferred. Any little greyish masses should be chosen and placed at once under the Microscope. Acetic acid will clear up the mucus, &c., and render more distinct the yellow fibres if they are present. If this examination reveals nothing, the following method should be adopted:

Make a solution of sodic hydrate, 20 grains to the ounce of water. Mix the sputa with an equal bulk of this solution and boil. Then add to this mixture four or five times its bulk of cold water. If possible, pour into a conical-shaped glass and set aside. Soon the yellow fibres, if present, will fall to the bottom; from where they can be drawn up with a pipette and examined. Several slides should be examined at a single sitting, and the examination should be repeated every few days until the presence or absence of these fibres is satisfactorily demonstrated.

Trichina-Examinations.—The microscopical examination of pork for *Trichinæ* is, as is well known, obligatory in many parts of the Continent. In Germany in particular such an inspection is encouraged pecuniarily and punishment awarded in case of negligence.

* Cincinnati Med. News, x. (1881) pp. 550–1.

An inspector was, in 1874, sentenced to six weeks' imprisonment for having overlooked the presence of *Trichinæ* in an animal which he had inspected. In Italy also pork is similarly examined.

We subjoin a copy of an official notice on the subject of such examinations.*

Official Notice.—*Directions for the Microscopist in the Examination of the Flesh of Pigs for Trichinæ.*—1. Approved physicians, veterinary surgeons, and apothecaries are without examination officially admitted as microscopists on application to the city magistrate according to the demand for their services, such appointment being revocable; other persons are only admitted after undergoing an examination as to their fitness before the royal district physician.

2. Every microscopist must have a Microscope, the efficiency of which has been examined by the royal district physician, and its lowest power must not be under 40 nor over 60 diameters. A Microscope which has not been examined or which has been found unserviceable may not be used for Trichinæ examinations.

3. The microscopists are appointed to certain districts, and are bound to undertake in their districts, or in those for which they are temporarily appointed as auxiliaries, examinations when required and without any delay, between the hours of 6 in the morning and 8 in the evening, from the 21st March to the 21st September, and between 8 in the morning and 8 in the evening from the 21st September to the 21st March.

4. The samples of flesh to be used for examination are to be taken from six places in the case of whole pigs, viz.:—

(1) From both sides.
  (*a*) From the eyes, or the masticatory muscles.
  (*b*) From the diaphragm.
(2) From one side.
  (*a*) From the muscles of the larynx or the loins and stomach.
  (*b*) From the intercostal muscles, in single portions of flesh and hams, to be taken from at least two places by the microscopist himself.

From each sample of flesh at least five preparations which can be put under a covering glass are to be prepared.

5. The result of the examination is to be entered by the microscopist, with his name and the date added, under the proper heading in the flesh-book, which the butcher has to keep. To private persons he has to give the certificate prescribed by § 4 of the Trichinæ examination regulations.

6. If a pig or a portion of one is found to be trichinous, the same must be guarded from being changed by a plain mark set upon it. Notice must be given immediately to the royal district physician, and the preparation in question produced to him for subsequent revision; immediate notice is also to be given to the police authorities.

* Zeitschr. f. mikr. Fleischschau, i. (1880) pp. 124–5.

7. The microscopist must keep a book in which he shall enter the examinations made by him in the following form:

1	2	3	4	5	6	7
Consecutive No.	Date when slaughtered.	Description of the pig examined, as to sex and age, or specification of the part of flesh examined.	Name and residence of the party who brought the animal to be slaughtered, or who gave the order.	Day and hour of the microscopical examination.	Attestation of the microscopist as to the result of the microscopical examination with respect to Trichinæ and flukes.	Remarks.

If flukes or anything else prejudicial to the use of the flesh for food is found to exist, immediate notice thereof is to be given to the police authorities, and a report made in the form of columns 6 and 7.

8. Hams or pieces of pork examined must always be marked with a brand. Whole animals are to be branded in different parts of the skin when it is required by the owner.

9. A microscopist may not undertake in one day more than twenty examinations of whole pigs. The examination of three hams and three pieces of pork are reckoned, for the purpose of examination, as equivalent to one whole pig.

10. If any case of evasion of microscopical examination becomes known to the microscopist, he must give notice to the police authorities.

Fees payable for examining pigs for Trichinæ.—By virtue of § 8 of the local police regulations for the microscopical examination of pigs' flesh for Trichinæ, the fees payable to the microscopist are hereby fixed until further notice, and shall be as follows:—

1. For examining a pig	1 mark (= 1s.)
2. When several pigs are examined at the same time in one and the same place, for the first animal	1 mark.
For every subsequent ditto . . .	70 pf.
3. For a piece of pork or a ham . . .	30 pf.
For examining at the same time several pieces of pork or hams in the same place:	
For the first piece	30 pf.
For every additional piece . . .	20 pf.
The minimum charge, however, for the examination of only one or two pieces of flesh or hams when not taken to the dwelling of the microscopist shall be . .	70 pf.

Some of the regulations are more elaborate than the preceding, those for Silesia, for instance, occupying twelve pages,* and including regulations for the examination of candidates, and instructions as to making and examining the preparation, and using the Microscope. The latter are as follows:—

* See Wolff, E., 'Die Untersuchung des Fleisches auf Trichinen,' pp. 14–15. 74 pp., 1 pl. and 2 figs., 6th ed., 8vo, Breslau, 1880.

"The tube of the Microscope must be tested each time before it is used to see whether any foreign body is enclosed in it, or one of the diaphragm stops has got on edge. The draw-tube must be pulled out before use. The glasses of the lens-systems of the instrument, and also the illuminating mirror, are to be carefully cleaned with a dry hair-pencil, or with very soft wash-leather.

With illumination by light from below, care must always be taken that it falls as horizontally as possible on the mirror. The Microscope should therefore not be brought nearer to the window than is absolutely necessary. Dazzling sunlight is a disadvantage. Double windows are an impediment to the examination.

Only in exceptional cases are examinations to be made by lamp-light, and on such occasions a low petroleum lamp is to be used, with a glass shade, the lower part of which is closed either by porcelain-glass or ground white glass.

Those who desire to examine with low powers and light from above must bring the Microscope near the window in order to obtain as much incident light as possible.

The hours of bright daylight are to be chosen for the examination, and the work should be done, if practicable, at an open window.

The greatest care must be used in attaching to the tube the systems selected, and the operator must make sure that the tube is exactly centered. Particular attention must be given to the estimation of the focal distance. With low powers the focal distances are much greater than with high-power objectives, and the tube will therefore require a greater distance between it and the preparation, in proportion as the powers used are low.

The preparation to be examined is now placed, with the cover-glass on, in such a position on the stage that it lies as nearly as possible over the centre of the opening of the stage. The largest diaphragm aperture is then to be brought underneath, and full direct light reflected by the mirror up the tube. Whilst the eye, kept as near as possible to the eye-piece, is directed towards the object, the tube is cautiously moved up and down till the image appears clearly."

The Prefect of the Seine has also recently established a course of six lectures for the teaching of micrography, and an examination has been instituted for inspectors for detecting Trichinæ in the substance of pork and ham of American or German origin imported into France.

Continuous Observations of Minute Animalcula.*—E. Holmes having found some difficulty in keeping minute living objects under observation on account of the water evaporating, and also that any attempt at a supply produced currents which washed away all very small organisms, was led to put upon a slide a small quantity of water, and a very minute portion of plant, not using enough water to occupy all the space under the cover-glass, but leaving part of it occupied by air. A ring of paraffin wax was put round the cover, thus sealing up the contents, embracing rotifers and diatoms, several hundred species in all. At the expiration of a week they were still

* Sci.-Gossip, 1882, p. 138.

alive. The same process tried on *Cyclops quadricornis* (only with a shallow cell to contain a depth of water just enough not to squeeze the creature betwixt slip and cover) allowed young *Cyclops* to hatch out of the eggs in each instance some dozens in number, and very active, the old and young doing well at the end of forty-eight hours. The author adds:—"Obviously if one finds a rare minute creature, and wishes to send it to a friend for inspection, one may seal it up in this way without the risk, or it may be, certainty of losing it involved in placing it in a tube. It will live comfortably enough during transmission by post, or during the few hours required to carry it to the meeting of a society, or a friend's house. It is even safer in transmission, because the quantity of water used is not enough to shake about as it will in tubes or small bottles, and half a day's fishing to find it again is dispensed with, as it is sure to be on the slide."

Microscopical Examination of Textile Fabrics.*—Prof. C. Cramer has paid special attention to the detection of adulterations of the three following kinds in textile fibres.

1. Detection of Chinese grass (*Boehmeria nivea*) in silk. In floss-silk containing adulteration to the extent of from 50 to 75 per cent., ordinary chemical tests are unable to detect the nature of the admixture. Microscopical and microchemical examination prove the presence in the silk of bundles of bast-fibres of *Boehmeria nivea*, which are snow-white, shining and rigid, in contrast to the yellow and more flexible threads of silk. They are at most 18 cm. in length, while the silk threads are much longer; the diameter of the latter varying between 0·0076 and 0·0214 mm., that of the former between 0·0061 and 0·00643 mm. The natural ends of the bast-fibres are finely pointed, of the silk threads abruptly broken. The bast-fibres have a cavity, sometimes too small to be measured, but varying to a width of 0·055 mm.; silk is solid and homogeneous. The walls of the former are swollen and knotted in places, exhibiting in sulphuric acid clear longitudinal striæ; silk has nothing of the kind. In polarized light the bast-fibres show bright colours in the middle and at the margin; the polarization colours of silk are dull and not visible in the middle. In addition, the bast-fibres readily take fire; are not coloured yellow by nitric acid, while silk is; remain white when warmed with Millon's reagent, silk becoming red; with iodine and sulphuric acid they turn a copper-red, violet, or indigo-blue colour, accompanied by swelling, while silk becomes golden-yellow or brown; and boiling with concentrated soda-ley does not attack the bast-fibres; this last test being used to determine the extent of the adulteration.

2. Detection of shoddy in woollen fabrics. In a specimen of blue cloth, the wool having been removed by potash-ley, were found vegetable adulterations, consisting of unconnected bast-fibres, and thickish branched and anastomosing bundles of bast-cells 0·006 to 0·015 mm. in thickness, and not more than 0·2 to 0·65 mm. in length. These

* Cramer, C., 'Drei gerichtliche mikroskopische Expertisen betreffend Textile-Fasern.' 29 pp., Zürich, 1881.

last are derived from the fruits of various species of *Medicago*, especially *M. apiculata*, *denticulata*, and *Tenoriana*. The unconnected bast-fibres are probably from the leaves and epidermis of the stem of *Gynerium argenteum*, the most abundant grass in the pastures of Uruguay, Buenos Ayres, Paraguay, and Entre Rios, from which the wool may have come. The animal fibres were entirely wool.

3. Distinction between fibres of hemp and flax. The bast-cells of hemp and flax present no character by which they can be distinguished with certainty under the Microscope, even with the assistance of reagents. The bast-cells of flax are slightly more slender, but this cannot be relied on. A transverse section of both is usually circular, but occasionally polyhedral or flattened, and the size of the cavity affords no certain criterion. The formation of layers is slightly more obvious in hemp; but the difference is too small for practical use. The pores described by Schacht and Wiesner are believed by Cramer to be transverse folds of peripheral layers of cell-wall. Both fibres are coloured blue by iodine and sulphuric acid; ammonio-oxide of copper causes appearances of swelling in both. Hemp-fibres are not always coloured yellow by sulphate of anilin. The best distinctive character of the two fibres is the substances which accidentally accompany them. The parenchyma which surrounds hemp-bast contains numerous crescent-shaped clusters of crystals of calcium oxalate, which the bast-parenchyma of flax does not. Among the bast-cells of hemp are also elongated cells widened tangentially, filled with an intensely red-brown endochrome, sometimes composed of connected ribbon-shaped masses, sometimes broken up into quadrangular pieces, insoluble in boiling potash, cold alcohol, ether, turpentine-oil, and benzin, offering long-continued resistance to concentrated sulphuric and hydrochloric acids, and rendered colourless by Schulz's solution. The epidermis of the two plants also presents differences. That of flax has numerous stomata and no hairs; that of hemp few stomata and unicellular hairs thickened in a warty manner. These characters are always easy of detection.

The Microscope in Engineering Work.*—The following is a paper by R. Grimshaw, read at a meeting of the Franklin Institute.

"The specimens shown are intended to outline a method of using the Microscope as an aid to the testing machine in estimating the value of structural materials. While it is not intended to suggest that the Microscope will determine definitely the elastic limit, nor even the breaking strain of structural materials, it is designed to convey very distinctly the idea that the Microscope may be used for preliminary investigations which will determine whether or not the material is good enough to warrant its being tried on the testing machine. If the Microscope condemns the material, it is not worth while going to the expense of having it tested by more expensive methods. If the Microscope fails to reveal any flaw, then the material may be sent to the testing machine to be further proved. The larger the specimens that would be required for testing in the machine, the more marked

* Journ. of the Franklin Institute, cxiv. (1882) pp. 173-5.

the advantage of the Microscope in saving, in the case of specimens readily determined to be bad, the expense of further testing, and the risk of using it in construction. The samples shown this evening are of bridge timbers, and the lesson they are intended to convey is that had this method of examination been followed, the material which was proved to be faulty after being built into the bridge, would have been promptly thrown out. The samples shown were photographed by Mr. W. E. Partridge, of New York, a professional engineer who is an enthusiastic amateur photographer, and to whom I am indebted for the particulars concerning them.

The timber from which the poor specimens were taken came in the form of a chip broken off when a highway bridge was wrecked in 1879–80. The timber formed a portion of the sill of a draw-bridge, which consisted of two 12-inch sticks, lying one on the other. The turntable casting having been somewhat too small, this 24-inch timber had to support one of the A frames of the bridge at a distance of about twelve inches outside of the bed-plate. After a few days of service, while an empty truck was passing over, the strain became so great that the A frame sheared the 24-inch sill, wrecking the whole bridge. The timber was so exceedingly poor that upon mounting it on the Microscope the porous and weak nature of its structure was at once discovered. Its annular rings are something like three times the distance apart which would be found in a piece of thoroughly good wood of a similar character. The medullary rays are few in number and short in length, while in good wood they are of considerable length, and so numerous that the tangential sections appear like a series of tubes seen endwise, or a number of parallel chains. After once seeing and comparing two samples of wood it is very easy to recognize their characteristic features by the use of a pocket magnifying glass.

The trunks and limbs of exogenous trees are built up of concentric rings or layers of woody fibre, which are held together by radial plates, acting like the trenails of a wooden vessel, or the "bonds" in a brick or stone wall. The rings or layers representing successive years' growths, are composed of tubes, the interstices between which are also filled with cellulose. The slower the growth of a tree the thinner these yearly layers, and the denser and harder the wood, other things being equal. This is true as between one kind of tree and another, and also between different individuals of the same kind.

Not only is the closeness of the growth an indication of the hardness and strength of the timber, but the size, frequency, and regularity of distribution of the radial plates which bind the layers together may be taken as a very close illustration or sign of the character of the wood and its ability to resist strain, especially that from crushing stress.

The micro-photographs of the sections of good and bad timber show that in the strong specimens the concentric rings are close in texture and of light width; and the radial plates frequent, wide, long, and thick, while in the poor material, the reverse characteristics are shown.

The lesson to be learned from these microphotographs is that having proper views of transverse and radial lengthwise sections, and of sections perpendicular to a radius, of a standard piece of timber resisting certain standard or minimum strains, all timber having fewer rings per inch of tree diameter, fewer fibres, and fewer and shorter radial plates per square inch of section, should be rejected as not up to the standard, and applied for other purposes or used with a greater factor of safety.

This method has the advantage of enabling every stick of timber in a bridge to be inspected and judged, and is offered as an interesting and valuable aid to the breaking tests made by the machine.

In this connection I may offer as the parallel in metal-work two portions of pure Lake copper, one an ingot as ordinarily found, in which the grain is coarse and crystalline, the colour dark red, and the mass full of blow-holes; this is an average sample of copper casting. The other is run from the same pig, at the same heat, and in a similar mould, but with proper precautions to prevent oxidization; in consequence, there are no blow-holes, the grain is close and fine like that of the best bronzes, and the colour is salmon, which is the true copper colour. The "deoxidized" casting weighs 25 per cent. more than the ordinary casting from the same pattern, calipering the same. For these I am indebted to the Philadelphia Smelting Works, Twelfth and Noble Streets.

Tests made of the deoxidized copper rolled into sheets ·035 inch thick showed on strips 2 inches wide a tensile strain of 33,760 lbs. per square inch, ordinary fine copper in sheets being quoted by Trautwine at 30,000 lbs. This would show 12·5 per cent. superiority in the metal having the fine fracture. No. 20 "deoxidized" wire shows a calculated tensile strength of 45,000 lbs. per square inch, and still later tests of wire of the same thickness showed a calculated tensile strain of 41,056 lbs. per square inch for the ordinary, and 47,552 lbs. for the deoxidized, a striking confirmation of the indications of the Microscope."

The Microscope in Metallurgy.—A paper on this subject by M. Atwood was recently read before the San Francisco Microscopical Society.

In a former paper on "The Microscope in Geology," the author remarked that the Microscope in mining would soon become as important an instrument in guiding the miner in his operations as the compass was to the navigator, as only by the aid of the Microscope could be correctly determined what was so necessary for him to know, namely, the true character of the inclosing rocks of the different metalliferous veins he was either prospecting or working, and thereby rendering mining a less hazardous undertaking, and not allow the art to degenerate into a mere "trial-all" system. We are now only beginning, in the author's view, to understand and realize the great value of the Microscope in metallurgy. One of its most important uses, however, and to which he more especially calls attention, is in the milling of gold quartz, where it has aided in distinguishing and proving in the most unmistakable manner the true condition of the

gold in iron pyrites, which we now know to exist in a metallic state, being therefore only mechanically mixed with the iron pyrites, so that the amalgamation of the gold in the raw ore can be easily effected, and with little loss, if ordinary precautions are taken to have the ore reduced fine enough to liberate the gold enclosed in the finer particles of pyrites. Mr. Atwood procured samples of pyrites from most of the mining counties of this State, and made a careful microscopical examination of them, the result confirming in every respect the conclusions of Daintree and Latta published in Australia in 1874.

The paper was illustrated with several mounted specimens. One slide showed the gold on a crystal of pyrites, which, with the aid of an inch objective, was seen as a beautiful gilding on some of the planes of cleavage. Another slide showed the gold in little drops, also filling some of the small cavities. Still another showed the gold in little specks, imbedded in the pyrites. Another specimen disclosed the gold in fine specks or scales mixed with the sesquioxide of iron. Mr. Atwood has found that in the examination of all metals good bright daylight should, if possible, be used. The specimens, as seen by lamplight, did not exhibit the gilding as well as it was seen in the daytime.

Micro-Chemical Methods for Mineral Analysis.*—T. H. Behrens publishes a very full paper on this subject, commencing with an historical account of the origin and progress of micro-mineralogical methods, and with a detailed description of his "new micro-chemical method."

If, he says, the number of micro-chemical reactions which are at the disposal of the microscopist in the subject of petrography is much smaller, and their application is much more limited than in the microscopical anatomy of plant and animal tissues, the reason is certainly not that less advantage may be expected from the examination of the rocks by such methods. If in felspar the potassium and calcium could be detected with the same ease and certainty and their quantity appropriately ascertained, as is done in the case of starch by means of iodine, and of cellulose by means of iodine and sulphuric acid, how much petrography would be advanced by such a method of examination will be evident to most microscopists.

Endeavours were early made to extend the means of determining the constituents of rocks. Zirkel first examined his rock sections in ordinary light, then in polarized light, and in 1868–70 he introduced hydrochloric acid as a reagent to distinguish between decomposable and undecomposable minerals in basalt, viz. labrador from oligoclase and magnetite from titanic iron. Since then this acid has had its use extended, but only in a few cases were the products of the reaction subjected to examination, thus the formation of carbonic acid, of sodium chloride and of gelatinous silica, capable of taking up colouring matters, were used to demonstrate the presence of calcite, nepheline and decomposable silicates as olivine, chlorite, &c., respectively. Other micro-chemical reactions are the detection of apatite by a nitric acid

* Versl. en Mededeel. K. Akad. Wetensch, xvii. (1881) pp. 27–73 (1 pl.).

solution of ammonium molybdate, of the minerals of the hauyn group by means of sulphur vapour, and of opal by means of a magenta solution.

In the meanwhile the methods of optical examination were being greatly improved; the use of gypsum and quartz plates for increasing the double refraction, determining the depolarizing directions, and distinguishing between positive and negative double refraction, were borrowed in a complete form from the accessories of zoologists and botanists; through Tschermak the test of dichroism was applied (1869), and through Descloizeaux the stauroscope of Von Kobell was added (1875). The now tolerably complete instrumental methods were united by Rosenbusch in a convenient form (1876), and rapidly made known by his treatise on the whole subject. New cutting and polishing machines, Microscopes, and accessories were afterwards introduced, and principally from the workshops of Fuess, in Berlin, and Seibert, in Wetzlar. The advantages of the purely optical method of examination are that with a compact apparatus and without any damage to the preparation, it can be examined and determined quickly, and in comparison, simply, in a way impossible with hand specimens. The physical properties at first relied on for the discrimination of minerals, and then replaced by Werner and Mohs for the chemical properties, have again, although under altered conditions, become of primary importance in modern micro-mineralogy and micro-petrography. Unevenness of the faces and partial opacity ("milkiness, muddiness"), which interfere so greatly with the use of the goniometer, polariscope, and stauroscope, are removed by the use of thin sections, or nearly so; cleavage directions, which otherwise have to be sought for with a hammer and chisel, are at once detected; crystal enclosures can only be completely studied under the Microscope, and their constant occurrence in certain mineral species affords a new means of detecting such species, i. e. hauyn, noseau, leucite, quartz, garnet, &c. The success obtained by clever observers by these methods during the last fifteen years has been such as to place on a new basis the study of rocks, but even in these methods much practice is necessary, while in not a few cases, especially where decomposition has set in, in spite of all endeavours deductions can only be regarded with uncertainty.

The method of acting on a rock powder with hydrochloric acid, and examining before and after treatment mounted in balsam, is not a very successful one. The solution of the soluble part can indeed be filtered off and chemically examined, but the uncertainties still remain considerable. E. Bořicky was the first to make known a connected system of micro-chemical reactions, he excludes filtration, and his method is simple. It depends on the action of hydrofluosilicic, or of hydrofluoric acid on small fragments of the mineral or on the rock section itself, the separation of crystalline silicofluorides by evaporation, and the recognition of the several compounds by their form under a magnifying power of 200–400 diams.

But though the method is capable of rendering service in some cases, yet in others it is very insufficient, and there are considerable

difficulties connected with it. Examples of these difficulties are :— the time required for the reaction, the formation of gelatinous pulverulent white crusts of aluminium silicofluorides which hide the minute crystals of the other silicofluorides, especially the very transparent sodium salt, and then the calcium, iron, magnesium, and other fluosilicates are very soluble, and crystallize only when the solution dries up completely. Owing to these difficulties, and the want of methods for detecting silica and alumina, the author was led to look for other methods more convenient, quicker, and having a wider application.

Preparation of the Test Sample.—If the individuals composing the rock are larger than 1·5 mm., then small fragments may be broken from splinters of the rock by means of a pair of pliers; their homogeneous nature is tested by a lens, or a low power under the Microscope. If the rock is of a finer grain it must be crushed and the dust removed; using a low power small fragments of any of the constituents may now be picked out for examination. If the constituents are such as not to be readily distinguished from each other, when coarsely powdered, a section must be made of the rock, but no thinner than is necessary to give sufficient transparency for examination under a magnifying power of a hundred diameters; the top surface of the section may be either slightly polished or smeared with glycerine or oil. The balsam is softened by a gentle heat, and the required fragments picked out under the Microscope with a needle or knife, using a low power and a high eye-piece, and freed by ignition from balsam, &c. The selected fragments are ground in an agate mortar. They are brought into solution by means of a very little fuming hydrofluoric acid, or of ammonium fluoride and strong hydrochloric acid (this is done in a small platinum spoon) and then gently evaporated to dryness; the residue is moistened with a small quantity of dilute sulphuric acid and heated till most of the free sulphuric acid is removed. Water is then added, and the whole gently boiled until but little more than one drop remains. This solution of the sulphates is taken up by a capillary glass tube of 0·2 mm. diam., and in this manner divided and placed on slides for examination by the tests for the various substances. The solutions are examined without cover-glass, since it allows of better and quicker working; the objective is protected by a small plate of mica fastened on with a drop of glycerine, a power of 150–250 diams. is most convenient. The weight of substance required is from 0·2 to 0·5 milligram.

Calcium.—If any considerable quantity is present gypsum begins to crystallize out at once in short prisms, or if in smaller quantity then after a few minutes as crystals of the usual form of gypsum, ∞ P. P. ∞ P. ∞ P. $\infty\acute{}$ $\acute{\infty}$. Mean size 0·060 mm. If but a trace of calcium is present it may be detected by allowing the drop to absorb a little alcohol vapour, the gypsum then separates in needles.

Potassium.—To the preceding test-drop is added a drop of platinum chloride solution, by means of a loop of platinum wire. The double salt soon separates; if not, it may be accelerated by the action of alcohol vapour. It forms very sharp light-yellow octahedrons, with

a high refractive index. Size 0·010–0·030 mm. The separation of the silico-fluoride is not so rapid, nor are the crystals nearly so easily recognized. The phosphomolybdate greatly resembles in colour and form the platinum double salt, but separates very much more slowly. Cerium sulphate quickly produces a precipitate of a double salt (see under Sodium).

Sodium.—The reagent used is a concentrated solution of cerium sulphate. If much sodium is expected place near the test-drop one of the reagent, and connect them by a small thread of glass, the latter drop then becomes turbid and under a power of 600 diameters is seen to contain whitish, translucent particles of scarcely 0·002 mm., and if potassium were present also larger spheroids greatly resembling potato starch, size 0·005–0·008 mm. If less than 1 per cent. of alkaline sulphate is supposed to be present, the two drops are at once allowed to touch each other, and the potassium salt forms in lumps, or occasionally in truncated rhombs, six or eight-sided, while the sodium salt forms short pointed prisms, like the Navicellia, size 0·003–0·005 mm. These are not to be confounded with crystals of the cerium sulphate itself, which have the same form, but are five or six times the size. Any great excess of sulphuric acid must be avoided. The separation of the sodium silico-fluoride is not so delicate (see under Fluorine).

Lithium.—After precipitating any lime present as gypsum, the lithium is thrown down by addition of an alkaline carbonate. The monoclinic crystals resemble those of gypsum, but are yet quite distinguishable, size 0·050–0·075 mm.; they are moreover distinguished by their solubility in dilute sulphuric acid. Crystalline magnesium double carbonates can only be formed if a large excess of alkaline carbonate is employed. Phosphoric acid may entirely prevent this test for lithium.

Barium and Strontium.—These exist as sulphates in the insoluble residue left in the platinum spoon. The residue is heated with concentrated sulphuric acid, and the solution brought by a capillary pipette on to a slide. On cooling and absorbing water the crystalline sulphates separate. Barium sulphate forms small crossed lens-shaped crystals, size 0·005–0·012 mm. Strontium sulphate separates after the barium salt, the crystals likewise form crosses, but are distinguished by their greater complexity and size, viz. 0·020–0·045 mm. If much calcium is present in the mineral, gypsum crystals will be formed, they appear last of all, and in their usual forms. Lead would also appear here, the crystals have the same size as those of barium sulphate, but the form of strontium sulphate.

Magnesium.—To the test-drop is added a little ammonium chloride and ammonia until alkaline, and left a minute or two for any iron and manganese present to oxidize. At one cm. from this drop is placed a drop of water containing a fragment of microcosmic salt, the two drops are connected by a thread or two of glass. The crystals are very characteristic, being hemimorphous, if formed quickly peculiar skeleton growths of 0·060 mm. result, but if formed slowly only well-defined crystals of 0·010–0·020 mm.

Aluminium.—After long searching a very satisfactory reagent was found in cæsium chloride. A platinum wire is dipped into the concentrated solution, and the test-drop stirred with it, brilliant octahedrons of cæsium alum rapidly form, varying in size from 0·035 to 0·090 mm. The presence of iron has no effect.

Iron and Manganese can be so easily detected by ordinary methods that no special microscopic method is required.

Sulphur requires to be converted into an alkaline sulphate; sulphides are fused with nitre and sodium carbonate, insoluble sulphates with sodium carbonate. The coarsely powdered fusion is put in a drop of water; near it is placed a drop containing aluminium chloride, hydrochloric acid, and cæsium chloride; on connecting the two drops with a thread of glass the formation of cæsium alum shows the presence of sulphur.

Phosphorus and Arsenic.—These are brought into a soluble form by fusion with sodium carbonate, or with addition of nitre if arsenides may be present. A concentrated solution of ammonium chloride is added to the test-drop, and close by side of this is a drop of water containing a particle of magnesium sulphate (see further under Magnesium). The ammonium magnesium phosphate is not to be distinguished in form from the arsenate; addition of silver nitrate or of sulphuretted hydrogen affords no satisfactory distinguishing test. If it is required to test for both, the substance is to be fused with cyanide of potassium and carbonate of sodium in a narrow tube, the arsenic sublimes as metal and the residue containing only the phosphorus is tested as above. The test with ammonium molybdate solution is less satisfactory than that with magnesium sulphate.

Chlorine cannot be detected by silver nitrate, as the precipitate under the Microscope has no characteristic appearance. Mercurous or lead nitrate are more suitable, but have disadvantages; thallium sulphate is the best reagent. The test is heated with an excess of sulphuric acid in the platinum spoon and the hydrochloric acid gas evolved collected in a small drop of water hanging to a cover-glass, which is cooled by a larger drop of water on the top, and lies on the platinum spoon. The top drop of water is removed, the glass turned over and laid on a slide, and into the test drop is put a particle of thallium sulphate. The crystals of thallium chloride formed by any of these means are octahedrons with rhombic dodecahedrons, with a very strong refractive index, size 0·010–0·015 mm. The crystals are often grouped together in threes or fours, and then reach to 0·050–0·100 mm. Bromide of thallium is scarcely to be distinguished from the chloride, but the crystals of the iodide are distinguishable by their smallness, the largest rosettes measuring 0·020 mm., and by their intense yellow colour in reflected light; the fluoride is more soluble, has a somewhat different form, but appears very transparent and pale compared with the chloride.

Fluorine.—The test is first fused with soda—and silica if necessary—and then after addition of acetic acid evaporated to dryness; the residue is moistened with sulphuric acid and gently heated, the platinum spoon being covered with a concave lid of platinum foil, the

convex under side holding a drop of dilute sulphuric acid, the top some drops of cold water; after the reaction the cooling water is removed and the underneath drop put upon a varnished glass or a polished plate of barytes. Into the test-drop is put a little sodium chloride, beautiful six-rayed rosettes of 0·1 mm. form, then hexagonal plates and prisms with pyramids.

Silicon and Boron.—The following method allows of these two, i. e. supposing both to be present, to be separated and detected. The test is treated in the platinum spoon with a mixture of sulphuric and hydrofluoric acids, and heated very gently, silicon fluoride alone volatilizes and is collected and tested as under Fluorine. After addition of more hydrofluoric acid the heating is repeated but until fumes of sulphuric acid escape. The drop on the platinum cover is then evaporated to dryness at about 120°, the residue moistened after a minute or two with a drop of water, the solution brought on to a varnished glass, and a little potassium chloride added; potassium borofluoride separates in acute plates and rhombs, whose diameters are as 2 : 3, size 0·030–0·050 mm., the obtuse angles are sometimes replaced by edges. If no crystals separate at first, it is necessary for the drop to evaporate to dryness before making a conclusion.

Water is tested for by heating in a capillary tube as usual, with due precautions. The delicacy of the reaction may be increased by bringing into the tube a very little of the residue left by evaporating an alcoholic solution of magenta on glass; these thin skins are opaque and have a beetle-green lustre, on becoming moist they appear transparent and red.

The author is still occupied with finding suitable tests for some of the rarer elements, and with the more difficult task of finding reactions capable of being carried out on the rock section itself. A dozen examples are given of the applicability of the above methods; thus in 0·2 mgr. of sodalite were detected aluminium, calcium, potassium, and sodium, and in 0·1 mgr., chlorine; in 0·2 mgr. axinite were detected silicum, boron, aluminium, magnesium, and calcium; and in 0·3 mgr. apophyllite containing 1 per cent. fluorine, the latter was detected.

Microscopical Characters of Hailstones.*—A hailstorm at Innsbruck in September 1881, afforded J. Blaas an opportunity of examining the hailstones and determining the following results amongst others.

The opaque white layers which occurred in alternation with transparent ones and showed the appearance of radiating structure owing to the radial arrangement of the air-bubbles, never afforded any evidence that the crystalline elements were radiating in their arrangement; on the contrary, they were seen by the use of polarized light to consist of granules of ice, quite irregular in shape. The enclosed air-bubbles, some of which were of the smallest possible dimensions, had very irregular lobate forms, which always showed a

* Bote f. Tirol u. Vorarlberg, 1881, No. 215. Cf. Naturforscher, xiv. (1881) p. 454.

tendency to radiating arrangement. Among the substances inclosed were certain vacuolated masses, exactly similar to the drops of liquid found in crystals; they were very small, the vacuoles being very wide with dark margins. No movement was ever observed in the latter, but an argument in favour of their liquid nature is that as soon as (by melting) they are at the margin of the section of hailstone, they suddenly become empty, while the surrounding ice persists for a time. The exact nature of the other dirty and dust-like masses inclosed, which were by no means scarce, could not be determined.

Appearances presented by Air-bubbles and Fat-globules in White and Monochromatic Light.—We extract from Professor Ranvier's work on Histology,* the figures which illustrate the appearance at various points of the focus of an air-bubble in water and Canada balsam, and of a fat-globule in water, a diaphragm of about $\frac{2}{3}$ of a mm. being placed at a distance of 5 mm. beneath the stage, and the concave mirror exactly centered.

Air-bubbles in water.—Fig. 142, No. 1, represents the different appearances of an air-bubble in water. On focussing the objective to the middle of the bubble (B), the centre of the image is seen to be very bright, brighter than the rest of the field. It is surrounded by a greyish zone, and a somewhat broad black ring interrupted by one or more brighter circles. Round the black ring are again one or more concentric circles (of diffraction) brighter than the field.

On focussing to the bottom of the bubble (A), the central white circle diminishes and becomes brighter, its margin is sharper, and it is surrounded by a very broad black ring, which has on its periphery one or more diffraction circles.

When the objective is focussed to the upper surface of the bubble (C) the central circle increases in size, and is surrounded by a greater or less number of rings of various shades of grey, around which is again found a black ring, but narrower than those in the previous positions of the objective (A and B). The outer circles of diffraction are also much more numerous.

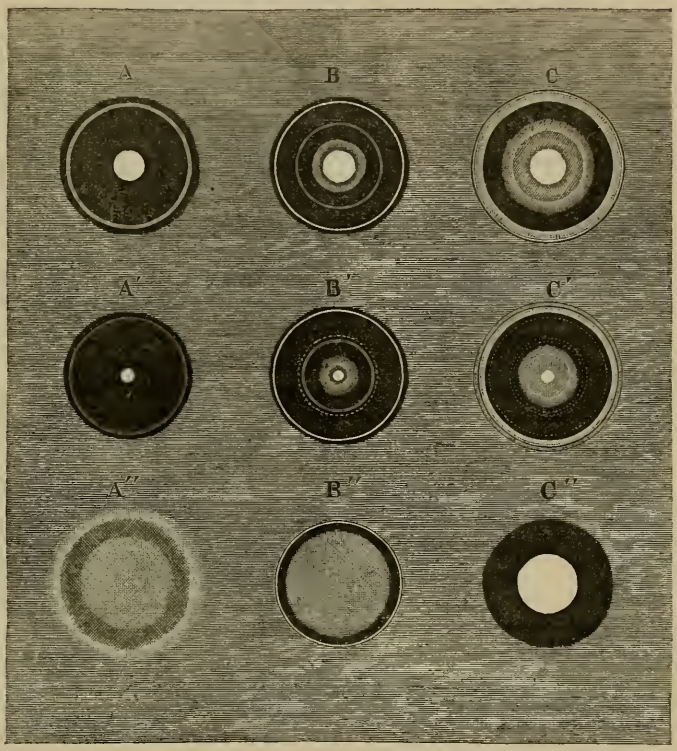
Professor Ranvier explains these appearances by reference to Fig. 143, which is a sectional view of an air-bubble (in water) receiving upon its base a series of parallel rays. The rays which passes through the centre of the bubble (undergoing no deviation) and those at a, a', a'' (which are more or less deflected by refraction) reach the eye of the observer, whilst a''' being incident at the limiting angle for rays which pass from water to air (48° 35′) is totally reflected, and does not reach the eye. The same is the case with the rays beyond a''', so that the margin of the bubble has a dark zone, varying as in Fig. 142, No. 1, A, B, C, according as the objective is focussed to the lower, central, or upper parts.

Air-bubbles in Canada Balsam.—Canada balsam being of a higher refractive index than water, the limiting angle instead of being 48° 35′ is 41° only, so that rays which are incident much less obliquely on the surface of separation undergo total reflection, and it will be

* Traité technique d'Histologie, 1878, pp. 14–20 (4 figs.).

only those rays which fall very close to the lower pole of the bubble that will reach the eye, and the black marginal zone will therefore be much larger.

Fig. 142.



This is shown in Fig. 142, No. 2. When the objective is focussed to the bottom of the bubble (A′), we have a small central circle, brighter than the rest of the field, all the rest of the bubble being black, with the exception of some peripheral diffraction rings. On focussing to the centre (B′) or upper part (C′) of the bubble, we have substantially the same appearances as in B and C, with the exception of the smaller size of the central circle.

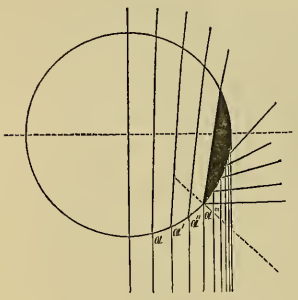
Fat-globules in water (Fig. 142, No. 3).—These illustrate the case of a highly refracting body in a medium of less refractive power.

When the objective is adjusted to the bottom of the globule A″, it appears as a grey disk a little darker than the field, and separated from the rest of the field by a darkish ring.

Focussing to the middle of the bubble (B″), the central disk becomes somewhat brighter, and is surrounded by a narrow black ring, bordered within and without by diffraction circles.

On further removing the objective the dark ring increases in size, and when the upper part of the objective is in focus, we have (C″) a small white central disk, brighter than the rest of the field, and sharply limited by a broad dark ring which is blacker towards the centre.

Fig. 143.



These appearances are the converse of those presented by the air-bubble. That, as we saw, has a black ring and a white centre, which are the sharper as the objective is approached to the lower pole of the bubble. The fat-globule has, however, a dark ring which is the broader, and a centre which is the sharper, according as the objective is brought nearer to the upper pole.

These considerations, apart from their enabling us to distinguish between air-bubbles and fat-globules, and preventing their being confounded with the histological elements, enable two general principles to be established, viz.—Bodies which are of greater refractive power than the surrounding medium, have a white centre which is sharper and smaller, and a black ring which is larger when the objective is withdrawn, whilst those which are of less refractive power have a centre which is whiter and smaller, and a black ring which is broader and darker when the objective is lowered.

Fig. 144.

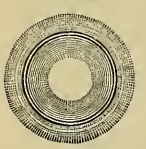


Fig. 145.

Monochromatic Light.—The same phenomena are observed by yellow monochromatic light, except that the diffraction fringes are more distinct, further apart, and in greater numbers than with ordinary light. A fat-globule, indeed, seems to be composed of a series of concentric layers like a grain of starch. With blue light these fringes are also multiplied but are closer together and finer, so that they are not so easily visible. Yellow monochromatic light, therefore, constitutes a good means for determining whether the striæ seen on an object are peculiar to it, or are only diffraction lines. In the former case they are not exaggerated by monochromatic light, but if, on the contrary, they are found to be doubled, or quadrupled, with this light, we may be certain that they are diffraction fringes.

Figs. 144 and 145 show the appearance of air-bubbles in water, when illuminated by yellow and blue monochromatic light.

Atwood, M.—The Microscope in Metallurgy. [*Supra*, p. 735.]
[Sep. Repr. (from Newspapers) of papers read before the San Francisco Microscopical Society.]

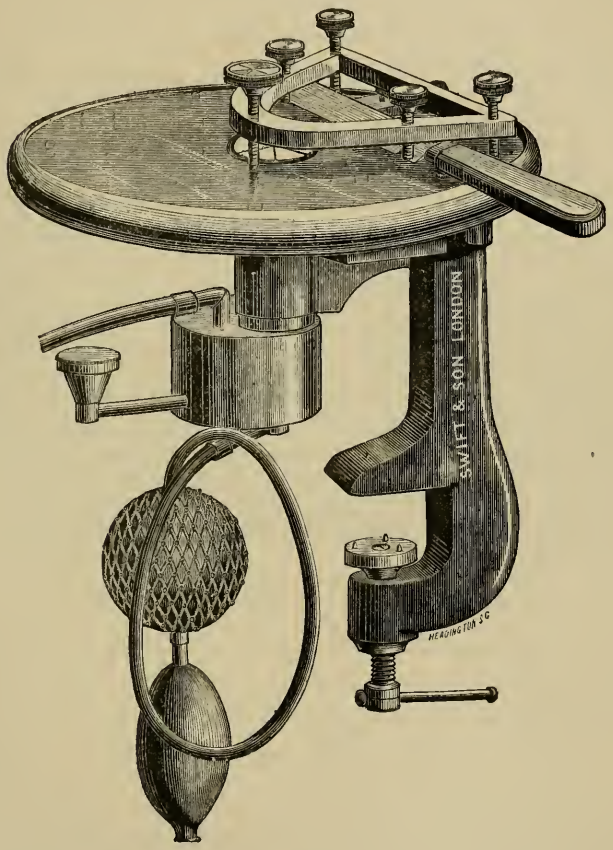
Beadle's (J.) Wire Clip for Mounting.
[No description—"it is one of the best and simplest devices we have seen."]
Sci.-Gossip, 1882, p. 207.

XVI.—*A Further Improvement in the Groves-Williams Ether Freezing Microtome.* By J. W. Groves, F.R.M.S.

(*Read 8th November*, 1882.)

In the present volume of the Society's Journal, page 430, Fig. 83, is described and figured the method by which, at my suggestion, ether was adopted as the freezing agent to a Williams microtome,* the chief merit being that the used ether is capable of being conveyed away into the external air without the operator being exposed

Fig. 146.



to its fumes, as is the case in most ether freezing microtomes, while at the same time the advantages of the Williams instrument are retained.

* Cf. this Journal, i. (1881) pp. 697–9 (1 fig.).

On page 432, Fig. 84, is shown a so-called improvement, though one which is useless, inasmuch as the razor is incapable of being levelled, and therefore cannot be kept parallel with the slides on which it works, the result being that no sections with parallel surfaces, and therefore no *thin* sections, can be cut.

The present further modification, Fig. 146, has consequently been made by Mr. Swift, of Tottenham Court Road, at my request. The machine now resembles that last mentioned in having an iron bracket with spring tube to receive either of the four holders for material, Figs. 84–7, and a clamp below by which it may be fixed to a table; but differs from it in that it has the glass top and razor-frame of the original Williams microtome.

The new Microtome, therefore, consists of an iron bracket to the top of which is fixed a glass plate with central aperture. Through this passes the upper end of the apparatus for holding the material to be cut, either for freezing by ether as in Figs. 146 and 84, or by ice and salt, as in that known as Pritchard's, Fig. 85, or for material imbedded, Fig. 86, or for clamping a tree stem or other structure not requiring to be frozen or imbedded. Each of these is held below the top in a spring tube capable of being tightened by a screw, and the whole instrument can be fixed to a table by a clamp which forms the bottom of the bracket. The sections are cut by a razor held in a Williams triangular frame, which is levelled by means of two base screws, and lowered for each section by means of the apex screw.

When using the ether freezing apparatus with this microtome, material to the thickness of $\frac{3}{16}$ inch can be frozen in $1\frac{1}{2}$ minutes, and good successive sections cut as thin as can be obtained by any microtome. When the material is once frozen scarcely any ether is required to keep up the action, so that the cost of the ether is rather less than that of ice, methylated ether sp. gr. ·720 at 1*s.* 6*d.* a lb. being used.

small; endochrome pale red; membrane delicate, coloured blue by iodine and sulphuric acid. Endochrome escapes simultaneously in two or three portions; the division taking place before the commencement of the escape. Zoospores very small, of irregular amœboid appearance, with only a few short pointed pseudopodia. In conjugating the zoospores envelope the isolated cells of the host (unicellular algæ), forming a new cyst round them, or several individuals are thus enveloped. Resting cysts unknown.

3. *Monas* Cnk. (only 1 species, *Monas amyli*, or *Protomonas* Haeck.). Cysts spherical, with simple thin membrane and colourless endochrome, from which a number of zoospores are formed. Zoospores, at first fusiform and bi-ciliated, with serpentine motion, afterwards amœboid or actinophrys-like, with several fine pointed pseudopodia and slow movements, during which they change their form. Small plasmodia formed from the coalescence of several amœboid zoospores. The hosts (grains of starch) are surrounded by the zoospores or plasmodia, thus forming a new cyst; several zoospores often coalesce on the same starch-grain. Resting cysts formed by the ordinary cysts throwing off the unconsumed nutrient material, and enveloping themselves with a new membrane, wart-like projections appearing on the inner side of the original membrane.

4. *Protomyxa* Haeck. (only 1 species, *P. aurantiaca*). Cysts spherical, with moderately thick membrane, structureless, and not coloured blue by iodine and sulphuric acid. The fine-grained orange-red endochrome breaks up into a number of portions, each of which escapes as a zoospore. Zoospores pear-shaped, with a single cilium at the narrow end, and slow motion, subsequently amœboid and protean. Large plasmodia formed by the coalescence of several amœboid zoospores, furnished with branched anastomosing pseudopodia and vacuoles. The hosts (various diatoms) are surrounded by the amœboid zoospores or plasmodia, and their shells thrown out after their contents have been absorbed; a new cyst is thus formed, a new membrane being excreted. Resting cysts unknown.

MICROSCOPY.

a. Instruments, Accessories, &c.

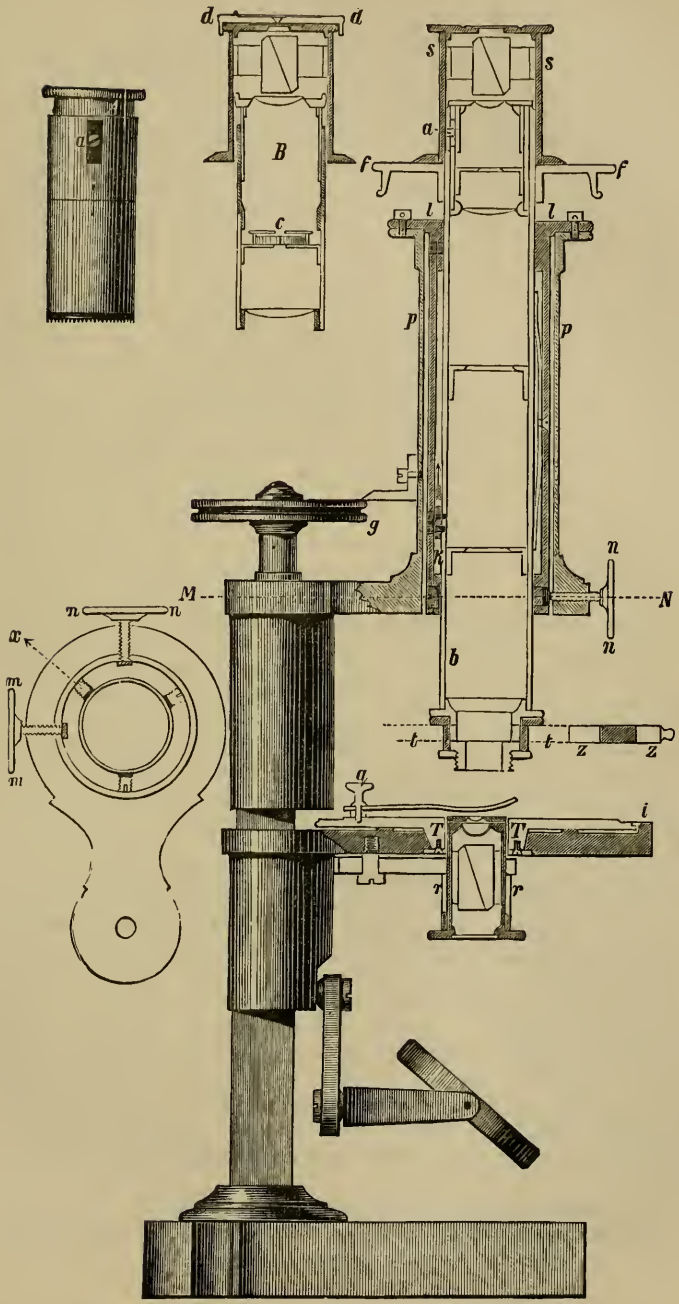
Petrographical, Mineralogical, or Lithological Microscopes.—Rosenbusch, Fuess, Beck, Swift, &c.—(1) *Rosenbusch's Petrographical Microscope.*—Special Microscopes for the examination of minerals and rocks are now supplied by nearly every optician. The original of such instruments * is the one devised by Professor Rosenbusch, in 1876,† which is illustrated in Fig. 150, with a few modifications introduced in its manufacture by R. Fuess, of Berlin.‡

* A "Mineralogical Microscope" was described by S. Highley in Quart. Journ. Micr. Sci., iv. (1856) pp. 281–6 (3 figs.).

† Neues Jahrbuch f. Mineral., 1876, p. 504.

‡ Cf. Loewenherz, L., 'Bericht über die Wiss. Instrumente auf der Berliner Gewerbeausstellung im Jahre 1879,' pp. 282–6 (1 fig.), pp. 350–3 (1 fig).

FIG. 150.



The chief advantages of the instrument consist*:—(1) In the facilities for turning an object in its own plane between fixed crossed nicols, the rotation being concentric with the axis of vision; (2) In the ability to read off accurately the angle through which the object may be turned in a horizontal plane by means of the graduation round the circular stage; (3) In the facility with which the polarizer and analyzer can be displaced and replaced, and the means by which the exact position of the principal sections of the polarizer and analyzer can be noted; (4) Where the total extinction of light by means of crossed nicols interferes with the researches on any mineral, means are provided for facilitating observation under such circumstances.

The peculiarities in the construction of the Microscope consist in the tube which carries the eye-piece and objective *b* (Fig. 150), being as it were suspended within an outer tube *p*, its only attachment being at the top at *l*. A block *k* is fixed between the inner and outer tubes to prevent any rotation during focal adjustment. The coarse adjustment is effected by hand, the thumb and forefinger sliding the inner tube up and down by pressure on the disk *f*, other fingers being applied to the top *l*, of the fixed tube. The fine adjustment consists of a micrometer screw, shown at *g*, graduated in 500 divisions, each being equal to 1 μ. The unattached portion of the inner tube is steadied in the outer one by means of a spring † and three little screws *x* (see side figure, a section through M—N), set horizontally and capped with scraps of parchment, which are more or less compressed as the adjustment is made. The arm of the Microscope carries two screws with milled heads, one of which is shown at *n*, and both at *n* and *m* in the side figure. These are set at right angles to one another, and serve to centre the tube. The eye-piece carries two cobwebs, which intersect at right angles in the centre of the field. To the outside tube of the eye-piece a small peg *a* is fixed, which slides into a corresponding slot in the top of the inner movable tube of the Microscope. This arrangement prevents any rotation of the eye-pieces, and so keeps the cobwebs in a fixed position. An analyzer *s*, fitting in a brass cap, slides over the top of the eye-piece. The bottom of the cap is surrounded by a bevelled flange, which is graduated to 5°. An index mark on the plate *f*, serves to record the angle through which the prism is rotated. The stage of the Microscope is circular, and a circular plate T is arranged so as to revolve horizontally on it. This plate is graduated on its margin, and an index to record the amount of the revolution is attached to the front of the fixed stage at *i*. It also has a spring clip *q*, and a Wright's indicator (two scales at right angles). Beneath the stage is set an easily displaceable polarizer *r*, consisting of a Nicol prism, which revolves within its external tube by means of the lower disk, which is graduated to 10°, and has its index marked on the fixed outer tube. This polarizer does not turn when the stage plate is rotated, but

* See Rutley's 'Study of Rocks' (8vo, London, 1879) p. 54.

† In the figure, in order to show the spring, it is brought too far round by 45°.

remains unaltered in position. A plate of quartz for circular polarization 3·75 mm. thick, and mounted in a little brass fitting, is shown at *z*. It slides into a slot *t*, situated close to the lower end of the inner microscope-tube and above the objective. The movement imparted to the microscope-tube by the screws *n m*, tends to throw the analyzer slightly out of position with regard to the polarizer, but Professor Rosenbusch finds that this produces scarcely any appreciable error.

For very strongly convergent light, the ordinary condensing lens (with a focus of 12 mm.) attached to the Nicol, is combined with a second one of only 8 mm. The axes to these mineral sections can thus be recognized without an eye-piece and with the objective alone.*

The stauroscopic eye-piece is shown in the side diagrams A and B of Fig. 150. The eye-lens is attached to a separate tube sliding in that holding the field-glass, and can be brought closer to the latter. The tube of the field-glass has a slit in which a pin *a*, inserted in the eye-lens tube, slides. The pin also passes into a slit in the microscope-tube, and thus fixes the position of the eye-piece. At *c* is a plate of calc-spar in the focus of the eye-lens. This was first used by Professor Calderon for stauroscopic measurement, and afterwards adapted to the Microscope by Fuess. For the purpose of accurately indicating to the eye the correct position with regard to the optical axis of the instrument, a cap with a very narrow diaphragm *d* is added, there being another diaphragm at *c*.

Professor Rosenbusch points out that the use of this Microscope is not confined to the purpose for which it was designed, but that it is also available for other microscopical purposes where exact measurements are required.†

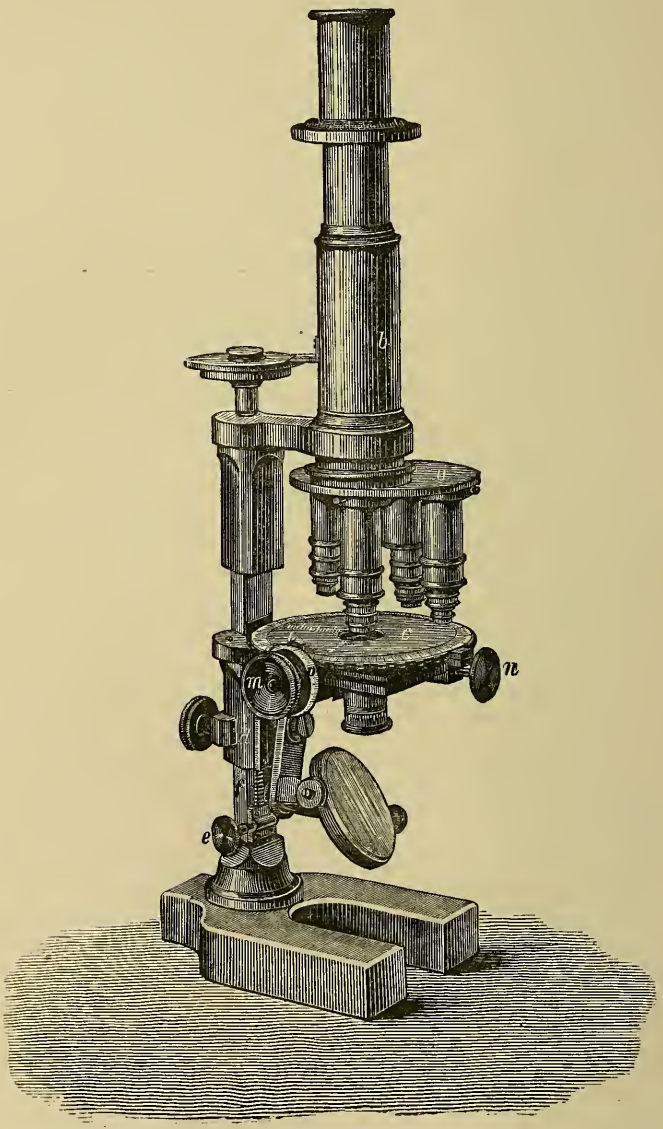
(2) *Fuess's "large Microscope for mineralogical and petrographical observations"* (Fig. 151), is designed as an improvement upon the preceding, especially as regards the stability of the centering arrangement. The sliding coarse adjustment is done away with, and instead of it, the stage *c* with the illuminating apparatus is attached to the slide *d* which moves on the upright support *f* of the stand to a distance of about 1·5 cm. (by means of the rack-work attached to *d* and actuated by the pinion *e*), and is held in the required position by the clamping screw behind. The fine adjustment is effected by the usual graduated micrometer screw. By the use of intermediate pieces of tubing the objectives can be so attached to a horizontal revolving plate *a*, that they all stand at about their focal distance from the object if the slide is of ordinary thickness. The centering of each objective with the optic axis of the tube *b* is then effected by three adjusting-screws below the revolving-plate, so that the arrangement

* See this Journal, i. (1878) p. 207.

† The graduation of the micrometer-screw and the addition of the plate of calc-spar and the Wright's indicator, appears to have been suggested by Professor A. v. Lasaulx. Cf. Bull. Soc. Belg. Micr., iv. (1878) p. clxxvi. The Microscope described by M. Renard, Bull. Soc. Belg. Micr., iv. (1878) ccxv., and this Journal, i. (1878) p. 270, appears to have been a Rosenbusch-Fuess instrument, but with the Lasaulx improvements and the addition of the quartz plate.

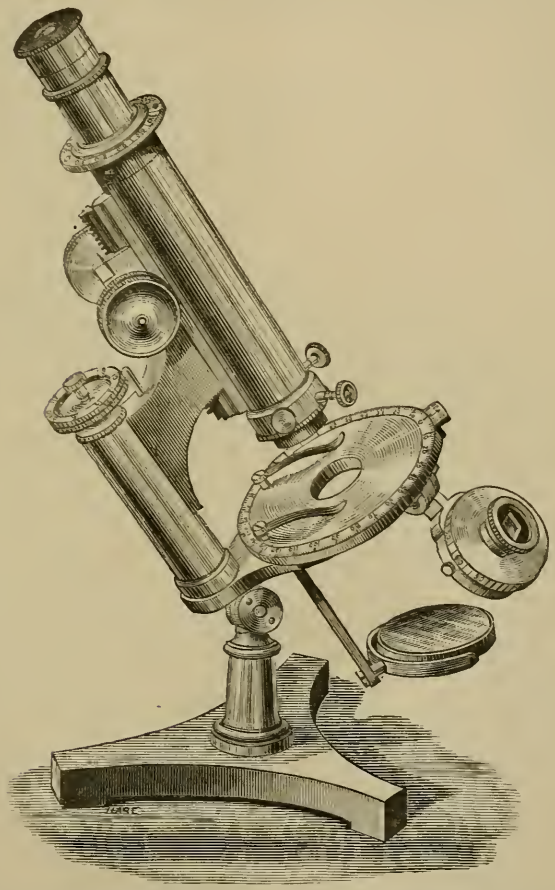
at the lower end of the tube of the Rosenbusch instrument is unnecessary. The diaphragm and polarizer can also be centered by means of the rectangular stage movements actuated by the milled

Fig. 151.



heads *m* and *n*. The former movement is made to do duty as a screw-micrometer, having a drum *p* attached, engraved with 125 divisions, each having the value of 0·002 mm., the screw pitch being 0·25 mm. The revolutions of the screw can be read off on an index *i*. The margin of the stage is graduated and also dentated, so that it can be turned by the finger. For convergent light, two Bertrand lenses of 12 and 8 mm. focal length are placed above the polarizer, and a third above the objective.*

Fig. 152.



(3) *Beck's Lithological Microscope* (Figs. 152–4).—This instrument (Fig. 152) is modelled on the plan of the "Economic" Micro-

* Cf. this Journal, i. (1878) p. 292.

scope with the alterations necessary to fit it for lithological examinations. The coarse adjustment is effected by the usual rack-and-pinion, and the fine by a micrometer-screw with a divided milled head, representing thousandths of an inch, for the approximate measurement of sections, &c. The stage is divided on the edge to degrees, and has a vernier reading to 10′, adapting it for use as a goniometer or for stauroscopic measurements, &c. It rotates concentrically with the optic axis, and to compensate for any slight variation in centering there is a centering nose-piece. Immediately above the latter is a Klein's quartz plate fixed on an arm by means of which it can be

Fig. 153.

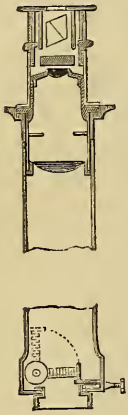
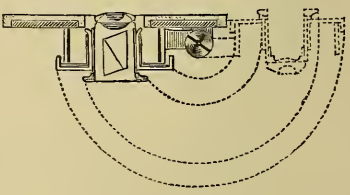


Fig. 154.



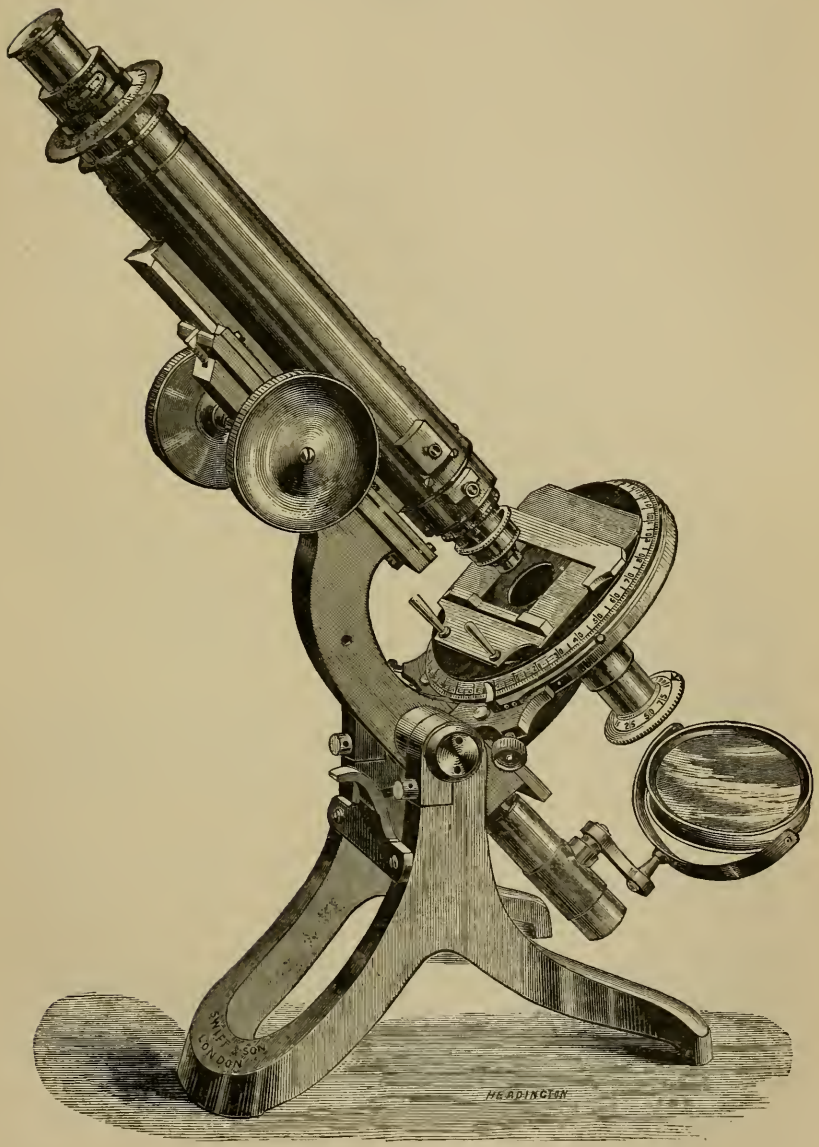
turned up out of the field with great facility as shown in Fig. 153. One of the three milled heads at the end of the body-tube effects this movement. The other two milled heads are for centering the objective, and their action is shown in the same figure.

The analyzer rotates freely over the eye-piece (Fig. 153), and has an index which by a divided plate on the draw-tube allows it to be read in any position and recorded. Between the analyzer and the eye-piece is placed a plate of calc-spar cut at right angles to the optic axis for stauroscopic measurements. The eye-piece has cross cob-webs. The rotating polarizer also has a divided circle to register its position, and it is fitted into a swinging arc which is in contact with the bottom of the stage, thus excluding any false light. By means of a hinge it can be instantly turned away from the stage (in the way shown in Fig. 154) when ordinary illumination is required. A condenser of large aperture, fitting into the tube of the polarizer above the prism, is intended for the examination of the interference brushes and rings in crystals with convergent light. This also is easily removed when not required. When the instrument is used for this purpose a lens is screwed into the lower end of the draw-tube.

The instrument, though specially constructed for the study of rock sections, can be used for any other work. It is only necessary to remove the analyzer and polarizer. The fitting on the swinging arm which carries the polarizer will take any other substage apparatus such as parabola, achromatic condenser, &c.

(4) *Swift's Petrological Microscope* (Fig. 155).—The general basis of this is Mr. Swift's well-known "Challenge" stand (see Vol. I. (1881) p. 810). A special arm carrying the polarizer is added so that it can

Fig. 155.



be readily turned away when not required, and a tube inserted in its place for sub-stage apparatus. The fitting of the polarizer is graduated and a spring catch indicates when the prisms are crossed. The rotating glass stage is graduated, and has a "self-centering" arrangement. Two sliding boxes at the lower end of the body-tube serve to carry the analyzer and, below it, a Klein's quartz plate, which can thus be readily slipped in and out. An extra analyzing prism with divided circle is placed over the eye-piece (which has crossed spider-lines) with a contrivance for rotating crystals between it and the prism.

There is also a new arrangement for showing the rings in biaxial crystals of extreme wide angle, diopside for instance, with its entire system of rings being (it is claimed) "exhibited as large and with greater brilliancy than with Nörremberg's Polariscope." For this purpose an achromatic lens is interposed by means of a supplementary draw-tube between the eye-piece and objective, an optical combination of large aperture being fixed over the polarizer.

Mr. Bulloch, of Chicago, has also issued a Microscope for the study of rock sections, adapting for the purpose the model shown in Fig. 140 of Vol. III. (1880) p. 1077. Cf. also Rutley's, Vol. II. (1879) p. 470, Nachet's Petrographical Microscope, Vol. III. (1880) p. 227, and Vérick's Goniometrical Microscope for Mineralogy, Vol. I. (1881) p. 812.

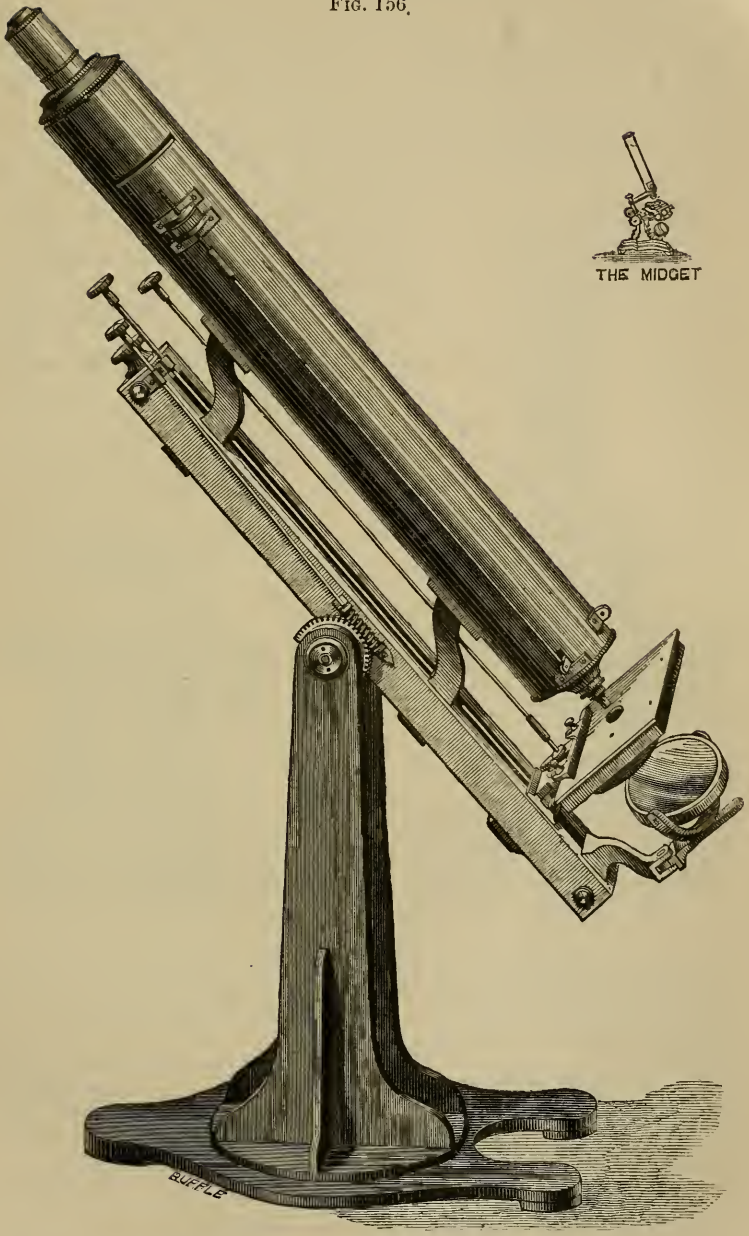
"Jumbo" Microscope.—The instrument, from Mr. Crisp's collection, shown in Fig. 156 (about $\frac{1}{8}$ nat. size) is another of the numerous instances of misdirected ingenuity in the designing of Microscopes. It was made in 1851 by G. Lowden, junr., a Dundee optician, for a gentleman then lately returned from India. It stands 4 feet high, weighs 1½ cwt., and the body-tube is 4 inches in diameter. It is therefore entitled to the distinction of being the largest and heaviest Microscope made within modern times!*

For the coarse adjustment the stage is moved up and down along the bar which supports the body-tube, its movement being controlled by the large milled head on the upper end of the bar. The fine adjustment is worked by the milled head and rod attached to the body-tube, by which an inner tube carrying the objective is raised or lowered.

As the stage is so far from the observer its movements are effected by the two longer rods terminating in milled heads shown in the figure above the end of the bar. One of these moves the stage from back to front, the other turning it to either side on a pivot at its base, giving it therefore a movement in a segment of a circle. The remaining shorter rod has a screw at its lower end which, working in a toothed wheel on the axis, causes the body of the instrument to incline as may be desired. The eye-piece is pierced with a slit to admit a slide holding prepared paper for "calotyping" an object by the old paper process.

* Schott, 'Magia Universalis,' 1677, describes and figures Microscopes of enormous size.

FIG. 156.



THE JUMBO.

"Midget" Microscope.—Fig. 156 also shows this Microscope to the same scale as the previous one. It was made by Mr. S. Holmes, and is only $4\frac{3}{4}$ inches high with a diameter of body-tube of less than $\frac{1}{2}$ inch. It is probably the smallest working instrument ever made.

Beck's Histological Dissecting Microscope.—This instrument (Figs. 157, 158) combines a compound with a simple and dissecting Microscope, the stout arm holding the single lenses being made so that a compound body (fitted with "Society" screw) can be substituted. A speciality consists in the adjustment of the mirror, which can be used as in Fig. 158 for transparent objects, or can be brought above the stage as in Fig. 157 for opaque ones.

Fig. 157.

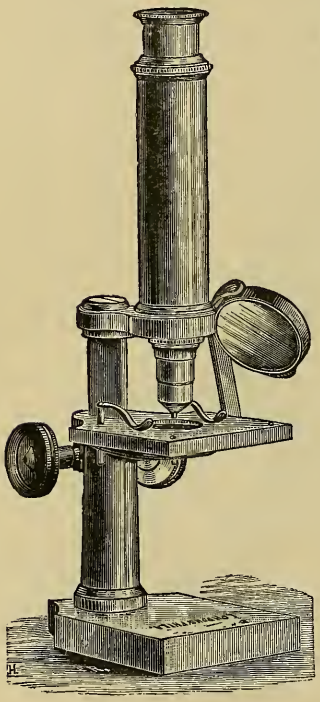
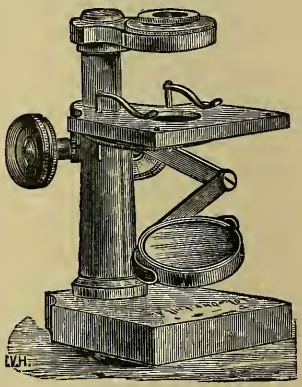


Fig. 158.



Gundlach's Globe Lens.*—This is a perfect sphere, consisting of a hollow flint-glass globe, made in halves, and enclosing a solid crown-glass globe. It is said to be constructed "according to a new optical principle discovered by Gundlach. By this principle the aberrations are corrected to a higher degree than has heretofore been attained by any other construction. The lens has an optical axis in any direction, hence the field is perfectly flat and distinct to the outer edges; and what is true of no other lens, the field is always the largest possible."

There are five sizes, 1, $\frac{3}{4}$, $\frac{1}{2}$, $\frac{3}{8}$, and $\frac{1}{4}$ inch.

* 'Descriptive Price List of Gundlach's New and Improved Objectives,' March 1882, p. 8.

Designation of Eye-pieces.*—At the Elmira meeting of the American Society of Microscopists, Dr. R. H. Ward, the chairman of the committee on eye-pieces (*ante*, p. 103), reported, that "all manufacturers but one had agreed to designate their eye-pieces by their focal-lengths, but no agreement had yet been made as to the diameter of the tubes." The committee was continued for another year.

Objectives of small and large Aperture.†—The Rev. W. H. Dallinger writes on this subject as follows:—"No one has appreciated or found more pleasure and profit in the use of the large angles with which our lenses have been more and more perfectly provided for the last ten or twelve years than I have. As they have been produced I have obtained them each and all, that had any real value, whether produced in this country, the Continent, or America, and in some cases I have incited certain English makers to produce certain special formulæ during that time. But while I have used all lenses, from the $\frac{1}{4}$ to the $\frac{1}{50}$, constantly during this time, what work I have done could never have been accomplished if I had *only* had lenses with *large angles* to work with. Much that had been done could never have been done *without them;* but the work, as a whole, could never have been done at all if only such had been at my disposal. Hence I have, in all my special working powers, *three* lenses of the same power, and in some cases four, and *each* of them, in following out the details of a life-history of an organism, say of the $\frac{1}{3000}$ to the $\frac{1}{6000}$ of an inch in length, is absolutely needed, and its place cannot be supplied by the other. Thus, I have two $\frac{1}{50}$ths, one having a very low angle, and the other as great a numerical aperture as an oil-immersion can provide when worked by the best makers. In the $\frac{1}{35}$th, I have but one lens, a medium angle, because it was intended only for general work and, mainly, central illumination. I have, however, three $\frac{1}{25}$ths, four $\frac{1}{16}$ths, and so on; and I know exactly what each will do, and no more attempt to get the work of one out of the other than the maker of them would attempt to get their several results by grinding them to the same formulæ.

I talked this matter over in detail, pointing out results, six years ago with some leading experts; and although, during two or three years, many have thought that Abbe's mathematics and views were adverse to this view of mine, I felt convinced by reading between the lines of his papers, and remembering their special object, that it was not so. Still Dr. Carpenter was good enough to get a detailed view of my experience and opinion before publishing the last edition of 'The Microscope,' and he has in his preface and throughout the volume, given in effect my views, which now the unmistakable declarations of Abbe coincide with and confirm. The homogeneous lenses have given me splendid results, some of which will shortly be published; but *no* immersion lens of *any* kind *could* be used to work out to the end an organic life-history—that is, if it involved life and movement, because the object being in a limited area, and possibly in fluid, the fluid *under* the cover does (when the movements of

* Amer. Mon. Micr. Journ., iii. (1882) pp. 175 and 171.
† North. Microscopist, ii. (1882) pp. 288–9.

the object are followed) at length, without the spectator's knowledge, mingle with the fluid *above* employed for the lens, and thus destroy the whole object of search and study. This fact, then, makes air angles of the highest importance, and I hope the highest results have not yet been attained with them. In the main, then, I agree with Abbe."

At the Montreal Meeting of the American Association for the Advancement of Science, Dr. W. B. Carpenter gave an address on the practical and theoretical results in the history of the Microscope, in which he dwelt mainly upon the question of wide aperture and high power eye-pieces.

Correction-adjustment for Homogeneous-immersion Objectives.* Dr. L. Dippel has already briefly published his objections to the use of a correction-collar in the case of homogeneous-immersion objectives (in opposition to the contrary opinion of Dr. H. Van Heurck) which he considers to be an abandonment of the practically most important advantage for scientific work which homogeneous-immersion has brought us, but is now led to return to the subject by the recent publication of the views of Dr. G. E. Blackham † (also of Dr. J. Edwards Smith ‡), in favour of the retention of the correction-collar, and he accordingly discusses the subject in some detail.

If we consider the matter first from the side of theory, it must on the one hand be allowed that the correction-collar, from a purely theoretical point of view, may have certain (though as will be seen in the sequel practically unimportant) advantages, while on the other hand it is undoubtedly the fact that the other advantages ascribed to it must be regarded as imaginary.

The advantages relate essentially to the following points:—First, with the correction-collar we are not so strictly limited to an immersion fluid of a particular index of refraction, as we are in the case of the fixed mounting, but various fluids can be used, which are different within certain—though always very narrow—limits.

In the use of an immersion fluid not precisely of the same refractive index as crown glass (which is the case with most of the immersion fluids hitherto employed, except the thickened cedar-wood oil), we can still obtain perfect correction for cover-glasses of varying thickness.

Further, those aberrations (comparatively considerable) can be corrected, which occur with dry preparations (rarely, however, coming under consideration in the scientific use of homogeneous immersion), if they do not adhere closely to the slide, but are separated from it by a thin stratum of air.

Finally, the correction-collar allows the same objective to be used with a longer or shorter tube, while otherwise one is confined to somewhat narrow limits in the length.

All the other advantages, however, urged by the advocates of the correction-collar are only imaginary, such as the possibility of most exact correction for the change in the index of refraction of a par-

* Zeitschr. f. Instrumentenk., ii. (1882) pp. 269–74.

† Cf. this Journal, *ante*, p. 407.

‡ 'How to See with the Microscope,' 1881.

ticular immersion fluid, in consequence of variations in temperature; or of an alteration in the optical properties of the cover-glasses, and the different powers of accommodation of the eyes of different observers.

The author has already shown * the practical insignificance of the difference in the refractive index of the immersion fluid produced by the varying temperature of the observing room in the ordinary use of the objectives in question, where the changes of temperature cannot be very important. Theoretically considered also, the matter will be seen to be of only little moment. According to the measurements of Professor Abbe, the difference with cedar oil is but 0·003 for a variation in temperature of 3° C. Since the correction of the objectives is arranged for a medium temperature of from 18° to 20° C., and the temperature at which normal microscopical observations are made is certainly (even if we allow very wide limits) between 15° and 28° C., the greatest deviation from the mean value in the refractive index is at most two or three units in the third decimal place. The aberrations in the divergence of the incident rays connected with this slight change and the consequent disturbance of the spherical correction, whilst it can be demonstrated by *very accurate* testing on the silver plate, is nevertheless in any case much smaller than those deviations from the *best* correction which occur with the correction-collar. It therefore follows that this much enforced deviation in the refractive index of the immersion fluid, caused by variations of temperature, which is to be balanced by the correction-collar, is at all events the *lesser* of two evils, and consequently can furnish no pretence for doing away with the fixed mounting.

Still less than the above-mentioned variations can the differences in the refractive index of different cover-glasses give any inducement for the introduction of the correction-collar. According to the observations of Professor Abbe during a period of ten years, these differences are so extremely small that they may be regarded practically as nil.

Finally, the suggested influence of the different powers of accommodation of the eye must be relegated to the region of dreams, as a simple theoretical consideration will show. If we take for example a power of 800, and two observers whose eyes are accommodated respectively to 100 mm. and an infinite distance, the difference in the adjustment thus produced—that is in the actual object-distance, assuming the objective to have air on both sides of it—can be easily computed from the formula :—

$$x\,x^* = -f^2.$$

For a long-sighted eye (where $x^* = \infty$)

$$x = 0.$$

For a distance of vision of 100 mm. (where $x^* = -100$) $x = \frac{f^2}{100}$, and since in the Microscope as a whole $f = \frac{250}{N}$,

$$\therefore x = \left(\frac{250}{N}\right)^2 \cdot \frac{1}{100}.$$

* Bot. Centralbl., No. 6.

Consequently, in the case assumed above of a power (N) of 800, x is rather more than 0·0009 mm. (or 0·9 μ), or if the object is in a medium of $n = 1{\cdot}50$, not quite 1·5 μ. This exceedingly slight displacement of the focus forms the measure of the alteration in the path of the rays in the objective, and it is the aberration which corresponds to the difference in the visual distance, assuming that accurate correction is first made for $x = 0$: much less if the largest possible aperture is assumed for that x, and generally not ascertainable, since it depends, like the moving of the lenses towards each other (by the correction-collar) upon the particular construction of the objective. Let us, however, assume that this movement of the lenses which is necessary for the equalization of the very slight difference in the path of the rays corresponding with the above ascertained difference of adjustment (and of the consequent disturbance of the spherical correction), amounts to even 0·1 μ, or 0·0001 mm., which is certainly *far too high*, this would still be a quantity which is unattainable by any *mechanical contrivance*, least of all by such a mechanism as the correction-collar. If Dr. J. Edwards Smith adduces against the results thus established by theory, a case in which three divisions on the scale of the correction-screw would be required for the equalization of the difference between the power of accommodation of his own eye and that of another observer (Mr. C. Spencer), it must be said that such a thing is entirely absurd. It proves in fact simply that what he regarded as the action of different powers of accommodation, was nothing more than an effect of "personal equation" in the judgment of the best image, and therefore rests entirely on purely subjective opinions.

If we now further examine the matter from a practical point of view, it may be at once allowed that the *technical* considerations against the correction-collar are not so weighty that it should be set aside on that account if *really practical* advantages were to be gained by it. For even if the greatest perfection of centering (such as is possible with the fixed mounting) cannot be obtained with the correction-collar nor its durability guaranteed, yet according to the examination by Professor Abbe of the correction-objectives of Powell and Lealand and Zeiss, a sufficient amount of accuracy can be obtained by very careful work. The question of expense, which the author previously laid stress on, need not be considered, because, as Professor Abbe observes, the technical difficulties in mounting the fixed objectives (on account of the final adjustment of the distances of the lenses to fractions of a hundredth part of a millimetre), are not less than in those with the correction-collar, and therefore the price for both kinds is about equal. In this respect, therefore, there is nothing to urge against the introduction of the correction-collar.

Now, however, the question arises, how and to what extent the *possible* advantages suggested by theory can be realized in practice without prejudicing the usefulness of the objectives, and on this point the author is strongly convinced that in the proper scientific use of the Microscope for the examination of *unknown objects and structural*

elements, the advantage to be expected by the use of the correction-collar is not only absolutely *illusory*, but that it is attended with many serious disadvantages.

In the observation of diatoms, which one has seen so often, and the structure of which is so simple and characteristic, it is not a matter of great difficulty to find *approximately* the best correction by experiment, since one forms a judgment from the clearness and distinctness of the image. For those, therefore, who study preferably the structure of diatoms, or who have set themselves the task of demonstrating test-objects a number of times (from whom has originated the desire for this contrivance), the correction-collar may prove of some slight advantage in the sharpness of the image, and for that reason may appear to be a desirable requisite. For this class of observation it may be readily admitted that at least no important disadvantage can arise.

For histologists, however, the case is very different. With the objects that come under their observation, especially if they are of very delicate and complicated structure, it is almost impossible to find the best correction by mere trial. In endeavouring to find the "best image" we are just as likely to arrive at a completely *false* correction (which produces *false* images) as upon the proper one. The widest latitude is thereby given to every possible subjective fancy and false arbitrary interpretation, and those deviations from the best correction which still remain, in the in other respects skilful use of objectives with fixed mounting and carefully corrected for a given length of the tube and a particular immersion fluid, are perfectly insignificant and harmless as compared with the great uncertainty and grave aberrations which the use of the correction-collar introduces.

If the best correction for a certain thickness of cover-glass is required, there is only *one* object by means of which this can be obtained with perfect certainty and with the smallest amount of subjective fancy, so that correct images of all objects of any structure can be guaranteed (without false differences in level, &c.). This object is the Abbe test-plate, by which the correct co-operation of all zones of the aperture can be judged of. That, in comparison with this plate, the structures of the valves of the Diatomaceæ are by no means sufficient, is best proved by the case brought forward by Dr. Edwards Smith, in which personal equation evidently played no unimportant part. And if even in the case of such an object—striæ of diatoms of well-known nature—such latitude was given for the exercise of personal caprice in the adjustment of the correction-screw for the "best image," how great may it be when we are dealing with *unknown* delicate and complicated structures? Under such circumstances, how easily may the employment of the correction-collar become rather a subject of misuse than of use? With high power dry objectives and water-immersion objectives the correction-collar is a necessary evil which must be endured. Where, however, it can be dispensed with, it would be folly to retain it on account of entirely subordinate and unimportant advantages. Especially may it be *very decidedly rejected* in all scientific work with homogeneous-immersion objectives. The slight restriction in the use of objectives with fixed mounting can the

more be endured, since on the one hand each of such objectives can be adjusted according to desire for the short Continental or for the long English tube, and thus effect can be given to personal inclinations; while on the other hand, where it is a question of *sharpest* observation, it is easy to provide a suitable medium thickness of cover-glass where the immersion fluid is not exactly uniform with crown-glass. Under all circumstances one gives up in using the fixed mounting only *unessential* conveniences and benefits hardly worth consideration, whilst far greater advantages are gained and very considerable defects avoided.

In conclusion, therefore, Dr. Dippel repeats:—"For all histological and similar scientific observations, hold firmly to the fixed mounting for homogeneous-immersion objectives. And if we have such an objective with correction-collar, I say with Prof. Abbe, 'after careful testing of the best correction for *medium conditions* by means of the silver plate, screw it up *tightly* ("niet und nagelfest," clinched and riveted), so that no mischief can arise.'" *

Nelson's Adapter for Rapidly Changing Objectives.—This appliance has been devised by Mr. E. M. Nelson to facilitate the rapid interchange of objectives without the necessity of triple or quadruple nose-pieces, or such an alteration of the existing system as would prevent the free interchange of objectives provided with the normal Society screw, as is the case with the devices of Parkes, Nachet, and Vérick.

Fig. 159.

In Fig. 159 N is an adapter,† the inner screw-thread of which is filed down smooth in three equal and equidistant segments, leaving the thread intact in the intervening three segments. The screw-thread on the objective is filed down in three places to correspond with N, so that where the gauge-slots S and S′ coincide the objective can be pushed in for the length of the screw, and then an eighth of a turn to the right screws it securely "home," just as it would be after the four turns required with the Society screw and ordinary nose-piece. Similarly to detach it, only an eighth of a turn to the left is necessary. Whilst the objective can be inserted at any of the three positions in which the segments of the nose-piece and objective coincide, it is only in the one position where the gauge-slots S and S′ coincide, that the screw-threads correspond, and the one-eighth turn for screwing "home" can be made without injury to the threads.‡

* Cf. the discussion on this paper, Proceedings, *post*.

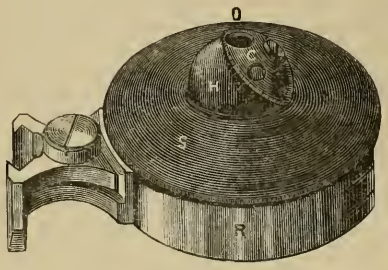
† By a mistake of the engraver the outer screw of N is drawn of less diameter than that of O. They are both of Society gauge.

‡ Since the construction of the adapter, Mr. Nelson's attention has been called to a communication in 'Science-Gossip,' 1879, p. 18, in which Mr. James Vogan suggested a similar system under the heading "A Substitute for Nose-pieces." The plan then proposed by Mr. Vogan involved cutting away two segments of one-fourth the circumference of the screw-thread.

If the thread of the nose-piece of the Microscope is filed down in the same way as in the adapter N, the latter may be dispensed with, and it is, as we have said, a special feature of Mr. Nelson's suggestion that the alteration to the objective thread in no way hinders its use with the ordinary nose-piece, and unaltered objectives will in the same way fit nose-pieces which have been filed down.

Gundlach's Calotte Diaphragm.—Mr. Gundlach has devised the very neat form of calotte diaphragm shown in Fig. 160, for application to his "College" Microscope (*ante*, p. 670).

Fig. 160.

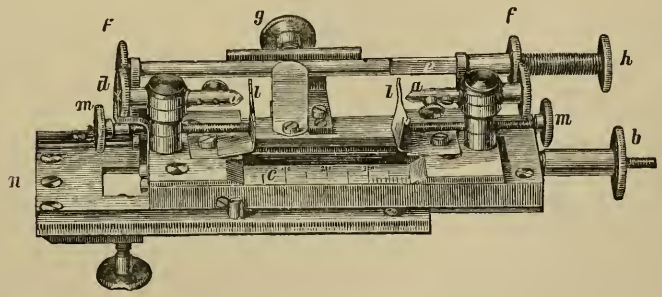


The calotte C is pierced with five apertures, varying in size from a pin-hole to $\frac{1}{6}$ inch, and is attached to a hollow metal hemisphere H, by a screw at a point 45° from the vertex, which allows it to rotate so that the apertures pass successively over an opening O at the top of the hemisphere. H itself is fixed to a spherical segment of metal, and the latter to a short piece of cylindrical tube so as to slide into the substage R; an outer shell S, of ebonite, rotates round H, and the edge of the calotte C being milled and in close contact with S, the rotation of the latter causes the calotte to revolve also. A projecting pin on the tube fits into a slot in the substage ring to prevent H from rotating.

More space for the hand between the stage and the outer edge of the ebonite shell would be obtained by adopting a conical instead of a spherical form of shell.

Bohm's Wool-measurer.* — This (Fig. 161) is intended for

Fig. 161.



examining the wool of sheep under the Microscope, but it can also be used for the anthropological comparison of human hair, as well as for

* Bericht u. d. wiss. Instrumente a. d. Berliner Gewerbeausstellung im Jahre 1879 (Loewenherz, 1880) pp. 313–4 (1 fig.).

other fibres. The hair or fibre is placed between two pincers *a* (exactly at their points). One of these is movable on the base-plate *c*, by means of the screw *b*, and the object can therefore be stretched, and the extent of the stretching read off on the scale on the plate. As, moreover, they each move on their axis, the object can be uncurled in case it is twisted, and the movement registered on a scale on the end of the screw *d*, to which an index is also attached. In order to be able to measure the various diameters of the object, it is necessary sometimes to turn it entirely round. For this purpose the bar *e* is added, whose two milled heads *f* are pressed towards the corresponding ones of the pincers *a* by means of the screw *g*, so that they act like cog-wheels. The simple turning of the bar *e* by means of the third milled-head *h* sets both the pincers in equal rotation.

This instrument also provides means for chemical treatment. For this purpose the base-plate has two spring-pieces *l* for the reception of a small slide. These supports are raised up when the pressure of the screws *m* is released, so that the object may lie on the slide. A glass cover can be placed over it, and the object treated in the usual way with alkalis, acids, &c.

By sliding the apparatus upon the plate *n* (clamped to the stage of the Microscope), the object can be passed across the field.

Gundlach's Substage Refractor.*—The formula in the description of this apparatus at p. 692 was taken verbatim from the original source, and in the bibliography at p. 699 we noted a further article by Mr. Gundlach (with a different heading) as "apparently the same as the preceding." On comparing the two articles, however, it will be seen that the earlier one was somewhat hastily prepared, and that the formula should stand as in the later one as follows:—

"For the determination of the angular aperture of objectives, if not less than 96° in crown glass, I propose to attach to the front surface of the objective, by means of a 'homogeneous' medium, in the usual way, a small piece of crown glass, which has, besides the adhering surface, two other polished plane surfaces at right angles to the former and parallel to each other, with a distance between them of at least the diameter of the front lens of the objective.

Then from two distant points, lying in the plane described by the optical axis of the objective and the perpendicular upon this axis and the parallel plane surfaces of the glass piece, let rays of light fall upon these surfaces, to pass through the glass and then through the objective.

Find, in the usual manner, by moving the lights sideways, that direction of the two light rays by which the latter will just strike the outer edge of the aperture of the objective. Then determine the angle described by the two rays before entering the glass piece, and find the true crown-glass angle of the objective by calculation after this formula:—

$$\frac{\cos i}{r} = \cos a,$$

i being half the angle of the two rays before entering the glass piece;

* Amer. Mon. Micr. Journ., iii. (1882) p. 176.

r, the refractive index of the glass piece; a, half the crown-glass angle of the objective."

Apparent Size of Magnified Objects.*—Prof. W. H. Brewer read a paper before the Section of Physics, at the Montreal Meeting of the American Association for the Advancement of Science, in which he gave the results of a long series of experiments on the apparent size of the image formed in the Microscope, as seen by different persons. About 440 different persons were questioned as to the size of the image of various objects, but finally a small insect was selected as the test object. The actual length of the image, as drawn by the camera lucida, using a 1½-inch objective, was 4·66 inches, including the antennæ, 4·87; the diameter of the field was 5·85 inches.

The results may be briefly summed up as follows:—Of the 440 persons, about 41, or 9 per cent., judged the size quite correctly; 82 of them, or 19 per cent., made the size 4·25 to 5 inches, which was reasonably good. The greater number of persons underestimated the size; 2 estimated it at less than 1 inch, 7 made it over a foot, 45 made it 2 inches, or less; 22 made it 10 inches. The largest estimate was by a mechanic, who said it looked like a picture projected on a screen and it seemed to be 5 feet long. Experience seems to correct false estimates, as was illustrated by three estimates by a gentleman who used the Microscope in drawing; in three successive years his estimates were respectively 9, 8, and 7 inches.

Committee on Ruled Plates.—At the meeting of the Section of Histology and Microscopy of the American Association for the Advancement of Science, at Montreal, after the reading of a paper by Professor W. A. Rogers on ruled lines, a resolution was proposed that a committee be appointed to receive ruled plates from different makers that might be offered for examination in accordance with the suggestions made by Professor Rogers. After some discussion the resolution was carried, but it was afterwards decided to postpone the appointment of the committee until some future time.

Professor R. Hitchcock regards this† "as a great step toward the settlement of the question of the practical limit of resolution, independent of any theoretical considerations," and "hopes and believes that at the next meeting of the Association a committee will be appointed."

Quekett Microscopical Club.—It has been determined to give a series of demonstrations upon elementary subjects connected with Microscopy on the "Gossip" evenings of this Club. The first six will be on the following subjects:—Dec. 8, 1882, The History of a Stained Section of an Animal Structure, by Mr. J. W. Groves. Jan. 12, 1883, Photo-micrography, by Mr. T. Charters White. Feb. 9, Sea-side Collecting, by Mr. A. D. Michael. March 9, Some Methods of Preparing Parts of Insects for Microscopical Examination, by Mr. E. T. Newton. April 13, Microscopical Vision, by Mr.

* Amer. Mon. Micr. Journ., iii. (1882) p. 161.
† Ibid., pp. 197–8.

W. T. Suffolk. May 11, The Structure of Mosses, by Dr. R. Braithwaite.

We are glad to find that this experiment is at last to be tried. That it should be done has been for several years the strong wish of many of the members. As, however, it was found that the suggestion gave offence to leading officials of the Club, it was not further pressed, in the hope that at some future time the force of events would enable the question to be dealt with on its merits and apart from any personal predilections one way or the other.

Hogg on the Microscope.*—A new (10th) edition of this book (bearing the date of 1883) has just been issued. It is now so well known from the numerous editions through which it has passed, extending over a period of nearly thirty years, that it is superfluous to describe its general plan. The new edition bears the marks of extensive revision, especially in the parts relating to the Microscope proper, which have in fact been nearly rewritten.

It is almost unnecessary to say that the book contains that without which no treatise on the Microscope is now complete, viz., an explanation of the Abbe theory of microscopical vision, and of the *pons asinorum* of the old school of microscopy—the aperture of objectives. Pages 69 to 80 are devoted to the most succinct and at the same time complete statement of the latter subject that has yet been printed. A similarly succinct statement of the principles on which homogeneous-immersion is based is given in pages 82 to 86. A chapter has been added on the application of the Microscope to mineralogy and spectroscopic analysis and the examination of potable water.

By a slip the preface omits to mention that more than fifty of the new woodcuts were lent by the Council of this Society, having originally appeared in this Journal.

The author may be congratulated on the issue of the new edition and on the fact that his book has so long maintained so large an amount of popularity.

Wright's Experimental Optics.†—This is also a book on which the author may be very much congratulated, as in our view it is by far the most useful work on its subject to which the general body of microscopists can refer. It is written throughout from an experimental point of view, and the author's endeavour (to use his own words) has been "to place clearly before the mind of the reader, through something like a complete course of actual experiments, the *physical realities* which underlie the phenomena of Light and Colour. As helps, there are solely employed simple mechanical analogies, and a few diagrams, explained in language which it is hoped may be found in reality simple and clear though not intended to be childish or to debar any private student from the healthful exercise of now and then considering what the writer means." We think that the author's explanations

* Hogg, J., 'The Microscope: its History, Construction, and Application.' New (10th) ed., xx. and 764 pp., 8 pls., and 356 figs. (8vo, Routledge, 1883).

† Wright, L., 'Light: a course of Experimental Optics, chiefly with the Lantern.' xxiv. and 367 pp., 8 pls., and 190 figs. (8vo, Macmillan, 1882).

will enable those who are new to the subject to master it more readily and satisfactorily than they could do by the more usual mode of treatment adopted in the ordinary text books.

The phenomena of polarization occupy 143 out of the 358 pages of the text, and this section is illustrated by 62 figs. and 6 plates, 2 of which are beautifully coloured. There is an Appendix on 'Diffraction in the Microscope,' condensed from this Journal, I. (1881) pp. 350–5.

Bradbury, W.—The Achromatic Object-glass. XI.
Engl. Mech., XXXVI. (1882) pp. 219–20.

Braintree Microscopical Society.
[Note on the first Annual Journal and Report.]
Sci.-Gossip, 1882, pp. 231–2.

Browning, J.—Letter on the Small Loss of Definition by using B, C, and D Eye-pieces. *North. Microscopist*, II. (1882) p. 282.

Bulloch's (W. H.) Newer "Congress" Stand.
This Journal, *ante*, pp. 666–9 (5 figs.).
Engl. Mech., XXXVI. (1882), pp. 151–2 (1 fig.)

Crouch's (H.) Students' Microscopes, and how to use them.
Catalogue (n.d.), pp. 25–34 (figs.).

Crumbaugh, J. W.—The History of the Microscope and its Accessories. III.
The Microscope, II. (1882) pp. 115–7.

D., E. T.—Drawings and Paintings from the Microscope. [*Post.*]
Sci.-Gossip, 1882, pp. 1–3.

„ „ Microscopical Painting. [*Post.*]
Sci.-Gossip, 1882, p. 230.

Dallinger, W. H.—Letter on Objectives of Small and Large Aperture. [*Supra*, p. 853.] *North. Microscopist*, II. (1882) pp. 288–9.

Davis, G. E.—Apertures and Amplification.
[Comments on paper of J. L. W. Miles, *infra*; also remarks on Professor Duncan's Presidential Address—"it is so clearly expressed that we commend it to the notice of members of all Societies both young and old."]
North. Microscopist, II. (1882) p. 278.

„ „ The Elements of Microscopy. I. The Human Eye.
North. Microscopist, II. (1882) pp. 293–303 (12 figs.).

"Density"—Micro-photography.
[Inquiry whether the visual and actinic foci of an objective are the same distance apart whatever the distance of the sensitive plate from the objective.]
Engl. Mech., XXXVI. (1882) p. 282.

Dippel, L.—Eine neuere Verbesserung der Abbe'schen Camera lucida. (A recent improvement of the Abbe Camera lucida.) [*Post.*]
Bot. Centralbl., XII. (1882) pp. 211–2.

„ „ Abbe's Spectro-polarisator. (Abbe's Spectro-polarizer.) [*Post.*]
Bot. Centralbl., XII. (1882) pp. 284–6.

Encausse and Canésie.—Mikrographoskop und Mikroskop zum Vergrössern und Photographiren zu gleicher Zeit. (Micrographoscope and Microscope for enlarging and photographing at the same time.)
French Patent, No. 145,999, 23rd November, 1882 (1881?).
Cf. *Zeitschr. f. Instrumentenk.*, II. (1882) wrapper.

"F.R.M.S."—Microscopy. Nelson's Adapter. [*Supra*, p. 858.]
Engl. Mech., XXXVI. (1882) p. 164.

Graff, T. S. Up de.—Letter descriptive of the Elmira Meeting of the American Society of Microscopists.
The Microscope, II. (1882) pp. 123–33.
See also *infra*, Stowell, C. H. and T. B.

Gundlach, E.—A Simple Method of Determining the Angle of Aperture of Immersion Objectives.

[Correction of the previous description at p. 142. *Supra*, p. 860.]

Amer. Mon. Micr. Journ., III. (1882) p. 176.

Hitchcock, R.—The August Meetings.

[Editorial on the Montreal meeting of the Amer. Assoc. Adv. Sci. and the Elmira meeting of the Amer. Soc. Micr.]

Amer. Mon. Micr. Journ., III. (1882) pp. 176–7.

„ „ The "Jumbo" Microscope.

[Brief comment. *Supra*, p. 850.]

Amer. Mon. Micr. Journ., III. (1882) p. 178.

„ „ The Microspectroscope.

[Description of the Zeiss, Sorby-Browning and Sorby-Hilger instruments, with observations on the application of the spectroscope to the examination of solutions or fluid compounds.]

Amer. Mon. Micr. Journ., III. (1882) pp. 183–7 (3 figs.).

„ „ Committee on Ruled Plates. [*Supra*, p. 861.]

Amer. Mon. Micr. Journ., III. (1882) pp. 197–8.

Hogg, J.—The Microscope: its History, Construction, and Application; being a familiar introduction to the use of the instrument and the study of microscopical science. New ed. 8vo, London, 1883, xx. and 764 pp., 356 figs. and 8 pls. [*Supra*, p. 862.]

Jennings, J. H.—The Aperture Shutter.

[Letter to the Editor in commendation, both in photo-micrography and ordinary microscopic work. "Some may say, 'why not use special low-angle lenses which will give all requisite penetration?' Simply because penetration is far from being the only desirable quality in an objective. Lenses that possess great penetration usually possess little else, and the loss of light entailed by their use is far greater than that experienced when using a wide-angle lens with the aperture shutter" (!)]

North. Microscopist, II. (1882) pp. 279–80.

Jones, T. R.—Journal of the Royal Microscopical Society.

[Review of Nos. 23–9.]

Geol. Mag., IX. (1882) pp. 476–9.

Kitton, J.—The sign ×.

[Reply to T. R. J., *ante*, p. 746. "An inch is an inch, although its smaller divisions are not indicated."]

Sci.-Gossip, 1882, p. 232.

Latteux, P.—Manuel de Technique Microscopique, ou guide pratique pour l'étude et le maniement du Microscope. (Manual of Microscopical Technic, or practical guide for the study and management of the Microscope). 2nd ed. 8vo, Paris, 1883, xi. and 477 pp., 176 figs.

Malley, A. C.—Microphotography.

[Reply as to finding the actinic focus of objectives, &c.]

Engl. Mech., XXXVI. (1882) p. 257.

"Micro."—Aperture.

[Criticism of J. L. W. Miles' paper, *infra*.]

North. Microscopist, II. (1882) pp. 281–2.

Mikroskop, das, und seine Anwendung bei Untersuchung von Hopfen, Hefe &c., nebst Beschreibung und Gebrauchs-Anweisung des Hefezählers. Eine Anleitung für Brauer u. Brenner. (The Microscope and its use in the observation of hops, yeast, &c., with description of and instructions for using the yeast-counter. A guide for Brewer and Distiller.) 8vo, Berlin, 1882, 20 pp., 1 pl.

Miles, J. L. W.—The Optical Performances of Objectives—Aperture—The Aperture-shutter.

[Paper read before Manchester Microscopical Society.]

North. Microscopist, II. (1882) pp. 284–91.

„ „ Apertures and Amplification.

[Reply to J. H. Jennings *supra*, and W. Stanley *infra*.]

North. Microscopist, II. (1882) pp. 319–20.

Moore, A. J.—Camera Lucida.

["An ingenious modification of the ordinary camera lucida, consisting of a silvered disk, somewhat smaller in diameter than the pupil, centered upon a round cover-glass, which is attached to the eye-piece in the usual manner."]

The Microscope, II. (1882) pp. 130–1.

Nelson, E. M.—Quick acting Adapter for Microscopical Objectives (Exhibition of). [*Supra*, p. 858.] *Engl. Mech.*, XXXVI. (1882) pp. 127–8.

"One who was present."—Aperture.

[Criticism of J. L. W. Miles' paper, *supra*.]

North. Microscopist, II. (1882) pp. 282–3.

Pelletan, J.—Microscope "Continental" du Dr. J. Pelletan, construit par E. Lütz. (Dr. J. Pelletan's "Continental" Microscope, constructed by E. Lütz.)

[Detailed description.]

Journ. de Microgr., VI. (1882) pp. 458–60.

" " A propos du Microscope "Continental." (On the "Continental" Microscope.)

[Reply to C. Stodder, *infra*.]

Journ. de Microgr., VI. (1882) pp. 532–3.

"Photo."—Aperture.

[Criticism of J. L. W. Miles' paper, *supra*.]

North. Microscopist, II. (1882) pp. 280–1.

"Prismatique."—Object-glass Working. II.

Engl. Mech., XXXVI. (1882) pp. 240–1.

Row, F.—Photo-micrography, and the Relation of Photography to Microscopy.

[Very general—26 lines.]

1*st Journ. and Rep. Braintree and Bocking Micr. and Nat. Hist. Club*, 1882, pp. 14–15 (1 photo.).

Shipperbottom, —.—The Aperture Shutter.

[Letter to the Editor in commendation—Useful for "aiding in the production of that amount of penetration which is essential for the production of Micro-stereograms."]

North. Microscopist, II. (1882) p. 282.

Stanley, W.—The Aperture Shutter.

[Letter to the Editor in commendation—"Polycistina placed under $\frac{1}{2}$-inch objective of 80° (!) and dark-ground illumination, with the condenser. The result was a glare, no definition, no penetration, but when the aperture shutter was applied an exceedingly good dark-ground was obtained with penetration sufficient to clearly define the whole of the interior markings of some of the larger cone-like forms."]

North. Microscopist, II. (1882) pp. 278–9.

Stevens, W. L.—The Physiology of Variable Apparent Magnification by the Microscope.

Amer. Mon. Micr. Journ., III. (1882) pp. 188–91.

Stodder, C.—A propos du Microscope "Continental." (On the "Continental" Microscope.)

[Letter to Dr. Pelletan commending the size of the new instrument as compared with the ordinary French and German models, and criticizing the length of the rackwork, the fine movement, &c.]

Journ. de Microgr., VI. (1882) pp. 531–2.

See also *supra*, Pelletan, J.

Stowell, C. H.—Notes on the Elmira Meeting of the American Society of Microscopists and the new President. *The Microscope*, II. (1882) pp. 137, 138–9.

See also *supra*, Graff, T. S. Up de, and *infra*, Stowell, T. B.

Stowell, T. B.—[Report of the Elmira Meeting of "the American Society of Microscopists, containing the President's Address in full." (The address is in full *abstract*.] *The Microscope*, II. (1882) pp. 97–106.

See also *supra*, Graff, T. S. Up de, and Stowell, C. H.

Taylor, G. C.—New Mechanical Lamp.

["A modification of the Hitchcock lamp, in which the burner is brought very low upon the table, while the inteusity of the light is regulated by a movable diaphragm which increases or curtails the volume of air admitted to the fan. A practical test of the light in resolving fine lines proved its superiority over all lamps yet devised."]

The Microscope, II. (1882) p. 128.

Trutat, E.—Traité élémentaire du Microscope. 1e Partie. Le Microscope et son emploi. (Elementary Treatise on the Microscope. Part I. The Microscope and its employment.) xvi. and 322 pp., 171 figs., and 1 phototype. 8vo, Paris, 1883 (1882).

Ward, R. H.—Report of Committee on Eye-pieces. [*Supra*, p. 861.]

Amer. Mon. Micr. Journ., III. (1882) p. 175. Cf. also p. 171.

" " Microscopy at the American Association.

[Note on the first meeting of the new section of Histology and Microscopy and Dr. Carpenter's visit.]

Amer. Natural., XVI. (1882) p. 931.

Wheeler, E.—Lecture on Light, the Microscope, &c.

1st Journ. & Rep. Braintree & Bocking Micr. & Nat. Hist. Club, 1882, pp. 12–14.

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

Methods of Microscopical Research in use in the Zoological Station at Naples.*—Dr. P. Mayer gives an account of the methods employed at the Naples Zoological Station for preserving, staining, and mounting objects, some of which have not previously been published. Although they are only mentioned in connection with marine forms they are in many cases applicable also to fresh-water organisms, insects, &c.

I. Preservative Fluids.—*Killing*, *hardening*, and *preserving* are three kinds of work, requiring for their accomplishment sometimes only a single preservative fluid, but in most cases two, three, or even more. As the same fluid often does the work of killing and hardening, and sometimes of preserving too, it is impossible to divide them into three classes corresponding to the kinds of work, except by repeating many of them twice, and some of them three times. While it is therefore more convenient to include them all under "preservative fluids," as Dr. Mayer has done, it is none the less important to remember what

* MT. Zool. Stat. Neapel, ii. (1880) pp. 1–27. We ought long since to have printed a translation of this paper, but in consequence of a succession of accidents we have been prevented doing so, notwithstanding that we had a complete translation made of it soon after it appeared. The abstract we now give is that (with slight alterations) of C. O. Whitman in Amer. Natural., xvi. (1882) pp. 697–706, who says "I have added the methods of Dr. Giesbrecht, Dr. Andres (*infra*), and some others who have worked in the zoological station. Dr. Mayer has further placed at my disposal such improvements and alterations as he has been able to make since the publication of his paper. I am also deeply indebted to Dr. Mayer for advice and generous assistance, for which I wish here to give expression to my most sincere thanks and grateful appreciation. I am still further indebted to Dr. Eisig, Dr. Lang, Dr. Andres, Dr. Giesbrecht, Professor Weismann, and Professor Dohrn, all of whom I have had occasion to consult with reference to matter contained in this paper." Mr. G. Brook, junr., also rendered a very useful service to microscopists by publishing a summary in 'Naturalist,' vi. and vii. (1881), parts of which are embodied in the text.

kind or kinds of work each fluid is expected to accomplish. Kleinenberg's picro-sulphuric acid, for instance, now so much used in the Naples Aquarium, is not a hardening fluid. It serves for killing, and thus prepares for subsequent hardening.

1. *Kleinenberg's Picro-sulphuric acid* * :—

Picric acid (cold saturated solution in distilled water)	100 volumes
Sulphuric acid (concentrated)	2 „

Filter the mixture, and dilute it with three times its bulk of water (or for Arthropoda undiluted), finally add as much creosote (made from beech-wood tar) as will mix.†

Objects are left in the fluid three, four, or more hours ; ‡ and are then, in order to harden and remove the acid, transferred to 70 per cent. alcohol, where they may remain 5 to 6 hours. They are next placed in 90 per cent. alcohol, which must be changed at intervals until the yellow tint has wholly disappeared.

The advantages of this fluid are, that it kills quickly, by taking the place of the water of the tissues; that it frees the object from sea-water and the salts contained in it, and that having done its work it may be wholly replaced by alcohol. In this latter fact lies the superiority of the fluid over osmic and chromic solutions, all of which produce inorganic precipitates and thus leave the tissues in a condition unfavourable to staining. Picro-sulphuric acid does not, like chromic solutions, harden the object, but simply kills the cells.

As this fluid penetrates thick chitine with difficulty, it is necessary, in order to obtain good preparations of larger Isopoda, insects, &c., to cut open the body with the scissors and fill the body-cavity with the liquid by means of a pipette. In larger objects care should be taken to loosen the internal organs so that the fluid may find easy access to all parts.

The fluid should be applied as soon as the body is opened, so that the blood may not have time to coagulate and thus bind the organs together. A large quantity of the fluid should be used (especially when objects with large internal cavities have to be prepared whole), and it must be changed as often as it becomes turbid. The same rule holds good in the use of all preservative fluids. It is well also, especially with larger objects, to give the fluid an occasional stirring up.

In order to avoid shrinkage in removing small and tender objects

* Quart. Journ. Micr. Sci., xix. (1879) pp. 208–9. See this Journal, ii. (1879) p. 461.

† Dr. Mayer prepares the fluid as follows :—Water (distilled), 100 vols.; sulphuric acid, 2 vols.; picric acid as much as will dissolve. Filter and dilute as above. No creosote is used.

‡ Dr. Mayer's own remarks are :—How long objects should remain in the acid depends of course upon their nature. Usually a few hours is sufficient, but for larger objects and those containing a large percentage of water a longer time is necessary. In some cases a whole day does not produce any injurious effect.

from the acid to the alcohol, it is advisable to take them up by means of a pipette or spatula, so that a few drops of the acid may be transferred along with them. The objects, sinking quickly to the bottom, remain thus for a short time in the medium with which they are saturated, and are not brought so suddenly into contact with the alcohol. In a few minutes the diffusion is finished; and they may then be placed in a fresh quantity of alcohol, which must be shaken up frequently and renewed from time to time until the acid has been entirely removed.

The sulphuric acid contained in this fluid causes connective tissue to swell, and this fact should be borne in mind in its use with vertebrates. To avoid this difficulty Kleinenberg has recommended the addition of a few drops of creosote, made from beech-wood tar, to the acid. According to Dr. Mayer's experience, however, the addition of creosote makes no perceptible difference in the action of the fluid.

Professor Emery finds the process very useful for embryos of vertebrates and for fishes, but they should not be allowed to remain in the acid more than three or four hours. Although the method is considerably the best for preserving Crustacea as a rule, it will not do for the parasitic species, in which it produces swellings, dissolution of parts of the tissues, &c.

2. *Picro-nitric or Picro-hydrochloric acid.*—Kleinenberg's fluid must not be used with objects (e. g. Echinoderms) possessing calcareous parts which it is desired to preserve, for it dissolves carbonate of lime and throws it down as crystals of gypsum in the tissues. For such objects picro-hydrochloric or picro-nitric acid may be used, prepared as follows:—

Water	100 volumes.
Nitric acid (25 per cent. N_2O_5)	5 „
[or hydrochloric acid (25 per cent. HCl)	8 „]
Picric acid as much as will dissolve.*	

Picro-nitric acid also dissolves carbonate of lime, but it holds it in solution, and thus the formation of crystals of gypsum is avoided. In the presence of much carbonate of lime, the rapid production of carbonic acid is liable to result in mechanical injury of the tissues, hence in many cases chromic acid is preferable to picro-nitric acid.

Picro-nitric acid is, in most respects, an excellent preservative medium, and as a rule will be found to be a good alternative in those cases where picro-sulphuric acid fails to give satisfactory results. Dr. Mayer commends it very strongly, and states that with eggs containing a large amount of yolk material, like those of *Palinurus*, it gives better results than nitric, picric, or picro-sulphuric acid. It is not so readily removed from objects as picro-sulphuric acid, and for this reason the latter acid would be used wherever it gives equally good preparations.

* This mixture is used undiluted.

3. *Alcohol.*—In the preparation of animals or parts of animals for museums or histological study, it is well known that the chief difficulties are met in the process of killing. Alcohol, as commonly used for this purpose by collectors, has little more than its convenience to recommend it. Dr. Mayer calls attention to the following disadvantages attending its use in the case of marine animals:—

(1) In thick-walled animals, particularly those provided with chitinous envelopes, alcohol causes a more or less strong maceration of the internal parts, which often ends in putrefaction.

(2) In the case of smaller Crustacea, e. g. Amphipods and Isopods, it gives rise to precipitates in the body-fluids, and thus solders the organs together in such a manner as often to defy separation even by experienced hands.

(3) It fixes most of the salts of the water adhering to the surface of marine animals, and thus a crust is formed which prevents the penetration of the fluid to the interior.*

(4) This crust also prevents the action of staining fluids, except aqueous solutions, by which it would be again dissolved.

Notwithstanding these drawbacks, alcohol is still regarded at the Naples Aquarium as an excellent fluid for killing many animals designed for preservation in museums or for histological work. In many cases the unsatisfactory results obtained are to be attributed not to the alcohol *per se*, but to the method of using it. Most of the foregoing objections do not, as Dr. Mayer expressly states, apply to fresh-water animals; and Dr. Eisig informs Mr. Whitman that he has no better method of killing marine annelids than with alcohol. Judging from the preparations which were shown him, and which were all beautifully stained with borax carmine, Dr. Eisig's mode of treatment must be pronounced very successful. The process is extremely simple; a few drops of alcohol are put into a vessel which contains the annelid in its native element, the sea-water; this is repeated at short intervals until death ensues. After the animal has been thus slowly killed, it may be passed through the different grades of alcohol in the ordinary way, or through other preservative fluids. Objects killed in this manner show no trace of the external crust of precipitates which arises where stronger grades of alcohol are first used. The action of the alcohol is thus moderated, and the animal, dying slowly, remains extended and in such a supple condition that it can easily be placed in any desired position. The violent shock given to animals when thrown alive into alcohol of 40 per cent. to 60 per cent., giving rise to wrinkles, folds and distortions of every kind, is thus avoided, together with its bad effects.

4. *Acid Alcohol.*—In order to avoid the bad effects of alcohol,

* Dr. Mayer first noticed this in objects stained with Kleinenberg's hæmatoxylin, and afterwards in the use of cochineal, where a grey-green precipitate is sometimes produced which renders the preparation worthless. Such results may be avoided by first soaking the objects a few hours in acid alcohol (1–10 parts hydrochloric acid to 100 parts 70 per cent. alcohol).

such as precipitates, maceration, &c., Dr. Mayer recommends acid alcohol—

97 volumes 70 per cent. or 90 per cent. alcohol,
3 „ hydrochloric acid,

for larger objects, particularly if they are designed for preservation in museums. The fluid should be frequently shaken up, and the object only allowed to remain until thoroughly saturated, then transferred to pure 70 per cent. or 90 per cent. alcohol, which should be changed a few times in order to remove all traces of the acid. For small and tender objects, acid alcohol, although preferable to pure alcohol, gives less satisfactory results than picro-sulphuric acid.

Acid alcohol as above prepared loses its original qualities after standing some time, as ether compounds are gradually formed at the expense of the acid.

5. *Boiling Alcohol.*—In some cases among the Arthropods, Dr. Mayer has found it difficult to kill immediately by any of the ordinary means, and for such cases recommends boiling absolute alcohol, which kills instantly. For Tracheata this is often the only means by which the dermal tissues can be well preserved, as cold alcohol penetrates too slowly.

6. *Osmic Acid.*—Dr. Mayer employs osmic acid as a staining medium for the hairs, bristles, &c., of the dermal skeleton of Arthropods. The lustre of *Sapphirina* is preserved by this acid,* and according to Emery, the colour of the red and the yellow fatty pigments of fishes. Van Beneden found osmic acid the best preservative fluid for the Dicyemidæ, and Mr. Whitman's experience leads to the same conclusion.†

Although Dr. Mayer seldom uses this medium where histological details are required, he observes that in those classes of animals whose bodies are easily penetrated with watery fluids, osmic acid is seldom to be dispensed with.

Bleaching.—It often happens that objects treated with osmic acid continue to blacken, after removal from the acid, until they are entirely worthless, and such results are even more annoying than the difficulties in the way of staining. It has been said that the blackening process can be arrested by certain staining media, but it is certain that picro-carmine will not always do this, as some of Mr. Whitman's preparations of Dicyemidæ show. It is therefore a very important step which Dr. Mayer has taken in finding a method of restoring such objects. The method‡ is as follows:—The objects are placed in 70 per cent. or 90 per cent. alcohol, and crystals of potassic chlorate ($KClO_3$) shaken into the liquid until the bottom of the vessel is covered; then a few drops of concentrated hydrochloric§ acid are

* See corrosive sublimate, p. 872.

† One of the best objects for testing methods is found in *Phronima sedentaria*. Here the cells and nuclei are so sharply defined that they can be seen in the living animal, and so the effect of a preservative fluid can be easily studied.

‡ A slightly modified form of the method originally given in Arch. f. Anat. u. Physiol. (Du Bois Reymond and Reichert) 1874, p. 321.

§ Nitric acid may be used instead of HCl.

added with a pipette, and as soon as chlorine (easily recognized by its greenish-yellow colour) begins to be liberated, the whole gently shaken. As soon as the bleaching is finished the objects are removed to pure alcohol. By this method Dr. Mayer has been able in half a day to restore large *Pelagia*, *Carinaria*, *Rhizostoma*, &c. Small objects generally require a shorter time and less acid. The process can be greatly accelerated by heating on a water-bath.

Using *Sapphirina* as a test-object, Dr. Mayer found that the lustre which characterizes the living animal entirely disappeared by the bleaching process. As this lustre, which has its seat in the epidermis, depends on the interference of light, it is evident that the cells had undergone some change, but a change so slight that the tissues could hardly be said to have been injured for histological purposes; besides, the removal of the osmic acid leaves the animal in a good condition for staining.

Dr. Mayer's experience with *Sapphirina* appears to support him in the following conclusions in regard to the nature of the action of osmic acid, viz. that the hardening effect of the acid is due to the formation of inorganic precipitates within the tissues. This is made evident by the fact that the animal becomes soft and flexible as soon as these precipitates are removed by bleaching.

This method of bleaching has been used by Dr. Mayer for removing natural pigment. Alcoholic preparations of the eye of *Mysis*, for instance, can be fully bleached *in toto*, but with better success by operating with single sections. To avoid swelling, which is apt to arise by the use of aqueous fluids, staining media of an alcoholic nature should be used.

7. *Chromic Acid.*—Chromic solutions have, in common with osmic acid, the peculiarity of hardening by virtue of the chemical combinations which they form with cell-substances, and all the consequent disadvantages with respect to staining. The use of chromic acid in the Zoological Station of Naples may be said to have been largely superseded by picro-sulphuric acid, corrosive sublimate, and Merkel's fluid, for it is now seldom used except in combination with other fluids.* It is sometimes mixed with Kleinenberg's fluid, for example, when a higher degree of hardening is required than can be obtained by the use of the latter fluid alone. It is a common error to use too strong solutions of chromic acid, and to allow them to act too long. Good results are in some cases obtained when the objects are treated with a weak solution ($\frac{1}{3}$–$\frac{1}{2}$ per cent.) and removed soon after they are completely dead.

8. *Merkel's Fluid.*—

Platinum chloride dissolved in water	..	..	..	1:400
Chromic acid „	„	..	..	1:400

* Dr. W. Pfitzner (Morphol. Jahrb., vii. (1882) p. 731) has recently made use of chromic acid followed by (1) osmic acid, or by (2) chloride of gold, formic acid and safranin (or hæmatoxylin) for the demonstration of nerve-terminations.

Flemming believes that chromic acid is one of the most reliable fixing reagents for the karyokinetic figures, and has proved that objects hardened in this acid can be beautifully and durably stained, *ante*, p. 715.

Professor Merkel,* who employed a mixture of these two solutions in equal parts for the retina, states that he allowed from three to four days for the action of the fluid. Dr. Eisig has used this fluid with great success in preparing the delicate lateral organs of the Capitellidæ for sections, and recommends it strongly for other annelids. Dr. Eisig allows objects to remain 3–5 hours in the fluid, then transfers to 70 per cent. alcohol. With small leeches Mr. Whitman has found one hour quite sufficient, and transfer to 50 per cent. alcohol.

9. *Corrosive Sublimate.*—Prompted by a statement found in an old paper by E. Blanchard,† Dr. Lang began experimenting with corrosive sublimate as a medium for killing marine Planarians, and his marked success led him and others to employ the same with other animals. In most cases Dr. Lang now uses a saturated solution of corrosive sublimate in water. A saturated solution in picro-sulphuric acid, which in some cases gives better results if a little acetic acid (5 per cent. or less) is added, is also used.‡ Blanchard's mode of treatment was to mix a quantity of the aqueous solution with the sea-water, and thus poison the animals. Dr. Lang, on the contrary, removes the sea-water so far as possible before applying the solution. With Planarians he proceeds in the following manner :—

The animal is laid on its back and the water removed with a pipette, the solution being then poured over it, it dies quickly and remains fully extended. After half an hour it is washed by placing it in water and changing the water several times during thirty minutes. It is next passed through 50 per cent., 70 per cent., 90 per cent., and 100 per cent. alcohol. In two days it is fully hardened, and should then be stained and imbedded in paraffin as early as possible, as it is liable to become brittle if left long in alcohol. The time required by the corrosive sublimate varies with different objects, according to size and the character of the tissues. As a general rule, it may be said that objects should be removed from the fluid as soon as they have become thoroughly saturated by it. In order to kill more quickly than can sometimes be done at the ordinary temperature, the solution is heated, and in very difficult cases may be used boiling.

Corrosive sublimate has been used with success by Dr. Lang and others in the following cases :—Hydroids, Corals, Nemertines, Gephyreans, *Balanoglossus*, Echinoderms, *Sagitta*, Annelids, Rhabdocœla, Dendrocœla, Cestodes, Trematodes, embryos and adult tissues of Vertebrates and, according to Mayer and Giesbrecht, Crustacea with thin chitinous envelopes, e. g. *Sapphirina*, Copepods and larvæ of Decapods. With the Arthropoda good results have not been obtained.

* 'Ueber die Macula lutea des Menschen,' &c., Leipzig, 1870, p. 19.

† Ann. Sci. Nat. Zool., viii. (1874) p. 247.

‡ These solutions are given in Zoolog. Anzeiger, ii. (1879) p. 46. The original solution (Zoolog. Anzeiger, i. (1878) pp. 14–15, this Journal, i. (1878) p. 256) now little used, stood thus :—Distilled water, 100 parts; common salt, 6–10 parts; acetic acid, 5–8 parts; corrosive sublimate, 3–12 parts; alum (in some cases) ½ part.

The two great advantages of Dr. Lang's method are (1) that animals so treated are easily stained, and (2) they are killed so quickly that they are left, in most cases, in a fully extended condition. Hot corrosive sublimate kills leeches so instantaneously that they often remain in the attitude assumed the moment before the fluid is poured over them. The colour, however, is not so well preserved as when killed with alcohol, or even with weak chromic acid.

It should be remembered that objects lying in a solution of corrosive sublimate must not be touched with iron or steel instruments; wood, glass, or platinum may be used.

II. Staining.—It has gradually become a settled custom in the Zoological Station to mount microscopical preparations in balsam wherever this can be successfully done; and to avoid, as much as possible, the use of aqueous media, both in mounting and staining. The disadvantages often arising from the use of these media in staining alcoholic preparations include the tearing asunder of fragile tissues caused by the violent osmosis set up on transferring an object from alcohol to an aqueous solution; swelling, the effects of which cannot always be fully obliterated by again transferring to alcohol; and maceration, which is liable to result where objects are left for a considerable time in the staining liquid (as Beale's carmine). These may all be avoided by using alcoholic solutions. Objects once successfully hardened may be left in such solutions for any required time, and when sufficiently stained, be washed in alcohol of a corresponding strength, and then passed through the higher grades without being exposed to water from first to last. As a rule, alcoholic dyes work quickly, and give far more satisfactory results than can be obtained with other media. They penetrate objects more readily, and thus give a more uniform colouring where objects are immersed *in toto*. Even chitinous envelopes are seldom able to prevent the action of these fluids.

It is not, however, to be denied that non-alcoholic dyes may often do excellent work, and, in certain cases, even better than can be otherwise obtained. In the case of the Turbellaria, Dr. Lang has found picro-carmine to be one of the best staining agents, and this has been Mr. Whitman's experience with Dicyemidæ. As Dr. Mayer has remarked, the swelling caused by aqueous staining fluids is not always an evil, but precisely what is required by some objects after particular methods of treatment.

From experiments recently made, Dr. Mayer has found that dyes containing a high percentage of alcohol, stain more diffusely than those of weaker grades, from which he infers that strong alcohol robs, to a certain extent, the tissues of their selective power, and renders them more or less equally receptive of colouring matter.

1. *Kleinenberg's Hæmatoxylin.**—1. To a saturated solution of chloride of calcium† in 70 per cent. alcohol, add a little alum and filter.

* May be used after all hardening fluids.

† Chloride of calcium, according to Kleinenberg, has no other use than to strengthen the osmotic action between the hæmatoxylin solution and the alcohol contained in the tissues. As chloride of calcium and alum give a precipitate of gypsum, it would probably be better to use chloride of aluminium.

2. One volume of No. 1 mixed with 6 to 8 volumes of 70 per cent. alcohol.

3. At time of using pour into No. 2 as many drops of a concentrated solution of crystallized hæmatoxylin in absolute alcohol as suffice to give the required depth of colour. A good solution should be violet inclining a little to blue. The red tinge that arises after the fluid has stood for some time, indicates that it has become slightly acid, in which condition it is unfit for use. To restore its proper colour, it is only necessary to open a bottle of ammonia over the mouth of the bottle holding the hæmatoxylin in such a manner that a very small quantity of the gas will mix with the fluid. If too much ammonia gas be added, a precipitate is produced which spoils the fluid.

If the colour appears too strong, the fluid may be diluted with solution No. 1.

Before immersing objects in this fluid, great care should be taken to free them from the least trace of acid by frequently changing the alcohol. If this is not done thoroughly, the acid left in the preparation will sooner or later cause the colour to fade; and such results have led to the erroneous conclusion that hæmatoxylin will not give durable preparations. Dr. Mayer has found that the fading is entirely due to the presence of acid, and that with proper precautions the staining is permanent.

Small objects are best stained in a weak solution, which colours more slowly but with greater clearness than stronger solutions. After staining, Kleinenberg transfers objects to 90 per cent. alcohol. In case of over-staining, the colour may be partly removed by adding a little *oxalic acid* or *hydrochloric acid* ($\frac{1}{2}$ per cent. or less) to the alcohol containing the objects. The acidulated alcohol is allowed to work until the colour is slightly reddened. On transferring to pure alcohol the colour passes again into a permanent blue-violet.

2. *Mayer's Cochineal Tincture.*—This medium is very similar in most respects to hæmatoxylin, and is made by soaking 1 gramme powdered cochineal in 8–10 ccm. 70 per cent. alcohol for several days, and then filtering.

The clear deep red fluid thus prepared may, like hæmatoxylin, be used in all cases where it is desirable to stain with an alcoholic solution, and will be found particularly useful for objects that, by reason of the thickness of the walls or other peculiarities, are not easily penetrated by the ordinary aqueous solutions of carmine. It is particularly suited for the Arthropoda, whose chitine only allows the dye to penetrate with difficulty.

It is necessary, before immersing larger objects in this fluid, to leave them a short time in 70 per cent. alcohol, otherwise there may be a precipitate. The time required for staining will vary from a few minutes to even days, according to the nature and size of the object. For small objects, such as very thin sections, minute worms, Protozoa, the lower Arthropoda, &c., an immersion of a quarter of an hour, sometimes even less, is usually sufficient. With larger objects requiring considerable time, it is important to use a large quantity of the fluid, otherwise the amount of colouring stuff in solution might

not suffice to give the proper depth of colour. Small and delicate objects, on the other hand, may be most successfully treated with a solution which has been diluted with 70 per cent. alcohol, or one which has been weakened by previous use. It is always necessary to free the tissues, after staining, from the surplus dye; and this may be done by washing in 70 per cent. alcohol, which must be changed until it shows no colour. This process requires, for larger objects, considerable time and alcohol, but may be hastened by using the alcohol slightly warm.

The colour ultimately assumed by objects treated with cochineal tincture varies much, and depends partly on the reaction of the tissues themselves, partly on the presence or absence of certain salts. It is certainly one of the best recommendations of this staining agent that varying with the nature of the object and its mode of treatment both before and after staining, it gives such an extraordinary diversity of results. On account of the great variety of substances contained in the dried dye-stuff, it is evident that the composition of the tincture must vary according to the strength of the alcohol employed as a solvent. Solutions in 90 per cent. or 100 per cent. alcohol have a light red colour, and stain too diffusely to have any practical value. The weaker the alcohol the stronger the tincture, and the stronger the alcohol the more easily it penetrates objects; the grade of alcohol may therefore be selected with reference to two points, depth of colour and readiness of penetration; 70 per cent. or 60 per cent. is recommended by Dr. Mayer as combining both these qualities in a very favourable degree. It is important to remember that whatever be the strength of the solution, a precipitate will always be produced if an alcohol of a different grade, whether higher or lower, be mixed with it. It is evident, then, that a tincture of any given strength contains substances that are insoluble in any other grade of alcohol, and this explains why superfluous colouring matter can only be removed from objects by the aid of alcohol of precisely the same degree as that of the tincture.

Over-staining, which seldom occurs, may be easily corrected by the aid of acid alcohol ($\frac{1}{10}$ per cent. hydrochloric acid, or 1 per cent. acetic acid). Acid makes the tincture lighter, more yellowish-red, while the addition of ammonia and other caustic alkalies changes it to deep purple. Still more important is the fact that salts soluble in alcohol give a blue-grey, green-grey, or blue-black precipitate. For example, if a piece of cloth that has been dyed in cochineal and washed be treated with an alcoholic solution of a ferric or a calcic salt, it will assume a more or less deep blue colour.

As the salts present in the living organism are seldom, if ever, fully removed by preservative fluids, but in some cases even increased, it will often happen that an object, though put in the red fluid, comes out blue, precisely as when stained with hæmatoxylin. Such a result cannot, however, be obtained where the tissue is in the presence of acids, or free from inorganic salts; under these conditions the colour is always red. It is not possible, therefore, to know what colour an object will ultimately present.

Usually, all Crustacea with thick chitinous parts are stained red, and most other animals blue; so that, for instance, the Vorticellidæ, which are parasitic on the Amphipoda, can be at once recognized as foreign bodies. Very often the different tissues of one and the same object present unlike colours. In the embryos of *Lumbricus*, Kleinenberg found the walls of the blood-vessels red, their contents dark-blue. Glandular tissues, or their contents, are frequently stained grey-green, and on this account are easily recognizable.

Objects when previously treated with chromic or picric solutions, or with alcohol, usually stain without difficulty; but osmic acid preparations should be bleached before staining. Cochineal does not colour so intensely as hæmatoxylin, and hence the latter often gives more satisfactory results in the case of large objects stained *in toto*.

As before pointed out, alcohol causes the salts contained in sea-water to be precipitated, thus forming a crust on the exterior of the animal, which interferes with the staining process. It is therefore necessary to treat marine animals that have been preserved in strong alcohol, with acid alcohol (1–10 parts hydrochloric acid to 1000 parts 70 per cent. alcohol), and then carefully wash in pure 70 per cent. alcohol before staining with cochineal.

3. *Carmine and Picrocarmine.*—Aqueous solutions of staining media are generally only used when alcoholic cannot be employed. The interpretation of the results obtained by carmine staining is not always satisfactory. For instance, in his work on the nervous system of *Aquilla*, Bellona describes the peculiar crescent-like structures in the ganglion cells. Dr. Mayer is of opinion that these are entirely artificial productions, and owe their origin to the carmine (Beale's) solution in which they were stained, for with careful preparation they do not appear. Picrocarmine is more certain in its results, and in some cases will give better specimens than can be obtained by any other medium. In commerce it often contains too much picric acid, and it is better to prepare it oneself in the following manner:—

To a mixture of powdered carmine (2 g.) with water (25 ccm.), while heating over a water-bath, add sufficient ammonia to dissolve the carmine. The solution may then be left open for a few weeks (Mayer) in order that the ammonia may evaporate; or the evaporation may be accelerated by heating (Hoyer). So long as any ammonia remains, large bubbles will form while boiling, but as soon as the free ammonia has been expelled, the bubbles will be small and the colour of the fluid begin to be a little lighter. It is then allowed to cool, and filtered. To the filtered solution is added a concentrated aqueous solution of picric acid (about four volumes of the acid to one of the carmine solution). The addition of the acid should cease before a precipitate begins to form.

In order to protect this fluid against changes attributed to bacteria by Hoyer,* Dr. Mayer places a small crystal of thymol in the con-

* Hoyer, "Beitr. z. histolog. Technik.," Biol. Centralbl., ii. (1882) pp. 17–19.

taining bottle; Hoyer uses choral-hydrate (1 per cent. or more) for the same purpose.*

4. *Acetic Acid Carmine.*†—Pulverized carmine added to a small quantity of boiling acetic acid (45 per cent.) until no more will dissolve; filtered and diluted to about 1 per cent. for use.

Flemming used the concentrated solution.

5. *Grenacher's Carmine Solutions.*‡ — (i.) *Alum Carmine.* — An aqueous solution of alum (1–5 per cent., or any degree of concentration) boiled with ½–1 per cent. powdered carmine for 10-20 minutes; allowed to cool, then filtered.

With the addition of a little carbolic acid the fluid will keep for years. It colours quickly, and nuclei more strongly than other parts. Objects washed in water after staining.

(ii.) *Acid Borax Carmine.*—*a.* An aqueous solution of borax (1–2 per cent.) and carmine (½–¾ per cent.) heated till the carmine is dissolved.

b. Acetic acid added by drops to solution *a*, while shaking, until the colour is about the same as that of Beale's carmine.

c. Solution *b* left standing twenty-four hours, then turned off and filtered.

This solution, which is a modification of Schweigger-Seidel's acid carmine, is not recommended for colouring *in toto*. It colours sections in ½–3 minutes diffusely, and hence, after washing in water, they are placed for a few minutes in alcohol (50 or 70 per cent.) to which a drop of hydrochloric acid has been added; then transferred to pure alcohol.

(iii.) *Borax Carmine.*§—*a.* An aqueous solution of borax (4 per cent.) and carmine, heated till the carmine is dissolved.

b. Solution *a* mixed with 70 per cent. alcohol in equal parts, left standing twenty-four hours and filtered.

This fluid may be used for colouring objects *in toto*. After staining, the objects are to be washed in 35 per cent. alcohol, to which a little hydrochloric acid has been added (4–6 drops to 100 ccm.), and allowed to remain here until the colour has been sufficiently removed. They are next passed through successively higher grades of alcohol for hardening.

(iv.) *Alcohol Carmine.*—A teaspoonful of carmine dissolved, by heating about ten minutes, in 50 ccm. of 60–80 per cent. alcohol, to which 3–4 drops of hydrochloric acid have been added, then filtered.

* Dr. Lang's picro-carmine and eosin method for Planarians, see this Journal, ii. (1879) p. 163, is also referred to. Dr. Mayer does not expect any particular advantage from its application to Arthropods.

† Schneider, Zool. Anzeig., 1880, p. 254.

‡ Grenacher, "Einige Notizen z. Tinctionstechnik," Arch. f. Mikr. Anat., xvi. (1879) p. 463. None of these solutions should be used where calcareous parts are to be preserved.

§ Dr. Mayer prepares, for some purposes, borax carmine of 50, 60, or 70 per cent. That of 70 per cent. contains little carmine, but is well adapted to staining delicate objects that would suffer if exposed to weaker solutions. Boiling alcohol (50 per cent. or 60 per cent.) dissolves about 1 per cent carmine and 1 per cent. borax.

Objects coloured in this fluid should not be washed in water, but in alcohol of a grade corresponding to that of the solution.

For diluting alcoholic solutions of carmine, alcohol of the same strength must always be used.

6. *Aniline Dyes.*—As a rule, aniline colours and the many others obtained recently from tar by chemical processes, cannot be used for staining objects *in toto*, and are therefore not much employed in the Zoological Station. In very small objects and sections already cut, very excellent results can be obtained by the methods developed by Böttcher,* Hermann,† Flemming‡ and others; for here diffuse staining may generally be avoided by first over-staining and then withdrawing the colour to any desired extent by means of alcohol. But to obtain satisfactory results, the sections must be thin enough to allow uniformity of action both to the colouring and the decolouring agent. It is evident that the process cannot be similarly controlled in larger objects, particularly where a dye is used, which, like most of those under consideration, is quickly extracted by alcohol, for in this case the colour would be removed from the superficial layers more rapidly than from the deeper ones, so that a uniform precision of colour would be impossible. In this respect,

a. Bismarck-brown forms an exception. The preparation of this dye, introduced by Weigert,§ is extremely simple:—

A saturated solution is made by dissolving the powder in boiling water or weak alcohol, or, according to Mayer, in 70 per cent. alcohol.‖ The solution should be used undiluted, and requires to be filtered from time to time. It colours very quickly objects hardened in alcohol or chromic acid.

b. Safranin.—1 part safranin dissolved in 100 parts of absolute alcohol; after a few days 200 parts of distilled water is added.

Dr. Pfitzner,¶ from whom the above formula is taken, recommends this solution as one of the best for staining nuclei. It is cheap, easily prepared, acts quickly, and stains only the nuclei. It works best with chromic acid preparations, from which the acid has been removed as much as possible.

Unless therefore it is desired to differentiate membranes or display the various stages of ossification this group may be dispensed with.

III. Injecting.—Professor Emery, who has lately studied the methods of injection, recommends the following:—

a. For injection of *thick carmine* he follows the prescription of Ranvier, in his 'Traité d'histologie technique,' but neutralizes the mass in a more simple way. Acetic acid is added by drops until the

* Böttcher, Mull. Archiv, 1869, p. 373. Virchow's Archiv, xl. p. 302.

† Hermann. Communicated to the Naturforscherversammlung in Graz, 1875. Tagblatt, p. 105.

‡ Flemming, Arch. f. Mikr. Anat., xiii. p. 702; xvi. p. 302; xviii. p. 151; xix. pp. 317, 742; xx. p. 1.

§ Arch. f. Mikr. Anat., xv. (1878) p. 258.

‖ According to Flemming, it may also be dissolved in dilute acetic acid.

¶ Morph. Jahrb., vi. pp. 478–80, and vii. p. 291.

smell of the ammonia becomes very faint. The reaction of the vapour is then tried with litmus paper. Sufficient acid has been added when the litmus paper begins to get red. Often, on stirring, the alkaline reaction will return, but this must be removed with another drop of acetic acid. In use it will be found that with a neutral or slightly acid mass, a diffusion of the medium through the cell-walls is scarcely likely to occur.

b. As a cold fluid mass, Emery recommends a 10 per cent. carmine solution prepared with ammonia, to which, while continually stirring, acetic acid is added until the carmine begins to be precipitated, and the liquid has a blood-red colour. The clear liquid only must be used, and after injection, the objects must be at once placed in strong alcohol, to fix the carmine.

c. For injecting the capillaries, good results are often obtained by gradually mixing 10 per cent. carmine solution with acetic acid, until part of the carmine is precipitated. The solution must be shaken shortly before use, only allowing it to settle for a few minutes, so that the coarser grains do not get into the syringe. In injections from the arteries a considerable quantity of fine sediment remains in the capillaries, while only a light fluid enters the veins. Thus the veins can easily be distinguished from the arteries, which are dyed dark red.

IV. Mounting.—The great object aimed at, in preparing permanent preparations for the Microscope, is to entirely get rid of the water in the tissues of the object, and supplant it by a preservative medium. Hence, at Naples the aqueous mounting media such as glycerine, glycerine jelly, acetate of potash, &c., are in little favour. After the water has been forced from the object and supplanted by alcohol, the process is usually completed by passing through oil of cloves, and mounting in balsam. Usually there is little trouble with this method. The oil of cloves, or other similar oil, is slightly heated, and as a rule it will penetrate the tissues without trouble. With larger objects, however, and particularly those with thin but not easily permeable walls, the alcohol will often leave before the oil can enter, and there will be a collapse of the walls. *Creosote* has been used to prevent this shrinking, but it appears to render no permanent good. Dr. Mayer meets the difficulty in the larger objects by making an insertion with a fine pair of scissors in an unimportant part of the body-cavity, so as to allow the oil to enter at once. This answers very well, and can be used with very small objects, such as *Auricularia* and other larvæ, if a fine flattened needle be used. If this should fail, and especially when the number of objects to be transferred to balsam is large, the alcohol may be supplanted gradually. Dr. Mayer has thus prepared very young larvæ of Echinoderms. The specimens were taken up in a capillary tube, with the surrounding alcohol, and then placed in a tube, with a drop of oil of cloves at the bottom. After the lapse of half-a-day the larvæ, which at first swam on the top of the oil, had gone to the bottom of it, and could be easily removed again by the same tube. Objects may be left in oil of cloves for months without any apparent detriment.

Recently Kleinenberg has recommended the use of *colophonium* instead of Canada balsam. The solution in absolute alcohol is not suitable, as under certain circumstances the finished preparations will show large bundles of. crystals. Turpentine should be used as a solvent; this, however, has the disadvantage that the preparations dry very slowly. The solution in chloroform seems to answer well, but must be filtered before use. Further experience is required with this medium before its use can be strongly recommended.

A solution of *sandarac* in absolute alcohol, which at first appeared to answer well, has not, on further trial, proved satisfactory.

V. Dissecting.—For the dissection of single organs, fresh animals are generally placed in dilute alcohol, or a weak chromic solution. But the tissues are liable to suffer from maceration in these fluids, and hence, where it is important that the tissues should be well preserved, it is advisable to use picro-sulphuric acid, regardless of the injurious effects of the same on the dissecting instruments. The fluid should be changed as soon as it gets thick and the preparation well washed in alcohol afterwards. The hardening capacity of the picro-sulphuric acid is extremely slight, but may be strengthened by the addition of chromic acid. Preparations thus obtained, and subsequently treated with alcohol, staining fluids, &c., should be transferred to creosote for further dissection, as the transparency induced by this medium will greatly facilitate the work.*

VI. Imbedding.—For section-cutting, objects are usually imbedded in paraffin. By low temperature, as in winter, it is necessary to work with a softer paraffin than is required for summer. Instead of softening by an admixture of lard, as generally done, it is better to use a paraffin which becomes soft in summer, on account of its containing liquid hydrocarbons, and is preferable to lard as it is not liable to become rancid.

Preparatory to imbedding, the objects are removed from absolute alcohol† to creosote, clove oil, or chloroform, and left until they become thoroughly saturated. The penetration of the clarifying fluid may, in some cases, be advantageously hastened by warming a little. They are next placed in soft paraffin, heated to about 50° C. over a water bath, and allowed to remain for an hour or so. The soft paraffin is then turned off and replaced by a mixture of hard and soft paraffin,‡ heated to about 50° C. After remaining for half-an-hour or less in the harder paraffin, kept at a steady temperature, they are ready for imbedding. For this purpose a small paper box may be used; or, much better, a box made of two pieces of type-metal, as used in Professor Leuckart's laboratory. As will be seen from Fig. 162, each

* In the original paper Dr. Mayer speaks not of creosote, but of oil of cloves. The brittleness which is caused by it is in most cases advantageous, but can easily be reduced by the addition of creosote. The tendency to collect in small drops which is peculiar to oil of cloves may be counteracted by the addition of oil of bergamot.

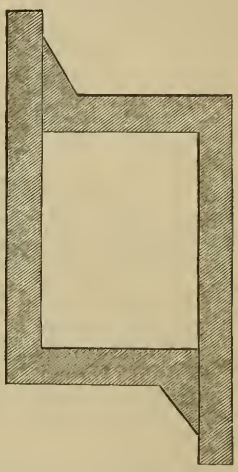
† In many cases a lower grade of alcohol will suffice.

‡ The ratio of combination must be determined by experiment, since it will depend on the quality of the paraffin and the temperature; two parts of hard to one of soft work very well for the winter temperature of Naples.

piece of metal has the form of a carpenter's square, with the end of the shorter arm triangularly enlarged outward. A convenient size will be found in pieces measuring 7 cm. (long arm) by 3 cm. (short arm), and 7 mm. high. With such pieces a box may be constructed at any moment by simply placing them together on a round plate of glass, which has previously been wet with glycerine and gently warmed. The area of the box will evidently vary according to the position given to the pieces, but the height can be varied only by using different sets of pieces. In such a box the paraffin may be kept in a liquid state by warming now and then over a spirit-lamp, and small objects be placed in any desired position under the Microscope.

It is well to imbed in a thin layer of paraffin, so that the object, after cooling, may be cut out in small cubical blocks, which may be easily fixed, for cutting, to a larger block of hard paraffin.

Fig. 162.



Only in the case of very delicate objects is imbedding in wax and oil after Brücke's plan to be preferred. White of egg has not proved as permanent as might be desired. Gelatine is a convenient imbedding medium, and Dr. Mayer has devised a process by which it is deprived of its elasticity. It is allowed to soak as usual in water, then heated and $\frac{1}{4}$ to $\frac{1}{2}$ a volume of castor oil added, shaken well, and shortly before getting cold pour the mixture into a bowl. When afterwards all the castor oil has been extracted by 90 per cent. alcohol the gelatine remains as a fine porous matter, a sort of artificial pith, and is at once ready for use. It must not of course be exposed too long to the air as this would soften it. Under the Microscope this form of gelatine is less troublesome than lilac pith and has the advantage that it can be produced in any size and always even.

VII. Cutting.—Objects are cut dry with a microtome, and the rolling of the sections may be prevented by holding a thin narrow spatula over the edge of the knife while cutting. The spatula may be made of brass, or of paper fastened to a flattened needle. The spatula should be bent slightly, and the convex face held over the paraffin without pressure. A small brush, slightly flattened, is used for the same purpose in Leipzig.

Andres' Methods of treating Actiniæ.* — Among the various methods employed by Dr. Andres in killing the Actiniæ, the three following, given in the order of their excellence, are said to have worked most satisfactorily:—

A. *Corrosive sublimate.*—With small animals a hot solution, used in the manner recommended by Dr. Lang, gives good results; with

* Atti R. Accad. Lincei, v. (1880) p. 9.

larger animals, where this mode of treatment fails, the fluid must be injected. The cannula of a glass syringe, filled with the hot fluid, is inserted into the mouth at the moment it opens, which act habitually follows on gently touching the lip. After injecting, the hot solution is poured into the glass containing the animal and a small quantity of sea water.

If the operation is cleverly performed, the animal remains fully expanded, as the mechanical pressure of the injected fluid prevents contraction.

After from five to fifteen minutes the animal is washed in distilled water, and allowed to remain twelve hours in 50 per cent. alcohol,* then passed through the higher grades of alcohol. Borax-carmine and hæmatoxylin used for staining.

B. *Glycerine and Alcohol.*†—

Glycerine	20 parts.
Alcohol (70 per cent.)	40 „
Sea water	40 „

This mixture, poured very slowly into the containing glass, often gives very good results, both for anatomical and histological purposes.

C. *Nicotine and Tobacco Smoke.—a.* A solution of nicotine (1 g.) in sea water (1 l.), conducted into the vessel containing the animal fully expanded in a half litre of sea water, by means of a thread sufficiently large to empty the flask holding the nicotine solution in the course of twelve hours.

b. The vessel containing the animal in an extended condition, covered by a bell-jar in which tobacco smoke is confined, until the animal becomes completely benumbed.

After being deprived of sensibility by either of these methods, the creature may be killed in corrosive sublimate, or in picro-sulphuric acid.

D. Dr. Andres finds that in the use of chloroform, dropped slowly into the water, or administered in form of vapour, maceration usually sets in before the power of contracting is lost. Good preparations of the internal parts may be obtained by injecting a weak solution of osmic acid. The method of freezing has also been employed with some success. For this purpose three vessels are placed one within the other, the central one containing the *Actinia*, the middle one ice and salt, and the outer one cotton.

The ice containing the congealed animal is dissolved in alcohol or an acid.

E. *Maceration.*—It is often important to see the cells of a tissue *in situ* before freeing them with needles. In such cases Dr. Andres proceeds as follows:—

1. Killed with corrosive sublimate.
2. Left in 25 per cent. alcohol twenty-four hours.

* A little camphor (1–100 ccm.) added to the alcohol will facilitate the removal of the sublimate.

† This method originated with S. Lobianco.

3. Soaked for a short time in a very thin solution of gum arabic then in a somewhat thicker solution, and finally imbedded in a very thick solution.
4. Hardened in 90 per cent. alcohol.
5. Thick sections prepared for dissection with needles. The sections are placed on a slide in water, which dissolves the gum.

Flemming's further Method for Staining Nuclei.* — In his recent researches on karyokinesis, W. Flemming states that he obtained serviceable staining of nuclei in the following ways:—

1. Living eggs of Echinoderms coloured on the slide, either with safranin or aniline dyes, followed by acetic acid (1 per cent.) which is allowed to flow under the cover and thus replace the staining medium, or with acetic acid carmine (after Schneider), used undiluted. The last mentioned staining agent causes swelling, but still gives the typical features of the karyokinetic figures.

2. Eggs first hardened in strong nitric acid (40–50 to aq. dest. 60–50), then washed in distilled water until the yellowish colour, due to the presence of the acid, disappears. Coloured with acetic acid carmine.

Iodine-green and Methyl-green.†—Dr. M. Flesch calls further attention to the suitability of the combination of the green with red staining matters. He has excellent preparations of cartilage, skin, and glands hardened in Müller's fluid and alcohol, and stained with methyl-green, and afterwards with picrocarmine. If the colour is not so beautiful as in the case of objects stained with carmine and hæmatoxylin, it is nevertheless very useful, as it is, he believes, easy to preserve, and moreover it gives very sharp differentiations.

Dr. Flesch uses an aqueous solution of commercial methyl-green diluted until the section in a watch-glass is still recognizable on a bright ground.

Preparation of Epidermis.‡—W. Pfitzner prepares the epidermis of tadpoles by first hardening in chromic acid, and making fine sections with the Thoma microtome of a piece as free as possible from pigment, imbedded in elder pith; the best thickness for the sections is ·01 to ·015 mm. The sections are washed for at least thirty minutes in distilled water to remove the chromic acid.

Pfitzner has three methods of mounting, either of which may be employed, with various modifications:—

1. Staining. *a*. With saffranin, mount in dammar. *b*. With hæmatoxylin, mount in dammar; or, *c*. As *b*, but mount in glycerine.

2. Gold treatment:—Treatment with 1 per cent. solution of gold chloride, with a trace of hydrochloric acid, for 15 to 30 minutes, in the dark; the sections are then carefully washed and exposed to daylight for 12 to 24 hours in a 5 per cent. solution of formic acid,

* Arch. f. Mikr. Anat., xx. (1881) p. 1. Cf. Amer. Naturl., xvi. (1882) p. 780. See also Flemming's earlier method, *ante*, p. 715.

† Zool. Anzeig., v. (1882) pp. 551–5.

‡ Morpholog. Jahrb., vii. (1882) pp. 731–2. See also *ante*, p. 871.

and then carefully washed again and mounted (*a*) simply in glycerine, or (*b*) in dammar, after staining with saffranin.

The delicacy of the sections necessitates the employment of good daylight, and illumination from below in their manipulation; the latter end may be attained by employing as working stage a cigar box, from which the front side has been removed, putting a piece of glass on the top, and an oblique mirror inside. Great care must be taken not to allow contact between the sections when made, as they would then probably become entangled.

Unpressed Mounting.*—Under this heading Mr. A. W. Stokes describes the mounting of the tongue of a blow-fly "without pressure," so that its true shape is preserved, a halfpenny test-tube being all the preparing apparatus required.

Into this test-tube place the fly's head, and fill the tube half-full with a solution of soda and potash. Stand the tube in boiling water, and leave it on the hob of a fire to keep hot till morning. Then examine the head and see if it looks almost transparent; if not, pour off the soda solution and add a fresh supply, and again keep the tube hot till the object becomes semi-transparent. Now pour off the solution and add hot water, in a few minutes emptying it out and adding some more:—Repeat this at least three times, and finally leave the last quantity of water on the object for an hour to cool. Next pour off all the water and replace it with spirit of wine; methylated spirit, if strong, will do sufficiently well. Heat this by immersing the tube in a vessel of hot water for one minute; then take it out, cork it up, and leave it for one hour.

So far we have, by means of the soda-solution, destroyed all the flesh and fat tissues, leaving only the cuticle and internal organs, such as the tracheæ, &c. In doing this, we have filled up most of the few natural air-spaces with soda-solution, which, however, being a somewhat dense fluid, would not enter many of the narrow tracheal tubes. Then with water we replaced the soda-solution, and washed away the parts destroyed thereby. On replacing the water by alcohol, a still less dense fluid, more of the finer air-spaces are penetrated and the air driven out; there are still, however, some tubes too minute even for alcohol rapidly to enter. So now we pour off the spirit, and add ether instead, which answers a double purpose; it enters the very minutest passages, displacing the contained air, and it also dissolves the globules of fat left unsaponified by the soda-solution. After leaving the ether for fifteen minutes in the corked tube, and shaking it once or twice, we pour it off and add turpentine; and then in ten minutes time the head is ready for mounting in Canada balsam or dammar.

If so mounted, however, it will be very difficult to see much of the finer internal structure, since these media render some parts far too transparent; and hence some of the glycerine media are preferable. In such cases, after pouring off the ether, add alcohol, and at the end of fifteen minutes replace the alcohol with cold water, and

* Journ. Post. Micr. Soc., i. (1882) pp. 129–35.

leave for fifteen minutes more. Then the water may be poured off, and the mounting-fluid, whether glycerine, carbolic-acid, gelatine, Goadby's or Thwaites' fluid, may be added. The object, if mounted in any of these, will have a far more natural appearance, and show more plainly the finer structures, than if mounted in Canada balsam. The times mentioned above are those it is *necessary* in most cases to wait, but longer intervals would often be preferable. If we are busy the tube and its contents may be left at any stage of the proceedings for days, with a certainty that the object will only benefit by the delay, *except* in the case of the soda-solution. It is not necessary to use distilled water, though it is better to do so; but whatever water is used, it should be just freshly boiled and be used hot. Cold unboiled water contains a large quantity of air, and if used in that state will certainly impart air to the object instead of helping to extract it.

The soda or potash solution is made by adding solid potash or soda to eight times its weight of boiling water, and the only expense of the process is for the tube, soda, alcohol, and ether—a pint of each of the latter will prepare some thousands of specimens.

The same system will answer for sections of wood, small seed-vessels, leaves, &c., only they must first be decoloured by pouring sodic hypochlorite into the tube, then, after well washing with water, the rest of the process may be followed as before, leaving out entirely the use of the soda-solution. The great difference is in the matter of speed, vegetable preparations being made far more rapidly. It is possible to cut a dozen sections from a living branch, bleach, stain, and mount them in Canada balsam or glycerine-solution, and finally, ring and label them, all within the hour.

Should any of the preparations—the blow-fly's head, for instance —become too colourless and transparent, all we have to do is to stain them by the addition of a few drops of an alcoholic solution of some colouring matter (logwood answers well) to the alcohol in the tube. The subsequent use of ether will fix the colour.

Usually, after this treatment, the object will be found to be quite clean; but if not, it should be gently brushed with a camel-hair pencil while in the turpentine or glycerine fluid. The wings of many insects are partially destroyed during the process, but since these can, if desired, be easily mounted separately, this is not of very great importance.

Directions are also given for mounting the object as above prepared in cells, the use of vulcanite rings being recommended.

Staining with Magdala-red.*—Dr. C. Nörner refers to the fact that picrocarmine (Ranvier's) affects different classes of animals very differently. Tape-worms, for example, redden very quickly, while other worms, like the Nematodes, take very gradually a yellowish tinge, because in their case the picric acid takes effect first and the carmine only after a longer time. Mites are also affected variously—some become yellow, others red, and others perhaps remain colourless. Magdala-red is not open to these objections, and

* Arch. f. Mikr. Anat., xxi. (1882) pp. 354-5.

is an exceedingly useful staining medium, because it answers all requirements in an equally favourable way. It possesses a marked differentiating power, and even surpasses picrocarmine in this excellent quality. It colours all tissues uniformly, whether they are fresh or are taken out of alcohol or chromate of potash. What is most important is that the differentiating power is well manifested in botanical preparations, in which each tissue takes a special tint. Care however must be taken that the sections remain only a few minutes in the solution, because it stains with remarkable intensity. For the examination of sieve-tubes (preserved with so much difficulty) Magdala-red will doubtless be very suitable. The vessels of the plerom are very clearly distinguished from the periblem, &c. The lower fungi also, such as *Mucor*, *Penicillium*, *Aspergillus*, &c., also take a beautiful colour, like histological sections. An exceedingly satisfactory result is likewise obtained with parasites (mites, worms, &c.). A further advantage is that this dye has a great capacity of resistance to potash, and thus, if required, specimens can be first stained and then treated with potash. For double staining it does not seem to be suitable, as it destroys the other colour.

The author adds, "whether it does not possess the same disadvantage as hæmatoxylin and other aniline colours, and disappears from the preparation after a time, and is therefore unstable, I am not yet able to determine."

Preparing Fossil Foraminifera, Spicules, &c.*—In a second paper† Mr. C. Elcock gives directions for preparing fossil Foraminifera. The material from which they may be most easily prepared is chalk powder, many ways of doing which are recommended by text-books, but all unsatisfactory in practice.

The only material worth handling from which to obtain the Foraminifera found in the chalk in a condition almost, if not quite, uninjured, is the powdery matter found in the cavities of the flints which abound in the chalk, but especially in cavities in the large nodules known as "Paramondras"—masses of flint of very irregular ovoid form in which are cavities of various sizes filled with chalk containing Foraminifera, which as a rule are in fine preservation.

On no account should the plan be adopted of shaking up the powder with water in a bottle, which is worse than useless; but if it is dry, the first thing is to sift it through a rather coarse sieve—zinc perforated with holes $\frac{1}{16}$ inch in diameter will do—so as to remove all the fine flakes of flint, which would cut gauze like lancets. If damp or wet, the powder may be *washed through* this zinc sieve under the tap into a sieve (9 inches in diameter and 4 inches deep), with Miller's silk-gauze 180 threads to the inch. Either way will answer well, but after much experimenting Mr. Elcock prefers first to dry perfectly and sift dry. What will not pass through this zinc sieve must be well and carefully washed, and looked over when dry, as it will contain

* Journ. Post. Micr. Soc., i. (1882) pp. 139–45.

† First paper (on recent Foraminifera) loc. cit., pp. 25-9. Cf. this Journal, *ante*, p. 436.

the largest forms, some of which, as *Nodosaria, Dentalina*, &c., may be nearly half-an-inch long.

A large cup-full of the fine sifted powder must now be put into the silk-gauze sieve, and a good stream of clear fresh water be allowed to wash it until all signs of milkiness have disappeared, and the water runs away quite clear, neither fingers nor spoon being used to stir up the material, but letting the stream of water from an indiarubber tube fixed to the water supply do all the work, directing it so as to move the powder well about. When the water runs away clear, wash all into a corner of the sieve, drain, and tip out the chalk powder on to a plate to dry *thoroughly* in the oven. Repeat this process until all is washed; and when dry and cold sift into sizes for examination. The finest siftings will probably be the richest in species. If the chalk-powder is good and the washing properly done, a considerable portion will be found to consist of Foraminifera, Ostracoda, sponge, and other spicules, the remainder being sand, &c.

If sponge spicules or other siliceous organisms only are being sought for, pour dilute hydrochloric acid over the chalk-powder, and let it remain for a day or two to remove all the lime; after which pour off the acid, and wash well with clean water until every trace of the acid is removed; then dry, sift, and examine.

As these Foraminifera are fossil and mostly siliceous they will not "float," but the washed material must after drying be examined under the Microscope and the individual shells picked out with a fine miniature red sable pencil, and for doing which there is no royal road. The best tray for the purpose is one made of black ferrotype plate 4 inches × $1\frac{1}{2}$ inch with the edges on each side and one of the ends neatly turned up about $\frac{1}{16}$ inch, on which a layer of the washed material is spread as thinly as possible, and the tray passed regularly from right to left across the field.

Directions are also given for dealing with fresh dredgings of sea-mud, shore-mud ,&c., and with ship's soundings, where the Foraminifera are mixed with tallow, lard, &c.

Of all ways of mounting Foraminifera none is to be compared with mounting them as opaque; they look best without a cover-glass. Ebonite rings should be selected of such sizes that one will just fit inside the other, the smaller being cemented to the slide and the larger to the cover-glass.

Preparation of Diatoms.*—Prof. J. Brun describes the following process which he employs for destroying the endochrome of diatoms.

If the diatoms are fresh and wet, crystals of permanganate of potash should be added, and 10 parts water for each 1 part of the salt. If the diatoms are dry (pure or mixed) they should be wetted with a little of the concentrated solution of the salt, having even crystals in excess. The reaction of the permanganate should last about 12 hours.

The mixture (placed in a 100 gr. phial) should be stirred occasionally and put in the sun or on a warm stove. The phial should

* Journ. de Microgr., vi. (1882) pp. 457–8.

then be half filled with water and 0·50 cgr. of calcined magnesia added and left to act for 2 or 3 hours, shaking it now and then. Pure hydrochloric acid is then added in 1 gramme doses every 10 minutes, and when the contents of the phial are colourless the operation is completed. To facilitate the reaction the phial may be plunged in warm or boiling water. The absolute purity of the distilled water to be used for the subsequent washings is an essential condition of success.

In this process we have first the energetic oxidization of the endochrome by the permanganate, then, by means of the acid, there is a disengagement of oxygen (or combustion), and finally the disengagement of chlorine which bleaches. It is to these successive reactions inside and outside the valves, to which must be attributed the perfect cleansing of their silex. By this treatment the delicate species are not corroded, particularly if, before the action of the acid, enough water is added.

The surfaces of the valves will be found to have lost all their coleacterine, and the minuter details, striæ or dots, clearly shown. The author has tried all the different physical and chemical processes which have hitherto been announced, and he has found none which succeed so completely and so regularly.

Mr. Kitton writes * that whilst theoretically the method appears to be a good one he fears that it will not prove so effective, when much vegetable or animal matter is present, as the old sulphuric acid and chloride of potash process.

Mounting Sections in Series.—The use of shellac † for fixing sections on the slide, introduced by Dr. W. Giesbrecht, is a very valuable addition to histological methods, as hundreds of small sections may be arranged in serial order, and all inclosed in balsam under the same cover without danger of disarrangement. The method is further extremely useful in mounting larger sections, particularly those composed of loose parts, or parts liable to swim apart.

The shellac is prepared and used in the following manner:—One part of bleached shellac ‡ is mixed with ten parts absolute alcohol, and filtered. The slide is first warmed to about 50° C., and then a thin film of the shellac laid on by a glass rod drawn once over its surface. Before using, the slide is again warmed, and the shellac surface washed with oil of cloves for the purpose of softening it.§

* Sci.-Gossip, 1882, p. 257.

† MT. Zoolog. Station Neapel, 1881, p. 184. Cf. C. O. Whitman in Amer. Natural., xvi. (1882) pp. 783–4. Also this Journal, i. (1881) pp. 953–4.

‡ Dr. Mark uses the bleached shellac in the form in which it is prepared for artists as a "fixative" for charcoal pictures. It is perfectly transparent, and a film of it cannot be detected unless the surface is scratched. He attaches a small label to the corner of the slide, which serves for the number of the slide and the order of the sections, and at the same time marks the shellac side (otherwise not distinguishable).

§ Cf. this Journal, i. (1881) p. 953, where the following direction is given :— "Before commencing cutting, brush over the shellac layer very thinly with creosote, and then lay the section upon it with as little paraffin as possible."

The wash is made with a small brush drawn backwards and forwards until the entire surface has been moderately but evenly wetted with the oil.

Sections are now cut and arranged for the first cover; this done, the slide is warmed over a spirit-lamp so that the paraffin adhering to the sections melts and flows together, forming an even layer, which cools almost instantly, and thus secures the position of the sections while those of the second cover are prepared. The sections for the last cover having been completed, the slide is warmed for ten minutes on a water bath, in order that the sections may sink into the shellac and become fixed, and the oil of cloves evaporate. After allowing the slide to cool the process is concluded by washing away the paraffin with turpentine, and mounting in balsam dissolved in chloroform.

The following mode of fixing sections is described by Dr. J. Gaule*:—

The sections are cut dry and placed on the slide in the order and position in which they are to be mounted.

They are then smoothed out by the aid of a fine brush wetted in 50–60 per cent. alcohol, until all wrinkles are removed and every part is in close contact with the slide.

The slide is allowed to stand several hours (or over night) until the alcohol has completely evaporated, and the sections are left adhering quite firmly to the glass. The process may be hastened by gently warming to 45–50° C.

The paraffin may be removed by any of the solvents in common use, but xylol is recommended. A few drops are allowed to flow over the sections, and after a few moments the paraffin is fully dissolved.

The balsam (a mixture of balsam and xylol in equal parts) is placed on the cover-glass, and this allowed to sink slowly, from one side, over the sections.

Dr. Gaule finds it convenient, especially with serial sections, to use large cover glasses—often nearly as large as the slide itself. Thus a single slide may often contain a large number of sections closely arranged under one cover.

For large sections this method offers one important advantage over that of Dr. Giesbrecht; by the former all wrinkles may be removed, while by the latter the sections must lie as they fall. In the case of smaller sections, not liable to get wrinkled during the placing, Mr. Whitman † prefers the shellac method.

Eau de Javelle for Removing the Soft Parts of Preparations.‡—Dr. F. C. Noll has found eau de javelle (subchloride of potassium KC2O) very suitable for preparations of *Spongilla*, and for destroying the protoplasm in other objects.

If siliceous sponges are burnt or boiled in potash the hard parts, spicules, &c., separate, and are not shown in their proper

* Arch. f. Anat. u. Phys., 1881, Phys. Abthlg., p. 156. Cf. also this Journal, *ante*, p. 428.

† Loc. cit.

‡ Zool. Anzeig., v. (1882) pp. 528–30.

connection. To remedy this a piece of the sponge is placed on a slide covered with some drops of eau de javelle and left to stand with a glass over it, until all the soft parts are dissolved, which, in the case of thin sections, does not take more than 20–30 minutes. Gemmules take a longer time and should be left over night; their contents are dissolved without destroying the outer coat.

When the protoplasm is all dissolved the object is carefully treated with acetic acid which removes all precipitated matters, then with weak and afterwards with absolute alcohol. Finally oil of cloves (which in 15 minutes completely clears any cloudy gemmules) prepares the way for mounting in Canada balsam. The gemmules of *Spongilla fluviatilis*, *S. Lieberkühnii*, and *S. contecta*, from specimens which spread out on the under side of stones, remain *in situ* between the spicules, and give a perfect representation of the form of the sponge. In the more compact sponges, such as the free growing specimens of *S. Lieberkühnii*, the spicules remain united to the framework, although the lining and cementing substance has been dissolved. The layer by which the sponge is attached to its support, like the membrane of the gemmules, is not destroyed; it is not, however, turned black, like the latter, with a solution of nitrate of silver. These three elements of *Spongilla* have, therefore, a different chemical composition.

Diatoms are often found in the tissues of sponges, and these are as well prepared by the above process as they are after burning or boiling with sulphuric acid, so that eau de javelle is to be recommended as a very useful reagent for diatoms also.

To ascertain the effect on calcareous forms small mussel or snail shells (with or without epidermis) were laid in eau de javelle. They were clean and partly colourless but their lime remained uninjured. The same was the case with the calcareous bodies from the crust of different Gorgonidæ.

Small skeletons can be cleaned of skin, muscle, &c., without injuring the bones.

The liquid is also admirably adapted for cleaning vegetable sections. Potash and glycerine swell up the cell-walls or break up the preparations. In a quarter of an hour the sections are freed from all the soft parts and show only the clear cell-walls. After treatment with acetic acid they are mounted in Mayer's fluid (glycerine 1 vol., distilled water 2 vols., and to 10 vols. of this mixture 1 part salicyl-pyrogallic acid) or in gelatine-glycerine, balsam rendering the cell-walls too transparent.

Gum and Glycerine for Imbedding.*—L. Joliet has found that the soap which he was in the habit of using for imbedding, and which succeeded perfectly with the *Salpæ*, gave very bad results with *Pyrosoma*. It did not penetrate the common transparent substance which envelopes all the ascidio-zoids, so that they were rapidly distorted, and could not be cut. The following combination has, however, been of the greatest use:—

* Arch. de Zool. Expér. et Gén., x. (1882) pp. xliii.–v.

Dissolve in a little water some very pure gum arabic, so as to obtain a liquid having the consistency of a thick syrup.* Pour a little into a watch-glass, so as not to quite fill it. Then add from six to ten drops of pure glycerine, and with a small stirrer carefully mix the gum with the glycerine until it forms a homogeneous mass. Then lay the preparations on the surface of the liquid, and with needles press them into it.

This done leave the whole to dry, which takes from one to four days, according to the condition of the air. The gum will assume the consistency of cartilage; without being soft it is supple and yields to the finger. The cake of gum is then cut into squares or strips, corresponding with the preparations, and removed. A plate of gum enclosing the preparations is thus detached without difficulty from the bottom of the watch-glass. These plates are turned over and again allowed to dry until they are wanted for use; they may be preserved in good condition almost indefinitely, the gum, when mixed with a sufficient quantity of glycerine, never becoming hard or brittle.

The following are points to be noted:—Between the limits of 6 to 10 drops of glycerine above mentioned, the proportions most suitable to the nature of the object under examination and to the season of the year may be found by experimental trials. Too much glycerine prevents the gum from acquiring sufficient toughness, too little allows it to become brittle. In the winter or in rainy weather less glycerine should be added than in the summer or in dry weather. It is often well to soak the object in glycerine before putting it into the gum; the quantity of glycerine thus absorbed by the object being taken into consideration, and less added directly to the gum.

With a stove or by the help of the sun the gum can be very quickly dried, but in most cases it is a question of patience. It is one of the great advantages of the gum and glycerine that they dry so gradually; they are generally liquid the first day, pasty the second, and cartilaginous the third. The object having remained in this liquid for twenty-four hours is perfectly soaked, the gum having penetrated into all the interstices of the cells, and the sections preserve the relations of organs which are not directly connected. With soap or gelatine the imbibition is in many cases less perfect, because, unless a high temperature is maintained for a long time, the solidification of the mass takes place too quickly and does not allow the liquid to penetrate so deeply into the tissues.

When the strips are removed from the watch-glass, it is better to wait until they have assumed such a consistency that they cannot be easily bent. It is after having waited almost a week that the author has always obtained the best sections.

Gum alone rapidly becomes hard and brittle; the effect of the glycerine is to preserve it almost indefinitely in a cartilaginous consistency. Another advantage of the method is the perfect transparency of the substance surrounding the object to be cut, so that it

* Solutions of gum, sold under the name of strong white liquid glue, may also be used. They have the advantage of having a uniform consistency.

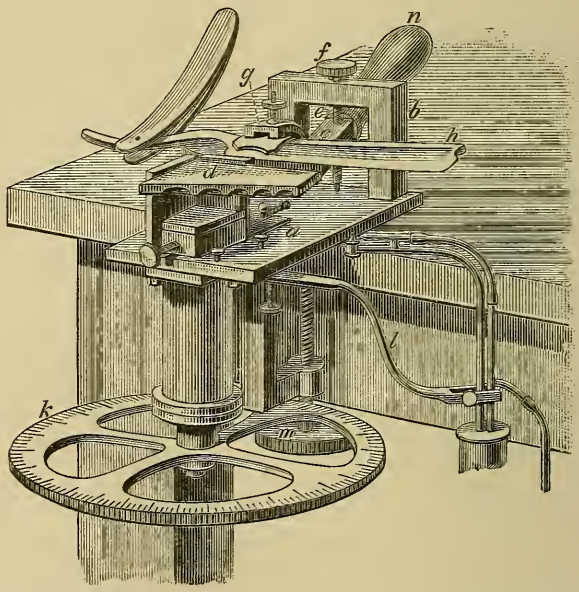
is easy to examine the preparation under the Microscope before cutting; the smallest details can be distinguished, and with a low power the object can be arranged very accurately, and the section can be made exactly through the desired point.

The sections being thus made, they are placed on a glass or a very dry surface, then taken up with a needle or fine moist brush and placed on the slide in a drop of water; the gum dissolves and leaves the preparation in place. A drop of glycerine placed at a corner of the cover-glass, quickly penetrates under it and replaces the water (which evaporates), and mixing with the melted gum, forms an excellent preserving liquid.

Roy's Microtome.* — Dr. C. S. Roy describes a microtome (Fig. 163) for cutting frozen or otherwise hardened substances.

The knife *h* is connected with the metal bar *c* by the clamp *g*. A small piece of leather laid on the back of the knife at the place where it is held by *g* enables the section to be made at any desired angle to

Fig. 163.

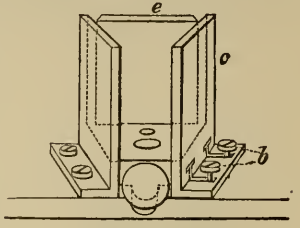


the horizontal. By a handle *n* the bar *c* can be moved on the pivot *e* furnished with the milled head *f*. The pivot passes through the support *b* which is attached to the base plate *a*. The knife is thus able to move over the object plate *d*, describing a circle on the pivot *e*. The object plate may be raised or lowered by *k*, and its under surface is deeply fluted, with the object of diminishing the thickness of the

* Arch. f. Mikr. Anat., xix. (1881) pp. 137–43 (1 pl.).

metal, and increasing the surface exposed to the ether-spray, which is applied by an arrangement of tubes supported by a rod *l*. The plate is large enough for pieces of tissue from 4 to 5 mm. by 2½ mm. downwards.

Fig. 164.



General directions are added as to freezing and cutting which it is unnecessary to repeat here. Specimens otherwise hardened, however, Dr. Roy prefers to imbed in a mixture of wax and olive-oil shaped in a mould to fit in the frame (Fig. 164), which is made by removing the plate *d* and adding a third vertical plate *c*, which is fixed by the screws *b*. A spring presses the plate *e* forward so as to prevent any lateral movement of the imbedding mass. The microtome is fixed to the table by a clamp with a screw the head of which is seen at *m*.

Dr. Roy adds subsequently * that the essential points for which he claims novelty in this microtome are the peculiar structure of the object-plate to increase the surface exposed to the ether spray, and the improvement in the manner of attaching the knife.

Professor C. Weigert,† in preference to the English razor, employs the knives made by Härtel of Breslau or Frank of Leipzig, for making the sections, as having a perfectly level surface and not rubbing with the lower surface the object which is cut. By applying the sliding principle of the Rivet microtome he avoids the *pressing* action of the razor which, for soft specimens, is so undesirable—a *drawing* motion being thus substituted. He diminishes the area of the plate over which the razor travels by bending its sides somewhat down. When using the sliding principle the objects must not be frozen too hard. When sections have been made by the freezing plan they are examined fresh or in salt solution.

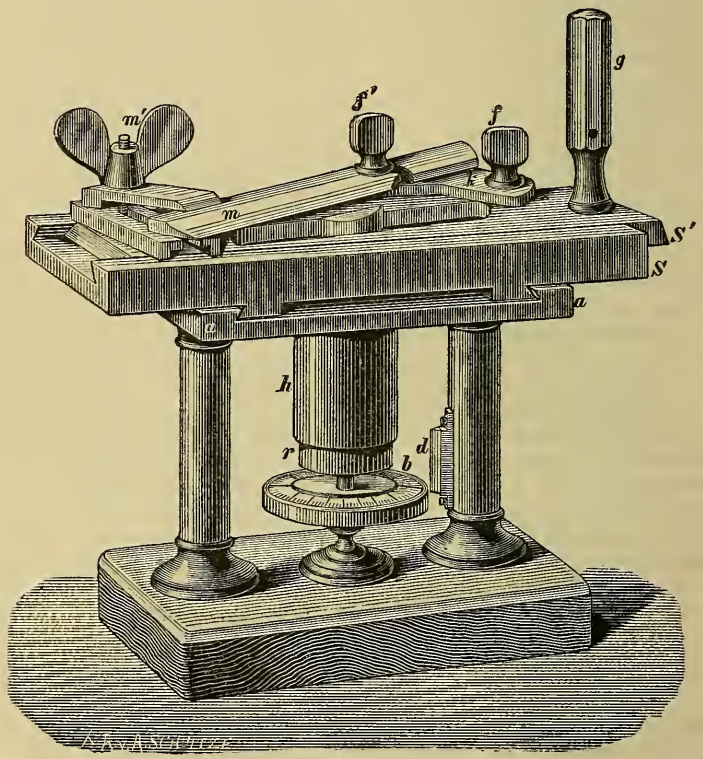
Boecker's Microtome with Automatic Knife-Carrier.‡—Although the microtome has now reached a high degree of perfection (writes E. Boecker) many defects still exist in the usual forms, as well as in those with sliding carriers for the knife. For this reason, perhaps, many still prefer free-hand cutting with the razor, although it is scarcely necessary to remark how little accuracy can be thereby obtained, and what inferior sections of often valuable material are turned out. The principal fault of the microtomes hitherto constructed, consists in the frequent tearing of cells or tissues, caused—at least in slide microtomes—by the fact that the knife is often wrongly placed and having only a forward movement, presses the object rather than cuts it. It is at least expected of a good microtome that with careful manipulation not a single section should be lost, a requirement of the utmost importance in series sections, or in

* Arch. f. Mikr. Anat., xix. (1881) pp. 527–8.
† Arch. Path. Anat. u. Physiol. (Virchow), lxxxiv. (1881) pp. 287–90.
‡ Zeitschr. f. Instrumentenk., ii. (1882) pp. 209–12 (4 figs.).

rare pathological injections, so that it should be possible to make extraordinarily thin sections without the least tearing of the cells or tissues. How far the thinness of the sections can be carried is, of course, different in different objects, and it is therefore difficult to lay down any hard and fast rules.

For the fulfilment of these requirements Boecker first endeavoured

Fig. 165.



to give to the knife the proper movement, so that it should move in the same way as if guided by the hand. It appeared to him that the ordinary method of moving the knife by means of a slide was not sufficiently firm, and involved the inconvenience of keeping the slide steady by the hand. He also decided to give the knife such a considerable inclination that it should be nearly parallel with the direction of the slide.

This attempt was successful in every respect. Two slides of brass-plate are connected in such a manner that their movements shall cross at right angles. If the one slide S′ (Fig. 165) is moved

longitudinally it must at the same time push the other slide S to the side. For this purpose S′ is provided with an oblique slit, in which the tube *h* slides backwards and forwards. The latter is attached to the plate *a*. The cylinder *r* serves for the reception of the object to be cut, and by means of the micrometer screw can be raised by hundredth parts of a millimetre, for which purpose a scale *b* with index *d* is added. The slide S has also a transverse slit, so that it does not come in contact with the tube *h*, and can move freely to a certain distance. The attachment for the knife is on the slide S′; the stability of the knife *m* is ensured by securing it in two places, first to the angle-piece *k*, which can be clamped in any position, and with the slide S′; and secondly by means of the screw *m′* which, with the piece belonging to it, moves in a slit as shown in the figure.

The slide S′ is moved by the handle *g*, and the oblique slit enclosing the tube *h* (see Fig. 166) causes the slide S to move in the

Fig. 166.

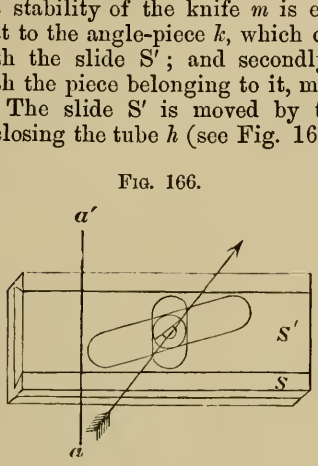
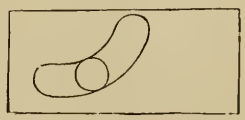


Fig. 167.



direction *a a′*, and thus effects a "drawing" movement of the knife. This movement is uniform if the slit is straight, as in the figure, and it can be effected quicker or slower according as the slit is more or less oblique. The drawing movement can also be accelerated during the cutting process; but in this case the slit must have a curved form, as in Fig. 167. The whole microtome must, however, be broader, although at the same time it may be shorter. By this arrangement the knife is able to cut in any oblique position.

In the microtome described the cylinder has a diameter of 25 mm., amply sufficient in most cases, but capable of being increased. For cases where it is preferred to use the knife with the hand, a circular glass plate is added to the slide S′.

Staining Bacillus tuberculosis.*—We have already described Dr. Koch's original process for detecting this *Bacillus* and Dr. Ehrlich's improvement upon it, as well as that of Dr. Van Ermengem.† Dr. H. Gibbes, referring to the unsatisfactory nature of the first two processes, says that the following simple process will bring out the bacillus with ease and certainty. It takes but a short time to carry

* 'Lancet,' ii. (1882) pp. 183–4. Brit. Med. Journ., No. 1137 (1882) pp. 735–6.

† See this Journal, *ante*, pp. 385, 572, and 706.

out, and the bacillus is stained so deeply and differentiated so fully from the surrounding substance that it can be seen with the greatest ease with an ordinary $\frac{1}{4}$-inch object-glass and daylight, the previous processes having stained it so faintly that high power or artificial illumination were required. The colours used are magenta crystals, which stain the bacillus, and chrysoidin, which stains only the surrounding substance. It is a brown which does not stain so intensely as vesuvin. The formulæ are:—

Magenta crystals	2 grammes.
Pure aniline	3 „
Alcohol (sp. gr. ·830)	20 ccm.
Distilled water	20 ccm.

Dissolve the aniline in the spirit, rub up the magenta in a glass mortar, adding the spirit gradually until it is all dissolved, then add the water slowly, while stirring, and keep in a stoppered bottle.

Make a saturated solution of chrysoidin in distilled water and add a crystal of thymol, dissolved in a little absolute alcohol, to make it keep; a dilute solution of nitric acid (coml.) is also required, one part of acid to two of distilled water.

The object of the process is to stain the sputum, or section, as the case may be, with a colour which the dilute nitric acid will remove from everything but the tubercle bacillus, and the subsequent staining with chrysoidin is only required to throw up the stained bacillus and make it more prominent. In Dr. Ehrlich's process, the stain for the bacillus is too faint, and the vesuvin, used to stain the ground substance, too opaque; consequently the bacillus appears a faint pink colour on a dense yellowish brown ground, and is not easily made out without high power or special illumination. His method of dissolving aniline in water, in which it is very sparingly soluble, is also open to objection, as it is very apt to vary in the amount taken up by the water.

For sputum the following process is the most simple. Spread a thin layer on a cover-glass and let it dry; when quite dry pass it two or three times through the flame of a small Bunsen burner and let it cool. Filter two or three drops of magenta solution in a watch-glass, place the cover-glass with the sputum downwards on the stain, taking care there are no air bubbles under it. Let it remain for fifteen or twenty minutes, then wash in the dilute acid until all colour has disappeared, remove the acid with distilled water, when a faint colour will return; then place the cover-glass in the same manner as before on a few drops of chrysoidin filtered into the bottom of a watch-glass, and let it remain a few minutes until it has taken on the brown stain; wash off the superfluous colour in distilled water and place the cover-glass in absolute alcohol for a few minutes, remove and dry perfectly in the air, place a drop of Canada balsam solution on the cover-glass and mount. It is better to use small glass funnels for filtering the stains, as they protect the fingers. Sections of hardened tissue are treated in the same manner with the necessary modifications.

With regard to the powers required to examine the bacilli after

they have been mounted by this process, an ordinary $\frac{1}{4}$-inch with daylight will show them perfectly, and a $\frac{1}{8}$ dry glass will show that they are rows of spherical bodies with the same illumination.

Brun, J.—Préparation des Diatomées. (Preparation of Diatoms.) [*Supra*, p. 887.] *Journ. de Microgr.*, VI. (1882) pp. 457–8.

„ „ Note sur les meilleurs procédés pour reconnaitre les bactéries de la tuberculose et en faire des préparations microscopiques. (Note on the best processes for showing the bacteria of tuberculosis and making microscopical preparations.) [*Post.*] *Bull. Soc. Belg. Micr.*, VII. (1882) pp. clxix.-lxxvii. *Journ. de Microgr.*, VI. (1882) pp. 500–3.

Bryan, G. H.—Pollen as a Polariscope Object.

[Pollen of *Godetia* polarizes "quite distinctly though not in a very marked manner"—also some others.]

Sci.-Gossip, 1882, p. 231.

Cole, A. C.—Studies in Microscopical Science.

No. 22 (pp. 161–4).—*Pilularia globulifera*. The Pillwort. Transverse section of stem, stained logwood. Plate × 149.

No. 23 (pp. 165–72).—The Lung. Vertical section Lung of Cat, injected carmine. Plate × 145.

No. 24 (pp. 173–6).—*Pilularia globulifera*. The Pillwort. Transverse section of sporocarp, unstained. Plate × 62·5.

No. 25 (pp. 177–84.)—The Thyroid Body. Transverse section of Human Thyroid Gland, stained carmine and sulph-indigotate of soda. Plate × 150.

No. 26 (pp. 185–96).—On the minute structure of the Sporocarp in *Pilularia globulifera*. The Pillwort. Dolerite of Dalmahoy Hill, Edinburghshire. Plate × 45, 65, and 150.

No. 27 (pp. 197–200).—The Thymus Gland. H.S. Thymus Gland of Calf, stained logwood. Plate × 65.

No. 28 (pp. 201–4).—Transverse section Thallus of Lichen. *Sticta pulmonacea*. Plate × 400.

No. 29 (pp. 205–8).—The Pancreas. Transverse section of Human Pancreas (part of a lobule), stained carmine. Plate × 333.

Davis, G. E.—The Dust from Boiler Flues under the Microscope.

[Describes principally the minute spheres found on the bottom and sides of the flues.]

North. Microscopist, II. (1882) pp. 316–7.

Egeling, G.—Ueber die Anfertigung Mikroskopischer Präparate in der Pharmacie. (On making Microscopical Preparations in Pharmacy.) *Deutsch-Amerikan. Apotheker-Ztg.*, New York, 1882, Nos. 13 and 14.

Flesch, M.—Kleine Mittheilungen zur Histologischen Technik.

[1. Employment of Iodine-green and Methyl-green, *supra*, p. 883. 2. Monobromide of Naphthaline as a Mounting Fluid, *post.*]

Zool. Anzeig., V. (1882) pp. 554–6.

Fredericq, L.—Note sur les préparations anatomiques sèches à l'essence de térébenthine. (Note on dry anatomical preparations with oil of turpentine.)

[Claim of priority (by 6 years) in publication of the method over Dr. Riehm and Professor Semper. Cf. I. (1881) p. 706, and *ante*, pp. 705–6.]

Zool. Anzeig., V. (1882) p. 588.

Geikie, A.—A search for "Atlantis" with the Microscope. [*Post.*] *Nature*, XXVII. (1882) pp. 25–6.

Gibbes, H.—An Easy Method of Detecting *Bacillus tuberculosis* for Diagnostic Purposes. *Lancet*, II. (1882) pp. 183–4.

„ „ A New Method for the Detection of the Tubercle Bacillus. *Brit. Med. Journ.*, No. 1137 (1882) pp. 735–6.

„ „ Further Remarks on Staining *Bacillus tuberculosis*. [*Supra*, p. 895.]

„ „ No. 1138 (1882) pp. 786–7.

HARRISON, J.—Report of Lecture on Mounting Microscopical Objects.
[Various receipts and directions.]
1st Journ. and Rep. Braintree and Bocking Micr. and Nat. Hist. Club, 1882, pp. 9–10.

HERON, G. A.—Ehrlich's Method for the Detection of Tubercle Bacillus in Sputum. *Brit. Med. Journ.*, No. 1137 (1882) p. 735.

HITCHCOCK, R.—Mounting Histological Specimens.
[Remarks on T. C. White's paper, *ante*, p. 438, and on mounting in fluids of various refractive indices.]
Amer. Mon. Micr. Journ., III. (1882) pp. 198–9.

KITTON, F.—Talc.
[Rarely used now for permanent preparations—sometimes substituted for selenite in polariscopes but not satisfactorily.]
Sci.-Gossip, 1882, p. 232.

„ „ Preparation of Diatoms.
[Translation of and Note on Professor L. J. Brun's paper. *Supra*, p. 887.] *Sci.-Gossip*, 1882, p. 257.

LEWIS, B.—On the Methods of Preparing, Demonstrating, and Examining Cerebral Structure in Health and Disease.
Brain, Jan. 1881, p. 502, April 1881, p. 82, Oct. 1881, p. 351, Jan. 1882, p. 441, and April, p. 74.

LIBBEY, W., jun.—A New Form of Constant Pressure Injection Apparatus. [*Post.*] *Amer. Mon. Micr. Journ.*, III. (1882) pp. 187–9 (1 fig.).

M., C. J.—The Preparation of Dammar Varnish for Microscopic Purposes.
[*Post.* Containing also directions for a substitute for Canada balsam made by gently evaporating copal varnish and adding pure benzole.]
Sci.-Gossip, 1882, p. 257.

MAPLESTONE, C. M.—Observations on Living Polyzoa.
[Contains note as to finding living specimens washed up on the beach. *Post.*]
Trans. and Proc. Roy. Soc. Victoria, XVIII. (1882) pp. 48–51 (1 pl.).

MARTIN'S (the late JOHN, of Maidstone) Unmounted Objects.
[Notice that the unmounted material from his laboratory has been forwarded to Rochester, N.Y., for sale.]
Amer. Natural., XVI. (1882) p. 931.

MAYER, S.—Beitrag zur histologischen Technik. (Contribution to Histological Technic.) *SB. Wien. Akad.*, LXXXV. (1882) pp. 69–82 (2 pls.).

MEYER, H. v.—Modificirte Form der Kleisterinjection. (Modified form of Paste Injection.) *Arch. f. Anat. u. Physiol.* (*Anat. Abth.*) 1882, pp. 60–1.

MINOR, —.—Ueber die combinirte Palladiumchlorid-Carminfärbung zur pathologischen Untersuchung der Centralnervensystems. (On Chloride of Palladium and Carmine for Pathological Researches on the Central Nervous System.)
Centrabl. f. d. Med. Wiss., 1882, p. 38.

Mounting Classes, Microscopical.
[Notice of the opening meeting of the present session of the Manchester Microscopical Society.]
North. Microscopist, II. (1882) p. 322.

MOYRET, M.—Micrographic Study of Dyed Silks.
Chem. Review, XI. (1882) p. 203, from *Teinturier Pratique*.

NEELSEN & P. SCHIEFFERDECKER. Beitrag zur Verwendung der ätherischen Oele in der histologischen Technik. (Contribution to the use of Ethereal Oil in Histological Technic.) *Arch. f. Anat. u. Entwicklgsg.*, 1882, pp. 204–6.

NOLL, F. C.—Eau de Javelle als Mittel zum Entfernen der Weichtheile aus Microscopischen Präparaten. (Eau de Javelle as a means of removing the soft parts of Microscopical Preparations.) [*Supra*, p. 889.]
Zool. Anzeig., V. (1882) pp. 528–30.

OLIVIER, L.—Les Procédés Opératoires en Histologie végétale. (Practical Processes in Vegetable Histology.) (*Concld.*) [*Post.*]
Rev. Sci. Nat., II. (1882) pp. 71–91.

RANDALL, B. A.—An Economical Cabinet for Microscopical Slides. [*Post.*]
The Microscope, II. (1882) pp. 134–5, from *Western Medical Reporter*.